Introducing User-Centred Design: a Longitudinal Study of a Healthcare Informatics Organisation

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Author's declaration:

I, Jessica Wardlaw, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

Information System designers report increasing difficulties applying User-Centred Design (UCD) techniques effectively due to the growing complexity of the domains in which they work and the techniques' prescriptive nature. The rapid growth of "Big Data" and associated analytical tools thus demands closer investigation of UCD activities and processes within the complex and rapidly-changing work domains in which they are designed, developed and used.

This thesis reports a longitudinal case study from inside a commercial organisation, through a six-year Action Research collaboration to introduce and embed UCD techniques in the design of health informatics tools in the UK. An assessment of the initial modus operandi is followed by the development of personas with data from interviews, user-generated screen captures and database server log files; these informed the redesign, evaluation and testing of the organisation's flagship product. Finally, stakeholder interviews explore the wider impact of UCD techniques.

In so doing, this thesis shows the value of auto-ethnographic documentation, based on being embedded in a design team and collaborative reflection, for practice-led research; it found the organisation's culture around UCD was dynamic and design practices can change this culture through, for example, training opportunities and fostering customer relations. Individuals and extrinsic factors played strikingly key roles in reshaping the organisation's culture; the commitment and resilience of individuals was important for sustaining UCD activities across several reorganisations and changes in business strategy. Finally, this thesis comprehensively presents and evaluates an innovative approach for grounding personas in database server and user-generated content.

These findings concern both research and practice by informing the scope of the designer's role, educational programmes and Action Research collaborations. They call for further attention on the compatibility of design and development processes and suggest that design practice can not only be tailored to organisations, but organisations can be fitted to design practice with the reassessment of the value of some UCD activities. Finally, this thesis can inform approaches to practice-led research, and more effective and efficient strategies for the introduction of UCD techniques to other organisations from the base of their hierarchy.

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List of Acronyms and Abbreviations

AAACM All Age, All-Cause Mortality

AHT Acute Hospital Trust

AR Action Research

CCG Clinical Commissioning Group

CHD Coronary Heart Disease

COPD Chronic Obstructive Pulmonary Disease

CPM Care Pathway Manager

CSCW Computer-Supported Cooperative Work

CSM Customer Support Managers

CUSUM Cumulative Sum Control Chart

CW Cognitive Walkthrough

DoH Department of Health

EED Effectiveness and Efficiency Dashboard

EngD Engineering Doctorate

EW Expert Walkthrough

FT Foundation Trust

GIS Geographical Information Systems

GP General Practitioner

GUI Graphical User Interfaces

HCI Human-Computer Interaction

HE Heuristic Evaluation

HES Hospital Episode Statistics

HHW Hospital Health Watch

HIT Health Informatics Tool

HIU High Impact User

HMB Hospital Mortality Benchmark

HSCIC Health and Social Care Information Centre

IS Information System

IT Information Technology

JSNA Joint Strategic Needs Assessment

KTP Knowledge Transfer Partnership

LA Local Authority

LSOA Lower Super Output Area

NHS National Health Service

OA Output Area

OD Organisational Development

OS Ordnance Survey

PAS Patient Administration System

PCG Primary Care Group

PCT Primary Care Trust

PD Participatory Design

PDF Portable Document Format

PHA Public Health Analyser

PHO Public Health Observatory

RHA Regional Health Authority

ROI Return on Investment

SAR Standardised Admission Ratio

SDLC Software Development Lifecycle

SDM Software Development Model

SHA Strategic Health Authority

SOA Super Output Area

SPSS Statistical Package for the Social Sciences

SQL Structured Query Language

SUS System Usability Scale

SVG Scalar Vector Graphics

UCD User-Centred Design

UCL University College London

UCM Usability Capability Maturity

UE Usability Engineering

UEM Usability Evaluation Method

UGSC User-Generated Screen Capture

UI User Interface

UK United Kingdom

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1 Introduction

1.1 Overview

Imagine your signature dish and think back to the first time you cooked it. Did someone show you how to cook it? Did you follow a recipe? Do you cook it in exactly the same way now? Are the results the same every time? Perhaps you have a gadget now that makes it easier to replicate the results or someone has suggested you add or remove an ingredient. It is possible that you occasionally have to substitute ingredients if you do not have one of the ingredients.

Research in Human-Computer Interaction (HCI) champions an early focus on users and their tasks, empirical measurement and iterative design as a User-Centred Design (UCD) approach to achieve user-friendly and successful technology (Gould and Lewis, 1983). Furthermore, this philosophy must pervade the entire system development lifecycle (Kushniruk, 2002). Towards these goals HCI researchers have developed principles, guidelines and methods over the last few decades, akin to "recipes" for practitioners to follow to design more usable technology. However, research continues to demonstrate that UCD techniques are rarely taken up in industry and, when they are, practitioners rarely use them as intended because, ironically, the techniques are not sufficiently user-centred and too prescriptive for the practitioners' purposes. Traditional usability evaluation methods (UEM), carried out in a laboratory, demand considerable time, money and expertise; practitioners therefore often underuse or misuse them through adaptations they have to make according to the constraints under which they work. "Discount" methods have emerged from the field of Usability Engineering (UE) (Nielsen, 1996) that can be adapted and applied throughout the software development process in contexts with limited time, money and expertise (Nielsen, 1996). The extent to which UCD can be achieved with such "light weight" methods continues to be debated (Cockton and Woolrych, 2002).

Following surveys of design practice, the influence of contextual factors on method choice and use is a growing area of research. One of the most exhaustive studies in this area used the lens of the methods themselves to describe the influence of the features in the contextual "landscape" on usability work: technical factors such as the usability issue at hand; social factors such as personal preferences and relationships; structural factors such as the stage and organisation of the project; communication factors such as the formality of reporting, and resources such as times, budgets and capabilities (Furniss, 2008), in addition to organisational barriers (Grudin and Markus, 1997). Research to date is largely prescriptive towards design practice and recommends particular methods to use in different situations and contexts, from evaluation of the methods themselves, without recognising that methods require resources, to which practitioners often do not have access, which can only result from evaluation of the organisation in which they are used (Furniss, 2008; Woolrych et al., 2011). Reports of real world design practice have tended to be limited to the design of internal systems within the public sector, or otherwise comprise recommendations made based on experience over a number of projects, without providing sufficient detail for the reader to ascertain how their situation compares. Case studies of the use of UCD techniques in commercial practice, within the context of real product development projects, will be valuable for educating and training HCI professionals, developing innovative HCI approaches to address new usage contexts and laying the foundation work for formal comparisons of HCI practices.

The challenges HCI practitioners face have increased over time due to the growing complexity of the domains in which they work (Chilana et al., 2010) and prescriptive nature of the techniques. Since such domains are likely to grow in number, with the proliferation of "Big Data", research requires focus on issues surrounding the use of UCD techniques in complex and rapidly changing work domains, and how they can be integrated within the design and development processes. The HCI field can benefit from investigating how methods are used in practice, so that methods are developed with a user-centred approach and more relevant to usability practice "in the wild".

This thesis aims to contribute to this research area by investigating the implementation of UCD techniques to the commercial development of health informatics tools (HIT). HIT are developed in a rapidly-changing and complex work domain, in which highly heterogeneous, large and rapidly increasing volumes of hospital admissions and health outcome data are analysed by clinicians and managers in different locations to improve the quality and efficiency of clinical care; as such, their development provides an appropriate context within which to carry an investigation of this nature.

1.2 Setting the scene

The research this thesis reports primarily aims to **utilise and subsequently evaluate UCD techniques from the perspective of the organisation, with a focus on techniques that can be executed quickly and cheaply, throughout the design process, with limited experience and access to users** with the objective **to inform strategies to introduce UCD to organisations that develop "Big Data" analytical tools**. This will be achieved by the "co-design" of UCD techniques with an organisation and their products with end users.

The recent exponential growth in volume and access to information stored worldwide has created the phenomenon of "Big Data"; this term refers to datasets that are so large, and grow so quickly, that conventional database systems cannot handle them efficiently (Brust, 2012). "Big Data" are emerging in many sectors of the economy, such as manufacturing and transportation, but especially on the internet where data streams rapidly and continually (e.g. web server logs, social media, and e-commerce). Other domains include but are not limited to financial services, the insurance industry, local government, social services, urban planning, large infrastructure projects, environmental management and climatology, in which the end users synthesise "Big Data" to make decisions that impact upon people's everyday lives.

Whilst "Big Data" present exciting opportunities, the design of systems to cope with large volumes of data is not trivial, especially when users do not have the requisite skills to manage and organise such large datasets. These challenges have hindered the realisation of the opportunities presented by "Big Data", as noted in a recent report by the think-tank Demos in the United Kingdom (UK) (Wind-Cowie and Lekhi, 2012). This report, amongst many, identified that healthcare domain faces these challenges (Hersh, 2002; Lee, 2012), specifically within the design of informatics software.

This thesis investigates the development of HITs, which are used to analyse patient records for the management of patients through the UK healthcare system, assessment of financial and clinical performance, and commissioning of services. Appropriate analysis of hospital data can ensure that services are in place when and where they are needed and, as a result, improve the effectiveness and efficiency of clinical care (Hersh, 2002; Reddy et al., 2012). The "National" element of the National Health Service (NHS) in the UK provides a unique opportunity to carry out this research since data is collected centrally to facilitate healthcare management across the entire nation and population.

Despite their great potential to improve the quality, efficiency and cost-effectiveness of healthcare provision, HITs continue to experience low levels of adoption (Ash and Bates, 2005), bringing into question their impact on medical care (Chaudhry et al., 2006). The literature largely attributes this to system-centred, as opposed to user-centred, design (McLeod and Guynes Clark, 2009; Renz, 2011; Van Gemert-Pijnen et al., 2011); this is in line with theories that technologies are "accepted" based on their perceived usefulness and ease of use (Bagozzi and Warshaw, 1992; Davis, 1989).

The usability of HIT typically lags behind other safety-critical industries such as the airline industry (Foley, 2012). The implementation and design of large information systems (IS) are "wicked" problems, which: you do not understand until a solution is developed; have no stopping rule; have solutions that are not true or false, but good or bad; are novel and unique; evolve with each solution attempt; and, do not have a discrete list of potential solutions (Camillus, 2008; Cockton, 2014a; Conklin, 2006; Rittel and Webber, 1973). The implementation of health policy and IS are said to be wicked problems (Westbrook et al., 2007), because ensuring that the volume of the data does not overwhelm its value is a significant challenge (Brown and Duguid, 2002).

This research then specifically aims **to introduce and embed UCD techniques, from the field of UE, within the design process of HITs in the UK**. To carry out the research I partnered with an organisation; in this thesis I refer to the organisation with the fictional name 'iHealth' to protect their identity. iHealth receive extracts of the Secondary Uses Service database, a data warehouse containing anonymous patient data for purposes other than direct clinical care (e.g. healthcare planning, commissioning services, public health and national policy development). A team from a top university then analyses the data before being uploaded to the iHealth tools. iHealth's system contains upwards of 825 million NHS outpatient and inpatient admissions records and, at the time of the research, was used by 168 secondary care providers, 58 Primary Care Trusts (PCTs), 34 Commissioning Groups and 1600 General Practitioner (GP) Practices. Managers use iHealth's web-based software to analyse records (e.g. mortality, readmission and length of stay rates) and benchmark against similar organisations, to underpin decision-making and performance monitoring towards improving the effectiveness and efficiency of service delivery and clinical outcomes.

iHealth's challenge is to provide innovative analytical tools that remain relevant to the rapidly-changing requirements of NHS organisations across the country. Technological constraints include slow computer networks, small computer monitors and dated hardware and software; in addition external organisational barriers and data concerns, identified by Renz (2011), hinder HITs being used to their potential. Whilst such issues are an on-going business concern of iHealth, investigation of them will have wider implications for the NHS and inform the harnessing and use of "Big Data" in other domains in the future.

1.3 Research approach

This thesis explores these issues using an Action Research (AR) approach. Collaboration began in 2007 when iHealth started to build a new product for public health professionals, with the specific aim to introduce the geographical analysis techniques this software required. iHealth did not have all the expertise that the development of this tool required; specifically, they lacked expertise in the availability, procurement, delivery and presentation of geographical data on public health outcomes and population characteristics. Over time, data's volume, additional datasets and real-time access presented further major challenges. Initially, the collaboration was planned to last for two years and finished with PHA's launch, but was extended by four years to implement various UCD techniques; such a prolonged collaboration with an organisation is seldom possible for the investigation of design practice. The three-phase approach over the full six years is outlined in Table 1-1.

AIM/OBJECTIVE	DESCRIPTION
PHASE ONE: IN THE BEGINNING	
Aim: To apply UCD to the design of a user interface to enable public health professionals to map health outcomes and population characteristics for the targeting of public health interventions, understanding the local population health needs and location services where they are most needed. **Objective:** To understand the current process used by the organisation to develop products and to identify obstacles and opportunities to apply UCD techniques within that.	The development of Public Health Analyser (PHA) is described and explained as a case study to illustrate how iHealth developed tools at the start of the collaboration. The introduction of mapping functionality specifically will be described in more detail to reveal what happened when UCD techniques were applied. Lastly, an Expert Walkthrough (EW), a combination of Heuristic Evaluation (HE) and Cognitive Walkthrough (CW), of the final tool is presented to illustrate some of the usability issues with the final tool and where and how it did not meet the users' requirements.

PHASE TWO: A NEW DAWN	
Aim: To apply UCD techniques to inform the development of company personas that would be introduced to the technical department. **Objective:** To investigate techniques to gather user data and requirements with few resources within a complex and rapidly-changing market in which customers are spread across a large geographic area, and then to disseminate the results.	In this phase, personas are developed using user data gathered with a mixed-methods approach: analysis of database server log files, interviews and a user-generated screen capture study. Posters of the personas are created to inform EWs of products and their design, to educate developers about the end users, and to spread my findings more widely.
Aim: To test a new design for the company's flagship product with existing customers. **Objective:** To observe the usability tests and then how the team fed the results of the tests back into the overall development process. To discover the practicalities, obstacles and opportunities related to usability testing in this context that might inform future projects.	An EW of a prototype new tool is carried out to inform the protocol for usability testing with existing users, informed by a persona developed in Phase 2. The EW aimed to determine if the system was ready to test with end users and inform usability test tasks. For the initial (six) usability tests my contribution comprised assistance with the protocol design, and observation and recording notes and videos of the tests. Participants completed a System Usability Scale (SUS) questionnaire at the end of their test.
PHASE THREE: THE POST MORTEM	
Aim: To gather the perspectives of a range of stakeholders in the research at the company. **Objective:** To verify my own account of events, gain a historical perspective from those who worked at iHealth before me and explore how usability test participants felt about their participation.	Stakeholders from iHealth are interviewed to substantiate my views and perspectives of events, and obtain new insights into events before and after the collaboration. Five of the six participants in the usability tests from research Phase 2 are also interviewed to obtain their perspective on usability testing. Collaborative reflection is a key contribution to the literature.

Table 1-1 Research Approach

Table 1-1 describes the aims and objectives of each phase of the research, which developed over the course of the collaboration, according to the events represented in the timeline in Figure 1-1; it shows that Phase 1 is addressed in Chapter 4, Phase 2 in Chapters 5 and 6, Phase 3 in Chapter 7. This timeline will be referred to in each of these chapters to guide the reader through the thesis and identify the events that took place in the NHS and iHealth at the same time. Ostensibly, UCD techniques can be adapted to help iHealth produce usable products for their NHS clients and UCD practices can be established at iHealth. This methodological approach allowed me to implement UCD techniques and carry out a thorough post mortem, and adapt to problems as they evolved, because I was embedded in the design team over an extended period. This research was not pre-planned. I originally aimed to explore usability aspects of geographic information and maps within the context of health informatics; this thesis reflects, however, that when I reached the end of the research, on reflection, this was not the most significant or interesting aspect of my time at iHealth.

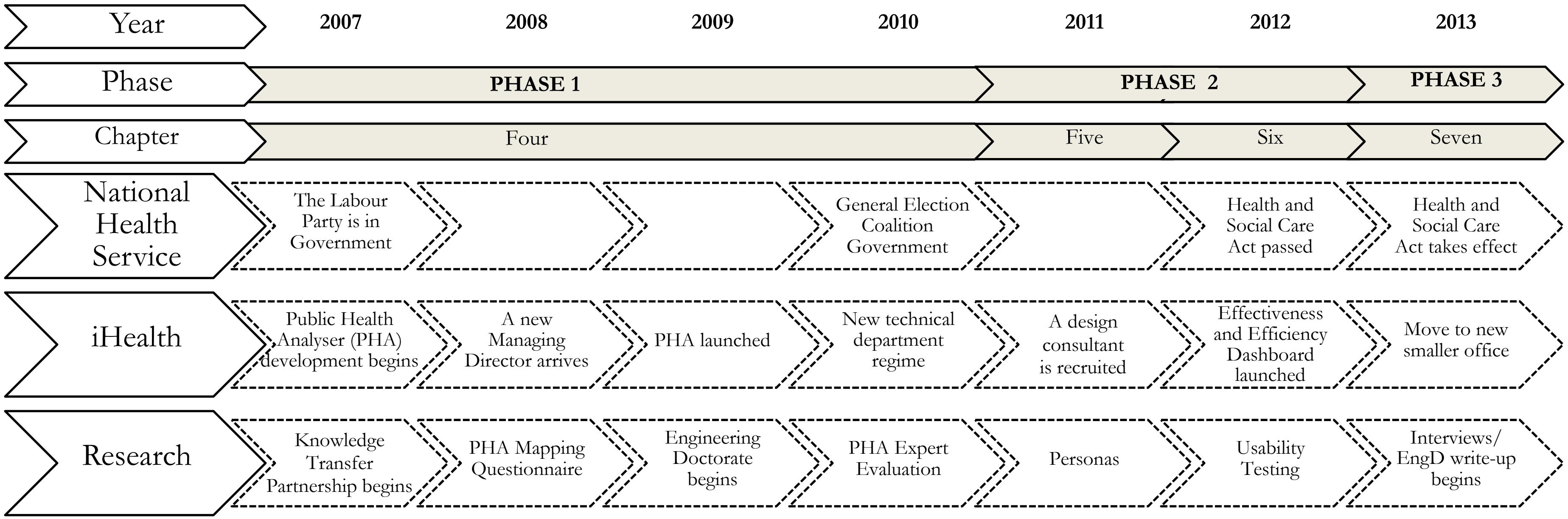

Figure 1-1 Timeline of Research

1.4 Scope

This thesis evaluates the impact of UEMs from the perspective of organisations, their customers, and their constituent individuals over a sustained period of, rather than a snapshot in, time. This includes the UEMs': downstream utility (i.e. their influence on redesigns, practicalities related to their execution); persuasive power (how likely a developer is to change the system as a result of a usability problem identified), usability (how easy it is for practitioners to use the method); and learnability. The complete UCD process will be considered, from the gathering and analysis of user data to the reporting of usability studies, as well as the perspective of people in charge of product development and software developers. End users will also be consulted to ascertain the challenges they experience using HITs and gather their perspectives on usability tests. The historical perspective and key role played by critical reflection provide valuable contributions to the field.

iHealth's business environment affected the implementation of UCD within the development of their products, and the scope of the research, from the very beginning. This will be reflected upon where relevant; for example, direct access to users was often difficult to obtain for commercial and practical reasons. The collaboration also coincided with significant political changes. A Strategic Spending Review the Government undertook in 2012, halfway through this research, requires the NHS to make efficiency savings of £20 billion over five years; furthermore PCTs were phased out and GP consortia have assumed responsibility for the commissioning of services and have control of an £80 billion annual budget (Health and Social Care Act, 2012). HIT can support the successful implementation of this policy. iHealth had to adapt rapidly to this changing market and understand the requirements of a very different set of users.

1.5 Contributions to the research field

The literature strongly suggests that UCD techniques can assist iHealth to meet these challenges and design tools that meet their users' requirements despite the challenging environment in which they work. The overarching research questions of this thesis are:

1. What are the challenges and opportunities for applying and embedding UCD techniques in these emergent design contexts?
2. Are there additional aspects of UCD techniques of value to organisations in these emergent design contexts?
3. What are the strengths and weaknesses of the AR approach for practice-led research?

By answering these questions, this thesis aims to make a number of key contributions to our knowledge of design practice, listed in Table 1-2, in addition to the objective of achieving each aim.

AIM	PURPOSE/BENEFICIARIES
To identify opportunities and obstacles and assess the terrain for the introduction of UCD techniques within design contexts emerging around "Big Data".	To further HCI researchers' understanding of the opportunities and challenges for practitioners working in complex work domains to adopt and integrate UCD techniques, within constantly changing business environments and limited resources; and how practitioners adapt the resources required for UCD techniques for design work within these real-world contexts. To build on the knowledge acquired by researchers via surveys, to better understand if it applies in these contexts. For practitioners, these insights will facilitate the more efficient and effective introduction of UCD to their organisations.
Exploration of the resources available that can be adapted and inform development of user requirements and usage scenarios for "Big Data" analytical tools.	To provide inspiration for UCD work within dynamic (rapidly-changing) businesses and have limited time, money and expertise for rigorous usability testing, with customers who are busy and distributed over a large geographic area. To demonstrate when and where the methods are useful in this context and how they can be adapted for design practice.
New understandings of the usability professional's role.	To inform HCI educational programmes and the recruitment strategy of product development organisations
Benefits and drawbacks of the AR approach for investigation of design practice.	To obtain insights that will inform future practice and research *through* design (Frayling, 1994).
A longitudinal case study of the introduction of UCD to a commercial organisation.	To train HCI professionals and lay the foundations for formal comparison of HCI practices. To obtain insights that will inform future practice and research *through,* as opposed to *into*, design (Frayling, 1994).

Table 1-2 Research Contributions

1.6 Structure of the thesis

The remaining thesis is divided into chapters as follows:

Chapter 2 – Literature Review

This chapter describes how the use of computers has moved into increasingly complex contexts to handle increasingly large volumes of data over time, and how user interfaces (UIs) and their designers have had to adapt accordingly. The usability professional's role has consequently become progressively more important but difficult to define and perform. Although HCI researchers have developed UCD techniques for practitioners to use to develop user-centred UIs, these techniques have been found to be disused and misused in practice, and too prescriptive. Researchers and practitioners have reported their experiences to advise practitioners how to introduce UCD to organisations; I summarise these reports but also highlight areas where they lack strength. Specifically it is unknown whether the advice is applicable in the complex domains in which “Big Data” are emerging, which may present several currently unknown challenges and opportunities for the introduction of UCD. As this thesis focuses on one such domain, health informatics, this chapter finally summarises the UCD efforts of HCI researchers in this area to date.

Chapter 3 – Research Framework and Context

This chapter describes the methodological approach and techniques that I applied to carry out the research in this thesis. First it paints a picture of the overall research process and the different phases it comprised. The chapter then introduces the concept of AR, an approach that facilitates collaboration between researchers and practitioners and is well placed to investigate and report upon the introduction of UCD techniques into a product development organisation within a rapidly-changing and unpredictable domain. It then describes how I evaluate my research and validate my account with semi-structured interviews towards the end of the collaboration, to capture the experiences of other key stakeholders in the research.

Finally, the chapter introduces the context in which the research takes place. Before it introduces iHealth, the chapter describes their place within the NHS, which forms their major client base, to convey the complex and dynamic nature of their market and why the AR approach was taken.

Structure of Core Chapters 4, 5, 6 and 7

To provide context, each chapter begins with a description of the NHS and iHealth at the time, and the system under investigation. For each technique used, the relevant chapter reviews the literature to motivate the approach, describes my use of the technique in detail and presents the results. Each chapter will then discuss the resources used to apply the technique and the opportunities and obstacles to the introduction of UCD techniques it has revealed for this type of organisation. Chapters 4, 5 and 6, and 7 correspond to Phases 1, 2 and 3 of the research respectively (as outlined in the first column of Table 1-1 and the timeline in Figure 1-1) and adopt the following structure:

1. **Introduction**:

    Each chapter will start with a description of the status of the NHS and the political climate, followed by an account of what was happening in the business and what the technical department looked like at the time; this will include whether contracts were at stake, the organisation’s investment in the product and the resources that were available for design work at the time. Finally it will describe when and how the product was developed, the motivation for the project, its target customers and the developers’ relationship to end users.

2. **Approach**:

   This section describes the methodology (UCD technique) employed and how I applied it in terms of participants, materials and procedure; finally it presents data and information that the technique gathered.

3. **Organisational Impact**:

   Finally, the chapter: describes the efforts made to disseminate the results of the approach and how they were presented to the organisation, which will be evaluated in the discussion chapter; identifies barriers to carrying out the methods in this context; identifies strengths/weaknesses of the techniques used and resources available; and, reviews the impact of the study within the organisation.

Chapter 4 – 'Public Health Analyser' Mapping: A Token Gesture Towards UCD

This chapter describes the development process for PHA, a fictional name for a product iHealth developed between 2007 and 2009, which was not adopted by the NHS to the extent they expected. It first presents iHealth's situation and market at this time, to explain the motivation behind the development of this product. The organisation brought in Geographical Information Science expertise at University College London to implement functionality for the mapping the vast quantity of health outcomes and population data they had. This chapter describes the collaboration's initiation and PHA's development with specific reference to the mapping interface.

The chapter finally considers the usability of the PHA tool as a whole. Inspection of part of the system, the mapping interface, demonstrates the system's problems and how "discounted" UE methods and a basic understanding of users can very easily highlight serious usability problems. Discussion of the trajectory of the organisational culture goes some way to explain how the tool was developed, in addition to internal and external obstacles and opportunities to introduce UCD.

It concludes that the investment made would have been more effective if UCD activities had taken place earlier in the development process and the scope of the work had encompassed the whole product, and not just the mapping interface. Its system-centred design resulted largely from insufficient knowledge of UCD and users' tasks. The rest of the thesis thus describes and evaluates the research's subsequent attempts to bring UCD into the organisation more widely.

Chapter 5 – Persona Development

This chapter describes the innovative mixed-methods approach taken to the development of personas and user requirements for developers and designers at iHealth. User data were gathered from database server usage logs, 14 interviews with users and 29 responses to a user-generated screen capture survey. Results from these studies were triangulated to produce personas that reflected the different information requirements and tasks of the users. The methods are described and their strengths and weaknesses discussed so that other usability professionals might be able to assess the techniques for their own use as appropriate. Evaluation focuses on the contributions of each technique used to the final personas, how they are used, how they can be developed in future, and the level of expertise required.

The techniques used were notable for the level of collaboration they required with people from across the organisation, which revealed further insights into the obstacles and opportunities for the introduction of UCD at organisations; for example, it raised awareness of my work and transferred knowledge of UCD horizontally through the organisation, despite communication barriers.

Chapter 6 – Usability Testing: Effectiveness and Efficiency Dashboard

iHealth was historically reluctant to carry out usability testing and the opportunity arose to explore why. I was given the rare opportunity to carry out an HE and CW of a new design for iHealth's flagship product, Hospital Health Watch, using the personas from Chapter 5. The aim was to pre-empt any problems that participants in usability tests might encounter and to inform tasks to be carried out in usability testing. Tests aimed to investigate how easily users can interpret information on a dashboard interface, tackle their normal tasks and use new functionality. The procedure comprised of ten tasks during which deviations from the optimal steps to task completion were noted; this was followed by an open feedback session, in which participants rated the system according to the SUS (Brooke, 1996). The process revealed insights into the usefulness of the feedback for the developers and how fixes were prioritised, in addition to how effectively they build relationships with customers and how the users felt about their participation. Finally, the chapter discusses practicalities of the study, from the process of recruiting users, the expertise required to design the protocol and facilitate the tests, to the analysis and feedback of results, to assess how iHealth could integrate formative usability testing more sustainably within software development.

Chapter 7: The Organisational Perspective

This chapter reports semi-structured interviews I carried out, seven to eight months after the usability tests reported in Chapter 6, to gather the perspectives and insights of nine people I worked with at iHealth to inform the effective introduction of UCD at similar organisations. The purpose of the interviews was to verify my own account of events and find out what had happened at the organisation since the usability tests because significant time had passed and other commitments had distanced me from the organisation. In addition I was keen to gain a historical perspective from stakeholders who started working at iHealth before me.

I was also interested to explore how usability test participants felt about their participation since I observed that they were much more willing to test, and engaged with, the new design than the organisation had feared; I interviewed five of the six participants of the usability tests reported in Chapter 6 a year after the tests. The goals and motivations of usability test participants are currently under-researched but are unclear and could be especially interesting in the context of this research because end users are not necessarily the customer and have little discretion in using the system.

Chapter 8: A UCD Organisational Culture?

This chapter discusses findings from the entirety of the collaboration and extends what I found at iHealth to other organisations. It first reflects on the significant impact of organisational factors on design work, building on the findings of Symon (1998). Secondly, it reflects upon how the organisational culture around UCD evolved. It then reviews how the culture was reflected in the UCD techniques and approaches employed over the course of the research, and aspects of UCD techniques that were especially attractive to the organisation. Importantly, the research found an interdependent relationship between organisational culture and the application of UCD techniques, and revealed insights into the role of usability professionals in such contexts, and the variety of skills required for design work. Finally it evaluates the suitability of the AR approach for the investigation of design practice.

Chapter 9: Conclusions

This chapter summarises the thesis and states what the research found in the accomplishment of its aims and objectives and the implications of its findings for both researchers and practitioners. It finally reviews the limitations of the research before outlining areas of interest that arose along the way but were out of scope and could not be pursued.

Chapter 10: Epilogue

After the completion of the research, an opportunity was taken to evaluate its findings' market potential. This chapter considers the implications of the research more widely: what is an effective approach for introducing UCD to other organisations? It describes an overall strategy formed by framing the learnings of the research and others' experiences around the Switch model of change (Heath and Heath, 2011). Finally, this chapter explores the value of this strategy with an analysis of the UK's "Big Data" economy. This chapter resulted from the award of a PhD Enterprise Fellowship from UCL Advances.

Finally, although the narrative defines technical terminology and acronyms as they appear, a glossary is provided at the end, as a reference to be consulted at any time.

2 Literature Review

This chapter at a glance…

This chapter reviews the existing literature to:

- Motivate investigation of introducing User-Centred Design (UCD) to an organisation;
- Identify the methodologies and findings of previous research;
- Propose limitations of and gaps in knowledge of the introduction of UCD, which I had the opportunity to fill with reporting UCD techniques' impact on an organisation.

2.1 Introduction

In this chapter we explore the importance of investigating the introduction of User-Centred Design (UCD) to an organisation. I will begin this by giving a brief history of the development of computers, to provide the reasons that underpinned the need and design of the UCD framework for the development of software (Norman and Draper, 1986). This will also frame discussion of concurrent changes in the meaning of the term "user interface" (UI), the role of systems' designers and the techniques they apply, in response to the increasingly complex contexts in which they work.

As we shall see, the literature reflects the increasingly complex context of design work, which has made the usability professional's role even more important but difficult to define and perform. Researchers and practitioners have combined their experiences to advise how to introduce UCD to organisations; I will summarise this but also highlight areas where it lacks in strength. Specifically it is unknown whether the advice is applicable in the complex domains in which "Big Data" is emerging; such domains may present several unknown challenges and opportunities for the introduction of UCD. As this thesis focuses on one such domain, health informatics, I will finally summarise UCD efforts of Human-Computer Interaction (HCI) researchers in this field to date.

2.2 Information Systems

2.2.1 A Brief History of Computers and their Users

Information Systems (IS) were initially designed by and for experts; the first computer users were engineers who needed a relatively complete understanding of the hardware in order to operate them. The typical users at the time therefore dealt with aspects of hardware and hardware was a central part of the UI. Although the 1950s saw the production of commercial computer systems, programmers remained the principal users through the 1960s and 1970s because computer time and equipment were expensive (Grudin, 1990).

After the success of the spreadsheet and word processing, computer development efforts moved towards licensed operating systems to drive sales of hardware in the late 1970s and early 1980s. Massive non-programmer markets were concurrently created by the development and use of multi-tasking, virtual memory and interactive terminals, which permitted users to interact with computers via text-entry (e.g. keyboards) and pointing (e.g. the computer mouse) devices instead of command line interfaces and input of code. This drove programmers to develop better UIs for non-programming end users and attend to their *usability,* defined as "the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments" (Frøkjær et al., 2000; ISO, 1998) and understood to be a property of interactive software, and terms such as "user-friendly" emerged (Cockton, 2014b). The Macintosh computer's success in the late 1980s demonstrated that a good UI could drive software and hardware sales (Grudin, 1991a). The next section will describe how product development organisations approached UI design for mass markets and that increases in attention to interaction design and computer literacy across the developed world led to improved ease of use of IS (Cockton, 2014b).

Finally, organisations began to apply IS to manage their processes; they saw improvements in productivity and efficiency, which increased profit margins and enabled them to invest in new product lines and expand the business further through research and development. Early development of IS for organisations was dominated by bespoke large-scale government projects, which demanded a project management approach that spawned some of the software development models (SDMs) that are still widely used today.

2.2.2 Developments in the "User Interface"

UI research and development has largely followed a similar pattern and adapted its focus to the users of computers (Grudin, 1990). Initially, UI improvements focused on freeing programmers from having to know about the hardware because they formed the majority of users; these developments included higher-level programming languages, virtual memory and operating systems.

As hardware costs fell and the market for computer systems extended to non-programmers during the 1960s and 1970s, off-the-shelf product development grew increasingly important, especially in the United States (Grudin, 1991a). The acquisition and requirements of products were no longer written into contracts before they were developed; product development organisations now developed products for users who were indistinct at the beginning of development and products sold because they appealed to people, not because they met lengthy predefined specifications written into contracts. Knowledge from the field of human psychology informed early design frameworks, demonstrated by the contributions of Don Norman and Ben Shneiderman to the formation of the field (Norman and Draper, 1986; Shneiderman, 1997); this research focused on finding causal relationships between UI features and human performance, assuming human cognitive attributes to be fixed and universal so that UI features could be inherently usable or unusable according to conformance with guidelines and principles that could be discovered, formulated and validated by psychological experiments (Cockton, 2014b).

The use of IS finally extended to organisations, producing different contexts of product development and design and the field of Computer-Supported Cooperative Work, which will be discussed later (Grudin, 1991a). Organisations comprise of complex networks of humans whose actions do not follow laws and cannot be predicted like much of the physical world. Software used within an organisation will have end users with a wide range of roles, skills, backgrounds and preferences; its design therefore requires some knowledge of the social, motivational, economic and political factors that affect its use, factors which do not affect systems used by individuals. Such group processes are often variable and context-specific, and unfold over time in different locations.

The growth in complexity of IS development and use, and number of stakeholders it involved, demanded that product development organisations adopt project management approaches, which brought about SDMs. Early systems could be developed in a linear fashion; for example the Waterfall SDM followed an unchanging sequence of phases: feasibility is established, requirements are specified and preliminary and detailed designs are drawn up before coding begins. This is followed by testing, integration, implementation, operation and maintenance. "Phased" approaches (Rosson et al., 1988) suited the development of the first IS because users were clearly defined from the start of development and had stable requirements; this permitted satisfactory completion of, and learning from, each phase before subsequent phases began.

Over time, the increasingly complex and dynamic nature of IS made it progressively challenging to apply phased approaches (Rosson et al., 1988) because they were devised when the dialogue between computers and their users did not have to be considered. Now that IS were designed and developed before they were purchased, users' requirements took centre stage. Product development organisations developed IS (and placed them on the market) without the detailed specification documents to which they were accustomed (Hammond et al., 1983). As a result, users, their location and requirements could be unknown until a working prototype had been reviewed, and even change after the design was finalised (Bak et al., 2008). Such a scenario could invalidate many hours of design and development work and increase cost, especially if significant resources have been invested in the early stages. Furthermore, future implementation difficulties may be unknown; for example, it may emerge that users require functionality that is difficult to implement and requires developers to reengineer their code (Parnas and Clements, 1986). Designs had to be changed according to the users' requirements or companies would risk continuing with a design that did not meet the users' requirements and fail in the market.

We can see then that the new market and demand for computing technology required new approaches to software development; the number and diversity of users of any given system increased, and the ways in which users employed systems (i.e. their requirements) became progressively unpredictable as they have become more proficient. IS design became what is called a "wicked" problem (Cockton, 2014a; McConnell, 2004); this term comes from the design and planning field and refers to a problem whose requirements and limitations cannot be entirely known before completion (Rittel and Webber, 1973). Wicked problems cannot be fully understood until a solution is committed to and adequately refined; however, solutions do not suggest when they require further revision or whether they are right or wrong (Cockton, 2014a). As such, project stakeholders (non-technical personnel) may not be fully aware of the capabilities of the technology being implemented (Brown and Duguid, 2002), so that users do not define expectations and requirements and its design does not meet the full potential of what the new technology can deliver, or replicates an existing application or process. Substantial changes to implementation requirements may then emerge once stakeholders start to use the new technology and become more aware of the functionality it provides. The positivist assumptions that underpinned the phased approaches to the development of IS (in which the design was frozen before development began) therefore became increasingly invalid; instead, IS researchers adopted and devised cyclical, "incremental" (Rosson et al., 1988) approaches to software development and UI design (Hammond et al., 1983).

Product development organisations found incremental approaches to be more suitable for developing computer systems for the mass market whose design was not restricted by specifications in contracts, and whose users and requirements were unknown. A popular example of an incremental SDM, which continues to deliver products on time and in budget, is Agile, which includes cyclical approaches such as 'Extreme Programming' and 'Scrum' (Brhel et al., 2015). These methods share a common philosophy with the following values: individuals and interactions rather than processes and tools; working software rather than comprehensive documentation; customer collaboration rather than contract negotiation; and, responding to change rather than following a plan (McInerney and Maurer, 2005; Sy, 2007). An Agile development lifecycle is characterised by a series of mini-releases; each mini-release, with a subset of the features for the whole release, comprises of its own requirements analysis, design, implementation and quality assurance phases, and produces a complete and stable *working version*. Working versions are created at regular intervals (*iteration cycles* or *sprints*) of two to four weeks and enable the product release date to coincide with any working version. The date on which each sprint ends is fixed and any features that cannot be completed are transferred to the next working version.

Incremental approaches to IS development also became attractive for their democratic nature because the use of IS spread to the workplace, and concerned the unions in Scandinavia because of their impact on people's health and wellbeing (Sandblad et al., 2003). Design frameworks and principles such as Participatory Design (PD) and UCD emerged during this time to help practitioners to develop usable systems. UCD includes the popular design framework offered by Gould and Lewis (1985). Without specifying how they could be achieved, they outlined three core principles for the implementation of UCD in design projects and suggested that no design activities should start until the users and their tasks are understood (Cockton, 2014a).

Early focus on users and tasks. 1) Users must be observed doing their daily jobs and users' goals and tasks should drive development; the focus should be on what users need to do and how the technology can support this. 2) The tasks' full context must be understood. Users' behaviour and context of use should be studied in detail to avoid focus on specific tasks. 3) Users' characteristics should be captured and taken into account during the design. 4) Users should be consulted throughout the design process and their input taken seriously. In short, all design decisions should consider the users' context, work and environment.
Empirical measurement. Users' reactions to, and performance with, design elements should be measured, from the initial prototype through to final version.
Iterative design. Critically, when problems are identified in usability testing, designers should repeatedly go back and redesign the appropriate elements.

Gould and Lewis demonstrated that these principles could be applied to the most complicated and critical systems whose design had to be right the first time, with the success of the 1984 Olympic Messaging System (Gould et al., 1987). A fourth principle, **Integrated Usability Design**, emerged from this project, which means that "all usability factors must evolve together, and responsibility for all aspects of usability should be under one control" (Gould et al., 1987: 766).

ISO/IS 9241-210 (ISO, 2010) mirrors these principles but, still, provides no advice on how UCD could be achieved (Boivie et al., 2006; Cockton, 2012). We will see in the next section that the field of HCI contributed methods towards achieving these principles. The progressively diverse contexts use of IS demanded that the term usability required renegotiation because it could no longer be an absolute, context-free and invariant property of a system (Cockton, 2014b); a competing view of human cognitive attributes emerged, in which they vary not only between individuals but across different settings, which made usability an emergent property that depends on more than the features and attributes of an interactive system, but also who is using it and why (Cockton, 2014b). This necessarily affected how a system's usability could be measured. If software can be inherently usable or unusable then usability can be evaluated solely through direct inspection; if usage must be considered then indirect inspection methods (walkthroughs) and empirical usability testing must be used. Since the first perspective became increasingly invalid, as IS spread to the workplace where multiple people with different cognitive attributes used them, it made more sense to talk of quality in use rather than usability, and that use could be frustrating but not unusable. The number of methods increased, however, so that designers not only had to apply a technique but also consider which technique would best suit their purpose. Design practices continued to assume technically knowledgeable and competent users who would be able to resolve their usage problems even as the proportion of users with high levels of training on operating systems and applications software diminished (Cockton, 2014b). Clashes between accepted methods for good interface design and efforts to standardise the development process also emerged (Grudin, 1990), which have been amplified with each subsequent change of approach. The next section will explore these issues as I discuss how the changes in computer use affected the role of the usability professional.

2.3 Implications for the Role of the Usability Professional

We have seen that the UI shifted away from the computer towards the user and work environment; this has had a significant impact on the role of usability professionals and how they carry out design work (Grudin, 1990). This section describes how the changes in IS and their UI impacted upon the role of system designers. First it will describe the development of Usability Evaluation Methods (UEMs) and the changes in the designers' requirements of UEMs since they were first devised, and how these changes have impacted upon the uptake of UEMs in practice. Second, it will look at how changes to the SDMs used by organisations to develop software have required designers to apply new approaches and skills. Finally, I review aspects of the organisations, and increasingly complex contexts, in which IS are developed, which have been found to impact on design work.

2.3.1 Techniques

UEMs have a long history within systems analysis and human factors (Hartson et al., 2001), with the purpose of helping designers to achieve usability in the design of their products. Usability testing in a laboratory has been the de facto approach for evaluating users' performance with a new or modified interface since the 1980s, in which practitioners observe systems or prototypes in use, and measure users' speed, accuracy and errors (Dumas, 2002). Developers were motivated to test their products to minimise the cost of customer support, improve sales with a more competitive product, minimise risk and set a standard against which future usability could be tested. Other techniques also emerged to gather more subjective data, to explain the users' performance, for example verbal protocols (Ericsson and Simon, 1984).

Over time, however, practitioners increasingly used many UEMs inconsistently (Gray and Salzman, 1998) and found them too prescriptive and unfit for purpose (Wixon, 2003). It is striking that reports suggest that this is partly because the engineering and cognitive scientists who designed UEMs did not adequately understand the requirements of their intended users, designers and developers in practice, in addition to the increasingly complex nature of the UI described in the previous section (Cockton, 2012; Hammond et al., 1983). Shum and Hammond (1994) usefully describe four categories of UEM attributes that hindered their uptake:

- *Consultancy* gulf: how useful (intelligible, relevant and applicable) results are to designers, which impacts how they are reported e.g. whether they generate redesign suggestions or usability problem lists (Hornbæk and Frøkjær, 2005; Lundell and Notess, 1991);
- *Cost* gulf: the knowledge, expertise and time required by designers to apply the approach;
- *Payback* gulf: the potential benefits in applying the approach, for example for both the design process and final design;
- *Pre-requisite* gulf: insufficient basic information about the approach for the designer to trust, and be able to try using, the approach (and engage the other gulfs) e.g. Makri et al. (2011).

We can now see that, although UEMs were designed to identify usability problems, practitioners were motivated to use UEMs for a much wider range of reasons. Other factors also came into play, such as whether a UEM identified problems that could be fixed, was easy to learn, fitted within the increasingly rapid development process and identified valid usability problems and so on. Developers also required UEMs that demanded less money and time than traditional usability testing, and could be used earlier in the development process when the design was not fully formed and could be more easily modified. Practitioners turned to expert inspection, so-called *analytical*, methods, which were designed to be faster, cheaper and more flexible, rather than thorough, as was the case with empirical methods. Analytical methods examine systems (for example, through models or specifications) to identify *potential* usability problems and many were intentionally designed to be used earlier in the design process. Examples include Cognitive Walkthrough (CW) (Lewis et al., 1990; Wharton et al., 1994) and Heuristic Evaluation (HE) (Nielsen, 1994a).

As the range of techniques increased, practitioners faced increasingly difficult decisions over which technique would best suit their purposes (Bellotti et al., 2009). To demonstrate the value of UEMs, and to inform practitioners' decisions, researchers began to investigate UEM performance according to different metrics and comparing the performance of UEMs (Cockton et al., 2003; Gray and Salzman, 1998; Hartson et al., 2001; Jeffries et al., 1991). Initial efforts tended to measure UEM performance according to their *thoroughness* (how many of the total usability problems with a system the method finds), *validity* (how many of the usability problems a method finds are real) and *reliability* (the extent to which results are independent of the individual performing the evaluation).

Practitioners found, however, that the results of UEMs were not always used in the overall iterative development process after usability data was gathered, regardless of their thoroughness, validity and reliability. They became more concerned that a technique would be useful in the overall context of a development project (Cockton, 2006). Consequently, researchers had to reconsider their understanding of how practitioners chose which technique to use. A measure of the usefulness, *downstream utility* (John and Marks, 1997), of a UEM was created to calculate this: the extent to which a UEM predicted real usability problems, persuaded developers to change their design and the effectiveness of the change implemented (Law, 2006; Uldall-Espersen et al., 2008), in addition to its ability to inspire new designs (Blandford, 2007). A UEM's e*ffectiveness* (a combination of thoroughness and validity), and *cost effectiveness* (a combination of a method's cost to learn and use and its effectiveness) also became of interest (Hartson et al., 2001). These issues needed to be balanced against a method's prescriptiveness and learnability to ensure appropriate use (Makri, Blandford, Cox, et al., 2011; Woolrych et al., 2011) so other studies investigated how easily novice evaluators found UEMs to use as this was found to influence whether a UEM was used or not (Blandford et al., 1998; Eriksson et al., 2009; Howarth et al., 2009; John and Packer, 1995).

Other researchers extended this work and compared the performance of different UEMs according to these metrics. Famously, however, faults were found with some widely-cited examples of these experiments, in terms of low validity (of statistical tests and their recommendations to practitioners) and the measures by which they were compared (Gray and Salzman, 1998). Wixon (2003) also heavily criticised comparison studies for being short-sighted and continuing to neglect the real purpose of UEMs, which is to impact on a design and identify problems that developers can fix (Hertzum, 2006; Hornbæk and Frøkjær, 2005). In addition, several assumptions made by UEMs were found to invalidate comparison studies. UEMs assume that the usability problems they identify are *real* (Hornbæk, 2010); at the very basic level different evaluators find different problems when they apply the same UEM (Hertzum and Jacobsen, 2001), so that UEMs can only claim to identify *potential* usability problems. Comparison studies introduce additional invalid assumptions:

matching problem descriptions is straightforward; UEMs are applied as prescribed and identify problems directly (Makri, Blandford, Cox, et al., 2011; Woolrych et al., 2011); a single best UEM exists (Hornbæk, 2010); usability problem counts are the best measure for comparison (Blandford et al., 2008) and that evaluation can be considered in isolation from design (Cockton et al., 2003). Cockton (2014a: 5) goes further to say that, "scientific validations and assessments of methods are impossible, and evaluator and researcher effects are unavoidable…Usability problems cannot be objectively or universally defined, nor could universal severity scales be devised or used reliably." Regardless, specific domains such as e-commerce still compare methods to determine which are most effective for identifying particular problem types (Hasan et al., 2011).

The continued failure of UEMs to be used by practitioners spurred yet further effort to develop more accurate, widely applicable and cost-effective methods (Hornbæk, 2010). The focus shifted to the field of Usability Engineering (UE) and "discount" methods, specifically designed for efficiency, rather than effectiveness (i.e. number of problems detected versus the effort and participants required) (Nielsen, 1994b). UE provides structured methods for achieving usability in UI design throughout the product development process (Boivie et al., 2006; Mayhew, 1999b). Even though UE techniques were designed to require minimal cost and time compared to empirical techniques, when they are compared this is not always the case (Chilana et al., 2010; Cockton et al., 2003). Usability professionals, however, continued to report that widely-used techniques such as informal expert review had little impact on product design (Vredenburg et al., 2002).

The popularity of UE techniques raised concerns that they are used only because it is better to do something than nothing at all, even though they may be so ineffective at identifying true usability problems that they threaten the credibility of the usability profession (Cockton and Woolrych, 2002). Discount inspection methods save on time and skill because they require less thinking from the evaluator, which frees them to work faster. CW, for example, confines the causes of potential problems to "labels" on the UI, which the user may or may not find based on assumptions about their knowledge (Wharton et al., 1994); likewise, HE describes classes of system features that can cause problems (Nielsen, 1994a). Both CW and HE require evaluators to choose sample tasks or system features, and even a structured reporting format requires time and skill to complete; furthermore, if more than one evaluator is required to compensate for the discounted nature of the technique, comparing problem reports and descriptions is time-consuming and non-trivial. Discounted usability testing inherently restricts the range of user capabilities, knowledge and tasks sampled, and may not expose usability test participants to the most unsatisfactory features (Cockton and Woolrych, 2002; Woolrych and Cockton, 2001). Nevertheless, practitioners continue to choose methods that are quick and cheap to perform over the number and validity of usability problems they identify (Nørgaard and Hornbæk, 2006; Vredenburg et al., 2002).

By the 2000s, practitioners had acquired the expertise to combine and adapt public and local resources for design work according to the constraints under which they worked (Cockton, 2014a; Roe Purvis et al., 1994; Uldall-Espersen et al., 2008; Wixon and Comstock, 1994). To manage these constraints, practitioners had to constantly modify, improve and combine existing UEMs towards their goals (Hartson et al., 2001). To describe these adaptations, Furniss's (2008) theoretical work extended the *downstream utility* metaphor to describe methods as flowing through a landscape, comprising of the social structures, use of tools and artifacts, procedures and changes over time. Usability practice is described as a "plug and play" technology that adapts its structure, procedures and methods to match the project and client need (Furniss, 2008). Adaptations include the use of domain experts to identify usability problems (Filippi and Barattin, 2012; Følstad et al., 2010) and remote usability testing for geographically-dispersed user populations (Scholtz, 2001). UEMs can arguably only ever be partly prescriptive, more accurately thought of as knowledge resources for UCD, and methods only in name (Cockton, 2014a; Woolrych et al., 2011).

This section has revealed that, although usability professionals found techniques based on human psychology helpful for the development of usable IS, the complexity of the contexts in which they designed and evaluated IS became increasingly incompatible with the prescriptiveness of UCD techniques developed before the dawn of SDMs; they increasingly applied techniques inconsistently via adaptation to their context of use. The next sections explore what it is about the context of real development projects that require designers to adapt UE techniques. First I will look at the causes attributable to changes in SDMs, and how these changes affected the work of designers; secondly, I will look at organisational and external obstacles to design work previous research has identified.

2.3.2 Processes

We have already seen that the growth in use of IS increased the number of stakeholders in IS development, so that SDMs were devised to coordinate development amongst all the disparate groups involved (Rosson et al., 1988). Practitioners found that UCD techniques were not always compatible with SDMs, since SDMs were designed before the design of the UI demanded particular consideration. We have seen that software was initially developed in distinct phases, for example the Waterfall SDM, which conspires against the early involvement of users and iterative design, which are fundamental principles of UCD (Axtell et al., 1997; Clegg et al., 1997; Gould and Lewis, 1983). Designs were created and fixed before any development began, and so had to be done right the first time. Researchers have reported that an iterative design process is very difficult to implement within Waterfall projects (Gulliksen et al., 2009) and products developed using the Waterfall SDM can often be given to customers with incomplete features because all features are developed simultaneously (Sy, 2007).

Incremental approaches ostensibly facilitate UCD more successfully than phased approaches (Gulliksen et al., 2006); both Agile and UCD focus on customers and users through a commitment to continual testing and iteration of designs (Da Silva et al., 2011; Hussain et al., 2009). These similarities seem to suggest that UCD and Agile can be integrated in a way that enhances their strengths and reduces their weaknesses; for example, Agile approaches need to know the true end users because they focus on usefulness and providing an appropriate functional specification, rather than usability, and UCD benefits from Agile's flexibility and adaptability and being present throughout the product lifecycle (Brhel et al., 2015). As such, usability professionals have reported benefiting from the Agile SDM in several ways. It enables them to focus on a few new features at a time and is user-centred to the extent that it encourages user involvement, and has an iterative and communicative nature (Sy, 2007); it is also transparent and reduces the chance of last minute surprises that could compromise a product's release (Loranger, 2014a; Lundell and Notess, 1991).

However, the designer's role within an incremental software development process is fundamentally different to that within a phased process, which has presented challenges in addition to the opportunities already identified (McInerney and Maurer, 2005). Within an Agile process, UI design is a team activity, and usability professionals do not work independently, head down, for long stretches of time, as they did in traditional SDMs, which demanded that all requirements were gathered and a design was completed before development began (Loranger, 2014a). Instead, Agile emphasises communication and collaboration; designers work with developers throughout the development process in order to ensure that designs are implemented correctly and they can understand the technical constraints that affect design decisions (Boivie et al., 2006; Butler and Ehrlick, 1994; Sy, 2007). For many, this is where Agile's assets lie, in allowing usability professionals to actually design products rather than simply evaluate them (Boivie et al., 2006); scrums[1] bring people together from different parts of a product development organisation who can contribute ideas, share responsibilities and refine the process and learn together (Loranger, 2014a). However, others have found that the responsibility for the user perspective within a scrum process can be unclear, resulting in neglect and lack of accountability for the user perspective (Cajander et al., 2013; Svanæs and Gulliksen, 2008). Agile approaches require usability professionals to channel communication between developers and users and work in a team. To obtain resources within

[1] Scrums are daily meetings in which an Agile project team meets to review progress of tasks, plan the work during the day and distribute tasks between the group (Lárusdóttir et al., 2013).

projects and organisations, they had to make their voice, and the users' voice, heard, and demonstrate the importance, value and validity of usability work (Boivie et al., 2006; Gulliksen et al., 2006). This required social and diplomatic skills, in addition to knowledge of system development tools and the application domain (Gulliksen et al., 2006).

Usability professionals also found that they had to adapt the depth of UCD activities in Agile projects; the short time scale of Agile sprints only permits the use of empirical qualitative techniques with a few users, rather than detailed and comprehensive user performance data (Lárusdóttir et al., 2013). An Agile process, however, frees practitioners from the constraints of project management, such as the obligation to write lengthy reports, and follow fixed rules, so that they can apply techniques when opportunities arise; for example, practitioners report that traditional laboratory-based usability testing often has to be forsaken for lightweight tests using paper prototypes away from the laboratory. Although lightweight techniques can still provide rich insight on design alternatives, they do not enable practitioners to make design decisions with as much certainty because they only have time to consult a few users within each sprint. Furthermore, away from the laboratory designers have to contend with issues such as system failures, users' non-attendance, disturbing surroundings and technical problems with recording devices (Nørgaard and Hornbæk, 2006). Agile projects also present designers with fewer opportunities to test complete task workflows because only parts of the design are completed at a time, and testing of incomplete products presents its own challenges (Bornoe and Stage, 2014).

Practitioners also had to choose *when* to carry out UCD activities in an Agile project, which they had not had in phased projects, in which the design work was carried out before development began. In an Agile project, UCD activities must occur at least one sprint or cycle ahead of development activities (Da Silva et al., 2011; Loranger, 2014a; Sy, 2007). Furthermore, the timing of a UCD activity could affect its impact on a product's overall development; for example, even early surveys of design practice found that the value of usability tests lies in their timing rather than their formality (Rosson et al., 1987). Consequently, there is uncertainty and disagreement about the best role for usability tests within an Agile process because code can be too unstable between sprints i.e. whether it should be used to validate the UI, integrated into acceptance tests or at the very end with remote users (Da Silva et al., 2011). Usability inspections of paper prototypes also became useful for refining the UI and validating UIs that were implemented (Da Silva et al., 2011). Furthermore, the high frequency of sprints makes it difficult for usability professionals to maintain a focus on the overall vision for a product from the users' perspective, especially if design activities take place over multiple sprints (Da Silva et al., 2011; Hussain et al., 2009; Sy, 2007). UCD demands that usability professionals consider systems holistically but, within Agile, a design must be divided according to the timescales of development cycles (Bornoe and Stage, 2014; Sy, 2007). Consequently, UCD activities tend to remain concentrated at the start of Agile projects and users are rarely involved in all three phases of software development: Discovery, Design and Development (Lárusdóttir et al., 2013; Vredenburg et al., 2002) and research effort has been put towards solutions such as "creative sprints", a term that refers to a single episode of evaluation and redesign activities focused on a group of one or more crowd-sourced usability problems (Garnik et al., 2014).

Finally, practitioners had to adapt how they report the results of user studies for the faster pace of development and diverse audience of daily scrums and cycle planning sessions in Agile projects. Usability professionals report feedback from users in a much more informal way within an Agile process, to minimise the effort and time required to demonstrate that the software is good enough and keep their voice heard throughout the development process (Boivie et al., 2006; Lárusdóttir et al., 2010). They found that developers tend to ignore lengthy documentation produced previously, such as UI specifications or usability test reports, because of the time constraints of Agile projects (Da Silva et al., 2011; Sy, 2007); instead, practitioners tend to provide immediate feedback from usability tests directly to the developers and write reports later (Lundell and Notess, 1991). Results of UCD activities within Agile project inform artifacts instead, such as new user stories to be included in the Backlog file for prioritisation, story cards, prototypes and personas (Da Silva et al., 2011), which, over time, provide a "common ground" for communication, in the way that design specifications and contracts had done previously (Blandford et al., 2006; Boivie et al., 2006).

This section illustrates that the integration of UCD techniques within both Agile and Waterfall processes is far from resolved and still sparks debate over solutions (Lárusdóttir et al., 2014).

2.3.3 Organisation

We have seen that, as the UI transitioned from the computer to users and then to organisations, the size of product development organisations and number and diversity of computer users grew. Design work concerned more stakeholders and was increasingly affected by the development practices just described. Many of these came from organisational structures and practices, so that development of software became situated in, and interdependent, with the organisational environment (Axtell et al., 1997). It is to the impact of organisational structures and practices on design work that I now turn.

The lack of uptake of UEMs in practice caused sufficient concern that surveys were carried out to explore the constraints on design in practice imposed by the organisational practices and processes within which it took place; several constraints were found to be unavoidable and had important implications for practitioners, in terms of the applicability or inapplicability of UCD techniques (Bellotti, 1988). The results of such surveys were sufficiently concerning that researchers began to engage with practitioners on projects to find out exactly what constraints they faced working within organisations (Curtis et al., 1988; Poltrock and Grudin, 1994). Such projects revealed an even deeper and complex picture of the obstacles organisations imposed on design work and how they affected designers' ability to apply the UCD principles outlined by Gould et al. (1987); issues investigated include the organisational context of the UI development, the tools used, how those tools affect the work, which disciplines are involved in UI development, how people from different disciplines coordinate contributions, and how the organisational structure affects this coordination. From this work I find that organisational structures, knowledge of UCD and access to users have the most striking influences on design work.

Structures

Within organisations, usability professionals had to adapt their role according to existing processes (Boivie et al., 2006; Rideout and Lundell, 1994). The place of usability within the organisation (whether those involved with the design process were under the same management, or usability professionals moved between project teams) and its funding model (whether design work was included within the budget for a project from the start, or whether it was paid for separately) became an important influence on the dynamic of design work (Rohn, 2007). Some believed usability could not be integrated if it was not placed under one management, and the UI was important to so many people that the development of the UI could not be iterative (Poltrock and Grudin, 1994). The flexibility of an organisation's design method, roles and size of the design team could thus have a big impact on the autonomy of a usability professional's work (Bellotti, 1988).

The organisation's structure not only affected the integration of usability work but communication between stakeholders in design work. Early IS development projects used artifacts for communication, such as requirements documents from marketing, which were assumed to convey all the information other groups required. For example, case studies of the development of in-house systems show the shared beliefs, politics and inter- and intra-group relations that affect a development team's activities, and that functions can be political and symbolic (Symon, 1998). In-house development teams would additionally manage the process and outcomes of technological change for the organisation and, whilst teams shared the objective to implement an effective IS, individuals may have conflicting goals and dispute rationales for designs and processes.

We see that the increasingly collaborative nature of large IS development, described in the previous section transformed it into a learning, communication and negotiation process (Curtis et al., 1988).

Organisational structures, however, habitually isolated engineering groups (such as hardware, software and systems), which inhibited communication about application functionality that concerned all groups (Bellotti, 1988). Coalitions would form around conflicting views of the design, and these tended to follow the same organisational lines. Designers then had to work within the politics that ensue when individuals and teams vie for organisational turf. Boundaries to communication among groups both within organisations and with their customers inhibited assimilation of domain and technical knowledge.

Knowledge of User-Centred Design

The structures of an organisation are largely determined by management, so it is unsurprising that designers have reported the significant impact that the attitude of management towards UCD has on their work. Management control the extent to which other factors that obstruct design work are present: attitudes and resistance to usability, and lack of understanding, trained expertise, guidelines, usability metrics and resources (Bellotti, 1988; Rosenbaum et al., 2000).

It was not, however, just the attitude of management that was found to impact upon design work. Designers worked alongside an increasing number of people and stakeholders in the design process. Coworkers had different backgrounds, experience, skills and knowledge regarding UCD. Developers might assume that UCD principles were obvious, believe that users do not know what they want, believe that user behavior follows logical patterns, underestimate the diversity of users and believe they could achieve the right design first time (Gould and Lewis, 1985). Even if developers recognised the value of UCD principles, they did not necessarily have the authority to change their work accordingly because software development was increasingly led by project managers, and they may be too focused on the technical aspects of their work (Ardito et al., 2014). The less structured the development process became, the more important it became for designers to communicate UCD activities to developers (Blandford et al., 2006). The buy-in of developers, determined by the individuals in each role (with their knowledge, background and skills related to UCD) then becomes important (Bak et al., 2008).

Access to Users

Designers have faced different challenges and opportunities for involving the users in the design process over time, as the point in a project's timeline at which developers and users are identified has changed (Grudin, 1991a); this has a knock-on effect for their understanding of users' tasks and requirements, so that techniques are not necessarily transferrable between projects (Bellotti, 1988). IS were initially developed for specific groups of users, and their involvement in the design process and requirements were typically defined within the contract and without consultation of the usability professional, who had little influence over this aspect of their work. Contracts and specification documents became the basis for communication and political devices to resolve design debates in these circumstances (Symon, 1998). Designers frequently found that organisations (both development and client) controlled access to users and were found to consciously prohibit developers from meeting customers, delegating this task to marketing, customer support, field service, training and other specialists (Poltrock and Grudin, 1994). This would result in the users' and customers' requirements being confused because marketing tend to be focused on the buyers of products, in addition to a product's competitiveness, rather than its usability and users, and customers were not always the users of the system.

Usability professionals employed by organisations to develop internal (or in-house) IS may encounter fewer obstacles to access users, but still face barriers from the end users themselves if they did not perceive the value in participating in the design process. When designers faced these barriers they had to educate members of the organisation about the value of usability, which required presentation and persuasion skills, in addition to being an effective coach and mentor.

Designers of systems for the mass market, on the other hand, could largely determine how they investigate users and their requirements, and had to arrange meetings with users themselves. Once development was underway, however, organisations can restrict developers' access to users for commercial reasons. Within incremental development it was also important for designers to ensure that usability testing was in a project plan from the beginning of projects, which required negotiation with, and the support of, project managers.

So far this chapter has shown how developments in the techniques available, processes used and the organisational context for design work influenced the nature of the role of the usability professional. We have just seen how developments in organisational context affected design work: specifically the structures and knowledge of organisations in which designers worked, and the way in which organisations managed access to users. Some recent efforts, such as those of Iivari (2010), are particularly notable for their recognition of the impact of organisational culture on usability work. Most of the research in this area to date has been carried out with surveys; there are relatively few accounts from researchers within organisations that report the decisions taken by organisations and their effect on design work in real time and whether survey findings reflect reality.

2.3.4 Extrinsic Context

As the domains in which IS were used became increasingly unfamiliar, unstable and unstructured, design work expanded to complex systems with which end users handle large amounts of data, known as "Big Data", and work in collaboration with other end users who may or may not be in the same geographical location. This exposed design work to external factors, for example technological constraints of users, strategic decisions (e.g. to change technological platform), and market pressures (Bellotti, 1988; Svanæs and Gulliksen, 2008). We will now see what previous research has found about the impact of domain complexity on the designer's role.

In addition to UCD expertise, usability professionals in complex domains have found that they need domain expertise, in order to be certain of users' requirements and for stakeholders to perceive their work as credible (Gulliksen et al., 2006). Designers found that team members with more advanced application domain knowledge exerted greater influence upon design decisions, and thus their credibility depended on the extent to which they understood the application domain. Expertise, even in the users' terminology, requires more time and sources of information in complex domains. Designers in complex domains found it more difficult to develop UIs that made sense in terms of the users' knowledge and goals, rather than the underlying code, and assumptions about how users processed information became increasingly invalid (Hammond et al., 1983). Without domain expertise, usability professionals cannot be certain that they ask end users the right question or design an appropriate task for usability tests because every situation can be unique (Bellotti, 1988; Chilana et al., 2010). The relevance or significance of problems may also be misinterpreted, especially if the user (domain expert) is distracted by detail in the data (Chilana et al., 2010). End users' goals and sub-goals can evolve as they move through the data to explore aspects of, or possible solutions to, a much larger goal; in an Agile development process, in which only components of a system are completed and available to test at a time, this can be especially challenging to investigate (Redish, 2007). The more complex the domain, therefore, the more important it is that usability professionals can access end users to test systems (Bornoe and Stage, 2014; Chilana et al., 2010). Usability professionals turned to social sciences and approaches such as "contextual research", "participant observer" studies and PD to overcome these complexities (Gulliksen et al., 2006), including field studies (McDonald et al., 2006; Monahan et al., 2008).

Whilst designers had a greater need for access to users in complex domains, the nature of the users' work can make the practicality of scheduling time with them more difficult (Redish, 2007). In such situations, usability professionals started to leave their laboratories to test systems with end users, for example at conferences, formative evaluations in partnership with domain experts, or formative evaluations with volunteers in their real environment for a defined period of time (Redish, 2007). Usability professionals have reported learning from domain experts upfront and in depth, developing partnerships in which they infrequently but regularly consulted with domain experts, and developing deeper more persistent relationships in which they integrated domain experts into their team (Chilana et al., 2010). This partnership approach involves the domain expert in the design process beyond cooperation and participation; instead, techniques such as pluralistic usability walkthroughs, participatory HEs and cooperative usability testing, allow the domain expert and usability professional to "hold hands" (Chilana et al., 2010). Partnerships, however, can depend heavily on the client organisation and the level of user involvement they can provide; in some instances they may provide a "user advocate" to represent all users, even though this is less likely in complex domains where user populations can be particularly heterogeneous (Iivari, 2004; Svanæs and Gulliksen, 2008). A tender process may also lend itself more naturally to phased approaches to development and hinder the iterative UCD activities (Svanæs and Gulliksen, 2008).

Usability practitioners in complex domains also need to understand the principles of information visualisation. As the volume of data grows, complex IS can overload users with more information than they have the skills to handle; even though they are often domain experts, the demands of their work may not permit the time required to learn new programs or presentation methods, or the cognitive space required for data analysis and recursive decision-making (Redish, 2007). Visualisations are an important means of handling and creating knowledge construction from large amounts of data, so designers had to consider the usability of visualisations of specific types of data for specific types of users. Information in such systems can be incomplete and unreliable and wrong decisions can be costly, which is an even greater risk when, as often, analysts and decision-makers are different people.

Finally, the burgeoning paradigm of product development for (individual or groups of) non-programming end users exposed design work to wider political and economic factors. The report of Marcus and Gasperini (2006) on the upgrade of a police emergency-response system illustrates this particularly well. The evaluation of the requirements for this project found that upgrading the system built in-house would be more costly than acquiring off-the-shelf components from a commercial vendor. Cost and functionality were prioritised above usability so user representatives were not consulted, and many officers reverted to audio communication. The amount of money spent on the system before it was evaluated caused fraught emotions and politics. The complexity of the situation demanded more effort to interview users, learn about the software and get to the situation's origins. The emotional and political climate further changed when reports of the problems reached the media.

In summary, as the complexity of domains in which usability professionals worked increased, they needed domain expertise, methods from the social sciences to understand the context of users' work, to grapple with how users process and visualise large datasets, and to work harder to gain access to users. These are issues that they experienced in other domains, but were particularly magnified within complex domains so that UCD activities were more challenging to carry out. Especially in the more technical design contexts, usability professionals had to work alongside many more people who were not aware of usability and UCD principles, which would severely restrict the work they carried out. They therefore had to find strategies for introducing UCD to organisations. The next section will consider how usability professionals have been able to integrate UCD within organisations with limited knowledge of UCD.

2.4 Introducing User-Centred Design

We have seen in the previous section that usability practitioners may face several obstacles when they apply UCD within an organisation, which can be amplified in complex domains. In addition to designing complex systems, usability practitioners began to find that they might have to work to introduce UCD and improve an organisation's "usability maturity" (Earthy, 1998; Nielsen, 2006; Staggers et al., 2011). The term "usability maturity" describes the extent to which management practices facilitate UCD activities in an organisation and Usability Maturity Models have been devised to measure and monitor the status of UCD in an organisation.

The literature provides advice and warnings for practitioners who wish to introduce UCD to an organisation and increase their usability maturity. Whilst there are few accounts from within organisations, particularly regarding the development of workplace systems, there are reports from practitioners on their experiences over multiple projects (Bloomer and Croft, 1997; Mayhew, 1999a; Rohn, 2007), results from surveys (Rosenbaum et al., 2000; Venturi et al., 2006) and accounts of active attempts to introduce UCD over extended periods of time (Cajander, 2010; Gulliksen et al., 2009). Significant amongst these is the "Usability Engineering Lifecycle", in which Mayhew (1999b) advocates practitioners to see themselves as agents of organisational change (Goodman et al., 2011; Symon, 1998). Mayhew (1999b) identifies myths, beliefs and attitudes held within organisations that can obstruct the introduction of UCD, in addition to the incentives, practices and structures of organisations that can also play a role. This section will summarise what Mayhew advises from her experience and updates this with reports that have been published since.

2.4.1 Motivators

Practitioners have reported particular moments when organisations can be motivated to introduce UCD. An opportunity commonly arises after a highly visible disaster, for example the commercial failure of a product or upgrade and users report it to be unusable (Mayhew, 1999b; Schaffer, 2004).

However, such a large scale failure does not need to happen for an organisation to be motivated adopt UCD approaches (Schaffer and Lahiri, 2013). An internal advocate or ally within an organisation can also provide an impetus for the introduction of UCD if they have sufficient vision, power and authority to drive the necessary changes, for example hiring an external usability expert onto a project (Boivie et al., 2006; Carlshamre and Rantzer, 2001; Schaffer and Lahiri, 2013). Others have reported success when senior management have put UCD into the business strategy and provided associated incentives (Butler and Ehrlick, 1994; Gulliksen et al., 2004; Logan, 1994; Venturi et al., 2006). Marketers may also put pressure on an organisation to introduce UCD if they perceive that the market demands it and the business is losing market share to competitors because their products are more usable. Organisations may also introduce UCD to address general business concerns such as low staff productivity and high training costs (Donahue, 2001), especially within organisations that develop IS internally, or to resolve internal design conflicts via external party or usability testing, for which they lack the requisite skills internally (Donahue, 2001). Finally, seminars and presentations can also persuade managers and developers that good design is more than common sense and preference, and that users' performance can be measured objectively.

2.4.2 Obstacles

Once UCD has been launched within an organisation, natural internal forces may obstruct its success. First, organisations may hold attitudes that conflict with the introduction of UCD:

1. *The quality of the UI does not really matter*. This view stems from the 1970s and 1980s when it was largely valid; products were developed according to detailed requirements defined in contracts. Usability only became a competitive advantage when the market for computers broadened to non-programmers and, if an organisation already has a successful product on the market, they may lack an economic incentive for usability work (Bak et al., 2008);
2. *As long as designers are familiar with available UI principles and guidelines they will design good UIs* and that one or two usability experts are sufficient. UCD can have a much greater impact at an organisational level with two or more UCD experts on a project (Vredenburg et al., 2002);
3. *UI design tasks do not arise until the design phase of a development project*. Organisations may believe that usability does not need attention until the design of individual pages and treat it like "cake frosting" that can be applied at the end of projects (Svanæs and Gulliksen, 2008);
4. *Usability is subjective and cannot be measured or engineered* and is merely aesthetics, common sense and opinion. Developers may not view it as an engineering problem and welcome changes in their engineering process;
5. *UI design can be done right the first time, in the design phase* and is implicit in software design and development. Organisations may not provide an explicit plan or budget for UCD because

they believe the current processes work and are unaware of experimental psychology techniques that measure human performance objectively.

Mayhew reports that organisational incentives can play an important role even with the most convincing cost benefit analysis. For example, performance reviews, salaries and promotions typically reward project managers for staying within budgets and schedules and providing the functionality agreed, rather than increasing user productivity or sales. Organisations can have other goals besides (but often linked to) budgets and schedules that can conflict with efforts to introduce UCD: technical goals (e.g. minimising processor use to maximise response time, and modularising code, which can prevent integration of functionality); cognitive processes and individual goals (e.g. collect and maintain organisational "turf", and apply new technology to keep skills current); social/group/team goals (e.g. reward for mastery of programming skills and a desire for cooperation resulting in design compromises); and business/marketing goals (e.g. maintain existing customer base by not innovating in ways that would increase training costs) (Grudin, 1991b). Such incentives indicate a lack of management support, which can obstruct UCD work (Lundell and Notess, 1991); usability professionals seldom have sufficient authority to link the achievement of usability objectives to performance bonuses when introducing UCD (Bloomer and Croft, 1997).

Organisational practices, tied to the historical roots of SDMs, can impede change efforts and, as we saw in the previous section, SDMs can be obstructive to UCD activities (Gulliksen et al., 2004; Svanæs and Gulliksen, 2008). As we have seen above, organisations may restrict contact with end users to marketers, trainers and field support, rather than developers; even then, client organisations may limit contact to customers who cannot be assumed to have the same requirements as the end users (Svanæs and Gulliksen, 2008). In Mayhew's experience this attitude can come from concerns that developers would not keep up with project plans and schedules, give false expectations or disclose commercially sensitive information such as the design of new products, if they met with users. Pressure to get products to market may also limit the time available to meet users (Bak et al., 2008). Efficient prototyping and development tools also emerged after many SDMs, so SDMs would need significant updating to accommodate them; this conspires against iterative design processes (Clegg et al., 1997). Traditional systems analysis and lack of contact with end users can also encourage a focus on features and functions rather than users' tasks. Finally, product design can tend to mimic the manual world; whilst appropriate when computers simply crunched numbers it can stifle creativity and result in huge inefficiencies if applied to highly interactive systems.

Organisational structures may also inadvertently obstruct UE because division of labour usually reflects ease of management rather than ease of learning and using the UI design. Organisations traditionally put different aspects of products (e.g. hardware, software, training, marketing) under separate management and froze requirements in order to coordinate the work of disparate groups within the same project because specialised groups are more easily managed if they work independently. It then becomes easier to implement the UI according to these organisational divisions, often at the expense of its usability. The geographical separation of organisational units, and developers and users, has been found to obstruct the introduction of UCD (Gulliksen et al., 2009; Svanæs and Gulliksen, 2008; Wilson et al., 1994). An organisation's culture can also affect how usability work is funded, which can have further implications for its integration; some report that project budgets should include usability work (rather than an external service that projects or departments pay for separately), even if the percentage of the project budget allocated to UCD activities does not affect their impact at an organisational level (Rohn, 2007; Vredenburg et al., 2002). Although Gould et al. (1987) advocate for integration of usability work within an organisation, and their organisation carried out subsequent surveys that substantiate their views (Vredenburg et al., 2002), some usability professionals have found that they can have a far greater impact, and impact design decisions much more easily, if they are embedded within project teams, rather than sitting together within their own team (Boivie et al., 2006; Gulliksen et al., 2006; Lundell and Notess, 1991; Rohn, 2007; Siegel and Dray, 2003). There is thus little consensus about how usability is best managed; my analysis suggests this is because of the variety of design contexts.

2.4.3 Success Factors

Mayhew and others also give examples of the practical means (i.e. roles, processes and methods) by which usability professionals can integrate usability into systems development and encourage the necessary shift in organisational culture, processes, attitudes and relations (Boivie et al., 2006).

Usability professionals can boost the credibility of, and receptiveness to, their work in several ways. They can be strategic and choose activities and projects that demonstrate their special skills, training and expertise, in addition to making recommendations with reference to business goals, instead of design principles or experience to demonstrate knowledge and consideration of technical and business concerns (Siegel and Dray, 2003). Subtleties such as the title of "Lead Designer" can give an erroneous perception that the usability professional's job is to impose design decisions on a group; it can be far better to assume a management role and facilitate the discussion of the pros and cons of design alternatives with reference to requirements analysis results, and meetings between developers and users (Boivie et al., 2006). It is also reportedly useful to apply techniques that quickly and dramatically demonstrate their value (Bloomer and Croft, 1997); it is known that the effectiveness of different techniques and approaches for introducing UCD varies and does not correlate with how often they are used by practitioners (Rosenbaum et al., 2000). For example, a style guide takes time to write and its benefit is not immediate; usability testing, however, provides dramatic, inarguable and convincing data in a very short time (Bloomer and Croft, 1997). The least complex and most humble techniques are also reported to be successful because they are more inclusive (Carlshamre and Rantzer, 2001). Finally, usability practitioners are advised to carefully manage expectations when introducing UCD (Goodman et al., 2011). Usability testing, for example, identifies problems but does not solve them, cannot predict sales, reflects performance (not preference or satisfaction), and only for the specific parts of the tool that are tested. Designers are also advised to be wary not to give the impression that principles and guidelines come from an interface design cookbook but are, in fact, rules of thumb.

Lack of knowledge or understanding of UCD (i.e. low usability maturity) has been found to be a major obstacle to the introduction of UCD, which can be exacerbated by ineffective communication (Bak et al., 2008; Svanæs and Gulliksen, 2008). Effective communication, on the other hand, can persuade stakeholders of the value of UE (Boivie et al., 2006; Furniss, 2008; Rosenbaum et al., 2000); this would include articulate presentations and clear written communications targeted to their audience and referring to competitor analysis (Venturi et al., 2006). Different stakeholder groups can be persuaded of UE's value and become allies for the introduction of UE techniques using different arguments (Boivie et al., 2006). For example, senior management will be interested to know that UE can influence marketing literature and early adopters, and also convince potential users of low training demands; in addition UE can reduce development, distribution and support costs, and project risk (Bloomer and Croft, 1997; Donahue, 2001). For project managers, UE can reduce time wasted on redesign and overall development; it can also objectively identify and prioritise problems that can be fixed early at minimal cost (Bloomer and Croft, 1997; Donahue, 2001). Usability professionals can persuade developers and software engineers that UE is objective, unbiased, measures usability with an engineering approach, and provides a framework for quick and creative design. The medium of communication should also be chosen carefully, since a well-illustrated oral presentation can often communicate design standards more effectively than a style guide; developers may also benefit from watching videos of usability tests to see how users interact with the system for themselves (Caplan, 1994; Dieli et al., 1994; Roe Purvis et al., 1994). Tracking problems identified in usability testing, and if/how/why they are fixed, may also demonstrate UE's value and encourage further budget and work.

Linked to communication, the production of well-defined work products can also be effective; for example, a well-structured proposal for usability work would include clear deliverables, such as a report that describes usability problems, how they were identified, in addition to how they can and, importantly, why they should be fixed a certain way, referring to design principles and including severity ratings to help stakeholders to prioritise the arising development tasks. In return, usability professionals should receive commitment to investigate the feasibility of their recommendations, for example in the form of a report back on how and why advice was taken or not.

Usability professionals often have the mandate to integrate UCD activities into the development process but do not always have the authority (Gulliksen et al., 2006); informal processes can therefore be just as important as an organisation's formal processes for the effective integration of UCD activities (Gulliksen et al., 2004; Rohn, 2007). Usability professionals should be proactive and make and take opportunities to educate influential stakeholders from across the organisation about UCD and to show them its benefits with their own eyes, whether in informal meetings, presentations in team meetings (Lundell and Notess, 1991) or by involving them in UCD activities directly e.g. taking developers to usability tests (Bloomer and Croft, 1997; Caplan, 1994; Dieli et al., 1994; Gulliksen et al., 2009; Roe Purvis et al., 1994). Usability professionals can also usefully use meetings to spot opportunities for requirements analysis and evaluation activities, such as questions raised that they could answer.

Designers can benefit from understanding the language of the end users, which we have already seen can be especially important when users are domain experts, and the technical language of developers (Boivie et al., 2006; Gulliksen et al., 2006; Wichansky and Mohageg, 1994: 254). Software developers are engineers, trained to think and work a certain way, and UE techniques were not designed with this in mind (Bak et al., 2008; Cockton, 2014b); measurable usability goals and structured techniques can be more successful because of this, in addition to reasoning from data and principles rather than opinion, preference or experience. Support and impact can be gained by demonstrating how UCD helps others to succeed and not just highlighting their flaws, so that the engineers in the organisation become invested in UCD skills and expertise (Goodman et al., 2011; Mayhew, 1999b; Rohn, 2007; Siegel and Dray, 2003).

Timing and choice of project has also been demonstrated to make a difference (Bloomer and Croft, 1997; Carlshamre and Rantzer, 2001); for example, UCD within highly-visible, mission critical projects is reported to be more successful at embedding UCD in an organisation for the long-term. Designers do not, however, always have control over which projects they are involved with (Boivie et al., 2006). Others have noted the importance of getting involved early in projects so that there is not too much to do late in the project (Lundell and Notess, 1991).

Overarching all of these success factors is the knowledge, experience and communication skills of the usability professional and their colleagues; processes and roles can be immaterial without the right people in place (Boivie et al., 2006; Gulliksen et al., 2006). Cockton (2014a: 8) describes these as "competences", which are necessary resources for putting practical methods in place from a set of incomplete approaches. The advice this section has reported, however, is highly context specific and based on individual experiences and projects; documented efforts to introduce UCD, such as those from Scandinavia, have generally been carried out with the explicit aim of introducing UCD, which could have highly influenced their outcome. They also emphasise top-down approaches (e.g. acquiring senior management support), which are more suited to organisations with a high level of usability maturity, rather than providing practical advice for practitioners in organisations who might already be successful and have a large share in their market but have a low usability maturity. In these organisations, the scope of a usability professional's role may only provide opportunities to work from the bottom up. Although this may limit what they can do, a more informal, bottom-up approach might be more fruitful because it could embed UCD within an organisation's subconscious and culture, rather than depending on individuals and processes. Previous research suggests it can take years to embed UCD into an organisation's culture (Nielsen, 2006; Rosenbaum et al., 2000) so my choice of approach in the next chapter will reflect this.

This review demonstrates demand for investigation of the introduction of, and how to sell, UCD to product development organisations developing complex, domain-specific tools for "Big Data" analysis. The nature of these tools necessarily demands a technology-focus; however, their use has grown into so many different areas that the "end user" is now more difficult to define and includes people who do not have the experience or skills to manage and analyse data effectively. This type of user is often new to organisations in complex domains, which brings the need for usability work into previously unchartered territory, where the requisite resources and experience may not exist.

As next chapter describes, I propose to carry out this investigation in the domain of healthcare informatics. Before I introduce the specific situation of my research, I will review how others have introduced UCD to the design and development of healthcare informatics tools (HIT). To do this I will briefly define HIT, demonstrate the complexity of this domain and the need for UE techniques for their design and development, and identify issues unaddressed by previous research.

2.5 Healthcare Informatics

IS and technological devices are increasingly used in healthcare delivery, from medical imaging right through to personal devices used to administer treatments. In healthcare, IS can facilitate strong and effective networking of clinical, epidemiological and administrative information across multiple centres, which is essential due to its dispersed nature (Zhang and Martinez, 2002). Globally, broad and consistent use of technology within health can increase the quality or effectiveness, and productivity or efficiency, of healthcare; prevent medical errors and increase procedural correctness; reduce healthcare costs; increase administrative efficiencies and healthcare work processes; decrease paperwork and unproductive work time; extend real-time communications of health informatics among healthcare professionals; and expand access to affordable care.

Health IS encompasses a wide range of products and services (including software, hardware and infrastructure) designed to collect, store, exchange and use patient data throughout the clinical practice of medicine for communication and decision-making; examples include everything from electronic medical records, clinical decision support to computerised physician order entry. When I use the term health informatics I must therefore be more specific. Health (or medical) informatics is "the study and application of methods to improve the management of patient data, clinical knowledge, population data, and other information relevant to patient care and community health" (Wyatt and Liu, 2002). Various branches of the discipline have appeared, including public health informatics, consumer health informatics, and clinical informatics.

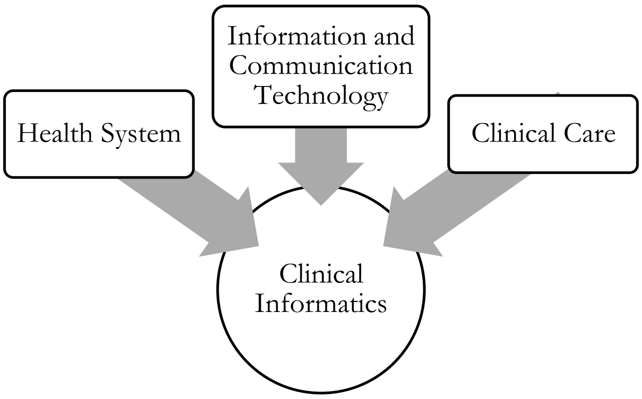

Figure 2-1 The Domain of Clinical Informatics after Gardner et al. (2009)

Gardner et al. (2009) define clinical informatics as the overlap of health system management, clinical use and information technology (Figure 2-1), which bridges the fields of IS, computer science and healthcare. Specifically, it refers to "the development and assessment of methods and systems for the acquisition, processing and interpretation of patient data with the help of knowledge from scientific research." (Imhoff et al., 2001, p. 179). Medical, clinical and health informatics are often used interchangeably to refer to conversion of patient data into medical knowledge (Taylor, 2006).

Doctors use HIT to obtain information to support decisions and actions that will improve patient outcomes (Sullivan and Wyatt, 2006). However, Hersh (2002, p. 1955) notes a "growing concern that information is not being used as effectively as possible" in healthcare. The value of usability to healthcare organisations and the individuals of which they are comprised is illustrated in Figure 2-2.

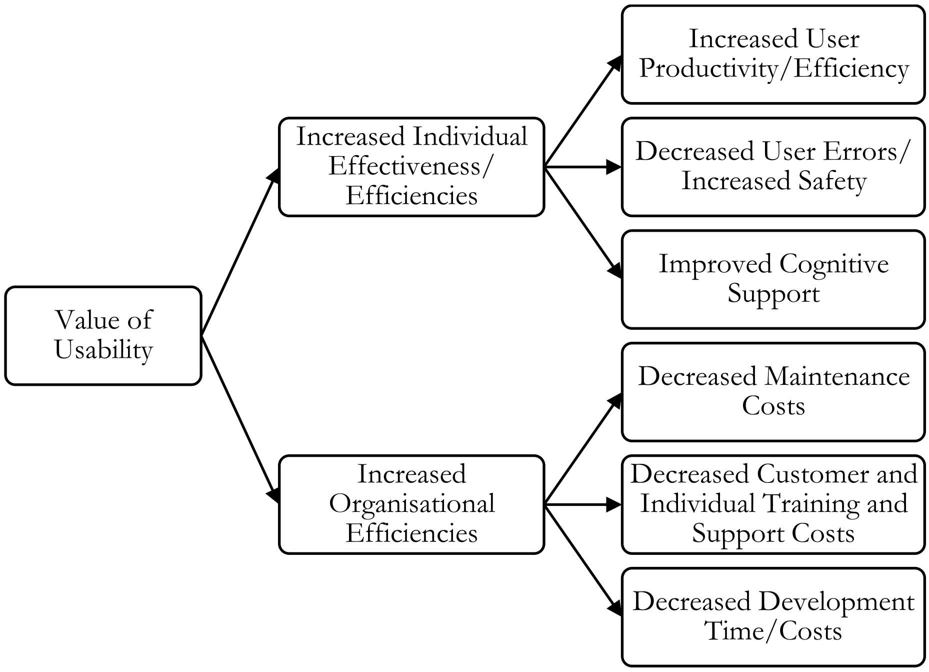

Figure 2-2 Elements of the Value of Usability to Health Organisations after Staggers et al. (2011)

This section describes the different approaches and techniques used to evaluate the usability of HIT and, finally, how researchers have so far introduced UCD to healthcare informatics organisations.

2.5.1 Approaches to the Design of Healthcare Informatics Tools

Van Gemert-Pijnen et al. (2011) review different frameworks for development of HIT and recommend a multidisciplinary approach, continuous and systematic evaluation and robust methods for evaluation (including combining qualitative methods such as observations and interviews with quantitative methods such as workflow sampling or questionnaires). A PD framework for HIT development has also been devised (Pilemalm and Timpka, 2008), formalising practical experience from the application of PD in the healthcare context, to facilitate large-scale user participation. Medical systems and their UIs have long been known to require better methodologies, both for providing input into the iterative design process (formative evaluations) and end product testing (summative evaluations) (Kushniruk et al., 1997).

Formative evaluations aim to improve systems under evaluation by providing developers and implementers with feedback in addition to demonstrating their acceptability and utility (Van Gemert-Pijnen et al., 2011). Proposed approaches to formative evaluation of HIT do not differ from those in other domains; development of test plan, selection of representative tasks/contexts, setting up the testing environment, conducting the usability test, data analysis, recommendations to developers and iterative input to design (Kushniruk et al., 1997). However, it is not clear how this can be achieved. Formative evaluations of HIT have employed UE approaches, such as video analysis of user interactions with prototypes and remote usability testing for web-based HIT, which record the user interactions with a system (Kushniruk, 2002; Kushniruk et al., 2001). Although these approaches overcome many logistical barriers to usability testing in this domain, they present others, for example transportation of video equipment to the user's location.

Stead et al. (1994) first proposed a framework that linked stages of a product's development to levels of evaluation for medical informatics, and. Kaufman et al. (2006) extended its use as a framework for IS design, development and implementation in the healthcare domain. Yen and Bakken (2011) devised a detailed usability specification and evaluation framework, based around the stage of the software development lifecycle (SDLC), evaluation type (task, user-task, system-task, system-user-task, or system-user-task-environment) and evaluation goal; they also reviewed which techniques had been used and at which points they had been used in the SDLC.

Summative evaluations investigate the outcome of an HIT in clinical routine, its impact on healthcare, and explore the validity and efficacy of HIT; examples include randomised controlled trials on the overall impact, in addition to the use of log files and chart reviews (Van Gemert-Pijnen et al., 2011; Yen and Bakken, 2011). Summative evaluations have most usefully identified adoption barriers (Yen and Bakken, 2011). For example, systems may be commercial products and, therefore, organisations may have lacked the opportunity for earlier evaluation. Summative approaches have adopted methodologies such as contextual enquiry (involving field observations and interviews) and stakeholder workshops to provide a forum to discuss a system's needs and goals via personas and scenarios that represent relevant goals, tasks, actions or decisions. Focus groups have also been used to inform design iterations for consumer health devices (Civan-Hartzler et al., 2010) and to gather the information needs of General Practitioners (GPs) in Norway, alongside observations of primary care visits and a survey of a random sample of GPs (Christensen and Grimsmo, 2008).

The next section will review the approaches and techniques applied to the design of HIT.

2.5.2 Techniques for the Design of Healthcare Informatics Tools

Empirical

Usability testing has been carried out on clinical decision support tools (Graham et al., 2008), which assess patient-specific information to make recommendations that are subsequently presented to clinicians for consideration. Participants were asked to "think-aloud" to specifically identify aspects of the UI they liked, disliked or wished to be changed; this was followed by a short post-test interview for reflective comments. The evaluators also installed automated screen and audio capture software onto the test laptops.

Personas have been used in the development of technology in other areas of healthcare. For example, direct observation, review of archival material, focus groups, semi-structured interviews and informal discussions with stakeholders have informed the development of personas for consumer health technologies (LeRouge et al., 2013), which, in turn, informed functional requirements, design, implementation and diffusion, by generating scenarios for the testing and evaluation of the design. Designers of medical equipment have recently explored the challenges and benefits of personas for their community (Vincent and Blandford, 2014).

Analytical

The use of expert-based inspections, specifically HE, CW and think aloud, for interactive healthcare computer applications has also been reviewed (Jaspers, 2009). It was noted that, as in other domains, analytical methods are more easily and cheaply used to test early system mock ups or prototypes than usability testing and are therefore easier to integrate into a development process. However, usability professionals apparently seldom have enough knowledge of the users' work to evaluate, for example, whether a system accurately follows the user's task flow. The validity of the results, as we have already seen, will therefore depend on the evaluator's domain expertise in addition to their knowledge of the method. Evaluations between 2003 and 2006 focused on issues such as effectiveness of the systems, the quality of care, user and patient satisfaction and the system's usability (Rahimi and Vimarlund, 2007). A tendency was also noted for using subjective approaches combined with quantitative studies to analyse cost and benefits.

2.5.3 Challenges for User-Centred Design of Healthcare Informatics Tools

Research to date has applied a subset of approaches and techniques from the field of HCI in the context of HIT. Despite this, HIT have not had the success that they have had in other domains because of a combination of challenges unique to the health domain (Ammenwerth et al., 2003).

First, the evaluation object is uniquely complex. HIT evaluation requires understanding both the technology, and the social and behavioural processes that affect and are affected by the technology. HIT success depends on a multiplicity of factors in addition to usability: how well the technology matches clinical workflow, the quality and security of information it offers, training and support, the depth of usage, and on the motivation of the users and their use of the system (Yusof et al., 2008a; Yusof et al., 2008b). Failure of a HIT can often have severe consequences, which means that HIT must prioritise their stability; especially consider that quite often the end user does not have an option in using the system (Koppel, 2013). The way that technology is implemented into healthcare organisations must also therefore be designed properly to increase the probability of effective use (Karsh, 2004). Functional, organisational, behavioural, cultural, political, management, technical, legal, strategic, economic, educational and user acceptance reasons may therefore determine the success or failure of HIT (Brender et al., 2006), which makes it particularly challenging to find the extent to which the failure of a system can be attributed to poor usability. The evaluation object can even change during its introduction, which invalidates conventional methods of evaluation, such as questionnaires and interviews with users, which are also limited by the user's ability to recall their user experience. Video recording of participants' actions, verbalisations and problems during either think aloud or interview can help to mitigate such issues. However, HIT is only one cog in the information processing wheel in a healthcare organisation, including the human actors involved and the technology used; evaluation must consider their interaction and the environment over a longer period of time and multiple centres of use, since healthcare organisations work in different ways (M I Harrison et al., 2007). Each hospital and national health system can operate differently so that no one system will work well for every hospital and healthcare system (Vincent et al., 2014).

Second, as in other complex domains, the users' heterogeneity makes it very difficult to define the user and their requirements (Fahey et al., 2011). Ostensibly the user's role should determine their level of access so that they only see information that is relevant to the aspect of patient care for which they are responsible. Some researchers have performed stakeholder analysis to identify users, but not all stakeholders are users in the healthcare domain (McLeod and Guynes Clark, 2009). A Director of Clinical Services, who reads a report containing data from a database extracted by an Information Analyst, is not the "user" of the technology. The Information Analyst is the user and the Clinical Director is the data recipient i.e. stakeholder. It might therefore be inappropriate to survey the Clinical Director's user acceptance or usability of the technology. Another way to describe this scenario is that the Information Analyst has brought the database into service by entering queries to retrieve the data; this makes the Information Analyst the stakeholder, user and data recipient. Since use of HIT is expanding, it is imperative that research in this area is conducted with a clear definition of the user. Conflicting results regarding the importance of user involvement when evaluating and developing medical devices can perhaps also be attributed to the inadequate definition of the user.

Third, in domains such as health, use does not always indicate design success and, conversely, lack of use is not evidence of design failure (Karsh et al., 2010). Clinicians may ignore alerts for legitimate reasons; for example, consider that the most highly skilled surgeons perform the most complex operations, which are associated with a higher risk to patients and their outcomes. This invalidates assumptions of discretionary use in models of technology acceptance (Bagozzi and Warshaw, 1992; Davis, 1989); the use of HIT is often *non*-discretionary and the customer (who assesses a technology's usefulness) is not always the end user, who decides how easy it is to use. The design of HIT cannot be validated by asking a clinician if they like it; what they say they want and what will actually improve their work may be quite different, so that they might rate a system in a very positive light in a questionnaire, despite video recordings of their interactions indicating the opposite (Kushniruk et al., 1997). Finally, HIT cannot be assumed or and designed to be used by a single user, such as a doctor, working with a single patient; much of the power of HIT comes from its ability to facilitate group work. Any HIT evaluation should thus investigate how clinical work is actually done, using combinations of methods like cognitive field analyses including cognitive work (Vicente, 1999) and task analyses (Schraagen et al., 2000), work- and task-flow analyses (Diaper and Stanton, 2004; Kirwan and Ainsworth, 1992) and UCD techniques (e.g. usability testing).

Fourth, the motivation for evaluation can impact the results. Evaluations tend to occur when there are sufficient funds and participants, both of which depend on the motivation of stakeholders, especially hospital management. Participation also usually requires some effort from staff, such as filling out questionnaires, or usability testing, which can cause a 'volunteer effect'; volunteers are inherently motivated and have time to participate and thus perform better. Stakeholders may also fear negative results that reveal deficiencies in systems already implemented.

2.5.4 Introducing User-Centred Design to Healthcare Organisations

Little research has considered the introduction of UCD to healthcare organisations, apart from the work of Staggers et al. (2011) who described a Healthcare Usability Maturity Model. This model presents five phases (unrecognised, preliminary, implemented, integrated and strategic) according to key milestones and elements associated with the successful integration of usability into a healthcare organisation. Each phase describes the state of usability within an organisation in terms of its focus on users, management, processes and infrastructure, resources and education, and provides some guidance for moving on to the next stage. Although the descriptions of each phase could reflect many other domains, I find the last part of the document has some useful suggestions of methods for introducing usability into healthcare organisations and then expanding usability within healthcare organisations; these are listed in Table 2-1. Notice that suitable strategies for the launch and expansion of usability into healthcare organisations do not differ greatly from those for other organisations, suggesting that healthcare can be a relevant field in which to investigate this area

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Launching Usability Into Organisations	• "Wake-Up" Calls • Individual Infiltration Methods • Finding Internal Champions • Using External Experts as a Catalyst
Expanding Usability Within Organisations	• Include usability in contracts • Create a feedback loop from users to vendors • Talk about tasks and workflows • Educate about Return on Investment related to usability • Engage organisational leaders in usability • Include usability metrics on one project • Interview users to determine key usability issues • Compile evidence from usability assessments • Look for and document usability wake-up calls • Find a business driver supporting need for usability

Table 2-1 Tactics to Introduce/Expand Usability in Healthcare Organisations (Staggers et al., 2011)

In this section I have defined "health informatics" and how it relates to other areas of technology in healthcare. UCD for HIT can increase individual effectiveness and efficiency (increased user productivity, fewer errors, improved cognitive support) and organisational efficiencies (less maintenance/training/support costs and less development time/costs). I have revealed that UE approaches and techniques have been applied in this context, but are not always successful because of particular challenges that are specific to healthcare: the diversity and volume of data, users and customers; furthermore, HIT are only part of a much wider socio-technical system, so the success of any system cannot solely be attributed to its usability. Given the clear benefits of UCD for healthcare organisations, research on how to introduce UCD to health organisations is important.

2.6 Conclusion

This chapter has described the increasingly context-specific and complex use and design of IS. Many people now use IS every day within the context of their work and it affects their health and wellbeing (Sandblad et al., 2003). Businesses and organisations use IS to improve efficiency and innovation, and even create new businesses. We have seen that developments in computers and their capabilities have been a catalyst for their use in increasingly complex domains, with increasingly complex, large-scale and diverse datasets and uses. This has made it progressively more challenging for usability professionals to carry out their role; we have seen that they need to adapt UCD techniques according to the development process and organisation in which they work. The challenges usability professionals face in the more complex domains that have emerged are magnified because software development can be especially technology-focused; in these circumstances usability professionals not only have to improve the usability of products, but also the status of usability work within the organisations.

How this can be done, however, is not clear. Practitioners with experience over a number of projects report several catalysts and opportunities for integrating usability into organisations, but it is not yet known whether their recommendations apply within the more technology-focused, complex domains in which usability professionals might have the mandate but not the authority to introduce UCD. The economic drive to profit from "Big Data" will only increase the number of associated analytical tools into the future.

One such domain is health, in which the use of technology has proliferated, particularly within the area of health informatics. Practitioners have applied UCD approaches and techniques within healthcare but only made recommendations for its introduction to healthcare organisations. The introduction of UCD techniques to a healthcare organisation could reveal new insights into the challenges and opportunities for practitioners to adopt and integrate UCD techniques into complex domains, new understandings; new understandings of the role of the designer; and, how designers can introduce UCD with few resources and little authority.

One of the main reasons this has not been investigated is because the problem is continually evolving and does not lend itself to the discovery of a universally satisfactory solution; furthermore, the length of time it takes to introduce usability does not lend itself to traditional, rational approaches to problem solving. HCI researchers have so far understandably found it difficult to accept the values and constraints of design practice without judgement. Organisations develop products every day behind closed doors, despite consistent recognition that its documentation would be valuable (Button and Dourish, 1996; Newman, 1994); researchers would be able to speak more authoritatively on design practice by exposing themselves to it and this requires over coming any barriers to its reporting (Lindgaard, 2014). Accordingly, knowledge of how UCD is accepted within product development organisations and the long-term future of the profession would benefit from insider reports, through collaborations between researchers and practitioners, of the implementation of UCD techniques and observation of an organisation's evolution over a sustained period, rather than experimental comparisons (Woolrych et al., 2011). The next chapter will outline the research framework I propose is the most suitable for this investigation.

3 Research Framework and Context

This chapter at a glance…

- Introduces and motivates the research approach for this thesis, **Action Research**, in addition to **semi-structured interviews**, which are carried out and analysed in Chapter 7 to obtain the perspectives of key stakeholders in the collaboration.
- Provides important information on the context in which I carried out my research to enable the reader to relate this research to other research settings.

3.1 Introduction

The last chapter showed that a body of research has built around the influence of organisational culture on User-Centred Design (UCD) practice and, more recently, the influence of UCD techniques on organisational culture (Iivari, 2010). The literature, however, lacks accounts of the operation and evolution of product development organisations and further suggests that this is particularly important in the emergent "Big Data" product development context, which is developing products that will be used by non-experts to explore massive and fast-growing databases. The design of these products will require particular consideration and novel approaches to UCD because end users may not have technical expertise and data grows exponentially.

This chapter describes the methodological approach and techniques that I applied to carry out the research in this thesis. First I paint a picture of the overall research process and its different phases. Specifically, I introduce the concept of Action Research (AR), an approach that facilitates collaboration between researchers and practitioners and is well placed to investigate the reality of introducing UCD techniques into the unpredictable context of a product development organisation in a rapidly changing business environment. I will then describe how I evaluated my research and validated my account with semi-structured interviews, which captured the research's key stakeholders' experiences and enabled me to consider my own perspective more objectively. Finally, to convey why I used this approach I will introduce the context in which I carried out the research. I will introduce the organisation I collaborated with and their place within the National Health Service (NHS), their major client base, to illustrate their market's complex and dynamic nature.

3.2 Methodological Approach

The collaboration this thesis describes utilised an AR approach comprising of three phases, or action steps, over six years. The research process is illustrated in Figure 3-1.

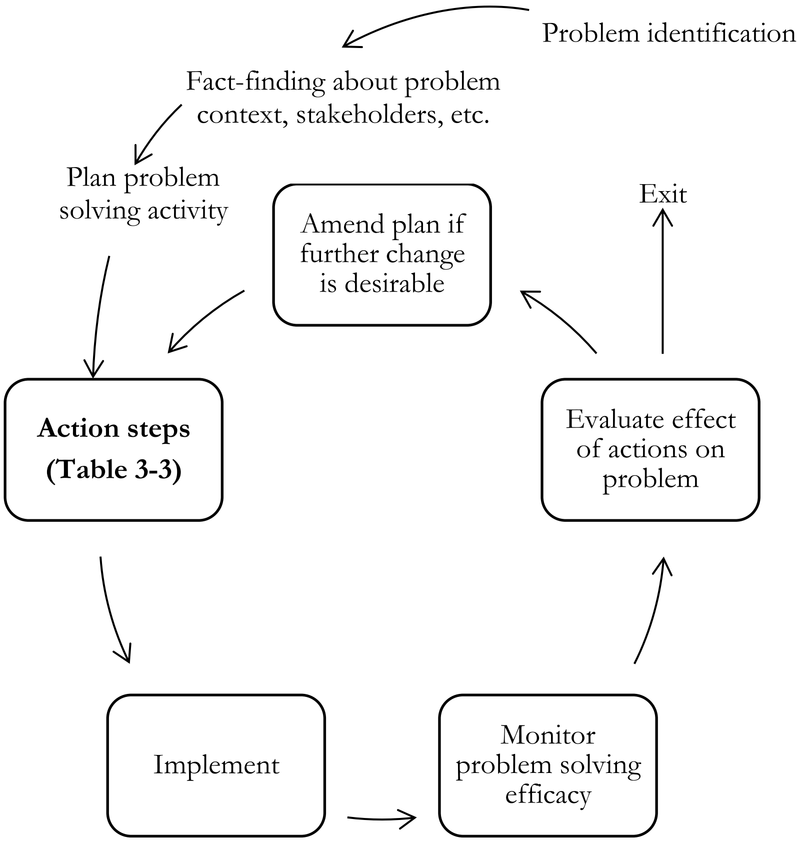

Figure 3-1 The Action Research Approach Applied in this Thesis

The collaboration extended over six years, with three action cycles of Figure 3-1, which are outlined below (Table 3-1), and spanned many external (political) and internal (organisational) changes. Subsequent chapters will describe the nature of these changes. Both my own and the organisation's knowledge of UCD and their customers increased over the course of the collaboration. As is to be expected for a longitudinal study of this nature, the personnel at the organisation also changed, which required me to develop new professional relationships with people who had different experience, skills and perspectives on my role and research. My line manager, including the collaboration's chief champion within the company, changed several times over the course of the research, which impacted specifically upon the autonomy I had with my work.

Over time, investigation of the initial research questions revealed new areas of interest to investigate further, which demanded reflection on potential solutions. Since AR desires learning from actions over their successful completion, teams may attempt interventions considered risky or underdetermined (Hayes, 2014). In this collaboration the interventions were not entirely risk free; the size of the business dictated that iHealth wanted to get design right first time for the business's reputation and financial future. Public Health Analyser (PHA), which appears in the next chapter, for example, was a highly risky project for iHealth because, as we will see, it was a new product in a new market and demanded expertise they did not have.

For clarity, the research process comprised three *research phases* over its six years. Each phase employed different UCD *techniques*. Table 3-1 summarises the techniques used in each phase.

Research Phase	Problem addressed	Techniques used
1 - Chapter 4: Public Health Analyser	The geographical representation of data for end users who we do not assume can interpret data on maps.	Online questionnaire
		Heuristic Evaluation
		Cognitive Walkthrough
2 - Chapter 5: Personas Development	System developers' unawareness of the end users and the tasks they aim to accomplish with the system.	Database Server Log File Analysis
		User-Generated Screen Captures
		Rapid Contextual Inquiry
3 - Chapter 6: Effectiveness and Efficiency Dashboard	To verify that existing end users of Hospital Health Watch can still accomplish tasks on the redesigned system and can use new features.	Heuristic Evaluation
		Cognitive Walkthrough
		User Testing
		System Usability Scale Questionnaire
4 - Chapter 7: Organisational Perspective	To mitigate bias in my report of events and ensure any relevant insights are included.	Semi-structured interviews

Table 3-1 Summary of Research Phases and Approaches

The research was guided by collaborative reflection throughout. The evaluation of each phase was formalised through the writing of reports and presentations to project groups. Phase 1 was carried out with two years' funding from the Department of Trade and Industry through a Knowledge Transfer Partnership (KTP) in 2007, for which I wrote monthly reports. On completion of the KTP, the collaboration continued through the Engineering Doctorate (EngD) scheme in the Department of Computer Science at University College London (UCL), for which I wrote annual reports for the funding bodies. The monthly cycle of KTP meetings provided opportunities to reflect on the project plan, what had been achieved and agree goals and objectives for the ensuing month; EngD reports still enabled valuable, deeper reflection albeit on a more infrequent basis. A final layer of analysis was facilitated with a PhD Enterprise Scholarship from UCL Advances, after the end of the collaboration; this was provided to explore the market potential of the research and to exploit the full value of its historical perspective. Chapter 9 presents its results.

Over time, I did (and could) not maintain the frequency of my presence at iHealth's offices; I increasingly found new people and processes on each return. Collaborative reflection became important because I was (and could not practically be) aware of the details of the organisation's project work. The champion of the collaboration from the organisation also found a new job shortly after my transition to EngD, which coincided with a change in business strategy for iHealth.

Table 3-1 somewhat simplifies what transpired to be a more flexible research process. For example I continued to work alongside the developers at iHealth to resolves issues with PHA, whilst I embarked on the collection of data for the personas in Chapter 5. Details of the approaches I employed and the data I collected with each approach will appear within the chapters for each research phase. Discussion is founded upon the Principles for Interpretive Field Research as described by Klein and Myers (1999) to demonstrate how I have taken them into consideration in all phases of the research: the design of approaches, and the gathering and analysis of data.

3.3 Action Research

I will now describe the pragmatic AR methodological approach of the research this thesis presents. AR stems from the 1940s and the work of Kurt Lewin (1946), who was frustrated with the scientific method's failure to address critical social problems after the Second World War. Instead, he proposed: "comparative research on the conditions and effects of various forms of social action, and research leading to social action" that uses "a spiral of steps, each of which is composed of a circle of planning, and fact-finding about the result of the action." AR ideas continued to develop and Rapoport (1970: 499) refined its definition to an approach that "aims to contribute to both the practical concerns of people in an immediate problematic situation and goal of social science by joint collaboration within a mutually acceptable ethical framework."

Although the AR approach has evolved significantly since its inception, Rasmussen (2004) identifies three core characteristics. First, it is participatory and democratic in nature. Researchers and practitioners collaboratively identify a particular problem and then plan, carry out and evaluate an iterative cycle of activities over a sustained time period to improve their understanding of the problem. Lewin (1946) describes a process of diagnosis, treatment and follow-up and likens the action researcher's job to steering a ship; they steer the wheel according to current conditions but must wait for steering to take effect. Research questions are developed collaboratively throughout the research cycle to ensure mutual benefit (Hayes, 2012). AR is thus a highly appropriate approach for testing the validity of theory; it allows researchers to design and take actions guided by theory, and evaluate their consequences for the problems that members of organisations face. It does not necessarily aim to find the best solution to these problems but to learn and gather knowledge from actions taken towards their resolution, regardless of its success (Hayes, 2011).

This type of engagement, although related to, is distinct from Participatory Design (PD). PD promotes the democratic and inclusive design of change but its scope is typically limited to the design of solutions whereas AR understands that taking action towards solving a problem leads to knowledge, or learning, about it, even if not its solution. This makes it a suitable approach for the investigation of so-called "Wicked Problems" that ostensibly have no easy or universal definition and solution (Rittel and Webber, 1973) and belong to "swampy low land where situations are confusing 'messes' incapable of technical solution", as opposed to "high, hard ground where practitioners can make effective use of research-based theory and technique" (Schön, 1983: 42).

The second characteristic of AR projects Rasmussen (2004) identifies is that their data collection methods are not restricted to formalised rules but often an integral part of the research process, moving away from the positivist promise of a single "best" method. Social science problems are highly contextualised and localised, so action researchers seek knowledge transferrable between contexts and domains, rather than knowledge or solutions that can be generalised to a larger case. The consequences of selected actions cannot be predicted, so the objectives, problem, and research method develop from the process itself. This approach frees the action researcher to gather data according to the flow of activity within the social setting, and to adapt the research purpose to any associated changes or new research questions that arise as understanding develops.

Third, and finally, Rasmussen (2004) notes that action researchers distinctively take different roles within their laboratory: the real world, of real people experiencing real problems in their everyday lives. Through active and deliberate involvement in the context of the investigation, they are not scientific advisors, but assume roles including "facilitator", "process-planner", "analyst", "evaluator", "co-ordinator", "friendly outsider" or "change agent" (Rapoport, 1970). I assumed a variety of roles within, not only the collaboration as a whole, but within in each phase in Table 3-1; I will discuss these roles in more detail as they arise.

I will now specifically outline the suitability of AR as an approach to discover what happens when UCD is introduced to a product development organisation, amongst other aspects of Information Systems (IS) and Human-Computer Interaction (HCI) research. I will demonstrate my points with examples of its use within these respective fields of the academic literature.

3.3.1 Action Research within Organisational Science

> "Change is the reweaving of actors' webs of beliefs and habits of action as a result of new experiences obtained through interactions…Organization is an attempt to order the intrinsic flux of human action, to channel it towards certain ends, to give it a particular shape, by generalizing and institutionalising particular meanings and rules."
> (Tsoukas and Chia, 2002: 570)

This definition conceives of organisations as being in constant flux and necessarily only describable at a given point in time, which supports the use of AR for the study of organisations. Organisations are systems of human actions, which humans carry out to meet their ends in accordance with their values (Susman and Evered, 1978). Humans affect any laws that organisations obey through their purposes and actions and make organisations incredibly complex when compared to much of the physical world (Avison et al., 1999). A positivist world view[2] would not be appropriate as it treats people as objects of inquiry even though they initiate and are subject to actions in their own right (Reason, 2006; Susman and Evered, 1978). Action researchers, as participant-observers within organisations, gain deeper understanding of a moving target (e.g. the evolution of a technology's integration and usage) because organisations and people constantly change (Cajander, 2010).

AR ideas are seen in Organisational Science as far back as the major post-war redevelopments in Europe, beginning with the Industrial Democracy Project in Norway in 1960, when the growth in many areas seemed to approach the limits of natural resources (Rasmussen, 2004). These projects resulted in the socio-technical systems approach in which the relationship between organisations and technology was seen as reciprocal. Such thinking now grounds methods used in UCD and research within IS and HCI.

3.3.2 Action Research within Information Systems Research

IS are applied within the tangled web of organisations just described, so IS researchers have recognised the benefits of the interpretive world view implicit to AR studies, despite its roots within comparatively predictable, black and white engineering principles (Baskerville and Wood-Harper, 1996; Orlikowski and Baroudi, 1991). Until the 1970s, IS developers designed and built IS for themselves and other technically proficient users; their use has now, however, spread across workspaces and organisations and been appropriated by humans in unpredictable ways, reflected in the emergence of the field of Computer-Supported Cooperative Work (CSCW) (Grudin, 1991a). The other characteristic of IS that lends them to the AR approach is constant change and innovation, which often leaves researchers trailing behind practitioners in proposing changes or evaluating methods for developing new systems (Benbasat et al., 1987). AR has significantly contributed towards the development of IS (Avison et al., 1999; McKay and Marshall, 2001), not least of all Peter Checkland's (1981) development of the Soft Systems Methodology and experience within the NHS in England. AR is a relevant way of investigating IS and issues surrounding them because information provision is the concern of human affairs, and information is inherently socially-embedded and localised (Brown and Duguid, 2002; Checkland and Holwell, 1998).

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[2] A positivist world view assumes the world is a causally ordered system whose structure can be inferred from empirical observation; data about the world can be logically reconstructed into laws (Susman and Evered, 1978). It assumes its methods are value neutral and does not accept improved knowledge as an outcome in its own right. Positivist science seeks results that may be generalised, a prescriptive truth that is "sitting there waiting to be gathered, like rocks on the seashore" (Klein and Myers, 1999).

3.3.3 Action Research within Human-Computer Interaction Research

HCI researchers are also increasingly interested in the insights AR can offer. As described above, human actions are situated, deeply embedded in the context in which they take place. This concept is at the core of one of the major theories of HCI, Suchman's (1987) theory of *Plans and Situated Actions*, which describes computer users as highly variable in how they use computers in their work, often in ways that cannot be predicted by empirical models. Work and its practices are thus shaped by their context. Beyer and Holtzblatt (1997) extended this idea into *Contextual Design*, a UCD process that emphasises ethnographic methods of data gathering such as field studies.

I am not the first to note, through reading the literature, the striking similarities between the iterative and reflexive cyclic approaches common to HCI, including UCD, and the AR approach (Hayes, 2011). A participatory approach to system development is encouraged because end users, unlike systems developers, have detailed knowledge of the organisation and its work practices. Much as action researchers adapt their research approach to local contexts, practitioners configure UCD techniques according to local resources and contexts. Organisational change through the values and ideas of usability depends on the transition of usability methods from theoretical models to activities in practice, which correspondingly requires knowledge to be transferred from theory into situated practice, which the AR approach can facilitate.

With their democratic culture, including trade unions, Scandinavian HCI researchers not only pioneered participatory (collaborative) system design, but also the use of AR as a research approach (Rasmussen, 2004) to examine and evaluate new methods as potential tools for adoption of User-Centred System Design (Cajander, 2010) and the introduction of usability methods to public authorities (Eriksson, 2009). This interest has now spread (Hayes, 2011) and can be seen in the HCI for Development literature as well as technology use "in the wild" (Johnson et al., 2012).

HCI research has evolved and matured since it considered interaction as a form of man-machine coupling (S Harrison et al., 2007). HCI research, and the technology it studies, has expanded into areas where the assumptions and viewpoints of this earlier model are no longer valid or, at least, need to be questioned, and the notion of problem and solution are obsolete (Ylirisku et al., 2009). Interaction design no longer exclusively pursues a single correct understanding and set of metrics of interaction, but is framed around the local, situated practices of users (Suchman, 1987). Humans understand the world, themselves, and interact with each other according to their location in a physical and social world as embodied actors; researchers cannot state in advance what they should hold constant in order for their predictions to continue to operate because background conditions in the world are in constant flux. Action researchers thus frequently adopt a constructionist perspective towards methodological issues; constructionist traditions stem from sociology, in which researchers are sceptical of empiricist foundations of knowledge, the objectivity and neutrality of scientific research methods, and the existence of an external, predetermined world and social reality (Maréchal, 2010b). Instead, it "defines knowledge as dependent upon human perception, and thus as never free from such influences as culture, history and belief." (Hinchey, 2008: 20).

This is not to suggest that a positivist perspective is invalid for all HCI research or, indeed, within many AR studies. A constructionist perspective highlights different kinds of (no less interesting) questions and methods for answering them, which makes it more amenable for answering many of the new problems that have arisen for HCI research since technology has infiltrated workplaces and homes. The literature review demonstrated that HCI researchers now accept a new perspective, in which people construct meaning and knowledge in real time, often collaboratively, according to specific contexts and situations. The positivist world view, focused on generalisability and objectivity, became troublesome to reconcile in many areas of HCI research; one major example of this is in the area of comparison of usability evaluation methods (Gray and Salzman, 1998). From this perspective, interaction itself is an essential element of meaning construction; both researchers' and users' knowledge is situated. Whilst formal models and methods are useful, they cannot drive or explain our activity in the world. Practical trade-offs in design are often more messy than principled and measures of a system's success can never be universally valid since they are context dependent. To understand what people are doing, researchers must track the situated contingencies and strategies people use to apply their knowledge in real situations; detailed and deep descriptions of specific situations, including multiple interpretations that provide a rich sense of the interaction's location, rather than a single, objective description, are thus of increasing value to the field of HCI.

One area in which HCI researchers have recently been particularly interested is the highly situated use of design and evaluation methods in practice. Although, as Chapter 2 showed, techniques have emerged to better understand what users do with technology in practice, methods to investigate how designers work with UCD techniques in practice remain immature. My integration within a software development organisation puts me in a position to account for what I observed with an AR approach and has potential to expand the horizon of other HCI researchers and reveal limitations in their current conceptualisation of design work (Wenger, 2000).

3.3.4 Summary

In summary, AR is a particularly suitable approach for investigating my research questions around the introduction of UCD to organisations, and was implicit and assumed within the formation of the collaboration in which I was recruited as a researcher to be embedded within an organisation. AR aims to solve both research questions and problems in practice (McKay and Marshall, 2001). It uniquely brings together researchers and practitioners with different experiences and knowledge to investigate and work towards a solution for a particular situation through cycles of reflection and change (Avison et al., 1999). Collaborations between academia and industry are growing in number in a variety of domains, particularly in the United Kingdom (UK) where academic research receives state funding. To date, research on design practice has predominantly focused on method and overlooked the realities of maturing usability practice (Woolrych et al., 2011). Such insights can inform how UCD techniques might better support practitioners' needs and aspirations.

The true effect of UCD techniques on an organisation is constructed by its members, as previously described, the nuances of which could be acquired through sustained collaboration with an organisation over a period of time. Collaborative reflection, particularly present in Chapter 7, valuably and fundamentally influenced how my research questions and the conclusions I reached evolved because it would be impossible to provide a single, objective and factual account of the events and situations I describe. This approach typifies Schön's (1983) notion of "reflective practice" and refutes that design problems can be solved with traditional, rational approaches, taken as given and without considering their setting. I set out to expose my own and the organisation's implicit knowledge base and learn from experience; Schön (1983) asserts that rigour lies in professional artistry, rather than technical rationality, and the uniqueness of every design task demands that design practice must investigate how to approach each task in isolation.

I find it helpful to structure my discussion around the resources I used to apply each UCD technique, to investigate whether and how design work changed at iHealth during the collaboration, notably: participant recruitment, task selection, problem identification, and formatting of results, since these aspects appeared most consistently within each technique. This will bring all phases of the research together in a way that is greater than the sum of its parts. It also follows from the suggestions made by Woolrych and colleagues (2011) in Chapter 2 that it is more appropriate to treat UCD techniques as approaches that are comprised of resources, much as recipes are comprised of ingredients, that designers adapt according to their situation; from their analysis it follows that, for example, one cannot assume that any two usability inspections follow the same protocol in terms of the number of evaluators, the heuristics used, etcetera.

3.3.5 The auto-ethnographic approach to the reporting of AR

I naturally assumed an *auto-ethnographic* approach in the reporting of my research, the etymology of which reveals its routes in ethnography. Ethnography is a qualitative approach to research in which the researcher observes people in naturally occurring settings and fine detail, based on the belief of early anthropologists that experience and immersion in a culture and way of life was the only route to understand them (Randall and Rouncefield, 2014). Fundamentally ethnography begins without any theoretical preconceptions as to what will be found, and views the social world too disorganised to be studied with traditional research methods; there is no natural end or boundary to the collection of data, and little that is deliberate about the research process. HCI researchers found ethnography during its 'turn to the social' in the 1980s and 1990s, when they found traditional approaches too simplistic for the analysis of socially-organised workplaces and the field of CSCW emerged to focus on the study of work and settings for which new technology is being designed, to inform its design. Ethnography has the advantage of the 'sensitising' it provides to the real world character and context of work. It documents the real-world character and context of work and can ensure system design resonates with the circumstances of its use; it can inform what can be automated and what should be left to humans. It illuminates: rich domain knowledge; a fuller view of the real-world nature of the problems that need to be solved; a critique of simplistic technical or organisational solutions; and, an overview of complex settings that would otherwise be difficult to obtain. Critics say that whilst ethnography can critique a system's design very well, it does not produce design solutions or translate its findings into good practice so well. Instead, it asks questions like, "What sort of problem have we got? What does it look like? How does it manifest itself?" and seeks sensitivity to designers rather than panaceas to the problems of design through recommendations and requirements. Ethnography accepts that workers make judgments and decisions in response to contingencies in even the most routine activities, which are not necessarily confined to the immediate, locally bounded situation. Ethnographic research then focuses on the study of work and how it gets done and places sociological significance to the variability of practice.

As time passed, my approach increasingly resembled what Maréchal (2010a) defines as *auto*-ethnography due to the natural evolution of my role: "a form or method of research that involves self-observation and reflexive investigation in the context of ethnographic fieldwork and writing." Researchers are personally engaged in a social group, but remain a distinctive and highly visible self-aware scholar and social actor in their writing, looking outward at distinct others to generate meaningful social analysis. More specifically it encompasses "research, writing and methods that connect the autobiographical and personal to the cultural and social. This form usually features concrete action, emotion, self-consciousness, and introspection." (Ellis, 2004: xix). It produces "a self-narrative that critiques the situatedness of self and others in social context." (Spry, 2001: 710) and democratises "the representational sphere of culture by locating the particular experiences of individuals in tension with dominant expressions of discursive power" (Neumann, 1996: 189). In recognising the importance of reflexivity between an ethnographer and his/her subject, auto-ethnography addresses critiques of ethnography that it can never be completely unbiased.

3.3.6 A Note on Quality and Ethics

Since I emphasise interpretive and constructionist perspectives in the reporting of my research, and I value its transparency and consistency, I now briefly comment on how I will ensure that my research is trustworthy and others may learn from my conclusions. Action researchers typically assess their work based on the extent to which a community achieves a desired behaviour change because the community must sustain positive changes after researchers leave. Technological solutions are insufficient; the community should be empowered to use and maintain them. For example, HCI researchers have traditionally sought to design UCD techniques that identify a greater number of usability problems, regardless of whether the technique suggests possible design solutions or persuades developers to change the design (Hertzum, 2006; Law, 2006).

Instead of generalisability, the quality of AR inquiry is evaluated against four distinct but related dimensions of trustworthiness: credibility, transferability, dependability and confirmability. These can be attained through, for example: the collection of *multiple perspectives*, which allows for data triangulation and member checking; *prolonged engagement*, which allows for the collection of sufficient evidence and can reveal deep-seated emotional responses or hidden-tacit knowledge; the *transparent collection, analysis and description of data*, and *generation and sharing of sufficient knowledge*, about a solution that it may be transferred to other contexts. These ideas are implicit in widely cited quality criteria defined for action and interpretive research, respectively, in the literature. For AR, Bradbury and Reason (2001) suggest the five criteria presented in Table 3-2 for evaluating the quality of projects.

Quality criterion	Definition
A relational praxis	Did the co-inquirers learn new ways to communicate and collaborate, for example in the resolution of conflict or generation of creative ideas with others?
A reflexive practical outcome	Did the co-inquirers learn new ways to act (e.g. their way of handling everyday life) and think (e.g. increase self-efficacy through new awareness)?
A plurality of knowledge	Is there an acceptance of different kinds of knowledge, and is the new knowledge grounded in the co-inquirers' language and understandings?
An engagement in significant work	The AR project should engage in worthwhile problems, and the choice should be made explicit.
An emergent inquiry towards enduring consequences	There should be a change after the action research project that is sustainable.

Table 3-2 Quality Criteria for Action Research after Bradbury and Reason (2001)

These ideas overlap with the Principles for Interpretive Field Research (Klein and Myers, 1999), presented in Table 3-3.

Principle	Description
Fundamental Principle of the Hermeneutic Circle	Suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.
Contextualisation	Critical reflection of the social and historical background of the research setting, so that the reader may see how the situation under investigation emerged.
Interaction Between the Researchers and the Subjects	Critical reflections on how data were socially constructed through the interaction between the researchers and participants.
Abstraction and Generalisation	Relating the ideographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.
Dialogical Reasoning	Sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings with subsequent cycles of revision.
Multiple Interpretations	Sensitivity to possible differences in interpretations among the participants as typically expressed in multiple narratives of the same sequence of events under study.
Suspicion	Sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.

Table 3-3 The Principles for Interpretive Field Research (Klein and Myers, 1999)

You will find that the ideas from Table 3-2 and Table 3-3 inspire my research design and my evaluation of its findings and implications of my research in Chapter 8. AR recognises that evaluation is never a natural or neutral act; it requires decisions as to who evaluates, what is evaluated, and openness about what power structures and decision processes led to an evaluation strategy. Evaluation of AR is a collaborative process and all partners must accept its outcomes, which invariably leads to disagreement. To support evaluation of my work I conducted semi-structured interviews at the end of the collaboration, which I will describe in the next section.

Throughout my research I followed the UCL Ethics Committee Guidelines for ethical research behaviour. I did not require ethical approval for the first phase of the research because it evaluated a service already in use, participation was entirely voluntary and no personal information was collected. To develop personas I emailed potential participants for interviews suggested to me by colleagues at the organisation who met end users. My email emphasised that "results will be recorded anonymously but will be used directly to improve the user experience of software developed at iHealth". I am content that their consent to participate indicated their understanding of the interview's aims and how I would conduct the meeting. Additionally, I conducted interviews in their place of work, an environment with which they are familiar, and allowed them to terminate the interview at any time. In contrast I paid closer attention to how I carried out the user-generated screen capture (UGSC) survey for the development of personas in Chapter 5, usability testing in Chapter 6 and interviews at the end of the collaboration in Chapter 7.

The UGSC survey did not need the approval of the UCL Research Ethics Committee. They confirmed via email that their guidelines exempted:

> *"Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behaviour UNLESS information obtained is recorded in such a manner that human participants can be identified AND any disclosure of the human participants' responses outside the research could reasonably place the participants greater at risk of criminal or civil liability or be damaging to the participants' financial standing, employability, or reputation."*

Responses to the survey, however, were not fully anonymised as they were sent via email, so I registered the study for Data Protection through the UCL Data Protection Administrator and set up a NHS.net email account with the additional and necessary security.

The UCL Interaction Centre Ethics Committee in the Department of Psychology and Language Sciences approved the usability testing in Chapter 6 and interviews in Chapter 7, since participants were not from vulnerable populations. In addition to this clearance I followed the British Psychological Society's "Guidelines for minimum standards of ethical approval in psychological research" (The British Psychological Society, 2004). Usability test participants signed a consent form that contained checkboxes for confirmation that they understood they could withdraw their voluntary participation at any time without giving any reason; agreed to the video recording of the usability test session; and, consented to anonymised data and quotes from the session to being used in this thesis and any arising academic publications. Colleagues, who I interview in Chapter 7, signed a similar consent form because interviews were audio-recorded. In addition I sought confirmation that interviewees understood they could request a copy of the final draft of the chapter in my thesis in which I report the interviews. I have taken particular care to anonymise the names of participants and refer to their job titles indirectly.

Table 3-4 presents the exact wording of these consent forms and the next section will describe the approach I took to these interviews, as well as to the interviews with usability test participants at the end of the collaboration.

USABILITY TESTING
• I confirm that I have read and fully understand the information sheet and agree to take part in this study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. • I agree to the user testing session being video recorded. • I consent to anonymised data and quotes from my user testing session to being used in Jessica Wardlaw's thesis and any arising academic publications.
INTERVIEWS
• I agree that I have read the information sheet; had the opportunity to ask questions and discuss the study; received satisfactory answers to all my questions or have been advised of an individual to contact for answers to pertinent questions about the research and my rights as a participant. • I understand that my participation will be audio recorded and I am aware of and consent to the analysis of the recordings. • I agree for the audio recording to be used by the researchers in further research studies. • I agree for the audio recording to be used by the researchers for teaching, conferences, presentations, publications, and thesis work • I understand that I may request to read the final draft of the chapter in Jessica Wardlaw's thesis in which the information I provide will be reported to correct any interpretation I consider inaccurate. • I understand that I am free to withdraw from the study without penalty if I so wish. I understand that I consent to the processing of my personal information for the purposes of this study only. I understand that any such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.

Table 3-4 Items on the Consent Form for Usability Tests in Chapter 6 and Interviews in Chapter 7

3.4 Semi-structured Interviews

The aim of the interviews was to gather, first, the experiences of iHealth's end users of their participation in usability testing and, second, supportive evidence and the perspectives of key stakeholders in the collaboration. This was important because my role as participant-observer in the research will have unavoidably biased my recording and interpretation of events. Furthermore, I had been distanced from the organisation for some time so I may have forgotten or been unaware of important changes in the organisation and its culture. The use of semi-structured interviews and open questions additionally left open the possibility for new insights.

Interviews are a suitable method for gathering people's perceptions and experiences, and widely used by social scientists (Blandford, 2014). As Flick (1998: 222) puts it, "Practices are only available through observation; interviews and narratives merely make the accounts of practice accessible." Interviews may be more or less structured along a spectrum from completely structured, in which all questions are pre-prepared like a questionnaire, to completely unstructured, in which the interview unfolds like a conversation, even if it has a purpose and focus. Semi-structured interviews fall between these extremes; the researcher plans themes or questions ahead of time but may pursue lines of enquiry within the interview to follow up on interesting or unexpected avenues that emerge. Implicit in a structured interview approach is the positivist premise that knowledge waits for the researcher to discover it; conversely, unstructured interviews allow knowledge to be created and negotiated through the conversation between interviewer and interviewee, which complements a constructionist perspective. Semi-structured interviews balance these two perspectives for the purposes of this study.

I will use selected quotes from transcriptions in Chapter 7 to inform evaluation of the collaboration with careful attention to the principles listed in Table 3-3. This AR project was not unique in forging close professional relationships between researchers and practitioners, in light of the duration of the collaboration. Such relationships can colour all phases of the research process (data gathering, analysis and reporting), especially if interviews are conducted, for example, which can be affected by the emotional state of participants and the researcher's concern to ask the right question and not lead the participants to give presumed answers.

Given the highly situated nature of human actions, organisations and IS, it follows that the development and use of IS within organisations is also largely context dependent (Clegg et al., 1997). I must now, then, introduce the reader to the context in which this work was undertaken: the organisation, to which I give the fictional name iHealth, which develops management information tools for the healthcare managers, predominantly in the NHS. I will begin by describing the NHS in general terms and the major changes to its structure that occurred during the collaboration, its use of information towards management of the system and, finally introduce iHealth. I will provide more detail on events at the beginning of each chapter before I present each phase of research because we have seen that organisations can only be described at any particular given point in time. The NHS and iHealth changed many times during the collaboration and, since these changes impacted on the work, their details will be described at the appropriate point in the thesis. The following section gives a brief overview to set the scene.

3.5 National Health Service

In the UK, the regional governments of Wales, Scotland, Northern Ireland and England hold responsibility for healthcare services. In England, the Department of Health (DoH) controls the health sector and is responsible for the running of the NHS, with a cabinet minister reporting as Secretary of State for Health to the Prime Minister. The NHS organises and provides health services like hospitals, doctors, dentists and chemists.

The NHS was formed after the Second World War and has always been funded by direct taxation, so that patients' care is free at the point of delivery, regardless of their ability to pay (Checkland and Holwell, 1998). It was founded on the belief that healthcare provision would cost less to run over time as the population's health improved. Costs, however, have continued to rise because the provision of "free" comprehensive healthcare raised the population's expectations, and the range of treatments and age of the population increased. The economic viability of the NHS has thus been a continual struggle and subject of political debate because these effects far outweigh any intervention to reduce costs, such as reducing patients' readmissions and length of stay.

Successive governments have attempted to improve the efficiency and effectiveness of the NHS through structural changes designed to deliver the necessary behavioural, procedural and attitudinal changes. The Griffiths Report (1983) found the NHS under-managed, and introduced a tiered structure of managers "charged with the general management function and overall responsibility for management's performance." This manifested itself in the introduction of Regional Health Authorities (RHAs) across England, comprised of 192 district health authorities headed by district general managers. Following the publication of 'Working for Patients' in 1989 a radical overhaul introduced a form of 'internal market' into the NHS, whereby General Practitioners (GPs) held independent budgets, hospitals could become autonomous Trusts as 'providers' of health services, and the districts were 'purchasers' of healthcare services for their local population (Sargent, 1989). Purchasers and providers would be linked through negotiated contracts that outlined the services that would be provided, for how long and at what cost. Although not legally binding, such contracts were intended to create sufficient pressure to drive efficiency improvements.

As a major governmental controlled organisation, which receives a significant share of the state budget, the NHS has always been influenced by the political context of its operation. In this study, the Government notably changed part way through the process. At the beginning, a Labour government was still in power; they had abolished the 'internal market' and the GP 'fund-holding' model described above when they assumed power in 1997. However, they retained the purchaser-provider split and the commissioning of health services remained with health authorities. GPs and primary care professionals formed Primary Care Groups (PCGs), which took over the purchasing of services; their role was to improve the health of the local population, to develop primary and community services, and to commission secondary and tertiary services.

The NHS Plan of 2000 replaced RHAs with 28 Strategic Health Authorities (SHAs) to ensure the NHS implemented DoH policy, which were further reduced to ten in 2006. SHAs oversaw all NHS activities (monitoring performance and standards and making sure health services in their area were run well) and were responsible for planning any necessary improvements. Primary Care Trusts (PCTs) replaced PCGs, with the mandate to manage the local primary care services that people seek when they first encounter a health problem (e.g. GPs, dentists, opticians and pharmacies). This hierarchy is depicted in Figure 3-2.

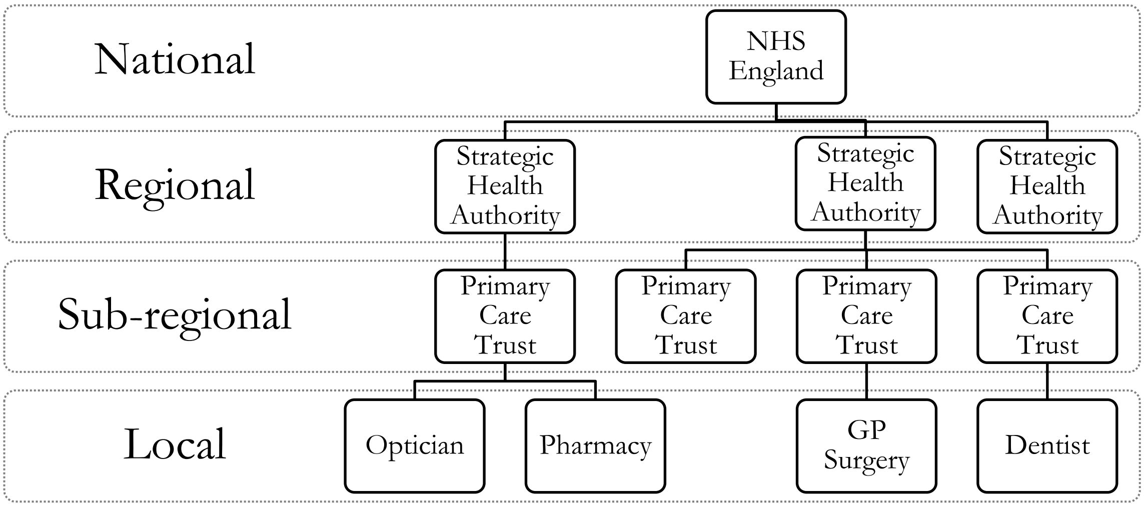


Figure 3-2 The NHS Structure according to the NHS Plan of 2000. Adapted from Jones (2008).

As local organisations PCTs were responsible for deciding what health services a local community needed and controlled 80% of the NHS budget, to provide sufficient and accessible health care services within their area, working with other local organisations where necessary. PCTs additionally influenced hospital service provision and monitored the quality of those services; for this they required access to up-to-date and reliable hospital records, for information relating to diagnoses and procedures carried out. Alongside PCTs, the DoH required Foundation Trusts (with accountability to the local community, rather than central government) to produce information for quality assessment and local and national accountability.

In 2010, a hard fought and highly fraught General Election resulted in a coalition Government, which both increased the NHS budget by £10.6 billion between 2011 and 2015 and asked it to deliver savings of £20 billion (HM Treasury, 2010). Furthermore, the health reforms proposed by the majority party were eventually passed in March 2012, so that from 1st April 2013 a new health and care system became fully operational to deliver the Health and Social Care Act (Department of Health, 2013). Fundamentally the DoH's purpose did not change; it still exists to help people live better for longer by ensuring they have the support, care and treatment they need. The DoH sets objectives and budgets and holds the system to account on behalf of the Secretary of State, who remains accountable for the whole system working together to meet the patients' and public's needs and reflect their experiences. National organisations (NHS England, Public Health England, NHS

Trust Development Authority and Health Education England) were established to work with the DoH to deliver services according to national priorities and in collaboration with other parts of Government. Health and wellbeing boards unite local organisations and Healthwatch represents patients and local communities to ensure services work together to meet their needs and priorities.

Locally, Clinical Commissioning Groups – comprising of doctors, nurses and other professionals – were given £80 billion a year to spend on hospital and community services for their patients (Health and Social Care Act, 2012), while local councils formally took over the promotion of public health. This was the first time they have had these responsibilities and one of the ways in which they will be able to adapt is to use health informatics tools, to underpin decisions made relating to population health needs, targeting services and delivering interventions.

3.5.1 Information Provision and Use in the NHS

Organisations such as the NHS require good quality data and information to manage their performance effectively. Healthcare providers, staff and patients need access to reliable information to make informed decisions and choices regarding clinical care. Health informatics tools provide multiple clinicians and healthcare managers with access to various data (e.g. hospital admissions data) to support service management. Healthcare professionals in the NHS are thus encouraged to use information and informatics tools to inform the service management process: the allocation, monitoring and coordination of activities (Chua, 1986). Examples of information healthcare managers can obtain from patient data, and how it can be used, are presented in Table 3-5.

Coordination: Management of patients through healthcare system	• Decide where and how to influence referrals and configure secondary healthcare provision for the future • Identify patterns in GP referrals and understand market share compared to other local and regional Acute Hospital Trusts (AHTs).
Monitoring: Assessing clinical and financial performance	• Near to real-time information on in- and out-patient outcomes to immediately identify potential clinical issues • Analyse performance against expected and national rates to compare outcomes between trusts across England • Monitor progress/compare historical data with current information • Identify gaps in current service provision
Allocation: Planning/ commissioning services	• Local health profiling e.g. which admissions are costly • Evaluation of commissioning decisions • Monitoring inequalities in service and treatment provision • Estimate patients' health needs by linking hospital data to local population-based geodemographic (lifestyle) data • Scenario planning • Evidence on which to base and design public health interventions

Table 3-5 Summary of Uses for Patient Information in Healthcare Management

Healthcare professionals obtain this information from a variety of sources. In the English NHS, many AHTs maintain Patient Administration Systems, which they use to manage patient records (e.g. name, address, date of birth, dates of outpatient appointments, dates of admission and discharge) and track appointments. NHS hospitals also submit data to be reimbursed for the care they provide, and are advised to do so via the Secondary Uses Service (Department of Health, 2007). This data goes into informatics tools such as the Association of Public Health Observatories (2010), HAPPI (Mayden Health, 2004) and the NHS Atlas of Variation in Healthcare (South East Public Health Observatory, 2010).

At a national level, the Hospital Episode Statistics (HES) database contains a detailed record for each period, or 'episode', of admitted patient care delivered in England by NHS hospitals or in the independent sector but commissioned by the NHS. HES resulted from a report on the collection and use of hospital activity information in 1987 (Korner, 1982), prior to which, only 10 per cent of admitted patient records were sampled nationally. Data is now available for every financial year from 1989-90 and every NHS hospital visit in England since 1996. In 2006-07, 13 million admissions resulted in nearly 15 million episodes. Each episode record contains the following types of rich information about individual patients: **clinical** e.g. diagnoses and operations; **personal** e.g. age group, gender, ethnic category; **administrative** e.g. waiting time and date of admission and discharge; and **geographical** e.g. where the patient lived and was treated.

Historically, HES were collected to monitor activity and performance, identify costs and allocate resources in the NHS. Table 3-6, however, illustrates that the uses for HES have evolved considerably since it was first established, from supporting the corporate business of the NHS to more clinical and professional purposes.

Known users	**Access to HES based on user group**
• DoH: policy areas, finance, future planning • NHS staff: both PCT and Hospital Trusts • Public health observatories • Cancer networks • Health Protection Agency • State departments/organisations: Transport, Home Office, National Audit Office, Office for National Statistics • National Institute for Clinical Excellence • Academic researchers and students • Private providers, actuaries, manufacturers • Media	• Benchmarking performance against other Hospital Trusts • Academic research • Analysing service usage and planning change • Providing advice to ministers and answering a wider range of Parliamentary questions • For national and local press articles • For international comparison

Table 3-6 Uses for the Hospital Episode Statistics

The quality of HES data has been under scrutiny since its early days. There have been many attempts to address this, including a major project at the Royal College of Physicians which promoted greater consultant engagement. However, data remains suspect, particularly for individual patients and practitioners, which some believe to be responsible for poor engagement and use by clinicians. Instead, clinicians have driven an explosion of data collection for specific purposes, resulting in an increasing number of disparate datasets, data collection processes and systems, focused on individual diseases, interventions or clinical contexts rather than the individual patient. This can be inefficient, require duplicate data entry and generate a multiplicity of systems containing data that are not standardised, interoperable or comparable between sites.

In response, the DoH established the Health and Social Care Information Centre (HSCIC) in April 2005 as a Special Health Authority to take responsibility for the collection and dissemination of data in the NHS. Their mandate was to rationalise and co-ordinate information collection and to analyse and distribute facts and figures, to help all health and social care organisations use information intelligently and improve how they run their business.

During the establishment of the HSCIC, the DoH recognised that it lacked sufficient expertise in publishing, marketing and producing relevant information products and services to encourage strategic level and senior NHS staff to make more intelligent use of information. Negotiations in 2005, and subsequent Ministerial approval, resulted in a joint venture between the HSCIC and iHealth, a fictional name for a private company formed in 2001 and already successful in health data dissemination. I found myself working for them in 2007.

3.6 iHealth

The following is based largely on my own recollection of historical events, my e-mail record, information online and reports of iHealth colleagues I acquired to fill in gaps in my knowledge and memory, and mitigate bias and prejudice.

3.6.1 History

The Secretary of State for Health announced the joint commercial enterprise iHealth in February 2006 to compete to provide management information to health and social care organisations, including voluntary and private. The DoH's rationale behind the joint venture was to combine private sector dynamism, efficiency and effectiveness with public sector expertise and ethics to improve delivery of patient and client-centred service reforms(National Audit Office, 2007)(National Audit Office, 2007)(National Audit Office, 2007)(National Audit Office, 2007)(National Audit Office, 2007). Specifically it would facilitate the development and delivery of further information tools and services more quickly than through typical public sector outsourcing, partnerships or internal investment. Furthermore, it was expected to help the HSCIC achieve some of its objectives through: more effective delivery of information to front line management; demonstrating how information can inform better decisions about care and services; encouraging front line staff to value their information and recognise how it can support their activities. In short, the DoH invested in iHealth with two aims. First, the DoH recognised that it urgently needed to improve use of information to support its reform agenda. Second, by working with the private sector it hoped to open the market for other private companies to provide information services to the NHS.

3.6.2 Function

iHealth predominantly focused on media in its early days, producing lifestyle magazines and nationally important reports, which disseminated and compared a measure of the quality of hospital performance that iHealth created. I will call this measure Hospital Mortality Benchmark (HMB). Explained briefly, it is an indicator of death rates at every hospital, adjusted to the national average, according to the age and gender composition of the patients who died. The Professor who devised its methodology continues to direct a team of academics at iHealth. Whilst HES records all hospital visits in England, this academic team append socio-economic deprivation measures, demographic and lifestyle characteristics, and several flags (e.g. emergency readmission within 28 days and patient safety indicators) to the data to enable monitoring of hospital admissions and their cost and, most importantly, benchmarking of clinical and financial performance between hospitals.

With the investment from the DoH, iHealth took the opportunity to develop software for healthcare managers to access HES for the purposes described in Table 3-5. The organisation's mission, however, remained to harness the power of information to improve services and people's wellbeing, and their vision remained to be the leading supplier of information for and about healthcare, social care and other public services by being trusted professionals, independent of government and special interests, and rigorous about the quality and value of their service.

The political drive behind better use of information in the NHS described above, patient choice agenda and high profile of the HMB, led iHealth to develop a large market share in health informatics tools. The organisation entered the health informatics market with tools for secondary care providers; NHS organisations bought annual contracts for access to their tools, in addition to bespoke analytics and marketing services based on their enhanced version of the Secondary Uses

Service extract of HES. iHealth's reputation gained it a highly lucrative contract to develop a nationally and strategically important website in June 2007. At this time, the business was sufficiently strong for iHealth to invest heavily in expansion of the data available in their software to include public health, mortality and Census data, to support the policy agenda around public health issues and reducing their associated health inequalities (Department of Health, 2004). This rich combination of data would, the organisation believed, provide healthcare managers with a wealth of information for tackling the UK's health problems and enable the organisation to expand into the primary and public health markets.

iHealth subsequently experienced troublesome times. They lost the contract for the aforementioned website in July 2008, when the website received over 600,000 hits a day. This had a negative impact on the business despite a temporary boost from a long-term contract with one PCT for informatics work, gained through its expansion into the public health area and its reputation for high quality analytics and marketing services.

The change in Government in 2010 also had a tremendous impact on the organisation. Two months after the General Election in 2010, the new Health Secretary bought the HSCIC's share in iHealth for £8 million, transferring their 48.75% shareholding to the DoH, and a month later announced a strategic review of the future of iHealth. This followed a White Paper called 'Equality and Excellence: Liberating the NHS', which committed the Government to an Information Revolution in the NHS, providing patients with quality information and data on all aspects of healthcare (Department of Health, 2010). Following this review, and the Government's Spending Review urging Departments to maximise value from assets that do not need to be held in the public sector, they announced that iHealth would be marketed for sale in November 2010.

This new political, and wider economic, climate threatened iHealth's status as a leading provider of health informatics in the UK. Competitors entered the market, many hospitals developed their own internal solutions to save money, and free alternatives, along with other commercial competitors, emerged. Financial constraints also led to increasingly demanding customers, with more complex and changing needs and demanding more choice. In recent years iHealth additionally lost their exclusive access to data, which has opened up the UK health informatics market considerably. More fundamentally, the company's reputation has been diminished by its heavy influence from DoH and its product quality, particularly when compared to their new competitors, including organisations such as Capita and Capse Healthcare Knowledge Systems. The requirements and geographical distribution of iHealth's customer base is also especially wide. All of these factors have reduced iHealth's ability to sell products and services solely on the basis of its expertise in health information; this makes it even more important that iHealth's tools are easy to use, as health information systems, and their usability, play an increasingly important role in the management of the UK's ever-changing healthcare system (Kay, 2005).

3.6.3 iHealth in Summary

In summary, there are several unique factors to the "context of design" presented in this thesis. From my description, iHealth is ostensibly a very unique software development organisation; however, examination below this surface will enable identification of similar organisations. Grudin (1991a) provides the most widely-used classification of software development organisations, which is founded on a CSCW perspective, distinguishes between *contract*, *product* and *in-house* development, each presenting unique barriers and opportunities for UCD. *Contract* development organisations are selected by a user organisation to fulfil a predefined contract; *product*, or *commercial*, development organisations, on the other hand, develop a product for users who often remain unknown until the product goes to market. *In-house* development is different again because both the developers and users are known from a project's outset. iHealth typifies Grudin's caution that these characteristics are not always mutually exclusive. iHealth is a public-private enterprise which was founded with an extremely well-defined but heterogeneous and market-limited customer base spread over a large geographic area, which is typical of in-house development; it also sells its products to customers (managers at healthcare organisations) who may not be the end-user of the system (the data analysts, for example). iHealth could take their first products to market with comparatively little risk because their acquisition was largely non-discretionary due to the political enthusiasm for better use of information within the NHS at the time, in addition to the DoH's investment in iHealth. However, this is where similarities with in-house development end. It is uncontroversial to say that this business model enabled iHealth to attain a monopoly in the UK's healthcare informatics market. They demonstrated that the UK had a market for healthcare informatics tools, which inspired other organisations in the private sector to follow and increased competition. At the beginning of the collaboration the organisation had commercial incentives for adopting elements of a product development business model and developing tools for users who were not so well-defined. In this sense iHealth typifies an organisation that develops "Big Data" analytics products in the business-to-business market e.g. local government, large infrastructure projects, environmental data, financial services and business consultancy. The size, rate of growth and complexity of the database, and the specialist domain knowledge required to use it, is exceptional and yet iHealth did not have technical expertise in its early days. It was a pioneering and ambitious start-up of which many more will appear as the economy around "Big Data" and data science grows exponentially in similarly fast-paced markets. I will reflect on this in Chapter 9.

3.7 Conclusion

This chapter has introduced and described the process through which I carried out the research this thesis presents and the AR approach to which it conforms. In addition I have noted relevant quality and ethical considerations and alluded to how I will account for them in my research, including the conduct of semi-structured interviews at the end of the research process, collaborative reflection and the development of a historical perspective. Finally, I introduced the context in which I carried out my research since it had such a significant influence on the overall research process and described the organisation with which I collaborated (iHealth) and the wider socio-technical system in which it operates (NHS).

In short, this is a case study centred on an organisation that was learning how to develop software at the same time as their customers and users, and how to sustainably involve them in the design process. The organisation began as specialists in information provision within a highly specialist domain and began to develop discretionary software to expand the business; with this software they accrued a reputation that enabled them to consider developing non-discretionary software for a different group of users within the same market. It is at this point in the organisation's history that we are now ready to pick up the story in the next chapter.

4 'Public Health Analyser' Mapping: A Token Gesture Towards User-Centred Design

This chapter at a glance…

This chapter…

- Portrays iHealth in the beginning, providing a reference point for later discussion.
- Focuses on the development of **Public Health Analyser (PHA)** from 2007 to 2009, to reveal resources for design work at this time and what was influencing them.
- Describes a **web-based survey** sent to intended end users to establish their preferences for how the map and health data should be presented in PHA to aid interpretation.
- Reveals, with an **Expert Walkthrough**, that wider system issues, and organisational and political changes limited benefits of applying User-Centred Design to the mapping functionality and resulted in poor uptake in the market despite high expectations.

4.1 Introduction

As described in Chapter 3, iHealth is a joint venture between the National Health Service (NHS) Health and Social Care Information Centre (HSCIC) and a private company called iHealth Ltd formed in early 2006; iHealth Ltd employed 67 people at the end of 2005, which, as a result of this new investment, grew to 81 the following June. The HSCIC initially invested £7.6 million in cash towards share consolidation and gave £12 million for a 50% share.

By 2007, iHealth had developed a reputation for epidemiological research and analysis at the hospital level and was a leading provider of information to secondary healthcare providers, Acute Hospital Trusts (AHTs). To grow the business, and increase turnover and profit further, iHealth saw an opportunity to expand its product portfolio into population health management. iHealth had 60% market share among AHTs but only 5% market share amongst Primary Care Trusts (PCTs), who had responsibility for population health at this time. Since AHTs provided most of iHealth's business, PCTs represented a clear market opportunity. Furthermore, the Labour Government had introduced targets around inequalities in public health issues such as smoking, obesity and sexual health. The company had already begun to consult with the directors of adult services in five Local Authorities (LAs) on how they could assist them to produce "Joint Strategic Needs Assessments" (JSNAs). These mandatory reports were a mechanism for PCTs and LAs to describe the future health, care and well-being needs of local populations and the strategic direction of service delivery to meet those needs. Key relevant individuals at iHealth thus began to discuss the possibility of developing a population health management tool, called Public Health Analyser (PHA), which would support the creation of JSNAs through automated report functionality. The change in strategy that PHA represented for iHealth cannot be understated: it was their biggest investment in software development to date, targeted at an untested market, and required a range of datasets that iHealth did not possess. The company had previously focused on the provision of information and only developed tools based on the data that they possessed in house. Customers would also require the facility to upload their own datasets and new analysis techniques such as mapping functionality to better understand local health needs, for targeting health interventions and evidence-based location of services.

The United Kingdom market for the 'marketing of health'[3] was estimated to be worth around £10 million at the time. There were few competitors: software and data companies, such as Active Solutions and Experian, possessed some of the requisite technical expertise and datasets (for example, lifestyle data at the postcode-level) to develop a similar product, but they did not have access to health data. Instead, NHS organisations obtained public health data from Public Health Observatories (PHOs), who did not have the commercial drive for the 'marketing of health'. iHealth ultimately collaborated with the Association of PHOs to provide them with data for PHA.

iHealth had high expectations for the success of PHA and it was of strategic importance for their transition from providers of information to developers of software. The sales revenue and market share objectives for 2007-2009 included the aim to acquire more than 60 new contracted customers and a total of 40% market share for PHA by the end of 2009.

iHealth had already moved into new premises to allow for growth. In addition to the high level issues described above, the physical layout of the work environment played an important role in this transition. The sensitive patient data required security and was stored behind a glass wall that separated part of the office space (see Figure 4-1). Only a few developers had desks in and were permitted access to this area via swipe cards; they likened working behind the wall to working inside a "fishbowl". The wall was a physical manifestation of the organisational "silo" within which the technical team worked and created a "tribal separation" between them and the rest of the organisation, including designers and customer-facing teams. This chapter shows how this affected PHA's development and the usability of the final system, but first describes the system.

[3] Marketing is defined as "the management process for identifying, anticipating and satisfying customer needs profitably" (The Chartered Institute of Marketing, 2009: 2); in the health context the customers are patients.

Figure 4-1 Photo of the Technical Team Area During Public Health Analyser's Development

4.2 The system

PHA is a secure web-based software application intended for use by commissioners of services for the NHS working in PCTs. It provides the information required to:

- Understand the local population and develop segmentation models of their health needs
- Identify and analyse local health inequalities to target unmet needs or gaps in care
- Monitor admission trends, forecast population health needs and predict future health trends.

Since the tool was intended to enter iHealth into a new market, the users' requirements were not expressly clear to the organisation. In order to establish more detailed requirements, the individuals building the business case for the tool networked with its intended users at conferences and NHS gatherings; they then brainstormed the tool's functional requirements amongst themselves.

These discussions resulted in the system being divided into sections, referred to as 'modules', grouped under the headings of 'Population Insight", 'Health Needs' and 'Understanding Trends' respectively. The modules within these groups are described in more detail in Table 4-1.

Module	Description	Example tasks
POPULATION INSIGHT		
Population projection	Enables the query and display of predicted population change data by geography and demographic group.	Compared to other PCTs in the Strategic Health Authority (SHA), what is the predicted change in the number of women aged 65+ between 2010 and 2020?
Population composition	Provides the demographic (lifestyle) make-up of the local (PCT) population for a specific year.	What is the current age and sex profile of the local population and how does this compare to the national average or vary between wards within a PCT?
Population density	Provides the density (number of people per km^2) of the local population or population subgroup.	Which Super Output Areas have highest concentrations of older males?
Target population	Compares the distribution of a population subgroup to the total population, to identify areas with higher than average 'high risk' population segments.	By ward, how does the distribution of males over 65 compare to the whole population?
HEALTH NEEDS		
Benchmark my area	Compares (or "benchmarks") a PCT's data to other PCTs in its region (SHA) and the national average.	How does the rate of admissions for Chronic Obstructive Pulmonary Disease (COPD) vary between my PCT, other PCTs in my region (SHA) and England as a whole?
Activity analysis	Analyses hospital activity trends and current commissioning patterns in terms of volume of patients and tariff and proportions across AHTs.	For a particular PCT, which General Practitioners (GPs) do not refer more than 75% of their patients requiring hip replacements to the local AHT?
Market analysis	1) Ranks local hospital activity and costs, by AHT or; 2) Analyses a PCT's share of their top 10 providers' markets, to provide a detailed picture of the local healthcare market.	1) 75% of hip replacements occur at the local AHT and account for 80% of the total tariff. 2) Hip replacements for patients from my PCT represent 90% of my local AHT's total number of operations.
Local inequalities	Simultaneously displays three different indicators for a chosen geographical unit or 'Analyse by' for comparative purposes.	Display the mortality rates for all cancers, admission ratios for lung cancer, and prevalence estimate for smokers.
Compare two datasets	Provides two different indicators or datasets to compare by geographical unit or demographic group.	Compare the Standardised Admission Ratios (SARs) by GP Surgery for all non-elective (unplanned) hospital admissions against total hospital admissions for a given period.
Dataset quick-view	Displays multiple indicators from any single dataset for a range of sub-units within the PCT.	Create a table of all cancer admissions with SARs, crude rates, tariff and patient count for all Census Wards within my PCT.
UNDERSTANDING TRENDS		
Historical trends	Displays past hospital patient activity and death rates over time for different population groups in a PCT.	By deprivation quintile how have total hospital admissions varied over the past five years?
Forecasting	Provides 'baseline' forecasts of hospital patient activity or death rates based on observed historical trends or projected population growth.	By broad age band and based on observed historical trends how might we expect total admissions for COPD to increase in the next five years?

Table 4-1 Description of "Modules" and Example Outputs from Public Health Analyser

Table 4-1 illustrates the range of functionality that PHA was developed to support. It reveals the complexity of the final product and some of the issues that iHealth had defining the customers' requirements. Screen captures of the user interface for a number of modules can be found in Appendix A. iHealth recognised that PHA required mapping techniques. Table 4-1 demonstrates how much geographical analysis PHA would be required to support; notice how many example tasks require analysis by geographical areas and whose answer could be revealed on a map.

Maps are a powerful means to create knowledge from and understand geographical data. Whilst some areas of the health sector, such as epidemiology or population health, commonly use maps for spatial representation of data, from John Snow in 1855 to contemporary atlases such as Pickle et al. (1999), and Wennberg and Cooper (1999), in many other domains of medical research the use of maps is less common (Robinson et al., 2005). Maps can expose spatial patterns that are not apparent from a simple table or chart (Koua and Kraak, 2004); maps of the Hospital Episodes Statistics, geodemographic and public health data can expose inequalities in health service provision and inform the commissioning of services. They allow commissioners to target services where they are needed and make a real difference to the quality and efficiency of health services on the ground. For example, a hospital manager could explore the referral patterns of General Practitioner (GP) surgeries within their area and analyse the socio-economic profile of patients. Public health practitioners at PCTs could therefore use Geographical Information Systems (GIS) to integrate, visualise and assess population health indicators for public health issues (such as obesity, smoking, heart disease and teenage pregnancy) down to neighbourhood level to target public health intervention (Cummins et al., 2007; Koch, 2005; Rinner and Taranu, 2006).

4.3 Maps development and survey

4.3.1 Introduction

Although iHealth had significant expertise at this time in the monitoring of health statistics, and representing it in tabular and chart form, it had little around the geographical representation of this data; for example, how to visualise and plot predicted disease incidence in a way which is statistically significant and useful for planning. This was principally due to the technical challenges associated with linking live to a database which is updated with approximately 6.3 million records a month, as described in Chapter 3. Given the importance of these topics within the new products iHealth recognised that they needed to develop a rigorous methodology around how to represent this data geographically. Many managers and analysts (e.g. Public Health, Performance and Information Analysts) responsible for health service provision may not be familiar with public health and epidemiology, yet need to manage and commission health intervention on a regional basis. Adherence to correct cartographic conventions, such as Monmonier (1993), is therefore critical for commissioners' confidence in the decisions they make based on maps.

Damian, head of iHealth's technical team at the time, had a background in geodemographics and had previous links to University College London (UCL). Academics in UCL's Departments of Geography and Civil, Environmental and Geomatic Engineering had considerable experience in the application of GIS for environmental policy making and environmental planning; computer assisted cartography; internet-based GIS and societal aspects of GIS. They had also collaborated with the education and the health sectors through Knowledge Transfer Partnerships (KTPs).

A KTP unites a company and an academic institution ('Knowledge Base' Partner) to facilitate the transfer of knowledge, technology and skills to which the company currently does not have. Each partnership employs one or more recently qualified people (known as an Associate) to work in a company on a project of strategic importance to the business, whilst also being supervised by the Knowledge Base Partner. Projects vary in length between 12 and 36 months. iHealth established a two-year KTP with UCL to develop mapping technology for PHA. I was selected as the KTP Associate and spent around 80% of my working hours at a desk located inside iHealth's secure area. This was at the beginning of PHA's development when there were few developers working on the product and only one developer had the knowledge, expertise and interest to develop the mapping functionality. The KTP aimed to develop functionality to allow users to extend basic analysis to:

- Produce maps alongside charts, graphs and models to support public health interventions
- View and map information in an easily accessible format on the basis of diagnosis and procedure from regional (SHA) level to postcode (GP Surgery) level
- Identify spatial health inequities.

Initially, the developer of the maps at iHealth used Scalar Vector Graphics (SVG) technology, which had cross-browser compatibility and technical support issues; at this time, most of iHealth's customers used Microsoft's Internet Explorer 6, which required users to download a plug-in to be able to render pages with SVG[4]. Most NHS Trusts, however, widely restrict their staff from downloading applications to their computers; in addition, the slow speed at which users could access iHealth tools within hospitals severely impacted on their ability to interact with the maps. For PHA, iHealth's developer used AspMAP to deliver maps to end users; AspMAP is a Web mapping component for embedding spatial data access, display and analysis functionality in Web applications. AspMAP integrates the images into the browser and is less interactive. Performance issues are generally related to the filtering of the millions of hospital records with a live link to the

[4] Google Maps uses SVG now to render its new vector maps because the technology has advanced so that the browser does not require a plug-in.

database server. Figure 4-2 shows how a live Structured Query Language (SQL) Server and a live Web Server deliver the maps to the user's computer screen.

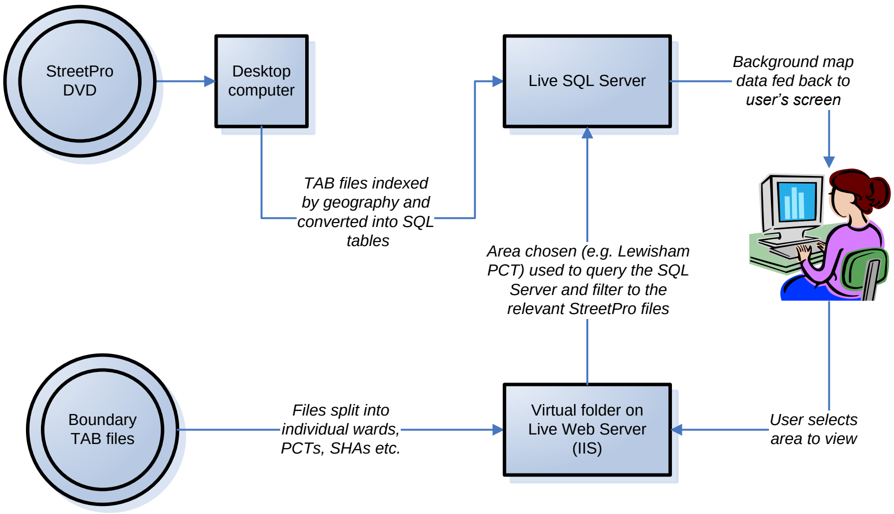


Figure 4-2 Diagram Illustrating How the Maps are Delivered to Public Health Analyser Users

A debate has emerged in the literature in recent years around the intuitiveness and usability of GIS for novices who use them to explore, analyse and visualise data. Many healthcare managers are novice GIS users, who are not necessarily spatially literate or experienced in reading and understanding maps, so their design requires careful consideration (Tobón and Haklay, 2003; Unwin, 2005). Poorly designed maps are not useful or usable and, if information is incorrectly represented, users will be less likely to trust the maps and the information they provide, and more likely to make poor decisions based on the maps.

With this in mind, I was assisted by academic colleagues to design and develop a questionnaire to get feedback directly from users on how easy they find different maps of health data to interpret, which I designed according to cartographic conventions of authors such as Monmonier (1993, 1996), MacEachren (2004) and Krygier and Wood (2005). This method was chosen because it could reach a large number of intended users at the same time, it would provide objective responses, including quantitative data that could be quickly and easily analysed and demanded little input from the time-pressured technical team at iHealth. The study aimed to determine the cartographic literacy of target users and gather information that would inform design and development decisions for PHA's mapping functionality and a style guide for future maps development at iHealth.

4.3.2 Method

In addition to the organisation's limited status within the primary healthcare market, I had limited experience of UCD techniques at this time. My expertise lay in cartography and mapping in general, so I conducted a survey to test prospective PHA users' reactions and preferences to a range of cartographic representations of the data they would analyse with PHA. I developed a bespoke web-based questionnaire using Microsoft's ASP.net development environment to facilitate distribution to a dispersed user community (Microsoft, 2008). The questionnaire design followed a wizard-based approach, to allow participants to step through questions in sequence, and move back to previous questions if required. Prior to submission to the web server, Javascript validated answers for completeness and collected responses in a Microsoft Access database for further analysis. iHealth colleagues and email lists provided potential participants via email, of which 31 responded.

The survey first acquired respondents' background information to aid analysis of their reactions to the maps and their preferences (Table 4-2). I consulted academic colleagues to design questions based on our experience of factors that might affect respondents' map style preferences and their ability to interpret health data on maps. Responses to the first five questions provided demographic information; questions 6 and 7 requested respondents' experience within the health sector; question 8 determined computer literacy; questions 9-11 spatial literacy and questions 12-13 data literacy.

No.	Question	Answer options				
1	Please type your name.	Text box				
2	Please type your organisation.					
3	Please type your job title.					
4	Please select your age group.	< 25	25-34	35-44	45-54	>54
5	Please select your gender.	Female		Male		
6	How long have you worked in public health? (years)	< 0.5	0.5- 1	1-3	3-10	>10
7	I am familiar with public health data such as information about obesity, smoking and cancer.	A Likert Scale with the following options: • Strongly disagree; • Slightly disagree; • Indifferent; • Slightly agree; • Strongly agree.				
8	I am familiar with browsing and analysing information using the internet.					
9	I often use maps to find out information about a location or a route.					
10	Maps can be used to show how data varies geographically, using colour, shading or symbols. I am familiar with this way of presenting data.					
11	I find that maps provide a useful way to show data.					
x12	When viewing and analysing data I find graphs easier to understand than maps.					
13	When viewing and analysing data I find tables easier to understand than maps.					

Table 4-2 Preliminary Survey Questions

I consulted with Damian to identify six different types of data that PHA would incorporate and six different geographical scales at which each data type would be mapped (Table 4-3); this would ensure that questions directly corresponded to map styles that would appear in the final product, and ultimately inform a style guide of how data should be visualised and classified at each scale in Table 4-3, colour schemes and style of background mapping. I designed the maps with MapInfo GIS software and data from PHA according to cartographic conventions.

Data types	Geographical scales
• Count i.e. number of patients • Rate e.g. Day Case, Day of Admission and Readmissions Rates • Index • Patient flow i.e. hospitals to which GP Surgeries refer patients • % difference between data sets • Standardised Admissions Ratios	• Mosaic (Postcode) • General Practitioner • Provider • Output Area • Super Output Area • Wards

Table 4-3 Public Health Analyser Maps

The design of the study was strongly driven by cartographic knowledge and prior research experience of the project team. Eleven cartographic attributes were investigated from map styles that cartographers (Krygier and Wood, 2005; MacEachren, 2004; Monmonier, 1993, 1996) have developed for mapping the types of data listed in Table 4-3. Since each map style is not necessarily appropriate for displaying every type of data, it was necessary to select the dataset for each map style carefully; one of eight datasets, ranging from prevalence of diabetes to volume of emergency admissions, was mapped for each of the eleven attributes (Table 4-4). In order to encourage participation, the number and complexity of the questions was constrained by the time it was likely to take to complete the survey; we sought responses from valuable customers of the organisation, whose time at a computer can be limited and for whom computing work is not necessarily integral to their role. Other notable constraints included the diversity of participants' web browsers; we could not assume that customers had the latest web browsers and were able to download additional software. This influenced the coding language we chose to develop the survey and dictated that we needed to ensure that the survey could be completed without the need to download additional plug-ins. Furthermore, we did not include other features of the PHA interface on the survey maps, which were not interactive and occupied more screen space than the final tool; for example they did not have the module menu, the tabs for viewing the data as a table or chart, or the buttons for zooming in and out. This was a necessary experimental control to ensure responses only related to the design of the maps and not to the rest of the PHA interface; this, however, meant that responses cannot be assumed to reflect the overall user experience of the maps, as they eventually appeared in the final tool. We deemed these compromises acceptable at this stage of the tool's development, so that the survey would reach many more potential participants, and that responses would relate directly to the design of the maps, unaffected by other aspects of the interface.

Cartographic attributes	Dataset selected	Map A	Map B	Map C	Data interpretation	Ease of interpretation	Map preference
1. Number of ranges	The reduction in number of smokers in Hampshire Primary Care Trust (PCT): % of population by Output Area.	Five colours to represent five data ranges	Seven colours to represent seven data ranges		Look at the maps and decide where smoking cessation services should be set up.	With which map was this task easier?	
2. Point data representation: Two-way comparison between Maps A, B and C: a) A v. B b) B v. C c) A v. C	% of patients at GP practices with Coronary Heart Disease (CHD) in Wakefield PCT.	Circles **sized** according to % patients.	Circles **shaded** according to % patients.		Identify areas on the following two maps where GP practices have the highest prevalence of CHD.	On which map was this easiest to identify?	Which of the maps do you prefer?
			Circles **shaded** according to % patients.	Circles **sized and shaded** according to % patients.			
		Circles **sized** according to % patients.		Circles **sized and shaded** according to % patients.			
3. Comparison of two different datasets: Two-way comparison between Maps A, B and C: a) B v. C b) A v. C c) A v. B	• Standardised Admissions Ratio (SAR) of Chronic Obstructive Pulmonary Disease (COPD) • % of population who are smokers in Greenwich PCT by ward.		Single map with two datasets overlaid	Single map with bar charts representing two datasets	Locate wards in Greenwich where the SAR for COPD and % of the population who are smokers are both relatively high.	Which representation of the data enabled you to do this most easily?	
		Maps of two datasets side by side		Single map with bar charts representing two datasets			

Cartographic attributes	Dataset selected	Map A	Map B	Map C	Data interpretation	Ease of interpretation	Map preference
		Maps of two datasets side by side	Single map with two datasets overlaid				
4. Maps for assessing change over time	Hospital Standardised Mortality Ratios for Acute Hospital Trusts (AHTs) in South Central Strategic Health Authority (SHA) 2003/4 -2006/7.	Two maps side by side, one showing the data for 2003/4 and the other showing 2006/7.	One map of the amount by which the mortality rate has changed from 2003/4 to 2006/7.		Identify on the maps where mortality rates have changed most.	Was it easier to identify this with Map A or Map B?	
5. Raster vs vector background	Unadjusted prevalence of diabetes at GP practices in Greenwich PCT (% of registered patients).	An Ordnance Survey map with circles to mark the locations of GP practices and sized according to the % of registered patients with diabetes.	Same as Map A but with a custom vector map background, showing only roads, place names and PCT boundaries.			Is it easier to assess the data on Map A or B?	Which map do you prefer?
6. Inclusion of roads on background map	Changes in emergency admissions in wards in Wolverhampton PCT 2003/4-2006/7.	With roads.	Without roads.				Which of these two maps do you prefer?
7. Colour scheme	Number of High Impact Users (HIUs) in South Central SHA, 06/2006-05/2007.	Green, sequential, colour scheme	Yellow to blue, divergent, colour scheme			Which of the two colour schemes allows you to identify the PCTs with the highest number of HIUs most easily?	

Cartographic attributes	Dataset selected	Map A	Map B	Map C	Data interpretation	Ease of interpretation	Map preference
8. Inclusion of hospital sites.	Number of HIUs in South Central SHA, 06/2006-05/2007.	Without AHTs.	With AHTs.				Would you like to be able to view AHTs when looking at a map of a SHA?
9. Inclusion of roads and place names.	Number of HIUs in South Central SHA, 06/2006-05/2007.	With roads.	With place names.	With both roads and place names.			Which map do you prefer?
10. Data classification	Waiting times for breast cancer diagnoses in Greenwich PCT 07/06-06/07.	Greenwich PCT data classified according to local, regional and national averages	Greenwich PCT data classified independently of local, regional and national averages.			Is the inclusion of averages (and shading according to averages) helpful to your understanding of the data?	Which of the maps would you use most, or find most useful, in the course of your daily work?
11. Inclusion of place names and ward names or GP practices and AHTs.	Waiting times for breast cancer diagnoses in Greenwich PCT 07/06-06/07	With place names and roads.	With GP practices and AHTs.				Which map do you prefer?

Table 4-4 Survey Questions Posed to Inform Public Health Analyser Maps

The survey posed one or two questions per cartographic attribute, some of which required an instruction to interpret the data (Table 4-4). Questions related to ease of interpretation or identification of map preference and gave a choice between two or three maps that varied one particular aspect of their design (see Figure 4-3**Error! Reference source not found.**). Respondents could access larger versions of the maps by hovering their cursor over them, and closed questions and radio buttons forced respondents to choose just one map to assist analysis.

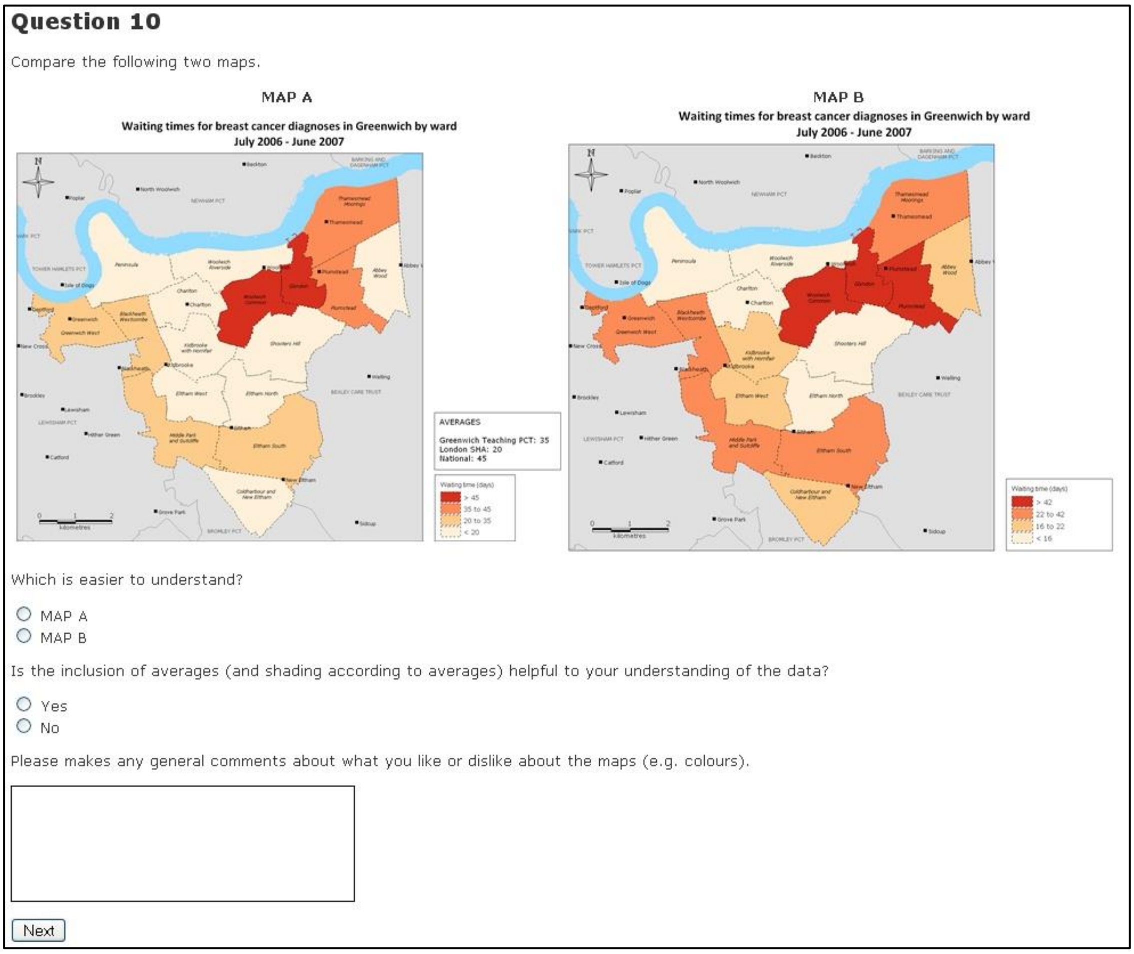


Figure 4-3 Screenshot of Question 10: The two maps show the same data but appear different because the data is grouped with different approaches to establish which was most useful.

Questions did not conform to a pattern due to the nature of the information sought for each cartographic aspect; for example, questions relating to the style of background map on which the data was overlaid focused more on preference and less on the interpretation of the data. Respondents were therefore forced to consider each question independently to mitigate habituation in responses. Every question invited respondents to "Please explain your choice and make any general comments about what you like or dislike about the maps (e.g. colours)". As respondents exited the questionnaire, a supplementary question encouraged them to "Please make any general comments about the questionnaire…" and "…let us know if you have any ideas for map presentation in general." The "Finish" button exported responses from the Microsoft Access database to a Microsoft Excel spreadsheet for analysis.

4.3.3 Results

This section summarises the answers that 31 respondents gave to each question in Table 4-4; the full set of responses can be found in Appendix B.

1. Number of ranges

The survey first investigated the number of ranges that will be useful for the users; it presented participants with maps of the same data but using different numbers of ranges, to see how much detail they required when exploring data (Figure 4-4). Feedback varied with some commenting that "Less ranges made it easier to identify the problem areas - Map B had too many ranges, with the areas of concern harder to pick out." (Research & Statistics Officer) and others "Fewer bands made it easier to interpret but to inform decisions would need more detail." These mixed comments were reflected in the respondents' preference: 17 preferred five ranges and 14 preferred seven.

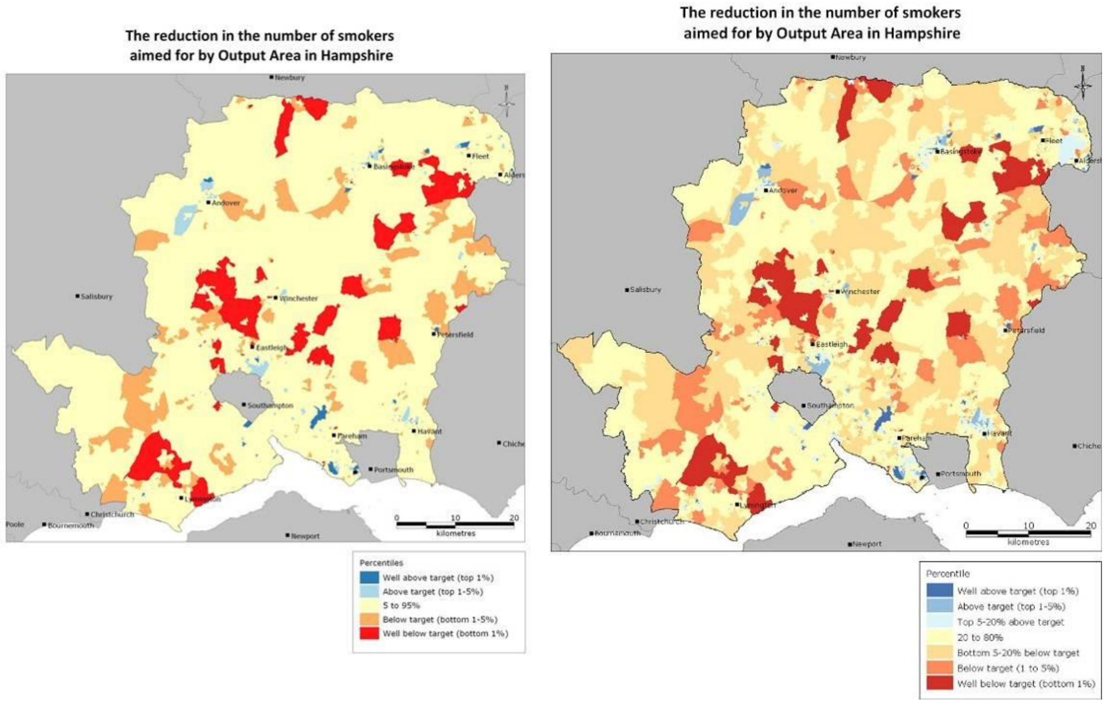


Figure 4-4 Question 1 Presented Two Maps of the Same Data with 5 and 7 Ranges Respectively

2. Point data representation: Two-way comparison between Maps A, B and C.

Maps typically represent an object as a point if it has a single, unique coordinate on the Earth's surface, such as a building or settlement; the point's size and colour can then reflect an attribute of the object, such as demographic or land classification data. The survey asked participants if they found maps with points varying by size, colour shade or a combination of both easier to interpret.

Respondents generally found maps with points varying in both size and colour easier to interpret (21 compared to colour alone; 31 compared to size alone) and preferred this representation (20 compared to colour alone; 23 compared to size alone). However, some respondents found that "using two forms of incremental display to represent a single indicator is confusing" (Public Health Research Specialist). 23 respondents found colour easier to interpret than size and 22 preferred it.

3. **Comparison of two different datasets: Two-way comparison between three maps**

The survey showed different maps of two datasets, known as 'bivariate' maps; first it presented the two datasets on bar charts (each bar representing a different dataset), second on a map with a colour shade and a pattern that increased in density (one dataset represented by the colour and one represented by the pattern), and third on two separate maps. 26 respondents found the bar chart map easier to interpret than to have the two datasets overlaid on one map and 18 found it easier to interpret than two separate maps. An economist at a PCT explained, "Flicking my eyes left and right between the two maps in A [two maps] makes me feel a bit dizzy. With B [bar charts], you can tell at a single glance, rather than several glances." 29 respondents also found the data easier to interpret on two separate maps, rather than displayed as two layers on one map.

4. **Maps for assessing change over time**

The user requirements included the ability to map trends in data. 27 respondents found it easier to identify changes in data over time if the information is displayed on one map, rather than two maps of each moment in time. A Director of Public Health said that one map "does all the thinking for you - easy to see the answer." This was reiterated by a PCT's Health Intelligence Manager who said that, "switching between…two is awkward, and more likely to result in misinterpretation." Some respondents noted, however, that the scenario question required knowledge of the absolute numbers of patients, which was not represented on the map.

5. **Raster vs vector background**

The questionnaire investigated whether participants preferred a raster image of a map they may be more familiar with, or whether they preferred a more simplified vector representation for the base map (Figure 4-5), and also which visualisation facilitated their interpretation of the data.

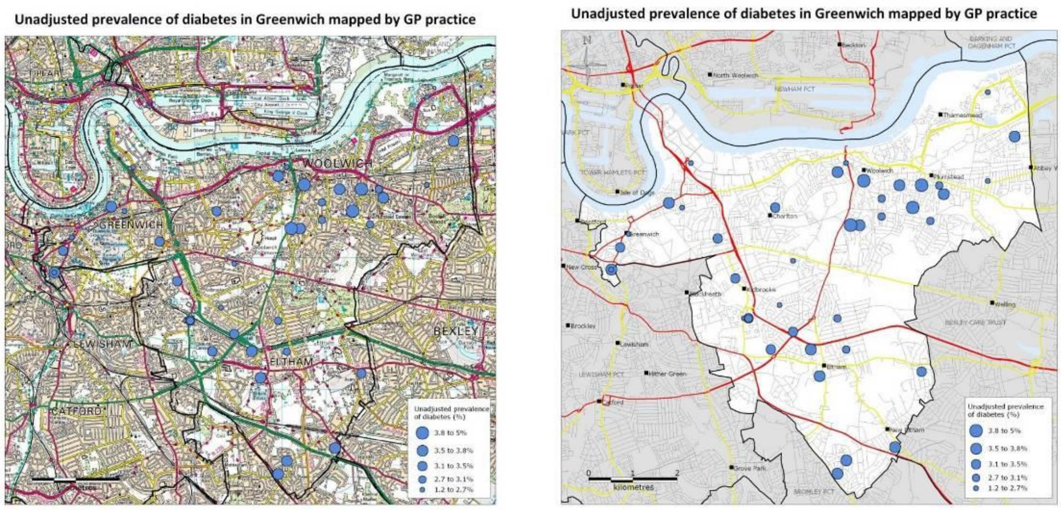


Figure 4-5 Question 5 Contrasted Raster (left) and Vector (right) Background Maps

Vector and raster are data models, according to which geographical features on the Earth's surface (such as roads, place names, rivers) are represented as data; the vector data model represents features as collections of points, lines and polygons, and the raster data model represents features on a grid of cells that stores numeric values. In Figure 4-5, the raster data model is an image, so the cells contain colour values. An online vector map, by definition, renders the geographic data on the map from GIS data files, held on a SQL Server database, in the order in which features have been layered. Vector maps rendered data every time there is a request to the server, and this requires computation time. The rendering of a raster image, in contrast, requires very little computation. This impacts on the user's interaction with the system; the user can select features on a vector background map and switch them on and off but cannot with a raster image. Finally, the raster map in the survey used familiar Ordnance Survey (OS) cartography, whereas the vector map would be less familiar to users 26 respondents favoured the simplified vector map; similarly, 28 reported that the vector map enabled them to interpret the data more easily. Respondents commented on the raster map that "some of the smaller circles seem to get lost - but I like it because it's a style of map I am more familiar with." (Health Information Researcher).

6. Inclusion of roads on background map

The survey asked respondents to indicate if they required roads on the background map. 14 respondents preferred maps to include roads but 17 preferred the map without. Respondents talked about the relevance of the roads to the data and task: a Performance Team Leader at a LA said, "Roads would have been relevant if different hospital catchment areas were being compared." A Health Policy Officer at a PCT added, "Roads may be related to emergency admissions." This was consistent with the responses of a Public Health Researcher ("Road detail is important on maps that perhaps deal with rates of accessibility, but a thematic layer of roads can also help to "frame" the picture and give context.") and a Consultant in Public Health ("If planning where new services need to go.") at PCTs. Respondents also reported that roads made it "easier to put [the data] in geographical context" (Director of Public Health, PCT).

7. Colour scheme

Users were asked if they preferred diverging or sequential colour schemes (Figure 4-6) for 'choropleth' maps. Choropleth maps are shaded according to their value (Krygier and Wood, 2005; Monmonier, 1996). 24 respondents preferred the green, sequential, colour scheme; comments included, "I find shades of the same colour easier to read than moving between two colours - easier to determine highest to lowest" (Senior Commissioning Analyst).

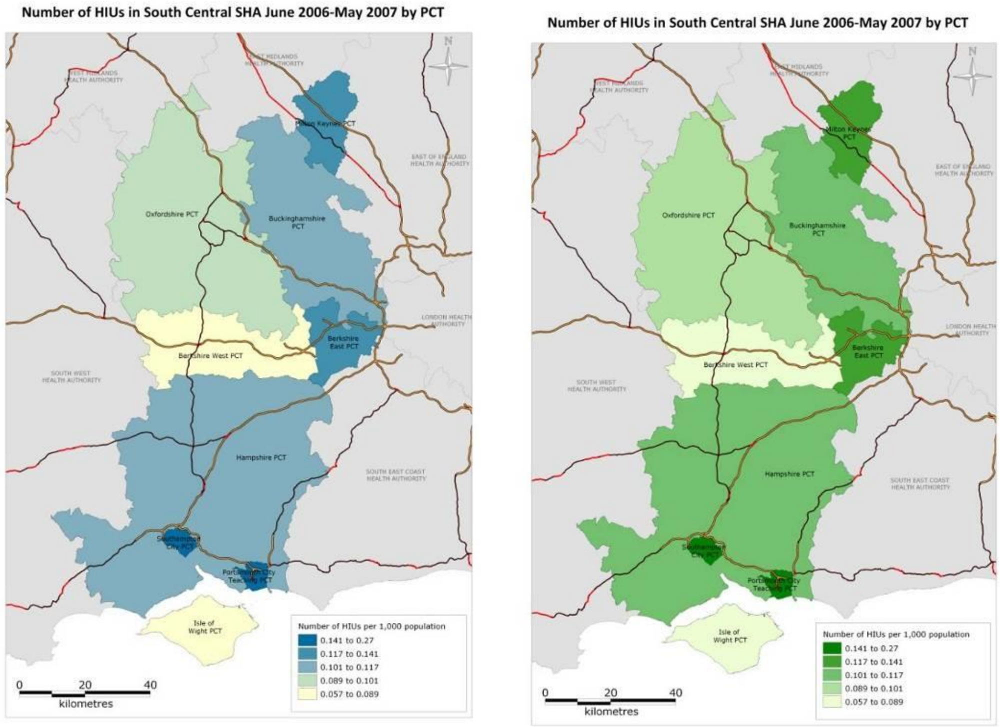


Figure 4-6 Question 7 Presented Diverging (left) and Sequential (right) Colour Schemes

8. Inclusion of hospital sites

27 respondents said that they found it useful to see the locations of hospitals on regional maps, but many requested "the ability to choose" (Public Health Researcher, PCT). Answers depended on the purpose of the map; for example, investigation of service accessibility was mentioned by a PCT's Statistician ("It might give some insight about accessibility.") and Director of Public Health ("Not unless relevant to the subject of the map e.g. access times to hospital."), and a Performance Manager at a Local Authority (LA) ("Allows comparisons on the relative distance to acute care for the inhabitants of the trusts."). A PCT's Health Intelligence Officer stressed the importance of these maps: "In terms of service redesign/relocation, it is important to be able to visualise where the greatest need is - and whether health care delivery is located in the right places."

9. Inclusion of roads and place names

Six respondents preferred background maps with only place names, four preferred only roads but 21 requested the option for both. Many respondents explained their answer with comments including terms such as, "orientation", "geographical context" and "spatial reference." A PCT's Assistant Director of Performance said this, "Surprised me...The area viewed is so huge I really did need spatial reference points." Respondents suggested that roads and place names would be useful to those unfamiliar with an area ("Useful for those who do not know the area." Public Health Analyst, PCT) but also those who are familiar with an area ("For an area I am familiar with the roads would help me create a mental picture of where hotspots are." Director of Public Health, PCT). Further to this, respondents suggested it would be useful to have flexibility in presentation; for example, a Statistician at a PCT said, "This will only work if there aren't too many roads and place names. It would be useful to be able to turn them on and off."

10. Data classification

The way in which data is classified or grouped can greatly influence the message that is interpreted from 'choropleth' maps (Krygier and Wood, 2005; MacEachren, 2004; Monmonier, 1993, 1996). The questionnaire presented participants with the same map but using two different data classification techniques (Figure 4-7). One map shaded areas so that there would be an equal number of areas with the same colour shade (the "equal counts" method), and the other map used the national, regional and local averages to shade the data, allowing for visual comparisons against these benchmarks. 29 respondents found the latter map more useful, with a Health Economist remarking that "I absolutely must have some kind of benchmark when looking at performance data…it is meaningless without context." Additionally, participants commented that this map "demonstrates areas most in need of attention – would lead to more efficient resource allocation." (Performance Manager, LA.)

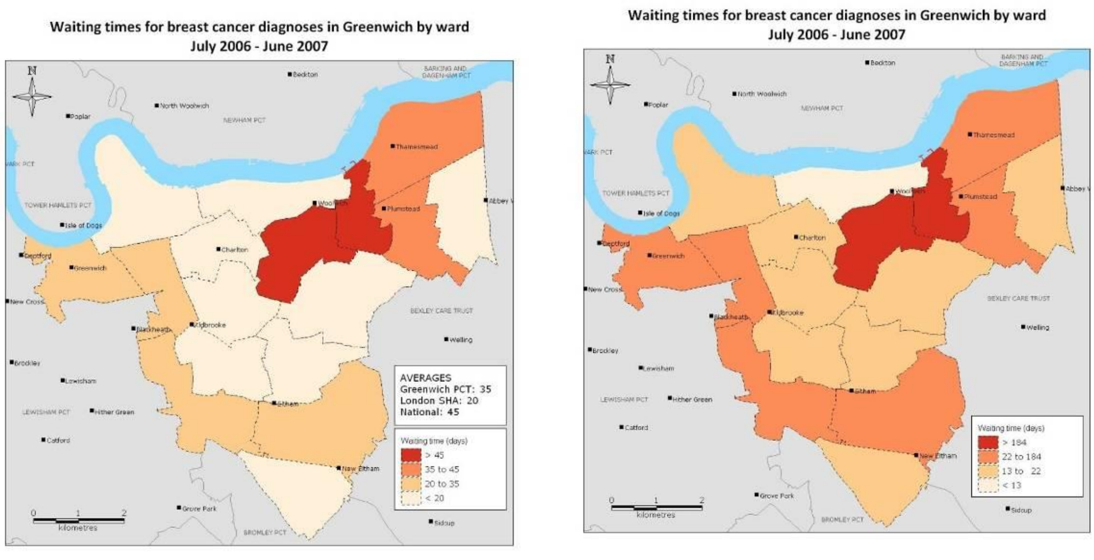


Figure 4-7 Question 10 Contrasted Two Maps of the Same Data but Classified Differently

11. Inclusion of place names and ward names or GP surgeries and AHTs.

Six respondents preferred background maps to include wards and place names, but 25 preferred GP surgeries and hospitals. An economist at a PCT commented it was more "helpful" because "we tend to look at the effectiveness of existing resources in meeting needs…where there may be gaps in provision." This comment was echoed by a LA's Performance Manager who said it "would better inform decision making around specific localities for resource allocation." Other respondents, such as this Information Analyst at a PCT, also recognised that "it depends on what you're interested in using the map for." A Public Health Analyst at a PCT said that the inclusion of

GP surgeries and hospitals was "more consistent with messages in the map." Respondents thus desired "flexibility in presentation" (Information Analyst, PCT).

4.3.4 Organisational Response

Based on responses to question one, users are now able to select the number of ranges they would like: 3, 5 or 7; users can also choose a red, blue or green colour scheme, as requested in response to question seven (Figure 4-8).

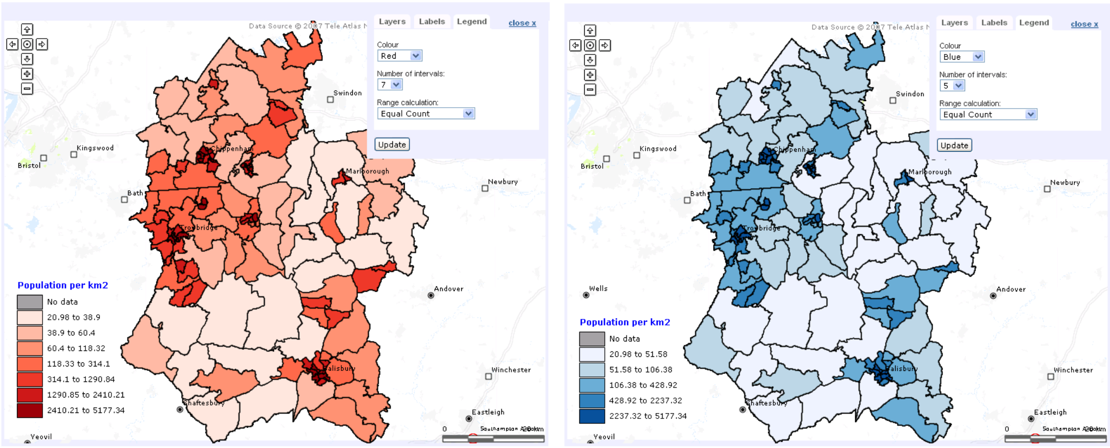


Figure 4-8 Screenshot from PHA Showing How Users Change the Colour Scheme of Maps

PHA did, however, ultimately include functionality for customers to change the range calculation for choropleth maps, with options comprising equal counts, equal ranges, standard deviation and percentile; it is a limitation of this study that we could not explore all these terms, which derive from cartographic practice and are unlikely to be familiar to non-experts. In Figure 4-9, the map on the left uses equal ranges and the map on the right uses equal counts to classify the same data.

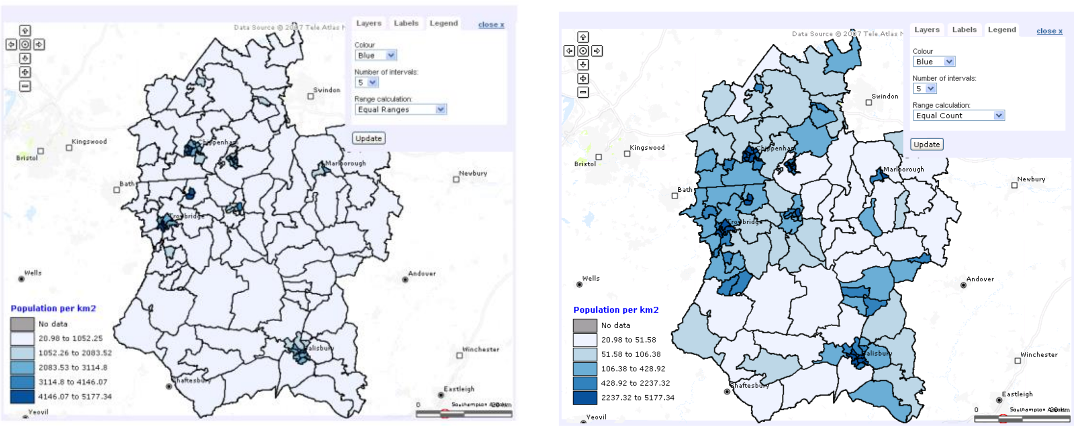


Figure 4-9 Screenshot from PHA Showing How Users Can Change the Classification of Data on Maps to Equal Range and Equal Counts

Figure 4-9 reveals that the interface included an "Edit Options" window (enlarged in Figure 4-10), for users to change the range calculation, number of ranges and colour scheme; users are also able to switch on GP surgery and hospital locations and labels with checkboxes on this window.

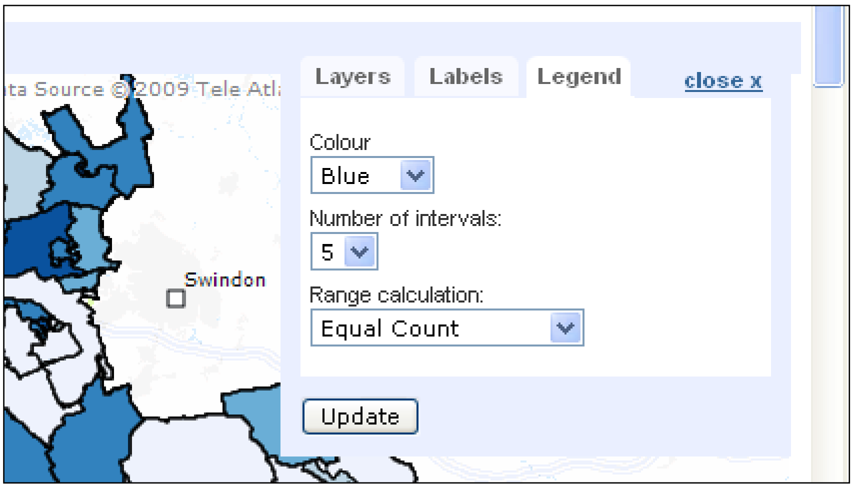


Figure 4-10 Screenshot of the "Edit Options" Window for PHA Maps

The separation between the maps' database and the database of patient admission records made these modifications possible. The user's query sent the selected records to a separate maps database for processing in order to render the map more quickly; any calculations associated with the maps could thus take place without risk to the patient record database and the maps developer could write the code comparatively quickly.

I investigated licences for a raster dataset, partly as a result of the survey, but also because the business desired to move towards a representation that users would be more familiar with, such as an OS map or Google Maps. For the business this would be more sustainable because it would require less maintenance. Respondents' preferences, however, demanded that a selection of vector data was used for the base map; several Figures (Figure 4-8, Figure 4-9, Figure 4-12, Figure 4-13, Figure 4-14) in this chapter illustrate that the software uses a very simplified vector base map as a result of this research. Vector data was already implemented in the system and so modifications comprised the careful selection of visible layers that would enable users to orientate themselves on the map at different zoom levels.

For mapping more than one dataset on the same map, respondents preferred a bar chart map but the organisation did not to develop this map because this preference was not strong[5] and deemed too resource-intensive to develop: the underlying data architecture would need to be altered and included many different types of data (e.g. rates, counts, ratios). Instead, PHA allowed users to compare datasets using an index ratio and fraction, Spearman's rank correlation coefficient and Pearson's correlation coefficient in a table and the maps were built to show one dataset at a time, with users able to switch between datasets using a dropdown menu. Figure 4-11 shows a good match between the number of smokers on the left and the Standardised Admission Ratio for Chronic Obstructive Pulmonary Disease. Users must, however, switch between the two representations in order to visually compare them, and it was beyond the scope of the study to investigate the consequences of this for users.

[5] 26/31 preferred the bar chart map when compared to two layers of data on the same map, and 18/31 preferred it when compared to two separate maps of each dataset.

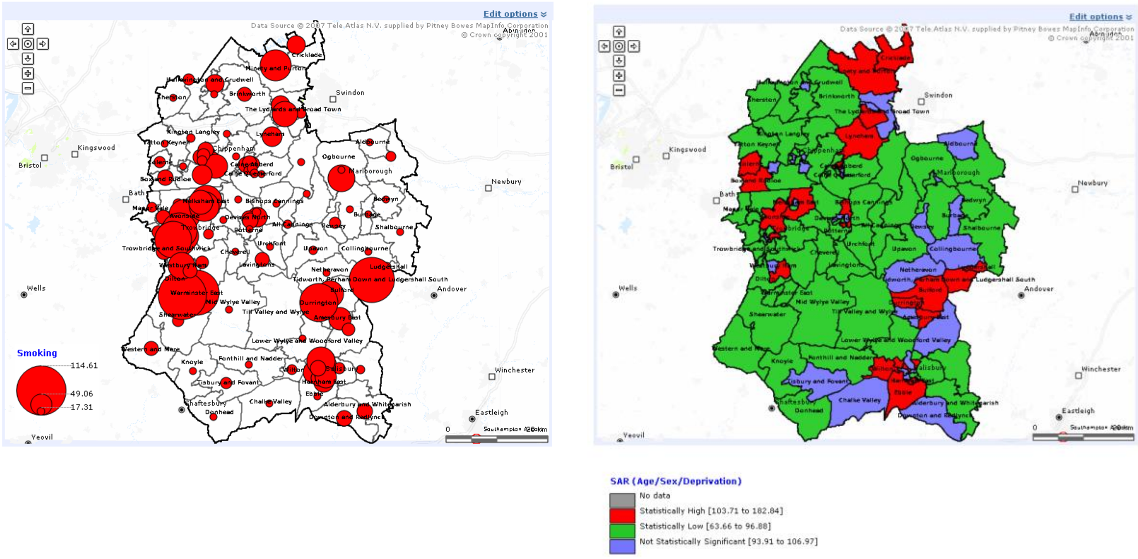


Figure 4-11 Maps of Smoking Counts and Chronic Obstructive Pulmonary Disease Admissions from PHA

Although iHealth developed functionality to map data for neighbouring health authorities for the comparison of performance (Figure 4-12), customers were unable to colour areas on the map according to whether they were above or below various averages (national, regional and local) in the final tool. As with bar chart maps, management deemed that the risks associated with modifying the database architecture for such tasks were too high and it would take too long to develop.

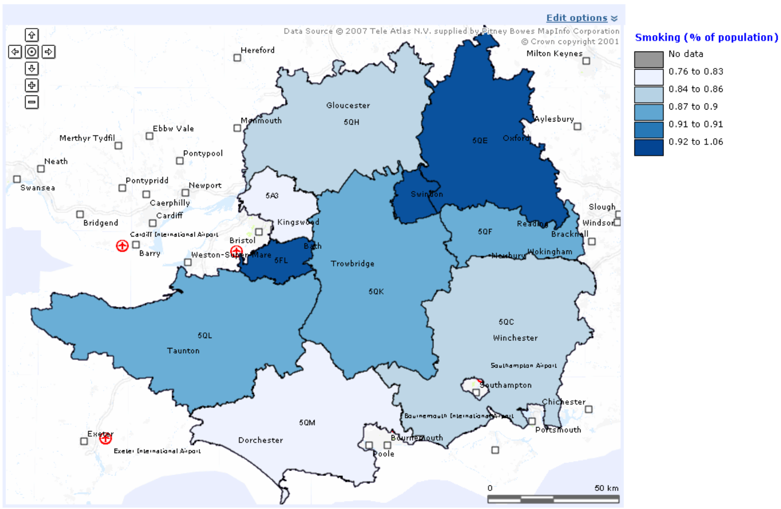


Figure 4-12 Map from PHA Showing Data for All Primary Care Trusts Within a Strategic Health Authority

Colour and size variation were only been used together in the case of trend data, where blue circles represented a decrease and red circles represented an increase (Figure 4-13).

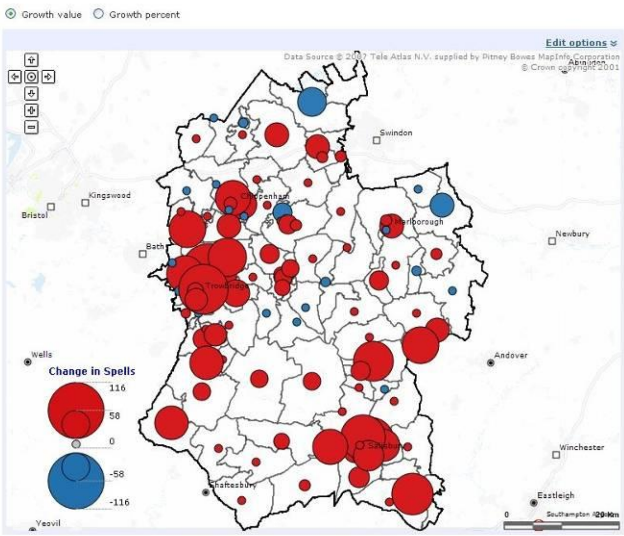


Figure 4-13 Map of Trend Data from PHA – Red for Increases, Blue for Decreases

A diverging colour scheme, preferred by seven respondents, was only used for trend data, so that increasing and decreasing trends could be easily identified (Figure 4-14). This was developed according to cartographic conventions, and despite respondents' preference for sequential colour schemes, based on only one colour, because this requirement came to light after the questionnaire had been sent out. PHA maps comprising of data points, such as GP surgeries, were shaded when they represented rates and varied in size for count data in accordance with cartographic convention and respondents' preferences. Colour and size variation were only used together to represent trends in data, with blue circles representing a decrease and red circles representing an increase; the questionnaire did not include this map because the number of questions was limited in order to encourage participation.

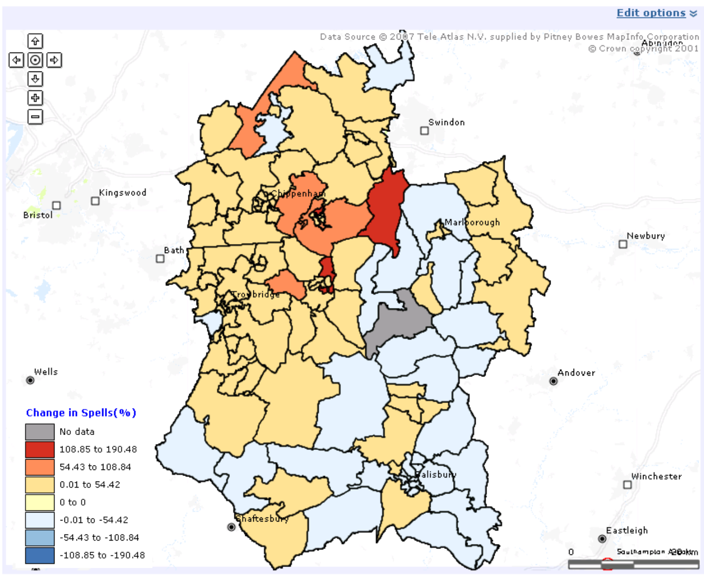


Figure 4-14 Map Displaying Data with a Diverging Red to Blue Colour Scheme from PHA

PHA included pie chart maps for hospital referral activity, which represent two aspects of the data: the number of referrals (indicated by the size of the pie chart) and to which hospitals GP surgeries refer patients (the size of the pie segments) (Figure 4-15).

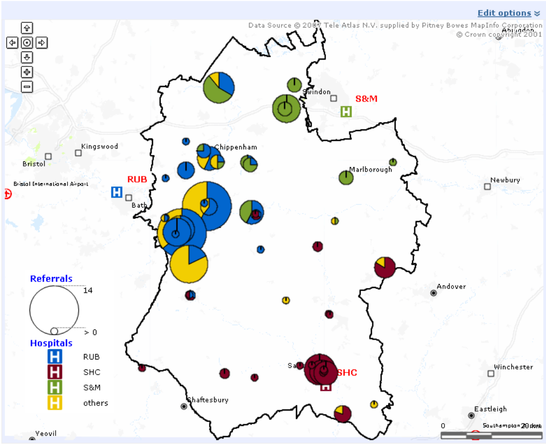


Figure 4-15 Pie Chart Map Portraying Referrals of Patients from GP Practices from PHA

The organisation did not test this map because customers with iHealth's Referral Intelligence product already used it. This was the only map iHealth customers used at the time of PHA's development; the organisation was reluctant to change it and alienate existing users, despite no evidence that the customers found this a suitable representation of referral activity.

In summary, some of the respondents' requests were not implemented due to a mixture of existing functionality, restrictions imposed by the project deadline and the system's architecture; however I started to notice success factors, notably my embeddedness in the design process. The study clarified and cemented my role within the design process, which until that point had been advisory, and helped to facilitate my integration with the team; Phillip, Damian's successor, at the time was particularly keen that I had 'deliverables' and featured on the project plan. The implementation of the questionnaire results was made easier because the two developers assigned to the maps sat next to me and I could give them direct advice and instructions on the requirements for the map design. It became a mutual learning process: the developers learned about cartographic principles from me and the questionnaire's results, whilst I acquired an understanding of the underlying database and how it impacted upon what they were able to implement. iHealth has not advanced its mapping technology since the original developer of the maps left the organisation; the developer wrote the code in a way that made it difficult for other developers to follow, which gave him ownership of the code. On reflection, it was to my advantage that only one developer worked on maps when I wanted to implement the questionnaire's results and develop the maps with a user-centred approach; it cut through many of the barriers that the project managers faced in translating user requirements to the screen.

Respondents commented that they found the questionnaire a useful exercise because they used maps in their work and it gave them ideas for how they could map their data differently. A PCT's

Director of Public Health said, “Quite interesting as I have been spending all afternoon looking at maps and wondering how they could be better presented - now I've got some ideas!”, whilst a Consultant in Public Health at a PCT found it “thought provoking”. I found this questionnaire a useful exercise to undertake. A PCT’s Lead Health Intelligence Officer, who had also worked in public health for over ten years said, “As I have undertaken many GIS mapping tasks over the years, this exercise has made me think more closely about the best presentational approach which can differ in effect considerably from data type to data type.” Such comments highlight the mutual benefit that User-Centred Design (UCD) methods can have.

The development of the mapping functionality, however, demonstrates how the organisational culture preferred to base development and design decisions on the software’s underlying technology and infrastructure rather than the users’ requirements at this time. I researched many different options for the background of the maps for PHA, inviting representatives from organisations such as GeoWise and OS to the iHealth offices for meetings, but ultimately the business appeared unwilling to invest the time and financial resources for a new infrastructure around which a more user-friendly system could be built. The organisation perceived that the cheaper license would require too much effort to administer; it required the number of “hits” on the maps to be logged, which was not possible with the database architecture at the time. It is also indicative of an organisational culture where words were not always translated into action; for example, although the maps developer expressed an interest in researching the difference in response times between vector and raster map backgrounds, the research never materialised because his role did not give him the scope to further it. It is noteworthy that the maps were hidden far inside PHA. Whilst the Cognitive Walkthrough (CW) in Section 4.7 will highlight this, it is worth noting here that the system required a lot of effort from users to create a map. Users must click through several screens and perform particular queries for the map option to become available; Figure 4-16 demonstrates the steps required.

1. Log in as: Bury PCT
2. Go to: Health Profiling >> Unit Analysis
3. Select: Analyse by: Stats Ward
4. Select: Data source: Mosaic – Total Population
5. Select: Mosaic hierarchy: Mosaic groups (11)
6. Select: Outcome: A - People with rewarding careers who live in sought after locations affording luxuries and premium quality products
7. Click “Generate Report”
8. Click on the Map tab

Figure 4-16 Example Steps to Create a Map in PHA

Furthermore, the default results page was the tabular view of the data; users who were unaware that they could now map the data might not see the button that would enable them to do this.

The relationships between individuals, which hinged on a delicate balance of team and personal interests, caused difficulties. The glass partition that separated the technical team from the rest of the office served to exacerbate this and caused frequent tension that directly hampered progress on the development of mapping functionality.

On its first launch, the product did not sell as well as anticipated and received poor feedback from customers; this, along with high staff turnover, negatively impacted upon the morale and atmosphere within the organisation. The organisation therefore decided to invest more in its software products and proceed with fixing PHA using a new approach to software development. Phillip was recruited to replace Damian and he brought with him extensive experience of managing development teams and the organisation introduced an Agile process for the first time, overseen by a new project management team. However, with more developers came more process and elements of Waterfall and "scope creep" began to re-emerge. Many developers, particularly those who had worked for the organisation since its early days, resisted and resented the changes to their working practices and project managers struggled to get their voices heard. The impact of this will be seen in the next section, in which an Expert Walkthrough (EW) will reveal the impact of the system-centred development process on the users, despite the attempts to introduce a user-centred approach to the mapping interface and functionality.

4.3.5 The Public Health Analyser Story So Far

The PHA story so far illustrates the usefulness of maps in the healthcare sector and how maps can support commissioning decisions for the NHS; they provide a visually powerful representation of local health needs. This research used a variety of mapping techniques to present the same data. A questionnaire sent to relevant health professionals identified those representations that would be more useful for the commissioners of health services, above and beyond what is currently used.

This chapter will now demonstrate that, whilst UCD efforts focused on the mapping, PHA had bigger issues. To get further insights into the consequences of the non-UCD process, and to illustrate issues that customers encountered, I subsequently carried out an EW of PHA.

4.4 Expert Walkthrough of Public Health Analyser

4.4.1 Introduction

Chapter 3 introduced iHealth and this chapter has so far reported iHealth's development of a tool for public health professionals, PHA. PHA was launched in September 2009. A General Election had been called for the following May and consequently there were big political discussions about the future of the NHS. In June 2009, the incumbent Shadow Health Minister gave a talk to iHealth about his plans to hand over the budget to Clinical Commissioning Groups and abolish the PCTs; he used the talk to endorse the work of the organisation towards a more evidence-based approach to commissioning for the NHS. However, the uncertainty over the future of the NHS and its organisation directly impacted upon the fortunes of PHA and iHealth's commitment to it.

As time passed a sense of urgency grew and the project was allocated more resources, in an act of recognition by the organisation that their structure and processes impacted directly on the design and performance of the tools. Reorganisations and some staff reductions contributed to the sense of urgency, as well as to indecision. In addition to these changes in the NHS, changes took place within iHealth. At the beginning of 2010, before the General Election, a co-founder of iHealth left the organisation and Phillip, who replaced Damian to lead the technical department, overhauled iHealth's software development process. iHealth used their new process to continue fixing usability problems with PHA, despite the uncertainty in its market; this will be touched upon later in the chapter. As part of the change in management, and to build an organisational culture around software development, iHealth stopped hiring developers on temporary contracts and redesigned the technical team, with developers given full-time employment contracts, assigned to individual products and reporting to a 'Product Manager'. This gave developers ownership and responsibility of their code and code could be traced back more easily, with the aim of fostering cleaner and more efficient code.

PHA was finally launched two and a half years after the KTP with UCL to develop its mapping functionality began. Immediately after the maps were implemented, I carried out an EW to assess the success of the implementation for the end users. In other industries, at the end of extensive and expensive projects, it is common to analyse the causes of any failures to identify areas for improvement and improve future practices. This is particularly important in the public sector with tax-funded projects, but in the private sector too, where shareholders and investors monitor the return on their investment; if investors lose money, they want to know why and evidence that the same mistakes will not be made again. In fast-moving markets it is not always possible to pause and evaluate projects in the same way and, as shown in the literature review, there are few analyses of the consequences of poor design and design processes, which could inform and improve design practice. By this stage in the PHA project the company had already invested a significant amount of money on a product that was selling poorly in the market.

I carried out an EW comprised of a Heuristic Evaluation (HE) and a CW based on a common task for which PHA would be used. Most PHA users are Public Health Analysts, Performance Analysts and commissioners of services; they have a variety of tools available to them for their work and if PHA was to succeed, it would need to be easy to learn. Consequently, the aim of the EW was to assess how well PHA supports novice and infrequent users to learn how to carry out their most simple and common tasks. Users' self-efficacy and hence their enjoyment of the system will affect their propensity to use it widely in their work; if users have difficulty with simple tasks then it is not a large leap of logic that they would be unlikely to explore the tool for its more advanced functionality. iHealth would benefit from this information because users might continue to create maps using their existing method, which might be to export the data and putting it into a desktop GIS, or use a competitor's product. This section describes a scenario in which PHA would be used to create a map and the techniques I used to evaluate the system. Strengths and weaknesses identified with the system will then be reported, followed by discussion of the limitations of these techniques and this study.

4.4.2 The Value of Heuristic Evaluation and Cognitive Walkthrough

HE is an informal usability inspection method, which requires expert evaluators to systematically critique a website's compliance with usability guidelines using a checklist. Checklists are habitually used now in safety-critical domains such as the airline industry and medical treatment to prevent accidents. The same technique is now commonly applied to the design of websites to identify usability errors and their severity. It is used early in the design process to ensure established web design guidelines are not contravened. HE can be completed early in the design process so any usability problems identified are easier to rectify; furthermore, no advance planning or ethical considerations are required since participants are not recruited (Preece et al., 2007). However, HE does not directly suggest how to solve the usability problems it identifies (Nielsen and Molich, 1990). Consequently, HEs do not normally generate design breakthroughs but are more concerned with identifying as many problems as possible. HEs can identify usability problems that do not appear during testing (false negatives); for example, we will see that this study identified that the font size is too small, which is unlikely to be articulated by users. Conversely, HE can overlook major usability errors; for example, its design renders it liable to miss problems users encounter in navigating a system for different tasks. In addition, there is an "evaluator effect" associated with HE, which means that multiple evaluators using the same method to evaluate the same interface detect significantly different usability problems (Hertzum and Jacobsen, 2001). I was the sole evaluator for this study because iHealth did not offer any additional resources. I had limited experience of carrying out usability evaluations, and required the support of a comprehensive and thorough list of heuristics. To account for this, I used a structured report of 296 heuristics available online (Pierotti, 1995) grouped according to Nielsen's ten usability heuristics (Nielsen, 1994a); I found the lower level of ambiguity in the more structured report made it more intuitive to use.

Many heuristics are available for the design of websites (Nielsen and Mack, 1994; Weiss, 1994; Pierotti, 1995; Nielsen, 2005[6]). In contrast, the relatively recent focus on GIS usability research has yielded few heuristics; Nivala et al. (2008) demonstrates heuristics for web mapping sites. Most research has instead focused on usability engineering and user testing (e.g. Harrower et al., 2000; Andrienko et al., 2002; Haklay and Tobón, 2003; Slocum et al., 2003; Robinson et al., 2005), analysing and enhancing the usability of software both during and near the end of software development (Slocum et al., 2001).

[6] Jakob Nielsen defined ten criteria for website usability: Visibility of system status; Match between system and the real world; User control and freedom; Consistency and standards; Error prevention; Recognition rather than recall; Flexibility and efficiency of use; Aesthetic and minimalist design; Help users recognise, diagnose, and recover from errors; Help and documentation. Xerox Corporation formed guidelines based on these (Pierotti, 1995) plus two more categories: Pleasurable and Respectful Interaction with the User; Privacy.

CW entails performing a typical user task and evaluating the interface's ability to support each step (Bowman et al., 2002; Polson et al., 1992; Shneiderman, 1997). CWs are preferably performed by groups of cooperating evaluators (Wharton et al., 1994), but evaluators may work individually (Hertzum and Jacobsen, 2001). CW helps understand the system's usability for new or infrequent users, in an exploratory learning mode (Bowman et al., 2002). It can be informative since it considers the cognitive process of users and gives insight into a system's learnability. CW has some advantages over user testing because expert evaluators are generally more critical than representative users. However, evaluators can find it difficult to simulate 'typical users' in CWs, especially expert users with specialised knowledge.

In this study, a detailed but fictitious description of a PHA user (a 'persona') was created from job descriptions available online. CW cannot replace user testing, although the persona was sufficiently detailed for a reasonable simulation of a situation in which PHA would be used. I chose to use inspection methods because of my experience at the time and I could inspect the interface autonomously, and it fortuitously boosted the credibility of my work at the organisation because it demonstrated initiative. Nevertheless, it is difficult to assess how well I was able to simulate the user. Importantly, to reflect the commercial context, the evaluation included an analysis of PHA's benefit over other tools users might have at their disposal; PHA is a commercial product and needs advantages over its competition for it to sell. This analysis was informed by a colleague, who met with a customer they hoped would use PHA, how the customer currently completed the evaluation task (Section 4.5.2) I had designed, and ensured that the whole study was relevant to the company.

4.5 Evaluation Scenario

4.5.1 Methodology

Although we will see in Chapter 5 that I developed personas of end users of iHealth's systems, the organisation was not yet familiar with the concept of personas. The HE and CW, however, first required me to create a specific persona of a target user for PHA, and a detailed scenario in which they would use the tool. Although iHealth wanted to target PHA at Public Health Analysts working in PCTs, their tasks were not well defined because it was a new product in a largely untested market for iHealth. To design a typical task and user for the CW, I read job descriptions for Public Health Analysts that were available online at http://www.jobs.nhs.uk/ in order to understand the variety of work that they did. A colleague at iHealth was able to verify the tasks and types of reports that PHA users would expect and need to complete because he was supporting a customer at a PCT to analyse public health data using PHA. Once I had defined the persona and evaluation task, I then performed the sequence of actions that were necessary to complete the evaluation task with PHA.

4.5.2 Result

The profile of a hypothetical target user called "Ben" is described:

"Ben", a 29-year-old Public Health Analyst who has worked at Wiltshire PCT for 18 months, has a BSc in Biology from Warwick University and MSc in Applied Epidemiology from Nottingham University. He has good knowledge of epidemiology, disease, determinants of health, research and statistical methods and data validity and reliability issues. His advanced data analysis skills enable him to interrogate, interpret and present complex data. He regularly uses statistical software (Statistical Package for the Social Sciences) and GIS software (MapInfo), and is proficient in standard business software having previously worked in Wiltshire County Council's Research and Information department. He uses databases (Microsoft Access) but mainly relies on the PCT's Information team to provide data as they have more advanced SQL skills.

Ben's professional duties include:

- *Providing specialist advice, guidance and support regarding collection, use and interpretation of public health information to colleagues*
- *Prioritising and responding to ad-hoc requests for public health information*
- *Evaluating and identifying local needs using various research methods*
- *Auditing health equity*
- *Disseminating information via written reports and presentations for internal and external stakeholders, e.g. Strategic Health Authorities, Hospital Trusts, and Local Authorities.*

Ben mainly uses PHA for health needs assessments. His monitor is 1024x768 pixels and he uses Internet Explorer 6 to browse the internet. Ben has been asked to analyse mortality in Wootton Bassett and Cricklade, which has the highest 'All Age, All-Cause Mortality' (AAACM) rate of 20 'community' areas in Wiltshire. Further investigation revealed high under-75 female mortality, mainly attributable to Chronic Heart Disease (CHD). Ben wants to map AAACM and under-75 mortality of Lower Super Output Areas (LSOAs) for a documented report.
Table 4-5 presents the 15 steps Ben needs to carry out in order to complete this task.

1. Log in
2. Click on PHA
3. Select Wiltshire PCT
4. Click on Health Needs
5. Click on Dataset Quick-view
6. Select Category: Deaths
7. Select Outcome: Directly Standardised Mortality Rates
8. Select Demographics filter
9. Select ages under 75
10. Select View From: 2003
11. Select Analyse By: Lower Super Output Area
12. Click on Generate Report
13. Click on Map
14. Zoom in to Wootton Bassett & Cricklade
15. Click on the 'Save' icon

Table 4-5 The Optimum Action Sequence to Create a Map of Mortality in Wotton Bassett and Cricklade

4.6 Heuristic Evaluation

4.6.1 Methodology

To expedite analysis, I selected the five (out of 12) categories of usability problem from Pierotti (1995) I deemed most relevant to the study's aims to examine to expedite analysis (Table 4-6)[7], and evaluated whether or not PHA complied with each usability guideline in those categories. The five chosen categories comprised of 149 usability guidelines out of the full set of 296 in all 12 categories.

Category	Description
Match between user and the real world	The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
Consistency and standards	Users should not have to wonder whether different words, situations or actions mean the same thing. Follow platform conventions.
Recognition rather than recall	Make objects, actions and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily accessible wherever appropriate.
Aesthetic and minimalist design	Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
Skills	The system should support, extend, supplement, or enhance the user's skills, background knowledge, and expertise – not replace them.

Table 4-6 Descriptions of the Heuristic Criteria chosen from Pierotti (1995)

Each guideline in Pierotti (1995) is presented as a question (e.g. "If the system supports both novice and expert users, are multiple levels of detail available?"), to which an evaluator answers yes, no or not applicable; there is also space for comments and justification. Finally, academic colleagues advised me to rate each usability problem against a four-point severity scale they had previously used from Rubin and Chisnell (2008) (Table 4-7), to help prioritise problems for developers to fix. I used my personal judgement and their guidance to set the severity level.

Rank	Level	Definition
4	Unusable	The user is unable to or will not want to use a particular part of the product because of the product's design and implementation.
3	Severe	The user will probably use or attempt to use the product, but will be severely restricted in their ability to do so. The user will have great difficulty in working around the problem.
2	Moderate	The user will be able to use the product in most cases, but will have to make some moderate effort to resolve the problem.
1	Irritant	The problem occurs only intermittently, can be avoided easily, or is dependent on a standard beyond the product's scope e.g. a cosmetic problem.

Table 4-7 Rubin & Chisnell Severity Rating (2008, p. 262)

[7] The categories omitted from analysis were: Visibility of System Status; User Control and Freedom; Help Users Recognise, Diagnose, and Recover From Errors; Error Prevention; Flexibility and Minimalist Design; Help and Documentation; Pleasurable and Respectful Interaction with the User; Privacy.

4.6.2 Results

HE identified 16 usability problems; 5 were rated as irritants, 4 rated as moderate, 6 rated as severe and 1 rated as unusable. Appendix C2 provides the notes from the HE and Appendix C4 lists the full set of usability problems it identified, but Table 4-8 describes usability problems representative of each severity level to demonstrate how I applied the technique. Figure 4-17 and Figure 4-18 illustrate two severe usability problems. I created a sparse template for reporting results that I felt would be simple and easy to follow, and suggest how problems could be fixed; I was concerned to produce a constructive and useful report so that developers would not dismiss it, so I based recommendations on design conventions I knew at the time. I was not aware of any templates to inform its contents.

Usability problem	Severity	Suggestion for redesign
User gets a limited choice of years.	4	Explain why or let them choose.
"Ward" labels shown for LSOA on Edit Options panel (see Figure 4-17) and labels do not work.	3	Remove that option for anything other than wards. LSOA/Output Area codes are meaningless to users.
Inconsistency between the labelling of "Intervals" and "Ranges" on the Edit option tabs (Figure 4-18).	3	Will need user testing, but these should at least use the same terminology.
Icons for exporting tables to PDF and Excel do not have tool tips to indicate what they do.	2	Tool tips help the user to understand what each tool tip does
The "Generate Report" button and the "Map", "Chart" and Table" links are too discreet.	1	These are key user actions so the text could be bigger and in colour.

Table 4-8 Usability Problems found with PHA Using Heuristic Evaluation

Figure 4-17 Screenshot of the "Ward label" Checkbox for Labelling Lower Super Output Areas

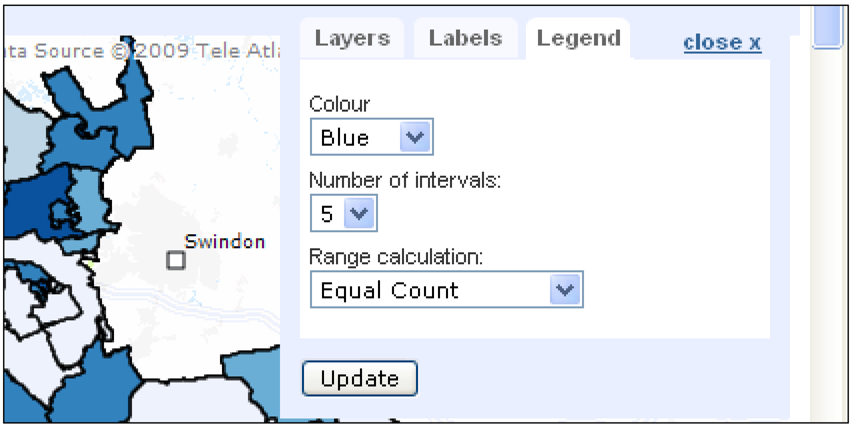


Figure 4-18 Screenshot of Inconsistency between the Term "Interval" and "Range"

These results must, however, be viewed cognisant that they were derived by a single evaluator. Nielsen and Molich (1990) found that individual HEs only find between 20% and 51% of known usability problems; three independent evaluators detect approximately 50% (Tobón, 2002), four to five identify about 80% and ten detect about 90% (Virzi, 1992).

Whilst HE identified these problems, it also highlighted some positive aspects to the design of PHA. Overall the system has a professional look and feel. Effort has been made by the designers to demystify a very complex system for the user; for example, users are able to save queries that they run regularly in a "favourites" list and also view recent queries. These concepts are familiar to internet users. Although modules are ambiguously named, each has a short description and an example query on the "Criteria Selection" page, which will help the user to understand how they can use the system (Figure 4-19). Good feedback exists throughout the system; for example, the "Criteria Selection" page updates filters as the user makes selections, giving the user confidence that their selection has been made. Although there are many filters and menus on the Criteria Selection page, users can quickly tab through them and start to type their selection; this will be useful for advanced users who are familiar with the options available. Criteria selections are cached whenever the user switches modules, negating any need to repeat selections.

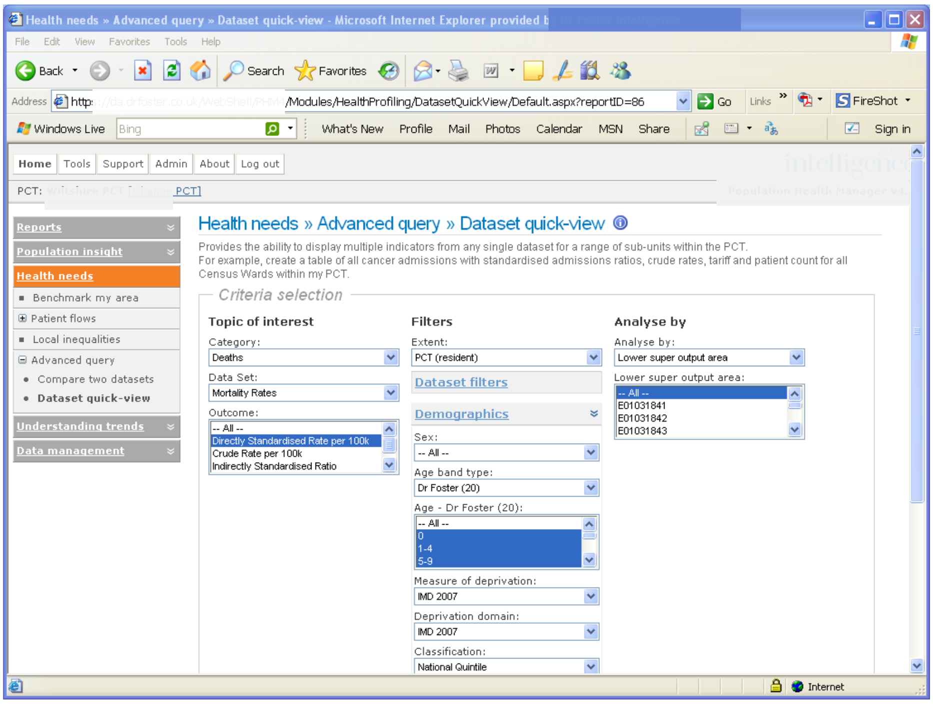


Figure 4-19 Screenshot of the Criteria Selection Page for the Dataset Quick-view Module

The map interface fills a standard 1024x768 monitor; size affects the efficiency with which users can interact with it (Haklay and Jones, 2008), since zooming and panning is not part of the user's original task. The background cartography has been simplified, which assists the interpretation and viewing of choropleth maps (Figure 4-20). Map colour schemes have been carefully chosen using ColorBrewer (Harrower and Brewer, 2003). The pan function is continuous, as recommended by Nivala et al. (2008). An effort has also been made to choose visualisations that are appropriate for the type of data being mapped (Wardlaw and Haklay, 2009). Some control over layers, labels and colour scheme for the map has also been afforded (Figure 4-18).

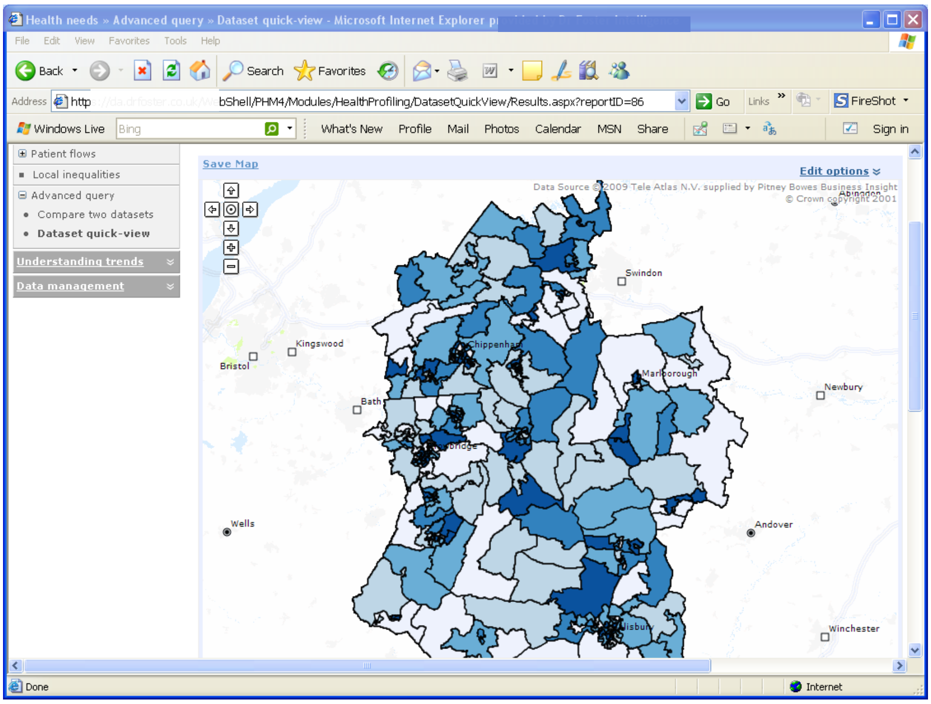


Figure 4-20 Screenshot of the Public Health Analyser Map Interface

4.7 Cognitive Walkthrough

4.7.1 Methodology

For this study, I performed the evaluation task presented in Table 4-5 and at each stage posed questions and justified answers (Table 4-9), according to Wharton et al.'s original protocol (1994).

Questions	Possible reasons for an affirmative answer
Will the user try to achieve the right effect?	a. It is part of their original task b. They have experience using a system c. The system tells them to do it
Will the user notice that the correct action is available?	a. Experience b. Seeing some device (like a button) c. Seeing a representation of an action (like a menu option
Will the user associate the correct action with the effect he or she is trying to achieve?	a. By experience b. Because the interface provides a prompt or label that connects the action to what they are trying to do c. Because all the other actions look wrong
If the correct action is performed, will the user see that progress is being made toward solution of the task?	a. Experience b. Recognising a connection between the system response and what they were trying to do

Table 4-9 Questions to be Asked at Each Stage of the Cognitive Walkthrough in Addition to Possible Justification for the Answer (Wharton et al., 1994).

At each stage of the CW, I also noted the benefit of PHA over other tools that users have at their disposal; this is important since one of the organisation's goals for PHA was that it would become a 'one-stop shop' for public health data and reduce the customers' need to gather data from different sources for themselves. The CW followed the format outlined by Polson et al. (1992), with the addition of a fifth evaluation question that asked what the system provided beyond the normal method by which users would carry out the task; this is an adaption I made to Polson's method, for which I based my assessment on conversations I had had with colleagues at the organisation. You will see in Appendix C3 that this question also underpinned responses to the other four questions.

As with the HE, I rated the severity of usability problems against the four-point severity scale in Rubin and Chisnell (2008: 262) presented in Table 4-7; this would help developers prioritise fixing the problems identified. Whilst carrying out the CW procedure, notes were made of any effective features of PHA and classified as "strengths", to be reported back to the developers to mitigate despondency and reassure them that I was their ally and not only looking for flaws in their work.

4.7.2 Results

The CW also identified 16 usability problems: 7 were rated as irritants, 6 rated as moderate and 3 rated as severe. Appendix C3 provides the notes from the CW and Appendix C5 lists the full set of usability problems it identified, but Table 4-10 highlights examples of problems with each severity rating to demonstrate how I applied the technique. Figure 4-21 shows an irritant usability problem.

Usability problem	Severity	Suggestion for redesign
Individual modules are hidden, forcing the user to make more clicks than necessary. The definition of each module is not clear to begin with.	3	Make the first page users see a criteria selection form, so that they are not forced to think about which module they need. This will help them get started with the system.
The Dataset quick-view module is found under "Advanced Query", however this is the module for all basic data queries.	2	Make "Dataset quick-view" the first page that viewers see when they log into PHA.
The double click zoom function does not centre the map so the user is forced to zoom then pan each time.	2	The zoom must centre on where the user has clicked for this zoom paradigm to be an alternative to the box zoom.
The "Save Map" prompt (Figure 4-21) is not as clear as it could be.	1	"Do you want to open or save this map?" Name: PHAmap. Type: PNG.

Table 4-10 Usability Problems Found with PHA Using Cognitive Walkthrough

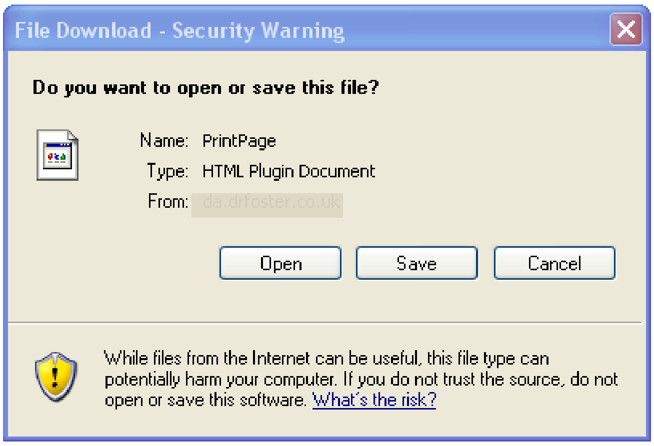


Figure 4-21 Screenshot of the Prompt Users Receive When They Try to Save the Map

4.8 Organisational Response

I now reflect on the impact these results had at the organisation. I was on a small team of designers by this point in PHA's development, and had moved outside the secure area. Although the team's formation signified a positive step towards a UCD approach and culture, their new location introduced significant challenges for communication between the designers and developers; for example, some errors with the map interface, such as boundaries not being rendered, resulted from changes that SQL developers made without consulting with the map developer.

Whilst iHealth was committed to fixing the problems PHA users reported, they allocated fewer and fewer resources to it because they had already invested a lot for little return. The studies presented in this chapter were thus limited by the resources available to me at the time, in terms of participant recruitment (finding the right type and number of participants), task selection (specifying tasks for inspection or user testing), reporting format (communicating problems and solutions for subsequent analysis, evaluation auditing, iteration and customer communication) and problem identification (tools and approaches for identifying/discovering problems) (Woolrych et al., 2011).

The organisation controlled contact with end users to protect client relations; this hindered the recruitment of participants and largely dictated that I use inspection methods. I created a target user and task, which were relatively simple to do as PHA had a clear and constrained market; nevertheless, I relied on the accuracy of colleagues' experience and contacts, and job descriptions I could find online at the time to construct them. As the evaluator in this study I was also involved in the design of the system so was very familiar with it, which could have biased both evaluations; expert users can find it difficult to recognise some usability errors because they adjust their use of the system to accommodate them. Despite this, the EW revealed errors of which I was not aware. I was also the only evaluator, which limits the number of potential usability problems found, as suggested in the literature, by the "evaluator effect" (Hertzum and Jacobsen, 2001).

In terms of task selection, PHA users' tasks were not well defined and there were no prior use cases because it was a new product in a largely untested market for iHealth; the organisation developed the requirements through conversations with intended users at conferences and the experience of individuals, rather than through a formal process. To design the task for the EW, and understand the range of work that Public Health Analysts did, I read job descriptions that were available online at http://www.jobs.nhs.uk/ and consulted a colleague, who was supporting a customer at a PCT to analyse public health data using PHA, to verify the tasks and types of reports that the users would expect and need to complete. Notice that, even without the EW, simply stepping through a task that the target user would have to complete shows that they need to complete 15 steps in order to create a map in PHA (Table 4-5); this is despite the organisation's enthusiasm for the mapping functionality and using it to sell the product.

To report the results of the study, the usability problems from the HE and CW were entered into BugNet (a software bug reporting system used by iHealth) for the Product Lead to prioritise and guided the developers to fix them; no one, including the Product Lead, was aware that they had originated from these studies. The study, however, took place when the tool was already in use, which impacted upon whether the usability problems were fixed or not; HE and CW are more usefully used earlier in the design process when the usability problems they identify will be easier to fix. In addition, a report of the results was sent to others on the design team and Phillip. The report included the background to the methods used, the evaluation scenario, the usability problems (including recommendations for how to fix them) and system's strengths that the evaluation identified (in order not to discourage the reader) and the limitations of the studies. Neither recipient, however, responded to this report.

To identify usability problems with PHA, I used published resources that provide novice evaluators with support for problem identification: a checklist (Pierotti, 1995), in the case of HE, and a series of evaluation questions (Wharton et al., 1994), in the case of CW. On the one hand, the scope of this study hindered the completeness of the HE and I influenced this in my category selection; more usability problems might have been identified had the full set of heuristics been used. On the other hand, the checklist I used was unusually long for HE, a technique that was designed to require little time. Some usability problem categories were beyond this study's scope and overlapped with the rest of the evaluation. For example, PHA contains an extensive help section but users will rarely consult this; importantly, if PHA is usable then users will not require the Help section. Many heuristics, even in the categories chosen, were not appropriate for this particular system because Pierotti's (1995) heuristics were designed for Xerox copier machines (e.g. "Have spatial relationships between soft function keys (on-screen cues) and keyboard function keys been preserved?"). The nature of the system checklist provided questions to which some had objective responses (e.g. "Are menu choice lists presented vertically?") and some had subjective responses (e.g. "Are prompts, cues, and messages placed where the eye is likely to be looking on the screen?"); consequently, a different evaluator is likely to find a different set of usability problems.

4.9 Story So Far: Learning from Public Health Analyser

Referring back to Figure 1-1, the end of the PHA project marked the end of Phase 1 of the research and a suitable point at which to reflect on the significance of what has been reported. iHealth had rapidly transformed from provider of information to the NHS, to developers of software, with little expertise or experience to manage this process. I was brought in to manage the development of the mapping functionality for a tool that the organisation was developing for public health professionals, with whom the organisation had little previous contact, other than through their social marketing projects. This was a commercial response to concurrent changes that were taking place across the NHS. A General Election was imminent and the future of the organisations that comprised a large proportion of iHealth's customer base was uncertain. PHA was finally launched two and a half years into the collaboration. It did not succeed as iHealth had hoped and individuals began to recognise that their development process was flawed and that they did not understand the requirements of their users sufficiently. When PHA was launched, I became more firmly embedded within the organisation. Up until this point my role had been more consultative, as illustrated earlier in this chapter; when recruiting respondents for the survey to gather the requirements for the map I sent it from my university email address and emphasised its academic purposes. Increasingly senior management at iHealth began to recognise that they needed to overhaul the technical department to continue to develop software in this market and recruit expertise that they did not possess at this time. iHealth lacked awareness of UCD and how to implement it; they did not have the tools or expertise to measure the performance of the tools empirically or a budget for design work.

At this time, I reflected on the initial research questions I had set out to investigate (page 21). Challenges and opportunities for UCD had emerged but appeared to be intertwined with the organisational culture. The scarcity of resources (4.8) resulted from more fundamental barriers to UCD that have been revealed by examination of the development of PHA according to Gould and Lewis (1985)'s three principles of UCD (Table 4-11); although these principles have arguably failed to stand the test of time, and do not comprise UCD's only definition[8], they have driven discussion of the UCD concept and I use them merely to reflect upon the status of UCD at iHealth at this time, where, as we shown, development of products was significantly design-led.

UCD Principle	Key Barriers
Early focus on users and tasks	• Inaccessibility of users to show prototypes or engage in user testing due to: – Time – Commercial constraints – Users' distributed locations – Poor communication between developers and customer-facing teams • Few intended users amongst existing clients and network; PHA was a new tool in a new market
Empirical measurement	• Lack of UCD awareness/knowledge within the organisation • Lack of performance metrics (Bellotti, 1988) • Lack of budget for design work
Iterative design	• Characteristics of the Waterfall development model: – Sequential – Fixed requirements – Long-term plan • The dynamic nature of the application domain

Table 4-11 Summary of User-Centred Design Barriers Encountered During the PHA Project

iHealth had limited engagement with PHA's intended users early in its design because they did not have the contacts or networks in the primary and public healthcare market at the time. iHealth felt

[8] Cockton (2008: 8) argued, "Gould and Lewis not only avoided social approaches to work, they also took design for granted…[something that] will just get done anyway." Ergo, their principles require prior existence of a design and it is to be expected that design, not primary user data, led research and practice for some time after. Cockton (2012: 6) adds, "evaluations need to…focus on the achievement of design purpose. Design purpose is [now] so potentially diverse…that a whole host of new measures and data coding schemes for evaluation are needed to truly support design."

that meeting users and changing the database architecture to meet their requirements would add time to the tools development. iHealth also had strategic reasons for not wanting to show potential or existing customers a product that was not finished; they felt it might diminish their credibility and did not want to discourage new business, or existing customers, from renewing contracts. The geographical spread of customers and end users also added to the time and cost required to meet them, and many did not have the time or interest to help iHealth develop a new product. Communication between the technical department and the customer-facing teams was also poor; remember that developers had desks behind a glass wall and users' requirements were gathered by a select group of iHealth employees who attended conferences.

iHealth's approach to product development after the launch of PHA was not iterative and inconsistent with the dynamic nature of the domain in which they worked. Instead it had many elements of the Waterfall development model described in Chapter 2; it was developed sequentially through phases: requirements analysis, design, implementation, testing, integration, and maintenance. Substantial effort was put into the project plan (including time schedules, target dates, budgets and implementation of the entire system at one time), which comprised of extensive written documentation, formal reviews, and approval by managers at the end of most phases before the next began. The literature indicates that this process comes with the risks of poor communication, predictive planning, ignoring uncertainty and change, not involving end users, and pushing high-risk tasks until the end of the project, which will impact the project scope, schedule and budget (Nielsen, 1994b: 5). The product might be late, too expensive, low quality, or it might not meet its users' needs. Such risks were exhibited by the PHA project.

The lack of user input to the PHA project had two major implications: wasted development efforts on functionality that went unused and requests for changes that the organisation did not have the resources to implement. Abstract specification documents resulted in incomplete requirements; no concrete prototypes were made, which may have reduced ambiguity. With limited access to the intended users, specifications for PHA were drawn up from knowledge within the organisation. Even with access to users, specification documents can make it hard to collect sufficient feedback from non-technical stakeholders early on in the project, when it is needed the most. It can also lead to communication problems between project stakeholders. Users provide feedback after they have seen the actual user interface or working application for the first time and may request significant changes close to the product launch. This will, in turn, impact upon scope, schedule and budget, and may result in risks being uncovered late in the project.

The mapping interface was evidently designed well but the EW suggested improvements could be made; it found the system to be essentially usable, although anticipated that users would have some difficulty to find the data and information they need because the data selection process is not trivial. System response times were good but users do not have the feeling of interactivity that they might expect. The system should distinguish between simple and advanced queries to improve the user experience so that the level of the system matched the level of the user more closely (Harrower et al., 2000). Further evaluations should compensate for the limited scope of HE and CW and test complex task scenarios; for example, it would be useful to assess PHA's effectiveness for spatial decision support since it can only present one dataset on a map at a time.

This timely reflection informed a subtle, but no less important, change in focus for the second research phase, towards the value of the methods to the organisation. Whilst I observed the challenges and opportunities just outlined, iHealth agreed to four more years of collaboration; this would enable me to observe the interplay between UCD techniques and the organisational culture, which I could already see had intriguing dynamics, in greater detail and over time. Phase 2 marks a turning point in the research process, when the organisation recognised the crisis I have portrayed and began to respond. When the project team evaluated my work within PHA, it recognised that a more holistic approach was required and expanded my role in response. The PHA project had revealed gaps in the organisation's knowledge and understanding of its end users. I was therefore given the task to create personas for all users of iHealth's tools, to introduce their voice to the development process, and for this I was given opportunities to meet with customers and users to create personas. The next chapter takes up this story and reports their development via the mixing of local resources and culture with UCD techniques as prescribed, a key emerging topic in human-centred design of which I was not aware at the time (Johnson et al., 2014).

5 Persona Development

This chapter…

- Covers the development of **personas**, after Public Health Analyser had launched, to improve the developers' understanding of end users.
- Describes techniques used and their results: **analysis of database server usage logs**, a **user-generated screen capture survey** and **interviews**.
- Illustrates how the results were combined to create personas.
- Evaluates the techniques I used to create the personas and what I learned from this in terms of the barriers to embedding User-Centred Design in the organisation.

Recall "Ben" from Chapter 4, the hypothetical user of Public Health Analyser (PHA). Imagery like this can help developers to understand why users request changes, and encourage them to consider redesign suggestions, by providing concrete detail on their tasks and motivations. Chapter 4 demonstrated that developers at iHealth had a poor understanding of the end users. They did not have regular opportunities to meet customers to understand their motivation for using the tools and technical personnel was often changing. This chapter reports the development of personas of iHealth's customers to improve the technical team's understanding of the end users, using a combination of techniques that could be carried out with the resources that were available. But first, we look at the context at this point in the research, as it is presented in Figure 1-1.

5.1 Introduction

Shortly after agreeing to collaborate for a further four years, the General Election in 2010 mandated the new coalition Government to push through reforms that would transform the management of the National Health Service (NHS). NHS organisations thus faced an uncertain future and, since they comprise the majority of iHealth's customer base, iHealth's contract renewals and new business declined. The collaboration team observed that this increasingly unstable market had an especially negative impact on sales of PHA because the management of public health services was subject to particular political debate. iHealth took the opportunity to refocus and a strategic decision to move away from the public health market, so the initial focus of the collaboration, geographical analysis techniques, was no longer of strategic importance to iHealth. The team thus needed to expand their focus to relate them to the organisation's new priorities.

Damian, who had been so instrumental in initiating the collaboration and the PHA project, left the organisation at this time. As part of a wider overhaul of its personnel and structure, the organisation recruited Phillip, to replace Damian, and transform the technical department and its development processes. Phillip took a more Agile approach to software development from day one and recruited new developers who had Agile experience. Frank, one of the organisation's original employees, also left at the end of 2009; his team of front end developers and designers, with skills in coding languages such as Java and Cascading Style Sheets, soon followed. This team was replaced by a User Interface (UI) team responsible for look and feel of iHealth products at the beginning of 2010, which comprised of three business analysts alongside two designers, including myself. Toby, who had previously led the database team and extensive knowledge and experience of the design of iHealth systems and data, switched to the role of Design Manager; a Lead Designer (Appendix D1) was subsequently recruited in June 2010. Toby's job description (Appendix D2) emphasised "functional" above "user" requirements, which reflects the organisational culture at the time.

The job descriptions illustrate the UI team's remit, which was to develop user requirements and stories. The UI team members had limited design experience, to the extent that one team member created an initial draft of user stories "off the top of my head" and compiled "a spreadsheet of user stories for the common components within the [iHealth] tools" (email, Jan 2011), which was based on a British Telecom template that Phillip had adapted and provided; each user story followed the outline, "As an end user I want to…so that I can…" The UI team collaborated to define a requirements "discovery process", which iHealth had not previously had.

Phillip had not worked with academics before and it took him some time to understand the nature of the collaboration; he was more concerned that I should be integrated within his department. He had learned from experience, however, that the new developers would need to rapidly assimilate knowledge of the end users despite the organisation's continued restriction of contact with end users to Customer Support Managers (CSMs) in order to maintain smooth customer relations.

With this in mind, he suggested that I could usefully develop personas of the key end users, drawing on my, and academic colleagues', quantitative and qualitative research skills. Importantly, I was in a good position to carry out this work because my role in the PHA project had exposed me to and given me a deep knowledge of the internal resources iHealth had for design work and how design work fitted into the business. It would also capitalise on my growing understanding of iHealth's market and customers. By this time, the technical team had accepted me as one of them and, after the organisation's overhaul, I was one of the longest serving employees. The opportunity for an auto-ethnographic approach to the research emerged, which enabled me to contribute to, yet work independently from, the technical team's day to day operations.

The research questions for this phase thus evolved to explore how I could build personas given the barriers I had to access the end users and how the organisation received them. This project facilitated closer engagement between the academic and industrial sides of the collaboration and greater visibility of my work within the technical team and across the organisation. I collaborated with Phillip to define the aims and outputs of a project based on these ideas. The project aimed to define the users of iHealth products, to develop a common understanding of users and language with which to talk about them; its output would be a document with detailed user profiles, each written in the user's language to help the developers understand how they speak, why they use the tools and the overall context within which the tools are used. iHealth developers would use it as a key reference and the new UI team would also use it to design useful and usable tools. The project team intended to turn the personas into posters for the iHealth office to provide developers with a visual reminder and to promote awareness throughout the organisation.

Personas (Figure 5-1) are hypothetical people, defined by their goals, to represent a group of real users who share common behavioural characteristics. Personas originated in the marketing profession where they are habitually used to represent a group of customers to help focus efforts. More recently personas have been used with some success in product design, particularly in software development, to put a human face on otherwise abstract data about customers; they enable developers and designers to better infer what a real user may need when opportunities to meet real users may be limited (Cooper, 2004) and can be used in training to think like an end user (Lievesley and Yee, 2007). Personas are particularly useful for the design of systems with heterogeneous users because it can be difficult for designers or developers to focus on the users' identity. To enable this, personas contain additional personal information about the behaviour, attitudes, competencies, motivations and life of the user. The impact and benefits of personas on product design is well documented in the literature (Cooper et al., 2007; Dantin, 2005; LeRouge et al., 2013; Pruitt and Grudin, 2003). They can be used for proxy user testing, to communicate user needs, to evaluate new features, inform design decisions, to help assess business decisions, and for task analysis, use cases and customer service scripts (Cooper et al., 2007; LeRouge et al., 2013).

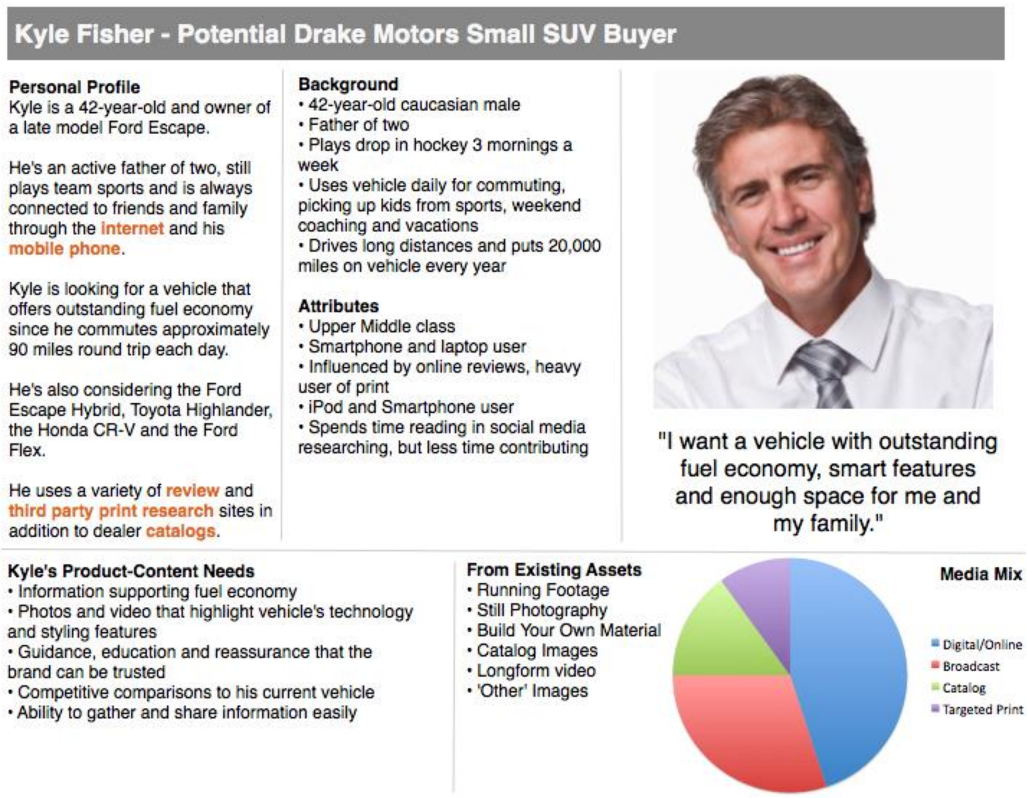


Figure 5-1 Example persona (https://www.flickr.com/photos/deizans/5525707263, 28/08/15)

Whilst a persona represents a group of users, they contain a detailed narrative about a specific, fictitious individual. The narrative describes the user's goals, needs and frustrations related to the product being designed, alongside demographic and lifestyle information to bring the persona to life. Although personas should reflect real users, it is traditionally considered more important to include precise and detailed information than it is to use accurate information about a real user (Sinha, 2003); real users can have idiosyncrasies that cannot be generalised across a complete user population (Cooper, 2004). However, more recently, literature has focussed on how personas are created; concerns exist around their reliability and validity because personas representing real users are used in product design and may take designers down a "wrong path" (Pruitt and Grudin, 2003). To avoid this, and stereotyping, personas should be based upon ethnographic research and other primary user data (McGinn and Kotamraju, 2008).

Personas have been created for products in a wide range of software domains, but particularly for websites of all types, with published examples including educational software (Dantin, 2005), environmental information (Normore, 2010) and digital libraries (Vyas et al., 2006). Recently personas have been extended to websites with more complex information architectures (Sinha, 2003) and for Critical Infrastructure protection (Faily and Flechais, 2011), that demonstrate their utility for conveying the mental model of users of complex products; this suggests that personas have potential to assist the design of systems to manage and control "Big Data".

The information needs and mental models of users are never more important and beneficial to software design than in complex, information-rich "Big Data" domains (Sinha, 2003) such as health informatics. As Chapter 2 noted, Human-Computer Interaction (HCI) researchers are increasingly interested in health informatics (Alpay et al., 2004; Graham et al., 2008; Jaspers, 2009; Karsh, 2004; Kay, 2005; Kushniruk, 2002; Pilemalm and Timpka, 2008; Rahimi and Vimarlund, 2007); the Association for Computing Machinery's Special Interest Group on Health Informatics first met in 2010 and the International Journal of Medical Informatics dedicated a special issue to human factors engineering for healthcare applications in 2010 (Beuscart-Zéphir et al., 2010). Whilst personas exist for some health technology (Calde et al., 2002), they do not in health informatics.

This brief overview of personas provides a basis from which to compare the novel persona creation process this chapter presents, which I designed to address the challenges of design contexts such as iHealth's and criticisms of traditional methodologies. I will emphasise the resources I used to apply my chosen techniques, since my research focuses on the organisational aspects of User-Centred Design (UCD) rather than the personas themselves. Although literature recommends that end users are interviewed to create personas, it was not clear at the time how easily this could be facilitated. My academic colleagues on the project had previously analysed database server log files to explore usage patterns and conducted a user-generated screen capture (UGSC) survey to obtain data about users. The project team agreed that these techniques would make effective use of the resources available for design work at iHealth and provide useful information for the personas to supplement any information I was able to obtain from customer interviews. The process of recruiting participants, selecting tasks, identifying usability problems, and reporting and disseminating results was configured accordingly.

5.2 The process of developing personas

The literature describes four main approaches for the creation of personas, distinguished by the volume and type of user data upon which they are based and the information they include (Nielsen, 2013). One approach is to base them on *users' goals* (Cooper et al., 2007); behavioural variables in user data are identified (activities, attitudes, aptitudes, motivations and skills) against which interviewees are ranked, so that significant behaviour patterns can be identified, based on users' goals, to inform personas. Pruitt and Grudin (2003) adapted this to create a pragmatic approach based on *users' roles*, in which they gathered a larger amount of information on the users initially, so personas are informed by knowledge and reasoning (e.g. market size, revenue, strategic importance). A third approach, the *engaging* perspective, was developed to mitigate the risk that personas evolve into stereotypes by exploiting the power of stories to evoke empathy (Nielsen, 2013); it conjures this through involvement and insight with information about the social background and psychological characteristics of users, and their emotional relationship with the subject matter. Finally, *fiction-based* personas can result from designers' intuition and experience and the project team's understanding of who is using a product and why (Nielsen, 2013).

Except this final fictional perspective, these approaches implicitly assume easy access to users. Specific discussion of how personas can be created for systems whose users are in large numbers and challenging to access is yet to take place; this is important because personas should represent as many users as possible. Although the rich contextual information that comprise personas is more effectively acquired with qualitative methods such as those described by Blandford (2014), the participation of users in the development of health informatics software is challenging to organise; user populations are frequently voluminous, heterogeneous and widely geographically dispersed, and their time at work is limited and valuable. Since iHealth users had these characteristics, the design of techniques to illicit user data required creativity in case few interviews were possible. The process used to create iHealth personas reflects this (Figure 5-2) and is now described.

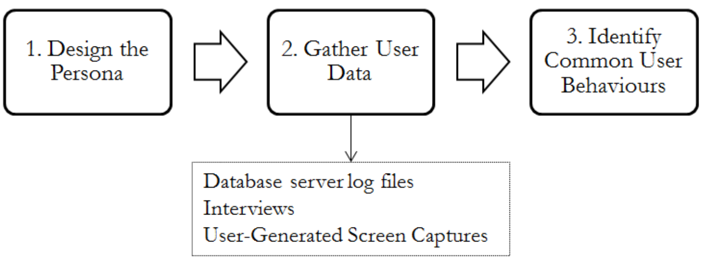


Figure 5-2 iHealth Persona Creation Process

5.2.1 Step 1: Design the Persona

The first step to create personas is to decide what information developers require to improve their understanding of how the information from the software is ultimately used. In this study I consulted the literature, and academic colleagues who had previously created personas, to identify the key components of personas (Cooper, 2004; Cooper et al., 2007). Table 5-1 lists the six components that I chose and agreed with colleagues at iHealth, and the information they included.

Persona component	Information required
Personal Information	Job title Job description How this user may look (e.g. clinician in a white coat; director in a suit) Their life outside of work
Goals	What are their reasons for using the tool? How are they using the information? What are their information needs?
Behaviour patterns	Which products do they use to obtain data and how frequently? A sample screen capture.
Environment	The organisational unit the user works in and their position in its hierarchy. Where this user may work – e.g. office or operating theatre
Attitudes	Likes and dislikes about the website Are they interested in summary information or detailed analysis?
Skills	Educational background and work experience, particularly with data and Information Technology (IT) What other software and data sources do they use?

Table 5-1 Components of iHealth Personas

iHealth personas comprised of users' goals, typical behaviour, working environment, attitudes and skills, in addition to a photo and some fictitious personal information to bring the personas to life (Table 5-1). Users' goals help designers and developers to make informed decisions about the functionality that users require from a product. Behaviour patterns pertain to the way in which, and for how long, the user interacts with and operates a system. iHealth users' background is important because different levels of computer literacy and domain expertise need to be supported. The environment in which users work can also affect their ability to complete tasks and how they interact with the system; for example, whether they can afford to spend time exploring the data or whether they need shortcuts to retrieve information in the least time. Users' attitudes (towards their job, technology and the product) reflect their values, which underpin their motivations for using the product. Skills are included because it is important that the software matches the users' computer literacy; this is particularly challenging in specialist domains such as healthcare informatics.

5.2.2 Step 2: Gather user data to inform personas

The next stage in creating personas requires consultation of user data for the information the personas require. Many data sources have been used to inform personas: primary data (e.g. surveys, focus groups, dramaturgical reading, ethnography, diary studies, interview, observation, contextual inquiries and high-level web analytics) and secondary data (e.g. information from stakeholders and domain experts, market segmentation models and data gathered from literature reviews or previous studies) (Cooper et al., 2007; LeRouge et al., 2013). Qualitative data sources tend to be preferred because they demand relatively low effort, costs are minimal, simpler persona stories tend to be better understood and few specialised skills are required (Mulder and Yaar, 2007). However, without quantitative evidence that personas represent all users, they risk reflecting existing beliefs about the users. For this reason, the use of more effortful but unbiased quantitative data sources has emerged, such as survey or web traffic data, either to validate qualitative data or in isolation. I emphasise the techniques used to capture information about iHealth users in the next section since the resource constraints on design work at iHealth impacted this part of the process the most.

5.2.3 Step 3: Identify behavioural characteristics in user data

The approaches of Cooper (2007) and Pruitt and Grudin (2003), whilst widely cited, have attracted criticism for their lack of rigor, and how difficult it is to verify that personas accurately reflect the users and to pick the right personas (Chapman and Milham, 2006). To identify the behavioural characteristics required for personas from user data, attention has turned to quantitative methods that may be repeated and more rigorous (Miaskiewicz et al., 2008). For example, Sinha (2003) used Principal Components Analysis to develop a more statistical technique for identifying the important underlying groupings in user data. Similarly Miaskiewicz et al. (2008) used latent semantic analysis, a technique used to represent similarity of meaning of terms in large volumes of text, to calculate similarity in interviewees' answers to specific questions, before hierarchical clustering grouped users with significant similarities. Tu et al. (2010) applied quantitative techniques to analyse qualitative data (questionnaires, surveys, interviews and observations) to create more reliable personas; multiple data sources are rarely combined to create personas and may be of further interest, particularly where resources for design work are limited.

Based on this literature, and leveraging the project team's experience and resources available at iHealth at the time, I set out to create personas with both qualitative and quantitative techniques: analysis of the database server log files, in addition to interviews with end-users and a UGSC survey to elicit contextual information to aid interpretation of the log files. I now review these techniques to motivate their use for creating iHealth personas. Mutual agreement dictated that UGSCs and usage data from database server log files were suitable sources of data on iHealth's end users; my academic colleagues had analysed these data for user information in similar domains and we deem them appropriate for the diversity and geographic spread of end users.

Database server log files contain rich information on users' behaviour that has yet to be exploited for creating personas.; database servers track the usage of individual users in log files, which contain information on which pages users go to, when and how long they spend on a page, and their interactions with a webpage such as selections they make on drop-down menus. At iHealth, each request to the Structured Query Language (SQL) database server is attached to an individual user for whom personal information is attributed, including their job title, where they work, and an email address. Analysis of end users' job titles could ensure that those chosen for interview, to create the personas, reflect the highest number of real users, and that behaviours they report were accurate, since users tend to have an imperfect impression of their real behaviours (Nielsen, 1996). Previously, high-level web analytics has informed remote usability evaluation; data can be assembled quickly, represent actual usage and is not prone to selection bias (Fourney et al., 2011; Frøkjær et al., 2000; Hilbert and Redmiles, 2000; Richardson, 2008; Winckler et al., 2000). Log files have also been used to assess usability computationally (Hong et al., 2001; Ivory and Hearst, 2001).

The analytics data just described are not sufficient to inform personas alone. More information is required about why the users need the tool, their goals and the context in which they use the tool, which quantitative data does not reveal. For contextual information, there is an ethnographic tradition in HCI, with a focus on methods such as interviews, contextual inquiry and diary studies, which follow users in their workplace. Although iHealth had previously limited access to users, at this point in the research the organisation permitted a number of **interviews** to take place.

The **UGSC survey** methodology is based on Haklay and Zafiri (2008). It was developed to inform the design of Graphical User Interfaces (GUIs), such as health informatics tools, for which screen captures can provide rich information about how users arrange their workspace to complete tasks (Haklay and Zafiri, 2008). UGSC surveys ask users to capture their screen whilst performing their daily tasks, thus capturing the perceptions and workflow of the users in the tradition of the "experience sampling" method (Larson and Csikszentmihalyi, 1983). Screen captures of a web-based Clinical Decision Support System have been used to research the contribution of usability to potential adverse medical events (Graham et al., 2008), but I adapt their use to inform personas.

Several methods exist for installing screen capture software on client computers; diary studies (Carter and Mankoff, 2005) and taskflow studies (Karlson et al., 2010) have used them to reveal users' goals and characteristics of their work environment across multiple centres of use and organisational settings. The approach this chapter presents is different because users generate the screen captures themselves. This has several important advantages. First, it is not always possible to get permission to install such software on clients' computers. Second, this software can slow performance if client computers are not powerful, as is common in corporate systems. Third, the request from users to take a 'typical' screen capture is more akin to ethnographic studies in which users are asked to take a picture of their working environment; users are aware of what they want to communicate and do it in a participatory way. Finally, it is easy to receive useful results because the simple process requires little effort for participants.

It was anticipated that screen captures received from iHealth users would provide information about the client-side constraints that hamper innovation at iHealth and an opportunity to test a novel methodology for evaluating tool usage, given the wide geographic distribution and diversity of iHealth's end users. Surveys are habitually used to assess users' perceptions about a system (Shneiderman, 1997; Chin et al., 1988; Dix et al., 2003). They are inexpensive and can yield a large number of responses compared to methods that require meeting users face-to-face such as usability testing (Nielsen, 1996). UGSCs do not provide the detail of traditional usability testing but are useful when information about the users' GUI is important in the design process, for example highly graphical desktop and Web-based applications such as the iHealth tools, and can reveal what users do with the software and characteristics of their work environment. For example, it would be expected that different types of iHealth users integrate the data with other software and arrange their desktops differently; analysts might have access to database software such as SQL Server, which more senior managers, such as Medical Directors, will not.

5.3 Database server log file analysis

5.3.1 Methodology

Participants and Materials

This technique did not require participants but it utilised materials held within the organisation. For this study, I analysed 12 months' data to obtain the most accurate picture of usage possible. New patient data is uploaded to iHealth's database monthly, which highly influences usage activity.

Procedure

The procedure consisted of three stages. Logs were first explored with SQL to identify which job roles should be represented by personas. When users register with the iHealth tools they set up a profile in which they can enter their job title. For this they have two options: they can either select an option from a dropdown menu or they can manually type it in. Job titles allowed for important and detailed analysis of how usage varies between user groups and ensured that iHealth personas represented as many users as possible. I compared manually-entered job titles to existing categories in Microsoft Excel, to either match them or create new categories accordingly. This was necessary because a large proportion of users manually entered their job title and would otherwise have been missing from my analysis; furthermore, some users had the same role at different hospitals but had different titles and typing errors needed to be corrected.

The next step was to identify the number of "distinct" users of all the products that can be accessed on the iHealth website; "distinct" users are defined as the number of individual users for each tool, for example if one end user accesses two tools they would count as two "distinct" users. Inactive users were removed from this analysis. A measure called "user days" was deemed the most accurate measure of usage frequency; a user day is a day on which an individual user has logged into the website. This measure was chosen since it removes multiple log-ins on one day caused by time outs or high frequency usage. The total number of user days was calculated for each tool; these totals were further broken down by the job titles that users selected when registered on the website, and the different "modules" or pages of each tool, to identify each tool's most frequently accessed page.

For each "distinct" user, I retrieved: number of sessions per month, total number of sessions, average session length and number of queries run in each session. Ultimately, this data did not inform the personas because it was too detailed and resource and time limitations dictated that I would require Toby's assistance. I will discuss this further in 5.7 and Chapter 8.

5.3.2 Results

The results of this analysis are presented in full in Appendix E1, but will now be summarised. Figure 5-3 shows that 39% of users entered their job titles manually ("Unknown/Other").

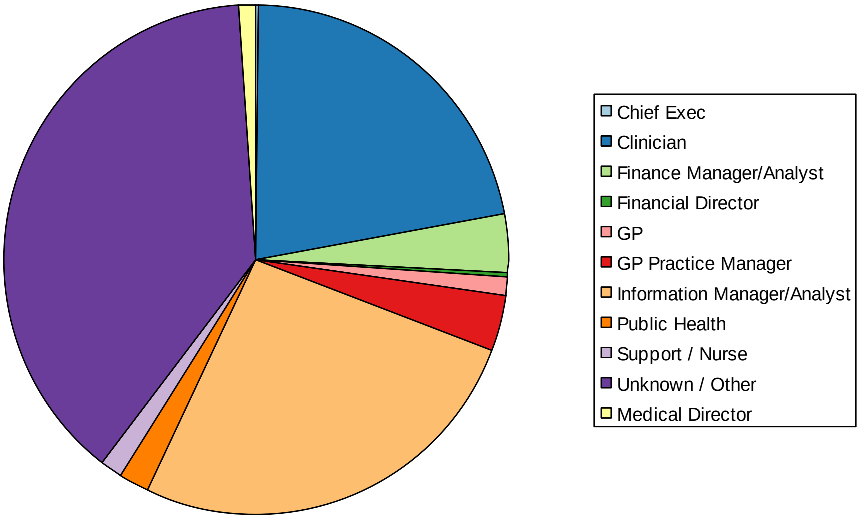


Figure 5-3 Pie Chart of the Proportion of Active Individual Users by Job Title (out of 5,551 users who logged on 14/12/09-13/12/10)

Further analysis identified that users who selected "Unknown/Other" had a wide variety of roles and worked in many different areas; the most numerous are listed in Table 5-2. The diversity of roles, and ways in which users defined themselves, in the "Unknown/Other" category was so great that I sought the advice of CSMs to further inform the choice of personas' roles.

Role	Area
Manager	Administration
Head	Commissioning
Director	Service Improvement
General Manager	Performance
Business Manager	Clinical Governance
Service Manager	Practice Based Commissioning
Facilitator	Operations
Project Manager	Nursing
Consultant	Clinical Audit

Table 5-2 Most Frequently Entered Roles and Areas of Users from the "Other/Unknown" Category

There were 11,595 “distinct” users in the 12 months analysed, of which 7,930 (68%) used three tools (Figure 5-4): Hospital Health Watch (HHW), used for monitoring mortality, readmissions and length of stay data; Care Pathway Manager (CPM), used for benchmarking clinical performance; and Referral Intelligence, used by hospitals to understand which General Practitioner (GP) surgeries are referring patients to them.

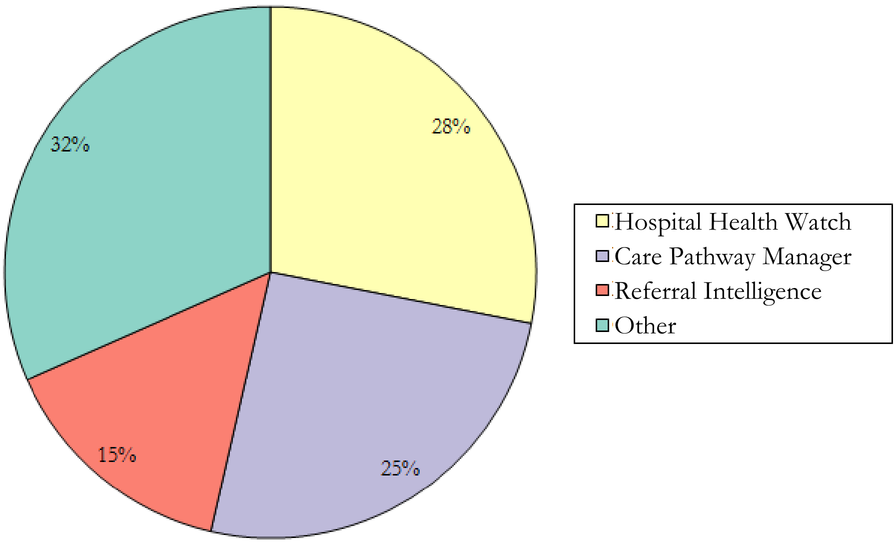


Figure 5-4 Pie Chart of the Proportion of Active “Distinct” Users by Tool (out of 11,595 who logged on 14/12/09-13/12/10)

The total number of user days was calculated for each tool (Figure 5-5); these totals were further broken down by the job titles that users selected when they registered on the website, and the different “modules” or pages of each tool, to identify which page was accessed the most for each tool. More detailed data was also obtained: number of sessions run per month, total number of sessions, average session length, average number of tools accessed in each session by each user type and number of queries run in each session. Again, this data did not ultimately inform the personas because the patterns found were not significantly noteworthy to include in the more generic user profiles recommended for personas.

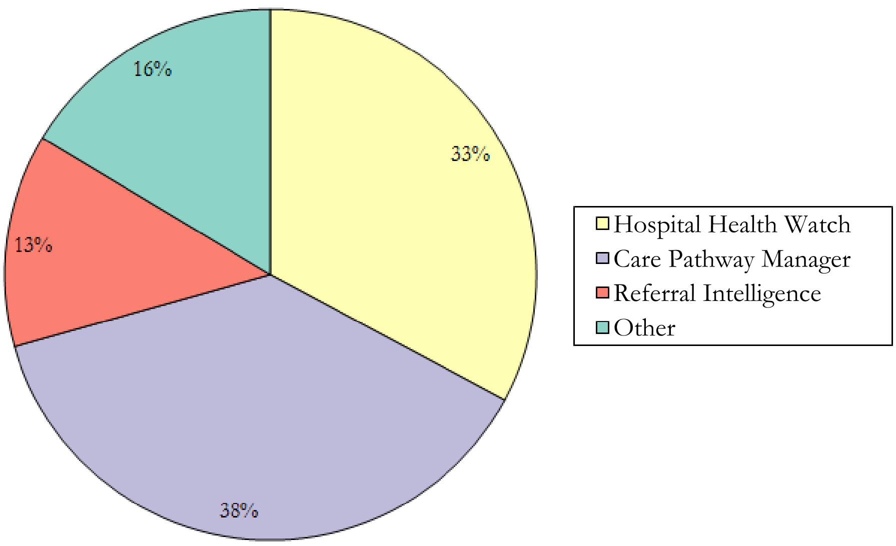


Figure 5-5 Pie Chart of the Proportion of User Days by Tool (out of 68,348 Total User Days on All Tools 14/12/09-13/12/10)

5.4 Interviews

5.4.1 Methodology

CSMs, who regularly meet with customers, provided 40 contacts in various suitable roles who might be agreeable to interview. I recruited fourteen users to participate in interviews, with the roles listed in Table 5-3; they reflected the broad range of iHealth's customers to gain a detailed picture of the context within which the tools are used, users' backgrounds and why they use the tools.

	Job titles	Dropdown menu category
1	Director of Finance and Information	Finance Director
2	Consultant in Intensive Care	Medical Director
3	Obstetrician Gynaecologist	Medical Director
4	Associate Medical Director	Medical Director
5	Head of Information	Unknown/Other
6	Head of Performance and Information	Unknown/Other
7	Head of Patient Safety	Unknown/Other
8	Consultant Paediatrician	Clinician
9	Consultant physician (interest in Hypertension)	Clinician
10	Directorate Manager for Critical Care	Clinician
11	General Manager for Clinical Governance	Unknown/Other
12	GP Liaison and Marketing Manager	Unknown/Other
13	Operational Performance Manager	Information Analyst
14	GP Practice Manager	GP Practice Manager

Table 5-3 Job Titles of Customers Interviewed about Their Usage of iHealth Tools

Most interviews were carried out and recorded within a month and the remainder took place in subsequent months. Interviews were semi-structured with a list of questions and instructions drawn up to guide the conversation and allow time for deviation. On average interviews lasted an hour. Questions were designed around the key areas required for the personas:

1. Please describe your job and, if possible, put it into context of the whole organisation.
2. Describe a typical working day or week.
3. Where do you spend most of your time working?
4. What do you like most about your job? What makes a good day and what makes a bad day?
5. What is your educational and professional background?
6. What reports and statistical analysis does your job require you to do?
7. Describe the information that the reports contain.
8. How do you present the data, in tables or charts?
9. Are you interested in summary or detailed data?
10. Where do you obtain the data you need for reports?
11. Are you comfortable on computers and internet? What software do you use for your work?
12. Which web browser do you use?
13. Are you able to install software on your computer?
14. Which iHealth tools do you use?
15. What shortcuts do you use?
16. Describe a time when the software was particularly helpful/unhelpful.
17. What do you find useful or frustrating about the tool?

Table 5-6 shows how answers to each question informed components of the personas (Table 5-1). At the end of these questions, I asked interviewees to demonstrate a typical task that they perform on the website; they could choose any task they felt represented their typical activity on the tool and, if they were unsure, I encouraged them to think of the last time they used the tool. They would then carry out the whole task flow, from logging into the website to finding their chosen data. If we had time I asked participants to demonstrate how they extracted the data from the website, who they would share it with, and how, when, why and where they presented it.

Video capture software recorded participants' demonstration of a typical task and participants commentated on their aims and thoughts at each step; this enabled me to capture serendipitous usability problems that participants did not report and more detailed information on the users' tasks and extra material to illustrate the user experience to the developers. Significantly, participants used my laptop[9], to negate the need for permissions and time to download the video capture software, and additional organisation issues; I connected my laptop to the internet with a mobile broadband dongle for the same reasons, despite any potential effects it may have had on the accuracy with which videos reflected the users' typical experience. Question 18 aligns the procedure with the traditions of Rapid Contextual Inquiry, documented by Holtzblatt and colleagues (Holtzblatt et al., 2005). I transcribed and coded the transcripts for emerging themes and information relating to the persona components listed in Table 5-1 using Atlas.ti software within two months of the interviews, whilst I could still recall details of the interaction and environment. Another member of the UI team, who had experience of working within an Acute Hospital Trust (AHT), also read the transcripts to verify the codes. This alleviated any bias my personal involvement may have caused.

5.4.2 Results

The interviews revealed insights into the users' jobs, why they use the tools, issues they have with the current toolset (particularly in relation to the data) and also recommendations for functional improvement. This information was used to create the personas (see 5.6 and Appendix E2). I also gained insight into the users' working environment by visiting interview participants, which ranged from a cubicle in a large busy open plan office to a large private office with a bay window.

Roles and responsibilities

Interviewees' responses to questions relating to their roles and responsibilities provided extra information beyond their job title, which helped me understand the wider context within which the tools are used. Interviewees' professional concerns were diverse, covering areas such as clinical governance, patient safety, care quality, finance, strategy, business development and corporate planning. I found users' work and educational backgrounds varied and not necessarily in medicine; interviewees had backgrounds in civil and chemical engineering, zoology, nursing, marketing and accounting, and one had worked up the NHS managerial hierarchy for the whole of their career.

[9] A Dell Latitude D620 with Windows XP Professional and Microsoft Internet Explorer 6, which we knew to be the most common browser on which users access the website

Responses revealed that many users have clinical duties, which take priority, including Medical Directors who retain clinical duties whilst also holding a position on the Trust Board; users carry out managerial duties when they are not in theatre or on a ward. Interviewees reportedly found their managerial role fulfilling, and enjoyed the variety it added to their work; it may not provide the instant gratification of operating on patients and seeing their health improve, but implementing a change and monitoring its effect on patient experience and clinical outcomes can also be rewarding.

Another group of users analyse data and write reports regularly. These users tend to be office-based, sometimes in open plan offices, and receive queries about the data. For example, if an AHT has been told by a PCT that their day case rate is low for a particular procedure, they can compare the day case rate for the same procedure at other AHTs in their Strategic Health Authority (region).

Interviewees disclosed a range of information requirements, from users who require quick access to high level information about hospital performance to more advanced users who want to drill down, cut the data in different ways and extract individual patient records. I found many users log on monthly when new data is uploaded to capture data for regular reports; they may use "favourites" to save time because they do not use the system often enough to be confident in their ability to use it. Advanced users log on most weeks and do not tend to use "favourites"; they are more familiar with the system and their queries are more ad-hoc. A Clinical Director said, "There have been a number of things ... that if I'd have just had favourites ... I'd have never have seen."

Many interviewees were members of committees, which require them to present reports and discuss the data. Examples of such committees are the Quality Board, Patient Safety Steering Group, Clinical Audit Committee and Clinical Strategy Group. Consequently, they spend significant time in meetings where they discuss what the data shows and devise action plans based on the data. Some users lead these meetings and discussions, whilst others compile the data and reports.

The interviews revealed that, in terms of software, many users do not use much more than Microsoft Office software on a regular basis and find the tools quite complicated to use; they prefer to export the data to Microsoft Excel where they can more comfortably filter the data and format the charts. Some users, for example Information and Performance Analysts, use other databases in their work such as the internal hospital Patient Administration System (PAS), although they can still find it quite difficult to find the data they want from the iHealth system. Users have access to other external software and data. For example, participants mentioned the Institute for Healthcare Improvement's Global Trigger Tool, which is a tool used in the NHS to identify "adverse events". A Medical Director, referring to a mortality review he was working on, said, "I am going to review all of these notes using the Global Trigger tools, looking for evidence of, not necessarily harm that occurred but, the potential for harm." Typically, users combine data from all these tools in reports, unless they are looking for a specific piece of information, in which case they will use the tool they are most confident will give them the information they need.

Some interviewees suggested they were the main user of iHealth tools at their AHT, together with one or two colleagues. To resolve any issues, they either consult these colleagues or contact support at iHealth. They do not find the Help section very useful and do not always get the data they expect when they run a report. More confident users try to resolve any issues themselves. For example, an Operational Performance Manager said, "I can work around it. Generally I don't really have too much formal training in software, it's just use it and…abuse it - you'll work it out somehow."

Main motivations for using the tools

Users have both professional and personal motivations for using the tools. Professionally, users expressed three reasons to use iHealth tools. First, iHealth's Hospital Mortality Benchmark has been high on the political agenda since an inquiry investigated a hospital's high mortality rates amongst patients admitted as emergencies (Francis, 2013). A Clinical Director said, "The most useful thing has been monitoring our mortality and then working out which…one of our disease processes seem to be the ones that score outside the range." Second, regulatory bodies such as Monitor and the Care Quality Commission set targets for mortality, length of stay and readmissions figures. AHTs report their performance against these targets in documents such as the monthly Board Report; this is a large, detailed monthly report that contains hundreds of indicators of clinical performance, presented as a mix of commentary, charts, tables and dashboards. A Head of Performance and Information said, "I use it quite extensively in the Board report." Other interviewees also used iHealth tools to collate data for the Board report. Third, AHTs also benchmark their performance against others; the Directorate Manager for Critical Care said, "There are a number of projects going on at the moment, Trust-wide, and actually really ought to be on-going projects so that we can benchmark our performance against other trusts, drill down when we have got something that isn't what you'd expect it to be, get down to patient level detail."

Personally, iHealth customers are also motivated by their own values to improve outcomes and patient experience. Most reports they compile or read are thus action-oriented. A Medical Director said, "The real power of the data doesn't come out until you take actions that change things as far as patients are concerned." The typical tasks carried out on the tools reflect these motivations.

Data issues

Analysis of interview transcripts revealed information about the participants' wider use of data and the factors that determine the reporting of data. The issues brought up will now be summarised.

The interviews revealed that users work with a wide range of internal and external data, whether they compile reports or read the reports and drive actions as a consequence. Experienced users are able to judge which figures feel the most reliable when comparing datasets. Most participants reported that they obtain data from the internal PAS (which holds patient records and tracks appointments) through requests to the Information department; for example, a Clinical Director in Medicine said, "We have a…data warehouse which I can access." They understand how those figures have been obtained and are comfortable to report them. Users also have access to other external software and data. Typically, users combine data from different sources in reports, unless they are looking for specific information, in which case they will use the tool they are most confident will give them the information they need.

Data quality and accuracy also came up in discussions. iHealth customers want to know more than just the numbers; they want to know how reliable the numbers are. For this reason they sometimes put data into Statistical Process Control programs. One Medical Director was especially concerned. "Poor information goes in, results in poor information coming out." This is a particular problem when benchmarking too according to one interviewee who said, "That's a big issue for me, finding [another AHT] you know is recording things in a similar fashion."

Connected to this is the timeliness of the data. One Medical Director said, "The power of data decreases very quickly if it's rather aged data." Data must be as up-to-date as possible. A Director of Finance and Information gave the example that if a trend for increasing mortality up to June is only reported in November, it is very difficult to act on it.

Relating to both the data's timeliness and accuracy, some interviewees raised concerns about the amount of unclassified data; users only report data that has been coded. Admissions that have not yet been coded under the Internal Classification of Diseases Tenth Edition system for diagnoses are categorised as "residual codes unclassified". Whilst they demonstrated a typical task for which they used the tool, the Head of Performance and Information commented, "There's an awful lot of uncoded activity in there to be reporting mortality and length of stay against."

The complexity of the data held at iHealth cannot be overstated. Its complexity can impede iHealth end users' ability to use the system; users can take a long time to find the data they need. This is a particular issue for infrequent users such as clinicians who are very busy; even clinicians who have additional managerial responsibilities spend 70% of their time on clinical duty. This is compounded by the slow speed of the networks in the NHS; more than one interviewee reported logging onto the tools at home in the evening because it was too time consuming on the computer in their office. Users have different levels of proficiency on the tools depending on how frequently they use them; users who spend more time on the tools are more proficient and confident in their ability to find the data they need by navigating the tools. Furthermore, users are often unable to cut the data in the way they need, even for a simple analysis to find the number of deaths per month. A GP Liaison and Marketing Manager, for example, was very clear that, "It's not flexible enough to run it the way I want it." Some users combine more than one report to get the data they need.

Data is presented in summary, dashboards, tables and charts depending on the audience; for example, one interviewee said they write a prose report for the Board to complement and aid interpretation of the tables and charts. Participants presented detailed information in tables and tended to use charts or dashboards to make it easily accessible. An Associate Medical Director explained that, "What you should be having is at each level it goes up…the probing of the data is increased, but less information needs to go up." This corroborated other interviews; the more senior the individual's role, the more interested they were in summary information and less in the actual detail. If data suggests action is required they instruct someone to investigate and analyse it by individual consultant, for example, to see who is responsible.

The format of reports and presentation of the data is very important; some users create templates in Microsoft Excel for the Board Report and simply copy and paste in the data because they cannot produce the graph they need within the iHealth tools. Different users require different presentations of the data, so iHealth have difficulty to provide one graph format that will meet the needs of all users. UGSCs verified this finding with many showing tables of data rather than charts.

5.5 User-Generated Screen Captures

5.5.1 Methodology

	Research questions	Objectives
1	How are the iHealth tools used? How many other applications do users run concurrently and what types of applications are they? Are users multi-tasking and using Microsoft Excel together with iHealth tools?	To inform functionality such as what software export functionality should be developed for, and to inform button and icon design so that they are familiar to users. To find out the technical expertise of users.
2	How do users customise their desktop for multitasking? Do they tile or overlap windows or do they tend to use full screen display?	To inform how the user interface and its elements respond to being resized. This is especially important for large drill down menus, tables, maps and graphs.
3	Do experienced and inexperienced users differ in the way they use the iHealth Tools?	To inform how experienced users may use shortcuts and any favourites they may have saved; novice users may need more guidance through the system to find the information they need.
4	What proportion of the screen is assigned to iHealth tools and to other applications?	To inform the user interface layout, how cluttered it can be and how it responds to resizing.
5	What screen resolutions and web browsers are generally used by users of the iHealth tools? Do they have additional tool bars and gadgets open that restrict the effective screen space?	To focus development efforts and resources by informing developers which browsers they should develop the iHealth tools to be compatible with.

Table 5-4 Research Questions and Objectives of the User-Generated Screen Capture Survey

The research questions listed in Table 5-4 were devised to ensure that the UGSC survey would inform the personas, as depicted in the final column of Table 5-6.

Participants were recruited by using the email addresses of users who had agreed to be emailed by the marketing team at iHealth; this ensured that participants were distinct from those interviewed, whose usage was captured on screen. Another researcher affiliated to iHealth was carrying out a study on the users' information needs at this time, and the organisation was keen that users would only receive an email to request participation in one of our studies, so that the emails would not confuse or upset users. I worked with the other researcher to divide the email list between us because they needed to email an equal number of large, medium and small AHTs for their study. I ultimately emailed 6,942 active users of iHealth tools at 57 AHTs to ask for screen capture data.

Users were asked to provide a screen capture of their entire screen while they were in the middle of their work, at about 10 or 11am, a time chosen to reflect core office hours when they could be using iHealth tools. A questionnaire supported the screen captures to obtain contextual information about the users and the task they were carrying out when they took the screen capture; questions explored specific aspects of the task to aid interpretation of the screen capture:

1. What is your job title? How long have you been in the job and using the iHealth website?
2. How frequently do you use the iHealth website?
3. What question were you trying to answer with the website when you took the screenshot?
4. Were you able to answer the question and how long did it take you?
5. How will you be using the information from the website?

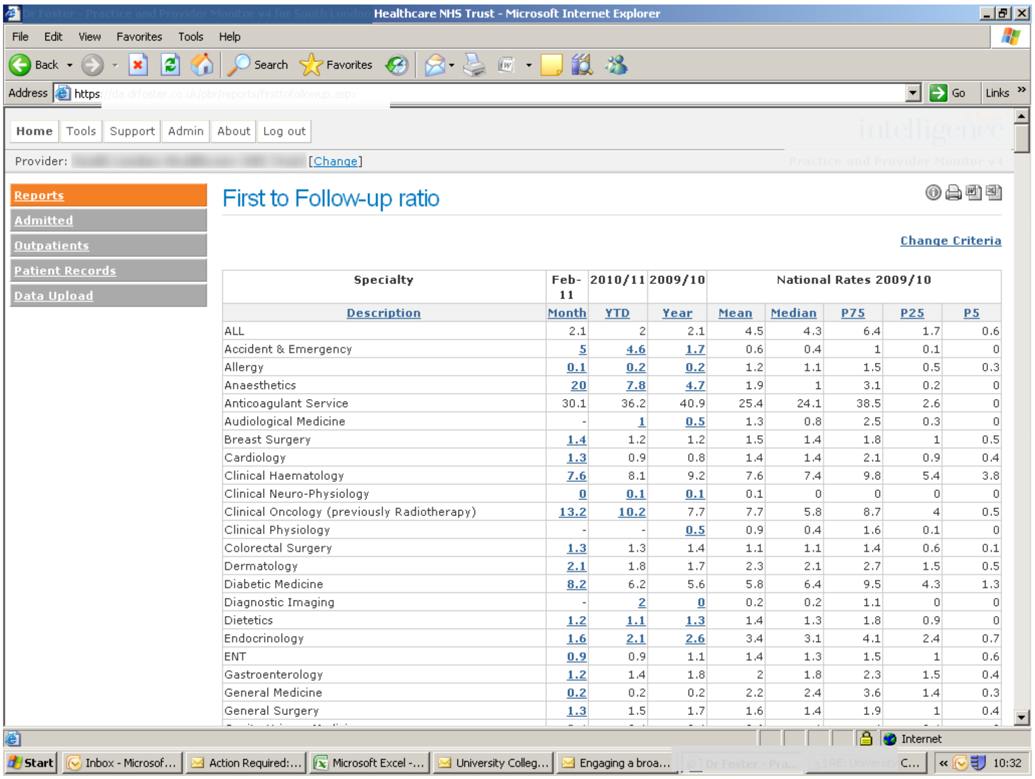
The whole procedure was designed to require less than five minutes' attention from participants.

5.5.2 Results

The survey received 29 responses with all the information requested. I deemed that this low response rate still provided sufficient information to merit analysis, even if I could not verify participants' motivations or the representativeness of the screen captures they provided. Answers revealed that about half the respondents (14 out of 29) accessed iHealth tools once or more per week. Over a third (10 out of 29) also accessed the tools monthly, when data is uploaded or they have a particular report to write, such as the Board report. Respondents' jobs ranged from Information or data jobs e.g. Head of Information, Information Analyst or Manager (7 out of 29); Marketing Managers and Business Analysts, to Management Consultants and a Clinical Director.

Screen captures revealed that the effective screen space on the interface is good; only one respondent sent a screen capture in which the browser window did not fill the screen, suggesting that users intuitively take advantage of screen real estate when using the iHealth tools. It also suggests that users are generally focused on the task they are trying to complete when using the system and do not multitask, although this could have been because the study asked users to send a screen capture of the iHealth tools. Also noteworthy is that 27 out of 29 respondents used the web browser Internet Explorer, whilst the remaining two used Mozilla Firefox. This confirmed interview findings and has direct implications for the tools' development. Most users would need to install add-ons to access technology such as Adobe Flash; interviewees indicated that they would be unable to do this without an administrator's help.

19 out of 29 screen captures included tables (e.g. Figure 5-6) and six included the "criteria selection" where users select data; from this it can be inferred that these are important in the users' tasks. Two users (Head of Performance and Information, and a Public Health Scientist) used two monitors, which Google Analytics and iHealth database server log files do not capture.



Specialty	Feb-11	2010/11	2009/10	National Rates 2009/10				
Description	Month	YTD	Year	Mean	Median	P75	P25	P5
ALL	2.1	2	2.1	4.5	4.3	6.4	1.7	0.6
Accident & Emergency	5	4.6	1.7	0.6	0.4	1	0.1	0
Allergy	0.1	0.2	0.2	1.2	1.1	1.5	0.5	0.3
Anaesthetics	20	7.8	4.7	1.9	1	3.1	0.2	0
Anticoagulant Service	30.1	36.2	40.9	25.4	24.1	38.5	2.6	0
Audiological Medicine	-	1	0.5	1.3	0.8	2.5	0.3	0
Breast Surgery	1.4	1.2	1.2	1.5	1.4	1.8	1	0.5
Cardiology	1.3	0.9	0.8	1.4	1.4	2.1	0.9	0.4
Clinical Haematology	7.6	8.1	9.2	7.6	7.4	9.8	5.4	3.8
Clinical Neuro-Physiology	0	0.1	0.1	0.1	0	0	0	0
Clinical Oncology (previously Radiotherapy)	13.2	10.2	7.7	7.7	5.8	8.7	4	0.5
Clinical Physiology	-	-	0.5	0.9	0.4	1.6	0.1	0
Colorectal Surgery	1.3	1.3	1.4	1.1	1.1	1.4	0.6	0.1
Dermatology	2.1	1.8	1.7	2.3	2.1	2.7	1.5	0.5
Diabetic Medicine	8.2	6.2	5.6	5.8	6.4	9.5	4.3	1.3
Diagnostic Imaging	-	2	0	0.2	0.2	1.1	0	0
Dietetics	1.2	1.1	1.3	1.4	1.3	1.8	0.9	0
Endocrinology	1.6	2.1	2.6	3.4	3.1	4.1	2.4	0.7
ENT	0.9	0.9	1.1	1.4	1.3	1.5	1	0.6
Gastroenterology	1.2	1.4	1.8	2	1.8	2.3	1.5	0.4
General Medicine	0.2	0.2	0.2	2.2	2.4	3.6	1.4	0.3
General Surgery	1.3	1.5	1.7	1.6	1.4	1.9	1	0.4

Figure 5-6 Screen Capture of a Table whilst Other Applications are Open (e.g. Microsoft Excel)

Respondents sent screen captures of different resolutions representing the 'screen assets' of end users. Screen captures revealed that the iHealth tools interface contains more white space when viewed on larger monitors (Figure 5-7 and Figure 5-8). A calculation reveals that the bar chart in Figure 5-7 occupies 32.6% of the screen, compared to 26.5% for the graph in Figure 5-8; these Figures also show different tools and illustrate the white space on a large monitor created by the menu on the left of the screen.

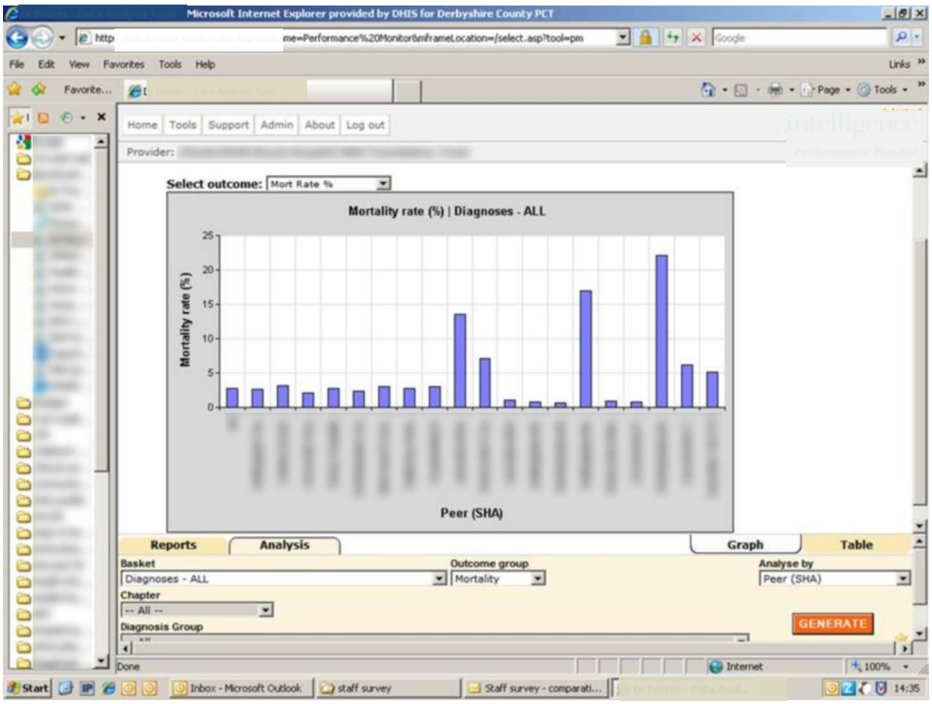


Figure 5-7 Screen Capture of a Bar Chart on a 1024x768 Pixel Screen

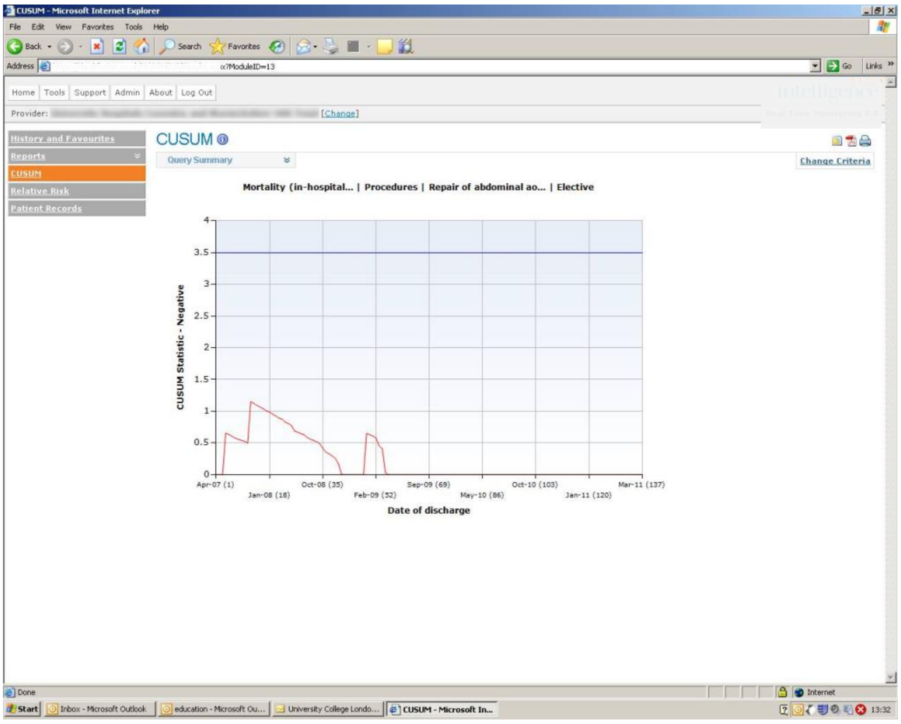


Figure 5-8 Screen Capture of a Cumulative Sum Control Chart on a 1280x1024 Pixel Screen

Screen captures validated many of the findings of the interviews, in terms of the users' tasks and how the information from the tools is being used. For example, screen captures provided further evidence that users integrate the data into Microsoft Word documents for reports such as the Board report and do not use many software applications other than those provided by Microsoft Office. This indicates users' technical capability and resources. 15 of 29 respondents had Microsoft Excel open (often multiple spreadsheets) and 10 had Microsoft Word open. Only one respondent did not have Microsoft Outlook open, and they were accessing email via the web. This is not such a surprising result since the survey was carried out by email, but still suggests that users have their email client open whilst using the tools, which can interrupt their workflow. Four respondents were apparently working with local databases, although this was not verified. One respondent was using MapInfo, a Geographical Information System desktop software package, when they took the screen capture, and another was using Statistical Package for the Social Sciences, a statistical analysis software, indicating their technical skill.

5.6 Personas

5.6.1 Methodology

Despite only having the results of 14 interviews and 29 screen captures, I was aware that the organisation expected me to produce personas. Fortunately, I had confidence by now that I had built up sufficient knowledge of the customers and end users, from the length of time I had been at organisation and speaking to colleagues that regularly met with them face-to-face, that I proceeded to create profiles of iHealth's different user groups. I chose nine roles for the personas (Table 5-5) to reflect differences in usage patterns between users and the diversity of their roles within the NHS (clinical governance, patient safety, care quality, finance, strategy, business development and corporate planning). They also relate to the roles of users I interviewed; personas represented more than one interviewee if they had the same role or used the tools for similar tasks. Usage patterns and technical/statistical expertise can vary according to job role and seniority.

No.	Persona Job Titles	Interviewees
1	Director of Finance and Information	Director of Finance and Information
2	Medical Director	Two Medical Directors, Associate Medical Director
3	Head of Performance and Information	Head of Information, Head of Performance and Information
4	Clinical Director in Medicine	Two Clinical Directors of Medicine, Directorate Manager for Critical Care
5	Head of Patient Safety	Head of Patient Safety
6	GP Liaison and Marketing Manager	GP Liaison and Marketing Manager
7	Clinical Governance General Manager	General Manager for Clinical Governance
8	Information Analyst	Operational Performance Manager
9	GP Practice Manager	GP Practice Manager

Table 5-5 Personas' Job Titles

I populated the components in Table 5-1 for each of the nine personas by generalising results obtained by the studies in 5.3, 5.4 and 5.5. Table 5-6 outlines how I completed each component.

Persona	Usage logs	Interviews	Screen captures
Personal Information	Job titles	Please describe your job and, if possible, put it into context of the whole organisation. Describe a typical working day or week.	Survey question: What is your job title? How long have you been in the job and using iHealth software?
Goals	The most frequently used tools and module and who uses them.	What reports and statistical analysis does your job require you to do? Describe the information that the reports contain. How do you present the data, in tables or charts? Describe a time when the software was particularly helpful/unhelpful. Demonstrate a typical task.	Survey questions: How will you be using the information from the tool? What question were you trying to answer when you took the screenshot?
Behaviour patterns	Frequency and length of log in sessions. Number of tools accessed Data queries in each session.	Where do you obtain the data you need for reports? Which iHealth tools do you use? What shortcuts do you use?	Survey question: How frequently do you use the iHealth tools?
Environment		Where do you spend most of your time working? Which web browser do you use?	Web browser and screen resolution/ monitor information
Attitudes	What level of information do users require? The modules that users access can indicate this since they provide different levels of detail.	What do you like most about your job? What makes a good day and what makes a bad day? Are you interested in summary or detailed data? What do you find useful or frustrating about the tool?	Survey question: How easily were you able to find the information you needed?
Skills		Are you comfortable on computers and on the internet? What software do you use for your work? What is your educational and professional background? Are you able to install software on your computer?	Information about the other software being used at the same time as the tool.

Table 5-6 Questions Put to Participants in the Persona Experiments

I found representative photos by searching Google for photos of people who were dressed similarly to the interviewees and were of similar age. Finally, I added the abbreviation of any iHealth products that the persona used to the top right-hand corner of the poster so that developers would consult the personas relevant to the tool they were developing.

5.6.2 Results

To illustrate how personas were created, Ian, Head of Performance and Information (Figure 5-9), will now be described; the eight other posters that resulted are available in Appendix E2.

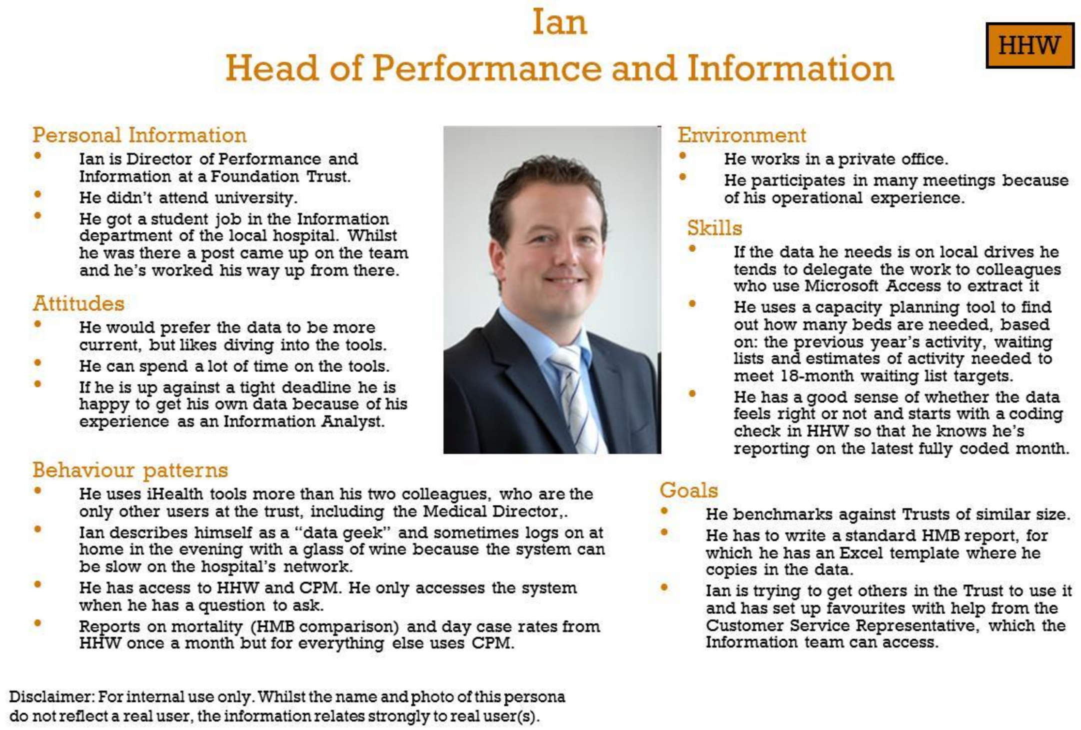


Figure 5-9 Example Persona: Head of Performance and Information "Ian"

I completed the Personal Information section using information on users' roles and responsibilities from the interviews, and responses to the UGSC survey, which asked participants to provide their job titles and indicate how long they had been using the tools. I also added fictitious personal details to bring the personas to life.

The Goals section was completed using information from all three studies: the usage logs (specifically, the most frequently used tools and module and who uses them) and responses to interview questions relating to their role (the reports and statistical analysis they are required to do, the information that the reports contain, how the data is presented and an example of when the tool had been particularly helpful). This was supplemented with information from the UGSC survey, which asked participants how they intended to use the information they were getting from the tool and the question they had when they took the screen capture. This provided a broader picture of the goals of the users and reduced the bias of personas towards the interview data.

Behavioural information was obtained from interviews and also data from log files. The SQL Server log files were first filtered by users' job titles; it was then possible to identify which pages each user type accessed the most frequently and how long they spend logged in. Additionally, interviewees were asked which parts of the website they used most frequently, and which shortcuts and other sources of data they used. The UGSC survey also asked participants how frequently they used the iHealth tools.

I drew on the diversity of office environments I encountered at interviews to describe the users' environment. The interviews provided information on the users' IT situation (for example, the web browser they used); screen captures also revealed the other applications that users had open when using the software, indicating how they would ultimately use the data.

For the Attitudes section, interviewees were asked what they liked about their job, if they were interested in summary or detailed data and what they found useful or frustrating about the website. Respondents to the UGSC survey also disclosed how easily they found the information they needed. Database server log files provided further information on how much detail users required since it records which pages within each tool are accessed most frequently by different user groups.

The Skills section was based on interviewees' self-reported computer literacy (specifically, responses to the questions: Are you comfortable on computers and on the internet? What software do you use for your work? Are you able to install software on your computer?), and educational and professional background; I also noted other software they used to demonstrate a typical task.

5.7 Organisational Response

I used various means to embed the personas in the company and disseminate the results of each experiment. These will now be described and then evaluated in Chapter 8.

I presented the database server log file analysis results to the Heads of Marketing and Customer Support. The presentation mainly consisted of tables and charts that described the headline usage data and explained how the job titles were analysed. The key aim of this meeting was to discuss how the Marketing and Customer Support teams might help recruit users for interviews to inform the personas. It had the additional benefit of making important people in the business aware of the customer data within the technical department and think about how departments might work together more closely to garner customer insight. CSMs meet regularly with users and provided me with an important channel to recruit participants for the studies this chapter describes. Toby, who mined the database server usage logs for this project, has subsequently reported that he continues to exploit the log files to gain insight into tool usage on a regular basis; he did not do this before this project. He explores this data to help iHealth understand which tools each user type uses, which parts of the tools they use, which outputs they access and how frequently. His feedback is reported further in the Chapter 7.

I compiled the personas into a Portable Document Format (PDF) file that comprised a page for each persona. Phillip asked iHealth's Creative Director to make posters of the personas for the office but these did not materialise so I printed A3 posters and put them on the walls of the developers' area of the office.

Subsequently I wrote a more detailed report of the main themes that the interviews revealed to extend the scope of information conveyed by the personas; this comprised of a summary of tool usage patterns, who the users are (their job titles, roles and responsibilities and main motivations for using the tools) in addition to problems that the interview data identified (transparency of data source, data quality, timeliness of data, unclassified data, data complexity, analysis and information presentation) and recommendations that interviewees gave for improving the tool functionality. The report recommended:

- Basic and advanced versions of iHealth tools (specifically HHW and PPM) to accommodate users who need high level information and users who require the detail;
- A more comprehensive Help section and online tutorials; in particular more transparency around the data and how it is collected;
- More flexibility in how users can cut data and present information, and less restrictive criteria selection. For example, one interviewee said she reports 14-day readmissions, for which she has to run 0-6 and 7-14 day readmissions separately and "glue them together";
- An automatic email to send data to users who log in once a month to obtain the same data.
- Statistical Process Control concepts for advanced users;
- Simple and effective functionality to export information to Microsoft Office programs, for users to integrate the data into reports.

To communicate the results I presented the personas and summarised the report (with a focus on the issues that interviewees identified with using the tools), at a UI team meeting for initial feedback and at a monthly technical department meeting six months after the interviews. A twenty-minute presentation was followed by ten minutes for questions. I then shared the personas, interview transcripts and report with the team on Sharepoint so that developers understood the language used by the users and the raw data was transparent.

5.8 Discussion

This chapter has described the internal changes in the organisation's structure and personnel that took place after the PHA project to enable the development of personas to take place. I was repositioned to the new UI team within the technical department; Toby reported to Phillip, who reported to a technical representative on the Executive board, demonstrating how usability work was buried within the organisation's structure (Rohn, 2007). I collected a large amount of data on users, and generated personas with a highly innovative process, using techniques that had the benefits of "discounted" usability engineering techniques but revealed more about the context of interaction than inspection methods (Cockton and Woolrych, 2002). I attempted to integrate personas into the company in various ways, which revealed barriers and opportunities for embedding UCD in this type of organisation. This section will begin the exploration of these barriers and opportunities, which will be developed further in Chapter 8.

I am unaware of any evidence of any overt attempts to heed my recommendations or use the personas because they coincided with a much wider effort within the organisation to focus on existing users rather than to target new ones. Thus, although I cannot attribute it to my report, I am aware that significant work took place afterwards to improve the tools' Help section and provide online tutorials. Changes in the organisation at the time, outside of the technical department, meant that the timing of the report negatively affected its impact; PHA's failure had made the organisation hesitant to make any further large risky investments in development of software.

I created personas at a time of great organisational instability. iHealth felt a growing competitive pressure from the failure of PHA. Whilst literature suggests that organisational instability can be a barrier to UCD (Svanæs and Gulliksen, 2008), it forced iHealth to rethink their software development strategy. New employees with fresh ideas and open minds joined after the PHA project, so that senior management and project leadership welcomed suggestions of innovative techniques for the tools' design and challenged the developers to work with new processes (Rosenbaum et al., 2000). The timing of these events was critical for how and why this work went ahead (Carlshamre and Rantzer, 2001); I could exploit the experience and competence of the project team with complementary areas of expertise (Rosenbaum et al., 2000; Uldall-Espersen et al., 2008). Phillip's suggestion to create personas indicates an individual understanding that UCD is more than something to stick on at the end of projects like "cake frosting" (Gulliksen et al., 2006) but it was still not core to the business strategy, which is important for its institutionalisation (Venturi et al., 2006). Training developers can be more beneficial than building artefacts such as personas (Svanæs and Gulliksen, 2008).

The creation of personas revealed time to be both a barrier and a facilitator for embedding UCD within this type of organisation. It took a very long time to arrange and conduct interviews because I had to negotiate contact with end users through their account managers and they often had busy diaries so they were unavailable for some time. I also needed significant funds and time for travelling to users' offices; often I would only have time to conduct one interview on any given day because of the travel time. I felt some considerable pressure not to waste interviewees' time and to put them at ease very quickly. Analysis of interview data was very time-consuming, in comparison to how long it took to gather and analyse the database server log files and UGSCs; however, transcribing and coding the data enabled me to immerse myself and become very familiar with the interview data, and I was able to identify new insights and patterns in the data that I had not picked up in the interviews. Unanticipated constraints also added time, for example I had to successfully apply for a secure NHS email account to administer the UGSC survey (which I required since responses could contain sensitive patient data) and carefully negotiate which customers I would email with another researcher. I also had to compose the email in a way that would ensure screen captures contained the information I required.

Whilst these aspects consumed time, the nature of my research role and the project permitted me sufficient autonomy and time to learn from each technique and collaborate where I saw opportunities. Note also that the personas represented the full range of iHealth's end users and there was no explicit aim to use them for the design of a particular system. Critically, the personas were independent of day-to-day business activity, which freed their creation from the organisation's formal processes and the political aspects of design decisions (Poltrock and Grudin, 1994; Rohn, 2007); this allowed me to take a more humble, ad-hoc and opportunistic approach according to circumstances and my level of authority (Carlshamre and Rantzer, 2001). I believe that Phillip viewed the results of the project as a "bonus". The organisation's restructuring did not merge all aspects of usability within one area of responsibility, but we have seen that Phillip did make efforts to improve communication with the marketing and sales teams.

In terms of business need (Rohn, 2007) and the organisation's motivations (Mayhew, 1999a), the project's independence from core organisational activities might have hindered its visibility; the techniques I used to develop personas, however, required one-to-one communication with various individuals in the organisation, which exposed them to UCD ideas and brought together members of different teams and levels of the organisation's hierarchy (Kowalski et al., 2006). This had the added benefit that I could learn the languages of, and what motivated, the different disciplines within the organisation, which I could usefully consider as I developed the UCD techniques presented in this chapter (Rosenbaum et al., 2000). I disseminated and discussed the results of this chapter with more of iHealth's personnel than the results from Chapter 4, the PHA project. Remember that I only discussed the results of the PHA maps survey with the two map developers, my line manager and Damian, but research within large product development organisations is emphatic that managerial support is essential for the successful integration of UCD ideas and techniques (Rosenbaum et al., 2000; Venturi et al., 2006). Whilst iHealth is a relatively small organisation and focused on the development of a small range of highly specialist products, senior managerial support enabled me to carry out the work presented in this chapter (Rosenbaum et al., 2000) and forge alliances with others in the organisation (Bloomer and Croft, 1997; Mayhew, 1999a). The results of the usage data analysis were well received across the organisation's hierarchy, including Phillip's superior on the Executive Board, who emailed me directly to say how "very interesting and useful" the information looked, and that the organisation should "factor this information into how we shape our future tool design." Initial analysis of the database server log files took place six months prior to the data presented in 5.3.2. Although the organisation took minimal action based on the initial data, it made the organisation aware of the data that was available, to the extent that updated information was requested by the organisation's Managing Director six months later. The Department of Health (DoH) had just put its half of the joint venture up for sale at this time and the Managing Director sought usage data to illustrate iHealth's market position to potential buyers. This request, from the organisation's most senior individual, hints that its culture was beginning to shift towards UCD, even if individuals were not familiar with the term. The transition from vertical to horizontal discussion of my work resulted in awareness of UCD, more deeply and broadly through the organisation (Carlshamre and Rantzer, 2001).

This project highlighted the distance between developers and users, and the role of mediators, because iHealth preferred to restrict contact with end users to account managers, a practice that stemmed from historical organisational structures. Organisations may have a variety of reasons for this restriction; developers may receive requests for features from customers not representative of the marketplace, lack social skills that might damage customer relations, or be distracted from productivity (Poltrock and Grudin, 1994). I contacted users through their account managers and trusted their assessment of which end users would be suitable to interview; some interviewees therefore confessed that they rarely used the iHealth tools and were concerned that they might not be able to help me. These interviewees tended to be "customers" rather than "users" (Poltrock and Grudin, 1994) who received data from the tools second hand, so were still able to provide me with insight into how the information supported their work. The organisation thus still controlled and limited access to end users, which I can speculate constrained the knowledge about users (their abilities, tasks, domain, interaction) and products (design and technical aspects) amongst staff. In specialist application domains such as health informatics such knowledge can be slow to develop and my analysis suggests that the pace of the market and staff turnover was too fast for this knowledge to grow. The continued physical separation of users and developers perpetuated the importance of mediators (in this case the CSMs and personas) as channels of communication.

My analysis would suggest that the organisation underestimated the heterogeneity of the users and preconceptions developed because the requisite knowledge did not exist at this time due to the complexity of the domain and the large number of users who are geographically spread. I found this to my advantage when I executed the techniques reported in this chapter because there was ostensibly little to lose; I believed that any knowledge I obtained about the users would benefit the technical department at this time, which gave me Phillip's support. Whilst organisations with a large and diverse user population can have difficulty in identifying the users, this project demonstrated to iHealth how it could profit from the data their users generate with quantitative studies. Such benefits may not, however, transfer to qualitative studies, which can still suffer from low participation and response rates in complex and fast-paced domains despite the large volume of users, as this chapter demonstrates. The informal processes of the organisation become very important in this case.

5.9 Conclusion

This chapter demonstrates how and why the resources available for UCD at iHealth had improved from the time of PHA. Communication played a vital role (Bloomer and Croft, 1997; Mayhew, 1999a); the techniques in this chapter opened up many lines of communication that did not previously exist, often with unanticipated results. I recruited participants for the studies in much closer collaboration with iHealth colleagues than I was able to for PHA. iHealth colleagues across the organisation also had a much greater input into the questions for the interviews and the UGSC survey, and end users guided the task selection at the end of the interviews. Client relationships had been largely protected, as would be expected for any commercial development organisation with busy users with whom they often have to consult due to the complexity of the domain; interviews and the UGSC study were pitched as an academic exercise for the collaboration, with the benefits for iHealth being explained in full before users consented to their participation. Colleagues even assisted in identifying usability problems; for example, we saw that a member of the UI team helped to code the interview transcripts because it was within the scope of their job description. Interest in the end users of the tools had increased across the organisation, which reflected the greater value the organisation placed on UCD more generally; we saw that the email list for the UGSC study was negotiated alongside another affiliated researcher who was carrying out a survey to find out the users' information needs. This resulted from word-of-mouth and individuals recognising that the two surveys might duplicate effort. Importantly, I perceived that the end users I interviewed genuinely appreciated our meetings and the opportunity to air their views of the tools' design.

The results of the individual approaches had a mixed impact on the design and development process at iHealth; for example, UGSCs provided information on the users' monitor size. Such information can persuade developers to spend time testing at different resolutions, which can have a direct benefit for the users, but this did not happen at iHealth. Although the screen captures revealed that some users' screens can contain a significant amount of white space, which can negatively impact the users' experience, this has not influenced the layout of the iHealth tools' user interface. Interviews provided the most important information but this was the most difficult approach to carry out with the resources available at iHealth. Whilst log analysis did not contribute to the personas' content, it provided me with invaluable insight into which users I should approach for interview, and it enlightened others in the organisation that the data was available and could be used to look at customers' behaviour without contacting them.

This chapter presented approaches that could be used, with the resources available, at the time. Whilst the representativeness of screen captures, interviewees and personas cannot be established, and the personas may not have had the impact they might have had if I had created fewer, the organisation showed increasing signs of understanding how they could, and importantly why they should, engage the users more in the design process.

5.10 Epilogue

The personas took seven months to create, due to the nature of the work, which required travelling to interview a sufficient number of end users and lengthy analysis. The project was fundamental for the research, since designing usable Information Visualisation products depends on a thorough understanding of the users. It also provided an excellent opportunity to forge links with customers who could be contacted for future usability testing. This study significantly increased the research's visibility and UCD internally at iHealth, since results interested sales and marketing teams.

I have hinted that I carried out this phase of research just prior to a period of massive changes at the organisation. These will be described in more detail in the next chapter but, around the time that the Health and Social Care Bill was passed, the Government transferred their share in iHealth to the DoH and they put it on the market. In amongst all this, the Managing Director left the organisation and a significant number of staff was made redundant, including Phillip, and I was put under the supervision of an Executive Board member we will call Ralph. I was far into my programme of study at this point and was spending an increasing amount of time at UCL for my personal and professional development, but I still had a desk at the iHealth office where I sat with the UI team. Many software development projects were put on hold during this period, until the waters settled. Instead the business decided it would be more prudent to focus product development resources on the products for which they already had a solid customer base, particularly amongst AHTs. During this time, Ralph assigned me shorter projects that I could complete alone, for example, reviewing the licenses the organisation held for geographical data.

I was beginning to find that, in the same way that software products do not sell themselves, the UCD techniques I had introduced were also struggling to sell themselves (Carlshamre and Rantzer, 2001). For example, we have seen that, despite repeated requests, the Creative Director at iHealth did not produce posters of the personas and I ultimately printed them myself. Although the persona posters were removed when the office space was reorganised, the personas resurfaced later with the redesign of HHW as Effectiveness and Efficiency Dashboard. In the aftermath of the redundancies, a vacancy was created for someone to lead the design of this new tool and he enlisted my help after receiving the document I created about the personas by a colleague. The ensuing chapter picks up the story here.

6 Usability Tests: Effectiveness and Efficiency Dashboard

This chapter:

- Describes usability tests to redesign iHealth's flagship product.
- Explains selection of participants, design of test tasks, how sessions proceeded, the data collected and how results were reported and fed back into the development process.
- Reports how different members of the organisation received the results and their response to them and the influence that the results had on the final product.
- Evaluates the success with which tests were integrated into the development process and whether iHealth changed their approach to product development as a result.

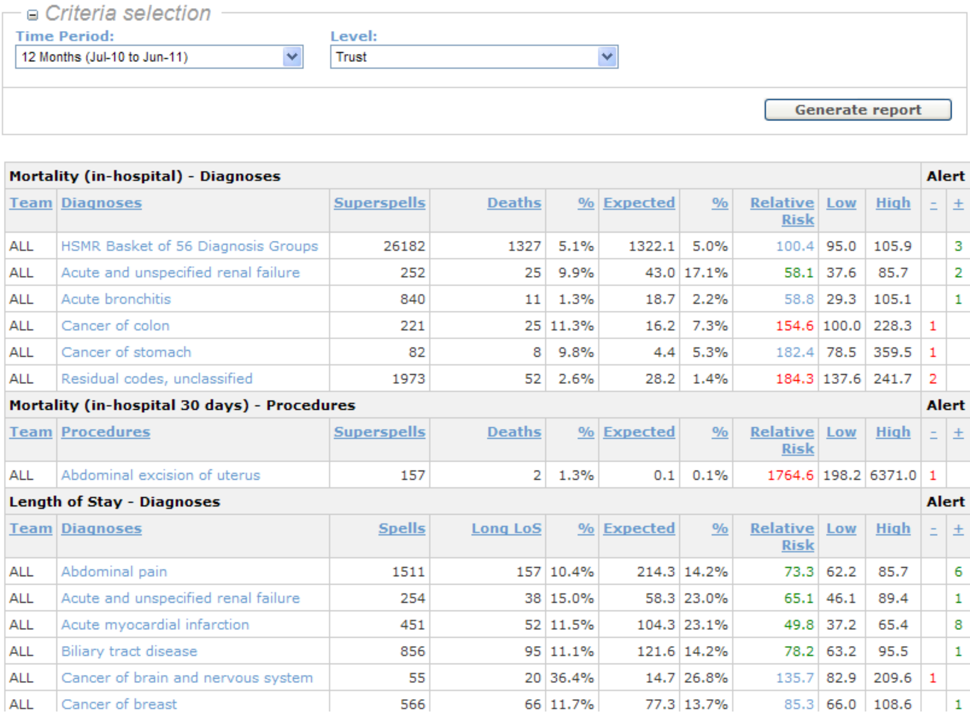
"I quite like it when I use it – it's just having time to do a different system when I know it will take me three minutes to go in on a system I use…or 10 minutes on a system I'm not familiar with."

This was the response of a user of iHealth's 'Hospital Health Watch' (HHW) when asked about its replacement, Effectiveness and Efficiency Dashboard (EED). Users will frequently be averse to change; once their brain is programmed to act in a particular way they often dislike having to learn a new way to do things. Many product development organisations face this challenge: keeping ahead of the competition, being innovative, whilst keeping existing users on board. This chapter will show, however, that users welcome change that improves their experience and does not force them to relearn things but dislike change that might improve their lives if they do not perceive its value.

6.1 Introduction

You saw in Figure 1-1 that in 2011, the coalition Government, in power since May 2010, intended to restructure the National Health Service (NHS), from a top-down to a bottom-up managerial framework. A white paper, *Equity and Excellence: Liberating the NHS*, outlined these proposals within two months of the election and was followed by an implementation plan, '*Liberating the NHS: legislative framework and next steps*', in December 2010. The House of Commons subsequently received the Health and Social Care Bill at the beginning of 2011. Mounting opposition to the proposed reforms, from some Liberal Democrats and the British Medical Association, led to the Government announcing a "listening exercise" to reflect on and improve the proposals in April 2011. The Bill was then recommitted to a Public Bill Committee in June and passed by the House of Commons in September 2011. The House of Lords approved the Bill in principle in October but revisions they requested delayed its passing until March 2012.

The Bill radically altered how NHS healthcare services are commissioned, particularly public health services which were the focus of Public Health Analyser (PHA). The uncertainty in this market area led iHealth to focus its product development efforts on its existing customer base and expertise. Rather than wait for the reforms to be passed, iHealth took the opportunity to redesign their flagship product, HHW. iHealth renamed the tool EED to distinguish it from HHW and better reflect its function. HHW already had an established and extensive customer base since healthcare managers required the data it provided for monitoring and auditing purposes. Despite usability issues, customers were satisfied with, and used to interacting with, HHW's dashboard (Figure 6-1).



Mortality (in-hospital) - Diagnoses											Alert	
Team	Diagnoses	Superspells	Deaths	%	Expected	%	Relative Risk	Low	High	-	+
ALL	HSMR Basket of 56 Diagnosis Groups	26182	1327	5.1%	1322.1	5.0%	100.4	95.0	105.9		3
ALL	Acute and unspecified renal failure	252	25	9.9%	43.0	17.1%	58.1	37.6	85.7		2
ALL	Acute bronchitis	840	11	1.3%	18.7	2.2%	58.8	29.3	105.1		1
ALL	Cancer of colon	221	25	11.3%	16.2	7.3%	154.6	100.0	228.3	1	
ALL	Cancer of stomach	82	8	9.8%	4.4	5.3%	182.4	78.5	359.5	1	
ALL	Residual codes, unclassified	1973	52	2.6%	28.2	1.4%	184.3	137.6	241.7	2	
Mortality (in-hospital 30 days) - Procedures											**Alert**
Team	Procedures	Superspells	Deaths	%	Expected	%	Relative Risk	Low	High	-	+
ALL	Abdominal excision of uterus	157	2	1.3%	0.1	0.1%	1764.6	198.2	6371.0	1	
Length of Stay - Diagnoses											**Alert**
Team	Diagnoses	Spells	Long LoS	%	Expected	%	Relative Risk	Low	High	-	+
ALL	Abdominal pain	1511	157	10.4%	214.3	14.2%	73.3	62.2	85.7		6
ALL	Acute and unspecified renal failure	254	38	15.0%	58.3	23.0%	65.1	46.1	89.4		1
ALL	Acute myocardial infarction	451	52	11.5%	104.3	23.1%	49.8	37.2	65.4		8
ALL	Biliary tract disease	856	95	11.1%	121.6	14.2%	78.2	63.2	95.5		1
ALL	Cancer of brain and nervous system	55	20	36.4%	14.7	26.8%	135.7	82.9	209.6	1	
ALL	Cancer of breast	566	66	11.7%	77.3	13.7%	85.3	66.0	108.6		1

Figure 6-1 Screenshot of the Hospital Health Watch Performance Summary Dashboard

So why change something that was ostensibly not broken? Subsequent interviews, reported in the next chapter revealed two key motivations for the redesign. First, the organisation wanted to build a tool in sustainable technologies because they recognised that the existing framework was fundamentally unsustainable. Second, competitive pressure had become increasingly fierce; the organisation wanted to keep ahead of competition by focusing attention back on their customers' needs, rather than being driven by technology and what was technically possible. Since the organisation had developed HHW, the Government had taken deliberate steps to encourage other product development organisations to enter the health informatics market to increase competition. Market intelligence showed that NHS managers often chose and preferred a product developed by a competitor, Capse Healthcare Knowledge Systems because they found it easier to use. iHealth hoped the new design would be more relevant and accessible, and easier and faster to use, and thus stimulate renewals of existing contracts and new business.

Senior management at iHealth learnt from the PHA project that the development process they employed was too rigid, and inflexible, for customers' recommendations to be implemented; they intentionally chose to change their approach to the Agile development model, including scrums and daily stand ups. For the EED project, iHealth also downsized the technical department to comprise a leaner team of developers, purposely recruited for their experience of using Agile methods and processes. Project Managers controlled the process, who reported deliverables to a Product Manager, a process employed towards the end of the PHA project.

Four years after PHA, the organisational culture at iHealth for product design and development was thus in transition from being technology-, or functionality-, led to being driven by customers. The organisation, however, was still opposed to testing products with their users before their launch. Chapter 5 presented personas of iHealth customers, which were developed as a foundation on which to build User-Centred Design (UCD) into the organisational culture at iHealth.

The changes described affected the collaboration. When iHealth made Phillip redundant, Ralph became my line manager. Ralph had significant academic experience and was highly supportive of the collaboration's aim to improve the usability of iHealth's products. He was the technical department's representative on the Executive Board and influential in the redirection of business strategy away from a product development process driven by technology, towards a process driven by customers and their needs. This positively impacted upon the collaboration. The Product Manager for EED, Oliver, had attended my personas presentation and passed on the document I created to the Lead Designer (reported in Chapter 5), and was enthusiastic about integrating the personas into the design process more. In addition, iHealth recruited a designer we will call Eric in October 2011 to lead the design of EED; importantly, Eric had experience of carrying out usability testing, which no one else in the organisation did at this time. The job description in Appendix D3 demonstrates that iHealth gave Eric scope to gather the user requirements (for example, to meet with users of the existing HHW and carry out surveys), right through to the final design of EED. I was based more at University College London (UCL) than at the iHealth offices during the development of EED, according to the project's requirements, but assisted Eric as required.

This chapter describes my input into the design of EED. This encompasses an Expert Walkthrough (EW) to inform the design of tasks for usability tests, followed by the recruitment of participants and protocol for the organisation's first attempt at usability tests. Results will present participants' task completion success, open feedback and responses to a System Usability Scale (SUS) Questionnaire. As in previous chapters, discussion will consider the following three points of interest: how I communicated results within iHealth and how they were used; the influence of the organisational culture on the techniques applied; and the techniques' influence on the organisational culture. This will identify techniques' wider benefits and their impact on the organisation's culture themes that will reappear in Chapter 8. Differences between the EW in Chapter 4 and this chapter will also be noted, since the resources available had changed in the two years between the two projects. Concluding comments will consider the study's practicalities: participant recruitment;

expertise required to design the protocol and facilitate the tests; analysis and reporting of results. This will reflect on the sustainability of integrating formative usability testing within iHealth's software development in future. To begin, I describe the EED system for the reader's benefit.

6.2 Effectiveness and Efficiency Dashboard

Developed three years after PHA, EED is a web-based tool that monitors quality outcomes and patient safety by assessing the clinical, process and coding factors of patient admissions data submitted by hospitals, such as mortality, length of stay and readmissions, all key indicators of clinical quality and efficiency. Its user interface comprises tabs for each of these indicators (Figure 6-2). Its dashboard highlights a hospital's Cumulative Sum Control Chart (CUSUM), in addition to alerts for diagnosis and procedure groups; negative CUSUM alerts (red bells) appear when indicators diverge sufficiently from expectations to suggest a systematic problem. 'Relative Risk' also provides the number of observed cases as a percentage of the risk-adjusted expected (reflecting case mix and national average). This permits analysis of patients by diagnosis or procedure group and comparison of clinical performance. The dashboard also shows the five diagnoses and procedure groups with the highest 'observed'[10] exceeding 'expected'[11] and crude rate[12]. Users can click on the 'Analysis' tab to drill down to specific data and patient records they require.

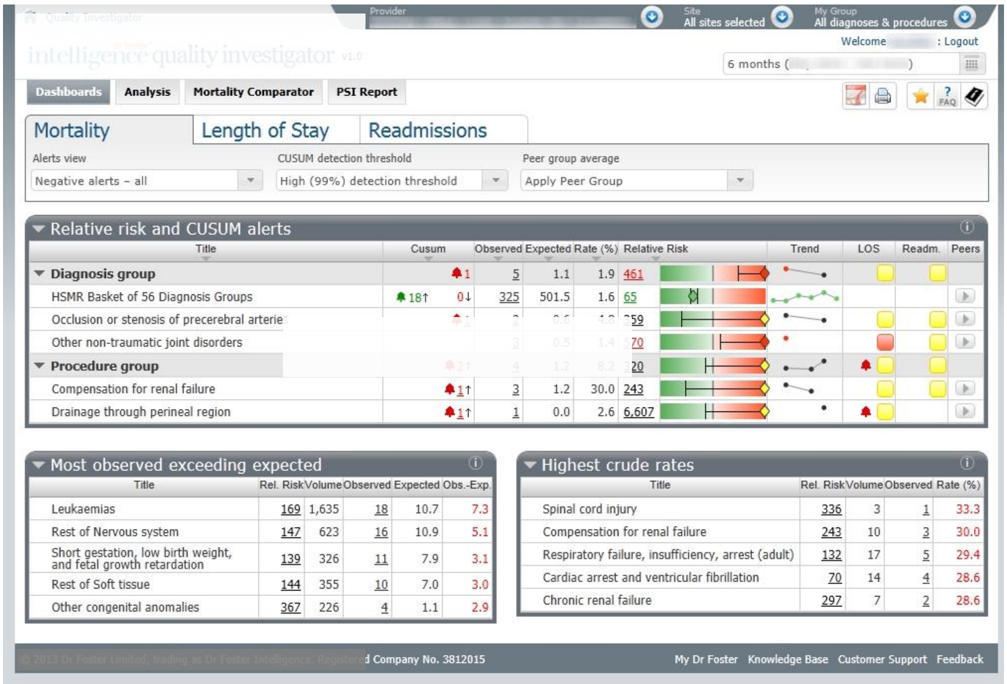


Figure 6-2 Screenshot of the Effectiveness and Efficiency Dashboard Performance Summary

The target users were existing users of HHW, such as Performance and Information Analysts, Clinicians and Medical Directors in Acute Hospital Trusts (AHTs), which are represented by the

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[10] number of cases within the selected dataset
[11] number of expected cases given the case mix
[12] observed cases as a percentage of volume

personas in Chapter 5, in addition to healthcare managers and analysts at other NHS organisations, such as Primary Care Trusts, who were not HHW customers at the time.

Eric carried out a 'discovery phase' to gather the user requirements for EED, also partly informed by the personas developed in Chapter 5. The discovery phase exploited the following resources, which were notably largely local and obtained from within the organisation, supplemented by primary data (that is core to UCD) gathered from a small number of users:

- Interviews with Account Managers;
- Feature and functionality suggestions sent in by each of the four regional sales teams;
- Loss report (reasons given for not using iHealth) provided by the marketing team;
- Competitor Analysis (based on customer and sales team feedback, and the loss report);
- 18 interviews with customers, former customers and prospects;
- An online survey with responses from 31 of the most frequent users of HHW;
- Interviews with 8 HHW users (Associate Medical Director, Quality Governance Manager, Head of Patient Safety, Consultant General Surgeon, Director of Information, Principle Information Analyst, Deputy Director of Risk & Governance, Lead Performance Analyst).

In addition, for the first time, the organisation included usability testing in a project plan. Eric recalled that the initial plan comprised "five days for the dashboard and five days for the analysis journey." Eric contacted me to see if I would like to assist him with usability tests because he was told that I was interested in the design process and had knowledge of the end users from my persona development work. We agreed that I should test EED for myself before we carried out usability tests in order to check the tasks that Eric had designed for the usability tests, identify common usability problems that might be fixed before the tests and familiarise myself with the system. To do this I used the personas (Chapter 5) to carry out an Expert Walkthrough (EW) of the new design, with Heuristic Evaluation (HE) and Cognitive Walkthrough (CW) before the usability tests. The next section will describe how I carried out these techniques, their results and outcome.

6.3 Expert Walkthrough

6.3.1 Methodology

The EW comprised of HE, followed by CW, as I was familiar with this process from the PHA project; I thus used the protocol described in Section 4.7 with one important difference: I had accrued knowledge of the end users over time. This has two important implications: 1) it would improve my ability to walk through the tool as a user, and, 2) it negated the need to create a detailed user profile as I had done for PHA, since I could bring the personas I had developed to mind without conscious effort. Importantly, personas work raised my knowledge of the domain above many other members of the technical team and since Eric had recently joined the company I was well placed to help him get to know who the users were. Eric had designed tasks for usability testing and I used these to perform the HE and CW (see Table 6-4). I was still the only evaluator for EED because I was the only person within iHealth that had experience of using these techniques and whose role provided sufficient scope.

The evaluation's objective was also different. For PHA my objective was to identify usability errors in place of usability testing, after the product had launched; for EED my objective was to identify potential stumbling blocks for the usability test participants and assess whether the tool was ready to be shown to users. I collaborated with Eric, who was not familiar with HE and CW, to set these objectives because we intended to test EED with existing users of HHW; iHealth hoped that the new design would encourage any concerned customers to renew contracts. Consequently, Eric was keen that the dashboard was sufficiently complete that participants would not encounter serious usability problems and tests would indicate whether the product was ready to launch.

6.3.2 Heuristic Evaluation Results

The HE identified 46 usability problems; 16 were rated as irritants, 16 rated as moderate, 10 rated as severe and 4 rated as unusable. The full list can be found in Appendix F1 but examples of usability problems with each severity rating are listed in Table 4-8 to illustrate the technique applied; Figure 6-3 illustrates one of these. Several of the usability problems in Appendix F1 are strongly similar to each other and could be resolved with the same change in design; for example, keyboard shortcuts, and an intelligent search that will query all the text in a menu for any items that contain the word that users type, would resolve more than one of the usability problems I found.

Heuristic	Usability problem	Severity	Suggestion for redesign
10.6	If menu items are ambiguous, the system does not provide additional explanatory information when an item is selected.	4	The help section needs to be developed in collaboration with users and to be made more accessible.
1.25	The system uses medical terminology that users may not be familiar with (Figure 6-3).	3	Speak to users to understand terminology they use.
3.8	Users are unable to cancel queries once they are running.	2	The response time is good enough that this won't apply in most cases. However, if a query takes a particularly long time to run, users will find a cancel button useful, to take them back to where they were.
4.35	Inconsistent labelling: "Start new query" on the Relative Risk tab and "Start new search" on the Patient Record tab.	1	Pick one wording and use it consistently.

Table 6-1 Usability Problems Found with Effectiveness and Efficiency Dashboard Using Heuristic Evaluation; the Number in Column One Refers to the Number of the Heuristic in Pierotti (1995)

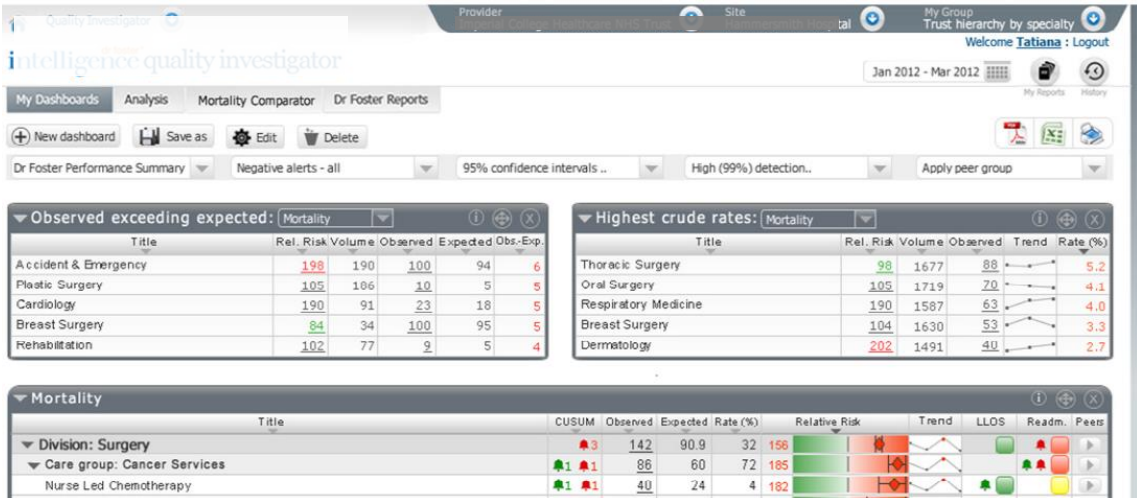

Figure 6-3 Effectiveness and Efficiency Dashboard Usability Errors: Notice how difficult it is to find the time period, 'MyGroup' and 'Sites' drop down menus, and 'History' button. Title columns are also wide, which makes it difficult for the user to read the table, and many medical terms and acronyms to learn. Drop down menus are not labelled, which makes users unsure what they do.

Table 6-2 shows that out of 292 heuristics, 167 (57%) were followed, 59 (20%) were not followed and 66 (23%) were not applicable to EED. Whilst it is beneficial for novice evaluators to use a comprehensive list, this demonstrates that the list must be chosen carefully, so that evaluators do not waste time looking for usability errors that are not relevant to the system. The checklist used for EED also contains many heuristics that are similar, which can extend the evaluation time unnecessarily; this may make it unsuitable (or insufficiently discounted) for time-pressured projects.

Category of heuristic	**Yes**	**No**	**N/A**	**Category of heuristic**	**Yes**	**No**	**N/A**
Visibility of System Status	25	1	3	*Flexibility and Minimalist Design*	3	*6*	7
Match Between System and the Real World	6	*4*	14	Aesthetic and Minimalist Design	8	4	0
User Control and Freedom	8	*5*	10	*Help and Documentation*	15	*7*	1
Consistency and Standards	37	8	6	Skills	14	5	2
Help Users Recover From Errors	14	4	3	Pleasurable and Respectful Interaction with the User	7	1	6
Error Prevention	5	2	8	Privacy	3	0	0
Recognition Rather Than Recall	22	*12*	6	TOTAL	167	59	66

Table 6-2 Number of Heuristics Met/Not Met by the Effectiveness and Efficiency Dashboard user interface, or otherwise not applicable, within each Category of Heuristics in Pierotti (1995).

I noted in Chapter 4 that previous studies tended to focus on finding the most usability problems and the proportion of total usability problems identified by different numbers of evaluators (Nielsen and Molich, 1990; Tobón, 2002; Virzi, 1992). In this study I was the only evaluator because no one else at the organisation had the knowledge or experience and I sensed doubt that time would permit it to affect the final product along with some disinterest in its results. I noted a significant number of usability errors more than once; this is demonstrated by the repetition of redesign suggestions in Appendix F1 and puts doubt on whether this technique was an effective use of time. This can also explain the notable number of unmet heuristics in some categories (in italics in Table 6-2) and predominantly assumed first time usage and not classified as severe.

Whilst the HE identified these problems, it also highlighted positive aspects to the design of EED. For example, the organisation had developed a 'loading' icon, the cursor became a hand when I placed it on links, list boxes and check boxes were used effectively, the system provided instructions and step numbers to guide users to create a group, it used familiar Microsoft Excel and print icons, and users can customise their dashboard and save their frequent queries. Figure 6-4 illustrates some of these positive aspects, but also how they were often tarnished by poor design.

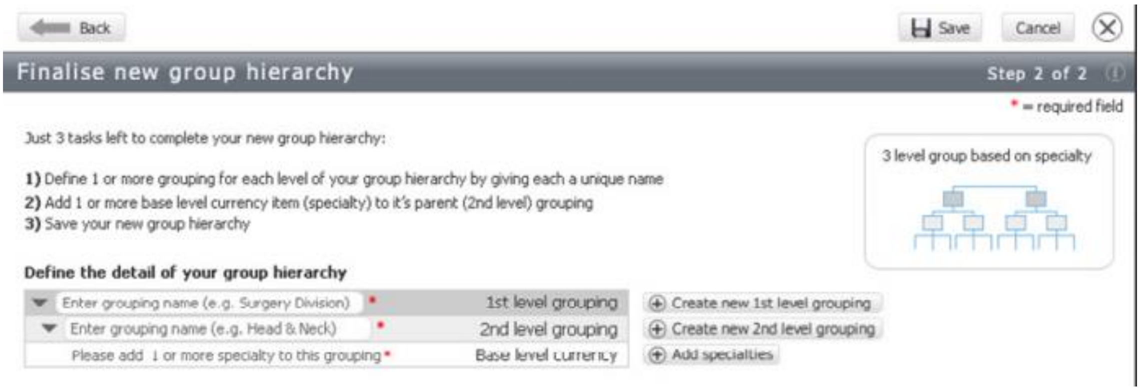

Figure 6-4 Positive Aspects of the Design of Effectiveness and Efficiency Dashboard. The new tool featured new functionality, for users to define groups of interest to them; notice good use of step numbers, instructions and diagram, to guide the user through the process of creating a group. The instructions and diagram, however, are slightly confusing and, despite 'Save' and 'Cancel' buttons, and a key to show the user which fields are required, the buttons are quite far from where the user might be looking. Colour would also improve the 'Back' and information buttons' visibility.

6.3.3 Cognitive Walkthrough Results

The CW identified 22 usability problems; 17 were rated as irritants, four rated as moderate and one rated as severe. The full list can be found in Appendix F2 but examples of usability problems with each severity rating are listed in Table 4-10 to illustrate the technique applied.

Usability problem	Severity	Suggestion for redesign
The language used for this form entry is too complex. There is an explanation underneath the header ('This is the data type that your hierarchy will be based upon.') but the mere presence of an explanation would suggest that the label for the text entry isn't intuitive. This would need to be tested with users.	3	Engage users to understand terminology they use.
Users may not immediately be aware of the time period they are looking at, and therefore whether or not there is an action to complete. That said, they are highly likely to ask themselves which time period they are looking at, and once they find the menu the action is straightforward.	2	The menu size could be increased and moved to a more prominent location to grab users' attention
The dropdown menu only states the time period, without any label to indicate that it refers to the data.	1	It would be better located above the dashboard.

Table 6-3 Usability Problems Found with Effectiveness and Efficiency Dashboard Using Cognitive Walkthrough

CW can identify the same usability problem multiple times so Appendix F2 lists only distinct usability problems; for example, interface elements that may not catch the users' eye and do not look 'clickable' even though they are.

Notice that the CW identified far fewer and less severe usability errors. This could indicate that the HE identified usability problems that will not affect users (false positives) or the CW could not identify usability problems found with HE. I may have also found more usability problems with HE because I carried it out before the CW; it also contained several ambiguous heuristics that appeared to be highly similar in nature. I did not control for these comparisons as previous studies that used CW in advance of HE have done, which concluded that, used in isolation 1) CW found fewer problems of lower severity, and 2) HE identified many more false positives (Sears, 1997); they do, however, suggest that the order in which the evaluator employs HE and CW matters.

6.3.4 Organisational Response

The EW of EED had little impact within the project or iHealth. I only discussed its conclusions with Eric because its aim was to inform the usability testing tasks and it was not formally in the project plan. The procedure was designed to inform the protocol for the first usability test session in the same way that each usability test informed the protocol of subsequent tests by anticipating usability problems that might be fixed, as the next section describes. Ultimately, the results did not influence the usability testing protocol because there was insufficient time and it was late in the tool's development; in addition, Eric had agreed test tasks with the project team based on the 'discovery phase', which identified the users' frequent tasks and which parts of EED worked at the time, without my input. I was now predominantly at UCL so I did not participate in project meetings where Eric discussed and agreed the protocol for the usability testing, and did not have the wider view of the project.

The EW was not in vain, however, as it immersed me in EED's design. I could ask Eric questions about its design that he had not considered due to his personal investment in the design. The process prepared me for the usability tests; I could better identify what problems users might have, particularly as I had met the first usability test participant when I developed personas. After I had carried out the EW we were ready to take the tool to the users.

6.4 Usability Tests

6.4.1 Background

Human-Computer Interaction (HCI) research has a long tradition of usability testing, a technique that evaluates a product by testing it with users. This technique is highly valued because it reveals how real users work with a system, in contrast to inspection methods such as HE and CW that rely on the evaluator's ability to simulate real users. Evaluators may use usability tests to assess products against a range of criteria they define, for example a product's ease of use or the extent to which a product achieves its design purpose (Cockton, 2007). It is applied to a variety of consumer products and devices, and is now widely used to evaluate websites because it provides rich information on the users' experience and websites' ease of use. As with other UCD techniques, however, there are a number of ways in which usability tests are adapted according to the circumstances of a project; usability tests are often conducted in very artificial circumstances and not in the context of the end user's real job because of the type of work being evaluated and project resource constraints.

iHealth had not previously conducted usability testing of its products. They put it into the project plan for EED, however, to achieve a more accessible tool design, which would be easier and faster to use. Moreover, iHealth was concerned at the time that customers would not renew contracts; not only did a significant amount of revenue come from HHW, but renewals had begun to decline in response to the wider economic climate. Ideally, the redesign would also attract new business. iHealth recruited a designer, Eric, who had carried out usability tests to lead on its design.

Subsequent interviews revealed that the various stakeholders in the usability testing valued the process differently; the next chapter will return to this. Oliver hoped it would empirically validate that EED met user requirements, and encourage users to buy and validate its design (for example, whether the system is intuitive to use, or whether users need help to complete tasks). In comparison, Eric aimed to: test the usability of the tool's existing and new features and correct any issues discovered; explore customer satisfaction, whether they could complete their tasks and how they rated the interface and new features on a scale of one to five; gain insight into the customer's overall view of the tool (for example, its look and feel, existing and new design features); and identify sources of user dissatisfaction and to consider how they might be fixed.

EED developers expected and wanted user feedback early in the project based on their experience of the Agile development process; this is congruent with UCD (Gould and Lewis, 1985). Eric, however, delayed tests until the interface was sufficiently functional to obtain more valuable feedback and not discourage existing, valued customers. This pushed the usability testing later in the project and closer to the product's launch. The discussion chapter will reflect on the impact that this had on the organisation's ability to act on participants' feedback.

To explore customer satisfaction, I suggested to Eric that usability test participants complete a SUS questionnaire, which would provide a more objective measure of the participant's satisfaction with the new design. SUS is a simple, ten-item attitude Likert scale that gives a holistic view of subjective assessments of usability, which was designed as a tool for usability engineering of electronic office systems (Brooke, 1996). It mixes positive and negative items to provide a balanced assessment provided the overall score is calculated correctly (Sauro and Lewis, 2011). Although SUS provides a quantitative measure of a system's usability little research explores how to interpret it; Bangor et al. (2008) consider that a SUS score between 80 and 90 is "excellent" and those in their 60s are "of less merit", and largely in agreement with this, Sauro (2011) averaged SUS scores from 500 studies, which provided a median average score of 68%. It is thus reasonable to consider systems that are scored above 68% are above average.

International Organisation for Standardisation standard 9241 Part 11 (ISO, 1998) defines usability with three dimensions: *effectiveness* (i.e. can users successfully achieve their objectives?); *efficiency* (i.e. how much effort and resource is expended in achieving those objectives?); and *satisfaction* (i.e. was the experience satisfactory?). These can only be measured by taking into account the context of use of the system: its users, what they are using the system for, and the environment in which they are using it. For example the effectiveness of a mobile phone application would generally be measured very differently to the effectiveness of a ticket machine. This makes it challenging to determine if one system is more usable than another because the measures of effectiveness and efficiency may be very different. However, a sufficiently high-level definition of subjective assessments of usability, such as the SUS, arguably allows for systems to be compared. A SUS questionnaire can be used to compare systems that are ostensibly dissimilar because it provides a single score on a scale of 0–100. Questions are thus necessarily quite general, which can be a drawback for some evaluations.

I proposed that participants score HHW against SUS at the beginning of usability test sessions, and for EED at the end, to quantify the benefits of EED's design over HHW. Eric was reluctant due to the project's time constraints and wanted to focus on testing EED; however, he agreed that participants might evaluate EED with SUS if there was time at the end of usability test sessions.

6.4.2 Methodology

Participants

There were two phases of usability testing. I was only involved in Phase 1; accordingly, this section will focus on Phase 1. Phase 1 participants largely comprised of customers who had responded to a survey conducted for EED's discovery phase. Eric recruited these participants because he considered that survey respondents might be interested to help shape the future design of the tool because they used the existing tool regularly and were interested enough to provide iHealth with feedback via a survey about their current usage. The organisation requested one additional participant for Phase 1 who had issues with the existing tool and whose contract was at risk. Logistics also influenced participant recruitment for Phase 1; time pressures demanded that we could travel to participants' offices easily to reduce the impact on project deadlines. Eric contacted customers that fitted these criteria and visited those that agreed. Ultimately six HHW users participated in Phase 1 (Head of Patient Safety, Project Manager for Service Line Management, cardiothoracic surgeon with a sub-specialty interest in thoracic surgery, Operational Planning and Performance Manager, Clinical Effectiveness Manager and Senior Information & Research Analyst) and nine participants in Phase 2. Note that the Head of Patient Safety who participated in Phase 1 of the usability testing of EED is the same person that I interviewed for the personas; iHealth had built a relationship with this user who met with their Customer Service Manager regularly.

Phase 2 aimed to test improvements that were made after Phase 1 and if EED was ready to launch. For Phase 2, the sales team wanted to recruit customers from outside of London and South England, to cover a larger area of England. Importantly, participants in Phase 2 had not seen the design before. Eric compared a spreadsheet of customers who had responded that they would be willing to be involved in the beta phase (compiled by Oliver and Nigel) to the survey respondents to ensure that Phase 2 participants had not seen the tool or gone through the process before. Phase 2 participants thus comprised customers who had indicated an interest in aiding the beta phase and/or the sales team requested to be involved.

Procedure

Test sessions comprised of scene setting, a review of the dashboard, the test tasks, followed by an open feedback session. Both Eric and I took notes of participants' comments and all participants consented to my request to record sessions on video for further analysis and to help absent iHealth developers interpret the results. iHealth's Lead Business Analyst, Nigel, also attended the first test session of Phase 1. During Phase 2, closer to EED's launch, Oliver attended a session. The Operations and Quality Assurance Lead[13] also attended one session; she had learnt about the usability testing in the daily stand ups and asked if she could witness sessions to understand how Eric carried out usability testing and used the results. She was also interested in how easily end users understood and navigated EED and how attractive they found it.[14]

Eric explained to participants that we aimed to test the design and not the person and that they could ask to skip tasks or end the session at any point; he also forewarned participants that some aspects of the tool may not be fully functional, and the data may not be correct, because it was still undergoing development. They then signed an information sheet and consent form I had prepared and Eric had emailed in advance. Before they saw EED, participants had the chance to describe their opinion of HHW's Performance Summary dashboard (Figure 6-1) and any improvements they would like to see. Finally, participants viewed the new dashboard and gave their initial thoughts.

Core tasks that the organisation knew users needed regularly informed the tasks that participants tested. The discovery phase for EED gave Eric insight into what motivated customers to use the tool, why they needed to use the tool and what they used the tool for, so he designed tasks that met

[13] The Operations and Quality Assurance Lead is responsible for support, development and maintenance of business applications and management information requirements, in addition to quality assurance and operational support of customer-facing services and products. She was in the QI Agile Scrum team and performed manual, exploratory and experience-based testing of tool performance and automated regression.
[14] From email communication.

customers' core needs. He felt that tasks should cover the most important aspects first because the usability testing fundamentally had to determine that core tasks worked and he only had a limited time to obtain rich information. Phase 1 thus tested tasks that EED was ready to support; Phase 2 participants explored more advanced analysis tasks because the tool was much more complete.

Phase 1 tests comprised of eleven tasks (Table 6-4) during which I noted any deviations from the optimal steps to task completion on the following scale I devised: task completed; completed with minor prompt; completed with help; not completed; deviated temporarily or deviated entirely.

Task	Description
1	Using only the performance summary dashboard try to find out the diagnosis/procedure group with the worst performance in terms of observed deaths exceeding the expected over the last 6 months?
2	Using only the performance summary dashboard try to find out the diagnosis/procedure group with the highest crude rate for readmissions over the last 3 months?
3	Using only the performance summary dashboard can you identify which procedure groups are performing the worst in terms of relative risk for the outcome of mortality over the last 12 months?
4	Is there any way to see the trend for that particular procedure group? Can you access a larger version of the trend information and find out the relative risk for the worst performing month?
5	With regards to that particular procedure group, can you tell how it is performing in terms of relative risk for readmissions?
6.1	With regards to that particular procedure group, what do you think would be the quickest way to get to the underlying list of patients?
7.1	With regards to that particular procedure group, please try to click through to find out more about the relative risk score.
8	In terms of the outcome readmission, can you see how to view only those items that have performed poorly in terms of relative risk?
9	Please see if you can see a way to view peer group performance information on the dashboard.
10	Can you see how to reload the performance summary dashboard so that it only shows data for two of your sites?
11	Please try to set up a custom group that reflects an element of your trust (e.g. a division or specialty group) and then view the dashboard based on this group
*6.2	Can you see a way to see a more detailed view of the patient record at the top of the list?
*6.3	Can you see a way to see the superspell information for that patient record?
*7.2	Can you see a way to see only results for the male patients within this dataset? (Specifically we needed participants to click on the 'More options' button and choose 'Male' radio button to pass the task).
*7.3	Can you see a way to change the 'analyse by' to "Age 10 years" and reload the report based on this?
*7.4	Can you see a way to drill down on only three rows within the results and at the same time change the 'analyse by' to GP practice?
*7.5	Can you figure out what the nested radio button will allow you to do? *(Results table not tested.)*

Table 6-4 Usability Test Task Descriptions. * indicates subtasks that only participants five and six tested, when functionality became available, which followed participants' 1-4 tasks six and seven

Eric modified some tasks according to the data that the participant found during tests; for example, some tasks requested a time period that resulted in insufficient data to continue with the next task, so Eric asked the participant to use a longer time period. Faulty functionality also resulted in some tasks being aborted. The final task exposed new functionality and participants gave feedback on how useful it would be to them in addition to its implementation.

Participants rated each unique page and function they had used on a scale of 1 (very poor) to 5 (very good) according to its usefulness to them and gave feedback on its design and functionality to justify their rating. If time permitted, Eric also showed parts of the tool still in development and asked participants if they were ready to move over to EED from HHW.

At the end of sessions, participants rated EED according to the SUS (Brooke, 1996). Participants responded to how strongly they agreed with the statements in Table 6-5 on a Likert scale: 1 for strongly disagree; 2 for disagree; 3 for neither agree nor disagree; 4 for agree; 5 for strongly agree.

Item	Statement
1	I think that I would like to use this system regularly.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need the support of a technical person to be able to use this system.
5	I found the various functions in this system were well integrated.
6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I needed to learn a lot of things before I could get going with this system.

Table 6-5 System Usability Scale Questionnaire

6.4.3 Results

Results of the usability tests and participant feedback, as they were reported to project leaders, can be found in Appendix F3 but are summarised here.

Opinion of Hospital Health Watch and first impressions of Effectiveness and Efficiency Dashboard:
When presented with the new dashboard, participants first tended to investigate its content for the data they need, and also functionality from HHW that they used most often. They noted what the dashboard did include (e.g. the mortality data) and did not include (e.g. missing information on the dashboard, such as patient numbers for the relative risk figures). Users were also unclear how the dashboard's data had been sorted, and why specific elements of the dashboard were displayed. In general, however, participants were happy to see "an immediate visual track of where you are."

Regarding its aesthetics, participants commented on the new dashboard's colour. One participant described it as "grey" and, in addition to one other participant, noted that the new tool used a new colour coding for alerts. "Has yellow replaced blue? I liked blue! Yellow looks more like an alert." Participants also described the dashboard as "busy" and likened it to a tool they used to obtain information from the East Midlands Public Health Observatory.

Usability testing tasks:

Phase 1 participants carried out 73 tasks; 58 (79.5%) were completed, four (5.5%) were completed with minor prompt, two (2.7%) were completed with help and nine (12.3%) were not completed (Table 6-6). This indicates that participants completed common tasks and used new functionality with comparative success.

Task number	P1	P2	P3	P4	P5	P6
1						
2						
3						
4						
5						
6.1						
7.1						
8						
9						
10						
11						
6.2						
6.3						
7.2						
7.3						
7.4						
7.5						

Table 6-6 Usability Test Task Completion Results

Key:

Task success	Colour
Task completed	
Completed with minor prompt	
Completed with help	
Not completed	
Not tested	

Open feedback:

Table 6-7 shows the scores that participants gave each page of EED at the end of the usability test sessions, based on the usefulness and usability of each page, and a total score. This demonstrates that participants generally valued the 'Outcome' widget but they could not see the benefit of the 'Crude Rate' widget. Only the final two participants tested the 'Relative Risk' and 'Patient Record' tabs but rated them highly.

Page	P1	P2	P3	P4	P5	P6	Total
Outcome widget (mortality etc.)	3	4	5	4	4	4	24/30
Observed - expected widget	1	1	5	5		2	14/25
Crude rate widget	1	1	5	2		3	12/25
My Groups	3	4	5	4	5	4	25/30
Relative risk tab					4	4	8/10
Patient record tab					5	3	7/10
Totals	8/20	10/20		15/20	18/20	20/30	

Table 6-7 Feedback Scores for Individual Effectiveness and Efficiency Dashboard Pages; 1 Very Poor - 5 Very Good.

System Usability Scale:

The results of the SUS Questionnaire were deemed positive by everyone in the organisation who saw them, and we will see in Chapter 7 that the business used them as a proxy for the readiness of the product to launch and customer satisfaction; they are presented in Table 6-8, which includes an overall SUS score out of 100 from each participant. It should be noted that I carried out the data analysis presented in Table 6-8 after the launch of the tool because there was insufficient time and lack of awareness of this calculation at the time. It shows that four participants scored it in the low 80s, one in the high 60s and one in the low 60s; all but one participant, therefore gave it an above average rating (Sauro, 2011).

Question number	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
1	3	3	4	4	4	3
2	4	3	4	3	4	2
3	1	3	3	3	1	2
4	4	4	4	4	1	2
5	2	2	4	3	4	2
6	2	4	0	2	4	3
7	1	3	4	3	4	2
8	2	4	4	4	4	3
9	4	2	3	3	3	3
10	4	4	3	3	3	3
TOTAL	27	32	33	32	32	25
SUS Score	**67.5**	**80**	**82.5**	**80**	**80**	**62.5**

Table 6-8 System Usability Scale Scores for each Participant

Concluding comments:

All participants, except one, said that they preferred EED to HHW; this indicates that they recognised and appreciated the improvements that had been made to HHW. One participant further indicated that they would be able to use the new functionality to encourage wider use of iHealth tools at their AHT, which might reduce her workload. Final comments suggest that participants log into the iHealth tools for the same data and tasks each time since they were concerned about how they could retain their favourite queries from HHW; participants were also concerned that it may still take time to adjust to using EED because they had become accustomed to working with HHW in a certain way. Participants were enthusiastic about the concept behind EED's new functionality but insisted that it could be simpler. Participants frequently asked about the terminology used, with one even offering to work with iHealth to improve this. This shows the benefit of usability testing complex systems with domain experts; whilst it is challenging to design a product that satisfies all end users, usability testing can usefully reveal how users would customise applications and navigate to some of the more advanced functionality they require.

6.4.4 Organisational Response

This section describes how EED usability test results were presented and disseminated within iHealth.

After each Phase 1 test session, Eric reported the usability issues identified, along with any requests or suggestions for improvement, to Oliver who worked with Jeremy to prioritise them and put them into the development plan. They prioritised suggestions and improvements that would take the least time and have the highest impact because the usability testing took place close to launch and the project plan had limited time. Consequently, changes made as a result of the usability testing tended to comprise of modifications to the user interface, and specifically the Performance Summary dashboard, which users see when they first enter the tool. I also collaborated with Eric to compile summary statistics of Phase 1 of the testing, which was forwarded to Jeremy and Oliver.

At the end of Phase 1 Eric presented a summary of the findings at a project meeting. The presentation included a video that I compiled, which demonstrated examples of both unsuccessful and successful task completion in order not to discourage the developers and maintain civil relations. Eric also attempted to show this video to Account Managers at a subsequent meeting between the two phases of usability testing; technical issues, however, arose so he verbalised the statistics and reported positive quotes from the participants. In addition, Eric emailed the video to one of the developers. Finally, Oliver summarised EED's progress to the organisation, and test results, at a Staff Update in October 2012.

For Phase 2, the tool was much closer to being launched so Eric produced a summary report after each session and sent it to a wide and senior team within the organisation, including Ralph, the Head of Marketing Services and Director of Sales, Lead Business Manager, the Head of Delivery and the participant's Account Manager, between two and seven days after the session.

Eric compiled both testing phases' results into one document, which included: summaries (without quotes) that identified which new features participants gave positive feedback; potential new high impact features; important features from the existing tool that had not yet been implemented; suggestions for training (particularly for customers who had not traditionally used the tool, since new functionality was intended to encourage tool usage by new users); and summaries of interviews with six customers from Phase 2. Eric shared this document towards the end of his contract.

6.5 Discussion

The EED project illustrates cultural shift in the organisation that occurred during the collaboration so that more resources were available for all aspects of design work, from the recruitment of participants to the reporting of results. I can now evaluate the EED project to identify which techniques (or aspects of techniques) are comparatively effective and ineffective. The length of the collaboration revealed how UCD can be introduced at organisations with limited resources, such as iHealth, and how this can be facilitated through careful adaptation of UCD techniques.

This chapter will now consider the effects that the organisational culture at the time had on the UCD techniques described; I will first look at the individuals involved in the project, the teams of which they were part, the organisation as a whole and its processes. It will then reveal the other side of this coin and discuss how the UCD techniques employed (in terms of task selection, participant recruitment, problem identification and reporting format) impacted upon the organisational culture.

6.5.1 What aspects of the organisational culture impacted the usability testing?

Individuals

Despite consensus that the usability testing was needed, power struggles between individuals with different opinions about how it should be carried out emerged. For the usability testing, I designed an information sheet and consent form for participants to sign their agreement that the sessions could be video-recorded. Eric was originally reluctant to add this formality to the test session, since "we're asking a lot of very busy people and so we need to play by their rules and keep the process as light and simple as possible. That will likely mean you, me, the participant, a room, a PC."[15] He talked about their "patience running dry…I can't afford to risk putting the participants off completing the testing session and so I'm not convinced that this additional formality is in the best interests of the project as whole." On the use of the SUS questionnaire for HHW, Eric felt it "not suitable…on account of the time it would take up." For EED, however, he could "see the benefit of the insight that this approach could provide."

The knowledge and experience of the project team also influenced how the EW and usability testing were carried out. Eric designed tasks based on the discovery phase at the beginning of the project: interviews with account managers, along with former, current and prospective customers, competitor analysis and an online survey of current users. I then used the tasks he designed to carry out the EW. Furthermore, at the beginning of this research phase, a Reader in HCI at UCL joined the project team, who suggested using the SUS questionnaire based on their experience. The effort required for recording the users' screens during interviews for personas, particularly since the data was not used, also led me to seek an alternative video technique.

A related aspect is individuals' protection of their role's territory. I had to fight for SUS to be included in the usability test sessions; I often had to sneak it in at the end as we prepared to leave. This is a similar problem to the one encountered by usability specialists at unit B in Iivari (2010: 16) who had to "sneak in their knowledge, the designers not even noticing this influence." It also affected how results were disseminated. Eric had designed the tool and led testing sessions, which the next chapter will show was noted and viewed with suspicion by other stakeholders in the project who were wary of the "my-baby-syndrome" noted by Boivie et al. (2006).

[15] From email communications at the time.

The scope of Eric's role hints that the organisation's approach to software development was perhaps incompatible with their approach to UCD; development was not iterative and users were not involved until late in the process. Eric was new to the organisation and had not worked with these developers before; many of the developers on the EED team were also new to the organisation. They therefore had to build their working relationship, and knowledge of the domain, from scratch. Eric was also outnumbered by developers, which created an imbalance during meetings that required careful management.

Processes

This chapter describes a new design approach for iHealth. Eric had responsibility for the whole process: gathering of requirements; designing the user interface; planning, facilitating and analysing usability tests; eliciting redesign suggestions from the usability tests; and feeding back results into EED's development. From email conversations I sensed that Eric found it difficult to keep up with the pace of development with this approach and iHealth had given him too much to do. It could also cast doubt on his partiality to its design, how he interpreted what happened in the usability tests and influence what and how he reported the results. I sensed that he was frustrated that the developers could not complete the dashboard faster, since he was anxious to test it as early as possible in the tool's development.

The inclusion of usability testing in the project plan for EED represents the integration of UCD into the organisation's formal processes, which Rohn (2007) suggests is important for embedding UCD in organisations in addition to informal processes. However, Eric later reported that it disappeared from the project plan and was ultimately carried out towards the end of the development process, as reported in other organisations (Iivari, 2004; Mayhew, 1999a). UCD is more successfully integrated when it is fitted seamlessly in a development process.

The planning and organising of usability tests had to be professional; the project team contacted end users through their Account Managers. The recruitment of end users, however, demonstrates how far the company had come: for example, in the PHA project I was unable to talk to end users about the mapping interface, but we can see that the organisation actively facilitated recruitment of end users for usability tests of EED. The tool's complexity dictated that EED was not in a suitable state to test until close to its launch. This reduced the impact of the EW's results on the usability testing protocol and the results of the usability testing on EED's final design.

An important aspect of the work reported is that the product under test was intended to replace an existing product. The organisation hoped that introducing the new product to existing users would help manage and smooth the change process so that customers would renew contracts and not be disconcerted when EED replaced HHW. I perceived that the usability tests acted as informal training sessions for the participants so that they would be less intimidated by a new design.

Organisation

First, the recruitment of a designer is an important indication of the organisation's commitment to UCD at this time; when Eric arrived, the UI team had dissolved so I stationed myself near his desk to work more closely with him whenever I was at the iHealth offices (Vredenburg et al., 2002). However, as previous research forewarns, senior management can often create roles like this with the belief that this in itself is enough and that an individual will be able to carry the usability torch alone; if this happens, then the success with which usability is implemented will be highly influenced by the effectiveness and experience of the individual employed (Boivie et al., 2006).

Whilst the results of UCD efforts in the PHA project were shared only within a very small team, the results of usability test sessions were shared with the whole organisation. This resulted, and was caused by, changes in its personnel and processes. The discussion of usability testing at the staff update demonstrates how UCD was slowly percolating horizontally and vertically through the organisation and into the business strategy (Venturi et al., 2006) and receiving greater management support (Gulliksen et al., 2009; Rosenbaum et al., 2000). Beyond the staff update, other organisation members were able to see the value of usability testing "for their own eyes" (Bloomer and Croft, 1997) by attending usability test sessions and watching the highlights video I compiled in Phase 1. The video demonstrated the thoroughness of the testing that had been done and also what usability testing was, for those who had not been present at the sessions or been aware of the concept of usability testing. Results assisted internal communication to mitigate resistance to design changes late in EED's development and reassure members of the organisation that customers gave positive feedback. Rapid feedback enabled the results to inform marketing as well as the product's development; the participants used the new functionality in ways that had not been anticipated so the sales team could use this information when they visited other customers, in addition to using the positive feedback from the usability tests to sell the new design to other customers. Results indicated how the tool was progressing in terms of usability and user satisfaction. Wide dissemination of usability test results gave the organisation confidence in our procedure and the product itself and that users gave the design positive feedback. In this way the technique educated internal clients about usability (Rosenbaum et al., 2000) and established credibility (Mayhew, 1999a).

6.5.2 What aspects of the usability testing influenced the organisational culture?

Task selection

Selection of tasks for the usability tests provided both challenges and opportunities for the fostering of a UCD culture at iHealth. I knew from the work I carried out to create personas that iHealth users' tasks vary from routine (i.e. repetition of the same queries on a regular basis for reports) to random (i.e. unconstrained and instinctive exploration of data). Designing suitable tasks for usability testing is a particular challenge in complex domains such as healthcare informatics; it can be difficult to set goals and tasks because they can change as domain experts move through the data and may be "what if" scenarios. Domain experts can find it especially difficult to verbalise their thought processes to explain their interaction because of the cognitive burden of tasks which are much more complex than the well-structured tasks of typical usability testing. Furthermore, tasks sampled may fail to expose participants to the system features that are most likely to produce unsatisfactory interaction (Cockton and Woolrych, 2002). EED usability testing tasks only covered parts of the tool that the project team knew functioned as intended; this would have had a positive bias on results and raises concerns that tests merely confirmed what the team already knew. The complexity of the domain, however, did provide an opportunity for engagement with users, which can only boost an organisation's UCD culture; it demanded that Eric contacted end users of HHW during EED's discovery phase to design suitable tasks, since the level of domain expertise required to design the system was so great.

Participant recruitment

There are several interesting aspects to the recruitment of participants for the usability tests that this chapter reports, which can influence the organisational culture for UCD. The redesign of an existing system provided an opportunity to engage with existing customers and users; we intentionally recruited users of HHW, since iHealth intended to replace HHW with EED, which could only have a positive influence on the organisation's UCD culture. However, getting the right users can be particularly challenging in complex domains (Chilana et al., 2010; Redish, 2007) and discount usability testing can further restrict the range of user capabilities and knowledge sampled (Cockton and Woolrych, 2002), which would be valid concerns with the results presented here.

Usability test participants were expert users of HHW so had already used the majority of the functionality. We were able to arrange sessions at very short notice and participants were generous with their time, despite our prior concerns that they would be too busy; it is thus possible that EED usability test participants were limited to users in roles that permitted them to manage their own time and had relatively few clinical duties. The users of complex systems are typically domain experts but not always computer or systems experts; the demands of their work may make it difficult for them to put much time or effort into the learning curve demanded by new programs or new presentation methods (Redish, 2007). Moreover, the project did not provide sufficient time or budget for extensive travel, which further limited the sample of users. We did not test EED with clinicians who might profit from it; instead, iHealth hoped participants would champion the tool amongst their colleagues. Nevertheless, access to users, not just customers, was a triumph of EED.

iHealth aimed to encourage customers to renew contracts by exposing them to upcoming developments. This in turn has increased management support for usability work; this is important because the visions and values of key stakeholders can highly influence how other resources are assembled and configured in design work (Uldall-Espersen, 2008). The approach we used to recruit participants is partly necessary because of the domain expertise required to test complex systems and contrasts with the approach of many design consultancies that are able to disseminate screening questionnaires to many potential participants (Furniss, 2008).

Problem identification

I carried out an EW of EED prior to usability tests to predict problems that usability test participants would encounter, rather than to assess the usability of a finished product as I did for PHA. Its influence was limited though because I was only given access to the beta version of the tool to carry out the walkthrough shortly before the usability tests were due to start. It was intended to inform the protocol for the usability testing, in the same way that each usability test informed the protocol for subsequent tests. Development was taking place at the same time as usability testing, so the tool was more complete each time a participant tested the tool.

Usability tests, on the other hand, provided the opportunity for others within the organisation to meet the users and gain an understanding of UCD. Apart from one usability test in Phase 2, at least one other person was present at all usability tests in addition to Eric. This facilitated usability problem identification because Eric could verify problems he identified and also investigate any he missed due to the demands of test facilitation and because he designed the tool. A template Eric prepared before the usability tests ensured that relevant notes were recorded and that the sessions followed the same structure. It also ensured that usability test reports were consistent, with task completion noted on a consistent scale.

Reporting format

The reporting of the results of the usability tests in this chapter provided an excellent opportunity to extend awareness of UCD at iHealth. Section 6.4.4 illustrated the different ways in which the results of the usability tests were presented. The use of multiple reporting formats for the same data is notable. Furthermore, the data collected was not only fed back into the development process to fix usability problems, but also presented to other staff members to communicate the progress of EED and raise awareness of the usability concept. I will return to this later.

A benefit of usability testing that I observed is that it counters any assumptions that the organisation might hold about the end users; team members who attended usability tests with us and saw the results for themselves seemed genuinely surprised at what they saw.

However, there was a trade-off between the richness of the data usability testing gathered and the demands of the project for rapid feedback; although usability tests obtained very rich information, there was insufficient time to feed it all back into the development process. The data required significant interpretation by the project team before it was passed on to developers. For example, although I recorded videos of the usability test sessions, development was taking place at such a rapid pace that we prioritised the production of a highlights video; we considered it unlikely that developers would have time to watch the videos, since they did not have the time to attend usability test sessions initially, and the examples we included very carefully. Furthermore, unless they watched all tests, they would not accumulate the wider picture that we were able to by attending all the sessions. Reports, to some extent, thus compromised detail and transparency of the process for the speed at which they needed to be produced and digested because tests took place late in the project. We will see in the coming chapters, however, that developers and others valued the video highlights as they enabled them to be a "fly on the wall" at the usability tests and Eric would not have had the time or equipment to record videos and edit them without my input.

6.6 Conclusion

This chapter has described the UCD techniques that were used and the resources for design work that were available at the end of the collaboration to demonstrate the extent to which the organisation had developed an awareness of UCD during the collaboration. We have seen that iHealth recruited a designer, Eric, to lead the redesign of their flagship product, I have described the EW and usability testing that took place and revealed their impact on the organisation.

My analysis suggests that the success of this project for the introduction of UCD at the organisation can be partly explained by the combination of techniques used, and not by one single technique. Previous researchers have also found this. Rosenbaum et al (2000) reported far more frequent use of HE despite its inferior ability to embed usability engineering in the organisational processes, culture and product roadmaps compared to usability testing. Usability testing, both inside and outside of the laboratory, was rated most effective. UCD's strategic value, it seems does not lie in a single method but the interplay between organisational factors and the usability methodologies chosen (Venturi et al., 2006).

The launch of EED created a natural end to my involvement at iHealth. We have seen that its launch was widely perceived to be a success at iHealth and the additional efforts put in to centre the product on customers had not only reaped rewards for the design of this tool but left the organisation with a platform for a suite of products that required comparatively little effort to maintain and a loyal customer base. We will see in the next chapter, though, that high level discussions at the organisation after EED's launch, however, took the business away from the development of new products in response to the adverse market conditions.

Having seen the organisation evolve through such a turbulent time and shrink its product development capacity, the end of the collaboration sparked my interest to explore what, if any, legacy my work had left at the organisation. From an ethical standpoint I was also interested to know, for the purposes of this thesis, if my observations and perceptions during the collaboration were similar to those of others in the organisation. It was with this in mind that I arranged interviews with key stakeholders from the organisation to coincide with the collaboration's end; this would allow me to gather their perspectives and new insights from which to formulate a richer discussion of the issues I began to uncover in Section 6.5 and more objectively assess the value of UCD to organisations, such as iHealth, who are working in fast-moving and specialist markets for 'Big Data'. I was also interested to reconnect with the usability test participants after EED's launch to investigate what, if any, impact their participation in the tests had on their experience of the tool. I had observed in the usability tests that end users were highly motivated to contribute to EED's design, which somewhat conflicted with the reasons behind the cautious approach that the organisation took to approaching customers, and I was interested to explore potential incentives for the organisation to test products in future. I will now report these interviews in the ensuing chapter to finally close the story of the introduction of UCD at iHealth.

7 **Organisational Perspective**

This chapter at a glance…

This chapter:

- Provides insights obtained from iHealth colleagues and Effectiveness and Efficiency Dashboard (EED) usability test participants.
- Discloses what happened after EED and the benefits of User-Centred Design (UCD) techniques for product development organisations and their customers.
- Lays the ground for a rich discussion of what Human-Computer Interaction researchers and practitioners might consider when choosing which UCD techniques to apply in similar contexts and the interplay between UCD techniques and organisational culture
- Reveals critiques and the business perspective towards the Action Research approach.

7.1 Introduction

The previous chapter described usability tests that iHealth carried out to inform the redesign of its flagship product; it revealed the organisational culture at the time and the extent to which it had become customer-focused since the beginning of the collaboration. This chapter reports interviews that I carried out to gather the perspectives and insights of iHealth stakeholders to inform the effective introduction of User-Centred Design (UCD) at similar organisations. Their purpose was to verify my own account of events because significant time had passed and I spent less time at the organisation's offices as the project evolved; it also provided the opportunity to gain a historical perspective from stakeholders who started working at iHealth before me, which helped me to understand the origins of its culture. I was also interested to explore how usability test participants felt about their participation since they seemed much more willing to participate than the organisation had feared. Literature has so far overlooked the goals and motivations of usability test participants; their perspectives could be especially interesting in the context of this research because end users are not necessarily the customer and or have discretion in using the system, so their motivation for participation is unclear.

As Figure 1-1 presented, the year after the Effectiveness and Efficiency Dashboard (EED) usability tests saw the Health and Social Care Act 2012 take effect. The Act disbanded Primary Care Trusts and Strategic Health Authorities and replaced them with Clinical Commissioning Groups, which would control about £60bn of the National Health Service (NHS) budget and commission local services through competitive tendering, opening NHS contracts to the voluntary and private sectors. In addition, the Act required all NHS Hospital Trusts to become Foundation Trusts (FTs) by April 2014. FTs differ from NHS Trusts in that they are financially free from central Government control; they have the financial freedom to borrow commercially and generate surpluses to expand, improve quality or develop new services. Nationally set targets and objectives still apply and both the Care Quality Commission and Monitor (the independent regulator of FTs) regulate and monitor them. Local people can become members of a FT and can elect Member Councillors to represent their views and work alongside the Trust to direct strategy and spending. Fundamentally the Act decentralised primary and secondary healthcare services management; this increased the value of data at a local level compared to the national data on which iHealth had built its reputation.

Reforms required that iHealth engage with new people in new organisations, some of whom may not know their information needs. At this time, iHealth was preparing to move offices because the downsizing of the business had made it uneconomic to remain in their existing office. I continued to attend staff updates and sensed that the business was shifting its attention away from the NHS towards international and independent healthcare providers due to their previous reliance on the NHS for revenue, which exposed the business when the NHS budget was threatened. Their high share of the secondary care market left them little room to grow and the reforms left them at risk of losing customers. Although they could increase the number of end users at existing client organisations, iHealth saw that they needed to widen their customer base to make the business more sustainable.

The day the Bill took effect coincided almost exactly with the end of the main research phase of University College London (UCL) and iHealth's collaboration. EED was now fully rolled out and Eric, who had managed its design, left iHealth at the end of 2012 when his contract came to an end. I was now based entirely at UCL and had had little contact with iHealth for some time. However, as noted in Chapter 3, it was important to me that I close my analysis of the effect of my work on the organisation and the impact that it had by obtaining the views of those I had worked with. Indeed, I felt it only fair for my colleagues to have the chance to influence what I was about to report and verify my views. I thus embarked on a series of interviews, firstly with members of the organisation, and subsequently with their customers.

7.2 Methodology

Participants

I interviewed nine iHealth colleagues seven to eight months after the EED usability tests; Table 7-1 lists their roles along with the date and duration of their interviews. I selected participants according to the extent of their involvement in my research and recruited them via email. I recruited participants with varying exposure to my research, from working directly with me on projects to simply being aware of my research results. I later recruited an additional member of the Executive Board to gather the business perspective and two more participants suggested by other participants.

Name	Position	Interview Date	Interview Duration
Damian	Head of Product Development	11 April 2013	45 minutes
Eric	User Experience Consultant	17 April 2013	90 minutes
Frank	User Interface Lead	22 April 2013	60 minutes
Ralph	Executive Board Member	22 April 2013	60 minutes
Nigel	Lead Business Analyst	22 April 2013	45 minutes
Toby	Design Manager	23 April 2013	52 minutes
Bruce	Executive Board	9 May 2013	41 minutes
Jeremy	Software Strategy Lead	19 June 2013	36 minutes
Oliver	Product Manager	19 June 2013	40 minutes

Table 7-1 iHealth Interview Participants

I interviewed EED usability test participants a month after I had completed the iHealth interviews and almost a year after the usability tests. I contacted the six end users who participated in Phase 1 of the EED usability tests via email. I successfully recruited five out of the six participants; the remaining participant had left their job. The project team considered that the interviews would be highly beneficial despite the length of time that had passed between usability tests and the interviews because literature lacks these insights. Table 7-2 details the job titles, interview dates and length of interview for these participants.

Participant	Interview Date	Interview Duration
Cardiothoracic Surgeon	11 July 2013	30 minutes
Senior Information and Research Analyst	15 July 2013	17 minutes
Operational and Planning Performance Manager	16 July 2013	22 minutes
Head of Patient Safety	17 July 2013	14 minutes
Clinical Effectiveness and Audit Manager	19 July 2013	14 minutes

Table 7-2 Interview Participants

Procedure

Interviews with iHealth stakeholders were semi-structured; I prepared an outline for each interview, with assistance from academics on the project team, but allowed the conversation to follow its natural course. The script contained a core set of questions in addition to questions that directly related to their involvement in my research. Core questions clarified participants' roles and involvement in my work, their perception and awareness of UCD and barriers to UCD at iHealth.

Most interviews with my colleagues took place within a fortnight (Table 7-1). First I met with two people who no longer worked for iHealth; two weeks later I interviewed four people still working at iHealth (one a consultant), and Bruce, an Executive Board member. Interviewees recommended two more iHealth employees aware of my research whom I met the next month. I had sufficient time for transcription and analysis between most interviews, whilst my recollections were still fresh.

Interviews with iHealth colleagues lasted between 40 and 90 minutes, depending on the interviewee's involvement in my work. Most interviews took place at the iHealth offices, apart from interviews with the first two participants; these interviews took place over Skype (with video) and face-to-face (café) respectively.

Interviews began with verification that the participant had read the information sheet I had emailed to them, understood the interview's purpose and how I would use the data gathered. I emphasised that participants could skip any question and/or end the interview at any time. I obtained written consent to record interviews on an mp3 player, which was given by all but one participant. One interviewee was sufficiently interested to record their interview for their own future training.

I interviewed usability test participants by telephone over the course of a week. Interviews followed one outline and lasted between 14 and 30 minutes depending on the length of participants' responses and the detail that they provided.

I transcribed interviews as soon as I could after they happened and then iteratively coded the transcripts according to the topic of the questions, plus any additional themes that emerged; for this I used Atlas.TI, which is a software commonly used for the analysis of qualitative data.

7.3 Results

I analysed the transcripts according to the themes that emerged from the previous four chapters; the process was inductive and implicitly influenced by what I had learned for myself over the course of my research, which influenced the questions that I asked. I identified four distinct theme categories, which I use here to report the results: individuals, teams, processes and the organisation.

7.3.1 Individuals

Words versus actions and tokenism

A strong theme that ran through all the interviews was 'tokenism'; iHealth employees at all levels of the organisation emphasised the importance of users but reported that words seldom translated into action. Even when iHealth recognised that the database architecture behind their software was difficult to administer and maintain, and was negatively impacting on the user experience and business, they took token actions. Ralph recalled that I reviewed various map data products for iHealth at the time of Public Health Analyser (PHA), work that arguably should have been done at the beginning of the collaboration. After PHA was launched, the organisation was keen to find out what license options were available since the current mapping database and interface was unstable and the maps' performance, particularly their response times, was unacceptable for users. The business also wanted to reduce maintenance efforts and costs for a type of technology that they did not wish to develop further; one developer had written the code and database structure in such a way that no one else could change its design when he left. I scheduled meetings with several organisations to discuss licenses for geographical data, from Ordnance Survey to GeoWise, in addition to other private contacts provided by the academic links to UCL. The meetings, however, came to nothing. Licenses that would have improved the maps' performance and reduced the maintenance required were too costly for the organisation at this time. For example, a license that permitted users unlimited use of the maps and did not require iHealth to record the number of maps users created was too expensive. Ralph describes:

> "We definitely wanted to have an external provider work with us as a partner and buy in mapping solutions because they weren't core enough for us to have dedicated staff sitting in house all the time maintaining and managing them. We built it ourselves the first time with one guy who knew how to do it well...and the cost of maintaining that over time was ridiculous...when you're only using it as a component you should buy it so you were really good at helping identify both what the technical options were, in terms of what we could buy, and the partners we might want to work with…it's no good buying a technical solution using some various jQuery library but you've still got to build it and maintain it. So that was really useful but again we then fundamentally decided that given the overall cost of change, given what we were doing with the toolkits...that we just weren't going to invest in a new mapping solution."

The organisation continued to pay "lip service" to user experience (Loranger, 2014b). Phillip initially requested the Creative Director to make posters of the personas; this request was not fulfilled so I printed each persona on A3 paper for the Product Development team area instead. To my knowledge, they were never used in design meetings and only actively spread within the technical department. Toby confirmed this:

> "I know he [Eric] used some of your persona work in some of the EED design stuff, but they've redefined some of the roles a little bit since then."

In addition to the difficulty I had to instil the style guide for PHA maps, these accounts support my perception that aspects of the organisational culture acted against the introduction of UCD.

Even though I provided interview transcripts and disseminated videos of usability tests, Ralph was surprised to hear of them. Individuals wanted to improve the tools' usability but reported little time or development resource for it; their role did not provide them with sufficient scope to act. For example, the PHA maps developer expressed interest in researching the performance of raster and vector map backgrounds but did not follow this through.

Communication

Interviews confirmed that intermediaries require significant communication skills, particularly when distanced from the organisation and the development team. Interviewees talked about the importance of effective communication and how usability tests created cross-functional teams and exposed other individuals to UCD. Nigel said of the usability test results:

> "It's a really good way of short circuiting endless internal discussions that won't be resolved…users gave answers and trumped whatever our internal opinions were."

Identity/roles

Interviews revealed insights into the effectiveness of Action Research (AR) in this context through others' perceptions of my role. The breadth of the scope of my role transpired to be both a help and a hindrance from interviewees' perspectives. Interviewees expressed confusion over my role, i.e. where I sat in the organisation and the extent to which I was an academic consultant and student versus full-time employee and team member. The collaboration team changed many times on the organisation's side over the six years, which disrupted its momentum. In addition, my academic work necessarily comprised of longer term deadlines than the product's development, which limited the extent to which iHealth was able to place me on projects. It did provide a foot in the door, which was further facilitated by individuals and the situation of the organisation and its market at the time I arrived. Individuals noted that, although I spent time learning how academic concepts fitted within a business environment, I did necessary work and created opportunities for which they would otherwise not have had time. Frank noted:

> "I needed some support on that side because it seemed that I wasn't going to get it elsewhere in the company…I think your time and expertise has been relatively cheap…and we wouldn't have ever got half as far if we didn't have some of that…I think there were positives and negatives to that status because I think you had the respect of being an academic that was looking in. Also, you weren't in some ways, it might not have been taken so seriously because you weren't believed to be part of the commercial company and you didn't have a real place in the hierarchy."

Interviewees also described Eric's role in the EED project, of which I was not wholly aware because I had ceased to work at iHealth's offices on a regular basis. Interviewees suggested his role's scope was too big and his relationship with the developers was poor. For example, Nigel said:

> "It was awkward that the person who had designed the tool was leading the testing. That was not an ideal situation, however, that's just the way it worked out…I think most of us thought it's just an open question how do users react to this and can we learn anything from it…because he designed the tool he was very defensive."

Since Eric designed the system alone, senior management often had to support him when his opinions conflicted with those of the developers. I found it interesting that Eric gave me a subtly different account of the usability testing than others in the project; he appeared to be alone in his reticence to test the dashboard before it was complete. Literature would suggest that designers would fight for early involvement of users in the development process.

Knowledge/experience

Previous chapters have revealed the influence of the collaboration team's experience on the choice of techniques for the design work at iHealth for this research. Interviews provided further support for this view. Eric, the designer iHealth recruited, revealed that he had a non-technical background; this may, in part, account for why other interviewees reported that he had a somewhat fraught relationship and difficulty communicating with the developers.

Interviews supported my perception that previous exposure to and experience of UCD techniques can also assist its introduction. Oliver enlightened me that he had used personas within the healthcare sector and shared those I created with Account Managers to get feedback.

This also applies to senior management; the promotion of personnel with knowledge of UCD and software development processes facilitated the introduction of UCD at iHealth. Frank, who worked at iHealth for many years, believed:

> "Once they'd got [Eric]…there was a bit more focus…people like [Ralph] had a more influential role. He was a lot more knowledgeable technically…more forward thinking in terms of design and the importance of design. And I think there was wider support from Board down…In the past…senior management probably…let product development get on with it…it's their responsibility…I think there's more of an interest in what's going on at all levels about how the tools are developed, and I think they've got some good individuals in place...to manage that process."

Eric also recalled that the usability tests disappeared from the project plan and they only reappeared because he committed to get them back in:

> "I did notice at one point it had dropped out of the project plan…but basically it was not going to be dropped out, we made sure that it happened, that it was always going to happen…and it did happen."

Nigel noted that individuals influenced the focus on users:

> "That is only working because it's driven by one or two individuals. It's certainly not been internalised within the company as a whole within the way we work."

Changes in the way that individuals worked

In response to a direct question, interviewees reported that the collaboration had affected the way in which they worked. Toby reported that he was unaware of the information contained in the database server log files before I asked him to investigate usage patterns to inform personas, but he now explores them to find user journeys. He said it "opened my eyes to…lots of data about the users that we should look at in more detail…I did a lot more detailed analysis on actual user journeys, more so than for the persona project."

Nigel even requested training in usability because he believed the organisation needed these skills and lost them when Eric's contract ended.

> "Last year I did a training course…on user experience…to get some more of that expertise into the company rather than just relying on a contractor which is what we'd done before…One of the things covered in that training course was around personas, I'd remembered that you had developed them and…I wanted to see them to present them to our development team so they could get a bit more understanding of who our end users and customers actually are and what their motivations are, cause I think that's something we need to do more of in the business."

7.3.2 Processes

Formal and informal processes

Interviews revealed the importance of both formal and informal processes for the introduction of UCD into organisations. The collaboration with iHealth started small; I worked solely on the mapping interface of PHA, to which I could apply techniques from the bottom up. Although interviewees acknowledged that this worked in many respects, its impact may have been impeded by the complexity of the system as a whole and the marginal status of mapping within users' needs.

Interviews with both Bruce and Ralph demonstrated that senior management considered usability and UCD as important beyond the user interface of iHealth's software and that it exists in informal processes as well as the formal processes, which depend on individuals. For example Ralph talked about "usability in the round" and Bruce explained that he thought everyone in the organisation should be customer-focused and he conveyed this alongside others on the Executive Board; his quote demonstrates the organisation's confusion between customers and end users:

> "I think the customer bit applies to everybody. It's not just the product development process. All of our salaries are paid by the customers. It doesn't matter whether it's…the reception desk or the guys in Finance, we're all responsible for customers at the end of the day and we all should be thinking of it in that way…It's about what you do rather than what you say though ultimately…The culture is set by the way people

> behave …so I can get up and my exec colleagues and managers can get up and say, "It's all about the customer" and everybody will go, "Oh yeah we've heard that before"…I try and get out in front of customers. I will go with the sales people etcetera to customer meetings. So we're trying to reflect that, and in the way that we also prioritise the things that we do."

Agile vs. Waterfall

The software development process involves individuals, teams and the organisation. iHealth shifted from practices more closely aligned to the Waterfall model of software development, towards a more Agile model; in addition they developed a more sustainable and flexible data architecture to facilitate faster responses to user requirements. This included a more formal integration of UCD techniques into the development process and using their results to prioritise development and inform "deliverables". The Agile model assumes that a design can always be improved. The organisational culture at iHealth, however, was built upon a confidence that they could achieve the correct design first time; perfectionism percolated from individual personalities, who were reluctant to admit errors or be told what to do, through to the organisational culture. It is not so surprising that iHealth began with practices from the Waterfall model because it emphasises an upfront design and corresponded to their belief that they were the experts in healthcare information and confidence in their design. Attempts to bring in Agile practices into the development of PHA were largely unsuccessful and interviewees regretted that users tested EED so late in its development, despite the recruitment of a designer. Ralph said:

> "We spent far too much time developing the entire skin before answering any of the engineering problems. We should answer the engineering problems one at a time as you develop the skin and get the feedback across time because then we could get earlier feedback as well and we would've spent less time building things that weren't so important as they appeared to be early doors [in the tool's development]."

Toby added that:

> "The idea of Agile is you're supposed to put something in front of your user ideally at the end of every two week sprint. In [EED] it wasn't until about four months that we even got customers looking at it…We're getting better but we're still not there yet with engaging our users."

Ultimately, feedback from the usability tests was provided too late for changes to be implemented. Interviews suggested that iHealth found fundamental aspects of software development models incompatible with UCD principles and the context in which the organisation operated. This is best illustrated by the following quote from Ralph:

> "There can be a discord between User Centred Design and Agile development if not well understood and we've been through quite a lot of internal working to try to understand how and where they align and unpicking aspects of both...They both have calls to them but they both also have specific methods and practices and they aren't necessarily aligned...From an Agile world the objective is effectively to just understand and deliver on your core priorities at all times and to do that through small iterative steps where you will deliver something small quickly, get quick feedback on that ideally from the end users and then refine that into a next stage of development...The whole point is user feedback and input, however it also requires a strong product owner who understands the end user, or goes through the mechanisms to understand what the users want and feeds that into that process as well. The User Centred Design approach is often more aligned to a Waterfall approach where there's been a lot more upfront thought and working through and more of a defined answer earlier in the programme of work that is then asked to be implemented."

iHealth's development process combined aspects of both Agile and Waterfall in an attempt to overcome drawbacks of both models, but still did not succeed to interviewees' satisfaction. Their experience contradicts literature in Chapter 2, which suggested the Agile model facilitates the integration of UCD principles much more easily than Waterfall; it promotes iterative design and communication between designers and developers, and also does not place importance on the first design (Boehm, 1988; Bornoe and Stage, 2014; Grudin, 1991a; Sy, 2007). Others, however, report similar challenges to fit usability testing into an Agile process (Lárusdóttir et al., 2010). It is clear that aligning UCD activities to either the Agile or Waterfall model is nontrivial; Waterfall is not iterative, like UCD (ISO, 2010), and whilst Agile *is* iterative, the short time allocated to sprint cycles can negatively impact upon users' involvement and their feedback informing designs.

Distance between the users and developers

Interviews revealed that a gulf between the technical team and end users, and even the Marketing team, had existed since the early days of the organisation. Frank explained:

> "They're incredibly complex products, particularly the data side and development was never going to be swift, but I don't think there's any excuse for it not being consistent and organised and done on a cooperative basis…Sometimes there was progress but it did feel like one step forward two steps back quite often…Other issues…like access to data held back the development of…[PHA]…We were developing the tool without knowing what data we had to work with and that created lots of problems. There was a disconnect between the development team and the front line as well in terms of how much the development team and the people who had designed the product actually

knew what the customers actually wanted. I don't think there was sufficient contact…I think the relationship between…the customer support at the time, and the product development was almost non-existent…I think as [iHealth] shrunk and the sort of tribal separation between the different developers and different teams, I think there's a lot of people that left which sort of enabled them to start again."

This last point reminds us that individuals set the culture of an organisation. As Nigel described:

> "Cultures are formed by individuals and the reason a culture is sticky is because people only change one at a time so that you can never get enough of a momentum to change things unless things get desperate for the business."

Iteration

The interviews revealed that EED team members had disagreed over when the usability testing should take place. Developers wanted individual elements of the interface to be tested, but Eric wanted to test a more complete "pixel perfect" interface in order to obtain richer information, impress existing customers and not waste their valuable time. A trade off had to be made between the completeness of the interface and early and frequent involvement of users in its design; ultimately a more complete version of the tool was tested with fewer end users because real customers were testing the redesign of a product they used and contracts were at stake, which impacted upon the extent to which developers could make any changes.

EED's initial development was not iterative in the Agile tradition that developers expected; interviews, however, revealed that EED's development was more iterative after its initial roll out and smaller products for new customers are developed iteratively. Toby reported:

> "Now with [EED] we are starting to iteratively release stuff to live almost at the end of every sprint…But during the early stages of developing a new product we didn't do that…We've been a bit more cautious on other projects…We're giving data to customers as a service and we've trialled that with a few customers before we spend a lot of effort on it…We've got some feedback from one or two customers saying this is what we think we want, we tried that with another few customers and they didn't want it so, that saved us spending a whole load of effort in developing something that was only useful to one user."

Jeremy described another project:

> "We've just been developing [a commissioning app]…we have been demoing to users from the second or third week…within six weeks we'll have a tool which is ready for market and whilst we don't have [Eric] we retained the budget…and have now a

> permanent member of staff...on the discovery elements and…analysis of usage stats…customers…competitors and our existing products…and understanding the market, but not with the visual design aspects."

He explained how the organisation's market makes it difficult to design products iteratively:

> "We're not a consumer product where we can just push something out on the web and see what people think of it. We have a finite number of users and we can't keep bombarding them…every time we need to make a decision, so it's not something that we could do on anything like the same scale as a consumer facing product."

Transparency

The reporting format of the results took into account the deadlines of the project and the time that recipients were likely to have to digest information; a trade-off was made between the transparency of results and rapid feedback of results into the development process. iHealth interviewees expressed that they would have liked more detail in the results so that they could draw their own conclusions from the data; Ralph even noted that this was contrary to the organisation's overall mission to increase transparency in health information:

> "As a company we have been pushing for and continue to push for greater transparency, in healthcare in general and in everything that's done and that's kind of a just, it's exactly the opposite of the mindset that we try to make happen everywhere."

The team also had to verify that usability test participants' verbal requests reflected how they carried out tasks in the usability tests, and also balance the consensus from all usability tests.

7.3.3 Product Development Organisation

Silver bullets

iHealth was a pioneering organisation in their field and Nigel described the organisation's attitude in these early days:

> "We're the experts in healthcare information. You should take what we're giving you and be grateful for it. Scattered across the business are people who understand that your users will always surprise you…however…as a business we're quite arrogant."

My analysis in the previous section would suggest that this attitude was reflected in the software development process at iHealth. The previous section described how the development process transitioned from Waterfall practices towards Agile practices; the Waterfall model emphasises the initial design of a system, and demands that this design will be right the first time. The transition towards Agile practices indicates that iHealth became increasingly receptive to customer feedback and recognised they may not get the design of their products right first time.

Position of design work in the organisation

The position of design work in the organisation changed during the collaboration according to its importance to the business. Between 2008 and 2011 a User Interface (UI) Team existed within the technical department. After that a consultant was introduced to the Propositions team[16]. Ralph described the deliberate positioning of Eric's work within the business:

> "We'd specifically put the usability…work within a different directorate so it was all within the Propositions Directorate … [Eric] worked for a business facing unit [because] we wanted to focus attention of development resource on business benefit."

This demonstrates that iHealth wanted Eric to work closely with customer-facing colleagues and put forward their requirements to the business, rather than tied to the technical team.

Identity change from technology to customer focus

Interviews revealed how technology drove the organisation's software development in its early days, but customers were now more central. Bruce said:

> "We've always been very technically-focused, and not quite as much customer-focused…Historically the company had had a tendency where the majority of project direction came from the technology angle of doing things for technology's sake rather than doing things for business benefit…given the competitive pressures, [with EED we wanted] to make sure we could jump step some of the competition by focusing our attention back on the customer and what they really needed, rather than driven by technology and thinking what was technically possible."

Quotes such as these provide supportive evidence for iHealth's increased usability maturity.

Change management

iHealth took advantage of usability tests to help existing users adjust to a new design. This was particularly important because many customers frequently used the tools in their work, and the redesign of EED forced them to learn a new way of working; usability testing helped to break the initial psychological barrier of a new design for existing users. Especially consider iHealth's market is finite and use of the tool is largely non-discretionary; customers' business is even more important.

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[16] The Propositions team oversee and manage the organisation's product and service portfolio across markets, translating clients' ideas and needs into products. Functions include market insight, strategy and road-mapping, product management, user experience, and data and information management.

These aspects were apparent in the interviews with customers. As user with responsibility for patient safety said, although they could perceive benefits from the system's redesign, they preferred to use the old system because they were an expert user, to the extent that they may not be using the new system if they had not participated in usability testing.

> "I simply haven't got time to…look at it when I'm more familiar with a different system…I got to learn something about it and otherwise, I have to say at this point in time, I would know nothing about [EED] and wouldn't have even looked at it…It gave me a training session that I haven't had time to plan myself."

The Clinical Effectiveness and Audit Manager also wanted to influence the tool's direction:

> "I don't use it very often at the moment…because of time more than anything else… When you know a system, it tends to be easier to stick with that than shifting over to learning something new…I get very used to seeing a particular thing and so I was less…wary of what the new system would be like...I have to use it so much, I would rather have a way in to influencing that a bit and getting a bit of insider information if you like…an hour or two of your time is probably well spent doing that."

The Senior Information and Research Analyst added:

> "Following the actual full release of the product, because I'd had a little bit of insight into how the tool works, I felt more comfortable using it from the start…I needed reassurance that…it was replicating what I could achieve in [HHW]."

Furthermore, the communication of the usability test results was important in supporting the change within iHealth, particularly the sales team. Ralph said the usability test results were "important from a communication standpoint internally as well." He said that usability test results demonstrated to Account Managers that:

> "This is…better. I know all change is difficult but this change is good and this proves it. Your end users will prefer this and you need to learn and encourage change."

Interviewees' responses suggested that the tokenism of individuals also existed at the organisational level. For example, Nigel believed that tokenism was also behind the creation of Eric's role:

> "The phrase user experience was an easy to grasp way of saying 'Look we've changed, we have a User Experience Manager.'"

7.3.4 Client Organisations

Changes in personnel

Interviews showed how personnel changes at client organisations can disrupt relations between product development organisations and their clients, especially since relations are often built by individuals. When I recruited usability testing participants for follow-up interviews, one had already moved on to a new job, one was due to move on to a new job and another was about to retire. In addition, changes in contract managers can affect developer-client relations. One participant noted:

> "We were on a bit of a roll but changing over the person that managed the contract and so on and who also manages the information, which is what mucked up our [data] submissions, has just caused us a bit of a break at a really bad time."

Training

One somewhat surprising theme that emerged from the transcripts is that both iHealth stakeholders and usability test participants described the opportunity that usability tests provided to train existing customers and foster customer relations more widely. This was especially important to iHealth because they planned to replace an interface with which existing users were familiar. Usability test participants also took the opportunity to comment on the other iHealth products they used, whilst they had the attention of an iHealth employee.

Perception of iHealth

Interviews suggested that UCD affected iHealth's brand reputation. Lead Business Manager, Nigel, thought that customers perceived iHealth as out of touch and described competitive pressures.

> "Our competitors, in some cases, present better and cheaper products to our customers…we had become, and are perceived as being, very out of touch, so there's a recognition that we needed to change."

Usability testing participants acknowledged and appreciated iHealth's efforts to consult them in EED's design; they also saw improvements since they tested it. The Cardiothoracic Surgeon said:

> "Things that were irksome [in HHW] have disappeared…it's visually…easier to use."

The Operational and Planning Performance Manager added that:

> "I have been quite impressed with the efforts [iHealth] have gone to…to listen to feedback on the tool…I think there does appear to be a genuine desire to produce something that's useful and listen to some feedback."

The Senior Information and Research Analyst also saw benefits of usability tests for iHealth:

> "I think it's also good for someone to see how a real user would be using the tool and how a typical user might be accessing or querying the data using the tool."

Usability tests were sufficient, therefore, to transform the organisation's perspective of the approach. Participants were far from inconvenienced as the organisation had feared, they welcomed the opportunity to influence the tool's design, recognised the organisation's efforts and reported positive opinions of the new approach; recall that I was previously encouraged to limit my contact with customers because the organisation did not believe that they would be interested in such activities and contracts were too valuable to risk damaging customer relations with incorrect or too much communication.

7.3.5 External environment

Technical limitations

iHealth's users are limited by the technology available to them in their organisations. The technology infrastructure in NHS hospitals necessitated that tools developed by iHealth were compatible with a range of web browsers; users rarely had a good network connection or the authority to download and use the latest browsers, or any additional software required to use some of the more advanced visual analytics tools. Saskia said:

> "If I use it on Google Chrome I can't download the patient identifiers part of the spreadsheet because it doesn't come up…I've now gone back to using it on IE but IE doesn't open it up in quite the same way and so there's some things that aren't so easy to see…I did have an email back from support about…how to do the security settings on Google Chrome because Google Chrome doesn't tell you which is really useful!"

Market position

Interviews confirmed my beliefs about iHealth's market position and the impact that changes in the market had on the organisation and its approach to product development. iHealth had built their reputation upon a national database of hospital admissions, but the Coalition Government elected in 2010 decentralised the commissioning work that iHealth developed PHA to support at a national level; consequently, when PHA finally came to market, its intended end users required local data for their work, rather than the national data sets that iHealth offered and on which their expertise and reputation was based. PHA's intended use was discretionary, which differentiated it from iHealth's flagship product. Frank explained:

> "Commissioners…didn't have an immediate operational need. The information that came from PHA was useful, interesting...[but] the market changed...councils and the

NHS, were going to have to work together to do their Joint Strategic Needs Objectives and healthcare and social care needs would have to be planned together and go hand in hand and that didn't really ever materialise. I think that's when the wheels came off of the whole PHA need…We were kind of predicting what would be required but the reality ended up being quite different."

Damian, who led PHA's development, also hinted that the licensing of data from other companies slowed its development and constrained how data could be presented to end users:

> "We [talked] to [other companies] about getting their data in and we did that because we thought it would distinguish it from other products, which it would have done, but it took ages to get those deals signed and argue about how we were going to show the data on screen and all sorts of things."

Others described how the market changes resulted in a moment of realisation for the organisation, which significantly raised the status of UCD. For example, Bruce said:

> "It's a bit like the Kodak issue, where they carried on using film rather than going digital…Do we spend money on [Referral Intelligence] to get rid of the bugs because we know that the sales people and account managers have got a problem with it…If we end up with great products just on [national Secondary Uses Service] data I think we're going to find ourselves being made less and less relevant."

7.4 Discussion

This chapter has presented the accounts of various stakeholders in the collaboration. Interviews with stakeholders from iHealth and their client organisations enable a comparison of their perspectives as well as verifying what I perceived for myself. The interviews generated insights into five main areas of interest: how user-centred methods can influence organisational culture, new understandings of the role of the designer, the impact of extrinsic factors on design work, the challenges and opportunities for practitioners to adopt and integrate UCD techniques in complex work domains, and the benefits and drawbacks of the AR approach for researching design practice.

Organisational culture

Interviews hinted that the status of UCD and design work grew during the collaboration and that the techniques I applied played a role in this; this is supported by the organisation's commitment to customer focus in its values statement[17], which staff created and agreed upon six months after the collaboration's end, and the influence of the techniques I applied on the way in which individuals worked. Interviews with both the usability test participants and iHealth stakeholders revealed the values and motives for usability work over the research period, which reflect the organisational culture. The organisation's motive for usability work at the beginning of the research was to "make more money" but eventually they actively facilitated usability work to foster customer relations.

At the same time, however, interviews spelled out the rockiness of the route towards an increased focus on UCD at the organisation. A particularly interesting dynamic between the organisation's individuals and its culture emerged over the duration of the research; despite reporting an increase in the focus of UCD, interviews painted a picture of a strikingly intransigent organisational culture. Efforts to introduce UCD to other organisations should account for this by both walking the factory floor and knocking on the boardroom door; interviewees strongly recalled the success of smaller scale efforts, such as the development of PHA maps, and attributed them to their discrete scope and individual collaboration, perhaps due to this research's context and the size of iHealth.

The designer's role

Interviews revealed interesting insights into the impact that an organisation's conception of design work can have on its effectiveness. For the EED project, iHealth created a role to manage its design that demanded a variety of skills and did not account for the subjectivity and extent to which the success of design work is intertwined with the individuals in place. This, however, came after a long period over which the organisation had experimented with the location of design work in its structure. Design work was originally stationed within the technical department, both in the workspace and in the organisation's structure; designers' and developers' desks were situated behind a glass wall, which required security access to enter. In the reorganisation of the department at the end of PHA, a UI team was created and positioned just outside this area due to lack of space; this impacted on the amount of contact between designers and developers. I can vouch for Frank's feeling that the UI team comprised people who did not fit elsewhere in the technical department. Since the UI team did not need access to the patient data that the security was in place to protect they were moved to the other side of the glass wall.

[17] All staff convened in November 2013 to determine core values: shared and agreed by everyone; authentic, reflecting the best of what they already believed in and would commit to; and, anchored in behaviour. They included "customer facing", defined as: engaging people; listening to, understanding and responding to customer needs; future focus; balancing customer needs and revenue; understanding the whole market, not isolated segments; making commercial decisions based on wider political, economic, social and technological analysis. They would not: over-service customers; make decisions based on insufficient evidence; neglect risk management; develop without reference to customers; focus on historic needs (Email communication, 2013).

Extrinsic factors

Interviews illustrate that the collaboration started when the organisation was very successful within its niche market. Interviews with both iHealth colleagues and usability test participants indicated that this was in large part due to the data that iHealth held rather than the products they designed.

A change in Government, and health policy, directly impacted on iHealth's business strategy. It created a sense of urgency within the organisation to retain customers whilst they investigated new markets. It is fair to say that the organisation lost their monopoly of the healthcare informatics market through these changes; interviewees described an increase in competitive pressure around the time that the Government changed.

Usability tests provided an opportunity to engage with existing customers more closely towards these goals. Customers were hesitant to renew their contracts due to the slow pace of political change, which was exacerbated by the election of a Coalition government and the strength of opposition to the changes they proposed.

Interviews again highlighted the limited technology to which iHealth users have access. Whilst the literature tends to endorse and advocate more current, novel and advanced visualisations (Communications of the ACM, 2014; Fisher et al., 2012; Grammel, 2010), many users are not accustomed to the latest visualisation techniques and do not have the time to learn them.

Complex work domains

Interviews highlighted risk factors for the introduction of UCD to similar organisations, but also opportunities. For example, iHealth stakeholders desired detailed information on users but the rapid pace of development only permitted the time for summary information to be reported and assimilated; my analysis suggests that similar-sized organisations would benefit from tools that can quickly, even automatically, assimilate very rich information about users in markets requiring significant domain expertise and that develop very quickly.

The technical constraints of the context this research describes demand particular attention so that users drive development rather than technology. Whilst the complexity of the domain demands technical people to deliver a technically advanced solution, who are inherently interested in technology, the end users' skills may not be compatible. UCD techniques can provide the opportunity to educate developers, and others in product development organisations, in the identity of users of the technology, at less cost than formal training and with more relevance.

Interviewees articulated trade-offs that were made to facilitate design work. Examples include the transparency and richness of results in order to feed them into the development process in a timely manner; also the early involvement of users in the design process was sacrificed for testing a more complete interface. Trade-offs were also identified in the recruitment of participants for usability tests; the sample was initially taken from those who we could travel to reasonably quickly and were already quite engaged with iHealth.

Finally, interviewees revealed that iHealth reaped unforeseen benefits from engaging their customers. For example, it helped them to manage the change in design of their most successful product, train both employees and customers, even the balance of power between themselves and their client organisations, and widen their user base even in their limited market place.

Action Research

Interviews revealed the positive and negative aspects of my role, particularly with respect to its academic nature, and AR in general. These insights can inform AR collaborations in future and demonstrate the value that lies within collaborative reflection. For example, roles should be clearly defined and given a position on the organisational chart. Interviewees noted that the collaboration spanned several changes in personnel and that perhaps the timescales of the collaboration were not always aligned with those of the organisation.

Quality considerations

I must consider the quality of the material these interviews provided. Several factors may have both positively and negatively affected the balance of power in the interview and interviewees' responses: for example my working relationship with the interviewee i.e. how well they knew me, my academic position, their involvement in and understanding of my research, their place in the organisation's hierarchy, whether they still worked there, the location of the interview, the recording of the interview on my mp3 player, the length of time interviewees had worked for iHealth and how well interviewees understood the reason for the interview and could anticipate my questions. Interviewees may have withheld information, for example, to protect my feelings. I accounted for these factors as well as I was able to at the time by recruiting interviewees by email, which allowed me to introduce the purpose of the interview and allay any fears of coercion, and, finally, giving them multiple opportunities (via email and at the beginning of the interview) to ask any questions. Resources, including time, dictated that interviews with usability test participants could only be carried out by telephone, which impacts the flow of any exchange, regardless of the individuals; this is something I was unable to affect, other than through direction of the conversation, but felt was worth overlooking for the opportunity to speak to them and gain the insights they could provide.

In light of these very real issues, however, I must specifically consider the trustworthiness of the responses interviewees gave. I was impressed and humbled by interviewees' honesty, exemplified by the quotations this chapter reports; interviewees ostensibly appreciated the opportunity to speak openly about the issues my questions raised. I even sensed frustration from some that iHealth had not taken my research further and, despite intentions, did not do more to listen to customers and users. My analysis thus suggests that UCD techniques can increase employee, as well as customer, satisfaction. To put participants at ease I let them choose the location of the interview and only recorded interviews with consent; I made it clear that interviewees could skip questions or abort the interview without reason. Finally, I interviewed employees until I detected sufficient consistency in their views to be confident in my analysis; when interviewees began to express similar ideas, I deemed that I could be confident in the themes I identified. The short time between interviews and analysis also helped to reduce the effort for recollection of the conversations.

7.5 Conclusion

This chapter demonstrates the value of and novel role played by collaborative reflection for analysis of ethnographic research, by presenting interviews with iHealth colleagues and EED usability test participants, which I carried out a year after EED was rolled out. Interviews verified much of the analysis previous chapters have presented, in addition to revealing new insights, including notable aspects of the culture at iHealth before and after the period of my research. I obtained perceptions of design work from major stakeholders and confidence in some of the views I had developed myself. I was struck by the strength of the feeling of frustration from many of my colleagues at iHealth but also their resolve to learn from our experience. I am also intrigued by a thought that discounted techniques might perpetuate a culture that merely pays "lip service" to UCD techniques. This will be worth reflecting on in the next chapter, which will conclude the research. In short, I detected changes in the status of UCD in the organisational culture from the UCD techniques I applied that I could not have anticipated at the outset of this research; these are insights that I could only have gained through the AR approach, a historical perspective and collaborative reflection.

Interviews enabled me to reflect and articulate what my work at iHealth had revealed: the intertwining of organisational culture and UCD techniques; new understandings of the role of the designer; the impact of extrinsic factors on design work; insights into the challenges and opportunities for practitioners to adopt and integrate UCD techniques in complex work domains; and benefits and drawbacks of the AR approach for researching design practice. I will now expand on these themes by adding my own reflections as I look back over the time of the collaboration and the techniques I used, and how iHealth's culture evolved alongside the status of UCD.

8 Conclusions

At a glance, this chapter…

- Revisits the research questions, aims and objectives;
- Briefly summarises the methodological approach;
- Highlights the memorable findings and how they differ from existing research to clarify their contribution to knowledge;
- Finds implications for Human-Computer Interaction research, usability professionals and their organisations;
- States the limitations of the findings and research approach;
- Identifies resultant areas for future research.

8.1 Thesis review

8.1.1 Reflecting back on the research aims and objectives

This juncture marks the closing of this thesis. It reflects on a journey that started out to introduce and embed User-Centred Design (UCD) techniques from the field of Usability Engineering (UE) within the design process of health informatics tools in the United Kingdom (UK) for the analysis of "Big Data". These products are designed to support: analysis of fast-growing datasets of vast volume and variety; domain experts to construct hitherto unknown knowledge; and, real time delivery of data. In so doing it provided the opportunity to pursue the following research questions:

1. What are the challenges and opportunities for applying and embedding UCD techniques in product development organisations?
2. Are there additional aspects of UCD techniques of value to organisations in these emergent design contexts?
3. What are the strengths and weaknesses of the Action Research (AR) approach for the investigation of design practice?

It has ended with an alternative perspective of UCD techniques, the role of usability professionals and the obstacles and opportunities for the introduction of UCD to organisations. Along the way, careful considerations were made for the context of design work and research questions were amended accordingly. This thesis goes above and beyond existing accounts of the introduction of UCD by investigating its introduction, over a significant period of time, within a single organisation that develops products for financial profit; previous reports have been limited to accounts of either public sector organisations or reports of aggregated experience over multiple projects, presumably to protect commercial interests. Furthermore, it has been proven that, although the AR approach presents several challenges, it provides a suitable framework for other Human-Computer Interaction (HCI) researchers to investigate design practice.

8.1.2 Implementation and outcomes for each study

This thesis presents a collection of UCD methods and techniques, implemented through three research phases, that weave together to produce an inimitable tale of design work from the trenches that moves forward previous research on UCD techniques and the introduction of UCD to organisations. As such, this contributes to research on design practice via a series of research phases in which UCD techniques were applied and their effects observed. In so doing, it further substantiates the need for HCI researchers to engage with real cases of design in order to keep research relevant to practice (Johnson et al., 2014). Table 8-1 summarises the problem addressed, UCD techniques used and outcome achieved by each research phase.

Research Phase	Problem addressed	Techniques	Outcome
1 - Chapter 4: Public Health Analyser	The geographical representation of data for end users who cannot be assumed to be able to interpret data on maps.	Online questionnaire Heuristic Evaluation (HE) Cognitive Walkthrough (CW)	The development of a well-functioning mapping interface and an understanding that the system was too complex for UCD on the maps alone to be sufficient to make whole system usable.
2 - Chapter 5: Personas Development	System developers' lack of knowledge of the end users and the tasks they aim to accomplish with the system.	Database Server Log File Analysis User-Generated Screen Capture Survey Rapid Contextual Inquiry	Innovative adaptation and use of UCD techniques to gather and analyse of remote user data. Production of posters and a detailed document of company personas, which raised awareness of end users within the technical team.
3 - Chapter 6: Effectiveness and Efficiency Dashboard	Verification that existing end users of Hospital Health Watch can still accomplish tasks on the redesigned system and can use new features.	HE CW Usability Testing System Usability Scale Questionnaire	The demonstration that the organisation could develop a product with a UCD process and of usability testing's additional benefits in addition to successful recording of video highlights for developers.

Table 8-1 Thesis Outline

The completion of the research's aims and objectives realised a number of key achievements that have importance for the design and development of "Big Data" analytical tools. Chapter 4 presented an interface that was developed to enable healthcare managers to map data from a database of almost a billion records in real time. Subsequently, external events provided the impetus for the development of personas in Chapter 5 with techniques that examined and exploited the resources available at the time. Finally, Chapter 6 revealed the insights and additional benefits of usability tests and the presentation of video highlights to developers; it gave the organisation and many of its members a new understanding of how design work is carried out and its importance. In so doing, a technology-focused organisation opened their eyes to both the desirability and necessity of UCD techniques such as user-generated screen captures (UGSCs), personas and videos for their software development and putting the customers at the heart of their business strategy.

8.2 Thesis discussion

This section will provide the answers that I found to the research questions originally outlined in Chapter 1, but also numbered in Section 8.1.1.

8.2.1 What are the challenges and opportunities for applying and embedding User-Centred Design techniques in these new design contexts?

External factors

Arguably, one of the most significant contributions and achievements of this research was the embedding of a UCD culture despite political and organisational turmoil. I was afforded privileged access to an organisation over a sufficient length of time to observe the effects of external events on product development, respond to them and gain a historical perspective of an organisation's culture around UCD. Extant literature only scratches the surface of how external events can affect the introduction of usability to projects (Svanæs and Gulliksen, 2008) and lacks detail of the deep impact that external events can have on an organisation's UCD culture over a period of time. A number of extrinsic factors impacted on the introduction of UCD at the organisation:

- Political changes that impacted the market place;
- Changes within the client organisations;
- Constraints of the technological infrastructure.

Changes in the Market Place

Just before the collaboration, a paradigm shift in healthcare policy reframed the finite resources of the National Health Service (NHS) to be more effectively managed and targeted at people with the greatest need, so that services were no longer targeted uniformly to all population groups, with its corresponding inefficiencies in cost and resources. In addition, there was a General Election half way through the collaboration that resulted in major structural reforms to the NHS and impacted the stability of the developer organisation and their client organisations. In a constantly changing policy-led NHS, there is a considerable time-lag between policy being conceived, communicated, implemented and adopted by health practitioners on the ground. I observed that changes in an organisation's market and product focus provided both an opportunity and an obstacle for the introduction of UCD, which I will now describe.

I noted that external events altered the balance of power between the organisation and their customers, which resulted in a fundamental change in the organisation's business model and a sense of urgency that was incompatible with the slow pace of change in the market. The insights I report thus emerged from and were contingent on the time and place of my research; I could not have anticipated the political changes that occurred and how they would impact on my research. Carlshamre and Rantzer (2001) also benefited from the timing of their project and Mayhew (1999a) identifies "a high-visibility disaster" and "a perception of competition and market demand" as motivators for the introduction of UCD to organisations, which usability professionals and organisations cannot control. My research suggests that organisations in complex domains might be persuaded to adopt UCD practices to mitigate damage from external events, for example by fostering customer relations and informing more efficient allocation of development resources.

Changes at the Client Organisations

Changes within the client organisations, independent of the changes of the market just described, also created opportunities and obstacles to introduce UCD. I observed that the organisation was exposed, and contracts put at risk, when the structure and personnel of client organisations changed because the number of end users at each client organisation was low; the organisation was especially concerned that contracts were renewed because of the finite nature of their market. Product development organisations in similarly finite markets might be inclined to reduce costs and risk by trying to develop all-purpose systems; however, I observed that organisations can remain sceptical of users' feedback if only a few end users exist at each client organisation, because feedback is coloured by a limited sample of all potential users.

Technical aspects

My research also revealed how technical aspects of complex domains can impact the introduction of UCD. The complex and sensitive nature of the data required the user interface (UI) to be developed independently of the underlying database, which limited UI development; other usability professionals may also find that the complexity of data and licensing restrictions make it difficult to integrate sources of data, and that issues related to the anonymity of participants in UCD activities and data subjects emerge. The terminology of the data presented particular challenges; participation of domain experts in UCD activities resulted in an offer of further assistance with terminology and serendipitously increased the impact of results, as also reported by Følstad et al. (2010).

For Information Systems (IS) such as the ones described, I found that knowledge of how the users think about the data is manifested in the database and software architecture. Easy modification of the UI depended on how well the database architecture matched the users' conception of the data much more than the separation of the UI and database platforms (Bass and John, 2003). The architecture of the underlying database made it fundamentally very difficult to implement some redesign suggestions, but the organisation reconfigured the architecture to be more stable so that developers could implement changes to the code with less risk. Such difficulties can be attributed to the complexity of the application domain and had a big impact on the resulting design decisions made and whether redesign suggestions were put through to development.

In addition, I observed that end users do not always have the skills and technology to interact with complex visualisations; the literature has tended to shy away from this finding in favour of endorsing the state-of-the-art. The organisation was surprised and frustrated by the limited technology available at client organisations and even found it difficult to develop a system compatible with all web browsers, despite evidence from meetings with end users in their workplace and UGSCs suggesting that this was needed. Google Analytics data also usefully revealed the range of web browsers and screen sizes on which users accessed the tools. Security concerns with external network communications and restriction of administrative control precluded the use of solutions such as Skype for remote communication with users; end users would have to install Skype but few had authorisation to install software on their workplace computer.

Organisational structure

Second, I also observed the impact of organisational structures on UCD. These included: changes in business strategy and model; separation of teams involved in the design process in both the organisation's hierarchy and the office space; developers outnumbering designers; little access to end users; lack of UCD knowledge across the organisation; inertia and resistance to change development processes and practices that had historically served the organisation well; and, lack of incentives or performance measures for usability.

Changes in business strategy and structure at the developer organisation, corollary to the external events just described, also impacted the introduction of UCD in both a negative and a positive way. The organisation in which I conducted my research initially achieved success because their client organisations had a statutory requirement for the data to which iHealth's products gave them access. Their success gave the business sufficient status and confidence to develop products for discretionary use elsewhere in the market; changes in the market just after they took this decision, however, forced the organisation to refocus and redesign existing products. As such, my account evidences the dangers of successful organisations resting on their laurels and lacking awareness of UCD. The resultant reorganisation of the office space, however, brought stakeholders in the design process closer to each other. From my perspective, this eased the organisation of UCD activities.
Previous research on the introduction of UCD has focused on organisations with comparatively simple business models and products (Martin et al., 2007). Different business models present different opportunities and obstacles for the introduction of UCD and, whilst previous work describes these according to very broad categories of product development (Grudin, 1991a), I found that the opportunities and obstacles that arose from the diversity of iHealth's business models (development of software products for both discretionary and non-discretionary usage)

were often in conflict and changed during the collaboration. The situation developed so quickly that the structures and processes that the organisation put in place to coordinate design work had little time to mature (Poltrock and Grudin, 1994). I was able to observe its effect due to the length of my research and my integration within the organisation. Whilst organisational change is a natural process and to be expected for a study of this length, the scale of the changes could not have been anticipated at the outset; the aims of the collaboration had to be redefined accordingly.

I observed that even though the organisation did not allocate a specific budget for usability work, it did not prevent it from taking place. Furthermore, we have seen that the business allocated more project resources to usability when their financial performance was poor (Effectiveness and Efficiency Dashboard - EED) than when their financial performance was good (Public Health Analyser - PHA). From my perspective, the motivation to focus on design work largely stemmed from the increased market pressure described; the status of usability work, and recognition of its importance, had to increase across the organisation, but particularly amongst senior managers, for improvements to be made. They recruited knowledge and expertise in usability, integrated design and evaluation techniques into the development process and used resources and techniques more successfully, which only became clear, as time passed.

Organisational practices

In general, several organisational practices also impeded the introduction of UCD: the separation of, and poor communication between, teams involved in the design process, both in the organisation's structure and office space; the competing priorities of, and speed of, the development process reduced the depth to which UCD activities could be carried out, reported and acted upon; differences of opinion between individuals; and, an organisational culture that prioritised technology over users in the allocation of resources.

Specifically my research demonstrates the challenges, and importance, of the smooth integration and synchronisation of UCD activities into a fast and dynamic software development process such as Agile. Whilst literature tends to endorse *incremental* software development for producing usable products (Hussain et al., 2009; Sy, 2007), members of the organisation reported difficulty integrating an *iterative* UCD process within both the Agile and Waterfall development approaches. The integration of UCD into formal software development processes is already known to be an important mechanism for embedding UCD within organisations (Rohn, 2007). At iHealth, senior management changed its development approach from phased to incremental to produce customer- rather than technology-centred products; they enacted this change without considering its effect on ostensibly failsafe UCD activities (Gulliksen and Göransson, 2001).

The format and medium in which I reported the results of UCD techniques required adaptation of public resources to the local development approach; an incremental approach to development demanded a faster and more concise reporting format than within a phased approach (Bansler and Bodker, 1993; Cajander, 2010; Gulliksen and Göransson, 2001). UCD techniques were more effective in this dynamic context when they supported the rapid analysis and feedback of results. In the Agile approach adopted towards the end of the collaboration, results were reported at weekly scrums, whereas the more phased approach used at the beginning enabled the writing of much more detailed reports (Sy, 2007); the usability process was more informal for PHA (phased) compared to the EED project (incremental). The communication of the results of UCD techniques was also more effective and efficient within a smaller team of developers.

My observations substantiated previous findings that the success of usability work depends on the characteristics and skills of the individual stake holders in the design process, rather than their roles (Eriksson et al., 2008; Gulliksen et al., 2004). In the same way that I benefited from allies, organisational "inertia" (Rosenbaum et al., 2000) impeded the introduction of usability because many individuals had worked at the organisation for a long time and become accustomed to particular working practices. Even though individuals recognised that the organisation's culture was not user-centred, a culture of tokenism percolated up from individuals to the organisation at the beginning of the collaboration. Whilst market changes created the commercial incentive to introduce UCD, I observed that the success of UCD introduction depended on individual end users at client organisations, and their various skills, values, behaviours and motivations for using a system and their participation in UCD activities.

8.2.2 Are there additional aspects of User-Centred Design techniques of value to organisations in the context that surrounds the development of "Big Data" analytical tools?

Embedding of a UCD Culture

Time revealed the ability of UCD techniques to embed a user-centred culture from the base of an organisation's hierarchy; this is an original insight into how UCD affects organisations and furthers our knowledge of the introduction of UCD to organisations. This presents exciting avenues and opportunities for usability professionals within other engineering and technology-focused domains. I found that, not only did the organisation's culture impact which and how techniques (Blandford and Wong, 2004; Iivari, 2010; Symon, 1998) were applied but, aspects of the techniques affected the introduction of UCD. Simply put, I found a feedback loop between UCD techniques and the usability maturity, or culture, of the organisation.

I highlight aspects of the UCD techniques that the organisation found valuable for fostering a UCD culture and found them to be inextricably linked to the knowledge resources they require and axiological resources to which they are associated. To summarise what I found, UCD techniques can: provide customers with training and reduce the support they require; manage the upgrade and redesign of systems; provide an organisation with an indication of customer satisfaction; foster customer relations and make customers feel valued; build teams and break down organisational silos; resolve conflicts of opinion over design decisions; foster a UCD culture at a developer organisation; increase transparency within an organisation, in addition to simulating more transparent and balanced relations with clients; and, humanise the users. I will now explore these aspects further.

Growth in UCD Awareness

In each of the studies the choice of UCD technique was heavily influenced by the knowledge and expertise available at any one time; for example, I gathered UGSCs to inform persona development, and I used the System Usability Scale (SUS) questionnaire at the end of usability tests on the advice of my academic colleagues who had previously used these techniques. Three years passed between the PHA and EED project, during which the organisation recruited Eric, a designer with his own expertise in managing client relations when conducting usability testing. Furthermore, the Product Development department became more knowledgeable in UCD through training, experience and arrival of new staff. Growth in knowledge surrounding UCD therefore directly resulted in more successful transfer of design resources during the collaboration. This historical perspective counterfactually contributes to our knowledge of how practitioners choose a UCD technique.

My own knowledge of UCD and its associated techniques will have also unavoidably coloured the way in which I applied the techniques and planned projects. At the start of the collaboration, in particular, I turned to highly structured public resources to support usability problem identification. I found the resources to be partly adequate but partly inadequate for the complexity of the interface I inspected. This corroborates previous research on the learnability of UCD techniques (Blandford et al., 1998; Eriksson et al., 2009; Howarth et al., 2009; John and Packer, 1995). However, over the course of the research I developed my own experience of using UCD techniques through guidance from academic experts, Masters courses and workshops.

The complexity of the domain posed some impediments to the introduction of UCD. Successful use of the system under examination required a significant amount of domain expertise, which takes time to develop (Bornoe and Stage, 2014). I developed my own knowledge of the domain as the research progressed until finally becoming one of the company's longest serving employees by association. The results of UCD techniques had a greater impact when reported by domain experts, replicating findings of previous research (Følstad et al., 2010).

Techniques that involved others in the organisation aided the horizontal communication of the UCD message and serendipitously improved inter and intra team communication and inspired others to continue UCD activities beyond individual projects. Some UCD techniques, however, were found wanting; it was not always possible to communicate the detailed results required within the time frames of the projects; for example, the usability test results could only be reported at a high level initially but stakeholders wanted more detailed results so that they could formulate their own conclusions from the data. Stakeholders appeared to conceptualise UCD differently, however, which may have impacted its introduction. Further research will need to be done in this area.

The realignment of an organisation's practices towards UCD

User representations and small-scale user studies demonstrated the value of user involvement to the organisation since it lacked expertise in UCD and encouraged further UCD activities. Users were dispersed across the country and remote from the organisation, so I found that techniques that brought the users to life (such as personas, UGSCs and recording usability tests on video), were particularly effective. One interviewee even suggested that the organisation could use personas to inform new recruits about the customers. Literature has discussed the challenges of, and different approaches for, user involvement in product development (Axtell et al., 1997; Iivari, 2004) but the end users in the domain in which I carried out my research were particularly heterogeneous and considerable effort and resource were required to gain access to them; this had consequences for the early and continual involvement of users in the development process, how iterative the process could be, and the representativeness of user sampling, as noted by previous studies (Chilana et al., 2010; Rasmussen et al., 2011; Redish, 2007).

The organisation largely dictated participant recruitment in order to protect client relationships. For example, I pitched persona interviews as a research exercise but explained the benefits for the organisation before users consented to their participation. This approach to participant recruitment was partly necessary due to the complexity of the work domain but in stark contrast to the approach of many design consultancies that can send screening questionnaires to many potential participants. I found that the success of UCD techniques largely depended on how representative participants were of the user population, but I found this difficult to achieve due to the complexity of the domain and diversity of users; usability test participants were limited to expert users and survey respondents were limited to those with the time and inclination to respond.

The choice and success of a technique for the introduction of UCD depended on the extent to which the techniques applied were compatible with the organisation's values (Loranger, 2014b; Rohn, 2007); the mismatch between what the organisation wanted to achieve and what they thought they wanted only became clear because I tried the techniques over time and had the opportunity to "see the wood for the trees". The organisation valued techniques that were transparent, resolved power struggles and uncovered customer satisfaction; organisations in similar contexts may have similar values because of the nature of the domain. Even if an organisation values redesign suggestions, they may not want to change the design based on the feedback of a limited number of users. The organisation also valued techniques that required the collaboration of different teams (Loranger, 2014b; Vredenburg et al., 2002) and could be easily integrated with the rapidly evolving time frames of the project. I will return to this later when I consider the suitability of the AR approach for this research. Serendipitously, the adaptation of the UCD techniques to meet the organisation's values helped to introduce UCD; this shows the benefit of the user-centred design of UCD techniques. I had to make trade-offs in participant recruitment, task selection, problem identification and reporting of results to apply UCD techniques because of the "wicked" nature of the problems the products were designed to address (Rittel and Webber, 1973); the complex domain in which I worked evolved at a much faster pace than the application of UCD techniques in text books required. Stakeholders from both client and developer organisations without knowledge of UCD might not have the time or inclination to participate in usability activities (Roast and Uruchurtu, 2013). Further research is needed to explore the extent to which usability professionals should accept the values and perspectives of organisations or try to change them (Cajander, 2010); my research suggests that both are possible.

Corporate culture and values that motivate UCD activities, and clients' needs and expectations from a method, are referred to as axiological resources (Woolrych et al., 2011); the historical perspective, collaborative reflection and range of UCD techniques behind my findings enabled me to go beyond anecdotal reports from practice-led research to serendipitously reveal the organisation's values. I found that the introduction of UCD was more effective when I had a better understanding of what motivated the organisation (Bloomer and Croft, 1997). For example, the organisation reported that they found the results of the SUS questionnaire useful because it explored customer satisfaction; the SUS questionnaire might have been given greater consideration if the organisation had expressed an interest in customer satisfaction prior to the usability tests.

In my research, I had two sets of clients: the organisation's clients (i.e. the end users of the organisation's products) and the collaboration's client (i.e. the organisation). I had to carefully manage expectations within both relationships at the individual level because the developer and client organisations placed different values on the techniques (Furniss, 2008), but it was clear from my own perspective and interviews that I did not fully succeed with this. I had to ensure that the organisation understood that any one technique, or combination of techniques, could not provide the perfect design; for example, I had to manage the PHA project team leadership's expectations of the final mapping interface according to what the developers told me could be implemented given the underlying database architecture. An organisation may have good reason to fear that usability test participants expect their suggestions to be implemented; for example, they may fear that participants may not agree to future usability tests or, worse, take their custom elsewhere. However, I found that end users might agree to participate in usability tests in the hope and expectation that problems they encounter and suggestions they make will be addressed. Stakeholders from the organisation emphasised that they wanted to reduce development time and cost, whilst end users were more interested in the training that usability tests provided, and opportunities to contribute to the development of products that will be useful to them.

8.2.3 Effectiveness of Action Research

This section will now address the third research question and consider the strengths and limitations of the methodological approach taken to carry out this research. This will allow me to comment on the risks and benefits of the AR approach for other HCI researchers in conclusion. **What are the strengths and weaknesses of the AR approach for the investigation of design practice?**

<u>**Strengths**</u>

Flexibility of Approach

The dynamic application setting of this thesis, in which users and their tasks associated with "Big Data" were initially unknown, presented a "wicked" problem, for which solutions constantly change and outcomes are unpredictable. AR was thus a good approach because, first, it allowed me to adapt my research to the unpredictable external events that impacted the organisation so greatly and engage directly in projects (S Harrison et al., 2007). I was able to take opportunities to influence and attend usability tests as they arose. It also allowed me to adapt my work to the market trends that may have otherwise weakened my contribution (Dray, 2009). AR provides the scope to iterate research questions over time, and facilitates knowledge transfer in such a way that the learning process was mutual; for example, individuals in the organisation reported that they continued with UCD techniques after the collaboration, so that the culture endured beyond a single project.

It is only through approaches such as AR that researchers can discover aspects of design work that they do not even know they should look for, advance the field and keep their work relevant to practitioners. In the same way that I was able to demonstrate that the users' experience of the system in their workplace was different to my colleagues' experience of the system in the office, AR enabled me to uncover differences between the application of UCD techniques in the field to their application in a laboratory (Johnson et al., 2012). I have revealed surprising strengths and weaknesses of UCD techniques in practice (Wenger, 2000), how design work can be supported (Ylirisku et al., 2009) and make a real impact (Hayes, 2011). HCI researchers will have to be increasingly open to possibility of previously unknown aspects to design practice, because the complexity of design contexts continues to increase and present new challenges.

Duration of Study

Since UCD cannot be introduced to an organisation overnight, AR provides a framework with which investigate its introduction. The duration of the study permitted me to observe the natural and perpetual changes at the organisation and experience their effect on design work (Tsoukas and Chia, 2002), and that textbook UCD techniques can be too prescriptive to be usable in this context.

The length of the collaboration enabled me to build strong professional relationships that permitted me to observe natural events unnoticed, carry out the final interviews with the participants' trust, and acquire the support of others within the organisation to keep the research relevant (Johnson et al., 2012). As one of the longest serving employees by association at the end of the collaboration, I could extract tacit knowledge from the organisation that cannot be found over shorter projects and timescales (Hayes, 2011; Kvale, 1995). I observed the buzz of the business when it was growing, but also the emptiness of the office after redundancies, which served as a visual reminder of the organisation's contraction until they found a new office, and I have already highlighted findings that only became clear with the passing of time.

The Reality of Design Practice

In a general sense, AR uncovers the realities of design work in a way that overcomes the limitations of self-reported design practice. For example, it has shown the dangers of a shared responsibility for usability issues, as previous research has found (Boivie et al., 2006; Cajander, 2010; Cajander et al., 2006), but also the impact of the scoping of a usability professional's role. Whilst the introduction of a designer helped to place usability on the organisation's agenda and increased awareness of usability in projects (Boivie et al., 2006; Clegg et al., 1997), the role itself was not enough; design work was not historically taken seriously at the organisation and Eric was ultimately given too much responsibility in the EED project, which caused design work to lag behind the pace of development. Although interviews indicated that stakeholders in the design process found the scope of Eric's role on the EED project was too great, it helped the team, and Eric, to know who was responsible for its design. More specifically I gained insights into the range of skills usability professionals require and gain naturally over the course of, and beyond, a single project. I will now report each skill with examples in turn.

Educator and mentor

Literature contains examples of usability professionals coaching other stakeholders in the design process (Cajander et al., 2010), and I was also called on to educate others in the organisation about usability. This was crucial for the credibility of my work and the collaboration to leave a UCD legacy at the organisation. I was asked to deliver a lunchtime presentation on usability to the whole technical team, including the developers, and I also enlisted help from several colleagues to create personas. I also educated others in the organisation about the domain and the language of the users (Bornoe and Stage, 2014); I incorporated this knowledge into personas, which triggered several subsequent requests for information..

I empowered individuals in the organisation to do usability work and grow their role by involving others in UCD activities. For example, a colleague with an engineering background assisted me to analyse the database server log files and reported that this prompted further investigation of user journeys in subsequent projects; another reported requesting and attending training on UCD after seeing the personas I created. From my perspective, many stakeholders in the design process had opinions on the UI because it is so visible and therefore involving others was in part necessary; we saw that the credibility of usability test results is diminished if the tests are facilitated and reported by the same person that designed the product

User champion

Consistent with previous research, I communicated and championed end users' requirements within projects (Boivie et al., 2006; Gulliksen et al., 2004). The organisation underestimated the breadth of motivations, roles and technical experience and competence of the end users and focused more on technology at the beginning of the collaboration; the developers were distanced from end users and customer-facing teams. The impact of this on design work was exacerbated by the heterogeneity and domain expertise of the end users. Persona development, however, raised awareness and the credibility of my work, which gained me a reputation amongst my colleagues as someone to ask whenever they had questions about the users.

I also championed end users outside of projects. One stakeholder admitted that they perceived that a lot of my time was spent on activities for which no one else had the time, scope or inclination; for example, interviews with customers to develop personas took a long time because they required scheduling and then travelling to different parts of the country. This is important because, in this context, users are domain experts but cannot be assumed to be the best designers (Bornoe and Stage, 2014). The organisation preferred not to change the design based on a few users' comments because they found to their cost (on the PHA project) that this can result in the continual addition of functionality, based on a belief that customers will find the product more useful or desirable, when it can make the product too complicated to use.

UCD activities also empower users; participants in the usability testing of EED reported that they were glad for the opportunity to contribute to the future direction of its development (Boivie et al., 2006). This can perhaps be explained by the largely non-discretionary use of the system. I found that the end users had little say in which systems they use for their work; they also depended on the system for their work and used it regularly (Gulliksen et al., 2004).

Facilitation

My research shows that usability professionals facilitate UCD activities, make sure they take place and that a user-focus is maintained (Boivie et al., 2006). My work facilitated communication within and between organisational units and external stakeholders including vendors of geographical data.

Change Management

The role of the usability professional carries some responsibility, whether implicitly or explicitly, for promoting UCD within the organisation; they have to sell design work and the concept of UCD itself, which is especially difficult when resources are limited (Bornoe and Stage, 2014; Eriksson et al., 2008). Like previous researchers, I benefited from carefully combining bottom-up and top-down approaches (Boivie et al., 2006); from my perspective, the introduction of UCD to iHealth was more successful because it focused on a particular product and lightweight UCD techniques, before attempting to change management practices, in agreement with Eriksson et al. (2008).

Mediation

I mediated between project and product managers and the developers assigned to the maps. The Product Manager assigned development requests to me, and it would then be my responsibility to work with the developers to fulfil it. I found that individuals in the organisation, the business and end users had different motivations for participation in design work, so that usability professionals have to mediate and negotiate the meaning of the term "usability" and expectations of design work (Boivie et al., 2006). The design work this thesis reports was a mutual learning process that required humility and diplomacy; there is a political element to usability work whereby practitioners represent and speak up for their constituent users, within a cauldron of competing interests.

Sales person

The organisation exploited usability tests to sell the new design of their flagship product to existing customers. Previous research has not observed the use of usability tests in this way, so my findings provide a new perspective on the role of usability professionals and usability tests.

Developer

Like previous researchers, I had to understand the language of the developers to communicate what they could practically implement back to the project managers (Boivie et al., 2006). This was extremely important because I often had to explain to project managers why the developers could not implement what was being demanded and the technical constraints under which the developers were working; in some instances this required going back to the developers and explaining why some requirements were non-negotiable and that it was necessary to find a solution (Gulliksen et al., 2004), particularly since the UI was developed very separately from the rest of the system (Rosson et al., 1988). I believe that the increasing complexity of IS around "Big Data" will require UCD practitioners to have an increasing knowledge of databases and computer programming.

I also required a strong grasp of the development process, as reported by previous research (Rosson et al., 1987). For example, Eric noticed that usability tests had disappeared from EED's project plan and had to reintroduce them. I echo previous researchers' calls that HCI education programmes should include some basic computer programming and project management skills; it also calls for more opportunities for students to participate in real product development projects.

Analyst

Throughout my research usability work demanded substantial amounts of analysis, for example analysis of the database server log files using Structured Query Language. The organisation gave

Eric responsibility for the whole of the design process, which included gathering and analysing user data to inform their requirements at the project's outset; after the EED project the organisation recruited a separate individual to research their market and competitors after the collaboration and the UI team included Business Analysts for this work at one point.

Weaknesses

This thesis found weaknesses with the AR approach, which are useful to articulate for other HCI researchers who consider it.

Ethical Considerations

Carrying out this research bestowed upon me significant ethical responsibilities towards iHealth and their customers, especially when I carried out interviews, because participants could have potentially put their position at the company and career at risk. My experience suggests that the additional steps required, to accomplish the action and reflection this thesis reports in an ethical way, could be an important reason why few HCI researchers are granted such privileged access to commercial organisations, and limit the breadth of practice-led research. I faced several difficulties, not only in reporting my research, but, most fundamentally in carrying out research within the commercial context in a way that protected the identity and interests of participants. When conducting interviews, I relied especially on participants' trust and willingness to be open, and their ability to recall events accurately. I was not always able to obtain access to people who would have provided valuable insights because personnel changed and the organisation controlled customer relations. The research's initial scope was intentionally broad, which largely facilitated its smooth progression and longevity, but also created a lack of clarity about my role and how my research fitted into the organisation's day-to-day operations, as found by other researchers (Gulliksen et al., 2009).

Changes of Personnel

Other aspects of AR presented challenges of which others should be aware. For example, multiple changes in personnel at the organisation impeded the momentum of the collaboration; the loss of Damian, who had academic experience and helped to instigate the collaboration, caused particular difficulties. This finding is reported by others (Gulliksen et al., 2009). I can now, however, reflect on the positive effects that changes in the personnel had over the course of the collaboration; for example, the establishment of a UI team gave my research a position and visibility in the company and enabled me to work with those who had similar interests. In particular, I found it helpful that Frank became my line manager because he had experience of UCD and had been working at the organisation for a very long time so was able to facilitate collaborations with others in the organisation more effectively. Like previous researchers (Gulliksen et al., 2009), I found it difficult to keep the research visible at the organisation. Usability professionals can search for allies to alleviate this risk.

Confusion of Roles

Confusion over my role within the organisation emerged as it developed over time, and this was compounded by changes in personnel because my role had to be explained to and reinvented with each new team member, which unavoidably impacted upon the momentum of the collaboration. According to interviews, confusion centred on the extent to which I was a consultant or a full time employee during the collaboration, as previous researchers have experienced (Baskerville and Wood-Harper, 1996; Gulliksen et al., 2009). From my perspective, this confusion arose from the broad scope of the project at the start of the collaboration, which was necessary to accommodate competing interests but left unclear and ambiguous expectations and responsibilities.

The changes in my role, however, gave me privileged access to the perspectives of a variety of stakeholders, through my involvement in such a wide variety of projects to different degrees, so that I could apply both bottom-up and top-down approaches (Johnson et al., 2012). These insights can inform AR collaborations in future. For example, roles should be clearly defined and given a formal position on the organisational chart.

The demands of the organisation (Hayes, 2011) often conflicted with the running of user studies, because the systems and tasks investigated were very real and difficult to define; the field of HCI values publication, whereas the organisation demanded production (Dray, 2009). Often the timescales of UCD activities were not aligned with those of the business; for example, I was asked to develop personas partly because it would release me from deliverables associated with projects. Similar to other AR projects, compromises had to be made to maintain the momentum and civility of the collaboration, although this does not diminish the value of the approach (Hayes, 2011).

8.3 Contributions to knowledge

Whilst the discussion above connects this body of research to previous work, and substantiates many earlier findings, it has unique characteristics that have added to the field's body of knowledge. The research demonstrates that:

1. **<u>The interaction between UCD practice and organisations is bilateral and dynamic.</u>**

Whilst the need for design practices to be compatible with organisational culture is identified by previous research (Furniss, 2008), the ability of design practices to change this culture is demonstrated in detail here. The design culture of organisations is in itself dynamic and shaped by both internal and external forces; organisations can therefore be fitted to design practices in the same way that design practices can be fitted to organisations. This finding is exemplified by my counterfactual understanding that the organisation was not ready to have its products tested at the beginning of the research, even though previous research recommends that this is the most effective approach for instilling UCD.

The evidence provided by the unforeseen organisational response to usability testing in Chapter 6 and persona creation techniques in Chapter 5 suggests that the value of some UCD practices may need to be reconsidered. The values that are implicit in the UCD techniques can be at odds with those of the organisation, which ultimately determine how the results are used.

2. **UCD professionals can be critical for the reshaping of organisational culture.**

Sustained individual proactive commitment to UCD practices, underpinned by effective communication and sharing of results, can encourage organisations to adopt UCD approaches that ostensibly do not fit their design culture. This research demonstrates that the effectiveness of this can be greater than targeting efforts at organisational policy alone as it establishes effective and sustainable mechanisms. Future researchers/practitioners should heed this in their work.

3. **Auto-ethnographic documentation, embedding within a design team and collaborative reflection are valuable practices in practice-led methodology.**

Whilst previous researchers hypothesised from anecdotal evidence that research *through* design has value (Frayling, 1994), the research this thesis presents contributes significant insights into the nature of its value. The research approach facilitated the recording of local impediments to professional/scientific standards in UCD, and their positive and negative; specifically, it enabled a historical perspective, which is strongly supported and guided by collaborative reflection, and the elicitation of contributions 1 and 2.

In addition, the research offers:

4. **The comprehensive presentation and evaluation of a new approach for grounding personas** in server log data and user-generated screen content.

Despite the limitations presented, I had to be pragmatic and accept that some battles were not worth fighting in the context of the wider war to shift the organisation's perspective on UCD.

8.4 Implications

This section will summarise the implications of these learnings for HCI researchers and practitioners and what I suggest that they think about or do differently in light of what I found.

8.4.1 For HCI researchers

First, there are practical implications for HCI researchers. In the course of this research, evidence has been produced to substantiate recent perspectives of design and evaluation methods in the commercial context as collections of resources, rather than recipes to follow (Woolrych et al., 2011). The additional advantages of UCD techniques that I found raise doubts over whether UCD techniques should be thought of as methods at all because they can do much more than improve a system's usability; for example, they can boost the image of a company, foster customer relations and provide training opportunities.

Furthermore, my findings suggest that the personality, skills and experience of individual stakeholders exerts such a large influence over design work that the individual in the role may be more important than the techniques they use to carry out their work or their role. This insight suggests that HCI researchers may need to be clearer about an individual's background and skills when they report UCD practice, and more appreciative of the messiness of the design problems usability professionals face; this will require a cultural change towards acceptance of the value of reporting case studies of design practice. Furthermore, it suggests that HCI education programmes should include internships and industrial placements for students to engage with design practice.

It has also revealed erroneous assumptions that HCI researchers can make about design practice:

a) Developers are intrinsically motivated to fix usability problems;
b) The timing of usability testing is negotiated;
c) Usability tests can be reported impartially and taken as read;
d) Stakeholders in the design process have time/inclination to participate in UCD activities;
e) Users are able to use the latest technology;
f) Introduction of UCD to organisations is non-trivial and follows the Usability Maturity Model (UMM) in a linear fashion. In reality it requires a different approach for different business models so we need techniques to assess an organisation's motivations and values before UCD is introduced.

My research has also demonstrated that practitioners in complex domains face particular difficulties to identify usability problems, which public resources do not currently support. I suggest that reports of innovative techniques, such as the UGSC survey, analysis of web server log file data and rapid contextual inquiry, can help to further inspire practitioners, in addition to the development of tools to support practitioners accordingly (Cockton et al., 2003).

My findings also demonstrate the advantages and limitations of the AR approach for HCI researchers. Along the way, the AR approach enabled and provided a framework for discovery of aspects of design practice that could not have been foreseen. My research provides proof of the pertinence of and profits to be gained from longitudinal studies and the AR approach for the investigation of and research into design practice. It is important within AR projects, for example, that all stakeholders know who is responsible for each aspect of the usability process to alleviate confusion over roles and responsibilities. Confusion over my role may have impacted on my working relationships and the credibility of my work (for example, the extent to which my colleagues heeded the advice I gave).

8.4.2 For Practitioners

The answers I found to my research questions also have implications for usability professionals within organisations. My research found obstacles to the introduction of UCD that pose risks to which usability professionals should be alert. I have also reported opportunities for usability professionals to introduce UCD more effectively and efficiently to product development organisations, so that a UCD culture endures at an organisation beyond a single project; practitioners can be alert to these opportunities and take them when they are available.

Given the obstacles and opportunities for UCD that I found, I recommend that usability professionals engage with as many customers and end users as possible to safeguard business in finite "Big Data" markets; they can also explore opportunities to widen usage within existing client organisations and recruit participants for UCD activities from client organisations whose contracts are soon to end. The fostering of customer relations is an additional benefit of UCD techniques, which practitioners can exploit when they introduce UCD to organisations with limited UCD knowledge or resources, and whose end users are not necessarily responsible for purchasing.

Usability professionals can boost management support for UCD activities by testing new products with end users at client organisations whose contracts are about to end because they might be encouraged to renew with exposure to upcoming developments. The support of key stakeholders can greatly influence how other resources are assembled and configured in design work (Uldall-Espersen, 2008). Usability professionals can maintain their credibility by demonstrating the unique skills and techniques required for designing the UI of complex IS; I recommend prioritising techniques that showcase these skills early in projects and making and taking opportunities to involve others in their work. If the organisation is averse to usability testing then I have shown techniques such as UGSC surveys can be helpful.

Other usability professionals can introduce UCD techniques from the bottom-up to instil a UCD culture, whatever the organisational structure. In terms of the UCD techniques, practitioners can learn from, and be inspired by, the innovative approaches employed in this thesis to recruit participants, because this can be especially challenging in finite markets and require negotiation. I can recommend, for example, that practitioners charged to introduce UCD to other organisations use techniques such as surveys of users' current usage to identify willing usability test participants who may then agree to help improve the terminology of a system. Literature tends to suggest that usability tests are the most reliable technique for introducing UCD to an organisation, and they should be prioritised (Rosenbaum et al., 2000); however, remote techniques such as UGSCs can be used as a stepping stone towards usability tests when access to users is limited. I would advise future projects to introduce UCD by starting small and working with a few client organisations to develop products for a new customer base.

Given the constraints of the users' hardware and software platforms, I can recommend techniques that elicit information on the users' working environment, such as the UGSC survey and database server log files. I also recommend techniques that provide transparency, are unambiguous in their execution and results, and humanise the users; they can empower and engage stakeholders, especially in domains with geographically-remote end users who have significant domain expertise, who developers cannot easily meet. Usability professionals should consider using UCD techniques with these attributes to introduce UCD and ensure that UCD stays within an organisation beyond the development of a single product; this is particularly important when an organisation provides few resources, has little UCD knowledge, restricts access to users and believes that a system can be designed correctly the first time (Bias and Mayhew, 1994; Donahue, 2001).

For this reason, practitioners must maintain cordial relations and communication with all stakeholders in the design process (marketers, project managers, developers) and be able to speak their language. Other usability professionals should note that improved flexibility in the database architecture furthered receptiveness of usability work at the organisation and they may need to collaborate even more closely with developers in "Big Data" domains. To this end I also suggest that practitioners are clear about responsibilities within the design process and carefully scope the role of the usability designer so that expectations are managed and stakeholders are accountable for their role. Other usability professionals should be careful that they are not fully responsible for testing products that they have designed; if they attend usability tests I suggest they educate a colleague or external party and delegate the facilitation and reporting of tests to them instead, in addition to obtaining commitment from developers to acknowledge their findings.

The extrinsic factors affecting design work that my research has revealed have implications for practitioners within organisations that lack UCD knowledge and resources. They will be especially important within organisations that have had success because of their expertise within a highly-specialised domain with a small market, of which many could emerge with the promise of "Big Data" and associated analytical tools. Practitioners can integrate UCD activities at successful organisations by persuading others of their importance to the resilience of a business (Gulliksen et al., 2009). My work shows that even the most successful organisations can lack resilience to external events if they do not have a UCD culture; usability professionals may have to start with small-scale user studies and make it their priority to educate colleagues about UCD if they find themselves in a technology-focused organisation. In direct contrast to previous research, for example, I found that usability tests cannot be assumed to be a silver bullet for the introduction of UCD. Stakeholders can quickly discredit the results of usability tests if participation is low and reticent to change the user interface based on the feedback of a few users. This can frequently be the case within Agile projects that do not provide much time to recruit participants. Future projects should be wary that whilst an organisation may wish to involve users in the design process, they may be hesitant unless you can communicate to customers that participation does not guarantee that their suggestions are put forward to development. In this sense, development and client organisations cannot "have their cake and eat it" with user studies.

I would also recommend that UCD professionals in such organisations pay close attention to the business model of the organisation, and their motivation, and design UCD activities accordingly; this could be achieved through the engagement of stakeholders across an organisation, perhaps in the form of a "usability taskforce," similar to a staff forum. For the development of a product in a similar situation, I would advise usability professionals to involve a few client organisations very early in the design process so that they can be more certain of the users' requirements, which can be even more challenging to discern in complex domains.

In light of the different skills I found that a usability professional invokes, organisations should hire individuals with these skills when recruiting for usability work; practitioners should also request training for, and HCI educators should harness, the skillsets associated with these roles. I recommend that usability professionals pick their battles carefully, listen and not press ahead regardless, like a bull in a china shop. The strong influence of individuals shown in this thesis also raises questions as to whether the success of UCD activities depends on individuals rather than roles, and that product development organisations should be careful when they recruit individuals to introduce UCD, as this can be more important than the techniques or their role (Uldall-Espersen, 2008). Organisations that lack UCD knowledge may find these insights especially useful and improve their understanding of what the role requires so that they recruit the right person and scope their role correctly. I suggest that HCI educators provide students with opportunities to develop contextual task analysis skills, centred around interviews and observations of users in their workplace and interpreting data in collaboration with users, through detailed accounts of specific past events when relevant. Whilst the UE literature does provide some guidance in this area (Mayhew, 1999b: 67), I firmly believe that students should receive training for and have the opportunity to experience the practical realities of the techniques required, including the basics of arranging, carrying out and analysing interviews. Professionals may also request to attend industry conferences and subscribe to industry magazines to acquire domain expertise, depending on the resources available to them.

8.5 Limitations of Findings

My findings are highly contingent on the type of organisation within which I carried out my research. iHealth is a highly unusual organisation; it uniquely has equal public and private funding and sells annual contracts to public sector organisations for access to products for profit. The context of the NHS, and the policy changes that came to fruition during the collaboration are also one-offs and simply impossible to transfer. This, however, does not diminish the value of the results; it is simply typifies the highly situated nature of design work. The implications for practitioners reported in the previous section are mostly applicable to any product development organisation, although some may be more challenging to realise, depending on the size and business model of the organisation; I would expect, for example, that many obstacles I report would be more difficult to overcome in a larger organisation and some of the opportunities more scarce.

I also recognise concerns that my colleagues raised about the low response rates to surveys and participation in usability tests, especially since my studies confirmed the heterogeneity of end users. I am comfortable, however, that the precautions I took enable me to draw the conclusions that I did; for example, I finished usability tests and interviews when participants began to find the same usability problems and express similar opinions and accounts. Nevertheless, I acknowledge that the results of interviews and the think-aloud protocol used during usability tests rely heavily on participants' self-report, which assumes that participants are honest and accurate in their responses.

Finally, iHealth's business strategy did not remain constant during the collaboration, which impacts upon the transferability of my findings. The individuals with a stake in the design process also changed repeatedly during the collaboration, which affected the knowledge resources available at any one point in time, which will have unavoidably affected the outcomes. It is impossible to separate the effects of my efforts from those of others in the organisation to be able to adequately ascertain the extent to which the techniques I used and my work were responsible for the changes I observed. As participant-observer I did not have complete autonomy over my work at any point in the collaboration; other practitioners may find that they have more control over the techniques that they can apply, depending on their experience and the organisation in which they work.

8.6 Future research areas

My research raises a number of questions and areas of interest that I believe are worth further exploration. I will now give these a brief consideration as seeds for future research.

The integration of UCD techniques with the Agile development process

An area of research certainly worth investigating in more detail is how UCD techniques can be adapted to the Agile development process. It is true to say that the development of products will continue to be managed according to these project management principles and that usability professionals will have to adapt accordingly. This has already attracted the attention of some HCI researchers (Ardito et al., 2014; Brhel et al., 2015; Garnik et al., 2014; Lárusdóttir et al., 2014).

Further investigation is needed on the integration of usability tests into the development of complex information analysis tools (Lárusdóttir et al., 2010) and that whilst an organisation might adopt an *incremental* Agile process, it can operate at a different pace than the *iterative* nature of UCD activities, and careful coordination of design and development activities is required.

The evaluation of knowledge construction from the visualisation of information, specifically in the context of exploratory data analysis, when users do not know what information they seek

The emerging paradigms of 'Big' and 'Open' data have increased the number of users without expertise in information visualisation having access to analysis tools, which makes it even more important that end users are able to analyse and interpret data effectively and efficiently. They require support from "Big Data" analysis tools to interpret data correctly, to make valid conclusions and decisions based on the data, which often affect everybody's everyday lives. It will also be interesting to explore the usability of "Big Data" analysis tools on limited software and hardware platforms; my research demonstrated, especially in Chapter 5, that even the most expert users do not always have access to the most advanced technology.

Development of tools for the rapid assimilation and analysis of large volumes of user data

This thesis has observed that technology-focused "Big Data" industries are inherently interested in and value data. HCI researchers therefore have an incentive to develop tools that rapidly assimilate and analyse large volumes of user data, to increase the credibility of UCD techniques. Although I had access to large volumes of user data, the Agile development process did not permit sufficient time to fully explore it. This is particularly important within organisations that develop tools for the analysis of "Big Data" because the individuals working in these organisations are likely to be interested in numbers and facts, and interpreting the data for themselves.

Investigation of innovative methods for participant recruitment and usability problem identification

The aspect of my work I found most challenging was the recruitment of participants, given the pressurised nature of the end users' work and their geographical spread. End user participation in the design of "Big Data" analysis tools is especially important because of their complexity and remains an unresolved problem. There is a clear need for more creative and innovative methods to engage end users in complex domains, since their input is even more important for the utility and usability of a system. Whilst previous research has described different models of user engagement, it has not discussed how they can be initiated; this could go some way to resolve difficulties that usability professionals have to identify usability problems in domain-specific applications.

Validation of Usability Maturity Model

I was not aware of the UMM (Earthy, 1998) at the beginning of my research because embedding a UCD culture was not my original aim; I was therefore unable to assess how much of the perceived increase in usability maturity could be attributed to my work. I would encourage others to consider whether it is possible to measure the extent to which a change in usability maturity can be attributed to UCD techniques, if indeed this is possible. In the very least, my research suggests that UMMs require updating to accommodate the external influences on design work and the dynamic nature of usability maturity. Techniques to assess an organisation's motivation for UCD could help practitioners to target UCD activities to the organisation's culture and smooth their introduction.

To Accept or Try to Change an Organisation's Culture

Interviews revealed that stakeholders had very different ideas about what UCD means. For me this raises the question, does it matter for the introduction of UCD techniques if stakeholders interpret the term "user-centred" differently? Or is it enough to understand their different interpretations and appreciate that they are different? More fundamentally, should usability professionals try to change an organisation's culture or learn to work within it? This is not a question to which my research has been able to provide satisfactory answers.

8.7 Concluding Remarks

At the beginning of this thesis the research set out to apply UCD techniques to the development of health informatics products in the UK. In so doing it was possible to follow the evolution of UCD culture at the organisation. From my privileged position I have been able to acquire knowledge about the introduction of UCD to an organisation that usability professionals can use to inform the choices they make in their work and also present HCI researchers with new perspectives of the role of usability professionals in organisations and how this might evolve in the expanding world of business intelligence and analytics (Chen et al., 2012). The ability to carry out a longitudinal account of the introduction of UCD to a commercial product development organisation provided new insights, and demonstrated the critical importance of such longer-term studies, built upon collaborative and historical reflection, to the development of UCD and, to the field of HCI.

9 Epilogue

This chapter at a glance…

- Considers the implications of the research more widely: what do the findings suggest is an effective approach for introducing User-Centred Design to other organisations?
- Describes an overall strategy based around the Switch model of change (Heath and Heath, 2011), and learnings from this project and others' experiences.
- Speculates about its value by analysing the United Kingdom's "Big Data" economy.

9.1 Introduction

The research that was described in this thesis has found that the introduction of User-Centred Design (UCD) to organisations requires management of change and yet this rarely forms part of the formal training of usability professionals. Previous efforts to introduce UCD to organisations, described in Chapter 2, have not considered models of change from the Organisational Development (OD) literature; this field could inspire new ideas for the introduction of UCD, which have not previously been considered by usability professionals and Human-Computer Interaction researchers. Furthermore, the research has shown how UCD can be introduced from the bottom up, whilst we saw in Chapter 2 that previous research has emphasised top-down approaches, which are often beyond the scope of a usability professional's role.

In order to explain the lessons of this thesis to other businesses interested in building a UCD culture and commercialise them in the form of consultancy work, I use a framework of organisational change that is accepted by the business community to build a strategy for introducing UCD. This type of activity stands on the shoulders of researchers such as Checkland and Holwell (1998), who devised the Soft Systems Methodology to transfer the learnings of Information Systems research into practice. The focus here is on creating a strategy for the introduction of UCD to organisations, like iHealth, who are developing tools for the analysis of "Big Data".

"Big Data" is the term used to refer to the phenomenal volume, velocity and variety of datasets being created and analysed; global enterprise IBM state that 90% of the world's data was created in the last two years and 2.5 million gigabytes of data is created each day – enough to fill 27,000 iPads per minute (Department of Business, Innovation and Skills, 2013). Data has been compared to the "oil" of the 21st century (Gartner, 2011), but, unlike oil, it will not run out. As access to computers and the internet becomes increasingly mobile, new technologies will fuel the growth of data.

The opportunities and challenges connected with this are significant. "Big Data" analytics and modelling are already transforming business sectors across the economy: from increased transparency and accountability through open data, to new scientific discoveries, and market-changing products and services which can be developed using modelling and simulation, analytics and data-driven science. However, its volume and variety, and the velocity at which it is created and processed can pose huge challenges. Designing systems to cope with large volumes of data is not a trivial design problem, especially when their users may not have the requisite skills to analyse and present such large datasets. A shortage of workers skilled in data analytics is cited as one of the key barriers to further data analytics (Department of Business, Innovation and Skills, 2013); such challenges have hindered the realisation of the opportunities "Big Data" presents (Wind-Cowie and Lekhi, 2012). UCD can help to remove such barriers through the design of tools that effectively support workers to analyse and present an increasingly large volume and variety of data; analytics tools must be usable for consumers, businesses and academia to realise the potential of "Big Data".

This chapter first identifies a framework suitable for the introduction of UCD to organisations and compares it to other frameworks for the implementation of organisational change from the OD literature[18]. I then consider the activities that the chosen model might recommend to carry out to introduce a UCD culture, based on the experience from this research and the experience of other researchers. Finally, this chapter explores the potential size and value of the market for "Big Data" analytic tools and the opportunity the strategy described presents.

9.2 Methodology

This section outlines the model of organisational change on which the strategy will be based (the Switch framework), where and why it has been successful in other contexts, the reasons for this model's suitability and how it can be used it to create an implementation plan. For broad-based change amongst groups, including change within organisations, one of the most comprehensive and useful frameworks is "Switch" (Heath and Heath, 2011). This book describes change using the metaphorical situation of a rider trying to get an elephant moving in a new direction, from the psychologist Jonathan Haidt. Psychology recognises that the brain comprises of two independent systems operating simultaneously: the emotional side, which is instinctive and feels pleasure and pain, and the rational side, or conscious system, which analyses, plans, and looks into the future. Haidt likened the emotional side to an Elephant and the rational side to its Rider, holding reins, attempting to control it. The Path is the environment, or "situation". The Heath brothers use this metaphor to explain why change in organisations can be difficult. The routine of daily life provides a familiar Path, on which the Rider can comfortably control the Elephant; the Rider, however, can think ahead, and often tries to change the Path accordingly. Changing direction, or automatic behaviours, requires extra effort from the Rider to control the Elephant; the Elephant can easily overpower the Rider. Change can be unsuccessful if it requires short-term pain for long-term gain

[18] I was fortunate to take the Masters in Business Administration Elective "Managing Change" at the London Business School during my Engineering Doctorate. Other designers will not have such an opportunity to acquire the skills I learnt on this course, which I have demonstrated are necessary for usability professionals.

because the Rider cannot keep the Elephant on the Path long enough to reach their desired destination. The Elephant's desire for instant gratification, however, enables us to 'get things done' when the Rider overanalyses. Progress on a new Path requires the Elephant's energy and drive, and the Rider's planning and direction.

Switch is a framework for managing change, based on this metaphor, which comprises of three broad principles: 1) *Direct the rider*: what appears to be resistance to change is often a lack of clarity. For example, do iHealth developers have a shared understanding of what represents a user-friendly product? 2) *Motivate the Elephant*: what looks like laziness is often exhaustion. For example, how do iHealth developers feel about modifying or writing extra code to accommodate novice users or users with basic computers? 3) *Shape the Path*: what appears to be a people problem is often a situation problem. For example, at iHealth, commercial reasons and the geographical spread of the users have thwarted the developers from meeting end users. Based on these principles, the Switch framework suggests how to bring about successful change; Table 9-1 lists each principle and how they can be applied to the management of change.

What to do	**How to do it**
PRINCIPLE 1: DIRECT THE RIDER	
Find the bright spots	• Detail the concrete processes that led someone in your organisation to a successful outcome. • Communicate successes to other employees in the form of brief stories. • Emphasise identity: bright spots are successes from within the organisation.
Point to the destination	• Craft and communicate a concrete vision of the future that simulates a sensory experience. It should convey objects, colours, and movement, and encapsulate a future experience, something people will witness or feel. • Complement the vision statement with the smallest number of values possible – preferably a single value. Emphasise that an organisation that governs its behaviour with this value will have a distinct identity.
Script the critical moves	• Communicate concrete behaviours needed for the change effort to succeed. • If possible, illustrate how a critical move will be achieved by describing an identifiable person performing an identifiable behaviour (e.g. someone performing a specific function on an assembly line).
PRINCIPLE 2: MOTIVATE THE ELEPHANT	
Find the feeling	• Go beyond an analyse/think/change approach; communicate using a see/feel/change approach with concrete detail. • Present stimuli that will tap into an important part of the audience's identity.
Shrink the change	• Set sub-goals: tangible goals are more concrete and they get people started; • Around the middle of the task, emphasise how far you have come rather than how far you have to go. This creates a sense of accomplishment (an important part of identity).
Grow your people	• Use language related to concrete concepts that invoke important identities.
PRINCIPLE 3: SHAPE THE PATH	
Tweak the environment	• Make concrete changes to structures, routines, machines and the office environment that reinforce the desired behaviour.
Build habits	• Create concrete if/then plans whereby you communicate a desired behaviour as well as the specific environmental cue that will trigger it.
Rally the herd	• Rather than forming subgroups via resources and promises, build subgroups by invoking values, superordinate goals and identity.

Table 9-1 The Switch Framework and How To Do It

This framework has been used to design individual behavioural changes such as losing weight and using less paper (Hostyn, 2011), but has also started to be used within the business world, for example to improve the effectiveness of meetings (Hammarberg, 2012), and within domains including software engineering (Campbell-Pretty, 2013). Within healthcare it can be used to improve the quality of care (Health Quality Ontario, 2013) and decision making (Renz et al., 2011).

In addition to Switch there are other frameworks for organisational change, based on different perspectives of change that have emerged within the field of Organisational Development (OD): *incrementalism*; *punctuated equilibrium* and *continuous transformation* (Burnes, 2004). Models of change can largely be categorised according to these perspectives as the following examples demonstrate.

The very first change models comprised of step-wise processes through which organisations change; Lewin (1947), also the father of Action Research, proposed that a successful change project involved three steps: unfreezing-moving-refreezing. More recently, Kotter (1995) has been especially influential upon theory and practice; his phased model describes eight steps to transform an organisation, based on observation of over 100 companies trying "to make themselves into significantly better competitors" (Kotter, 1995: 59). These steps are listed in Figure 9-1 and should be worked through in sequence because "skipping stages creates only the illusion of speed and never produces a satisfying result."

1. Establish a sense of urgency based on market and competitive realities and current or potential crises;
2. Form a powerful guiding coalition to lead the change;
3. Create a vision and strategy to direct the change;
4. Communicate the vision with words and examples;
5. Empower others to act on the vision by removing obstacles, modifying structures and systems, and promoting risk-taking;
6. Create short-term wins and recognise those responsible;
7. Consolidate improvements by aligning systems, structures and policies;
8. Institutionalise new approaches by connecting new behaviours to corporate success.

Figure 9-1 Kotter (1995)'s Eight Steps to Transform an Organisation

Kotter's framework is not suitable for the introduction of UCD to organisations because it does not facilitate parallel processes. Implicit in Kotter's model, and other incrementalist models, is that organisations are stable and organisational change is planned (i.e. predictable), pre-determined and top-down, which is consistent with a positivist perspective of organisations. Other major criticisms of this perspective are that it is only suitable for small-scale change efforts and ignores the power and politics of organisations.

The scope of OD has broadened over time in response to the perceived needs of organisations; after the 1970s' oil crises, OD accepted that organisations needed to be more resilient to rapid and brutal market transformations. The slow, linear, consensual nature of planned approaches to change, such as Lewin's, was increasingly deemed inappropriate and ineffective. In the new world order, many organisations were unable to plan and flexibility became essential; this perspective produced models such as the punctuated equilibrium (Romanelli and Tushman, 1994) and continuous transformation models of change (Brown and Eisenhardt, 1997; Greenwald, 1996).

The punctuated equilibrium model depicts organisations as evolving through long periods of stability in their activity followed by relatively short bursts of fundamental change; proponents of the continuous transformation model reject both this and incrementalist models of change and argue that organisations must learn to change themselves continuously in fundamental ways. Approaches with both these perspectives allow for and promote change to emerge organically from the bottom up, in the day-to-day activities of the whole organisation and recognise that not all changes can be driven from the top.

More recently, this non-linear conceptualisation of organisational change has driven new theories, including Agile, an approach that we saw in Chapter 2 is also used within software development. Agile change involves accidents, refinements, incidental changes, small experiments and tweaks. Agile changes are made by: making existing processes explicit and breaking them into small subcomponents; changing one small thing at a time so that the result of each change and their effect can be traced; and, iterating with a change-reverse-change approach, so that conclusions are not drawn from a single experience. This approach has several benefits: it is cost-effective and fosters a climate of continuous improvement and learning orientation; reduces the need for major upheavals; promotes expansive thinking and allows for serendipitous discoveries that transcend the limitations of any vision; it can be usefully used when the nature of the change needed is unclear; and, it allows for change outside of official change efforts, from the bottom up.

Although some organisational changes may arguably be planned and predicted, we saw in Chapter 3 that organisations comprise of individuals whose actions do not consistently obey laws like much of the physical world; based on the extrinsic influences on design work that this research has revealed, organisational change can be organic, evolutionary, gradual, reactive and continuous, as these approaches suggest, and a UCD introduction strategy must account for this.

The Switch framework is appropriate because it allows for multiple actions to run concurrently and changes to be planned when it will be beneficial and not when it is detrimental, and it retains the experiential learning of an Agile approach; most importantly, it is a humble approach that puts stakeholders at the centre of the change effort. It encompasses a mixture of top-down and bottom-up actions over different timescales, which focuses on aspects of change that can be controlled and allows for the situational and contextual awareness that design work demands. We now consider each action in Table 9-1 and use them to identify techniques that will comprise the change effort.

9.3 Implementation Plan

Based on the lessons learned through the longitudinal approach and collaborative reflection this thesis presents, and those that others have used at other organisations, this section opens by using the Switch framework to suggest what actions will comprise the change strategy. After discussing this, we move to the questions: how to approach organisations, where and when it would be most suitable, how activities should be prioritised and the time frame over which to apply the strategy.

9.3.1 Find the bright spots

We have seen that iHealth already practice this as part of their development process to an extent. In Chapter 6, participants in the usability testing of the new dashboard interface for Effectiveness and Efficiency Dashboard were told that the aim was to enhance their experience and not to remove functionality that they found valuable; instead we reassured them that the functionality they found useful would be retained and improved. Consideration of this principle also suggests that the strategy could usefully ensure that developers understand what aspects of their current work practices are user-centred. There will be more on this later, in Section 9.3.5. Finally, for any project a "usability taskforce", comprised of people from across the organisation, should be formed; importantly, senior management should be represented, ideally a member of the Executive Board, whose support and knowledge of the business priorities will be crucial (Rohn, 2007).

9.3.2 Point to the destination

Gulliksen et al. (2009) established an organisational usability policy, as part of a project to introduce usability and UCD at a public authority, which was kept deliberately short and concise to be effective; they found it to be valuable for legitimising the importance of usability across the organisation and clarifying objectives. In addition, they also devised a vision seminar series, comprising of at least four half or two full day sessions, during which current practices were discussed by members from across the organisation to establish what is currently working (i.e. the *bright spots*) and a future work process is developed iteratively. Process leaders also documented the prerequisites for and important aspects of future development and scenarios describing future work (i.e. *pointing to the destination*).

Building on these initiatives it can be proposed that a product development team vision statement such as "to flick the switch that transforms the users' frosty frowns of frustration into sunny smiles of satisfaction and self-efficacy" could galvanise a UCD culture. Consultations with developers and key stakeholders from outside product development, including product managers and customer support should be part of a process to create this statement. This would also help to manage the expectations of the organisation (Mayhew, 1999a). It is advisable to schedule routine meetings between developers and customer support, similar to vision seminars; this could perhaps be facilitated through a mentoring scheme, whereby each developer has a contact on the customer support team with whom they can discuss design decisions. At iHealth, lunchtime presentations on usability were found to be useful for spreading the word about usability and could additionally be strategically employed to communicate successes (Mayhew, 1999a); one presentation, however, was insufficient, perhaps because attendance was not mandatory. Success was also found with a style guide for the Public Health Analyser (PHA) maps in Chapter 4, which unambiguously presented expectations for the map design to the developers; future work might extend the creation of style guides to the development of interactive prototypes, which can be tested for their effectiveness.

9.3.3 Script the critical moves

One critical move a team can take is to define usability and agree on its appearance; for example, 95% task completion rates in usability tests or a minimum average score of 80 on the system usability scale questionnaire (Brooke, 1996), which was introduced as part of the usability testing protocol in Chapter 6. It can be unhelpful to tell developers that their system's 'ease of use' is rated 'poor'; wins must be unambiguous. Instead, it was helpful to make objectives concrete; for example in Chapter 4 a style guide for PHA maps was helpful in addition to close collaboration with the developers. In future projects, developers could give feedback on requirements documentation. At iHealth, product managers developed specifications and passed them to developers and it was beyond the scope of this thesis to determine whether the developers interpreted them correctly. In the strategy I present, product managers and developers would collaborate to create a document template and agree its format so that developers are less likely to misinterpret it.

9.3.4 Find the feeling

The research presented in this thesis overlapped with market changes that triggered a sense of urgency across the organisation and a motivation for UCD; however, this is an extrinsic factor for which usability practitioners cannot plan and cannot be included in a strategy to introduce UCD. We saw in Chapter 5, however, that personas helped the developers connect with the users, through rich narratives that represent different user groups, containing concrete details of their professional goals, motivations, behaviours and environment, in addition to personal information to give the end users a distinct identity with which the developers could connect. In future projects personas could be enhanced with a description of a particular instance in which the user found the tools helpful and vital to their role, which can be elicited, as in Chapter 5, during interviews with end users; this would help the developers better understand why users need the software.

In addition to personas, it was worthwhile to record the usability tests in Chapter 6 on video and present highlights to the developers at a project meeting; developers subsequently enquired about specific design issues that the video presented. If developers cannot attend usability tests, videos give a much more visual, unambiguous and accurate portrayal of the user experience than any written report or usage data can provide. Although it was beyond the scope of this thesis, in future it may be worth investigating how much of the video the developers can remember after a period of time, to evaluate the extent to which the imagery of the video has endured.

9.3.5 Shrink the change

This module of the Switch framework suggests that developers should be made aware of what they are already doing that demonstrates care for the end users, so that the change does not feel so unachievable. During the usability testing in Chapter 6, task completion rates were very high, and if this had been communicated to developers it may have provided encouragement. This may additionally reduce adverse reactions to the change effort; there is the potential for developers to infer from efforts to introduce UCD that they do not currently care about the users.

The team can also carry out usability capability maturity (UCM) assessments and use them to set concrete objectives for user-centred behaviour and monitor progress; UCM assessments can be used to systematically and objectively evaluate a development organisation or project in terms of UCD and help to identify strengths that need to be protected as well as prioritise where to focus improvement efforts, for example in UCD techniques, user analysis and documentation of usability practices. Typically these models comprise of several levels of ‘maturity’ or ‘capability’ levels from low to high, and iHealth’s usability maturity appeared to grow during the collaboration (Earthy, 1998; Staggers et al., 2011). Charting progress in this way can encourage developers and clarify the types of practices that exemplify user-centred behaviour. In the right context, organisations could be encouraged to devise their own UCM as part of a usability policy.

9.3.6 Grow your people

One of the biggest challenges of the work presented in this thesis was that developers appeared to see themselves as writers and fixers of code, and viewed their roles through a black and white filter, where either the code works or does not work. In such cases, developers can interpret being asked to change their code as a negative reflection on their abilities. Future UCD introduction efforts with developers such as these should spend time to demonstrate to them that their influence goes beyond making computer systems and that their work enables the end users to perform their job effectively. For example, at iHealth the end users’ work has a direct impact on the quality and efficiency of clinical care. This will, however, be challenging if management practices do not permit developers to influence design decisions and they work from specifications. Concrete actions may enlighten them as to the impact of their work, for example involving the developers directly in UCD activities so that they will see themselves as crafters and engineers, and take ownership of the user experience and to see their work, by contrast, in glorious technicolour.

9.3.7 Tweak the environment

Organisational culture can be highly influenced by environmental factors; for example, the work of this thesis hints that commercial reasons and a wide geographical spread of users can prevent developers from meeting users as part of the development process. Changes to the environment may help in these situations. For example, developers at iHealth had higher spec computers than the end users and the network at the iHealth office was much faster than in hospitals; they were therefore unable to accurately mirror the users' experience. Many iHealth users reported slow access, with one even admitting that they sometimes logged on at home in the evening because it was faster. Future projects should investigate whether similar barriers, which significantly impact on the user experience, are present and, if they are, consider how they might be broken down; for example, replicating the user's experience on the developers' computers.

We saw in Chapter 5 that the work environment was 'tweaked' by putting posters of the personas on the office walls; other creative ways to instil the personas could be mugs or coasters in the office displaying the personas, or role plays in team meetings. Future projects should make it clear how the personas should be used by specifying expected behaviours; for example, references to them during project meetings and their invocation when making design decisions. Personas may also inspire the writing of usage scenarios (against which products are tested in-house) and smooth communication when different teams are talking about the products and their users.

We have seen in this thesis that the introduction of UCD can be greatly inhibited if there is a great distance and lack of communication between developers and the field support. It is important that future projects facilitate communication between the two teams. For example, Cajander et al. (2010) describes a process for the coaching of usability within an organisation; a mentoring or coaching type scheme could work at iHealth since the customer support team is based remotely.

9.3.8 Build habits

This thesis has demonstrated that developers need to receive user feedback effectively and efficiently; it is also important for developers to understand the users' requirements and how well they are met. Other efforts to introduce UCD to organisations should consider how to facilitate communication of users' feedback to developers. This thesis has shown what happens if developers receive feedback too late for the code to be changed and receive limited positive feedback; we saw in Chapter 6 that a more balanced approach was more fruitful, when the highlights video of usability tests included positive and negative examples of user experience. Other habits, such as testing the system on the different web browsers used by customers, can also be introduced.

9.3.9 Rally the herd

Future projects should facilitate discussion about the customers and end users amongst the developers; this can run alongside the introduction of personas. Similar to previous researchers (Bloomer and Croft, 1997), the research has demonstrated that UCD activities are more sustainable if they have the buy in of developers. Developers at iHealth also benefited from a focus on and commitment to end users from senior management, particularly at staff updates; other researchers have found it similarly important that senior management "walk the talk" for the introduction of usability to organisations to be successful (Cajander et al., 2010; Collins and Porras, 1996; Gulliksen et al., 2009). Future projects will benefit from the support of allies amongst senior management, who understand UCD, to provide reassurance and encouragement to developers.

9.3.10 Keep the switch going

Finally, future efforts to introduce UCD to organisations should pay close attention to the development process in use; UCD activities should be introduced to the development process to instil discipline and focus and help a UCD culture to endure. For example, we saw in Chapter 6 that usability testing did not fit into the development process seamlessly at iHealth. It was beyond the scope of this thesis, but in future longer-term projects, after some initial success on a specific project has established credibility, attention will be paid to the extent to which the development process enables UCD activities to be carried out and influence product design. Previous researchers have noted that software development models vary in the extent to which they are user-centred (Gulliksen et al., 2009; Iivari and Iivari, 2011; Mayhew, 1999a) and developed methodologies to assess the user-centredness of a project (Gulliksen and Göransson, 2001).

Whilst this thesis focused on extrinsic influences on UCD practice, this chapter has demonstrated that the Switch model provides a useful framework for considering intrinsic factors that usability practitioners can control when they introduce UCD to organisations. Table 9-2 now summarises a strategy for the introduction of UCD to organisations, based on the Switch framework. The activities carried out and timeframe over which they are carried out would vary according to the organisation and their motivation for introducing UCD. Organisations of different size, domains and usability maturity may be interested in improving their UCD focus. Organisations requesting assistance with the development of a specific product would be welcomed, as UCD within individual projects can provide the momentum and impetus required for a much broader focus on UCD within an organisation's culture. Working on a particular product initially would provide a window through which to see how the organisation operates and the basis for a more extended cultural transformation. This thesis has shown that the introduction of UCD to an organisation's culture requires a long-term commitment and engagement from an organisation to be truly successful, so if this was an organisation's ultimate goal then a series of activities should be planned to run and be reviewed over an extended period.

What to do	How to do it
Find the bright spots	• Review developers' current work practices to highlight user-centred aspects; • Create a usability taskforce with representatives across the organisation.
Point to the destination	• Form a departmental/organisational usability policy, ideally collaboratively; • Establish a vision seminar series; • Create style guides; • Arrange regular lunchtime talks from customer support.
Script the critical moves	• Set task completion rates in usability tests; • Make objectives concrete e.g. style guides; • Evaluate whether developers interpret specification documents correctly.
Find the feeling	• Create personas with professional goals, motivations, behaviours and environment, as well as personal information; • Describe a particular instance in which users find tools particularly helpful; • Make a video of usability tests and investigate how much of the video the developers can remember after a period of time.
Shrink the change	• Review developers' current work practices to highlight user-centred aspects; • Usability Capability Maturity assessments.
Grow your people	• Involve the developers directly in User-Centred Design (UCD) activities; • Establish links between developers and customer support personnel.
Tweak the environment	• Investigate and then replicate the situation in which a system is used in the developers' office e.g. network speed, monitors, web browser; • Design posters, mugs and coasters of personas for the office; • Set and agree how personas will be used and monitor their use e.g. role plays in team meetings, references to them during project meetings, a design decision making tool, their use to write usage scenarios and as a communication tool; • Monitor how UCD activities fit within the development process and the timeliness of user feedback; • Review how user feedback reaches the developers and whether communication between customer support and developers can be improved through techniques such as usability coaching.
Build habits	• Review how user feedback reaches the developers and whether communication between customer support and developers can be improved through techniques such as usability coaching; • Investigate and then replicate the situation in which a system is used in the developers' office e.g. network speed, monitors, web browser.
Rally the herd	• Facilitate discussion about the customers and end users amongst the developers through personas; • Strive for a focus and commitment to end users from senior management by seeking allies for UCD amongst senior management.
Keep the switch going	• On-going review against mutually agreed objectives and expectations for the organisation's UCD culture and what they want to achieve with UCD.

Table 9-2 A Strategy for Introducing UCD Based on Switch

Before the plan is formulated, the organisation's modus operandi would need to be assessed in order to identify its values and key business drivers; this would enable the identification of potential opportunities and obstacles to UCD at the organisation (Bloomer and Croft, 1997). For example, is it important to the organisation that training/support and development costs are minimised? This ground work may require two weeks if the organisation is interested in introducing UCD for the development of a specific product, culminating in a report and presentation of its findings, illustrated with organisation specific data and external case studies (Bloomer and Croft, 1997);

similar ground work for wider cultural transformation efforts may require a month. The report and presentation, however, would encourage the organisation to pursue the recommended activities, through an outline of the resources required in terms of assistance and time from other members of the organisation and access to users, and a price. For wider cultural transformation efforts, the activities outlined in Table 9-2 could run over three years, during which there would be both short- and long-term plans. It is expected that organisations would require less assistance (and thus charged less) over the course of such a project, as they develop their own competency in UCD. We can see in Table 9-2 that a few core activities can foster a UCD culture on more than one level of the Switch framework and that some tasks, such as the writing of a usability policy and formation of a usability taskforce, should be carried out before and prioritised above others, such as reviewing how customer feedback reaches developers. Personas also seem important and should be developed within the first month of working in any organisation that did not yet possess them.

Future projects will conduct a thorough review of the organisation's processes from the very beginning of projects, to identify opportunities to implement sustainable UCD activities at the organisation. For example, improvements in the effectiveness and efficiency with which developers receive user feedback; ideally developers would meet users or observe usability tests with members of the support team (Bloomer and Croft, 1997; Rohn, 2007).

9.4 Market Opportunity

The previous section presented a framework for the effective and efficient introduction of UCD to organisations with a more user-centred approach that builds on the lessons of this thesis and others' experience of introducing UCD to organisations in addition to the OD literature. We will now explore the potential of this approach: its potential clients and its value.

It is envisaged that such a framework will be of particular benefit to organisations such as the one described in this thesis; i.e. organisations who develop "Big Data" analytics software for end users who may not have the requisite skills to interact with such large, heterogeneous and rapidly-growing datasets. "Big Data" are frequently so large that they cannot be analysed using 'traditional' methods, such as Microsoft Excel spreadsheets, relational databases and Structured Query Language (SQL) queries, but new tools have been developed to analyse them such as NoSQL and the open source software Hadoop. These tools can be especially useful for the gathering of business intelligence from market data, so organisations may be interested to boost their efficiency by harnessing the power of vast quantities of customer and business data. The framework places particular emphasis on techniques that are suitable for the fast-moving and unpredictable world of "Big Data", in which market circumstances can change very rapidly and without warning and, especially, where vast numbers of users depend on systems to carry out their everyday work activities and cannot afford for them to be unavailable at any time.

Such organisations are emerging in many sectors of the economy, such as manufacturing and transportation, but especially on the internet where data continually streams at a fast pace (for example, web server logs, social media, and e-commerce). Other domains include (but are not limited to) financial services, the insurance industry, local government, social services, urban planning, large infrastructure projects, environmental management and climatology, in which the end-users synthesise "Big Data" to make decisions that impact upon people's everyday lives.

In 2012, the Centre for Economics and Business Research estimated that "Big Data" could add £216 billion to the United Kingdom (UK) economy (via increased business efficiency, innovation and creation) and create 58,000 new UK jobs, between 2012 and 2017 (2012). This is equivalent to 22% of the UK's net debt (c. £1 trillion) or more than the 2011/12 defence, health and education budgets combined and explained in Table 9-3.

Revenue and cost saving mechanism	**Explanation**
GAINS IN BUSINESS EFFICIENCY	
Customer Intelligence	• Profiling and segmentation of customers, which will enable marketing to different segments based on their discrete preferences and, in turn, boost customer satisfaction and retention rates; • Online social network analysis to identify trends in customer satisfaction and identify influential individuals for direct marketing; • Models to predict customer behaviour and purchase patterns, which can inform the direction of resources towards profitable customers; • Analysis of response to price or product changes to inform optimal pricing and stocking.
Supply chain management	• Forecasting demand changes to match supply and reduce expenditure on warehousing etc; • Automated replenishment decisions through analysis of stock utilisation and delivery data, to minimise costly delays and process interruptions; • Use supplier data to monitor performance, and inform decisions to switch supplier based on superior quality or price; • Computation of optimal inventory levels and monitoring of data through the whole supply chain in order to achieve demand-driven supply and just-in-time delivery.
Quality management	• Minimise performance variability and pre-empt quality issues with early-warning alerts; • Identify disruptions to production, which saves equipment/machinery and labour costs for unforeseen maintenance and repairs; • Monitor quality data in real time to enable managers to make swifter quality decisions and reduce any resulting loss of custom.
Risk management	• A full and dynamic appraisal of all external and internal risk exposures to inform investments in the financial sector; • Integration of 'risk silos' into enterprise-wide risk profiles, so that separate departments do not manage interdependent risks in isolation; • Real-time analysis of external market conditions, balance sheet composition and trading updates to inform capital buffers and hedging strategies according to an organisation's risk appetite.
Performance management	• Monitoring and forecasting of staff performance; • Introduce performance information to the budgeting process to improve expenditure control and public sector management and transparency.

Revenue and cost saving mechanism	Explanation
Fraud detection	• Flagging of outlier occurrences or suspiciously divergent activity; • Learning of new types of fraud; • Social network analysis to identify networks of collaborating fraudsters, or fraudulent insurance or government benefit claims.
GAINS FROM BUSINESS INNOVATION	
More effective research and development	• Increased operational efficiency and profitability, which can be reinvested into using analytics to support product innovation.
GAINS FROM BUSINESS CREATION	
Reduced costs of entry and increased profit signals	• Deeper market intelligence; • Demand for data-specific roles, such as software programmers and data analysts.

Table 9-3 Mechanisms by Which "Big Data" Boost the UK Economy. Adapted from CEBR (2012)

The public sector is an increasingly important source of data that private companies put to creative use in their products and services because governments across the world continue to make their data more seamless and useful. A report from Deloitte estimated that the direct value of UK public sector information alone is around £1.8 billion per year to the economy, with wider social and economic benefits bringing this up to around £6.8 billion (Deloitte, 2013). In the United States, just to highlight a couple of examples, companies now use open access to weather data to power insurance and web-based software, which helps farmers to manage risk and optimise their fields; companies in the real estate sector also use federal and local government data, including satellite photography, tax assessment data and economic statistics, to provide potential buyers with a more dynamic and informed view of the housing market (Parekh, 2015).

The research in this thesis was based in the healthcare sector, in which "Big Data" are especially driving innovation through the digitisation of the healthcare system and the introduction of wearable devices. Healthcare providers are following e-commerce leaders on how to acquire and retain patients through data analytics and from the manufacturing sector on managing patient pathways and optimising clinical supply chains (Huskins et al., 2014). Doctors are also using applications on smartphones to engage patients remotely and improve outcomes; they will soon be able to customise drugs and treatments according to an individual's genome, activity level, and actual health, to deliver the best course of treatment and outcome (Parekh, 2015). Health Information Technology (IT) has already received significant investment, but clinical decisions are still mostly based on guidelines, not on hard data; digital technologies to support clinical decisions and streamline operations, however, are set to drive changes (Huskins et al., 2014). Retrospective data (basic event data collected from medical records) and real-time data (captured and presented at the point of care e.g. imaging, blood pressure, oxygen saturation, heart rate, etc) can be combined in predictive tools to identify trends that will impact the future of healthcare (Jones, 2014).

The National Health Service (NHS) has been an early adopter and investor in intelligent data use (Wind-Cowie and Lekhi, 2012) and the UK's healthcare sector stands to benefit significantly from

"Big Data" analytics, especially through gains in productivity, into the future. Research has estimated that the cumulative economic benefits of "Big Data" will boost the healthcare sector to the tune of £14.4 billion at 2011 prices between 2012 and 2017 (Centre for Economics and Business Research, 2012), which is significant in context of the level of efficiency savings the Government is currently demanding of the NHS. Staff performance information can now be dynamically monitored and forecast through predictive analytics tools, allowing departments to link strategic objectives with service-user outcomes. Performance information is also already used in budgeting processes across the UK's public sector to improve the setting of objectives, monitoring of performance, planning and management functions and transparency. With respect to patient data, IT can improve healthcare's efficiency and quality through the efficient communication and integration of patient data across departments and institutions. Despite uncertainty over the care.data project to link primary and secondary care data, efforts to digitise patient records across the NHS continues (Flanagan, 2014).

Within the commissioning market there is also scope for "Big Data" analytic tools to provide customer intelligence. Since the Health and Social Care Bill disbanded Primary Care Trusts in 2013, Clinical Commissioning Groups (CCGs) are now responsible for commissioning the majority of local health services. Their commissioning remit encompasses all planning activities to determine how healthcare should be best delivered, agreeing what healthcare services will be available (through contracts with a wide range of providers) and monitoring that services have been delivered to the agreed specification and that quality and safety continue to improve for patients (NHS Commissioning Board, 2012). To help the transition, Commissioning Support Units were established to assist CCGs with the transactional (e.g. contracting and procurement) and transformational functions (clinicians leading change and improvement through service redesign, and engaging with local stakeholders to set agreed priorities) associated with good commissioning. CCGs have statutory obligations, however, to have their own processes to obtain commissioning support in place by 2016, opening the door for the private sector to deliver services through joint working arrangements. To this end CCGs are already working to develop their own models of commissioning support, often in partnership with the private sector; to give just one example, the consulting firm Capgemini was recruited to model potential scenarios for future services (Randall, 2014). There is thus the clear potential for external consultants and product development organisations to develop "Big Data" analytics tools to provide the customer intelligence CCGs require for the effective and efficient commissioning of healthcare services since the point remains that the UK lacks people skilled in data analytics (Wind-Cowie and Lekhi, 2012).

This section has demonstrated the clear potential to work as an independent consultant, or as part of a team, to bring UCD to organisations across sectors and domains. Over time, this could evolve into a specialist service company that provides the know-how to other organisations.

9.5 Conclusion

This chapter has demonstrated how models of organisational change from the OD literature can be used to create a strategy for the introduction of UCD to organisations and presents a strategy based on the 'Switch' framework devised by Heath and Heath (2011) and the lessons learned from this thesis, in addition to those reported by other researchers. The strategy prioritises techniques that involve a wide range of people, from across an organisation, and those that are compatible with the software development model and processes they use. A major lesson learned from the work of this thesis is that the introduction of UCD requires much more than the application of UCD techniques; if UCD techniques are to endure, careful consideration must be given to their underlying philosophy and how this philosophy can be introduced to organisations from the bottom up. The strategy presented will be of particular interest to organisations that develop "Big Data" analytic tools because this is the context in which this thesis was carried out.

We have seen that the research in this thesis was facilitated through of a two-year Knowledge Transfer Partnership, with the remit to introduce UCD techniques and deliver a mapping interface for a specific project (Chapter 4); this was followed by a four-year Engineering Doctorate, comprising of two further projects, one to develop company personas (Chapter 5), and another to assist with the usability testing of the redesign of the organisation's flagship tool (Chapter 6). This experience, backed by interviews with project stakeholders (Chapter 7), suggests that the introduction of UCD requires significant commitment and time from an organisation, short-term goals can help to keep them on board. Based on this, there is a clear market for consultancy in UCD introduction with the strategy outlined in Table 9-2; although resources can be limited, Section 9.4 showed much can be gained from UCD, and outsiders, such as consultants, can be in a better position to deliver unwanted information (Kotter, 1995).

Finally, this chapter presented, and provided evidence that there will be an increasing demand for such tools in wide range of sectors, across the economy, in the coming years. Research into the market for "Big Data" analytics suggests that a UCD approach will provide organisations looking to develop such tools with some resilience against the rapid and unpredictable changes in the sectors in which "Big Data" is used; indeed it has also suggested that the use of "Big Data" tools will provide organisations with a similar resilience against changes in their markets, but this is beyond the scope of this chapter. This thesis has demonstrated that the introduction of UCD and its associated techniques can be paramount for the successful design of "Big Data" tools because they will have such a vast range of users, who may not have the necessary skills to handle such datasets; UCD of analysis tools will help "Big Data" to attain its full economic potential.

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Glossary

Action Research (AR)

AR is an approach for "comparative research on the conditions and effects of various forms of social action" that uses "a spiral of steps, each of which is composed of a circle of planning, and fact-finding about the result of the action" (Lewin, 1946). It is democratic; does not restrict data collection to formal rules; and actively involves researchers in the investigation (Rasmussen, 2004).

Acute Hospital Trust (AHT)

Hospitals in England are managed by AHTs to ensure hospitals provide high-quality healthcare and spend their money efficiently; they also decide how a hospital will develop, so that services improve Some AHTs have gained Foundation Trust status; see "Foundation Trust".

Agile

The term "agile" encompasses approaches to software development that are defined by beliefs and practices that value: individuals and interactions over process and tools; working software over comprehensive documentation; customer collaboration over contract negotiation; and responding to change over following a plan (McInerney and Maurer, 2005).

Big Data

"Big Data" is the term used to refer to the phenomenal volume, velocity and variety of datasets being created and analysed each day across the world.

Care Pathway Manager (CPM)

CPM is a secure web-based software application developed by iHealth, used by healthcare managers to benchmark clinical performance.

Clinical Commissioning Group (CCG)

A CCG is an NHS organisation comprising of local GPs and experienced health professionals with commissioning responsibilities for local health services: planning services to meet the needs of local people; buying local health services including community health care and hospital services, and monitoring that the services are delivering the best possible care and treatment for those in need.

Cognitive Walkthrough (CW)

CW is a method for the inspection of a user interface, in which an evaluator, or groups of cooperating evaluators, perform a typical user task and assesses its ability to support each step (Bowman et al., 2002; Polson et al., 1992; Shneiderman, 1997). CW considers the cognitive process of users and, as such, provides insight into a user's cognitive process and a system's learnability.

Department of Health (DoH)

The DoH is the ministerial UK government department that is responsible for strategic leadership and funding for both health and social care in England.

Effectiveness and Efficiency Dashboard (EED)

Developed three years after PHA, EED is a web-based tool that monitors quality outcomes and patient safety by assessing the clinical, process and coding factors of patient admissions data submitted by hospitals (Secondary Uses Service), such as mortality, length of stay and readmissions, all key indicators of clinical quality and efficiency. It was designed to replace HHW.

End user

A person who interacts with a software product, also called a direct user (ISO, 2011)

Expert Walkthrough

An approach to usability evaluation in which a usability expert designs a task scenario for which an end user would use a system and puts themselves in the shoes of the end user to carry out the task. As they undertake the task they use inspection methods to evaluate the system's usability. In this thesis, expert walkthrough comprised of a Heuristic Evaluation and a Cognitive Walkthrough.

Foundation Trust (FT)

NHS FTs are AHTs with an independent legal status, which are accountable to, and have a duty to consult and involve, local people in the strategic planning of the organisation through a board of governors. As self-governing organisations, free from central government control, they have the financial freedom to retain surpluses for investment in the delivery of new NHS services.

Health and Social Care Information Centre (HSCIC)

The DoH established the HSCIC in April 2005 as a Special Health Authority to take responsibility for the collection and dissemination of data in the NHS. Their mandate was to rationalise and co-ordinate information collection and to analyse and distribute facts and figures, to help all health and social care organisations use information intelligently and improve how they run their business.

Healthcare Informatics

This refers to "the study and application of methods to improve the management of patient data, clinical knowledge, population data, and other information relevant to patient care and community health" (Wyatt and Liu, 2002) through "the development and assessment of methods and systems for the acquisition, processing and interpretation of patient data." (Imhoff et al., 2001, p. 179).

Heuristic Evaluation (HE)

HE is an informal usability inspection method, in which expert evaluators systematically critique a website's compliance with usability guidelines using a checklist of "rules of thumb" (Nielsen and Molich, 1990). It can be used early in the design process to ensure established web design guidelines are not contravened and "potential" usability problems are easy to rectify.

Hospital Episode Statistics (HES)

HES is a secure data warehouse that contains details of all admissions, outpatient appointments and emergency attendances at NHS hospitals in England with a separate record for each period of care. Details include clinical (diagnoses, operations), patient (age group, gender, ethnicity), administrative (time waited, dates, admission/discharge methods) and geographical information (where patients are treated and live).

Hospital Health Watch (HHW)

HHW is a secure web-based software application developed by iHealth, which hospitals use to monitor mortality, readmissions and length of stay from a monthly update of Secondary Uses Service data.

Hospital Mortality Benchmark (HMB)

HSMR is an indicator of death rates calculated for every hospital, based on crude rates but adjusted to the national average, according to the age and gender composition of the patients who died.

iHealth

iHealth is a provider of healthcare information in the UK, monitoring the performance of the NHS and providing information to the public. It is a joint-venture with the DoH and was launched in February 2006. It aims to improve the quality and efficiency of health and social care. It monitors the performance of the NHS and provides information to the public limited.

In-direct user

A person who receives output from a system, but does not interact with the system (ISO, 2011).

Joint Strategic Needs Assessment (JSNA)

JSNA is a process Local Authorities and Primary Care Trusts have a statutory obligation to carry out to identify the current and future health and wellbeing needs of a local population, to inform local priorities and targets and lead to agreed commissioning priorities towards improving outcomes and reducing health inequalities.

National Health Service (NHS)

This is the UK's healthcare system, funded by general taxation; it provides healthcare free at the point of use to legal residents. Some services (e.g. emergency and infectious disease treatment) are universally free, including for visitors, whilst others (e.g. eye tests, dental care and prescriptions) require a cash-in-hand contribution unless patients are from a vulnerable or low income group.

Organisation

An organisation is a system of human actions, which humans carry out to meet their ends in accordance with their values (Susman and Evered, 1978); they exist to order the intrinsic flux of human action, to channel it towards certain ends, to give it a particular shape, by generalising and institutionalising particular meanings and rules (Tsoukas and Chia, 2002: 570).

Output Area

The Output Area (OA) is the lowest geographical level (smallest area) at which UK census estimates are published. In 2001 OAs were constructed from clusters of adjacent unit postcodes, which were designed to contain similar population sizes (of a minimum size) and be as socially homogenous as possible based on tenure of household and dwelling type. Urban/rural mixes were avoided where possible; an OA preferably consists of entirely urban or entirely rural postcodes.

Participatory Design (PD)

PD is an approach to design that attempts to actively involve all stakeholders (e.g. employees, partners, customers, citizens, end users) in the design process to help ensure the result meets their needs and is usable. PD invites participants (putative, potential or future) to cooperate with designers, researchers and developers at any point during an innovation process.

Primary Care Trust (PCT)

From 2001 to 2013, PCTs were largely administrative organisations that managed roughly 80 per cent of the total NHS budget for delivering healthcare to, and improving the health of, areas of around 100,000 people. PCTs were responsible for commissioning services according to their own priorities, within the overarching priorities and budgets of the Strategic Health Authority to which they belonged, and the DoH.

Public Health Analyser (PHA)

PHA is a secure web-based software application developed by iHealth between 2007 and 2009 for use by commissioners of NHS services within PCTs. It provides the information required to:

- Understand the local population and develop segmentation models of their health needs;
- Identify and analyse local health inequalities to target unmet needs or gaps in care;
- Monitor admission trends, forecast population health needs and predict future health trends;
- Produce JSNAs.

Referral Intelligence

Referral Intelligence is a secure web-based software application developed by iHealth, which hospitals use to understand which General Practitioner (GP) surgeries are referring patients.

Scrum

Scrum is a daily meeting within an Agile software development project in which the team meets and plans the work during the day and where the tasks are distributed through the group (Lárusdóttir et al., 2013); each member provides a brief update on their progress, plans and any obstacles blocking their work (McInerney and Maurer, 2005).

Secondary Uses Service (SUS)

The NHS uses data primarily to support patient care but secondly for planning and commissioning. SUS is a single data warehouse that pools HES and other data collected by providers of NHS care to meet the data requirements of NHS commissioners. Every secondary care provider in England sends a set of standard data files (Commissioning Data Sets) to the SUS system.

Socio-Technical System

This refers to the interaction between society's complex infrastructures and human behaviour, so that society and most of its sub-structures, are complex sociotechnical systems. As an approach to complex organisational work design, it recognises the interaction between people and technology in workplaces, with their interrelatedness based on two main principles:

- Social and technical factors interact to create the conditions for successful (or unsuccessful) organisational performance;
- Optimisation of the socio or technical aspects in isolation tends to increase the quantity of unpredictable relationships and those that negatively impact the system's performance.

Sprint

Sprints are regular intervals within Agile software development, that have fixed end dates on which a stable *working version* is complete (Sy, 2007). Each working version contains a subset of the final product's features, and is developed with its own requirements analysis, design, implementation and quality assurance phases. Any incomplete development work is moved to the next working version.

Stakeholder

"individual or organization having a right, share, claim or interest in a system or in its possession of characteristics that meet their needs and expectations" (ISO, 2011)

Standardised Admission Ratio

The number of patients admitted to hospital with a diagnosis as a ratio of the number of patients that would be expected given the demographic composition of the local population.

Strategic Health Authority (SHA)

SHAs were organisations within the NHS with the responsibility for enacting the directives and implementing fiscal policy dictated by the DoH at a regional level. Each SHA area was responsible for the strategic of various PCTs which took responsibility for running or commissioning local NHS services. SHAs were abolished in 2013 under the Health and Social Care Act 2012.

Super Output Area (SOA)

SOAs are a geography that was introduced in 2004 to improve the reporting of census estimates and built up from groups of Output Areas at two different levels: Lower Super Output Areas (LSOAs) and Middle Super Output Areas (MSOAs). The Census 2011 boundaries for SOAs also align with those of Local Authorities.

System Usability Scale (SUS)

SUS is a simple, ten-item attitude Likert scale that gives a holistic view of subjective assessments of usability, which was designed as a tool for usability engineering of electronic office systems (Brooke, 1996).

Usability

Usability is "the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 2011). Originally understood to be an attribute of a system, its conception has evolved with the understanding that it is a measure of the quality of the use of a system.

Usability Engineering (UE)

UE is a sub-discipline of HCI which emerged in the mid-1980s to address 'system usability in a reliable and replicable manner. UE provides systematic methods and tools for the complex task of designing user interfaces that can be readily comprehended, quickly learned, and reliably operated.' (Butler, 1996: 59).

Usability Evaluation Method (UEM)

UEMs are methods or techniques used to perform formative usability evaluation (i.e. usability evaluation or testing to improve usability) of an interaction design at any stage of its development (Hartson et al., 2001). This includes laboratory-based formative usability testing with users, expert- and model-based usability inspection methods, and remote evaluation of systems after deployment.

Usability Maturity

This describes the extent to which an organisation has management practices in place that promote User-Centred Design.

User-Centred Design (UCD)

UCD is a term applied to a system design process that prioritises and focuses on end users' goals and needs in its development. It is driven by the following core principles: early and continual user involvement; empirical recording and analysis of users' performance and reactions; iterative refinement of features and prototypes; and integration of all aspects of usability (Gould et al., 1987).

User-Centred Design Techniques

This is a term that encompasses all activities carried out within development process that establish the goals and needs of the end users.

User-Generated Screen Capture (UGSC)

This is a survey methodology developed to inform the design of user interfaces for which screen captures can provide valuable information about how users arrange their workspace to complete tasks (Haklay and Zafiri, 2008). UGSC surveys ask users to capture their screen whilst they are performing their daily tasks, thus capturing the perceptions and workflow of the users.

Waterfall

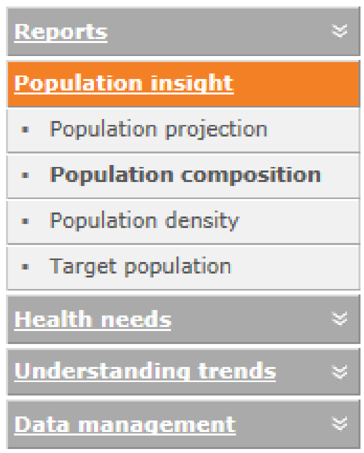
This is a model for managing the development of software, in which development progresses systematically through predefined phases in a linear fashion: definition; study/analysis; basic design; technical design/detailed design; construction; testing; integration; management; and, maintenance. Development only progresses from the first to last phase on the completion of each phase in turn.

Wicked problem

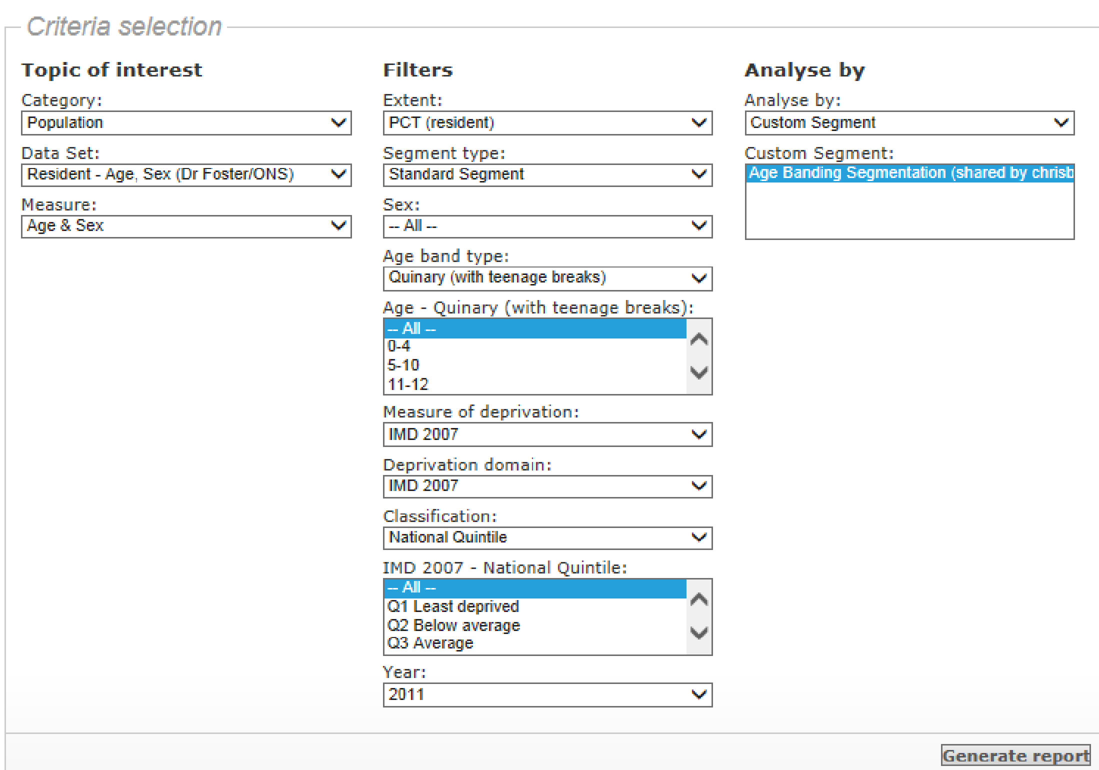
This is a term from the design and planning field, which refers to a problem whose requirements and limitations cannot be entirely known before completion (Rittel and Webber, 1973) and cannot be fully understood until a solution is committed to and adequately refined; however, solutions do not suggest when refinement should cease or whether they are right or wrong (Cockton, 2014a).

Appendices

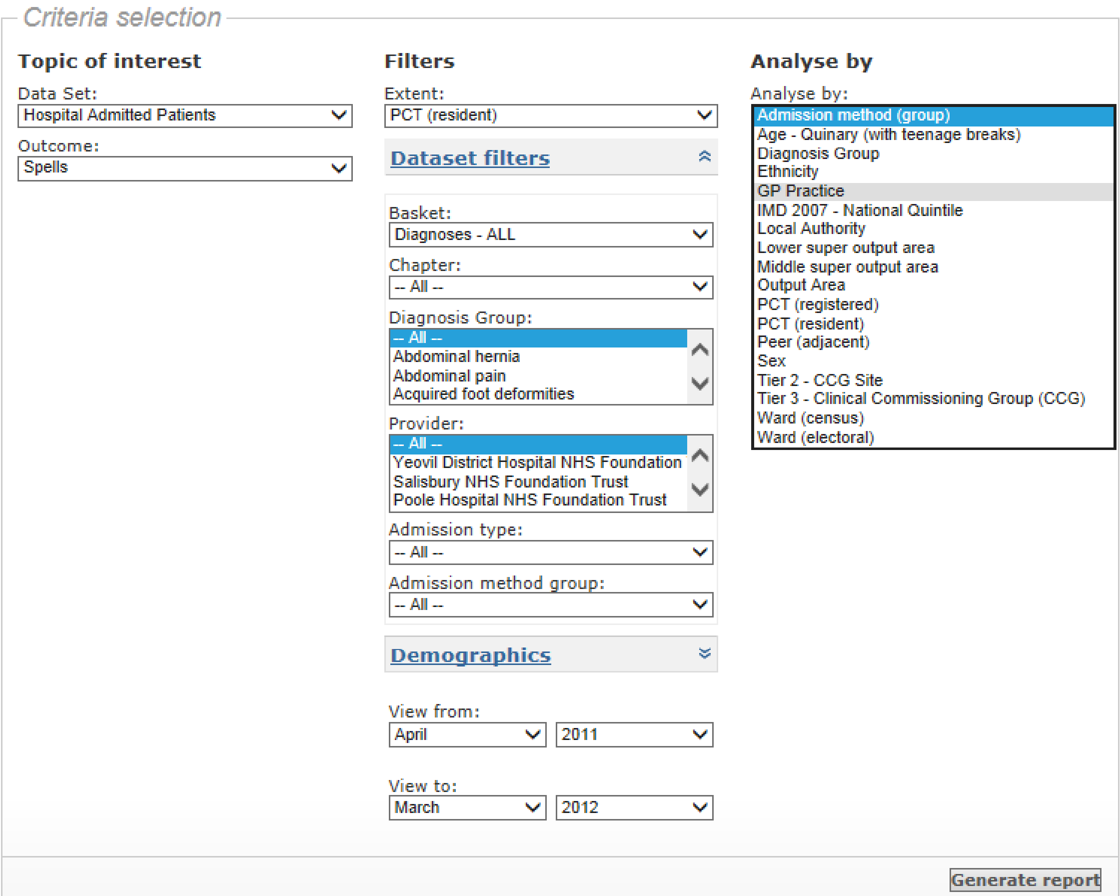
A Screenshots of Public Health Analyser (PHA)



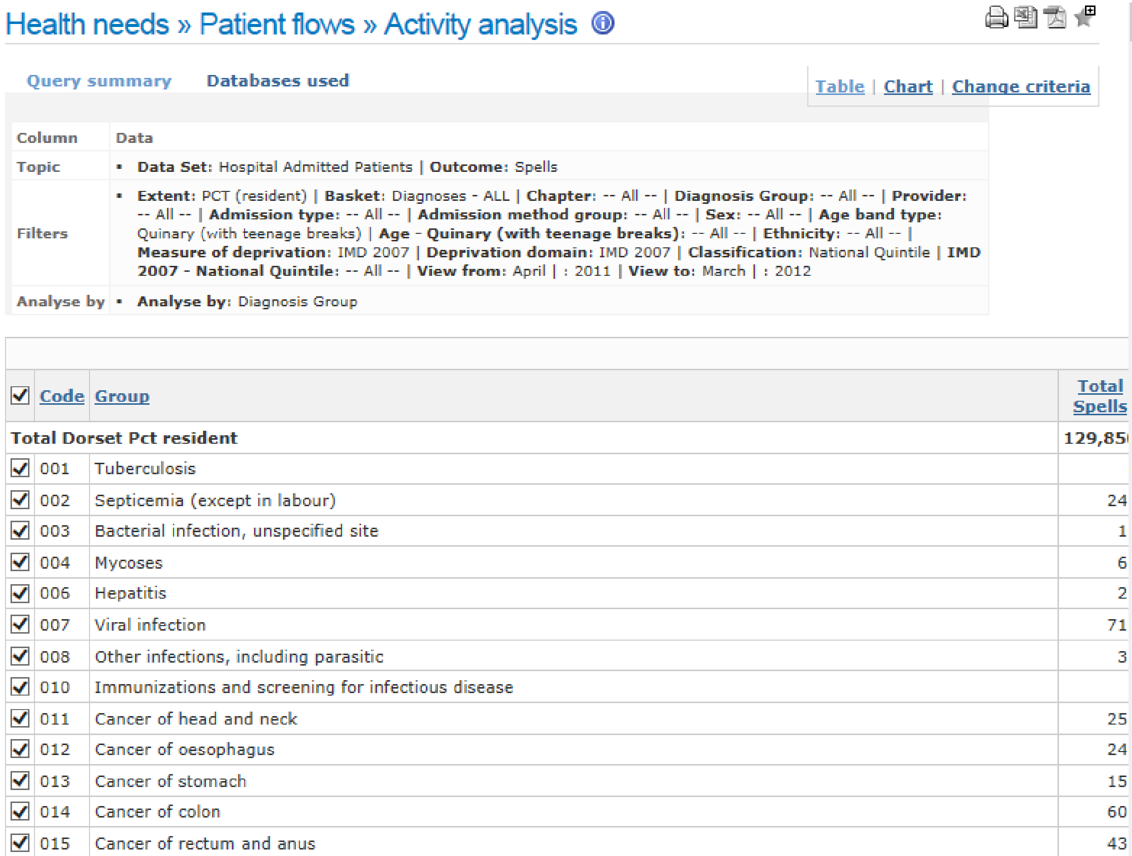
Module menu



"Population composition" module criteria selection



"Dataset Quickview" module criteria selection



Health needs » Patient flows » Activity analysis

Query summary | Databases used

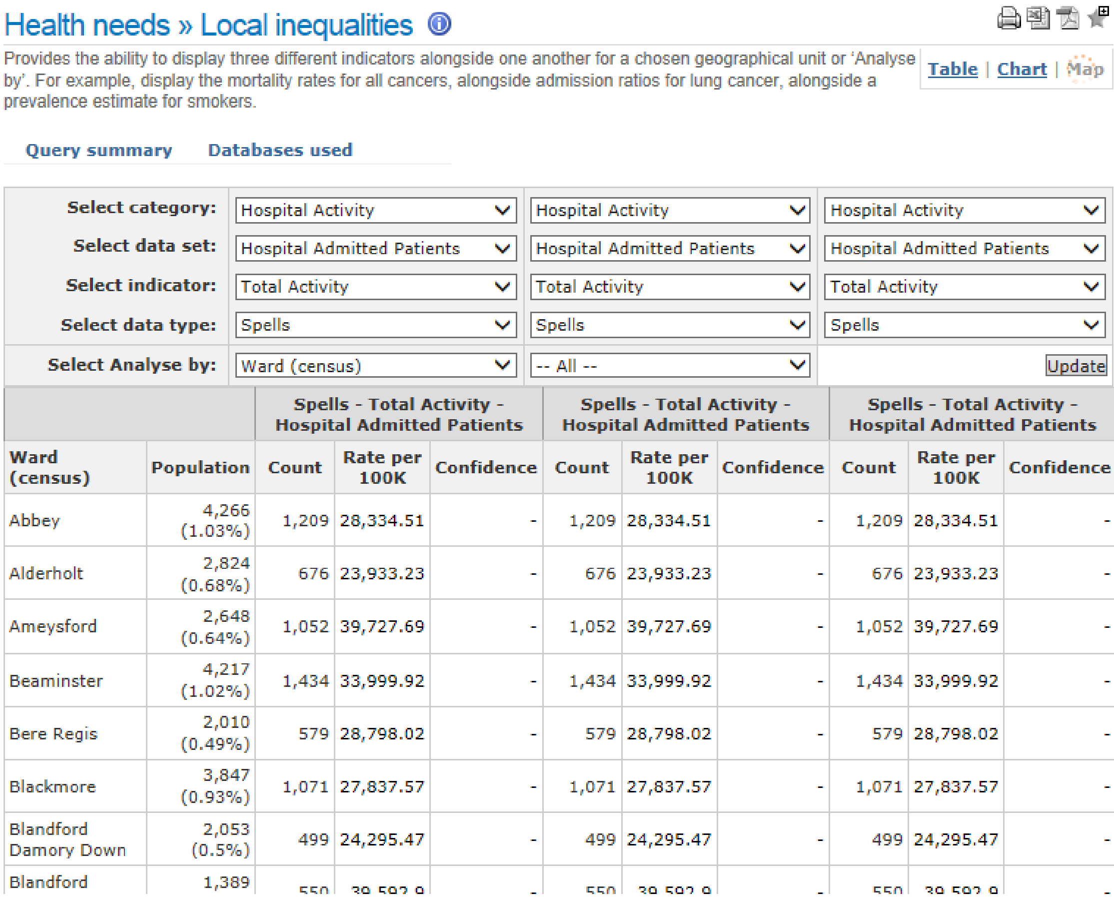
Table | Chart | Change criteria

Column	Data
Topic	▪ **Data Set:** Hospital Admitted Patients | **Outcome:** Spells
Filters	▪ **Extent:** PCT (resident) | **Basket:** Diagnoses - ALL | **Chapter:** -- All -- | **Diagnosis Group:** -- All -- | **Provider:** -- All -- | **Admission type:** -- All -- | **Admission method group:** -- All -- | **Sex:** -- All -- | **Age band type:** Quinary (with teenage breaks) | **Age - Quinary (with teenage breaks):** -- All -- | **Ethnicity:** -- All -- | **Measure of deprivation:** IMD 2007 | **Deprivation domain:** IMD 2007 | **Classification:** National Quintile | **IMD 2007 - National Quintile:** -- All -- | **View from:** April | : 2011 | **View to:** March | : 2012
Analyse by	▪ **Analyse by:** Diagnosis Group

Code	Group	Total Spells
Total Dorset Pct resident		**129,85**
001	Tuberculosis	
002	Septicemia (except in labour)	24
003	Bacterial infection, unspecified site	1
004	Mycoses	6
006	Hepatitis	2
007	Viral infection	71
008	Other infections, including parasitic	3
010	Immunizations and screening for infectious disease	
011	Cancer of head and neck	25
012	Cancer of oesophagus	24
013	Cancer of stomach	15
014	Cancer of colon	60
015	Cancer of rectum and anus	43

"Activity Analysis" module criteria selection

Notice that the table contains a long list of check boxes, which are not explained. Also notice the large amount of white space on the user interface, which could make it difficult for the customer to match the group name to the total number of spells. The customer could also struggle to read the query summary because of the way it is formatted.



Health needs » Local inequalities

Provides the ability to display three different indicators alongside one another for a chosen geographical unit or 'Analyse by'. For example, display the mortality rates for all cancers, alongside admission ratios for lung cancer, alongside a prevalence estimate for smokers.

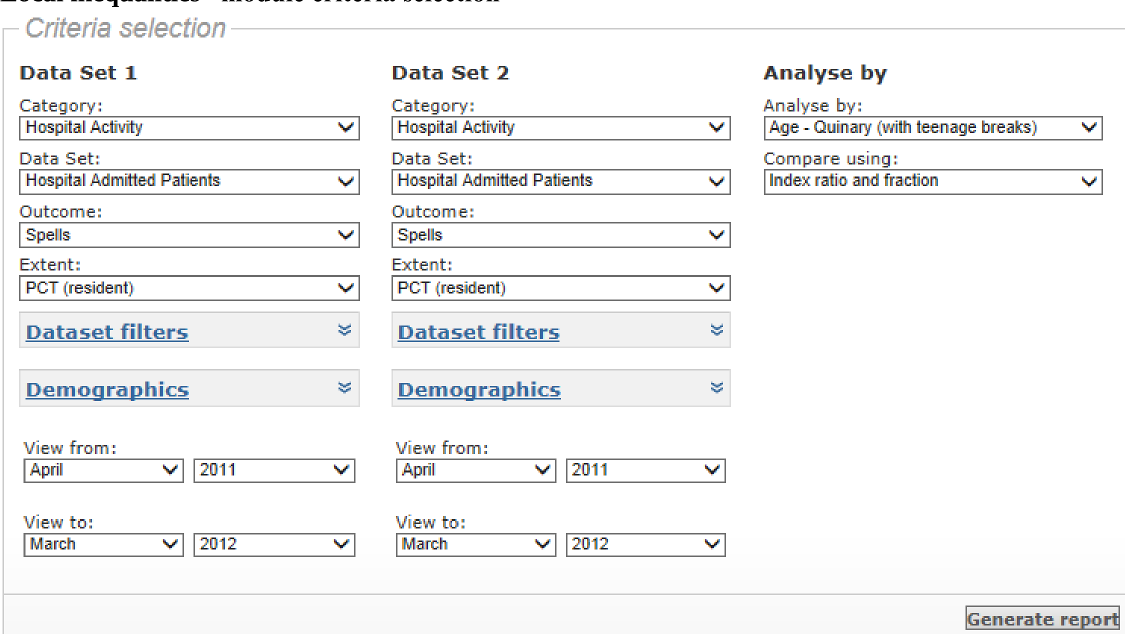
Table | Chart | Map

Query summary   Databases used

Select category:	Hospital Activity	Hospital Activity	Hospital Activity
Select data set:	Hospital Admitted Patients	Hospital Admitted Patients	Hospital Admitted Patients
Select indicator:	Total Activity	Total Activity	Total Activity
Select data type:	Spells	Spells	Spells
Select Analyse by:	Ward (census)	-- All --	Update

		Spells - Total Activity - Hospital Admitted Patients			Spells - Total Activity - Hospital Admitted Patients			Spells - Total Activity - Hospital Admitted Patients		
Ward (census)	Population	Count	Rate per 100K	Confidence	Count	Rate per 100K	Confidence	Count	Rate per 100K	Confidence
Abbey	4,266 (1.03%)	1,209	28,334.51	-	1,209	28,334.51	-	1,209	28,334.51	-
Alderholt	2,824 (0.68%)	676	23,933.23	-	676	23,933.23	-	676	23,933.23	-
Ameysford	2,648 (0.64%)	1,052	39,727.69	-	1,052	39,727.69	-	1,052	39,727.69	-
Beaminster	4,217 (1.02%)	1,434	33,999.92	-	1,434	33,999.92	-	1,434	33,999.92	-
Bere Regis	2,010 (0.49%)	579	28,798.02	-	579	28,798.02	-	579	28,798.02	-
Blackmore	3,847 (0.93%)	1,071	27,837.57	-	1,071	27,837.57	-	1,071	27,837.57	-
Blandford Damory Down	2,053 (0.5%)	499	24,295.47	-	499	24,295.47	-	499	24,295.47	-
Blandford	1,389	[illegible]	[illegible]	-	[illegible]	[illegible]	-	[illegible]	[illegible]	-

"Local inequalities" module criteria selection



Compare two datasets

B Maps Questionnaire Results

B1. Profiles of Respondents

PID	Organisation	Job Title	Date	I am familiar with public health data.	I am familiar with browsing and analysing information using the internet.	I often use maps to find out information about a location or a route.	Maps can be used to show how data varies geographically, using colour, shading or symbols. I am familiar with this way of presenting data.	I find that maps provide a useful way to show data.	When viewing and analysing data I find graphs easier to understand than maps.	When viewing and analysing data I find tables easier to understand than maps.	Age	Gender	Time working in public health
1	London Borough of Greenwich	Research and Statistics Officer	29/01/2008	Slightly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Slightly disagree	25-34	Male	1-3 years
2	W D PCT	consultant	29/01/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Slightly disagree	45-54	Male	Over 10 years
3	Penny Brohn Cancer Care	KTP Associate - Health Information Researcher	05/02/2008	Slightly disagree	Strongly agree	Strongly disagree	Slightly agree	Slightly agree	Indifferent	Strongly disagree	Under 25	Male	1-3 years
4	Redcar and Cleveland PCT	KTP Associate in Public Health Analysis	05/02/2008	Strongly agree	Strongly agree	Slightly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree	25-34	Female	1-3 years
5	Isle of Wight Council	Performance Team Manager	28/02/2008	Slightly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly disagree	Over 54	Male	Over 10 years
6	Hampshire County Council	Performance Manager	28/02/2008	Slightly agree	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree	Indifferent	Indifferent	25-34	Male	1-3 years
7	Sefton PCT	Director of Public Health	06/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly disagree	35-44	Female	Over 10 years
8	County Durham PCT	Assistant director of performance	06/03/2008	Slightly agree	Strongly agree	Indifferent	Strongly agree	Indifferent	Slightly agree	Slightly agree	35-44	Male	Less than 6 months
9	North Somerset PCT	DPH	07/03/2008	Strongly agree	Strongly agree	Slightly agree	Strongly agree	Slightly agree	Strongly agree	Slightly agree	45-54	Male	Over 10 years
10	Somerset PCT	Statistician	07/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly disagree	45-54	Female	Over 10 years

PID	Organisation	Job Title	Date	I am familiar with public health data.	I am familiar with browsing and analysing information using the internet.	I often use maps to find out information about a location or a route.	Maps can be used to show how data varies geographically, using colour, shading or symbols. I am familiar with this way of presenting data.	I find that maps provide a useful way to show data.	When viewing and analysing data I find graphs easier to understand than maps.	When viewing and analysing data I find tables easier to understand than maps.	Age	Gender	Time working in public health
11	Southwark PCT	Data Analyst	07/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Indifferent	25-34	Female	6 months - 1 year
12	Kingston PCT	Head of Information & Performance	07/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Indifferent	45-54	Female	Less than 6 months
13	Bristol Primary Care Trust	Public Health Analyst	07/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Indifferent	35-44	Male	3-10 years
14	Blackburn with Darwen PCT	consultant in PH	09/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree	Slightly disagree	45-54	Male	Over 10 years
15	Warrington PCT	Contracts Performance Manager	10/03/2008	Slightly disagree	Strongly disagree	Strongly disagree	Strongly disagree	Indifferent	Slightly disagree	Indifferent	25-34	Male	3-10 years
16	Lambeth PCT	Senior Commissioning Analyst	10/03/2008	Slightly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree	Indifferent	25-34	Female	3-10 years
17	Plymouth PCT	Health Economist	10/03/2008	Slightly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Slightly disagree	35-44	Female	Less than 6 months
18	Hammersmith & Fulham PCT	Senior Analyst	10/03/2008	Strongly disagree	Strongly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree	Slightly agree	25-34	Female	Less than 6 months
19	Kirklees PCT	Information Analyst	10/03/2008	Strongly disagree	Indifferent	Strongly agree	Strongly agree	Strongly agree	Indifferent	Indifferent	25-34	Female	Less than 6 months
20	Wakefield PCT	Public Health Research Specialist	11/03/2008	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree	Indifferent	Indifferent	25-34	Male	1-3 years
21	Liverpool Primary Care Trust	Lead Health Intelligence Manager	11/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly disagree	Slightly disagree	35-44	Female	Over 10 years
22	Nottingham City PCT	Consultant in Public Health Medicine	11/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Indifferent	Indifferent	45-54	Male	3-10 years

PID	Organisation	Job Title	Date	I am familiar with public health data.	I am familiar with browsing and analysing information using the internet.	I often use maps to find out information about a location or a route.	Maps can be used to show how data varies geographically, using colour, shading or symbols. I am familiar with this way of presenting data.	I find that maps provide a useful way to show data.	When viewing and analysing data I find graphs easier to understand than maps.	When viewing and analysing data I find tables easier to understand than maps.	Age	Gender	Time working in public health
23	Bath and North East Somerset PCT	Director of Public Health	12/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree	Over 54	Male	Over 10 years
24	iHealth	PR and Internal Communications Manager	12/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly disagree	25-34	Female	1-3 years
25	Cumbria PCT	Associate Director of Performance	13/03/2008	Strongly agree	Strongly agree	Strongly agree	Slightly agree	Strongly agree	Indifferent	Strongly disagree	45-54	Female	Over 10 years
26	East Riding and Yorks PCT	DPH	14/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Slightly disagree	Slightly disagree	35-44	Male	Over 10 years
27	Cornwall and Isles of Scilly PCT	Information Analyst Specialist	14/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Indifferent	25-34	Female	3-10 years
28	Darlington PCT	Locality DPH	14/03/2008	Strongly agree	Strongly agree	Slightly agree	Slightly agree	Slightly agree	Strongly agree	Slightly agree	45-54	Female	Over 10 years
29	Glos PCT	PH analyst	17/03/2008	Strongly agree	Strongly agree	Slightly agree	Strongly agree	Strongly agree	Indifferent	Slightly agree	45-54	Male	Over 10 years
30	Gloucestershire PCT	Public Health Intelligence Analyst	17/03/2008	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Indifferent	Indifferent	35-44	Female	3-10 years
31	Southwark PCT	Health Policy officer	20/03/2008		Strongly agree	Slightly agree	Strongly agree	Strongly agree	Slightly agree	Slightly agree	45-54	Female	1-3 years

B2. Responses to Questions 1 and 2a

PID	1. Which data classification is easiest to interpret?	1. Comments	2a(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size or those that vary in colour/shade?	2a(ii) Do you prefer proportional-point symbols to vary in size or colour/shade?	2a. Comments
1	Map A (Five colours)	Less ranges made it easier to identify the problem areas - Map B had too many ranges, with the areas of concern harder to pick out.	Size	Size	The dot density map made it easier to identify the areas where prevalence was high.
2	Map A (Five colours)	both equivalent - neither clearly delineate the towns and population	Colour	Colour	Colour easier than size (but not when b/w photocopied)
3	Map A (Five colours)	Whilst I liked the fact that Map B shows more detailed percentile bands - I felt Map A was easier to pick out the darker colours.	Size	Colour	I find the colour scheme quite difficult on Map B (differentiating between orange and red) and the sizes or circles quite hard on Map A - would a more diverse range of colours be possible?
4	Map B (Seven colours)	More information to make decisions about service provision, particularly as map A shows mostly the extremes of the current situation.	Colour	Colour	The choropleth in Map B is something many PCTs etc. have become familiar with - although the shades could be more distinctive.
5	Map B (Seven colours)	More information in Map B the increased granularity would inform decisions - would like more info about transport routes. Colour use good as showing a spectrum.	Colour	Colour	Use of colour brought out the relative severity of problems
6	Map A (Five colours)	Has less banding so easier to see the extremes, those performing well and those under performing. Personally though I do prefer map B as it allows you to the variations and the subtitles between the other locations as not all homogeneous	Colour	Size	Prefer map A as the pale colours in map B make it difficult to see the results of all locations, apart from areas of high prevalence. If it was possible to better distinguish between the bands in map A this would have achieved been better and easier to interpret.
7	Map B (Seven colours)	More gradations of colour on Map B I like areas that need to be focussed on to be in dark colours and others in lighter shades of same colour rather than different colour. I don t know if the red areas on these maps have many people living in them and whether they are good places to base services	Size	Colour	The bigger circles on Map A could easily be misinterpreted as the places with the highest numbers of CHD patients rather than practices with a higher percentage of patients on their list
8	Map B (Seven colours)	easy to be duped into looking at Reds, however need to know the result for surrounding area (hence b) in order to ascertain how wide the issue is ; Without knowing Hampshire, I would also like to understand population density and social factors	Colour	Colour	Colour is a straightforward differentiator, size is subjective (be better if it was both colour and size to aid I/d.

PID	1. Which data classification is easiest to interpret?	1. Comments	2a(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size or those that vary in colour/shade?	2a(ii) Do you prefer proportional-point symbols to vary in size or colour/shade?	2a. Comments
9	Map A (Five colours)	Not sure either help- I presume smokers are concentrated in areas of population, so unsure how much this adds to basic intelligence about population size and inequalities. However, too many colours in Map B	Colour	Size	map A looks simpler and clearer at first glance. However, to answer the question, you have to look at the size of the circles- which is much harder that with Map B, where the red ones have immediate visual impact.
10	Map A (Five colours)	A if purely for the purpose of picking out the outlying areas, but in general would prefer B as then could see the whole picture	Colour	Colour	I find it easier to distinguish between colours than between sizes when they are so similar. However there are still places that can only print out in black and white and on occasions A would be the map of preference.
11	Map B (Seven colours)	There are more ranges in Map B hence more detail. The use of colours to indicate ranges in reduction is good (dark red for well below target, blue for above the target).	Colour	Colour	By using different colours it is much easier to quickly identify the areas with the highest rates
12	Map B (Seven colours)	I would use these maps to make a decision. They would be just one factor in the decision making process. Chose B because it gave me more detail that could then be used in conjunction with other data.	Colour	Colour	Size of dots more difficult than colour [although colour differentiation may be a problem for the colour blind?]
13	Map B (Seven colours)	map B gives more detail, i.e. more groups.	Size	Size	I'm colour blind - so ranking small dots by colour is risky as some colours look the same. It is not such a problem for larger areas, but is an issue for point data.
14	Map A (Five colours)		Colour	Colour	Map A is influenced by geographical clustering of practices
15	Map A (Five colours)	Tighter definition on the well performing areas and the less well performing areas makes them easier to identify quicker.	Colour	Colour	I find it easier to identify different colours rather than bigger or smaller shapes
16	Map A (Five colours)	broader areas covered makes it easier to see which are the poorest performing areas. Map B shows too much information	Size	Colour	Personally I found it easier to determine the poorest performers by looking at the sizes - this has the advantage that it doesn't t need to be printed out in colour to be taken to a meeting. However I prefer to look at the traffic lighting of Map B.
17	Map B (Seven colours)	I found it easier using Map B due to the greater level of detail shown on the map. Not only did this provide more detailed information on which to base decisions, visually it also made the OAs stand out more clearly. I m not sure about using blue on a map though, because it looks like a lake!	Colour	Colour	When scanning the maps, it seemed easier to pick out all the red ones than it was to pick out all the big ones . Making the colours more different would make Map B even easier to use - right now, it s a bit too easy to mistake an orange dot for a red one. The main drawback of Map B is that it requires a colour printer for hard copies.
18	Map A (Five colours)		Colour	Colour	

PID	1. Which data classification is easiest to interpret?	1. Comments	2a(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size or those that vary in colour/shade?	2a(ii) Do you prefer proportional-point symbols to vary in size or colour/shade?	2a. Comments
19	Map B (Seven colours)	The colours of the areas were easier to pick out when contrast against adjacent areas.	Colour	Colour	Easier to distinguish the various levels according to colour rather than size of data point
20	Map B (Seven colours)	While the degree of discrimination on Map A made it easier to "see" where problem areas were, Map B gave greater detail and specificity.	Size	Size	While Map A is easier to associate "size of the problem" with "size of the blob", it would not be appropriate for other indicators that are in close geographical proximity.
21	Map A (Five colours)	Decision making can be impaired by too many colour codes on a map. Do like the used of Red for well below target percentiles - effective colour to highlight hot spots (and likewise blue as cold spots for better performing areas)	Size	Size	Although Red a useful hotspot colour - the use of size of spot to indicate degree of CHD prevalence easily recognised. Map two colours gradient also confusing - colours close together - also doesn't t lend itself well to printing given variations in colour printer capabilities
22	Map B (Seven colours)	Better Graded with 5-20% bands. Although 1% bands are the same, there are areas that may need attention to them that are not adjacent. Perennial issue of rates v numbers on a single axis, so rates may be high where numbers are small. Therefore on their own insufficient to be able to decide. combination of two maps or composite measures if only using maps, or maps and table.	Colour	Colour	Can clearly see where highest prevalence is by GP practice by filtering out non red colour which is easy to do. On the graded size of circle have to keep looking around. Same problem as before, prevalence and numbers both important. Alternative would have been to use the different colour map and grade the size of the circle by the registered list size.
23	Map A (Five colours)	Map A is simpler to view and Map B does not add any further information despite being noisier. Incidentally, the question says the maps show the extent to which targets are being met but the titles say they are about targets aimed for. I have assumed they are about the latter.	Colour	Colour	The symbols in Map A are graded like a continuous variable whereas those in Map B have thresholds in contrasting colour which makes identification easier.
24	Map B (Seven colours)	Map B shows more detail, making it easier to place services near the red but not directly in it, potentially picking up more people.	Size	Colour	Map A was simpler - I think the different sized dots are really hard to see/read; however, I like Map B more because it is more detailed and since I have to stare at the map to gauge the dot size, the different coloured ones make it easier for me to more quickly identify the problem areas.
25	Map B (Seven colours)	Map B contained more detail but neither were visually easy to read and understand	Colour	Colour	The different colours made it easier to read and understand
26	Map A (Five colours)	Not enough information to decide, since it is unclear for example whether targeting should be at bottom 5% or bottom 20 %. Incidentally, insisting that either A or B is marked with know "neither" category makes this a flawed exercise. My answer is neither but I have marked A rather than give up.	Colour	Colour	Categorical colour differences are easier

PID	1. Which data classification is easiest to interpret?	1. Comments	2a(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size or those that vary in colour/shade?	2a(ii) Do you prefer proportional-point symbols to vary in size or colour/shade?	2a. Comments
27	Map A (Five colours)	Map A is less cluttered and therefore easier to identify those areas which are below the target. However, this info alone is not sufficient to identify where to locate SSS - this depends on many more factors than just targets met so far and these should also be presented.	Colour	Size	5 sizes of red dots is too many to provide meaningful display of info especially given that the range of results is small - Its difficult to distinguish between the dots in Map A and therefore Map A is perhaps clearer as the eye is immediately drawn to the red areas. I think that using different colours is not a good idea for this because this is a continuous dataset and giving different colours and cut off points to these colours imposes a judgement on it e.g. using yellow suggests this is a safe percentage but who makes this judgement - this should be made by those health professionals viewing the data rather than being given already made maps which present the data in a way judged the best by someone with little knowledge of the dataset.
28	Map A (Five colours)		Colour	Colour	Colour good
29	Map B (Seven colours)	Used more informative scale on map B. Colour differentiation good - useful town/geographical reference points, scale and direction included	Colour	Colour	Colour of dots is much easier to differentiate than diameter
30	Map A (Five colours)	Found the legend in Map A easier to process than the legend in Map B. The legend in Map B has too many categories.	Size	Size	Same colour used in the legend in Map A and the smaller the size the lower the prevalence. However in Map B I had to go back to legend again and again to see what prevalence size the colour represents.
31	Map A (Five colours)	More straightforward - not so many categories	Colour	Colour	Difference of colour clearer than difference of size

B3. Responses to Question 2b

PID	2b(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size AND colour or those that vary only in colour/shade?	2b(ii) Do you prefer proportional-point symbols to vary in size AND colour or only colour/shade?	2b. Comments
1	Size and colour	Size and colour	
2	Size and colour	Size and colour	both colour and size
3	Colour	Colour	Some of the small yellow circles on A are not too easy to spot.

PID	2b(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size AND colour or those that vary only in colour/shade?	2b(ii) Do you prefer proportional-point symbols to vary in size AND colour or only colour/shade?	2b. Comments
4	Size and colour	Size and colour	The reduction in prevalence is accounted for by both a lighter shade and a smaller shape, making higher prevalence areas stand out. As long as the data was consistently arranged to ensure that priority areas were represented by darker colours/larger points, this way of viewing data makes priority areas easier to identify.
5	Size and colour	Size and colour	combination of size and colour aided easy identification of problem hot spots
6	Size and colour	Size and colour	Better key
7	Size and colour	Colour	Same reasons as before re the different sizes of circles being easy to misinterpret
8	Colour	Size and colour	Easier on B since small and yellow is hard to see, better on A if a different colour was used or dots had a black border.
9	Size and colour	Size and colour	The mix of colour and size is very powerful
10	Size and colour	Size and colour	you don t need to look up the key to see which colour reflects which level. however if the map is reproduced in black and white and fairly small then you might not be able to distinguish the smaller, paler dots.
11	Size and colour	Size and colour	By having different sized points it is even clearer to determine the GPs with the highest rates
12	Size and colour	Size and colour	Map A could be printed off on B/W printer & still be useful
13	Size and colour	Size and colour	the size of the dot is much easier for identify high prevalence, I guess by colouring them from light to dark enhances that.
14	Colour	Colour	
15	Size and colour	Size and colour	The combination of colours and shapes differences makes it easier to look at.
16	Size and colour	Size and colour	Sizing + traffic lighting makes it very easy to pick out at a glance where the worst areas are.
17	Size and colour	Size and colour	Combining the size and the colour of the dots works well, although it could make things a bit more tricky if one were trying to spot the surgeries with the lowest prevalence. If printed in black and white, the yellow dots may disappear altogether.
18	Size and colour	Size and colour	
19	Colour	Colour	The increase in size of the circles as well as the difference in colours overconfuses interpretation of the data points
20	Colour	Colour	Using two forms of incremental display to represent a single indicator is confusing. It is more appropriate to use the size of the blob to indicate prevalence, and the colour to represent some other indicator (perhaps rates of referral or smoking prevalence).

PID	2b(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size AND colour or those that vary only in colour/shade?	2b(ii) Do you prefer proportional-point symbols to vary in size AND colour or only colour/shade?	2b. Comments
21	Size and colour	Size and colour	Again - size element makes prevalence easier to identify - however feel the colour gradient on Map A unnecessary - and confuses the visualisation of the prevalence
22	Colour	Colour	Map A is bad because you are using two measures to show the same metric, colour and size and this is confusing as expect different aspects varying to imply different measures being displayed.
23	Size and colour	Size and colour	
24	Colour	Colour	Map B just looks like the information in it is larger.
25	Colour	Colour	The same size dots are visually easier
26	Size and colour	Colour	Map A diminishes the importance of low prevalence practices
27	Size and colour	Size and colour	The different sizes are useful
28	Colour	Colour	
29	Colour	Colour	Not much difference this time but still prefer the colour difference than diameter
30	Size and colour	Size and colour	
31	Size and colour	Size and colour	Size and colour together helpful as indicators

B4. Responses to Question 2c

PID	2c(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size AND colour or those that vary only in size?	2c(ii) Do you prefer proportional-point symbols to vary in size AND colour or only size?	2c. Comments
1	Size and colour	Size	Although the colour range makes it possible to identify the area with the highest prevalence, I'm more used to seeing these types of maps as dots of one colour and don't think a colour range is necessary and if anything confuses the simplicity of the dot density scale.
2	Size and colour	Size and colour	as above
3	Size and colour	Size	I find the colour scheme on B a bit difficult to distinguish between
4	Size and colour	Size and colour	Similar reasons as the previous 2 responses/comments
5	Size and colour	Size and colour	Use of size and colour in Map B communicated the message better. Some of the paler colours in Map B were difficult to resolve on screen.
6	Size and colour	Size and colour	
7	Size and colour	Size and colour	

PID	2c(i). Which kind of proportional-point symbol do you find easiest to interpret? Those that vary in size AND colour or those that vary only in size?	2c(ii) Do you prefer proportional-point symbols to vary in size AND colour or only size?	2c. Comments
8	Size and colour	Size and colour	See previous question re border but you have it here on the reds (A) - can we have it on B too . How about green for lowest (below "warning level" but need to set locally?), orange for warning and red for outliers
9	Size and colour	Size and colour	
10	Size and colour	Size	The smaller, paler dots are not so easy to see as the smaller, red dots.
11	Size and colour	Size and colour	By using different sized points and different coloured points it is much easier to determine what GPs have the highest and lowest rates.
12	Size and colour	Size and colour	More obvious on Map B
13	Size and colour	Size	The size is the important issue for me. as someone is colour blind I do not respond well to colour as a cue as certain colours look the same to me.
14	Size and colour	Size and colour	
15	Size and colour	Size and colour	The combination of colours and shapes makes the map easier to use
16	Size and colour	Size and colour	Sizing + traffic lighting makes it very easy to identify worst performing areas.
17	Size and colour	Size and colour	The use of different colours makes it easier to take into account areas where there are both high and moderate prevalence rates.
18	Size and colour	Size and colour	
19	Size and colour	Size and colour	Easier to identify the various categories using the different colours
20	Size and colour	Size	As previous question.
21	Size and colour	Size	Same reasons as outlined before generally
22	Size and colour	Size and colour	Neither good - see comments previous question. Prefer Map B as colour filters out the different size, and I don't have to consider it.
23	Size and colour	Size and colour	
24	Size and colour	Size and colour	The different colours really help me see things better.
25	Size and colour	Size and colour	Different colours made it easier to read
26	Size and colour	Size and colour	Map A diminishes the importance of low prevalence practices
27	Size and colour	Size	Colour isn't a good way to present a continuous type of data
28	Size and colour	Size and colour	
29	Size and colour	Size and colour	Not much difference this time but still prefer the colour difference than diameter
30	Size and colour	Size	
31	Size and colour	Size and colour	

B5. Responses to Questions 3a and 3b

PID	3a. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or two layers on the same map?	3a. Comments	3b. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or on two separate maps?	3b. Comments
1	Bar charts	The COPD data is less obvious on the two layer map and it is difficult to see the pattern and differentiate. Not too keen on the colour ranges in Map A.	Bar charts	Most simple to use, comparing both sets of data on the same map.
2	Bar charts	could not work out hatching on A	Two maps	Easier
3	Two layers	A is obvious from first glance, B takes a bit more looking at but I like the idea of having the graphs on the map in B	Two maps	I liked the colours on A, same comment as last question - B takes more examination but is quite useful.
4	Bar charts	The darker shades of Map A make it harder to identify shading detail (COPD admissions), this would make print-out data particularly problematic, especially when maps are scaled down to fit reports etc. Although Map B is also fairly difficult to interpret.	Two maps	
5	Bar charts	Map B presented the information in a way that made the direct comparison easy, very much harder work to get at the Map A information. A danger that the COPD area shading on Map A would modify falsify perceptions of the colours of the smoker data	Bar charts	Map B makes the comparison directly in one place. Dark colours made the text hard to read on the cloropleth map
6	Bar charts		Two maps	
7	Bar charts	The two layered one didn't show up very clearly on the screen and I was conscious of having to check the legend a few times to understand what it was showing. The other one is much clearer	Bar charts	Al info re individual wards in one place rather than having to scan back and forth between two maps.
8	Bar charts	A is simply horrible!, B is intelligible	Bar charts	Quicker assimilation of B
9	Bar charts	Immediately obvious- had to work out the meanings in map a	Bar charts	Obvious visual impact
10	Bar charts	Can't distinguish the shading on map A	Bar charts	don t need to compare areas in different maps
11	Two layers	I find both maps difficult to interpret, map A slightly less so. In Map A it is hard to determine the COPD admissions in particular. In Map B, it is hard to compare bar charts particularly when they are scattered throughout the map, it is hard to determine scales and compare each graph with the other. I would rather have 2 maps side by side, one for COPD the other for smoking and compare that way.	Two maps	Please see explanation for previous question! You can clearly see that the Thamesmead ward has the highest smoking rate and highest COPD admissions.
12	Bar charts	Found COPD admissions almost impossible on Map A	Two maps	Colour/shade easier to compare than size

PID	3a. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or two layers on the same map?	3a. Comments	3b. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or on two separate maps?	3b. Comments
13	Bar charts	Map A was impossible to understand. map B wasn' t fantastic, but was easier to read - although you might want to try two pie charts rather than bars as it's difficult to gauge where the maximums would be on bar charts without a scale	Bar charts	moving between two maps (like in A) is difficult
14	Bar charts	Smoking % not easy to identify	Two maps	
15	Bar charts	Map B is much simpler to understand. It's quite difficult to spot the different patterns in Map A	Bar charts	Map B is easier to use because the info is presented together. Its more difficult to pick up the connection between two different indicators when they are on different pages
16	Bar charts	Two layers can look confusing, have to constantly refer back to the legend. bar charts show both pieces of information next to each other in a clear and concise way.	Bar charts	As per previous, bar charts present both pieces of information together clearly without having to cross reference other data.
17	Bar charts	Definitely, definitely, definitely B! Even when I enlarged the image, I could not distinguish between the different types of shading on Map A. My eye-sight isn' t too bad, so I imagine this would be a complete non-starter for anyone with a visual impairment.	Bar charts	Map B is far easier. Flicking my eyes left and right between the two maps in A makes me feel a bit dizzy. With B, you can tell at a single glance, rather than several glances. It may be nice to make the boundaries between the wards a bit clearer though.
18	Bar charts	Detail on both maps to small to identify easily - hovering over maps does not bring up more detail.	Bar charts	Neither very easy
19	Two layers	Neither are particularly easy to interpret. I would say that Map A could be improved by using more differentiation between the patterns indication COPD admissions.	Two maps	There is clearer differentiation between colours rather than the size of the bars. The bars are too small to clearly compare the size of them in relation to each of the areas.
20	Bar charts	Map A makes it incredibly difficult to interpret the COPD information. Perhaps the JPEG quality is not high enough in this example, but I feel it lacks the immediacy that a map should have.	Bar charts	Using two different maps could be the solution, but using two different colour schemes for comparison doesn't t help ease of interpretation. I would advise using either the same colours for both maps (or if possible) using a colour scheme that is a couple of shades lighter than the first map.
21	Bar charts	Use of textured layers in Map A is not clear - again does not lend itself well to printing. Map B clearly identifies quickly where both COPD and smoking are highest	Bar charts	Combination of two maps to view in Map A with contrasting colour schemes not easy on the eye - and also difficult to work across the two. The low red and blue bar charts in Map B clearly highlight the area where COPD admissions and smoking are low. The graded colours in Map A maps also is difficult to interpret given that you are immediately drawn to darker hot spot areas which detract from answering the question

PID	3a. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or two layers on the same map?	3a. Comments	3b. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or on two separate maps?	3b. Comments
22	Bar charts	Can't clearly identify the background layer. Might instead normalise both data sets to 0 to 1 and multiply to produce composite measure. High in both comes out highest, low/med, med/low, med/med come out in the middle, and low/low comes out lowest. Map B easier to compare side by side, but need to be normalised again, so that highest is the same height of bar chart, otherwise more importance subjectively given to red (nb legend with red lowest and blue highest does not appear on map)	Two maps	Can flick between the two maps to identify 1 or 2 areas where it coincides, but would be difficult on a larger map. For Map B, see comments about normalisation on previous question
23	Bar charts	Neither is very clear	Bar charts	
24	Bar charts	B is definitely easier to quickly understand; however, it is difficult to gauge the difference in size between the blue bars - if you could do something to make the blues easier to compare that would be really useful.	Bar charts	The A maps are a lot nicer to look at but B is a lot easier to quickly understand.
25	Bar charts	Visually I preferred Map A however Map B was actually easier to understand quickly	Bar charts	Easier to make a judgement when all the data is together
26	Bar charts	Easier to visualise. A is confusing.	Two maps	
27	Bar charts	I've only picked a map because I had to but sorry but I don t like either of these maps - Map A is impossible to tell what the SAR is. Map B is showing 2 different datasets next to each other which is not a good idea - in presenting the data in this way you are suggesting that the thing of interest in the map is these 2 datasets compared with each other but really the point of interest is how the areas compare with each other. This map tells you very little about this - the percentage of the population who are smokers looks pretty similar in all the areas. You shouldn't t put a ratio next to a percentage like this.	Two maps	Don t like the bar charts as explained previously but map A has too much colour
28	Bar charts		Two maps	
29	Bar charts	map A is too visually complex requires a lot of effort to make decision	Bar charts	Easier to look at 2 data items on one map than 2 separate maps although both have some merit
30	Two layers	Legend in Map B not instantly self-explanatory.	Two maps	Thematic representation quicker to interpret than trying to figure out height of bar chart.
31	Two layers	Lack of scaling on B makes it hard to interpret - but A is too busy	Bar charts	But very crude

B6. Responses to Questions 3c and 4

PID	3c. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or on two separate maps?	3c. Comments	4. Do you find it easier to identify changes in data over time if they are displayed on one map or two maps (with a snapshot of each moment in time)?	4. Comments
1	Two maps	Neither are great, map A is better to look at but think that map B would be the preferred option but with a different colour scale	One map	Easiest to see the change on one map
2	Two maps		One map	
3	Two maps	I think 2 maps is easier, on reflection - some of the differences between the layers are quite subtle	One map	I find it easier on the eyes to look at one map than back and forth at 2
4	Two maps	As previous comments	One map	
5	Two layers	Map B presented the data in one place and was easier to read extract the information from.	One map	Map B presented the information directly and accessibly, Map A would have required a item by item comparison
6	Two maps		One map	
7	Two maps	Shading on Map B not clear on screen - and on badly photocopied versions it would be even harder to interpret. Map A was OK although dislike scanning between two different maps	One map	Just one map to look at is much easier than scanning from one to another. Don t mean to be picky but I can’t tell where mortality rates have changed most as it is a mortality ratio map.
8	Two maps	A - it is 2 maps therefore a 2 stage process to assimilate, I still HATE map B non the less	One map	Not sure, probably B but judgement is made within the map, not by studying the map
9	Two maps	Map B just looks too complex and requires too much thought for easy assessment	One map	Map B does all the thinking for you- easy to see the answer
10	Two maps	Can’t distinguish the shading on B	One map	don t have to compare two maps, but B doesn't t show the whole picture as you don t know what the absolute levels are
11	Two maps	Please see previous explanation	One map	One map showing the change over time, rather than 2 maps showing ratios for the two years you want to compare is much more effective. By including different colours showing decreases in blue and increases in red it is easy to see that the Trust near Portsmouth had the only increase in SMRs over the time period.
12	Two maps	Shading for COPD difficult to pick out on B	One map	B simpler to interpret
13	Two maps	map A wins just, although neither are particular good. map B is terrible.	One map	map A is too complicated to work out change, map B is easier to understand
14	Two maps		One map	
15	Two maps	Map A is not ideal but it is still better than the confusing patterns on Map B	One map	Map B does the comparison work for you. Although it does not show the baseline where each area started from

PID	3c. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or on two separate maps?	3c. Comments	4. Do you find it easier to identify changes in data over time if they are displayed on one map or two maps (with a snapshot of each moment in time)?	4. Comments
16	Two maps	neither are easy to read but using different colour schemes works better than overlaying crosshatching.	One map	presenting the change on one chart is a much faster way to determine where the biggest change has happened.
17	Two maps	I still can t make out the shading in map B at all.	One map	Map B was much easier. Although it contained less detail (i.e. the actual SMRs for each year), I prefer to identify key areas very simply using visual means, then refer to an accompanying table to obtain greater detail.
18	Two maps	Map B too small to see detail of 2nd layer.	One map	
19	Two maps	Because of the difficulty distinguishing the difference in pattern representing each category for each of the areas	Two maps	It is easier to see the relative change. You know where they ratios started as well as the absolute amount of change
20	Two maps	Map A is the lesser of two evils.	One map	Map B is clearer, although comparing hospitals in this way may have limited usefulness.
21	Two maps	Given that the bar chart route is not an option - in line with previous comments - would avoid the two layer map presentation approach as although the thematic mapping of colours immediately identifies hot spots (although would prefer to be a red colour) - the texture layer is not clear - and again - not particularly good for printing purposes	One map	Using a map to visualise change is more effective and easier to interpret than the two in Map A where switching between the two is awkward, and more likely to result in misinterpretation
22	Two maps	Map B background does not show through the darker colour. May have worked if using a different colour pallet where darkest colour still allowed the cross hatching to show through	One map	Map A have to check each individual pairing and try and work out where the differences are. Map B slightly better, but you have plotted an absolute difference, not sure if this is why the full scale is not used. Perhaps better to do relative difference. also on map A, the issue of not being able to compare two SMRs from different populations, not an issue in map b
23	Two maps		One map	
24	Two maps	Definitely A - the two layers take me a lot longer to figure out.	Two maps	I think it is easier to compare when you can see them side by side rather than just different sized dots.
25	Two maps	Map B is more difficult to identify shading over colours	One map	
26	Two maps	Two maps means less overlay confusion	One map	When asked to look at a change it is easier to use a map that presents change

PID	3c. When mapping two datasets (to compare them) do you find it easier to interpret the data if it presented as bar charts or on two separate maps?	3c. Comments	4. Do you find it easier to identify changes in data over time if they are displayed on one map or two maps (with a snapshot of each moment in time)?	4. Comments
27	Two maps	Can't see the info in map B (see previous comments) This wouldn't t photocopy at all well which is often what happens to maps that are used by decision makers	Two maps	SMRs are calculated using indirect standardisation which is a method for comparing areas with the national and not with each other. Map B is completely inappropriate way of handling the data - SMRs for 2 different time periods should never be looked at in this way. The SMR is only useful for what it tells you about the area compared to the national at a given point in time. Between 03-04 and 06-07 your population structure could have completely changed. This illustrates that people making maps need to understand the data being mapped otherwise meaningless and misleading maps are produced. Also, this data is likely to be very small numbers - there should be some mention of confidence intervals in the presentation of this data.
28	Two maps		One map	
29	Two maps	Easier to pick out areas of darker colour on the separate maps than colour and hatching patterns	One map	far easier to interpret the map which reflects the actual change rather than the maps presenting to two time points
30	Two maps		Two maps	Neither map easy to interpret
31	Two layers	But pattern underlay is hard to read - too close	One map	

B7. Responses to Question 5

PID	5(i). Is it easier to assess the data on a raster background or vector background?	5(ii). Which background do you prefer?	5. Comments
1	Vector	Vector	Map A has far too much detail on it, making it difficult to pick out the data
2	Vector	Vector	
3	Raster	Vector	On map A I felt some of the smaller circles seem to get lost - but I like it because it's a style of map I am more familiar with
4	Vector	Vector	For print-outs and small scale maps, map B is much less confusing
5	Vector	Vector	Way too much detail on Map A, cluttered
6	Vector	Vector	
7	Vector	Vector	Difficult to tell the size of the circles on Map A as too much extraneous information. The other map with key roads and landmarks is good for being able to orientate yourself
8	Vector	Vector	Map A is far too busy

PID	5(i). Is it easier to assess the data on a raster background or vector background?	5(ii). Which background do you prefer?	5. Comments
9	Vector	Raster	Thought they were both unhelpful- ,and it would depend on who the audience was. Not knowing Greenwich I like Map A, but if it was my patch, would prefer the simplicity of Map B
10	Vector	Vector	A is too busy
11	Vector	Vector	There's too much going on in the background in Map A which distracts from what the map is trying to show. Map B is clearer as the blue points are easier to analyse with less going on in the background.
12	Vector	Vector	B less cluttered
13	Vector	Vector	No real difference in assessing data but Map B is simpler and easier to take in quickly. buw you should really acknowledge OS if you're using their maps.
14	Vector	Vector	
15	Vector	Vector	The details of the streets on Map A makes it difficult to see the results. Map B is more useful.
16	Vector	Vector	Simplified map works better - people don t necessarily need all the extra info in map A
17	Vector	Vector	Map A is visually too crowded, and it is difficult to make out the dots, whereas Map B is very clear. Any advantage that Map A offers in terms of additional detail is lost, because the detail cannot really be seen.
18	Vector	Vector	
19	Raster	Raster	I think they are both useful. It depends which level of geography you are interested in.
20	Vector	Raster	Map B is undoubtedly the clearer picture, however, end-users and analysts will invariably want street-level information (street names, buildings, landmarks, etc.). Therefore, Map A is preferred.
21	Vector	Vector	It is completely unnecessary to have such a detailed back layer as in Map A which detracts the eye from the important information. Given current experience with GIS, the likes of Map A are useful once perhaps drill down is necessary to identify streets, neighbourhoods etc. - however see this as a separate mapping task to support the information better presented in Map B
22	Vector	Vector	Extraneous data on map A given equal prominence to data that we are concentrating on, so cant distinguish it, Map B eye drawn to what is important, and then can check background if necessary.
23	Vector	Raster	Map A has more information which helps to orientate the viewer although it is noisier and less easy to see the symbols
24	Vector	Vector	Different sized dots are really hard for me to view, so I think B is easier to read because the lack of colour makes it easier to see the dots; colour coding the dots would help I think.
25	Vector	Vector	Map A is too busy
26	Vector	Vector	Less extraneous information
27	Vector	Vector	What is the point of including a busy raster layer (map a) - it just distracts from the info. You probably need more useful info on these maps to make them meaningful - e.g. map B is only useful if you have further identifiers so people can see which GPs they are. Also, perhaps too many classifications here - maybe 3 or 4 better than 5
28	Vector	Vector	

PID	5(i). Is it easier to assess the data on a raster background or vector background?	5(ii). Which background do you prefer?	5. Comments
29	Vector	Vector	Detailed OS background is distracting and occludes the defined area under study - Map B has far more clarity due to its simpler base layer.
30	Raster	Raster	The street background gives Map A busy background. Can identify the same information on Map B without the Street background.
31	Vector	Vector	Less clutter

B8. Responses to Questions 6 and 7

PID	6. Do you prefer Map A (with roads) or Map B (without roads)?	6. Comments	7. Which colour scheme allows you to interpret the data most easily?	7. Comments
1	Map B	Definitely value in having roads on the map, but think it makes the map more confusing to look at	Green	Prefer the one colour range in the first map. Easier to identify the areas with the highest numbers as the darkest range, this can be confusing when grading from one colour to another
2	Map A	Hospital not marked	Green	better gradation
3	Map B	Roads didn't t feel relevant to what was being displayed on the map	Green	I found the 2 darkest blues quite difficult to distinguish between when they re not adjacent.
4	Map B		Yellow to blue	Colours in map B are more distinct
5	Map B	Roads would have been relevant if different hospital catchment areas were being compared... or hospitals them selves where marked. Darker colours obscured the text on my screen	Green	easier to make the comparison with shades of one colour
6	Map A		Green	
7	Map B	Whilst I said I liked seeing the roads on previous one - the ones on this one are too similar in tone to the map colours themselves and only served to create a cluttered look	Yellow to blue	Generally I prefer one colour maps with a clear gradation in shading. The distinction between the two darker greens isn't t great on this map though
8	Map B	No strong feelings, as its ward boundaries and a person reading the data should already know ward locations without need for reference points. Hate the colours - shades of same are not easy plus a PC screen may represent differently to printer or intent ?	Green	High to low, without worrying about what colours meant but previous comments apply re shades of the same colour though green is better to me than purples
9	Map A	Helps to orientate oneself	Green	Obvious single colour shading make interpretation easier. Have to think whether yellow or blue represents the highest.

PID	6. Do you prefer Map A (with roads) or Map B (without roads)?	6. Comments	7. Which colour scheme allows you to interpret the data most easily?	7. Comments
10	Map A	Gives a reference to where the areas are on the ground without being too intrusive	Green	there is more of a difference between the background purplish colour and green than there is between it and blue. A single colour gives a more gradated picture which changing from yellow to blue does not.
11	Map B	I don't think roads add anything to this map. Something more worthwhile to add might be the hospitals/practices where the admissions occurred.	Yellow to blue	By having a range of colours it is easier and quicker to identify the PCT's with the highest number of HIUs (Portsmouth, Southampton)
12	Map A	More detail - but still uncluttered	Green	Less room for ambiguity with shades of a single colour
13	Map A	I can't see the maps	Green	
14	Map A		Green	
15	Map A	Map A is more useful as it helps with identifying locations	Yellow to blue	The colour difference on Map B is easier to see
16	Map B	As per previous - people don t necessarily need all the extra detail	Green	I find shades of the same colour easier to read than moving between two colours - easier to determine highest to lowest
17	Map B	Not so much of a preference here; it really depends how interested you are in the effects of major roads. I m not so keen on these pink and purple colours - for some reason the progression is less obvious than with yellow-orange-reds and shades of blue.	Green	I think it's easier to compare like with like, so it's better just to stick with the same colour and have the difference in its tone. Mind you, yellow-orange-reds work better than yellow-green-blues. I think it's probably the dark-to-light progression that's the key thing.
18	Map B		Green	
19	Map B	Both are very similar. The roads could potentially confuse boundaries between areas.	Yellow to blue	Slightly more differentiation between the various category colours
20	Map A	I think the presence of roads allows people to associate particular areas of concern more easily with their experience of reading maps. Of course, road detail is important on maps that perhaps deal with rates of accessibility, but a thematic layer of roads can also help to "frame" the picture and give context.	Green	A single colour scheme is easier to interpret until you go beyond quintiles. As the shading becomes subtler, it becomes harder to interpret, let alone have a colour printer recognise the subtleties of shading. It also depends on the geographical spaces your dealing with. LSOAs or OAs may not always "stand out" in a single colour scheme.
21	Map B	If the focus is the emergency admissions increase in terms of geographical area - then see no need for the roads - however do value roads included on maps where further investigations are undertaken (e.g. travel time, access to services)	Green	Personally prefer single colour gradients in mapping - they are much clearer - and again present better when colour printing. Also, use of different colours sometimes detracts from quick identification of hot spots - although sometimes presentationally can look better - more professional
22	Map B	Depends on purpose. Identifying areas is better in Map B, or that there is a difference at all. If planning where new services need to go in order to address, then map A may be better.	Green	I can filter out the less dark green areas, but when looking at the darker blue areas I'm aware of the light green and tan areas which pulls my eye away from what I'm looking for, especially since the darker blue areas are smaller.
23	Map B	Map A contains information of little relevance	Green	
24	Map A	I like the colours - the same family of colours helps connect the data in my mind; the roads on A make the map much more easily understood because it puts it in the context of the real world/set up of the area rather than just a stylised image.	Green	The big splodge of cream in the middle of the blue map really distracts me and makes it hard to connect the data, whereas when the colour is all in the same family, it makes it more cohesive.

PID	6. Do you prefer Map A (with roads) or Map B (without roads)?	6. Comments	7. Which colour scheme allows you to interpret the data most easily?	7. Comments
25	Map B	Map A is too busy with the roads	Yellow to blue	
26	Map A	Easier to put in geographical context	Green	
27	Map B	Very pretty but perhaps too many categories and colours	Green	
28	Map A		Yellow to blue	
29	Map A	The colours are a bit hard on the eye - prefer green brown yellow blue shades probably influenced a bit by OS backgrounds. Road network gives some geographical reference	Green	Hard to chose - both effective at enabling the hot spots to be identified but personal preference is the single graded colour scheme
30	Map B	The key information is emergency admissions by wards. Think the road layer is unnecessary.	Green	Easier to interpret the same shade of a colour when displayed as a gradient that different colours.
31	Map A	Roads may be related to emergency admissions	Green	Logical to have dark to light spectrum

B9. Responses to Questions 8 and 9

PID	8. Would you like to be able to view Acute Hospital Trusts when looking at a map of a Strategic Health Authority?	8. Comments	9. Which map do you prefer - with roads, place names or both?	9. Comments
1	Yes		With both roads and place names	
2	Yes	But use short labels	With both roads and place names	Read a book on cartography
3	Yes	Seems to be very relevant	With both roads and place names	I liked the place names and found that the roads gave me more of a feel for where the places were in relation to each other
4	Yes		With place names	
5	Yes	Allows comparisons on the relative distance to acute care for the inhabitants of the trusts	With both roads and place names	Map C facilitates orientation to the population centres and transport options…
6	Yes		With both roads and place names	

PID	8. Would you like to be able to view Acute Hospital Trusts when looking at a map of a Strategic Health Authority?	8. Comments	9. Which map do you prefer - with roads, place names or both?	9. Comments
7	No	Not unless relevant to the subject of the map e.g. access times to hospital	With roads	For an area I am familiar with the roads would help me create a mental picture of where hotspots are, without too much clutter. In an area I didn't know I d prefer Map B
8	Yes	Yes when considering impact of data on service redesign - in this case though incidence of VHIU may be linked to ease of access to acute care so very relevant (but should also consider UCC and WIC too ??)	With both roads and place names	Surprised me ! - I prefer C since the area viewed is so huge I really did need spatial reference points
9	Yes	It does depend on the purpose and the audience.	With both roads and place names	Sufficient detail for orientation, but so much as to make the map cluttered
10	Yes	It might give some insight about accessibility	With both roads and place names	Gives a better picture. This will only work if there aren't too many roads and placenames. it would be useful to be able to turn them on and off
11	Yes	It doesn't t detract from the main aim of the map. It also adds additional useful information.	With place names	Map B is the clearest map to read, however I would also remove all place names outside South Central SHA.
12	Yes	More information	With both roads and place names	More information available
13	Yes	POIs are useful, doesn't t necessarily have to be hospitals though	With both roads and place names	Much more useful have geographical info on the maps - helps users locate areas
14	Yes		With both roads and place names	
15	Yes	Its better to see Acute Hospitals to see if they have an impact on results.	With both roads and place names	The roads and place names add context to the map
16	Yes	useful for context, i.e. does having an Acute Trust nearby make the numbers better/worse?	With place names	
17	Yes	Well, it entirely depends upon the reason why I was looking at the map in the first place, but I guess it would be useful, so yes.	With both roads and place names	In this case, I think the combination of roads and place names make it easier to visualise where you are on the map.
18	No		With roads	
19	Yes	Maybe the data labels could be shorter for the various trusts	With place names	The roads slightly confuse the area boundaries

PID	8. Would you like to be able to view Acute Hospital Trusts when looking at a map of a Strategic Health Authority?	8. Comments	9. Which map do you prefer - with roads, place names or both?	9. Comments
20	Yes	I'd like the ability to choose. If it's possible to add that as a thematic layer, then do so. However, it would be more useful to see AHT boundaries when looking at a lower level of geography.	With both roads and place names	For strategic purposes, Map C is more useful. For presentation purposes, Map B is the preferred format.
21	Yes	This may be a personal preference, however the inclusion of hospital trusts does improve understanding of the local geographical area - and given the information, it makes sense to me to identify the location of hospital trusts when investigating high impact users. In terms of service redesign / relocation, it is important to be able to visualise where the greatest need is - and whether health care delivery is located in the right places	With place names	For this map, the road layer is not as key as perhaps giving the map some clear geography as to where people live who are the HIUs. Map C is far too busy and makes interpretation very difficult. Would prefer to see single colour gradient for thematic mapping too. If the focus is upon this one SHA, it is of no added value to map the boundaries for the neighbouring SHAs as is done in Map A, however would be of use as a separate follow on mapping task
22	Yes	does depend on purpose, but often yes. May be better to have key by type of hospital, users are likely to know what the local hospitals are - alternatively a double key (number in icon) then can look up name by number	With both roads and place names	Does depend on purpose, also see previous comments about colour of key. HIU may be influenced by access to hospital, therefore relevant
23	No		With roads	
24	Yes	Again, the bigger picture is a lot more informative and helps keep information in perspective.	With both roads and place names	I like the most information possible in an easily understandable visual format.
25	Yes	The location of Acute Trusts will impact on demand for other services	With place names	Roads are an unnecessary distraction
26	Yes		With roads	Geographical context but not too complicated
27	Yes	It depends on what else the map is showing - it could be irrelevant and cluttering to include this or could be useful	With both roads and place names	useful to have place names as orientation
28	Yes		With both roads and place names	
29	No	Doesn't seem to add anything useful by including trust sites given the geographical area chosen - do like the colour scheme.	With both roads and place names	Towns and road layers add to the overall information without cluttering the image. Easier to define the extent of London from MAP C than either of the other two - gives a clear geographical reference point for the map and the area defined by it.
30	Yes	No harm in having it on can be of added value.	With both roads and place names	Useful for those who do not know the area
31	Yes	Useful info - especially if not familiar with the area. Many people don t live in the areas where they work	With both roads and place names	

B10. Responses to Questions 10 and 11

PID	10a. Would you find it useful to classify data by averages (on maps) for your work?	10b. Do averages help you to understand the data?	10. Comments	11. Would you prefer maps to include ward and place names or GP practices and hospitals?	11. Comments
1	Without averages	No	Found the inclusion of averages less easy to use	GP Practices and AHTs	
2	With averages	Yes		GP Practices and AHTs	But starting to get busy
3	With averages	Yes	I felt the national average was useful, I wondered whether there would have been other relevant local comparisons to make?	GP Practices and AHTs	I felt B was a bit more explanatory than A - not to draw any conclusions with - just give a bit richer information about the area.
4	With averages	Yes		GP Practices and AHTs	
5	With averages	Yes	Map A is more useful as it demonstrates the areas most in need of attention and relates those areas to national comparisons, the use of Map B could well lead to more diffuse responses and inefficient resource allocation	GP Practices and AHTs	Map B would better inform decision making around specific localities for resource allocation.
6	Without averages	Yes		GP Practices and AHTs	
7	With averages	Yes	I didn't immediately appreciate that Map As colouring was related to the averages - but I did find it helpful to have something to benchmark the figures against - otherwise its difficult to tell whether there is a significant issue to address or not	Ward and place names	When describing the map I would say there was a problem with waiting times in Area A rather than near Hospital A
8	With averages	Yes	Bad or relatively good in a nation of poor performance ? - benchmarking is essential	GP Practices and AHTs	
9	With averages	Yes	In reporting. usually need to reflect our relative performance as well s absolute- and this makes it very easy	Ward and place names	It will depend on the audience. For a general audience (which includes me at this moment), the general geography is better. For a primary care audience the health service orientated data may be better.
10	With averages	Yes	Not really a clear cut answer for this one. it depends on what question you are asking. If you are looking at the situation within a PCT with respect to allocating resources then B might be sufficient (it isn't obvious why the cut points between colours were chosen for B) if however you are seeing if Greenwich is underperforming and you are asked by your SHA what you are going to do about it you need to see how everywhere is doing compared to the national and SHA rates.	GP Practices and AHTs	Because this is the why referrals are made and interventions would be at practice or acute trust level
11	With averages	Yes	I think it is important to be able to compare rates with other areas (e.g. national/regional). Using these rates to show ranges within the PCT would be more useful than Map B where ranges don t seem to be based on anything.	GP Practices and AHTs	I think Map B would probably be more useful but it looks a little cluttered ....by removing the GP practices and Acute Hospital Trusts outside of the PCT it could reduce some of the clutter.

PID	10a. Would you find it useful to classify data by averages (on maps) for your work?	10b. Do averages help you to understand the data?	10. Comments	11. Would you prefer maps to include ward and place names or GP practices and hospitals?	11. Comments
12	With averages	Yes		GP Practices and AHTs	B info more useful
13	With averages	Yes	I don t understand what the different measures are between the maps, are they using different standard populations – it's not clear. some extra information such as averages may be useful, depends on what you are looking at	GP Practices and AHTs	More info = more useful
14	With averages	Yes		GP Practices and AHTs	Not interested in GP practices
15	With averages	Yes	Again the averages add context and help with benchmarking	GP Practices and AHTs	Both are useful because they help to identify trends which are down to area or the Health services that are available
16	With averages	Yes		GP Practices and AHTs	
17	With averages	Yes	I absolutely must have some kind of benchmark when looking at performance data - without this, we cannot know whether we are good or bad. Performance data is meaningless without context. I should know: I was a performance manager for five years! It has to be the right context though, so if we're looking at our own progress over time, then historical figures on our own performance would be more relevant than comparator data, but you get the idea.	GP Practices and AHTs	This is tricky to answer, as map A could be better for some pieces of work, and map B for others. As we tend to look at the effectiveness of existing resources in meeting needs, and at where there may be gaps in provision, I guess map B would be more helpful. I like the colours on these maps.
18	With averages	Yes	Averages often helpful, but in this case national target would be more useful than average.	Ward and place names	
19	With averages	Yes	Is there a need to show the standard deviations as well?	GP Practices and AHTs	It depends on what you interested in using the map for. The additional points on Map B do overcomplicate the map if they are not required.
20	With averages	Yes	Regional or national comparators are always useful. Shading according to a particular threshold (such as the national average or pre-set deadline) is useful.	Ward and place names	I'm not sure what added value GP locations gives to the maps.
21	With averages	Yes	When looking at something like service delivery / waiting times - it is not often useful to be so inward looking as in Map B where although identifying poor performance, this may not necessarily be the case on a wider geographical footprint. The benchmarking possibilities in Map A are much more informative, and also clarify areas where they may not necessarily be as good or bad as indicated in the more restricted information provided in Map B	GP Practices and AHTs	Although a busy map (Map B) - investigation of delays in diagnosis would be best viewed in terms of those primary and secondary care sites responsible for delivery of diagnosis / treatment. The investigation is perhaps less to do with where people live than the timeliness and access to services
22	With averages	Yes	They appear to be giving the same data, just different intervals. To be consistent with previous answers I would go with Map B on the intervals, but Map A has the relative positions - may be helpful to have put a colour key alongside the local, SHA and national averages to be able to compare against the map	GP Practices and AHTs	Depends on purpose. If just showing that there is variation then A, if trying to understand if placement of services explains variation then B
23	With averages	Yes		GP Practices and AHTs	

PID	10a. Would you find it useful to classify data by averages (on maps) for your work?	10b. Do averages help you to understand the data?	10. Comments	11. Would you prefer maps to include ward and place names or GP practices and hospitals?	11. Comments
24	With averages	Yes	Being able to compare to national averages would be most useful for big picture strategic work; maybe it would be useful to be able to have an option to see just the PCT information as a pop up or something similar, with the benchmarked info the main map.	Ward and place names	A is easier to understand but B gives more relevant data - B could be improved by making the shapes stand apart more for the practices and trusts.
25	With averages	No		GP Practices and AHTs	
26	With averages	Yes	Usefulness depends entirely on context and for different jobs either might be appropriate. Difficult to comment on shading when it is not presented.	GP Practices and AHTs	
27	With averages	Yes		GP Practices and AHTs	The preferred map depends - sometimes it is useful to have ward names and sometimes to have GP practices. it is good to have that flexibility in presentation
28	With averages	Yes		GP Practices and AHTs	
29	With averages	Yes	Much more useful data on map A - can pick out hotspots above local and national average waiting times from A	GP Practices and AHTs	More appropriate to include GP practice and acute hospital sites for this measure - consistent with messages in the map
30	With averages	Yes		GP Practices and AHTs	Colour scheme ok. Useful to have the GP surgery and acute trust locations on.
31	With averages	Yes		Ward and place names	

C Expert Walkthrough of Public Health Analyser

C1. Public Health Analyser Users

Sex	Job Title	Job Type	Total Queries
M	Economic Advisor	Finance	1562
F	Information Analyst	Information Analyst	1425
F	Social Care Researcher	Social Care	1144
M	Public Health Scientist	Public Health	1084
F	Public Health Specialist	Public Health	931
M	Consultant in Public Health	Public Health	879
F	Unknown	Unknown	379
M	Trainee Health Intelligence Analyst	Health Intelligence	317
M	Data Analyst	Information Analyst	312
F	Health Intelligence Manager	Health Intelligence	260
F	Senior Information Analyst	Information Analyst	258
F	Public Health Consultant in Training	Public Health	254
M	Epidemiologist	Epidemiology	254
M	Consultant	Consultant	223
M	Director of Public Health	Public Health	214
F	Strategic Analyst	Strategy	211
F	Health Intelligence Analyst	Health Intelligence	204
M	Senior Information & Performance Analyst	Performance Analyst	202
M	Public Health Scientist	Public Health	191
M	Public Health Intelligence Analyst	Public Health	179
M	Public Health Analyst	Public Health	165
F	Insight Manager	Health Intelligence	151
F	Head of Information	Information Analyst	146
F	Strategy & Redesign Manager	Strategy	139
M	Contracts Manager	Finance	139
F	Public Health Information Specialist	Public Health	122
M	Commissioning Intelligence Analyst	Commissioner	120
F	Informatics Specialist	Information Analyst	118
M	Unknown	Unknown	115
M	Senior Public Health Information Specialist	Public Health	108
F	Unknown	Unknown	107

Sex	Job Title	Job Type	Total Queries
M	Deputy Director of Public Health	Public Health	107
M	Development Librarian	Librarian	104
F	Lead Health Intelligence Manager	Health Intelligence	103
F	Analyst	Information Analyst	102
F	Health Intelligence Manager	Health Intelligence	101
M	Health Intelligence Manager	Health Intelligence	98
F	Unknown	Unknown	97
F	Head of Stop Smoking Services	Public Health	96
M	Unknown	Unknown	93
M	Head of Performance	Performance Analyst	90
M	Public Health Analyst	Public Health	89
M	Information and Performance Analyst	Performance Analyst	83
F	Research & Evaluation Fellow	Strategy	82
F	Public Health Information Specialist	Public Health	79
M	Enterprise Project Manager	Project Manager	77
M	Information Analyst	Information Analyst	77
M	Needs Assessment Manager	Commissioner	75
M	Information Analyst	Information Analyst	71
M	Senior Accountant Financial Management	Finance	71
M	Trainee Public Health Information Analyst	Public Health	70
F	Project Officer	Project Manager	68
F	Locality Commissioning Manager	Commissioner	67
F	Health Improvement Manager	Health Improvement	66
M	Snr Information Analyst	Information Analyst	65
M	Business Information Manager	Strategy	64
M	Partnership Support Manager/Analyst	Analyst	64
F	Health Intelligence Analyst	Health Intelligence	62
F	Unknown	Unknown	62
M	Unknown	Unknown	62
F	Locality Director	Commissioner	58
F	Public Health Information Analyst	Public Health	57
F	Unknown	Unknown	54
F	Information Analyst	Information Analyst	51
M	Head of Information	Information Analyst	50
F	Finance Manager–Community Services	Finance	48

Sex	Job Title	Job Type	Total Queries
M	Snr Info Analyst	Information Analyst	44
M	Impact Officer	Health Improvement	44
F	Unknown	Unknown	43
F	Needs Assessment Manager	Commissioner	40
M	Senior Statistical Information Officer	Information Analyst	38
M	Information Analyst	Information Analyst	37
M	Unknown	Unknown	36
F	Information Analyst	Information Analyst	34
M	Unknown	Unknown	34
F	Unknown	Unknown	33
M	Statistical Officer: Adult Social Care	Information Analyst	33
F	Unknown	Unknown	32
M	Senior Modelling Manager	Analyst	32
M	Unknown	Unknown	32
F	Unknown	Unknown	31
M	Information Analyst	Information Analyst	31
F	Quality in Commissioning	Performance Analyst	30
F	Service Manager: Business Support	Strategy	29
F	Public Health Information Analyst	Public Health	28
F	Health Improvement	Health Improvement	27
F	Specialist Information Analyst	Information Analyst	27
M	Unknown	Unknown	27
F	PBC Support and Development Manager	Commissioner	25
F	Unknown	Unknown	25
M	Programme Director PBC	Commissioner	22
M	Programme Manager LTC (Long Term Care)	Project Manager	22
M	Locality Director	Commissioner	21
F	Unknown	Unknown	20
F	Unknown	Unknown	20
F	Health Improvement Practitioner	Health Improvement	19
F	Information Analyst	Information Analyst	19
F	Policy & Research Officer	Strategy	19
M	Information Analyst	Information Analyst	19
F	Senior Information Analyst	Information Analyst	18
F	Specialist Information Analyst	Information Analyst	18

Sex	Job Title	Job Type	Total Queries
M	Information Analyst	Information Analyst	18
M	Director of Commissioning Intelligence	Commissioner	17
M	Consultant	Clinician	17
F	Unknown	Unknown	16
M	Information Analyst	Information Analyst	16
F	Unknown	Unknown	15
F	Unknown	Unknown	15
M	Data Validation Officer	Data Quality	15
F	Housing R & D and Enabling Officer	Project Manager	14
M	Unknown	Unknown	14
F	Unknown	Unknown	13
M	Informatics Analyst	Information Analyst	12
M	Consultant in Public Health	Public Health	11
M	Lead Commissioner for Mental Health	Commissioner	11
M	Public Health Trainee	Public Health	11
F	CVD Commissioner	Commissioner	10
F	Specialist Information Analyst	Information Analyst	10
F	Unknown	Unknown	10
F	Consultant in Public Health	Health Improvement	9
F	Unknown	Unknown	9
F	Unknown	Unknown	8
F	Public Health Information and Intelligence	Public Health	7
F	Quality and Performance Manager	Performance Analyst	7
F	Unknown	Unknown	7
M	Assistant Director Health Improvement	Health Improvement	7
M	Data Analyst	Information Analyst	7
M	Information and Performance Analyst	Performance Analyst	7
M	North West Lead for Public Health	Public Health	7
M	Senior Accountant: Community Services	Finance	7
F	Clinical Governance Manager	Clinical Governance	6
F	Contracts Support Officer	Finance	6
F	Librarian	Librarian	6
F	Nurse Consultant	Consultant	6
F	Unknown	Unknown	6
F	Unknown	Unknown	6

Sex	Job Title	Job Type	Total Queries
M	Senior Public Health Practitioner	Public Health	6
M	Unknown	Unknown	6
F	Public Health Commissioning Analyst	Public Health	5
M	Director of Public Health	Public Health	5
M	Unknown	Unknown	5
F	Health Improvement Practitioner	Health Improvement	4
F	PBC Analyst	Commissioner	4
F	Project Co-Ordinator	Project Manager	4
F	Senior Information Analyst	Information Analyst	4
F	Unknown	Unknown	4
F	Unknown	Unknown	4
M	Unknown	Unknown	4
F	Information Analyst	Information Analyst	3
F	Medicines Management Technician	Medicine Management	3
F	Public Health Information Analyst Trainee	Public Health	3
F	Unknown	Unknown	3
M	Unknown	Unknown	3
M	Unknown	Unknown	3
M	Unknown	Unknown	3
F	Public Health	Public Health	2
F	Senior Finance Officer	Finance	2
M	Clinical Director	Consultant	2
M	General Manager	Project Manager	2
M	Medical Statistician	Information Analyst	2
M	Public Health Information Specialist	Public Health	2
M	Specialist Analyst	Analyst	2
M	Unknown	Unknown	2
M	Unknown	Unknown	2
F	Head of I M&T	Information Analyst	1
F	Healthy Lifestyle Coordinator	Project Manager	1
F	Information Analyst	Information Analyst	1
F	Reading Development Librarian	Librarian	1
F	Research and Information - Team Leader	Information Analyst	1
F	Screening & Immunisation Programme	Public Health	1
F	Specialist Intelligence Analyst	Health Intelligence	1

Sex	Job Title	Job Type	Total Queries
F	Unknown	Unknown	1
F	Unknown	Unknown	1
F	Unknown	Unknown	1
F	Unknown	Unknown	1
M	Commissioning Intelligence Manager	Commissioner	1
M	Commissioning Manager	Commissioner	1
M	Information Analyst	Information Analyst	1
M	Information Analyst	Information Analyst	1
M	Information Analyst	Information Analyst	1
M	Information Analyst	Information Analyst	1
M	Primary Care Commissioning Manager	Commissioner	1
M	Unknown	Unknown	1
M	Unknown	Unknown	1
M	Unknown	Unknown	1

C2. Heuristic Evaluation of Public Health Analyser

Usability Techniques

Heuristic Evaluation - A System Checklist

By Deniese Pierotti, Xerox Corporation

Heuristic Evaluation - A System Checklist

1. Visibility of System Status

The system should always keep user informed about what is going on, through appropriate feedback within reasonable time.

#	Review Checklist	Yes No N/A	Comments
1.1	Does every display begin with a title or header that describes screen contents?	O O O	
1.2	Is there a consistent icon design scheme and stylistic treatment across the system?	O O O	
1.3	Is a single, selected icon clearly visible when surrounded by unselected icons?	O O O	
1.4	Do menu instructions, prompts, and error messages appear in the same place(s) on each menu?	O O O	
1.5	In multipage data entry screens, is each page labeled to show its relation to others?	O O O	
1.6	If overtype and insert mode are both available, is there a visible indication of which one the user is in?	O O O	
1.7	If pop-up windows are used to display error messages, do they allow the user to see the field in error?	O O O	
1.8	Is there some form of system feedback for every operator action?	O O O	
1.9	After the user completes an action (or group of actions), does the feedback indicate that the next group of actions can be started?	O O O	
1.10	Is there visual feedback in menus or dialog boxes about which choices are selectable?	O O O	
1.11	Is there visual feedback in menus or dialog boxes about which choice the cursor is on now?	O O O	
1.12	If multiple options can be selected in a menu or dialog box, is there visual feedback about which options are already selected?	O O O	
1.13	Is there visual feedback when objects are selected or moved?	O O O	
1.14	Is the current status of an icon clearly indicated?	O O O	
#	Review Checklist	Yes No N/A	Comments
1.15	Is there feedback when function keys are pressed?	O O O	
1.16	If there are observable delays (greater than fifteen seconds) in the system's response time, is the user kept informed of the system's progress?	O O O	
1.17	Are response times appropriate to the task?	O O O	
1.18	Typing, cursor motion, mouse selection: 50-1 50 milliseconds	O O O	
1.19	Simple, frequent tasks: less than 1 second	O O O	
1.20	Common tasks: 2-4 seconds	O O O	
1.21	Complex tasks: 8-12 seconds	O O O	

1.22	Are response times appropriate to the user's cognitive processing?	O O O	
1.23	Continuity of thinking is required and information must be remembered throughout several responses: less than two seconds.	O O O	
1.24	High levels of concentration aren't necessary and remembering information is not required: two to fifteen seconds.	O O O	
1.25	Is the menu-naming terminology consistent with the user's task domain?	O O O	
1.26	Does the system provide *visibility:* that is, by looking, can the user tell the state of the system and the alternatives for action?	O O O	
1.27	Do GUI menus make obvious which item has been selected?	O O O	
1.28	Do GUI menus make obvious whether deselection is possible?	O O O	
1.29	If users must navigate between multiple screens, does the system use context labels, menu maps, and place markers as navigational aids?	O O O	

2. Match Between System and the Real World

The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

#	Review Checklist	Yes No N/ A	Comments
2.1	Are icons concrete and familiar?	✓ O O	Tooltips would still be useful.
2.2	Are menu choices ordered in the most logical way, given the user, the item names, and the task variables?	✓ O O	Would need user testing.
2.3	If there is a natural sequence to menu choices, has it been used?	✓ O O	Would need user testing, but seems to tell a story.
2.4	Do related and interdependent fields appear on the same screen?	✓ O O	
2.5	If shape is used as a visual cue, does it match cultural conventions?	O O ✓	Shape not used as visual cue.
2.6	Do the selected colors correspond to common expectations about color codes?	✓ O O	Colours chosen using ColorBrewer and after consultation with some potential users.
2.7	When prompts imply a necessary action, are the words in the message consistent with that action?	✓ O O	eg. saving map, although this could be better written.
2.8	Do keystroke references in prompts match actual key names?	✓ O O	
2.9	On data entry screens, are tasks described in terminology familiar to users?	O ✓ O	Would need to be tested with users, but think not.
2.10	Are field-level prompts provided for data entry screens?	X	
2.11	For question and answer interfaces, are questions stated in clear, simple language?	O O ✓	
2.12	Do menu choices fit logically into categories that have readily understood meanings?	O ✓ O	Categories dubiously named eg. Analyse By.
2.13	Are menu titles parallel grammatically?	✓ O O	
2.14	Does the command language employ user jargon and avoid computer jargon?	O O ✓	
2.15	Are command names specific rather than general?	O O ✓	

2.16	Does the command language allow both full names and abbreviations?	O O ✓	
2.17	Are input data codes meaningful?	O O ✓	
2.18	Have uncommon letter sequences been avoided whenever possible?	O ✓ O	LSOA Codes for example.
2.19	Does the system automatically enter leading or trailing spaces to align decimal points?	O O ✓	
2.20	Does the system automatically enter a dollar sign and decimal for monetary entries?	O O ✓	

#	Review Checklist	Yes No N/A	Comments
2.21	Does the system automatically enter commas in numeric values greater than 9999?	O O ✓	
2.22	Do GUI menus offer activation: that is, make obvious how to say *"now do it"*?	✓ O O	Menus / list boxes all used correctly.
2.23	Has the system been designed so that keys with similar names do not perform opposite (and potentially dangerous) actions?	✓ O O	
2.24	Are function keys labeled clearly and distinctively, even if this means breaking consistency rules?	✓ O O	

3. User Control and Freedom

Users should be free to select and sequence tasks (when appropriate), rather than having the system do this for them. Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Users should make their own decisions (with clear information) regarding the costs of exiting current work. The system should support undo and redo.

#	Review Checklist	Yes No N/A	Comments
3.1	If setting up windows is a low-frequency task, is it particularly easy to remember?	O O O	
3.2	In systems that use overlapping windows, is it easy for users to rearrange windows on the screen?	O O O	
3.3	In systems that use overlapping windows, is it easy for users to switch between windows?	O O O	
3.4	When a user's task is complete, does the system wait for a signal from the user before processing?	O O O	
3.5	Can users type-ahead in a system with many nested menus?	O O O	
3.6	Are users prompted to confirm commands that have drastic, destructive consequences?	O O O	
3.7	Is there an "undo" function at the level of a single action, a data entry, and a complete group of actions?	O O O	
3.8	Can users cancel out of operations in progress?	O O O	
3.9	Are character edits allowed in commands?	O O O	
3.10	Can users reduce data entry time by copying and modifying existing data?	O O O	
3.11	Are character edits allowed in data entry fields?	O O O	

3.12	If menu lists are long (more than seven items), can users select an item either by moving the cursor or by typing a mnemonic code?	O O O	
3.13	If the system uses a pointing device, do users have the option of either clicking on menu items or using a keyboard shortcut?	O O O	
3.14	Are menus broad (many items on a menu) rather than deep (many menu levels)?	O O O	
3.15	If the system has multiple menu levels, is there a mechanism that allows users to go back to previous menus?	O O O	
#	**Review Checklist**	**Yes No N/A**	**Comments**
3.16	If users can go back to a previous menu, can they change their earlier menu choice?	O O O	
3.17	Can users move forward and backward between fields or dialog box options?	O O O	
3.18	If the system has multipage data entry screens, can users move backward and forward among all the pages in the set?	O O O	
3.19	If the system uses a question and answer interface, can users go back to previous questions or skip forward to later questions?	O O O	
3.20	Do function keys that can cause serious consequences have an undo feature?	O O O	
3.21	Can users easily reverse their actions?	O O O	
3.22	If the system allows users to reverse their actions, is there a retracing mechanism to allow for multiple undos?	O O O	
3.23	Can users set their own system, session, file, and screen defaults?	O O O	

4. Consistency and Standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

#	Review Checklist	Yes No N/A	Comments
4.1	Have industry or company formatting standards been followed consistently in all screens within a system?	O O O	
4.2	Has a heavy use of all uppercase letters on a screen been avoided?	O O O	Font is pleasant, if a bit small.
4.3	Do abbreviations not include punctuation?	O O O	Hospital trust abbreviations / names.
4.4	Are integers right-justified and real numbers decimal-aligned?	O O O	
4.5	Are icons labeled?	O O O	Export functions don't have tooltips (Excel / PDF)
4.6	Are there no more than twelve to twenty icon types?	O O O	
4.7	Are there salient visual cues to identify the active window?	O O O	
4.8	Does each window have a title?	O O O	
4.9	Are vertical and horizontal scrolling possible in each window?	O O O	Just vertical.
4.10	Does the menu structure match the task structure?	O O O	This would need user testing.
4.11	Have industry or company standards been established for menu design, and are they applied consistently on all menu screens in the system?	O O O	

4.12	Are menu choice lists presented vertically?	✓ Yes	dropdowns + list boxes all vertical.
4.13	If "exit" is a menu choice, does it always appear at the bottom of the list?	✓ N/A	
4.14	Are menu titles either centered or left-justified?	✓ Yes	
4.15	Are menu items left-justified, with the item number or mnemonic preceding the name?	✓ Yes	
4.16	Do embedded field-level prompts appear to the right of the field label?	✓ N/A	
4.17	Do on-line instructions appear in a consistent location across screens?	✓ Yes	
4.18	Are field labels and fields distinguished typographically?	✓ Yes	Across the modules it is consistent apart from
4.19	Are field labels consistent from one data entry screen to another?	✓ No	date entry differs. Age left-justified?
4.20	Are fields and labels left-justified for alpha lists and right-justified for numeric lists?	✓ No	

#	Review Checklist	Yes No N/A	Comments
4.21	Do field labels appear to the left of single fields and above list fields?	✓ Yes	Always above.
4.22	Are attention-getting techniques used with care?	✓ Yes	Bold, Italics, colour, show/hide filter.
4.23	Intensity: two levels only	✓ No	
4.24	Size: up to four sizes	✓ No	Think there are more.
4.25	Font: up to three	✓ Yes	Consistent here.
4.26	Blink: two to four hertz	✓ N/A	No blink
4.27	Color: up to four (additional colors for occasional use only)	✓ Yes	More on the maps.
4.28	Sound: soft tones for regular positive feedback, harsh for rare critical conditions	✓ No	No sounds.
4.29	Are attention-getting techniques used only for exceptional conditions or for time-dependent information?	✓ Yes	
4.30	Are there no more than four to seven colors, and are they far apart along the visible spectrum?	✓ Yes	Map colour schemes were designed with ColorBrewer.
4.31	Is a legend provided if color codes are numerous or not obvious in meaning?	✓ Yes	
4.32	Have pairings of high-chroma, spectrally extreme colors been avoided?	✓ Yes	
4.33	Are saturated blues avoided for text or other small, thin line symbols?	✓ Yes	Blue not saturated
4.34	Is the most important information placed at the beginning of the prompt?	✓ Yes	
4.35	Are user actions named consistently across all prompts in the system?	✓ Yes	eg. "Generate Report"
4.36	Are system objects named consistently across all prompts in the system?	✓ Yes	
4.37	Do field-level prompts provide more information than a restatement of the field name?	✓ N/A	
4.38	For question and answer interfaces, are the valid inputs for a question listed?	✓ N/A	

4.39	Are menu choice names consistent, both within each menu and across the system, in grammatical style and terminology?	✓ O O	
4.40	Does the structure of menu choice names match their corresponding menu titles?	✓ O O	I think so!
4.41	Are commands used the same way, and do they mean the same thing, in all parts of the system?	✓ O O	
4.42	Does the command language have a consistent, natural, and mnemonic syntax?	O O ✓	
4.43	Do abbreviations follow a simple primary rule and, if necessary, a simple secondary rule for abbreviations that otherwise would be duplicates?	✓ O O	
#	**Review Checklist**	**Yes No N/A**	**Comments**
4.44	Is the secondary rule used only when necessary?	O O ✓	
4.45	Are abbreviated words all the same length?	O ✓ O	
4.46	Is the structure of a data entry value consistent from screen to screen?	✓ O O	
4.47	Is the method for moving the cursor to the next or previous field consistent throughout the system?	✓ O O	
4.48	If the system has multipage data entry screens, do all pages have the same title?	O O ✓	
4.49	If the system has multipage data entry screens, does each page have a sequential page number?	O O ✓	
4.50	Does the system follow industry or company standards for function key assignments?	O O ✓	
4.51	Are high-value, high-chroma colors used to attract attention?	O ✓ O	Colour could be better used.

5. Help Users Recognize, Diagnose, and Recover From Errors

Error messages should be expressed in plain language (NO CODES).

#	Review Checklist	Yes No N/A	Comments
5.1	Is sound used to signal an error?	O O O	
5.2	Are prompts stated constructively, without overt or implied criticism of the user?	O O O	
5.3	Do prompts imply that the user is in control?	O O O	
5.4	Are prompts brief and unambiguous.	O O O	
5.5	Are error messages worded so that the system, not the user, takes the blame?	O O O	
5.6	If humorous error messages are used, are they appropriate and inoffensive to the user population?	O O O	
5.7	Are error messages grammatically correct?	O O O	
5.8	Do error messages avoid the use of exclamation points?	O O O	
5.9	Do error messages avoid the use of violent or hostile words?	O O O	
5.10	Do error messages avoid an anthropomorphic tone?	O O O	
5.11	Do all error messages in the system use consistent grammatical style, form, terminology, and abbreviations?	O O O	

5.12	Do messages place users in control of the system?	O O O	
5.13	Does the command language use normal action-object syntax?	O O O	
5.14	Does the command language avoid arbitrary, non-English use of punctuation, except for symbols that users already know?	O O O	
5.15	If an error is detected in a data entry field, does the system place the cursor in that field or highlight the error?	O O O	
5.16	Do error messages inform the user of the error's severity?	O O O	
5.17	Do error messages suggest the cause of the problem?	O O O	
5.18	Do error messages provide appropriate semantic information?	O O O	
5.19	Do error messages provide appropriate syntactic information?	O O O	
5.20	Do error messages indicate what action the user needs to take to correct the error?	O O O	
5.21	If the system supports both novice and expert users, are multiple levels of error-message detail available?	O O O	

6. Error Prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

#	Review Checklist	Yes No N/A	Comments
6.1	If the database includes groups of data, can users enter more than one group on a single screen?	O O O	
6.2	Have dots or underscores been used to indicate field length?	O O O	
6.3	Is the menu choice name on a higher-level menu used as the menu title of the lower-level menu?	O O O	
6.4	Are menu choices logical, distinctive, and mutually exclusive?	O O O	
6.5	Are data inputs case-blind whenever possible?	O O O	
6.6	If the system displays multiple windows, is navigation between windows simple and visible?	O O O	
6.7	Are the function keys that can cause the most serious consequences in hard-to-reach positions?	O O O	
6.8	Are the function keys that can cause the most serious consequences located far away from low-consequence and high-use keys?	O O O	
6.9	Has the use of qualifier keys been minimized?	O O O	
6.10	If the system uses qualifier keys, are they used consistently throughout the system?	O O O	
6.11	Does the system prevent users from making errors whenever possible?	O O O	
6.12	Does the system warn users if they are about to make a potentially serious error?	O O O	
6.13	Does the system intelligently interpret variations in user commands?	O O O	
6.14	Do data entry screens and dialog boxes indicate the number of character spaces available in a field?	O O O	

6.15	Do fields in data entry screens and dialog boxes contain default values when appropriate?	o o o	

7. Recognition Rather Than Recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

#	Review Checklist	Yes No N/A	Comments
7.1	For question and answer interfaces, are visual cues and white space used to distinguish questions, prompts, instructions, and user input?	o o ✓	
7.2	Does the data display start in the upper-left corner of the screen?	✓ o o	
7.3	Are multiword field labels placed horizontally (not stacked vertically)?	✓ o o	eg. Analyse By
7.4	Are all data a user needs on display at each step in a transaction sequence?	✓ o o	
7.5	Are prompts, cues, and messages placed where the eye is likely to be looking on the screen?	o ✓ o	Generate Report button not seen without scroll + "Save" Map.
7.6	Have prompts been formatted using white space, justification, and visual cues for easy scanning?	✓ o o	Almost too much white space!
7.7	Do text areas have "breathing space" around them?	✓ o o	
7.8	Is there an obvious visual distinction made between "choose one" menu and "choose many" menus?	o ✓ o	Ctrl/Shift multi-select method is used.
7.9	Have spatial relationships between soft function keys (on-screen cues) and keyboard function keys been preserved?	o o ✓	
7.10	Does the system gray out or delete labels of currently inactive soft function keys?	✓ o o	It updates menus automatically but user can makes erroneous selections.
7.11	Is white space used to create symmetry and lead the eye in the appropriate direction?	✓ o o	Too much!
7.12	Have items been grouped into logical zones, and have headings been used to distinguish between zones?	✓ o o	
7.13	Are zones no more than twelve to fourteen characters wide and six to seven lines high?	✓ ✓ o	Middle column too long.
7.14	Have zones been separated by spaces, lines, color, letters, bold titles, rules lines, or shaded areas?	✓ o o	Columns headed in bold type.
7.15	Are field labels close to fields, but separated by at least one space?	✓ o o	
7.16	Are long columnar fields broken up into groups of five, separated by a blank line?	o o ✓	
7.17	Are optional data entry fields clearly marked?	o ✓ o	Although show/hide been used for infrequently used selections.
7.18	Are symbols used to break long input strings into "chunks"?	o o ✓	
7.19	Is reverse video or color highlighting used to get the user's attention?	o ✓ o	
7.20	Is reverse video used to indicate that an item has been selected?	✓ o o	Blue.
7.21	Are size, boldface, underlining, color, shading, or typography used to show relative quantity or importance of different screen items?	✓ o o	
7.22	Are borders used to identify meaningful groups?	✓ o o	

7.23	Has the same color been used to group related elements?	✓ O O	
7.24	Is color coding consistent throughout the system?	✓ O O	
7.25	Is color used in conjunction with some other redundant cue?	✓ O O	
7.26	Is there good color and brightness contrast between image and background colors?	✓ O O	Esp. on the map.
7.27	Have light, bright, saturated colors been used to emphasize data and have darker, duller, and desaturated colors been used to de-emphasize data?	O ✓ O	
7.28	Is the first word of each menu choice the most important?	O ✓ O	Menus are alphabetised (mostly!)
7.29	Does the system provide *mapping:* that is, are the relationships between controls and actions apparent to the user?	✓ O O	
7.30	Are input data codes distinctive?	✓ O O	
7.31	Have frequently confused data pairs been eliminated whenever possible?	O ✓ O	Deprivation measure Deprivation domain.
7.32	Have large strings of numbers or letters been broken into chunks?	✓ O O	
7.33	Are inactive menu items grayed out or omitted?	✓ O O	Filtered automatically.
7.34	Are there menu selection defaults?	O ✓ O	Default not really appropriate.
7.35	If the system has many menu levels or complex menu levels, do users have access to an on-line spatial menu map?	O O ✓	
7.36	Do GUI menus offer affordance: that is, make obvious where selection is possible?	✓ O O	
7.37	Are there salient visual cues to identify the active window?	✓ O O	
7.38	Are function keys arranged in logical groups?	✓ O O	
7.39	Do data entry screens and dialog boxes indicate when fields are optional?	O ✓ O	
7.40	On data entry screens and dialog boxes, are dependent fields displayed only when necessary?	O O ✓	

8. Fexibility and Minimalist Design

Accelerators-unseen by the novice user-may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. Provide alternative means of access and operation for users who differ from the "average" user (e.g., physical or cognitive ability, culture, language, etc.)

#	Review Checklist	Yes No N/A	Comments
8.1	If the system supports both novice and expert users, are multiple levels of error message detail available?	O O O	
8.2	Does the system allow novices to use a keyword grammar and experts to use a positional grammar?	O O O	
8.3	Can users define their own synonyms for commands?	O O O	
8.4	Does the system allow novice users to enter the simplest, most common form of each command, and allow expert users to add parameters?	O O O	
8.5	Do expert users have the option of entering multiple commands in a single string?	O O O	
8.6	Does the system provide function keys for high-frequency commands?	O O O	

8.7	For data entry screens with many fields or in which source documents may be incomplete, can users save a partially filled screen?	○ ○ ○	
8.8	Does the system automatically enter leading zeros?	○ ○ ○	
8.9	If menu lists are short (seven items or fewer), can users select an item by moving the cursor?	○ ○ ○	
8.10	If the system uses a type-ahead strategy, do the menu items have mnemonic codes?	○ ○ ○	
8.11	If the system uses a pointing device, do users have the option of either clicking on fields or using a keyboard shortcut?	○ ○ ○	
8.12	Does the system offer "find next" and "find previous" shortcuts for database searches?	○ ○ ○	
8.13	On data entry screens, do users have the option of either clicking directly on a field or using a keyboard shortcut?	○ ○ ○	
8.14	On menus, do users have the option of either clicking directly on a menu item or using a keyboard shortcut?	○ ○ ○	
8.15	In dialog boxes, do users have the option of either clicking directly on a dialog box option or using a keyboard shortcut?	○ ○ ○	
8.16	Can expert users bypass nested dialog boxes with either type-ahead, user-defined macros, or keyboard shortcuts?	○ ○ ○	

9. Aesthetic and Minimalist Design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

#	Review Checklist	Yes No N/A	Comments
9.1	Is only (and all) information essential to decision making displayed on the screen?	○ ✓ ○	Filters used but when opened there is too much info on the screen.
9.2	Are all icons in a set visually and conceptually distinct?	✓ ○ ○	Although could be bigger.
9.3	Have large objects, bold lines, and simple areas been used to distinguish icons?	✓ ○ ○	
9.4	Does each icon stand out from its background?	✓ ○ ○	
9.5	If the system uses a standard GUI interface where menu sequence has already been specified, do menus adhere to the specification whenever possible?	✓ ○ ○	
9.6	Are meaningful groups of items separated by white space?	✓ ○ ○	
9.7	Does each data entry screen have a short, simple, clear, distinctive title?	✓ ○ ○	
9.8	Are field labels brief, familiar, and descriptive?	✓ ○ ○	
9.9	Are prompts expressed in the affirmative, and do they use the active voice?	✓ ○ ○	eg. "Generate Report"
9.10	Is each lower-level menu choice associated with only one higher level menu?	✓ ○ ○	Although dataset filters get complicated.
9.11	Are menu titles brief, yet long enough to communicate?	○ ✓ ○	
9.12	Are there pop-up or pull-down menus within data entry fields that have many, but well-defined, entry options?	○ ✓ ○	There is a lot of jargon that could be unfamiliar to users + some menus are really long.

10. Help and Documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

#	Review Checklist	Yes No N/A	Comments
10.1	If users are working from hard copy, are the parts of the hard copy that go on-line marked?	O O O	
10.2	Are on-line instructions visually distinct?	O O O	
10.3	Do the instructions follow the sequence of user actions?	O O O	
10.4	If menu choices are ambiguous, does the system provide additional explanatory information when an item is selected?	O O O	
10.5	Are data entry screens and dialog boxes supported by navigation and completion instructions?	O O O	
10.6	If menu items are ambiguous, does the system provide additional explanatory information when an item is selected?	O O O	
10.7	Are there memory aids for commands, either through on-line quick reference or prompting?	O O O	
10.8	Is the help function visible; for example, a key labeled HELP or a special menu?	O O O	
10.9	Is the help system interface (navigation, presentation, and conversation) consistent with the navigation, presentation, and conversation interfaces of the application it supports?	O O O	
10.10	Navigation: Is information easy to find?	O O O	
10.11	Presentation: Is the visual layout well designed?	O O O	
10.12	Conversation: Is the information accurate, complete, and understandable?	O O O	

#	Review Checklist	Yes No N/A	Comments
10.13	Is the information relevant?	O O O	
10.14	Goal-oriented (What can I do with this program?)	O O O	
10.15	Descriptive (What is this thing for?)	O O O	
10.16	Procedural (How do I do this task?)	O O O	
10.17	Interpretive (Why did that happen?)	O O O	
10.18	Navigational (Where am I?)	O O O	
10.19	Is there context-sensitive help?	O O O	
10.20	Can the user change the level of detail available?	O O O	
10.21	Can users easily switch between help and their work?	O O O	
10.22	Is it easy to access and return from the help system?	O O O	
10.23	Can users resume work where they left off after accessing help?	O O O	

11. Skills

The system should support, extend, supplement, or enhance the user's skills, background knowledge, and expertise ----not replace them.

#	Review Checklist	Yes No N/A	Comments
11.1	Can users choose between iconic and text display of information?	o ✓ o	Although maps can be labelled.
11.2	Are window operations easy to learn and use?	o o ✓	User testing required.
11.3	If users are experts, usage is frequent, or the system has a slow response time, are there fewer screens (more information per screen)?	✓ o o	Screens have been kept to minimum. Although many modules for novices.
11.4	If users are novices, usage is infrequent, or the system has a fast response time, are there more screens (less information per screen)?	o ✓ o	Same screen for both.
11.5	Does the system automatically color-code items, with little or no user effort?	✓ o o	eg. SARS data.
11.6	If the system supports both novice and expert users, are multiple levels of detail available.	o ✓ o	No novice/ advance switches.
11.7	Are users the initiators of actions rather than the responders?	✓ o o	
11.8	Does the system perform data translations for users?	✓ o o	SARS, pop. dens.
11.9	Do field values avoid mixing alpha and numeric characters whenever possible?	o ✓ o	OA/LSOA codes.
11.10	If the system has deep (multilevel) menus, do users have the option of typing ahead?	✓ o o	
11.12	When the user enters a screen or dialog box, is the cursor already positioned in the field users are most likely to need?	o ✓ o	No typing required. users can tab through interface but it tabs through everything, not just menus.
11.13	Can users move forward and backward within a field?	o ✓ o	
11.14	Is the method for moving the cursor to the next or previous field both simple and visible?	✓ o o	
11.15	Has auto-tabbing been avoided except when fields have fixed lengths or users are experienced?	✓ o o	
11.16	Do the selected input device(s) match user capabilities?	✓ o o	
11.17	Are cursor keys arranged in either an inverted T (best for experts) or a cross configuration (best for novices)?	o o ✓	
11.18	Are important keys (for example, ENTER , TAB) larger than other keys?	o o ✓	
11.19	Are there enough function keys to support functionality, but not so many that scanning and finding are difficult?	✓ o o	
11.20	Are function keys reserved for generic, high-frequency, important functions?	✓ o o	
11.21	Are function key assignments consistent across screens, subsystems, and related products?	✓ o o	
11.22	Does the system correctly anticipate and prompt for the user's probable next activity?	o ✓ o	

12. Pleasurable and Respectful Interaction with the User

The user's interactions with the system should enhance the quality of her or his work-life. The user should be treated with respect. The design should be aesthetically pleasing- with artistic as well as functional value.

#	Review Checklist	Yes No N/A	Comments
12.1	Is each individual icon a harmonious member of a family of icons?	o o o	

12.2	Has excessive detail in icon design been avoided?	O O O	
12.3	Has color been used with discretion?	O O O	
12.4	Has the amount of required window housekeeping been kept to a minimum?	O O O	
12.5	If users are working from hard copy, does the screen layout match the paper form?	O O O	
12.6	Has color been used specifically to draw attention, communicate organization, indicate status changes, and establish relationships?	O O O	
12.7	Can users turn off automatic color coding if necessary?	O O O	
12.8	Are typing requirements minimal for question and answer interfaces?	O O O	
12.9	Do the selected input device(s) match environmental constraints?	O O O	
12.13	If the system uses multiple input devices, has hand and eye movement between input devices been minimized?	O O O	
12.14	If the system supports graphical tasks, has an alternative pointing device been provided?	O O O	
12.15	Is the numeric keypad located to the right of the alpha key area?	O O O	
12.16	Are the most frequently used function keys in the most accessible positions?	O O O	
12.17	Does the system complete unambiguous partial input on a data entry field?	O O O	

13. Privacy

The system should help the user to protect personal or private information- belonging to the user or the his/her clients.

#	Review Checklist	Yes No N/ A	Comments
13.1	Are protected areas completely inaccessible?	O O O	
13.2	Can protected or confidential areas be accessed with certain passwords.	O O O	
13.3	Is this feature effective and successful.	O O O	

System Title: Population Health Manager Release #: 4.0

Evaluator: Jess Wardlow Date: 25.2.10

Primary Source

Making Computers-People Literate. © Copyright 1993. By Elaine Weiss ISBN: 0-471-01877-5

Secondary Source

Usability Inspection Methods. © Copyright 1994.By Jakob Nielsen and Robert Mack ISBN: 1-55542-622-0

This article is part of the Usability Toolkit.

Download the Word file: he_chklst.doc

C3. Cognitive Walkthrough of Public Health Analyser

Task	Will the user try to achieve the right effect?	Will the user notice that the correct action is available?	Will the user associate the correct action with the effect he or she is trying to achieve?	If the correct action is performed, will the user see that progress is being made toward solution of the task?	What does PHA provide beyond the standard method by which would carry out this task?
Logging in	Yes, very clear. Users will have experience of using online applications.	Yes, the user name and password text boxes are very clear. They see the "Log In" button as well.	Yes, the button is labelled "Log In" and connects the action to what users are trying to do.	Yes, if they look at the status bar of the browser window. Users will recognise a connection between the system response and what they were trying to do.	Users wouldn't ordinarily have to log in, although PHA is online so it adds a level of security.
Selecting PHA	There is a long list of the tools available on the left hand side, but really they could be clearer links. They will trying clicking on PHA since it is part of their original task.	The font on the tools list is too small and users might start reading the text under the header "Welcome to iHealth data analysis tools." Users will know the option to open PHA is available though when they see the link.	I think so but the PHA text would be recognised as a link more if it was underlined. Although when the cursor is over it then it becomes underlined; it provides a link on the interface connecting the action to what they are trying to do and every other option looks wrong.	In the status bar of the browser window again. They recognise a connection between the system response and what they were trying to do.	This step is added because the PCT may be signed up for another of the toolset offered by iHealth (who designed PHA)
Selecting Wiltshire PCT	Probably but it is distracting having the PHA navigation appear on the left hand side; it should not be there or greyed out. The system tells them to select a PCT.	Yes, it's an empty window apart from the PCT Select box. It is a representation of the action they are trying to do.	Yes, this action is very clear and unambiguous - button is labelled "Select". The user can change the PCT in case they have made the wrong choice. The interface provides a prompt that connects the action to what they are trying to do.	Yes, in the status bar. They recognise a connection between the system response and what they were trying to do.	This saves them from doing the spatial query later on when finding the data and making the map. I consider this a good thing. Presumably real users only access their data so perhaps this step is not necessary?

Task	Will the user try to achieve the right effect?	Will the user notice that the correct action is available?	Will the user associate the correct action with the effect he or she is trying to achieve?	If the correct action is performed, will the user see that progress is being made toward solution of the task?	What does PHA provide beyond the standard method by which would carry out this task?
Clicking on Health Needs	As a user I would probably expect to see the criteria selection as soon as I log in. Would users know to look under "Health Needs" for mortality data? They would need experience of the system to do this or training.	There is a very obvious navigation structure on the left hand side. Users may not know how this works though, since the individual modules are hidden. There is, however, a down arrow next to each group, inviting the user to click on it to see more options.	Mortality data could be in any number of modules. It is possible that the user will look in Understanding Trends erroneously unless they have experience of the system.	Yes, in the status bar. There is also a loading icon that appears after a certain length of time. Users will recognise a connection between the system response and what they were trying to do.	This is a superfluous click. Why are they not able to do all queries from the one interface? A standard interface should be offered. Too many clicks will annoy users and adds to the time taken to complete the task.
Going to Dataset Quick-view	User may not know to look under "Dataset quick-view" for mortality data. They would need experience of the system in order to complete this, which they gain through training.	There is a very obvious navigation structure on the left hand side. The links to the individual modules are fairly clear, inviting the user to click on them to do a particular kind of analysis.	Mortality data could be in any number of modules. It is possible that the user will look in Historical Trends erroneously unless they have experience of the system. Especially since Dataset Quick-view is under "Advanced query".	Yes, in the status bar. There is also a loading icon that appears after a certain length of time. Users will recognise a connection between the system response and what they were trying to do.	This is another additional click for the user that they wouldn't normally have to carry out.
Selecting Category: Deaths	The user may not know that Deaths comes under the Category dropdown list, but since it is in the top left hand corner of the form, they are likely to look there first and find it. The system is helping them there.	The user may not know immediately that mortality data is available under the Category dropdown list. (They will know it is a dropdown list because there is an arrow next to "Hospital Activity".) When the user clicks on this dropdown list they will see "Deaths" and be confident in their selection.	Yes the user will be confident that this is the correct option because the label is very clear and is directly linked to the task they are trying to achieve.	They will be confident that the selection has been made because they will see all the other menus and filters update accordingly. An alert says, "Your filters are being updated." The Deaths option will appear in the space underneath Categories.	Bearing in mind the PHAs would normally be given data by their information team, it would maybe be better to have a keyword search perhaps. Not immediately obvious where to look.

Task	Will the user try to achieve the right effect?	Will the user notice that the correct action is available?	Will the user associate the correct action with the effect he or she is trying to achieve?	If the correct action is performed, will the user see that progress is being made toward solution of the task?	What does PHA provide beyond the standard method by which would carry out this task?
Selecting Outcome: Directly Standardised Mortality Rates	The user can see in the Outcomes list box that they can look at Directly Standardised Mortality Rate and this is part of their original task.	They will see the menu option for Directly Standardised Mortality Rates, which is linked to their original task.	Users may take a look at the Data Sets drop down list first but will see that all other options are wrong. They may also be interested to see what other "Outcomes" they can look at apart from DSMR, but will choose this as the most appropriate for their task.	They will be confident that the selection has been made because all the other menus/filters update. Message says, "Your filters are being updated." DSR option will be highlighted in blue to show that this is the one selected.	PHAs would normally have the data handed to them directly. However, all the options for mortality measures available are presented, providing an easy way to view the different measures and compare them.
Selecting Demographics filter	The filter for selecting age is well hidden underneath a filter. They will try to look for it though since it is part of their original task.	They won't see that the action is available immediately. They will see the word "Demographics" which appears to be a link but they could be unsure since there is no down arrow inviting them to see more information until the cursor is over the link.	Demographics is a link connecting the action to what they are trying to do. However, above Demographics is a link for "Dataset Filters" and users could be expecting to see it there. It is ambiguous. Also	Yes, the user will be confident that their selection has been made because "Female" will appear in the box under Sex. I feel that these filters take some time for the user to understand though.	This stage is confusing for the user. When they see the filters they may not know what data they get if they don't change the default settings. Adds a level of ambiguity compared to usual.
Selecting ages under 75	Yes the user will try to produce the right effect because it is part of their original task.	Yes the user will notice that the correct option is available because there is a list box with the iHealth (20) age groups. iHealth (20) will probably not mean anything to users without explanation.	The interface connects a label to the action they are trying to achieve. The Shift mechanism for selecting multiple age groups could cause difficulty, with a small list box and scroll bar.	Yes because the selected age groups become blue and those that aren't selected stay white.	A very strange method for selecting age groups, which the user wouldn't normally be faced with. PHA presents a list of many small age groups.
Select View From: 2003	The user is very likely to move onto the second column next as this is where their eyes will look next. The system does not tell them to do this but it assists them to do it.	Yes the menu option for changing the year is very clear. The more advanced filters have been helpfully hidden away so as not to distract from the common user task of changing the years they are analysing.	The system provides the necessary labels to connect this action to what the user is trying to do. "View from" and "View to."	2003 is unavailable and this will confuse users without explanation. I doubt that they will look at the Help section. They will choose 2001, which appears in the space for "View From:".	Why would they use PHA if it doesn't allow them to select the year they want? They would go to their Information team instead.

Task	Will the user try to achieve the right effect?	Will the user notice that the correct action is available?	Will the user associate the correct action with the effect he or she is trying to achieve?	If the correct action is performed, will the user see that progress is being made toward solution of the task?	What does PHA provide beyond the standard method by which would carry out this task?
Select Analyse By: Lower Super Output Area (LSOA)	Users may miss the "Analyse By" column because there is so much white space underneath it and their eyes will be looking near the "Generate Report" button at this point. However, since it is part of their original task they might be hunting for this option and find it.	The label "Analyse By" is quite ambiguous and does not immediately suggest that this is the dropdown menu to select the geographical units for the map. User testing could find more suitable terminology, otherwise only experienced users may understand what "Analyse By" does.	Users may also click on the "Analyse By" dropdown menu because all the other options look wrong, and at the moment the user can't see any option to create a map. They will also soon learn this through experience of the system.	They will be confident that the selection has been made because they will see all the other menus and filters update accordingly. There is a message to say, "Your filters are being updated." The LSOA option will also appear on the form underneath Analyse By so that the user knows it has been selected.	This is the sixth choice the user has to make in order to get their data. It wouldn't normally be this laborious.
Click on "Generate Report"	Users will click this since this is what the system suggests is the next step, and all the selections have been made. For this simple task a user may get distracted by the list box for all the LSOAs. Do users ever need to look at one specific LSOA?	They will know the action is available because there is a button on the interface at the bottom right hand corner of the criteria selection box.	The label connects the action to what they are trying to do, although "Generate Report" may not be the most appropriate label. "Return data" or "Run query" are alternatives.	Yes the loading icon tells them that they have clicked the button and the query is running.	This is equivalent to the Execute function in SQL so is fine – it's what the user would be used to.
Click on Map	This is part of the original task so they will be looking for a way of converting the table to a map. The user may be investigating the table and the first two columns of the table won't mean anything to the user.	The user will see the map link at the top right hand corner of the table, which represents the action they are trying to achieve.	The label is sufficiently clear for the user to be confident that by clicking the link they will be creating a map.	The Map link only becomes blue once it has loaded. While it is loading it is grey and has the loading icon so you cannot click on it. I like that the user cannot interrupt the creation of the map if this will break the system.	Usually PHAs would have to import data to MapInfo and they would have to worry about the interoperability of files. In this sense this button is actually saving them time, by giving them a direct to map their data.

Task	Will the user try to achieve the right effect?	Will the user notice that the correct action is available?	Will the user associate the correct action with the effect he or she is trying to achieve?	If the correct action is performed, will the user see that progress is being made toward solution of the task?	What does PHA provide beyond the standard method by which would carry out this task?
Zoom in to Wootton Bassett & Cricklade	Although not part of the user's original task, PHAs will be familiar with mapping applications and expect there to be a zoom and pan function through experience. The map is a good size but does not change according to the size of the screen. I suggest this would be an improvement.	As users of more sophisticated GIS systems, PHAs may expect a zoom function similar to that in desktop GIS. The double click zoom is now common in WebGIS though so users will double click west of Swindon (which is clearly labelled). This does not centre the map on where the user has clicked and they then need to "pan" the map to the correct location. The pan function is continuous as in standard WebGIS.	Again, they will choose the correct action through experience of other WebGIS, although could get frustrated that there isn't a quicker box zoom function that they can use. The user may also like to select rows in the table to highlight on the map and at the moment this is not possible e.g. Ben could not select the three areas with the highest AAACM for under 75s.	The map's response time is very good and the "Please Wait" sign tells users something is happening. However, users must zoom in quite far to see the place names they would expect (Wootton Bassett and Cricklade) to appear. They may want to highlight these places on the map and this option isn't available on the Edit Options dropdown window.	This is equivalent to "Export Map" in MapInfo so is a step they would have to carry out anyway.
Save the image	This is part of their original task so they will be looking for a way to save the map.	The icon for saving the map is in the top left hand corner of the PHA window, however because it has a text label rather than an icon, users may not notice it there. In MS Office applications the save icon is a disk, but this is not there. Instead, users may notice the PDF icon and click on that, which saves the whole report to PDF and not just the map.	I think the PDF icon connects the action to what they are trying to do so they will be confident that it will save the map to PDF. However, what they will not expect on their PDF is the table and chart as well. There is no easy way for a PHA to put this map into the report. They will also notice the query summary on the PDF which is not suitable as a title for their map and is formatted somewhat confusingly.	The status bar gives them the indication that something is happening. A prompt appears (which is not very clear - see Figure 3) which invites the user to open or save the file as PNG. In Internet Explorer 6 the map would not open Many PHA users are restricted to use by the NHS so cannot upgrade or download another browser).	Equivalent to "Export Map" in MapInfo.

C4. Usability Problems with Public Health Analyser Identified by Heuristic Evaluation

Usability problem	Severity	Suggestion for redesign
User gets a limited choice of years.	4	Explain why or let them choose.
"Ward" labels shown for LSOA on Edit Options panel and labels do not work.	3	Remove that option for anything other than wards. LSOA/OA codes are meaningless to users.
Inconsistency between the labelling of "Intervals" and "Ranges" on the Edit option tabs.	3	Will need user testing, but these should at least use the same terminology.
Query summary is not formatted very helpfully and cannot be used as a map title.	3	Create more useful map titles and a more meaningful query summary.
Some of the terminology is very specific to the domain and could be difficult for unfamiliar users to understand.	3	The terminology throughout PHA (labels, buttons and menus) needs user testing to be sure users understand it.
Hospital trust names are abbreviated on the charts. Users are then forced to remember their name.	3	Hospital "sites" (not trusts) may be more useful to users. Hospital trusts should have their full name.
Although filters on the interface update, there are places where the user can still make errors. For example, the timescale of the data can be selected such that the finish date is earlier than the start date.	3	Make it impossible for the user to select a start date that occurs after the finish date. This can be done by greying out or removing those dates.
Icons for exporting tables to PDF and Excel do not have tool tips to give the user an indication of what they do.	2	Tool tips help the user to understand what each tool tip does
There is no indication on the interface of which fields are optional.	2	Drawing users' attention to compulsory fields can speed up the query process for the user.
Users are unable to save selections until the report has been generated.	2	Some of the forms are very long so users would be helped if they could save selections to come back to.
Users can type ahead to get through long lists within list boxes, but functionality has not been applied consistently.	2	Type ahead should work consistently across the application.
Users may be expecting more flexibility over the colour scheme (only blue, red or green available). The colour schemes could also be previews rather than names of colours.	1	User testing would determine solution. It depends on whether the users are expecting the PHA map to behave like MapInfo.
Date filters are not consistent through PHA. In one place the user can select by month and in another place year.	1	Consistency through the tool is better for the user.

Usability problem	Severity	Suggestion for redesign
More colour could be used on the interface to grab users' attention to certain elements. The interface looks professional but uninspiring.	1	Colours can be used to help guide users' attention to particular buttons or menu items.
Too much white space in Analyse by column.	1	Redesign the layout to prevent this.
The "Generate Report" button and the "Map", "Chart" and Table" links are too discreet.	1	These are key user actions so the text could be bigger and in colour.

C5. Usability Problems with Public Health Analyser Identified by Cognitive Walkthrough

Usability problem	Severity	Suggestion for redesign
Individual modules are hidden, forcing the user to make more clicks than necessary. The definition of each module is not clear to begin with.	3	Make the first page users see a criteria selection form, so that they are not forced to think about which module they need. This will help them get started with the system.
It is very difficult in general for the user to find the data they are looking for.	3	Perhaps a keyword search of data would be a quicker way for users to access the data they are looking for.
The users may not understand what the Analyse By column does.	3	Work with users to find more suitable labels for dropdown menus. Remove white space from final column.
The Dataset quick-view module is found under "Advanced Query", however this is the module for all basic data queries.	2	Make "Dataset quick-view" the first page that viewers see when they log into PHA.
Users may not know that Deaths is on the Category dropdown list.	2	Categories could be radio buttons so that users are able to see all possible options from the beginning.
The list box and scroll bar for the age groups are very small and the Shift/Ctrl Shift paradigms for selecting is not easy for users.	2	Allow the user to enter the ages they want to view via text input, without being restricted to age groups.
A zoom function similar to desktop GIS may be expected by Public Health Analysts for more efficient zooming.	2	Have a set of basic functions but then another set for more advanced users, perhaps.
The double click zoom function does not centre the map so the user is forced to zoom and then pan every time.	2	The zoom must centre on where the user has clicked for this zoom paradigm to be an alternative to the box zoom.
The "Save Map" button is in the wrong position and could be missed. Also, opening the map does not work in IE6, only saving the map to a file, which could frustrate users.	2	Develop this functionality.

Usability problem	Severity	Suggestion for redesign
The link to PHA is small and does not look like a link.	1	Increase the font size and underline the text to make it look like a link.
Users can click on the PHA navigation before selecting which PCT to analyse.	1	The PHA navigation should not appear until users have selected PCT.
The "Dataset filter" and "Demographics" filter do not have down arrows until the cursor is over them.	1	Double down arrow is the convention when there is more information to be show on the interface.
The label for "Generate Report" could be better worded.	1	Users could create more suitable labels for buttons such as this.
The map is too large for the size of screen that most users have: 1024 x 768 pixels.	1	The map size should change size according to the size of the screen.
In this study's scenario the desired labels for towns and villages did not show until the scale was too large for the study area.	1	Have separate scales for the display of villages in rural areas and urban areas e.g. London.
The "Save Map" prompt) is not as clear as it could be.	1	"Do you want to open or save this map?" Name: PHMmap. Type: PNG.

D Job Descriptions

D1. Lead Designer

Job summary

"Managing a team of solution designers, the Lead Designer will work closely with Product Managers & Business Analysts, and take responsibility for the functional design of products, the effective representation of statistical data and the end to end user experience. Core to this is the ability to model users, effectively prototype design options using modern techniques and tools, and conduct appropriate usability testing. An ability to innovate and excellent written & verbal communication are key aspects of this job."

Key duties and main responsibilities

1. Managing and directing a team of designers
2. Leading on usability engineering including usability testing
3. Bringing innovative thought to functional designs and solutions
4. Creation of prototypes to further clarify and support product requirements
5. Documentation of functional designs
6. Written & verbal comms of functional designs to internal & external customers
7. Working with the Application Development team to support the implementation of designs
8. Acting as end to end design authority for products, and providing expertise where required

Essential:	Desired:
• Computing or design degree	• Data analysis or statistical experience
• Experience of leading small teams	• Experience of a wide variety of prototyping tools such as Axure
• Experience of applying usability engineering principles in the design of customer applications	• Experience of RIA tools such as flex
• Experience of prototyping and prototyping toolsets	• Photoshop
• Experience of working in a rapid application development environment	
• Experience of working with and visualising data	
• Excellent written and verbal communication	
• Self-driven	
• Highly innovative	

Key Internal and External Relationships

Internal include:

- Product Managers – a key internal relationship, representing customer requirements
- Application Development Manager
- Quality Assurance Manager
- Business Analysts (for requirements engineering)
- Project Managers
- Customer Service Managers (who support the end customers)

External include:

- End customers including health analysts, clinicians and managers

D2. Design Manager

Job summary

"Managing a multi-skilled team, the Design Manager will take responsibility for the planning and delivery of architecture, requirements engineering, prototyping & functional design, research and analytical/statistical solutions. The Design Manager works closely with Product & Project Managers during the Discovery phase of new product development. Core to this is the ability to effectively plan, monitor and continually balance resource allocation. The ability to innovate & motivate is key to this role."

Key Duties and Responsibilities

1. Managing the Architecture, Design, Business Analysis and Statistician functions
2. Planning, monitoring and reporting on the work of the Design function
3. Process owner for Design & Discovery processes
4. Defining architecture and leading on selection of suitable technologies
5. The creation of product requirements, prototypes and functional designs

6. The delivery of statistical analysis and algorithms for use in data/tools
7. Proving research & investigation in to new concepts and components
8. Recruitment/management of business analysts, designers, architecture and statistician staff
9. Creation of centres of excellence as well as resilience in technical skills

Essential:

- Computing degree
- Managing medium-sized teams (min. 3 years)
- Strong motivation & coaching skills
- Strong personal development skills
- Strong personal drive and focus
- Innovative
- Experience of working in a rapid application development environment
- Strong platform & application architecture skills
- Strong data analysis skills
- Experience in developing functional design and prototypes
- Excellent written & verbal communication
- Good knowledge of MS SQL 2005/2008; SSIS; ASP.NET 2.0/3.5; C#; MS TSQL; SQL; Ajax

Desired:

- Requirements engineering experience
- Product research experience
- Project Management experience
- Usability engineering and testing experience

Key Internal and External Relationships

The Design Manager is responsible for managing:

- Senior Architect –, responsible for the end to end technical architecture
- Lead Designer – responsible for the functional design of products, the effective representation of statistical data and the end to end user experience
- Statistician – working to the Design Manager, responsible for statistical analysis, risk modelling and computational algorithms
- Business Analysts – working to the Design Manager, responsible for requirements engineering

Internal include:

- Product Managers – representing customer requirements
- Application Development Manager – responsible for software development & release management
- Project Managers – end to end
- Quality Assurance Manager – responsible for end to end quality and testing
- Customer Service Managers – 1st line end customer support
- Head of Production Systems / Operations – 2nd line in-life support

External include:

- End customers including health analysts, clinicians and managers
- 3rd party Vendors
- 3rd party Contractors

D3. User Experience Designer

Job summary

This new role offers the opportunity for a User Experience Designer, working with our Senior UX Designer, to establish the principles and processes of excellent user experience to all aspects of proposition development at the UKs market leading provider of health informatics. The successful candidate will be responsible for developing and driving a coherent vision for outstanding user experience across all new product lines.

Reporting to the Head of Propositions the role holder will work closely with the product management, sales and marketing, and product development teams in the design and development of the next generation of health informatics products. This role will champion user needs at all stages of the product lifecycle, specifically focusing on the delivery of innovative new product lines for both Acute Hospital Trusts and NHS Commissioners.

The User Experience Designer's goal will be to help ensure the growth of new business through the design of a new generation of products, conceived to promote increased usage and acceptance by clinicians and other NHS professionals. The successful candidate will support the Senior UX Designer in existing programmes of work, will work closely with UI and BA designers within the development team and will also have the opportunity to lead projects in developing the UX function across the business.

Key duties and main responsibilities

- Design new products and applications, using cutting-edge BI solutions based on product concepts and market requirements identified within the propositions team
- Innovate the delivery of health informatics to our NHS customers to promote increased usage of (new) iHealth products by clinicians and managers.
- Work closely with commercial, data and market-focused specialists within the Propositions team to deliver compelling, innovative products
- Develop and drive long-term UX strategy into all aspects of new proposition development
- Participate in vetting product roadmaps for customer relevance and impact
- Collaborate and lead Business Analysts within the development team to deliver best-of-breed health informatics products through wireframes, prototypes, etc.
- Catalyse a culture of innovative delivery, centred around the customer need
- Be active in full product lifecycle, from early requirement definition, to UX and UI design, to on-going monitoring and evaluation of customer satisfaction and effectiveness
- Champion users' needs and make recommendations for improving the user experience
- Lead the adoption of new business intelligence technologies for enhanced user experience

Essential:	*Desired:*
• Computing, design, statistics, or health focused degree (or relevant equivalent) degree	• *Experience working with clinicians and health professionals*
• At least 3 years relevant experience in UI/UX design	• *Experience of NHS/public sector management information tools*
• Experience of designing visualisation	• *Passion to design products and services that*

tools for complex data

- Expert UX skills & knowledge (Information Architecture/User Research/User-Centred Design)
- Strong customer focus and a passion for User Experience
- Keen interest in current/future developments in business intelligence innovations
- Confident persuasive communicator – experience working with stakeholders
- In-depth knowledge of UX/UI & design best practices and industry standards
- In-depth knowledge of user/customer-centred design and development approaches
- Strong commercial awareness
- Team player/collaborative outlook
- Excellent written and verbal communication

positively impact health and well-being

- *Experience of working in a rapid application development environment*
- *Self-driven with ability to work independently*

Key internal relationships:

- Propositions & Business Development
- Innovations & Product Development
- Product Management team
- Marketing

Key **external relationships**

- End-user / customer groups – e.g. GPs, Consultants, NHS Managers, Analysts
- Knowledge of competitor offers

E Persona Development

E1. Database Server Usage Log Analysis

Role	**Total**
Chief Exec	14
Clinician	1219
Finance Manager/Analyst	195
Financial Director	19
GP	66
GP Practice Manager	193
Information Manager/Analyst	1451
Public Health	111
Support / Nurse	71
Unknown / Other	2146
Medical Director	66
TOTAL	5551

Tool name	Total Queries	Distinct Users	Total User Days
Real Time Monitoring	294854	3256	22437
High-impact User Manager	24324	322	731
Performance Monitor	16151	338	1538
Unit Peer Finder	3595	1024	1473
Hospital Marketing Manager	218735	1716	8868
Clinician Outcomes Benchmarking	10973	884	2356
Practice and Provider Monitor	318726	2958	25844
Population Care Manager	28	7	9
Mental Health Activity Tracker v2	2547	16	105
US HSMR Monitoring	5761	67	659
Pfizer - HIT	15505	151	1437
Public Health Analyser v4.0	11708	161	1080
Data Effectiveness and Efficiency Dashboard 2.0	3068	633	1032
Healthcare Market Intelligence	12403	22	399
IMS Regional Healthcare Analysis	5219	40	380
TOTAL	943597	11595	68348

E2. Personas

RTM

Ian
Head of Performance and Information

Personal Information
- Ian is Director of Performance and Information at a Foundation Trust.
- He didn't attend university. He got a student job in the Information department of the local hospital. Whilst he was there a post came up on the team and he's worked his way up from there.

Attitudes
- He would prefer the data to be more current, but likes diving into the tools .
- He can spend a lot of time on the tools.
- If he is up against a tight deadline he is happy to get his own data because of his experience as an Information Analyst.

Behaviour patterns
- He uses DFI tools more than his two colleagues, who are the only other users at the trust, including the Medical Director.
- Ian describes himself as a "data geek" and sometimes logs on at home in the evening with a glass of wine because the system can be slow on the hospital's network.
- He has access to RTM and PPM. He only accesses the system when he has a question to ask.
- He reports on mortality (HSMR comparison) and day case rates from RTM once a month but for everything else uses PPM.

Environment
- He works in a private office.
- He participates in many meetings because of his operational experience.

Skills
- If the data he needs is on local drives he tends to delegate the work to colleagues who use Microsoft Access to extract it.
- He uses a capacity planning tool to find out how many beds are needed, based on the previous year's activity, waiting lists, and estimates of activity levels required to meet 18-month waiting-time targets.
- He has a good sense of whether the data feels right or not and starts with a coding check in RTM so that he knows he's reporting on the latest fully coded month.

Goals
- He benchmarks against trusts of similar size
- He has to write a standard HSMR report, for which he has a Microsoft Excel template where he copies in the data.
- Ian is trying to get others in the trust to use it and has set up favourites with help from the Customer Service Representative, which the Information team can access.

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RTM

Colin
Clinical Director in Medicine

Personal Information
- Colin is Clinical Director in Medicine. He completed his medical training 18 years ago, and has been working in secondary care since.
- As a Consultant Physician he spends 70% of his time doing clinical work (including three ward rounds and three clinics a week) and spends 30% on management.
- For his managerial work he can access the in-house data at the hospital, relating to outcomes. He visits the hospital's bereavement office to get the notes for the deaths each week. From that he writes a report which he emails out to 400 to 500 people in the trust.

Attitudes
- He likes both his clinical and managerial work and finds them both rewarding in their own way.
- He generally finds he has access to more data than he can actually do something with

Goals
- He's interested in and very passionate about reducing harm and finding preventable causes of harm

Skills
- Collecting data from a lot of different sources and quickly compiling it into a report
- Presenting that information to other people

Behaviour patterns
- He logs into RTM once a month when the new data's been added.
- He first scans down to see where the red blocks are and then drills down through to pull up the notes of the patients that had been marked up as being of concern. This goes into a report.
- He takes all the numbers off, physically writes down each number and types them into the hospital's electronic patient record system to see what actually happened to each patient.
- He's also finds it useful to look at the mortality of particular disease groups and find out which ones are outside the normal range.
- He doesn't use favourites. He is quite happy to spend time exploring the system and this enables him to notice things he wouldn't do otherwise.

Environment
- A small private office without windows, near his ward

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RTM

Penny
Head of Patient Safety

Personal Information
- Studied Biology at university
- The Clinical Governance Manager reports into her and underneath that Clinical Audit
- Involved in PCT contracting work and also the Patient Safety Federation of the SHA

Environment
- Open plan office with partitions
- Does a weekly ward walk-around

Attitudes
- Doesn't like that she spends so much time on the computer – she joined the NHS to help patients
- Would prefer to be sent the data once a month via email so she didn't have to log in at all

Behaviour patterns
- She logs into RTM once a month – clicks on her favourites to report the HSMR rolling twelve months as part of the Board report
- She also emails out the Performance Summary and the alert summary to the Clinical Directors and Divisional Directors
- She does not log in after lunchtime because she knows it will be slow
- Sometimes logs in at home because she has faster broadband at home

Goals
- Ultimately she wants to help patients
- She has to write many reports for which she needs access to information. She will get the data from Global Trigger Tool, the PAS system of the hospital, cause of death certificates etc as well as RTM
- Reports include the Board report (for which she has an Excel template), a prose report for the Board, Clinical Governance board, adhoc reports, outlier reports if there's a mortality alert from Dr Foster or CQC.
- She wants to monitor deaths per month and also report the HSMR to the Board every month

Skills
- Very competent, uses statistical software as part of her job. An experienced data analyst.
- Creates statistical process control charts from the data as well to demonstrate its reliability
- Struggles to cut the data in the way that she wants in the tools

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PPM HMM

Maria
Marketing Manager

Personal Information
- Maria has a background in Marketing, having done a graduate traineeship with a pharmaceutical company from where she worked in healthcare insurance.
- To get more involved with patients, she is now GP and Marketing Manager for a large Foundation Trust, for which she is the key liaison between the Trust and all their GP referrers.
- She is also responsible for ensuring that the Trust's service provision is marketable, so she additionally provides the Service Managers with up-to-date market share information.

Goals
- She particularly enjoys working on improving the Trust's market share and marketing for a particular service
- For this she needs market share data over the last three or four years by specialty

Environment
- Maria shares her office with one other person, but her department is situated quite far from the busy main hospital

Behaviour patterns
- She uses HMM for the quarterly Marketing Report, which reports on market share by specialty, for example. She has a template set up in Excel, which she populates.
- She also uses the Practice Profiles occasionally when visiting GP Practices, which she thinks makes her look professional.
- She has access to PPM but isn't sure what it can do for her

Skills
- Uses some favourites that were set up by her Customer Service Representative.
- She is very experienced at designing marketing material in the health sector, which she feels passionate about.
- She's used to learning software through tutorials or video demos – or having people around her who can teach her

Attitudes
- She gets frustrated when she can't cut the data how she wants
- She would prefer to spend less time trying to find the data and more time analysing the data

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RTM

Catherine
Clinical Governance General Manager

Personal Information
- Catherine is a Nurse by background, but became bored of the routine. She was a Matron with Nuffield for a few years before a project management role came up. Then she got the Risk Manager job at a hospital.
- Her department deal with all the litigation claims and complaints against the hospital. They are also responsible for patient information leaflets, patient surveys, patient safety alerts - the guidance from NICE and the Care Quality Commission also go through her department.

Environment
- Catherine has her own office to work in but she is often disrupted by people knocking on her door and asking her questions. She find it very inconvenient when she is timed out of the system.

Skills
- She's quite comfortable on the computer and is confident in doing the basics. If she has any problems on Excel she asks a couple of girls on her team who are whizzes
- She also gets on well with the IT team who answer her queries promptly, and she feels that her Customer Service Representative from Dr Foster is very helpful.

Goals
- Catherine feels very passionately that patient safety runs through everything at the hospital. She knows that the number of patients leaving her hospital with an infection hasn't changed in 15 years and she wants to improve it.
- It is important that Catherine has access to patient records.

Attitudes
- She doesn't like it when she can't find data she thinks should be easily available.

Behaviour patterns
- She only uses RTM and looks at the alerts in Performance Summary when she logs in. She will then drill down through to the patient records.
- She will often export the summary to Excel where she is more comfortable manipulating the data.
- She has a number of favourites, which were set up for her by the Customer Service Manager

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PPM RTM

Paul
Information Analyst

Personal Information
- Before working for the NHS, Paul worked as a software engineer for five years. He joined the NHS as an Information Analyst at a PCT before moving to the local Acute Hospital Trust.
- He reports hospital performance against Monitor, Care Quality Commission and contractual targets to the Trust Board. In addition, the Exec team consult him if they have any urgent information queries.
- He analyses and forecasts capacity and demand.

Attitudes
- He is a pedant for formatting so he usually exports DFI data into Excel where he can manipulate it further
- He is very concerned that he doesn't report false alarms and puts the data into a Statistical Process Control program to verify the statistical significance of any trends

Goals
- He wants to benchmark the hospital against SHA peers.
- RTM and PPM are just one tool he uses for acquiring data on hospital performance. Outside of the standard adverse event queries, for his monthly 20-note review, he would use the system to answer any questions from the Execs.

Behaviour patterns
- He obtains the information he needs for the Board report from the Patient Administration System and uses the Global Trigger Tool to gather data for the Adverse Events group; he uses PPM and RTM to obtain inpatient records.
- Paul logs into the DFI tools most weeks. He first checks for red bells on RTM and extracts the CUSUM and patient records, so that notes are ready ahead of Adverse Events Forum.

Skills
- Highly computer literate – often writes small C++ programs
- Has some limited admin rights for the work he does on SQL Server
- He is confident enough on the computer to try to resolve any problems he encounters but he occasionally gets frustrated when he tries to use the Help system

Environment
- Shares office with a colleague
- Works to tight deadlines

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F Effectiveness and Efficiency Dashboard

F1. Usability Problems Identified With Heuristic Evaluation

Heuristic	Usability problem	Severity	Suggestion for redesign
10.6	If menu items are ambiguous, the system does not provide additional explanatory information when an item is selected.	4	The help section needs to be developed in collaboration with users and to be made more accessible.
10.9	The help system interface (navigation, presentation and conversation) is not consistent with the navigation, presentation and conversation interfaces of the application it supports.	4	See 10.6.
10.14	The help system is not goal-oriented (What can I do with this program?	4	See 10.6.
10.17	The help system is not interpretive (Why did that happen?)	4	See 10.6.
1.25	The system uses medical terminology that users may not be familiar with.	3	Speak to users to understand terminology they use.
2.2	Menus are ordered according to medical terminology that users may not be familiar with; this impacts upon the users' ability to	3	See 1.25.

Heuristic	Usability problem	Severity	Suggestion for redesign
	find the correct option on the menu.		
2.3	There is no logical ordering to the menus apart from using the alphabet.	3	Develop keyboard shortcuts and an intelligent search that will query all the text in a menu for any items that contain the word that users type.
2.9	Some task terminology will be unfamiliar to users e.g. "base currency" for the creation of custom groups.	3	See 1.25.
2.12	Menu items are grouped according to ICD-10 codes, with which the user may not be familiar.	3	See 1.25.
3.7	There is no "undo" function as such, unless the user finds their search history.	3	Ensure that the back button on the browser will take the user back to exactly where they were, with the selections they had made, and develop an undo button.
4.45	Lots of abbreviations eg. HSMR, LoS.	3	Develop tooltips for each abbreviation that reveals what the abbreviation stands for.
7.5	Some prompts, cue, and messages are not placed where the eye is likely to be looking on the screen e.g. the 'Continue' button and time period dropdown menu.	3	The 'Continue' and 'Generate Report' buttons should be located consistently through the system, and the time period for the dashboard should be much larger and prominent. Check with eye tracking and usability testing. Rated severe because the user may even miss the time period. It is also not obvious enough how the tables have been sorted.
11.3	The system does not provide fewer screens (more information per screen) if users are experts, usage is frequent, or the system has a slow response time.	3	A basic and advanced version of the tool should be developed. Whilst the GUI can be customised, novice users will often use the tool for the same queries and require a quick way to perform this query.
11.4	The system does not provide more screens (less information per screen) if users are novices, usage is infrequent, or the system has a fast response time.	3	This can be implemented through the basic/advanced versions of the tool. See 11.3.
3.8	Users are unable to cancel queries once they are running.	2	The response time is good enough that this won't apply in most cases. However, if a query takes a particularly long time to run, users will find a cancel button useful, to take them back to where they were.
3.22	The 'Back' button on the browser does not allow the user to retrace their steps.	2	See 3.7 and 3.8.
4.5	Only some icons and buttons are labelled, e.g. 'Save As', 'Edit' and 'Delete'	2	Most unlabelled icons are recognisable but advisable to check with usability testing.
4.11	Inconsistent menu design.	2	e.g. Diagnosis Group on the analysis tab is not a dropdown menu. The menus above the Results table are also slightly confusing. 'Query Summary' should not be designed like a drop down menu, but similar to 'Readmissions', 'Length of Stay' and 'Day Case Rate' on the dashboard.

Heuristic	Usability problem	Severity	Suggestion for redesign
4.31	There is no legend for the colours used, but conventions are used.	2	Develop a tooltip for the bell to clarify what the coding means.
7.15	Field labels are not always close to fields e.g the dashboard is very wide, particularly when viewed on a wide screen.	2	The dashboard should be formatted so that the column widths are fitted to their contents.
7.17	Optional data entry fields are not clearly marked e.g. users may be confused by the 'All' option on dropdown menus, which means the menu has not been filtered.	2	A criteria selection that starts with "Filter by…" etc would make more sense. The "All" option is ambiguous, which could make users uncertain what data will come back.
7.36	It is not always obvious where selection is possible on the GUI e.g. users may believe some numbers to be clickable when they are not.	2	Usability testing should reveal the severity of this problem. Use conventions e.g. underline clickable text.
7.39	It is not clear on data entry screens and dialogue boxes where fields are optional.	2	This can be indicated by asterisks.
7.40	Are dependent fields displayed only when necessary?	2	This could be implemented with the suggestion for 7.17.
8.12	The system does not offer "find next" or "find previous" shortcuts for database searches (unless the user finds "History").	2	The search 'History' link should be made more obvious on the GUI. Also, an undo button should be developed.
8.13	On data entry screens, users do not have the option of either clicking directly on a field or using a keyboard shortcut.	2	See 2.3.
8.14	On menus, users do not have the option of either clicking directly on a field or using a keyboard shortcut.	2	See 2.3.
9.2	Not all icons in a set are visually and conceptually distinct e.g. info button.	2	Some icons are very difficult to see, such as the 'info' button, which could be in a different colour to its background.
10.5	Data entry screens and dialogue boxes are not supported by navigation and completion instructions.	2	The only place where it is used is the myGroups functionality; these instructions can be improved.
11.10	Users do not have the option to type ahead (despite the system's multilevel menus).	2	See 2.3.
2.6	Although the system uses a traffic light system to code alerts (red = statistically significantly high; yellow = not significant; green = statistically significantly low), the middle colour was changed from blue. This may confuse existing users to begin with.	1	Current users should get used to this, but perhaps a tooltip on the bell that clarifies what the coding means would help.
3.21	Users cannot easily reverse their actions.	1	See 3.7 and 3.8.
4.35	Inconsistent labelling: "Start new query" on the Relative Risk tab and "Start new search" on the	1	Pick one wording and use it consistently.

Heuristic	Usability problem	Severity	Suggestion for redesign
	Patient Record tab.		
5.15	The system does not place the cursor in the offending field when there is an error.	1	Make the menu or radio button for the relevant field active.
5.16	There is no indication of the severity of errors.	1	This can be done through formatting of error messages.
5.21	Novice and expert users receive the same error messages.	1	Test error messages with novice and expert users to ascertain their comprehension.
6.3	The menu choice name on a higher-level menu is not used as the menu title of the lower-level menu.	1	Check that where menu titles update that they are consistent with the user's selection.
6.12	The system does not warn users if they are about to make a potentially serious error.	1	See 5.16.
7.13	Zones are more than twelve to fourteen characters wide and six to seven lines high.	1	The GUI is extremely cluttered. Check its layout meets this criterion. Amend as necessary.
7.25	Colour has been used in conjunction with some other redundant cue.	1	Each cue should refer to different variables.
8.1	The system supports both novice and expert users but does not offer multiple levels of error message detail.	1	See 5.21.
8.3	Users are unable to define their own synonyms for commands	1	The names given to actions in the system should be checked with usability testing.
9.3	Large objects, bold lines, and simple area have not been used to distinguish icons.	1	'Favourite', 'Export to PDF', 'Export to Excel' and 'Print' icons should be separated.
11.12	When the user enters a screen or dialogue box, the cursor is not already positioned in the field users are most likely to need.	1	The system is mostly operational through the cursor and a mouse. This could be diversified.
11.13	Users cannot move forward and backward within a field.	1	Users should be able to use the Tab button on their keyboard to navigate through the interface.
12.7	Users cannot turn off automatic colour coding if necessary.	1	This can be implemented; colour blind users may struggle with the traffic light alerts.

F2. Usability Problems Identified With Cognitive Walkthrough

Usability problem	Severity	Suggestion for redesign
The language used for this form entry is too complex. There is an explanation underneath the header ('This is the data type that your hierarchy will be based upon.') but the mere presence of an explanation suggests that the label for the text entry isn't intuitive. This would need to be tested with users.	3	Engage users to understand terminology they use.
Users may not immediately be aware of the time period they are looking at, and therefore whether or not there is an action to complete. That said, they are highly likely to ask themselves which time period they are looking at, and once they find the menu the action is straightforward.	2	The menu size could be increased and moved to a more prominent location to grab users' attention

Usability problem	Severity	Suggestion for redesign
The user wants to find the time period and change it as necessary, but the dropdown menu is quite conspicuous in the top right hand corner.	2	See above.
The sorting arrows are not intuitively 'clickable' but some users may click on it because it is a form of interaction that is used in other applications. It is also not clear from the direction of the arrow in which direction the column will be sorted. For this task the user must click the arrow twice.	2	Increase the font size for column headings or have them resize automatically to the width of the screen.
Users may not realise that clicking the number will bring up the patient records since there is no tool tip when the cursor is placed over it.	2	Use the convention: Underline the number to indicate that it is a link.
The dropdown menu only states the time period, without any label to indicate that it refers to the data.	1	It would be better located above the dashboard.
Will users notice that readmission data is available? If the user doesn't click on the 'Mortality' dropdown menu then the information button in the top right of the window instructs the users that the action is available and how to complete it.	1	Better labelling of the menu.
The dropdown menu isn't labelled very intuitively but the items on it make sense, so hopefully users will understand that 'Negative alerts – all' has to be changed. The menu is also situated directly under the title for the Mortality tab.	1	Clearer labelling.
Users may not realise they have to sort the table and would instead read the numbers from the five procedure groups visible. I didn't even notice that I had to do this myself!	1	Make the arrows more prominent.
Users may not immediately notice the arrows under the column headers, which they must use to sort the table.	1	See above.
The distance between the relative risk score and the trend line is quite far, due to the length of the red-green bar, and the white space in the column heading.	1	See above.
Users may or may not intuitively look for a trend line on the dashboard otherwise because it wasn't there in RTM.	1	Reducing the width of the 'Title' column may help.
The trend line does not look clickable unless the user places their cursor over it.	1	A thicker border may help.
User might try to click on the 'Length of stay' or 'Readmissions' tab but existing users of RTM will know to click on the square.	1	Increase size of column headers or reduce the width of the 'Title' column.
Users may find it difficult to find the data they require because there are so many columns on the dashboard.	1	Confirm which columns are necessary with usability testing.
To get the relative risk score users need to place their cursor on the square, which they may not necessarily do.	1	Make the border of the square thicker.
Site' dropdown menu is hidden at the top of the window and the RTM users may not know that this action is available.	1	Move the menu to the top of the dashboard.
The 'Peers' column is quite hidden on the right hand side of the dashboard; the column header font seems to be small so that all the columns will fit a small screen.	1	Increase the font size for column headings or have them resize automatically to the width of the screen.
Users of RTM were not able to view peer performance in this way.	1	Provide training to ensure they are aware it is there.
The arrow button is too pale for users to find it quickly.	1	Make it a darker shade.
Users may not intuitively click on "Create a New Group" but there are no other options that they are likely to try.	1	The text can be underlined to indicate that it is a link.
The 'Continue' button is very far from the last item on the form (back at the top). Perhaps the user will have seen it at the beginning, or noticed the "Step 1 of 2" in the window header. The arrow is also coloured in a very bright green.	1	Position the "Continue" button in the bottom right hand corner, where users will see it.

F3. Summary Results of Usability Tests for Project Leaders

					REFINED DESIGN	
Participant	P1	P2	P3	P4	P5	P6
Task 1 Using only the performance summary dashhboard try to find out the diagnosis/procedure group with the worst performance in terms of observed deaths exceeding the expected over the last 6 months?						
Task 2: Using only the performance summary dashboard try to find out the diagnosis/procedure group with the highest crude rate for readmissions over the last 3 months?						
Task 3: Using only the performance summary dashboard can you identify which procedure groups are performing the worst in terms of relative risk for the outcome of mortality over the last 12 months?						
Task 4: Is there any way to see the trend for that particular procedure group? Can you access a larger version of the trend information and find out the relative risk for the worst performing month?						
Task 5: With regards to that particular procedure group, can you tell how it is performing in terms of relative risk for readmissions?						
Task 6.1: With regards to that particular procedure group, what do you think would be the quickest way to get to the underlying list of patients?						
Task 7.1: With regards to that particular procedure group, please try to click through to find out more about the relative risk score.						
Task 8: In terms of the outcome readmission, can you see how to view only those items that have performed poorly in terms of relative risk.						
Task 9: Please see if you can see a way to view peer group performance information on the das4hboard.						
Task 10: Can you see how to reload the performance summary dashboard so that it only shows data for two of your sites?						
Task 11: Please try to set up a custom group that reflects an element of your trust (e.g. a division or specialty group) and then view the dashboard based on this group						
Task 6.2: Can you see a way to see a more detailed view of the patient record at the top of the list?						
Task 6.3: Can you see a way to see the superspell information for that patient record?						
Task 7.2: Can you see a way to see only results for the male patients within this dataset? (**NOTE**: Specifically we needed user to open CS panel using 'More options' button and choose 'Male' radio button in order to pass task).						
Task 7.3: Can you se a way to change the analyse by to "Age 10 years" and reload the report based on this?						
Task 7.4: Can you see a way to drill down on only three rows within the results and at the same time change the analse by to GP practice?						
Task 7.5: Can you figure out what the nested radio button will allow you to do? *(Results table not tested.)*						

Key
Task completed
Completed with minor prompt
Completed with help
Not completed
Not tested

Score out of 5 given by user (5=very good)

	P1	P2	P3	P4	P5	P6	Totals	Key
Outcome widget (mortality etc.)	3	4	5	4	4	4	**24/30**	Score suggests pos. validation
Observed - expected widget	1	1	5	5		2	**14/25**	Score suggests neither pos. or neg. validation.
Crude rate widget	1	1	5	2		3	**12/25**	Score suggests neg. validation
My Groups	3	4	Concept 5 (clin. terminology 2)	4	5	4	**22-25/30**	
Relative risk tab					4	4	**8/10**	
Patient record tab					5	3	**7/10**	
Totals	**8/20**	**10/20**	**17-20/20**	**15/20**	**18/20**	**20/30**		

Usability questionnaire (1=Strongly disagree, 5=Strongly agree)

	P1	P2	P3	P4	P5	P6	Mean score for each question:	Key (pos. or neg. side of the mid point (3)
I think that I would like to use this system frequently	4	4	5	5	5	4	**4.5**	High number is good
I found the system unnecessarily complex	1	2	1	2	1	3	**1.7**	Low number is good
I thought the system was easy to use	2	4	4	4	2	3	**3.2**	High number is good
I think that I would need the support of a technical person to be able to use this system	1	1	1	1	4	3	**1.8**	Low number is good
I found the various functions in this system were well integrated	3	3	5	4	5	3	**3.8**	High number is good
I thought there was too much inconsistency in this system	3	1	5	3	1	2	**2.5**	Low number is good
I would imagine that most people would learn to use this system very quickly	2	4	5	4	5	3	**3.8**	High number is good
I found the system very cumbersome to use	3	1	1	1	1	2	**1.5**	Low number is good
I felt very confident using the system	5	3	4	4	4	4	**4.0**	High number is good
I needed to learn a lot of things before I could get going with this system	1	1	2	2	2	2	**1.7**	Low number is good

Question number	P1	P2	P3	P4	P5	P6	Average
1	4	4	5	5	5	4	4.5*
2	1	2	1	2	1	3	1.7^
3	2	4	4	4	2	3	3.2*
4	1	1	1	1	4	3	1.8^
5	3	3	5	4	5	3	3.8*
6	3	1	5	3	1	2	2.5^
7	2	4	5	4	5	3	3.8*
8	3	1	1	1	1	2	1.5^
9	5	3	4	4	4	4	4.0*
10	1	1	2	2	2	2	1.7^

Table 0-1 System Usability Scale results

*High number is good

^Low number is good