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1. Abstract

This thesis explores the intersections of ubiquitous technologies, embedded democracies, and bright green futures and how that is resolved in a user interface design for a citizen centric mobile phone application.

My main question of enquiry is: How can I connect citizens to their local environment through human interface design on a mobile platform? *The Politics of Nature* by Bruno Latour proposes;

> *'An end to the old dichotomy between nature and society... of a collective, a community incorporating humans and non humans and building on the experiences of the sciences as they are actually practiced.' (Latour, 2004, p. 186-206).*

Design research throughout this thesis explores the intersections of urban health, human interface design, captology, mobile and sensor technology and citizen science while proposing an interactive mobile application for local and national governments to engage with an increasingly urban and technological savvy agora.

The aim of the accompanying mobile application prototype titled *Tune In, Share Out* (TISO), gives access to air and water quality information coupled with a mobile air quality sensor device which enables urban citizens to directly participate in the concept of the quantified self (Fawkes, 2010) by monitoring their pollution paths, while sharing this information through their respective social networks within a mobile mapping platform.

Concurrently this project contributes air quality information to aid citizens, scientists and city planners to make more informed and sustainable decisions within their local environment and agora.

Benefits of this application include citizen and environmental interaction and awareness, the ability for local government and citizens to enhance their tacit and embodied knowledge of respective groups and individual's, enabling greater understanding of each others perspective, while offering a channel of participation to an otherwise silent segment of society.

2. Ubiquitous Technologies, Embedded Democracies and Bright Green Futures

This thesis explores the intersections of ubiquitous technologies, embedded democracies, and bright green futures and how that is resolved in a user interface design for a mobile phone.

The aim of this research is to design a mobile application for individual's, local and national governments to engage with an increasingly urban and mobile population. The intention is to encourage citizens to interact with their local environment, by offering an application that provides for a citizens inherent need for self-preservation or safety, by accessing real-time air and water quality information and to be able to access life supporting information via a mobile device. The resulting application aims to satisfy basic human needs seen in the first and second tiers of Maslow's Hierarchy of Needs (below). The possibility of contributing to the collective good through annotating personal visions and citizen science observations, sharing air quality data via a personal sensor and through social media on a mapping interface, helps contribute to the top three tiers of Maslow's *Hierarchy of Needs* (Maslow, 1943).

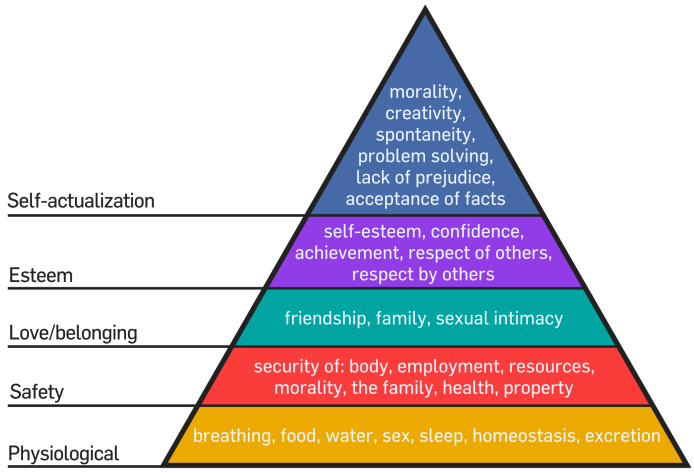


*Figure 1: Maslow's Hierarchy of Needs, (*Maslow, 1943*).*

The intention for this research is the result of the desire to change an existing situation into a preferred one, or as Alan Kay once famously said, '*The best way to predict the future is to invent it'* (Kay,1971).

At its heart this thesis explores technological convergence, where technologies evolve to perform similar functions and how this convergence manifests itself and is resolved in a user interface design. There are two major parts in the thesis: the first part *Ubiquitous Technologies, Embedded Democracies, and Bright Green Futures* explores a number of evolving technologies in turn and the relationship these have with people and their environment; the second part *Design*, explores current thinking regarding user interface design on a mobile platform together with design considerations employed to create the final application interface.

3. Ubiquitous Technologies

3.1. Mobile Phone

From the first mobile demonstration in 1973 and the first commercial service in 1983 (Shiels, 2003), mobile technology has come a long way. The technological adoption and diffusion worldwide of mobile phones is greater than any other technology humanity has known (Liang, Meeker et al., 2009). The adoption of mobile technology and mobile web is growing at an unprecedented rate, with mobile growth outpacing desktop internet (Morgan Stanley Research, 2009). Gartner (Plummer, 2010) echos many similar predictions that mobile phones will overtake PCs as the most common worldwide web access device by 2013, with 505 million enhanced phones in use. Specifically within the Asia-Pacific region 54% of all devices are estimated to be smart mobile phones by 2015 (Mobilesquared, 2010).

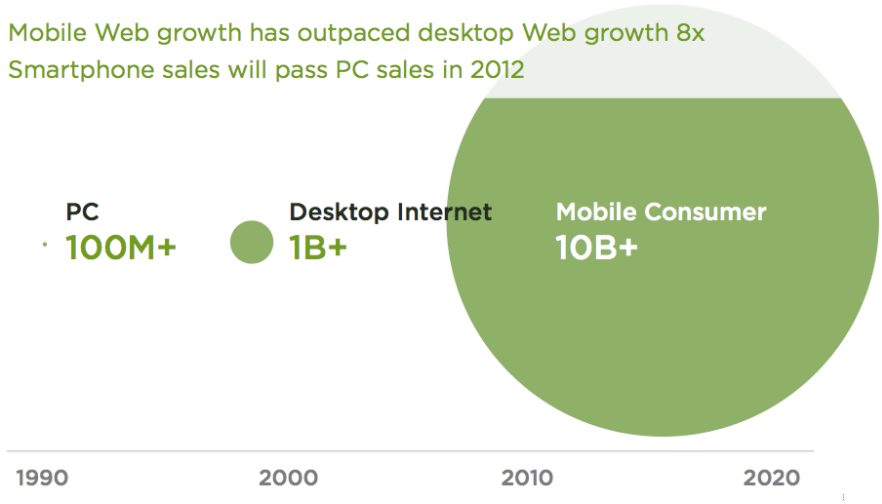


Figure 2: Mobile Web Growth,
Note: PC installed base reached 100MM in 1993, cellphone / Internet users reached 1B in 2002 / 2005 respectively. Design For Mobile 2010 (Wroblewski, 2010).

Mobile phones are a scalable technological platform that enables the inherent human need to communicate and connect with our various communities of interest. While there are some drawbacks to mobile use, such as personal privacy, work life balance intrusions, and feelings of being watched over or on call, it is ultimately the individual's choice to enable GPS, turn the device on, or even have it on their person.

Human behavioural researcher Chipchase, (2007) found that the three most important things people carry with them at all times, across cultures, gender and contexts are: keys, money, and a mobile phone. Proof that besides technological statistics of increasing mobile ubiquity, the mobile phone has moved away from a luxury device to a more common place tool.

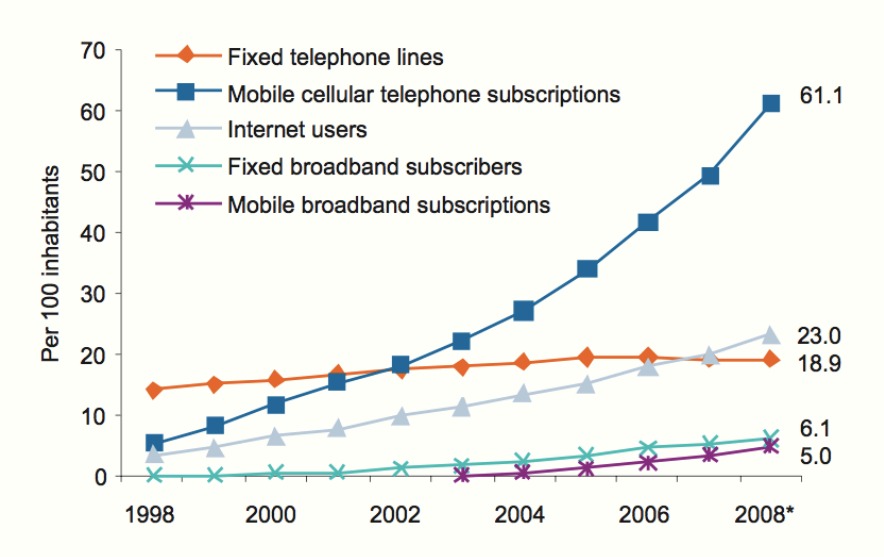


Figure 3: Measuring the Information Society - The ICT Development Index, International Telecommunication Union ITU World Telecommunication database (2009).

3.2. Digital Tools

'We shape our tools and thereafter our tools shape us'. (McLuhan, 1994, p.ix).

The earliest form of human technology is the hand axe - the Swiss army knife of the Palaeolithic period. It afforded the holder similar benefits to that of a mobile phone owner today. The hand-axe, in contrast to the rapid change in manufacturing processes since the industrial revolution, was replicated almost identically by Homo Erectus for over 30,000 generations (Ridely, 2010). The speed of innovation, manufacturing and distribution has increased dramatically to a point where many people consider their mobile phone to be out of date whenever a new one is on the market.

The thirst for new mobile tools is seemingly unquenchable, yet the consideration for the lifecycle of the product is often a throwaway thought (International, 2009). While worldwide accurate statistics regarding the number of mobile phones discarded annually is difficult to find, conservative estimates in 2003 predicted the American market to have 500 million used

cell phones weighing in total over 250,000 tons disposed of in a developing world market where minimal environmental or worker protection laws exist (Most, 2003).

The hand axe had a recyclable advantage in that was made out of a single material, according to the *Cradle to Cradle* model (McDonough and Braungart, 2002), in which it can be considered a biological nutrient, in comparison to the confection of plastics, silica and metals that make up the current day mobile phones. McDonough and Braungart argue that systems thinking since the Industrial Age is not a sustainable way to carry us into the future. They assert that as we become more aware of how interconnected our biological, social and technological systems are, it is imperative that the tools and products developed, together with the industrial processes and social systems that support them, are coupled with sustainable economic strength, cultural diversity and environmental health.

Environmental business practices are predicted to grow to recognise carbon cycles and energy usage (Plummer, 2010). Tim O'Reilly in his article titled *Tools of Change* (2004) discusses technology having an impact on society and business in unexpected ways. One business factor to consider, he states, is a:

> *'Profound change in business rules that well find in the new paradigm, in which competitive advantage comes not from controlling software APIs (which are standardized and commoditized), but by leveraging user contribution to create powerful network effects.' (O'Reilly, 2004).*

Everyware (Greenfield, 2006) discusses the differences between analogue and digital tools, where once previous mechanical, electric or a combination of the two, have since been reset as digital. The affordances of digital over analogue is the high fidelity of information encoding in ones and zeros, which equals more efficient transmission and almost cost free replication.

So if the increasing connectivity and access reduces the cost of replication and transmission, then convergence culture is in a prime position to participate and contribute digital tools which converse not only between themselves, but contribute to the wider environment.

3.3. Maps

Thematic maps combine a theme or topic with a specific geographic location and have been used to make sense of spatial information, using reasonably accurate data, since the mid seventeenth century (Vaughan-Nichols, 2009). They remain a popular communication language today as they visually encode complex data as graphics in a familiar and easily understood format (Chittaro, 2006).

There are three important aspects of the modern mobile phone that make it well suited to map based applications. First, the screens are large enough to display a map with sufficient detail

to be useful. Second, they utilise either G.P.S, cellular or wifi triangulation to geographically place the device in real time — a feature that distinguishes them from desktop computers and fixed phone lines (Meng and Reichenbacher, 2005). Third, due to their near ubiquity, they allow for the unification of open-ended systems such as the real and virtual or augmented world (Chittaro, 2006).

Using a familiar visual language allows for easy communication and collaboration between wider groups of people. The possibilities of progressive disclosure through zoom, allows for easily assimilated information. A familiar language also allows for layers of information that do not confuse the cognitive process, yet operate at the level of function desired (Cartwright, Peterson et al., 2010).

Designing for the reduced screen size of a mobile device, when compared to desktop computer screens, poses an interesting design challenge. The interactivity, infographics, icons, colour and other media solutions need to be precisely planned, while the many new perspectives and expressiveness of the map is greatly improved (MacEachren, 2001). Touch screens allow for direct manipulation of the map, and by extension with the surrounding environment, while interactions such as zooming and swiping are design strategies which facilitate exploration. The freedom to play with the content and to discover new ways of understanding connections between various data encourages curious thinking (Moore, 1965).

3.4. Man and Machine

Eugene Delacroix is known for stating:

> *'We work not just to produce, but to give value to time.' (Hannoosh, 1995, p.12).*

The mobile phone is an apt platform to enable connectivity between citizens, local governments and the environment, not least in decreasing entry costs due to *Moore's Law* (1965); but most importantly as the collaborative place where citizens can contribute and gain a sense of connectedness with the real time environment through live data feeds and by contributing air quality (Rheingold, 2005). This information can aid others health, increase social proof and therefore contribute to a personal feeling of time well spent and assimilate with the five levels of Maslow's *Hierarchy of Needs* (Maslow, 1943) (Mehta, 2010).

My application aims to provide an opportunity to extend the value of time by contributing to the local environment through an *always on platform*, whether it be through sharing ones perspective on urban planning needs and flora and fauna, uploading air quality data for the wider collective, or accessing live information for health based decisions.

Social critic Ivan Illich predicted in the 1970s the encroachment of machines on human behaviour and introduced the idea of *counterproductivity*. He believed that the institutions that

are here to assist the smooth functioning of people and processes would become an obstacle to the objectives they were meant to serve. He argued against machines that use humans as servants, but for social tools that could become *expressions* of the user. Considering *Moore's Law* (Moore, 1965), that the capability of electronic devices improves exponentially and the fact that two-thirds of the world now have mobile phones (Ahonen, 2010), the next logical step is to make digital tools which aid the connectivity that humans need with one another. Couple that with digital tools which aid in their connection with the sciences and their environment and thereby create benefits not only for the individual's life but that of the collective.

3.5. Internet of Things - Human Networks

The rise of networked intelligence through digital pathways in the last 50 years, could be seen as an intellectual or collective consciousness sea change, similar to the Renaissance (Rheingold, 2000). The Renaissance is known in part for the flourishing of education, with a strong scientific approach to discovery, which I believe coupled with technological advances is an essential component needed for solutions to our current environmental predicament. Environmental awareness and quality of life can be significantly enhanced by both interconnected and aware technological networks.

In 1950 the techno-cognoscenti of computer technology believed that computers were mysterious devices meant to be used for mathematical calculations (Rheingold, 2000. p.14). Just as some scientists today believe, computing technology then, was considered too valuable and complicated for non-specialists to interact with. The few dissenters to this limited notion had confidence in the fact that personal computing would be used to enhance the creative aspects of human intelligence - for everybody, not just the techno-cognoscenti.

The internet has more recently witnessed a rapid uptake in many-to-many publishing and access to open publishing platforms such as open source software, and intuitive interactions afforded by touch technology. These enable a broader spectrum of citizens to participate in networks designed either by individuals or governments for the many facets of collective good (Coote, 2009).

The modern day digital network has evolved to the point Bruno Latour calls the sociology of translation (Galloway, 2010). Where the social and technological interactions are given version numbers to try to keep some semblance of order to classify knowledge, practice, concerns and claims. This denotes that they are static, yet in reality they are non sequential and constantly learning and evolving from one another. For clarity of communication and this discussion I will follow on from the belief that Web 2.0 is seen as the *Communicative or Interactive* Web, defined by user-generated content and social interaction and 3.0 as the *Semantic* Web, while the Web 4.0 tag is predicted to move toward greater *cloud computing*

with the main focus being *The Internet of Things* (Group, 2009). Web 4.0 is envisaged to be focussed on the transmutation of data; a return to community and local sovereignty, global transparency and governance.

The term '*Internet of Things'* comes under the original term *Ubiquitous Computing* (abbreviated as ubicomp), coined by Marc Weiser in 1988, Palo Alto Research Center (PARC). It has many different flavours of thought or domain crossovers, such as pervasive computing, physical computing, ambient intelligence, or the web of things. It is a technological revolution that unlike the *dramatic machines* (Biggs, 2005), of today, ubicomp becomes so natural, and therefore invisible that they are used without conscious thought. Ubiquitous Computing as defined in the words of Weiser:

> *'We believe that people live through their practices and tacit knowledge so that the most powerful things are those that are effectively invisible in use... Our preliminary approach: Activate the world. Provide hundreds of wireless computing devices per person per office, of all scales (from 1 display to wall sized). This has required new work in operating systems, user interfaces, networks, wireless, displays and many other areas. [Ubiquitous computing]... is different from PDAs, dynabooks, or information at your fingertips. It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere'. (Weiser, 1996).*

Ubicomp is a new type of computing where the computer or sensing electronics, permeates the life of the user to become an invisible force assisting and complementing their life. The implementation of this domain ranges from government sponsored free wifi, mesh networks, wireless sensors to nanotechnology (Council, 2010).

> *'The future is already here. It's just not evenly distributed'. Attributed to William Gibson.*

Wireless sensors, nanotechnology and similar technologies are no longer ideas hidden in science fiction movies and secret laboratories; they are more pervasively throughout society than some may think. Nanotechnology (Edwards, 2010) is a broad term encompassing science, engineering and technology. It exists for the wider public currently through RFID and location based technology seen in cashless travel cards like Snapper (New Zealand), Oyster (London), and Octopus (HongKong). Worldwide stock transportation and around the clock monitoring including the current RFID embedded New Zealand Passport.

The melding of crossover domains like science, engineering and technology; the increasing trend of governmental transparency and local decentralisation (Gill, et al., 2003), all offer many opportunities for helpful and harmful human application. To ensure ultimately the safety and privacy of the citizens within those networks, enabling technological infrastructure and the intention for which they are made needs constant monitoring and is a paramount.

3.6. Case Study: Pachube

Pachube is a scaleable infrastructure platform for the Internet of Things that enables real-time data exchange between environment sensors and technology platforms (United Nations Population, 2007). It also offers individuals and community minded tinkerers a web based space for creating web applications and sharing data and code.

The founder Usman Haque was inspired by Dutch architect Constant Nieuwenhuys and his 1956 proposal for a visionary society, New Babylon.

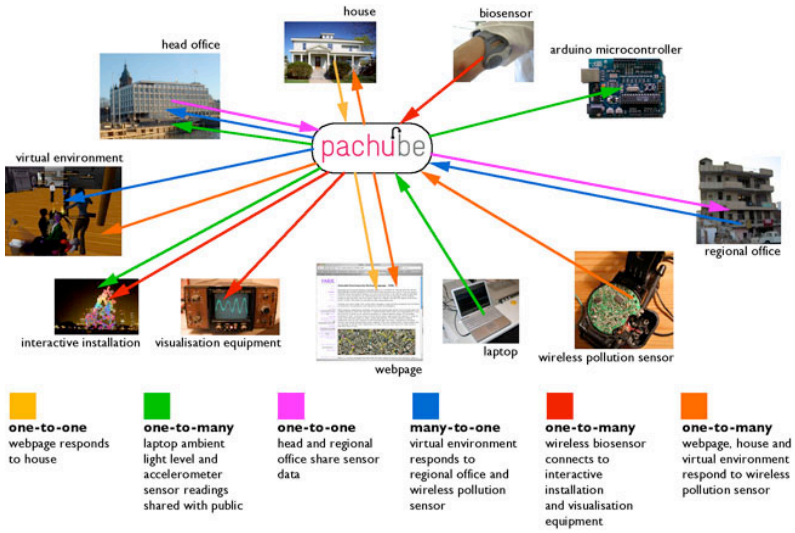


Figure 4: Pachube (MacManus, September, 2009).

3.7. Networked Cities and Urban Ecology

The last 3,000 years has seen the city evolve from a few disparate groups living together to share resources and safety in numbers, to over half the worlds population now living in cities (Pentland, 2004). Cities are now dense ecologies of natural, unnatural, impersonal and personal interactions.

Mobile technology and social software are a physical reminder that citizens are in a networked environment and are part of a constant flow of interconnected interactions. Pentland (2004) and Castells (1983) discuss the various benefits of mobile sociality over static desktop

platforms. In particular an application called Serendipity which aims to untether social profiles from the desktop to the urban network where they are most useful. My application aims to solve a similar problem of un-tethering delayed environmental health data, which is currently monitored by Wellington City Council (published quarterly) and publish this data to a live mobile specific application (TISO). Cities need to serve both nature and citizens alike if we wish to have a worthwhile future.

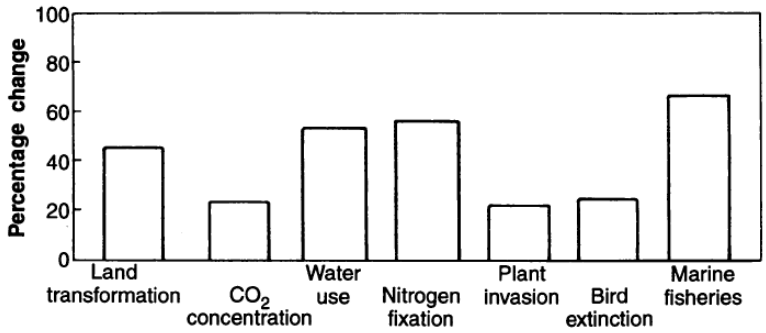


Figure 5: Human Domination of Earths Ecosystems
Human dominance or alteration of several major components of the earth system expressed as (from left to right) percentage of the land surface transformed; percentage of the current atmospheric CO2 concentration that results from human action; percentage of surface accessible fresh water used; percentage of N fixation that is human caused; percentage of plant species in Canada that humanity has introduced from elsewhere; percentage of bird species on earth that have become extinct in the past two millennia (almost all of them as a result of human activity; and percentage of major marine fisheries that are fully exploited overexploited or depleted (Vitousek, 1997, p.494-499).

The City And The Grassroots (Castells, 2004) is a study of people, urbanisation, and the relationship between citizen and city. The ties between the two are most evident when people mobilise to change their city.

Three core themes of modern urban social movements according to Castells are: Collective consumption, defence of cultural-territorial identity and local government as a target for political mobilisation. The increasing trend of local body and national governments opening up their data for public use, is one step towards greater synchronicity between citizens, and authoritative bodies.

The broad focus for my application is to provide an informational service to people concerned with the health of themselves or accompanying loved ones, while blending aspects of

territorial identity or local connectedness. This is achieved through city vision map annotations i.e place markers on a collective map to visualise citizen needs or wants through to sharing this information with city officials and interested parties to encourage greater city governance to citizen communication.

4. Embedded Democracies

The transformation towards a sustainable human future requires a participatory dialogue between the individual and the collective, to create solutions to address current day ecological disintegration. As science, much like design, is such an integral, invisible and embedded aspect of society, encouraging and enabling citizens to become more educated and involved aids the positive direction and panacea for humanity.

The following section will discuss perceptions of science within the wider public, the application of citizen science and how my application aims to provide a solution. Latour asserts the real dialogue between science and politics will begin only when we stop to think of science and politics as two separates worlds. It depends on how we harmonise the requirements of both parts. Latour argues, that science is political, as much as politics is scientific (Allum, Sturgis et al., 2008). The process of making knowledge requires the inclusion of many politics and the products (knowledge, facts, artefacts, technologies, etc.) are, as a result, convergences or hybrids of nature and the social, or science and politics.

4.1. Science and Society - Lost in Translation

The heterogeneous word *science* encompasses many aspects of technology, namely knowledge and its application but for the purposes of this thesis I shall refer to them collectively as science.

Prolonged controversies over issues such as evolution, stem cell research, and global climate change show that scientific knowledge itself is often not enough to win political debates, change government policies, or sway public opinion. That's because policymakers, the media, and the public use that knowledge in very different ways than the scientists who create it.

> *'The problem is not with scientific knowledge, but with translating that knowledge into public acceptance and appropriate policy'. (World Commission on Environment and Development, 1987, p.54).*

4.2. Citizen Science – Community as Part of the Solution

> *'There is a single light of science, and to brighten it anywhere is to brighten it everywhere, ascribed to Isaac Asimov.' (Darknight, 2006).*

Concern regarding the relationships between citizens, science and technology seems to be an important attribute of modern day society. Many political, social and special interest groups are seeking to educate, propagandise and push for their particular views on certain subjects such as energy efficiency, solutions to worldwide diseases (such as AIDS) and the various

pressing concerns regarding a resolution which is equitable for all, especially the current environmental predicament. The United Nations World Commission on Environment and Development report in 1987 titled *Our Common Future* made public the idea of sustainable development and defined it as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (1995).

Author Alan Irwin in Citizen Science - A Study of People Expertise and Sustainable Development (Irwin, 2002, p.34) argues that:

> *'Issues of environmental threat and world development cannot be successfully tackled without a full consideration of local as well as global initiatives and that of citizen-oriented as well as state led programs.'*

There are various opinions regarding the differences between crowd sourcing and citizen science. They are two separate fields yet there are many crossovers: citizen scientists are generally concerned with environmental monitoring and measuring. Citizen science or participatory or civic science is an ancient idea likely originating from ancestors who learnt which plants were poisonous or beneficial to their health. Nature lovers of the sixteenth and seventeenth century through to modern day contributions enabled by accessible technologies that aid environmental understanding from amateurs or people not academically trained in a specific area.

E. Wilson commented to the Earthwatch Institutes 2005 Annual Conference;

> *'About 200 years of amateur science of very good quality has made its way into the literature. The result is that birds, above all, and to some extent flowering plants, are so well known. The database is so big you are really able to draw a lot of important conclusions.' (Earthwatch Institute, 2010).*

Some well known historic amateur contributors to environmental holism are Benjamin Franklin, Charles Darwin, Henry Thoreau and John Audubon.

4.3. Case Study: Audubon Society and Cornell Lab of Ornithology

John Audubon contributed an invaluable legacy for American Avifaunal history. Audubon's 14 years of avifauna field observations contributed to discovery of twenty-five new species, twelve new subspecies, painting cataloguing and describing in his book first published in 1827 *Birds of America* (Audubon,1999), which is still today held as the standard for bird painting. His observations show a different time in history when wildlife was plentiful and there was little legal concern or protection in place for the birds. To date there are seven species which have since become extinct and four on the endangered lists (National Audubon Society, 2010). The longest running citizen science project started in 1900 – the *Audubon Societies Christmas*

Bird Count, where the scientific analysis of the long term collective efforts of citizen science volunteers has shown that since 1967 common bird population of America has declined by 68% and 60% of North American birds have moved their natural habitat north by an average of 35 miles, due to global warming. This long-term species view, is only possible through voluntary citizen scientists providing data to aid scientists in future modelling planning and provides evidence for local community groups to petition lawmakers and plan future projects.

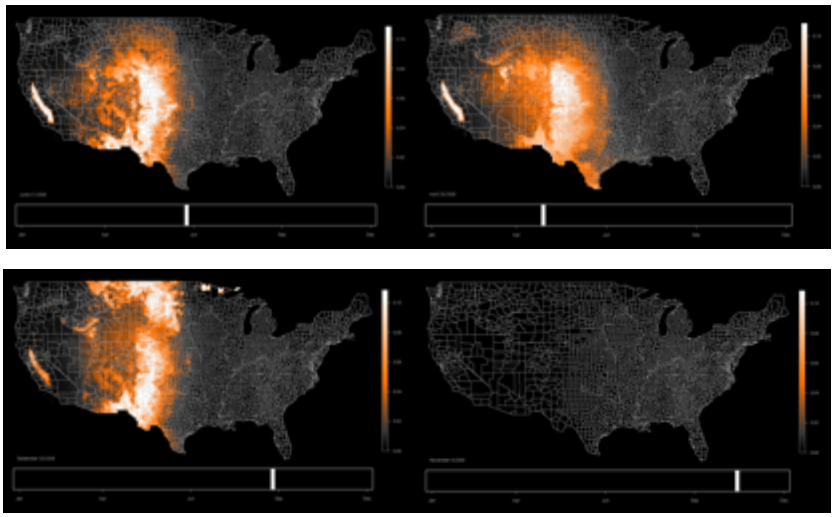


Figure 6: eBird Animated Occurrence Maps. Patterns of bird occurrence at continental scales. Only now, visible and possible through the contributions of citizen scientists (42 million records). Ongoing research at the Cornell Lab is currently producing cutting-edge graphics (visible above. A result of Audubon Society and Cornell Lab of Ornithology partnership (eBird. 2010)).

4.4. Value of Biodiversity and Citizen Scientists

Numerous worldwide projects are greatly aided by citizen scientists to help monitor and gather data on flora and fauna biodiversity, from star gazing to water and air quality. Some projects, like the United States Environmental Protection Agencies (EPA) Volunteer Monitoring and Assessing Water Quality Program, have links between national scientific agencies and local citizens to foster training and contributions; but smaller countries with less resources or state funding such as New Zealand's non-profit Forest and Bird Society, estimate 864,000 volunteer hours are donated each year, and are vital to the continuation of environmental monitoring programs (Earthwatch Institute, 2010).

The benefits for the individual citizen scientist, besides a greater bioregional awareness, are a greater sense of place, local connection and connection with like minded individuals and therefore an extended community. Wider societal benefits include, an increased scientific and environmental knowledge base, which encourages a greater interest in the local environment that could lead to increasing pressure being placed on governments to espouse more meaningful environmental policy actions.

Dr. Wilson a world expert on biodiversity, touts citizen science as the answer to the lack of awareness and action regarding species extinction (Google, 2009). He goes on to say that there are three great interlocking and overlapping problems hindering action and environmental solutions: lack of concern for the environment, failure of science education, explosive growth of biology as a *science*. These problems are addressed and enabled in this application (named Tune In, Share Out) through the principles of captology and the ever ubiquitous mobile phone.

4.5. Citizen Science

As more devices become location aware, and the Internet of things flourishes, social uses will continue to evolve beyond just who and what, to when and where. Eric Paulos, a computer scientist at Carnegie Mellon University, predicts the rise of citizen scientists able to measure and sample their surroundings wherever they go.

Figure 7: N.A.S.A iPhone Chemical Air Tester Prototype (NASA, 2009).

When people can report mundane variables such as the level of traffic noise in their street or the degree of air pollution at the bus stop, he argues, their outlook on science changes. People develop a relationship with and a sense of ownership over the data. He foresees amateur experts being driven by a new sense of volunteerism, the 21st-century equivalent of cleaning up the neighbourhood park.

4.6. Case Study: ParkScan

A successful example of this volunteerism crowd-sourced citizen science, is currently functioning well in the USA. *ParkScan* is a website that enables San Franciscans, via a web enabled device to report issues they observe in parks, directly to city staff. ParkScan gives everyone a way to get involved in keeping San Francisco parks clean, safe, and fun. Budget constraints make it impossible for City staff to be in every park every day. ParkScan allows City residents to report and monitor conditions they feel are important to their parks upkeep. This information is vital to the Recreation and Parks Departments timely response to maintenance issues. Reports provide invaluable data for them because they substantiate the need for resources during the budget process. ParkScans annual reports provide important trend information about park maintenance across the city, so data can be compared year to year.

Figure 8: Trees Crimes and Cabs by Shawn Allen from Stamen Design. San Francisco city is a good example of the recent governmental trend towards transparency and opening up citizen centered and municipal data and the resulting citizen centric applications (Allen, 2009).

4.7. Case Study: Fix My Street

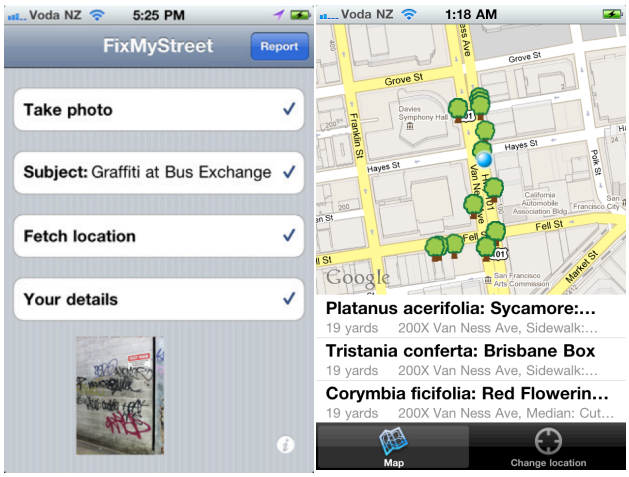


Figure 9: Fix My Street (left)(Hunt, 2010). Figure 10: SF Trees (right)(Madrigal, 2010).

An iPhone specific application called *SF Trees*, encourages people to learn more about the flora within local parks. This is made possible by the local municipal body opening up land and environmental use data. SF Trees uses the GPS within the phone to locate the nearest tree with the common and Latin names available. Creator Amber Bieg said *'It was really inefficient for one individual or even a group to go out with GPS units and survey trees'*, so by opening up previously hidden data and crowdsourcing tacit information, the local community benefits, while municipal authorities can allocate funds more accurately. Conducting tree surveys is expensive for local governments, costing $3 per tree. If you are LA and you have 10 million trees, you're spending 30 million dollars, estimates Bieg. Thats bigger than the entire urban forestry budget.

Built with open data principles in mind, the data is made available for government, developers and local communities alike. Possible future extensions to this idea will be made possible with developing mobile camera recognition technology, such as Google Goggles. (Google. 2010).

A New Zealand based application, which encourages community and council engagement, and directly applies Broken Windows theory is *Fix My Street*. Inspired by the UK OpenSource, MySociety version of Fix My Street, which is now available in both web and iphone application formats (as of October 2010). The application enables local citizens who are more likely to be aware of and have greater concern for their own area, to directly report problems to their council through either the desktop or mobile platforms.

4.8. Benefits for City Citizen Technological Engagement

As the internet, mobile phones and sensors are relatively new subjects of study, there is some argument but little evidence that internet enabled technologies will further entrench current democratic and political beliefs yet there are many more (Eagle 2010). This may be true for the short term, however as technology driven societal change is a hall mark of our era (Liang, Meeker et al., 2009) the political will be slower to change than the rate of technology adoption. This combined with diffusion to a broader reach of people's alongside trends towards governmental transparency, means there is likely to be a balancing of the scales.

The benefit of the street as a platform (Dan Hill, 2008) or, when the world is invested with sensors and human platforms for engagement, is that there is the opportunity to look at the processes, scales and rhythms that are beyond the threshold of human perception. The examination of previously unseen patterns (Eagle, 2009), increases scientific understanding and knowledge and it encourages citizens to become change agents, or active participants and stakeholders within their city.

Explicit sensor data could lower the information costs for government and society associated with decision making, lower the human and environmental costs of making uninformed decisions, close the gaps between state, science and society (Chee-Yee Chong et al., 2003) engage the human subject as an active, imaginative agent, as well as a source of knowledge, insight, and memory (Smith, et al., 2009), and engage the citizen in the co-creation of the cityscape.

4.9. Communities and Social Media

With any new technology there are positive and negative consequences. The rise of online networks and enabling technologies can distance human beings from one another, yet at the same time there are multiple positive benefits for social participation.

A Sociological study (McPherson. et al., 2006) argues that new technologies since 1985, such as the internet and mobile phones, have caused Americans to become more socially isolated, the size of their discussion networks has declined, and the diversity of those people with whom they discuss important matters has decreased. In particular, the study found that Americans have fewer close ties to those from their neighbourhoods and from voluntary associations.

These findings have been recently disproved in a Pew Research Center Report titled Social Isolation and *New Technology* (Hampton, et. al. 2009) which explores for the first time the role of the internet and mobile phones in people's core social networks. The study found that Americans are not as isolated as has been previously reported. People's use of the mobile

phone and the internet is associated with larger and more diverse discussion networks (the diversity of core networks tends to be 25% larger for mobile phone users and 15% larger for internet users). When people's full personal network was examined (their strong and weak ties), internet use, and use of social networking services were associated with more diverse social networks. Therefore a wider range of social networks could help people become more rounded and accepting of differences, than people who have less contact with people or information that is outside of their comfort zone.

Another pertinent finding in the report showed that the Internet use does not pull people away from public places. Rather, it is associated with engagement in places such as parks, cafes, and restaurants, the kinds of locales where people are likely to encounter a wider array of people and diverse points of view.

While the trend towards isolation regarding the effects of mobile phones argued by McPherson, (McPherson. et. al. 2006) has since been debunked, research in *Social Isolation and New Technology* (Hampton, et. al. 2009) revealed close family ties have dropped concurrently with a slight drop in the number of people who have no close confidant. Perhaps this loose connection with family ties is a naturally occurring phenomenon, due to a particular stage in a persons life (that is a large proportion of mobile owners are young adults who may be leaving home for the first time), world wide trends towards urbanisation and reduction in western family size, or related to differences in personality types affecting network size, as opposed to something which can be pinpointed to particular uses of technology.

4.10. Social Media and Political Engagement

High levels of income have typically dominated political engagement, yet recent findings show the opposite (Smith, 2009). Social networking, media, blogs and access to the internet are providing a platform where typically younger citizens, are becoming more politically active (Howell, 2006).

Concurrently, participation in civic matters discussed in blogs and social networking sites is slowly altering traditional socio-economic participation patterns. While citizens who participate online are shown to be more active offline as well (Smith, 2009). As the internet is becoming more a place involved with political activities and discussions, half those who are involved politically online, concurrently communicate with other digital communities.

Moore's Law, the fall in the price point of accessing the internet, and the rapid growth of the mobile web, coupled with predicted growth in social media and content sharing (Plummer, 2010), will enable greater political and environmental participation.

4.11. Case Study 1: Recovery

A good example of open government data being applied to an augmented reality mobile application for greater public understanding and awareness, is Sunlight Labs use of *Recovery*. This application uses the Layer platform as a technological service to visualise where the United States government spent the $787 billion from the *American Recovery and Reinvestment Act*. Layer enables viewers to download pertinent layers of information of interest to the mobile owner that enable exploration, more informed decisions and serendipity in real time that blend real world maps with computer generated graphics for an augmented or virtual reality.

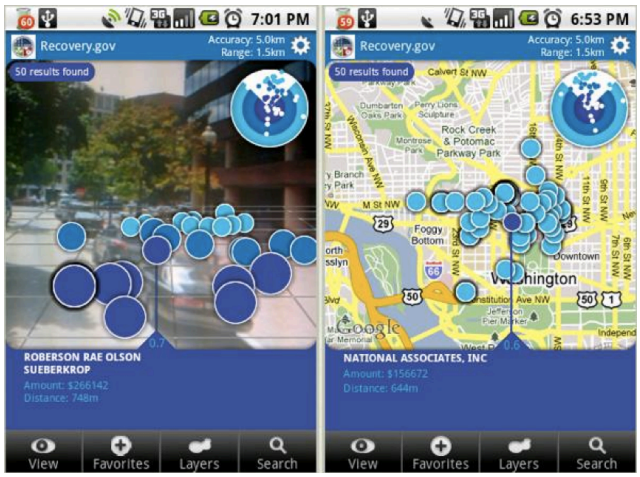


Figure 11: Recovery is an Augmented Reality iPhone application which tracks where 2009 US govt. bailout trillions were spent (Turk, October 2009).

4.12. Case Study 2: Ushahidi

One example of concerned citizens creating a democratic use of technology, mapping platforms and mobile technology which enables a more integrated socially aware society, is *ushahidi.com*. This platform was built after the contested Kenyan elections in December 2007, where the resulting breakout of ethnic violence caused the Kenyan government to impose a media blackout. Lawyer Ory Okollohs blog commentary about the local violence and local Kenyans comments, became an important source of media for locals as well is international media. The blog was swamped with comments, which prompted a cry for assistance from Okolloh to create a platform that could handle the traffic, which in turn led to two of her readers helping to create Ushandi (or *testimony* in Swahili). The initial website deployment which aggregated tacit local knowledge sent from Mobile SMS on a map, now known as crisis mapping; was so popular it had 45,000 users in Kenya. This enabled an accessible platform

for local knowledge to become available for all. Ushandi platform has since been grown from Kenya to be used worldwide by multiple groups, (such as International Center for Transitional Justice, and Al Jazeera during the war on Gaza and more recently, 2010 Haiti earthquake, and the 2011 Christchurch earthquake). It has now developed into a free downloadable, open source platform for any person or organisation.

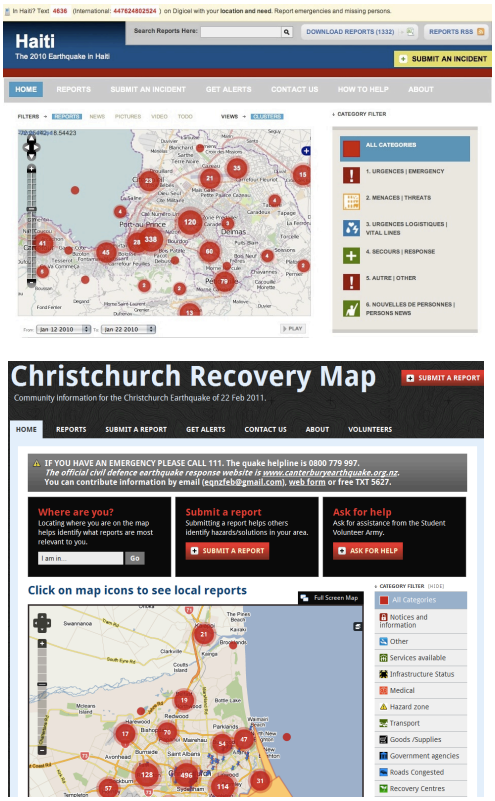


Figure 12: Two recent examples of Ushahidi.com. (top) Haiti 2010 Earthquake. (below) Christchurch 2011 Earthquake Map.

4.13. Collective Intelligence and Crowdsourcing

To understand where the Web is going, it helps to return to one of the fundamental ideas of the start of the internet and now extended in Web 2.0, namely that successful network applications are systems for participating in and extending collective intelligence (O'Reilly, 2004).

Many people now understand this idea in the sense of crowdsourcing, meaning that a large group of people can create a collective work whose value far exceeds that provided by any of

the individual participants (Pool, 1983). The Web as a whole is a marvel of crowdsourcing (Benkler, 2006), as are marketplaces such as those on eBay and Trademe, mixed media collections such as YouTube and Flickr, and the vast personal lifestream collections on Twitter, MySpace, and Facebook.

Many people also understand that social applications can be constructed in such a way as to encourage their users to perform specific tasks, like building an online encyclopedia (wikipedia.com), annotating an online catalog (amazon.com), adding data points onto a map (the many web mapping applications), finding the most popular news stories (digg.com, twine.com) or mapping the galaxy (Matson, 2009).

4.14. Media Convergence, Participatory Culture, Collective Intelligence.

'Convergence between historically separated modes of communication lies in the habitability of digital electronics'. (Pool,1983, p.31).

U.S. Mobile Internet Time by Category: May 2010

RANK	Mobile Sector	Share of mobile Internet Time based on total time at an individual site-level*	Share of mobile Internet Time based on average time spent at a category-level**
1	E-Mail	38.50%	41.60%
2	Social Networking	10.70%	10.50%
3	News & Current Events	7.20%	4.40%
4	Search	6.30%	7.10%
5	Portals	4.60%	11.60%
6	Entertainment	4.30%	3.30%
7	Sports	4.10%	2.30%
8	Music	4.00%	3.10%
9	Videos/Movies**	3.00%	2.00%
10	Weather	2.80%	2.80%

Source: The Nielsen Company

*The original share of time analysis was based on the average time spent at a category-level **The Videos/Movies category refers to time spent on video-specific (e.g., YouTube, Yahoo! Videos, Hulu) and movie-related websites (e.g., IMDB, Blockbuster and Netflix) only. It is not a measure of video streaming or inclusive of video streaming on non-video-specific or movie-specific websites (e.g., streamed video on sports or news sites).

**New Analysis

Figure 13: (Company, T. N. 2010).

The majority of the twentieth century was controlled by a few media companies and technology types, only accessible through separate modes of use or technological capabilities. Due to their economies of scale they tended to dictate and drip-feed (what little) aspects of culture and information were and are presented. This can have a homogenising and skewed effect on societal intelligence and acceptance of difference. Technological advances in the last quarter of the twentieth century have led towards the digitisation of greater amounts of information available on the internet, enabling increased information

sources for mobile phones, and have disrupted traditional economic production, copyright law and established competition (Benkler, 2008). This disrupts the old industry monopolies, in favour of empowered individuals who are then put on a level playing field with industry giants.

4.15. Old Media and New Network Culture

> *'For more than 150 years, new communications technologies have tended to concentrate and commercialize the production and exchange of information, while extending the geographic and social reach of information distribution networks'. (The Neilsen Company, 2010).*

This led to monopolies of information or mass-media (McLuhan and Nevitt, 1972; Lawson, 2009), which due to their economies of scale, could dictate what aspects of culture and information were presented. This can have a homogenising and skewed effect on societal intelligence, which inevitably leads to passive and undifferentiated citizens.

The rise of the internet and therefore decentralised intelligence and information, has led to a new networked information economy. The most important aspect of the networked information economy, according to Yochai Benkler (2006) is the possibility it opens for reversing the control focus of the old industrial information economy, or a hierarchy that constructs and mediates reality (Jenkins, 2006).

Today, there is a multitude of public and private interconnected networks, which cater for a wide variety of knowledge and purposes (Castells, 1996). These range from interest communities, newsgroups, forums, blogs, and the increasingly popular social media category such as Facebook or Twitter.

The level of intimacy on this social media platform by being public or privately accessible is individually determined, and security details like the geo-tagging of tweets, are individually determined. The people who inhabit these spaces are not like the people of yesteryear, passively drip-fed manufactured information from a small source. These are people who give another layer of meaning to the 1980 term coined by Alvin Toffler, *prosumer* (1996), these participants who actively engage with participatory culture therefore are contributing to collective intelligence (Steffen, 2006).

4.16. Platforms for Urban Participation

Castells takes a more critical perspective of modern global information flows, convinced that the urban landscape is a more them versus us mentality regarding urbanism as the global elite versus the sectarianism of local communities. He thinks that identity crises are occurring due to the lack of communication between the elite and local population (Steffen, 2006). This it

seems is less of an issue in less populated countries, like New Zealand, where access to decision makers is easier in comparison with more populated countries. However auto-ethnographical research from social media and face to face discussions during seminars and conferences has led me to believe that there is a significant body of people within New Zealand who feel alienated from their local political and ruling governmental bodies and wish there were more platforms for participation.

Kazys Varnelis states instead of individuals, we are made up of multiple micro-publics, inhabiting simultaneously overlapping *telecocoons* (Varnelis, 2007) as if this recognition of the smaller self in a larger network is a negative occurrence, where in fact greater community participation contributes to a happier society (Maslow, 1943).

Manuel Castells in *The Rise of The Network Society* (Fisher, Rolfe et al., 2002) believes that '*our societies are increasingly structured around the bipolar opposition of the Net and the Self*' where *the net* stands for vertical governing hierarchies and *the self* as an individual's worldview.

I believe the combination of the popularity of social media platforms, coupled with rising access to these online informational platforms, with the worldwide trend towards more governmental transparency, will enable greater trust and feeling of connection with our governmental bodies or as Castells says *nets*.

4.17. My Sensor

> *'Tell me and I will forget,*
> *Show me and I may remember,*
> *Let me do it and I will understand'.*
> *Attributed to Confucius, 450 BC (*Confucious, et al.,1994).

My iphone application is coupled with an Arduino based sensor device, which enables the wearer to: Become part of a city-wide community of distributed intelligence, get outside and observe and interact with the built environment literally as opposed to experiencing life virtually, due to its design, have the choice of contributing to urban health information, participate and observe personal pollution paths and the quantified self.

Arduino is an open-source electrical prototyping platform, which extends the capabilities of Moore's Law by making interactive electronics easily accessible for a wide range of creatives and therefore through the products created, the general public.

The design of this sensor and mobile application follow the *Ethical Development* principles outlined in *Everywhere* (Greenfield, 2006): default to harmlessness; must be self disclosing; conservative of face; conservative of time; must be deniable. While the Arduino and mobile hardware can both track GPS coordinates, the mobile application and sensor have been

designed to give the individual the choice of deciding to contribute or share, publicly or privately, their urban perspectives or health information (air quality data).

5. Bright-Green Futures

> *'Nature is over. The twentieth century did it in. There's not a litre of seawater anywhere without its share of PCB and DDT. An altered climate will reshuffle the ecological deck for every creature that breathes. You can't escape industrialism and hide from the sky. It's over. From now on, Nature is under surveillance and on life-support. A 21st century avant-garde has to deal with those consequences and thrive in that world'.*
> *Bruce Sterling, Founder of the Viridian Design Movement . (Robertson, 2007)*

This section explores a number of evolving technologies and the relationship these have with people and their environment.

On the surface environmentalism seems to be a modern fad, yet historically concern for the environment can be traced back to Plato, where he despairs for the downfall of Athenian forests (Roemer. H, 2001). Athenian citizens by comparison to modern man and the scientific advancements since, were living in harmony with nature. They were more connected and aware of the cycles and interconnectedness of life than modern society seems to be.

Modern society has now developed various shades of environmentalism, ranging from gray to bright green (Steffen, 2009). As with the colour spectrum there are many crossovers between the definitions, but for the intentions of this thesis, the focus stems from a bright green perspective.

Bright green environmentalism is a term coined in 2003 by Alex Steffen; a founder and writer of the modern day version of the *Whole Earth Catalogue*, called *Worldchanging*. Worldchanging and Whole Earth Catalogue, were both non-profit ventures, ahead of their time which provided solutions based journalism coupled with a positive attitude and tool based approach towards environmental issues.

Bright Green environmentalism is a version of environmentalism that believes in urban revitalisation, innovation, design, and entrepreneurial zeal to reconstruct the cycles and systems of modern day life. The futuristic focus embraces green technologies, closed loop material cycles, and sustainable product designs combined with well-built communities to improve quality of life for all. The technological focus of Bright Green thinking is expanded on in the book Worldchanging (Steffen, 2006), where a cleaner greener life cycle approach to computing is advocated. The mobile application Tune In Share Out (TISO) and accompanying mobile sensor device I have designed as part of this thesis submission follows the Bright Green ethos.

The main Bright Green computing touch points are:

The computer of the future will be super-efficient - due to the bright green focus and production of more efficient processors and CPUs to lower energy usage.

The computer of the future will be clean and green - deadly toxins will be removed from all internal and external computer circuitry and mobile devices with compostable cases. The end cases for the environment and the hands which the salvageable parts pass through are considered.

The computer of the future will be recyclable, and the parts reusable - modular design of computer components will enable a greater solutions for the environment and the consumers pocket.

The computer of the future will be about services - an idea with similarities to citizen science, in the sense of collectivising well-being. Bright Green thinking discusses the sharing of currently wasted energy and processing power of computers idling.

Designers and creative citizens alike are now in a privileged position with emerging technologies such as self replicating rep-rap machines that can use recycled plastics to print items from the desktop, lessening the printed objects carbon foot print, through to open-source communities internationally sharing and building easily repairable knowledge platforms such as OLPC (Howard 2008). Many emergent bright green technologies are evolving to enable the individual to create a more sustainable future for the present, and with a little bit of foresight, create quality closed-loop or modular products and services for a brighter future.

5.1. Health and Pollution

> *'The global city is a distributed phenomenon. There is only one global city, and it floats on top of the others like lace'. Manuel Castells (Merholz, 2004).*

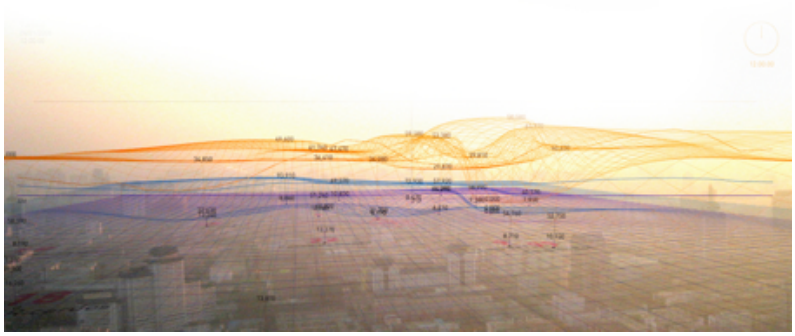


Figure 14: In The Air. A desktop based air quality visualisation collaboration in Madrid (Calvillo, 2008).

The health of cities is typically accessed by GDP, unemployment, educational test scores, and literacy levels. It is a sad indictment of humanity when the the dominant measure of progress is typically financial, where social justice, sustainability, health and happiness should be the most important indicators. (Marks, 2010). Yet the global, social and health limitations of these variables for assessing life satisfaction in behavioural economics research are currently limited.

I believe an essential responsibility of design and designers (especially considering that the field of design plays a large role in purchasing decisions and therefore the ingredients and life cycle of a product or service and its many butterfly effects), is to envision ethical products that consider current social and environmental difficulties, and *create solutions* for future or current problems. The Tune In Share Out mobile application and mobile sensor is the result of this thinking and aims to contribute to the collective solution.

5.2. Air Pollution Sources

Local weather, the lay of the land, and the quantity of pollutants emitted from largely anthropogenic sources all cause or contribute to air pollution.

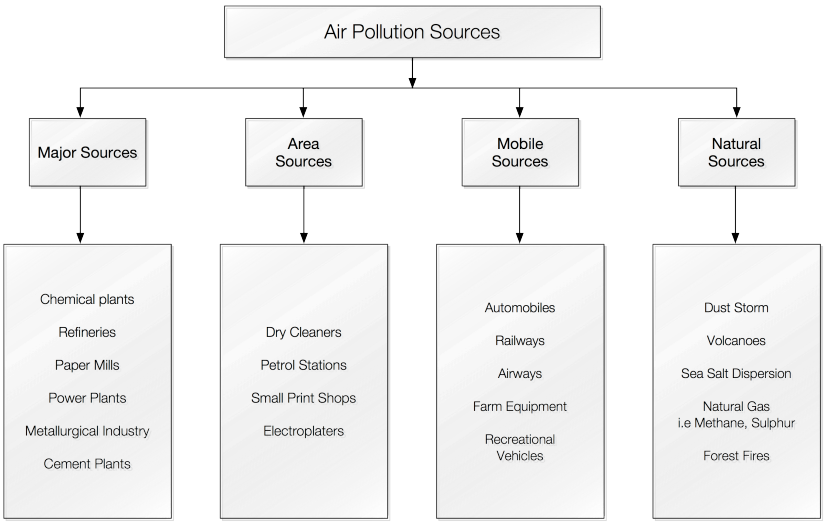


Figure 15: Visual Summary of Air Pollution Sources.

5.3. Health Consequences and Historical Background

'Air pollution is most often invisible to the naked eye, yet the short and long term effects can harm, mutate or kill many organisms including humans' (Brunekreef, 2002).

Two well known historical cases associated with instigating public perception and awareness, civil and legal regulation and scientific correlations pertaining to air quality and public health are the 1948 Killer Fog in small town Donora, America, and the London Smog of 1952.

The Donora Killer Fog was acerbated by a temperature anomaly that caused pollutants largely from industrial factories to stagnate over the town, where normally they were dispersed by winds. This caused the death of twenty people and six thousand illnesses. While air pollution problems had resulted in legal suits successfully filed against the local zinc works in 1918 and the 1920's for adversely affecting local residents health, and killing livestock and crops in the area, air pollution monitoring was not undertaken until 1929 (Templeton, 1998). It was only continued for seven years as it was considered an inconvenience and not a health threat. The Donora Killer Fog is said to be an instigator of growing air quality awareness and the first time that there was an organised effort to document health impacts of air pollution in America, which eventually led to the United States Clean Air Act of 1970 (Peterman, 2009). The London Smog of 1952 lasted for four days and caused at least four thousand deaths and many illnesses, therefore is considered '*most disastrous event of its kind known to have occurred anywhere in the world'* (Wilkins, 2006). It had similar governmental, societal and scientific implications to the Donera Killer Fog for increased awareness and correlation between air pollution and health effects.

While historical events have made evident the causality between air pollution such as coal production, transport emissions (Brunekreef, 2002) and population health and mortality (Lidwell, 2003), there are few opportunities to access mobile, *design specific*, live air quality information for individual's ability to make decisions. As of January 2011, there are four publicly available air pollution specific mobile applications (AQMD, London Air, Oreck, WorldAQI) available to New Zealand citizens from the Apple iTunes store (all have either American or European centric data).

5.4. New Zealand Air Quality

The Ministry for the Environment in 2004 and 2005, introduced revised national environmental standards for air quality. The date for local body adherence has recently been contentiously (N.Z. R. 2011) extended from 2013 to 2020.

The 14 standards include (Ministry for the Environment, 2007); seven standards banning activities that discharge unacceptable quantities of dioxins and toxics, five standards for

ambient outdoor air quality, new standards for wood burners installed in urban areas, and a new standard for landfills over 1 million tonnes of refuse requiring collection of greenhouse gas emissions.

New Zealand's air quality is on average considered '*passable'* (Fisher, Rolfe et al., 2002). However, many places exceed the Ministry for the Environment or World Health standards multiple times per year, especially during winter. Not all chemical pollutants such as benzene, a known carcinogen from car exhausts, are included in the types of chemicals monitored. Air pollution in New Zealand ultimately causes the death of 1,100 people per year, and the economic costs (from negative health impacts and premature death) is estimated to cost $1.14 billion per year ($421 per person) (G.W. Fisher, 2002). Epidemiological short and long-term studies show that people with respiratory conditions, both the young and elderly are more susceptible to air pollution as indicated by hospital admissions and the recorded acerbated cardiac deaths (Johnson, 2007).

Informal research (via discussions with asthmatics, participation in community open data an health related technical discussions during conferences, symposiums and professional meetings) coupled with ethnographic, literary research has led me to believe that New Zealand citizens could benefit from an application that gave access to live local environmental data. This in turn can give the individual a *choice* around which path or time they choose to travel that best meets their health requirements.

5.5. Mapping

Monitoring air pollution data on a mapping platform is a helpful analytical tool for concerned citizens, local and national governance, which clearly shows spatial relationships between pollutants and human and non-human activities and helps locate spatially the viewer in their environment.

5.6. Benefits

The multiple benefits of TISO and the sensor device for the individual, community and environment are:

- main pollution sources could be discovered, isolated and monitored
- causes and concentrations of respiratory diseases could be discovered
- local and national governance could source data for legislative purposes and future urban planning

- individuals could use GPS to share tracked paths with their health professionals
- non governmental organisations (NGOs), universities, research institutions and special interest groups such as environmental and motoring groups could make use of an independent source of data
- information from this device could help keep official monitoring stations accountable

5.7. Stakeholders

Citizens that may have a vested interest in this project and its application in society are: Individuals and people with respiratory problems, such as asthma, children, elderly, city council, national government departments, special interest groups such as environmental pressure groups, unions, motoring groups; community based organisations (i.e., the Asthmatic and Respiratory Foundation), industrial or commercial companies that affect and contribute to air pollution, health organisations (i.e., local hospitals) and doctors.

6. Design

This section examines the user interface design and discusses the design considerations and the processes employed to create the mobile phone application. Consideration is given in the relationship with specific aspects of the technological landscape.

> *'Where previously human and other processes in the urban fold were lost to insight and to history, the contemporary cities rhythms and processes speak themselves' (Greenfield, 2009).*

6.1. Designing for Mobile First

Until recently the mobile web failed to gain traction and was considered a secondary thought with regard to aesthetics, interaction and speed considerations, that are necessary for the growing mobile web. Accessing web content on a mobile phone was often a painful experience as networks were slow and made slower by trying to view desktop sized imagery on tiny screens. Due to the larger screens and increasingly capable phones, designing for the mobile web first, has multiple benefits for the designer and citizen alike.

The philosophy of designing for the mobile platform first was initially pushed by respected designer and technologist Luke Wroblewski (2009). This has since been publicly adopted by Facebook (Aronowitz, 2010), Adobe CTO Kevin Lynch during his keynote speech at Adobe Max 2010 conference (Lynch, 2010), and Google's CEO Eric Schmidt during his 2010 Mobile World Congress keynote (Eddy, 2010). Schmidt considers the current and future mobile ecosystem to be the result of three intermeshing factors: connectivity, computing power and cloud computing.

Designing for the mobile first offers designers and developers a platform with known specifications (unlike the multitude of desktop sizes such as the old 800x600 or 1024x768 resolutions). While there will always be variances caused by new devices going to market such as notebooks and tablets, creating responsive designs that are tailored for smaller devices enables the designer to consider content, bandwidth speeds and interactions that make the most of the mobile experience. This creates an interaction that always has the end viewer and citizen in mind.

6.2. Inherent Constraints Encourage Focus.

Paretos Theorum otherwise known as the *80/20 Rule* (Lidwell, 2003) works in reverse for the mobile platform, every pixel is given a higher value and every aspect of the screen is designed for optimum intention. Where desktop design has space to display content of questionable value, mobile designers are afforded constraints.

Constraints force the designer to focus on *Design 101* basic principles (Lidwell, 2003). The intent of the site or application is very important, no less so: who is the audience? What are their needs? Also efficient and clear navigation; how to optimally convey meaning through delightful design while considering current learned interaction and iconography conventions.

Consider the difference between the amount of information and clarity of purpose on the front page New Zealand iPhone application of Air New Zealand's website (Figure 14) with the first two screens of the Air New Zealand Mobile application (Figure 15). In comparison the first screen of my application is designed to succinctly give the viewer a quick synopsis of the air and water quality at their geolocation.

Figure 16: Air New Zealand Desktop Screenshot (airnewzealand.co.nz).

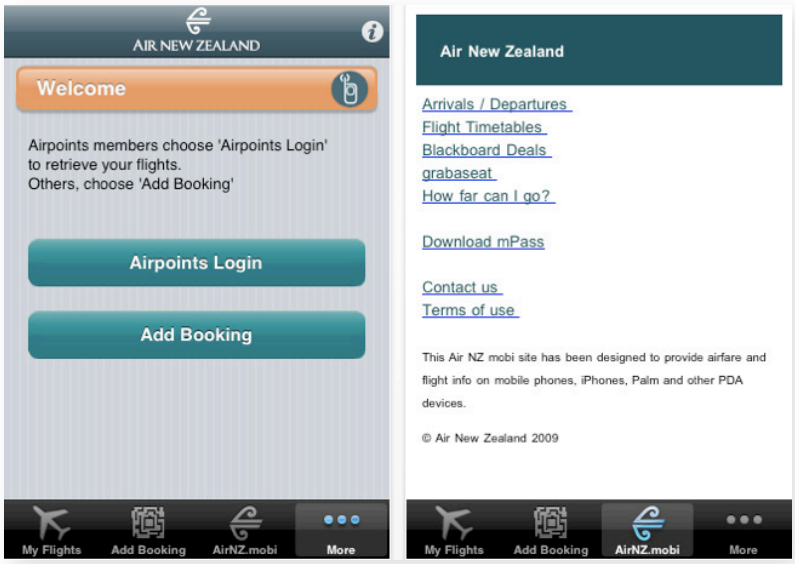


Figure 17: Air New Zealand iPhone application Screens.

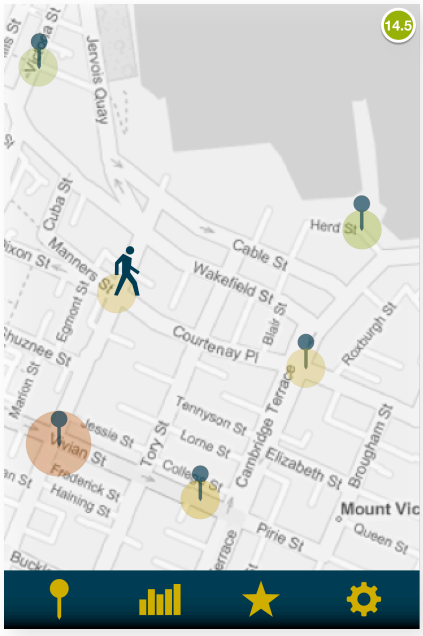


Figure 18: Tune In Share Out Screen. The final design for the first screen of the Tune In Share Out application.

6.3. Context of Use

Mobile researcher Jan Chipchase (2007) found that the three most important things that people carry with them at all times, across cultures, gender and contexts are: keys, money, and a mobile phone. The mobile phone has moved away from being a luxury device to a more common place tool.

Mobiles are also used in many different scenarios (locations, times, social settings) so designing for mobile needs to consider multiple contexts of use as Savio and Braitererman (2007) point out *mobile interactions are often small steps in part of larger user goals.* Part of the larger goal of my application is to encourage citizens to connect with the environment. By having quick access to mobile meaningful live health data, and the opportunity to quickly share with like minded people through social media, a citizens personal timeframe is enhanced.

The nature of the quick checkin is encouraged by social media sites such as Twitter, and Facebook leverage like-minded networks with quick time killing tasks or knowledge retrieval. This idea of the quick check-in task also corresponds well with the citizen scientist who wishes to communicate or share helpful information.

Social media growth on the mobile platform currently accounts for 50% of mobile internet traffic and is predicted to become the most important form of communication by 2015 (Read/WriteWeb 2010).

Designing for the mobile web forces consideration of the end user and how best to deliver succinct, meaningful information.

Figure 19: The Context of Mobile Interaction. (Savio, 2010).

6.4. Mobile Capabilities

Mobile devices offer dynamic new interactions with people, data and their local environment. These capabilities include geolocation, mutitouch input and audio, video and photographic input. Future inclusion of smart technologies such face and object image recognition and pollution monitoring sensors built into mobile phones have the opportunity to transform people and natural environments.

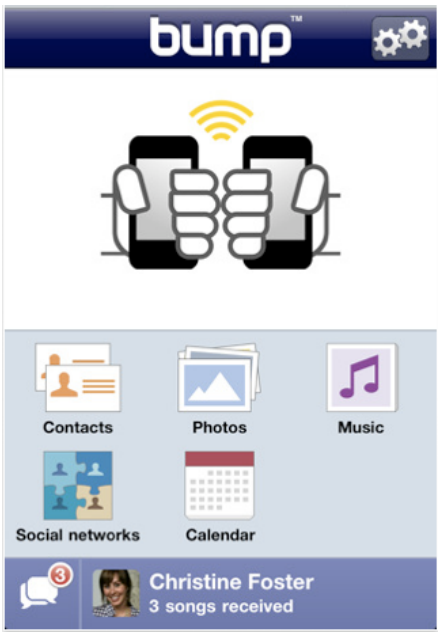


Figure 20: Bump iPhone Application Screen.

An example of dynamic interaction using iphones and sensors is the mobile application called Bump. It encourages physical interaction with people by sharing calendar, photo, music and contact information. It uses a matching algorithm coupled with the iphones sensors, to send information between two people via Bumps cloud servers.

No longer relegated to science fiction, multitouch or touch interaction offers a compelling user experience that often makes routine web activities easier, more pleasurable and natural.

The ease of use for touch screens is perhaps the defining capability of modern mobile devices. The worldwide market for touchscreen mobile devices is predicted to exceed 362.7 million units, a 98% increase on 2009 sales according to Gartner (Plummer, 2010).

Designing for touch often requires larger target areas and visible content in comparison to mouse driven interaction. '*Obvious visual controls make for obvious visual gestures'* states Clark (2009 p.244). Clark goes on to say that the guiding principle for desktop software is the same but that there is no longer the visual and mouse feedback loops such as hover effects to guide interaction. However touch screens create the expectation that individual buttons as well as the whole screen interface is directly controllable, which is more akin to real world gestures; flicking the colour wheel in an application feels like spinning a rolodex just as the pinch and zoom method of expanding a map is reinforces concepts of scale.

6.5. Designing the App - Design Process

The research and application of design throughout this thesis follows an iterative, *agile design* approach (Greger, 2009; Bowles, 2010). While usability testing can uncover problems in a UI, usability practice itself doesn't offer design solutions. Furthermore Molich the inventor of heuristic evaluations states that usability testing cant make up for bad design, he goes on to say:

> *'Alan Cooper has wisely said If you want to create a beautifully cut diamond, you cannot begin with a lump of coal. No amount of chipping, chiseling, and sanding will turn that coal into a diamond'. (Perfetti, 2003).*

The final mobile application, Tune In, Share Out design is informed broadly by captology (Fogg, 2009; 2003), UX thinking (Bowles et al., 2010), Apple's HCI Guidelines (Apple, 2010) personas (Cooper, 1990), and social web psychology.

Similar applications were surveyed for emerging user interface design patterns, information architecture and interactivity modes such as: London Air, Roambi, Everyblock, Dopplr, AQMD, iSmog, Wide Noise amongst others, while exploring navigation methods; testing colour clarity in various lighting; content structure and visual tone.

The interface is informed by Apple's Human Interface Guidelines, auto-ethnographic research. The other guiding principle being Olsons Law.

> *'The less user effort required, the higher the percentage of users who will do it, so that technology and interface design do not get in the way of humans connecting with their local natural world'. (Pearson, 2010).*

Informal discussions were held with citizens belonging or involved with environmental groups. Amongst these were citizens from Forest and Bird; Intersect; NIWA; Landcare Institute; OLPC Wellington Testing group members, asthmatics. I also conducted auto-ethnographic research in public meetings and social media channels; discussions in conferences; specialist Design and User Experience meetings and the general public. These all included a wide of technical familiarity with mobile devices, from not owning a mobile through to specialist mobile developers. Main findings were that simplicity of screen design was preferred for finding information, and larger target areas for buttons were preferable. Many initial features such as blogging and bird calls were eliminated to comply with requests for simplicity of purpose within mobile applications (Apple, 2010).

Iterative interface design experimentation (both high and low fidelity) planning and experimentation through: Paper Prototyping, Flash Catalyst, Omnigraffle, Illustrator, Photoshop, Processing.js, LiveView Screencast, created a set of six personas: influenced by The Inmates are running the Asylum (Cooper, 1990)(Jones, 2006)(Clark, 2010).

Researched various mapping platforms such as: Bing, Open Street Map, Cartogen, Koordinates. A simplified Google being the final choice for technical versatility, visibility in various lighting conditions and theming possibilities.

I then conducted informal testing with a wide range of mobile device owners from: not owning a mobile through to iPhone, Android and Nexus owners.

6.6. Application Audience

This application is not limited to age, gender, or any other imposed stereotype or demographic, but it is designed to be accessed by any person with a mobile phone with an internet connection.

The intended audience for this web application is time-poor local citizens who are proficient with smart phone technology, are aware of our current environmental predicament and who wish to stay au courant with, benefit from and contribute to the discourse of their local environment.

6.7. Site Map

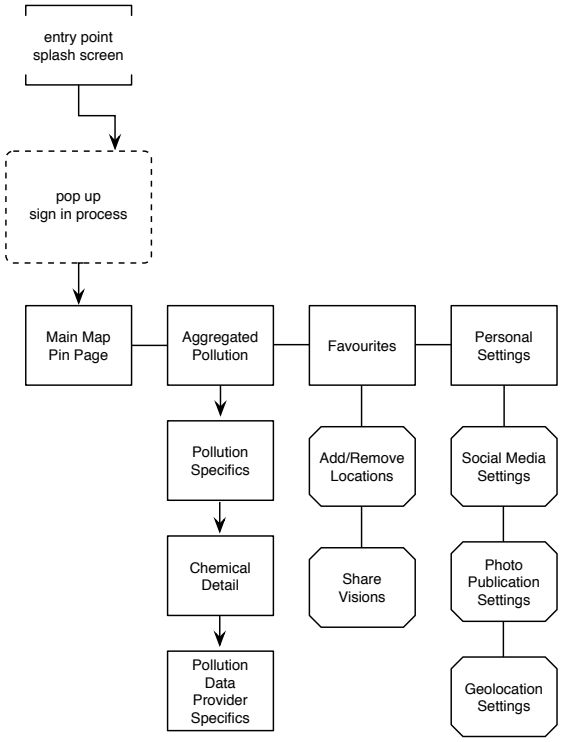


Figure 21: Tune In Share Out Site Map. Created in OmniGraffle following Jesse James Garrets visual vocabulary. (Garrett, 2002).

6.8. Interface Design - Main Considerations

The interface design of TISO takes into account context of use, direct manipulation, and clarity of purpose to affect behaviour change in a local environment. Context of use has been designed to be as simple and straightforward as possible so that when the application is needed the main functions are available within one second of the application opening. The main functions are accessing live air and water quality information. Direct manipulation of the interface is therefore direct manipulation of the local environment. Clarity of purpose and the absence of *OS chrome* and *chartjunk* as discussed by Tufte (2003) have been applied to the application through the use of minimal colours. Many informational elements are arranged on the same surface to limit deep hierarchies of information, and the use of sparklines convey the most amount of information in a simplified datascape. The interface interaction leverages the existing ubiquity and understanding from Apple's Human Interface Guidelines (HIG) guidelines

(Apple, 2010) and therefore minimises learning curves through known tap, swipe and zoom gestures.

The TISO application encourages behaviour change through individual and immediate personal benefit of contingent information. Akin to a doctor in your pocket like the Ubifit Garden (Fogg 2003, p.77), becomes aware of long term behaviour trends and can gain a long term view of how daily behaviours can affect everyday life. This information can be saved to a personal map which can be taken to a medical practitioner for further in-depth analysis. Limiting the use of forms in TISO takes away frustrating and time consuming screens to enable the viewer to focus on health information, (Ballard, 2007), (ACM Pervasive and Mobile Computing, 2008). This is accomplished through direct image manipulation either in the map based screens or the sparkline data.

6.9. Persuasive Design

Principles of Mobile Persuasion and Persuasive Design (discussed below) otherwise known as Captology have been employed throughout the research and design process. Captology is a term coined by B.J Fogg to define the study of Computers As Persuasive Technologies (CAPT-ology), where he defines persuasion as an attempt to change attitudes or behaviours or both (Fogg, 2003).

6.10. Perceived Credibility

As my mobile prototype needs real time scientific data as part of its core service, the public perception of science is integral to my research. According to captology (Fogg, 2003) principles of technological persuasion, perceived credibility equals perceived trustworthiness plus perceived credibility. Ergo for the application to be perceived as credible, the live air data must be from a trusted scientific body such as the Wellington City Council or NIWA and is essential to the perceived credibility of TISO.

6.11. Intentional Persuasion

The Captology definition focusses on true persuasion (without using coercion or deception) either by computers or humans, which requires intentionality, ergo persuasion needs to be endogenous or built into the design if it is to fit into Captology methodology. PUSH notifications of health dangers of marked favourite locations is one way where TISO directly employes Intensional persuasion. Note that this is an opt-in feature for the viewer, no coercion is involved (Fogg, 2005).

6.12. The Principles of Mobile Persuasion

Mobile technologies can influence and motivate users by leveraging one or more of the following nine principles:

Kairos - Offering suggestions or solutions at the right moment in time or place.

Mobile Loyalty - A service that fulfils the needs of the individual first before providing value to the provider or outside party.

Mobile Marriage - Frequent positive interactions with a service or application over a long time period.

Information Quality - Current and relevant information has a greater potential for attitudinal or behavioural change.

Social Facilitation - By allowing observation of people's performance by technology and others encourages learning and continued participation of behaviours.

Social Comparison - Performance and contribution information of others especially like minded people increases motivation.

Competition - Leveraging human beings natural drive to compete.

Cooperation - Leveraging the social side of human nature to cooperate.

Recognition - Public either individual or group recognition increases target attitude or behavioural adoption.

6.13. Application Classification

According to Apple's iPhone Human Interface Guidelines (HIG) the combination of live data access through web views and including iPhone OS user interface (UI) elements classifies Tune In Share Out as a hybrid application.

While there is no rigid structure to the *Three Application Styles* included in the guidelines and Tune In Share Out does have elements from all three styles, it is predominantly a mix of productivity and immersive styles.

An immersive application is defined as presenting information that is more visual than text based, where the focus is on the content and the users experience with that content. It involves an element of game-play or story to display the content and data, through custom navigation methods instead of data driven methods, used in productivity or utility applications.

The interface is designed to hide a large majority of standard user interface (UI) devices while replacing it with custom UI that intensifies the designers intended environment.Immersive applications may involve large data sets but the presentation and navigation of that data is not intended to be drilled down into.

Alternatively a productivity application is based on the manipulation and organisation of detailed information. The information is structured to keep the user experience focussed on the task through hierarchically structured data.

Tune In Share Out is a mix of the task focussed hierarchically structured data of the Productivity style and the visually rich content and slightly playful interaction of the graphed data from the Immersive style.

6.14. Iconography

Due to multiple iconography interpretations from initial informal testing, I chose to follow Apple's HIG to make the application more intuitive by using familiar iconography.

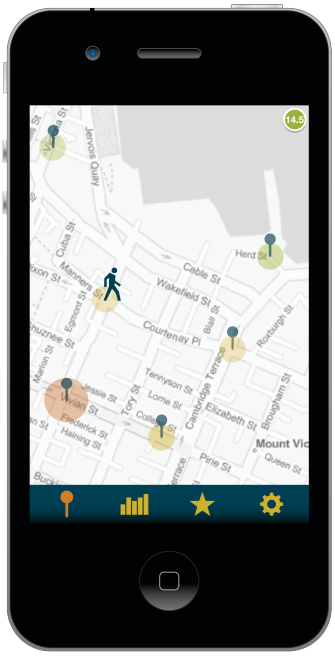
Initially I experimented with designing icon multiples. One example is the multiple designs of the pin (evident in workbook). Several designs were explored ranging from Google's mapping pin, to my self made designs, standard mapping pins employed by well known web companies to the current version. Informal testing showed that some people were unfamiliar with Google's mapping pin concept. Other users requested a simpler pin as the shadows and 3 dimensional design of some variations created confusion. Ultimately the final pin (map icon) was chosen because it is clear in its display of purpose and meaning.

Having icons named on the tab bar is employed more in utility style applications. I found that applying the text underneath icons cluttered the screen. Informal testing showed that 80% of people could understand the meaning of four out of five icons first time.

6.15. Specific Screens

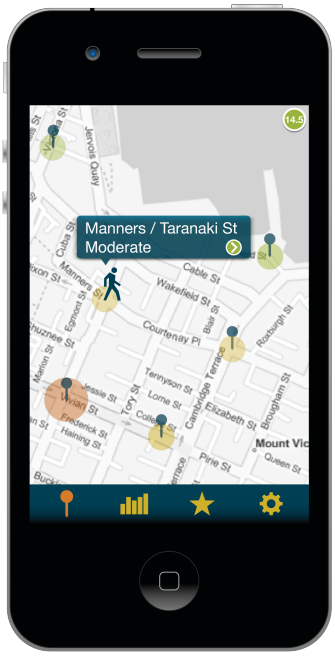
The splash screen is designed to be displayed for 1 second upon opening, before fading into the first screen. Due to the application having a health focus, the main colour of white is chosen to give the impression of cleanliness while the dark blue, orange, green and yellow ties in to the core colours evident throughout the rest of the application.

The name Tune In Share Out is a modern take on the slogan given to Timothy Leary by Marshall McLuhan. Tune in Drop Out was a counter culture slogan of the 1960s. Tune In Drop Out was intended to embrace cultural changes through the use of psychedelics, and encourage the detachment of the self and hierarchies in society. My take is that people can explore alternative realities (or augmented realities) through the mobile phone, by Tuning In to official and crowdsourced health information and monitor their own health (aided by the sensor device). This information can then be shared out through mobile social media and mapping platforms form the application Tune In Share Out.



Map Screen (first page upon opening app.)

The tab bar is positioned at the bottom of the screen and designed at 50 pixels wide based on Apple's HGI and Tapworthy by Josh Clark's individual's Rule of Thumb concepts (minimum recommended touch size is 44 pixels for a button) The dark blue tab bar is designed with a faint black gradient at the base so that it blends seamlessly into the phone hardware, while the four icons main navigation in highly saturated contrasting colours are clearly visible (tested with LiveView Screencaster) for any light conditions.

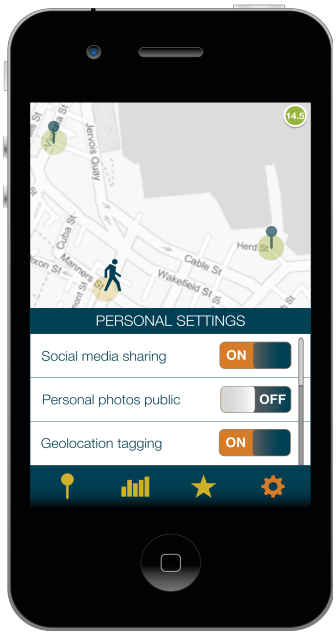


Annotated Screen

Pop-up detail is accessible by tapping on pollution map marker for quick pollution access (pops up the precise location and rating and icon for access to more information). Likewise, the sea temperature is shown in the top right hand side - with similar colour associations for instant health warning to air quality information.The human icon is representative of the individual's phone, while the adjacent pins represent individual's and public bodies pollution level reading locations. The size of the coloured circle denotes the range of the sensor, ergo an individual's sensor will generally have a smaller circle radius in comparison to a public body such as Wellington Greater Council or NIWA's sensor equipment. As is the sea temperature marker, the colour of the circle is in line with the health scale.

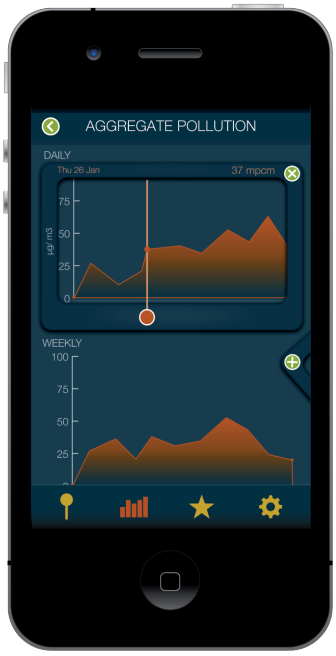
Share Your Visions Screen

The main intention of this screen is two-fold. One is to encourage application owners and Wellington citizens to annotate a map with amenities desired or needed, or participate in a citizen science project such as bird counting. The second is to gather tacit information to be shared publicly on a map (although the option to be private is built in too).



Personal Settings Screen

After the initial sign-in upon downloading of the application, the viewer can push health notifications into their social media, or email stream, annotate a map by turning their geolocation positioning on, or take a quick picture to further annotate their public or private map.

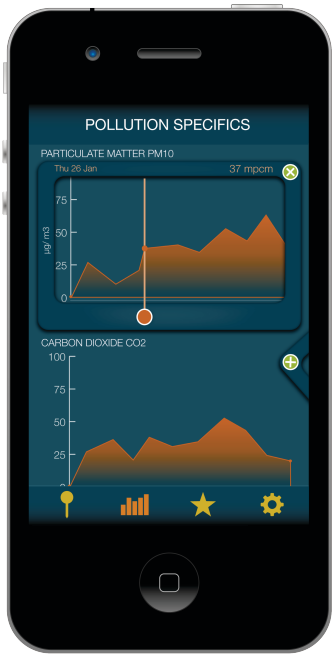


The Aggregate Pollution Screen

Designed to follow Tuftes chartjunk theories (Tufte, 1997), having an interactive orange slider, to display date and measurement details - shown on the sparkline frame. This allows the viewer to directly manipulate the data details and eliminates the need for superfluous information.

The green button with the + activates by tapping once to show slide, and tap again to hide slide frame.

Some unexpected informal feedback showed that the three screen buttons with white around the outside successfully indicated they were buttons.



Pollution Specifics Screen

By tapping the chart without the slider made active on the previous page (Aggregate Pollution) takes the viewer into pollution specific data i.e. Particulate Matter (PM10). By tapping this screen twice without the detail slide takes the viewer into a screen that displays the pollution data uploader's details (it is up to the viewer if they wish to be verified-but anonymity is the uploader's choice).

Chemical Detail Screen

This is for the viewer to learn more about the causes and health effects of a particular pollutant. Notice that the bar chart icon is indicating where the viewer is in the navigation hierarchy. If they wish to jump back into the map view the left hand side pin icon is a direct link.

All screens with the detail slide are hidden on opening. The pollution data provider can be discovered when the Chemical Detail screen first appears by tapping the sparkline (the same interaction method as in the previous screens).

Repetition of similar movements allows the user to adjust and learn the application quickly and as the large target is in the middle of the screen, it is easy to find.

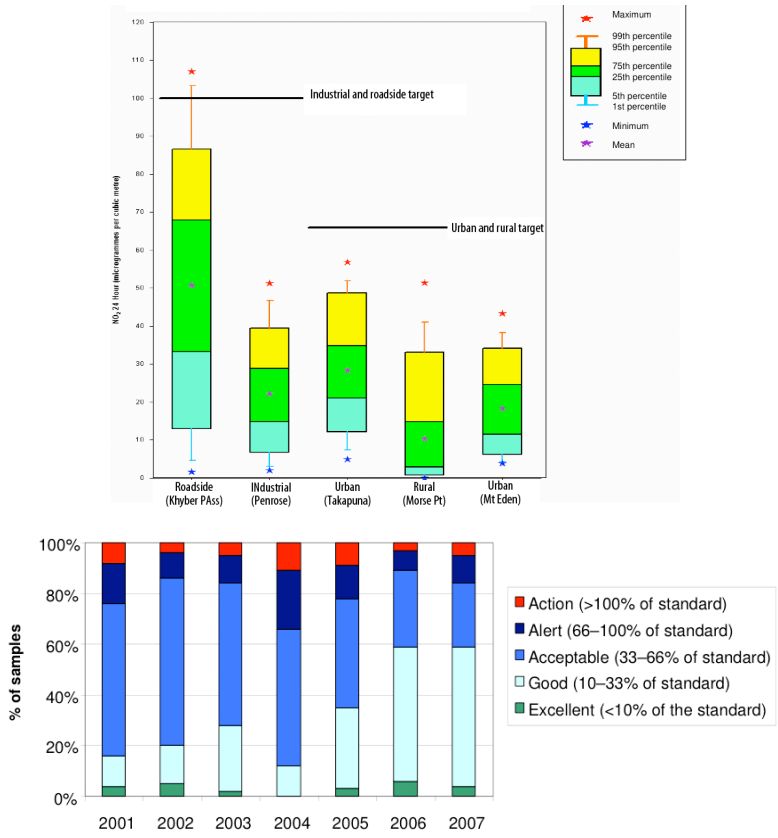
Colour experimentation, icon design, navigation design experimentation is recorded in the workbook.

6.16. Colour Choices

User interfaces on the iphone platform are typified by lush colour and beautiful imagery. Apple's Human Interface Guidelines coupled with *Tapworthy* (Clark, 2010) were the main colour reference points, aside from direct experience with iphone applications and various web articles. Apple's HIG (Apple, 2010) allows for variety; the colour palate is not constrained to web-safe colours and alpha transparency is allowed for in the application itself but not for the application icon. The application icon (below) shares the same visual language with the air pollution application itself and the launch page to provide visual continuity.

Figure 22: TISO Application Icon - Visible on iPhone Screen.

So that there was no reinvention of the New Zealand air quality colour wheel, I decided to use colours chosen by the air quality national regulatory body, Ministry for the Environment (MFE). After conversing with MFE's Air Quality department I discovered there is no national standard and councils can use any variation of colours they choose.



MFE's 2009 Good Practice Guide for Air Quality Monitoring and Data Management report; shows a wide range of colours representing air quality data. Figure 23: (top) Auckland Nitrogen Dioxide 24 hour Sample. Figure 24: (bottom) Proportion of PM10 Samples Belonging to Different Air Quality Categories.

Surveying international governmental and regulatory bodies air quality data shows a broad range of colour standards in use (with slight variations) ranging from blue or green at the healthy spectrum to purple or red at the dangerous levels.

The final mobile application (Tune In, Share Out) air quality index colour range is based on the New South Wales Environment Climate Change and Water Government Values (Figure 22) with the addition of white and a very dark navy for the tab bar, header, alerts and representative of the individual's map annotations. The map is intended to be light while the alert boxes stand out on the lighter map with the darker header to blend in with the phone, encouraging greater visibility of the orange and yellow icons.

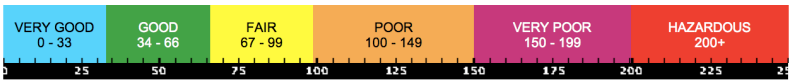


Figure 25: Air Quality Index Values (Government, 2011).

The mobile interface being backlit does not require colour to be of a very high saturation for optimum viewing, however colour contrast is a very important aspect to consider, especially if the application is designed to be used outdoors and easily accessible by the applications broad audience base.

My colour final choices displayed in the mobile application are various saturation levels of the colours below. More examples of colour exploration can be seen in the accompanying Workbook (9. Appendix)

7. Conclusion

How can I connect citizens to their local environment through human interface design on a mobile platform? My answer is informed through the nine principles of mobile persuasion: kairos, mobile loyalty, mobile marriage, information quality, social facilitation, social comparison, competition, cooperation, and recognition coupled with the Ethical Development principles; default to harmlessness, must be self disclosing, conservative of face, conservative of time, must be deniable, and outlined in Everyware (Greenfield, 2006, p.76).

In turn it aims to assimilate into convergence culture and participatory urbanism by providing the following potential benefits for citizens:

A richer deeper pool of information to inform and aid future health and geomedicical decisions and inform medical records.

- Quality health information to plan urban travels.
- Future city planners, dwellers and scientists have a larger pool of information from which to draw for urban planning, consents, and other research initiatives which consider public health a priority.
- A person with respiratory problems could negotiate with more available information with future employers and make the best decision for themselves, family and company.
- The mobile marriage of health data on a mobile phone is portable enough to be taken anywhere anytime.
- Possibility of mapping airborne diseases (similar to the cholera outbreak in London) and contribute to computational epidemiology.
- Providing a solution for tacit knowledge to be distributed and shared.
- Directly interact with scientific data and have the opportunity to collaborate in crowdsourced health.
- Association with community through proximity.
- As New Zealand does not have a Toxic Release Inventory program like the United States does; the data it could provide could be the basis for one.

7.1. Future Applications

> *'In a world increasingly mediated by technology, we must ensure that the human core to our activities remains untouched. On the road to the Internet of Things, this can only be achieved through people oriented strategies, and tighter linkages between those that create technology and those that use it. In this way, we will be better equipped to face the challenges that modern life throws our way.' (Union, 2005. p.13)*

Tune in Share Out could become an application with multiple sensor plugins able to attend to different health needs. For example if a person had an allergy or sensitivity towards CO2 but not NO2. The sensor device could be single function and therefore smaller in size like the NASA prototype (page 20). TISO application and sensor device could be modified to become an indoor application that monitors industrial or office pollutants such as paint fumes. It could be applied in developing countries where air pollution is a growing burden (World Health Organisation, 2011) and often can be up to 10 times more polluted indoors. For parents of children who are asthmatic or have another respiratory disease an alternative future application could be attached to children's backpacks to monitor classroom and travel paths (Johns Hopkins University et al., 2009).

Tune In Share Out might be just like John Snows mapping of the London 1854 cholera outbreak, that prompted changes in science and connected it to local health providing help to make London a more sustainable city. The map too could become '*a map of deaths that ended up creating a whole new way of life'*. (Johnson, 2007).

Through the thoughtful and considered application of Bright Green Technologies, such as Tune In Share Out, citizens can participate in, visualise and listen to the natural voices of nature and the city to inform current and future healthy choices for all.

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9. Appendix

A Workbook DVD is attached to the back cover which contains sketches, inspiration and process developments.