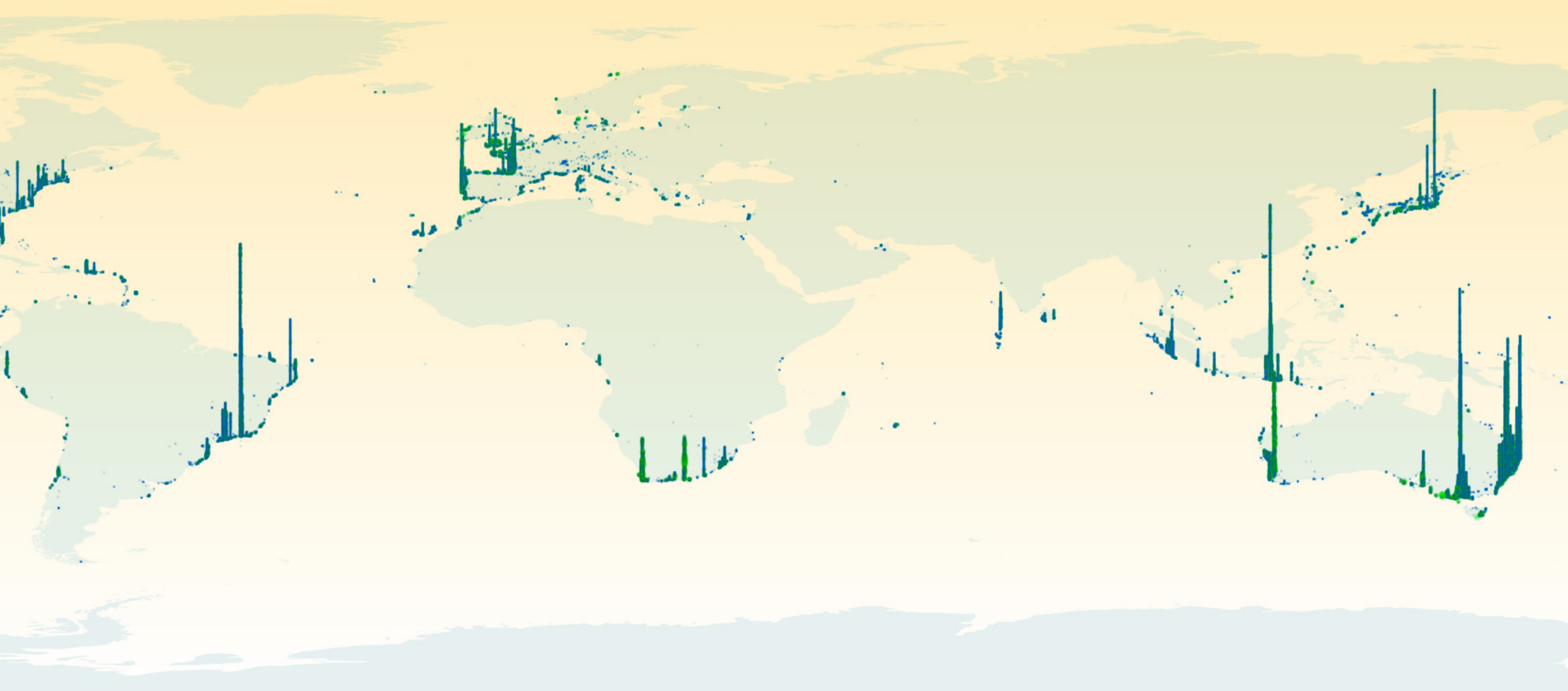
DATA FOR SURF'S SAKE

Illustrating a sub-culture through interactive data visualisation and action sports trackers



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Illustrating a subculture through interactive data visualisation and action sports trackers

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Preface

Data for Surf's sake is a media design thesis which focuses on the design of an interactive web application. The research process consisted of the creation of many interactive sketches focusing on interaction and animation of visualisations.
Due to its interactive nature an online copy of this thesis is available at:

everittcreative.me/data-for-surfs-sake

The final design output of this thesis, ***Gone Surfing***, is a web based application for exploring the a database of surfing. Gone Surfing and its video documentation can be found at:

everittcreative.me/gone-surfing

Acknowledgements

Firstly I would like to thank Rhazes Spell, my initial supervisor, for giving me that push to pursue an area that I am passionate about. Secondly, my supervisor Kah Chan, for accepting that I was going to stick to with this path, and subtly directing me to create something acceptable in research standards.

I would also like to thank, my family for their support throughout this process, my flatmates for finding ways to distract from this project, and my classmates, for slowly going crazy with me so we all looked a little less insane.

Finally, I would like to thank everyone who asked what I was doing for my thesis. The constant badgering allowed me to iterate over thousands of answers to that question and narrow it down to one sentence: I am communicating what I know about surfing through the visualisation of data generated by surfers around the world.

Abstract

Over the last two years action sports trackers have emerged for those seeking thrills in risk-taking sports (Mitchell, 2014). The data generated by these trackers is creating digitised representations of communities participating in action sports such as surfing. The surfing database comprises of activity all over the globe, and due to its size and complexity it can be categorised as big data. Understanding this complex database requires specific data visualisation methods which visually map relationships and patterns. This research asked: can an interactive data visualisation illustrate hierarchical, nomadic, and experiential aspects of the surfing subculture?

This thesis is based on ethnographic research which focuses on exploring qualitative visualisations of the quantitative databases generated by action sports trackers for surfing. The research focused on the design of data visualisations which explored contemporary methods and principles of data visualisation and their applicability to communicate aspects of the surfing subculture. This manifested in the design of an interactive web application, ***Gone Surfing,*** which focused on ***global***, ***local***, and ***personal*** views which communicate Stranger's (2011) substructure model of the surfing subculture.

The hierarchical, nomadic, and experiential aspects of the surfing subculture are only known from long term immersion in the subculture itself. This design made these aspects explicit through the visualisation of the database. For example, pilgrimage's to revered surfing locations and hierarchy within local communities, and a surfer's relationship with the waves are forms of implicit knowledge which were made explicit. The final creative output, Gone Surfing, visualises these aspects in an interactive web application consisting of global, local, and personal views to each communicate an aspect effectively. The interactive visualisation allows non-surfers to explore the subculture while enhancing a surfer's understanding of their position within the surfing nation.

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Glossary

aerial	a manoeuvre performed above the lip of the wave.
beach break	a wave that breaks on sandbars just offshore.
drone	unmanned aerial vehicle commonly used for aerial photography.
Processing	a Java based programming language for creative coding.
point break	wave that wraps around and breaks along a rocky point.
surf	to ride waves on a surfboard.
surf spot	a specific location where a wave breaks, one beach usually contains more than one break.
surf session	any time spent surfing.
turn	a manoeuvre performed on the face of the wave while riding the wave.
WebGL	a Javascript API for rendering interactive 2D and 3D graphics in a web browser.

Introduction

The integration of wearable technologies in sports as a means to track performance and experience has become a trend in the last few years (Mitchell, 2014). Earlier examples of wearable technology for tracking activities focused mainly on geo-location, speed and biometrics such as heart rate (Fitbit, 2016) to give the user feedback on their performance. As the technology has advanced certain devices are now able to capture data associated with the user's motion in real world space. For example, Trace (2015) allows surfers to capture the motion of their surfboard while riding a wave by attaching a waterproof Global Positioning System (GPS) sensor and motion sensor to their surfboard. These action sports trackers are focused on collecting the data for the user to review and share with friends. As a result, large databases are being created which contain digitized representations of the participating communities.

Generating meaning or knowledge from these big databases can be difficult, especially when they contain a complex number of variables. However, Tufte (2001) defines the use of graphics as the most effective way to explore and summarize large data sets. The database generated by a global surfing community includes up to 1000 surfs per day, with each surf containing data associated with waves caught, distances travelled, speeds, and so on. A data visualisation communicates relationships between these factors efficiently by taking advantage of the human visual system's ability to understand patterns (Fry, 2004). The designer's responsibility is to analyse the variables and establish their importance in the communication of this information. Therefore, understanding the context of the data is of great importance in the design of data visualisations.

This thesis asks: can an interactive data visualisation illustrate the hierarchical, nomadic, and experiential aspects of the surfing subculture? In response to this question, this research analysed data generated by surfers in relation to the surfing subculture through a series of design experiments. These experiments aimed to firstly, imitate the capture capabilities of action sports trackers, to capture and visualise a surfers intent to surf, and capture and visualise the action of surfing. Secondly, to visualise existing data generated by the current action sports trackers. These experiments aimed to establish important data variables and their relationship to certain aspects of the surfing subculture, and methods of visualising said variables so that they were representative of the subculture. The final output of this research attempted to utilise the successful methods from the design experiments to visualise the sample database so that aspects of the surfing subculture could be explored.

Throughout the research a model of the final data visualisation emerged in response to the review of the surfing subculture and the design process. The model consisted of three views, ***global***, ***local***, and ***personal***. Each of these views was designed to disseminate specific aspects of the surfing subculture. For example, the ***global*** view provided a macro view of the surfing nation, the ***local*** view broke down the surfing nation to communicate local ***hierarchy*** and the surfer's ***pilgrimage***, and the ***personal*** view provided an in-depth surf break down for a specific users, this will be referred to as the ***experience*** for the duration of this thesis.

Thesis Overview

The literature review of this thesis reviewed current literature and design to identify successful methods and to establish areas where this research could contribute. This section focused on data visualisation research to identify methods for visualising complex data, surfing subculture literature to better understand the context of the data being visualised and to create a cultural criteria, and precedent designs to establish methods of visualising data with strong contextual relationships.

The design experiments chapter outlines the applicability of the visualisation methods and cultural criteria identified in the Literature Review. These experiments either consolidated the cultural criteria, identified new aspects, or identified inapplicable aspects. Throughout this process the visualisation methods were applied to the cultural criteria to create a brief for the final design.

The design section of this thesis covers the development of the process the final application, Gone Surfing, in response to the brief defined through the design experiments. This section focused on the development on the global, local, and personal views as means of communicating the developed cultural aspects most effectively.

The discussion chapter discusses the conclusions from the final design and their implications within contemporary design, it goes on to identify the pitfalls of the design. Finally, the chapter identifies further areas of research.

It is important in the reading of this thesis to understand the background of technologies within the surfing subculture. Surfing is not ignorant of the digital age. Many professional surfers taking advantage of social media to share short surf clips weekly which creates a steady stream of visual impetus for surfers. These surfers usually have a photographer or videographer following them continuously to capture the perfect shot. Amatuer surfers do not have this liberty, therefore they take advantage of devices such as the GoPro action sports camera (Fig 01). These small cameras can be held, worn, or attached to a surfboard to capture first person video of the surfing experience. Although these devices are very effective, they can sometimes be distractions in the surf. Therefore, a more covert device for capturing a surfer's experience may permit a more immersive experience. The SearchGPS Watch and Trace action sports tracker are examples of more covert technologies to record a surf, and as part of this research a mobile application, Surfone, was designed to replicate these devices (Fig 02).

Figure 01
Examples of GoPro mounts

The SearchGPS Watch (Rip Curl, 2014) tracks the geo-location of the surfer to record statistics while remaining covert in its nature. The watch tracks statistics such as top speed and the number of waves caught per session and then allows the user to share this data with other watch users. Members of Rip Curl's professional surf team also participate so that users can compare themselves to the top tier of surfing. The outcome of this data collection is a quantitative database covering a global community of surfers. The database provides an opportunity to visualise the surfing subculture so that parts of its more complex substructure can be revealed. A sample of this database was released for the use in this research.

Figure 02
Surfone mobile application concept

The complex nature of the surfing subculture has been defined in literature. However, the opportunity to overlay these theories with such a comprehensive database has not been done. According to Stranger (2011) the surfing subculture consists of a ***surface*** generated by the commercial powers in surfing and a complex ***substructure*** of neo-tribes which is held together by the ***transcendent experience*** of which "only a surfer knows the feeling" (Stranger, 2011). The ***surface*** consists of the general symbols and media associated with surfing such as films and magazines. Whereas the ***substructure*** consists of neo-tribes held together by implicit knowledge, observations, and shared experiences by the participants. The database which is being generated by the action sports trackers adds a quantifiable layer to these tribes and their experiences and provides an opportunity to make the substructure more accessible to non-participants.

Action sports trackers are translating the surfing subculture into databases which can be powerful tool of cultural expression in the computer age. According to Manovich (2007) the database is a "symbolic form of the modern age". He further references Jean-Francois Lyotard's ***Postmodern Condition***, on the database as "a new way to structure our experience of ourselves and of the world". This structure differs from the conventional narrative approach of cinema, rather, it is a collection of items with significance to each other. The translation of these experiences from database to information and so on to knowledge can be achieved through data visualisation. The visual design of information can aid in the understanding of data (Fry, 2004), however due to the large quantity of data, special techniques should be implemented.

As part of understanding our experiences in the world, we can begin by understanding ourselves. Li, Dey, & Forlizzi (2010) describe the field of personal informatics facilitates an understanding of self-knowledge through the collection and reflection of information about oneself . Specific motivations for those who take part in this practice according to Choe et al (2014) are: to improve health, to improve other aspects of life, or to find new life experiences. Action sports trackers have likely emerged from the field of personal informatics, specifically, for those aiming to learn something interesting about their participation in the sport or to improve their abilities.

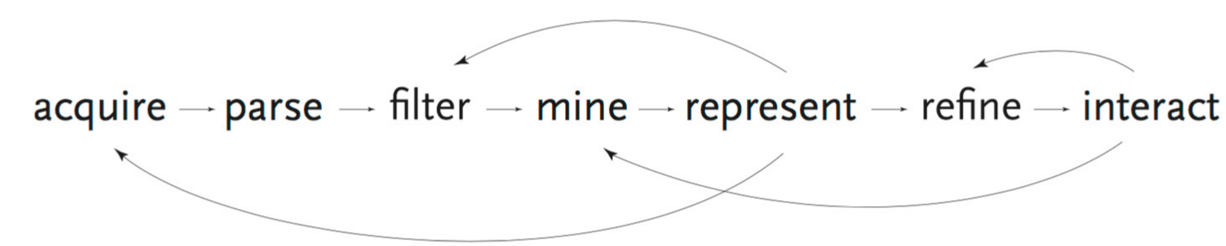
Figure 03
The SearchGPS Watch (2014)

Literature Review

This research project created an interactive data visualisation of a surfer's experience over time. This was achieved using existing wearable technologies to collect data and a mixture of web based visualisation tools to create visualisations that illustrate the relationships within the database. The literature reviewed in this section explores the areas of data visualisation and the surfing subculture that were analysed for their relevance to the final design in the experimentation stage. This section also analyses visual precedents relevant to the design development.

Data Visualisation

Researching an efficient process of data visualisation for visualising complex networks is important for understanding large datasets and the relationships they contain. An efficient method of visualisation allows for quick design iterations of the datasets and the ability to evaluate the relevance of the data in relation to the aims of the data visualisation. Visualising complex networks on different scales such as ***micro***, ***relationship***, and ***macro*** allows different patterns to be seen and explored (Lima, 2011). The literature included provides a framework for an efficient and flexible data visualisation process by Fry (2004). Lima's (2011) work covers the visualisation of complex networks and defines different scales and the information they contain.



Fry's (2004) defines a process which combines the fields of information visualisation, data mining and graphic design into a singular process: ***Computational Information Design*** (Fry, 2004). He defines the process as: ***acquire***, ***parse***, ***filter***, ***mine***, ***represent***, ***refine***, and ***interact***.

Figure 04
Computation Information Design (Fry, 2004)

Computation Information Design provides a solution for the individual to approach data visualisation, rather than making it into an interdisciplinary field. Fry (2004) suggests, to be able to understand the data, one must understand the handling of the data from start to finish. Typically the process would contain the fields of computer science (acquire and parse), statistics (filter and mine), graphic design (represent and refine), and human computer interaction (interact). By merging these fields he attempts to make the process of data visualisation more efficient and flexible. As part of his dissertation Fry (2004) co-developed *Processing*, an open source programming language designed "to simplify the computational process for beginners, and can be used as a sketching platform by more advanced users". This was used as the main tool for visualisation experiments.

The consolidation of these fields and the efficiency and flexibility of this process were an important factor in the progress of this design thesis. As Fry (2004) suggests, the initial format of the data will often drive the next step in the process and so on, so that the representation of the data is a result of the statistical analysis, not the initial question. Therefore, the ability to efficiently 'sketch' data visualisations allowed swift experimentation with different data capture and visualisation methods. This 'sketching' method granted the efficient exploration of the surfing dataset and attempted to reveal patterns and relationships which cannot be seen in the initial data. The visual methods utilised in the exploration of this data were derived from Lima's (2011) principles of *Complex Network Visualisation* and other successful visual examples such as *Just Landed* (Thorpe, 2009).

Figure 05
Just Landed (Thorpe, 2009)

Literature Review

The visualisation of complex networks can be achieved through a combination of common visual principles and more specific multivariate principles. The principles that should be considered during the visualisation process are: start with a question, look for relevancy, enable multivariate analysis, embrace time, enrich your vocabulary, expose grouping, maximise scaling, and manage intricacy (Lima, 2011). The specific principles which were used in the design experimentation stage are analysed below.

The first principle relevant to this research explains the importance of enabling multivariate analysis. Due to the complex nature of the dataset being generated, a multivariate analysis is critical "to the holistic understanding of the depicted topology" (Lima, 2011). For instance, the database contains surfs which consist of many variables: time, location, duration, wave count, swell conditions, among many others. The multivariate approach should allow users to identify certain behaviours. For example, whether a big swell on the north shore of Hawaii is related to a rise in the number of people surfing there.

Embracing time is the second principle of note and it is important in the animation of the visualisation. Lima (2011) proposes that by properly measuring time, "it would provide us with a comprehensive understanding of the social group's changing dynamics". The data retrieved from Rip Curl spans a year, and has values which change daily and others which change at a rate of milliseconds. These differences in time scales can illustrate the dynamics of the surfing community on a *global* level (the increase in surfing during summer seasons), on a *local* level (the pilgrimage of surfers to a surf spot), and on a *personal* level (the amount of time spent paddling compared to riding waves).

Exposing grouping is one of the most important principles described, and works in conjunction with *maximising scaling.* Lima (2011) builds his grouping principle off of Gestalt psychology, specifically, the rules of perceptual organization. He identifies similarity, proximity, and common fate as particularly important laws.

> The law of similarity asserts that elements that are similar - either in terms of color, shape or size - are perceived to be more related than elements that are dissimilar.
>
> The law of proximity states that elements that are close together are perceived as being more related than elements that are farther apart.
>
> The law of common fate proclaims that elements that move simultaneously in the same direction and at the same speed are perceived as being more related than elements that are stationary or that move in different directions. (Lima, 2011)

The ability to visually group surfers by location or other factors can identify patterns of surfer movements and will most likely expose popular surf spots around the world.

Finally, *maximising scaling* allows the design to be arranged into views which will emphasise specific relationships within the visualisations. Lima identifies 3 views, *macro*, *relationship*, and *micro*. The first view, *macro*, should be the entry point to the visualisation and "highlight certain clusters, as well as isolated groups (Lima, 2011)". The *relationship* view should allow the analysis of the relationships between the surfers. The *micro* view is for insight into an individual surfer's qualitative attributes. "this qualitative exposure helps clarify the reasons behind the overall connectivity of the pattern (Lima, 2011)". These views relate to the *refine* section of *Computational Information Design* in which the hierarchy of information becomes important in communicating the desired aspects. The refinement of information based on these three views developed into the *global*, *local*, and *personal* views of the final design.

Lima's (2011) principles of network visualisation provide this project with a set guidelines that will assist in the layout of the final design framework, and in the communication of key relationships within the database. These principles will be used in conjunction with Fry's efficient and flexible (2006) process of visualisation in the design experimentation stage of this project. This stage will hope to identify certain technologies and the effectiveness of certain visual methods in communicating aspects of the surfing subculture.

Surfing Subculture

The complex network under investigation is that of data being generated by surfers around the world. The surfing subculture is a complex system of individuals and groups, its ***surface*** consisting of the recognisable symbols and attitudes of surfing, and its ***substructure***, consisting of different levels of neo-tribal groups (Stranger, 2011). These neo-tribes categorise the surfing community based on the shared experience of searching for surf, territory and shared culture, and the common understanding of the ***transcendent experience***.

Stranger (2011) categorises surfing's grounded neo-tribes into ***bands***, ***tribes***, and the surfing ***nation***, each group being an abstraction of the previous. A ***band*** of surfers usually consist of two to six surfers of similar ability and the same 'surfer type' (hardcore, core, recreational), their formation generally spawns from shared surfing experiences during 'the search' for the perfect wave. This group usually belongs to a wider community defined as a ***tribe***, which gets its definition based on territory and shared local culture. The surfing ***nation*** is the global level of these tribes and is constructed by surfing media's presentation of surfing styles and attitudes.

The shared nature of the surfing experience, a feeling of being one with nature, is the foundation of these tribes. Stranger (2011) analyses this experience in comparison to Csikszentmihalyi's theory of ***flow (1988)*** and Lyng's (1990) ***edgework*** interpretation of ***flow***. The theories describe 'the zone' that can be achieved through a balance of motivation and ability. Stranger (2011) explains the common points between two, "that a distortion of time can be involved and that the experience can involve feelings of oneness with the objective surroundings."

Another important aspect used in this research is a surfer's pilgrimage to experience new or revered waves. Booth (1995) uses the term ***the search*** to define a surfer's desire to find the perfect wave. Stranger (2011) attributes the myth of ***the search*** to surf films such as the Endless Summer by Bruce Brown. This drive by popular culture to fuel the myth is continued in the present by surf companies such as Rip Curl. Stranger (2011) mentions their Search product line focuses on the experience that is the foundation of the surfing subculture. The desire to surf new waves and enhance experience can inspire a surfer to explore new territory both nationally and internationally.

Identifying aspects of the surfer's pilgrimage to surf spots, and local hierarchies generated a criteria for the design stages of this project. As part of the design experiments this cultural criteria was developed with the information gained from the experiments. The ***hierarchy*** and ***pilgrimage*** aspects were explored with the ***macro*** and ***relationship*** views proposed by Lima (2011). Furthermore, in the design experiment section of this research, a surfer's ***experience*** with the waves at specific locations was visualised, this represented a ***micro*** view of the database.

Precedent Design

The design precedents section analyses technological and visual techniques used with action sports trackers and time-based, data-driven media. This includes the SearchGPS Watch (Rip Curl, 2014) and other action sports trackers such as Trace (2015), also new media experiments such as Your Year (AKQA, 2014) and Force of Nature (FIELD, 2015). Also, this section reviews contemporary methods of capturing surfing media and attempts to identify successful aspects to be taken forward into the design.

Part of this research explores the concept of consolidating databases created from wearable technologies used by surfers. A example of wearable technology is the SearchGPS Watch, an action sports tracker to record a surf session. The watch uses Global Positioning Systems (GPS) to track your movements and uses this data to keep track of statistics such as duration, wave count, longest wave, max speed, and distance travelled.

The Trace is a similar action sports tracker which is mounted on the surfer's surfboard. This device is similar to SearchGPS Watch. However, it also contains sensors which record the orientation of the surfboard. This extra layer of data allows the device to calculate when a manoeuvre such as a turn or aerial is being performed by the surfer.

Figure 06
Trace action sports tracker (2015)

The action sports trackers mentioned provide feedback to the user by synchronising with a computer or smartphone application. Once the device has transferred the information, the surf session can be reviewed by viewing the surf track overlaid onto Google Map. The applications also allow users to share the surf with friends.

The design of the SearchGPS application shows location, max speed and wave count in a preview of the surf. This suggests that these statistics were valued more highly than others such as, distance travelled, and longest wave. This hierarchy of information is explored further in the design stages of this research by analysing the variables ability to be communicated visually.

Figure 07
SearchGPS mobile application (2015)

Figures 08, 09, 10, 11
Your Year
(AKQA, 2014)

Figures 12, 13, 14, 15
Force of Nature
(FIELD, 2015)

Your Year (AKQA, 2014) and Force of Nature (FIELD, 2015) are examples of using sports tracking data to drive a media experience. These media experiences demonstrate the relationship between time, and how the data is refined, in order to effectively communicate the desired message. Your Year compresses a year of running data from a user into a one and a half minute, data-driven animation. Force of Nature on the other hand, is real-time experience driven by the user running on a treadmill.

The first example, Your Year, features a refined representation of the database. It refined the statistics from every run a user took that year to generate a clip from 1500 animation clips (AKQA, 2014). This refinement highlighted particular aspects of the data such as personal bests or least active day of the week. In contrast, the Force of Nature experience features less refinement of the data, to create a more direct representation of the user. There is less need for refinement because of the user's ability to interpret their actions as direct drivers of the visualisation.

The previous designs demonstrate a relationship between time and the level of detail of data being used or captured, and also include a relationship between the detail of the data and the way in which it is being presented. For example, the Your Year project uses a stylised representation of the runner and their environment, showing different views to illustrate location and weather. Whereas the Force of Nature project is a direct representation of the runner projected directly in front of them, abstracted by the speed and colour data that is being captured. This relationship can be seen as a more detailed level of data requires a more realistic representation of its form. For example, the detailed data captured from a surf session could be visualised using methods similar to current surf media to represent it more accurately.

Current surfing media have begun to utilise drones to capture surfing from different perspectives (Pipeline Winter, 2013) and 360 degree cameras to create virtual surfing experiences (GoPro, 2015). These methods of filming provide precedents for methods of viewing the database created, specifically the detailed data captured during a surf. When visualising the data in a virtual environment, virtual cameras can be created to imitate these real cameras.

Design Methodology

Through the process of this research it became evident that unconventional ethnography through data visualisation of the surfing community was being conducted. Therefore, an interpretation of an ethnographic approach was used for this project. The research used an ethnographic strategy of inquiry to develop a qualitative analysis of a quantitative database. The qualitative analysis was conducted using iterative design sketches to establish hierarchies and relationships within the quantitative databases' created by surfers. The methods utilised are based on an ethnographic interpretation of a strategy of inquiry proposed by Knigge and Cope (2005), *Grounded Visualisation*.

An important aspect of ethnographic research methods is the researcher's participation in the activities. This element is from a constructivist worldview in which the researcher recognises that the researcher's own background shapes their interpretation (Creswell, 2009). The researcher for this project has been a member of the surfing community for over 20 years. Therefore, the implicit knowledge of the surfing subculture developed over this period has shaped this research significantly. Aspects of the culture already known to the researcher such as hierarchies within local communities, popular surf spots, and knowledge of surf breaks were validated through literature.

This research uses ethnographic methods to investigate the visualisation of the surfing subculture. The methods include observation of participants activity through data capture, and attempting to understand patterns that emerge through data visualisation. Typically ethnography focuses on the collection of qualitative observational data of a cultural group (Creswell, 2009). This research focuses on the creation of visual sketches as qualitative data. However, these sketches are based on a quantitative digital representation of the surfing cultural group rather than direct observation. The knowledge gained from direct observation is already known to the researcher due their significant immersion in the surfing community.

Knigge and Cope (2005) propose a method which utilises commonalities between grounded theory and visualisation to build an approach they call ***grounded visualisation***. These are: they are both ***exploratory***, they are both ***iterative*** and ***recursive***, both enable the simultaneous consideration of particular instances and general patterns, and both encourage multiple views and perspectives for building knowledge. Knigge and Cope (2005) conclude, "The combination of qualitative and quantitative data, together with a commitment to iterative, reflexive rounds of analysis, enables research to be attuned to multiple subjectivities, truths, and meanings." The similarities between the steps outlined here and ***Computational Information Design*** support the applicability of these methods.

The commonalities identified by Knigge and Cope (2005) between grounded theory and visualisation can also be found between ethnography and visualisation. For example, Creswell (2009) describes ethnography as being flexible and evolving in response to experiences in the field. Where ethnography differs from grounded theory is that ethnography does not attempt to generate theory which is grounded in the view of the participants (Creswell, 2009). This difference can be accommodated in this project as the aim is not to generate theories of surfing subculture, but rather visualise the theories of the surfing subculture identified in the literature review.

The steps outlined by Knigge and Cope (2005) as part of a case study are as follows: exploring the data, exploring the area, mapping connections and context, and further iteration of analysis and data collection. These steps have been reworked for this project so that they relate to the ***Computational Information Design*** process (Fry, 2004). They are as follows: capturing the data, exploring the data, mapping connections and context, and continued iteration of analysis and data collection. These steps define the process used in the design experimentation stage of this project.

Researching an efficient process of data visualisation for visualising complex networks is important for understanding large datasets and the relationships they contain. An efficient method of visualisation allows for quick iteration of datasets and the ability to evaluate the relevance of the data in relation to the aims of the data visualisation. Visualising complex networks on different scales also allows different patterns to be seen and explored (Lima, 2011). The literature included provides a framework for an efficient and flexible data visualisation process by Fry (2004). Lima's (2011) work covers the visualisation of complex networks and defines different scales and the information they contain.

Design Experiments

The aim of this project is to design a visualisation of data captured from a global community of surfers. The experiments aim to provide insight into the technology and techniques needed to successfully develop a design that illustrates the surfing subculture, and develop and validate the cultural criteria.

The methods used by this research as defined in the methodology section revolves around the capture, exploration, mapping, and iteration of data. These steps are important in understanding the applicability of the techniques used to acquire the data and the applicability of the dataset. The first two experiments capture data associated with checking the surf via web services and the data of a physical surf. Respectively, these experiments analyse the ***intent*** and ***action*** of a surfer. Each experiment can be divided into capture and visualisation stages. The data is captured and explored in its raw form to try and identify pieces of information that should be visualised. The visualisation allows the connections to be mapped and to identify whether the databases' context is relevant. The final experiment focuses on the exploration and mapping of the database generated by the SearchGPS Watch (Rip Curl, 2014).

The first experiment identified users on swell forecasting websites and their location to understand a surfer's desire or ***intent*** to go surfing. The second experiment replicated current action sports trackers by tracking a surfing session. This experiment aimed to capture and visualise the experience of being in the surf. The third experiment visualised the global database generated by the SearchGPS Watch (Rip Curl, 2014) to evaluate its applicability to this project. This experiment differs from the previous two because of the lack of control of the data capture process. The database was already being generated before this project began and continues to grow.

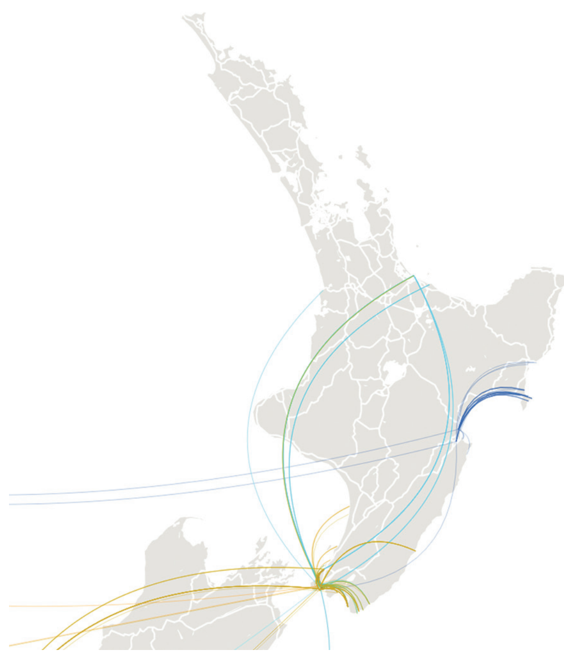


Figure 16
Intent paths
North Island, New Zealand

Experiment One

The first experiment was designed to explore methods for capturing and visualising a surfer's *intent* to surf by tracking a user's visits to swell forecasting websites. For example, a surfer located in Wellington, New Zealand, may be viewing surf spots 2 to 3-hours drive from their location. This experiment included design problems associated with tracking users on the web, and visualising which surf spots a user viewed in relation to their current location. This experiment also hinted at the nomadic nature of surfing participants by capturing a surfers international movements over time.

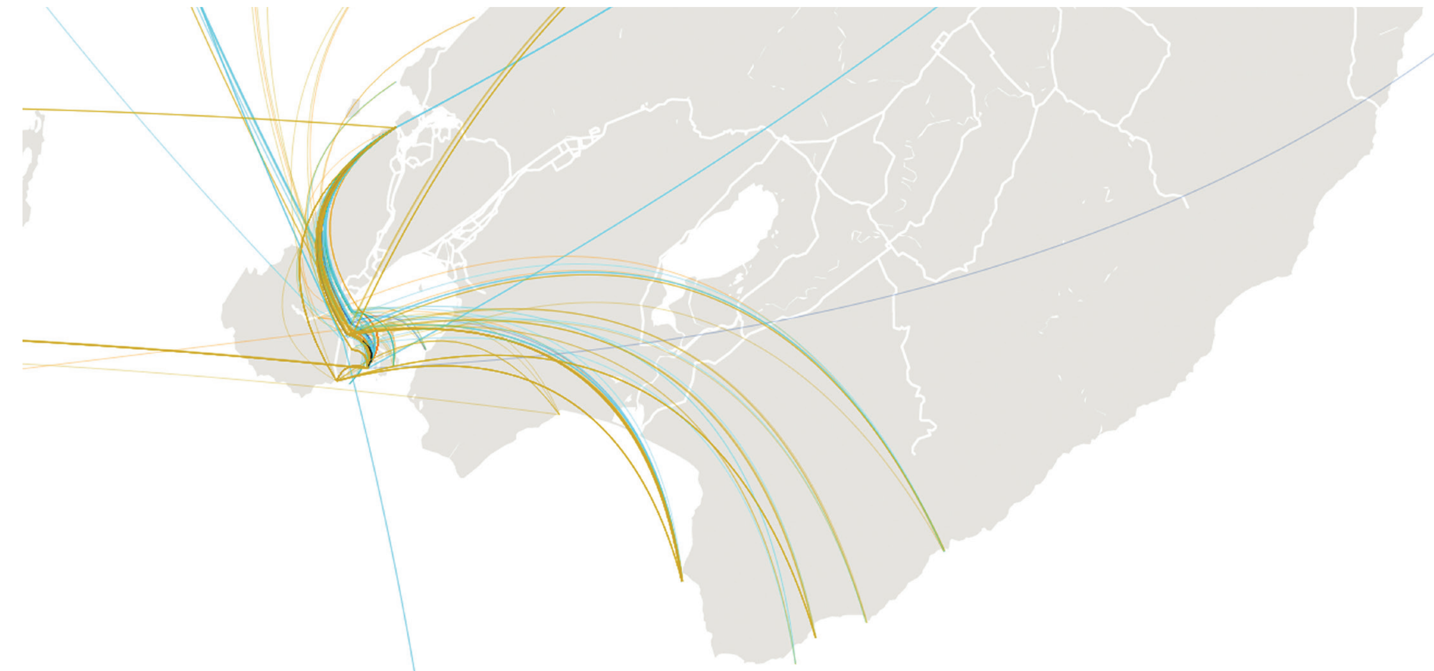


Figure 17
Intent paths
Wellington Region, New Zealand

Computers and mobile devices have the capability to accurately locate where users are in the world. Many visualisations take advantage of these data points to visualise where people are moving and communicating within the world. Just Landed (Thorpe, 2009) demonstrates this by visualising ***tweets*** (from Twitter users). By using the location of ***tweets*** containing the words 'just landed' and comparing that to the user's profile location, flight paths could be visualised. Thorpe's method of visualisation consisted of a map containing arcs from the user's original location to the 'just landed' location. They effectively showed a user's movements over time. Therefore, similar methods were employed in the first experiment (Fig 16, 17, 18, 19).

Experiment One consisted of 10 university-aged surfers based in Wellington, New Zealand, using a chrome web extension that tracked which swell forecasting sites they visited and their location when they visited it. The sites included swellmap.com, Magicseaweed, SURF2SURF, and Surf-forecast.com. Whenever a user visited one of these sites a package of data would be sent to the database. This package contained anonymous user id, timestamp, location (latitude, longitude), and the url of the website visited. The url would contain the location name that could then be matched with a database containing the locations of each surf spot. For example, 'lyall bay' could be extracted from this url: http://www.swellmap.co.nz/surfing/new-zealand/lyall-bay. The database that was generated by the web extension was then visualised using arcs between a user's location and the surf spots they had viewed on a Google Map. Each user was assigned a separate colour and the visualisation could be viewed over time as an animation and in a static state.

After a month, the experiment collected just under 300 usable data points gathered from 10 participants. Most of the users were viewing local surf spots all within 2-hours drive. More specific groupings began to emerge (during the university break). Users could be seen accessing the websites from other locations around New Zealand, such as Gisborne and Christchurch. Even from these locations, the users were still viewing surf spots within a 2-hour drive. However, one user, located in Wellington, was viewing surf spots in Samoa. The extension then recorded the user viewing the same surf spots from a location *in* Samoa. The visualisation had communicated a surfer's *intent* to surf in Samoa and also tracked their *pilgrimage* to Samoa (Fig 18, 19).

The aim of this experiment was to identify a group of surfer's *intent* to surf—through the capture and visualisation of data associated with the practice of viewing swell forecasting websites. Therefore, quantifying an aspect of the surfing subculture and qualitatively evaluated it through data visualisation. Due to the small number of participants there was insufficient data for this experiment to go further. However, the arc visualisation methods from *Just Landed* (Thorpe, 2009) effectively communicated a surfer's *intent* to surf. The *pilgrimage* of the surfer to other countries visualised in this experiment was also identified in Experiment Three. This aspect of the subculture was identified in both the literature and design experiments. Therefore, it became an important aspect in the final design.

Figure 18 / Top
Intent path to Samoa

Figure 19 / Bottom
Intent paths in Samoa

Experiment Two

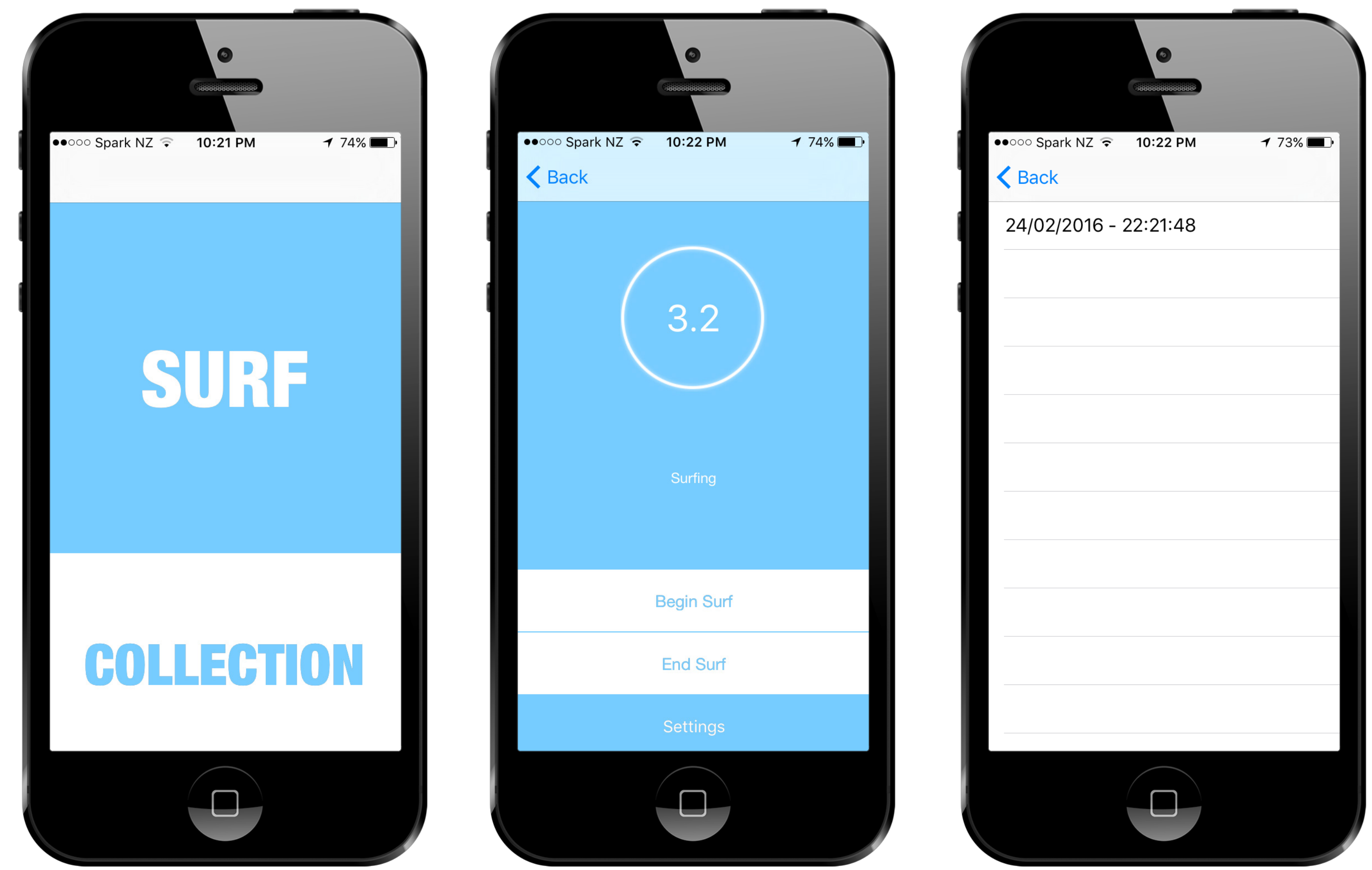
The second experiment explored the generation and visualisation of a database pertaining to the physical action of surfing, specifically, paddling on the board to position oneself to catch a wave and the movements associated with catching and riding a wave. The SearchGPS Watch and the Trace action sports trackers both capture data generated from a surfing session, then allow the user to review the session via a mobile application. The aim of the experiment was firstly, to understand what surfing data should be captured, and secondly, to define methods of visualising a surf session in ways that communicated the surfing *experience*.

Figure 20
Surf Footprint
Lyall Bay, New Zealand

Figure 21
Nike+ City Runs (YesYesNo, 2016)

The data generated by the SearchGPS Watch is visualised on a Google Map in a static form that the user can then zoom and pan. This is contrasted with Nike+ City Runs (YesYesNo, 2016), a visualisation that generates animated GPS traces according to user's running patterns. The runner's track is viewed from a 'drone' style camera—because it is revealed over time, it slowly reveals shapes of the city. This creates a compelling visual which establishes relationships both with time, location, and speed—factors which are lost in the SearchGPS visualisation. The visualisation methods used to create this successful visualisation were explored in this design experiment.

The SearchGPS Watch and the Trace restrict the access to the raw data produced. Therefore, a proxy mobile application was designed so that similar data could be captured in order to be visualised. The design of the proxy application for this experiment focused on capturing two levels of data, the gps track of the surf, and the actual movement of the surfer on the wave. The application named Surfone used the GPS and motion sensor capabilities of mobile devices (commonly used to control gaming, or track running on mobile devices) in an attempt to capture a surfer in a three dimensional (3D) virtual space. The device can be placed in a waterproof case on the back of a surfer using a custom pocket in their wetsuit. At the end of a surf, all the data can then be sent to the online database to be visualised. For this experiment, the researcher acted as participant and attempted to use the application to record a surfing session. Once a session was captured, the data was then stored in an online database for visualisation.



Figures 22,23,24
Surfone mobile application

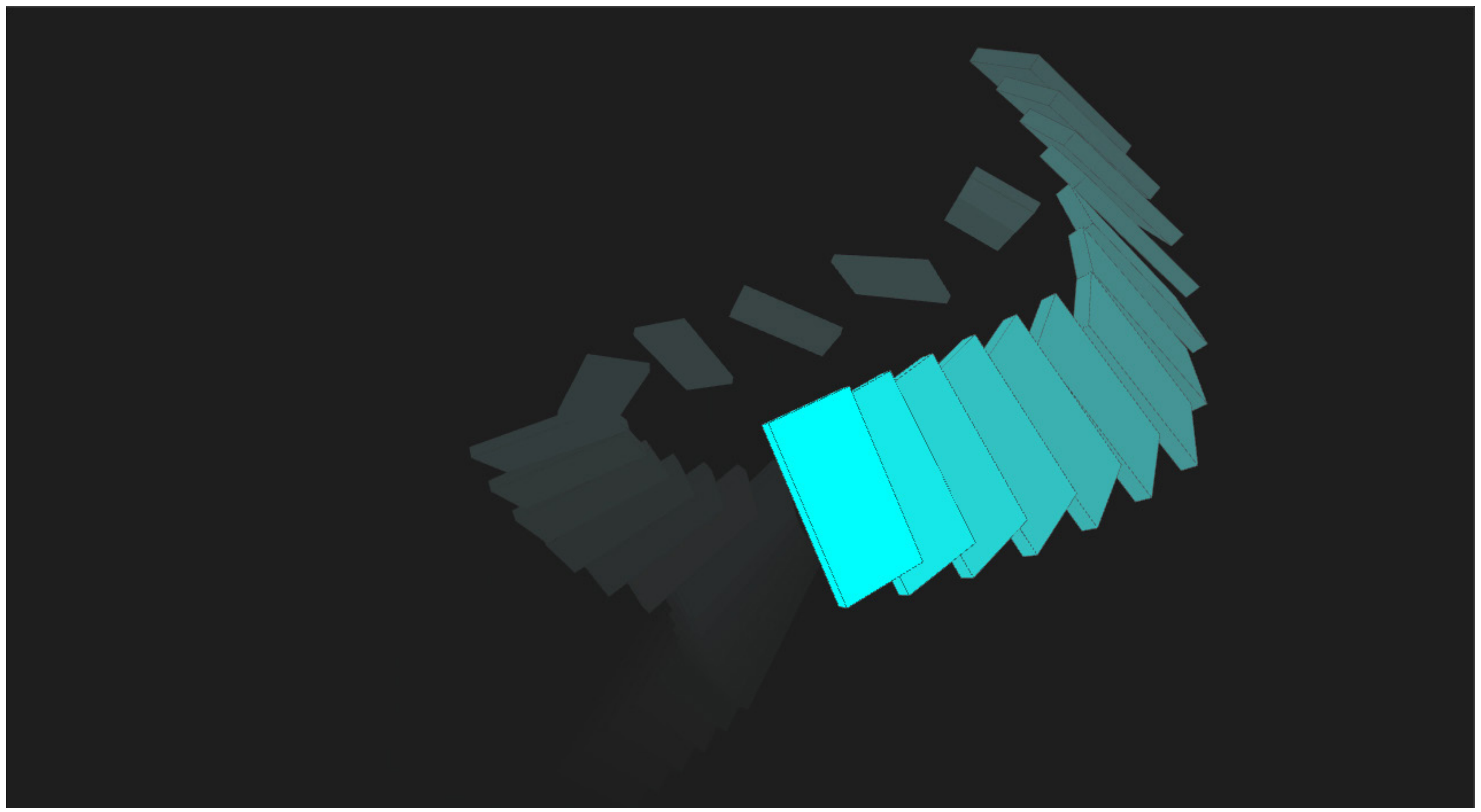


Figure 25
Surfer motion visualisation

The *Processing Development Environment* was used as a tool for visualising the action of surfing in way that demonstrated the relationships prevalent within a surf session. The initial visualisation explored motion of the surfer's body. The second visualisation explored the gps track, and the speed of the surfer. The motion of the surfer can be measured via rotation and acceleration. These measurements were used to drive an animation of a rectangular prism representative of the surfer (Figure 26). This visualisation projected the movements of a surfers torso into a virtual environment. The GPS track and speed were visualised by animating the location of the surfer over a Google Map. By creating a speed threshold of 10 kilometers per hour, waves could be identified. These were visualised by lines, and the time spent paddling was represented by small circles (Fig 20, 26, 27, 28, 29, 30, 31, 32, 33).

Figure 26
Surf Footprint
Breaker Bay, New Zealand

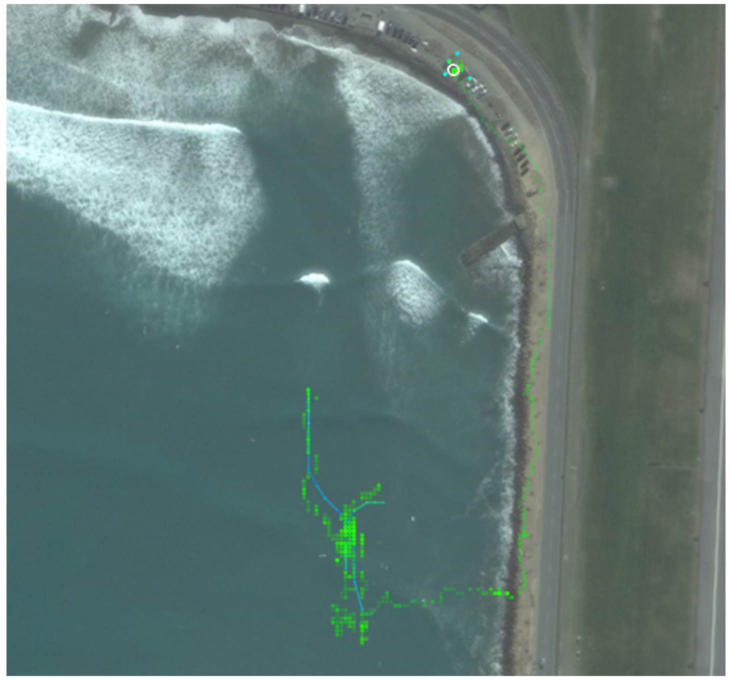


Figure 27
Surf Footprint
Lyall Bay, New Zealand

Figure 28
Surf Footprint
Fitzroy Beach, New Zealand

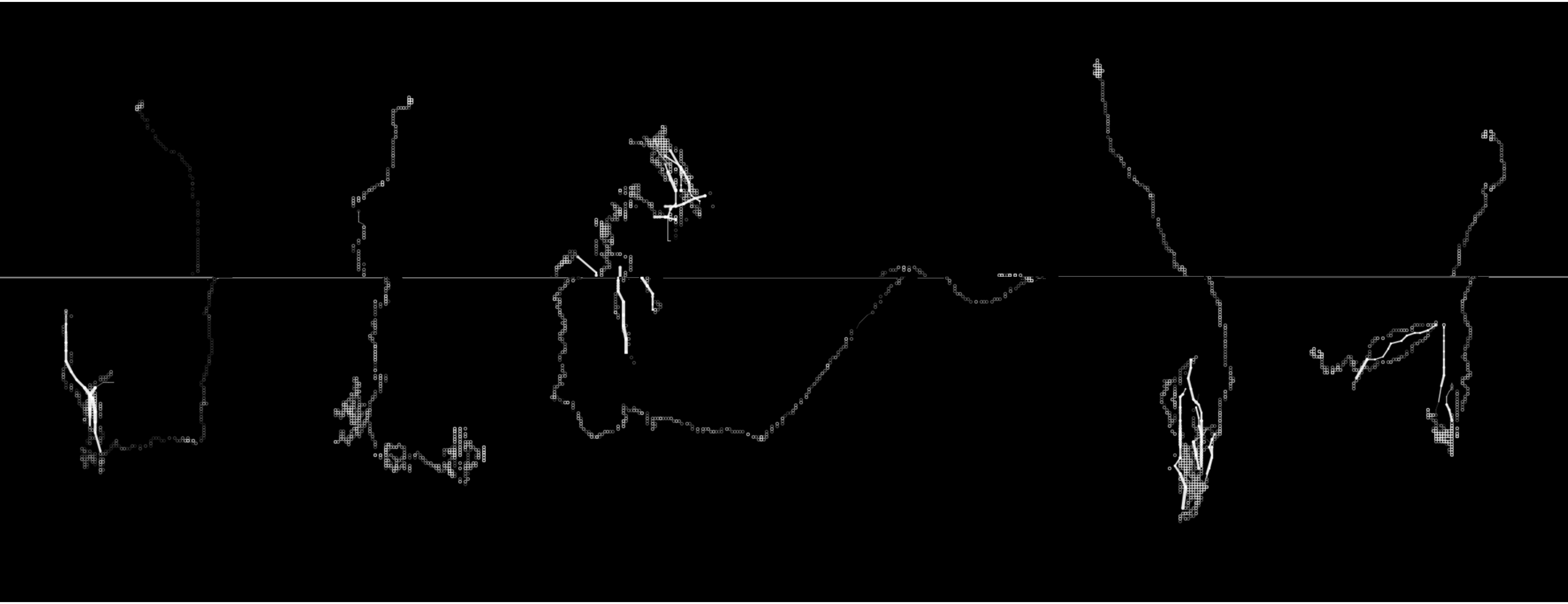
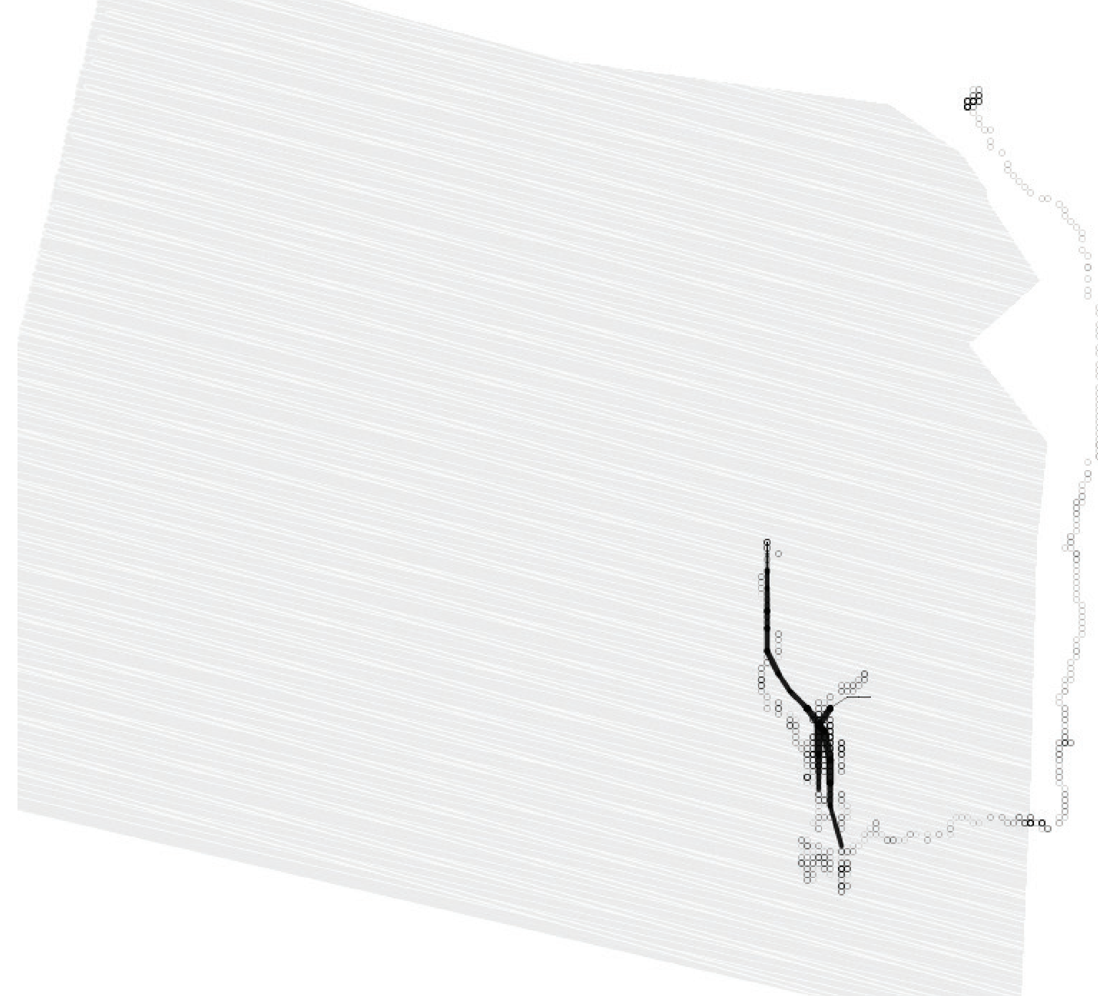
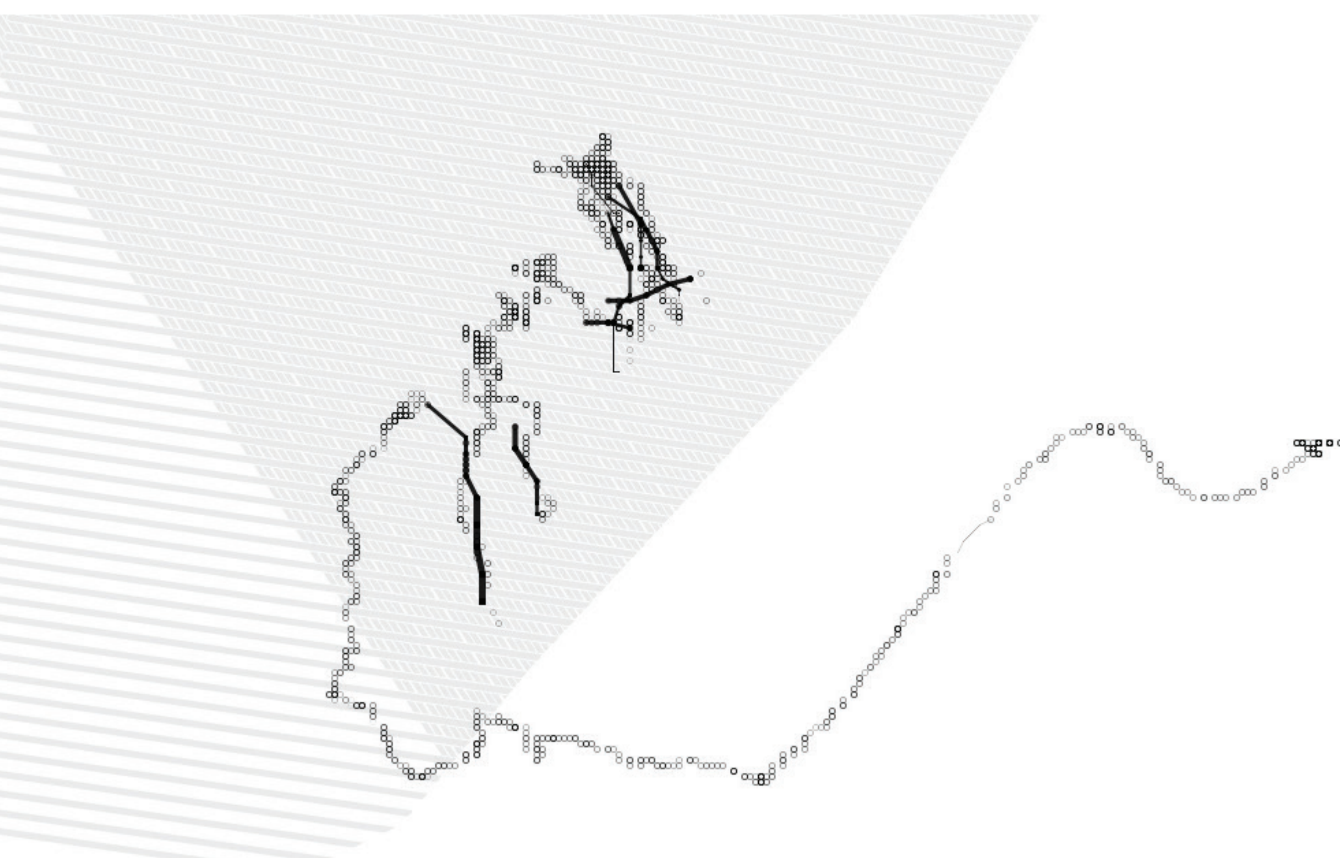


Figure 29
Stylised Surf Footprints





The results from Experiment Two extended the traditional visualisations of the commercial products by animating the GPS tracking data and adding another layer of data for multivariate analysis. For example, the colour value of the GPS track could be used to visualise the speed, rotation, or acceleration of the surfer. Therefore, the movements of the surfer could be visualised in relation to their position in the surf. The visualisation determined when a surfer was in the sitting or prone position, as well as where a turn was performed on the wave.

Figure 30 / Top Left
Stylised Surf Footprint
Lyall Bay, New Zealand

Figure 31 / Left
Stylised Surf Footprint
Fitzroy Beach, New Zealand

Figure 32 / Top Right
Stylised Surf Footprint
Lyall Bay, New Zealand

Design Experiments

Because the data was collected multiple times at an individual surf spot (The Wall, Lyall Bay, Wellington, New Zealand), conclusions were drawn on the style of waves compared to the position of the surfer. Lyall Bay has a few distinct breaks—one which which breaks off the break wall and runs to the right as seen from the beach (in surfers' terms this would be called a ***left hand point break***), and another further down the beach which breaks on the sand bar and runs to the left as viewed from the beach (***right hand beach break***). The visualised data illustrated the different directions of the surf breaks. When a wave was caught at The Wall, the surfer would move perpendicular to the beach. Whereas when a wave was caught at the ***beach break*** the surfer's movements were more parallel to the beach. The visualisation also communicated the paddling movements of the surfer in their attempt to position themselves to catch a wave.

The aim of this experiment was to determine methods of visualising the surfing experience. The visualisation communicated implicit knowledge of the surf spot. By showing the way in which the waves break, this experiment subverts a cultural knowledge learnt by the surfer through years of experience in the surf (Stranger, 2011).

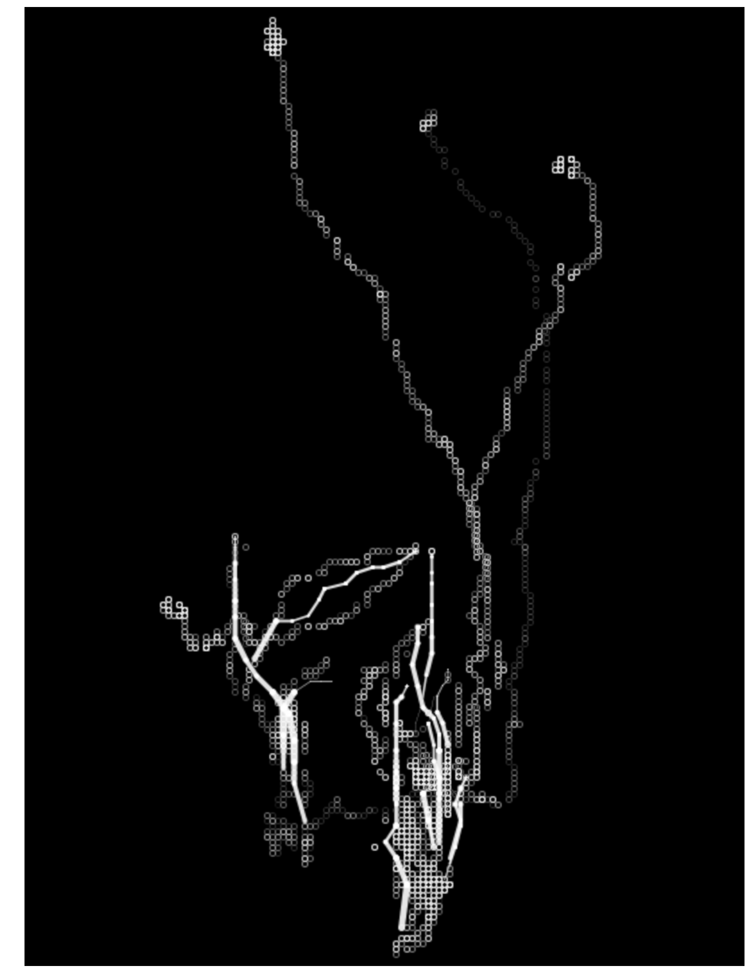
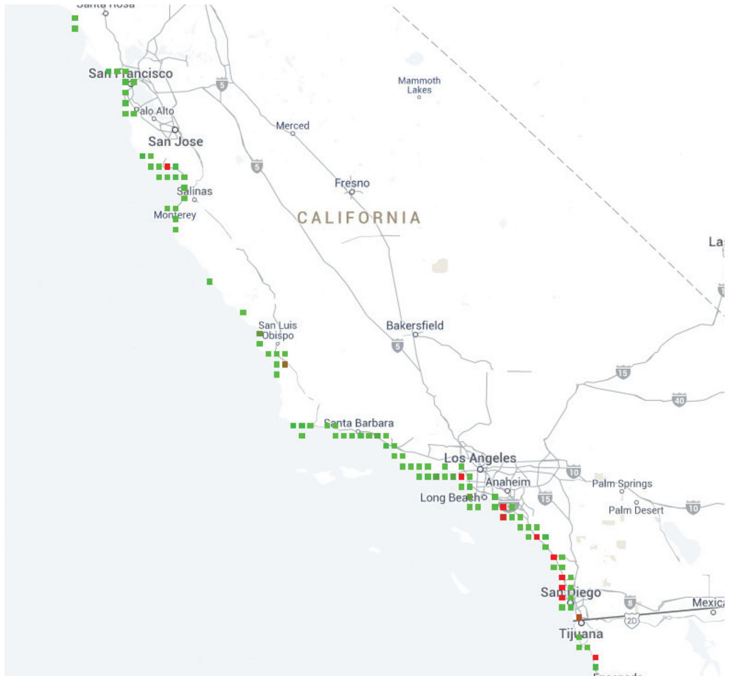


Figure 33
Stylised Surf Footprint of Three Surfs
Lyall Bay, New Zealand



Experiment Three

The final experiment in this research was a response to the sample of data released by Rip Curl from the SearchGPS Watch database and consolidated the aspect of ***pilgrimage***, identified false positives, and provided this research with its first visualisation of the global surfing community. The previous experiments investigated methods of capturing data which could be implemented efficiently in the scope of this project. These came about because of a lack of access to the data generated by the commercial trackers already in use (SearchGPS and Trace). With the release of a sample of this data this experiment was able to work with a database generated by the global surfing community.

Figure 34
Popular surf locations California

Figure 35
Shipping lanes visualisation (Kenny, 2012)

The Rip Curl database covered a year's worth of surfing from over 9,000 users, totalling over 250,000 surfs. The experiment aimed to identify the applicability of this database to this project. It also explored the technological requirements of visualising big data. This data was donated after experiments one and two had been completed and became the core of the data used in the final project. This was combined with the data captured from Experiment Two to create a more complete database that ranged from a ***global*** to a ***personal*** level.

With a large database, newer technologies for ***parsing***, ***filtering***, and ***mining*** large amounts of data were employed to make working with the data easier for the designer. The database's used in the previous experiment were small, five megabytes at the most. In comparison, the Rip Curl database was over 80 megabytes. Google's Big Query is a tool for querying large databases with a set of rules, so that the smaller sections of the database can be returned. For example, the database could be queried to return a surf's location, unique ID, and timestamp. This reduces the size of the data being worked with by 80%. This is useful when experimenting with the data to efficiently work with certain variables and add more variables if needed.

WebGL is a browser based technology which allows a website to take advantage of a computer's graphics processing capabilities. This feature has been implemented by designers wanting to create more immersive web experience and the visualisation of complex particle systems (Chrome Experiments, 2016). WebGL has also been used to visualise large databases, typically geographic in nature. A shipping lanes visualisation (Kenny, 2012) implements WebGL with Google Maps to visualise over 200,000 points gathered from ships. This visualisation was created to demonstrate how Google's ***big data*** toolset can work with WebGL. Furthermore, it visualised information of global shipping industry such as popular shipping lanes and false positives such as offshore oil rigs. Not only can these points be animated smoothly they are also interactive. The interactivity allows the user to hover over a ship to get further information such as the course and speed of the ship. These factors contributed to this experiment's shift to WebGL.

The visualisation sketches for this experiment began by visualising just over 3000 surfs from the month of January (Fig 36). This was done using the Processing Development Environment and an external Google Maps library. These initial sketches established surf locations and movements of users from one location to another. Visualising these movements communicated many surfers' nomadic tendencies. The tendencies ranged from extreme cases such as one user who travelled between Australia and Hawaii many times over one month, to less extreme such as users travelling from Australia to Indonesia and spending more than a couple of weeks in that location. This second group are examples of surfer's who make a *pilgrimage* to popular locations. The *pilgrimage* was explored further in the final design stages so that it could be communicated more effectively.

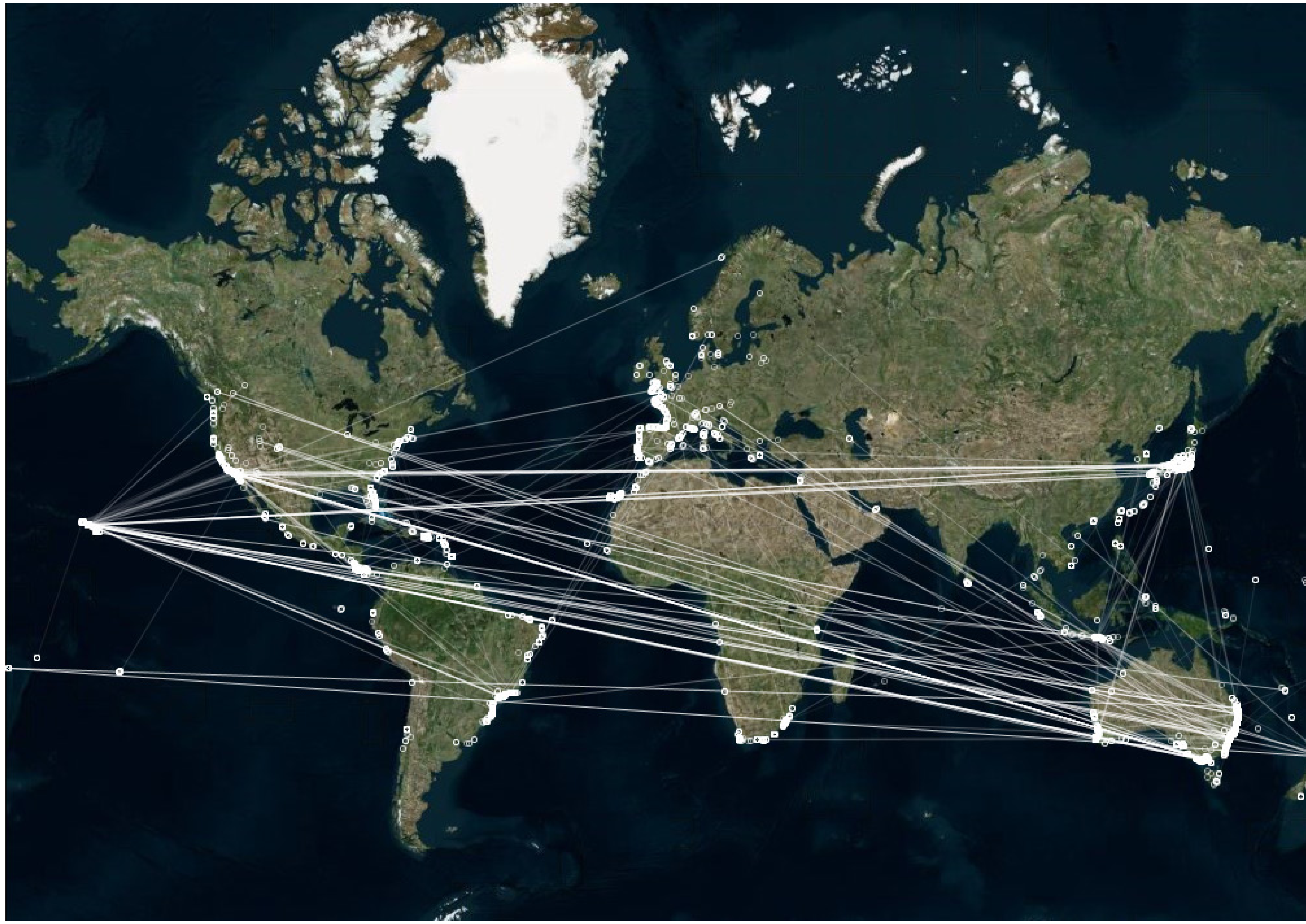


Figure 36
International pilgrimage visualisation

Figure 37
SearchGPS database
Surf geo-locations

Using newer web technologies in this experiment identified the limits of the computer's ability to visualise large amounts of data on the screen. The visualisation in this experiment placed every surf on a global map so that the relationships between these statistics could be analysed. By utilising WebGL in this experiment most of the processing power required to visualise the large dataset was passed on to the graphics processor of the computer. This allowed for the 250,000 to be visualised on a single map (Fig 37). It also meant that the colour, size and transparency could be altered to represent statistics such as, swell size, wave count, and session duration.

By plotting the location on Google Maps, 'surfs' in locations not near surf spots could be identified as alternative activities, this was emphasised using the color of points to denote speed. For example, a specific user's surfs were located in Lake Geneva, Switzerland (Fig 38). This could mean that the user was participating in a flat water based sport such as waterskiing, wakeboarding, or jetskiing. When visualised with speed as a variable the user could be seen travelling at speeds over 40 kilometers per hour, which is much faster than most surfers would travel on a wave. Another example is 'surf' locations found in mountain ranges such as the French Alps and the Japanese Alps. These are most likely winter sports sessions such as skiing or snowboarding. These false positives were important to keep in mind during the final design process.

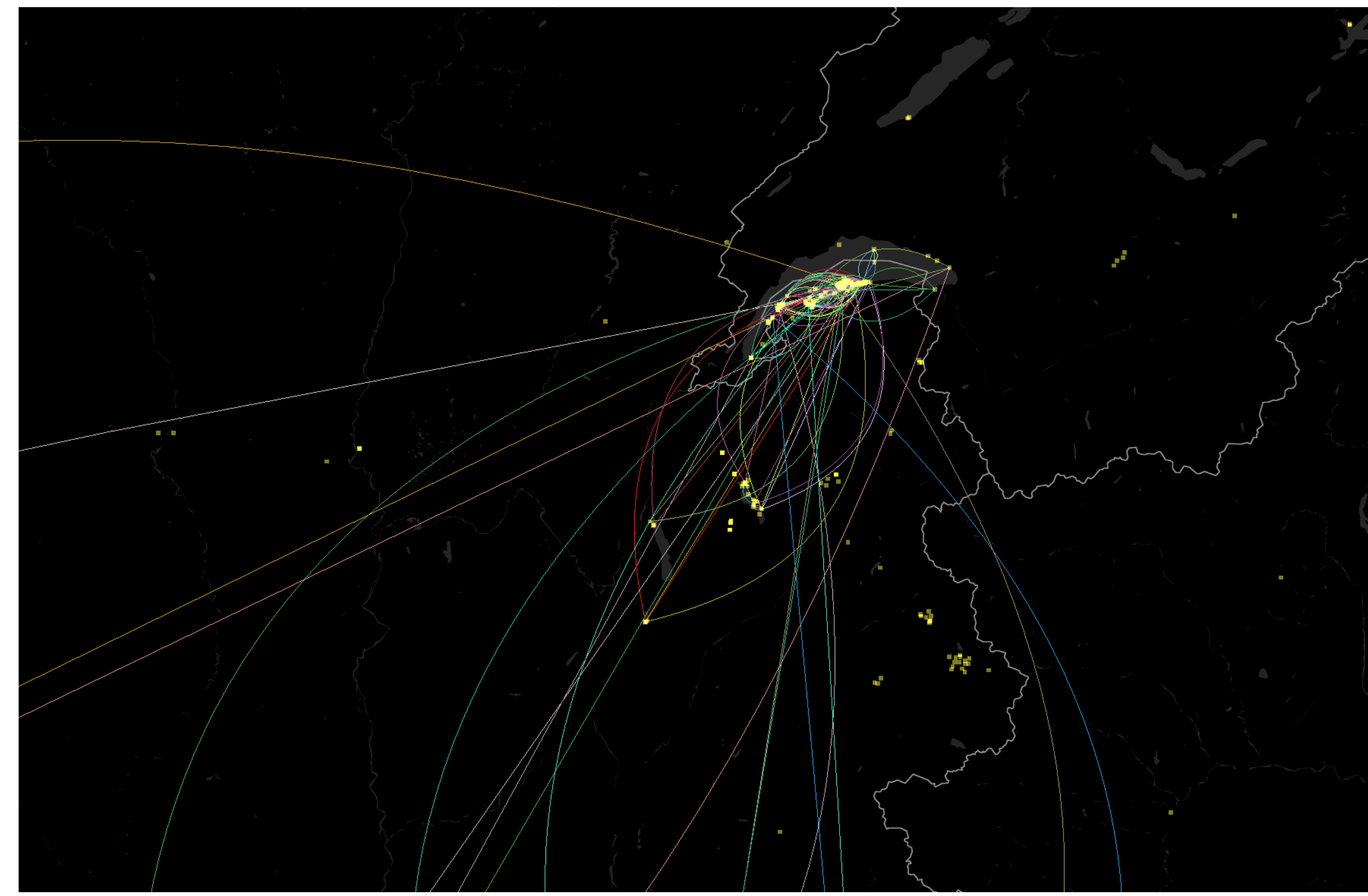
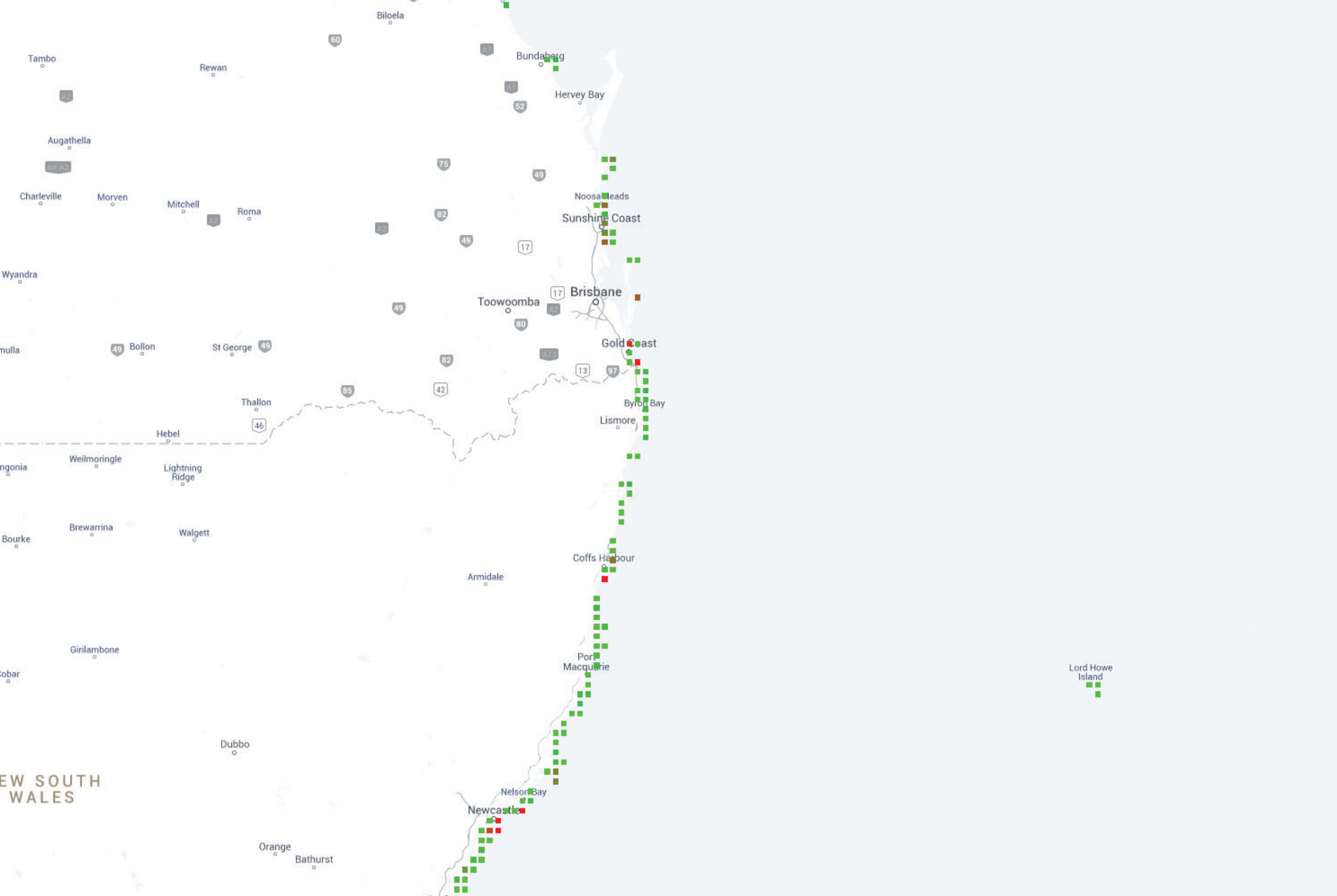
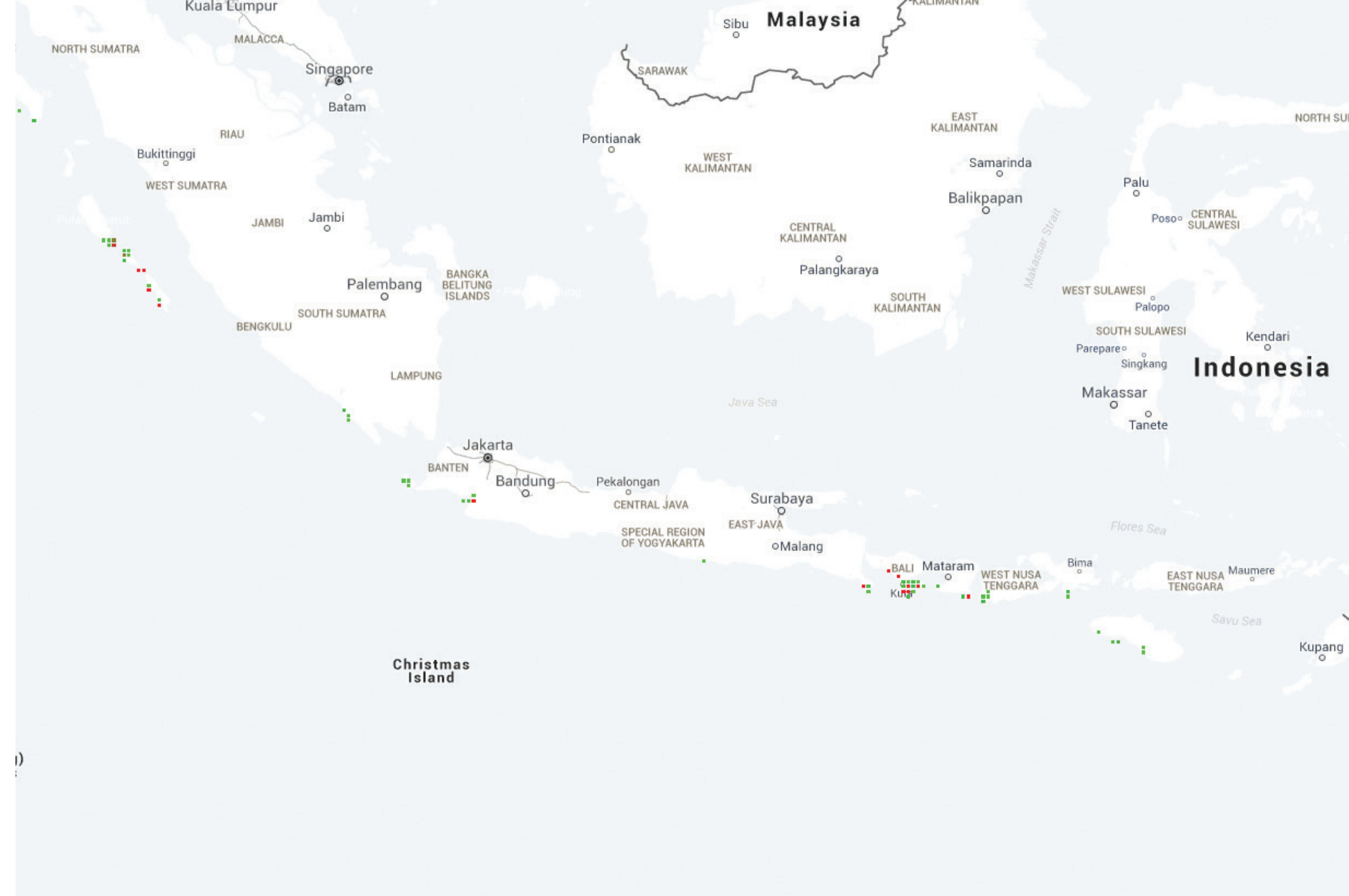


Figure 38
False positives
Lake Geneva, Switzerland



Interactivity is an important feature which enables a multivariate analysis of the database. Yi et al (2007) highlights the importance of interactions as "a way to overcome the limits of representation and augment a user's cognition". The previous paragraph established the analysis of the visualisation with different variables as a key factor in identifying outliers. This analysis was executed in the Processing application through code which is not user friendly. Therefore, implementing a user friendly interaction method to allow users to make comparisons themselves became important.

Figure 39
Popular surf locations
Australia



The results of this experiment generated the most complete picture of the contemporary surfing community. The amount of surf's per location were visualised which showed popularity on the west coast of United States, Surfers Paradise and the Gold Coast on the east coast of Australia, and the surfing *mecca*, Indonesia (Fig 34, 39, 40). By visualising swell size the south western coast of Australia along with the North Shore of Hawaii were identified as a popular big wave surf areas. Visualising the data over time showed the increase in surfing frequency due to seasons. Visualising the movements of surfers from surf spot to surf spot identified where surfers were coming from 'in search of the perfect waves.' Furthermore, the visualisation identified users participating in non-surfing sports.

The methods identified in this experiment came together to visualise a surfing ***nation*** at a global level. The global mapping identified top locations and elite surfers, it also identified isolated surf spots and movement patterns between surf spots. Furthermore, the outliers were identified through a multivariate analysis as users participating in alternative activities while wearing the watch. The data has enough detail to begin visualising it on a ***relationship*** level. This level will be important in identifying the local ***tribes*** and ***bands*** of the ***neo-tribal*** structure defined by Stranger (2011).

Figure 40
Popular surf locations
Indonesia

Outcomes

The purpose of the experiment phase was to identify important technological and aesthetic aspects that would define the final design brief. The first experiments implemented new web capabilities for tracking users and mobile tracking devices in the water to generate data, then implemented basic visualisation techniques to identify the validity of the data. The final experiment focused on the design of the data generated from the SearchGPS Watch, importantly, it investigated web graphic technologies for visualising large datasets. The result of these experiments was a brief.

Design Brief

Design a web based application that visualises the surfing ***nation***, ***hierarchy*** aspects of the surfing subculture, a surfer's pilgrimage, and a surfer's personal ***experience*** at a surf spot. The application should be both, interactive and allow the user to explore the database. Lastly, users of the SearchGPS Watch can 'login' and compare themselves within the surfing community.

The cultural criteria emerged from comparisons between Stranger's (2011) model of the surfing substructure, and the analysis of the data generated from Experiment Two and three. Experiment two established a method of visualising the act of surfing itself and provided the most in-depth view into surfing a wave. This combined with the global view established in the third experiment to create the two extremes of the database. These two views are representative of Lima's (2006) ***macro*** and ***micro*** scales of visualisation. Therefore, the development of this design focused on establishing a third, relationship view of the database which sits between the ***macro*** and ***micro*** views utilising the pilgrimage visualisation methods identified in Experiment One. For the development of this design, these views were defined as follows: ***global***, a macro view of global surfing locations, visualising the surfing ***nation***; ***local***, a relationship view of a specific surfing location, visualising ***hierarchy*** and ***pilgrimage***; and ***personal***, a micro view of an individual surf, visualising the act of surfing.

Experiment Three also demonstrated that interactivity within the data visualisation was important due to the large amount of data and the multivariate nature of the database. Interactivity allows the user to explore the database at their own pace and to the level of their desired detail (within the limits defined by the designer). For example, the initial view of the visualisation may show swell sizes, whereas a certain viewer may be more interested in wave counts, top speeds, or certain surfers (professionals). The development of the design aimed to identify the most important and visually striking of the variable's so that they could be shown initially, and then allow the user to explore the other variables.

The final part of the brief defines a need for users of the SearchGPS Watch to be able to view a representation of themselves within the surfing community. The ability for analysis of oneself among the community is an important factor in the visualisation. Choe (2014) describes that participants within personal informatics are invested in either personal knowledge, personal improvement, or the desire to share and compete with others. Therefore, by allowing SearchGPS Watch user's to view themselves in a global, local and personal context, the design aims to establish this self-reflection users have invested in.

Design

The purpose of this research was to identify methods of visualising the relationships between a database generated by action sports trackers in surfing and the subculture of surfing. The design experimentation section researched the applicability of *Computational Information Design* and *Complex Network Visualisation* on the surfing database. This section describes the design research undertook to answer the brief defined in the previous section.

Design a web based application that visualises the surfing ***nation***, ***hierarchy*** aspects of the surfing subculture, a surfer's pilgrimage, and a surfer's personal ***experience*** at a surf spot. The application should be both, interactive and allow the user to explore the database. Lastly, users of the SearchGPS Watch can 'login' and compare themselves within the surfing community.

One of the problems identified in the design of a big data visualisation is filtering the data to reduce visual clutter. Of the 250,000 surfs, each contained 37 variables. Therefore, a hierarchy needed to be established so that the most important variables are communicated first, and after further interaction of the visualisation more variables can be communicated. Establishing this hierarchy required a strong understanding of the database's context, in relation to visual aesthetic. Understanding the database in a surfing context informed the design of which aspects were more important than others. This hierarchy translated directly into ***global***, ***local***, and ***personal*** scales. With these scales defined the development process refined the visual and interactive aesthetic of the web application.

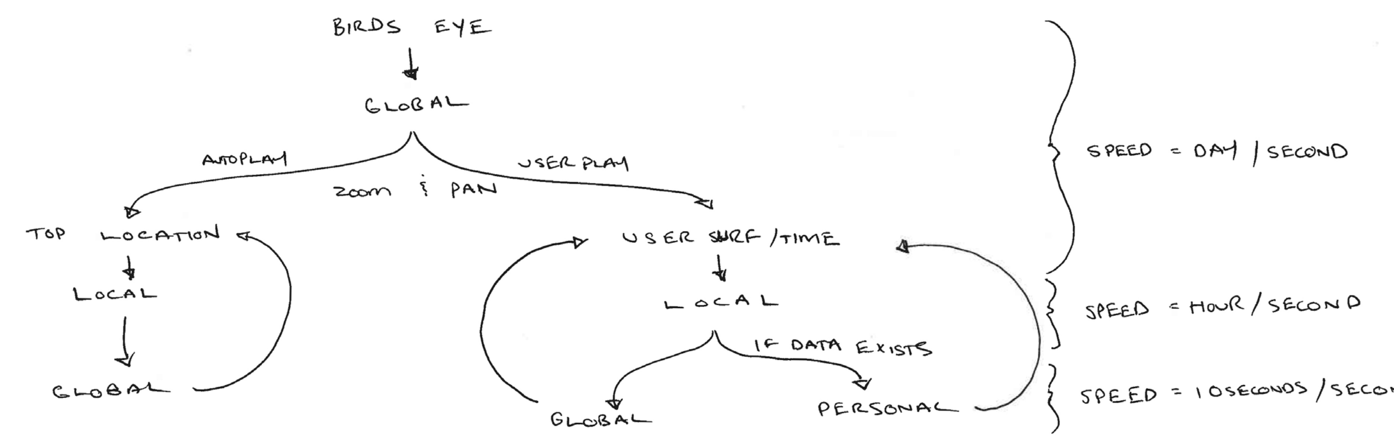


Figure 41
Web application map concept

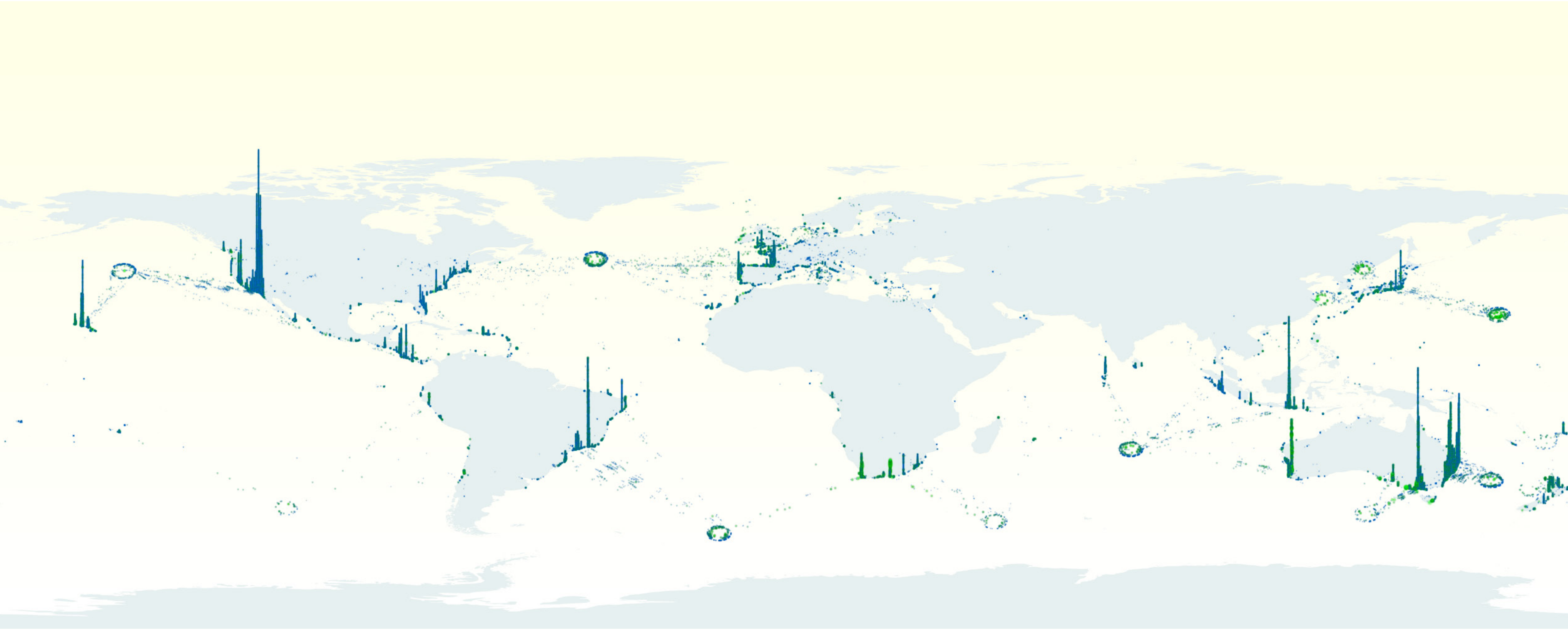
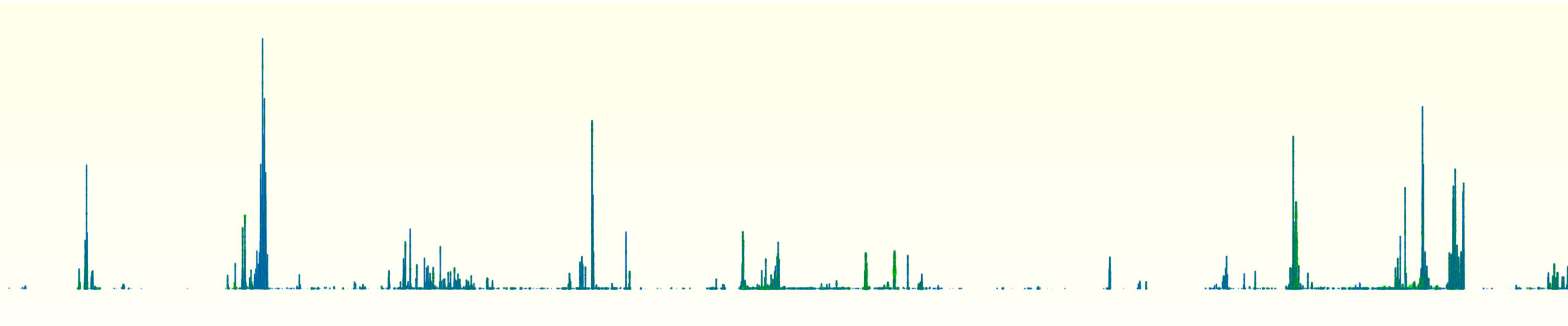


Figure 42
Gone Surfing
Global View

Figure 43
Gone Surfing
Global View - Histogram



Global

Grouping the data geographically was a successful method of reducing the visual clutter while maintaining enough detail to convey the surf locations. This was emphasised further by the breakdown of geolocations into recognised surf spots. The distinct surf locations could be generated from a 'detected location' variable associated with each surf. This grouping of the data communicated the popular surf locations around the globe.

By 'stacking' surfs on the z-axis the amount of surf's per location could be viewed as a 3D histogram. This visual aspect was further enhanced by the use of virtual cameras within the application. The cameras could be moved to set locations so that the histogram could be viewed traditionally in 2D (Fig 43), and an elevated view in 3D (Fig 42). The traditional histogram view allowed for a more accurate view of the surf count per location. Whereas, the 3D view allowed the viewer to identify the locations faster and was more visually engaging. Each 'stack' consisted of particles which represented a surf. The particles were coloured using the swell size variable and were stacked over time. This meant that each 'stack' visualised a timeline of swells over the year.

Implementing time in design allowed the surf particles to be animated so that surfs and swells could be visualised over time. Furthermore, the origin of the swell could be estimated to communicate where swells for certain surf spots are predominantly generated. These 'swell emitters' were estimated by studying global swell maps and identifying where swell was typically generated such as the areas in the Southern Ocean and the North Pacific Ocean.

The final development in the global view was the visualisation of the professional surfer's location's and the location where the user had surfed. This visualisation was to efficiently establish where the top surfers are surfing, whether it be in the popular locations, or more remote locations; and where the user had been surfing. This visual allows the user to compare his locations to the professionals, to popular locations, or to see how far they have travelled around the globe in search of the perfect wave. These locations were visualised using semi-transparent columns which overlayed that location's 'stack.'

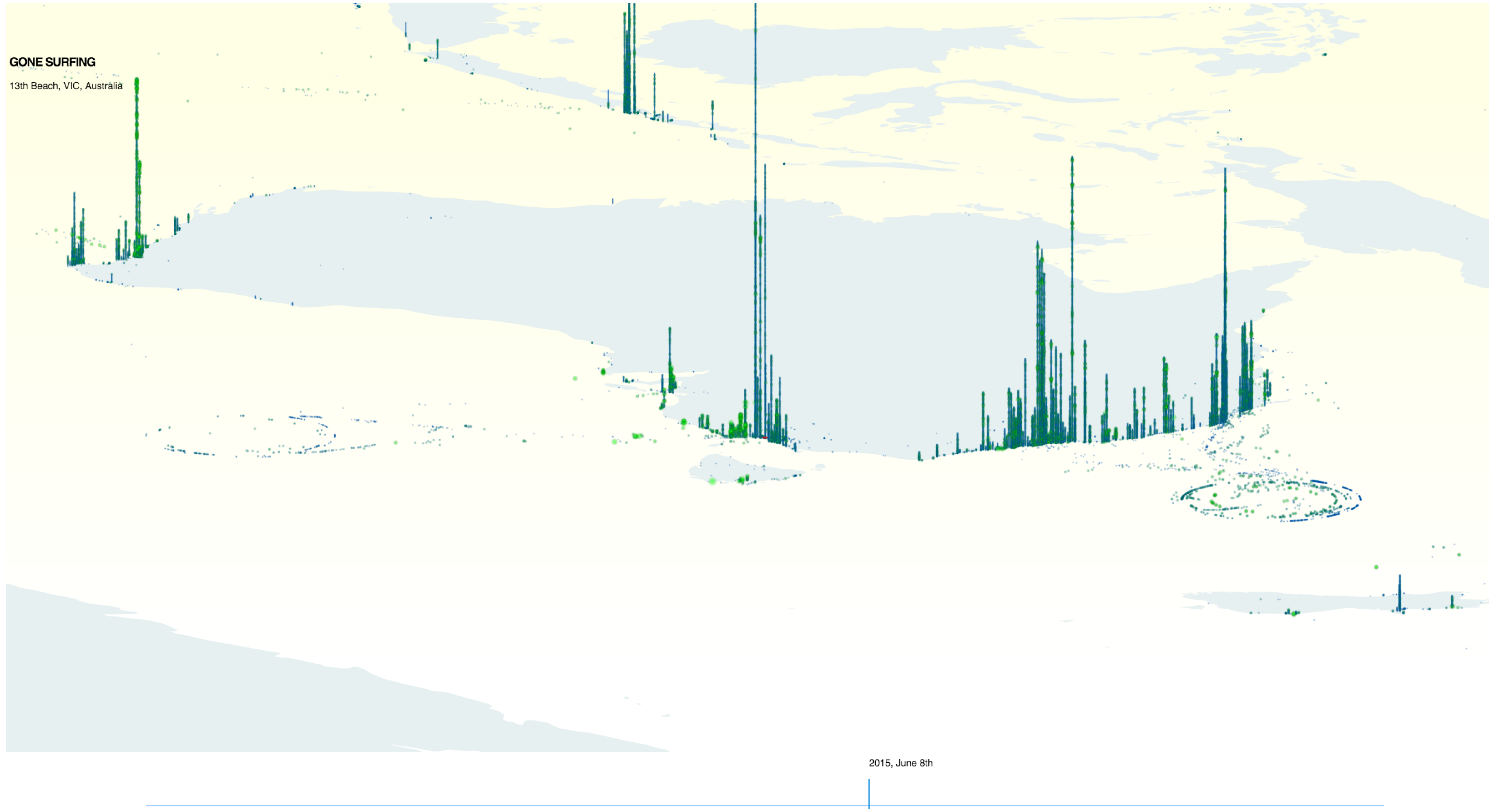
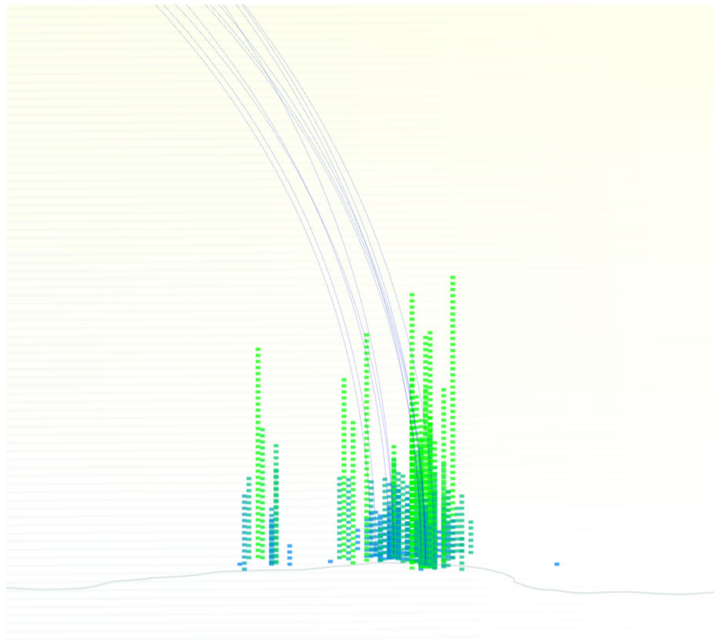


Figure 44
Gone Surfing
Global View - Top surf spot

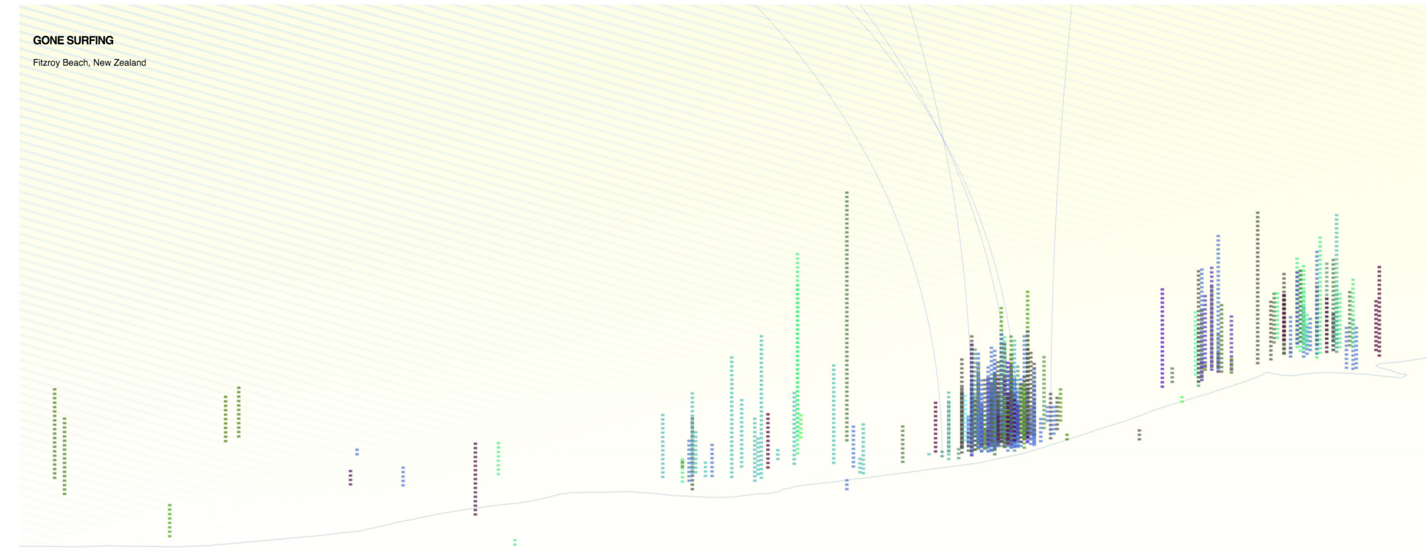


Local

The local view of the web application focuses on visualising the ***hierarchy*** and ***pilgrimage*** of surfers to the selected location. The aim is to communicate the top surfers in that location and the international journey surfer's may undertake to surf a specific spot. For example, Manu Bay in Raglan, New Zealand is rated very highly both nationally and internationally (Hersey, 2012), this could be due to the surf spots appearance in the 1996 surf film Endless Summer. Therefore, by visualising the ***pilgrimage*** of a surfer from another country to a surf spot we generate knowledge of whether the surf spot is known internationally. Furthermore, by introducing visitors to the break we begin to visualise who the 'locals' at the surf spot are and generate a hierarchy based on those surfers statistics at a certain break.

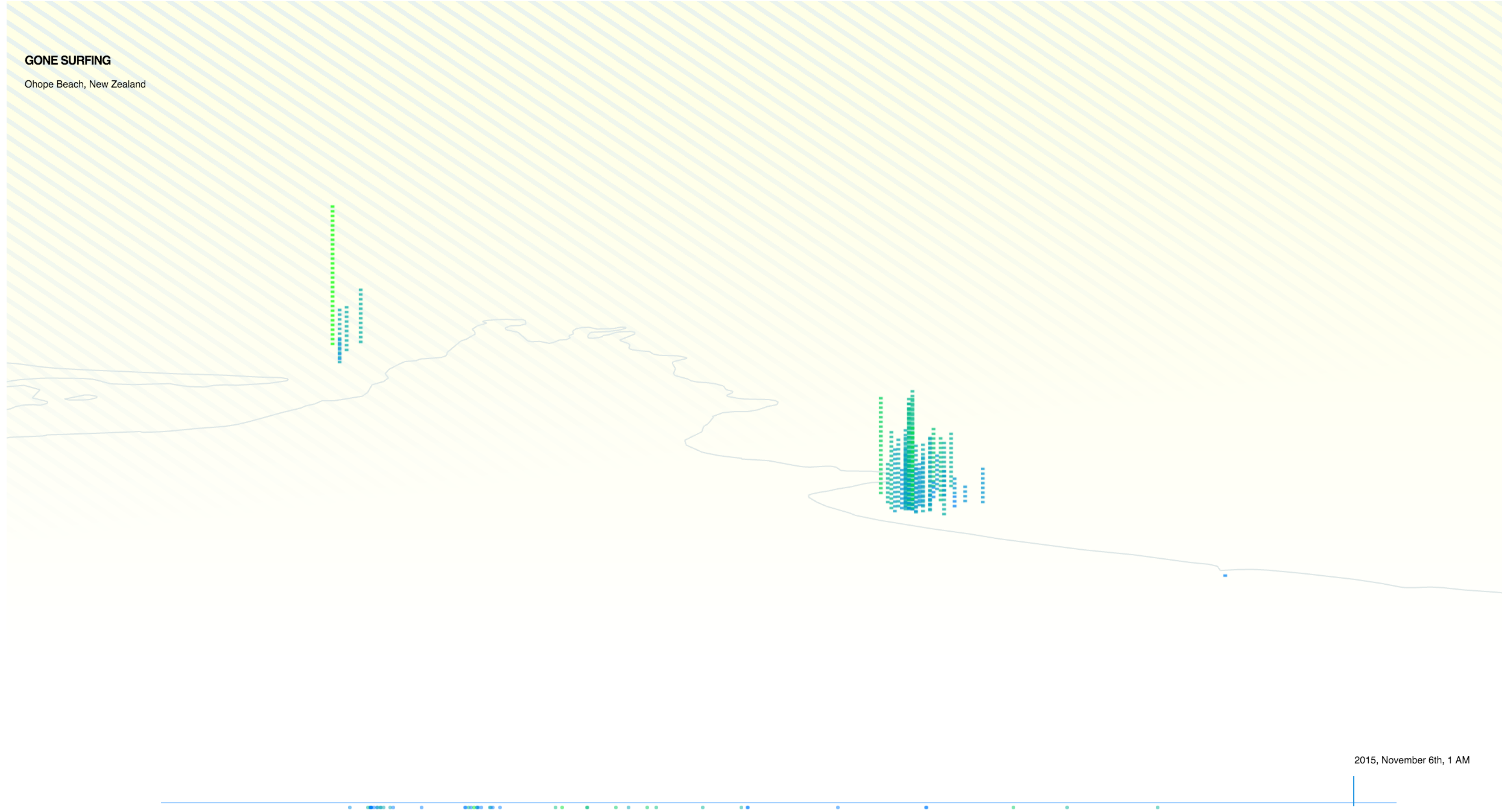
Figure 45
Gone Surfing
Local View - Color based on duration

Figure 46
Gone Surfing
Local View - Color based on user



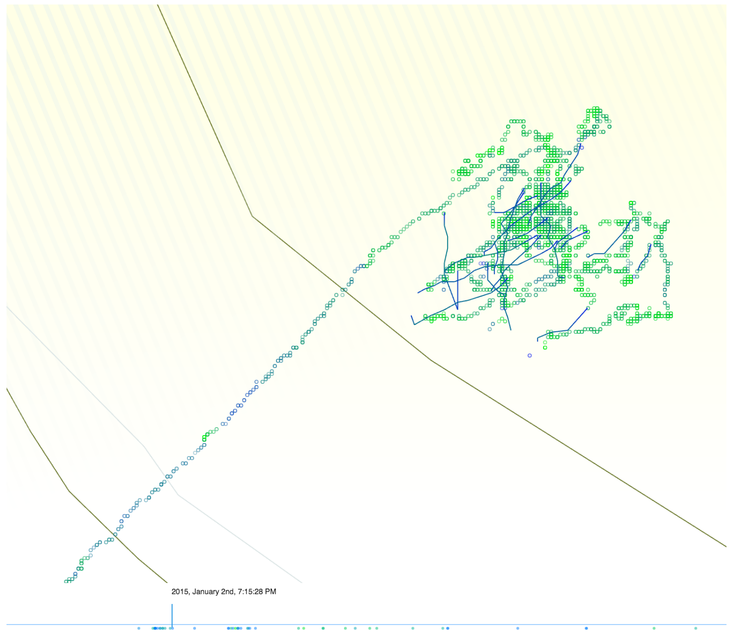
The ***pilgrimage*** of the surfer to location is visualised using a flight path technique (Fig 46). An arc animates from the direction of their previous location and tracks into the current surf location. Furthermore, when seen from a bird's-eye view these flight paths generate a compass of previous locations. This method allows the viewer to efficiently establish if a given location is the target of many surfing pilgrimages.

The data allows each individual surf in the selected location be totalled per user, this means that the maximum of each statistic can be identified to visualise the ***hierarchy*** of that location. For example, the user with the most surfs, most waves, top speed and others, can be identified. Once the top surfers are identified these filters can be applied to show the top user's surfs in the location. Each surf is visualised using a similar stack method to the global view, where the stack height is dependent of the waves per surf. This allows the viewer to see the relationship between the variables, such as surf count and wave count. The viewer with the largest surf count may not have the largest wave count.



Another aspect that was visualised in the *local* view was the estimated swell direction over time. By using the 'swell direction' variable associated with each surf a lined plane could be rotated to visualise the direction of the swell hitting that surf spot at a specific time. This aspect is useful in communicating which breaks people are surfing within a surf spot depending on the swell direction. Most surf breaks have ideal conditions where the wind, tide, and swell combined to generate the best possible wave at that location. Therefore, by visually associating a surf from the database with the swell conditions at the surf spot we can begin to understand which break surfers are surfing depending on the swell.

Figure 47
Gone Surfing
Local View

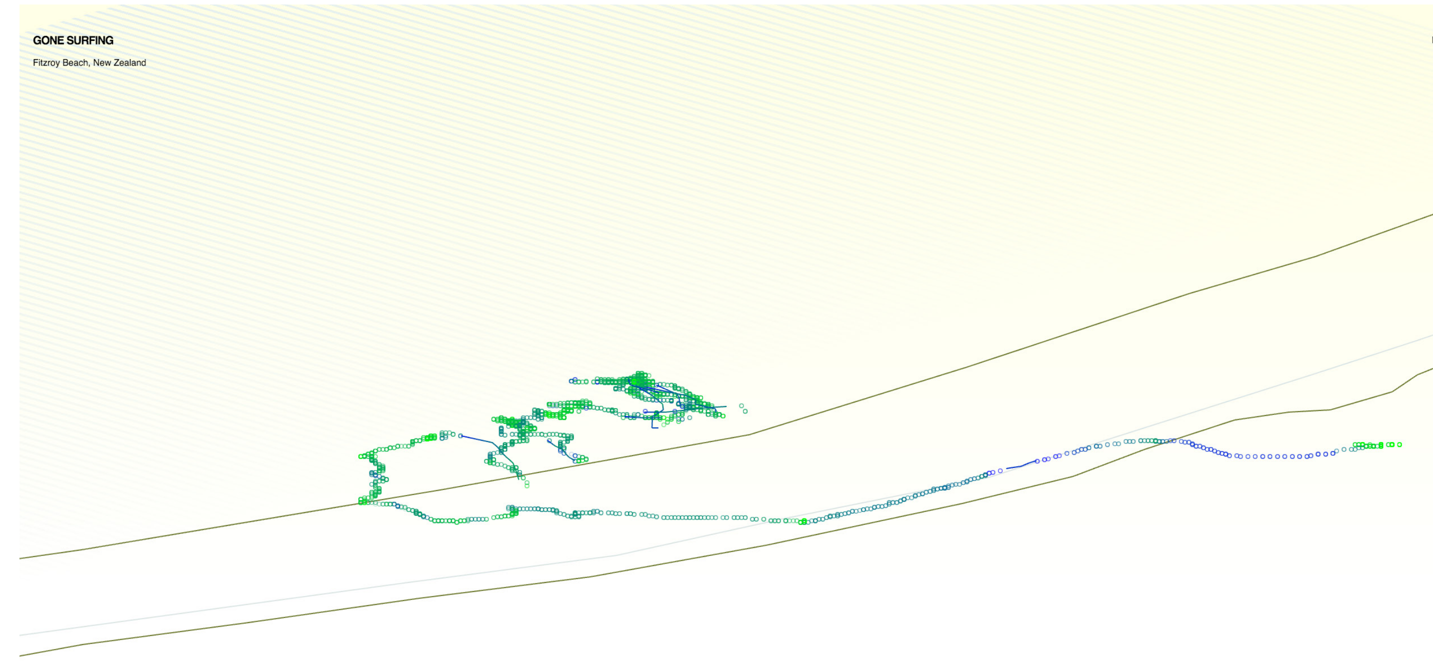


Personal

The *hierarchy* of the users in each location can also be understood through a combination of location of surfs at the surf spot, and wave count. For example, most surf spots contain a higher level break than the others such as The Wall in Lyall Bay, New Zealand. In the right conditions this wave creates a world class surf break which surfers compete over to get their wave. Through the visualisation of a surfer's position within a surf spot over time, the data can demonstrate their ability or ranking within the *hierarchy.* In the *local* view of Lyall Bay, surfers with high wave count could be seen surfing mostly around the The Wall rather than the beach break, where surfers with a much lower wave count were surfing.

Figure 48
Gone Surfing
Personal View - bird's eye

Figure 49
Gone Surfing
Personal View - 3D



The *personal* view explores a surfing session to illustrate aspects such as positioning within a surf spot, the amount of time paddling versus the time spent on a wave, and the different styles of waves per location. The view uses a mixture of cameras to provide an in depth view of the surf session and highlights when waves are caught by manipulating time. This view relies on the database generated by the proxy application from Experiment Two and generates a proof of concept of what could be achieved if all the data from the SearchGPS database was available. The researcher used both the watch and the application together so that the surf session data could be added manually for this visualisation. The GPS surf track is captured by the watch and in future implementations of this application would be used, however, this data lacks the acceleration and rotation which is captured by the application.

By implementing the successful methods from Experiment Two this view creates a surf *footprint* that efficiently communicates a surfer's movements throughout a surf session. A surfer's paddling movements through the water are illustrated by groups of ellipses, these create a general pattern that also emphasises the "wandering" of a surfer looking for the right position to catch a wave. Whereas, lines of different strokes widths visualise the surfers ride to emphasise the precise trail of the wave and illustrate the style of wave. For example, in experiment two, the difference between a wave running off a break-wall and a wave running along a sand-bar could be seen. This type of knowledge is usually understood by the surfer as they move between positions depending on tides and swells. Therefore, successfully visualising these aspects is important in generating knowledge for the viewer.

The final design decision in the personal view focused on the camera angles being used. With the aim of this view being to illustrate a surfer's experience in the surf, the decision was made to mix traditional camera angles from surfing media, shot from the beach or a position in the water, with newer camera angles such as drones (Pipeline Winter, 2013) or interactive 360 degree cameras (GoPro, 2015). These could be switched to place the viewer in the position of the surfer or to view the surf from the beach or the sky. The newer technologies attempt to create a more immersive environment for the viewer to experience surfing. The options also allow the viewer to interact and dictate their view of the surfing session.

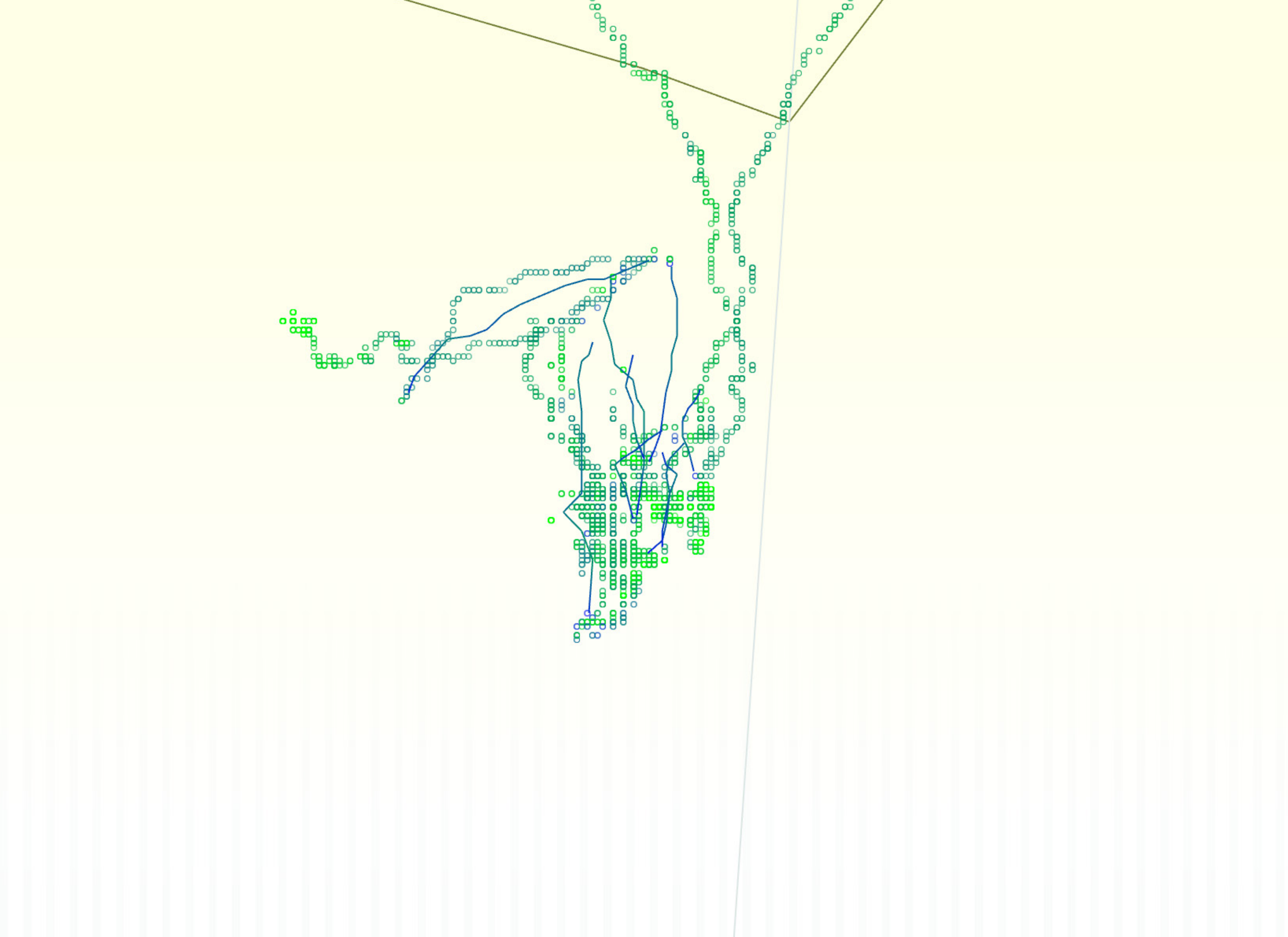


Figure 50
Personal View
Lyall Bay, New Zealand

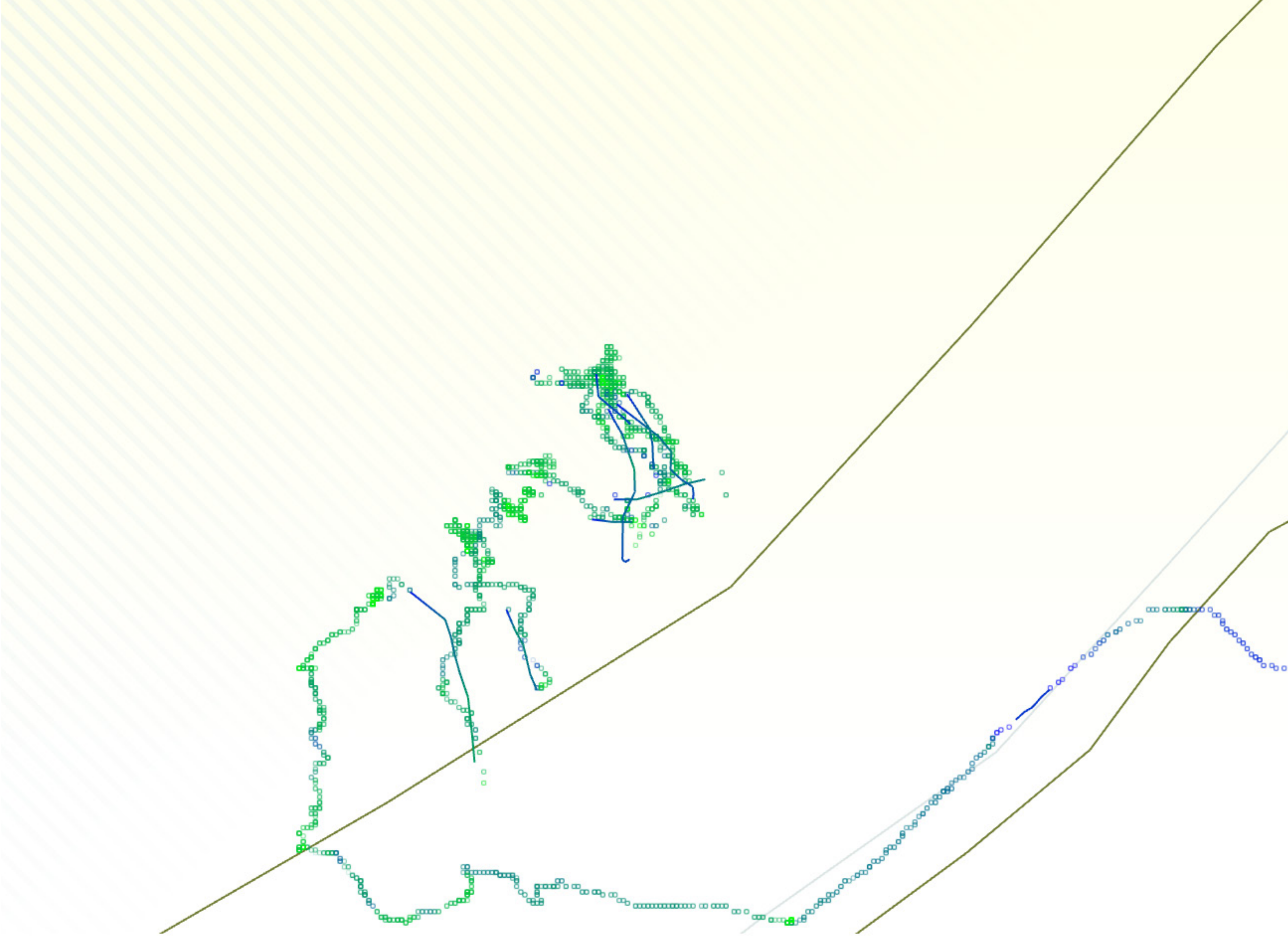
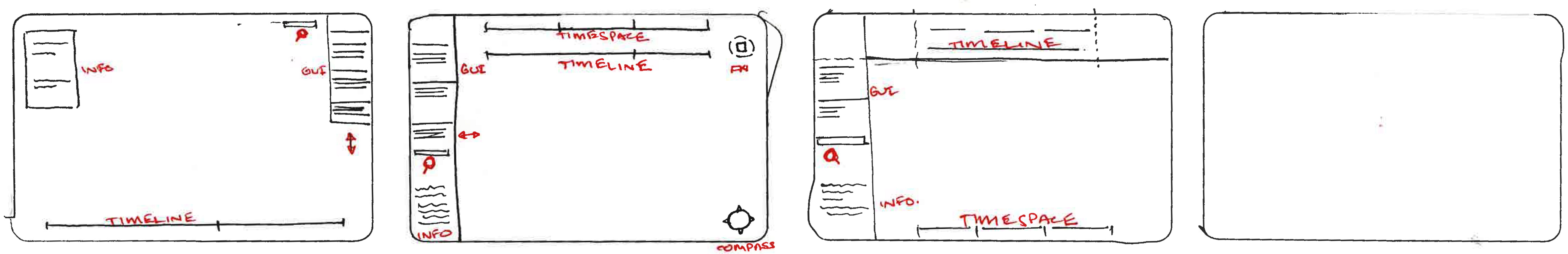


Figure 51
Personal View
Fitzroy Beach, New Zealand

Figure 52
Graphical User Interface concepts

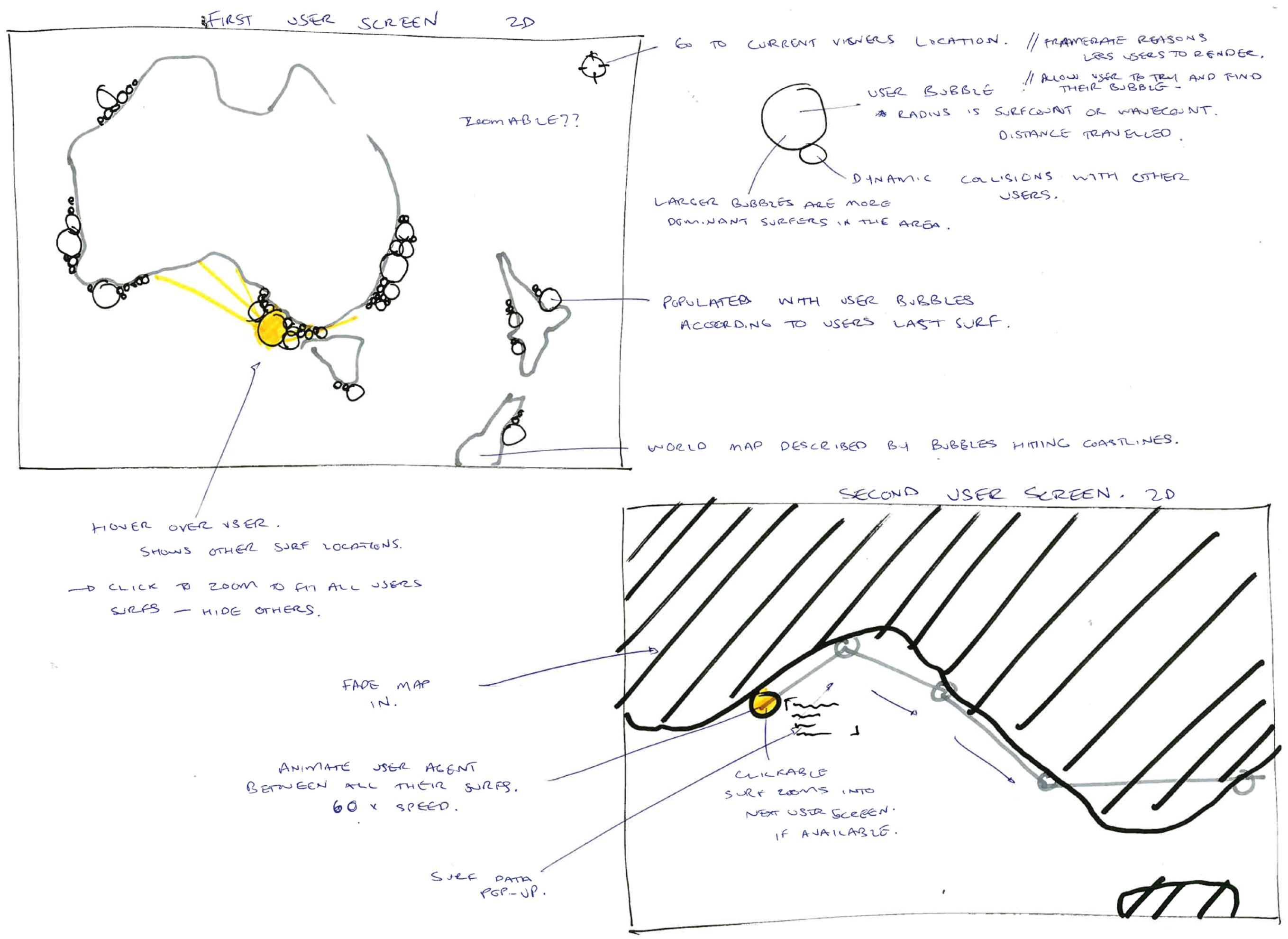


Narrative & Interactivity

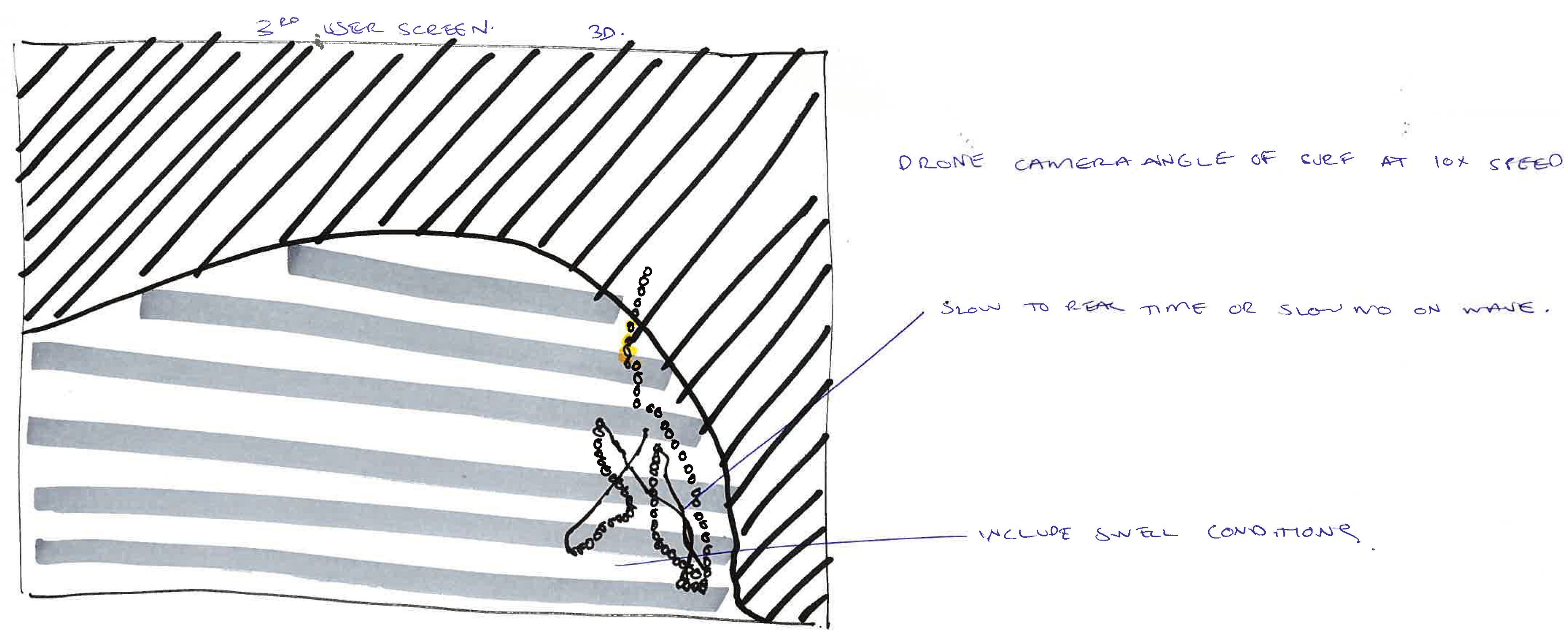
As a designer, it is important to construct the application in a way that fosters exploration of the database while emphasising the most important factor of the subculture which were identified through the design process. The application was designed to work both as a linear web experience, where the journey through the surfing nation over a year could run automatically and was curated by the designer; and as a database exploration tool, where the viewer could explore certain locations that interested them or follow a certain user who exhibited a specific relationship to the viewer.

The narrative aspect of the visualisation acts as an introduction to the database, highlighting top locations and top users over the year while moving through each view. This function demonstrates the level of detail and time contained within each view so that when the user has the option to explore they understand where they sit contextually with each other. Conceptually if the viewer is a searchGPS user they could log-in and place themselves within the narrative, creating a 'year in review' visualisation similar to the Your Year project (AKQA, 2014). From here users can explore the database further by selecting certain locations.

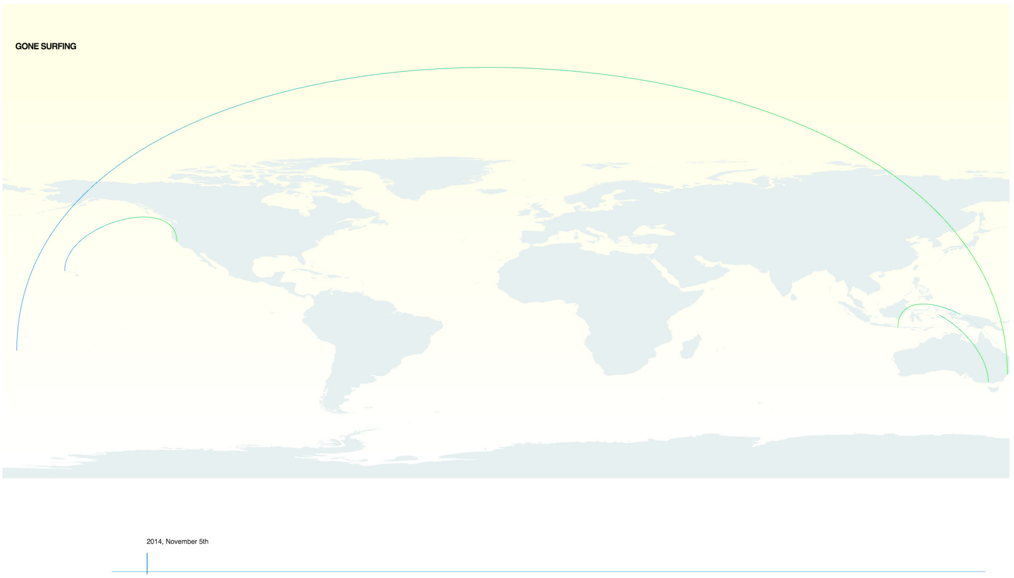
The design approach answered the brief by applying the successful methods and responding to the unsuccessful methods analysed in the design experimentation stage. The design implemented a hierarchy of variables based on their ability to communicate the cultural aspects of ***hierarchy***, ***pilgrimage*** and the surfers ***experience*** with the waves. The hierarchy of variables allowed each cultural aspect to be emphasised through specific views, ***global***, ***local***, and ***personal***; and the most suitable visualisation techniques to these aspects. The web application creates a system through which to experience the database generated by a sample of the surfing nation, and communicates knowledge through this experience.

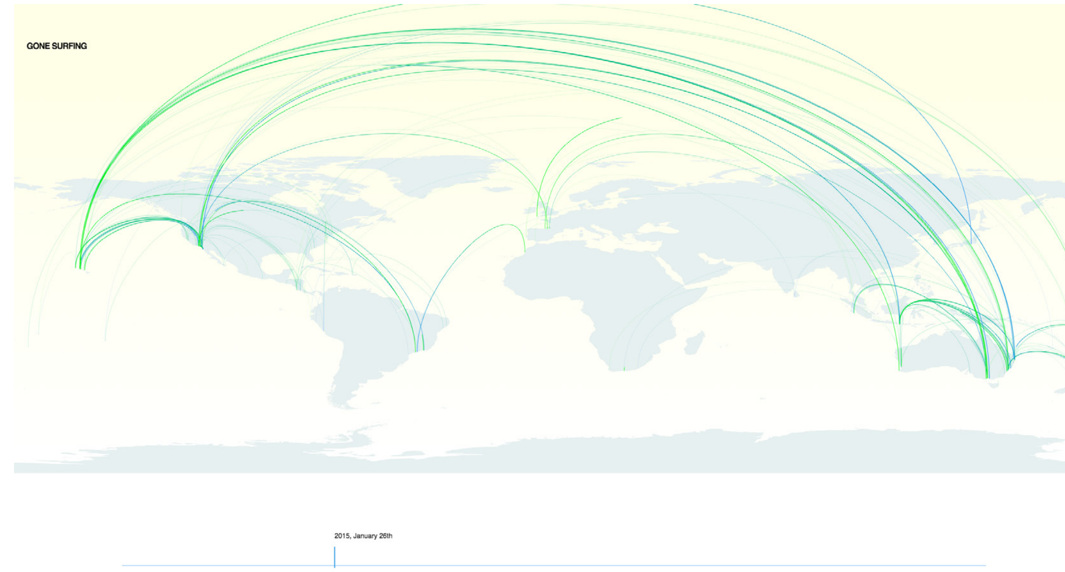


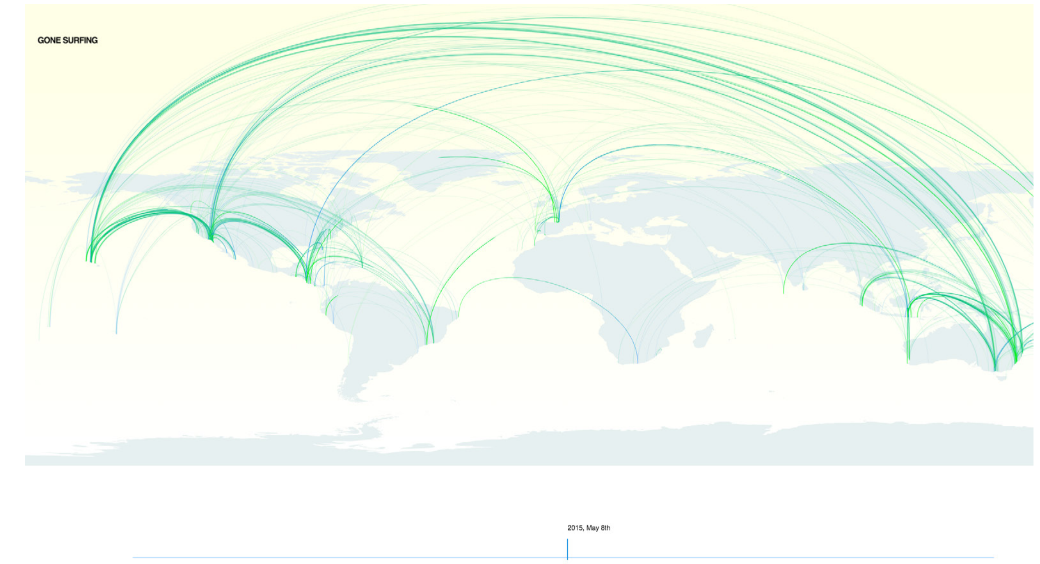
Figures 53 / Left
Global, local, view concepts

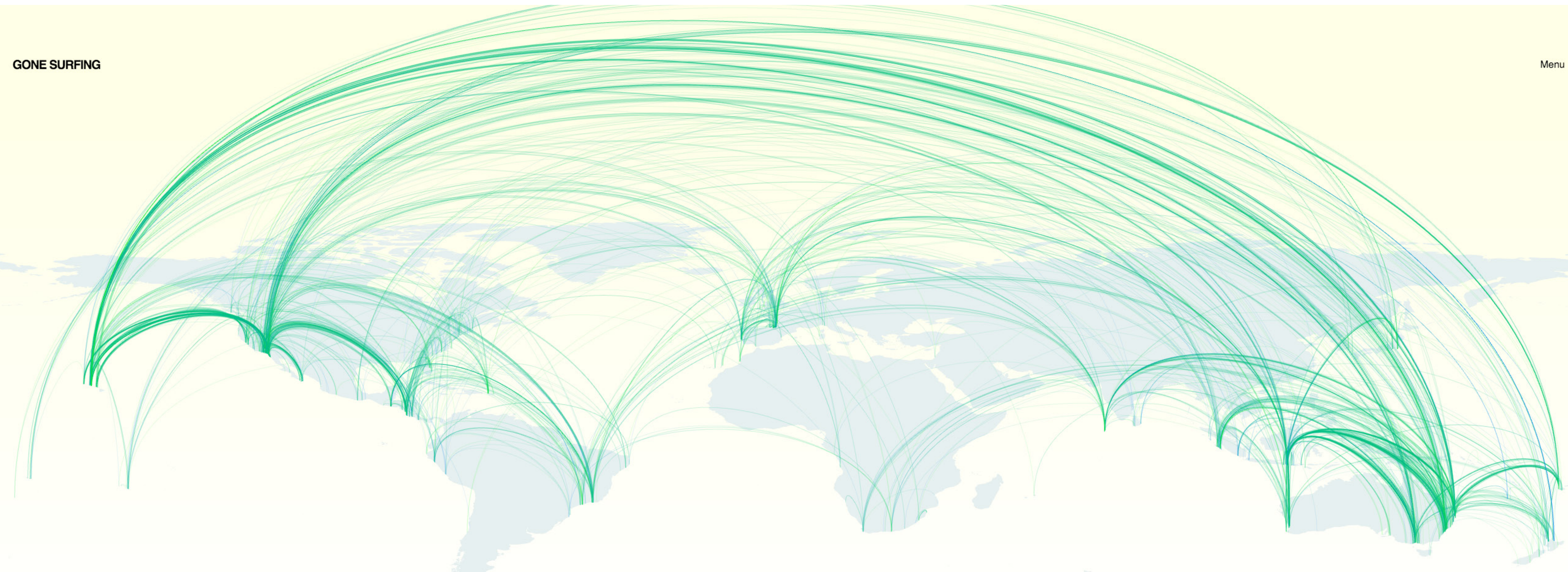


Figures 54 / Right
Personal view concept









Figures 55, 56, 57, 58
International pilgrimage sequence

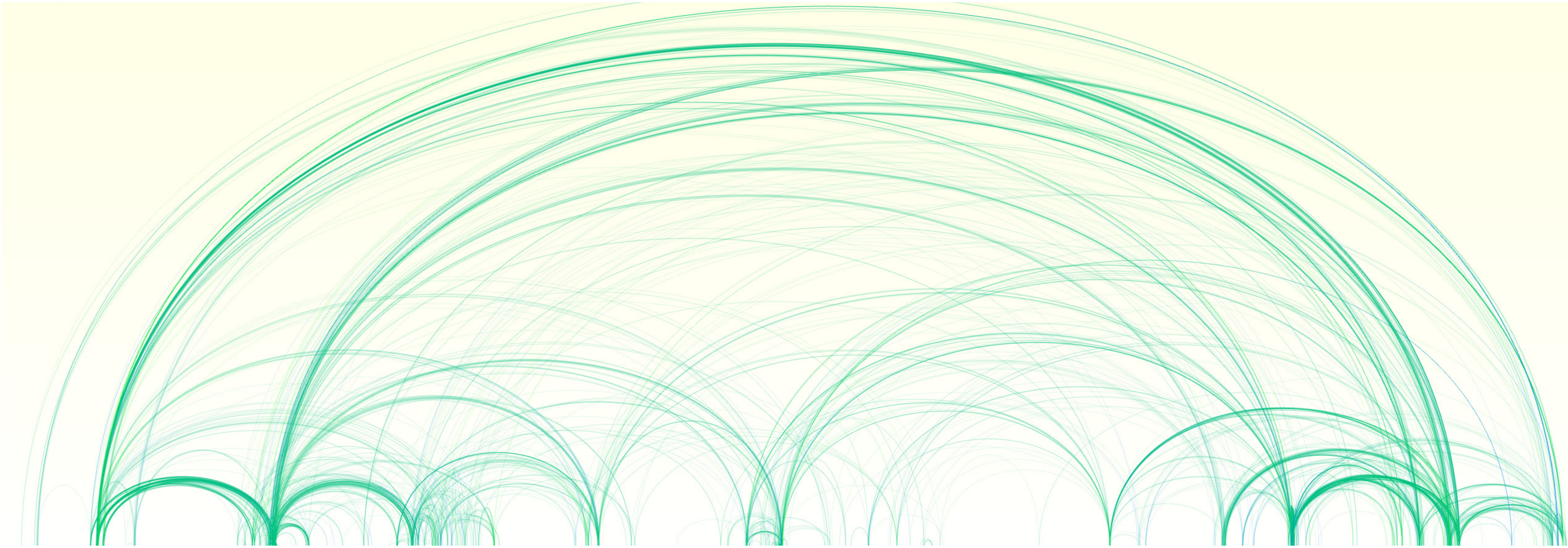


Figure 59
International pilgrimage
front view

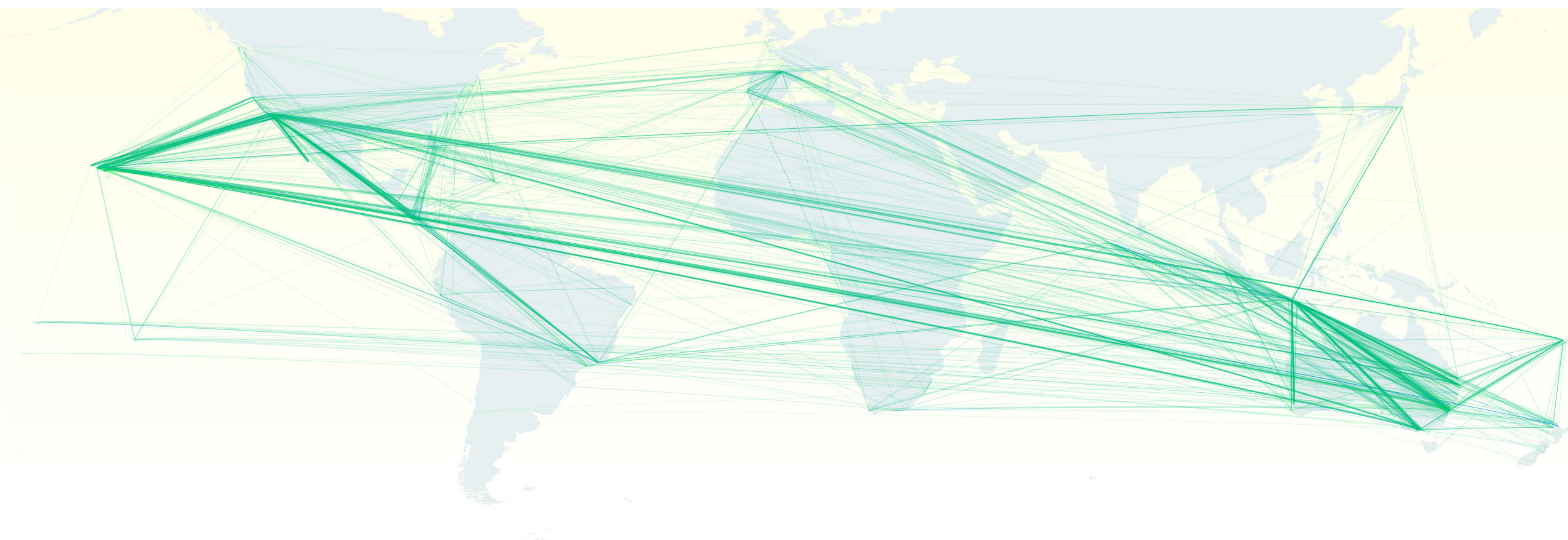


Figure 60
International pilgrimage
top view

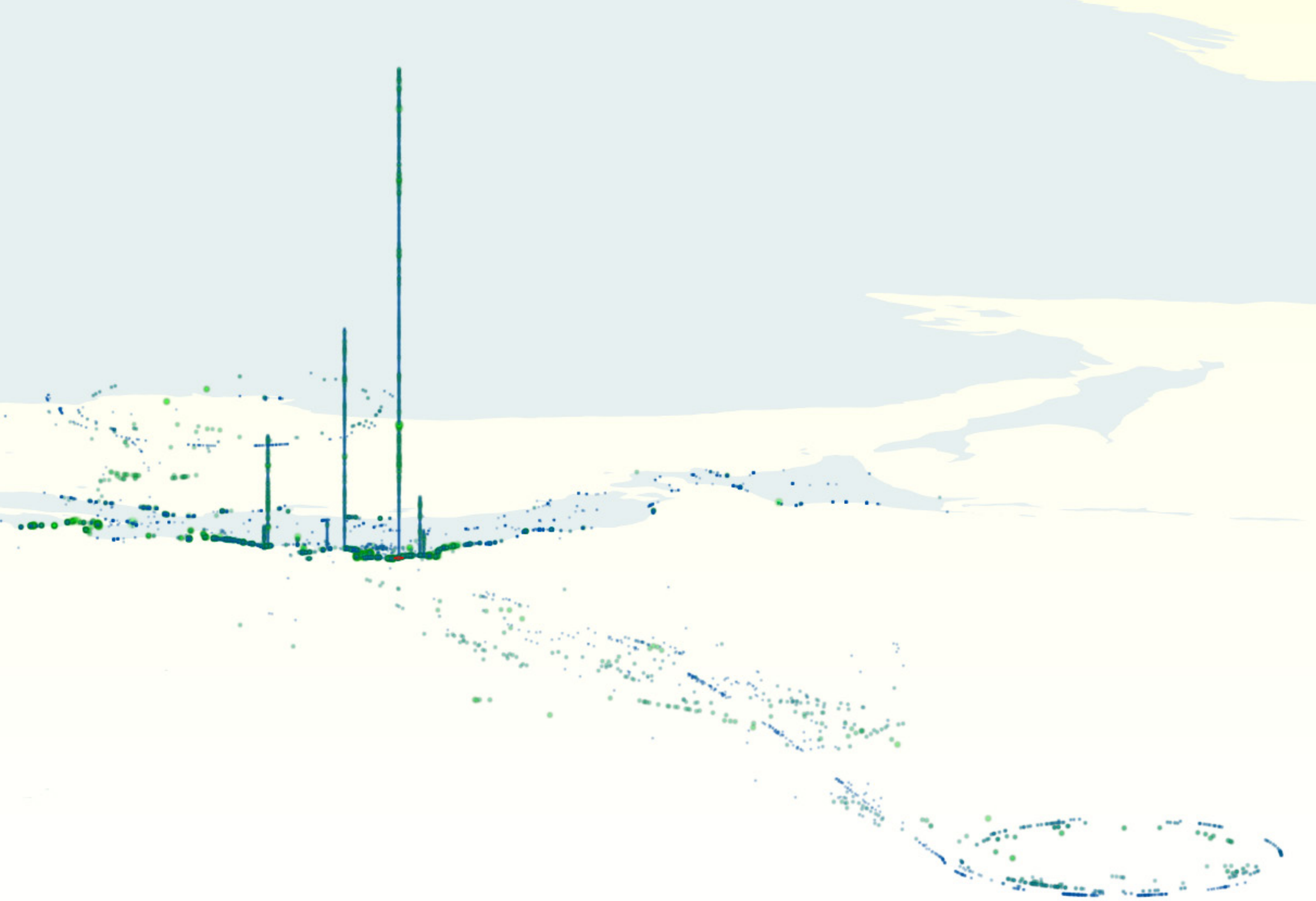


Figure 61
Top Surf Spot
Shidatora, Japan

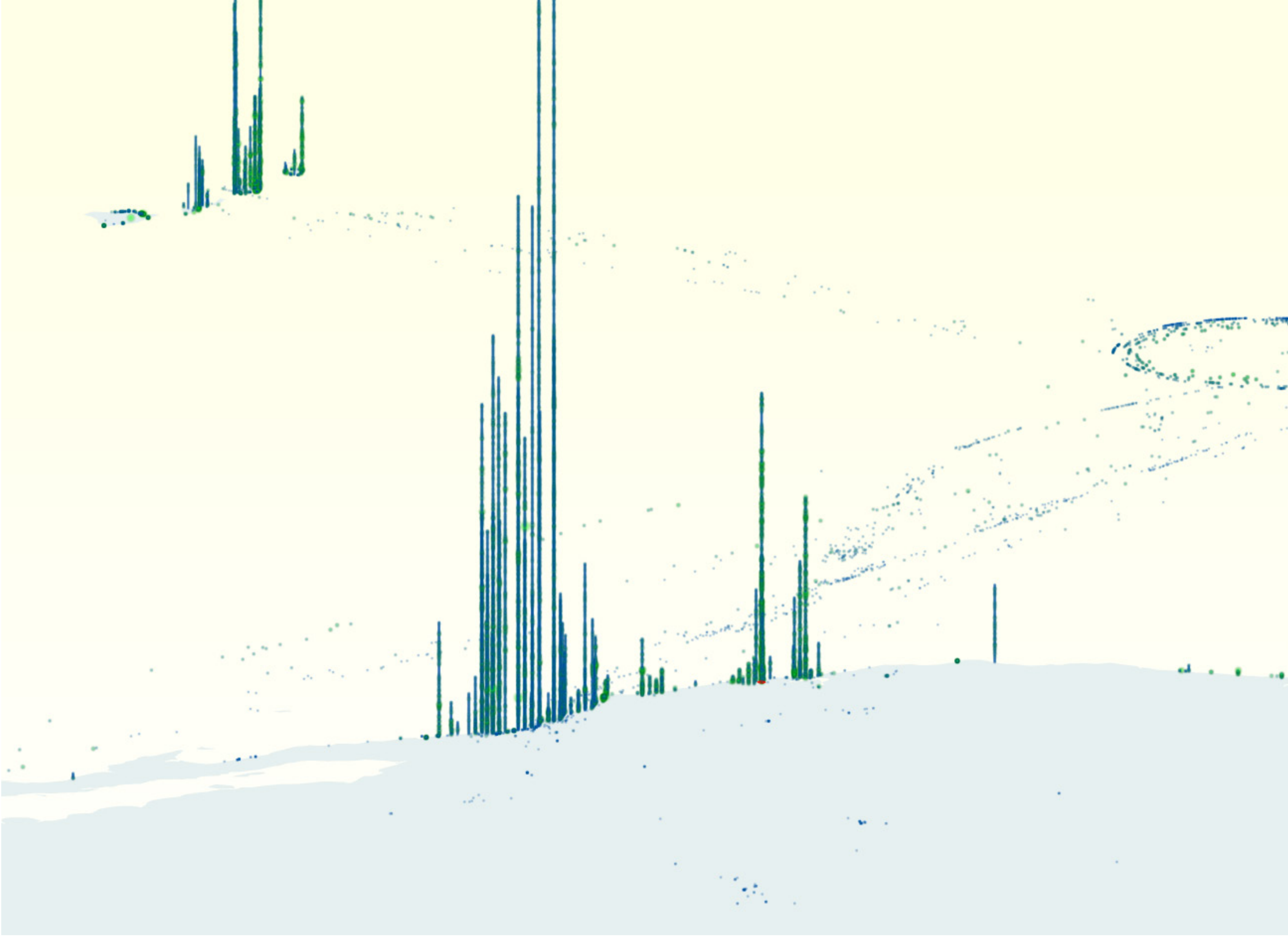


Figure 62
Top Surf Spot
38th St, CA, USA

Conclusion

This project aimed to create a data visualisation of the data generated with surfing, and within this visualisation communicate relationships and experiences found within the surfing community. The research approached this aim using typical visual design methods used in the visualisation of information such as ***Computation Information Design*** (Fry, 2006) and ***Complex Network Visualisation*** (Lima, 2011).

This thesis asked: can an interactive data visualisation illustrate hierarchical, nomadic, and experiential aspects of the surfing subculture? In response to this question, this research identified the substructure within surfing defined by Stranger (2011) and generated a design criteria, it then developed this criteria in response to a iterative design process to define a brief. Finally, the design process responded to this brief by creating a web based visualisation that allows the viewing and exploration of the database. This research process successfully extracted implicit knowledge of hierarchy within tribes of surfers, the pilgrimage of a surfer, a surfer's interaction with the waves, and made these aspects explicit through data visualisation and interaction.

The effectiveness of the final design was based on a strong understanding of the database in the surfing context. With such a multivariate database it was important that a criteria was developed before the design stages so that the relationships visualised throughout the research could be easily identified. This criteria was influenced by Stranger's (2011) model of ***surface*** and ***substructure*** within the surfing subculture, specifically the ***substructure***. The criteria formed around three cultural aspects; the formation of neo-tribes and ***hierarchy*** within these tribes, a surfer's ***pilgrimage*** in search of the perfect wave, and the surfer's personal understanding of the waves. These criteria were developed into a brief by analysing the data generated by surfers using data visualisation 'sketches.' This experimentation process analysed the data by plotting geo-locations, visualising movements of surfers between locations and animating movements of the surfer while on a wave. Thus, by understanding the context of the data a well informed design brief could be established for the final design.

The hierarchy of information in the visualisation was important in communicating different levels of information and relationships to different viewers. Each view within the application, ***global***, ***local***, and ***personal***, contained a hierarchy of information to best communicate the cultural aspects. These consisted of statistics such as location, swell size, time, and so on. These views, allow for the exploration of the database through different levels of detail to gain a general understanding of the surfing nation quickly and a detailed understanding of the hierarchies, pilgrimages, and experiences from further interaction.

This research found that designing a data visualisation of the surfing subculture involves a iterative approach where the designer is able to respond to, and develop, a criteria based on research into that cultural group. Engaging in the context of the database, in this instance the surfing subculture, allows for a clear hierarchy of information that promotes different levels of engagement, interaction, and understanding. The process of analysing the visual design in response to cultural cues authenticates this digitized representation of the surfing subculture.

Discussion

This research found that designing a data visualisation of the surfing subculture involves a iterative approach where the designer is able to respond to, and develop, a criteria based on research into that cultural group. Engaging in the context of the database, in this instance the surfing subculture, allows for the development of a hierarchy of information that promotes different levels of engagement, interaction, and understanding.

The hierarchy of information within the SearchGPS database was developed into a structure which communicated specific aspects of the databases context. ***Global***, ***local***, and ***personal*** views of the structure visualised the ***hierarchy***, ***pilgrimage***, and ***experience*** aspects of the surfing subculture.

These aspects were the result of using the cultural criteria this research defined through the Literature Review in *Computational Information Design* process (Fry, 2011). The process both consolidated some aspects, developed others, and highlighted new ones. The research process then used the macro, relationship, micro model defined by Lima (2011) to develop the ***global***, ***local***, ***personal*** structure of the final design.

Limitations of this research were evident in both the data collected and the technology used in the visualisation. The SearchGPS database only represents the group of surfers willing to embrace technology during their surfing experience and share it with others. Those who are not so inclined to share their surfing with online, could be more likely to share the experience on a more personal level. As Stranger (2011) discusses in his description of the surfing ***band***, these surfers thrive of the shared experience with others in their small group, rather than those in a ***tribe*** or the surfing ***nation***. The extreme of those not willing to use these technologies could be described as ***soul surfers***, a development of the early counterculture to the surfing subculture which rejected materialism and the work ***then*** play aspect (Booth, 1995). Although not as prevalent as they were in the 1950's, these surfers could be seen as the most inaccessible group of the surfing ***substructure***.

In some ways, this research aimed to negotiate the tension between these extremes of the surfing subculture by generating a representation of the surfing community in a way that respected the more hedonistic nature of surfing. This respect was developed both from the researcher's personal experience of the subculture and the information from the Literature Review.

Technically, the final web application relies on computer specifications that all users may not meet. Using WebGL requires a user to have a graphics card installed on the computer and also requires a browser with WebGL enabled. When working with web based designs, they need to be compatible across many web browsers and devices. Further work on this design would focus on making the ***Gone Surfing*** more compatible with less powerful devices.

Further improvements to the application could be made in the rendering of the world map and local coastlines. The ***Gone Surfing*** visualisation uses vector based shapefiles to render the world map at a low resolution. This resolution is inadequate when the visualisation enters the ***local*** view as the definition of certain coastal features are not communicated. However, for surf spots located in New Zealand a higher resolution shapefile was used to demonstrate more accurately where people were surfing. For example, surfs at Ohope Beach, New Zealand, are located either at West End, or The Heads, two local surf breaks. Therefore, using the higher resolution coastline the visualisation communicates whether surfers are surfing at the either breaks.

The resolution of the map is important for identifying separate surf breaks within a surf spot because of the way swell conditions affect each break. In the previous example two breaks were identified within a surf spot. The Heads, a surf break that breaks on the sandbar generated by a river mouth, usually creates a better wave from an easterly swell. Whereas, West End, a beach break on the opposite side of the peninsula, usually creates a better wave on a North Westerly swell.

This research could contribute to current research being undertaken to evaluate national significance of surf spots by generating detailed wave analysis of the breaks. Currently in New Zealand research is being undertaken to evaluate surf spots of national significance for a government policy backing their protection (eCoast Marine, 2015). As part of the project a company, eCoast, is employing the use of searchGPS surf watches to gather baseline data to create detailed descriptions of the surf spot both physically and culturally. Using the visualisation as a tool we can visually communicate ***local*** knowledge of the breaks, the ***pilgrimage*** of surfers to that surf spot both internationally and nationally, and also generate a visual breakdown of the wave.

The company behind Trace (2014) implemented a similar analysis at Lower Trestles, an iconic surf break in San Diego, California. From November 2014 to April 2015, Trace was able to capture data from eight professional surfers, this data was then generated into a heatmap which could be overlaid on a Google Map to show where the surfers gained speed, and performed manoeuvres such as a turn or an aerial (Transworld Business, 2015). The aim for Trace was to was to depict wave patterns and performance trends to contribute to the athlete's performance. Their results proved that the ***right-handed break*** produced a longer ride with more manoeuvres, and the ***left-handed break*** equated in a more vertical style of surfing with smaller turn angles.

The analysis of a surf spot is important in understanding the ***hierarchy*** of surfers in the water. For example, the ***tribes*** which develop in smaller local communities usually consist of unspoken pecking orders among surfers. The ***local*** view of the visualisation this attempted to communicate this aspect using location and wave count. Only using these variables was a limitation. Therefore, a more reliable ranking system for each surf could be implemented, by incorporating the distance travelled on waves, the wave count in relation to the duration, top speed. A good surfer may catch only a few waves of high quality. Whereas, a newer surfer may catch more waves, but of lower quality. Furthermore, a beginner surfer would catch very few waves.

Another potential avenue for this research to go further is the integration of other types of media within the visualisation. As mentioned in the literature 360 degree cameras have been used to capture the experience of riding a wave. If the ***personal*** view of the application contains a 360 video of the specific surf spot, viewers could immerse themselves in a virtual reality experience of that surf spot. The ***personal*** aspect of the application attempted to recreate this experience digitally by placing a camera in the point of view of the surfer. However, including the video would provide a truly immersive experience.

There is also an opportunity to link the visualisation with surfing media posted on social media. Many of the top surfers in the World Surfing League rankings have a strong social media presence, posting short clips to websites weekly for consumption by the surfing community. These surf sessions could be linked with the surfs contained in the visualisation.

For example, a video of a professional surfer surfing Shipsterns, a large wave break in Tasmania, Australia while using the SearchGPS Watch was featured online in September, 2015 (Stabmag). While following the professional surfer in the web application, the surf session is evident. Ideally, the viewer would be able to access an external link to the video to further enhance the visualisation.

This research highlighted the ability of visualisation as a tool to translate quantified statistics of the surfing community into visual information about the subculture. Some of the members of the surfing subculture are aware of the hierarchical, nomadic, and experiential aspects of their culture. However, many observers of the subculture are unaware of these aspects. Through interactive data visualisation these subcultural aspects can be communicated to generate knowledge of a somewhat mysterious group of individuals.

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Figures

All figures not listed were created by the author of this thesis.

Figure 03	Rip Curl. (n.d.). Search GPS Watch by Rip Curl | The World's First GPS Surf Watch. Retrieved January 20, 2016, from http://www.ripcurl.com/searchgps/
Figure 04	Fry, B. (2004). Computation information design. Massachusetts Institute of Technology.
Figure 05	Just Landed: Processing, Twitter, MetaCarta & Hidden Data | blprnt.blg. (n.d.). Retrieved from http://blog.blprnt.com/blog/blprnt/just-landed-processing-twitter-metacarta-hidden-data
Figure 06	Trace - The World's Most Advanced Action Sports Tracker - Trace. (n.d.). Retrieved January 20, 2016, from http://www.traceup.com/
Figure 07	Rip Curl. (n.d.). Search GPS Watch by Rip Curl | The World's First GPS Surf Watch. Retrieved January 20, 2016, from http://www.ripcurl.com/searchgps/
Figures 08, 09, 10, 11	Your Year. (n.d.). Retrieved September 16, 2015, from http://www.akqa.com/work/nike/your-year/
Figures 12, 13, 14, 15	FIELD.io - Digital Art + Design. (n.d.). Retrieved January 20, 2016, from http://field.io
Figure 21	Nike+ Collab: City Runs. (n.d.). Retrieved January 22, 2016, from http://www.yesyesno.com/nike-collab-city-runs/
Figure 35	Google Developers. (n.d.). Google I/O 2013 - Google Maps + HTML5 + Spatial Data Visualization: A Love Story. Retrieved from https://www.youtube.com/watch?v=aZJnI6hxr-c

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MEMORANDUM

TO	Matthew Everitt
COPY TO	Kah Chan
FROM	AProf Susan Corbett, Convener, Human Ethics Committee

DATE	10 September 2015
PAGES	1

SUBJECT	**Ethics Approval: 22033** Data based visual system for action sports film

Thank you for your application for ethical approval, which has now been considered by the Standing Committee of the Human Ethics Committee.

Your application has been approved from the above date and this approval continues until 29 February 2016. If your data collection is not completed by this date you should apply to the Human Ethics Committee for an extension to this approval.

Best wishes with the research.

Kind regards

[redacted]

Susan Corbett

Convener, Victoria University Human Ethics Committee