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Anticipative interfaces for emergency situations

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This case study explores concepts and methodologies in user interface (UI) and user experience (UX) design with a view to increasing information retention and memorisation through the inclusion of human-centred design principles. It focuses on the participants' individual context, mental state and abilities. In emergencies, visual perception and situation awareness may be restricted due to the impact of sensory symptoms (panic, tunnel vision or limited motor skills), thus calling for a linear course of action. This applied research project, 'Floodscape', is a mobile application designed to educate its user about possible inundation zones resulting from a tsunami. Ongoing user engagement through interactive simulation is the prime focus of the initial (dormant) state of the app. In case of an actual tsunami the app registers the event and adapts its UI accordingly. Crucial life-saving wayfinding information will then be displayed in a contextual manner considering contrast, typography, limited user attention and ease of use.

1. Background

Only a few people have experienced a large-scale natural disaster. Although this can generally be seen as a good thing in terms of survival rate, the flip side is a resulting complacency and limited understanding of avoidable risks. According to a science report from Webb, the 2004 Boxing Day tsunami in Thailand has significantly increased public awareness of the risk involved in a large scale flooding disaster. However, the pictures and stories spread by the media have not notably raised the number of people actively researching the tsunami risk in their area, nor have they increased preparedness and education levels (2005).

Another factor that has a bearing on this situation is the differing outcome expectancy of the affected people. Fatalism is the notion that "nothing I do will affect the outcome, so I may as well stop trying". This perception is engendered by TV coverage of natural disasters that focus on the most dramatic, immediate damage rather than on the success stories that occur in the aftermath. People who read more analytical reports published after the Kobe earthquake were more informed and less fatalistic about the actual damage than people exposed to the immediate news reports about the same earthquake (Cowan, McClure & Wilson 2001). Mobile media can play a role in providing people with more

in-depth information, as media reporting tends to be superficial.

The project in this case study demonstrates a way to move beyond simply providing information on tsunamis. The app utilises a predictive function based on knowledge of how people react mentally and physically when stressed so as to provide information that is more contextually relevant.

2. Methodology

The project was inspired by two research papers: Nielsen and Bjelland's report on the need for design guidelines for people in stressful situations (2006), and Weiser and Brown's paper "Designing Calm Technology" (1995). In many cases, implementation of their findings was not available at the time of their publication.

Webb (2005) describes how, when asked about tsunami risks in their area, most residents of coastal communities reported knowing how and where to find personal escape routes, remembering how warnings would be disseminated, and being capable of identifying the location displays indicating specific hazard zones. However, people unfamiliar with the same areas were incapable of identifying evacuation routes and risk areas. This situation required finding a system to provide immediate, contextual and customised access to essential information.

3. The problem

New Zealand offers a range of public information material assisting in the understanding of tsunamis. However much of the material has limited access, availability or effectiveness due to the generic, non-situation-specific and static information it provides. In-depth educational media are available in various printed forms, such as signage around community hubs, and brochures available

on demand or as downloadable PDFs, which require additional software for accessing on mobile platforms. These resources can be convoluted and may require local knowledge to be understood in context. But little is offered for those looking for personalized information. This research project aims to reduce this gap by devising a mobile app that provides quick and personalised contextual access to relevant information. The design of a mobile app brings with it several technical challenges. For example, it was necessary to merge two different software packages into a comprehensive solution: Unity 3D for the 3D simulation part, and JQuery for the interactive framework. The incompatibility of these two systems (in particular interactivity and inability for back-end data gathering and processing) restricted the solution to a visual prototype.

4. Floodscape: A tsunami education and evacuation app

Emergency management research has shown that education and awareness campaigns are more successful tools for enabling communities in crisis than the building of shelters and central hubs for emergency evacuation. As a result, our task was to create a personalised mobile application capable of educating and enabling risk awareness in a community. In the event of a real tsunami, the app would retain a consistent visual language to aid and reassure affected users. "Floodscape" combines adaptive and anticipatory UI taking into consideration the limited cognitive abilities and visual perception of a user in a stressful situation. Aimed at residents and visitors to coastal communities, the main purpose of this app is education about tsunami risks. In addition, it also serves as a notification and emergency wayfinding system should an actual tsunami occur.

The application is split into two sections. The first is the educational section, which shows the user

what does happen in a large scale tsunami disaster in their community. The UI consists of an elaborate and engaging visualisation inviting the user to simulate and experiment with various outcomes of a possible flooding event in their area. Existing fault lines and plate tectonics of the local area are shown on an interactive 3D map and the user can trigger virtual tsunami simulations on their screen by choosing from various scenarios. A close-up view of the flooded area lets the user explore the outcome in greater detail and offers a starting point for conversations and the planning of possible nearby evacuation routes (See Figure 1).

The experience design of this educational section is intentionally elaborate, inviting and detailed in order to encourage ongoing engagement and discovery. This section of the app suggests the group of people users are most likely to want to get in contact with, how they can prepare, and where to seek further information. In this state, the app is described as “dormant” (See Figure 2).

The second section of the app, which presents the calm state, focuses on the timely evacuation and transmission of crucial information needed in an actual

event. In case of a verified tsunami warning, the detailed UI of the educational state makes way for a plain and unambiguous interface catering for a person with limited situational awareness, reduced motor skills and restricted visual perception. Backgrounds are kept neutral to enhance contrast when needed, and colour is only used to shift attention. Background and coloured elements are consistent in their function and visual treatment throughout the warning states. Screens showing risk maps in the educational state of the app are presented as response maps with suggested escape routes depicting only absolutely necessary information. In these maps, primary colours are only used for high priority information content. There are two separate kinds of maps available: a converted risk map focusing on emergency infrastructure, and an anticipative, personalised and responsive tracking system displaying the current position and suggested evacuation routes. This system is especially useful for users not familiar with a location. A countdown displaying the estimated time of arrival of the first wave increases in contrast and size according to the level of urgency (See Figure 3).

Figure 1. Exploring an animated tsunami simulation on a 3D map.

Figure 2. The app suggests adding emergency contacts and shows an overview of inundation zones.

The readability and accessibility of the typography were important considerations in the development of this section. A modular messaging system allows the user to pick a variation from a range of concise sentence modules. These modules are compiled into a comprehensible message indicating the level of urgency, which can then be sent to predetermined groups such as neighbours, family or emergency services (See Figure 4).

The interactive navigation elements in both states of the app reflect their functions and encourage explorations by users. The warning stage can be activated at any

time and a simulation function lets the user investigate its visual communication and features. Learning and memorising the functions of the emergency state facilitates their quick recollection in a real tsunami scenario. An audible single alarm plays only once as an initial warning. It is not repeated to avoid stressing the affected person further (See Figure 5).

The project Floodscape was self-funded as a proof of concept, and resulted in a working prototype using static data rather than real-time data. At the time of the development, a visual prototype was more desirable for testing user reactions and acceptance. Although it was not possible to test the app in a real tsunami scenario, the app's warning system was designed with more than a single user in mind. Potential other uses include utilising the simulation part of the app for civil defence training purposes, or for large scale education in a classroom environment. Emergency management organisations are considered major potential stakeholders. Further advancement of mobile technology would allow the inclusion of neogeography tools permitting the real time tracking of all users' locations and statuses.

Figure 3. The estimated time of arrival countdown increases in size and contrast allowing quicker comprehension.

Figure 4. Swiping on the text fragments reveals different levels of urgency of the message.

Figure 5. The blue, dormant state of the app informs and allows for a personal set up. By utilising an elaborate and detailed UI, it encourages exploration and ongoing engagement. In the event of a real tsunami warning, this UI is replaced with a straight forward, and unambiguous UI, so that during a disaster, the app becomes easier to use.

Mapping user data will provide an invaluable resource for visualising areas that need immediate attention, such as the users' evacuation speed, their topographic elevation, and traffic volume.

5. The process

The various responses to triggering simulated tsunami scenarios were considered key milestones during the evaluation process. Members of Wellington's coastal communities were chosen as a test audience due to the location's predisposition to geological movement and given tsunami threat. The group of test users consisted of people living in possible inundation zones, visiting tourists, as well as a small number of foreigners who were unfamiliar with the location and its vulnerability to natural disaster. All user testers knew how to use mobile apps and were knowledgeable about tsunamis and how they develop. However, none stated they had actively searched for tsunami information.

Most local test users immediately searched for reference points on the map, and tried to locate their houses and see how they would be affected. This outcome showed that residents of coastal communities were very concerned about a disaster's impact on them personally. Further, after every demonstration, the audience asked how (and if) the app would change its ability for communication if existing telecommunication infrastructure were compromised after an earthquake. Although not part of the initial research questions, such a question demonstrated the desire for a minimum of communication and led to the inclusion of a directed and unobtrusive messaging system.

A major challenge in the project was the design of the user experience when the interface transitions from the dormant, educational and engaging state into the active and simple state in the case of a real warning. The user will need to be able to navigate an app that can change

its previous learned functions and visual language in the warning state, and still be able to make sense of its features and visual aids. Including and translating the design model of "calm technology" into the UI was an effective method to achieve this. Weiser and Brown coined the term "calm technology" in 1996 to describe their findings that the ambient features of design existing in the periphery of the users experience, rather than demanding immediate attention, have a positive assisting effect.

6. Advantages

Compared to traditional media, mobile applications have a greater potential advantage in educating and warning its audience about large scale disasters. Utilising the inherent sensors of current smartphone technology offers a directed, personalised and timely method of emergency communication. The design and experience need to fit the context in order to be effective, and should focus on the user's individual needs. Calm technology offers ways to achieve transitional, anticipative and adaptive functions in mobile apps. Furthermore, it enables the ideation and development of individual solutions for users with limited situational awareness.

Calm technology is a design philosophy and industrial design practice enhancing the usability of a product without imposing its function on the user experience. Calm technology is not commonplace in interface design and this case study proposes its inclusion in the design of UIs. The goal is to allow information to move in and out of the periphery of the user's experience and to assist in focusing on the task at hand—especially in a situation of stress when visual perception and other human responses may undergo dramatic changes in situations of stress. This case study encourages UI designers to include a second, invisible layer of functionality in their products. In UI design, calm technology shows great potential in helping users to focus on what they need and when

they need it. It also enhances their ability to complete tasks that may not be possible otherwise. Considering and incorporating the concepts of calm technology as a second layer into everyday applications can not only aid in the perception of the displayed information but also offer an advantage in timely decision making.

Other areas which may benefit from the use of calm technology include medicine, transport, emergency and evacuation systems, and sports. Calm technology might also enhance situations in which personal mobile devices collect and assess individuals' personal data.

7. Conclusion

Personal observation and experience of real tsunami warnings in our community led to the conclusion that behavioural expectations in emergencies differ in each individual person. Situations of extreme stress can result in irrational thinking and behaviour, and carefully laid plans can quickly be abandoned as part of a fight-or-flight response. In user-testing the app, mobile devices have shown to be viable platforms for reassurance, as for most people, they have become the first stop for information access in various situations. The tsunami simulation appeared to be a well-received feature for possible long-term engagement and led to lively discussions about disaster resilience. Over time, users familiarised themselves with the functionality and visual language. Comparable emergency-related apps, notification systems or social media alerts are often flawed with confusing reports, complicated layout, or congested timelines and undirected communication 'white noise'. Although social media can be undeniably useful in an emergency, test users reported their frustration about having to resort to outlets that are not fit for the specific purpose of emergency communication. The expectation is that an app would do one thing only, and do this one thing exceptionally well. In order to achieve this level

of usability, designer and design need to acknowledge the impaired cognitive capabilities of users in extreme situations. Effective support needs to better the dissemination of the message by using inherent sensors to predict an individual's situation, adapt the UI according to context, and communicate a directed, coherent and reassuring solution.

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About the author

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