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Designing for communities in bushfire-prone situations: Redesigning the FireWatch website interface

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Designing for communities in bushfire-prone situations: Redesigning the FireWatch website interface.

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Abstract

This research describes the redesign of Landgate's FireWatch service — a web-based map application that uses data derived from satellites to provide near real-time bushfire information. FireWatch was originally built for emergency services personnel, but recent Australian state government inquiries have called for individuals, households and communities to have independent access to bushfire information. Therefore, it was necessary to redesign FireWatch with a new remote community-based audience in mind. The thesis describes multiple iterations of a user-centred action research design process that resulted in a publicly accessible web application known as MyFireWatch. Due to delayed access to actual community-based users, scenario-based design and a personas framework were created to consider the user's perspective. These personas then informed the recruitment of community-based users in the remote Western Australian town of Kununurra. Working with these remote community-based users quantified what functionality provided by FireWatch could be useful to this new audience. It also revealed that the information presented to them could be used in unanticipated ways and that satellite information can assist users in identifying key landmarks. However, user feedback indicated a lack of awareness of bushfire map applications in Australia, including FireWatch. Results from an online questionnaire verified that the design process undertaken resulted in a usable interface that met the needs of the majority of users, although several participants noted that the interface was slow to respond to user input. There was significant support for user-sourced fire information, although several participants raised concerns of how the information would be verified and how user-sourced information would impact the usability of the application. Participants used social media, but were also highly reliant on traditional media and word of mouth — something that Landgate will need to consider in future efforts to increase awareness of MyFireWatch. Two frameworks arose from the research undertaken: a pattern language for presenting map-based hazard information and a personas framework for designing for remote Australian community-based users.

The declaration page
is not included in this version of the thesis

For Edward Charles "Charlie" Allen.

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"Communication is the process of creating participation"

John Dewey, *Art as Experience* (1934, p. 253)

1

Introduction

This thesis examines the redesign of the FireWatch service: a web-based map service that provides near real-time bushfire information in Australia. Created by Landgate — a statutory authority in Western Australia (WA) that specialises in geographical data and land information, FireWatch was originally built for emergency services personnel in WA. Bushfires are one of the most common natural hazards to occur in Australia and can have devastating consequences. Due to a need for people in remote and regional communities to have relevant and easy

access to bushfire information, it was necessary to redesign the user interface of FireWatch for users in these communities, particularly those in remote and regional parts of WA. This research makes up one half of a larger project funded by the Australian Research Council (ARC) with the aim to examine the design and communications of bushfire information in Australia. This thesis describes the work undertaken within the design half of the project. The redesign process — undertaken in collaboration with Landgate — was informed by theory from the academic disciplines of interaction design and Human-Computer Interaction (HCI), as well as modern principles and practices from web design and web development. There was also a strong case in disaster management literature for creating people-centred early warning systems, and, following inquiries into major bushfire events in Australia, there was an emphasis on information sharing. To ensure that the redesigned interface met the needs of these remote and regional community-based users, the design underwent several iterations that sought the perspective of users through direct and indirect methods including personas (to model user archetypes), user testing of the interface, a card sorting system (to rate features of the interface), interviews and an online questionnaire. It was also necessary to work closely with the service provider Landgate to ensure that the design was undertaken bearing in mind the possibilities and constraints of the technology.

1.1 The need for a publicly accessible interface

Australia, being a fire-prone continent, has a clear need for easily accessible bushfire information. Recent inquiries into major fire events have suggested that individuals, households and communities require independent and simple access to relevant bushfire information. Several sources of map-based bushfire information exist in Australia, but these applications were built with domain specialists such as emergency services personnel and pastoralists in mind — not community users who require a simple and easy to use interface. Therefore it was necessary to construct an interface that

met the needs of community-based users rather than expert users familiar with complex, technical interfaces that display spatial information. This study determined what functionality community-based users required from the FireWatch interface, while also ensuring that it was usable for this same group of users. This is likely to be the first study of its kind in Australia to design map-based fire information for remote and regional community-based users that directly involved these users in the design process.

1.2 Context of the research

Australia is one of the most bushfire prone continents on Earth (Clode, 2006, p. 66). Bushfire is one of the most common natural hazards that impacts most of the continent (Geoscience Australia, 2007, p. 101). Fires are typically started by either human activity or lightning strikes (Geoscience Australia, 2007, p. 101). The losses incurred from fires in Australia are immense. Loss of human life, property, possessions, wild animals, bushland and farmland are typical effects of severe bushfires (Keelty, 2012; Victorian Bushfires Commission, 2010). With Australia's population in rural-urban areas increasing, and the impact of climate change, bushfire related risks are likely to increase (Victorian Bushfires Commission, 2010, p. 3). Members of the community, fire agencies and governments at the local, state and federal levels all share a responsibility for people's safety, preparation and response to bushfire threats (Victorian Bushfires Commission, 2010, p. 2; Moritz et al., 2014, p. 59). Due to the increasing impact of bushfires in recent years, the provision of systems to alert communities, fire agencies and other government departments to the threat of bushfires is also increasingly important (Victorian Bushfires Commission, 2010, p. 12).

Since the mid-1990s, Landgate has produced a range of fire monitoring services derived from multiple sources, such as near real-time satellite imagery, aerial photography and lightning strike detection (Steber, Allen, James & Moss, 2012, p. 115). There are several versions of FireWatch made

accessible to different users. While built primarily for the use of fire and emergency services professionals by subscription, a publicly accessible version of the website has been available since the early 2000s (Figure 1.1).

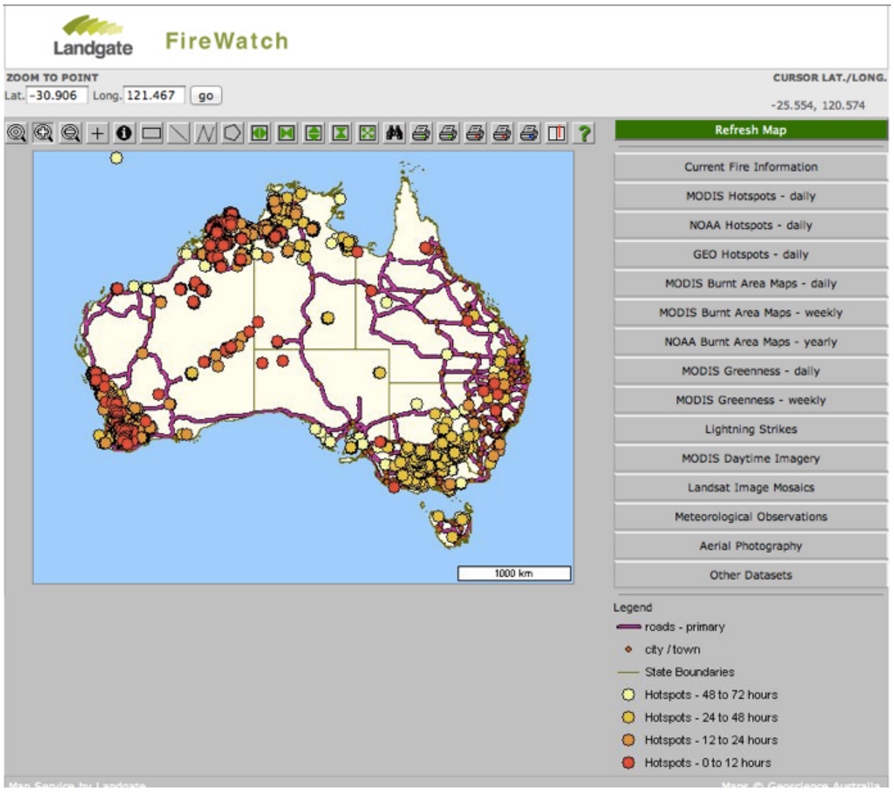

Figure 1.1: Landgate's previous version of the FireWatch website (Landgate, 2012). This version of FireWatch was created for emergency services personnel. As a result, the interface offers substantial functionality but lacks usability for a non-technical audience.

Although this website offered substantial functionality, in usability terms it suffered from its history as a service for professional technical users. Throughout this research, this version (Figure 1.1) of the website is referred to as the *previous expert-user version* of FireWatch. The major aim of the research described in this thesis was to redesign this previous expert-user version of the website for the use of ordinary, non-technical users from the wider community, focusing on a trial regional

area to fine-tune the service. Kununurra was chosen as the trial area as it met several criteria relevant to the project. These criteria are explained in detail in Chapter 5. The redesign aimed to present a more usable and intuitive interface for these non-technical users in the community. The research described in this thesis was one half of an ARC linkage project: *Using community engagement and enhanced visual information to promote FireWatch satellite communications as a support for collaborative decision-making*. ARC linkage projects "are collaborative between higher education researchers and other parts of the national innovation system, which are undertaken to acquire new knowledge, and which involve risk or innovation" (ARC, 2013, para. 1). By supporting collaborative research projects, the scheme aims "to apply advanced knowledge to problems and/or to provide opportunities to obtain national economic, social or cultural benefits" (ARC, 2013, para. 4).

The ARC project had two halves: one focused on the design of the interface and the other focused on the communications surrounding bushfires in remote and regional WA. This thesis describes the design work undertaken. Part of the work of situating the redesigned FireWatch service within a community was undertaken by the other half of the ARC project and is ongoing at the time of writing. However, the design half of the project discussed here required engagement with the community to ensure that user input to the design was achieved. The community half of the project is investigating the community networks in which the redesigned FireWatch service will be situated.

The redesigned version of FireWatch — which came to be known as MyFireWatch in the final iteration of the design (Figures 6.7 and 6.10) — differs from previous versions of FireWatch (Figure 1.1), and other early warning systems in Australia, in that it is not intended for use primarily by emergency services organisations. Its focus is on wider community use, particularly focused on planning and preparation, rather than emergency response. It is also worth noting that although the FireWatch service is referred to here and by Landgate as an "early warning system", it is not intended to act as an alert system. It is intended to inform communities of actual and potential fire dangers

in their area and assist them in making decisions related to the planning, preparation and response to these dangers. It is intended to be a resource supplementary to the alerts provided by emergency services organisations, rather than a replacement for them. The purpose of the overall ARC project is to redesign and broaden a fire warning system for use by non-experts (i.e., the wider community) and in non-emergency settings, rather than focusing primarily on the needs of emergency services organisations.

1.3 Motivation for the study

There is a strong case for information sharing amongst individuals, households, communities and all levels of government in the inquiries into major bushfire events in Australia, and more broadly in disaster management literature. Fire ecologists have recently argued that humans need to learn to co-exist with fire in much the same way as they do with other natural hazards, such as earthquakes, hurricanes and floods; that is, viewing them as an "inevitable and natural process" (Moritz et al., 2014, p. 58). Part of this co-existence means responsibility for hazard reduction is shared at all levels, including governments and land-owners (Moritz et al., 2014, p. 63). The development of better bushfire maps allows for those vulnerable to bushfires to better assess hazards (Moritz et al., 2014, p. 63).

Over the past five years, several major bushfire events in Australia have resulted in state government-led inquiries into the causes of these fires, as well as how to improve communications related to bushfires between government organisations, individuals and communities. Recent inquiries include:

- Victorian Bushfires Commission Final Report (2010)
- A Shared Responsibility: The Report of the Perth Hills Bushfire February 2011 Review (Keelty, 2011)

- Inquiry into the 2011 Kimberley Ultramarathon (Economics and Industry Standing Committee, 2012)
- Appreciating the Risk: Margaret River Bushfire Special Inquiry Report (Keelty, 2012)
- Tasmanian Bushfires Inquiry Report (Tasmanian Government, 2013).

Although these reports used slightly different definitions of what constitutes a community, each addressed communication between government organisations, non-government agencies, communities and individuals (Brady & Webb, 2012). Nevertheless, these reports contain frequent references to "vulnerable" and "bushfire-prone" communities that are generally situated on the fringes of or outside of Australia's urban areas (Keelty, 2011; Victorian Bushfires Commission, 2010).

The most devastating of these recent major fire events were the bushfires of 2009, which resulted in 173 people losing their lives (Victorian Bushfires Commission, 2010). The inquiry resulting from this incident recognised the need for people in communities to have independent access to bushfire information by stating that "communities, individuals and households need to take greater responsibility for their own safety and to act on advice and other cues given to them before and on the day of a bushfire" (Victorian Bushfires Commission, 2010, p. 7). Similarly, the United Nations International Strategy for Disaster Reduction (UNISDR) stated that it is necessary to "develop systems that are people centred... which take into account the demographic, gender, cultural and livelihood characteristics of the target audiences" (2005, p. 7). More recently, the Human Development Report from the United Nations suggested that "[disaster] preparedness and recovery can be pursued at all levels — global, regional, national and community — and can be enhanced by information sharing" (Malik, 2014, p. 7). The need for accessible hazard information has coincided with the rise of the geospatial web. The geospatial web — led by the popularity of Google's Maps and Earth applications — has brought spatial data to a new audience (Harris, Rouse, & Bergeron, 2010). This popularity has meant that spatial data — which previously required technical knowledge of geographic

information system (GIS) software — is now more accessible to the wider community (Harris et al., 2010, p. 127).

There are several bushfire maps that are available in Australia, including the FireWatch service from Landgate (Steber et al., 2012), Sentinel from Geoscience Australia (2011), ERIC (Emergency Response Intelligence Capability) from the CSIRO (Commonwealth Scientific and Industrial Research Organisation) (Power, Robinson & Wise, 2013) and NAFI (Tropical Savannas CRC, 2012). Similar applications exist in the United States of America, such as Calfire's statewide fire map (2012) and the National Forestry Service's Active Fire Mapping program (2014). It is likely that the demand for services such as FireWatch is only going to increase as Australia's rural populations grow (Australian Bureau of Statistics, 2012), so importance was placed on creating an interface that was straightforward and easy to use. The redesigned FireWatch service needed to have the capacity to highlight serious problems, giving local communities the ability to respond in a more timely manner and gain a clearer picture of the level of danger in their vicinity. The redesigned FireWatch platform also needed to meet several criteria. The website interface needed to meet modern challenges of adhering to web standards while being accessible across several web browsers, including on devices such as tablets and smart phones. The previous version of FireWatch (Figure 1.1) was originally built before the widespread use of tablet and smart phones, meaning that the interface did not perform adequately on these modern, commonplace devices. Note that personal computing devices — including laptops — are referred to as *desktop* devices in this research for ease in differentiating them from modern internet devices such as *tablets* and *smart phones*. It also needs to take into consideration the potentially very stressful circumstances in which it will be used. In addition to this, the redesigned FireWatch needs to ensure that it is viewed as a credible and authoritative source of information, particularly after the negative light in which DEC (Department of Environment and Conservation) was held after the Margaret River bushfire in 2011. Input from users in a regional community was crucial to this redesign.

Motivation for undertaking the redesign

Recently, design has become increasingly multifaceted, as pragmatic disciplines turn to it as a way of addressing various concerns (Walker, 2014). In his *New York Times* article, "The Golden Age of Design", Walker (2014) highlighted how design is now being used as a medium "for expressing ideas, raising provocative questions and addressing social and individual anxieties" (para. 10). Given recent events in Australia, this research aims to provide a small contribution towards addressing societal anxieties regarding bushfires — particularly in remote and regional communities susceptible to fires.

It is important for designers of interactive products to remember that these products can have a direct impact on the lives of people using them. As such, interaction designers "must be sure that the results of our labor do good things" (Cooper et al., 2014, p. 152). Similarly, Italian-American graphic designer Massimo Vignelli noted that design as a discipline needs to be responsible towards both users and society by designing for needs rather than wants (Challand, 2009). Cooper et al. (2014, p. 153) argued for design being used to improve human conditions. Some of these conditions that interactive products can broadly improve include:

- Increasing understanding (individual, social, cultural)
- Increasing efficiency/effectiveness of individuals and groups
- Improving communication between individuals and groups
- Reducing sociocultural tensions between individuals and groups
- Improving equity (financial, social, legal)
- Balancing cultural diversity with social cohesion (Cooper et al., 2014, p. 153).

Interaction designers ought to keep these broad issues in mind as they design interactive products, and designers should be looking for "opportunities to do good" (Cooper et al., 2014, p. 153). Some of these conditions listed above align with the objectives for ARC linkage projects for providing social and cultural benefits for the nation, as well as the recommendations from the Victoria

Bushfires Commission (2010) on improving bushfire communications for individuals, households and communities. Designing an interface that could enable a positive outcome for individuals, communities and society in Australia was a broad yet fundamental motivation for undertaking this research.

1.4 Aim of the study

This study aimed to present accurate, relevant and timely bushfire information to community-based users in a simple and intuitive user interface. To do this, the study directly involved a set of trial users from the remote community of Kununurra in the design process to ensure that the application meets their needs. The aim was to ensure that the redesigned FireWatch interface provided adequate functionality to this new FireWatch audience while also ensuring that the application provided adequate usability. The provision of bushfire information to community-based users through the redesigned FireWatch interface is considered to be one of the information cues for individuals, households and communities referred to in the Victoria Bushfire Commision's recommendations (2010, p. 7). In this context, it aimed to meet the ARC's objective for linkage projects by "obtaining national economic, social or cultural benefits" (ARC, 2013, para. 4). The research also aimed to adhere to Cooper et al's principle of using design for improving human situations, particularly by improving social understanding and "improving communication between individuals and groups" (2014, p. 153). Constructive design research involves building something — in this case a prototype — that is informed by previous practice and theory (Koskinen, Zimmerman, Binder, Redstrom & Wensveen, 2011, p. 5). In undertaking such research, new knowledge is generated in the process (Koskinen et al., 2011, p. 119). By reflecting on how this knowledge acquired from the design research process undertaken could be applied by others working on a similar problem, it was considered necessary to construct a set of guidelines for designing such a system. These guidelines were informed

by theory from interaction design and HCI, web best practice, and the evidence described in this thesis. These guidelines were seen as a theoretical contribution to the field of interaction design. In terms of a practical aim, the research aimed to create a working prototype interface in which to conduct user testing with, as well as influence how Landgate's development team approached future versions of FireWatch.

It was necessary to consider the kinds of people encountered in remote and regional communities in order to ensure that the redesigned FireWatch service met their needs. In doing so, it was necessary to determine how to obtain the perspective of these users, particularly as their remote location meant that there was limited direct contact with these users. Attention needed to be given to how the interface could portray a sense of credibility and authority to community-based users. Credibility and authority were thought of as important aspects of the design as recent major fire events in the south-west of WA painted some state government organisations in a bad light (Keelty, 2011). The interface also needed to reflect the modern realities of how people use the internet, such as the devices and browsers that they used, as well as the connections that were available (i.e., broadband, 3G, etc.). As FireWatch was originally built to meet the needs of emergency services personnel, such as Department of Fire and Emergency Services (DFES) WA employees, there was a lack of awareness of the FireWatch service outside of those involved in emergency services work. Social media was one possible way of addressing this lack of awareness, but it was unknown what kinds of media - both online and traditional - were commonly used by community-based users.

1.5 Research questions

The motivation for this study, as described above, was that recent inquiries into bushfires, along with disaster management literature, have called for increased information sharing with individuals, households and communities. The aims of the study included several facets that the interface and

the research needed to adhere to. Early warning systems need to be people-centred and consider the demographic information of the intended users. As noted in the introduction, FireWatch was originally created to meet the needs of emergency services organisations. By re-situating the redesigned FireWatch within remote and regional communities of WA, there was a clear need identified to create a version of FireWatch that was intuitive and easy to use that provided relevant, credible and timely information to those in the community at risk. To address aspects related to the interface identified in the aim of the study above, and how to obtain feedback from users to inform the interface design, the following research questions were created:

1. How can FireWatch be redesigned to incorporate global best practice and modern principles of dynamic information design to develop a more usable and intuitive version for members of the wider community?
2. What kinds of user input are required for effective revision of the FireWatch service?
3. How should the information system interface adapt to accommodate increasingly dangerous situations while providing required information for different user groups?
4. What relationship exists between the visual characteristics of an information source and its credibility or authority?

It was clear from the outset of this research that there was a lack of awareness of the FireWatch service amongst people outside of the emergency services. To address the issue of how to facilitate an increased awareness of the FireWatch service in the wider community, the following research questions were created:

5. How can we engage with communities to increase an awareness of the FireWatch website?
6. What role can social media play in building and increasing awareness of the FireWatch website?

How the research undertaken answered these six questions is provided in the discussion sections of Chapters 4, 5 and 6. Question 4 is also addressed in the literature review.

1.6 Significance of the study

The context of the study explained at the beginning of this introduction chapter highlighted the lack of easy to use map-based bushfire information available in Australia available to those outside of the emergency service — particularly remote and regional community-based users. The study aims to present this bushfire information to these community-based users through a more easy to use and intuitive interface. To do so, it involved a sample of these users in the design process to ensure that the functionality provided met their needs and that the interface was usable. There were two outcomes of this design process: (1) a better understanding of the functionality necessary to inform remote and regional community-based users while still providing adequate usability; and (2) two frameworks in the form of a pattern language (Alexander, Ishikawa & Silverstein, 1977) and a personas framework (Cooper, Reimann & Cronin, 2014). These frameworks were informed by the relevant literature as well as findings from the design research process, and are intended to assist other researchers and practitioners working on similar problems, including the development team from the industry partner Landgate. These frameworks will allow designers and researchers presenting map-based hazard information to community users to have a better understanding of how to approach the design of such systems.

The significance of the research to the fields of interaction design and HCI research and practice lies in the focus on usability and utility as a way to design for an experience, rather than attempting to design an experience (Hassenzahl, 2004a; Roto, Law, Vermeeren & Hoonhout, 2011). Services such as FireWatch should be designed with the user's needs at the forefront, rather than their emotions (Hassenzahl, 2004a). Significantly, in the absence of actual users in the early design iteration,

Cooper et al's (2014) personas framework and scenario-based design (Rosson & Carroll, 2002) came to play a key role by "kick-starting" the design process and allowing for a set of requirements to be created. Utilising personas framework and scenario-based design allowed for the development of the first working prototype. This working prototype was then tested with actual participants in the Kununurra community in two rounds of user testing and interviews. Finally, an online questionnaire was used to verify that the design process undertaken had resulted in a usable interface that met the needs of this new non-expert FireWatch audience. The design research process made several findings, including what functionality was useful to this new FireWatch audience, as well as user attitudes towards information sharing. Also of significance is the contribution to the theory in the form of two frameworks. The first is a pattern language for designing a map-based interface that provides hazard information to a community-based audience. The patterns serve as a set of guidelines for designing a similar interface and are based on the relevant theory as well as evidence provided in this research. The second framework is a personas framework, based on the work undertaken in the initial design iteration, where several personas were created to serve as user archetypes in the absence of direct contact with users. The personas in the framework were based on the characteristics of actual users encountered in the Kununurra community. These two frameworks serve as a means for interaction design researchers and practitioners to undertake work in a similar area. They will also serve to assist Landgate in the future development of their publicly-accessible map applications. Therefore the creation of these two frameworks has both a theoretical and practical contribution. A significant outcome of this research was the practical output in the form of a working interface.

1.7 Overview of the thesis

This thesis comprises two parts, and a total of eight chapters:

- Chapter 1: Introduction

Part 1:

- Chapter 2: Literature review
- Chapter 3: Research design

Part 2:

- Chapter 4: First stages of design
- Chapter 5: Engaging with community-based users
- Chapter 6: Final stages of design
- Chapter 7: Frameworks: a pattern language and community-based personas
- Chapter 8: Conclusion

1.7.1 Part 1: background to the study and research design

Chapter 2 introduces the relevant literature from HCI, interaction design, graphic design and web interface design. It also covers disaster information and the bushfire inquiries that have arisen as a result of recent major fire events in Australia. The literature covered shows that there is a good case for involving all stakeholders in the design process, with an emphasis on input from users. Literature from graphic design regarding visual rhetoric and real versus abstract imagery is also discussed in the context of this research. The disaster management literature showed that it is important to design early warning systems that are people-centred. The literature covered suggested that although considering the emotions of users is important, a focus on usability and utility was likely to be a suitable approach for the redesign of a system that presents bushfire information to community-based users.

Chapter 3 introduces the research design and conceptual framework. The research undertaken took a constructive design approach, in that it focused on the development of a prototype as a way of generating new design knowledge. The redesign was framed as a service design process and involved working with the two key stakeholder groups: the service provider (Landgate) and the end

users. An iterative action research process was introduced — a common methodology for undertaking design-based research, which was followed throughout the entire redesign, as described in Chapters 4, 5 and 6. An overview of the two frameworks that arose from the process and results is also given, but these are explained in greater detail in Chapter 7.

1.7.2 Part 2: The design process, results and conclusions

Chapters 4, 5 and 6 describe the design process, the research instruments used and the findings from each design iteration. Due to the limited access to the remote community, it was necessary to address the redesign in different ways in each iteration. As each iteration took a different approach to input from users, the chapters are somewhat self-contained. These three results chapters follow the four stages of the iterative action research process described in the research design (Chapter 3). Therefore, each of these chapters describes a planning stage where requirements for the interface are established, a prototyping and designing stage, an exploring stage where use of the interface is explored (either through the use of personas or actual users) and a reflection stage in which the data collected is analysed and discussed.

Chapter 4 examines the first iteration of the design process. In this iteration, due to circumstances in the ARC project, it was not possible to directly engage with actual users. Therefore, scenario-based design and a personas framework were utilised to consider the needs of users. Simplicity as a design goal was also a factor in the first prototype's design, as was the influence of rhetoric on the user. This first iteration of the iterative design process resulted in the first working prototype.

Chapter 5 examines the second and third iterations of the design process. In these two design iterations, actual users from a remote community were directly engaged as part of the design process. These two rounds of user engagement involved a card sorting system for rating the functionality offered by the prototype interface, users testing the prototype interface and an interview regarding usability of the interface. In the first stage of user engagement, users in the remote town of Kununurra

in WA were engaged to test the prototype built as a result of the initial design work described in Chapter 4. This resulted in further refinements to the prototype, which again underwent further testing with the second sample of users from Kununurra.

Chapter 6 examines the fourth, final iteration of the design process. In this iteration, Landgate committed to making the prototype interface a live publicly-accessible and fully supported web application, known by this stage as MyFireWatch. Coinciding with the public launch of the application, an online questionnaire was created to gauge the usability of the interface and to ask users a series of open questions related to the usability and functionality of the interface, their internet usage and other media usage.

Chapter 7 Two frameworks that arose as a result of the design process are explained in this chapter. These frameworks take the form of a pattern language (Alexander et al., 1977) for designing a map-based hazard information interface for community-based users and a personas framework (Cooper et al., 2014) for considering remote and regional community-based users in the design process without their direct input. These frameworks are intended to assist Landgate in the future development of FireWatch and other map-based applications, as well as other designers and developers working on similar applications.

Chapter 8 is the conclusion chapter. It summarises the findings from the three results chapters (4, 5 and 6). It also summarises the two frameworks created in the previous chapter and how they can be applied by those working on similar problems. The implications of the work undertaken are also discussed, and how these implications relate to the theory and practice of interaction design and the objectives of the ARC linkage project. Several suggestions are made regarding future directions for interaction design work in this field.

2

Literature review

2.1 Introduction

This chapter reviews relevant literature that was used to guide the redesign of the FireWatch public access website. Although this research is very much within the paradigm of interaction design and Human-Computer Interaction (HCI), the interdisciplinary nature of design-based research means that it was necessary to cover relevant areas such as disaster

management and cartography, as well as issues related to working in the medium of web design, such as web-browser and device compatibility and accessibility. The evolution of the interaction design discipline and how it relates to Human-Computer Interaction (HCI), along with the evolution of methodologies within interaction design is also explored. Traditionally, HCI and interaction design have focused primarily on the user, through a methodology referred to as user-centred design. In recent years, there has been increasing interest in service design as a core practice within interaction design. Other issues within interaction design, such as how to approach a reduction in functionality and the place of emotions in design are also considered in this literature review. As the FireWatch application is a map-based interface, Geographic Information Systems (GIS) are briefly discussed, but within the context of the emerging area of the geospatial web, also referred to as web cartography. The review provides a background of disaster management theory and discusses relevant aspects of government led inquiries into bushfire disasters in Australia. An overview is also given of remotely-sensed information and the role that map interfaces can play in disaster management. Finally, how to design for credibility and authority is also discussed. It was necessary to investigate these diverse areas of research to properly inform the redesign of the public access FireWatch interface.

2.2 Modern interface and communication design

2.2.1 From Human-Computer Interaction to Interaction design

Computer interfaces have not historically focused on user-friendliness. Computer programmers have focused more on functionality than the needs of the end user (Norman, 1981; Shneiderman, 1980). The field of Human-Computer Interaction (HCI) arose to address the lack of focus on the user interface and since the early 1980s there have been vast improvements to interfaces (Dix, 2004; Hewett, 2009).

HCI stemmed from several disciplines, including computer graphics, human factors, ergonomics, cognitive psychology and computer science (Hewett et al., 2009, para. 11). Early HCI research sought knowledge from cognitive psychology in an effort to make computer interfaces more usable, effective and efficient (Card, Moran & Newell, 1983, p. ix). Advances in cognitive psychology led to a greater understanding of human cognitive behaviour, which allowed for applications in practical areas, such as computer science (Card et al., 1983, p. iiv). Norman (1981, p. 12) raised his concerns and noted that programmers should create the system for the users. How to achieve this was not clear at the time, due to a lack of user interface design principles to guide researchers and designers (Norman, 1981; Shneiderman, 1980). Both Shneiderman (1980) and Norman (1981) recommended involving users in the design process, recognising a need for a user-centred approach.

As HCI emerged as a discipline focused on usability, it helped evoke technological advancements of the user interface, and evolved alongside these technological advancements throughout the 1980s (Carroll, 1997; Norman, 1994). The most significant of these advancements were computer systems that leveraged graphical user interfaces, incorporating elements such as menu hierarchies and direct manipulation — where users' actions directly perform a task (Carroll, 1997; Shneiderman, 1983). These developments made computer systems accessible to people who previously did not have the required technical knowledge to work with computers driven by ambiguous command-line syntax (Shneiderman, 1983, p. 58). This meant that early HCI had achieved some notable success in improving the user interface. Computer users shifted from programmers to end-users: that is, consumers who used them as tools (Carroll, 2013). Yet HCI was still focused primarily on improving usability and functionality (Carroll, 1997, p. 70; Shneiderman, 1983), neglecting the social and emotional characteristics of human users. Emotion in design refers to the impact that a designed product has on a user. This can include the product's touch, feel and appearance (Norman, 2004, p. 37). The aesthetics of a design can change the user's emotional state. This could include positive effects, such as joy, happiness or satisfaction, or negative effects, such as anger or frustration (Norman, 2004, pp.

182-185).

By the late 1990s, HCI had become a more holistic discipline by broadening its scope beyond usability. Researchers such as Norman (2004), Laurel (1993) and Jordan (2002) highlighted the fact that users have emotions and that these need to be considered when designing computing interfaces. The term *user experience*, also referred to as simply UX, was first brought to the attention of the HCI discipline by Norman, Miller and Henderson (1995, p. 155). The term UX was initially used to refer to the human-computer interface (Norman et al., 1995, p. 155). More recently, its meaning has broadened to encompass a wide range of factors in human-computer interactions. While this term was introduced in 1995, the concept itself can be traced back to the previous decade. Futurist John Naisbitt (1982) stated that "We must learn to balance the material wonders of technology with the spiritual demands of our human nature" (p. 40), insisting that human needs be addressed by modern technology. The main factors of user experience include pragmatism, emotion, affect, experience, pleasure, aesthetics and value (Law, Hassenzahl, Vermeeren, & Kort, 2009, p. 719). User experience expanded on the original idea of user-centred design to include more human aspects, such as affect, emotions and pleasure (Law et al., 2009, p. 719). However, while the focus of HCI has shifted significantly to emotional aspects of design, usability is still a major aspect underlying the design of all interfaces (Hassenzahl, 2004a, p. 47; Mahlke & Lindgaard, 2007, p. 166). Usability is, along with performance and function, a major facet of the user experience (Norman, 2004, p. 37). Roto et al consider the term user experience to be a synonym for "usability, user interface, interaction experience, interaction design, customer experience, web site appeal, emotion, ?wow effect?, general experience, or as an umbrella term incorporating all or many of these concepts" (2011. p. 4). As such, the term user experience has come to be understood in a variety of ways (Roto et al., 2011, p. 4).

HCI has emerged as a design-orientated discipline. Fallman, when discussing design within the context of HCI, stated that "design is a matter of making; it is an attitude to research that involves

the researcher in creating and giving form to something not previously there" (2003, p. 225). Zimmerman et al pointed out that the HCI community and design community used the term "designer" to mean slightly different things. The former used it to refer to an HCI practitioner — that is, someone who "might be an interaction designer, a usability engineer, a software architect, a software developer, etc." (2007, p. 494). The latter used the term to refer "to someone who has had training or extensive practical experience in a discipline such as architecture, product design, graphic design, or interaction design" (2007, p. 494). Rogers, Sharp and Preece pointed out that the job of an interaction designer is to know several things about users and technologies, as well as the interactions between them (2011, p. 11). Given this definition, and that the purpose of this research is to redesign the FireWatch application's user interface, the second definition from Zimmerman et al seems to be more appropriate here (2007).

Fallman described HCI design research as being either design-orientated research or research-orientated design (2003, p. 230). The former is interested in the acquisition of new knowledge as its main contribution — often brought forth through the development of a prototype. The design and use of this designed artefact generates new knowledge and truth (Fallman, 2003, p. 230). Conversely, the latter is primarily concerned with the generation of a newly designed artefact, but this design process may be related to research (Fallman, 2003, p. 230). The former — design-orientated research — is where the research undertaken here sits. Design research that generates a design artefact is effective at acting as a "conduit for research findings to easily transfer to the HCI research and practice communities" (Zimmerman et al., 2007, p. 493).

The term interaction design emerged in the 1990s and is considered to be a more-encompassing term than HCI (Rogers et al., 2011). Rogers et al described interaction design as being concerned with the development of interactive products that are usable: that is, that they are easy to use, provide a pleasant user experience and are effective at what they do (2011, p. 2). Rogers et al argued that interaction design had broadened the scope of HCI by emphasising the role of aesthetics, emotions

and sensuality in the user's interaction experience and through the examination of technologies, products and systems beyond computers (2011, pp. 9-11, 15). In contrast, Lowgren — much like Fallman (2003) — considered these changes to be part of a shift within HCI itself (2002, p. 189). However, Lowgren also pointed out that the majority of those working in the discipline have favoured interaction design as a term over HCI (2001, p. 31). Practitioners who may have previously described themselves as system designers or interface designers now describe themselves as interaction designers (Rogers et al., 2011). Rogers et al considered interaction design to be informed by several design practices including product design and graphic design, while also being informed by several disciplines such as HCI, design, cognitive science, computer science, human factors, ergonomics, engineering and several social sciences (2011, p. 10). Cooper et al. (2014, p. 154) argued for interaction design research to create new knowledge that is pragmatic in its nature. New design knowledge that cannot be used in the real world serves no real purpose: "A design must get built to be of value. Once built, it needs to be deployed in the world. And once deployed, it needs to provide benefits" (Cooper et al., 2014, p. 154). As part of the research undertaken here is centred around the creation of a working prototype, Cooper et al's (2014, p. 154) pragmatic outlook seems an appropriate approach.

2.2.2 User-centred design, user participation and service design

User-centred design has been a part of HCI since the 1980s. It has been a key method for improving usability of computer interfaces (Garcia et al., 2009, p. 153). It is a development process with the primary goal of improving the usability of computing interfaces (Carroll, 1997, p. 67). At the core of user-centred design since its beginning has been an array of research endeavours known as *usability engineering* (Carroll, 1997, p. 69; Nielsen, 1994, p. 26). There are three central principles to usability engineering (Table 2.1).

Table 2.1: Usability engineering principles (Carroll, 1997, pp. 68-70). These three principles consider measurable objectives, user participation and cost effectiveness and are central to usability engineering.

Principles	*Descriptions*
Measurable objectives	Also known as usability specifications. The purpose of these is to guide iterative development.
Increased user participation	Users, who were experts in their chosen field, would work closely with developers, who were experts in computing technology. This became known as *participatory design*, where users can assist in the setting of design goals and early prototyping.
Cost effectiveness	Developers need to create efficient methods to carry out the processes of prototyping, evaluation and redesign.

In addition to this, Nielsen (1994, p. 155, 2005) created ten usability principles, known as heuristic evaluation. Nielsen (2005, para. 1) considered them to be general "rules of thumb", rather than specific guidelines (Table 2.2).

Table 2.2: Nielsen's (2005, para. 2) ten usability principles for heuristic evaluation. These principles are considered "rules of thumb" rather than specific guidelines.

Principles	*Descriptions*
Visibility of system status	The system's interface should keep users informed about what is going on, through appropriate feedback within a reasonable time.

Match between system and real-world	The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-based terminology. The interface should follow real-world conventions, making information appear in a natural and logical order.
User control and freedom	Users often choose system functions accidentally and will need a clearly marked exit to leave the unwanted state without having to go through extra dialogue.
Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions and stay consistent.
Error prevention	Either prevent error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
Recognition is preferable to recall	Minimise the user's memory load by making objects, actions, and options highly visible. The user should not have to remember information from one part of the dialogue to the next. Instructions for use of the system should be visible or easily accessible whenever appropriate.
Flexibility and efficiency of use	Actions can be sped up for expert users so that the system can cater to both experienced and inexperienced users. This should allow users to customise frequently used actions.

Aesthetic and minimal design	The interface should only contain information which is relevant and needed by the user. Every extra unit of unnecessary information competes with relevant units of information and decreases their relative visibility.
Assist users in the recognition of, diagnosis of and recovery from errors	Error messages should be expressed in plain and simple language, precisely diagnose the problem, and helpfully suggest a solution.
Provide help and documentation	Although an ideal system is highly usable without help and documentation, it may be necessary to provide it. Any such information should be easy to search, focused on a user's tasks, describe specific steps to be carried out, and not be too cumbersome.

Tognazzini (2012), also created an extensive set of principles to guide usability of an interface (Table 2.3).

Table 2.3: Tognazzini's (2012) First Principles of Interaction Design.

Principles	*Descriptions*
Anticipation	The system should attempt to anticipate the needs and wants of its users.
Autonomy	Users should feel in control of the task at hand. Users require some boundaries, but do not like to feel restricted.
Colour Blindness	Interfaces should cater for colour blindness, so it is best to not rely on colour alone to portray meaning. Difference in greyscale can help users differentiate objects.

Consistency	Interface objects should appear consistent with their behaviour. Objects with different behaviour should appear differently.
Defaults	Default options should be easy for users to change. These should be referred to as "settings" or some other user-friendly term.
Efficiency of the User	Focus should be on making the interface efficient for the user, not the computer. Use natural mappings (Norman, 2002).
Explorable Interfaces	It should be clear to users where they are, through navigation "breadcrumbs", so that they can orientate themselves. This includes a "home" screen that users can always return to and a way for users to return to where they were previously.
Fitts' Law	Fitts' Law states that "The time to acquire a target is a function of the distance to and size of the target". Tognazzini recommends that important functions should have large buttons, and that important actions (such as navigation) should be pinned to the corners of the screen as these areas are easy to get to.
Human Interface Objects	Human interface objects are any objects that can be seen, touched, heard or perceived in any other way. They are a standard way of engaging with an interface. They should be easy to understand, consistent and stable.
Latency Reduction	The user should not experience any obvious latency. Tognazzini recommends removing any element of an application that is not required in order to avoid latency.
Learnability	Try to make the learning curve as small as possible, without trading off any required functionality.

Metaphors	Metaphors must enable the user to grasp the finest details of the conceptual model instantly.
Protect Users' Work	Ensure that users never lose their work as a result of human or system errors.
Readability	Text that must be read must have high contrast. Tognazzini recommends black text on a white or pale yellow background.
Track State	The user needs to know where they are and where they are going.
Visible Navigation	Avoid invisible navigation. The navigation should always be clear to the user.

With the cost of user testing becoming an issue, evaluation checklists like Nielsen's (2005) heuristic evaluation and Tognazzini's (2012) usability principles have become supplementary to — or have even completely replaced — user testing (Carroll, 1997, p. 70). Nevertheless, usability testing is still commonly used when evaluating new technologies in interaction design (e.g., Gu, Koh, Chen & Duh, 2010).

In addition to usability engineering, user-centred design includes the process of *design rationale* (Carroll, 1997; Nielsen, 1994). This involves documenting the reasons behind decisions made during the design process as well as the design solution. A design rationale can explain why a design is the way it is, the motivations behind a particular design and the reasoning behind any design ideas that were considered and rejected (Design Rationale Group, 2010, para. 1; Burge & Bracewell, 2008, para. 1). It can provide deep insights into both the design and the decisions made during the process (Burge & Bracewell, 2008, para. 1). This includes factors such as deciding how the system would meet user requirements, reasons for including or excluding features and discussions, debates and negotiations between various stakeholders (Carroll, 1997, p. 72; Nielsen, 1994, p. 108).

Information collected for a design rationale can prove useful for many applications, including re-

design, reuse, maintenance, learning, documentation, collaboration and project management (Burge & Bracewell, 2008, para. 1).

Moran and Carroll (1996) considered a design rationale to have six aspects:

1. A design rationale encompasses the reasons for the design of an object
2. It includes the justification of why something is being designed — the purpose behind the object being designed
3. It can involve the format for recording reasons for the design
4. It can be a method for design. It can act as a tool for guiding the design process
5. It can act as a way of documenting the design. This can include documenting social, cultural, political and organisational considerations
6. It can offer explanations to questions raised about a design (Moran & Carroll, 1996, p. 9).

While the phrase design rationale covers all these aspects, it most likely provides a potential method of documenting design decisions. It can be considered a resource for design (Moran & Carroll, 1996, p. 373; Burge & Bracewell, 2008, para. 3).

Finally, user-centred design can also involve *cooperative activity*: it is a social and organisational approach to design, which has been suggested after cognitive models in HCI had failed to produce a comprehensive, holistic paradigm (Carroll, 1997, p. 74; Nardi, 1995, p. 5). Cooperative activity gives the designer the opportunity to consider social factors, along with users' attitudes and experiences (Carroll, 1997, p. 74; Nardi, 1995, p. 6). This consideration of social factors has continued with co-design and co-experience in user experience design (Battarbee, 2003; Roto et al., 2011) and interaction design (Zimmerman et al., 2011).

Bourguin, Derycke and Tarby (2001, p. 5) suggested that a system needs to evolve and adapt to support the needs of users as they emerge. However, the working methods and practices of the users of the system may also evolve in parallel to the system's evolution (Bourguin et al., 2001, p. 5). Evolv-

ing interactive systems, according to Bourguin and colleagues (2001, p. 4), are considered to be mediating between the users and the system's designers in two ways. Firstly, mediating between the capabilities, needs and wishes of users, the technological constraints and the capabilities and wishes of designers. Secondly, mediating for supporting both evolution and maintenance of the system in the long term. It is therefore "necessary that the developed interactive system serves itself as a bridge between the two parties, through the artefact itself" (Bourguin et al., 2001, p. 4). The final system, in the view of Bourguin and colleagues (2001, p. 4), is an implementation reflecting the balance between the wishes, needs and capabilities of the users and designers.

In recent years, the concept of cooperative activity has been heavily integrated into an emerging discipline known as service design. Service design is an interdisciplinary approach that combines different methods and tools from various disciplines, including visual communication design, information design and interaction design (Sanders & Stappers, 2008, p. 10; Stickdorn & Schneider, 2010, p. 29). Service design emerged as a multidisciplinary approach as post-industrial countries moved from manufacturing towards service delivery (Zimmerman, 2011; Forlizzi & Zimmerman, 2013; Holmlid, 2007). While there is no common definition of what service design is, there is some agreement of what its characteristics are. Service design follows processes which develop services through the user's perspective, but aim to involve all potential stakeholders (Segelstrom, Raijmakers & Holmlid, 2009, p. 4349; Stickdorn & Schneider, 2010, p. 29). It is not possible for one discipline alone to design interaction effectively: technical expertise of the technologies being used is required, and fields such as ergonomics and sociology can also have a role to play. An understanding of the user is also required (Dix, 2004, p. 4). Service design places prominence on the socio-technical context in which a design is used, meaning that a designer has to consider the social context as well as the technologies utilised in the delivery of the service (Beaumont, Bolton, McKay & Hughes, 2014). Although HCI has traditionally considered the user to be an "expert in their field" (Carroll, 1997, p. 69), Holmlid (2009) suggested that users that do not have technical knowledge can offer valuable in-

sight into a design because of this lack of expertise. Holmlid suggested that users who are involved in the design process are "not regarded as experts on utility of technology" (2009, p. 7) and that this is a benefit of participatory design. Service design addresses these users by involving them in the design process, which allows them to become familiar with the technology, while also allowing the designer to gain a clearer understanding of the user's contexts and abilities (Holmlid, 2009). Designing interaction requires a multi-disciplinary approach. As Dix stated, this means that "input is needed from all sides" (2004, p. 4).

Service design is gaining traction as an approach to design within interaction design (Forlizzi & Zimmerman, 2013; Holmlid, 2007). Zimmerman (2011) has even called for user-centred design to be "killed off" because of its lack of consideration for other stakeholders in the design process. The strength of service design is that it allows a more holistic approach to the design process than user-centred design, allowing designers to work closely with service providers and draw upon well-established design conventions in order to meet the needs of the users (Zimmerman, 2011; Zimmerman et al., 2011). As Zimmerman noted, it is important to remember the reason why users were involved in the first place — to ensure that the designed product or service would meet their needs (2011, p. 11). The purpose of involving users in the design process was to increase the chance of a service provider having a successful product or service (Zimmerman, 2011, p. 11). Despite the growing interest in service design, much of the attention in interaction design is still primarily on the user, with interaction design researchers still referring to user-centred design (Garcia et al., 2010; Holmlid, 2007; Kohno, Yasu, Sugawara, & Nishikawa, 2013; Parker, May, & Mitchell, 2014).

2.2.3 Simplicity as a design goal

Simplicity is an interaction design method for improving usability. Maeda (2006, p. 2) asserted that simplicity is of great importance, but this is affected by the requirements of functionality. Maeda (2006) addressed simplicity in an interface, by identifying 10 Laws in which it can be applied (Table

2.4).

Table 2.4: 10 Laws of Simplicity (Maeda, 2006, p. ix). Simplicity is a design method for improving usability.

Law	*Description*
Reduce	The simplest way to achieve simplicity is through thoughtful reduction.
Organise	Organisation makes a system of many appear fewer.
Time	Savings in time feel like simplicity.
Learn	Knowledge makes everything simpler.
Differences	Simplicity and complexity need each other.
Context	What lies in the periphery of simplicity is definitely not peripheral.
Emotion	More emotions are better than less.
Trust	In simplicity we trust.
Failure	Some things can never be made simple.
The one	Simplicity is about subtracting the obvious, and adding the meaningful.

Maeda stated that the "easiest way to simplify a system is to remove functionality" (2006, p. 1). If a design works just as well without an element, then that element ought to be removed (Rogers et al., 2011, p. 30). In the context of providing information of an important nature, such as FireWatch, this appears to be a sensible approach when compared to providing maximum functionality. The balance between functionality and simplicity is of great importance to the FireWatch redesign project. Simplicity, as a design goal, differs to a minimalist aesthetic. Minimalism, perhaps summed up best by the axiom "less is more" (Obendorf, 2009, p. 16) is essentially an aesthetic choice rather than the strategic reduction in functionality advocated by Maeda (2006). A similar approach to Maeda's "thoughtful reduction" (2006) is the requirements engineering method known as "Interaction Deconstruction" (Lamminen, Rousi & Saariluoma, 2011). This method involves identifying key user actions, and their sub-actions, and addressing how each can be improved in terms of usabil-

ity and user experience (Lamminen et al., 2011, p. 161). By identifying only key user actions that help users achieve their goals, Lamminen et al's (2011) method also acts as a practical means of simplifying the interface.

Norman (2007, p. 40; 2008, p. 45) considered the concept of designing for simplicity as "highly overrated". Norman suggested that users want simplicity in products that they use, but that it is the job of designers to provide this without substantially sacrificing functionality (2007, p. 41; 2008, p. 46). Norman (2008, p. 45) pointed out that complex interfaces need to be managed by a designer by making these more understandable. A product needs to have the capacity to do the job required while being understandable to the user. It needs to give the user the feeling of being in control, giving them the satisfaction of accomplishment (Norman, 2008, p. 46) or achieving a goal (Hassenzahl, 2004a, p. 47).

Given that the redesigned FireWatch service aims to cater to users situated in remote communities, it was considered essential that the interface is understandable and usable for a wide range of users. Users generally work well within a system with constraints, as these make it simple for the user to ascertain what actions are possible and what the results of these actions will be (Laurel, 1993, p. 105; Norman, 2002, p. 86). However, Talamo, Giorgi and Mellini (2011) identified that users do not necessarily prefer simple interfaces — their preference is for designs that they are familiar with.

Web users in general seek familiarity and consistency in the interfaces they use (Nielsen, 2000, p. 188). It is necessary that a redesign for a service such as FireWatch should provide users with the familiarity that they expect when using a website. Boulton (2009) offered classic web design principles (Table 2.5) as a means of providing familiarity to users.

Table 2.5: Classic web design principles (Boulton, 2009).

Principle	*Description*

Researching and ideas	This involves the design process, brainstorming, researching relevant information and ideas. This sometimes involves direction from a client in the form of a creative brief, which outlines factors which the designer needs to consider.
Typography	Typography includes typesetting, hierarchy and being aware of the defining characteristics of fonts.
Colour	Designers need to be aware of colour theory: which colours combine well and how they can set a particular mood.
Layout	Layout involves being aware of composition, spatial relationships and how and when to align elements.

Page elements such as margins, page and column widths and indentation can all affect the readability and usability of a web page (Allsopp, 2000 para. 43; Boulton, 2009 Chapter 5). Aside from setting mood, colour can also help establish a visual identity and draw the user's attention to a particular element (Allsopp, 2000 para. 48). Colour is vital in identification of elements and allows users to understand which elements belong with others and which are different (Allsopp, 2000; Boulton, 2009).

A website should make it as simple as possible for a user to achieve their goal (Krug, 2000, p. 179; Nielsen, 2000, p. 380). Consistent and simple interfaces are easier on the user, reducing the cognitive burden (Krug, 2000, p. 77; Nielsen, 2000, p. 380). Loyal visitors, who keep returning, indicate the success of a website as users preferred websites that are easy to use and navigate (Krug, 2000, p. 62; Nielsen, 2000, p. 380). To address the need for return visitors, Nielsen (2000, p. 380) identified that a website needs to adhere to the following principles: high-quality content, often updated, minimal download time, ease of use and relevance to users' needs.

Norman (2002, p. 188) offered a set of design guidelines for focusing primarily on the needs and interests of the user: (1) use constraints to make it simple for the user to ascertain what actions are possible; (2) the result of user actions should be clear to the user, as well as any alternative actions; and (30) it should also be simple to understand the current state of the system and it should be obvious which actions can carry out a user's intentions, what the result of their actions will be and what state the system is in should be easily interpreted (Norman, 2002, p. 188). These points were also covered in interface design guidelines offered by Foley (1996) for improving functionality and usability of a system's interface: Provide simple and consistent interaction sequences, do not overload the user with too many different options and styles, show the available options clearly at every stage of the interaction, give appropriate feedback to the user and allow the user to recover gracefully from mistakes (p. 41).

These guidelines and principles are intended to ensure that the interface design is self- explanatory and intuitive (i.e., the user can work out what they can do with the system), and that the user knows what is going on with the system (Foley, 1996, p. 41; Norman, 2002, p. 188). Norman (2002, p. 23) stressed the importance of intuitive design by further extending the use of "natural mappings". The primary prerequisite of natural mapping is to ensure that the spatial relationship between a system and its controls is as direct as it can be. Hence, reducing the cognitive load on the user (Laurel, 1993, p. 131; Norman, 2002, p. 188). The aforementioned guidelines and principles from Maeda (2006) and Boulton (2009), as well as points made by Nielsen (1994, 2000), Norman (2002), Laurel (1993) and Foley (1996), offered some insight into how the redesigned FireWatch interface should address simplicity as a design goal. An interface should aim to achieve simplicity by exploiting natural mappings, having a clean, consistent interface that uses elements familiar to web users and aimed to make functions as easy to use as possible, as well as undertaking a strategic reduction in functionality.

2.2.4 The place of emotions in interaction design

One of Maeda's (2006, p. ix) laws of simplicity states that there should be more, rather than less, emotions in an interface. The place of emotions in HCI is something that researchers have placed at the forefront of HCI for some time (Jordan, 2002; Laurel, 1993; Norman, 2004). Designers were seeking a more holistic approach to design user interfaces. In an attempt to capture the essence of the elusive nature of emotions in design, Norman (2004, p. 5) identified three key levels of product experience:

(1) *Reflective*: This level is concerned with emotions and feelings, and is influenced by a person's education and experiences. It involves a person's sense of self and personal satisfaction, and can invoke memories. Examples of experiences at this level include a person feeling pride in owning a product or thinking that it is "cool".

(2) *Behavioural*: This is the level where most human behaviour occurs, and is concerned with practicality and functionality. It influences the visceral level, but is also influenced by the reflective level. At this level, the user will determine whether a product or service is useful or not.

(3) *Visceral*: At this level the user makes quick decisions about what is good or bad, safe or dangerous, allowing them to act accordingly — it is concerned with surface level appearances, or aesthetics. When someone finds an object beautiful or elegant, this is the visceral level at work. Users often consider beautiful products to work better and can even overlook flaws in functionality because of their perceived beauty. Any designed object works to some degree on all three of these levels. A design addressing these three levels effectively needs to be aesthetically pleasing, functional and sensitive to human emotions (Jordan, 2002, p. 14; Norman, 2004, p. 10).

The reflective, behavioural and visceral levels work interdependently with each other: "Emotions are inseparable from and a necessary part of cognition. Everything we do, everything we think is tinged with emotion, much of it subconscious." (Norman, 2004, p. 8). Aesthetics can therefore

have an impact on both human emotions and cognitive functions (e.g., interpretations of what we perceive) (Jordan, 2002, p. 47; McCarthy & Wright, 2004, p. 18; Norman, 2004, p. 18; Tractinsky, Katz, & Ikar, 2000, p. 129). In his 2007 book *Emotional Design*, Don Norman writes:

> "In the 1980s, in writing 'The Design of Everyday Things', I didn't take emotions into account. I addressed utility and usability, function and form, all in a logical, dispassionate way — even though I am infuriated by poorly designed objects. But now I've changed. Why? In part because of new scientific advances in our understanding of the brain and of how emotion and cognition are thoroughly intertwined" (2004, p. 8).

Due to this symbiotic relationship between emotion and cognition, Hassenzahl stated "Designers can shape, but they cannot determine. They can create possibilities but they cannot create certainties. The same holds true for emotional experiences" (2004a, p. 47).

The idea of aesthetics serving a practical purpose is not a new idea. John Dewey (1934, p. 78) argued that art should be a part of people's everyday experiences; that aesthetics should have pragmatic applications. Aesthetics can make users of a product perceive that it is more usable (Norman, 2004, p. 69; Tractinsky et al., 2000, p. 141). It is important for designers to be aware of the three layers of processing although there are no solid rules for these with regards to design (Jordan, 2002, p. 62; Norman, 2004, p. 67).

Nevertheless, some researchers have offered guidelines for considering emotions in design. Reimann (2005) offered user-centred design principles addressing the three levels of design raised by Norman (2004) and Jordan (2002), particularly at the visceral, aesthetic level. Reimann (2005 para. 17) suggested that an interface should seek to make the user feel smart or in control, have fun, feel cool or "hip" or relaxed, or remain focused and alert. Making the user feel in control and remaining focused and alert are suitable outcomes for the redesigned FireWatch interface, as it may be used in potentially stressful situations.

McCarthy and Wright (2004, p. 66) suggested considering the implications of interface aesthetics. Interface aesthetics should seek to connect values, emotions, and physical activities. They should respect meanings already given to traditional activities and artefacts but offer them in a new context, and should seek a balance between tradition and innovation. Aesthetics should be balanced with usability and functionality (McCarthy & Wright, 2004, p. 66; Norman, 2004, p. 58; Jordan, 2002, p. 6). The emphasis should, however, be on aesthetics and the emotions of users and because of the pervasive nature of modern technology in our lives (McCarthy & Wright, 2004, p. 18; Norman, 2004, p. 103).

Hassenzahl (2004a) has offered a perspective on the place of emotions in the interaction design equation. Contrary to emotional design, which considers emotions to be the most important aspect of design, Hassenzahl (2004a, p. 47) emphasised that products and services should be designed with the user's needs at the forefront, rather than their emotions. As both Hassenzahl (2004a, p. 47) and Schneller (2010, p. 164) put it, designers should not be aiming to design an experience, they should be looking to design *for* an experience or intended effect. This is also something that Rogers et al emphasised in the context of user experience (2011, p. 14). John Dewey (1913, p. 65) expressed a similar sentiment decades earlier, albeit in the context of education. He suggested that for an activity to be engaging, it must appeal to the needs of the individual (Dewey, 1913, p. 65). Likewise, designer Max Bill, in 1949, raised the concept of design appealing to the emotions of people engaging with it. Bill stated that a design object used "daily and all the time, from a pin to interior decor should be designed in the spirit of a beauty developed from function, and that through this beauty it fulfils a function of its own" (Muller-Brockmann & Muller, 2001, p. 28). The aesthetics of a designed object should perhaps attempt to draw its inspiration from the function of the product or service. Hassenzahl (2004a, p. 47) suggested that a design will be emotionally satisfying to a user if it allows them to successfully carry out a task, meeting their needs.

Accordingly, there are four distinct needs that users may have: (1) goal-achievement, (2) personal

growth — acquiring knowledge and skills, (3) identification — self- expression, interaction with relevant others and (4) evocation — self-maintenance, memories (Hassenzahl, 2004a, p. 47). If a design allows a user to successfully fulfil one (or more) of these needs, it is likely to promote positive emotions (Hassenzahl, 2004a, p. 47). In the case of the redesigned FireWatch service, it is probable that the needs of users will include goal-achievement (preparing or responding to the threat of a bushfire) and personal growth (learning how to cope with the threat of a bushfire). Designer Massimo Vignelli emphasised the importance of designers focusing on the needs of users: "We really have to define what people need rather than what people want, which was what was done before by marketing. Marketing was looking for what people want — people do not know what they want… Design has to be more responsible towards design itself, towards the user, and towards society" (Challand, 2009, para. 3).

2.2.5 Designing for cross-browser and cross-device compatibility

The redesigned FireWatch service must be built to be accessible across as many different devices and web browsers as possible. It is important to consider browser and device usage when designing an interface. Australians are using several web browsers to access the internet, with *Internet Explorer*, *Mozilla Firefox*, *Google Chrome* and *Apple Safari* amongst the most popular desktop browsers (Cowling, 2011, para. 2). Australians — and web users generally — are also increasingly accessing the web through mobile and tablet devices (Marcotte, 2011, p. 6). As of December 2011, over 18% of Australians were accessing the internet at home solely through mobile devices (KPMG, 2011, para. 6). 53% of Australian adults said that a smart phone was their primary communication device, a number which is increasing (Australian Communications and Media Authority (ACMA), 2013b). Making a website adaptable to different devices and web browsers is one way to make it more accessible (Allsopp, 2000, para. 24; Marcotte, 2011, p. 96). Making layout elements and fonts scalable and flexible for various devices means that pages will be more accessible across multiple browsers and de-

vices (Allsopp, 2000, para. 43; Marcotte, 2011, p. 96). It is also ideal to build an interface with *graceful degradation* in mind, that is, that it will work on both modern and older devices, and will likely work on new devices in the future. Graceful degradation ensures that there is reasonable consistency of web interfaces between versions of various browsers and devices (Florins & Vanderdonckt, 2004, p. 141). It means that interface designers have to cater for varying screen sizes, resolutions and number of colours. Florins and Vanderdonckt (2004, p. 141) recommended graceful degradation as a useful way to design user interfaces for multiple browsers and devices when the capabilities of each browser or device vary greatly. Florins, Simarro, Vanderdonckt and Michotte (2006, p. 1) noted that interface elements may need to be moved around to accommodate devices with smaller screen sizes, such as mobile phones.

There has been a recent focus in web design towards using a grid system to guide the placement of page elements (Terror, 2009, para. 12). Using a grid to guide the placement of elements in a designed object has been a part of the Swiss graphic design school since just after the Second World War (Muller-Brockmann & Muller, 2001; Hollis, 2006) and popularised by graphic designers such as Massimo Vignelli (Carusone, 2010). The approach of using a grid system to guide the layout of web pages has been gaining popularity in recent years (Taylor, 2012; Terror, 2009; Smith, 2012). Despite the rigidity of grids in the print world, their online version can be adapted to be more flexible. Some developers have made responsive layout grid systems open to other developers to use and modify (Smith, 2012; Taylor, 2012). These grid systems present a grid layout as a base, which is flexible enough to contract down to the dimensions required by devices such as tablets and mobile phones (Smith, 2012; Taylor, 2012).

A flexible interface that allows designers to cater for several browser window sizes, including mobile and tablet devices, has been described as "responsive design" (Marcotte, 2011, p. 9). Through the use of Cascading Stylesheet (CSS) "media queries" — code that targets specific browser sizes — designers can target several different devices. This allows a designer to create a flexible layout that will

expand or contract, depending on the device that it is viewed on. CSS allows a designer to provide a simpler, more condensed version of an interface for smaller devices. As Marcotte (2011) has noted, responsive design allows designers to "craft sites that are not only more flexible, but that can adapt to the media that renders them" (p. 8). Responsive design allows an interface designer to deal with the flexibility of the modern web without losing the control that designers require over a medium (Marcotte, 2011, pp. 5-6). Responsive design provides the designer with the means to provide a flexible design grid and flexible images across several devices (Marcotte, 2010, para. 5). It also allows an interface designer the option of catering for many different types of devices without having to forward users of particular devices to a sub-domain hosting a simplified version of the website (Marcotte, 2010, para. 4). Nevertheless, Marcotte (2010, para. 4) suggested there are some circumstances where the best approach might be to serve different content to mobile devices. Given the reality of today's web being accessed by several browsers across desktop machines, laptops, tablets and mobile phones, using a responsive design layout for FireWatch is an essential approach to the redesign of the interface. Marcotte (2010) suggested the following as ways to provide content to users on smaller devices: increase the target area on links for smaller screens; selectively show or hide elements that might enhance a page's navigation; and employ responsive typesetting to gradually alter the size and leading of our text, optimising the reading experience (para. 23). This means that users of devices with smaller screens, such as tablets and mobile phones, will get access to more readable content and a more usable interface. It also means that the design will more likely be "future-proof", in the sense that it will be able to adapt to future devices without significant redevelopment (Marcotte, 2011).

2.2.6 Visualising spatial data

Displaying visual information "creates a visceral connection to the content that goes beyond what is possible through traditional text documents" (Harris et al., 2010, p. 130). Most people prefer to access visual representations of information prior to viewing it in greater detail (Davis, 2001, p. 11).

Maps have a role to play in the presentation of complex data because they present data to the viewer in a way that allows them to quickly and easily gain an initial impression (Davis, 2001, p. 11). Allowing multiple datasets to be viewed spatially in the one application reveals relationships between the data that may not be apparent when viewed in other contexts (Kraak & Ormeling, 2013, p. 10). Maps are useful because they allow a designer to easily show vast quantities of data in a small form (Tufte, 1983, p. 16).

In terms of software, geographic information systems (GIS) are an efficient and effective way of visualising data (Davis, 2001, p. 11). More recently, modern web technologies such as HTML 5, CSS and JavaScript have enabled web designers and developers to create elaborate ways of visualising data online (Fhala, 2012, p. 1). These technologies, along with open-source frameworks, have expanded the possibilities of data visualisation on the web (Fhala, 2012, p. 1). These possibilities include web-based map applications developed through the use of map frameworks such as Google Maps (Petroutsos, 2014), OpenStreetMap (Muehlenhaus, 2013, p. 208) and OpenLayers (2014). Google Maps, along with other web-based mapping products from Microsoft and Yahoo, and standalone map software such as Google Earth and Virtual Earth, have made geospatial information more easily accessible to users, as these remove the need to deal with the complexity of GIS software (Harris et al., 2010, p. 127). These platforms allow users with no knowledge of cartography to easily build their own maps (Muehlenhaus, 2013, p. 10).

These new mapping products, often referred to as *The Geospatial Web* (Harris et al., 2010), support a range of data services that contain geospatial data. Standardised formats such as Web Map Service (WMS), Web Feature Service (WFS) and Keyhole Markup Layer (KML) provide geopositioned bitmap and vector information that give a new dimension to the landscape (Harris et al., 2010, p. 139; Scharl & Tochtermann, 2009, p. 4). GIS consultant Eric Edmonds has emphasised the importance of making online map applications easy to understand, recommending that developers create applications that serve a single purpose so as to avoid information overburden on public users

(Edmonds, 2013).

With the advancement of web-based map interfaces, several functions have emerged as standardised means of interaction and presentation. Due to the ubiquity of Google Maps, panning and zooming have become common features of web-based map applications, as have tiled layers (Muehlenhaus, 2013, p. 10). With access to the Google Maps' Application Layer Protocol (API), and its adoption of KML, users can easily create their own data layers on top of Google's base-map layer(Muehlenhaus, 2013, p. 10). Google's map interface is associated with being a good quality and reliable source of map information (Dransch, Rotzoll, & Poser, 2010).

Using these technologies to visually plot data makes a map more meaningful to users, when compared with static imagery (Watanabe, 2013).While GIS software still has its uses for specialists, The Geospatial Web has made spatial information more accessible to general users and researchers in the humanities (Harris et al., 2010).

2.2.7 Realistic versus abstract imagery

It is worth investigating how users may expect the satellite-derived information presented by the redesigned FireWatch to be visualised. Rather than realistic graphic presentations that users may be familiar with through high-end gaming contexts, meaning can be conveyed to users in more abstract terms. For example, Errea (2003) quoted John Grimwade as a designer who worked with publics and who himself preferred a schematic representation because "the schematic gives a hierarchy to the information and invites me to enter further into the graphic. This is the language of infographics, which is not the same as photography" (p. 17). The realism continuum also suggests that an abstract representation is better at conveying meaning to the observer (Medley & Haddad, 2011). The realism continuum is a "visual model that presents any image as a series of pictures, iteratively reduced in fidelity from its referent" (Medley & Haddad, 2011, p. 147). Observer's visual systems (i.e., eyes and brain) preferred images at the more abstract end of the continuum compared to photo-realistic

images when ascertaining meaning (Medley, 2013, p. 85; Medley & Haddad, 2011, p. 147). Nevertheless, this is highly dependent on the context in which the imagery is being used (Medley & Haddad, 2011). Photography can be an effective means of providing a realistic portrayal of the environment and its specific elements (Heller & Pomeroy, 1997, p. 46; Medley, 2013, p. 85).

2.2.8 Visual rhetoric

Visual rhetoric refers to the way that graphic designers communicate meaning to people, through the use of colour, contrast and other design elements (Schneller, 2009, p. 352). Rhetoric generally, is the practice of persuasive communication — including written, verbal and visual — and the art of studying this communication (Buchanan, 1985). Gui Bonsiepe (1965) had the following to say about rhetoric, in the context of visual design:

> "Information without rhetoric is a pipe-dream which ends up in the break-down of communication and total silence. 'Pure' information exists for the designer only in arid abstraction. As soon as he begins to give it concrete shape, to bring it within the range of experience, the process of rhetorical infiltration begins" (p. 30).

Visual rhetoric borrows knowledge and methods from verbal rhetoric and applies them to graphic design (Schneller, 2009). The theory proposes that "visual communication follows rhetorical rules — which might be followed unconsciously by the designer" (Schneller, 2009, p. 352). The idea of visual rhetoric rejects the view that information can simply be displayed in an objective or neutral manner. It suggests that even purely informative pieces of design, such as signposts and timetables, still attempt to have an effect on the user — for example, to inform them or orient them. In fact, Schneller (2010) stated that "the act of informing is deeply rhetorical" (p. 162). Designers need to think about the rhetorical facets of design when they are creating something for others to use (Kostelnick, 1990, p. 200). A designer also needs to consider visual conventions and the viewer's

expectations based on the context in which a design sits (Kostelnick, 1990, p. 200). It is therefore important to consider the effects on the user that the redesigned FireWatch interface might have. The interface should ensure that it allows users to carry out the task that they want to achieve: namely, being informed of the locations of possible bushfire threats in their community. To do this, the interface needs to be built considering the conventions of modern web-based map applications that users may be familiar with.

Rhetorical effects can be defined and categorised in two ways, according to Schneller (2009). Firstly, people confronted by a visual object can experience emotional or cognitive changes — for example, confusion, surprise, feeling informed or impressed. Secondly, they can feel that the visual object has a property — such as being fresh, sweet, light, modern or mysterious. These qualities are subjective and open to interpretation, depending on the person viewing the visual object (p. 352). It is likely to be important that the redesigned FireWatch interface leads to users experiencing emotional or cognitive changes beneficial to the situation. Given that people will be using the redesigned FireWatch service in potentially stressful situations, it would be ideal that the interface makes them feel, for example, informed rather than confused.

Kinross (1987, p. 18) stated that there is no neutral or "pure" information. Schneller (2010, p. 162) expanded on this, explaining that even objects such as timetables are designed with a goal in mind. Secondly, visual effects go beyond the use of pictures: the designer makes conscious decisions regarding aspects such as colour and placement (Schneller, 2010, p. 162). Thirdly, behind every decision made by a designer, is a design rule that has been tried and tested (Schneller, 2010, p. 162). This means that behind even the most "neutral" design are historical, cultural and zeitgeist meanings of what a purely neutral, informative, design actually is (Schneller, 2010, p. 162).

Visual rhetoric, much like the user experience (Hassenzahl, 2004a; Norman, 2004; Jordan, 2002), works on three levels, according to Schneller (2010). These three levels are: *logos* — the functional, objective aspects of design; *pathos* — well-being, the joy or other emotions the user derives from the

design; and *ethos* — trust and reliability that the user experiences with the design (Schneller, 2010, p. 162). These aspects have been covered previously, but within the context of HCI. The objective (logos) side of the redesigned FireWatch service is that it provides a map of Australia to alert users to current bushfire locations. As stated previously, an effort will be made with the interface to balance functionality and simplicity (Maeda, 2006; Boulton, 2009). Hassenzahl suggested (2004a, p. 47) that successfully designing for a user's needs will likely lead to them experiencing satisfaction with the interface. Addressing the user's needs in this way is considered the pathos of the redesign process. Trust and reliability (ethos) will be addressed by considering Fogg's (2003; Fogg & Tseng, 1999) guidelines for designing a credible and authoritative interface.

In the Keelty report on the Margaret River bushfires, there are several references to "red flag burn", that is, a fire that "has high potential and/or high consequence for loss" (Keelty, 2012, p. 33). The colour red, in western societies, is associated with danger (Evans & Thomas, 2007, p. 138). It makes sense for dangerous elements within the map component to use red to bring them to the user's attention. Fire warning systems generally use yellow, orange and red to indicate varying levels of risk, with red indicating the highest risk (e.g., Bureau of Meteorology, 2011; Country Fire Authority, 2012; Hong Kong Observatory, 2009). Other elements, such as page navigation and instructions should be high contrast compared to their background, as this will maximise legibility (Evans & Thomas, 2007, p. 124). These are conscious rhetorical design decisions to be considered in the context of the FireWatch interface redesign.

2.3 Designing for disasters

This section frames where the redesigned FireWatch website is situated within the realm of disaster management, as well as discussing relevant interaction design issues regarding disaster information, credibility and authority. The redesigned FireWatch is intended to act as an information system, act-

ing as a supplementary information source to the alerts provided by state emergency services. The Report of the Perth Hills Bushfire and the Victorian Bushfires Royal Commission frequently uses the term "shared responsibility" (Keelty, 2011; Victorian Bushfires Commission, 2010). The term is also frequently used in recent fire ecology research that discusses the need for people to learn to co-exist with fire (Moritz et al., 2014). While emphasising that in some areas, the state and fire authorities hold greater responsibility than other groups and individuals, the Victorian Bushfires Royal Commission report stated that "communities, individuals and households need to take greater responsibility for their own safety and to act on advice and other cues given to them before and on the day of a bushfire" (2010, p. 6). In this context, the redesigned FireWatch could be considered one of these cues available to communities, individuals and households.

2.3.1 Disaster preparedness and early warning systems

In several countries, governments generally utilise a "four stage model such as MPRR (mitigation, preparation, response, recovery) or PPRR (prevention, preparation, response, recovery)" (Heath, 1998). Emergency management in Australia also generally bases its strategies on the PPRR model (Hosie & Smith, 2004). This is an iterative model (Figure 2.1), where, according to Hosie and Smith, the four elements are interrelated and "learning is an axiomatic and critical recurrent feature" (2004, p. 91):

Figure 2.1: The PPRR (prevention, preparation, response, recovery) Crisis Management Model (Hosie & Smith, 2004, p. 91). This is an iterative model where the four elements are interrelated.

Disaster risk reduction includes measures to "minimise vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards" (United Nations International Strategy for Disaster Reduction [UNISDR], 2004, p. 2). Part of these measures include the provision of training, research and information and "early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities" (UNISDR, 2004, pp. 2-3).

The UNISDR defines an early warning system as the "provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response" (2004, p. 3). It goes on to explain that early warning systems "include a chain of concerns, namely: understanding and mapping the hazard; monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings" (UNISDR, 2004, p. 3). The Hyogo framework identifies "risk identification, assessment, monitoring and early warning" (UNISDR, 2005, p. 2) as a key area that poses challenges for disaster risk reduction. The Hyogo framework listed early warning systems as a

key component of reducing disaster risk and created the following guideline for their development:

> "Develop early warning systems that are people centred, in particular systems whose warnings are timely and understandable to those at risk, which take into account the demographic, gender, cultural and livelihood characteristics of the target audiences, including guidance on how to act upon warnings, and that support effective operations by disaster managers and other decision makers" (UNISDR, 2005, p. 7).

There is a clear need to ensure that the public understands early warnings and their implications (López-Carresi, Fordham, Wisner, Kelman, & Gaillard, 2013, p. 487). The 2014 *Human Development Report* from the United Nations (UN) identified that "planning for preparedness and recovery can be pursued at all levels — global, regional, national and community — and can be enhanced by information sharing" (Malik, 2014, p. 7). López-Carresi et al also identified the need to "involve community members in identifying the best communication mechanisms and strategies" (2013, p. 487). It is also important that warnings reach their audience quickly and effectively (López-Carresi et al., 2013, p. 487). For example, when designing for an Australian audience, it is necessary to consider the significant number of people using tablet and mobile devices to browse the internet: as of 2013, more than 11 million people have a smart phone (ACMA, 2013a). Early warning systems may also play a significant role in areas susceptible to fires due to the policy of "prepare, stay and defend" (Stephens et al., 2009). Researchers have also recommended that a similar policy be adopted in the United States, particularly California (Stephens et al., 2009).

In recent years, fire behaviour in Australia has had a devastating impact on both people and property, with the Black Saturday bushfires considered one of Australia's worst natural disasters (Saffron & John, 2012). Australia is one of the most bushfire prone continents on Earth (Clode, 2006, p. 66). Australia is expected to "experience consistent and extensive increases in fire probabilities", which is likely due to a changing climate (Moritz et al., 2012). Vulnerability is a key phrase that is mentioned

throughout the Victorian Bushfires Commission inquiry into the Black Saturday bushfires (Victorian Bushfires Commission, 2010) as well as the UN's 2014 *Human Development Report* (Malik, 2014). In the context of emergency management, the UNISDR defined vulnerability as "the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (2004, p. 8). Considering the vulnerability of remote and regional users of FireWatch, and to ensure that the redesigned FireWatch meets the needs of community members as a bushfire information system, demonstrates why it is necessary from a disaster management perspective to engage with real-world participants in the design process. Recent research has suggested that a grassroots, "ground up" approach is needed to better inform and prepare communities in bushfire-prone circumstances (Brady & Webb, 2013; Frandsen, Paton, Sakarisiassen, & Killalea, 2012), as well as disaster-prone situations more broadly (Palen & Liu, 2007).

Information Communication Technology (ICT) has a role to play in the mitigation, preparedness, response and recovery stages of emergency management (National Academy of Sciences, 2007). Effective emergency warnings can reduce the loss of life, minimise damage and assist in recovery (National Academy of Sciences, 2007, p. 60). Warnings are most effective when:

> "(1) they are accurate and result in appropriate action; (2) any probabilistic aspects are clearly communicated; (3) They are standard, consistent and easily understood; (4) They are delivered to just the people at risk and in a timely manner; and (5) They are delivered through a variety of mechanisms to achieve maximal reach" (National Academy of Sciences, 2007, p. 60).

Warning systems can be improved by incorporating existing and emerging technologies, and digital communications are an effective way of reaching the public (National Academy of Sciences, 2007, pp. 61-62). Digital technology has also changed the flow of disaster information: not only can it be

used to inform the public, but technology such as mobile communications also allow "the public to both gather and communicate information" (National Academy of Sciences, 2007, p. 62). However, a system that would facilitate the public submitting disaster information would require "considerable shifts in culture among public safety and emergency management professionals" (National Academy of Sciences, 2007, p. 61). Nevertheless, ICT has allowed for the public to engage in "information integration, extraction and reuse for local decision-making" (Palen et al., 2010, p. 4). Geonet (2014) in New Zealand is one example of an application where a government agency is facilitating this new dynamic flow of information in a disaster context. The Geonet application allows users to submit tremor effects from earthquakes via an online form, which acts as a method of data collection for scientists and "contributes to a better understanding of these hazards" (2014, para. 10). In California, FireWhat Incorporated, a private company that creates software for emergency services, runs the Wildland Fire (2014). This application also allows for the website's users — primarily firefighters — to submit information, which is then verified by the online community before it is added to an interactive map interface. The Center for Fire Research and Outreach at University of California Berkeley runs a Fire Information Toolkit for researchers, community leaders and home-owners. This resource does not allow users to submit fire information but encourages them to contact the researchers who run it (n.d.). This site features "Practical tools for homeowners and communities in the wildland-urban interface", such as assessments to ascertain one's vulnerability to fires as well as links to several other resources (Center for Fire Research and Outreach, n.d.). Significantly, the CSIRO's Emergency Response Intelligence Capability (ERIC) application has incorporated publicly submitted data from Twitter from specific fire events — alongside its web feed of satellite-detected fire hotspots — as a means of providing recent fire information to emergency services (Power et al., 2013). It was found that when compared to the fire hotspots web feed, data sourced from Twitter "contained more specific event information, included details of impact to the community, was updated more frequently, included information from the public and remains available as a source of

information long after the web feed contents have been removed" (Power et al., 2013, p. 1). This new dynamic of information flow is something that government agencies providing emergency information need to accommodate (Palen et al., 2010, p. 4).

Social media allows users to express their social connections and present an online representation of their own identity (Zhao, Grasmuck & Martin, 2008). Australian uptake of social media is particularly high, 95% of internet users having a Facebook account and 19% having a Twitter account (Sensis, 2014, p. 6).

Social media platforms are increasingly used for topic exploration (Choudhury, Counts and Czerwinski, 2011; Rajaraman, 2009). Recent interaction design research has also utilised social media as a way of engaging stakeholders in the design process (Sari & Tedjasaputra, 2013). These uses of social media rely on its ability to deliver information in real time and allow users to search user-generated content such as discussions, opinions and reviews; something lacking in conventional search engines (Choudhury et al., 2011; Rajaraman, 2009). As discussed by Wu (2008), timeliness and relevancy of information is critical in potential emergency situations. The arrival of Web 2.0, and its participative social technologies, have helped users to gain a greater understanding of issues that lead to the well-being of communities (Hesse et al., 2011, p. 27). Hesse et al noted (2011) that "the engagement of average citizens and civic leaders is leading to a grassroots restructuring of local environments to be conducive to health and well-being" (p. 26). As Wurman and colleagues (2001) stated: "We don't invent information; we allow it to reveal itself as it marches past. The parade must be encouraged, so that we can develop marvellous new organisational patterns that spark new understandings" (p. 52). In the instance of an emergency, this "parade" has to occur seamlessly and reach the end user as easily as possible and in a timely manner (Wu, 2008, p. 260; Lanfranchi & Ireson, 2009, p. 198).

2.3.2 The provision of remotely sensed information

The Landsat program is a series of ongoing satellite missions conducted as a joint effort between NASA (National Aeronautics and Space Administration) and the United States Geological Survey since 1972 (Committee on Implementation of a Sustained Land Imaging Program, 2013). In studying the history of the Landsat program from its inception, Pamela Mack (1990, p. 92) identified that the initial development of the technology could not be understood from looking at the later uses for which it was leveraged. This technology, known as remote sensing, has been used for a range of applications since 1972. Remote sensing has the ability to detect wavelengths ranging from the visible spectrum to the thermal spectrum (Liang, 2005, p. 1). Satellite imagery provides raw data for a range of applications and is used in several management arenas. Examples include precision agriculture (Cook, Adams, Bramley, & Whelan, 2002; Seelan, Laguette, Casady, & Seielstad, 2003), hydrology (Caputi, Chubb, & Pearce, 2001) and municipal planning (Spencer, 1985). Only recently have those in the GIS field come to realise that the presentation of geospatial data is as important as the data itself (Peterson, 2009, p. 1). Peterson considered it the responsibility of map-makers to make truthful and informative maps and to "keep making cartographic advances so that data can be transformed into wisdom" (2009, p. 3). Peterson argued that both communicative and aesthetic aspects of map data were necessary to consider when designing map interfaces (2009, pp. 4-5).

Emergency services use of remote sensing data depends on the timing of image availability — providing timely information is critical in potential emergency situations (Wu, 2008, p. 260). Multiple satellites that source imagery, combined with presentation technology, have made near real-time mapping of fires a reality. This gives the potential to provide people with the information and tools to make time- critical decisions regarding their safety. No one at the launch of Landsat 1 in 1972 would have predicted the recent popularity of applications such as Google Maps and Google Earth (Google, 2012; Harris et al., 2010). It is the trajectory of the internet's development that has led to

the possibility of Google Maps and Google Earth, and the popularity of these platforms offers the potential for greater community acceptance and use of the redesigned FireWatch. In fact, during the bushfires of February 2009 in Victoria — the worst bushfires of Australia's history — many members of the public turned to online mapping services to assess the risk of fires reaching their property (Moses, 2009, para. 6).

2.3.3 The role of digital maps in disaster management

Due to the increasing impact of bushfires in recent years, the provision of systems to alert communities, fire agencies and other government departments to the threat of bushfires is becoming increasingly important (Victorian Bushfires Commission, 2010, p. 12). It was suggested that the internet was an effective way of delivering this information. Another significant event in recent years was the El Questro bushfire of 2011. An ultra-marathon (a race significantly longer than a traditional marathon) was organised across a large section of the Kimberley region of northern Western Australia (Economics and Industry Standing Committee, 2012). Due to a lack of communication between the race organisers and local fire authorities, runners in the ultra-marathon ran into the path of a large fire, resulting in several runners suffering horrific injuries (Economics and Industry Standing Committee, 2012, pp. 2-3). The government-led inquiry into this event specifically highlighted the need for greater access to fire information.

The government-led inquiry into the El Questro bushfire drew attention to publicly accessible web applications that present bushfire information on a map of Australia (Economics and Industry Standing Committee, 2012, p. 12). Sentinel is a web-based map application run by Geosciences Australia to meet the needs of emergency service managers, allowing them to identify fire locations that are a potential hazard to communities and property (2011). NAFI is a service provided by the Tropical Savannah CRC in the Northern Territory, which was originally built to meet the needs of pastoralists and other land management (Tropical Savannas CRC, 2012). FireWatch has provided

hotspot data and other relevant environmental information to emergency management in Australia since the mid-1990s (Steber et al., 2012). All three of these applications were named by the inquiry into the Kimberley Ultra-marathon disaster as tools that the public have access to in order to be better informed about bushfires (Economics and Industry Standing Committee, 2012). These map interfaces use fire hotspot data derived from satellite imagery. This hotspot data, which is referred to as thermal anomaly data, is sourced from satellites such as NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) and LandSat through infrared technology (Tansey et al., 2008). This hotspot data is also utilised by other applications in Australia, including the Country Fire Authority (CFA) website in Victoria, and CSIRO's ERIC application (Moses, 2009; Power et al., 2013).

During the Black Saturday bushfires of 2009, two mapping websites displaying bushfire information came to prominence during the Victorian bushfires of 2009. Google created a map service (http://mapvisage.appspot.com/fires/FireMap.html) after demand placed on Victoria's Country Fire Authority (CFA)'s website caused it to struggle (Moses, 2009, para. 6). Aus-emaps.com was another website service displaying locations of bushfires in Australia that the public turned to (Moses, 2009, para. 8). This service sources its information from both NASA and Geosciences Australia and uses Google Maps (aus-emaps.com, 2012). NASA (NASA Earth Observatory, 2009) presented a snapshot from its satellite imaging showing the bushfires in Victoria (Moses, 2009, para. 9). This is hosted at http://earthobservatory.nasa.gov/IOTD/view.php?id=36861 (NASA Earth Observatory, 2009). The fact that mapping services were in extremely high demand during the Victorian bushfires of 2009 bodes well for community acceptance of the redesigned FireWatch service.

Digital maps have come to play a significant role in the communication of disaster information, and are considered to be amongst the most important tools in disaster management (Dymon, 2003). GIS has had a role of providing geospatial information to support decision-making during emergency situations, where it is used to map hazards, render visualisations and provide personnel with situational awareness (Rauschert et al., 2002, p. 1). In Japan — one of the most disaster prone coun-

tries in the world, but also one of the best prepared — the government's cabinet office recommends using GIS to deliver disaster information to the public (Cabinet Office — Government of Japan, 2011, p. 16). However, as previously discussed, the geospatial web has made spatial analysis more accessible to the public by removing the need to deal with the complexity of GIS interfaces (Harris et al., 2010).

Recently several areas have become interested in crowd-sourced data within a disaster context. These research areas include crisis informatics (Palen et al., 2010), disaster sociology (Hughes, 2012), participatory GIS (Kemp, 2008) and computer-supported cooperative work (CSCW) (Liu, 2014). The role that social media can play in communities before and during a bushfire suggests that users in Australian communities have a desire to share bushfire information (Brady & Webb, 2013; Akama, Chaplin & Fairbrother, 2013; Hughes, 2012). Participatory GIS is a growing area that merges participatory learning with GIS technologies (Corbett et al., 2005; Dunn, 2007), and, being built on mapping technologies, is relevant to the redesign of the FireWatch interface. Participatory GIS is described by Dunn as a "more socially aware type of GIS which gives greater privilege and legitimacy to local or indigenous spatial knowledge" (2007, p. 616). This involves an integration of community-sourced and "expert" information (Dunn, 2007, p. 619). Participatory GIS has the potential to foster innovation and can enhance the communication of spatial information (Corbett et al., 2007, p. 13). Dunn (2007, p. 616) considers participatory GIS to be context-driven rather than technology driven. Corbett et al consider good participatory GIS practice to be "careful, user-driven/user-centred, and ethically conscious" (2007, p. 15). Although user-centred and being derived from crowd-sourced content, the design of participatory GIS interfaces specifically does not seem to have been addressed in the literature. Participatory GIS has also been considered in light of community-based disaster risk reduction (Kemp, 2008). Kemp noted, however, that a "moderate" (i.e., simple) implementation of GIS software is required when presenting communities with new knowledge (2008, p. 101). The emergence of participatory GIS, therefore, bears some relevance to

the redesigned FireWatch interface, as crowd -sourced content is something that may be necessary to consider in the design process.

2.3.4 Designing for emergency situations

Due to the fact that FireWatch's purpose is to provide users with locations of bushfires, it is worth investigating how information of an urgent nature is best presented to users. The Keelty report on the Margaret River bushfires (Keelty, 2012, p. 3) noted that the losses incurred and the emotional impact of the bushfire were significant. In addition, there was a financial impact on businesses and employees in the Margaret River area, as this is an area of both national and international tourism (Keelty, 2012, p. 3). It is fair to assume that people faced with bushfire situations will be highly stressed, and fears of loss of property, income and other emotional impacts will be significant. A key factor to consider is the emotional volatility of users in rural communities who are at risk (Manoj & Baker, 2007, p. 52). Negative emotions, such as fear and stress, can be exacerbated by a lack of regularly updated information (Manoj & Baker, 2007, p. 52). It is critical that the redesigned FireWatch provides such information to users within rural communities when there is a threat of a bushfire. A distinct advantage that the FireWatch service has is that delivering near real-time information on bushfire threats means that it is possible to locate, plan for and respond to threats with greater precision (Horan & Schooley, 2007, p. 75). Quantarelli (1985) — a researcher on disaster preparedness — created a set of principal activities for disaster preparedness planning:

- Developing techniques for training, knowledge transfer and assessments
- Educating the public and others involved in the planning process
- Obtaining, positioning and maintaining relevant material resources
- Undertaking public educational activities
- Establishing informal linkages between involved groups

- Thinking and communicating information about future dangers and hazards (p. 21).

The points raised by both Quantarelli (1985) and Manoj and Baker (2007) emphasise the importance of keeping users educated, informed and involved in the process. Another issue raised by Manoj and Baker (2007) is that technology-based methods of informing the public may not be willingly adopted by everyone due to factors such as resource constraints (p. 52). Therefore, it perhaps makes sense to cater for as many devices and browsers as possible, even those with a slower internet speed.

Rauschert et al's (2002, p. 119) study suggested that the interface design of systems using geo-spatial information needs to be changed significantly. This study was based on the experiences of people who had to make time-critical decisions based upon the geo-spatial information presented to them (Rauschert et al., 2002, p. 119). This study found that rather than using complex menu systems and keyboard commands, natural gestures were the preferred methods of interacting with the interface (Rauschert et al., 2002, p. 122). Gestures, such as touching and swiping, have become the de-facto standard way to interact with modern mobile and tablet devices (Ruiz, Li & Lank, 2011). Like the HCI principles discussed earlier (Norman, 2002; Nielsen, 2000; Nielsen, 1994), Rauschert et al's study also suggested that usability engineering should be utilised to lessen the cognitive burden on the user (2002, p. 123). As asserted by Perera and Tateishi, the aesthetics of an interface should not prevent users from being able to easily access the data being supplied (2012).

Similarly, Lanfranchi and Ireson (2009)'s study has implications for the FireWatch redesign. Lanfranchi and Ireson (2009) investigated a system known as "WeKnowIt" — a project that aims to allow Emergency Response organisations and the general public to participate in the monitoring of emergency situations. While the functional requirements for WeKnowIt differ to the requirements of the redesigned FireWatch, it is likely that the non-functional user requirements (Table 2.6) have some relevance to the new FireWatch interface.

Table 2.6: Non-functional user requirements (Lanfranchi & Ireson, 2009, p. 201).

Requirement	*Description*
Trust	The users need to trust the system and the information it provides.
Privacy	Different user roles must be accounted for when displaying information.
Resilience/Robustness/Reliability	The system... must be resilient, maintaining an acceptable level of operation in case of external influences, such as network faults.
Ease of use	In general for community users the system must be easy to use, as they may conceivably access the system only in times of need.

In general for community users the system must be easy to use, as they may conceivably access the system only in times of need. Ease of use and simplicity are of significance when an interface may be used in an emergency situation (Anderson & Schram, 2011; Palen & Liu, 2007).

Wu's (2008) model for intention to adopt emergency response technology also has implications for the redesigned FireWatch. Firstly, this model considered individual factors, such as perceived risk and perceived benefits. Secondly, it also contained technology factors, which were broken into two aspects: *Perceived Usefulness*, which contains *Information Accessibility*, *Information Relevancy* and *Information Amount*; and *Perceived Ease of Use*, which contains *Controllability* and *Customisability*.

Thirdly, Wu's (2008) model considered social factors: specifically community context. This is important for the FireWatch service, as there is currently little awareness of the website outside of people directly involved with emergency services. Therefore, consulting directly with community-based users about how to build this awareness within a community context is a key aspect of this

project. Building this awareness involved investigating the media usage of community-based users and how they would find out about a service such as FireWatch.

2.3.5 Designing for credibility and authority

The literature examined in this section answers the research question *(4) What relationship exists between the visual characteristics of an information source and its credibility or authority?*

The dissemination and sharing of information is of great importance in emergency situations. It can also be problematic, as the public may not be sure of who to trust when in unfamiliar circumstances (Manoj & Baker, 2007, p. 52). As mentioned previously by Lanfranchi and Ireson, "users need to trust the system and the information it provides" (2009, p. 201). For a website to be considered an authority, means that it is "an accepted source of information or advice, either an expert on the subject or a persuasive force" (Conrad, Leidner & Schilder, 2008, p. 1). Visual rhetoric theory also highlighted that users can gain trust and a sense of reliability from a design (Schneller, 2010, p. 162)

Members of the public expect authorities to deliver useful information: agents of authority are generally assumed to be powerful and intelligent (Fogg, 2003, p. 111). If a computer product is able to do this in a convincing manner, it is more likely to be viewed as being authoritative and therefore more credible (Fogg, 2003, p. 111; Fogg & Tseng, 1999, p. 80). Two important elements to a computer system being credible are trustworthiness and expertise: systems that have these qualities will be considered highly credible (Fogg & Tseng, 1999, p. 80).

Until recently, very little has been discussed regarding website credibility (Conrad et al., 2008, p. 2). Nevertheless, Fogg (2003, p. 150) has discussed the issue of website credibility: specifically the findings of a study done at Stanford University. The following elements were discovered to improve the credibility of a website, and should be considered when redesigning the FireWatch interface:

- The site looks like it was designed professionally
- The site should be updated since the user's last visit
- The site is arranged in a way that makes sense to the user
- The site is easy to navigate
- The site remembers each user's preferences
- The site matches each user's expectations about what tasks it should perform and what goals it should allow the user to achieve
- The information provided is current and relevant
- The information source is a known organisation and the source is made known to the user clearly (Fogg, 2003, p. 154).

A credible website will entice users to use its services, buy its products and users will be more likely to tell their friends about it (Fogg, 2003, p. 177). A priority for the FireWatch redesign will be to appear as a credible and authoritative source of information. A system's interface should be aesthetically pleasing (Fogg, 1999, p. 85). Information needs to be reliable and the amount of information made available to the user should be adequate (Guimarães, Pereira & Silva, 2011, p. 26). Kidawara (2008, p. 3) also pointed out the importance of websites needing to provide authentic information and have a professional appearance. The National Institute of Information and Communications Technology (NICT) in Japan assesses a website's credibility based on the following criteria: (1) content, (2) sender, (3) appearance, and (4) authenticity of content (Kidawara, 2008, p. 3).

Ahmad, Komlodi, Wang and Hercegfi (2010) detailed user experience elements that influence a user's opinion on whether a website is credible or not. They found that a website that contains the following elements is likely to be deemed a credible source of information: information timeliness, information language, information organisation, information citation, information consistency, testimonials and author-expertise (Ahmad et al., 2010, p. 2).

Tanaka and colleagues (2010, p. 6) offered recommendations for improving the credibility of websites using mapping information. The key aspect for a mapping interface to appear credible is to have up to date and correct information. Objects should also appear true to their real-world location and be presented in a meaningful way (Tanaka et al., 2010, pp. 6-7).

Sundar (2008), offered several recommendations of how a website can improve its credibility through heuristics. Like Fogg (2003), Guimarães and colleagues (2011) and Kidawara (2008), Sundar (2008, p. 73) emphasised the importance of information seeming credible and authentic, delivered in a timely manner and clearly. In addition to these, Sundar (2008) suggested that a credible website should have clear, well-structured and easy to use navigation. Aside from reducing the cognitive burden on users, this improves the quality of represented information and this enhances credibility (p. 90).

2.4 Conclusion

This chapter reviewed relevant literature that guided the redesign of the FireWatch interface. It argued that while HCI has emerged as a design discipline, interaction design has become the preferred term for practitioners and researchers who work in this space. Interaction design is considered to be a wider-encompassing term than HCI due to its emphasis on the role of aesthetics, emotions and sensuality in the user's interaction experience. Interaction design also examines technologies, products and systems beyond computers. Service design has gained traction as a methodology within interaction design, although several researchers still rely heavily on user-centred design as a methodology. Disaster management literature emphasised the necessity for communities to be involved in disaster management and that there ought to be tools provided that are relevant to their needs. The argument for involving real-world users is compelling due to its importance in interaction design literature, as well as disaster management literature.

The next chapter discusses the methodologies that provided a framework for the redesign process. As HCI and interaction design evolved, so too did the approaches and methods that were used. While HCI rightly placed focus on the user, which led to improvements in the usability of interfaces, some researchers in HCI and interaction design have recently attempted to take more of a service design approach. This means that it is necessary to consider the perspective of all stakeholders in the design process. The following chapter discusses how scenario-based design, user-centred design, participatory design and service design all informed the design process undertaken during the FireWatch redesign. The chapter also discusses the techniques and technologies used for creating the interface.

3

Research design

3.1 Introduction

The previous chapter discussed modern interface and information design within the context of interaction design and HCI, while also discussing relevant literature from disaster management research. Interaction design and HCI have both emphasised the importance of engaging actual community-based users in the design process. Disaster management

accentuated the importance of providing disaster information to communities vulnerable to hazards and recommended involving them in both decision-making and the design of systems intended to keep them informed before and during disasters. This chapter discusses the relevant methodologies for undertaking design research from interaction design and HCI, design prototyping methods and relevant research methods, and how they were applied in this research. This research was undertaken as constructive design research, which centred on the construction of a working prototype. The research used an iterative action research process — a common methodology in design research. In interaction design, the design process generally follows four stages: establishing requirements; designing; prototyping; and evaluating. These steps can be repeated, allowing for several iterations and refinement of the design artefact. Additionally, user input is considered a necessary part of the design process. Recent work in interaction design has emphasised co-creation and co-design, which attempts to involve all relevant stakeholders in the design process. Therefore, the research presented here was designed with multiple stages of user input in mind, while also allowing for input from the service provider, Landgate. Usability and usefulness — that is, ensuring that adequate functionality was provided — were considered the most important facets of the interface redesign. These two aspects were made the main focus for input from users so that an appropriate interface could be designed. The outcomes of the research are briefly described: new design knowledge, a live web application and two frameworks in the form of a pattern language and a personas framework.

Structurally, this chapter consists of an explanation of where the thesis sits within design research, and provides an overview of the iterative interaction design process undertaken. Scenario-based design, user-centred design and participatory design are all discussed, as these have a history of use in HCI and were considered relevant ways to consider input from users in this research. This research was undertaken through a service design methodology, as this allows for the views of all stakeholders to inform the design process. Finally, the research design — informed by the aforementioned interaction design approaches — is articulated. This research design followed previous interaction

design and service design research in its iterative approach to the design process. The four stages of this iterative process are discussed in detail: planning; prototyping and designing; exploring; and reflecting. An overview of the research instruments used is given, although these are discussed in further detail in the next three chapters. The outcomes from this iterative process are also discussed: new design knowledge, two frameworks and the working prototype, which became a live, publicly accessible website in the latter stages of the design process. An overview is also presented of the two structures of the frameworks described in Chapter 7. The first uses pattern language, and the second uses personas.

3.2 Conceptual Framework

The previous chapter discussed how Fallman made a clear distinction between design-orientated research and research-orientated design (2003, p. 230), with the research undertaken here being the former. Design-orientated research concerns itself with the acquisition of new knowledge, which can be brought forth through the development of a prototype, as its main contribution. The design and use of this prototype artefact is the mechanism for generating new knowledge and truth (Fallman, 2003, p. 230).

Furthermore, Fallman created a basic model for three types of interaction design research (2008): *design practice*, *design studies* and *design exploration* (Figure 3.1). It is possible for research to fall between different points of the triangle and move between them at different stages of the research (Fallman, 2008, p. 10). This dynamic characteristic is what distinguishes interaction design from related disciplines such as HCI, Computer Science and Informatics (Fallman, 2008, p. 10). Fallman pointed out that there are multiple ways in which the model has proven useful: the discussion of specific design research projects, particularly serving as a background for larger projects; defining which of the three activities the research gravitates towards; what kind of measures should be in

place, and what kind of contributions are to be expected (2008, p. 15). As my research produced a tangible design artefact and has been driven by context of use, it was at various times a form of *design practice*. However, as it involved multiple prototypes that attempted to address current societal concerns, it also gravitated towards *design exploration*. Finally, as it was design-based research — that is, it aimed to create new truth and knowledge by explaining the design processes undertaken, it also moved towards *design studies*. Throughout, particularly during prototyping, the research moved towards both design practice and design exploration. However, as the research sought to explain — and to actually build a design artefact — it could be said to be both design studies and design practice. As asserted by Fallman (2008), interaction designer researchers build, but always "with an appropriate research question in mind" (p. 7).

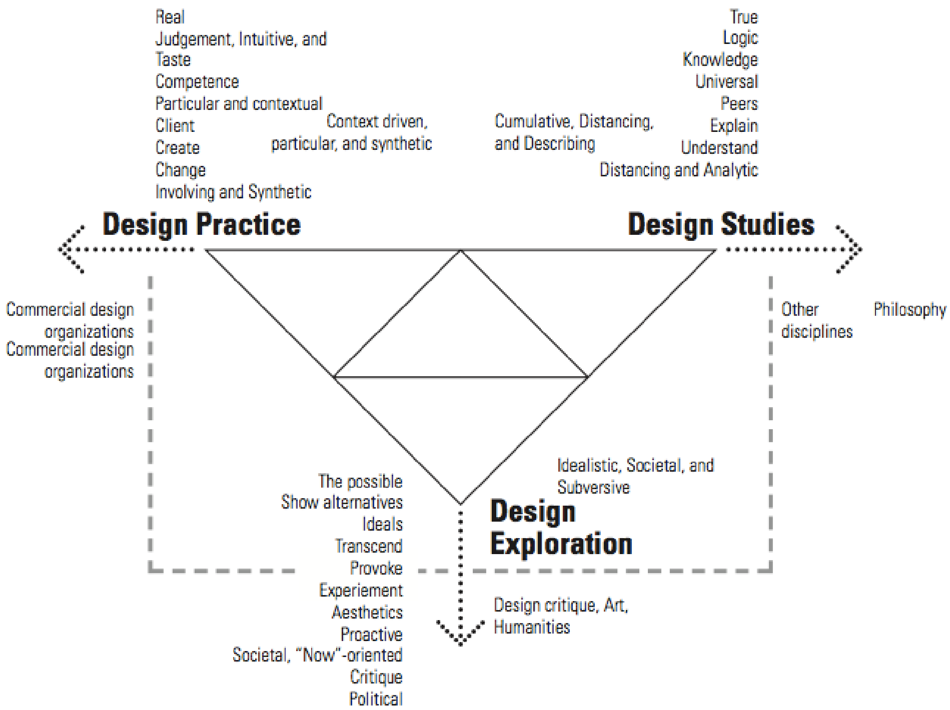

Figure 3.1: The complete model of interaction design research (Fallman, 2008, p. 14). This model categorises design research as design practice, design studies or design exploration.

Although the research undertaken here resulted in a design artefact, the development of new knowledge was considered a primary focus: significant effort was placed on iterative development of a prototype, which was guided by design theory and web best practices, with this prototype development leading to the construction of new knowledge. This kind of research can be described as *constructive design research*: a relatively new term, which "refers to design research in which construction — be it product, system, space, or media — takes center place and becomes the key means in constructing knowledge. Typically, this 'thing' in the middle is a prototype" (Koskinen et al., 2011, p. 5). By focusing on the development of a prototype, constructive design research highlights that construction is fundamental to this type of design research (Koskinen et al., 2011, p. 5). In con-

structive design research, the significant effort that is placed on the development of a prototype leads to the development of frameworks that are generalised from this process (Koskinen et al., 2011, p. 119). These frameworks are formed by researchers reflecting on the design work undertaken after the fact, but are informed by theory, debates and the design process itself (Koskinen et al., 2011, p. 119).

3.2.1 The user in interaction design

Much of the literature from HCI focuses on the needs and wishes of users of an interface. User-centred design has been at the core of much HCI research since the 1980s (Carroll, 1997). During the 1990s there was a shift towards co-creation, with greater user participation through participatory design (Sanders, 2002). This shift from user-centred design to participatory design is summed up by Sanders, who described it as a "shift in attitude from designing for users to one of designing with users" (2002, p. 1). Participatory design is a methodology utilised in HCI as a logical extension of the principle of user-centred design. It is at the heart of the usability engineering guideline of *increased user participation* (Carroll, 1997, p. 71). Participatory design originated in Scandinavia in the 1970s and 1980s, driven by a desire for creating a more democratic workplace, where workers were given an increased say in the way that new technologies were being implemented in their workplace (Spinuzzi, 2004, p. 2). Participatory design allows the user to reflect on their own practices, how they organise tasks and the tools that they use (Spinuzzi, 2004, p. 8). Gaining these insights from the user can be of great benefit to the designer and researcher. Participatory design methodology consists of three aspects. Firstly, it is meant to improve the lives of users, allowing them to do tasks and achieve goals with greater ease. Secondly, collaborative development between users, designers and researchers is key to attaining this improvement in the users' experience. Thirdly, it needs to be an iterative process, consisting of sustained collaboration, revisiting stages and periods of reflection (Spinuzzi, 2004, pp. 7-9). As stated by Winschiers-Theophilus and colleagues (2010), participatory design allows the researcher to "consider any account about users' suggestions and experience, in-

cluding those that are analytical and those realised by prototypes, to be part of an evolving design product" (p. 4).

The most recent shift in interaction design and HCI's view towards the design process has been the approach of service design — a practice that evolved across multiple disciplines (including design, marketing and operations management) as post-industrial countries moved from manufacturing to service delivery (Zimmerman, 2011; Forlizzi & Zimmerman, 2013; Holmlid, 2007). This shift has aimed to incorporate the views of all stakeholders in the design process (Stickdorn & Schneider, 2010; Zimmerman, 2011). Service design also goes beyond user-centred design and participatory design by considering the entire socio-technical context in which a service exists (Beaumont et al., 2014). Socio-technical context considers both the technical and social aspects in which a service resides (Beaumont et al., 2014, p. 121). As the redesigned FireWatch was built to meet the needs of a new, non-technical, audience, it was considered necessary to have a substantial amount of user input in the design process from the outset. Aside from users of the redesigned FireWatch, it was also necessary to work closely with the development team from the service provider, Landgate. Recent interaction design literature has criticised user-centred design for placing too much emphasis on the user, at the expense of working closely with the service provider, or worse, forming an adversarial view of the service providers (developers) in the design process (Zimmerman, 2011, p. 11). Additionally, user-centred design considered users to be experts in their field (Carroll, 1997, p. 69), a view that was not considered appropriate for this research. Previously, FireWatch was built to consider the needs of emergency services personnel — who were experts in their field. The redesigned FireWatch interface aims to meet the needs of community-based users who were not considered experts in the type of information provided by FireWatch. These users were a new audience for FireWatch and it was not known how familiar these users were with the type of information that the FireWatch service delivered. A participatory approach to users, where users influenced the way that new technologies were being implemented in their lives (Spinuzzi, 2004, p. 2), was chosen as a way to ensure that users be-

came familiar with the content FireWatch could deliver and that these users had input in how much of that content was informed by the previous expert-user service. Mutual learning between design researchers and users is a fundamental aspect of participatory design research (Robertson, Leong, Durick & Koreshoff, 2014). By learning about users through participatory approaches, researchers can make informed, accountable design decisions (Robertson et al., 2014).

Holmlid considered service design to be a revitalisation of participatory design in the sense that it facilitated designing with users (2009, p. 2). The research described here was considered service design, rather than participatory design. The design of a service and its use should be viewed "as touchpoints through which value is co-created" (Holmlid, 2009, p. 5). The web application interface that arose during the design process was considered one of these touchpoints, as it was a tangible form that allowed users to interact with the service. These touchpoints can take a variety of forms, such as "rather abstract organisational structures, operation processes, service experiences and even concrete physical objects" (Stickdorn & Schneider, 2011, p. 14).

Working closely with the two primary stakeholder groups — the user and the service provider — was crucial to this redesign process. Service design recognises the holistic nature of a service, perhaps creating more value than participatory design by allowing co-creation between the various stakeholders (Holmlid, 2009, p. 2). Importantly, Holmlid pointed out that users and service providers (and consequently their services) do not know a lot about each other, but rectifying this imbalance can lead to the development of innovative solutions (2009, p. 7). Additionally, an apparent strength of service design is that it appears "to embrace the figure of thought that cooperation between actors [stakeholders] sharing capacities and resource will leverage every actor, in the process, and toward their own and their shared goals" (Holmlid, 2009, p. 9). The holistic nature of service design meant that it allowed for a participatory approach to users in my research, but not at the expense of valuable input from the service provider.

While the focus of HCI shifted significantly to emotional aspects of design (Norman, 2002; Jor-

dan, 2002), usability is still a major aspect underlying the design of all interfaces (Hassenzahl, 2004a; Mahlke & Lindgaard, 2007), and usability testing is still a key method of exploring interactions between people and technology (e.g., Gu et al., 2010). Emotions in the redesign process discussed here were addressed in the manner suggested by Hassenzahl (2004a). That is, the interface aims to meet the needs of the user, with the intention of leading to positive feelings of satisfaction, achievement and goal accomplishment (Hassenzahl, 2004a). The interface needs to give the user the feeling of being in control, giving them the satisfaction of accomplishment (Norman, 2008). Simplicity was also considered a key aspect of the interface, and as part of the redesign process, a "strategic reduction" (Maeda, 2006) in functionality from the original FireWatch interface was considered vital to this redesign — particularly in the early stages where the expectations and needs of users were unknown. Care was taken to ensure that the remaining functionality would meet the needs of the majority of participants. The aim was to ensure that the redesign process resulted in an interface that was both usable and useful. Although Norman (2008, p. 8) pointed out that cognition and emotion are intertwined and inseparable, design that is both useful and usable "may lead to satisfaction if a valued goal is achieved in a particular situation and at least a part of the success is attributed to the product" (Hassenzahl, 2004a, p. 47). Emotions, being ephemeral (Hassenzahl, 2004a), are difficult to measure. Hence, the emphasis in this redesign was on utility and usability: two aspects of the user experience that can be measured. A core part of user experience design is ?identifying the aspects of the design that are important to the target user group? (Roto et al., 2011, p. 11): it was therefore considered crucial to involve users and ascertain which features of the interface would be useful for them. For this research usability issues were addressed with Maeda's (2006) approach to simplicity through "thoughtful reduction". Usability was measured through user testing and an online questionnaire based on a standard usability survey (Brooke, 1986). Utility was measured through the use of a card-sorting system — a common way of conducting user testing (Nielsen, 1994) — as a way of measuring usefulness of the interface. The instruments used and the data collected are explained in

the results chapters (Chapters 4, 5 and 6).

3.2.2 Interaction design as an iterative process

The research undertaken here followed an iterative process of establishing requirements, designing, prototyping and evaluating. These four simple activities form the basis of interaction design research (Rogers et al., 2011, p. 15). Each of the four steps undertaken informed the other and were repeated through an iterative design process, which is a cyclical approach of continual planning, testing, evaluation and refinement used to improve the usability of interfaces (Carroll, 1997, p. 64). Iterative design is based on the idea that a designer often needs to actually build a design in order to understand the problems being addressed (Carroll, 1997, p. 64). Service design also relies on an iterative process of prototype designing, testing and retesting (Stickdorn & Schneider, 2010, p. 124). Usability specifications, which set out clear and measurable objectives and guidelines for a design, are used to manage iterative design (Carroll, 1997, p. 68). These specifications enable the designer to implement a design, test its effectiveness with representative users, evaluate the design and the process, and make changes accordingly (Blake & Tucker, 2006, p. 4). An iterative, participatory design process has been used in previous design research conducted in regional communities (Taylor & Cheverst, 2006; Blake & Tucker, 2006). Participatory design methods have also been used in previous community-focused bushfire research in Australia (Akama & Ivanka, 2010). Taylor and Cheverst (2006, p. 3) created an iterative, participatory model for their HCI study in a rural setting (Figure 3.2). This model has a mechanism for significant input from the user, while allowing for relevant theory to be incorporated into the design process. It also demonstrated that research findings can be developed out of the iterative design process.

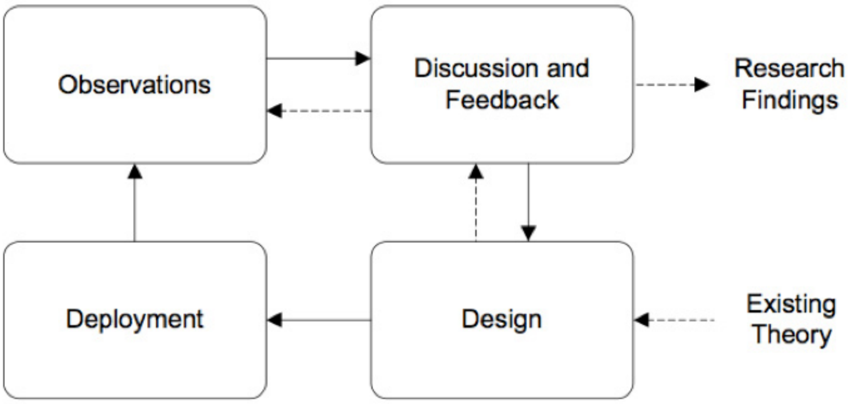

Figure 3.2: Taylor and Cheverst's (2006, p. 3) iterative, participatory approach. This model shows how participatory design is informed by existing theory and produces a tangible output.

Service design also relies on iterative design process through the use of action research as a method (Stickdorn & Schneider, 2010, p. 287). Action research is a form of research available to practising designers, with the connection between theory and practice at its centre (Crouch & Pearce, 2012, p. 233). It has the potential to bring benefits both to users and researchers in the process by providing solutions to problems (Blake & Tucker, 2006, p. 3), and is one of the key methodologies identified by Crouch and Pearce that can be used when undertaking design research (2012, p. 13). Co-design is a key principle of action research, which includes participants in the design process (Crouch & Pearce, 2012, p. 56). This characteristic — along with the iterative nature of action research — meant that it was considered a suitable approach for the research undertaken here. According to Blake (2010), action research is useful for any research relating to Information and Communication Technology (ICT), because it is an "ideal way of addressing situations where designers do not initially understand local issues and culture and where, at the same time, the local communities cannot appreciate the potential of ICT to address their development needs" (p. 2). The cycle of Crouch and Pearce's (2012) action research is demonstrated in Figure 3.3.

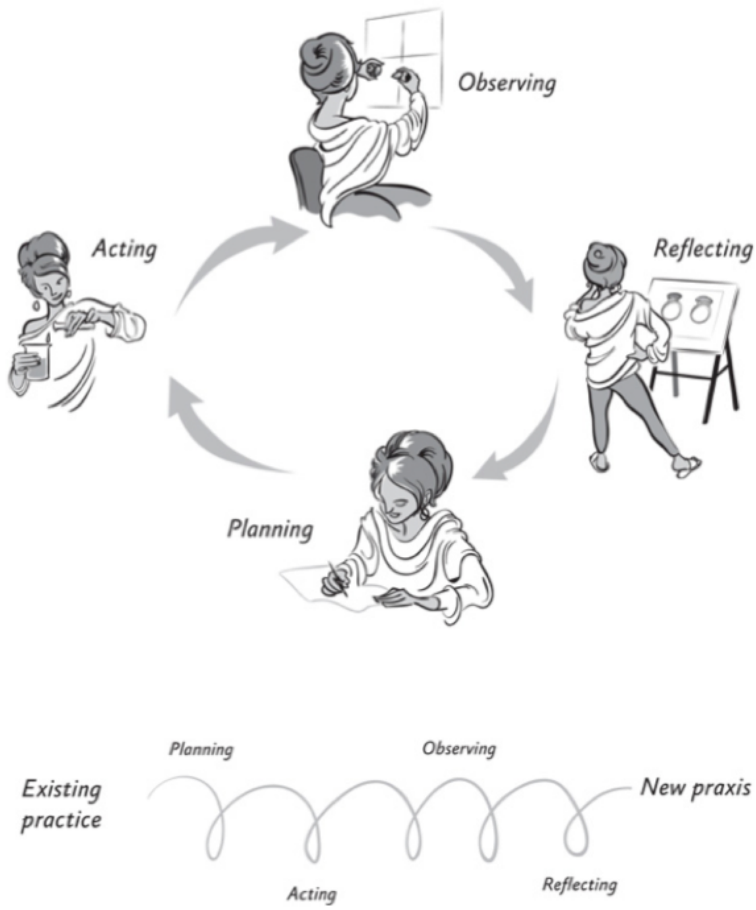

Figure 3.3: Action research cycle (Illustration: Medley in Crouch & Pearce, 2012, p. 237). This cycle, similar to Taylor and Cheverst's (2006, p. 3) iterative process, involves four stages of planning, designing, observing and reflecting. Both of these processes lead to new knowledge.

The action research approach in service design advocated by Stickdorn and Schneider uses a similar approach to Crouch and Pearce's (2012, p. 237) method. An overview of how each of these stages were addressed in the FireWatch redesign process is described in Table 3.1. These stages are discussed further in the research design.

Table 3.1: Stages of an iterative action research design process. This table describes each of the four stages and also describes an overview of what was done for these stages in the FireWatch redesign process.

Action research stage	*Stickdorn and Schneider's description*	*FireWatch redesign process*
Plan	Develop a theory of how to solve certain problems. This can, for instance, be based on previous research or, observations of customer behaviour (2010, p. 286).	A set of requirements were established for each *planning* stage, considering the user's perspective. These requirements were also discussed with the service provider to ascertain what was and was not feasible. Initially, these were established using scenario-based design and personas to create empathy for the user's perspective. In subsequent iterations, the previous *exploring* and *reflecting* stages informed the establishment of new requirements.
Design	Give shape to the service offer based on your theories and knowledge from the previous *planning* stage (2010, p. 286).	The prototype designed in this stage was informed by user input and previous research, which informed the establishment of requirements in the previous planning stage.

Explore	Try your service on real customers in the right environment. Here you collect insights both by observing the customers interacting with the service and by interviewing them about their experience using the service (2010, p. 286).	In the first iteration, due to lack of access to actual users, personas were used to explore how users would interact with the interface. In subsequent iterations, users were engaged through the use of semi-structured interviews, a card sorting system, user testing and an online questionnaire.
Reflect	To process all the research data and transform them into manageable insights. You map the customers' journey through the service and highlight problems as well as things that work well. After reflecting, you continue on to the planning phase (2010, p. 286).	The data collected in the previous *exploring* stage was analysed. In the first iteration, this analysis discussed the effectiveness of the personas created, as well as the previous research that informed the redesign. In subsequent iterations, recurring themes in user interviews, user testing and the online questionnaire responses were analysed.

The previous version of FireWatch, the capabilities of the technology, interaction design theory, input from real world users and best practices in web design all informed the redesign process. Iterations of the redesigned FireWatch allowed users to learn about the technology and its possibilities, while enabling the research to be informed of the social and cultural context of the interface's users (Blake, 2010, p. 2). One of the advantages of action research when used in interaction design is that

it allows a researcher to learn about an interface's users, while also allowing the users to learn about the technology used in the interface (Rogers et al., 2011, p. 413). These two aspects of action research meant that it was a useful method for conducting the service design research in this project, where importance was placed on socio-technical context (Beaumont et al., 2014).

3.2.3 Service design: beyond User-Centred Design

As part of the design process of the FireWatch redesign, it was considered necessary to gather user input from the outset. Service design thinking highlights the need for a service to empathise with the user perspective (Stickdorn & Schneider, 2011, p. 205). Service design is also a "stakeholder-centered practice" (Forlizzi & Zimmerman, 2013, p. 1). Service design also places prominence on the socio-technical context in which a design is used (Beaumont, 2014). Since the redesigned FireWatch introduced remotely-sensed bushfire information to users in a remote regional area, it was deemed necessary to work towards understanding the socio-technical issues specific to the area (Figure 3.4).

Figure 3.4: This figure demonstrates how the shift from user-centred design, to participatory design and finally to service design, has considered the role of the user. Service design expands this view by involving all stakeholders and considering the entire socio-technical context of a service.

While there is no strict definition of service design, there is general agreement of what its main characteristics are (Stickdorn & Schneider, 2010, p. 29). To articulate these characteristics, Stickdorn and Schneider created 5 Principles of Service Design Thinking (2010, p. 34): (1) *user-centred* — services should be experienced through the eyes of the user; (2) *co-creative* — all stakeholders should

be included in the service design process (3) *sequencing* — the service should be visualised as a sequence of interrelated actions; (4) *evidencing* — intangible services should be visualised in terms of physical artefacts; and, (5) *holistic* — the entire environment of a service should be considered. Therefore, an iterative design process was required that allowed for input from users during each iteration, as well as input from the service provider, Landgate. The redesigned FireWatch interface was considered to be the tangible artefact of the interface. The environment in which the interface would be used was defined by the technical capabilities and constraints of the technology, as well as the circumstances of the public users involved in the design process. Non-technical users in the community were a new type of user for the FireWatch service. The five principles from Stickdorn and Schneider's 5 Principles of Service Design Thinking (2010, p. 34) were contextualised within the setting of the FireWatch redesign process: (1) *user-centred* — the FireWatch service should be experienced through the eyes of users through the use of design scenarios and personas, and directly engage with users through interviews, user testing and an online questionnaire; (2) *co-creative* — all stakeholders should be included in the service design process, which includes actual community-based users and the service provider, Landgate (3) *sequencing* — the service should be visualised as a sequence of interrelated actions: this was articulated in the service blueprint (Figure 3.6); (4) *evidencing* — intangible services should be visualised in terms of physical artefacts: the redesigned prototype interface is the physical artefact of the service; and, (5) *holistic* — the entire environment of the redesign FireWatch service should be considered: that is, that users will likely be in remote and regional areas of Western Australia, and an understanding of where and how they access the internet was necessary.

Undertaking the role of the design researcher meant that it was necessary to be informed by the service provider about these capabilities and constraints of the technology so that these could be discussed with the users. It was also necessary to relay input from users back to the service provider regarding the functionality users desired. In this sense, the role of design researcher was, in part, one

of mediator between these two primary stakeholders. The final iteration of the redesign process also involved input directly from emergency services personnel. In service design, all stakeholders have the ability to participate in the design process “by contributing contextual information of domain specific expertise” (Stickdorn & Schneider, 2010, p. 52).

3.2.4 Design scenarios and personas

At the beginning of the redesign process, the overall ARC project was in its early stages. A research officer was yet to be appointed to the other half of the ARC project and decisions were still being made regarding which regional community to select as a trial site for the redesigned interface. The intention was to incorporate direct user involvement in the design process from the outset. However, this was not possible due to the aforementioned circumstances delaying access to users. Through the service design methodology, it was possible to use design scenarios and personas as key methods in the early stages of design. Similar to previous interaction design research (Rogers et al., 2011, p. 496), the research undertaken here used design scenarios to build a prototype to later present to a group of users. Design scenarios and personas methods allow for the review, analysis and understanding of factors that define a service experience (Stickdorn & Schneider, 2010, pp. 178-184). Although service design aims to be co-creative through direct stakeholder involvement, it can rely on design scenarios and personas as a way of informing the design process through the perspective of users (Stickdorn & Schneider, 2010). The flexibility of scenarios means that they “can be used in almost any stage of a service design project” (Stickdorn & Schneider, 2010, p. 179). Scenarios were employed in the early stages of the FireWatch redesign process. Scenarios were used to inform the design process from the perspective of users prior to the involvement of actual community-based users (Rosson & Carroll, 2002, p. 66). To “kick-start” the redesign process, personas were created that were considered to be representative of a rural community in Western Australia. These personas were “represented as specific individual human beings [but]... not actual people” (Cooper et

al., 2014, p. 81). When using personas, it is necessary to: (1) label them as personas and explain them as such, (2) use existing data to inform them, (3) explain what data was used and any assumptions made, (4) create visual representations (not photos) of the personas, (5) avoid stereotyping and (6) avoid focusing on demographics, focus on motivations and behaviours (Cooper et al., 2014, p. 88). The scenario-based design of Rosson and Carroll (2002, p. 50) contained five sections that described the scenarios created prior to the initial redesign process: root concept, field studies, summaries, problem scenarios and claims analysis (Figure 3.5). These were established at the beginning of the redesign process in order to provide a starting point for the prototype interface.

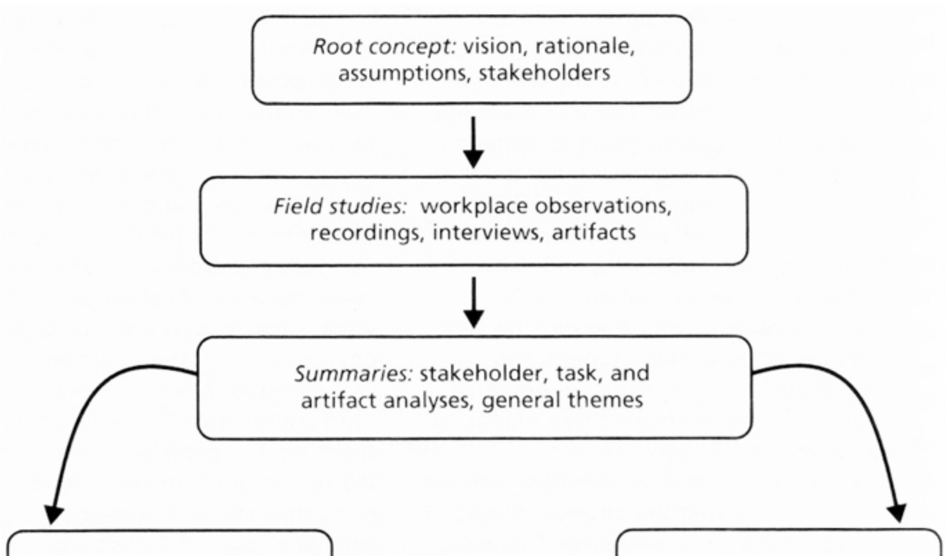

Figure 3.5: Overview of scenario-based requirements analysis (Rosson & Carroll, 2002, p. 48). This analysis involves establishing descriptions of a root concept, field studies, summaries, problem scenarios and claims analysis.

The requirements analysis diagram (Figure 3.5) provided a strong grounding on which an ini-

tial design could be built, but also allowed for flexibility in future iterations of the design process. This stage considered both functional and non-functional requirements of the interface (Rosson & Carroll, 2002, p. 15). These requirements that were established followed the model of requirements created by Cooper et al (2014): expressed as functional, data and other requirements (Table 3.2). Requirements were thought of in terms of *objects*, *actions*, and *contexts* (Cooper et al., 2014, p. 122) and a new set of requirements were established in the planning stage of each design iteration.

Table 3.2: Cooper et al's (2014) framework for creating requirements. Requirements are sorted into categories of functional, data and other requirements. Requirements were established in the planning stage of each design iteration.

Requirements	*Description*
Functional requirements	Functional needs are the operations or actions that need to be performed on the objects of the system and which are typically translated into interface controls. These can be thought of as the *actions* of the product. Functional needs also define places or containers where objects or information in the interface must be displayed (p. 122).
Data requirements	Data needs are the objects and information that must be represented in the system... Common examples include accounts, people, documents, messages, songs, images, as well as attributes of those such as status, dates, size, creator, subject, and so on (p. 122).

Other requirements	Other requirements can include: (1) Business requirements, such as "timelines, regulations, pricing structures, and business models" (p. 122). (2) Brand and experience: "attributes of the experience you would like users and customers to associate with your product, company, or organisation" (p. 123). (3)Technical requirements, such as "weight, size, form factor, display, power constraints, and software platform choices" (p. 123).

To enable designers to create useful scenarios, Rosson and Carroll (2002, p. 18) created a table of elements characteristic of interaction scenarios (Table 3.3).

Table 3.3: Rosson and Carroll's (2002) elements characteristic of interaction scenarios. The scenario elements were described in the context of the redesigned FireWatch.

Scenario element	*Definition*
Setting	Situational details that motivate or explain goals, actions and reactions of users.
Actors	People interacting with the computer interface — personal characteristics relevant to the scenario.
Task goals	Effects on the station that motivate the actions of actors.
Plans	Mental activity directed at converting a goal into a behaviour.
Evaluation	Interpreting features of the situation.
Actions	Observable behaviour.

Events	Actions or reactions produced by the computer, which may not be visible to the actor but relevant to the scenario.

3.2.5 Direct engagement with users in the remote community

The personas and scenario-based design frameworks described in the previous section provided a way of factoring in the user's perspective at the early stage of the redesign process. However, once the trial community of Kununurra had been selected, a small sample of participants was directly involved in the design process. There were two stages of user engagement that comprised using a card sorting system, user testing of the interface, and a semi-structured interview where usability of the interface was the primary focus. Finally, the website application that resulted from this redesign process was launched, where people in the Kununurra community, including local authorities, were present. This coincided with coverage in the press. At this stage, an online questionnaire was used to gather further input from actual community-based users. The details of these research instruments will be discussed in subsequent chapters.

Stakeholders

The stakeholder list is a representation of the stakeholders involved in the FireWatch redesign process (Table 3.4). Stakeholder maps and lists provide a way for researchers to "gain a high-level view of the system" by describing all stakeholders involved in service delivery (Forlizzi & Zimmerman, 2013, p. 4). Given that there were only two primary stakeholders involved, it was not necessary to create a detailed stakeholder map. Instead, the list in Table 3.4 was created.

Table 3.4: Stakeholder list showing the two primary stakeholders involved in the FireWatch redesign process. The primary stakeholders are the end users situated in rural and remote communities in Western Australia, plus the service provider, Landgate.

Primary stakeholder	*Description*
Community-based users of the redesigned FireWatch site	A new type of user for the FireWatch service. Primarily situated in remote and regional parts of Western Australia. Initially represented by the personas described in Chapter 4.
Landgate, the service provider	Provider of the FireWatch service. FireWatch has traditionally focused on expert users, particularly those in emergency management. Landgate works closely with emergency services organisations, especially the Department of Fire and Emergency Services (DFES) in Western Australia.

Service blueprint

The service blueprint offers an overview of the flow of actions related to the redesigned FireWatch service. This view of the system helps people to understand the dynamics involved. A service blueprint is a visual representation of "the resources needed to enact the redesigned product-service system" (Forlizzi & Zimmerman, 2013, p. 5). The sections shown at Figure 3.6 were taken from Forlizzi and Zimmerman's (2013, p. 6) example. It is worth pointing out that the redesign undertaken here only concerns itself with the interface presented to the user and not the whole process of information delivery: the backstage actions and support processes (Figure 3.6) .

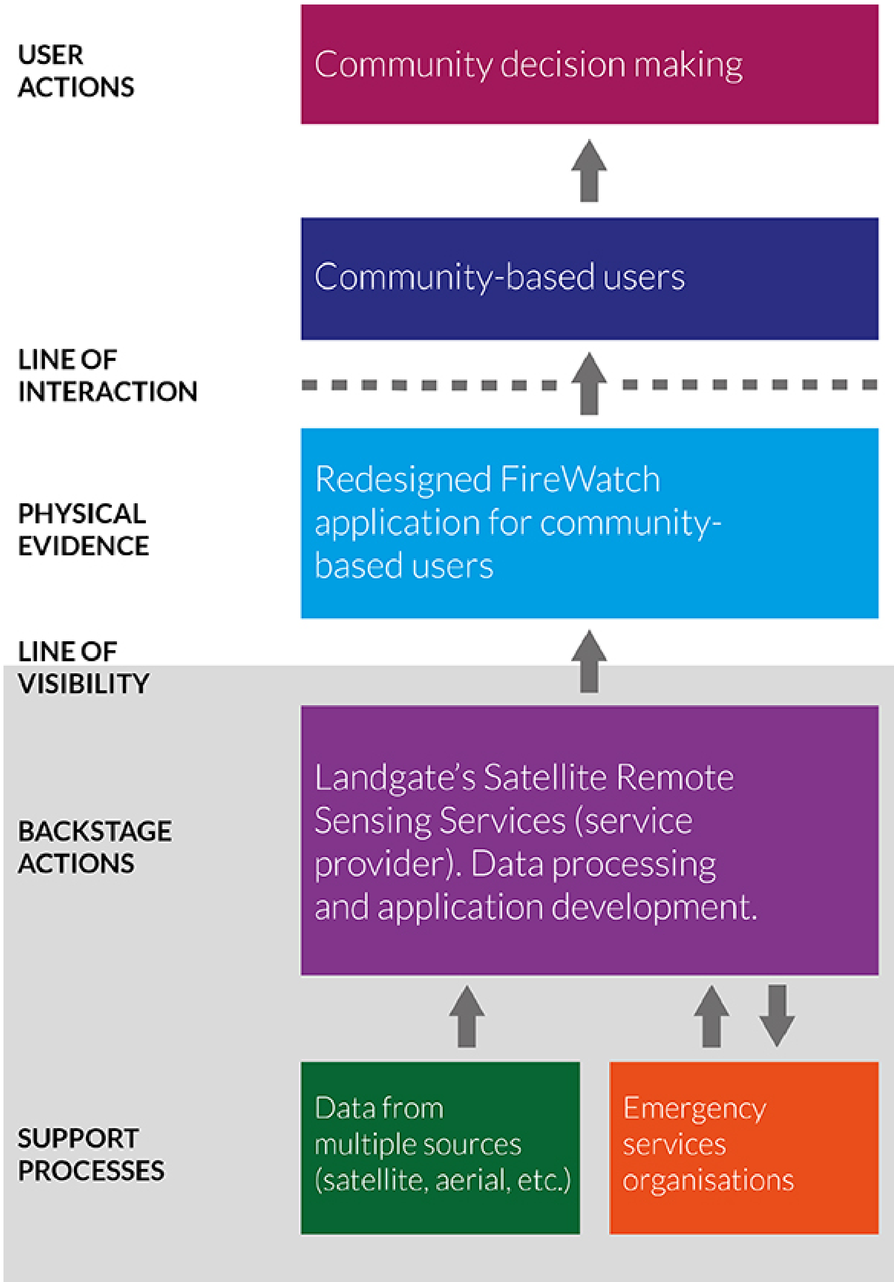

Figure 3.6: The service blueprint. A service blueprint is a visual representation of "the resources needed to enact the redesigned product-service system" (Forlizzi & Zimmerman, 2013, p. 5).

During the research it was necessary to have an activity that acted as an "ice-breaker" so that participants were relaxed, allowing them to "take part in the session more fully" (Stickdorn & Schneider, 2010, p. 175). Card sorting — an activity associated with participatory design (Martin et al., 2012, p. 26) and usability testing (Nielsen, 1994), and adopted by service designers — played the role of an ice-breaker that was followed by user-centred methods of interviews, user testing and observations (Stickdorn & Schneider, 2010, p. 135).

3.3 Research design

3.3.1 Field studies

The working prototype of the website was trialled in the remote community of Kununurra, a town with a population of approximately 3000 people in the far north of Western Australia. Kununurra was chosen as the site of field studies for the community work, as it met several criteria relevant to the project: Its population is made up of indigenous and non-indigenous people, a number of government and community organisations are based there and there is access to ADSL 2 internet connections and 3G mobile phone networks. Our industry partner, Landgate — the service provider — agreed that it was a suitable location in which to conduct direct engagement with actual community-based users. In interaction design, field studies serve the purpose of participants evaluating a design in settings in which they are comfortable (Rogers et al., 2011, p. 440). Field studies allow the design researcher to identify opportunities for new technology, assist in establishing requirements and can help with the adoption of the technology in this new environment (Rogers et al., 2011, p. 440). In this research, field studies occurred after the design process began, limiting the amount of information that could inform the scenarios and personas created.

3.3.2 Participants

Participants were selected from the community of Kununurra in two rounds of interviews and user testing. As the redesigned FireWatch aimed to meet the needs of those in the community who do not work in emergency services, care was taken to select participants whose occupation did not involve local authorities. It was clear that Kununurra was a small town heavily reliant on tourism, plus it had several small businesses that catered to local residents and visitors to the town. Additionally, agriculture plays a significant role in the area. Consequently, effort was made to engage with participants who worked in agriculture, tourism or one of the other local businesses located in or near the town. This broad selection was considered to be representative of both the town of Kununurra and the northern area of Western Australia.

3.3.3 Instruments and analysis

The research instruments used, as well as the results and analysis undertaken, will be discussed in further detail in the next three chapters. Details of this process are given in the section "Iterative design process". This includes an overview of the research instruments used during each stage. Due to the remoteness of Kununurra and the communications research officer from the ARC linkage project (p. 11) starting on the project six months after the design process commenced, it was necessary to use different research instruments throughout each iteration.

3.3.4 Ethical considerations

Information about users in the project was and will continue to be handled responsibly and ethically. Care was taken to ensure that participants cannot be identified. This research adheres to the National Statement on Ethics (National Health and Medical Research Council, Australian Research Council & Australian Vice- Chancellors' Committee, 2007) and complied with Edith Cowan

University's ethics approval process. All work undertaken involving people was approved by Edith Cowan University's ethics committee. A copy of the consent form and information letter provided to participants prior to being interviewed have been included in the appendices. Participants were given all the time they required to read through these two documents prior to signing a copy of the consent form. The online questionnaire used in Chapter 6 opened by asking for the consent of participants. The online questionnaire is described in detail in Chapter 6. The information and online questionnaire included contact details for the Edith Cowan University's research ethics officer if participants wished to contact an independent person regarding the ethics of the research project.

3.3.5 Limitations

Research limitations

It was considered ideal to have user input from the outset, but due to the circumstances in the larger ARC project, it was not possible to engage directly with users until the second design iteration, which occurred approximately four months after the initial prototyping commenced. The remoteness of the town of Kununurra (and therefore the expense of travel) meant that only two rounds of user engagement were possible in the data collection period. Scenario-based design and the personas framework were used in place of actual users, but direct user input would have been preferable from the beginning, since recent design literature has placed emphasis on co-design and co-creation (Zimmerman et al., 2011; Holmlid, 2009).

Participants that took part in the online questionnaire were self-recruiting. Therefore the demographics of the participants, as well as the number of responses, were not set by parameters in the research. This was not considered an overly significant issue, as by the time the questionnaire was available (which measured overall usability as well as asking open questions about the interface and people's internet and media usage), there had been two rounds of engagement with rural

community-based users to determine which features would be included. Additionally, although the website was targeted at users in rural communities, being a publicly accessible website meant that users in urban areas could access it.

Technical limitations of the application

A technical limitation of the satellite data is that it can only detect larger fires, which are more prominent in remote areas of WA. This limitation may change as more accurate remote-sensing satellites become available in the next few years. Additional satellites will also mean that the hotspots will update more frequently. Currently, hotspots can take more than two hours to appear, although this is dependent on the availability of satellites. Another technical limitation was that Landgate are not responsible for providing emergency alerts — these are provided by emergency services organisations. This meant that there were limitations regarding what was possible in terms of presenting alerts to the user. Although it is common to develop with modern techniques such as HTML 5, CSS 3 and modern Javascript libraries, XHTML was used, and most CSS was limited to CSS 2 to ensure compatibility with older browsers. As it was unknown what devices users would have access to, the prototype was built mainly in XHTML and CSS 2. Additionally, being a government department, Landgate required the interface to render correctly in older browsers such as Microsoft's Internet Explorer 7. As this research looked at the redesign of Landgate's FireWatch service, this meant that only web technologies that were deliverable through common web browsers were considered. Other technologies that may be used in emergencies, such as SMS, email or cell broadcasting, were not applicable to this research. Nevertheless, alerts from state-based emergency services organisations were added to the application. Additionally, some users and colleagues mentioned that the application was slow in responding to user input. The datasets used by FireWatch are large — for example the hotspot layers often contain up to 10,000 points on any given day. These dataset files are several megabytes in size and can affect the application's performance, especially on slower connections.

Performance of the application was also limited by the power of Landgate's servers, which host the FireWatch service (as well as the end-user's internet connection and device impacting on performance).

3.3.6 Delimitations

A decision was made to not discuss socio-emotional aspects of the interface. Modern cognitive science tells us that emotion and cognition are intertwined and cannot be separated (Norman, 2008; Hassenzahl, 2004a). As discussed in the literature review, Hassenzahl (2004a) asserted that designers cannot design an experience, but they can design *for* an experience. Allowing a user to achieve a valued goal — such as being informed about an important issue — can lead to a feeling of satisfaction or accomplishment (Hassenzahl, 2004a). Emotions are difficult to measure, but usability and utility are not. This seemed to be an appropriate way to consider the purpose of the interface. Part of the work of user experience design involves determining which parts of a design are of importance to its users (Roto et al., 2011, p. 11). Consequently a focus was placed on both utility and usability of the interface to increase the chances of users being better informed about bushfire threats. The population studied in the two rounds of user engagement was confined to a small sample from Kununurra. Kununurra was considered an appropriate representation of a rural town in northern WA. Other populations outside of WA, populations closer to urban areas and overseas populations may have different needs to those who took part in the user engagement. It was known from the outset that the prototype was likely to go through several iterations, as is typical of user experience design (Roto et al., 2011, p. 11). Therefore, it seemed appropriate to choose a research methodology that would allow for multiple iterations of a design process. It was also known that there would be limited access to users in the remote community. This meant that other common methodologies in design research, such as ethnography, narrative and case study (Crouch & Pearce, 2012), were not considered feasible. The research instruments used also may mean that the findings cannot be generalised

significantly. The card system was useful for keeping users focused on the topic at hand. However the semi-structured interview guide lacked this focus, which meant that users were not strictly confined to topics related to the interface or even bushfire information and communications. Both the semi-structured interview guide and the online questionnaire focused on usability and utility, which was also considered a limitation of the research.

3.3.7 Iterative design process

To undertake this research, an iterative design method was created (Figure 3.7) that incorporated user input — both through the use of personas and directly by working with actual community-based users, as well as consultation with the service provider, Landgate. As this research was a constructive design project (Koskinen et al., 2011, p. 5), at its centre was the working prototype developed over several iterations of the redesign process.

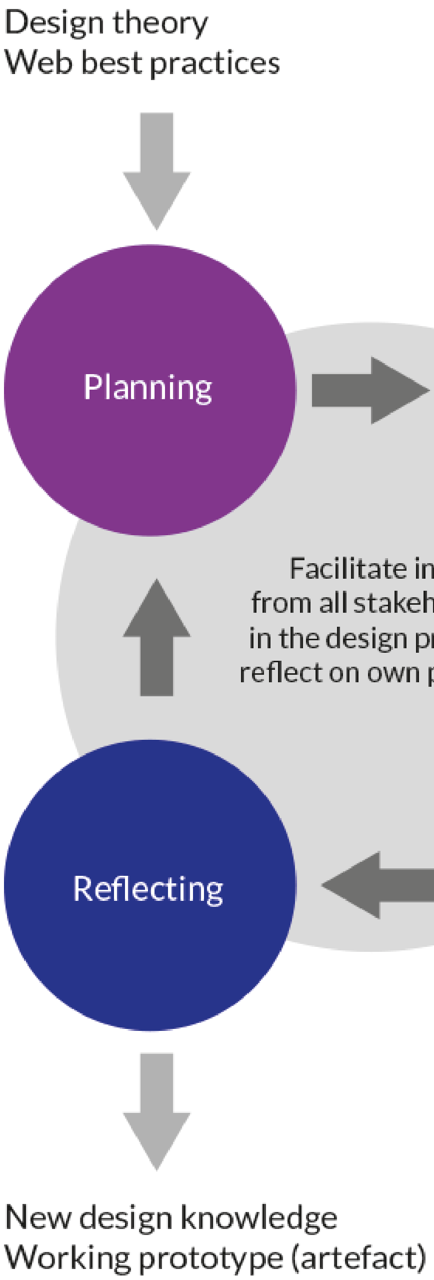

Figure 3.7: The iterative design process undertaken in this research. This iterative design approach is based on the iterative action research process from Stickdorn and Schneider (2010, p. 286) as well as the participatory iterative process described by Taylor and Cheverst (2006, p. 3) that was also undertaken in a rural setting.

To ensure that adequate functionality was provided to users, methods were used to gauge which features would be useful to participants, as well ensuring usability of the interface. Due to the various research instruments used, this iterative design process yielded both qualitative and quantitative data, although there is focus on the latter. Service design borrows several perspectives from product design, including the use of sketching, prototyping and other visualisation techniques (Stickdorn & Schneider, 2010, p. 54), as well as design ethnography (Stickdorn & Schneider, 2010, p. 103). Mechanisms for acquiring feedback, such as interviewing and questionnaires, are also used (Stickdorn & Schneider, 2010, p. 124). Therefore, these specific research instruments — interviewing and questionnaires — were considered to be suitable for the research undertaken here. The design method described in Figure 3.7 allowed for consideration and reflection of how to integrate the perspectives of both the users and the service provider at each step, and how the perspective of these key stakeholders could inform each iteration of the design. Reflecting on one's own limited perspective allows a designer to "recognise that the design decisions you ultimately make should be the result of a co-design process. The users of the design should have a central role in the design process" (Crouch & Pearce, 2012, p. 133). Furthermore, the design needed to consider the perspective of the service provider, as well as the socio-technical context in which the interface was being used. This meant that it was necessary to consider the technical and social aspects in which the redesigned public access FireWatch service would be used (Beaumont et al., 2014, p. 121). The four stages of the iterative design process are described in further detail here.

Planning

Analysis of the previous expert-user version of the FireWatch interface was undertaken prior to any prototyping commenced. This involved identifying the key functionality provided by the previous version. The scenario-based design requirements analysis framework (Figure 3.5) provided a means in which to establish requirements at the beginning of each iteration. This included establishing a

set of requirements based on the structure created by Cooper et al (2014), which contains *functional requirements*, *data requirements* and *other requirements*. This requirements analysis, along with the personas created, provided a way of considering the perspective of users prior to the commencement of any design work. More details of the early planning and design work are discussed in the next chapter which describes the role that scenario-based design and the personas framework played in the design of the first iteration of the prototype interface. Stickdorn and Schneider noted that the planning stage should involve the development of a "theory of how to solve certain problems". The theory here is that interaction design usability guidelines, Maeda's (2006) approach towards simplicity and web best practices, can all help to improve the usability and utility of the interface. The guidelines discussed in the previous chapter provided a solid foundation on which to commence building a prototype. Additionally, modern web best practices, specifically responsive design (Marcotte, 2011) informed the redesign process. These guidelines (Table 3.5) addressed both interface usability and functionality issues, and were informed by the theory discussed in the previous chapter.

Table 3.5: Guidelines for the prototype. These guidelines were formed from several of the interaction design, HCI and web design guidelines discussed in the previous chapter. This list informed the initial design of the prototype, as described in the next chapter.

Guideline	*Description*
Responsive design	Page elements will line up in a grid format. The grid layout will be flexible through the use of responsive design so as to cater for multiple browser and screen sizes, including tablet and mobile devices.
User control	The interface will make users feel that they are in control.
Focus	The interface will allow the user to focus on the task at hand.
Typography	Simple, clear use of typography — typesetting should adjust for users on various screen sizes.

Everyday language	Everyday, clear and simple language is used, avoiding jargon.
High contrast	The interface will use only high contrast colours.
Navigation	Clear and easy to use navigation — this should adjust to ensure navigation works across multiple devices/browser sizes.
Appropriate use of colour	Colour will be used appropriately, such as high contrast between text and its background, and colours such as red to indicate danger.
Layout	Appropriate layout of page elements, space and alignment.
Consistency	Consistent use of fonts, colour and layout.
Ease of use	Simplicity where appropriate, but not at the expense of required functionality.
Minimal download time	The site should download as quickly as possible, as it will be used in potentially stressful situations, and by people with slower (e.g., mobile) connections in rural areas.
Accessible	The site should aim to work on desktop, mobile and tablet devices. It should also aim to adhere to Web Content Accessibility Guidelines (WCAG).
Trust	Users need to trust the system and the information it provides. This is related to the next guideline, appropriate information.
Appropriate information	Information delivery is current, relevant and timely, accessible and an appropriate amount. The information source is a known organisation. Determining the right amount of information was considered a crucial aspect of the redesign process.
Map controls	The map has a toolbar, including controls to allow a user to zoom in and out. The map has distance measurement tools or a scale.

Map markers	Markers on the map indicate levels of threat for current fires, with red indicating the most recent threat.
Multiple layers	The map has multiple layers that show information such as lightning strikes, fire history, cloud-cover, weather data, etc.
User settings	Users can customise their preferences — particularly regarding location, and the system will remember these. This will depend on the browser being used, as location detection is only supported by modern browsers.
Simplicity	Where possible, increase usability by removing unnecessary functionality. However, care needs to be taken when ascertaining what to remove.
Context of use	The context of where and how a service will be used should be considered. This includes the technical concerns, such as the devices and technology used to deliver the service, as well as the technical capabilities of the users.

Prototyping and designing

This stage involved the design and development of a prototype that was iteratively refined and re-designed. The prototyping and design was informed by the theories and knowledge from the previous stage (Stickdorn & Schneider, 2010, p. 286). Prior to any actual design in the first iteration, a wireframe — a diagram with the purpose of communicating an overview of a design — was created (Brown, 2007). The prototype was designed in Photoshop, and then built with CSS (Cascading Stylesheets), HTML (HyperText Markup Language) and JavaScript (including jQuery, OpenLayers and Google Maps JavaScript frameworks). The prototype accessed several map data layers created and processed by Landgate's application development team. The guidelines described in Table 3.5 directed the design and development of the prototype. The working prototype was uploaded to a

web server and tested across several browsers and devices prior to being presented to users.

Exploring

The exploring stage comprised direct and indirect observations of users engaging with the redesigned prototype interface. In the first iteration of the redesign process, this stage involved reflecting on the personas constructed in the first planning stage, due to the delay in direct access to participants in the rural community of Kununurra. This reflection involved describing how each persona would interact with the prototype interface. In subsequent iterations, direct observations were undertaken: Data was collected by getting participants to rate features using a card sorting system, observing the participants exploring the prototype's interface and by interviewing them about their experience with the prototype (Stickdorn & Schneider, 2010, p. 286). The card sorting system and semi-structured interviews were undertaken to ensure that the needs of different types of users in the community were accounted for in the design and to ascertain what these users were expecting in the FireWatch redesign, in terms of usability and functionality. After the final iteration of the prototype went live, a link to an online questionnaire was added. The next two chapters will discuss in detail the work undertaken in multiple iterations of this exploration stage.

Reflecting

This stage encompassed analysis of the data collected from the previous stage in order to transform it into "manageable insights" (Stickdorn & Schneider, 2010, p. 286). In the first iteration, this stage involved reflecting on the personas created in the initial planning stage. In subsequent iterations, this stage captured the participants' experience of the prototype through the use of interviews, which highlighted how participants interacted with the prototype interface, as well as their requests for certain features, or the features being presented in a particular way. After reflecting, the iterative

process continued on to the planning stage again (Stickdorn & Schneider, 2010, p. 286), where the data collected would inform the next stages of planning and design. The next three chapters discuss the reflecting stage in greater detail.

3.3.8 Research outcomes: new design knowledge and a publicly accessible web application

This research, being constructive design research (Koskinen et al., 2011, p. 5), centred around the development of a prototype interface. The redesigned FireWatch interface was initially considered to be a prototype which could enable input from the users and the service provider: the artefact would enable feedback that could then inform future designs of the public access FireWatch — while also generating data for the research. However, as previously mentioned, the interface was adopted by Landgate and eventually became a live website that they officially supported. The website went live in March 2014 and was officially launched in Kununurra in July 2014. Prior to being launched, the website was rebranded as MyFireWatch, hosted at http://myfirewatch.landgate.wa.gov.au. The redesign process involved undertaking multiple iterations of the same process, which is discussed in further detail in the next three chapters. Chapter 4 describes the first design iteration. In this iteration, due to a lack of direct contact with users, a personas framework (Cooper et al., 2014) was constructed as a way of considering the user's perspective. A working prototype was constructed based on existing research, web best practices and considering the user perspective via the aforementioned personas. Outcomes from Chapter 4 include the role of scenario-based design and personas in the design process, as well as simplicity as a design goal. Chapter 5 describes two iterations of the design process where direct engagement was undertaken with community-based users in Kununurra. Feedback from these users had several outcomes, including the role that satellite imagery can play in orientating the user, and that users can find unanticipated uses for the information provided to them. The expanding and evolving role of the user is also discussed, as is the role of rhetoric. Chapter 6 de-

scribes the final iteration of the design process, which considered feedback from users in Kununurra and the service provider Landgate. Participant feedback was acquired through an online questionnaire which launched simultaneously with the MyFireWatch web application. Feedback from the questionnaire validated that the interface was highly usable. However it did reveal that there were performance issues for several participants. Despite several participants also having issues with the greenness of vegetation imagery, the interface seemed to generally provide adequate functionality for most users. There was mixed support for user-sourced content, and that the promotion of MyFireWatch needs to consider social media but also traditional media. As a way of generalising the outcomes of the research findings, two frameworks were created, which are described in Chapter 7.

3.3.9 Frameworks: a pattern language and a personas framework

As a result of the design process undertaken, two frameworks were generalised so that researchers working in a similar domain can apply them in different contexts. As Koskinen et al stated, "the question, then, is not whether theory is useful, but how should it be used. Design is not a theoretical discipline" (2011, p. 118). Cooper et al. (2014, p. 154) argued for new design knowledge to be useful for real world application: "Design specifications that gather dust on a shelf are of no use to anyone" (Cooper et al., 2014, p. 154). The intention of these two frameworks is to point designers in the right direction when designing hazard information interfaces for communities. The frameworks came to fruition through the use of the iterative action research process. The frameworks constructed were informed by pattern language (Alexander et al., 1977; Borchers, 2000) and the personas framework (Cooper et al., 2014). The pattern language created was also informed by interaction design theory, web best practices and the disaster research literature discussed in the previous chapter. The frameworks are described in detail in Chapter 7.

Pattern language

Part of the approach of constructive design research involves the generalising of the design process and results as a means of contributing new design knowledge (Koskinen et al., 2011). To do this, a set of guidelines was created in the form of a pattern language. The original idea of a pattern language was envisaged in the 1970s within the field of architecture (Alexander et al., 1977). A pattern language is a series of individual patterns. Each pattern describes a recurring design problem and offers a solution of how to address the problem (Alexander et al., 1977, p. x). Each pattern has the same structure: a headline that summarises the problem, then descriptions of the problem, its context and a solution (Alexander et al., 1977, pp. x-xi). Design patterns have been used in architecture (Alexander et al., 1977), software engineering (Gamma, Helm, Johnson & Vlissides, 1994; Winn & Calder, 2002) and HCI (Borchers, 2000; van Welie & van der Veer, 2003). In an interaction design context, pattern language is considered to be "one of the most effective design knowledge management tools available" (Welie & Veer, 2003, p. 8). Patterns have come to play a key role by formalising interaction design knowledge and documenting best practices (Cooper et al., 2014). In this context, design patterns serve several key purposes:

- Reduce design time and effort on new projects
- Improve the quality of design solutions
- Facilitate communication between designers and programmers
- Educate designers (Cooper et al., 2014, p. 156).

In interaction design, patterns are viewed as a way to improve on style guides and standards as an expression of interaction design experience (Borchers, 2000, p. 5). Patterns provide interaction designers with a means to provide both a concrete example and a generalised solution while also offering a context in which to apply the solution (Borchers, 2000, p. 5). The pattern language presented in this research follows the same structure as Borchers, which he considered to be the essential components

of a pattern in interaction design (2000, p. 2). Table 3.6 shows the structure of an interaction design pattern.

Table 3.6: Formal structure of a design pattern in interaction design (Borchers, 2000). Although patterns can have this formal structure, Borchers (2000) noted that the structure is flexible in order to ensure that it is readable and clear.

Pattern element	*Description*
Name	The name of a pattern helps to refer to its central idea quickly, and build a vocabulary for communication within a team or design community (2000, p. 3).
Context	Each pattern has a context represented by edges pointing to it from higher-level patterns. They sketch the design situations in which it can be used (2000, p. 3).
Problem	The problem states what the major issue is that the pattern addresses (2000, p. 4).
Examples	The examples section is the largest of each pattern. It shows existing situations in which the problem at hand can be (or has been) encountered, and how it has been solved in those situations (2000, p. 4.
Solution	The solution generalises from the examples a proven way to balance the forces at hand optimally for the given design context. It is not simply prescriptive, but generic so that it can generate a solution when it is applied to concrete problem situations of the form specified by the context (2000, p. 4).
Diagram	The diagram supports the solution by summarising its main idea in a graphical way, omitting any unnecessary details (2000, p. 4).

References References show what lower-level patterns can be applied after it has been used. This relationship creates a hierarchy within the pattern language. It leads the designer from patterns addressing large-scale design issues, to patterns about small design details, and helps him locate related patterns quickly (2000, p. 4).

Borchers (2000, p. 4) noted that although patterns can have a formal structure, this structure is flexible and readability and clarity of patterns is more important than following this structure. The following shows an example of one of Borchers' (2000) patterns for interaction designers. This pattern was created as part of a pattern language for an interactive musical exhibition. Note that the capitalised names refer to other patterns in the pattern language that Borchers (2000, p. 7) created.

Name: INCREMENTAL REVEALING
Context: Designing a computer exhibit interface that ATTRACTS VISITORS with its initial SIMPLE IMPRESSION, but that still ENGAGES VISITORS for a while with sufficient depth of functionality and content. Problem: A simple appearance, and presenting the system's depth are competing goals.
Solution: Initially, present only a very concise and simple overview of the system functionality. Only when the user becomes active, showing that he is interested in a certain part of this overview, offer additional information about it, and show what is lying "behind" this introductory presentation.
Examples: *WorldBeat* is structured into a short introductory screen, followed by a simple main selection screen with only names and icons of the main exhibit components (conducting, improvising, etc.) If the user moves the pointer towards one of the component icons, a short explanation appears (first revealing stage). Then, if he selects it, a separate page opens up that explains the features in more detail (second revealing stage).

References: Most information systems reveal their content incrementally through a FLAT AND NARROW TREE STRUCTURE. The DYNAMIC DESCRIPTOR pattern also implements incremental revealing.

Personas framework

Personas are "composite archetypes" of users that provide designers with a powerful way of considering the perspective of users without their direct input (Cooper et al., 2014, p. 76). The personas framework acts as a "powerful tool for communicating about different types of users and their needs, then deciding which users are the most important to target in the design of form and behavior". Personas were used in the initial design iteration, as described in the next chapter. These personas were informed through "Information about users supplied by stakeholders and subject matter experts [and]... data gathered from literature reviews and previous studies (Cooper et al., 2014, p. 81). Individual personas should use photos or illustrations to represent them, as these visual representations can help the designer to empathise with the user (Cooper et al., 2014, p. 103). Cooper et al (2014) demonstrated how even simple personas can inform the design of vehicles (Figure 3.8).

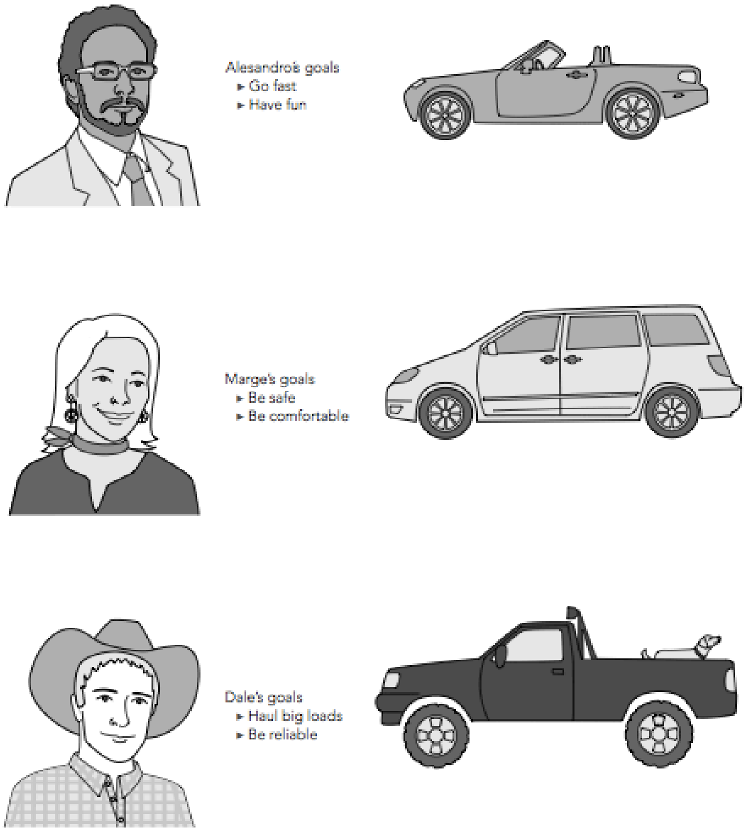

Figure 3.8: Cooper et al's (2014, p. 78) example of three simple personas. These personas were created to illustrate how even simple personas could inform the design of motor vehicles.

Grudin and Pruitt (2002, p. 3) took a more detailed approach to their personas, giving an example of a foundation document for personas that they create as a way of considering the perspective of users without their direct input (Table 3.7).

Table 3.7: Grudin and Pruitt's (2002) example of a foundation document for personas that they use as a starting point for creating personas. This framework for a persona is more detailed than the simple example given by Cooper et al (2014).

Persona attribute	*Description*
Overview	Patrick Blakeman (Small Business Owner)
A Day in the Life	Follow Patrick through a typical day.
Work activities	Look at Patrick's job description and role at work.
Household and Leisure Activities	Get information about what Patrick does when he's not at work.
Goals, Fears, and Aspirations	Understand the concerns Patrick has about his life, career, and business.
Computer Skills, Knowledge, and Abilities	Learn about Patrick's computer experience.
Demographic Attributes	Read key demographic information about Patrick.
Technology Attributes	Get a sense of what Patrick does with technology.
Technology Attitudes	Review Patrick's perspective on technology, past and future.
Communicating	Learn how Patrick keeps in touch with people.

As designers should be "open-minded and flexible" (Cooper et al., 2014, p. 117) in their use of scenarios and personas, a simple framework for the personas was created, based on criteria from Grudin and Pruitt's model that seemed relevant to the FireWatch redesign. The goal-orientated approach of Cooper et al's (2014) personas framework also informed these criteria. That is, only characteristics of remote community-based users that could influence the design were considered. This approach was taken as the personas were originally created prior to any real-world studies. Therefore, the personas created in Chapters 4 and 7 use the following structure:

- Overview
- Computer Skills, Knowledge, and Abilities
- Internet-enabled devices
- Expectations of the redesigned FireWatch
- Experience with map websites.

A personas framework is presented in Chapter 7 as a way of allowing the service provider Landgate — and others working on designs for a similar audience — to consider the perspective of a non-expert remote community-based audience.

3.4 Conclusion

This chapter discussed the relevant theoretical background that informed the research undertaken. It discussed how interaction design has considered users in the design process. This evolution has seen a transition from user-centred design, to participatory design, and more recently to service design. Carroll (1997) described the traditional view in HCI of users being experts in their field. Holmlid (2009) noted that in participatory design and service design, users do not have an understanding of applying the technology being used, and for this reason they are useful to the design process. The role of users in the research undertaken here reflects the shift in thinking of the user's role as described by Holmlid (2009). The interest in service design has meant that not only are users considered co-designers, but all stakeholders are considered in the design process. Service design has also meant that the entire socio-technical context of a service is considered. This research took the approach of constructive research, as it was centred on the development of a prototype: something that is fundamental to this type of design research, as it allows a researcher to explore users' behaviour, attitudes and experiences (Koskinen et al., 2011). The intention of this prototype building was to develop new knowledge, which included two frameworks that could be generalised from

the process. Both interaction design and service design use iterative design processes, with the latter relying on an iterative process from action research. The approach taken here was informed by Stickdorn and Schneider's (2010) action research model, while also borrowing from Taylor and Cheverst's participatory iterative process undertaken in a rural setting. Action research allows the research to be informed by the social and cultural context of the user, while also allowing the user to become familiar with the technology. This meant that action research was a suitable method for service design research. The iterative process comprised four stages: planning; prototyping and designing; exploring; and reflecting. There was an attempt to ensure that the interface was useful and usable for participants, leading to positive feelings of satisfaction, achievement and goal accomplishment (Hassenzahl, 2004a). Useful and usable aspects of the interface were addressed in the requirements analysis in the planning stage and were the focus of the observations undertaken in the exploring stage. Providing simplicity was a key aspect to the interface as a way of improving usability. This was addressed by relying on Maeda's (2006) approach of "strategic reduction" in functionality from the original FireWatch interface. The aforementioned frameworks were two outcomes that were derived from the redesign process. The prototype that eventually became a publicly accessible web application officially supported by Landgate was also a significant and practical outcome of the research. The next chapter discusses the first iteration of the design process, which relied on the use of design scenarios and the personas framework. The work undertaken in the following chapter followed the iterative design process articulated in Figure 3.7 of this chapter, with stages of planning, prototyping and designing, exploring and reflecting. The following chapter covers the early stages before and during the design process and describes the circumstances that led to the use of scenario-based design and the personas framework. Consequently, both scenario-based design and the personas framework are discussed in greater detail. The personas, along with theory, informed the construction of an initial working prototype. How the personas created would interact with the prototype was then considered. The result of this first iterative process resulted in an early working prototype

that would then be tested with actual community-based users in Kununurra.

4

Early stages of the redesign process

Three peer-reviewed publications (one journal article and two conference papers) have arisen from the results discussed in this chapter:

- Haimes, P., Medley, S., & Clarkson, B. (2014). Geo Spatial Simplicity: Designing Map Interfaces for Bushfire Planning. *The International Journal of Visual Design, 7*(2), 37-45.
- Haimes, P., Brady, D., Clarkson, B., & Medley, S. (2013). *Engaging with communities as a design process: redesigning the FireWatch interface*. Paper presented at the Australian & New

Zealand Disaster and Emergency Management Conference, Brisbane.

- Haimes, P., Jung, J., & Medley, S. (2012). *Bridging the Gap: Scenario-Based Design as a Solution for Delayed Access To Users*. Paper presented at the Australian Council of University Art and Design Schools (ACUADS), Perth.

4.1 Introduction

The previous chapter discussed the methodology and research design. It discussed how the research undertaken here has taken the form of constructive design research, that is, that at its centre is the development of a prototype interface (Koskinen et al., 2011). The previous chapter also described how interaction design and service design both rely on iterative design processes, with action research being identified as a key methodology of both service design (Stickdorn & Schneider, 2010) and design research more widely (Crouch & Pearce, 2012). This previous chapter also discussed how due to the circumstances in each iteration of the design process, the research instruments varied in the first and final iterations of the design process. These research instruments are described in greater detail in this chapter and the next two chapters, which discuss the four design iterations undertaken and the results they yielded in greater detail.

This chapter discusses the first design iteration from the analysis of the old expert-user version of FireWatch through to the completion of the first working iteration of the prototype interface. The choices made, guided by theory, with scenario-based design (Rosson & Carroll, 2002) and the personas framework (Cooper et al., 2014) compensating for a lack of input from real-world users, were reflected on. The purpose of this stage was to produce a working prototype for testing by community-based users in the trial site of Kununurra. The process of analysing the previous expert-user version of the FireWatch service, the use of a scenario-based design requirements analysis and framework, and the creation of a persona framework were described. The use of scenario-based

design and persona frameworks — along with considering Maeda's (2006) approach to simplicity — provided the catalyst for development of a prototype for the first round of user testing.

Structurally, this chapter first discusses the planning stage, which was larger than subsequent planning stages due to it informing the first generation of the prototype interface. This first planning stage involved identifying the key features offered by the previous expert-user version of FireWatch and ascertaining how to present these in a simplified way. In the planning stage, consideration was also given to the rhetorical affects of the interface and these were documented in the process. The scenario-based design requirements analysis and elements framework were created, along with a personas framework detailing several personas representing a small but diverse group of users from Kununurra. The requirements from the planning stage were summarised as functional requirements, data requirements and other requirements. The prototyping and designing stage details how the requirements from the planning stage were addressed. This stage shows the first wireframe (Brown, 2007) created; a diagram showing the outline of the components making up an interface. It also shows all of the features of the previous expert-user version of FireWatch and how these were simplified in the first iteration of the prototype. The exploring stage of this design iteration was only briefly discussed as it did not directly involve users. Instead their perspective was considered in the planning stage through the use of scenario-based design. However, the service provider Landgate was presented with an early working prototype at this exploring stage. Finally, the reflecting stage is discussed. As the exploring stage of this design iteration did not directly involve users, the reflecting stage involved reflecting on the approach to simplification of the interface and the role of rhetoric in the design. It also reflected upon the use of scenario-based design and the personas framework as a way to "kick-start" the design process. The various facets of the planning stage that led to the first working prototype are also discussed in detail in the next chapter, particularly how the personas created in this chapter informed the recruitment of community-based users in the next chapter.

4.2 Planning the first iteration of the prototype: scenario-based design and personas

This section explains the planning stage of the first iteration of the design process as described in the previous chapter. The planning stage involves the development of "a theory of how to solve certain problems" (Stickdorn & Schneider, 2010, p. 286). The theory here addresses simplicity as a design goal and the role of rhetoric in designing an interface. As users could not be directly engaged in this iteration of the design process, scenario-based design and the personas framework were used to consider the design from the users' perspective from the outset. Previous HCI research has highlighted the difficulty in undertaking design research in remote Australian communities (Brereton, Roe, Schroeter & Hong, 2014). This previous research suggested using reciprocity and engagement as ways of building a rapport with the communities prior to commencing design work (Brereton et al., 2014). The problem in the case of the FireWatch redesign was that the research team could only access the community after the design work had commenced, meaning that a different approach was required. Scenario-based design and personas were considered to be an indirect way of incorporating co-design into the design process, as scenario-based design can facilitate participatory design (Rosson & Carroll, 2002, p. 23). Also of note is that the other significant stakeholder in the research — the service provider Landgate — provided input into the first design iteration. Scenario-based design and personas helped to explain to the service provider the types of users that the redesign needed to consider, and why it was considered necessary to simplify the interface.

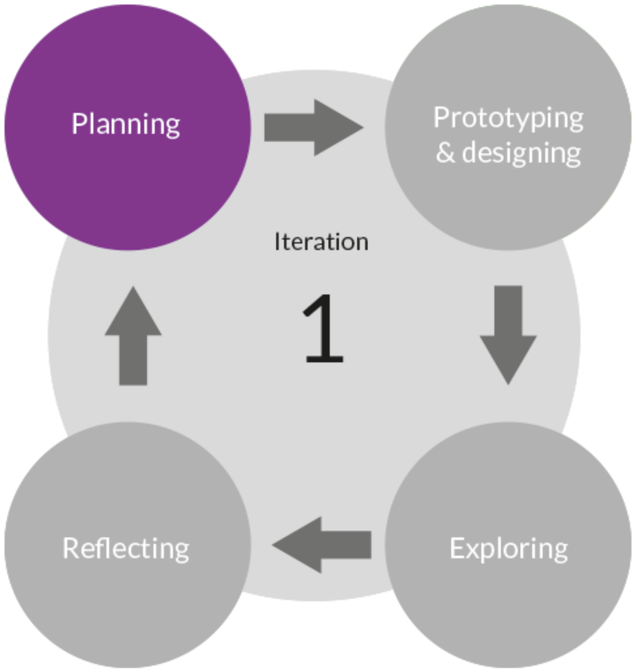

Figure 4.1: The planning stage of the first iteration of the design process described in the previous chapter. The planning stage involves the development of "a theory of how to solve certain problems" (Stickdorn & Schneider, 2010, p. 286). This theory included addressing simplicity as a design goal, the role of rhetoric in designing an interface and how scenario-based design and the personas framework could be used to consider the design from the users' perspective.

4.2.1 Simplicity as a design goal

The redesign of the public access version of FireWatch needed to deliver a usable and intuitive interface for non-technical users — particularly those situated in a rural setting. Ease of use and simplicity are emphasised in HCI (Krug, 2000; Maeda, 2006; Nielsen, 2000), and are of further significance when an interface may be used in an emergency situation (Anderson & Schram, 2011; Lanfranchi & Ireson, 2009; Palen & Liu, 2007). Although the purpose of FireWatch has never been to act as an alert system, it may still be used in potentially stressful situations, so ease of use was considered a key objective of the new prototype interface. It was considered imperative that users of FireWatch should be able to quickly determine the purpose of the map-based interface and orientate them-

selves through the map functionality provided. A simple map interface with reduced functionality is more likely to be successful than one that has not considered design aesthetics and overburdens users with complicated functionality (Edmonds, 2013). Providing users with an aesthetically pleasing map interface and accurate geographic information would allow them to gain a greater understanding of fire risks in their vicinity (Perera & Tateishi, 2012). Maeda's statement that the "easiest way to simplify a system is to remove functionality" (2006, p. 1) was considered an appropriate way to address enhancing the usability of the redesigned FireWatch interface. In the context of the FireWatch redesign, Maeda's statement pointed the way — it was anticipated that a decision to remove much of the functionality would provide non-technical users with accessible and relevant information in the right amount. The design guidelines that were summarised in the previous chapter (Table 3.5) also guided the design decisions made. An emphasis was placed on consistency, high-quality content, regularly updated content, minimal download time, ease of use and information relevant to the users' needs. By following these principles, it was assumed that usability would be improved. It was also worth bearing in mind the goals of usability. A usable design should be "effective to use, efficient to use, safe to use, have good utility, easy to learn and easy to remember how to use" (Rogers, Sharp & Preece, 2002, p. 14). Providing a simplified interface with only the core functionality appeared to be the most sure-fire way to deliver an interface that met these usability goals. However, the user experience encompasses more than usability and consideration should be given to other aspects of the design (Hassenzahl, 2004a; Rogers et al., 2002). The redesigned interface needed to consider what the users were hoping to achieve. Would they find the interface useful? Would using the interface be a satisfying experience? Would it be an informative experience? These questions concerned how the design *feels* according to users and are somewhat more difficult to define and are more subjective than usability goals (Rogers et al., 2002) but do have a bearing on the user's impression of functionality (Hassenzahl, 2004b). These questions were considered at this planning stage of this initial design iteration, but were not answered until feedback from community-based users

was obtained. Improving usability and utility were priorities and that the primary goal was to ensure that future users would be better informed about bushfires in their vicinity.

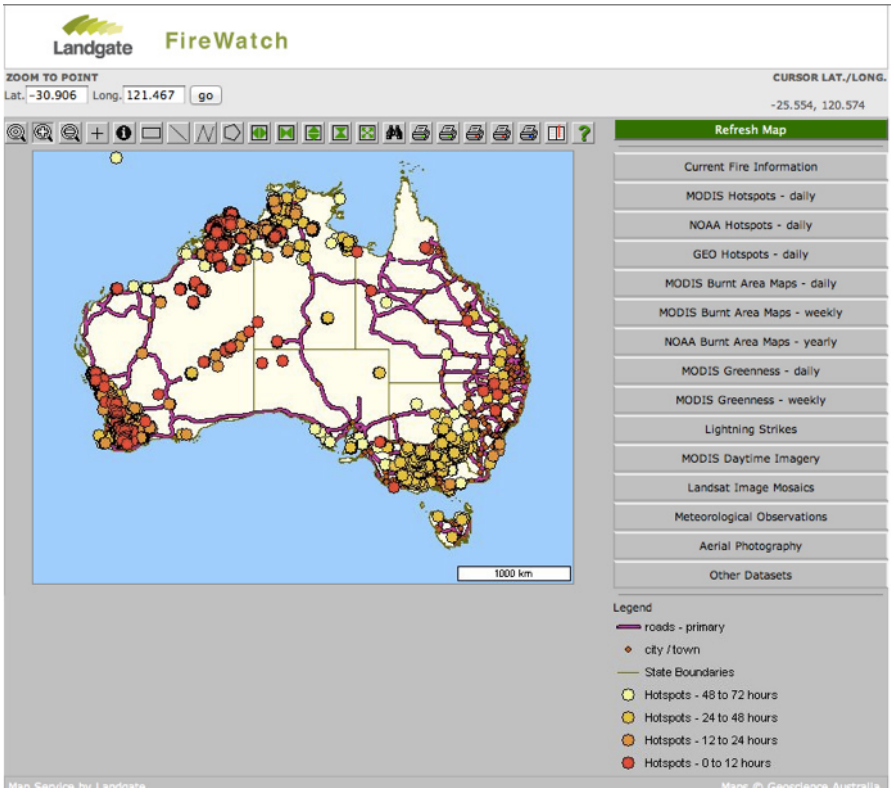

Figure 4.2: Landgate's previous version of the FireWatch website (Landgate, 2012). This screenshot was first introduced in Chapter 1 (Figure 1.1).

An analysis of the previous expert-user version of the FireWatch website (Figure 4.2) was undertaken. As previously explained, the circumstances of the ARC project meant that direct contact with community-based users was not initially possible. The role of the research officer was to conduct the initial ethnographic work and establish key contacts in the Kununurra community. Members of the Kununurra community were then approached to trial the prototype website and interviews were conducted based on their experience with the website, map-based interfaces generally and com-

munication issues around bushfires. The ethnographic work commenced several months after the beginning of the initial prototype development. This timing meant that it was necessary to find a way to bridge the gap between starting the design process and having the ability to directly engage with actual community-based users.

4.2.2 Kick-starting the design process with scenario-based design and the personas framework

Scenario-based design was utilised to commence the development of a prototype interface. The introduction of scenario-based design — through informal storytelling about users and their tasks (Rogers et al., 2002) — allowed for the identification of a set of requirements appropriate for this redesign. Functional, data and other requirements are explained at the end of this planning stage, using Cooper et al's (2014, p. 122) model for requirements based on scenarios and personas. Based on the scenario-based design framework of Rosson and Carroll (2002, p. 50) the five sections below were used to describe the scenarios of use that were created prior to the beginning of the initial redesign process.

Root concept

The previous expert-user website was the starting point. The initial objective was to try to improve upon the usability of the current site, catering for members of the community (with a focus on people outside of the emergency services) and catering for cross-browser and cross-device compatibility. Input from users from a remote community in Western Australia was considered to be necessary in order to ensure that the redesigned interface met their needs. This root concept was the basis of this research project and was agreed upon by Landgate and ECU as part of the initial ARC research proposal.

Field studies

The initial design was conducted prior to real-world studies (in the form of user testing and a semi-structured interview, followed by an online questionnaire), hence the need for a scenario-based approach at this stage. The scenario — and the personas framework — were based on information provided by Landgate staff and publications, the knowledge of the ARC project research officer, publicly available information about the trial site of Kununurra and information from the NAFI project. The stakeholders in this design were users in the remote community of Kununurra, the service provider (Landgate) and other ECU colleagues from the communications side of the project.

Summaries

The initial task was to improve upon the usability of the previous expert-user version of FireWatch. Further iterations, which involved real community-based users, focused on both usability and functionality while ensuring to meet the needs of users — particularly those situated in remote areas of Western Australia. User archetypes were explained in the personas framework, and were expanded upon once user-testing and interviews with community-based users commenced. Throughout the design process — all stakeholders were consulted and considered — this included users (both through scenario-based design and real-world participation) and the service provider, Landgate, as well as work done in consultation with the ARC project research officer.

Problem scenarios

The primary problem addressed by the design process was how to enhance usability while ensuring that the right amount of functionality was provided. This became clearer after feedback was received from actual community-based users through the online questionnaire and semi-structured interviews. Prior to this, scenario-based design and the personas framework provided the perspective of

users. Initially, enhancing usability was addressed in the initial prototype design and users — in the form of personas — provided a way of considering whether the functionality provided was adequate to meet their needs. Addressing usability and considering what functionality would be useful to these users led to the establishment of requirements, which were addressed in the first iteration of the prototype.

Claims analysis

As discussed previously, this research combined theory from HCI and interaction design, web best practices (including responsive design to cater for multiple browsers and devices), visual rhetoric, input from Landgate and the research officer, and findings from the NAFI website. As part of the personas framework, a clearer idea formed of the new audience of FireWatch, and with it came an impression of how these new users intended to engage with it.

Describing the scenarios of use defined the root concept, the types of input that would contribute to the redesign process and the methods for input from real-world users at a later stage. In addition to articulating these requirements, elements characteristic of interaction scenarios were examined. These elements were based on Rosson and Carroll's table of characteristic elements (2002, p. 18), shown in the previous chapter (Table 3.3).

These characteristics were explained within the context of the FireWatch redesign, prior to the commencement of any actual design (Table 4.1).

Table 4.1: Descriptions of characteristic elements within the context of redesigning the FireWatch interface. These elements come from Rosson and Carroll's (2002) table of characteristic elements, which are described in Table 3.3.

Element	*Description*
Setting	The goal of this redesign is to improve the usability and functionality of the public access version of the FireWatch system, allowing for it to be easily adopted by the wider community.
Actors	There will be various types of users interacting with FireWatch: these may include pastoralists, local council representatives, indigenous land managers, tourist operators and members of community organisations. Personas will be used to describe each type of user in detail, along with their reasons for using the interface and their technical experience and limitations.
Task goals	The task goal will be for users to easily locate bushfire threats near their location, allowing them to make informed choices about how to respond to these bushfire threats.
Plans	Using the interface, users should be able to easily pan to the desired location and zoom to a reasonable level to allow them to view fire threats in their vicinity. It will also easily allow them to select the type of information layers that they desire.
Evaluation	Carried out after feedback from users has been obtained through various means including user testing, interviews, questionnaire feedback.
Actions	User actions will be determined by feedback from users and observations made during user testing.
Events	Actions will include zooming and panning the map, allowing users to select layers of information and refreshing the map. Future events (i.e., functionality) may be added or removed, as required, based on feedback from users.

The elements described a scenario where various types of users were engaging with the FireWatch interface, with the goal of gaining information on fire threats in their vicinity or another point of interest. The scenario elements detailed the way in which users would interact with the map and the tasks that they would be attempting to achieve through this interaction (Table 4.1).

4.2.3 Personas

Personas are a way of modelling user types that provide a powerful way of considering the perspective of users without their direct input (Cooper et al., 2014). These models can be considered archetypes, rather than stereotypes (Cooper et al., 2014, p. 76). Distinct personas were created to address the various types of users (described as 'actors' in Table 4.1) that may be encountered throughout the duration of the FireWatch project. These personas were informed by information from Landgate (who had received feedback from FireWatch users prior to this research), information from the Kununurra Visitor's Centre (2011), the research officer's prior ethnographic experience in rural communities and previous research related to the NAFI project (Tropical Savannas CRC, 2012) and FireWatch (Steber et al., 2012). In this planning stage, the distinct personas were identified as (1) a pastoralist, (2) a local police officer, (3) a volunteer of a community organisation, (4) an indigenous land manager, (5) a local tourist operator and (6) a local community organisation leader. Visual representations of these personas were also created as a means of making the personas more realistic (Figure 4.3).

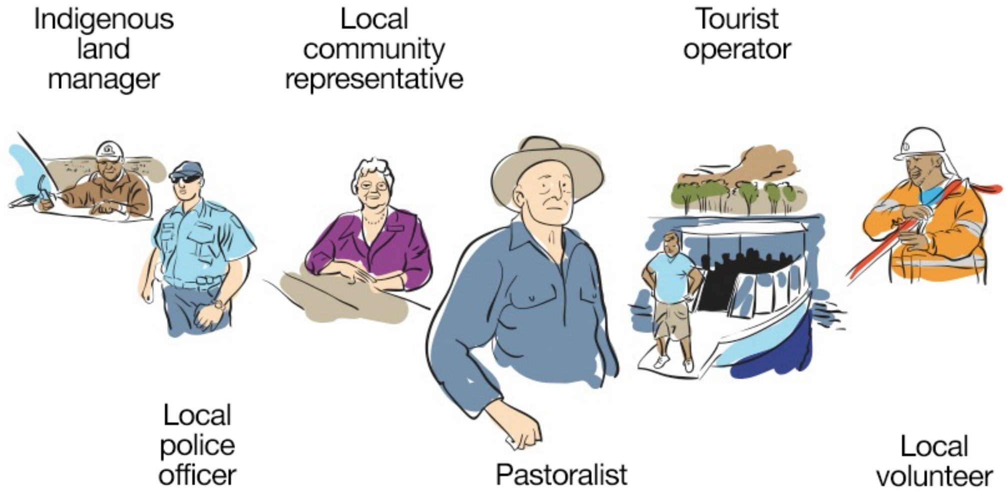

Figure 4.3: Visual representations of the personas framework. These personas were considered representative of the types of people one would find in a remote town such as Kununurra. The personas framework explained several of each persona's characteristics in detail, including an indigenous land manager, a local police officer, a local community representative, a pastoralist, a tourist operator and a local volunteer. Illustrations by Dr. Stuart Medley.

Characteristics of these six personas were described in detail below. These personas used the framework explained in the previous chapter and were based on criteria presented by Grudin and Pruitt (2002). As little was known about actual users in Kununurra at this stage, the criteria were limited, similar to Cooper et al's simpler personas framework (2014). This process also envisaged the computer skills and technical devices that these personas would use on a daily basis. Although HCI has traditionally viewed the user as an expert in their field (Carroll, 1997), Cooper et al (2014, p. 41) pointed out that users can range from complete beginners to experts, with the majority being at an intermediate level. The personas created were generally considered non-experts: that is, that few would have significant experience with bushfire information presented through a map-based interface. How these personas would possibly engage with the first prototype is described in the observations stage.

Indigenous land manager

Overview: Acts as a traditional custodian of the land. Indigenous people have a deep cultural and spiritual connection to the land.

Computer Skills, Knowledge, and Abilities: Moderate level of computer skills. May be familiar with NAFI website.

Internet-enabled devices: Work computer and smart phone.

Expectations of FireWatch: Intends to use FireWatch primarily as a planning tool.

Experience with map websites: Knows NAFI, Sentinel and the Bureau of Meteorology website well.

Local police officer

Overview: A local figure of authority. Has ties to many organisations and government departments in the area.

Computer Skills, Knowledge, and Abilities: Moderate level of computer skills. Used to using email, the internet and Microsoft Office software.

Internet-enabled devices: Work computer, home computer and smart phone.

Expectations of FireWatch: Intends to use FireWatch to assist in the preparation of fire response plans. Also may use it as an information source in an emergency response situation.

Experience with map websites: Is familiar with Google Maps and Bureau of Meteorology website.

Community organisation representative

Overview: Leader of the Kununurra branch of an organisation such as the CWA or Rotary Club.

Computer Skills, Knowledge, and Abilities: Moderate level of computer skills — familiar with Office software, email and internet.

Internet-enabled devices: Work computer and home computer.

Expectations of FireWatch: Intends to use FireWatch primarily as a planning tool.

Experience with map websites: Is familiar with Google Maps.

Pastoralist

Overview: A livestock farmer, who may also grow crops.

Computer Skills, Knowledge, and Abilities: Has a low level of computer skills.

Internet-enabled devices: Home computer.

Expectations of FireWatch: Intends to use it to plan for fire threats and in the instance of emergencies in the vicinity.

Experience with map websites: Has some familiarity with NAFI and the Bureau of Meteorology website.

Tourist operator

Overview: Owns and/or runs a local tourism company. Would know many people in several industries and about local events.

Computer Skills, Knowledge, and Abilities: Moderate-high level of computer skills. Frequently uses email and internet, and administers own website.

Internet-enabled devices: Work computer, tablet device (iPad) and smart phone.

Expectations of FireWatch: Intends to use FireWatch to assist in the preparation of fire response plans.

Experience with map websites: Is familiar with NAFI, Google Maps and the Bureau of Meteorology website.

Local volunteer

Overview: Local community member who volunteers for an emergency organisation, such as Kununurra Volunteer Fire & Rescue.

Computer Skills, Knowledge, and Abilities: Low-moderate level of computer skills. Uses internet and email.

Internet-enabled devices: Work computer and home computer.

Expectations of FireWatch: Intends to use FireWatch to assist in the preparation of fire response plans. Also may use it as an information source in an emergency response situation.

Experience with map websites: Is familiar with NAFI and Google Maps.

While it was difficult to establish the accuracy of these characteristics, they at least allowed for consideration of a variety of potential users in the initial design process. Describing these characteristics also gave an indication of the sorts of people whose input was necessary to inform the design process.

4.2.4 Considering the rhetorical aspects of interaction design

Prior to commencing the actual design and development of the prototype, consideration was given to the rhetorical effects of the interface. Visual rhetoric rejects the view that information can simply be objectively presented in a neutral manner (Kinross, 1985). Prior to and during the design stage, awareness was given to the rhetorical aspects of the interface and the levels in which rhetoric can operate: *logos* — the functional, objective aspects of design; *pathos* — well-being, the satisfaction or enjoyment that the user derives from the design; and *ethos* — trust and reliability that the user experiences with the design (Schneller, 2010, p. 162). In the process of designing, rhetorical rules might be followed unconsciously by a designer (Schneller, 2009). The view was taken that it is in

the best interest of the designer to consider how a design will affect its audience as this would influence whether it allowed the user to achieve their goal(s) or not. There were significant aspects that needed to be addressed by the interface: An emphasis was placed on readability and legibility; and the interface needed to be as accessible to as many people as possible. Ease of use was considered a key facet of the redesign, particularly due to the potential of it being used in an emergency situation. To ensure this, only essential functionality was included and the map component itself was the most prominent feature. The following informative and persuasive rhetorical aspects of the design were documented prior to the design stage, and the justification for each was explained.

Informative rhetorical aspects

Design consideration: High contrast between the background and elements in the foreground, clean, mostly sans-serif fonts.
Justification: High contrast between elements in the foreground and the background will draw the user's attention to these (Evans & Thomas, 2007). It will increase readability and legibility of the interface. Clean, simple font choices allow users to focus on the content of the text over the typography.
Rhetoric level(s): Pathos.

Design consideration: Large map component.
Justification: Essentially, the map is the key focus of the website. Making it the largest component of the interface will draw the user's attention to it (Evans & Thomas, 2007). Secondly, because this interface will also be used on mobile and tablet devices, it makes sense to provide these users with a large map that scales according to the width of the browsing device, since they will be viewing the site on a small screen (Marcotte, 2011). Map controls will be minimal and simple.
Rhetoric level(s): Pathos, logos.

Design consideration: Responsive layout.

Justification: The website will use a responsive layout to cater for various screen sizes. This means that the layout will adapt to ensure that users on desktop machines, laptops, tablets and mobile devices will all receive a well designed layout that is customised for their device's screen size (Marcotte, 2011).

Rhetoric level(s): Pathos, ethos.

Design consideration: Monochrome map.

Justification: The map itself has been made monochrome. This has been done to draw attention to the coloured markers placed on the map. Having bright colours on a grey background increases the saturation of the markers in the foreground (Evans & Thomas, 2007).

Rhetoric level(s): Pathos, logos.

Design consideration: Clear legend.

Justification: The legend is clear and simple. It also gives users the ability to switch layers of fire information on and off, doubling as navigation. This will change to a dropdown for smaller screens, as a dropdown will avoid visual clutter on tablet and mobile devices (Marcotte, 2010).

Rhetoric level(s): Pathos, ethos.

Persuasive rhetorical affects

Design consideration: Appearance of a government website.

Justification: The Landgate and state government logo are prominently featured in the top right of the design. The layout is simple, clean and fairly conservative. This is intended to give the website an authoritative appearance, to maximise credibility in the content (Fogg, 2003).

Rhetoric level(s): Pathos, ethos.

Design consideration: "Warm" colours, such as warm red, orange and warm yellow contrasting strongly with cooler, more muted background colours such as greys and grey-blues
Justification: Since the purpose of the FireWatch interface is to alert users to the presence of bushfires, colours that indicate a level of danger will be used to indicate locations of bushfires (Evans & Thomas, 2007).
Rhetoric level(s): Pathos, ethos

Design consideration: Simple design
Justification: Overall, the design will be kept simple, providing minimal functionality with a focus on ease of use. This will make the interface more accessible to those not using a traditional browsing device. It is also important to present users with a simple interface, as it is possible that they may be emotionally stressed while using the website.
Rhetoric level(s): Logos, pathos

Effects were broken down into two categories: *informative* and *persuasive*. Informative effects were intended to merely provide information to the user in a simple and effective way. For example, making the map monochrome and taking up a large part of the screen to highlight the data on the map, drawing the user's attention to the information the map was presenting. Persuasive effects were created in an aim to influence the user to feel or act in a certain way. For example, the map markers use "warm" colours, such as warm red and orange, as a way of creating a sense of danger to the user (Evans & Thomas, 2007). These decisions were taken within the context of improving usability and the user experience overall. By attempting to inform the user through an aesthetically pleasing interface, the intention was that users would feel satisfied: this would achieve the goal of them being more informed about bushfires in their vicinity. Being conscious of the rhetorical effects of a design may help a designer to more effectively communicate with users, but whether this was

successful would not be known until real-world user testing had been undertaken.

4.2.5 A summary of functional, data and other requirements

As this was the first stage of the first design iteration and informed the generation of an early working prototype, the planning stage discussed here was larger than the planning stages of subsequent iterations. To summarise the various inputs into this planning stage of the first design iteration, functional requirements, data requirements and other requirements were created, following Cooper et al's (2014, p. 122) model for creating requirements from scenarios. .

Functional requirements

1. Must work on desktop machines, and provide adequate functionality for users on mobile and tablet devices — at a minimum, users should be able to at least view the current fire hotspot layers on the map. The interface should cater for cross-browser and cross-device compatibility by using responsive design.
2. Must provide a map interface that includes a location search feature, zoom controls and data layers (explained further under data requirements). The map layer will use muted colours in order to highlight the data layers on top of it.

Data requirements

1. The map layers provided should include: (1) Fire hotspots 0-72 hours old, (2) two years of burnt areas, (3) satellite view, (4) lightning strikes for the past 48 hours, and (5) weather information.
2. The data should be regularly updated, but this is dependent on the availability of satellites and the service provider's infrastructure.

Other requirements

1. Minimal download time due to the possibility of many users relying on 3G internet connections.
2. The interface's navigation should be simple and consistent.
3. To begin with, the only sections will be the map interface, an "about" page and a "contact" page. Content will be expanded upon in later stages, dictated by the needs of the two key stakeholders groups — community-based users and the service provider, Landgate.
4. The legend should be consistent, clear and concise. This will act also act as navigation for toggling layers on and off. The terms used should avoid jargon.
5. The interface should have the appearance of a government website, adding to its sense of authority. It will include the Landgate logo.
6. Users will have varying levels of ability, from a low level of computer skills, to a high level of computer skills. The interface needs to cater for all of these users, ensuring ease of use, but supplying enough functionality to be useful to most of these users.

4.3 Prototyping and designing the first iteration

This section explains the prototyping and designing stage of the first design iteration. The prototyping and designing stage described here gave shape to an initial working prototype. The design of the prototype was shaped by the theory and knowledge discussed in the planning stage (Stickdorn & Schneider, 2010, p. 286).

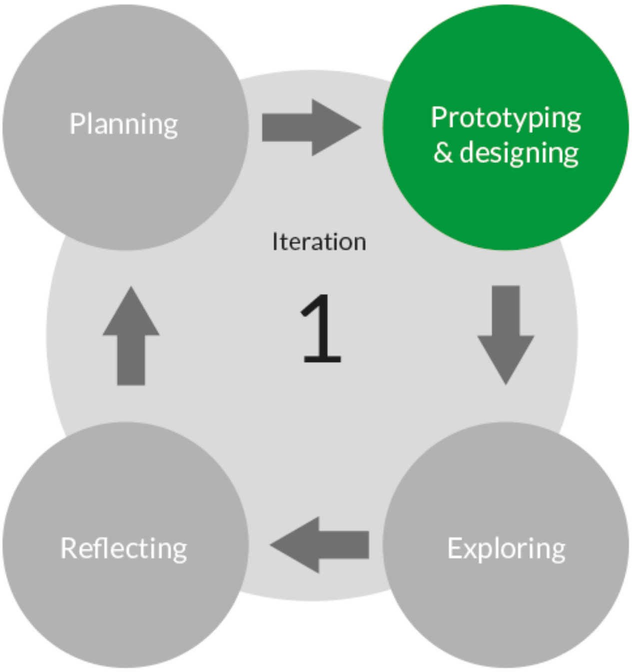

Figure 4.4: The prototyping and designing stage from the first iteration of the design process. This stage was informed by the theory and knowledge explained in the previous planning stage. The prototype generated in this stage was the first iteration of the design artefact that evolved throughout multiple iterations of the design process.

Summarised from the persona framework analysis undertaken, the first iteration of the prototype needed to consider the following circumstances: (1) all users would have access to a desktop or laptop computer, while only a few users would use mobile or tablet devices; (2) There would be a range of technical abilities amongst the users, ranging from a low level of computer skills to a high level of computer skills; (3) users would be familiar with popular map-based web applications, such as the Australian Bureau of Meteorology (2012) and Google Maps (Google, 2012); (4) only two of the six personas would use latitude and longitude to search for a point of interest, so it would be necessary to provide other users with other options for zooming to a point of interest; (5) current fire information would be the key information to provide on the map. Some users may be interested in previously burnt areas. As many users were likely to be familiar with the Bureau of Meteorol-

ogy, weather conditions and lightning data would be included. Due to many users being familiar with Google Maps, Google's satellite view would also be included. Any references to satellite names, such as NOAA or MODIS, should be removed, as these terms would not be familiar to this new community-based FireWatch audience.

Identifying the circumstances listed above highlighted the key user actions. Unlike Lamminen et al's (2010) interaction deconstruction method, only higher-level actions were included, as removing the majority of sub-actions from the previous expert-user version was considered necessary to improve usability. The considerations were also kept broad at this early design stage, as it was considered likely these could be better informed once actual users were directly engaged with in the design process.

4.3.1 Development of the first prototype

Prior to starting the actual design, a wireframe — a diagram with the purpose of communicating an overview of a design (Brown, 2007) — was created to show approximately where the various features would be placed (Figure 4.5).

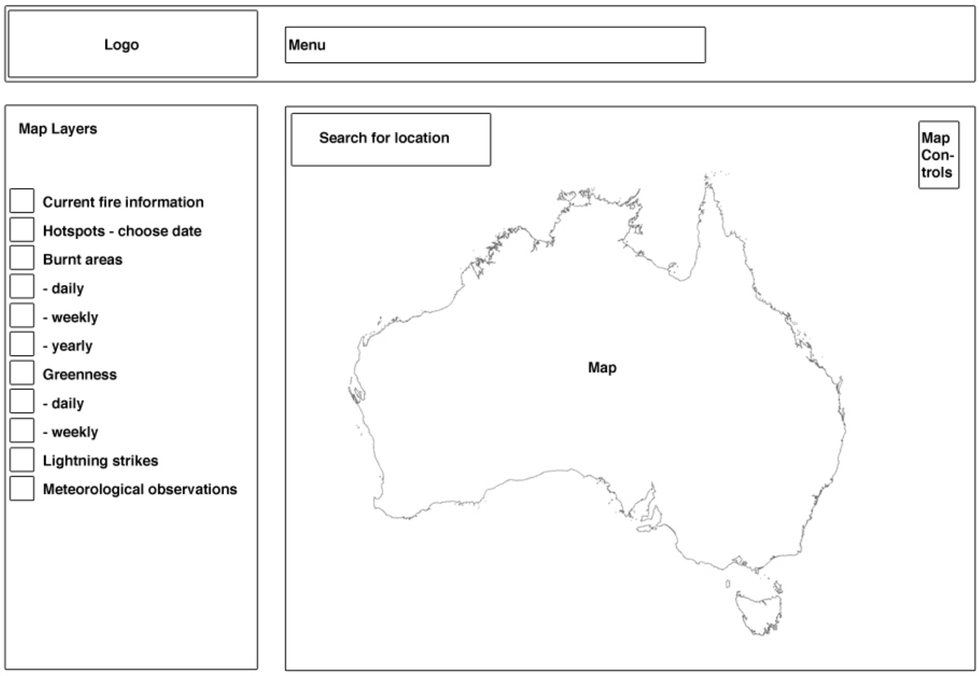

Figure 4.5: A wireframe (Brown, 2007) showing the various elements that featured in the first iteration of the prototype. The wireframe shows an outline of where elements were to be placed in the actual working prototype. These elements included the logo, a menu, navigation for map layers and the map component itself, which included map controls for zooming in and out and a box for users to search for their location.

This wireframe emphasised that the map itself would be the most prominent feature, using relative proportion to other page elements as a way of focusing the user's attention to it (Evans & Thomas, 2007). The purpose of this was to encourage users to interact with it before noticing other features. Plotting data on a map is an effective way of communicating a large volume of data in a way that is easily comprehended (Tufte, 1983). Maps are also amongst the most important tools in disaster management (Dymon, 2003). As noted by Dransch et al, "The interactivity of a map should be determined and guided by the communication goal and tasks" (2010, p. 302). Maps also have a role to play in decision-making processes related to risk management and digital interactive maps offer a useful way of presenting information in this context (Dransch et al., 2010). A digital map fea-

ture would encourage users to orientate themselves and explore what information the map could provide. It is worth pointing out that the approach of providing a large map feature is common practice on bushfire information websites (North Australian Fire Information, 2013; Tropical Savannas CRC, 2012) and map-based applications generally (Bureau of Meteorology, 2012; Google, 2012). Following this common practice was a rhetorical decision to prompt users to interact with the map component.

The core functionality was identified through the initial requirements analysis undertaken as part of the scenario-based design and persona frameworks. This involved analysing the original interface (Figure 4.2) and considering the key purpose of each feature. Considering the data that Landgate was capable of providing also influenced what functionality was offered. The functionality of the first iteration of the prototype was initially restricted to: (1) current fire "hotspots", ranging from 0 to 72 hours; (2) two years of burnt area data; (3) A satellite (aerial terrain) view; (4) Weather data; (5) Three days of lightning strike points; (6) A map with zoom controls and the ability to pan, including "pinch-zoom" functionality on mobile and tablet devices; and (7) A search bar where users can enter their town or address. Following the scenario-based and personas analysis in the planning stage, this was considered enough functionality to be useful to the majority of non-technical users. These features allowed users to identify current fire locations, view previous fire behaviour in the form of burnt area data, be aware of potential fires from lightning strikes, give them an overview of weather conditions and the option of finding key points of interest (for example, their place of employment or their home) using a satellite view. The persona framework demonstrated that these users would access the internet through a variety of devices, including smart phones and tablets, but the majority of users would still use desktop computers primarily. For the first iteration of the prototype, the emphasis was placed on a version of the interface that worked well on desktop web-browsers, although responsive design was used to ensure that most functionality would resize for mobile and tablet devices.

An initial working version was completed in September 2012, built on the OpenLayers (2014) open-source map framework, with Google Maps working as a presentation map layer on top of OpenLayers. OpenLayers was chosen — on the advice of Landgate's development team — as the map framework because it allows a high degree of flexibility and customisation for geographical data. Google Maps was chosen as the presentation map layer so as to provide users with a familiar map in terms of aesthetics and interactivity, meaning that map behaviours such as zooming and panning would be familiar gestures. The decision to use Google Maps also meant that it was straightforward to implement the search functionality. Landgate provided data layers for the fire locations, lightning strike locations, burnt areas and weather using the OpenGIS Web Map Service Interface Standard (WMS) format (OpenGIS, 2014). A screenshot of the working prototype is shown in Figure 4.6. Note that the continent is larger than that shown in the original interface (Figure 4.2) due to different map applications rendering zoom levels differently. A full list of the technologies used for the development of the prototype is included in the appendices.

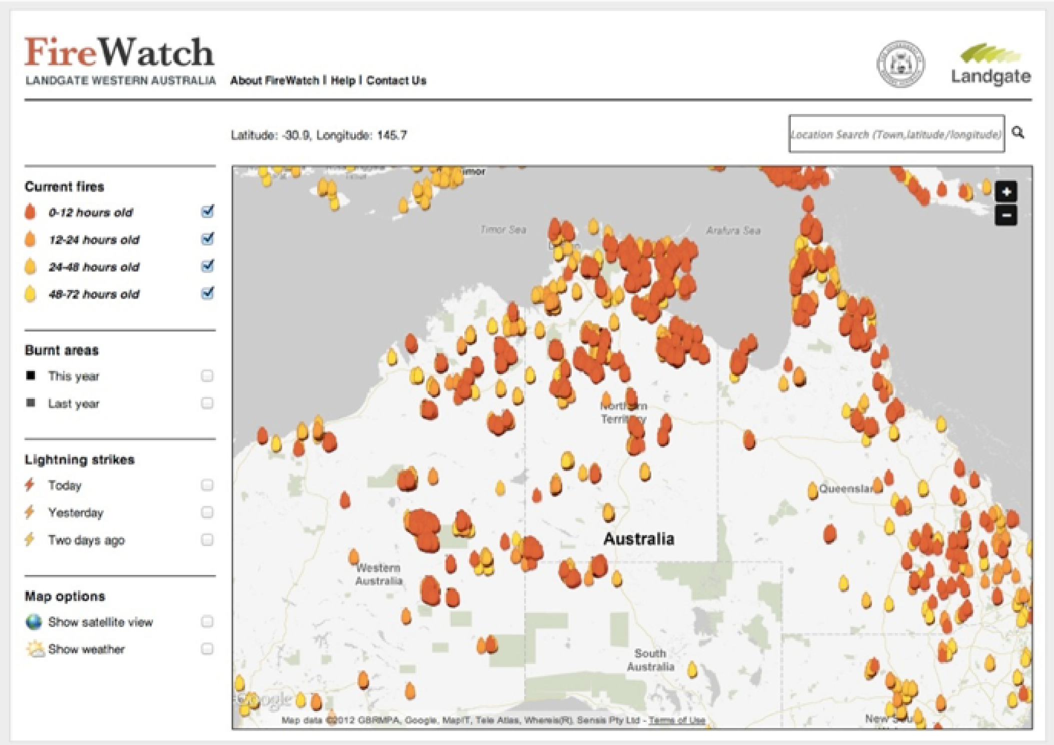

Figure 4.6: The first iteration of the prototype interface. This iteration was the result of the planning stage, which used scenario-based design and the personas framework, along with input from the service provider Landgate. It also demonstrated how simplicity could be a design goal, as well as how rhetoric can be considered during the design of an interface.

Several changes were made to the aesthetics of the map layers. There has been discussion around the use of common symbols in the emergency management domain (Dymon, 2003), but any symbols used by emergency management agencies were not likely to be familiar to this new community-based FireWatch audience. The hotspots were changed from coloured circles to flame icons but retained the basic colours used in the previous expert-user version of FireWatch. The lightning icons were changed to lightning bolts. The intention of changing these icons was to make it more obvious what the icons were representing, reducing the cognitive burden on the user by exploiting natural mappings (Norman, 2002).

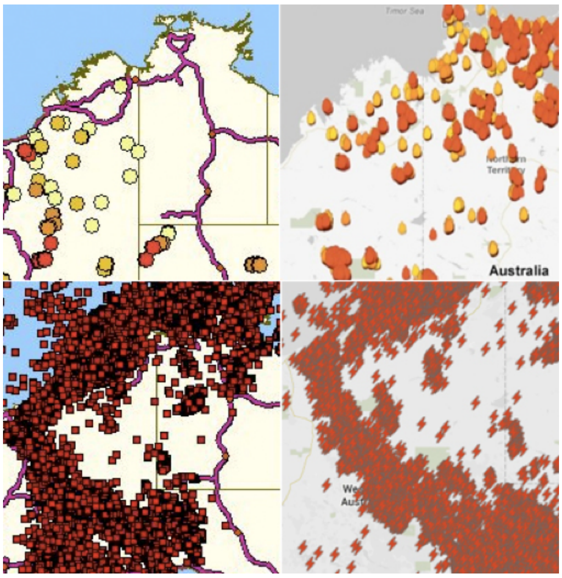

Figure 4.7: A comparison of the fire hotspots (top row) and lightning strikes (bottom row). Data from the old expert-user version of FireWatch site is shown on the left and data from the first iteration of the prototype is shown on the right. Changing the shape of the icons to better represent their respective layers was done to better convey their meaning to users.

The weather data format did not significantly change as it only provided very basic information: temperature, wind direction and wind speed. All satellite and aerial imagery was replaced with one layer from Google Maps' satellite view.

A side-by-side comparison of interactive features shows the differences in complexity between the previous expert-user version and the first iteration. This demonstrates how the first iteration of the prototype attempted to effectively simplify many of the features and improve usability, but without significantly reducing the overall functionality and utility provided in the previous expert-user version. Note that several of the features in the previous expert-user version have archives going back several years, which are not shown in Figures 4.8, 4.9, 4.10, 4.11, 4.12 and 4.13. It was considered that much of this archival data would not be of use to the majority of new FireWatch users and removing them would further simplify the interface. It was also considered effective design to incorporate

the map legend into the map navigation, which were separate elements in the previous expert-user version of FireWatch. Like the previous expert-user version, the prototype interface featured current fire hotspots displayed by default on the map. To the left of the map were controls for switching layers on and off. Users could search for their location using the text-box above the map. This initial prototype of the interface had far fewer features and options than the previous expert-user version of FireWatch (Figure 4.2) but it was likely that it provided enough functionality to be useful for the majority of the potential new FireWatch audience.

The following figures show a comparison of functionality between the previous expert-user version of FireWatch and the first iteration of the prototype. The left side of the figures show how the various features were presented in the previous expert-user version of FireWatch and the right side of the figures show how these features were displayed in the first iteration of the prototype. These figures demonstrate how this research undertook the "thoughtful reduction" advocated by Maeda (2006).

Search functionality

In the previous expert-user version, a search required entering a latitude and longitude and pressing the "Go" button. It was possible to click on the map, which would zoom in one map level. There were also buttons that would allow users to zoom in, out or to show the full extent of the map, which revealed the whole of Australia, along with an option to pan the map. A search function, where users could search for towns or pastoral properties was also available, with a button to access the function. In the first iteration of the prototype, the location search features were replaced with a search box, where users could either enter a latitude and longitude, an address or town name (Figure 4.8).

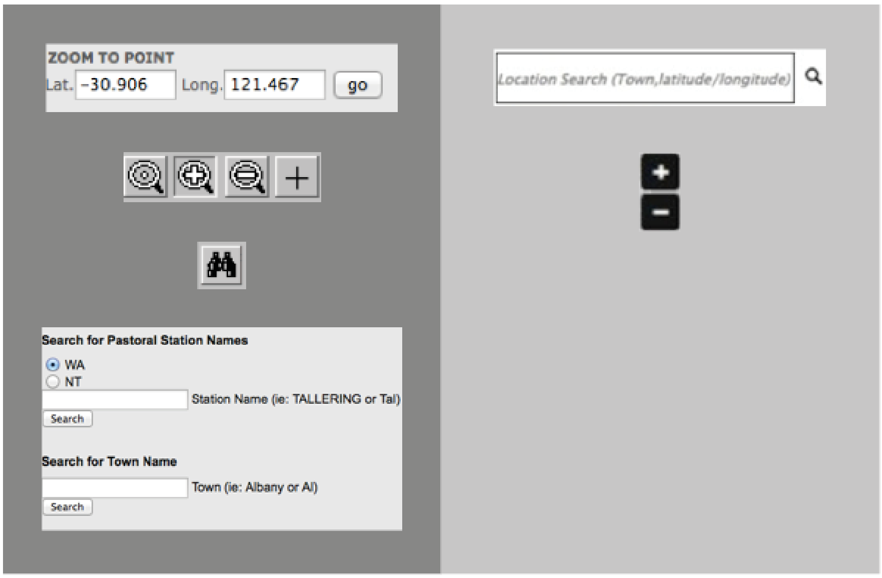

Figure 4.8: Comparison showing the difference between the search functionality of the previous expert-user version of FireWatch on the left and the search functionality of the first iteration of the prototype on the right. The four features from the previous expert-user version include searching by longitude and latitude, zoom functionality and searching by pastoral station name or town name. The location search on the right allowed users to search with latitude and longitude, a town name or address.

Current fire hotspots

The previous expert-user version displayed a default set of current fire hotspots, showing fires 0-12 hours old, 12-24 hours old, 24-48 hours old and 48-72 hours old. It also had features for displaying MODIS hotspots, NOAA hotspots and GEO hotspots, which also had options with additional functionality. The first iteration of the prototype had only one set of current fire hotspots, showing fires 0-12 hours old, 12-24 hours old, 24-48 hours old and 48-72 hours old(Figure 4.9).

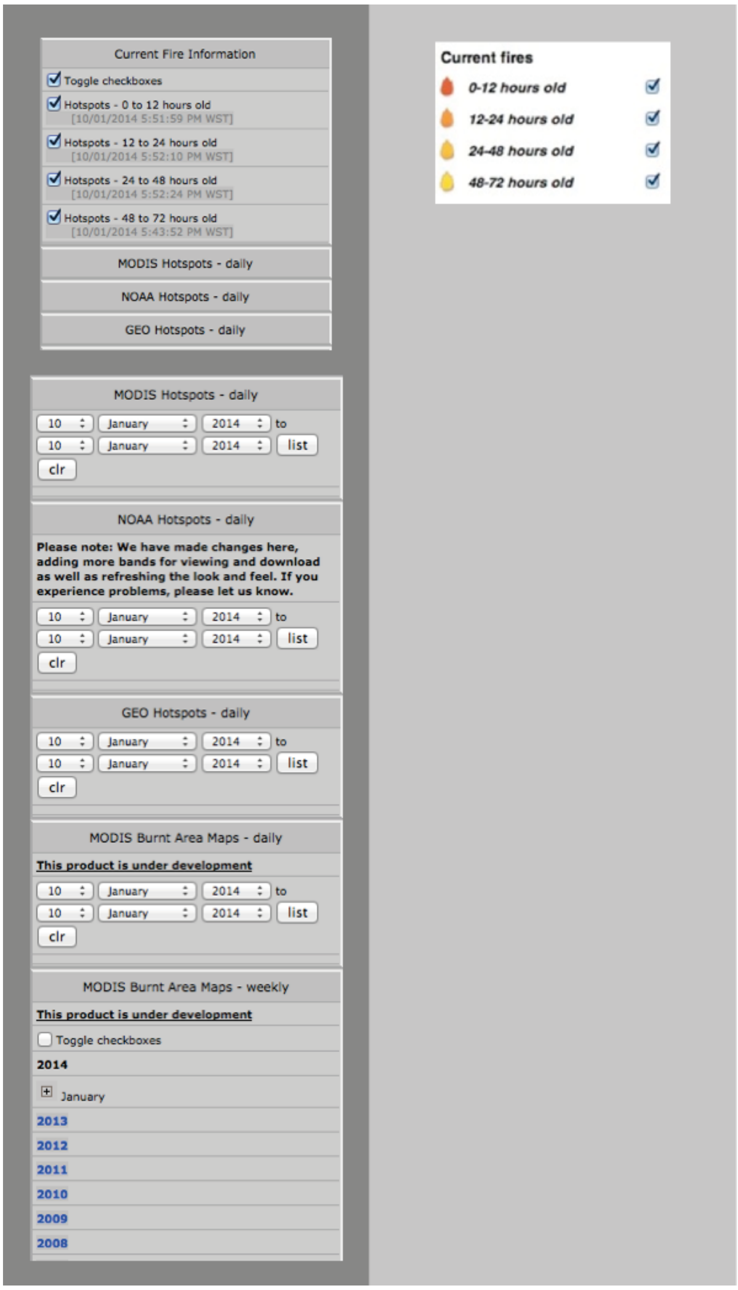

Figure 4.9: Current fire hotspot information in the previous expert-user version (left) and current fire hotspot information in the initial prototype interface (right). The previous expert-user version included hotspots from MODIS, NOAA and GEO, as well as the default hotspots. Archives going back several years were included. In the first iteration of the prototype, only the current fire hotspots, from 0-72 hours, were shown.

Burnt areas

The previous expert-user version showed daily and weekly burnt area maps from MODIS and yearly burnt area maps from NOAA. The first iteration of the prototype had only two years of burnt area data (Figure 4.10).

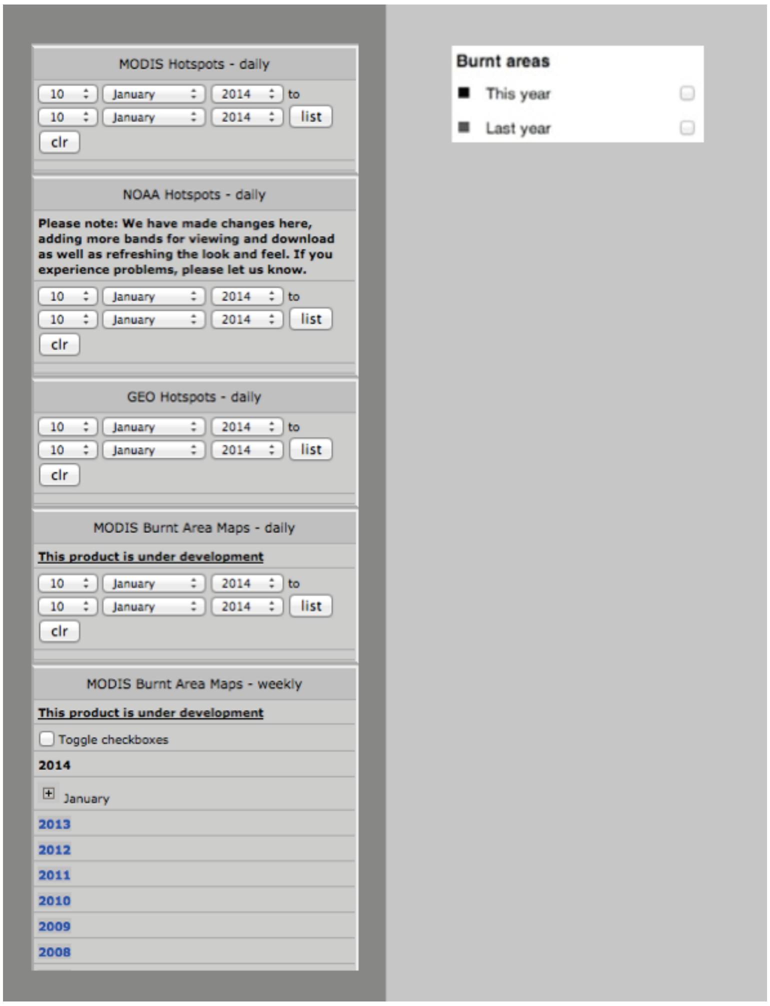

Figure 4.10: Burnt areas information in the previous expert-user version (left) and burnt areas information in the initial prototype interface (right).

Aerial view of the terrain and other imagery

The previous expert-user version showed MODIS daytime imagery, Landsat image mosaics, aerial photography and other datasets. The first iteration of the prototype had only one aerial view of the terrain, referred to as "Satellite view", using Google's imagery. This option was under a menu item with the label "Map options (Figure 4.11).

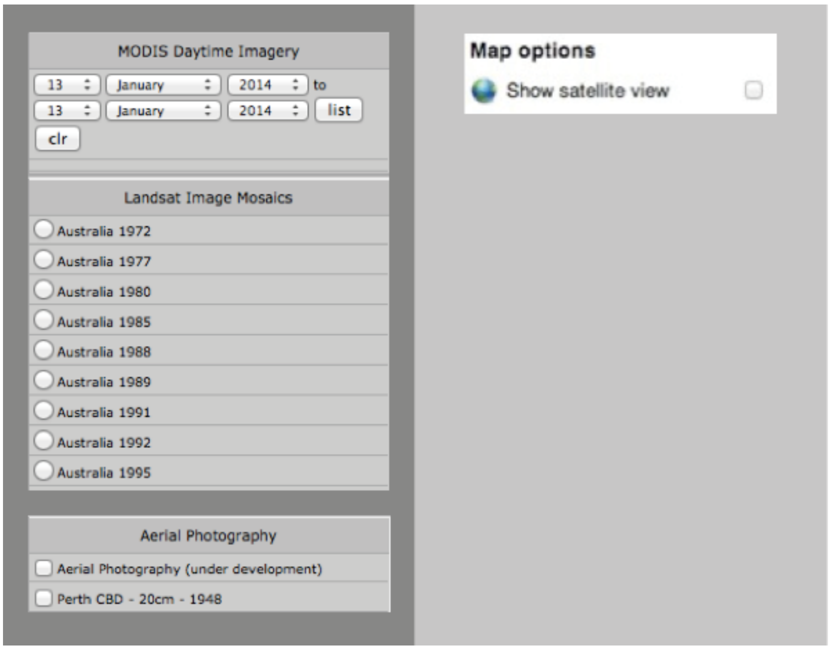

Figure 4.11: Aerial view of the terrain and other imagery information in the previous expert-user version (left) and satellite information in the initial prototype interface (right). The previous expert user version provided MODIS satellite imagery, Landsat imagery and aerial photography. The first iteration of the prototype only had one satellite view, provided by Google Maps.

Weather information

The previous expert-user version had one feature for weather data, labelled "Meteorological observations". The first iteration of the prototype had one layer of weather data, showing temperature,

wind direction and speed and the time it last updated. This was also under the "Map options" label (Figure 4.12).

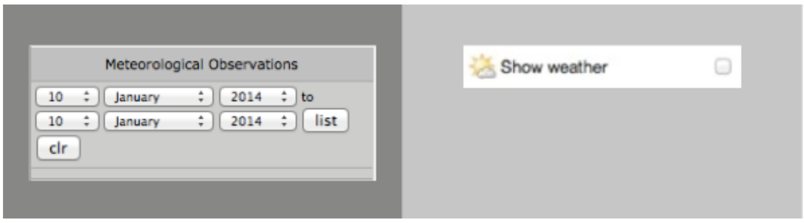

Figure 4.12: Weather information (referred to as meteorological observations) in the previous expert-user version (left) and weather information in the initial prototype interface (right).

Lightning strikes

The previous expert-user version had one feature for "lightning strikes". The first iteration of the prototype had one feature for lightning strikes, featuring three days of data (Figure 4.13).

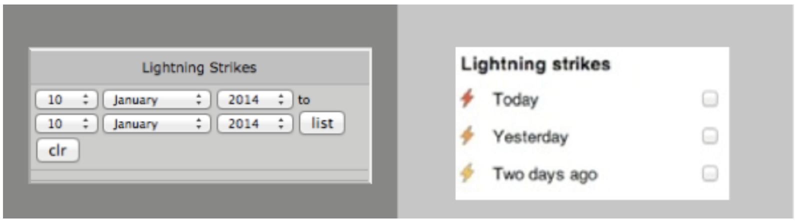

Figure 4.13: Lightning strike information in the previous expert-user version (left) and lightning strike information in the initial prototype interface (right).

Other map features

The previous expert-user version had several options for measuring distances on the map. There were also several options for printing. Several other features were supplied under the "Other datasets" tab. The first iteration of the prototype did not include any of these extra features or datasets. Greenness of the vegetation — which uses Normalised Difference Vegetation Index (NDVI) imagery (Liang, 2005) to identify vegetated areas — was also a feature of the previous expert-user ver-

sion. At this point it was not considered a feature that may be used by most users in remote communities. A decision was made to leave it out of the initial version of the prototype but obtain feedback from actual community-based users before deciding whether to include it in a future iteration of the prototype. As previously mentioned, the approach taken here of focusing on higher-level user actions differed slightly from Lamminen et al's (2010) interaction deconstruction method, as removing the majority of sub-actions from the previous expert-user version was considered necessary to improve the usability of the remaining functionality.

The layout was made flexible — through the use of responsive design — so that the content would be easy to navigate on tablet and smart phone devices. Despite the fact that responsive design advocates designing for "mobile-first" (Marcotte, 2011), emphasis at this stage was focused on getting the desktop version working because it was presumed that most users would have access to desktop computers, while only a few would have access to smart phones and tablets.

4.4 Exploring the first prototype with personas

Stickdorn and Schneider described the exploring stage as the collection of insights and experiences from observing and discussing users' engagement with the designed object (2010, p. 286). Although the exploring stage requires input from users, this was not possible due to the logistics of the project, as was explained in the planning stage of this first design iteration. To compensate for the lack of input from actual users, scenario-based design and the personas framework were used in this planning stage. In the exploring stage here, consideration was given to how each of the personas created would use the interface.

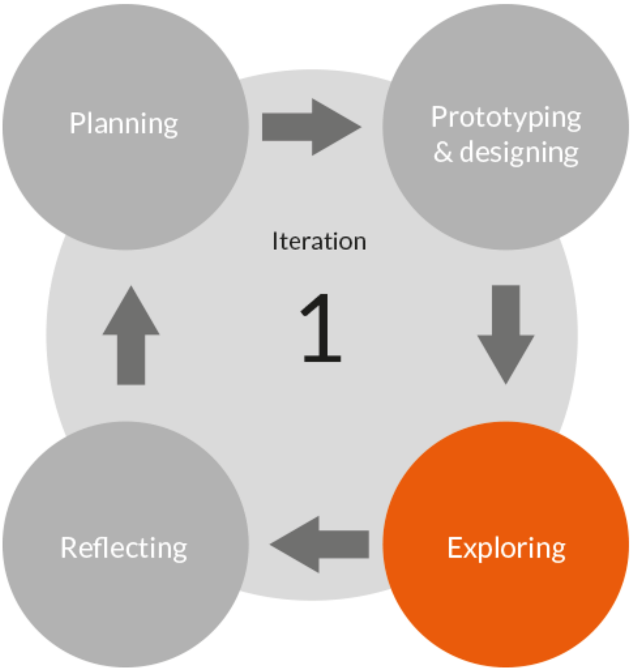

Figure 4.14: The exploring stage of the first iteration of the design process. Although the exploring stage requires input from users, this was not possible due to the logistics of the project, as was explained in the planning stage. To compensate for the lack of initial input from actual users, scenario-based design and a personas framework were used.

The following describe how the six personas created might engage with the first iteration of the prototype interface. As the personas that these descriptions were based on contained important details such as demographic information, technical ability and devices used, they provided useful insight into how actual users may engage with the interface (Cooper et al., 2014, p. 76).

The indigenous land manager

The indigenous land manager will use the redesigned FireWatch to monitor fires around the greater Kununurra area. He will likely search using the town name to view fires in the vicinity. Due to previous experience with NAFI and Sentinel, the indigenous land manager has higher technical capabil-

ity than other users.

The police officer

The police officer will use the redesigned FireWatch to monitor fires around the wider Kununurra area. He will use the search function to zoom to view the entire town and surrounding areas. He will also want to view previous fires to assist in planning for emergencies.

The local community representative

The local community representative will use FireWatch to monitor fires around the greater Kununurra area. She will use the search function to zoom to view the entire town and surrounding areas. She will also want to view previous fires to assist in planning for emergencies.

The pastoralist

The pastoralist will use FireWatch to monitor fire threats close to the boundary of his or her property. He will likely know the longitude and latitude of their property, and will use this to zoom into view the area around their property.

The tourist operator

The tourist operator will use FireWatch to monitor fire threats close to the boundary of known tourist attractions and to check if any fires are near roads. He may know the longitude and latitude of tourist attractions, and will use this feature to zoom into view the areas of interest.

The local volunteer

The local volunteer will use FireWatch to monitor fires around the greater Kununurra area. He will use the search function to zoom to view the entire town and surrounding areas. In particular, as a volunteer of an emergency organisation, he will also want to view previous fires to assist in planning for emergencies.

Landgate, as the service provider, were presented with the early working prototype at this stage but did not provide input until the next planning stage explained in the next chapter.

4.5 Reflecting on the first design iteration

The following section describes the reflecting stage of the first round of the iterative design process undertaken. The purpose of this stage is to "process the research data and transform these into manageable insights (Stickdorn & Schneider, 2010, p. 286). Although the reflecting stage in later iterations focused on users' experiences with the interface, in this first iteration, reflections were made on the theoretical approaches undertaken, with emphasis placed on the role of scenario-based design, the personas framework and simplicity as a design goal.

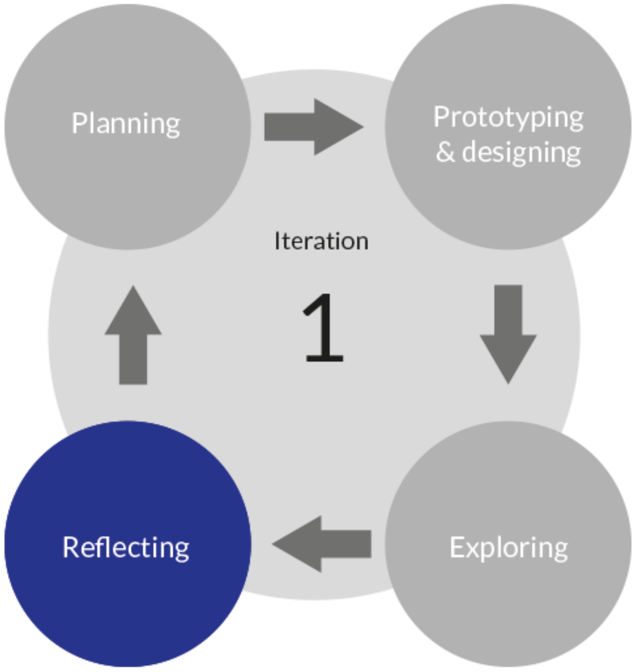

Figure 4.15: The reflecting stage of the first iteration of the design process. Instead of reflecting on the direct feedback from participants (as in the next iterations of the design process) here, reflections included the role of the various theoretical approaches to the design, with emphasis on the role of scenario-based design, the personas framework and simplicity as a design goal.

4.5.1 Findings

Simplicity as a design goal

At this stage it was not possible to gauge how successful the strategic reduction in functionality was, due to the lack of input from actual community-based users. Despite this, a decision was made to strip down the functionality to its core components while ensuring — through the use of the scenario-based design and persona frameworks — that the remaining functionality was useful to users. Whether or not the remaining functionality was adequate would later be determined by input from community-based users and the outcome of this approach will be discussed at greater length

in the following chapter. Following Maeda's strategy — that the "easiest way to simplify a system is to remove functionality" (2006, p. 1) — seemed to be a sensible approach to the redesign, and also helped in addressing the principles of a successful web presence highlighted by Nielsen (2000, p. 380). In contrast, Norman (2007) stated that designing for simplicity was "highly overrated". His point still stands: namely that it is the job of the designer to improve usability by making the required functionality easy to use. During this initial stage of the FireWatch redesign, it was considered appropriate to remove a significant amount of the functionality in order to provide optimum usability for the remaining functionality. However, this could only occur through careful consideration of which features would likely be useful to the community-based users whose needs this new version of the interface had to meet. It is fair to say that simplicity should not be a design goal in and of itself, unless one is purposely aiming for a minimalist aesthetic — perhaps best described by the axiom "less is more" (Obendorf, 2011, p. 16). The approach to simplicity here has been demonstrably more than just applying a minimal aesthetic: each feature of the interface is analysed with consideration given to how much — if any — of its functionality is likely to be useful to the design's audience. The key is to maintain a balance between usability and providing enough functionality to be of use to its users. When a designer is considering how to improve the usability of a particular feature, it is vital to ask "Do the users need this feature?" and if so, "how can it be simplified or its options reduced?" This echoes a statement from Maeda on simplicity and what he referred to as *thoughtful reduction*: "When in doubt, just remove. But be careful of what you remove" (2006, p. 1). This is why input from key stakeholders is a vital step when aiming to improve the user experience through simplicity — it is necessary to ensure that users are able to perform their desired goals and tasks.

The role of scenario-based design and the personas framework

Scenario-based design played a roll of 'bridging the gap' in this collaborative project. Circumstances explained in the introduction and planning section of this chapter meant that vital, direct information from users was unavailable before the prototyping stage. As HCI, interaction design — and design research more broadly — has accentuated, a designed object is more likely to meet the needs of its users if a designer directly engages with those users in the design process. Additionally, disaster management literature has suggested that a more grassroots approach is needed to better inform and prepare communities in bushfire-prone circumstances (Frandsen et al., 2012; Palen & Liu, 2007). Recent trends in design have gravitated towards methodologies that emphasise co-creation, such as service design, participatory design and design thinking (Holmlid, 2009; Stickdorn & Schneider, 2010; Zimmerman et al., 2011), where participation from all stakeholders, including users, is sought from the outset of the design process. Although co-creation — in terms of user input — was not possible at the outset of this project, scenario-based design did make up for this shortcoming in the initial design stage by allowing for a set of requirements to be established, which led to the development of a working prototype. It was also clear, by creating these personas, that the majority of users were not users as HCI had previously considered the user: that is, they were not "experts in their field" (Carroll, 1997, p. 69). Community-based users were a new audience for the redesigned FireWatch interface. These kinds of users have been referred to as "ordinary residents" (Akama et al., 2013, p. 8) in recent bushfire research on community social networks. These community-based users would likely have varying degrees of technical ability, and several would not have significant experience with map interfaces presenting bushfire information.

Scenario-based design also acted as a catalyst to 'kick-start' the project, compensating for the lack of direct contact with users. Aside from 'bridging the gap', scenario-based design provided a structured framework for collating information from a variety of sources. Scenario-based design was used

as a ‘brain-storming’ communication tool to explore and establish requirements for the redesigned website. It provided a framework where all points of view could be considered from a design perspective: It allowed for combined knowledge from the service provider, Landgate, colleagues on the project team such as the research officer, and the input of related studies and other information. In doing so, scenario-based design provided a framework for considering the needs and requirements of all stakeholders involved in the design process, including the end-users and the service provider Landgate. In this sense, scenario-based design was facilitating participatory design (Rosson & Carroll, 2002) despite the lack of contact with real-world users. The documentation that arose from the scenario-based design and personas frameworks led to the list of technical requirements including the core functionality. This functionality was also explained in the wireframe diagram (Figure 4.5). These technical requirements, and the wireframe itself, enabled a clear picture of what data feeds, data formats and other technical aspects were necessary to obtain from Landgate. As HCI theory has a long history of demonstrating, a focus on the user is necessary to meet their needs, but it is also necessary for designers to work closely with service providers who know what is technically feasible and pragmatic to implement. This appears to be the reason why some HCI researchers are following the lead of other design disciplines and incorporating a service design approach into their research and practice (Zimmerman, et al., 2011). It is clear that the ability of scenario-based design to consider the perspective of all stakeholders in the design process is one of its advantages and this may explain its use as a method within the service design discipline (Stickdorn & Schneider, 2010). It is likely that in situations where designers are unable to engage deeply with their users that scenario-based design has a role to play. In addition, both the scenario-based design frameworks and the personas framework have the ability to provide a structure to process and analyse data collected through other methods. It is the flexible yet concrete approach of scenario-based design and the personas framework that allows this, and in doing so it gives designers a way of dealing with uncertainty at the early stages of a design process (Rosson & Carroll, 2002).

Finally, rich information was gathered through investigating the characteristics and population of Kununurra, gaining insights into remote communities from both Landgate and the ARC project's research officer, previous work published about FireWatch (Steber, et al., 2012) and research related to the NAFI project (Tropical Savannas CRC, 2012). Scenario-based design, and the persona framework, applied a formalised structure for the presentation and analysis of this information, which presented a number of factors that impacted the initial design process. The persona framework, in which six personas were described, was later used to inform the recruitment of participants. The personas framework provided a realistic depiction of the sort of people one would encounter in the town of Kununurra. The personas described at this stage of the research would also later act as a form of entrée into the Kununurra community by guiding the recruitment of real participants. Six personas was also considered to be an adequate number for two reasons: (1) six people was considered to be a typical small but diverse sample for user testing; and (2) it would be a large enough sample to begin recruitment for real-world testing in Kununurra and could 'snowball' into a larger sample size. Undertaking the scenario-based design and personas processes highlighted that Kununurra was a town heavily reliant on tourism, community organisations, a significant indigenous population and pastoral properties, but also included fire authorities, state government departments and a police presence. Even if the personas were not quite individually true to life, undergoing this process at least created a broad snapshot of the Kununnura community. The vocations and occupations described by the personas framework would allow the research officer to target specific people more easily in the initial participant recruitment process. Another outcome of the scenario-based design work and particularly the personas framework was that Landgate — being the service provider — had a clearer understanding of what types of people existed in remote communities such as Kununurra.

The rhetoric of interaction design

Schneller (2009) stated that in the process of designing, rhetorical rules might be followed unconsciously by the designer. Although they may be following rhetorical rules unconsciously, it is perhaps in the best interest of the designer to consciously consider how a design will affect its audience, as this will allow the designer to increase the possibility that the user will achieve the desired goal. A designer should consider both the informative and persuasive aspects of the design as they can influence the actions of users. If a designer is attempting to guide the user to undertake a specific task or goal, it is important for the designer to consider ways in which the design may facilitate the desired actions. By creating an interface where the map is the most prominent feature, with bushfire information the only information being provided by default, the intention was to encourage users to interact with the map, orientating themselves to observe if any bushfire information was in their vicinity. The design choice to use shades of red and orange prominently was done to convey a sense of urgency and to exploit natural mappings by associating the icons with the colours of actual fire (Evans & Thomas, 2007), while a simple interface was designed so as to not overload the user with information. These choices were made consciously and with the intention of providing clear, concise, reliable and relevant information to the user in an easy to use interface. Previous work on visual rhetoric (Kinross, 1985; Schneller, 2009; Schneller, 2010) showed that design decisions convey meaning to users and come from historical, temporal and cultural contexts. One obvious example of this in the redesign process was the decision to use Google Maps as the map presentation layer. This was done to provide users with a familiar interface, complete with interactive gestures that would also be familiar to the user through past experience with the Google Maps application. Choosing Google maps was a conscious decision because it was known that it would be considered as a quality and reliable source of map information (Dransch, et al., 2010). Being conscious of — and documenting — the rhetorical effects of a design may improve the chances of the user achieving the goal or task

that the user has in mind. If and how the rhetorical effects of the redesigned interface had the desired impact on users would be determined in the first round of user testing with community-based users.

4.5.2 Discussion

Research questions

The findings discussed in the reflection stage partially answer the following research questions.

(1) How can FireWatch be redesigned to incorporate global best practice and modern principles of dynamic information design to develop a more usable and intuitive version for members of the wider community?

Design guidelines from Tognazzini (2012), Krug (2000) and Nielsen (2000) pointed to consistency, high-quality content, regularly updated and relevant content, minimal download time and ease of use as a means of presenting a usable and intuitive interface to users. These guidelines were summarised in the previous chapter (Table 3.5). Maeda's (2006) approach to simplicity — removing much of the functionality, but being careful about still providing utility — led to a more simplified interface. Through the scenario-based analysis providing perspective from the user's point of view, the first iteration of the prototype should provide adequate functionality for most users. Additionally, Marcotte's (2011) responsive design technique is a modern and pragmatic way of providing a usable interface to multiple browsers and devices. Despite the focus at this stage being on desktop computers, creating a flexible, scalable interface meant that users could still view the interface on mobile and tablet devices. Rhetoric has a role to play in designing the user experience. Designers conscious of the rhetorical effects of design can persuade a user to interact with an interface in a particular way (Schneller, 2009). Rhetoric can also communicate meaning from the design to the user. Informative aspects of rhetoric can have a desirable outcome for the user, such as achieving a goal

(e.g., being more informed about something that orientates them) (Schneller, 2010). This outcome was addressed by providing map navigation elements that would allow a user to easily identify fire information in their vicinity.

(2) What kinds of user input are required for effective revision of the FireWatch service?

It is clear that direct input from users would be ideal to ascertain whether the design is adequate in terms of functionality, provides ease of use and allows them to be more informed. In circumstances where direct input is not feasible, scenario-based design — and the personas framework specifically — can provide a means of considering the perspective of the users. Scenarios offer a concrete yet flexible means of collating relevant information from several sources, and in a sense act as a form of participatory design (Rosson & Carroll, 2002). The flexibility and ability to allow input from all stakeholders may explain why design scenarios are one of the key methods used in service design (Stickdorn & Schneider, 2010). It is also clear that input is required from the service provider, Landgate. The success of FireWatch is dependent on what services Landgate is able to provide users, and it is only in consultation with the service provider that this can be ascertained. Taking this view, this research question should be broadened to ask "What kinds of stakeholder inputs are required for effective revision of the FireWatch service?" as it was already clear at this stage that as a designer it is important to work with both the users and the service provider.

4.6 Conclusion

This chapter discussed the first iteration of the design process undertaken. The iterative process involved the planning, prototyping and designing, exploring and reflecting stages as explained in the methodology chapter. The resulting first stage prototype of the interface meant that there was success in choosing scenario-based design and the personas framework to compensate for the lack of direct user input into this iteration of the design process. Although it would not be known at

this stage whether it actually met the needs of users until after testing with community-based users, it demonstrated how scenario-based design allows a designer to consider the perspective of users even when circumstances do not allow for their direct involvement. Significantly, the decision to use scenario-based design yielded a working prototype that would be the focus of the first round of user testing with community-based users. Without knowing anything about the characteristics of Kununurra and its inhabitants, the prototype may not have ended up in a state where it featured a suitable amount of functionality.

The findings regarding simplicity showed that a nuanced approach may be necessary in the act of simplifying an interface. Maeda's assertion that the "easiest way to simplify a system is to remove functionality" (2006, p. 1) needed to be weighed against Norman's (2007) that "simplicity is overrated". While it was necessary to remove much of the functionality in the redesign process, consideration was given to how each feature should be redesigned and whether it could be simplified. Care was taken to provide enough functionality to be of use to users: that is, to ensure that they can achieve the desired goal of using the FireWatch interface: become informed about bushfire threats in their vicinity. Although the approach suggested by Maeda (2006) was taken, Norman's (2007, 2008) point is still valid: simplicity for the sake of it is overrated: a more sophisticated approach is necessary and it is up to designers to find ways to improve usability without drastically reducing functionality.

Schneller asserted that rhetorical rules may be followed unconsciously by a designer. In the instance of FireWatch it seemed appropriate to consciously consider how a design will affect the audience. A designer should consider both the informative and persuasive aspects of the design as they can influence the actions of users. A designer should be aware that rhetoric has the potential to encourage a user to undertake a specific task or goal. It is therefore important for the designer to consider ways in which the design may facilitate what the user is hoping to achieve with the interface. Scenario-based design's role at this stage of the project had two significant outcomes that led to

the next iteration of the design. Firstly, it provided a working prototype that would be used in user testing. Secondly, the personas framework pointed the way to what types of people it was necessary to engage with in the Kununurra community in order to get valuable input into the design process.

The next chapter discusses the process and outcome of real-world participation from residents of and visitors to Kununurra. It will discuss the results of in-depth interviews and user testing undertaken in two stages. This direct participation also determined how successful the approach to simplicity has been. The next chapter also discusses how the frameworks used in this chapter guided the recruitment of participants for the first round of fieldwork. It also describes whether the user actions and comments reflected the implied rhetorical intentions and user experience goals.

5

Engaging users in the design process

Two peer-reviewed publications (two conference papers) have arisen from some of the results discussed in this chapter:

- Haimes, P., Brady, D., Clarkson, B., & Medley, S. (2013). *Engaging with communities as a design process: redesigning the FireWatch interface.* Paper presented at the Australian & New Zealand Disaster and Emergency Management Conference, Brisbane.
- Holloway, D., Haimes, P., & Green, L. (2013). *Developing a User Friendly FireWatch Site:*

Debunking Sociotechnological Assumptions about Internet Users in Remote Communities. Paper presented at the Australian & New Zealand Disaster and Emergency Management Conference, Brisbane.

5.1 Introduction

The previous chapter discussed how scenario-based design and the personas framework, along with literature on simplicity and rhetoric, guided the first iteration of the design process. This first iteration began with analysis of the previous expert-user version of FireWatch and resulted in a working prototype that would become the focal point for input from actual community-based users. Due to circumstances meaning that direct access to actual community-based users was not possible, scenario-based design and personas were utilised to provide the perspective of users. The reflecting stage of the first iterative design process found that scenario-based design and the personas framework served several purposes. It allowed for the "teasing out" of a set of requirements prior to commencing the design. It allowed for the "kick-starting" of the design process, which resulted in a working prototype. It also allowed for Landgate — the service provider — to develop a clearer picture of the types of users that the new version of FireWatch would be designed for. Simplicity was also discussed, as simplicity — specifically Maeda's (2006) approach of "thoughtful reduction" — was a pragmatic way to improve the usability of the remaining functionality. Rhetoric was also discussed, as being conscious of the role of rhetoric — considering both informative and persuasive aspects of the interface — was a useful way in which to consider how users would react to various elements of the interface.

This chapter discusses the two iterations of the design process where actual users from the Kununurra community were directly involved in the design process. Input from users was obtained in two ways: a card sorting system to gauge usefulness of the functionality and a usability-focused

semi-structured interview that was conducted after users had spent several minutes with the prototype interface. Observations were also noted while participants were viewing the prototype. This user engagement took place in two rounds of user trials in Kununurra: the first was in September 2012 and the second was in July 2013. The majority of users responded positively to the interface and the feedback received suggested that generally speaking, a suitable amount of functionality had been provided. Directly engaging with users highlighted some unanticipated outcomes and emphasised the need for their direct input in the design process. In addition to the focus on design, the ARC research officer also interviewed people about communications issues surrounding bushfires in separate interviews. The first round of interviews demonstrated that very few people in Kununurra were aware of FireWatch or similar websites, such as NAFI and Sentinel. Consequently, in the second round of interviews, an effort was made to gauge whether social media had a role to play in "spreading the word" about the new version of FireWatch. Users were also asked whether they would be interested in the option of contributing content to FireWatch.

Structurally, this chapter comprises of two iterations of the design process explained in the methodology chapter. The first iteration begins with the planning stage and prototyping and design stage, but these are brief due to the work explained in the previous chapter resulting in a prototype for testing with actual users. The first exploring stage discusses the recruitment of actual community-based users and how they were engaged for input into the design process. Users were presented with a card system for rating the features provided by the FireWatch prototype. They then spent several minutes using the prototype interface before being asked a series of questions in a semi-structured interview regarding usability of the interface and general communications regarding bushfires. The feedback from these users was then analysed, with quantitative results from the card system, as well as rich qualitative descriptions of how users might find the features offered by FireWatch to be useful, along with discussion regarding usability of the interface. The feedback from these users then informed the planning stage of the next design iteration. How the feedback was addressed is then

examined in the prototyping and designing stage, along with figures showing the actual interface. The exploring stage involved a second round of engagement with actual community-based users, with a focus on the tourism industry and local small businesses. This stage of feedback also involved the use of a card system and semi-structured interview, but also including questions regarding how they would likely find out about a service such as FireWatch and whether they were interested in contributing content to the FireWatch service.

5.2 Planning the first round of engaging with community-based users

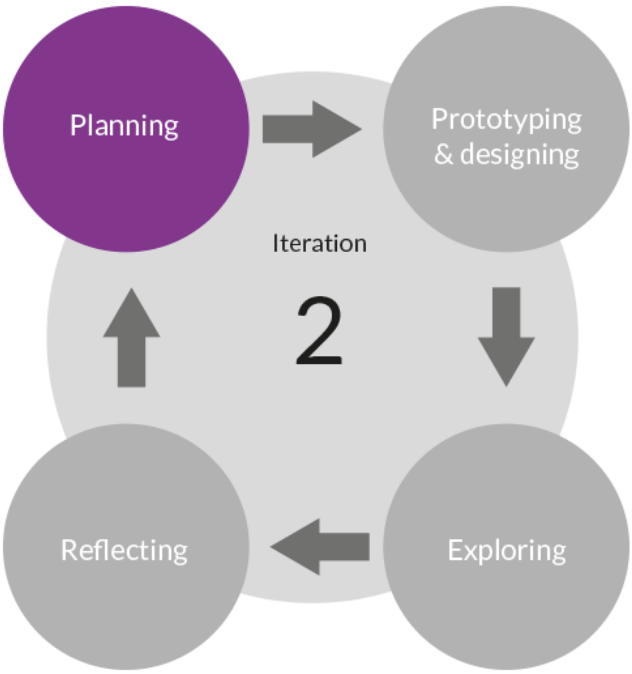

Figure 5.1: The planning stage of the second iteration of the design process. In this planning stage, it was it was considered necessary to engage directly with community-based users from Kununurra. This was considered necessary for two reasons: to gauge the usefulness functionality provided by the prototype interface explained in the previous chapter and to test its usability.

In this iteration of the design process, it was considered necessary to engage directly with community-based users from a remote regional town of northern Western Australia. The planning stage involves developing a theory of how to address a certain problem (Stickdorn & Schneider, 2010, p. 286). The problem in this stage was that it was still not clear if the interface provided sufficient functionality to be useful to community-based users while still being usable. Therefore, the theory here was that direct user input was necessary to gauge the usefulness of functionality provided by the prototype interface explained in the previous chapter and to test its usability. As community-based users were presented with the prototype described in the previous chapter, functional and non-functional requirements were not created in this planning stage. However, in the designing and prototyping stage, browser testing was done to ensure that the interface would work as intended on common web browsers. Kununurra was chosen as the trial site for this stage as it met several criteria relevant to the ARC project: Its population is made up of both indigenous and non-indigenous people, a number of government and community organisations are based there and there is access to both ADSL 2 internet connections and 3G phone networks. Kununurra also has a population of approximately 6000 people (Government of Western Australia, n.d.), which was considered a suitable size on which to draw a sample of several diverse participants. Landgate agreed that it was a suitable location.

5.3 Prototyping and designing: a simplified interface

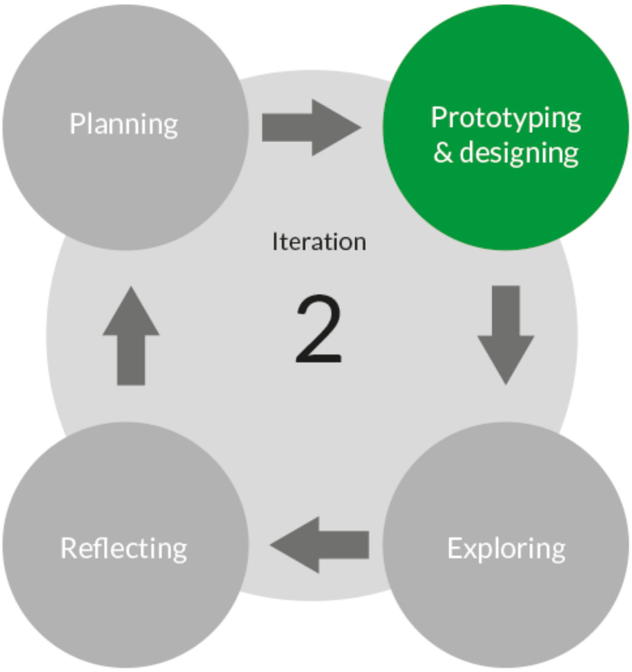

Figure 5.2: The prototyping and designing stage of the second design iteration. The design was not significantly changed from the previous iteration as it was deemed necessary to gain feedback from actual community-based users prior to making further changes to the design process.

At this prototyping and designing stage, no significant changes were made to the design from the working prototype that was explained in the previous chapter. Nevertheless, testing was done to ensure that the prototype was displaying and behaving correctly in the browsers that it was assumed that participants would have access to, such as Google Chrome, Mozilla Firefox and Internet Explorer. The prototype interface was shown to the service provider Landgate during this stage, prior to it being evaluated by actual community-based users. While they expressed some concern at the significant reduction in functionality, they were interested in the response from community-based users before providing further input into the redesign process.

5.4 Exploring — capturing community-based users' experiences with the prototype interface

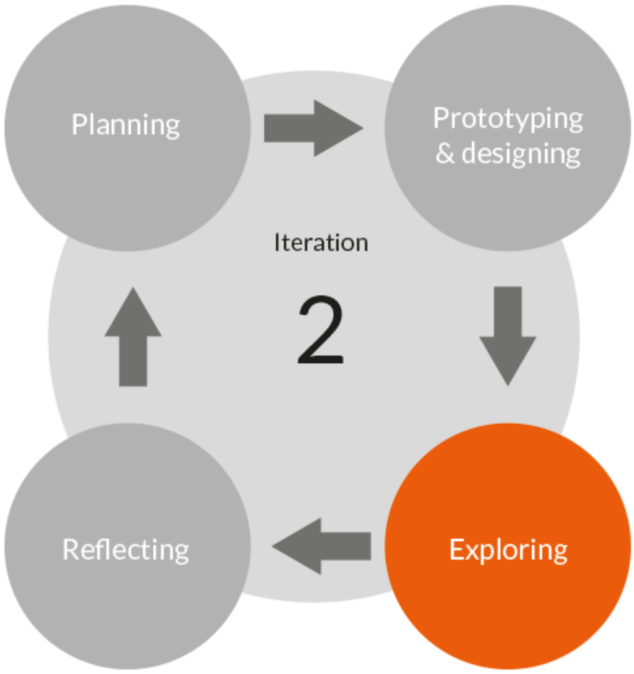

Figure 5.3: The exploring stage of the second design iteration. This exploring stage was where the first direct engagement with actual community-based users took place. The user engagement involved a card system for rating the features of FireWatch, followed by user testing of the interface and a semi-structured interview discussing usability of the interface and communications issues around bushfires.

This exploring stage was where the first direct engagement with actual community-based users took place. Stickdorn and Schneider described the exploring stage as the collection of "insights both by observing customers interacting with the service and by interviewing them about their experience with the service" (2010, p. 286). For this round of user engagement, users rated the features provided by the prototype interface using a card sorting system before spending several minutes with the interface. They were then interviewed about their experiences with the interface, other map ap-

plications and bushfire information. Observations were made while users were interacting with the interface.

5.4.1 Research instruments

While the design stage discussed in the previous chapter relied on the research methods of scenario-based design and the personas framework, this stage took a participatory user-centred approach by directly involving users. Prior to the first field trip to Kununurra, preparations were made as to what sort of feedback would be useful for gaining a perspective from users. It was decided that the design interviews would be conducted in two stages: the first established what functionality would be of use to new users of FireWatch; and the second was a semi-structured interview that was intended to promote further discussion around usability aspects of the interface. The approach to the user experience taken here was to make usability and usefulness a priority due to the complexity of the previous expert-user version of FireWatch. Hassenzahl's (2004a) assertion of improving usability and usefulness as a way of promoting user satisfaction influenced the decision to place emphasis on usability and usefulness. This was addressed by the utilisation of two research instruments: A card system was used to determine the usefulness of the various features available on the previous expert-user version of FireWatch; and a semi-structured interview was used to discuss usability aspects of the interface. It was assumed that addressing both usefulness and usability when engaging with participants would likely lead to satisfaction if it allows the user to achieve a valued goal (Hassenzahl, 2004a).

5.4.2 Card system

As discussed in Chapter 4, the core functionality of the previous version of FireWatch was identified in the initial analysis prior to the design commencing. This strategic reduction process removed sub-

features wherever possible, using Maeda's approach of "when in doubt, remove" (2006, p. 1). The remaining functionality provided the following:

1. Current fire "hotspots", ranging from 0 to 72 hours
2. Two years of burnt area data
3. A satellite (aerial terrain) view
4. Weather data
5. Three days of lightning strike points
6. A map with zoom controls and the ability to pan, including "pinch-zoom" functionality on mobile and tablet devices
7. A search bar where users can enter their town or address.

Simple descriptions of these seven features provided the focal point to the first half of the user testing and interview process and were presented on paper cards, based on a research instrument known as the *Experience of Change* (Ainscow, Hargreaves, Hopkins, Balshaw, & Black-Hawkins, 1994). This instrument was chosen because it yielded both quantitative and qualitative data (Ainscow et al., 1994), and it was previously found to provide a focal point to discussions in the context of adopting new technology (Clarkson, 2002). A version of this instrument had been previously used to ascertain whether ICT had been successfully adopted by teachers in an educational setting (Clarkson, 2002). Card sorting systems have been a significant research instrument for usability engineering, where users sort cards labelled with ideas (e.g., interface features) into piles, giving them ratings (Nielsen, 1994, p. 127). It was therefore considered appropriate to use this research instrument as a way of determining whether the functionality offered by the new version of FireWatch would be useful for this new group of users. Participants were asked to take a card, consider how useful the feature would be to them, and then rate the feature by placing the card in one of the following categories: *very useful*, *somewhat useful*, *somewhat non-useful* and *very non-useful*. Participants had the

option to justify their rating. Participants were also given two blank cards in which they could describe a feature not included on the other cards. Blank cards were part of the original *Experience of Change* (Ainscow et al., 1994) research instrument. These were considered a useful means of giving users the option of describing functionality not included in the seven cards. This was done to ensure that the strategic reduction undertaken by the initial design stage (explained in the previous chapter) had resulted in an adequate amount of functionality for these new users of FireWatch. Figure 5.4 shows the feature cards that participants rated and Figure 5.5 the categories in which the cards were placed.

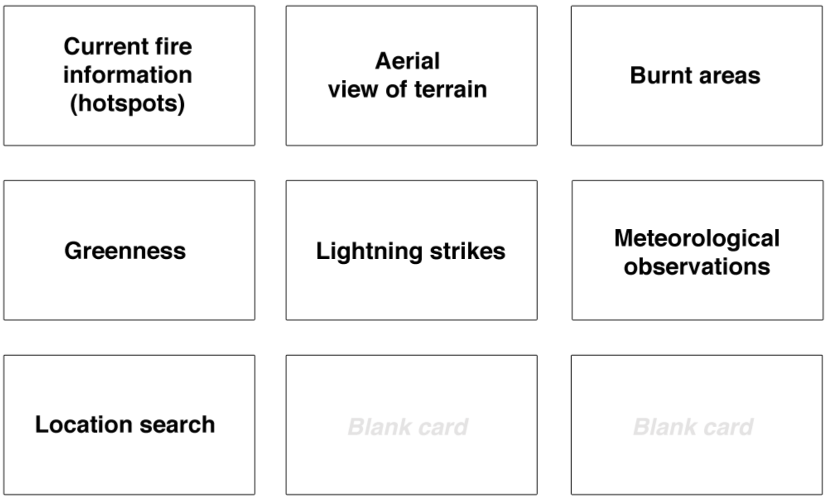

Figure 5.4: The cards describing the various features proposed for the redesigned community-based user version of FireWatch. These cards described seven features for participants to rate by placing the cards in one of the categories shown in Figure 5.5. Two blank cards were given to participants if they thought that a feature should be included that was not covered by the seven cards provided.

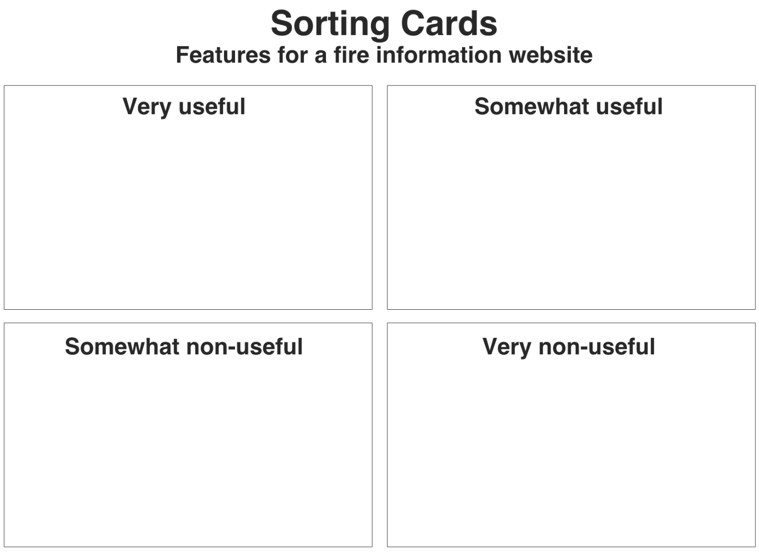

Figure 5.5: Categories for sorting the cards describing the features of the redesigned FireWatch (Figure 5.4). Participants placed each card in a category and were then given the option to elaborate on their decision.

5.4.3 Semi-structured interview

A semi-structured interview guide was created (Table 5.1), based on a series of usability questions from the System Usability Scale (Brooke, 1986). The terminology was adjusted to refer to a website rather than a system as this was considered a more appropriate term in this context. Two questions were added: a question asking participants to describe their occupation was added to ensure that a diverse range of occupations were covered; and a question regarding which devices they used to access the internet, as this was deemed relevant to the actual design and development of the interface. The semi-structured interview was conducted after users spent several minutes looking at the prototype interface.

Table 5.1: Semi-structured interview guide questions for the first stage of data collection. These questions were focused on usability but also asked demographic information and information about how participants accessed the internet. The majority of these questions came from the System Usability Scale (Brooke, 1986).

Semi-structured interview guide

1. Please describe your occupation.
2. Which age bracket do you belong to?

   18-30, 30-40, 40-50, 50-60, 60+
3. Did you find any aspects of the website unnecessarily complex?
4. Did you find overall that the website was easy to use?

   Was it easy to learn?
5. Were the functions of this website well integrated?
6. Did you think there was too much inconsistency in the website?
7. Did you feel confident using this website?

   Which aspects of the website were you most comfortable with?
8. Do you think that you will use this website frequently?

   Please explain your answer.
9. What sort of devices do you typically use to access the internet?

5.4.4 Working with community-based users: data collection

The first round of user testing and semi-structured interviews occurred in September 2012. The early working prototype described in Chapter 4 was tested with seven participants. Participants were asked about the various features of FireWatch using the card-based system. Users then spent several minutes with the prototype interface and were then asked a series of questions about their experience with the interface.

5.4.5 Participants

The personas developed in the scenario-based design framework explained in the previous chapter provided a sound rationale with which to select a small, but relevant, sample of users. These participants were approached by the ARC research officer, who had arrived in Kununurra a week previously and was conducting interviews about bushfire communications and people's experiences with bushfires generally. Seven participants from a range of occupations, the majority of which approximately matched one or more of the personas described in Chapter 4, were identified. The seven selected participants were invited to participate and were then interviewed in-depth regarding their fire preparation and response, and communication issues surrounding bushfires — including whether they turned to the web as an information source in this process. Descriptions of the seven participants are provided in Table 5.2.

Table 5.2: Occupations and descriptions of the seven participants chosen for user testing and interviewing in Kununurra. These participants were chosen based on the scenario-based design and personas framework analysis undertaken in the initial design stage described in Chapter 4.

User occupation	*Description*
Indigenous fire manager.	Works with indigenous community members to coordinate controlled burns.
Farmer/tourist operator.	Runs a small farm and also runs treks in remote areas.
Forester.	Works at a sandalwood farm near the town centre.
Store owner.	Runs a small shop in the main part of town.
Tourist operator (1).	Runs a local caravan park near large tracts of bushland.
Tourist operator (2).	Runs tours and camps along Kununurra River.
Local volunteer/forester.	Volunteers as part of the emergency services in the town. Also works in forestry.

There were seven interviews conducted with the participants described in Table 5.2, lasting an average of approximately 30 minutes. Prior to viewing the prototype, six of these participants were asked to explain how the core functionality of the previous version of FireWatch would be useful to them. Due to time constraints, one participant was unable to partake in the card sorting activity. The six participants who took part in this stage rated all seven features described on the cards. After making their decision, participants were encouraged to describe the reasons behind their decision. All seven participants spent several minutes exploring the interface and were then asked a series of questions, based on the semi-structured interview questions shown in Figure 5.1.

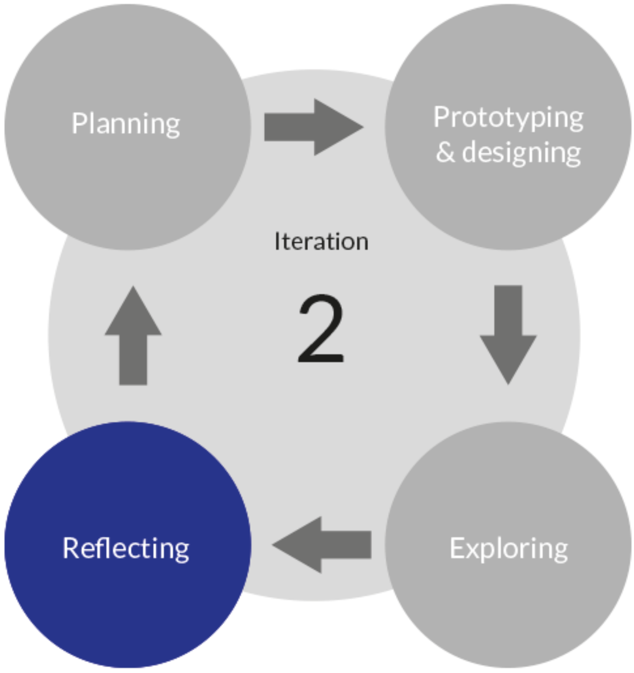

Figure 5.6: The reflecting stage of the first iteration of the design process. Instead of reflecting on the direct feedback from participants (as in the next iterations of the design process) here, reflections included the role of the various theoretical approaches to the design, with emphasis on the role of scenario-based design, the personas framework and simplicity as a design goal.

The reflecting stage involves processing the data and creating "manageable insights" (Stickdorn & Schneider, 2010, p. 286). Following is the analysis of participant responses to the card system, as well as quotes from users sorted by relevant themes. These themes include the features of FireWatch, as well as usability issues with the interface.

5.5.1 Analysis

Participant responses to the card system yielded both qualitative and quantitative data, which provided valuable insight into which features were considered useful to this new community-based audience for the redesigned FireWatch. Table 5.3 shows the quantitative values of each of the features. These scores were based on the ratings that users gave during the card sorting system. Scores were calculated by assigning the following values to ratings: Very useful = 3, somewhat useful = 2, somewhat non-useful = 1, very non-useful = 0. Assigning these values to the ratings clearly shows which features are most useful to participants.

Table 5.3: Participant ratings for the seven features of the FireWatch prototype. These features were based on the previous expert-user version of the FireWatch website and the majority of them featured in the prototype interface tested with these users. These scores were based on the ratings that users gave during the card sorting system.

Prototype feature	Satellite view	Burnt areas	Current fire hotspots	Greenness of vegetation	Lightning strikes	Location search	Weather data
Overall rating	15 *	17	17	11	14	11 **	14 *

* One participant did not rate this feature

** Two participants did not rate this feature

Feedback from these semi-structured interviews was sorted by themes with quotes from users "to illustrate points of interest" (Rogers et al., 2002, p. 398). The themes covered included the features provided by FireWatch, as well as issues surrounding usability of the prototype interface. The devices that these community-based users had for accessing the internet and the availability of internet connections were also discussed, as context of use is an important factor when considering the delivery of a service (Beaumont et al., 2014). Feedback from the interviews was supplemented by observations recorded while users were exploring the interface.

Table 5.4: Ratings of FireWatch prototype features. User ratings from the card-sorting system to gauge the usefulness of FireWatch features. The occupations of the six participants who took part are described in the far left column. The ratings used were *very useful* (VU), *somewhat useful* (SU), *somewhat non-useful* (SNU) and *very non-useful* (VNU). Some features were *not rated* (NR) by some participants.

User occupation	*Satellite view*	*Burnt areas*	*Current fire hotspots*	*Greenness of vegetation*	*Lightning strikes*	*Location search*	*Weather data*
Indigenous fire manager	VU	VU	VU	SNU	SU	*NR*	VU
Farmer/tourist operator	VU	VU	VU	SNU	SU	VU	VU
Forester	VU	VU	VU	SU	VU	SU	VU
Tourist operator (1)	*NR*	VU	VU	SNU	VU	*NR*	VU
Tourist operator (2)	VU	SU	VU	VU	SU	VU	
Local volunteer	VU	VU	SU	VU	SU	VU	*NR*

When rating features, users often simply gave a rating with no explanation, but in some instances they elaborated on their choices, explaining why they considered the feature useful or not. Following are quotes and observations that gave some insight into how users envisaged the usefulness of various features.

Aerial view of terrain (satellite view)

Four out of the six participants who rated features, rated the satellite view — which shows terrain from an aerial point of view — as being *very useful*. The local volunteer considered an aerial view useful: "Last week when we were fighting the fire at the back here… The information that came

from [an] aerial view of the fire was absolutely invaluable".

While the forester claimed that it might not be useful in their context, she considered it to be very useful for those in other parts of Kununurra: "*Very useful* — not so much for us because we know our terrain is very flat, but very useful for outside the irrigation area".

The indigenous fire manager said that his team relied heavily on aerial imagery from Google:

> That's the way the guys will go every time, and that shows our access roads and access points if it is Google Earth, even if it is a little bit historic it still gives us an idea — we can get in and out in that area… We've found the new developments out here for the Ord — there might be a road in but might be something there now. Even though it is a bit out of date it is utilised more than anything, as far as navigation goes for the team. We'll print that out and we'll draw for the other guys in the team just in case their vehicle gets bogged or something — we'll draw a line which way we are going. So definitely an aerial view.

While the above users worked in specialist areas that may have needs beyond others in the wider community, everyday users also saw a need for an aerial view of the terrain. When asked about the usefulness of this feature, the farmer/tourist operator answered "Yes, definitely". When viewing the prototype, the farmer/tourist operator was able to pinpoint locations of interest just by viewing the aerial view layer. Tourist operator 2 mentioned: "You can zoom in to the point where you can see the roof of the structures". When viewing the aerial view on the prototype, this tourist operator was able to view the exact location of his campsites. These comments and observations reflected the usefulness of providing this aerial view of the terrain. The usefulness of the satellite view was underestimated and it was incorrectly assumed to be superfluous to a non-technical audience.

Burnt areas

Previously burnt areas was another feature that participants believed would be *very useful*. It proved particularly useful to those who worked with the land. The local volunteer stated that:

> If you had areas that were burnt in January and had a monsoon go over it, it now has a low coverage of grass that is burnt off, if that is classed as a burnt area, that information is probably *somewhat useful* to *very useful* on the basis that it may give you an opportunity to burn back against because you'll have a very slow burning easily controlled opportunity to create a firebreak. So previously burnt areas would be *very useful*. If it's burnt areas now you'd say Kununurra is absolutely secure from bush fires because it is burnt so much recently.

The indigenous fire manager said:

> With the planning, historic information is quite handy for us because the model that we use is the Thema model and one of the variables that go in is historic. If the guys that are on the team don't know the history of the area or they are too young it is hard to ascertain the history. If there was a link there that would be handy for the planning stage... Yes it would [help]. Scar data.

The forester also said that it was a useful feature: "For future planning if you know that an area is already burnt, then it is providing protection".

Participants that worked in tourism also saw a need for this feature. The farmer/tourist operator stated that it was *very useful* and said that they would like at least 3 years of data. Tourist operator 2 mentioned that this would be a useful feature for monitoring conditions around his campsites: "Then I'd know if there is a fire break around and put my mind at ease for the rest of the season. If I know it is all burnt around my camps but didn't go into my camps, I'm good".

This feature, like the aerial view of the terrain, proved to be a key feature for users within the tourism industry.

Current fire hotspots

Unsurprisingly, current fire information was ranked as a *very useful* feature by all participants, with the exception of the local volunteer, who said he would consider it useful if more people acted on the information by helping to fight fires: "If people were prepared to go and fight fire here and essentially stop fire from having these broader and unforeseen consequences, then hot spots would be *very useful*, but as it stands it is *somewhat useful*".

In contrast, the indigenous fire manager emphasised the importance of this feature: "100%. We need that". Given that all other participants rated this feature as *very useful* demonstrated that there was a clear need in the community for access to this information.

Greenness of vegetation

Greenness was rated as being *somewhat non-useful* by three participants, but *very useful* to two other participants — one of whom worked in forestry and likely had specific needs for this feature. The forester explained: "When you are doing your fire hazard rating you talk about curing the fuel and how dry it is".

The local volunteer stated: "I think it will play a very important part... in some way representing the original cycles of fire for early wet season burning".

However, the indigenous fire manager did not consider this information to be relevant to his team's work, although he mentioned he would use it (NDVI imagery):

> That is not relevant for our unit because we are very specific and localised. It would be on a larger scale but not for us as a unit, because we are chemical spraying and any

> vegetation we'll be clearing anyway. We are basically taking the greenness out, so it will be a visual greenness survey for us. I know that other organisations that work on a larger scale would use it. I would use the NDVI index. That would be something I would look at if they said we want you to burn a big scale.

There were also mixed responses from those participants involved in tourism. Only one saw a use for it but the other two did not think it was an accurate picture of actual conditions on the ground. One tourist operator (1) stated that it was "Not really [useful] because spinifex is very green and it burns even better when it is green".

Similarly the farmer/tourist operator mentioned that "It will show you that the country is not burnt out but it won't show the state of the country".

Tourist operator 2, however, believed it would be useful to his situation: "I know that if it is all green around my campsite I don't have to worry". At this stage, greenness was not included in the prototype, but further engagement with users was later undertaken to monitor this decision.

Lightning strikes

There were mixed responses to lightning information. Tourist operator 2 considered it to be a primary cause of fire:

> Most of the fires are started by lightning strikes, or a lot of them. Not that important to me personally, but if it is another button… click, click, click — and it changed the picture, how easy is that? If you make it easy to follow with the right titles — put the ones that are less important at the bottom, and the really important ones like current fire information at the top, then we'll know exactly where to go.

Similarly, the forester identified it as a key source of ignition:

> Lightning is our other form of ignition source in the plantation, especially in the build up and going into the wet season when there is a lot of thunderstorms but not necessarily much rain with them. There can be a heap of lightning and only a bit of rain in one place but the lightning has gone all the way through. Once it is the wet season, when you have lightning you have heavy rain with it but in the build up there is a lot of lightning and not much rain.

The local volunteer also considered it to be important to fire management: "I see it as useful but you look at it with the radar information where the storms are and where they will likely impact". The farmer/tourist operator stated that it would be useful:

> Only if you were wanting to prove something. Fires do start from lightning strikes... There was a big controversy two years ago in November, a big fire burned out the Bungles and DEC claimed it was lightning. All the locals had information that it was Aboriginals, so I guess it would help somebody in that case.

The indigenous fire manager did not think that lightning information would be useful to his team, but would still want the option of seeing it:

> We'd hopefully done all our protection burns before the lightning comes in. It would be useful in the next planning year but then I could just utilise the scar data. It is interesting, I'd like to know that and the guys would be quite interested but it wouldn't be a huge functionality for our unit... Not particularly useful for our specific objectives as a fire unit, though I'd like to see it.

Lightning information was included in the prototype at this stage (Figure 4.6) as one of the less prominent features.

Location search

Input from participants regarding location search was useful. The local volunteer mentioned that he used latitude and longitude for location information:

> I use lat/long or UTM [Universal Transverse Mercator] grid reference. It is so easy these days... I use the iPad for the navigation. [Name suppressed] was taking control of the fire ground and said where are you now, so I just gave my position and read out the coordinates in lat/long or UTM, so he puts that down. All of the updates were then being delivered on a Google Earth shot of where we actually were. He had Google Earth shots of where we were, and the timeliness of back burning. That's where I think we should be going with information.

The farmer/tourist operator mentioned that Google was good at handling both address information and longitude and latitude:

> Google is pretty good on addresses but both work well [searching by address or longitude and latitude]. I tend to not use anything because I've done navigation for so many years in the Kimberley area, I can just bring it up and I know where I want to go. I was looking for a friend's property in Darwin today on Google and I used the road address and it came straight up. Both ways would be good.

One tourist operator (1) was generally interested in location search functionality: "A reference to find out where you are and get your bearings". While some of the above users were comfortable using latitude and longitude to orientate themselves, other users would want to search by an address or by manually scrolling to a point of interest. The other tourist operator (2) said:" I'd type in [my street address]... I don't know the latitude and longitude of my camps — however I would if I was registering them with your service. I'd go with a GPS and get them".

The forester mentioned land titles, which Google understands as a normal address:

> Would you be able to do it by land title? On that map of the irrigation area it looks like a lot of little paddocks, but it has the cadastral information and that is definitely available electronically, and outside of that busy hot spot it is just pastoral leases from here to Broome, so there are not a lot of addresses. Everyone around would know their location by lot number, but not latitude/longitude, so being able to search by lot number would be useful.

The indigenous fire manager explained how his team found points of interest:

> A Google Earth search — because I'm not the only one utilising it. The guys won't use lat/longs because some of the guys can't use GPSs and don't know time zones or what zones to put in, so they'll use a satellite style view. We'll have Google Earth up on one, and also our imagery up on another and go that way. Be scrolling in and see — we've got a huge fire scar for 2011 around here; another guy will be on another computer zoning in and say, I think it is here. It's quite simplistic but it works.

This feedback from participants verified the decision — informed by scenario-based design and the personas framework — to include the ability to search by both latitude and longitude and by an address or town was the correct one to make. Like the indigenous fire manager mentioned, both the farmer/tourist operator and tourist operator 2 also zoomed and panned the map to locate key points of interest with the aerial view of terrain showing. These two participants used the map view to find the Kimberley area and then used the terrain view to find their points of interest. It was noted that most users overlooked the search bar provided initially and mainly used the map controls (zoom and pan).

Weather data

Most of the users that the ARC project's research officer and I spoke to were familiar with the BOM website and clearly had an interest in monitoring weather conditions. The local volunteer explained how useful weather data was to his team:

> In the morning we all get a synopsis of the day's wind, rain and things like that. You do a determination on vegetation and dry matter, potentials etc. You go through all those equations on the ground... To actually get an ongoing up to date synopsis of the expectations of the weather and any changes that were likely, we would go to the BOM site... At 6am we will get an update on the expectation of the day's wind activities and temperature. Wind direction and speed, temperature and expectations over the day where the wind is likely to go, will it oscillate — backwards, forwards, 360°, or as it did the other day, work from the south east and roll around to the north, which was perfect because we started on one side, waited for the change around 9.30 and picked it up and went from having 10m of break and managing it with water very slow, to all of a sudden having a 150m in a matter of minutes, and blokes running flat out with fire sticks to build on that opportunity.

Likewise, the indigenous fire manager saw weather data as a key feature:

> Wind direction is our primary — when the winds drop we can burn, so if it is a windy day — that's why we went to nocturnal burns. Later in the season all the wind drops at 6pm, we bring a bigger team in. Most of the smoke travels up instead of getting into people's view if it is near a road. Temperature — we already know roughly but we'll be looking at ambient temperature. We know there is not going to be any rain, so we already know the other variables.

The forester stated that weather data was *very useful*: "I don't know if it is worth doubling up, whether you need it on your site when it is available somewhere else but I guess if it is all together that's handy... Temperature, wind direction, wind speed".

The users involved in tourism also considered weather data to be key information to include. Tourist operator 2 said: "If it is a light breeze it will do a really slow burn, but if she's blowing like it took two days instead of four to get to my camp site, I needed to know that... No [we don't need to know the temperature]. We live up here and it is hot and wet or hot and dry".

The farmer/tourist operator mentioned: "I think that would be really helpful. The future is all predictions on BOM". This feedback provided useful insight into what type of weather data would be most useful to this new audience for FireWatch.

Other features requested

Two participants requested two features that were not available in the previous expert-user version of FireWatch and were therefore not implemented into the early prototype. These participants showed interest in predictions of fire behaviour, based on available weather data and previous fire behaviour. The store owner stated: "[Fire behaviour prediction] would be a lot more useful to me. This is where we think it is going to go, people in this area should start getting ready — this is where we think the fire is heading. That's all you can do because the wind can change that quick here and shoot off in a different direction".

One tourist operator (1) was also interested in fire prediction technology. He also expressed interest in GPS satellite tracking, and showing live smoke trails:

> To link with one, two or three of these tracking device people, not so much for someone like myself, but for people actually battling the fires. It really highlighted that night with the bush walkers, that we could see where they were and we withheld our

> actions until we knew they were in a safe location. We could not have done that without the satellite trackers... I think showing live smoke trails would be very handy. If you can show on a map a hot spot of the fire, and you see what has been burnt, but if you can show the general direction of the burn — if you can show, the hot spot was here but now it is here, so you know the general direction.

Landgate — in collaboration with DFES WA and the University of Western Australia — has provided a fire prediction service since 2013 but has restricted access to emergency services personnel and relevant government agencies (Steber et al., 2012). Smoke direction — as requested by a tourist operator (1) — is something that is not currently provided in the available satellite imagery. The second tourist operator (2) requested an alert system that notifies them (e.g., through email, Short Message Service (SMS) or social media) of fire hazards: "Alerts or warnings (increasing with intensity as it gets closer) ". The local volunteer alluded to social media playing a role in informing communities:

> If you are pitching it to the community, for those people who need to watch out for fire, I think it would be an incredibly good tool but it is like what came out of the Roleystone fire. Not a lot of people were home. Most people were looking to get information from Facebook and Twitter on their homes because they were in town.

The farmer/tourist operator mentioned that FireWatch having a better accuracy compared to Sentinel and NAFI would be ideal: "Sentinel will only pick up if an area is over 1km and it is very hot. I don't know if NAFI take from that or how it works. If we could have something a little bit more accurate it would be hugely helpful".

General comments about the interface

Comments from users suggested that six out of the seven participants did not find the interface too complex, found it easy to use and that its features were well integrated. Only one user out of the seven interviewed — the store owner, stated that there was "too much going on" in the interface and answered with "probably not" when asked if the prototype would be useful to him. In contrast, the majority of other users were content with the interface and the functionality provided. The Farmer/tourist operator remarked: "This looks so much better than Sentinel. You couldn't get in [zooming] that close on the Sentinel. It is fantastic".

One tourist operator (2) simply stated: "It looks fine". The local volunteer appeared to be content with the functionality provided, but suggested that the aesthetics needed to be addressed: "It probably needs a bit of bling on it. It is supplying the information that I want to see".

Devices used to access the internet

An unanticipated outcome from the interviews was that five of the seven participants used mobile or tablet devices. All participants used a desktop computer at either work or home, or both. The forester mentioned: "We are thinking about iPads more and more... a few of us do travel quite a bit and it would be good rather than carrying a laptop".

The store owner claimed that many people in the area have smart phones or tablets but that he did not: " I don't [have a smart phone or tablet] but a lot of other people do. We've got wireless here and wireless at home".

iPads and smart phones were used by the local volunteer and two people involved in tourism. "I use the iPad for the navigation... the iPhone and iPad have inbuilt GPS" (Local volunteer).

"Yes [I use 3G for the iPhone]. I am on Telstra and get good reception" (Tourist operator 2).

"We've got an iPad but we only use it for travelling. We just use these two computers here... [I

have] the HTC ” (Farmer/tourist operator).

5.5.2 Summary of the findings

Based on the feedback and input from user participation explained in the analysis, the following findings were revealed.

Aerial view of the terrain

People found the aerial view of the terrain — referred to as “Satellite view” in the prototype — to be *very useful* for orientating themselves and finding key points of interest in the landscape. This finding underlined the benefit of input from users identified through scenarios. It was incorrectly assumed that this feature would be of limited use to those users outside of fire and forestry management. When navigating, many people overlooked the search bar in favour of scrolling and zooming in. This may have been because the search bar was not visibly distinct from the rest of the interface. Participants used the default map view to orientate themselves to the general Kimberley area, then switched to the terrain view when zooming in.

Scenario-based design and the personas framework

The scenario-based design and personas framework analysis undertaken in the previous chapter provided a broad but limited and somewhat inaccurate picture when compared to the reality in Kununurra. While the individual characteristics of the personas may not have been exactly true to life, going through the scenario-based design and personas framework analysis resulted in a prototype that generally met the needs of the actual community-based users. It is clear that scenarios and the personas framework can play a useful role when direct contact with users is not possible. However, the depth of input from having real users spend time with an interface, interacting with it, and both

answering and asking questions about the various features, has the ability to provide a designer with valuable feedback. This user input was particularly crucial to this redesign, as these users were a new, non-expert audience for the FireWatch service.

Awareness of FireWatch

Feedback from the majority of users showed that there was a lack of awareness of publicly available bushfire websites such as Sentinel, NAFI and FireWatch. In contrast, all participants were familiar with the BOM website and many of its features. Several users also mentioned being familiar with Google Maps or Google Earth. This familiarity may bode well for the adoption of a map-based interface but it is clear that the service providers of publicly available bushfire websites could do more to make their services known to this non-expert audience.

Device usage

Interviews with participants in Kununurra revealed that smart phone and tablet use are commonplace. It is fair to say that people in Kununurra were more "tech savvy" than expected. Participants had access to broadband and 3G, as anticipated. All participants also had access to at least one desktop or laptop computer.

Community-based users

Community users — outside of those who worked in fire or forestry management — offered significant feedback. These users were all small business owners, many of whom worked in tourism. It was clear — both from this stage of user testing and the scenario-based design work described in the previous chapter — that tourism was a very significant industry in Kununurra and further engagement with participants in this industry was needed.

5.6 Planning: further engagement with community-based users

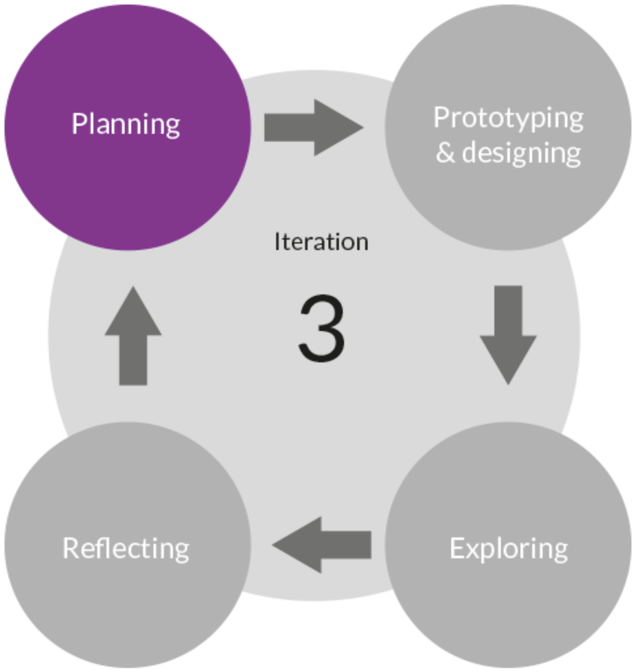

Figure 5.7: The planning stage of the third iteration of the design process. This planning stage incorporated feedback from the first round of engagement with actual community-based users. A set of requirements arose from this feedback, which were addressed in the next prototyping and designing stage.

The results from both the card-system and semi-structured interview had a direct impact on the next iteration of the prototype. As a consequence of this user input, several alterations were made to the prototype interface. These changes are shown in the following designing and prototyping stage. As a result of the first stage of participant involvement, functional and non-functional requirements were created. As in the previous chapter, Cooper et al's (2014, p. 122) model for creating requirements from scenarios was used. Functional requirements, data requirements and other requirements are described below.

Functional requirements

1. The mobile and tablet interface was to be improved upon substantially, utilising Marcotte's (2011) responsive design technique, as there were more users of these devices than originally anticipated
2. Due to one tourist operator requesting an alert system, plus the local volunteer mentioning that social media could play a role in fire management, a page was added that displayed Twitter alerts from DFES
3. HTML 5 location detection (Lawson & Sharp, 2011) was to be added which would automatically take a user to their location if they shared it with the browser

Data requirements

1. An additional year of burnt area data was to be added, as multiple users requested more historic data for this feature

Other requirements

1. The "Map options" layer, which was at the bottom of the map layer options in the first prototype was to be moved to just below the hotspot layers. This would place the aerial view of terrain (referred to as "Satellite view") and weather data as the most prominent layers after the hotspots
2. General improvements to the aesthetics of the menu, icons and logo also needed to be made

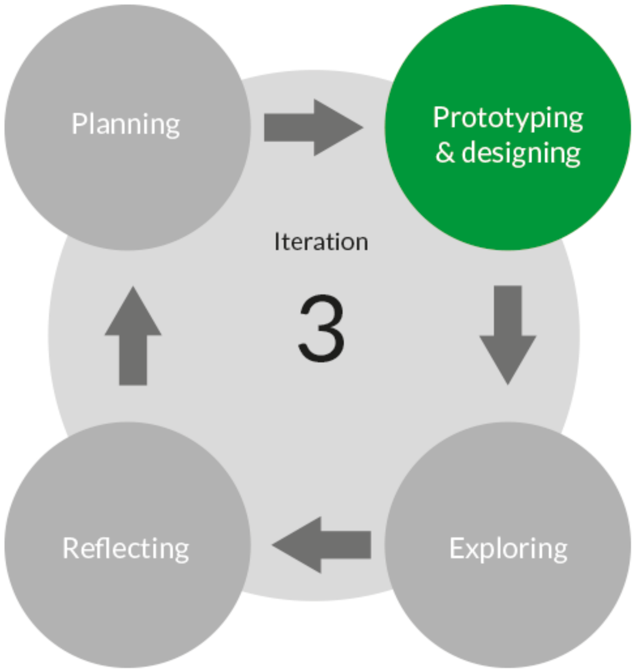

Figure 5.8: The prototyping and designing stage of the third iteration of the design process. This stage incorporated the requirements formed in the previous planning stage, which addressed the issues that arose in the previous round of user engagement.

To incorporate user input from the first round of user testing into the prototype interface, functional requirements, data requirements and other requirements were created in the planning stage (Figure 5.8). How these requirements were addressed in the actual design is shown in Figures 5.9 and 5.10. These figures show how the interface appeared to users viewing it on a desktop computer and how it will appear to users accessing it with mobile and tablet devices.

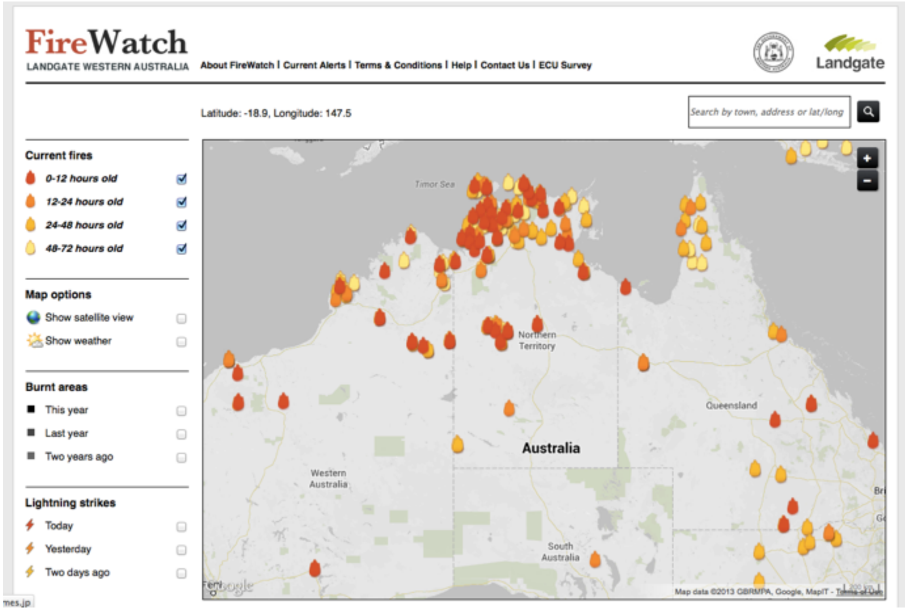

Figure 5.9: The prototype running on a desktop web browser after the first round of user feedback. This iteration of the prototype made the satellite and weather information more prominent. It also added an extra year of burnt area information and a page for alerts. Further changes were made after the second round of user feedback.

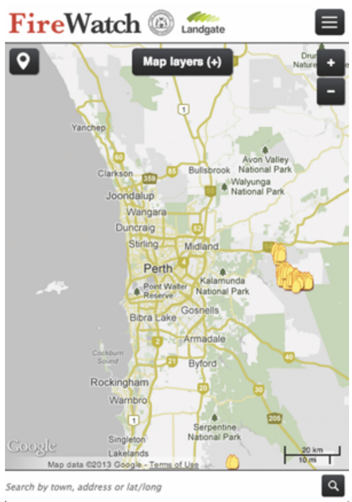

Figure 5.10: The prototype running on a mobile phone web browser. The initial feedback indicated that most users had access to mobile or tablet devices, so it was necessary to ensure that the device displayed correctly on these devices. Mobile and tablet devices were catered for using responsive design (Marcotte, 2011).

To summarise the alterations to the interface:

1. The satellite view and weather data were made the most prominent layers after the hotspots
2. The mobile and tablet interface improved upon through the use of responsive design
3. An additional year of burnt area data was added
4. A page was added that displayed Twitter alerts from DFES
5. General improvements to the aesthetics
6. HTML 5 location detection (Lawson & Sharp, 2011) was added, which is not visible in the prototype screenshots.

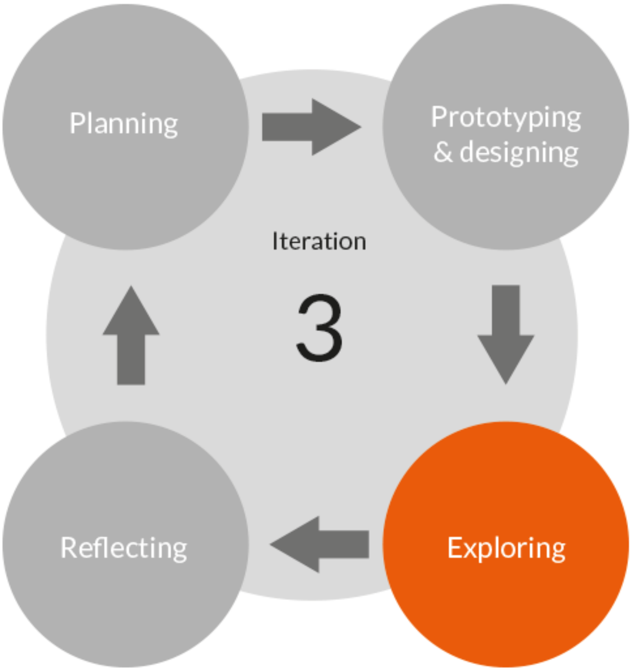

Figure 5.11: The exploring stage of the third iteration of the design process. This exploring stage involved the second round of user participation in Kununurra. The research instruments used again included the card-sorting system, observations and semi-structured interviews.

The early working prototype described in Chapter 4 was tested with seven participants from Kununurra. Participants were asked about the various features of FireWatch using the card-based system discussed previously. Participants then spent several minutes with the prototype interface and were then asked questions from the semi-structured interview guide about their experience with the interface. This user input was then addressed in the design and the prototype was tested again with second group of participants from Kununurra.

5.8.1 Research instruments

The research instruments used in the second stage of user testing were the same as the first stage: the card system (Figures 5.4 and 5.5) and a semi-structured interview guide (Table 5.1). This time, participants were asked additional questions (Table 5.5) regarding their social media usage, community communications and whether they were interested in contributing content to FireWatch. The previous round of user engagement found a general lack of awareness of the FireWatch service, so these topics were added to investigate how this could be addressed. The additional questions are shown in Table 5.5.

Table 5.5: Additional questions asked to participants in the second round of user testing and interviews. These questions focused on how to raise community awareness of the FireWatch service, what social media platforms people and businesses used, and whether they wanted the option to contribute content to FireWatch.

	Additional semi-structured interview guide questions
10.	We are trying to improve the level of community awareness of and participation in the FireWatch website. Thinking about your own community and social circles, can you describe how you or members of your community would be likely to hear about a website like FireWatch?
11.	Which of the following do you use? - Email - Facebook - Twitter - Google+ - Blogs - Forums - Other (If participants had Facebook, Twitter or other social media, they were asked the following): - How many friends do you have on Facebook/Twitter? - How often do you check Facebook/Twitter? - (For business owners) Do you have a Facebook/Twitter presence for your business? - Do you read or share news on Facebook/Twitter?
12.	Would you want the option of being able to contribute content to the FireWatch website (e.g., reporting fires)?
13.	Any final comments you'd like to make regarding the FireWatch website?

5.8.2 Participants

As discussed in the findings of the exploring stage describing feedback from the user testing and interviews, Kununurra was found to be a town heavily reliant on tourism, many of which were local small businesses. With the second round of user participation, an effort was made to focus on participants who worked in tourism and ran or worked in small businesses, particularly as many of them dealt with visitors to the town. Visitors to the town were also interviewed. The occupations and descriptions of the ten participants interviewed are described in Table 5.6.

Table 5.6: Description of the ten participants who participated in the second round of interviews and user testing. These participants were primarily working in the tourism industry or in local small businesses: key areas in the town of Kununurra.

User occupation	*Description*
Backpackers' owner	Runs one of the local backpackers' accommodations in the town. Also previously lived in another country town and worked as an emergency services volunteer
Art gallery owner	Runs a local art gallery and shop frequented by tourists and local residents. Liaises with many artists in the area.
Restaurant owner	Runs a restaurant in the centre of town. Clients include many tourists as well as local residents. Knows many other local business owners and people in the tourist industry.
Local business owner /farmer	Runs a local business and also works in agriculture. Also involved with the town's council and has volunteered for local emergency services.
Indigenous art gallery worker	Works at a local art gallery that showcases the work of indigenous artists. Also liaises heavily with the local indigenous community and partakes in cultural practices.

Tourist/volunteer	Spends several months in Kununurra every year. Also volunteers at a local art gallery and is well connected in the town.
Local artist and tourist (interviewed together)	Local artist whose work is heavily inspired by the Kimberley region's landscape. Was also interviewed with her friend who was visiting from another state.
Local business worker	Works at a local business approximately 10 kilometres from the town centre. Lives in town and commutes out of town daily.
Tourist centre worker	Works at the tourist centre. This is the starting point for many visitors to Kununurra. Also well connected to many who own and run local businesses.
Tourist operator (3)	Runs tours to and from Lake Argyle daily. Has lived in the area for several years and has witnessed the changes in the landscape due to fire.

There were ten interviews conducted with the participants described in Table 5.6, lasting an average of approximately 20 minutes. Due to time constraints, nine of the participants rated the seven features described on the cards and were given the option to describe the reasons behind their decision. All ten participants spent several minutes exploring the interface and were then asked a series of questions, based on the semi-structured interview questions shown in Tables 5.1 and 5.5.

The ARC research officer also interviewed the following participants separately. Most of these interviews were conducted with two participants at once. These participants were asked about communications issues surrounding bushfires in the Kimberley but also participated in the card system (Figures 5.4 and 5.5) and viewed the prototype. This focus on tourism and small business was considered vital to gain a clearer picture of the socio-technical context in which the FireWatch service would be used (Beaumont et al., 2014). Only the five participants who viewed the prototype and

rated features using the card system are described in Table 5.7.

Table 5.7: Description of participants who participated in interviews with the ARC research officer. These participants were asked primarily about wider communications issues surrounding bushfires in the Kimberley region.

User occupation	*Description*
Two grey nomads	Retired couple who travel around Australia. They have travelled around Australia twice previously.
Kimberley researcher and tourist/academic	The Kimberley researcher conducts geological and environmental research in the Kimberley region. The tourist/academic visits the Kimberley region regularly but lives in Perth.
Grey nomad	Travels around Australia with her husband. They are both retired from full-time work but often work in the towns that they are visiting.

5.9 Reflecting on the second round of feedback from community-based users

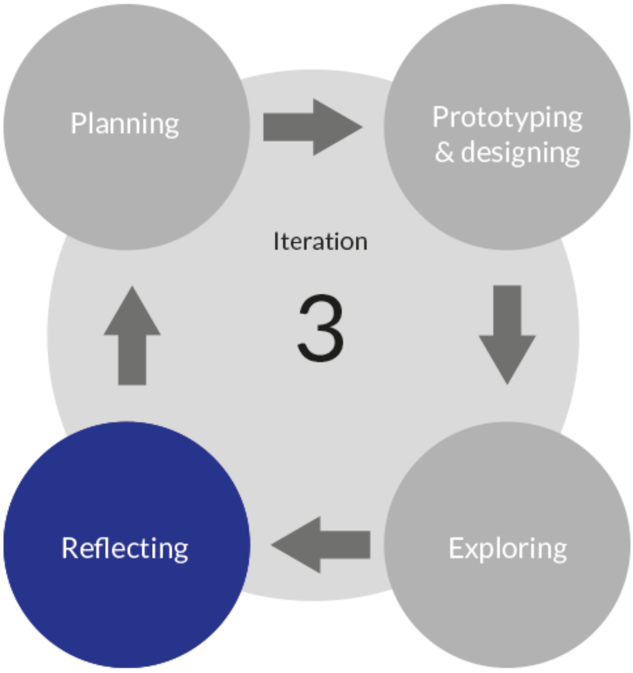

Figure 5.12: The reflecting stage of the third iteration of the design process. This stage reflected on the feedback from the second round of direct user engagement. This included analysis of the card-sorting system results and thematic analysis of user responses to the semi-structured interview, along with observations.

5.9.1 Analysis

This second round of engagement with users in Kununurra again provided insight into which features were considered useful to community-based users. This round demonstrated that both social media and traditional media could play an active role in promoting awareness of the redesigned FireWatch. Table 5.8 shows the quantitative values of each of the features. Scores were calculated by assigning the following values to ratings: Very useful = 3, somewhat useful = 2, somewhat non-useful = 1, very non-useful = 0. Features rated in interviews with two participants got doubled scores, un-

less the two interviewees gave different ratings.

Table 5.8: Participant ratings from the second round of user testing for the seven features of the FireWatch prototype.

Prototype feature	Satellite view	Burnt areas	Current fire hotspots	Greenness of vegetation	Lightning strikes	Location search	Weather data
Overall rating	36	30	45	32	26	40	39

As in the first round of user engagement, the themes covered include the features provided by FireWatch, usability of the interface and information about internet connections and devices that participants had access to. Qualitative feedback was again sorted by themes (p. 180). Feedback from the interviews was again supplemented by observations recorded while users were exploring the interface.

Table 5.9: User ratings of features from the prototype FireWatch interface that were included in the card-sorting system. These ratings were used to gauge the usefulness of the features provided by the prototype interface. The occupations of the six participants who took part are described in the far left column. The ratings used were *very useful* (VU), *somewhat useful* (SU), *somewhat non-useful* (SNU) and *very non-useful* (VNU).

User occupation	*Satellite view*	*Burnt areas*	*Current fire hotspots*	*Greenness of vegetation*	*Lightning strikes*	*Location search*	*Weather data*
Backpackers' owner	VU	SU	VU	SU	SU	VU	SU
Art gallery owner	VU	SU	VU	VU	SU	VU	SU
Restaurant owner	SU	VU	VU	SU	SU	VU	SU
Indigenous art gallery worker	VU	SU	VU	SU	SU	VU	VU

Tourist /volunteer	SU	SU	VU	SU	SU	SU	SU
Local artist & tourist	SU	SU	VU	SU /SNU	SU	SU	VU
Local business worker	SU	SU	VU	SU	SU	VU	VU
Tourist centre worker	VU	SNU	VU	VU	VU	VU	VU
Tourist operator (3)	SU	VU	VU	SNU	SU	SU	SU
Two grey nomads	SU	SNU	VU	SU	SU	VU	VU
Kimberley researcher & tourist /academic	VU	SU	VU	VU	SNU /VNU	VU	SU
Grey nomad	VU	VU	VU	SU	SU	VU	VU

Some users elaborated on their ratings shown in Table 5.9, explaining why they considered these features useful or not. The analysis of this feedback, and observations made, is described below.

Aerial view of terrain (satellite view)

Like the first round of user testing and interviews, the second round also found that many people considered an aerial view of the terrain either *very useful* or *somewhat useful*. Only one user who rated features — the restaurant owner — did not consider an aerial view of the terrain to be a use-

ful feature. However, the Kimberley researcher and the tourist/academic suggested that the aerial view of the terrain lacked detail: "To be honest even with the satellite image that you have of the earth I don't think the detail is enough. I think you still need to be able to — I'm looking at what river systems you have mapped here... I think you need to be able to orientate oneself to this map pretty quickly".

Burnt areas

Burnt areas was another feature that was rated as *very useful* by most participants. In this round of testing, it was the third-highest rated feature after the fire hotspots and location search. The local artist and her tourist friend considered this to be a useful feature for users who have environmental concerns: "For eco people it would tell them what has been going on in a particular area and if someone was beginning to collate information this is exactly what they would need".

The grey nomad thought that burnt areas was a *very useful* feature but indicated that it would mean different things in different parts of the country: "Depending on the area you are going to. If you are going to a place with a high rainfall and you don't have a lot of burnt areas like Victoria, depending on the area you are going to. For us if you are going to a city you won't find too much — more so out here".

The Kimberley researcher and academic thought that burnt area data was very useful but voiced concerns about how the data layers were presented.

> The colours are not right because if you take last year's off — do this year, it is black; do last year and it's grey. The problem is that you can't see where the grey superimposes over the black in all cases... You need to be able to see all the layers at once. This is what FESA and DEC do with their sites too. You can never tell whether the same area has burnt, the way they do their maps... It goes to 2 years which is great but the

> real problem is that the colours are not right. It doesn't show the 3 levels. I think you need to be able to see the areas that have been repeatedly burnt and you can't see that. About the squares when you zoom in. It is great that you can see it as it is based on the historical data and zoomed out, but when you're looking at the current information it doesn't tell you very much when it is in squares.

The indigenous gallery worker explained that this information may be of use in ways beyond bushfire information: "I'm hoping to go and cut down trees for artefacts, so in that aspect I wouldn't want to go to a burnt area because the artefact would be damaged. Also a lot of the locals like eating goanna so that would be a perfect area for them because the goannas haven't got reeds to hide in".

Current fire hotspots

All participants who rated the features rated current fire hotspots as *very useful* and most participants were content with the information being provided. The Kimberley researcher and the academic/tourist — who both had serious environmental concerns about the impact of fires — wanted hotspots going back further than 72 hours:

> You probably need the availability of 2 weeks information on that as well, and then a direct link into history. The length of time that a fire is raging through an area also gives you much more of an indication of the incredible area that it is burning, so here you only have fires that go back to 72 hours but they may have been burning for a fortnight and so you get much more of an idea of the area that has been burnt and I think that is really significant for the sort of work that we do, because it tells you immediately that if the fire has been going for 2 weeks and it has burnt out 5,000 square kilometres and there is hardly anything left un-burnt in that area, how does biodiversity survive.

Greenness of vegetation

The tourism operator (3) was interested in greenness of vegetation from an environmental point of view, but said it would not be useful for his work: "As a lover of the land and the environment everything is incredibly important, but for me as a tourism operator, looking at a site before I go and do tours it doesn't make a difference".

The artist and tourist shared a similar view, acknowledging that it would be useful for monitoring the impact of fires on the environment, but *not very useful* for managing them: "As the fire turns the Kimberley into a desert it will be interesting to see and if it accumulates over years you will be able to see how the ecology is being affected by fire to some degree, depending on whether they can identify what the greenness means — whether it is trees, spinifex or grass".

The local business worker considered it a useful feature for knowing about conditions in the vicinity: "If you were in a valley and you've got gum trees all around you and there is a fire spreading through I guess it would be *very useful*".

Similarly, the backpackers' owner considered it useful for knowing how much fuel there is: "Depending on what time of the year it is. If we are talking about fires, about how much fuel is there for it to generate a pretty decent fire out of it, it is not going to burn as much if it is a lot greener. That depends on what time of year it is".

The grey nomad also considered that it may be a useful feature for establishing conditions on the ground: "I'm curious because I did notice driving up here a lot of things burnt out and yet there was still greenery. Certain trees and shrubs were very green yet others were very burnt".

The Kimberley researcher and academic/tourist considered it be useful information, but that it did not necessarily mean it would reflect conditions on the ground: "Areas like Tropical Rainforest Refugia would show very green versus an area of even woody weeds can be green but are not necessarily healthy. They might be native but are not good for country… It would be *very useful*

information".

Similar to the burnt areas feature, the indigenous art gallery worker mentioned that greenness of vegetation would be useful for cultural practices: "Similar to what I said about the previously burnt areas, looking at it from a cultural Aboriginal point of view. We often chuck a lot of people in the car and go looking for bush turkey or goanna, so greenness wouldn't be a perfect spot to go".

Lightning strikes

The art gallery owner considered lightning information to be *somewhat useful* and pointed out that Kununurra receives more lightning than anywhere else in the country: "There are the most lightning strikes in Australia recorded here in Kununurra".

The backpackers' owner said that it was not a useful feature and that not much could be done about lightning:

> There is not much we can do about lightning strikes unless there is an immediate threat with a fire that it may create. I've never searched a lightning strike before. Unless it's created a fire and you could be in harm's way of the fire itself — you can't predict where it is going to be and what it is going to do.

The Kimberley researcher and academic/tourist considered the currently available lightning information to be insufficient:

> I would use lightning strike information but what is available at the moment is *somewhat non-useful*, bordering on *very non-useful* because there is insufficient information. Most fires at this time of the year are not caused by lightning strikes but when they are, they're likely to burn longer than a day or two. If you are not aware of a fire, whether it is an incendiary burn or whatever, it may be two or three days before it gets to your area. You may not necessarily be aware of it at the time but if you want

> to track it you need to go back to where it was burnt, how it started... you also need a history. The same as with the burnt areas. You need more of a history with lightning strikes... For me to use something like that, particularly with the work I'm doing, I would need a lot more history. I would like to be able to track how many lightning strikes — where and when, over a period of at least a decade... I would still want to have at least a week and up to 2 weeks' worth of information. That would be the absolute minimum. Also with a link to the history, even if it can't be brought up on here, but a link under the lightning strike section — a direct link to where the information is.

Location search

Location search rated very highly as a feature with the second round of participants. The only participants to offer detailed feedback about the location search were the Kimberley researcher and the academic/tourist. They considered location search to be *very useful*, but thought it would be better if it included the names of pastoral stations and indigenous communities.

> The locations I would be interested in is the Bungle Bungles because that's what affects us... I think what would be interesting for the location search would be to have the major Aboriginal communities... all of these Aboriginal communities where the burning is starting from because then we can potentially track... I think the station names should actually be on there because we are talking huge tracts of land for a station, and if people are going to be looking at this and there is a fire around Nicholson, they will put in Nicholson — they are not going to put Kununurra... A lot of people would know the latitude and longitude but you'd have to go to a map. Most people would be working on a GPS reading. That's what we work on, not lati-

> tude/longitude... An added feature of GPS readings would be very useful. It is useful — but needs more information about Aboriginal communities and stations — particularly communities.

While working with GPS readings was beyond the scope of the functionality of FireWatch, the prototype at this point included HTML 5 location detection (Lawson & Sharp, 2011).

Weather data

Weather information was considered *somewhat useful* or *very useful* by all of the participants who rated features. The weather layer of the prototype — which featured wind direction and speed, temperature and humidity — seemed to meet the needs of participants. The tourist operator (3) said that all of the useful information relating to fire was in the prototype: The fundamentals that make fires go [are in there] — humidity, heat, wind. The Kimberley researcher and the academic/tourist considered humidity to be useful information in the context of fires:

> It is quite [useful] knowing what the humidity is, because the higher the humidity the less intense are the burns. Just from knowing that information... if there is higher humidity in the atmosphere and it is less dry it gives me an idea of the intensity of the burns but apart from that... It is interesting for me to see that where we have lower humidity we've got some really hot burns... some recent burns. They are very hot burns.

Other features requested

In the second round of user participation, there were a handful of requests for additional features. The two grey nomads wanted to know where it was likely that they would receive phone reception:

It would be great to know where you could get communication like 3G or Telstra — if that could be noted on there you would know where you were heading where there would be communication.

The indigenous art gallery worker mentioned that prior warnings would be useful:

> There are a lot of homelands and communities around here. I go to the border and there is another artist just before there. The country around that area is too grassy and it is all dry and dead. Especially for people in those places, some kind of prior warning. I know it would cost a lot of money but to make a note of someone driving past and saying there is a fire over here.

This type of service would be beyond the scope of FireWatch, but may be something that the local communities could consider implementing. The local business worker mentioned wanting to know water sources: "The other thing I would like to know is if there is water nearby (natural sources, dams, swimming pools, rivers, tributaries)".

Many of these are shown on the Google Maps layer, but swimming pools are not, although some may be visible on the satellite view layer. She also mentioned: "The other thing I'd like to know is clearings. If you are in a bushy area, [I would want to know about] a clearing that you could get to".

This is an application where the greenness of vegetation information may be able to assist.

General comments about the interface

Generally, participants found the interface easy to understand and use, and it seemed that most participants were interested in using it. Some participants, such as the art gallery owner, only gave brief feedback when asked whether it was too complex ("No, I like it"), if it was easy to use and if they would be a frequent user. The grey nomad said: "I think it is very interesting. They are doing a very good job". Other participants provided very detailed feedback and descriptions of how they envisaged using the site. The backpackers' owner said: "I'm not that great with computers and don't

have one of these [smart] phones but it seems pretty simple to me. Obviously I can use it but I don't feel that it's really that hard to use or to get around the website".

He also considered the information provided by FireWatch to be valuable:

> I think the more the awareness the better. With that tragic thing that happened out on the Gibb, that was really bad. I've seen the devastation of fires. I'm in a volunteer fire brigade in our area. For the farmers to lose their livelihood — insurance is there but still to see someone's crop or sheds or anything getting burnt down is not the greatest thing to see happen… I think it will be good to give everyone a bit more information. It might prevent a few fatalities or bad injuries.

The local business worker suggested that a simple interface was ideal: " I think the simpler it is the better. If you make it too complex people will just go, not really".

When asked if she considered the interface easy to learn, she answered: "Yes, I can see what it does and I am not a computer person". When asked if the interface was too complex, the tourist/local volunteer said: "I don't think so. I think it is user friendly… even to somebody like myself". He also mentioned that he would feel confident using it and explained how he envisaged using it: " What I would see us doing when we leave to come up each year, [is] having a look at this… I could see it being helpful because when we leave we always like to see if there are any obstacles ahead of us".

The tourist centre worker indicated that it would be useful in Kununurra, but not in other areas:

> If there was a fire around and I was interested in it I would [use the site]. Possibly I'd check up here if fires were burning. Normally if you were somewhere else I don't know that you would use it particularly often. Definitely people up here with land holdings would use it all the time. If I was out driving and I saw a fire I'd use it at that time.

The tourist centre worker had also viewed the NAFI website: “We’ve used it quite extensively. My partner was in fire fighting — emergency services in Central Australia and I’ve seen him using it, watching fires at Kings Canyon, around Alice Springs”.

The restaurant owner also found the interface simple: “I think it is quite easy to understand and to learn”. He also said he would be a frequent user of the site, but only if he was travelling: “If I am travelling yes, but otherwise probably not”. The local artist also considered the interface to be easy to use and would be interested in the information provided despite not being a frequent user:

> It looks easy to manage. I could even manage that and I am a computer dummy... it is easy to access. I wouldn’t be a frequent user but I would be very interested to look and see what has happened over a season. If I was planning to drive somewhere to walk up a gorge I could start to see that I could use it more frequently than I was initially thinking.

The tourist operator (3) could also see a use for the website: “I’d be a user. I’m not a very frequent website user unless I need something. As soon as the fires start burning around here we’d certainly use it”.

This tourist operator also had some experience with the NAFI website:

> It is interesting. I’m not a regular and not a very good user of it. I’ve looked at it and I’ve got friends who use it a lot and when they’ve got it up I’ll look at it... It is very visually impressive and when you look at the Kimberley land mass at the end of any given dry season it is incredibly impressive but it’s all flames.

Aside from the tourist operator (3) and the tourism centre worker, no other participants had used or heard of FireWatch, NAFI or Sentinel. The indigenous art gallery worker could see FireWatch being useful for planning trips out to country: “I could be [a frequent user of the site] because there are a lot of trips here for the artists. I would check if they were going out bush that everything is

fine, that there are no outbreaks. They go all over the place, up to 70 or 80kms from town to get inspiration for their art".

The local business owner/farmer indicated that in his situation, the information being provided was not useful, although he could see a use for it in other areas of Western Australia:

> Over all the state I can see this thing working but up here in the north, there might be somebody. But I'm here, I've been out bush, I go out metal detecting. Even if there was a fire there... The other day I went down here and went into there [pointing to areas in the Kimberley]. If there was a fire anywhere in there it wouldn't faze me one bit. To the people up here in the north there is fire all the time. You don't worry about it.

The Kimberley researcher and the academic/tourist found that this version of FireWatch did not have enough historical information to meet their needs: "I think it needs to have more options... a history essentially... The same as with the burnt areas. You need more of a history with lightning strikes... For me to use something like that, particularly with the work I'm doing, I would need a lot more history".

It is likely that these researchers required a lot more historical information compared to other users due to their interest in the long-term ecological effects of fire in the Kimberley.

Devices used to access the internet

Similar to the first round of user participation, many of the participants had access to smart phone and tablet devices. Out of the ten participants who took part in the user testing and interviews, four users had Android phones, two users had iPhones and one participant had an iPad.

Community communications, social media and user-sourced data

Asking participants about how they would likely hear about a service such as FireWatch suggested that although many people used social media, traditional media and "word of mouth" were still significant forms of communication in Kununurra. Several participants had Facebook profiles for themselves, their businesses or both. No one interviewed used Twitter. When asked about how she would hear about something like FireWatch, the art gallery owner answered: "It would be word of mouth, Tourism Centre, Chamber of Commerce. The police send out a monthly newsletter and they would include something like this".

When asked about her presence on social media, she stated that she used: " Facebook — [for the] business and personal". The tourist operator (3) did not use social media, but his business did have a Facebook page. The tourism centre worker used Facebook for the centre and also had a personal profile. She stated that: "Social media in this town is pretty strong. There is a community page on Facebook that everyone puts everything on. If there were fires around, I'm sure people would promote the fact that you can go onto that website. So definitely social media and also word of mouth".

The local business worker had a personal Facebook profile, as did the business she worked for. The tourist/volunteer was not personally on Facebook but mentioned that his wife used it. He also mentioned the importance of radio, television and the internet generally: "We constantly listen to ABC radio. We watch the TV regional programs and we use our computer to keep in touch with things".

The backpackers' owner did not personally use Facebook, but the backpackers' business itself had its own profile. He also said that he would likely hear about a service like FireWatch through word of mouth: "For me probably word of mouth because I'm not on the computer all the time". The artist and tourist also considered both social media and traditional media as playing a role in communications, despite neither of them being on social media personally:

> It would have to be advertised, I don't know where. All the normal places that people look. It would have to be 'Googleable'... social media is one way, and the young ones will tell the oldies. There are remote communities so information centres. You would need a poster of some kind to put up in information centres and visitors centres. And maybe tourism locations, caravan parks and places like that.

These comments from participants demonstrated that although many businesses and individuals in Kununurra have a Facebook presence, traditional media in the region cannot be ignored as valuable methods of communications. Due to time constraints, only seven participants were asked about whether they would be interested in the idea of reporting fires through the redesigned FireWatch interface. Generally, amongst the seven participants asked, there was significant support for this feature: only two of the participants — the art gallery worker and the restaurant owner — did not think they were the right people to provide the information. One tourist operator (3) was interested in this feature but hadn't considered the possibility of this type of feature: "It's not something I've thought about, but possibly". The tourism centre worker simply stated: "Yes, I think that would be good". The tourist — who also volunteered at a local art gallery — stated that he would like to have the option of reporting fires:

> Yes, if I saw one I would like to be able to do that. Up here, generally by the time you see one it's quite often been... the other day I opened the gallery door and could see black billowing clouds, but I knew they would be on to it.
>
> Driving in an area where there was fire on either side of the road was scary, so I think that anybody reporting something that's of help, getting it to somebody responsible and today the computer is the best way of doing that.

The local business worker thought that it would be helpful to others: "Yes, if you knew it was there and it was helping other people, why not?". The backpacker owner also saw this as being use-

ful and saw the benefit of reporting fires that appeared to be a threat: "If there was something to do with an immediate threat I would definitely be contacting someone to let them know that there was a fire".

The tourist — who was interviewed with the local artist — thought this was a useful feature, but noted that some sort of verification process would be required to prevent duplicates of the same fire: "It makes sense to be able to report the fires. Providing there is a way to reduce multiple reports of the same fire — then it seems like different fires".

5.9.2 Summary of the findings

Simplicity as a design goal

The approach to simplicity undertaken — as explained in the previous chapter — was clearly a successful way of increasing ease of use. Maeda's approach to simplicity — that the "easiest way to simplify a system is to remove functionality" (2006, p. 1) — is clearly appropriate when providing information that needs to be accessed quickly and easily. Ease of use is crucial in a potential emergency situation (Lanfranchi & Ireson, 2009; Rauschert et al., 2002; Wu, 2008). Maeda's *thoughtful reduction* — "When in doubt, just remove. But be careful of what you remove" (2006, p. 1) — is also worth bearing in mind here: as a designer, care needs to be taken in deciding what to remove. As shown by the analysis here, user participation has a significant role to play when trying to achieve a balance between usability and adequate functionality.

Satellite imagery can assist in users orientating themselves

Participants used the map layer to orientate themselves to a certain zoom level (in the above analysis, to the general Kimberley area), then switched to the aerial view of the terrain. This suggests that whether people prefer real or abstract imagery is highly dependent on context, despite abstract im-

agery generally being better at conveying meaning (Medley, 2013, p. 85). John Grimwade's statement that a schematic representation is "much easier to understand" (Errea, 2003, p. 17) generally seemed to apply to the data layers, but it was clear that the photographic realism provided by the aerial view of the terrain allowed participants to identify key landmarks. Photography is an effective means of providing a realistic portrayal of the environment and its specific elements (Heller & Pomeroy, 1997, p. 46; Medley, 2013, p. 85), which may explain its usefulness in allowing users to orientate themselves to specific landmarks. Providing both the map view, as well as an aerial view of the terrain will enable users to navigate at all zoom levels, using either place names or a detailed photographic view of the terrain to find points of interest.

Users' internet usage

Broadband is considered the most common internet connection in Kununurra (Kimberley Development Commission, 2014). Although it may seem that Marcotte's (2011, p. 111) view of "mobile first" may not be appropriate in this circumstance, it is clear that responsive design allows a designer to consider all devices being catered for by the one interface. Many participants used mobile and tablet devices through a 3G network and the usage of these devices is increasing in Australia (ACMA, 2013a). In this regard, the use of responsive design can be considered a way of catering for devices and screen resolutions that may not be commonplace currently. At this stage, further work needed to be done in order to further optimise the interface for mobile and tablet devices, with Maeda's approach of thoughtful reduction (2006) and Marcotte's "mobile first" (2011) approach influencing the design decisions.

Publicly accessible bushfire information

There was clearly an interest from participants in communities having access to this information. The information is already publicly available on the web (Geoscience Australia, 2011; Landgate, 2012; Tropical Savannas CRC, 2012) and this should be made easily accessible to people in regional and remote communities, particularly as it may be used in an emergency situation (Lanfranchi & Ireson, 2009; Wu, 2008). Recommendation 1 from the Victorian Bushfires Commission (2010, p. 12) is to revise bushfire safety policy including i) enhancing the role of warnings and vi) ensuring that local solutions are tailored and known to communities through local bushfire planning. Participants also found uses for the information beyond bushfire planning, something that was an unexpected outcome. Given that members of the public can find unanticipated uses for this type of information strengthens the argument for making it publicly available and easy to use.

Social media usage

Social media usage — Facebook specifically — was common amongst participants in Kununurra, with both businesses and individuals using it to communicate and share information. This usage reflects the popularity of social media and Facebook specifically within Australia (Sensis, 2014). Despite several participants using Facebook, many people in Kununurra are still reliant on traditional media. If organisations that provide bushfire information wish to increase the usage and awareness of these services within remote and regional Australian communities, it will be necessary for them to utilise both social media and traditional media.

Rhetoric in interaction design

Rhetorical affects were difficult to gauge. Nevertheless, it is possible that considering the rhetorical affects at the design stage did indeed have an impact on participants. As Schneller stated, "design al-

ways tries to influence or persuade its audience" (Schneller, 2010, p. 259). In that sense, the approach to simplicity taken did influence the participants, as many stated that it provided enough useful information and that it was easy to use. Participants also explored the map functionality without being prompted to do so, suggesting that the decision to make this clearly the most prominent feature did influence the actions of participants. More work needs to be done to consider how to better capture rhetorical affects in interaction design.

Card sorting system

As a research instrument for determining the usefulness of an interface's features, the interpretation of the *Experience of Change* instrument (Ainscow et al., 1994) used here proved to be fruitful. It provided quantitative data on how useful the seven core features of FireWatch were, as well as providing rich, detailed descriptions of how participants envisaged using the features. It also provided a mechanism for participants to suggest additional functionality and provided a focal point to the discussions (Clarkson, 2002), keeping the participant engaged with the features of FireWatch. The rich information provided by participants, as well as being able to quantify the usefulness of key features, means that this interpretation of the research instrument can assist in providing users with a more satisfying user experience (Hassenzahl, 2004a).

Creating a satisfying user experience

As stated by Hassenzahl (2004a, p. 47), a "usable and useful product may lead to satisfaction if a valued goal is achieved in a particular situation". Focusing on usefulness and usability is an effective way of increasing the chance of providing the user with a satisfying experience. Given that most participants gave positive feedback and said that they would like to use the website — or at least saw that there was a need for it, it is likely that focusing on usefulness and usability is a way of facilitating

a satisfying user experience.

Evolution of the user's role

As discussed in the previous chapter, the traditional view of users in HCI as being "experts in their field" (Carroll, 1997, p. 69) seems out-dated in light of the types of users encountered in the work explained in this research. Cooper et al (2014, p. 41) pointed out that users can range from complete beginners to experts, with the majority being at an intermediate level, which was true of the users encountered in Kununurra — they were more tech-savvy than previously assumed. Other literature that discusses the use of bushfire information sharing in communities refers to the users as "ordinary residents" (Akama et al., 2013). The new users of FireWatch cannot be considered experts because the information being presented to them was something that the majority of users did not have experience with. Holmlid, in discussing how participatory design can inform service design, stated that "the users involved are not regarded as experts on utility of technology" (2009, p. 7) and that has been a strength of participatory design. Service design addresses these users by involving them in the design process, which allows them to become familiar with the technology, while also allowing the designer to understand the user's contexts and abilities (Holmlid, 2009). This mutual learning is seen as a "strength for innovativeness" (Holmlid, 2009, p. 7). This inclusive and holistic approach of service design means that interaction design can go beyond HCI's narrow view of what a "user" is (Forlizzi & Zimmerman, 2013, p. 10). This is one of the reasons that Forlizzi and Zimmerman recommended service design as a core practice in interaction design (2013). Borrowing Akama et al's (2013) adjective of "ordinary" to describe users seems appropriate in the context of this research, where users were not experts, but were still more "tech-savvy" than previously assumed.

Unintended uses of FireWatch information

The work here uncovered unintended uses of the information provided by FireWatch. It is fair to say that Landgate had never envisaged that the burnt area data and greenness imagery would be used by indigenous communities for planning hunting treks and collection of native materials for creating cultural artefacts. Similarly, the Tourist Operator (2) from the first round of interviews was interested in burnt area information as a way of protecting his campsites. His campsites were in remote areas, so using the burnt area information was one way of increasing the likelihood of avoiding them being burnt. As stated by Forlizzi and Zimmerman, interaction design "has a tradition of pushing new technical systems into the world and waiting to see how users appropriate this technology and invent entirely new uses for it" (2013, p. 10). That was clearly the case with this unanticipated outcome.

5.9.3 Discussion

Research questions

The findings from the two iterations of the design process discussed in this chapter answered the following research questions.

(1) How can FireWatch be redesigned to incorporate global best practice and modern principles of dynamic information design to develop a more usable and intuitive version for members of the wider community?

Responsive design (Marcotte, 2011) provides a means of catering for users with mobile and tablet devices, as well as desktop devices. Due to a number of participants in Kununurra using mobile and tablet devices — and the Australian community generally having a high rate of mobile use (ACMA, 2013a) — responsive design is an effective way of ensuring that this content is accessible to the ma-

jority of users.

Simplicity, as advocated by Maeda (2006), clearly has a role to play when presenting information that may be used in an emergency situation (Lanfranchi & Ireson, 2009; Wu, 2008). Maeda's approach of *thoughtful reduction* (2006, p. 1) is an effective way to approach a reduction in functionality — if there is doubt that something is useful, then remove it, but care needs to be taken in considering what gets removed. As suggested by Norman (2008), a more refined approach is needed than removing purely for the sake of simplicity. Direct input from users is clearly useful for establishing what functionality is required.

Visual rhetoric may also be something that designers should be considerate of, but its impact on the user is difficult to gauge. Further investigation is required in this area.

(2) What kinds of user input are required for effective revision of the FireWatch service?
Although the work done on scenario-based design explained in the previous chapter led to the development of a working prototype that met the needs of the majority of participants in the first round of user participation, the benefits of directly engaging with participants are evident in this chapter. While the previous chapter demonstrated the role that scenarios and personas can play in the absence of participation from actual community-based users (Grudin & Pruitt, 2002; Rosson & Carroll, 2002), the depth of feedback received in the two stages of user participation proved fruitful. It also seems that focusing on both usefulness and usability in user testing can enhance the chances of providing a positive user experience (Hassenzahl, 2004a). However, it is necessary to work closely with the service provider in order to determine the possibilities of what the service itself is capable of delivering (Zimmerman, 2011).

Additionally, how the user is considered in interaction design has evolved beyond how HCI has traditionally considered the user (Carroll, 1997). Service design helps interaction design to "move past the... simplistic concept of 'user'" (Forlizzi & Zimmerman, 2010, p. 10) and this is one of the

reasons it is gaining traction as a key practice in interaction design. Determining which features are important to the target audience of an interface is a key trait of user experience design (Roto et al, 2011, p. 11). Although the results discussed in this chapter suggested that the interface was usable and provided enough utility for participants to find it useful, these community-based users still had a variety of concerns over the impact of bushfires in their community. Community-level communications, particularly word-of-mouth and local radio, were still significant aspects of information sharing: something that the prototype interface did not address. Ways that the interface can facilitate this complex community-level of communicating needs to be explored through more user engagement, as this could further enhance the user experience provided and bring about other ways that communications issues can be addressed, enhanced and explored. That users have the ability to offer researchers valuable but complex insights shows that considering the entire socio-technical context of a service is a crucial part of design research.

(3) How should the information system interface adapt to accommodate increasingly dangerous situations while providing required information for different user groups?

With the exception of the Kimberley researcher and the tourist/academic, generally the prototype interface provided adequate functionality for most participants. It is likely, due to their interest in monitoring the long-term environmental effects of fire, that these two users had needs for historical information far beyond that of other users in the community. These participants may be better served by the more technically-focused version of FireWatch known as FireWatch Pro, which at this stage was undergoing development separate to the interface described here. In essence, the answer to this question is that users in the community will likely have adequate information provided to them by the new version for community-based users, while users that need longer-term data, such as researchers or emergency services personnel require more functionality and long-term historical data.

(4) What relationship exists between the visual characteristics of an information source and its credibility or authority?

This question was answered in the literature review, where guidelines from Fogg (2003), Kidawara (2008), Ahmad et al (2010), Tanaka et al (2010) and Sundar (2008) revealed how to address credibility and authority in an interface. This literature then informed the guidelines that were introduced prior to the commencement of the design (Table 3.5). Generally participants did not question the validity of the information that they were presented with. Although it was hard to determine why this was, it is likely that the guidelines discussed in the literature review for building trust and credibility — such as having a professional looking design that is easy to navigate and use, with information from a known source (Fogg, 2003, p. 154) — did play a role. However, it is worth pointing out that once participants were aware that the hotspot information was derived from satellites, they did not appear to show any doubts as to the credibility of the information. It is expected by members of the public that authorities deliver useful information (Fogg, 2003, p. 111) and in this sense, the FireWatch prototype seemed to meet the majority of participants' expectations.

(5) How can we engage with communities to increase an awareness of the FireWatch website?

There was significant usage of social media amongst both individuals and business in Kununurra, with Facebook being the preferred platform. However, it was also clear that traditional media also had a significant role to play in "spreading the word" about services such as FireWatch throughout the community. Radio, television and newspapers were mentioned as significant media to participants, as was general word of mouth. How to harness this information and use it to build and increase awareness — and whether it was feasible for Landgate to do so, as the service provider — was determined at a later stage.

(6) What role can digital communication technologies play in building and increasing awareness of the FireWatch website?

It is clear that due to the high amount of social media use — Facebook specifically — in Kununurra, digital communications could indeed play a role in building and increasing awareness of the FireWatch service in remote and rural communities. It is possible that going by recent trends in Australia (Sensis, 2014), that social media usage may increase further, so using it as a means of increasing awareness of FireWatch is something that Landgate, as the service provider, needs to consider.

5.10 Conclusion

This chapter examined the research instruments and processes undertaken during two rounds of user participation in Kununurra. These two iterations resulted in a vast amount of rich data from several participants representing a broad, but strategically selected, cross-section of the Kununurra community. Analysis showed that for the most part, the decision to remove many of the options in the previous expert-user version of FireWatch still left enough functionality in the prototype interface for these community-based users. The feedback from participants indicated that these community-based users were more "tech-savvy" than assumed, with the majority using smart phones and tablet devices in addition to desktop computers. It was also revealed that at certain zoom levels, participants preferred a satellite view of the terrain for identifying key points of interest in the landscape. The feedback also unveiled some unexpected outcomes, where users were finding unanticipated uses for the information provided by FireWatch.

The next chapter discusses the final iteration of the design process. During this period, the service provider, Landgate, was presented with the feedback from the two rounds of user participation discussed in this chapter. In the final iteration of the design process, it was necessary to work closely with Landgate's development team in order to determine which services could be provided and how. This period resulted in the launch of a new version of FireWatch aimed to meet the needs of community-based, non-technical users, known as MyFireWatch. An online questionnaire was

also launched at the same time as MyFireWatch as a way of further measuring usability of the interface. This questionnaire also attempted to address the lack of awareness of the FireWatch service and whether users would be interested in contributing content.

6

Final stages of the redesign process

6.1 Introduction

The previous chapter discussed two iterations of the design process, which involved direct engagement with community-based users in the Kununurra area. It explained how the scenario-based design work undertaken informed the recruitment of actual community-based users. It also discussed the process of engaging with these participants through

the card sorting, user testing and semi-structured interview research instruments. How this user engagement influenced the planning and design stages was also described. The direct engagement with participants meant that they were able to learn more about the possibilities and limitations of the technology while also allowing the research to be informed of the social and cultural context in which it would be used. The findings from this stage of the redesign process were discussed, and how these findings were relevant to the research questions posed in the introduction chapter.

Significant findings from the two design iterations explained in the previous chapter included users' preference for a satellite view of the terrain for orientating themselves at close zoom levels, a higher than expected number of participants with mobile and tablet devices, as well as an interest in contributing fire information to the application. Another significant and unanticipated outcome was that the information provided by the redesigned interface could have unintended uses, specifically those related to an indigenous community's cultural practices. Feedback from the participants was generally positive, with the majority of them finding the interface easy to use. Additionally, there were few requests for features in addition to the functionality that the redesigned interface provided.

This chapter discusses the final round of the iterative design process described in the research design. Firstly, it was necessary to incorporate the input from actual community-based users into the design itself. Secondly, it was necessary to work closely with Landgate in the planning stage as a decision had been made to implement the prototype as a real publicly accessible web application, known as MyFireWatch. The input from the two key stakeholder groups — community-based users and Landgate — informed a set of functional and non-functional requirements that were addressed in this design iteration. In the final exploring stage, it was not possible to engage with actual community users in-person. Consequently an online questionnaire was used to gain feedback on the live web application. In the final reflecting stage, data from the online questionnaire is reflected on. The data from the questionnaire suggested that the final version of MyFireWatch provided adequate

usability for the majority of users and there were only few suggestions for additional features. The questionnaire revealed that social media is a significant form of communication, but as was the case in Kununurra, traditional media such as radio, TV, newspapers and even word of mouth were still significant forms of communication. In contrast to the second round of user testing and interviews in Kununurra, there were mixed opinions about the possibility of providing functionality for user-sourced fire information.

Structurally, this chapter contains the planning, prototyping and designing, exploring and reflecting stages of the final iteration of the design process. It discusses how feedback from community-based users from the previous chapter, along with feedback from Landgate, influenced the final iteration of the design. It also discusses the final data collection in the exploring stage, which utilised an online questionnaire focused on usability. The final data collected was then analysed in the reflecting stage, with comparisons to the analysis of data collected in the previous chapter. The data collected suggested that overall, the MyFireWatch interface was considered usable by the majority of participants.

6.2 Planning: the final round of user engagement

This planning stage followed on from the second reflecting stage of the previous chapter. This planning stage actually occurred in two parts. In the first, analysis from the feedback given by community-based users in the previous iteration informed the creation of a set of requirements, which then informed the next iteration of design. In the second part of the planning stage, there was a set of requirements that arose from Landgate's input into the design process. Since there was a commitment from Landgate to make the prototype interface a live web application known as MyFireWatch, there were several issues that the interface needed to address. It was necessary to address some design aspects to ensure that it adhered to decisions that Landgate had made internally, as well as matching

— to some degree — the aesthetics of the FireWatch Pro interface (Landgate, 2014b).

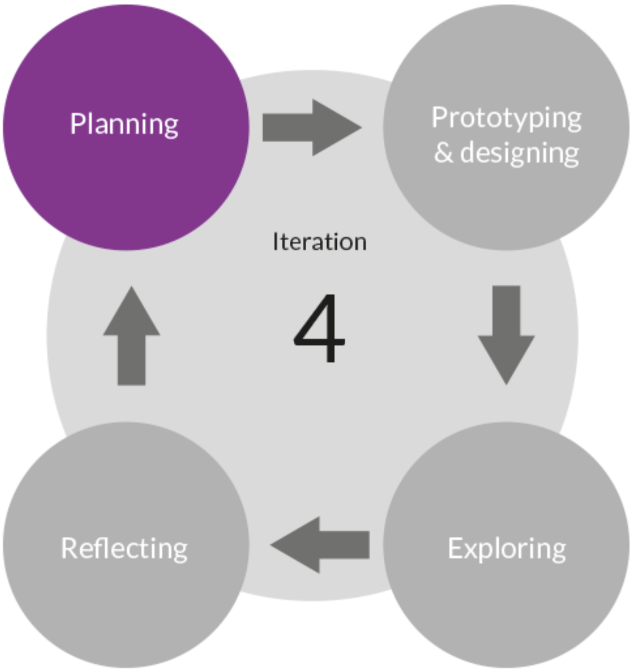

Figure 6.1: The planning stage of the fourth iteration of the design process.The work discussed in this section was the planning that occurred before the final changes to the design. This included considering feedback from community-based users from the previous chapter and considering how this could be applied to the next stage of the design. This planning stage involved addressing feedback from community-based users from Kununurra, as well as requests from Landgate themselves.

The following section shows how feedback from the participants in the previous design iteration was considered in this iteration of the design process. These considerations, like the previous two chapters address design issues in the form of functional requirements, data requirements and other requirements (Cooper et al., 2014, p. 122).

Functional requirements

1. Greater focus to be given to the mobile and tablet interface, as both rounds of user participation indicated that use of these devices was prevalent in the community. This will require testing on a variety of mobile and tablet devices

Data requirements

1. Greenness of vegetation to be added using imagery derived from NDVI data (Liang, 2005) The feature showing longitude and latitude of the mouse cursor is to be removed, as this was superfluous on mobile and tablet devices and most participants did not know the coordinates of relevant landmarks
2. Add a button for user feedback, in anticipation of further user input through an online questionnaire

Other requirements

1. The top navigation bar to be made darker to draw attention to the other pages. This will make the main menu more readable on mobile and tablet devices, as well as making it consistent with Landgate's new versions of FireWatch Beta and Aurora
2. The search button and search bar to be made more prominent, as many participants generally overlooked the search functionality in both rounds of user testing

Feedback regarding social media and giving users the option to submit content was not addressed at this stage, as these were considered beyond the capacity of the services delivery team. It is worth pointing out that the functionality of linking to Tweets or alerts related to specific fire hotspots was raised at this point (i.e., so that specific hotspots would link to relevant Tweets from emergency

organisations). However, the Tweets and alerts provided by DFES and other emergency organisations in Australia did not contain "geo-tagged" data (that is, latitude and longitude information), meaning that it was not possible to implement this functionality. Instead, it was decided that a link should be added to all hotspot popups that said "View current alerts".

In the second part of the planning stage, it was necessary to address certain aspects of the design to ensure that it met several requirements from Landgate themselves. These were expressed as functional, data and other requirements (Cooper et al., 2014, p. 122).

Functional requirements

1. Add links to alerts page on the popup boxes for each of the fire hotspots
2. Add links to FireWatch Pro on all pages aside from the map, so that advanced users can access a version of FireWatch that provides more layer options and historical data

Data requirements

1. Provide current alerts from DFES WA on the Alerts page, along with alerts from other states and territories, where available

Other requirements

1. Add both the Landgate and the new FireWatch logo to the design so that there is visual consistency between the new public access version of FireWatch and the other new versions of FireWatch that Landgate launched around the same time that this final design iteration began
2. Terms and conditions page to describe the capabilities and limitations of the satellite data. Providing this information will add to the credibility and authority of the information being

provided

3. Minor changes to the aesthetics of the map hotspots and layer navigation

The FireWatch Pro website, which was built to meet the needs of emergency services personnel, and serve as a replacement to the previous version of FireWatch aimed at expert users, launched in late 2013. Aurora, which was a subscriber-only service, also launched at this time. As there was now a suite of FireWatch products, it was necessary to accommodate some aesthetic changes to the prototype interface to make it consistent with the other products. Screenshots of the new FireWatch portal, along with FireWatch Pro, are shown in Figures 6.2 and 6.3.

Figure 6.2: The home page for FireWatch Pro (Landgate, 2014b). This version of FireWatch is intended for advanced users, particularly those that work in emergency services organisations. FireWatch Pro was launched prior to MyFireWatch, but they were considered to be part of the same suite of bushfire information applications provided by Landgate. Therefore, Landgate considered it necessary that the aesthetics of MyFireWatch needed to match those of FireWatch Pro.

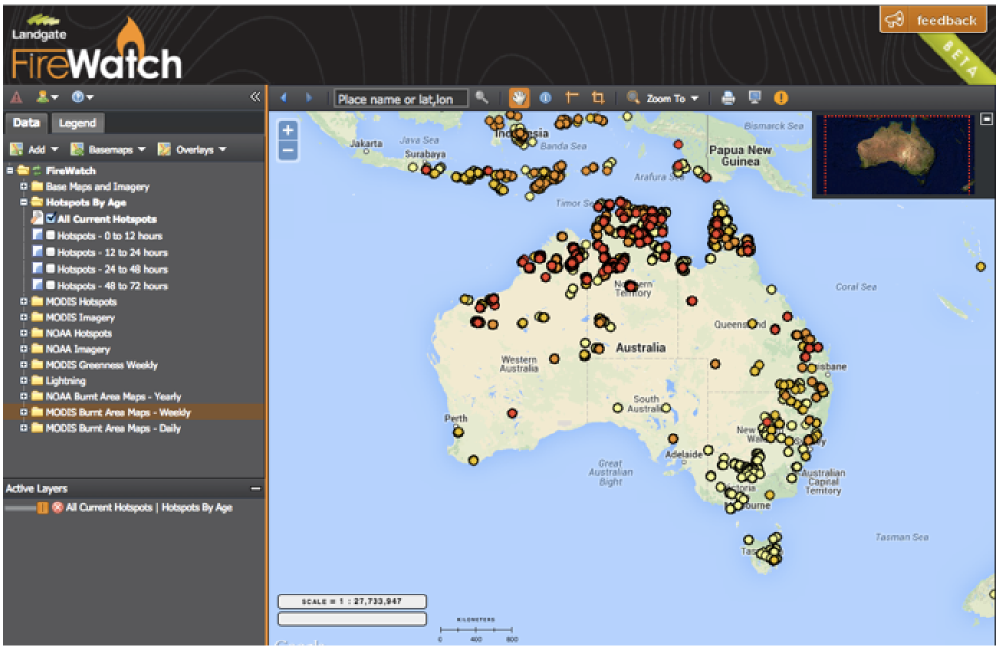

Figure 6.3: FireWatch Pro's main screen. This version of FireWatch launched prior to MyFireWatch (Landgate, 2014c). FireWatch Pro is aimed at expert users who require detailed information and more historical data. It contains several datasets, which are accessed through the menu on the left of the screen. FireWatch Pro and MyFireWatch are considered to be part of the same suite of bushfire information services produced by Landgate.

6.3 Prototyping and Design: final iteration of the design

This final prototyping and designing stage involved addressing the input into the design process from the two key stakeholder groups: community-based users and the service provider Landgate. This input is discussed in the previous *planning* section and led to the creation of two sets of functional, data and other requirements. The specific requirements were addressed under the functional, data and other requirements explained in the previous planning stage. As there was a gap of several months between input from community-based users and input from the service provider, the design occurred in two parts.

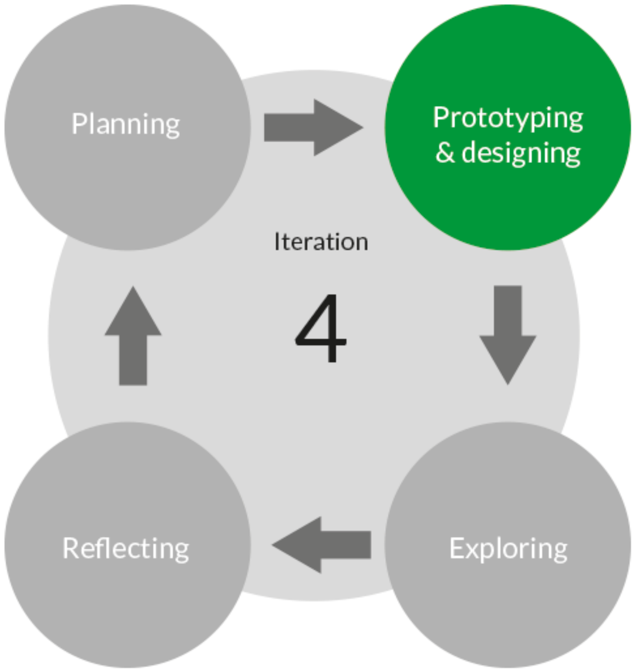

Figure 6.4: The prototyping and designing stage of the final design iteration. After discussing input from community-based users with the service provider Landgate, and discussing changes that Landgate themselves also required, the design was refined to accommodate input from these two key stakeholder groups. This occurred in two parts: first addressing input from the users, then addressing the feedback from the service provider Landgate.

Figures 6.5 and 6.6 show how the functional, data and other requirements based on input from community-based users was addressed in the fourth design iteration. The first figure shows the interface running on a desktop computer. The second shows the interface running on a smart phone. Notably a layer showing greenness of vegetation was added. The top navigation was also changed to create consistency between the desktop and mobile/tablet version.

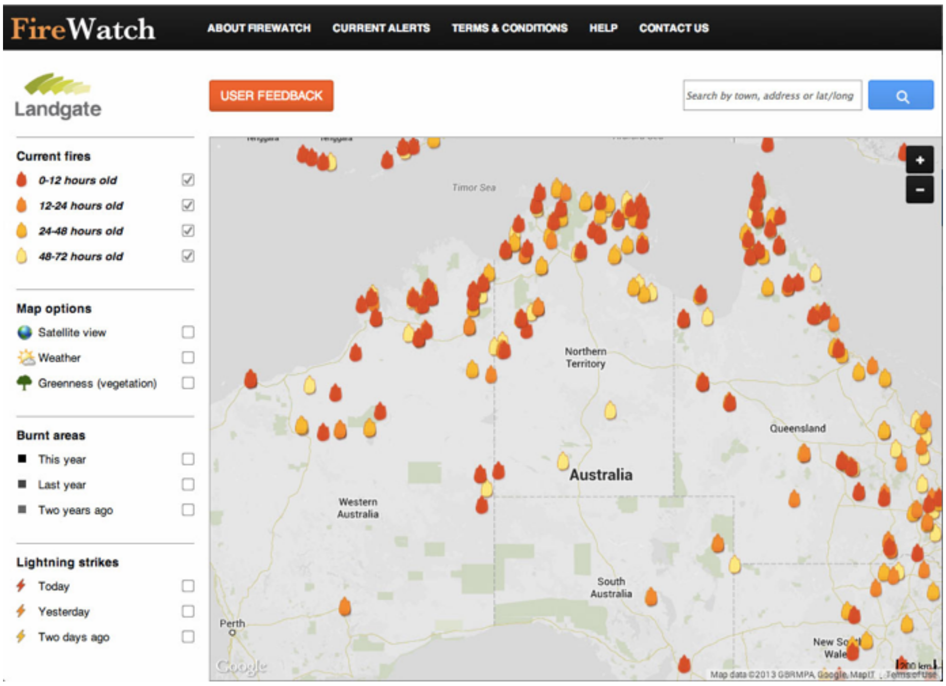

Figure 6.5: The desktop version of the interface after addressing input from the second round of user participation. Notably the search functionality was made more prominent and a layer showing greenness of vegetation was added. The top navigation was also changed to create consistency between the desktop and mobile/tablet version. Minor changes were also made to the aesthetics of the hotspot markers and the layer navigation on the left.

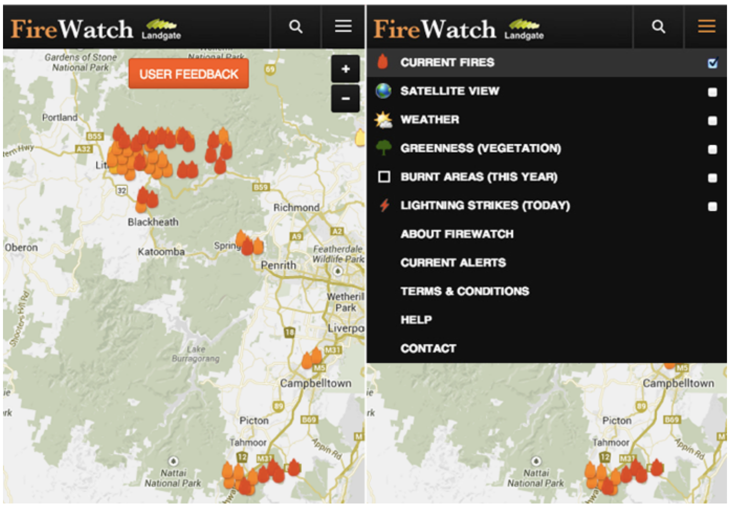

Figure 6.6: The mobile and tablet version of the interface after the second round of user participation. On the left side is the default screen. On the right is the interface with the menu displayed, which is accessed via a button in the top right corner. The mobile and tablet version has less options than the desktop version but still offers the same features.

Figures 6.7, 6.8 and 6.9 show the final iteration of the design that became the publicly accessible web application. This final iteration was based on the second functional, data and other requirements addressed in the planning stage as a result of input from the service provider Landgate. The changes made at this stage included adding the new FireWatch logo to match the logo used on other versions of FireWatch. The "My" was added to both the logo and the URL so as to differentiate it from the products that Landgate provided for expert users. From this point on, the redesigned public access site was referred to as "MyFireWatch". Other alterations at this point were relatively minor. The *About* page's title was changed to "About MyFireWatch". Additionally, the "User feedback" button was moved to sit on top of the map area so that the search bar could be extended to take up more of the screen. This was done because some participants in the previous round overlooked the search feature.

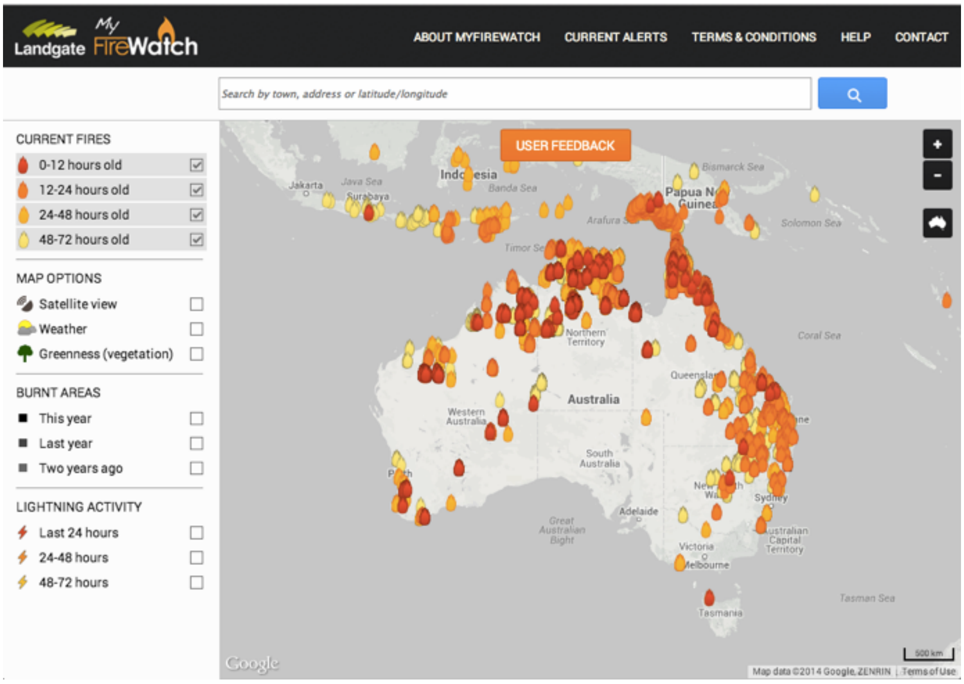

Figure 6.7: The final version of the user interface as it appeared on desktop machines with a browser size greater than 1024 pixels wide. Design changes at this point were relatively minor, with the most significant being moving the feedback button onto the map itself in order to widen the search box. The new FireWatch logo was also added so that the same logo appeared across all of Landgate's FireWatch products.

Figure 6.8 shows the final version of the *Alerts* page. This page displayed content sourced from RSS (Rich Site Summary) feeds provided by various emergency services organisations from the states and territories. Where available, links were also provided to their Twitter accounts and official websites. Links to the Alerts page were added on all of the popup boxes for the current fire hotspots on the map.

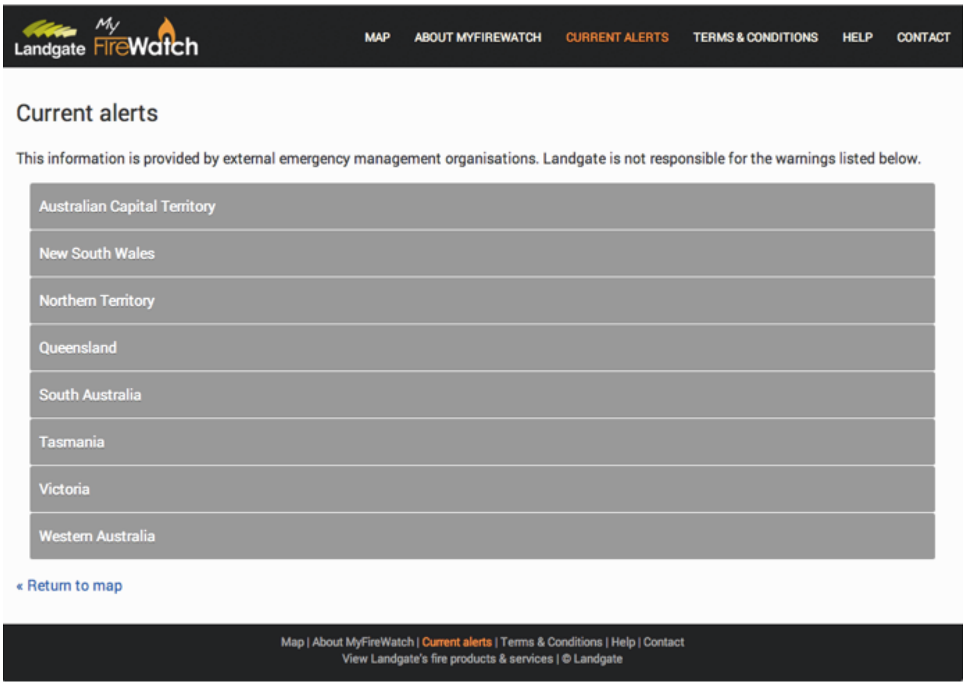

Figure 6.8: The Alerts page as it was presented to users accessing MyFireWatch (Landgate, 2014a) through a desktop computer. The alerts were sourced from the RSS feeds of various emergency services organisations from the states and territories. Where available, links were also provided to their Twitter accounts and official websites.

The other pages presented to users on the desktop interface were simple. The example in Figure 6.9 shows the About MyFireWatch page, which provides a brief description of MyFireWatch (Landgate, 2014a), along with a description of the other versions of FireWatch in the suite of products provided by Landgate. All other pages (Terms and Conditions, Help and Contact) had the same layout. Note that the footer contains a link that states "View Landgate's fire products & services". This linked to the sub-domain http://firewatch.landgate.wa.gov.au/ (Landgate, 2014d), allowing users who required more information to easily access it. This URL contained links to all versions of FireWatch available to the public, as of 2014. Linking to the FireWatch subdomain meant that users could find out more about the sources of the information being provided, adding to the credibility of the website (Fogg, 2002).

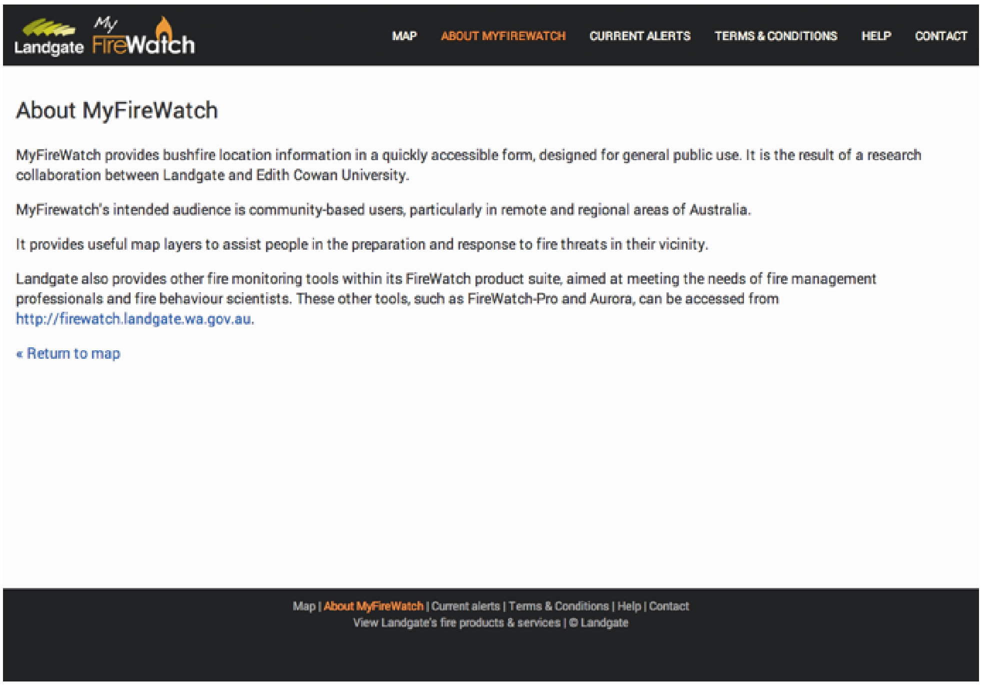

Figure 6.9: The About page as it was presented to users accessing MyFireWatch (Landgate, 2014a) through a desktop computer. All other pages without dynamic content (i.e., the map and alerts pages) had the same layout. Note that the footer contains a link that states "View Landgate's fire products & services", which gives users the option to access other versions of FireWatch.

Figure 6.10 shows the map interface that was presented to users on mobile and tablet devices. The interface presented on mobile and tablet devices simplified the toggling of map layers by providing only one option for current fires, satellite view, weather, greenness (vegetation), burnt areas (this year) and lightning activity (24 hours).

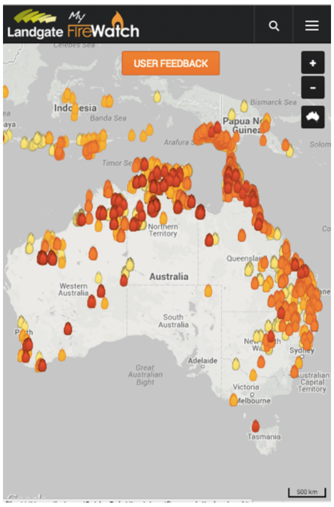

Figure 6.10: The final version of the user interface as it appeared on mobile and tablet devices. The menu in the top right of the interface allowed users to toggle map layers on and off and also provided access to other pages. The menu is shown in the previous figure. Note that the user feedback button on the map was removed after the data collection stage.

The menu (Figure 6.11) for mobile and tablet devices offered fewer options to users but still allowed them to access most of the information available to users on the desktop version. Users on tablets and smart phones were restricted to only one year of burnt area data and one day of lightning activity as a way of catering for slower 3G connections, as providing more data than this significantly slowed down the functionality of the map, making it difficult to pan and zoom.

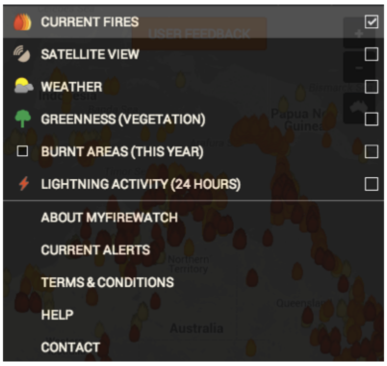

Figure 6.11: The menu presented to users accessing the application with a tablet or smart phone. This menu offered fewer options to users but still allowed them to access most of the information available to users on the desktop version. Users on tablets and smart phones were restricted to only one year of burnt area data and one day of lightning activity as a way of catering for slower 3G connections.

Once the feedback from both participants and Landgate had been considered in the design process, the website's HTML and CSS was run through the W3C's validator to check for any errors or warnings. This process would help ensure that the site would render correctly across various browsers and platforms (Boulton, 2009). The prototype was then deployed to a web server hosted by Landgate, with the web application publicly accessible through the http://myfirewatch.landgate.wa.gov.au/ (Landgate, 2014a) domain. There is a detailed description in the appendices section that discusses all of the design and development technologies used in this final version of the design. The MyFireWatch application linked to an online questionnaire created in Qualtrics — an online tool for creating web form-based questionnaires on the internet (Qualtrics, 2012).

6.4 Exploring: engaging with users online

The engagement with participants at this stage occurred remotely. Rather than interviewing participants directly, an online questionnaire was created in Qualtrics to collect insights and demographic information from users of MyFireWatch.

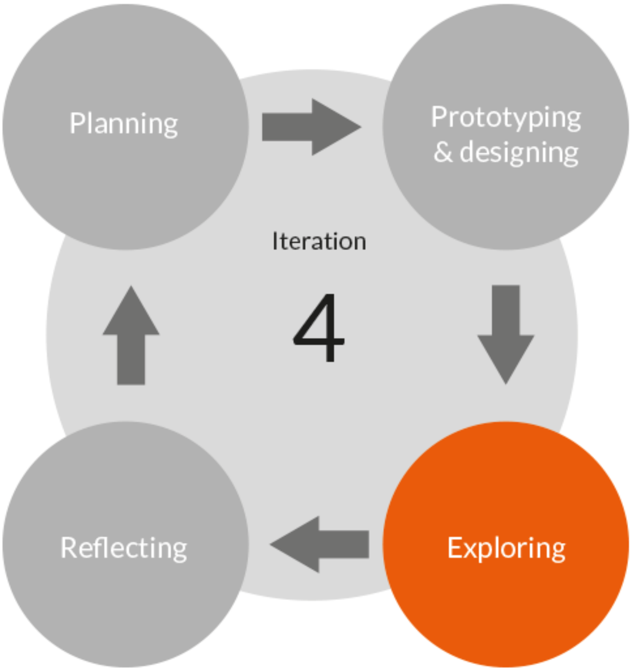

Figure 6.12: The exploring stage of the fourth and final design iteration. This stage involved collecting feedback from participants for the last time. The feedback at this stage was collected through both direct and indirect channels. Direct feedback was collected through an online questionnaire created in Qualtrics, linked from the live MyFireWatch (Landgate, 2014a) website.

The online questionnaire was created to gauge the usability of the interface. The questionnaire also asked participants about how they would expect to hear about a service such as FireWatch, about their social media use and whether they would be interested in contributing content to the application. The online questionnaire also asked participants to include their postcode, so this provided some idea of whether rural users were accessing the application.

6.4.1 Research instruments

An online questionnaire was created in Qualtrics (Table 6.1), which was accessed by clicking on a button with the description of "User feedback" prominently displayed on the MyFireWatch map

interface (Figure 6.7; Figure 6.10). The questionnaire was launched on February 12, 2014 and data was collected from this date until October 31 2014.

The first question was preceded by several paragraphs describing the project, the purpose of the questionnaire and contact details for myself, Stuart Medley (the principal supervisor for this thesis) and ECU's ethics officer, in the event that participants had questions regarding ethics. The wording of these paragraphs was similar to the information letter provided to participants who were engaged in Kununurra (as explained in the previous chapter). It also explained to participants that they had left the MyFireWatch website and were accessing a questionnaire created by ECU. Only participants who answered "Yes" to this first question were able to proceed to the remaining questions. A copy of the wording of this opening question is provided in the appendices. Questions 2 to 9 in this online questionnaire were based on questions from the same usability survey used for the basis of the semi-structured interview guide explained in the previous chapter: the *System Usability Scale* (Brooke, 1986). Again, the word *system* was replaced with *website*, as this was considered a more appropriate term in the context of this research; and two questions focusing on training were not included as this was not possible for users of MyFireWatch. In addition to the usability focus, the online questionnaire — as in the second round of user engagement explained in the previous chapter — asked participants about their internet and media use, how they expected to hear about a service such as FireWatch and whether they would like to contribute content. It also included demographic information including age bracket, occupation and postcode. Questions 2 to 9 used the Likert scale as used in the original System Usability Scale (Brooke, 1986):

- Strongly disagree
- Slightly disagree
- Neither agree nor disagree
- Agree

- Strongly agree.

Questions 10, 11, 14, 15 and 17 provided a text box field for user responses.

Table 6.1: Questions from the online questionnaire that launched during the final design iteration. This questionnaire was based on the System Usability Scale (Brooke, 1986). It also contained extra questions regarding demographics, internet and media usage and whether users were interested in contributing content to the application.

	Online questionnaire questions
1.	Have you used the FireWatch application? - Yes - No
2.	I found the FireWatch website unnecessarily complex.
3.	I thought the FireWatch website was easy to use.
4.	I found the features of the FireWatch website were well integrated.
5.	I thought there was too much inconsistency in the FireWatch website's design.
6.	It is quick to learn how to use the FireWatch website.
7.	I found the FireWatch website cumbersome to use.
8.	I felt confident using the FireWatch website.
9.	I will use the FireWatch website frequently.
10.	If you would like to help us improve the FireWatch website, please provide suggestions or describe any problems you may have encountered.
11.	We are trying to improve the level of community awareness of and participation in the FireWatch website. Thinking about your own community and social circles, can you describe how you or members of your community would be likely to hear about a website like FireWatch?

12. Which of the following do you use (You may select more than one)?

- Email
- Facebook
- Twitter
- Google+
- Blogs
- Forums
- Other

13. Would you want the option of being able to contribute content to the FireWatch website (e.g., reporting fires)? You have the option to explain your answer.

- Yes
- No

14. Please enter your postcode.

15. Please describe your occupation.

16. Which age bracket do you belong to?

- 18-30
- 30-40
- 40-50
- 50-60
- 60+

17. Any final comments you'd like to make regarding the FireWatch website?

6.5 Reflecting on the final round of user engagement

The reflecting stage involved processing "all the research data and transforming them into manageable insights" (Stickdorn & Schneider, 2010, p. 286). This involved considering users' experiences with the interface to "highlight problems as well as things that work well" (Stickdorn & Schneider, 2010, p. 286). The users' experiences were captured through the online questionnaire linked from the user feedback button displayed on the interface.

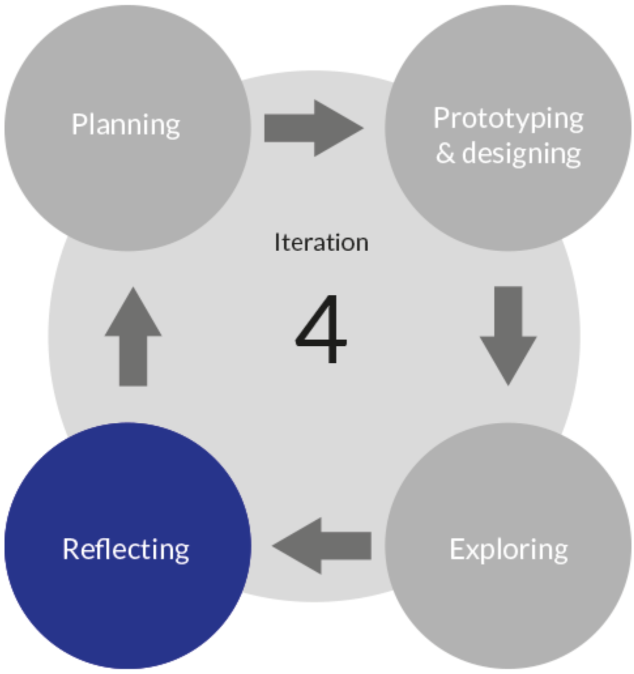

Figure 6.13: The reflecting stage of the final design iteration. This stage involved analysing the direct feedback that was collected in the exploring stage through the online questionnaire. The questionnaire focused on usability but also asked participants about their internet and media use, whether they would be interested in contributing content to the application and demographic information.

The following section contains analysis of the responses to the online questionnaire. Firstly, the demographics of questionnaire respondents are described. Secondly, responses to questions 2-9 are

analysed, as these were used to rate usability of the interface. This analysis follows the same analysis explained by Brooke (1986) in the original System Usability Scale research instrument. Thirdly, as was done in the analysis of participant interviews in Chapter 5, the remaining analysis describes recurring relevant themes revealed in the responses to the open questions from the questionnaire. The themes covered include the features provided by the MyFireWatch application, usability of the interface and information about participants' internet and media usage.

Demographics of the questionnaire respondents

Participants who took part in the survey were self-recruiting, meaning that the demographics of the respondents were not controlled. There was a total of 35 participants who responded to the majority of questions. However only 31 participants provided information related to demographics. At this latter stage of the research, the limitation of not controlling the demographics of users was not considered a major drawback, as there had already been significant input from community-based users. Additionally, as MyFireWatch was now a publicly accessible web application, there were no restrictions in place regarding who could access the website. Participants came from several areas within Australia, with the majority being from Western Australia. Figure 6.14 shows the approximate location of the 31 participants who provided their postcode. This figure was generated with Google Fusion Tables (Google, 2014) from a CSV (Comma Separated File) file exported from Qualtrics. Although MyFireWatch was aimed at meeting the needs of users in rural and remote areas of Western Australia, the majority of participants were based in and around urban areas of Australia, with the majority situated in and around the Perth and Sydney areas.

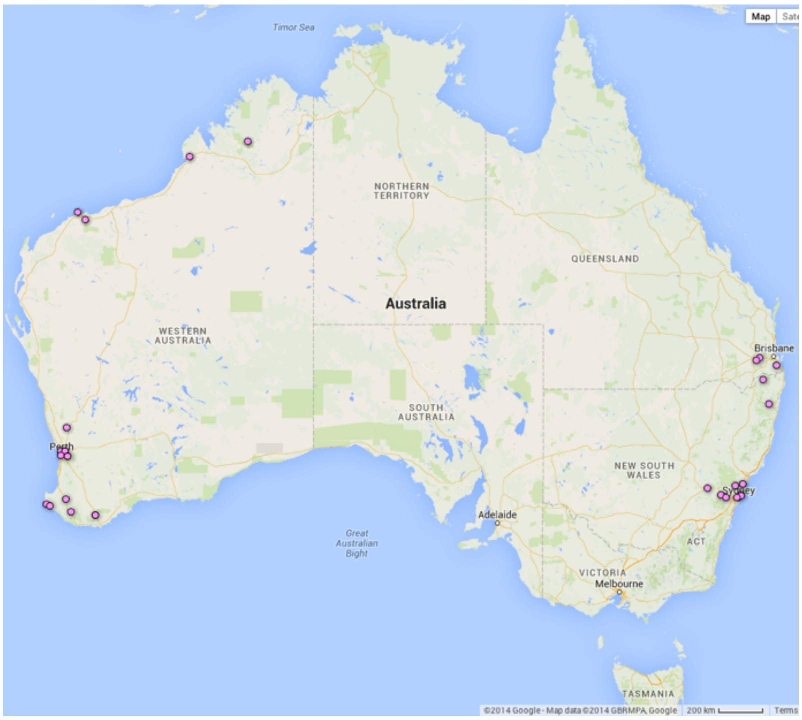

Figure 6.14: Map of Australia showing the location of participants (n=31) who provided their postcode in the online. As the map demonstrates, the majority of the participants were based in and around the Perth and Sydney areas. Although the MyFireWatch application (Landgate, 2014) was intended to be used primarily by people situated in rural areas, these users based in and around urban areas provided useful feedback on the usability and utility of the interface.

The participants who took part in the online questionnaire came from a diverse range of occupations. Three of these participants were in emergency management. Participants were located in the Perth area, regional areas of Western Australia as well as other states, such as New South Wales and Queensland. Some participants were not willing to provide details regarding their occupation. Table 6.2 shows the most commonly occurring occupations of questionnaire participants.

Table 6.2: Participant occupations from the online questionnaire created with Qualtrics, which was accessed via a link from the live MyFireWatch application. Question 15 from this online questionnaire asked participants to describe their occupation. This table shows the occupations that were shared by at least two respondents.

Occupation	*Frequency*
Retired	7
Education (including students)	5
Emergency services	3
ICT-related	3
Media-related	3
Retail	2
Professional (e.g., legal, accounting)	2

While FireWatch Pro was created by Landgate to cater for emergency services personnel, their input was still considered valuable to the design of MyFireWatch as bushfire awareness is now considered a shared responsibility amongst stakeholders at all levels (Victoria Bushfires Commission, 2010) and there was now significant input into the redesign from several community-based users. Although these occupations were not representative of the types of users encountered in Kununurra, the results discussed in this section confirmed that generally speaking, the interface was usable and met the needs of users outside of emergency management. The age of participants who provided their age was from 18 to 60 and above. Seven participants were in the 18-30 bracket, seven were also in the 50-60 bracket and eight were in 60 or above.

6.5.1 Analysis

Feedback from the questionnaire was generally positive. Overall, the answers provided suggested that the interface was not too complex and that it was easy to use. The positive responses indicated

that the initial approach of "strategic reduction" (Maeda, 2006), followed by direct engagement with community-based users, resulted in an interface that was both usable and provided enough functionality to be useful to most participants.

Measuring usability

Questions 2-9 from the online questionnaire created with Qualtrics (Table 6.1) addressed usability of the MyFireWatch interface. These questions were based on the System Usability Scale (Brooke, 1986). Figure 6.15 was created with an online tool for plotting Likert scales (Maurer, 2013), which generated nine individual SVG (Scalable Vector Graphics) files based on user responses to these nine questions. These SVG files were imported into Adobe Illustrator and compiled into one figure, with some minor aesthetic adjustments made.

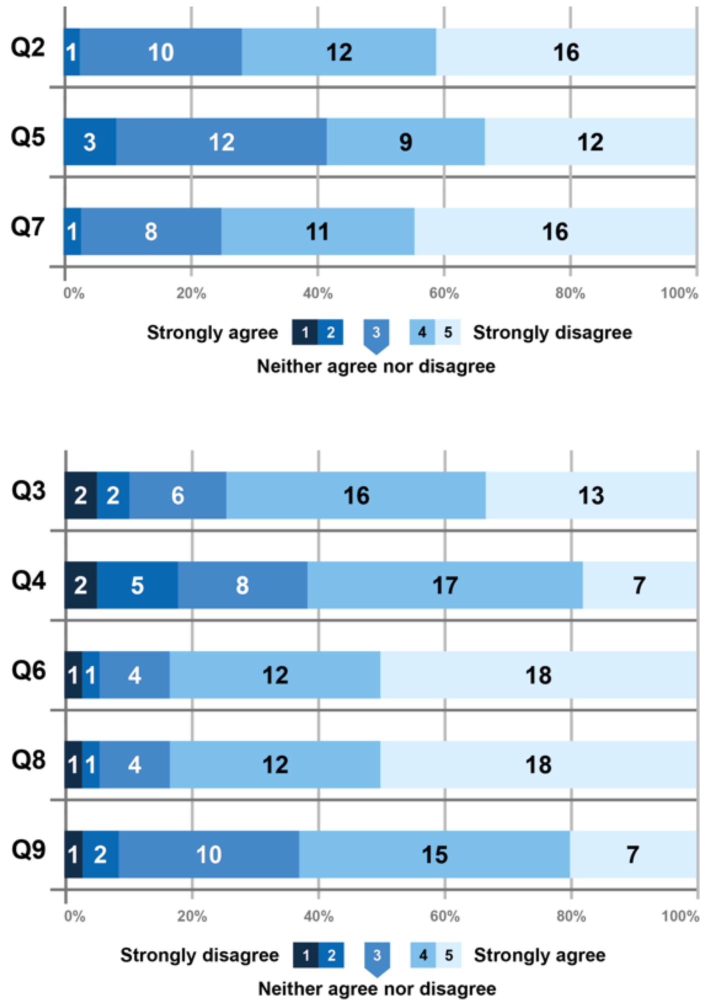

Figure 6.15: The scores from responses for Questions 2-9 from the online questionnaire. These questions addressed usability and were based on the System Usability Scale (Brooke, 1986), a standard instrument for measuring usability of a system's interface. Questions 2, 5 and 7 have had their scale reversed to reflect the positive results in the same manner as the other questions. The lighter the shade of blue, the more positive the result. Therefore this graphical representation indicates a positive result for overall usability of the MyFireWatch interface.

The System Usability Scale (Brooke, 1986) allows a researcher to calculate a score for rating usability based on results from participants:

"SUS [System Usability Scale] yields a single number representing a composite mea-

sure of the overall usability of the system being studied. Note that scores for individual items are not meaningful on their own. To calculate the SUS score, first sum the score contributions from each item. Each item's score contribution will range from 0 to 4. For items 1, 3, 5, 7, and 9 the score contribution is the scale position minus 1. For items 2, 4, 6, 8 and 10, the contribution is 5 minus the scale position. Multiply the sum of the scores by 2.5 to obtain the overall value of SU. SUS scores have a range of 0 to 100"

(Brooke, 1986, p. 5).

As two questions from the original survey were not included in the online questionnaire, the score calculated was out of 80 rather than 100. Average user responses values were calculated automatically by Qualtrics. User responses were given a value by assigning a number for every answer on the Likert scale (e.g., a response of *Strongly disagree* was assigned a value of 1 and a response of *Strongly agree* was assigned a value of 5). A *mean* was then automatically calculated according to the number of responses for each question. To calculate a score for questions 3, 4, 6, 8 and 9, one was subtracted from the average (mean) user response value:

$$x - 1 = y$$

$x =$ average user response; $y =$ score

For questions 2, 5 and 7, the average user response value was subtracted from five:

$$5 - x = y$$

- Question 2 score = 3.10.
- Question 3 score = 2.92.

- Question 4 score = 2.56.
- Question 5 score = 2.83.
- Question 6 score = 3.25.
- Question 7 score = 3.17.
- Question 8 score = 3.20.
- Question 9 score = 2.71.

The sum of these scores was then calculated:

$$3.10 + 2.92 + 2.56 + 2.83 + 3.25 + 3.17 + 3.20 + 2.71 = 23.74$$

The total score was calculated based on multiplying the sum of the scores by 2.5:

$$23.74 \times 2.5 = 59.35$$

This total was then calculated as a percentage (rounded to the nearest whole number):

$$\frac{59.35}{80} \times 100 = 74\%$$

A score higher than 68% indicates that an interface has above average usability (U.S. Department of Health & Human Services, 2014). Although the wording of the original instrument was modified to suit the context of the FireWatch redesign, these results from the questionnaire validate that the MyFireWatch interface provides users with a usable interface.

6.5.2 Usability and functionality of the MyFireWatch interface

The following sections discuss the usability and functionality of the MyFireWatch interface, as well as participants' digital and traditional media usage. User-sourced information is also discussed, as is the role that MyFireWatch can play within an emergency services context.

Greenness of vegetation functionality

One participant who worked in education suggested that the greenness of vegetation was not necessary, but was still interesting, although it required a key so that the colours were more easily understood: "The vegetation layer is interesting but there is no key for the vegetation layer, which to me seems a little useless because it has nothing to do with trying to locating a fire".

Similarly, a participant working in agriculture mentioned: "A key for the Greenness (Vegetation) option would be useful". The lack of key was also mentioned by a retiree, along with the imagery becoming pixelated at higher zoom levels: "I could not find a legend for the different colours of 'greenness'. However, switching from the Satellite to Greenness view did clarify the matter to a large extent. The 'greenness' view became pixelated at a very low level of map detail".

It was considered impractical to place a legend or key within the map navigation, particularly with limited space on mobile devices. More intuitive colours are necessary for representing greenness and this should be addressed in future iterations of the interface. It may also be necessary to further ascertain the usefulness of the greenness feature before deciding whether to include it in future iterations of the MyFireWatch application.

User-sourced bushfire information

In the previous chapter (5), the majority of participants asked in the second round of user engagement expressed interest in contributing content to the application. Six out of the eight participants

asked whether they were interested in contributing content (e.g., reporting a fire) responded positively. However, in the results of the questionnaire, there were mixed opinions about whether such functionality should be provided to users. Of the 34 participants who answered the question regarding whether they would want the option of being able to contribute content to the FireWatch website, 14 (41.18%) participants answered "yes" and 20 (58.82%) answered "no".

The following explanations were given by those participants who responded with "no". Several participants raised concerns regarding authenticity of the information: "Can get false info. All fires should be via fire authorities before showing in [the] system (Chinese whispers)"(Professional).

"Unless someone has a GPS to give the exact reference and it's verified or given a 'to be verified' [status] it might be open for misuse" (ICT worker).

"How would you control for hoaxes?" (No occupation given).

"The possibility of inaccurate information could cause issues" (No occupation given).

One participant who worked in emergency services noted that user submissions could impact on usability: "I believe that the system could be overloaded with minor fires and then that would make the sight cluttered and possibly not friendly to use".

Two participants did not consider themselves in a position to contribute content: "There are other better suited to contributing to this site" (Media worker).

"I'm constantly travelling from Sydney to Urbenville. Not always in a position to help" (Education worker).

The explanations given for responding with "yes" included the following. One retiree saw potential for collaboration: The Helidon Hills has a Volunteer Smokespotters Network? who coordinate initial outbreaks of fire to the Fire Services. I will forward you detail to the Coordinators and they may decide to participate.

Similar to those who selected "No" in response to the question regarding user-sourced content, three participants who selected "Yes" raised concerns regarding authenticity or accuracy of the infor-

mation: “It would be good to have users submit fire warnings, but at the same time, you’d have to ensure the legitimacy of the fire to avoid panic” (Media worker).

“I think this would be beneficial as long as posts required official confirmation and approval before being published on the site” (Media worker [2]).

“If this became an option, it would have to be monitored closely to ensure information is correct. People are weird and perceptions are differently measured. What seems huge to me might be small to others etc.” (Retail worker).

Other participants saw it as being a useful feature, but two noted that location-based data may be necessary too: “If we were able to report the location of a fire (from triangulation of compass bearings on smoke, and where known the nature of the fire (e.g. planned burn, it could be a useful community service” (Retiree [2]).

“Using your GPS location on phone [to] report fires” (ICT worker).

“The more information that can get out there could help to save lives, property, etc.” (Administration worker).

As is evident from the responses given, several participants raised issues surrounding accuracy and authenticity of user-sourced data. This is a challenge for organisations that are considering handling emergency information provided by their users. From Landgate’s perspective, this would likely mean some sort of strict verification process in collaboration with each state and territory’s emergency services — something well beyond the original scope of FireWatch. Yet going by the response to this online questionnaire, along with the strong support for this kind of user-sourced functionality in the second round of user engagement in Kununurra, it is something that organisations providing this kind of emergency-related information may need to address at some point in the future. Between the second round of user engagement and the questionnaire results, there were 20 participants (seven interviewees from Kununurra and 33 questionnaire participants) that were both for and against the idea of contributing content. As pointed out by six of the questionnaire participants

— a verification process would be needed for such a system to maintain its sense of credibility and authority.

Digital and traditional media used and how these could improve awareness of the MyFireWatch service

Participants were asked about their digital and traditional media usage to glean how community awareness of MyFireWatch could be addressed through media. As in the previous chapter, participants that took part in the online questionnaire relied on both digital and traditional media. In the second round of user engagement in the previous chapter, no participants used Twitter, but several participants had Facebook profiles for themselves, their businesses or both. However, participants who took part in the online questionnaire used a range of online media, including Facebook, Twitter, Google+, Blogs, Forums and Email, with email and Facebook being the most widely used.

One participant in education who lived in a remote area mentioned that due to lack of mobile coverage and radio coverage, television and the internet would be more appropriate forms of media for raising community awareness of MyFireWatch: "Television, by word of mouth or adverts on other weather monitoring websites. We are in a radio and mobile black spot, so text msg [message] or radio ad wouldn't reach us. Most farmers [a]round here are keen weather channel and/or weather monitoring website enthusiasts".

Several participants mentioned social media as a way of promoting awareness of MyFireWatch. Several participants suggested multiple forms of media. One media worker mentioned "email, social media, radio ads". Eight participants mentioned social media, with Facebook being the most common suggestion. One participant from a rural area who worked in media made the following suggestion of how social media could be used for promoting MyFireWatch:

> I think people in my community would most likely share it on Facebook? I think

> utilising social media channels would be the best way to get this website out there, this would include having sharing options on the actual website, as well as having accounts for the page that give regular updates on various social media such as Facebook and Twitter.

However, several participants said that while digital media was useful, traditional media were clearly still the preferred means of communicating: "I would prefer a mail drop. A simple pamphlet. Sometimes I feel we get too spammed and we don't even look anymore. But I feel the letterbox is still a little different. The local newspaper as well. People still like to read the real deal" (Retail worker).

Five participants mentioned "word of mouth" being a useful way of raising awareness. Advertising in local newspapers was also mentioned by five participants.

At the time of writing, most of the significant media coverage has been related to the coverage of the WAiTTA awards (2014) and iAwards (2014) wins. A full list of known media coverage related to MyFireWatch is included in the appendices. In terms of promoting MyFireWatch, both traditional and digital media clearly have a role to play. Ongoing and future work regarding resituating MyFireWatch within remote and regional communities is briefly discussed in the conclusion chapter (8).

Issues with the interface

Some users described problems with the interface responding slowly. This could have been due to the devices being used in two cases: "I found it a little slow to load but it might be my end. Not sure" (Retail worker).

"I found it quite slow responding to whatever I touched, but that could be my iPad" (Administration worker).

Some issues may have been related to an intermittent internet connection: "There is a glitch with the background tiles when selecting multiple years for previous burn history. The background map tiles don't load for around 50% of the background" (Emergency services worker).

"I think there are some technical things that need addressing for make it a little smoother and responsive" (Media worker).

"On zooming in on an area, I found I got a blue 'spinning ball with a pointer at 11 o'clock mark', which wouldn't go away" (ICT worker).

Another participant from emergency services said that MyFireWatch was a good concept but that the mapping was "clunky". In defence of the MyFireWatch interface, none of these problems seemed to inhibit users from accessing the fire information itself. Although it is difficult to ascertain the cause of some of these problems, generally performance issues would likely improve as Landgate eventually upgrade their server infrastructure, the map frameworks used become more responsive and internet connectivity in Australia improves.

One participant who worked in media found some of the alerts to be confusing: "I found that the website was very simple and easy to use. The only thing that was unclear was under the Current Alerts page; in my opinion, 'Assist SES — Sutherland Shire 16 October, 16:33' wasn't descriptive enough".

It is worth mentioning that the content of the alerts page is not controlled by Landgate but is simply displaying content sourced from each state and territory's emergency services organisation.

One participant who worked in education reported problems with the weather layer not displaying correctly. At the time of writing, the Bureau of Meteorology had recently changed its data feed, which resulted in the weather layer not displaying correctly. This is something that Landgate will address in the near future.

Requests for additional functionality

Generally there were few requests for additional functionality. One retired participant familiar with the previous expert-user version of FireWatch mentioned MyFireWatch using some of the functionality offered by the expert-user version: "Two of the useful features that Landgate FireWatch has, and which might be useful on MyFireWatch are the ability to see the Lat/Long coordinates of the cursor position, and the ability to measure the distance between two points (e.g. my known location and the location shown for a fire)".

One participant who did not provide an occupation noted: "It would be prudent to clearly state on screen the time limitations surrounding FireWatch updates".

The limitations of the technology behind MyFireWatch are clearly stated in the Terms and Conditions page of the application. The hotspots themselves also contain information — accessed by clicking the hotspot — that described the time and date that it was last detected by a satellite overpass. By doing so, it adheres to Nielsen's (2005) heuristic of *visibility of system status*. Another participant wanted preventative information: "Provide preventive impending bush fire indicators for example, degree of risks warning before bushfire actually breaks out" (ICT worker).

This preventative information would be more likely to come from emergency services organisations, rather than Landgate. One retired participant suggested adding: "A feature to set default, local view, so that opening the website starts with the relevant region".

Similarly, another ICT worker suggested a "save my favourites" option. Currently, the map uses "cookies" to remember the last point that a user had navigated to. When users first visit, they also have the option of sharing their location. Saving a "default" or "favourite" view may be a future enhancement of the interface. Another participant suggested turning it into a smart phone application and also applying the design to flood information: "Turn it into an app with alerts — this design could also be used for flood information, the info during 2011 flood for blocked roads was totally

inadequate and inconsistent" (ICT worker).

Presently, MyFireWatch is only delivered as a web application with no plans to turn it into a smart phone application. Alerts are provided by emergency services organisations, but these are linked to on the alerts page. A participant in education also requested more information on the fires themselves: "It would be nice to have a little bit more data on the fires when you click on them (e.g., size, control status)". This functionality is currently not possible, as the information provided by emergency services is not "geo-tagged" and therefore cannot be associated with specific fires on MyFireWatch.

Emergency services and the role of MyFireWatch

There were mixed responses regarding the role that MyFireWatch could play in terms of it being a supplementary bushfire information service for people in communities, although generally participants saw it playing a useful role.

One participant who worked in emergency services saw MyFireWatch as a way of assisting the work undertaken by the emergency services: "Thank you for providing this service. In my role it makes my job easier and we can identify fires and any assets at risk earlier".

Another emergency services worker simply stated "Nice work". Nielsen's (2005) usability heuristic of *flexibility* and *efficiency of use* seems to apply here, in that the system can cater for both experienced (i.e., emergency services) users as well as inexperienced (i.e., community-based users) users. One participant was also positive about the role that MyFireWatch could play specifically in remote Kimberley communities:

> Great site, only early days but this will be an extremely valuable resource for those of us who live in remote areas. Look forward to it evolving in the future, I'm sure it will become as popular as the BOM [Bureau of Meteorology] site is to us in the

> Kimberley. Congratulations from a born and bred Kimberley resident!
>
> (Security worker).

Another participant — who did not provide an occupation — noted: "000 is a clear message and that kind of clarity is necessary in emergencies".

It is worth mentioning again that MyFireWatch is not considered an emergency system, but rather a supplementary service in addition to the alerts provided by emergency services. It is considered one of the cues to assist communities, as mentioned in the Victoria Bushfires Commission final report (2010). Nevertheless, MyFireWatch provides links to the website, Twitter and RSS feeds (where available) for the emergency services for each state and territory.

Generally those outside of the emergency services were positive about MyFireWatch being accessible to the public: "It is great to see this initiative come online. We have been using the old Landgate Firewatch Map service (non-subscribers) for several years. Your MyFireWatch Map is simpler and so probably more comfortable for the average user" (Retiree).

"I am a resident of a retirement village in Sydney NSW and am involved in emergency evacuation of the village in emergencies" (Retiree [2]).

A community resource centre worker in rural WA said that it was a useful tool for them because "I am the emergency services". Therefore, MyFireWatch seems to be viewed as a useful source of emergency information for those outside of emergency services.

General comments regarding usability and utility of the interface

Overall, comments regarding the interface were positive. One retiree said that it was "A great start to what could be an extremely valuable tool". An administration worker also considered it a useful service, stating that the more information that can be available to the public, the more it "could help to save lives, property etc.". A participant who worked in education simply stated "Kudos!!! Keep

up the good work". Another participant stated that it was: "A great idea, but the most important thing is for the map to be updated regularly and to be as accurate as possible" (Retiree [2]).

Over the coming years, the accuracy and frequency of the satellite information will improve as more satellites become available. One professional was very positive: "A great initiative overall! Real world application that has potential to save lives!".

One participant who works in education was glad that the application extended beyond WA: "Wonderful concept competently executed. Living in the fire-prone Hawkesbury River region, I was delighted that FireWatch extended beyond WA. The existence of FireWatch needs to be further publicised".

One media worker noted that the website was "very simple and easy to use" — suggesting that the process of removing functionality to improve usability was a successful strategy.

6.5.3 Summary of the findings

Situational fulfillment of user needs

From the early stages of the redesign, attention was focused on two facets of the user experience: usability and utility. Hassenzahl (2004a) recommended that focusing on these two facets of the user experience would result in allowing users to achieve something, which would lead to feelings of satisfaction. As Hassenzahl stated, "situational fulfillment of needs promotes positive emotions" (2004a, p. 47). In the case of MyFireWatch, these needs involve being able to easily and independently access information that can assist in the preparation and response to bushfire threats. In the questionnaire there were few requests for additional features. Other than participants identifying issues with the greenness imagery and performance issues, there were minimal problems identified with the functionality provided. Hassenzahl asserted that "a usable and useful product may lead to satisfaction if a valued goal is achieved in a particular situation and at least a part of the success is attributed to

the product." (2004a, p. 47). By considering what is useful to community-based users by involving them directly in the design process increased the chances of MyFireWatch being a useful product to these users. The positive results from the questionnaire discussed in this chapter indicate that MyFireWatch is also a usable product. By providing something to community-based users that is both useful and usable will allow these users to achieve the objective of being better informed and therefore more able to prepare for and respond to changing conditions in their environment.

Building awareness of MyFireWatch

Although the results of this chapter verified that the design processes undertaken had led to the MyFireWatch interface being both usable and useful, it is clear that there is still some work to do in addressing awareness of the application. The results here suggest that both social media and traditional media — including local newspapers, radio and television could all play a role in increasing awareness of the application. Word of mouth also plays a significant role in rural communities.

A mixed response towards user-sourced content

There was also mixed opinions regarding the provision of functionality for users being able to submit content (e.g., reporting a fire). The results of the previous chapter suggested that there was significant support for this type of functionality in Kununurra. Research on participatory GIS (Dunn, 2007), bushfire map applications (Power et al., 2013) as well as recent crisis communications research (Brady & Webb, 2013; Akama et al., 2013; Palen et al., 2010), also seems to suggest that there is significant community interest in this type of functionality — particularly through harnessing social media. How to address this type of functionality while maintaining a sense of credibility and authority will be a challenge for the organisations that provide information related to hazards. The impact that user-sourced information could have on usability also needs to be considered.

6.5.4 Discussion

Research questions

The work undertaken in this chapter provided answers to the research questions posed in the introduction of this thesis.

(1) How can FireWatch be redesigned to incorporate global best practice and modern principles of dynamic information design to develop a more usable and intuitive version for members of the wider community?

Although this question was addressed in the previous chapter, it is again worth mentioning that the approach of "strategic reduction" (Maeda, 2006) — reducing the functionality to its core components — appeared to be a successful approach in making the interface usable. The results from the questionnaire in this chapter confirmed that this was a pragmatic approach to the redesign process, particularly at the early stages prior to engaging directly with community-based users. In terms of global best practices and dynamic information design, responsive design is a useful technique to cater for devices of all sizes. Although efforts were made in the final iterations to present a mobile and tablet-friendly interface, this final iteration's exploring and reflecting stages revealed that the majority of users are still accessing MyFireWatch with a desktop machine. Additionally, although it has been a part of interface design for several years, it is worth remember Nielsen's point that users expect familiarity and consistency in the interfaces they use (2000, p. 188). Following de-facto conventions of map interactivity — e.g., following the examples of well-known platforms such as Google Maps — was also a successful strategy. Generally, the participants in the iteration discussed in this chapter did not find significant issues with the interface.

This chapter also considered the requirements of the service provider, Landgate, as they had needs that had to be met prior to the launch of the MyFireWatch website. Working closely with

both the service provider and end users during this final iteration of the design process demonstrated why it is necessary that designers engage with all stakeholders in the design process.

In this chapter, the online questionnaire — which included questions from a standard usability instrument — was used to gauge the usability of the MyFireWatch interface. This questionnaire also allowed for users to provide suggestions or describe any problems they may have encountered. It also asked users whether they were interested in contributing content and whether they had suggestions for improving awareness of the website. The positive responses from a wide array of community-based users — and emergency services personnel — meant that the design process resulted in an interface that is both usable and useful.

(2) What kinds of user input are required for effective revision of the FireWatch service?

The previous chapter explained the in-depth fieldwork undertaken in two stages in the remote community of Kununurra. This chapter explained the use of an online questionnaire to elicit responses from users of the live MyFireWatch application. Due to these participants being self-recruiting, it was not possible to recruit users based on their characteristics, such as location or occupation.Therefore, participants were asked questions regarding usability but did not undertake the card-sorting system addressing functionality that was done in the previous chapter. Nevertheless, participants still provided feedback regarding usability, which was considered valuable. The way that HCI and interaction design consider users is changing. Focusing on the community in the previous chapter, as well as the responses to the questionnaire in this chapter coming primarily from those outside of emergency services, verified this shift. Users can no longer be considered the "experts in their field" (Carroll, 1997) in situations such as this research, where a design is created both with and for a small but diverse community. By learning more about users by directly working with them in the design process, a researcher can allow these users to learn about the technology being presented to them (Holmlid, 2009). In the responses to the questionnaire discussed in this chapter

— and the second round of user engagement described in the previous chapter — there was significant support for allowing users to contribute content to an application such as MyFireWatch. Service design and participatory design methods have shown interaction designers that users can be co-creators and co-designers (Holmlid, 2009; Zimmerman et al., 2011; Zimmerman, 2011), but the support for user-sourced content suggests that users can be content creators too. These "ordinary users" in the community — that is, those that are not considered experts — have the ability to significantly shape the products and services built for them, despite their lack of expertise or experience with the information presented to them. As designers continue to work directly with users, and viewing them as co-designers or co-creators — their role is clearly expanding beyond what the term "user" suggests. Engaging directly with several users, as demonstrated in this research, also allows an interface to provide the right amount of functionality, ensuring that the designed object meets the needs of these users. A research instrument — such as the card sorting system used in the previous chapter — is required to measure the usefulness of features provided by the interface. Addressing functionality in this way, along with capturing aspects of usability, will increase the chances of the interface allowing its users to accomplish the goal of being better informed about bushfires in their vicinity (Hassenzahl, 2004a). The System Usability Scale has been used in HCI and software engineering since the 1980s (Brooke, 1986). Here, the version of it that appeared in the questionnaire not only allowed for usability to be measured, but the positive response acted as a way of verifying the design processes undertaken. The results of this chapter and the previous chapter demonstrate that MyFireWatch is a web application that is both useful and usable to community-based users.

(3) How should the information system interface adapt to accommodate increasingly dangerous situations while providing required information for different user groups?

As stated in the previous chapter, prior to MyFireWatch being launched, FireWatch Pro was released by Landgate to serve the needs of professionals working in emergency management. Never-

theless, the generally positive feedback from the two rounds of user engagement discussed in the previous chapter, along with the positive results from the online questionnaire discussed in this chapter, suggests that the needs of most users outside of emergency services should be met by the functionality provided by MyFireWatch. The way that the interface should adapt to accommodate various user groups is to work closely with representatives of those user groups to ascertain the functionality that those users require.

(4) What relationship exists between the visual characteristics of an information source and its credibility or authority?

Overall, users did not express any doubt towards the credibility or authority of the information being presented to them. This could have been because, at least in Western Australia, Landgate was considered a valid source of geographical information. Additionally, if users visited the Terms and Conditions page, or the main FireWatch portal (Landgate, 2014d), they could have discovered more information about the sources of information. When participants were asked about the possibility of users contributing content to the application, several participants raised concerns over how the information could maintain credibility or authority. This apprehension towards user-sourced data implied that the existing information provided by Landgate was credible. How to maintain credibility and authority when sourcing data from users requires further investigation.

(5) How can we engage with communities to increase an awareness of the FireWatch website?

After the first round of direct user engagement undertaken in the previous chapter, it was clear that there was a lack of awareness of the FireWatch service in Kununurra. In the second round of user engagement, participants were asked about their social media usage, and how they would likely hear about a site such as FireWatch. Participants who took part in the questionnaire described in this chapter were also asked how they would likely hear about a site such as FireWatch. Participants were reliant on digital and traditional media, with several citing ABC radio, local newspapers and

word of mouth as significant forms of communication. From the middle of 2014, efforts were made to engage with local media in Kununurra (specifically the Kimberley Echo and ABC local radio), and Western Australia more broadly. A full list of the known media mentioning MyFireWatch is included in the appendices. Landgate and ECU also shared information about MyFireWatch on their social media profiles. These are also included in the appendices. As suggested by the results of the online questionnaire, future efforts to increase awareness of MyFireWatch will need to focus on both traditional media (local newspapers, local radio and word of mouth) and digital media such as Facebook.

(6) What role can digital communication technologies play in building and increasing awareness of the FireWatch website?

The results in this chapter revealed that participants were heavy users of social media. Participants used a variety of social media, including Facebook, Twitter and Google+, although email and Facebook were the most significant digital platforms that participants used. This was possibly due to more participants from urban areas taking part. However, as noted earlier, traditional media still have a significant role to play in "spreading the word" in remote and regional communities.

As Facebook and email was mentioned by several participants, it would be ideal for Landgate to consider adding a "share" feature, that allows users to share a link to MyFireWatch via Facebook, email and other social media. Additionally, it may be worth considering a presence on Facebook and other social media for the MyFireWatch application, in addition to Landgate's main social media presence. Including this sharing functionality for social media platforms would be a useful addition, as sharing of bushfire information is gaining popularity in communities susceptible to fires (e.g., Brady & Webb, 2013; Akama et al., 2013), something that this research verifies.

6.6 Conclusion

This chapter discussed the final iteration of the design process. As was done in previous iterations, this iteration involved planning, designing, observing and reflecting stages. The planning stage involved considering input from participants in the previous round of direct user engagement, as well as input from the other key stakeholder in the process, Landgate. Significantly the prototype was launched as an officially supported web application, known as MyFireWatch. Participant engagement in the exploring stage took the form of an online questionnaire, with participants from Western Australia and other Australian states providing valuable feedback. Reflecting on the data collected found that overall, participants found the MyFireWatch website easy to use, its features well integrated, with participants considering the interface easy to learn and not too complex. Importantly, this feedback verified that there was value in ascertaining usefulness of the various features in the previous two rounds of user engagement. The participants who took part in the online questionnaire used several social media platforms such as Google+, Twitter and Facebook, as well as email; yet these users were still reliant on traditional media such as radio, newspapers and TV, and word of mouth. In the previous round of user engagement there was substantial support for the idea of sourcing fire information from users, whereas there were mixed responses towards this type of feature in the the questionnaire. Nevertheless, there was still significant support for users being able to submit content and this support is something that organisations providing information related to hazards need to consider. How to address this type of functionality while still maintaining a sense of credibility and authority, along with maintaining adequate usability in the process, will be a challenge. The next chapter presents two frameworks. The first is a set of guidelines that was created as a way of guiding others who are designing interfaces presenting map-based hazard information to community-based users. These guidelines are presented as a pattern language: a set of design patterns that describe a problem, context and present a solution. The second framework is a revised

personas framework. This framework uses the same structure as the personas used in Chapter 4, but the personas are updated to reflect the characteristics of actual community-based users encountered in Chapter 5. These two solutions are underpinned by the findings discussed in the results of this and the previous two chapters, as well as evidence in the existing literature covered in Chapter 2.

7

Frameworks: a pattern language and community-based personas

7.1 Introduction

The previous chapter discussed the final round of the iterative design process explained in the research design. Input from community-based users and the service provider

Landgate was addressed in the final designing stage. In this designing stage, the prototype launched as an officially supported web application, known as MyFireWatch. In the final exploring stage, an online questionnaire was used to gain feedback on the MyFireWatch application. In the reflecting stage, data from the online questionnaire was analysed according to relevant themes, the results of which indicated that the MyFireWatch interface provided adequate usability for the majority of users with few suggestions for additional features. The questionnaire revealed that social media was a significant form of communication, but traditional media such as radio, TV, newspapers and even word of mouth were also significant forms of communication. In contrast to the second round of user testing and interviews in Kununurra, there were mixed opinions about the possibility of providing functionality for user-sourced fire information.

This chapter introduces a framework in the form of a pattern language, followed by a personas framework for considering the needs of community-based users. Part of the process of undertaking constructive design research is the generation of new knowledge resulting from the design process undertaken (Koskinen et al., 2010). New knowledge and the intention to explain is also part of design studies in Fallman's (2008) interaction design research paradigm. Hence the two frameworks described here were created as a result of the processes undertaken, with the intention to guide others working on similar problems, including the industry partner Landgate.

Pattern language was originally created by Alexander et al (1977) as a way of providing solutions to recurring design problems in architecture. Design patterns were adopted by software engineering (Gamma et al., 1994; Winn & Calder, 2002), HCI and eventually interaction design (Borchers, 2000). The pattern language explained in this chapter consists of 17 individual design patterns to guide designers, researchers and developers working with map-based hazard information. As a way of generalising from the results discussed in the previous three chapters, these patterns were created as a way to guide others working in a similar area. The patterns were also created to assist Landgate in the event that they design or redesign other map-based products that present hazard informa-

tion to community-based users. In addition to the pattern language, a framework in the form of personas was created as a way of assisting Landgate and others in their design and development of similar products for remote community-based users. Personas are a powerful way of considering the perspective of users when gaining their direct input is not feasible (Cooper et al., 2014). The six personas created in this research provided a broad overview of community-based users in Kununurra. However, the direct engagement with members of the Kununurra community revealed that the personas were generally less "tech-savvy" than the real-life users. Also, it was clear that Kununurra and surrounding areas were heavily reliant on tourism and local small businesses. Therefore the personas have been updated to be a better representation of the people who directly informed the redesign of the FireWatch interface that resulted in MyFireWatch.

Structurally, this chapter first introduces how pattern language has been used in software engineering, HCI and more recently, interaction design. Then a set of guidelines is described for designing a hazard map interface for community-based users. These guidelines are categorised in the same manner as the requirements used throughout the design process: functional, data and other. Then the structure of the patterns is introduced, followed by the individual patterns themselves. The patterns follow the same structure as what Borchers (2000) described within the context of HCI and interaction design, with each pattern consisting of a name, problem, context, solution, example, references (to other relevant patterns within the pattern language), and, where appropriate — a diagram of an example solution. The example diagrams are taken from the final version of the MyFireWatch interface. Then the updated personas framework is introduced. The personas framework was introduced in Chapter 4 and as such only a brief overview is given. Similar to the personas created at the commencement of the design process, the six personas are first represented visually. Then their characteristics are fleshed out in the same way: detailing their occupation, the devices they have access to and the level of their computer skills. These characteristics are considered representative of the actual users encountered in Kununurra.

7.2 A pattern language: designing a hazard information map interface for community-based users

This research took a constructive design research approach (Koskinen et al., 2011). Cooper et al. argued for interaction design research to create new knowledge that is pragmatic in its nature: "Design specifications that gather dust on a shelf are of no use to anyone: A design must get built to be of value" (2014, p. 154). The research undertaken here was successfully pragmatic: It revolved around the development of a prototype interface, which became a fully working application officially supported by the service provider Landgate. Still, part of undertaking constructive design research involves generalising from the specific in order to generate frameworks and guidelines for others who may be working in a similar realm (Koskinen et al., 2011). Hence, a framework is presented here — in the form of a pattern language — that generalises from the process and results generated by this research so that those aiming to present hazard information to community-based users — including the development team of the industry partner Landgate — have a starting point for undertaking their own design work. These guidelines focus on improving both usability and utility of an interface.

Created by Alexander et al as a language for describing solutions to problems identified in architecture (1977), pattern language found its way to software engineering and HCI in the 1990s (Gamma et al., 1994; Borchers, 2000). Interaction design has continued this practice (Cooper et al., 2014; Rogers et al., 2011). An example from Borchers (2000) of a pattern language in interaction design is shown in Chapter 3. Design patterns improve on style guides and standards as a way to express interaction design experience (Borchers, 2000, p. 5). Patterns provide interaction designers with a means to provide both a concrete example and a generalised solution while also offering a context in which to apply the solution (Borchers, 2000, p. 5). A pattern language also has a hierarchy, which "leads the designer from patterns addressing large-scale design issues, to patterns about

small design details" (Borchers, 2000, p. 3). For ease of use and quick reference, the pattern language explained here only has two levels in the hierarchy.

In interaction design research, design patterns serve the purpose of formalising design knowledge and documenting best practices (Cooper et al., 2014). Design patterns serve to reduce design time and effort on new projects, can improve the quality of design solutions, facilitate communication between designers and programmers and educate designers (Cooper et al., 2014, p. 156). The pattern language explained in this chapter was created for two reasons: to guide designers and researchers who are designing a similar system, and to provide Landgate with a set of design guidelines for map interfaces that they might design or redesign for a community-based, non-expert audience.

Part of the work of patterns involves identifying appropriate use of them (Dearden & Finlay, 2006). It is envisaged that these design patterns will assist others looking to provide this kind of information to users based in a community — that is, those that are not directly involved with emergency services. Not every designer or developer has the luxury of substantial user input to guide the design: therefore, these patterns will go some way to providing something that is both useful and usable to community-based users.

Borchers (2000) defined the following semantics for a design pattern within the context of interdisciplinary design. These semantics are considered to be the essential components of a design pattern (Borchers, 2000, p. 2): Pattern, Name, Context, Problem, Solution, Examples, References and a Diagram. Definitions of these semantics were described in Chapter 3.

7.2.1 Guidelines: Structure of designing a hazard information map interface

The guidelines and patterns are grouped into three categories, based on the categories of the requirements used to guide the design iterations: functional requirements, data requirements and other requirements (Cooper et al., 2014). Grouping requirements into these three categories proved to be effective when establishing requirements in the iterations of the redesign process. They are there-

fore used here for categorising the design patterns. By following the requirements described in these design patterns, it is likely to provide a strong foundation for a map-based hazard information application that is both useful and usable. An interface that is useful and usable may increase the chance of user satisfaction by allowing them to achieve a worthwhile goal (Hassenzahl, 2004a): easy, relevant and timely access to hazard information. The pattern language has been created with both researchers and practitioners in mind.

The structure of the guidelines follows the structure of the requirements that were created at the beginning of each design iteration: *functional* (Table 7.1), *data* (Table 7.2) and *other* (Table7.3).

Table 7.1: Functional guidelines for designing a hazard information map interface.

Name	*Summary (Context)*	*Hierarchical level*
Simplicity	Only provide features that are crucial to the application	1
Consistency	Similar elements should look and act consistently with each other	1
All devices	The interface should work on mobile and tablet devices as well as desktop	1
Geo-locate	Auto-detects the user's location	2
Search	Provides a prominent search bar	2
Zoom	Users require controls to zoom in and out on the map	2
Map	The map should be the most prominent component on the page	1

Table 7.2: Data guidelines for designing a hazard information map interface.

Name	*Summary (Context)*	*Hierarchical level*
Map navigation	Map navigation and legend should be combined	1
Default information	A hazard map should show only the hazard information by default	2
Alerts	Provide warnings or alerts if available	2
Satellite view	Provide an aerial or satellite view of terrain as layer option	2
Other layers	Other data layers (limited to those relevant to hazard)	2
Layer options	Only provide up to 3 options for other kinds of data	2

Table 7.3: Other guidelines for designing a hazard information map interface.

Name	*Summary (Context)*	*Hierarchical level*
Information source	The source of the information being provided should be available to the user	2
Simple language	Only simple language should be used within the interface — avoid jargon	1
Minimal download time	The interface should load quickly, especially as users may be accessing it on mobile devices	1
Natural mappings	Visual characteristics should make sense to the user	1

For each design pattern, evidence is provided from the literature that guided the design process and results that arose from this study. These interaction design patterns comprise of the following structure: name, context, problem, solution, example, reference, and, where appropriate — a diagram showing an example (Borchers, 2000). These components are considered essential to design patterns (Borchers, 2000, p. 2). Borchers noted that Alexander's intention with pattern language was "to allow not architects, but the inhabitants (that is, the users) themselves to design their environments. This is strikingly similar to the ideas of user-centered and participatory design" (2000, p. 2).

7.2.2 Functional patterns

Pattern name: SIMPLICITY

Context: A simple interface will be more usable. Simplicity is important, particularly when presenting hazard information to users.

Problem: Information related to hazards needs to reach the user quickly but also needs to be easy to understand (Wu, 2008, p. 260).

Solution: Only provide features that are crucial to the application. Identify the core features. Consider whether or not to include sub-features. Any complex aspects need to be managed by a designer to make them easily understandable (Norman, 2008, p. 45). However, to quote John Maeda, "When in doubt, remove" (2006, p. 1).

Examples: The original expert-user version of FireWatch provided several datasets for current fires. This included map layers labelled "Current Fire Information", "MODIS Hotspots — daily", "NOAA Hotspots — daily", "GEO Hotspots — daily" and "NPP Hotspots — daily". MyFireWatch contains only one set of current fire hotspots, labelled "Current fires". This single set of hotspots met the needs of the community-based users.

References: The MAP feature should only initially display DEFAULT INFORMATION. OTHER LAYERS should be available, but these should only use minimal LAYER OPTIONS.

Pattern name: CONSISTENCY

Context: Elements that perform a similar function should be consistent in their actions and aesthetics.

Problem: Interface objects should be consistent with their behaviour. Objects with different behaviour should appear differently (Tognazzini, 2012). Users also prefer interfaces that they are familiar with (Nielsen, 2005, para. 2).

Solution: Elements that perform the same type of function — such as the main site navigation and the map navigation — should have the same appearance and perform in the same way. They should use the same font, same font size and colour. If icons are used, they should be around the same size, and where appropriate, use the same or similar colours. Navigation should behave the same when clicked or touched. Web users in general seek familiarity and consistency in the interfaces they use (Nielsen, 2000, p. 188), so follow conventions found in other map applications that users will be familiar with, such as Google Maps.

Examples: The MyFireWatch application's main navigation and map navigation's text and link behaviour are the same. The map navigation had different icons for each map layer, but these icons were approximately the same size, and similar layers (such as the four hotspot layers) were the same size.

References: Only use SIMPLE LANGUAGE in the interface. DEFAULT INFORMATION, OTHER LAYERS and LAYER OPTIONS should all be consistent in their appearance and function. Consider NATURAL MAPPINGS in the context of the visual aspects of the interface.

Diagram: Figure 7.1.

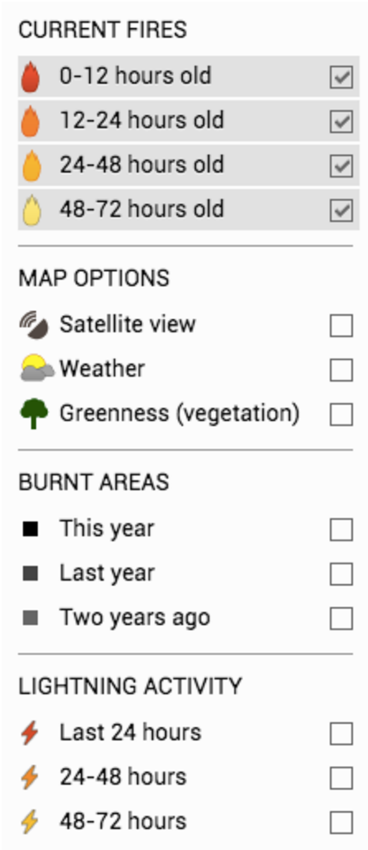

Figure 7.1: The map navigation of the MyFireWatch application. The text and the links look and behave in the same way as each other. The icons are slightly different for each layer, but those that are similar (such as the four hotspot layers shown) have similar icons to show that they are related.

Pattern name: ALL DEVICES

Context: The interface should work on mobile and tablet devices as well as desktop.

Problem: A modern interface needs to cater for several screen sizes, from a large monitor to the portrait orientation of a small smart phone. It should work on all common web browsers. Smart phone and tablet devices account for more than 18% of home internet use in Australia (KPMG, 2011, para. 6), so an interface needs to cater for these devices.

Solution: Use responsive design (Marcotte, 2010) to cater for all screen resolutions. All content should be flexible in its width. Wherever possible, use percentages rather than pixel values for an element's width. For example in CSS, set the content area's width to 100Text should be readable on all devices by using font sizes around 16 pixels and maintaining high contrast between the background and font colour.
Examples: In the MyFireWatch interface, the top area's width stretches across the entire width of the screen. This area adjusts according to the size of the screen being used.
References: The MAP component will be the most prominent feature of the interface.

Pattern name: GEO-LOCATE

Context: The map should automatically detect the user's location.
Problem: The user needs to easily locate fires in or near their location.
Solution: Use HTML 5's in-built geo-location functionality (Lawson & Sharp, 2011). This feature is included in most modern browsers, including common smart phone browsers.
Examples: MyFireWatch automatically detects the user's location using HTML 5's automatic geo-locate. This feature makes it easier for the user to orientate themselves.
References: SEARCH and ZOOM also allow the user to orientate themselves, but GEO-LOCATE automates this process.

Pattern name: SEARCH

Context: Users need to search for a location by address, a town name or postcode.
Problem: Users need to contextualise the information provided to a location of their interest. To do so, they want to search by information such as postcode, address or town name.
Solution: Allow users to enter information in an easy to understand format such as postcode, ad-

dress or town name. The search bar should be easy for the user to locate and should be displayed prominently above the map.

Examples: MyFireWatch allows users to enter location information in a variety of ways, including an address, a town name, postcode or latitude and longitude. The search bar is prominently displayed above the map feature. As some users overlooked the search feature in early iterations of the design, it was made wider and more prominent in the final design iteration.

References: GEO-LOCATE can automatically detect a user's location. ZOOM can allow a user to display the map at a resolution that is useful to their personal circumstances.

Diagram: Figure 7.2.

Figure 7.2: The search functionality provided by the MyFireWatch application. This feature was placed directly above the map and took up more than two thirds of the screen width. As some users overlooked this feature in early iterations of the design, it was made more prominent in the final design iteration.

Pattern name: ZOOM

Context: Users require controls to zoom in and out on the map.

Problem: Users need to scale the map feature to a resolution that is meaningful to their personal circumstances.

Solution: Add zoom controls in the top right corner of the map. These controls should be big enough to be easily accessed on a mobile or tablet device. A plus and minus sign have become de-facto standard ways of visualising this feature.

Examples: MyFireWatch includes zoom controls in the top right of the map. These controls are displayed prominently and are big enough to be easily accessed on mobile and tablet devices.

References: GEO-LOCATE and SEARCH can also allow the user to contextualise the information to a location of interest.

Diagram: Figure 7.3.

Figure 7.3: The zoom controls provided by the MyFireWatch application. The buttons are consistent with each other and are big enough to be easily accessed on mobile and tablet devices. These controls were positioned in the top-right of the map

Pattern name: MAP

Context: The map is the main focus of the application.

Problem: Spatial information related to the hazard should be displayed clearly and simply.

Solution: The map should be the largest component of the interface, using proportion to draw attention to it in relation to other elements (Evans & Thomas, 2007). The width of the map should take up most of the browser's width. The map itself should show town names, names of national parks and roads.

Examples: In the MyFireWatch interface, the map's width stretches to the right-hand side of the screen. On the desktop version, there is a left margin of 236 pixels to make room for the layer navigation. On the mobile version the map stretches to the left-hand side of the screen, meaning that the map component has a width of 100% of the screen.

References: MAP NAVIGATION is required to toggle the map layers — including DEFAULT INFORMATION and OPTIONAL LAYERS — on and off.

Diagram: Figure 7.4.

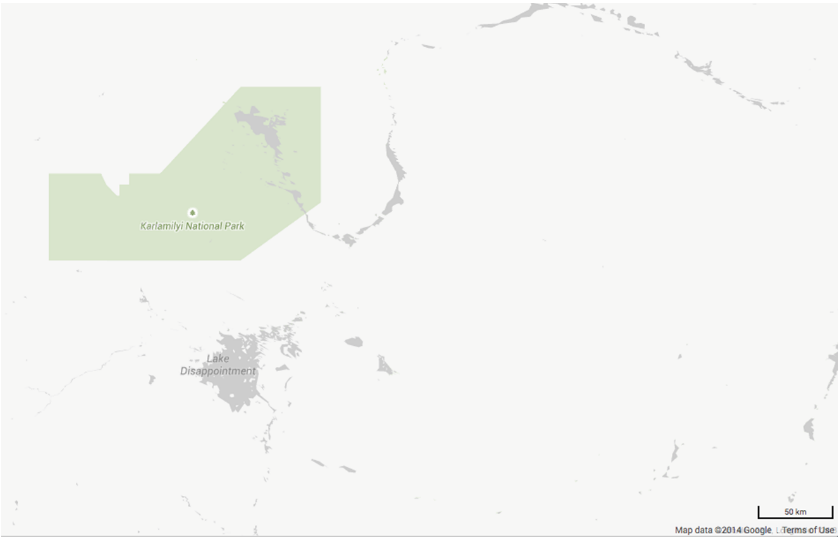

Figure 7.4: The default map background layer. This is the default background layer shown in MyFireWatch. The MyFireWatch application uses Google Maps for this layer. This layer shows town names, names of features such as national parks and road names.

Pattern name: MAP NAVIGATION

Context: Controls are required to allow the user to toggle map layers on and off. The default hazard information is switched on by default.

Problem: Users require access to the information provided, and the ability to toggle the map layers on and off. Users also need to easily understand what the layers mean.

Solution: The navigation should allow users to toggle layers on and off. Where appropriate, the navigation icons can act as a legend for the map. Use both text and icons — multimodal communication — to portray the meaning of the layers. Simple terms should be used when labelling the layers. On the desktop version of the interface, the map navigation should be situated to the left of the map. This is the case with well-known map applications, such as Google Maps (Google, 2012) and Bing Maps (2014), as well as MyFireWatch.

Examples: The MyFireWatch application provides navigation controls for every layer. The naviga-

tion is displayed to the left of the map feature on the desktop interface and is accessible via the dropdown menu on the mobile and tablet interface. Both text and icons are used to convey the meaning of the layers to the user. Only simple terms are used, such as “Current fires” and “Burnt areas”. In the case of the current fires, burnt areas and lightning activity, the navigation icons also act as a legend. For example, the fire hotspots navigation also acts as a legend — telling the users which icons refer to which timeframe.

References: The map navigation is used to control which map layers are displayed on the MAP. The navigation should only use SIMPLE LANGUAGE. Adding GEO-LOCATE makes is easy for the user to orientate themselves. Consider NATURAL MAPPINGS when creating icons for the map navigation.

7.2.3 Data patterns

Pattern name: DEFAULT INFORMATION

Context: A hazard map should show only the hazard information by default.

Problem: Information related to hazards needs to be provided to the public. The information needs to be “timely and understandable to those at risk” (UNISDR, 2005, p. 7).

Solution: The hazard information should be the only layer that appears on the map by default. This will make the information easy to understand for users at risk. Use of colour should be appropriate: for example, if there are common ways of representing a particular kind of information, that standard should be followed.

Examples: The MyFireWatch application only shows current bushfire information by default, on top of the map layer. Other information is accessed through the map navigation to the left of the map or by the dropdown menu on mobile and tablet devices. Layers that are currently shown

on the map display a tick and a grey background. The colours of the icons use the same spectrum of colours used in the previous expert-user version of FireWatch (Landgate, 2012), FireWatch Pro (Landgate, 2014b) and Sentinel (2011).

References: The MAP should be the most prominent feature of the interface. ALERTS and OTHER LAYERS can provide additional information to users. GEO-LOCATE, SEARCH and ZOOM can assist users in displaying the information at a resolution that is meaningful. Consider NATURAL MAPPINGS when creating icons for the default layers.

Diagram: Figure 7.5.

Figure 7.5: The default fire hotspot information provided by the MyFireWatch application. These are the only layers displayed when the interface initially loads. Only the essential hazard information should be displayed initially. Layers that are currently shown on the map display a tick and a grey background.

Pattern name: ALERTS

Context: Alert information should be added where available in addition to the default hazard information.

Problem: Users seeking more information about hazards will look to official alerts for further information.

Solution: Where possible, provide information from — or links to — official feeds of emergency services organisations. If the alerts are geo-tagged, they can be added to the map. Otherwise they will need to be displayed separately to the map feature.

Examples: The MyFireWatch application provides an Alerts page accessed by the main menu. MyFireWatch users requested that alerts be provided (p. 191). These alerts are also linked from the popups accessed by clicking or touching the fire hotspots. The information is provided by state and territory-based emergency services organisations with external links to those organisations. Where available, links to an organisation's Twitter page were also provided. The CalFire (2012) state-wide map application for California is an example of a fire information map interface where the hotspots have individual alerts displayed in the popup information.

References: By default, the MAP should only provide DEFAULT INFORMATION. This default information can be supplemented by alerts and OTHER LAYERS.

Diagram: Figure 7.6.

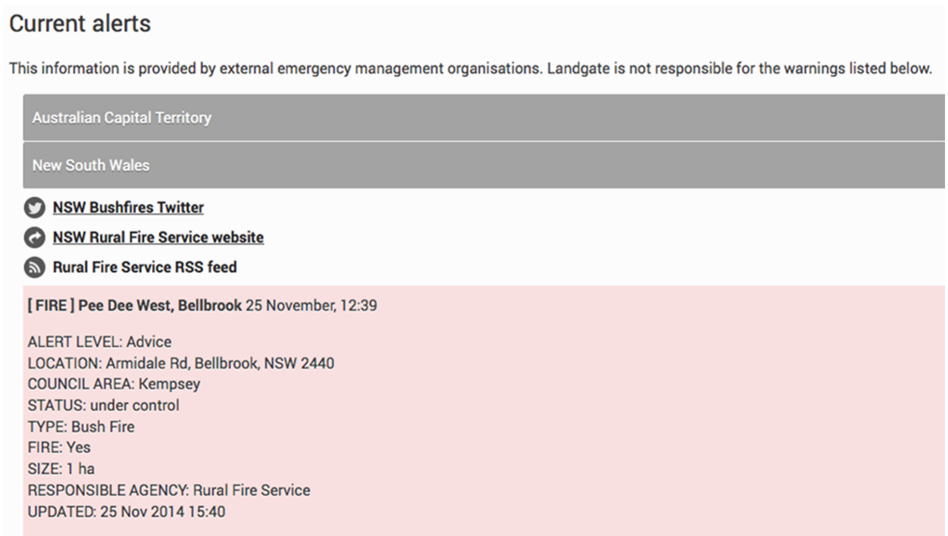

Figure 7.6: The alerts in the MyFireWatch application. Alerts from official sources of emergency information — such as emergency services — should be provided in addition to the map information. The alerts were supplemented with links to official pages of emergency services organisations, and where available, Twitter accounts of these organisations.

Pattern name: SATELLITE VIEW

Context: Provide real imagery of the land by providing users with a satellite or aerial view of the terrain.

Problem: Users require real imagery of the land to orientate themselves to key features in the landscape at closer zoom levels.

Solution: Provide an aerial or satellite view that provides real imagery of the terrain (pp. 181-182).

Examples: In the MyFireWatch application, a satellite view is available under the "MAP OPTIONS" heading in the map navigation. MyFireWatch uses the satellite view from Google Maps. Participants who took part in user testing were more easily able to locate key features in the landscape when this layer was visible at closer zoom levels (i.e., larger scales).

References: The satellite view should be one of a few OTHER LAYERS provided to users.

Diagram: Figure 7.7.

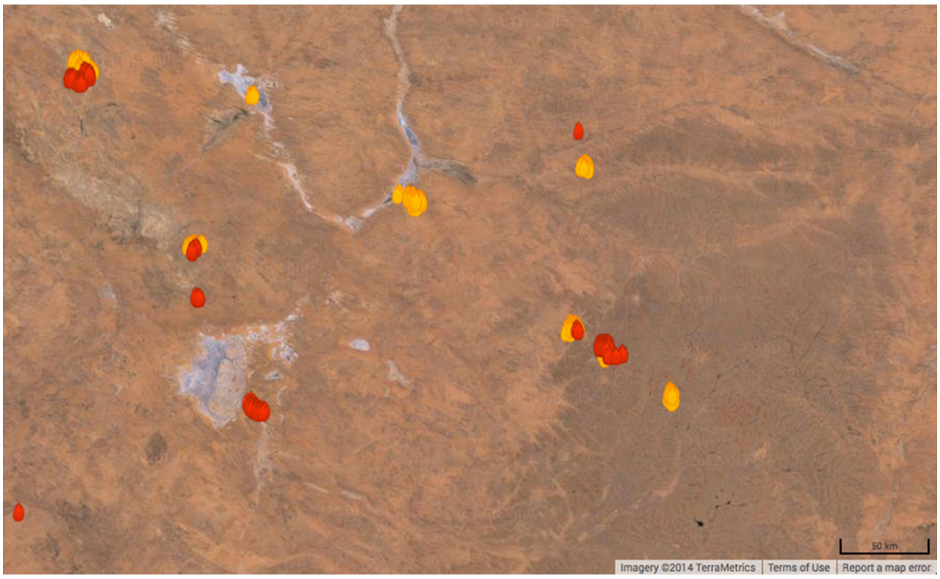

Figure 7.7: The satellite view provided by the MyFireWatch application. The application uses satellite imagery from Google Maps. Users require this realistic view of the terrain in order to orientate themselves to key features in the landscape.

Pattern name: OTHER LAYERS

Context: Provide some additional layers to supplement the default hazard information. These layers should not be visible by default.

Problem: Additional layers should be provided to users to supplement the default hazard information (p. 173). This additional information can assist users in decision-making related to the hazards in their vicinity.

Solution: Provide additional information that is related to the hazard. This should include a satellite or aerial view of the terrain. Care should be taken to only provide information that is useful for non-expert users. Relevant supplementary information may include historical data and meteorological information.

Examples: MyFireWatch provided users with five other types of information in addition to the fire

hotspots: a satellite view, weather, greenness of vegetation, burnt areas and lightning activity (p. 173).

References: Only provide up to three LAYER OPTIONS to users. Amongst these other layers should be a SATELLITE VIEW. Remember to consider NATURAL MAPPINGS when using icons.

Diagram: Figure 7.8.

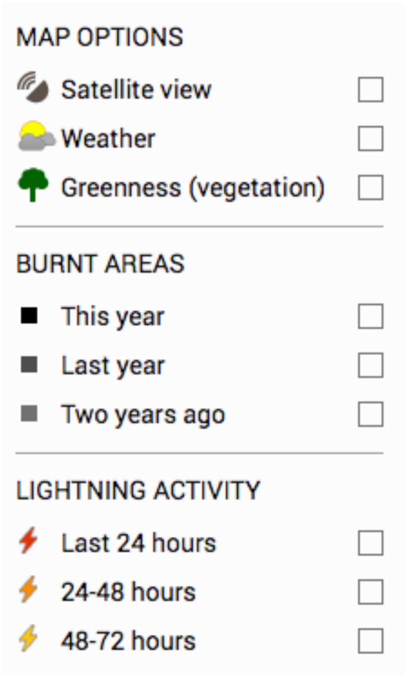

Figure 7.8: The other layers provided by the MyFireWatch application. Care should be taken to ensure that these layers only provide information that is considered essential to a community-based, non-technical audience.

Pattern name: LAYER OPTIONS

Context: Additional information on the map interface should only provide up to three options.

Problem: Information in addition to the default hazard information needs to be provided to users,

to assist in decision-making. However, care needs to be taken to not overburden the user with too much information.

Solution: Provide up to three options for each type of additional information (p. 173; p. 183). This amount of information should meet the needs for the majority of community-based users.

Examples: MyFireWatch provides three map options to users: a satellite view, weather and greenness of vegetation. There are three years of burnt areas and three days of lightning activity. These layers met the needs of most community-based users.

References: OTHER LAYERS should be provided, in addition to the DEFAULT INFORMATION.

Diagrams: See the diagram provided in the OTHER LAYERS pattern (Figure 7.8).

7.2.4 Other patterns

Pattern name: INFORMATION SOURCE

Context: Information about the source of the hazard information should be available to users.

Problem: Users need to know the source of the hazard information being provided.

Solution: Information about where the data comes from should be provided. The information provided should be timely and relevant to the user. The navigation should also be easy to use. These aspects will add to the credibility and trustworthiness of the application (Fogg, 2003, p. 154). If necessary, provide disclaimers if the data comes form external providers. The information source should be a known organisation and the source of the information should be made known to the user (Fogg, 2003, p. 154).

Examples: In the MyFireWatch application, Landgate is clearly the organisation responsible, as their logo appears on every page. Knowing that Landgate — a known state authority in WA — owns the application adds to its credibility and authority (Fogg, 2003). There is also information about the

source of the data — and its limitations — on the Terms and Conditions page, the About page and on the main page of FireWatch.

References: The source of the information should be described in SIMPLE LANGUAGE. MAP NAVIGATION should be easy to use.

Pattern name: SIMPLE LANGUAGE

Context: The terms used in the interface should be easy to understand for a non-technical audience.

Problem: The interface needs to be easily understood by a non-technical audience.

Complicated terms, such as industry-specific information, can confuse a non-technical audience.

Solution: Avoid jargon — it is likely that community-based users will not be familiar with many of the terms used by professionals. Use only simple language. The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-based terminology (Nielsen, 2005).

Examples: In the redesign of the expert-user version of FireWatch, which resulted in the community-user focused MyFireWatch interface, all jargon was removed. This included terms such as references to satellites (e.g., NOAA, MODIS, etc.) as these terms were unlikely to be familiar to community-based users.

References: Features of the interface, such as SEARCH and MAP NAVIGATION should use simple language.

Pattern name: MINIMAL DOWNLOAD TIME

Context: The application needs to be quick to load (Nielsen, 2000, p. 380).

Problem: Many users will be accessing the application by a mobile or tablet device, and therefore may be reliant on a slower connection.

Solution: Only provide information that is essential to community-based, non-technical users. By default, only provide the minimum hazard information required when the map interface initially loads. Since users on mobile and tablet devices may have limited internet access, restrict the number of layers that they can access. Note that the application's performance will be affected by the capacity of the server it is on, which may be beyond the control of those working on the application.
Examples: In MyFireWatch, the fire hotspots are the only map layers displayed by default. Additional layers only load when accessed via the map navigation. On the mobile and tablet interface, only one day of lightning activity and only one year of burnt area data are available.
References: The MAP feature should only initially display the DEFAULT INFORMATION. OTHER LAYERS should be restricted to those that are considered essential information for community-based users.

Pattern name: NATURAL MAPPINGS

Context: It should be obvious to users what effect the controls have on the system.
Problem: A design needs to be intuitive, ensuring that the spatial relationship between a system and its controls is as direct as it can be (Norman, 2002, p. 188).
Solution: The icons used should represent their function obviously. This obvious representation reduces the cognitive load on the user (Norman, 2002, p. 188). The choice of icons should reflect the kind of information being provided and the type of actions being performed. A common example of this is using a "plus" symbol for zooming in on the map and a "minus" symbol for zooming out.
Examples: In the MyFireWatch application, the current hotspot map layers use flame icons to indicate the location of current fires. The choice of icons used for the map layer information (and the map navigation icons) relates directly to the type of information that the map layer provides. The zoom controls for the map use plus and minus symbols for zooming in and out — a common way of providing this functionality.

References: When creating the MAP NAVIGATION, SEARCH and ZOOM features, consider natural mappings.

Diagrams: Consider the diagram under OTHER LAYERS (Figure 7.8). The icons used should relate directly to the kind of information provided by the map layers.

7.3 Personas: Remote community-based users in north Western Australia

As a way of "kick-starting" the design process, prior to the first iteration of the design, personas were created as a way to represent actual users. Personas are a way of modeling user types that provide a powerful way of considering the perspective of users without their direct input (Cooper et al., 2014). Personas were introduced at the initial planning stage of the redesign, which commenced prior to being able to directly engage with actual community-based users in Kununurra (as explained in Chapter 4). These personas informed the recruitment of real users in Kununurra. It was found that the personas offered a general, broad overview of users in a remote community and were useful as a way of considering users at the early stage of the design process, as described in Chapter 4. However, the personas created in the early stages underestimated the technical abilities of actual users in Kununurra, and how vital a role tourism and small businesses play in the town. Several characteristics of the community-based users in Kununurra surfaced during the user testing and interviews. The personas created here are based on characteristics of two or more actual users who were encountered in Kununurra, as described in Tables 5.2, 5.6 and 5.7 in Chapter 5. It should be noted that the intent of these personas is to inform a design where direct input from actual participants is not possible. For this reason, they are intentionally simplified so as to not run the risk of stereotyping or making too many assumptions. However, as the depth of insights from actual participants in this research showed, personas are no substitute for actual users. This updated version of the personas framework is intended to provide a means for Landgate's development team to consider end

users, as they generally do not have the capacity to work directly with users based in remote areas of Western Australia. The descriptions of the personas are as follows: Art gallery worker, grey nomad tourist, tourism operator 1, forestry worker, tourism operator 2 and café owner.

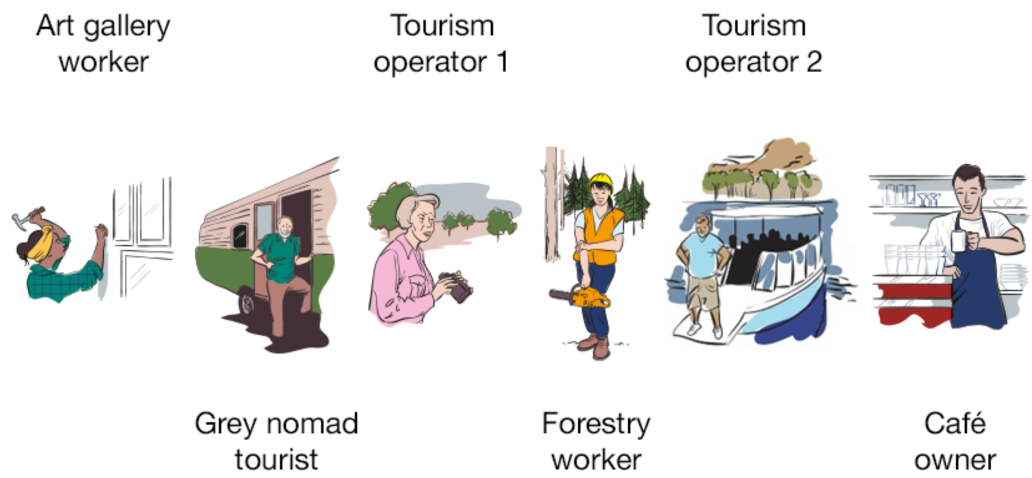

Figure 7.9: Visual representations of the revised personas framework. These personas were created as a result of direct engagement with users in the Kununurra community. These personas were considered a more accurate representation of the kinds of people found in and around the Kununurra area and were created to assist Landgate in their development. Illustrations by Dr. Stuart Medley.

The characteristics of the personas created in the Figure above are explained below. These model users are considered archetypes, rather than stereotypes (Cooper et al., 2014). These personas follow the same personas framework used in the initial planning stage prior to the first iteration of the design.

Art gallery worker

Overview: Runs an art gallery in town. Knows several other local businesses in the area.

Computer Skills, Knowledge, and Abilities: Moderate level of computer skills. Is not familiar with

bushfire map applications but runs the gallery website. Maintains contact with clients and other locals through social media.

Internet-enabled devices: Desktop computer and smart phone. *Expectations of MyFireWatch:* Will use it for planning trips out of town.

Experience with map websites: Google Maps and Bureau of Meteorology.

Grey nomad tourist

Overview: Retired. Spends half of the year living in the Kimberley area.

Computer Skills, Knowledge, and Abilities: Moderate level of computer skills. Uses the internet and email regularly.

Internet-enabled devices: Desktop machine only.

Expectations of FireWatch: Travels several hundred kilometres across the Northern Territory and Western Australia. Would check the MyFireWatch site prior to leaving a location with internet access.

Experience with map websites: Checks the Bureau of Meteorology website regularly. Occasionally uses Google Maps.

Tourist operator 1

Overview: Owns a local tourism company. Plans treks through remote parts of the wilderness.

Computer Skills, Knowledge, and Abilities: High level of computer skills. Uses Google Maps for planning of treks. Comfortable using web map applications.

Internet-enabled devices: Work computer, tablet device and smart phone.

Expectations of FireWatch: Intends to use FireWatch to assist in the planning of trek tours. Also for planning firebreaks around property.

Experience with map websites: Is familiar with NAFI, Sentinel, Google Maps and the Bureau of Meteorology website.

Forestry worker

Overview: Works at a local sandalwood plantation.

Computer Skills, Knowledge, and Abilities: High level of computer skills. Regularly works with a tablet device that includes GPS software.

Internet-enabled devices: Desktop computer and a tablet device.

Expectations of FireWatch: Will use MyFireWatch to check perimeter of plantation

Experience with map websites: Familiar with Google Maps and Google Earth. Has used NAFI but found it complicated.

Tourist operator 2

Overview: Runs a local tourism business.

Computer Skills, Knowledge, and Abilities: Moderate to high level of computer skills.

Internet-enabled devices: Uses a desktop and smart phone for her job.

Expectations of FireWatch: Would use it to alert tourists to fire threats in and around the Kununurra area.

Experience with map websites: Has used NAFI and Google Maps.

Café owner

Overview: Runs a local café. Deals with local customers as well as visitors to the town.

Computer Skills, Knowledge, and Abilities: Moderate computer skills. Does not use computers regularly outside of the business.

Internet-enabled devices: Uses a desktop and smart phone.
Expectations of FireWatch: Does not travel regularly outside the town but would use MyFireWatch if travelling long distances.
Experience with map websites: Has used the Bureau of Meteorology website and Google Maps phone application.

7.4 Discussion

The pattern language explained here generalised the results described in the previous three chapters as well as the literature that informed the design process undertaken. The design patterns aim to address problems that designers working on a similar map interface may encounter. It is intended as a guide for others working with map-based hazard information and will also assist the Landgate development team on their future development of map-based products for community-based users. The patterns describe the context of these problems, offer a generalised solution, and provide a specific example from the MyFireWatch redesign process and examples from other applications and literature. It is anticipated that these patterns will prove useful as organisations providing disaster information recognise the importance of providing systems that are both user-centred and community-focused (Victoria Bushfire Commission, 2010; UNISDR, 2005). Given that according to Borchers (2000) it was Alexander's intention to allow user input into patterns, a future research opportunity exists to refine and expand on the patterns created here in collaboration with actual users.

The personas framework presented here introduced a revised version of the personas that were created in the initial planning stage of the first design iteration. The revised version of the personas framework was informed by the direct engagement undertaken in Kununurra. Therefore, the personas presented in this chapter are considered more accurate than those that were used in the early stages of the redesign process: particularly as they now have a more realistic impression of the over-

all "tech-savvyness" of the users encountered in Kununurra, as well as an emphasis on industries that are key to the community: tourism and local small businesses. The shortcoming of the research initially lacking direct user participation led to the use of the personas presented in Chapter 4. By allowing these personas to be informed by actual users in Kununurra led to the creation of a useful personas framework which can be applied by the industry partner Landgate, or others working in a similar domain.

7.5 Conclusion

This chapter introduced two frameworks based on the results discussed in the three previous chapters: a pattern language and a personas framework. A set of guidelines for designing a map-based hazard information system for community-based users was created. These guidelines took the form of a pattern language — a series of related design patterns. Patterns are a structure that allows design knowledge to be generalised by describing a solution to recurring problems in a design context. The simplicity of patterns means that they are conducive to input from end users as well as developers and designers. The patterns were divided into the same categories that were used for the requirements at each planning stage of the design iterations described in this research: functional, data and other requirements. The pattern language provides other designers, researchers and developers with a solid foundation on which to build a map-based interface that displays hazard information for a community-based, non-technical audience. It is hoped that this pattern language will assist developers and designers at Landgate in future product development, as well as other researchers, practitioners and even users working on similar applications. Secondly, a revised version of the personas were created. Personas are a way of modeling user types that provide a powerful way of considering the perspective of users without their direct input. The personas used in the initial planning stage of the redesign were not entirely accurate. Therefore the revised personas presented here aimed to present

a more realistic portrayal of users from the Kununurra community. An emphasis was placed on the "tech-savvyness" of these users, as well as the fact that many people in Kununurra work in tourism or other small local businesses. This revised personas framework is intended to assist Landgate and others working on map-based applications intended for a non-technical community-based audience.

The next (and final) chapter discusses the conclusions and implications drawn from undergoing the entire design process that resulted in the live, MyFireWatch web application officially supported by the service provider, Landgate. It summarises the role that scenario-based design played in "kick-starting the design process" and allowing the requirements of the design to be established in the early stages of the first design iteration. It also discusses how the creation of personas were used in the absence of actual community-based users at the early stage, and that these personas later informed the recruitment of community-based users. It summarises the value of input from two rounds of engagement with community-based users into the redesign process. This research demonstrated the value of user input: that users can play a role in determining what functionality an interface should include, as well as gauging and improving on its usability. Future directions in the area of map-based hazard information — and digital disaster information in general — are also discussed, including the challenges of catering for user-sourced information.

8
Conclusion

8.1 Introduction

The previous chapter documented two frameworks that arose from the research undertaken throughout the four design iterations explained in Chapters 4, 5 and 6. The first framework was in the form of a pattern language, which introduced a set of guidelines for designing map-based hazard information for community-based users. The guidelines were then

explained as individual design patterns, which offered a description of the problem, its context, a proposed solution and an example from the research undertaken, with diagrams and code examples where appropriate. These patterns followed a structure similar to the original pattern language created by Alexander et al (1977) but modified the example described by Borchers (2001) who used them in an interaction design context. The second framework introduced was a personas framework (Cooper et al., 2014), based on the structure used in the personas framework at the beginning of the first design iteration explained in Chapter 4. These personas were based on the characteristics of actual users encountered in the two rounds of user engagement in Kununurra, as explained in Chapter 5. Both of these frameworks were created to assist other researchers and designers working on a similar problem. These two frameworks will also assist Landgate in future development of FireWatch products and other map-based products that they make available to the public.

This chapter restates the aim and motivation of the research as explained in the introduction (Chapter 1). It describes how recent inquiries into bushfire incidents in Australia — and disaster management literature more broadly — have called for individuals, households and communities to have more relevant, timely and accessible bushfire information. To address this need for greater access, the research aimed to ascertain what kind of features would be useful to regional and remote community-based users, and in doing so, ensure that adequate usability and utility was provided to these same users through the redesigned FireWatch interface.

This chapter also discusses how a practical aim of the research was to construct a prototype through which to conduct user testing, and how the final iteration of the prototype interface was adopted by Landgate (the industry partner) and launched as an officially supported web application. The research findings from Chapters 4, 5 and 6, and the two frameworks discussed in Chapter 7, are summarised in light of the aim of the research. This chapter then suggests the implications of the findings in terms of interaction design research theory and practice, and the practical and national benefits of the research. These implications are grouped into key themes that emerged in the

research process. How these implications answered the research questions presented in the introduction chapter is also discussed.

This chapter then makes suggestions for future work in related areas such as design research and communications research, as well as future development of the application. These directions include working within map-based bushfire information in other contexts and how the research may be applicable to other disaster-related contexts and interaction design more broadly. These possibilities are explained within the context of interaction design, but may have some relevance to communications researchers also working on the ARC linkage project described in the introduction, as well as other researchers working in a similar domain. Future research and development related to the MyFireWatch web application is also briefly explored.

8.2 Aim and motivation of the research

The research explained in this thesis aimed to present an interface that provided accurate, relevant and timely bushfire information to remote and regional community-based users in a simple and intuitive way. In presenting this information to these community-based users, an emphasis was placed on producing an interface that was both useful and usable, as this was considered an approach that would likely lead to user satisfaction (Hassenzahl, 2004a). To ensure that the interface provided to users was usable and met their needs through the features provided, the study directly involved a set of trial users from the remote community of Kununurra in the design process. Further information was obtained via an online questionnaire that provided confirmation that the MyFireWatch interface was usable and met the needs of the majority of users. The provision of bushfire information to community-based users through the redesigned FireWatch interface was viewed as a potential information cue for individuals, households and communities referred to in the Victoria Bushfire Commission's recommendations (2010, p. 7). Given that the prototype interface developed through

this research was adopted by Landgate and became a publicly accessible web application increases the chances of it becoming one of these important information cues. The research also aimed to adhere to Cooper et al's principle of using design for improving human situations, particularly by improving social understanding and "improving communication between individuals and groups" (2014, p. 153). Given the descriptions of use by community-based users in Kununurra (Chapter 5), as well as the positive feedback in responses to the online questionnaire (Chapter 6), this research goes some way towards improving social understanding and improving bushfire communications. This research aimed to meet the ARC's objective for linkage projects by "obtaining national economic, social or cultural benefits" (ARC, 2013, para. 4). However, there is still significant work required in raising awareness of the MyFireWatch application. The benefits of the research are discussed further under the "Implications" section. This research was undertaken as a constructive design research, which involves building something that is informed by previous practice and theory (Koskinen et al., 2011, p. 5). This "thing" at the centre was intended to be a prototype in which to conduct user testing with, but was launched as a live web application, officially supported by the industry partner Landgate. In this sense, the aim of the research far exceeded expectations. New knowledge was generated in the design process undertaken (Koskinen et al., 2011, p. 119) by creating two frameworks in the form of a pattern language and a personas framework, as well as developing a clearer understanding of the features required by the new community-based audience for FireWatch. This knowledge would also be of interest to organisations and designers working with hazard information.

The recent bushfire inquiries listed in the "Motivation for the study" described in the introduction highlighted the need for improved communications between communities and relevant government and non-government organisations. The Victorian bushfires of 2009 were the most devastating of these, with 173 deaths and widespread loss of property and livestock (Victorian Bushfire Commission, 2010). The inquiry into this incident called for greater accessibility to bushfire information at the community, household and individual levels (Victorian Bushfire Commission, 2010).

This recommendation of improved community access is also a key aspect of literature on disaster management, notably in the Hyogo Framework (2005) and more recently the United Nations report on human development (Malik, 2014). The Hyogo framework in particular highlighted the need for disaster information to be human-centred and built keeping the demographics of its intended audience in mind (2005). Both the recent bushfire inquiries and disaster management literature more broadly provided a strong motivation for undertaking this research.

This research aimed to ascertain the kind of features required by community-based users from the redesigned FireWatch interface while also ensuring that it was easy to use. The usefulness of features was ascertained by getting community-based users in Kununurra to rate these features, test the interface and then interview them about their experiences with the interface and bushfire information generally. A follow-up online questionnaire was used to validate the usability and functionality of the interface, along with questions about users' internet and media usage. The results from the questionnaire rated the interface as highly usable, and there were minimal requests for additional functionality.

As explained in Chapter 6, the final iteration of the design was adopted by the industry partner Landgate, and launched in March 2014 as an officially supported web application. Although initially constructed as a prototype with which to conduct user testing, the prototype was adopted by Landgate as an officially supported web application and launched in March 2014. This web application became known as MyFireWatch and is available at http://myfirewatch.landgate.wa.gov.au. Since its launch, the MyFireWatch application has won a Western Australian Information Technology (WAiTTA) award from the WA Information Technology and Telecommunications Alliance (2014) and a national Australian iAward (2014). These events were covered in Kununurra, WA and national media in Australia. More information on this extensive media coverage is included in the appendices. Despite minimal publicity outside of the media reports covering the aforementioned award nominations, the application has received more than 2000 page views at the time of writing,

and receives several visitors daily, mainly from within Australia. This outcome greatly exceeded the initial aim of the research, as the prototype was originally developed solely as a means in which to provide a point of focus in user testing, and to influence Landgate's interface design practices. It also observes the principle from the Hyogo framework (UNISDR, 2005) of creating emergency information systems that are provided to communities and individuals are people-centred and consider their demographics in the design. MyFireWatch — a usable publicly accessible web application built to meet the needs of remote and regional community users — can now be considered one of the information cues referred to in the Victorian Bushfires Commission's report (2010).

8.3 Summary of the findings

The first results chapter (Chapter 4) revealed that the personas framework, as described by Cooper et al (2014), and scenario-based design (Rosson & Carroll, 2002), could play a useful role in the commencement of designing a prototype interface. Personas were created that were considered broad archetypes of the kind of people one would encounter in a remote town such as Kununurra. In this context, personas and scenario-based design were able to guide the establishment of requirements by acting as a "brainstorming" activity to provoke discussion amongst the stakeholders available at this early stage of the design — which included Landgate's development team and the communications researchers from the ARC project. Personas and scenario-based design were also able to "kick-start" the design process by substituting for the perspective for actual users. Therefore, personas and scenario-based design bridged a gap in the design process between the commencement of the design and when actual users were able to view and test the first prototype. During this initial stage of prototype designing, improvements to the interface were made by simplification of the functionality provided in the previous expert-user version of FireWatch. The approach of simplification through a process of "thoughtful reduction" (Maeda, 1996, p. 1) was an effective way of improving usability

by removing unnecessary functionality. Rhetorical aspects of the interface — such as using proportion in relation to other elements to draw the user's attention to the map — were also considered when making design choices during the construction of the first prototype.

In the second results chapter (Chapter 5), the personas created in the previous chapter directly informed the recruitment of real participants from the community of Kununurra. Using personas in this way — and as a way of establishing requirements in Chapter 4 — was a positive outcome from not having direct access to users, which was initially seen as limitation in the research. Although the personas did not exactly match the characteristics of real users in Kununurra, they did assist in creating a broad overview that allowed the design process to consider the perspective of users. The two rounds of user engagement in Kununurra gave a clear picture of what functionality these community-based users required from the redesigned FireWatch. This user engagement revealed the importance of providing realistic imagery to users at closer zoom levels (i.e., higher resolution satellite photography). Several users were only able to identify points of interest in the landscape when the satellite view was enabled. Both rounds of user engagement also revealed that users adapted the information provided to their own circumstances and this could include unintended uses. The second round of user engagement revealed that the majority of users were interested in contributing content to the application, such as having the ability to report fires. Both rounds of user engagement confirmed that overall, the approach to simplicity undertaken — as explained in Chapter 4 — was a successful strategy for increasing ease of use. Maeda's approach to simplicity — that the "easiest way to simplify a system is to remove functionality" (2006, p. 1) — was a suitable approach when providing information that needs to be accessed quickly and easily. It was unknown whether the rhetorical considerations that influenced the design decisions made in Chapter 4 had an influence on the user experience. The use of the *Experience of Change* instrument (Ainscow et al., 1994) as a card-sorting system yielded quantitative data on how useful the seven core features of FireWatch were, and provided detailed descriptions of how participants envisaged using these features. This instru-

ment quantified the usefulness of these features and provided useful feedback on how these features would be used by a non-expert audience.

The results of Chapter 5 challenge the traditional view of users in HCI as being "experts in their field" (Carroll, 1997, p. 69). Cooper et al (2014, p. 41) asserted that users can range from complete beginners to experts, with the majority being at an intermediate level, which was true of the users encountered in Kununurra — they were more tech-savvy than previously assumed. With participatory methodologies including service design now being a core practice in interaction design (Forlizzi & Zimmerman, 2013), users can be viewed as co-creators and co-designers. However, as the results from Chapter 5 — and the results from Chapter 6 — demonstrated, community-based users are motivated to be content creators too. Previous research in crisis communications (Brady & Webb, 2013; Akama et al., 2013; Palen et al., 2010) and participatory GIS (Dunn, 2007) has highlighted non-experts as sources of information. It is unclear how to facilitate this user participation in an interface while still maintaining credibility and authority — important factors in an interface providing hazard-related information (Lanfranchi & Ireson, 2009; Wu, 2008). Chapter 6 explained the final design iteration. Significantly, the prototype interface was launched as a publicly accessible web application known as MyFireWatch. An online questionnaire was also launched at the same time, asking users several questions about the usability and functionality of the interface, and their internet and media usage. The questions regarding usability were answered positively and as such confirmed that the MyFireWatch interface was indeed usable. In comments provided, responses regarding the interface were generally positive, although some raised issues surrounding the visualisation of the greenness imagery and minor performance issues. As in the previous chapter, there was strong support for users being able to submit content. However, more than half of the questionnaire participants did not want the option of submitting content. Choosing to focus on usefulness and usability — as suggested by Hassenzahl (2004a) was effective at increasing the chance of providing the user with a satisfying experience. The user experience, according to Roto et al (2011) emphasises the out-

come of a user?s interaction with a system and at the least, bushfire information is now more easily accessible to a non-expert audience. The initial approach of simplification of the interface through "thoughtful reduction" (Maeda, 2006) appeared to improve usability while still providing adequate functionality to meet the needs of the majority of community-based users.

8.4 Implications

The implications of this research are discussed here, sorted by relevant themes that arose in the research process. How the research questions have been answered by the results of this research is also briefly discussed.

8.4.1 Theoretical

Simplicity as a design goal

This research also addressed the approach to simplicity in the design process. To do this, Maeda's (2006) approach of thoughtful reduction was used: that is, that if something was not considered useful it was removed. The thoughtful reduction undertaken was similar to the approach taken by Lamminen et al (2011), although in the case of this research, few sub-features were provided to users — only functionality that was considered essential to community-based users was kept from the original expert-user version of FireWatch. Nevertheless, care is required when addressing what needs to be removed. As stated by Norman (2008; 2009), simplicity for its own sake is overrated — a more nuanced approach is required to ensure that usefulness is not sacrificed in the simplification process.

Real versus abstract imagery

Prior to their direct involvement in the design process, it was assumed that the satellite view provided by the prototype interface would be superfluous for most users. However, the direct user engagement in Kununurra revealed that this was a very useful feature for most participants — especially for orientating themselves to key points in the landscape. The realism continuum suggests that an abstract representation is better than photo-realism at conveying meaning to the observer (Medley & Haddad, 2011). However, photography can be effective at providing a realistic portrayal of specific elements (Heller & Pomeroy, 1997, p. 46; Medley, 2013, p. 85). This realistic portrayal was obviously useful to those users wishing to find key parts of the natural landscape, but users required the abstract default map view to get to the general vicinity (e.g., the Kununurra area) prior to honing in on a specific part of the landscape. This result suggests that in interaction, application of the realism continuum is dynamic and dependent on the user's context. Therefore, providing options for both abstract and real imagery is important when providing spatial information to users.

Rhetoric in interaction

The consideration of rhetoric within the context of the interface guided the design decisions being made in the prototyping and designing stage of the initial design iteration. The positive outcomes from both the user engagement conducted in Kununurra, and the results of the online questionnaire suggested that the design decisions made were successful at providing users with an interface that was both intuitive and uesful. However, more work is required to work towards a way of measuring rhetorical effects in an interface. Considering simplicity, the influence of rhetoric in interaction, and appropriate use of real satellite imagery — along with the web practice of responsive design (Marcotte, 2011) — guided the design of the interface. Undertaking the design in this way answered the research question *(1) How can FireWatch be redesigned to incorporate global best practice*

and modern principles of dynamic information design to develop a more usable and intuitive version for members of the wider community?

Engaging with users

How users were engaged in this research answered the research question *(2) What kinds of user input are required for effective revision of the FireWatch service?* Ensuring that the interface offered adequate functionality is where directly engaging with actual users played a useful role in this research. It was for the sake of usefulness that both rounds of user engagement in Kununurra were asked to rate the features being provided. Research instruments are obviously required — such as the card system used in this research — to gauge the usefulness of application features. Although initially the decision to reduce functionality to improve usability was successful in producing a useful and usable prototype, it was only through testing directly with community users that we could be sure that the application provided adequate functionality. Only through knowing what features are useful to users can a designer confidently know what to remove when undertaking "thoughtful reduction" (Maeda, 2009). The results of the online questionnaire verified that the interface was usable, and there were few requests for additional functionality.

Personas framework

The role that personas can play in interaction design as a way of considering users' needs has been well established (Grudin & Pruitt, 2002; Cooper et al., 2014). The role that personas played in this research extended this role. It allowed the perspective of users to be considered from the outset, despite their characteristics not quite being true to life. This perspective allowed for the establishment of a set of requirements in the planning stage of the first design iteration. Significantly, the personas provided a sound foundation for the recruitment of real users in Kununurra in the first round of

user engagement. The characteristics of actual users then informed a new set of personas that will act as a framework for the service provider Landgate — and others working in a similar domain.

The expanding role of the user

The results of the research undertaken here suggests that the role of the user is evolving far beyond how the user has traditionally been considered in HCI and interaction design. The users encountered in the two rounds of user engagement in Kununurra — and the majority of participants who undertook the online questionnaire — were outside of professions related to the emergency services. The information presented by the redesigned FireWatch interface (which later became the MyFireWatch application) was new to the majority of participants. Additionally, these users played a role of co-designing and co-creating, reflecting the shift towards service design and a generally participatory approach in interaction design (Forlizzi & Zimmerman, 2013; Holmlid, 2009). Finally, several users in the two rounds of user engagement in Kununurra and the online questionnaire were interested in submitting content. The HCI definition of users being "experts in their field" (Carroll, 1997, p. 69) clearly did not apply to this new FireWatch audience. Cooper et al (2014) recognised that users can have varying degrees of technical ability, ranging from novice to expert, with the majority having intermediate abilities. The users encountered in this research reflected this attribute. But users can clearly offer more than their technical abilities: they can be co-designers, co-creators and content providers. These dynamic attributes show that the very concept of an end user is fluid and constantly evolving far beyond previous notions.

Providing an interface that the majority of users found usable and useful answered the research question *(3) How should the information system interface adapt to accommodate increasingly dangerous situations while providing required information for different user groups?* Most participants had an intermediate level of technical skills — something suggested in the literature (Cooper et al., 2014). The results from the user engagement in Kununurra, and the online questionnaire, suggested

that the interface was usable for the majority of users. FireWatch Pro (2014b) is available for users who require advanced features. Providing an interface that users with intermediate technical skills are comfortable using was a way of accommodating for different user types, while those requiring more information were served by a separate, more advanced application. Simplicity may not be appropriate in all circumstances as a way of providing better usability. Nevertheless, in the context here — where information provided could be relevant to an emergency situation — simplicity through a process of "thoughtful reduction" was an appropriate way of working towards an interface that was both usable and useful for a non-expert audience. However, care is required to ensure that the application is still useful for a non-expert audience with intermediate technical skills.

Unintended uses of information

The user engagement in Kununurra revealed that the information provided by the redesigned FireWatch prototype interface could be applied in ways not envisaged by either ECU researchers or the service provider Landgate. Given that the information provided by FireWatch could be utilised in ways beyond bushfire preparation and response strengthens the argument for this type of information being shared with individuals, households and communities (Victoria Bushfires Commission, 2010, p. 7).

Credibility and authority of information, information sharing and user-sourced data

Literature from Fogg (2003), Kidawara (2008), Ahmad et al (2010), Tanaka et al (2010) and Sundar (2008) revealed how to address credibility and authority in the interface, which answered the research question *(4) What relationship exists between the visual characteristics of an information source and its credibility or authority?* This literature informed the guidelines that guided the initial

design of the prototype (Table 3.5).

In the second round of user engagement in Kununurra, there was substantial support for users being able to provide content to the application. In the online questionnaire — there was mixed support for user-sourced data. Previous research has examined the role of user-sourced content as it relates to disaster information (Brady & Webb, 2013; Akama et al., 2013; Palen et al., 2010). Nevertheless, user-sourced content has does not appear to have been addressed specifically within an interaction design context, especially when looking at hazard-related information such as bushfires. In such scenarios, maintaining credibility and authority is paramount (Lanfranchi & Ireson, 2009; Wu, 2008) — something raised by a respondent in the online questionnaire. Balancing these aspects of credibility and authority in the interface with users' interest in contributing content will be a challenge for organisations who wish to provide this type of feature to users. The literature described ways of presenting an authoritative and credible interface. Useful information needs to be provided by agents of authority (Fogg, 2003, p. 111). The information provided needs to be updated regularly, and the interface should be easy to use and match the user's expectations of what the application is supposed to do (Fogg, 2003, p. 154). These aspects informed the design of the interface (Table 3.5) presented to actual community-based users.

8.4.2 Practical benefits

The following two questions were asked as a way of considering how to raise awareness of FireWatch amongst a community-based, non-technical audience: *(5) How can we engage with communities to increase an awareness of the FireWatch website?* and *(6) What role can social media play in building and increasing awareness of the FireWatch website?* The example of MyFireWatch demonstrates that it is possible to make bushfire information that was previously the domain of experts more accessible to a wider audience. As of writing, MyFireWatch has received more than 2000 views since it first went online and this is with no substantial marketing other than the coverage following

the announcement of the WAiTTA and iAwards wins (More detail regarding this is mentioned in Chapter 6 and related media is included in the appendices).

Participants in both the user engagement in Kununurra and the online questionnaire suggested Facebook as a way of raising awareness of MyFireWatch. Yet users also explained that traditional media — specifically local newspapers, local radio and television — were also significant sources of information. Simple "word of mouth" was also offered as a common way of sharing information. Landgate — and other organisations presenting similar information — will need to consider both online media and traditional media when aiming to raise awareness of such services in remote and regional communities.

8.4.3 National benefits

Part of the motivation for undertaking this research was the recommendation from the Victoria Bushfires Commission (2010) that being better prepared for bushfires is considered a shared responsibility at all levels, which meant that individuals, households and communities need to follow cues provided to them. MyFireWatch — as a publicly accessible web application that works on computers, tablets and smart phones — can now be considered one of these cues. The research undertaken here — and the publications that have arisen so far — can also inform the work of others investigating the presentation of bushfire (and other hazard) information to communities. As Cooper et al (2014) proposed, interaction designers should design systems that improve human situations, noting that this can improve understanding amongst individuals and society, and improve communications amongst communities and individuals. MyFireWatch, in the long term, may contribute to Australian communities in this way.

8.5 Directions for future research

The following section presents possibilities for future research. These possibilities apply to interaction design researchers and practitioners working in a similar domain but may also be relevant to others working with bushfire information or hazard information more broadly.

Other fire-prone communities in Australia and beyond

As stated in the limitations in Chapter 3, part of the reason for focusing on a regional and remote community is that the satellites that FireWatch source their data from are currently limited to larger fires, which are more common in remote and regional parts of the country. As technology becomes better at detecting smaller fires, there may be an opportunity to test MyFireWatch and similar systems with users at the urban-rural fringes of major urban centres. Personas could be created in situations where direct contact with these users is not feasible, using and refining the personas structure presented in this research in Chapter 4 and Chapter 7. Additionally, other regions of the world that are prone to bushfires — such as the western states of the USA and areas of the Mediterranean — may be able to use the pattern language created in this research as a starting point for evaluating and improving their publicly accessible map interfaces.

Other disaster management contexts

The pattern language created can be tested in other disaster management contexts. Several regions of the world are prone to natural hazards, such as earthquakes, tsunamis and flooding. The guidelines in the pattern language presented in the previous chapter can be verified, refined and expanded on in other contexts. The personas framework may also be tested in other disaster management contexts, provided that the application being tested is intended for a similar remote or regional community in

Australia. Additionally, there is opportunity to address the communication of disaster information beyond web and mobile applications in areas such as wearable devices and responsive architecture.

Mapping of crowd-sourced disaster management data

The findings of Chapter 5 — which discussed two rounds of engagement with users in Kununurra — suggested that there was strong support for reporting fires through a service such as MyFireWatch. The findings of Chapter 6 — which used an online questionnaire to obtain feedback from users of MyFireWatch — found that there were mixed responses to the question regarding users being able to submit content. Nevertheless 14 out of 34 (41.18%) participants were interested in the option of submitting content to MyFireWatch. Given that many people also now turn to social media during a disaster (Brady & Webb, 2013; Akama et al., 2013; Palen et al., 2010), this is an area worth exploring in a design context. Focusing on the actual interface facilitating this sort of user input means that this is a research area distinct from, but still related to, participatory GIS. Some users pointed out in Chapter 6 that it will be necessary to have a verification process in place to verify this type of information. As one user pointed out, it will also be a challenge for an organisation to maintain credibility and authority if they were to incorporate user-sourced information and this may even impact on usability of the interface. These are all issues that need to be considered from a design perspective. Given the trend towards user-sourced content in disaster-related situations (Brady & Webb, 2013; Palen et al., 2010), this is clearly an area of interest that interaction design researchers and practitioners can explore further.

The Experience of Change research instrument

The Experience of Change instrument, originally used by Ainscow et al (1994) in an education context, was later used within an ICT in education context (Clarkson, 2002). It was in this latter role

that it was used to ascertain how new technology was being adopted in a new workplace situation. In this research, it was used to gauge the usefulness of the features provided in the prototype interface. Lack of direct contact with remote community users was a limitation in this research. Accordingly, development of a digitised version of the Experience of Change instrument is currently underway. This digitised version will be used in other contexts, but still related to interaction design. The digitised version will allow researchers to customise the content through a content management system. One possible future research project could compare the effectiveness of a digital version and the traditional paper-based version. New ways of analysing the data collected from the use of this research instrument may also be explored.

Evolving role of the user

As stated in the implications, the view in HCI of users being "experts" (Carroll, 1997, p. 69) was considered an outdated notion in the context of this research, as the audience that MyFireWatch was designed for (and with) was distinctly non-expert. As suggested by Cooper et al's (2014) description of user abilities, most of the users encountered had an intermediate level of technical ability. Service design and participatory design describe these users as "co-designers" or "co-creators". But as this research found, users also have an interest in contributing content. Interaction design should perhaps consider whether the term "user" is still appropriate. There are also several opportunities to re-code much of the data collected in an attempt to discuss the less easily-tangible aspects of the user experience, which may form the basis of future publications.

The realism continuum in interaction design

Both photo-realistic and abstract imagery convey meaning to the user, with the former being useful to the users in this research for locating areas of interest in the natural landscape at closer (i.e. higher

resolution) zoom levels. More work needs to be done to ascertain other circumstances in the presentation of spatial information where photo-realistic and abstract imagery can help users orientate themselves. As stated in the implications, due to its fluid nature, interaction is a dynamic process. Like graphic design theory, interaction design theory has had little to say about pictorial graphics (Medley et al., 2014), other than the role of aesthetics in the user experience (Tractinsky et al., 2000). Yet, unlike printed media, interfaces are interactive and dynamically designed objects. Interaction designers need to consider where photo-realistic and abstract imagery are best applied, particularly where it can assist the user in information seeking.

The role of rhetoric in interaction design

More work needs to be done to address the role that rhetoric plays in interaction design. Although this research found that it is useful for a designer to consider rhetorical aspects in the design process, this research did not address rhetoric directly in the user engagement stages. In this research however, it did prove useful to reflect on both the informative and persuasive effects of the interface itself, although considering how these aspects would influence the end user essentially played a role in affirming the design decisions being made. Schneller (2010; 2009) and Buchanan (1983) pointed the way in how to consider rhetoric in graphic design but it is still unclear how rhetorical effects of design artefacts can be measured beyond merely observing participants engaging with the design. Measuring rhetoric in an interface is a worthy direction for research. A pattern language that addresses rhetorical aspects of an interface may also be a useful development.

The MyFireWatch web application

Maintenance and further development of the MyFireWatch application will continue beyond the end of the collaborative ARC project explained in the introduction. The application is now a pub-

licly accessible and officially supported application offered as part of a suite of FireWatch applications offered by Landgate. Maintenance and future development of the MyFireWatch application will be undertaken solely by Landgate's development team. At some point, the development team may need to consider ways in which to cater for the clear interest from users in submitting content (Chapters 5 and 6). How they manage this will be a challenge — particularly as they will need to balance this user need with the need to be seen as a credible and authoritative source of information. Ways that social media can be incorporated into the application may also need to be considered — particularly as a way of increasing further awareness of the MyFireWatch application within communities. This could involve adding a "share" feature that lets users share the application on social media. It could also include a MyFireWatch presence (perhaps separate to Landgate's corporate presence) on social media. At the time of writing, other ECU researchers are looking to further explore how MyFireWatch can be embedded in remote and regional community networks. The work undertaken in the two rounds of user engagement provides some background on the types of communication and media usage that remote and regional communities rely on. This background provides a sound basis on which to further explore how MyFireWatch can assist these types of communities in adequately preparing for and responding to bushfires.

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A
Media coverage of MyFireFwatch

A.1 List of media coverage of MyFireWatch, as of January 2015

- http://www.abc.net.au/news/2014-09-28/myfirewatch-brings-bushfire-information-to-wa-outback/5772860
- https://au.news.yahoo.com/a/25127770/myfirewatch-brings-better-bushfire-information-to-regional-communities
- http://www.australiansecuritymagazine.com.au/2014/06/bushfire-information-systems-winners-awards/
- http://www.acs.org.au/news-and-media/news-and-media-releases/2014/iawards-winners-announced
- http://www.ecu.edu.au/news/latest-news/2014/09/ecu-again-succesful-at-iawards
- http://www.youtube.com/watch?v=fnbBFKxsa00
- http://www.iawards.com.au/index.php/winners/2014-winners/2014-national-iawards-winners
- http://theconversation.com/new-bushfire-map-now-available-29958
- http://www.theaustralian.com.au/news/fire-tracking-website-myfirewatch-could-save-lives-in-outback-wa/story-e6frg6n6-1226995933248?nk=3b12f6e4c66fca208eebd915e7782186
- http://www.abc.net.au/news/2014-07-24/fire-watch-website-launched/5621458
- http://www.abc.net.au/news/2014-07-24/stakeholders-say-the-website-will-improve-communication/5621704
- http://www.iawards.com.au/index.php/winners/2014-winners/2014-winners-waitta

- http://www.waitta.asn.au/winners/
- http://www.ecu.edu.au/news/latest-news/2014/06/ecu-continues-winning-ways
- http://wildfire.blog.nfpa.org/2014/12/development-of-new-tools-to-monitor-wildfires-down-under.html

B
Technologies used in MyFireWatch

B.1 Summary of the technologies used in the front-end of MyFireWatch

- XHTML (Extensible Hypertext Markup Language) 1.0
- HTML (Hypertext Markup Language) 5
- CSS (Cascading Style Sheets) 3
- JQuery v1.9.1
- OpenLayers v2.13.1
- Google Maps API v3
- All graphics were created in Adobe Photoshop and Adobe Illustrator
- WMS (Web Map Service) map layers

C
Information letter

C.1 Information letter to participants who took part in interviews

Information letter for participants

MOUNT LAWLEY CAMPUS
2 Bradford Street, Mount Lawley
Western Australia 6050
☎ 134 328
www.ecu.edu.au
ABN 54 361 485 361 CRICOS IPC 00279B

Title of project: Designing for communities in bushfire-prone situations: Redesigning the FireWatch website interface.

My name is Paul Haimes and I am doing a PhD at Edith Cowan University in Perth, Western Australia. You are invited to take part in this research project, which I am conducting as part of the requirements of my degree. The research project has ethics approval from the university's Human Research Ethics Committee.

This project aims to improve the design of a version of Landgate's FireWatch system aimed at members of rural communities. If you choose to take part in the project, you will test a prototype of the FireWatch website, as well as the current public access version of FireWatch, followed by a few questions regarding your experience with both versions of FireWatch. This should take no longer than 40 minutes.

All information collected during the research project will be treated confidentially and will be coded so that you remain anonymous. All data collected will be stored securely on ECU premises for five years after the project has concluded and will then be confidentially destroyed. The information will be presented in a written report, in which your identity will not be revealed. You may be sent a summary of the final report on request. I do not anticipate any risks associated with participating in this research project. Participation in this project is voluntary and you are free to withdraw at any time and there will be no penalty for doing so. If you would like to take part in the project, please sign the consent form that I will provide you with.

If you have any questions about the research project or require further information you may contact the following:

Student Researcher: Paul Haimes
Telephone: 0407 539 005
Email: phaimes@our.ecu.edu.au

Supervisor: Dr Stuart Medley
Telephone: (+61 8) 9370 6709
Email : s.medley@ecu.edu.au

If you have any concerns or complaints and wish to contact an independent person about this research project, you may contact:

Kim Gifkins
Research Ethics Officer
Telephone: (+61 8) 6304 2170
Email: research.ethics@ecu.edu.au

Thank you for your time.

Yours sincerely,

Paul Haimes

Figure C.1: The information letter to participants who took part in interviews. Providing participants with a copy of this letter was a requirement of the ethics committee's approval of the research.

D
Consent form

D.1 Consent form for participants who took part in interviews

Consent form for participants

Title of project: Designing for communities in bushfire-prone situations: Redesigning the FireWatch website interface.

- I have been provided with a letter explaining the research project and I understand the letter.
- I have been given the opportunity to ask questions and all of my questions have been answered satisfactorily.
- I am aware that I can contact Dr Stuart Medley or Kim Gifkins (Research Ethics Officer) if I have any further queries, or if I have concerns or complaints. I have been given their contact details in the Information Letter.
- I understand that participating in this project will involve testing a prototype of the FireWatch website, as well as the current public access version of FireWatch. I will then answer questions regarding my experience with both versions of FireWatch. I understand that this should take no longer than 40 minutes.
- I understand that the researcher will be able to identify me but that all the information I give will be coded, kept confidential and will be accessed only by the researcher and his supervisor.
- I am aware that the information collected during this research will be stored on a password-protected hard drive at ECU for 5 years after the completion of the project and will be destroyed after that time.
- I understand that I will not be identified in any report, thesis, or presentation of the results of this research.
- I understand that I can withdraw from the research at any time without penalty.
- I freely agree to participate in this project:

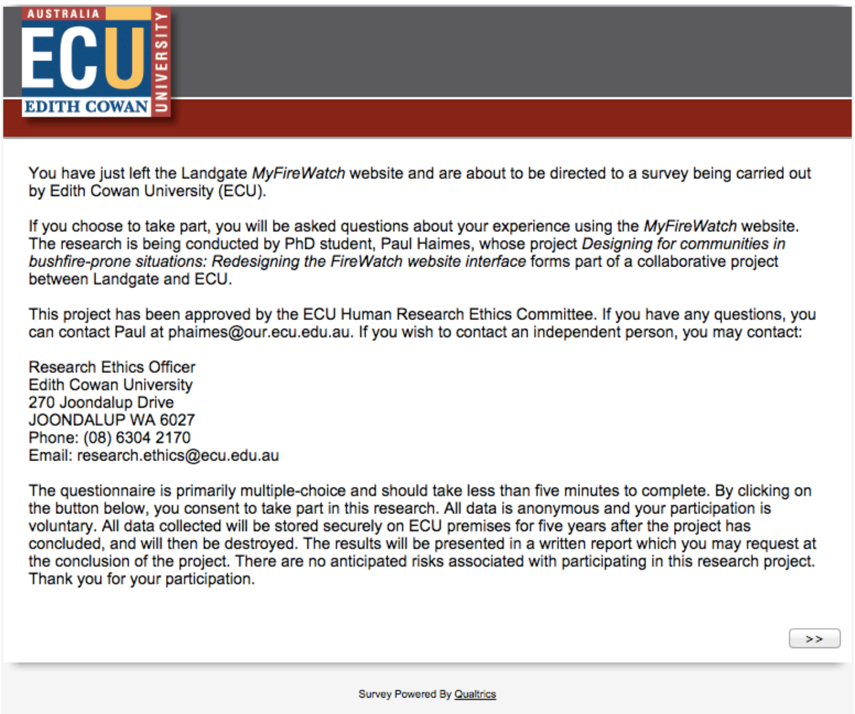
NAME: ____

SIGNATURE: _____________________________ DATE: ____________

Figure D.1: The consent form for participants who took part in interviews. Obtaining participants' permission was a requirement of the ethics committee's approval of the research.

E
Opening screen

E.1 Opening screen from the online questionnaire to inform participants and gain their consent



AUSTRALIA ECU EDITH COWAN UNIVERSITY

You have just left the Landgate *MyFireWatch* website and are about to be directed to a survey being carried out by Edith Cowan University (ECU).

If you choose to take part, you will be asked questions about your experience using the *MyFireWatch* website. The research is being conducted by PhD student, Paul Haimes, whose project *Designing for communities in bushfire-prone situations: Redesigning the FireWatch website interface* forms part of a collaborative project between Landgate and ECU.

This project has been approved by the ECU Human Research Ethics Committee. If you have any questions, you can contact Paul at phaimes@our.ecu.edu.au. If you wish to contact an independent person, you may contact:

Research Ethics Officer
Edith Cowan University
270 Joondalup Drive
JOONDALUP WA 6027
Phone: (08) 6304 2170
Email: research.ethics@ecu.edu.au

The questionnaire is primarily multiple-choice and should take less than five minutes to complete. By clicking on the button below, you consent to take part in this research. All data is anonymous and your participation is voluntary. All data collected will be stored securely on ECU premises for five years after the project has concluded, and will then be destroyed. The results will be presented in a written report which you may request at the conclusion of the project. There are no anticipated risks associated with participating in this research project. Thank you for your participation.

>>

Survey Powered By Qualtrics

Figure E.1: The consent form for participants who took part in interviews. Obtaining participants' permission was a requirement of the ethics committee's approval of the research.

F
Interview list

F.1 List of interviews undertaken in Kununurra

F.1.1 First round of user engagement in Kununurra

- Indigenous fire manager: 28th September 2012
- Farmer/Tourist operator: 24th September 2012
- Forester: 24th September 2012
- Store owner: 25th September 2012
- Tourist operator (1): 23rd September 2012
- Tourist operator (2): 25th September 2012
- Local volunteer/Forester: 25th September 2012

F.1.2 Second round of user engagement in Kununurra

- Backpackers' owner: 23rd July 2013
- Art gallery owner: 23rd July 2013
- Restaurant owner: 24th July 2013
- Local business owner/Farmer: 24th July 2013
- Indigenous art gallery worker: 27th July 2013
- Tourist/Volunteer: 27th July 2013
- Local artist and tourist: 25th July 2013

- Local business worker: 24th July 2013
- Tourist centre worker: 23rd July 2013
- Tourist operator (3): 26th July 2013

F.1.3 ARC research officer's interviews in Kununurra

- Two grey nomads: 27th August 2013
- Kimberley researcher and tourist/academic: 24th August 2013
- Grey nomad: 28th August 2013

COLOPHON

This thesis was typeset using LaTeX, originally developed by Leslie Lamport and based on Donald Knuth's TeX. It contains approximately 81500 words. The body text is set in 11 point Egenolff-Berner Garamond, a revival of Claude Garamont's humanist typeface. Figures were created in Adobe Illustrator and Adobe Photoshop, except for the questionnaire usability results figure, which was created with Max-Emanuel Maurer's Likert plotter application: (likertplot.com). This thesis document is based on a template created by Jordan Suchow (suchow@post.harvard.edu), which has been released under the permissive MIT (XII) license, and can be found online at github.com/suchow/Dissertate.