Visualising database content using metadata

Geoffrey Brian Ebbs – Graduate Certificate Interactive Media

Arts, Education and Law, Griffith University

Submitted in partial fulfilment of the requirements of the degree of Masters of Interactive Media

November 2018

i - Research question

Developing a visualisation tool for online databases using metadata to give the user control of the algorithms that filter and display the content they consume.

ii - Statement of Authenticity.

I declare that all material presented in this exegesis is my own work, or fully and specifically acknowledged wherever adapted from other sources. It has not been published before and I understand that if at any time it is shown that I have significantly misrepresented material presented to Griffith University College of the Art, any degree or credits awarded to me on the basis of that material may be revoked.

Signed: Geoffrey Ebbs Date: 5th November 2018

iii -Abstract:

This research project explores ways in which metadata can be used to present and navigate content in online databases. The final project is a tool that allows users to navigate an image library in a WordPress site using an HTML Canvas application written in JavaScript.

The project builds on the work of digital artists and interactive documentary makers to provide an interface that is interesting and functional. The interface is built on a framework that was developed during the Masters degree, initially to display text-based content using the metadata categorising that text.

The focus on metadata reflects its importance in the modern information economy. Metadata is important for a number of reasons. The current market focus is on the metadata generated as we humans navigate cyberspace. This project is based on the historical notion of metadata that describes the content and so forms the basis of an information catalogue designed to facilitate searching and authentication.

Library catalogues and nomenclature systems such as Dublin Core are examples of this traditional approach to metadata and it is notable that they require significant investment time and expertise to create useful sets of categories. This effort has been a major obstacle in the widespread adoption of proposed metadata based categorisation systems such as the Semantic Web, proposed by web founder Tim Berners Lee in 2000.

As a response to research into the current use of metadata, rapid prototyping of potential navigation tools was undertaken using the metadata in existing WordPress sites to test different visualisations of metadata as a navigational tool.

The second stage of research focused on the work of digital artists and documentary makers and how they used metadata to assist users navigate their content. Some of these approaches were integrated into the framework that had already been developed for the initial prototypes and these approaches ultimately became the focus of the final project. This was partly because the visual nature of these approaches

could be exhibited as a digital art-work and also because they represented a complete tool, rather than proof of concept of a framework: their limited scope ensured the delivery of a polished product.

As a result, this exegesis contains a description of the project submitted with this exegesis accompanied by a discussion of the relationship of this project to the overall framework on which it was built. That discussion includes the probable requirements of a minimum viable product that might initiate and inspire the widespread use of metadata as a navigational tool. It also includes a forward plant to promote the visual navigation of metadata as a means of providing context and meaningful links between related content.

iv - Acknowledgement

The study, research and development of this project have been challenging and exciting. I want to thank the extraordinary group of individuals that makes up the Interactive Multimedia department at the Queensland College of the Arts.

My lecturers, Seth Ellis, Andrew Brown, David Harris, Luke Jaaniste, James Brownlie, Skye Smith, Naomi Hayes and Jason Nelson have challenged and encouraged me. Despite Skye's gentle inspiration and patient guidance I still design like an engineer (or a caveman) but that is outside her influence.

Two years ago I had not heard of the HTML Canvas, the Semantic Web or FreeBase. My experience with JavaScript was limited to enough fiddling to alter the behaviour of web pages. Similarly I had tweaked numerous WordPress elements but was not aware of, let alone versant with, the API, the Loop and other WordPress conventions.

My mentors, David Lloyd Lewis, Paul Bardini and Petra Perolini have supported, upheld and inspired me despite having students and businesses of their own. Lecturer James Brownlie and friends, Steve Goschnick and David James have contributed their experience, wisdom and knowledge to the project at critical points.

I thank my lecturing colleagues, Tom Allen and Rowan LaMont, for teaching me enough about design to teach business to design students and to perceive the nuances of this course.

My cohort, especially those that stayed by my side through the two years it took me to finish this project have been a constant source of joy, amazement and cultural enrichment. Others have joined Quentin Shuai, Jack Li Beng, Robert Lu, Christina Nielson and Fan Gao for some part of the journey and I thank you all for your input as well.

I am a happier, more rounded and better person for this experience and I hope the joy, wonder and enthusiasm that have infected me, comes through in the work and this exegesis.

v -Table of Contents.

vi - Contents of submission

Table 1. The elements submitted for examination

Gebbs_s2980212_Exegesis.pdf	This Exegesis
PresentWP.zip	The WordPress plugin (list of files below)
PresentingPresentWP.mp4	A movie describing the work
PresentingMetadex.mp4	A movie describing the theoretical background
http://PresentWP.com	A website promoting and delivering the work
http://lifejacket.ebono.com.au	A website demonstrating an implementation of the work

Table 2. The contents of the plugin P.zip

/metadex.php	WordPress controls and setup or global variables
/elements/metadex.js	framework of visualisations and basic image control
/elements/float.js	float visualisation
/elements/floatControl.js	controls to setup float visualisation
/elements/metadexVisuals.css	formatting of the basic visualisations
/elements/metadexSelection.css	formatting of the controls
/images/<icons and controls>.png	buttons and other visual elements of the interface

1 Introduction

1.1 Overview

The initial research for this project explored the current state of the art in the **use of metadata to organise and find content on the web.** It was my intention to explore visual interfaces for distributed content to build on work I had done twenty years ago creating an indexing system based on metadata and designed to create web-based applications including an early content management system. I had discovered through that work that, while the approach to organising data functioned effectively as an application framework, end-users do not have an intuitive grasp of data categorisation and organisation. It is largely because of its relative simplicity, that text-searching came to dominate the web as the primary means of retrieving information. Unfortunately its very simplicity limits its usefulness. “The use of keyword and corresponding search techniques that utilize indices and textual information without associated context or semantic information … is the most common way of searching today. Unfortunately, … the search context is not specified and ambiguities are hard to resolve.” (Sheth, 2002)

The streaming of content into mobile devices also changes the nature of our understanding of content organisation. The development of text searching tools from the late eighties onwards shifted the form in which content is delivered from tables of content to a simple list of results. The notion of the stream is now firmly embedded in the public imagination as a sensible form of information delivery. “Compared with traditional databases, streaming databases pose new challenges for query processing due to the streaming nature of data which constantly changes over time.” (Liu and Ferhatosmanoğlu 2003) On the web, those results are generally web pages and documents posted to web servers granting them a URL. Early WAN-based text-searching returned simple lists of documents “text mining differs from search systems in that it can be incorporated into the organization’s business processes.” (Upshall 2014)

The first round of research in early 2018 identified that Tim Berners Lee, founder of the World Wide Web, had initiated a major project called the Semantic Web in 2000 designed to "harness metadata and provide a mechanism for searching the web meaningfully and in context". (Berners-Lee and Fischetti 2001) An army of academics, developers and entrepreneurs are building the protocols, tools and content repositories to create the Semantic Web. "The main purpose of the Semantic Web is driving the evolution of the current Web by enabling users to find, share and combine in formation more easily." (Choudhury 2014)

Figure 1 - The Semantic web logo

Figure 2 - The Freebase logo

One of the most successful projects working toward a Semantic Web was FreeBase, the inspiration of Danny Hills at MetaWeb. MetaWeb was bought by Google in 2010. Describing the impact in their 2014 submission to the 25th World Wide Web Congress, Thomas Pelissier Tanon said, "Due to the success of Wikidata, Google decided in 2014 to offer the content of Freebase to the Wikidata community." (Tanon, Vrandečić et al. 2016) FreeBase was absorbed into Google's Knowledge Graph and switched off in that same year. (Google 2014)

Despite the intensity of this widespread activity it has resulted in very few commercial products. In fact, the majority of the work focused on the APIs, query languages and communication protocols and the work on interfaces for it is patchy. "important gaps exist which hinder a wide adoption of Semantic Web technologies (e.g. lack user interfaces based on semantic technologies for social and mobile applications)" (Gaˇsevi´c 2012) Most of the interfaces that have been developed for are primarily data visualisation approaches rather than navigation systems. (Rice 2018)

My proposed interface used the paradigm of a spaceship flying through a sea of content with a set of controls in the spaceship. The physical universe provides a

natural hierarchy of categories – Galaxy, solar system, planet, continent, region, town, street, building, floor, room, desk, filing cabinet etc. The controls are a three dimensional representation of the way the knowledge space is organised which the user (pilot) can manipulate to reorganise the physical representation of the knowledge universe as well as controlling their journey through that universe. A visual representation of the proposed interface was developed as an exercise for the Visual Design unit of this degree.

Figure 3 - Early visualisation of interface applied to pathology knowledge base, T1 2017

As I began prototyping approaches to this visual representation of categories and content and thinking through how these prototypes might link to or integrate with existing approaches to navigating the Semantic Web, I realised that the initial vision was well beyond the scope of a single student doing a Masters degree. At the same time, research into systems for organising web content, revealed that WordPress, at that time running over 30% of the websites on the visible web (W3Techs 2018) was making a major play in building a distributed search engine and providing an interface for sites to communicate content and metadata across the web. It seemed possible then to use WordPress as a simplified stand in for the entire web and test possible interfaces against this significant, but much more organised, subset of the whole.

On this basis, two early prototypes were developed as projects, one for a coding subject and the other for a theory subject in this degree. These prototypes focused on the representation of categories as navigational tools that controlled the view of the content. This set out to be a two dimensional representation of the controls in the spaceship flying through a sea of content.

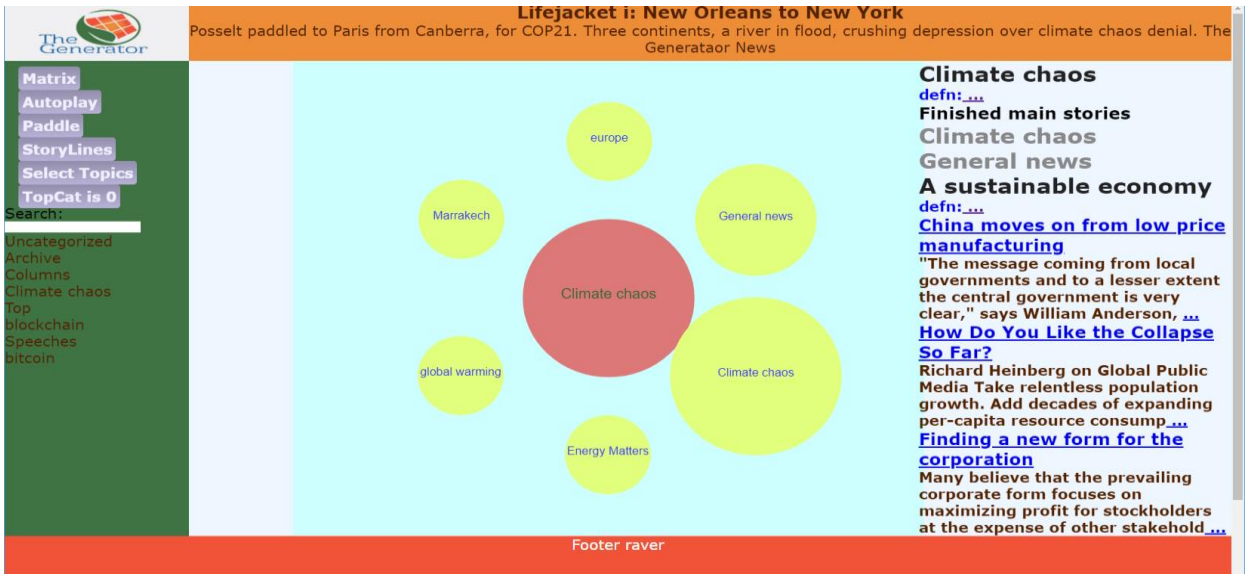


Figure 4 - 2D prototype showing categories and posts related to selection

The second area of research focused on digital artists and interactive web documentary makers using metadata as a means of navigating content. This was undertaken with a view to exploring existing interfaces and whether they worked. In addition to libraries of visualisation tools, such as Voyant and D3.js, I looked at the work of specific artists and interactive documentary makers that employed metadata as navigational tools.

An outcome of that research was to mimic these interfaces with quick prototypes to see if they might be applicable to the overall project. The integration of the different visualisations required a large amount of work creating a framework for the visualisations to communicate with WordPress and to allow the different visualisations to communicate with each other. I ended up with two diverging implementations, one that focused on categorisation and presentation of text posts and the other that concentrated on end-user manipulation of the image library.

To ensure that the practical project produced an operational product, as opposed to a proof of concept, I stopped work on the categorisation tools in August 2018 and concentrated on polishing the visual interface for navigating content.

This exegesis, therefore, describes a creative tool designed to allow WordPress bloggers to present their visual images in novel and interesting ways and also explores the relationship between that visual tool and the proposed metadata navigation system.

In the second half of 2018, as the project was being refined and tightened up, Google and Samsung released automated tools for their users' image libraries to create collages, stories and animations. <citation needed> These tools significantly overlap with and now go beyond the functionality of PresentWP, undermining its claim to originality and innovation while, at the same, time verifying the validity of its intent. It is too late in the project to find alternative approaches and so the emergence of these tools is simply noted as part of the external environment in which this development has taken place. The capacity of providing these type of tools to WordPress site owners may be a valid starting point for a commercial enterprise.

1.2 Methodology

This project largely relies on a practice-based methodology, led by interpretive research and refined by expert feedback. The primary effort is prototyping different interfaces in a consistent environment to expose the methods to expert feedback. The approach conforms to a pragmatic research paradigm, "setting out to explore solutions that work in the eyes of the subjects, rather than satisfying the requirements of a theoretical framework about how knowledge is formed." (Connell, d et al.)

The overall process was planned and organised in line with the human centred design process promoted by the British Design Council as the “double diamond” process.

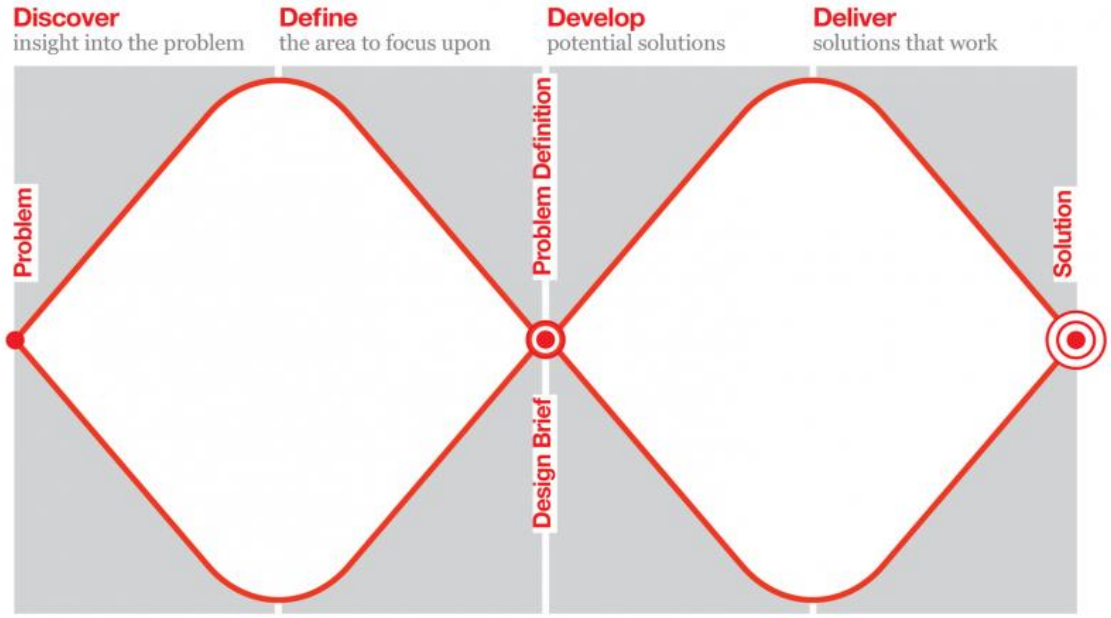


Figure 5 - The double diamond of the British Design Council. Defining both the problem and solution involve a divergent stage of exploration and a convergent stage of refinement.

In exploring different approaches to design in their March 2008 article for Design Studies, Howard and colleagues described it as one of a range of models that united design approaches across creative and scientific disciplines. “... of particular interest are the divergent–convergent models, which include controlled convergence (Pugh, 1991) and the double diamond (Design Council, 2006). These divergent–convergent models differ from the traditional linear style by assuming some form of integrated evaluation and selection of ideas and concepts.” (Howard, 2008)

Not only does the double diamond separate the process of defining the problem from the process of defining the solution, it allows for the iteration of development where feedback on the viability of one approach is fed back into the search for better approaches. “... design is a dynamic process, and that great design comes through iteration and the process of trial and error. It is common to create a few design solutions for the same problem. The ultimate solution might take elements from each prior solution” (Derrick, 2018)

In this project, the literature review was ongoing and regularly diverged to explore new areas that were revealed through feedback on a revised prototype. Thus there are five prototypes refered to in the discussion of the process below, some of them quite different from the project as finally presented. The methods used to implement this approach include:

A literature review to examine

- the role of metadata in content organisation of the World Wide Web
- conceptual framework of the Semantic Web,
- the current tools being used to explore it ege Freebase, YaCy, Pool Party
- the nature of interfaces
- the interfaces available to display and navigate metadata
- the WordPress tools available to implement those interfaces

A context review of:

- Whale Hunt, Prison Valley and D3 JS to evaluate existing interfaces
- Pool Party, YaCy and SPARQL tools to explore the Semantic Web APIs

A prototyping phase to develop:

- Different interfaces making use of metadata to navigate content
- A consistent framework for demonstrating those interfaces
- A platform to share the interfaces with the target audience
- A mechanism for collecting usage data from those prototypes

Expert reviews with Solid Software, Story Boxes and Ephox to:

- Evaluate development approaches
- Determine what aspects of each interface are useful
- Study patterns emerging from the use of metadata as a primary navigation tool
- Explore the nature of the boundary between metadata and the content it describes

2 The work

This section deals with the project, PresentWP, submitted as the practical component of the Masters Degree. The submission consists of:

- this exegesis;
- the plugin, PresentWP as presentwp.zip;
- the website explaining and presenting it, http://presentwp.com;
- a sample website illustrating the use of it. http://lifejacket.ebono.com.au and
- a movie providing an overview of the project, PresentingPresentWP.mp4

PresentWP is software, specifically a plugin for WordPress, written in PHP, JavaScript and CSS.

Figure 6 - PresentWP: the brand

The use and implementation of the plugin is described below, following the structure of the movie included as part of this submission. A section dealing specifically with the technical structure has been included as Appendix C.

At the top level, **the work** consists of three components:
an ***open source plug-in*** (http://github.com/giobono/metadex)

The contents of the plugin are as follows:

/metadex.php (WordPress controls and setup)
/elements/metadex.js (framework of visualisations and basic image control)
/elements/float.js (float visualisation)
/elements/floatControl.js (controls to setup float visualisation)
/elements/metadexVisuals.css (formatting of the basic visualisations)
/elements/metadexSelection.css (formatting of the controls)
/images/<icons and controls>.png (visual elements of the interface)

These files are submitted with this exegesis in the file presentwp.zip which is the same file available as a WordPress plugin. The system can be installed using only these files.

a ***site that promotes and delivers*** the plug-in (http://presentwp.com)

This is a website that is submitted in the form of a link

The movie PresentingPresentWP.mp4 is accessible from the site (as a YouTube movie) but is submitted as a file along with the other files described here.

an ***example implementation*** of plug-in (http://lifejacket.ebono.com.au)

This is a website that is submitted in the form of the link provided above.

2.1 Lifejacket

Lifejacket is an example of the application of PresentWP to an existing website to present the content in different ways. A small section of the story is told, using the visualisations available in a number of slightly different ways. It has been used to introduce the concepts of what PresentWP can offer.

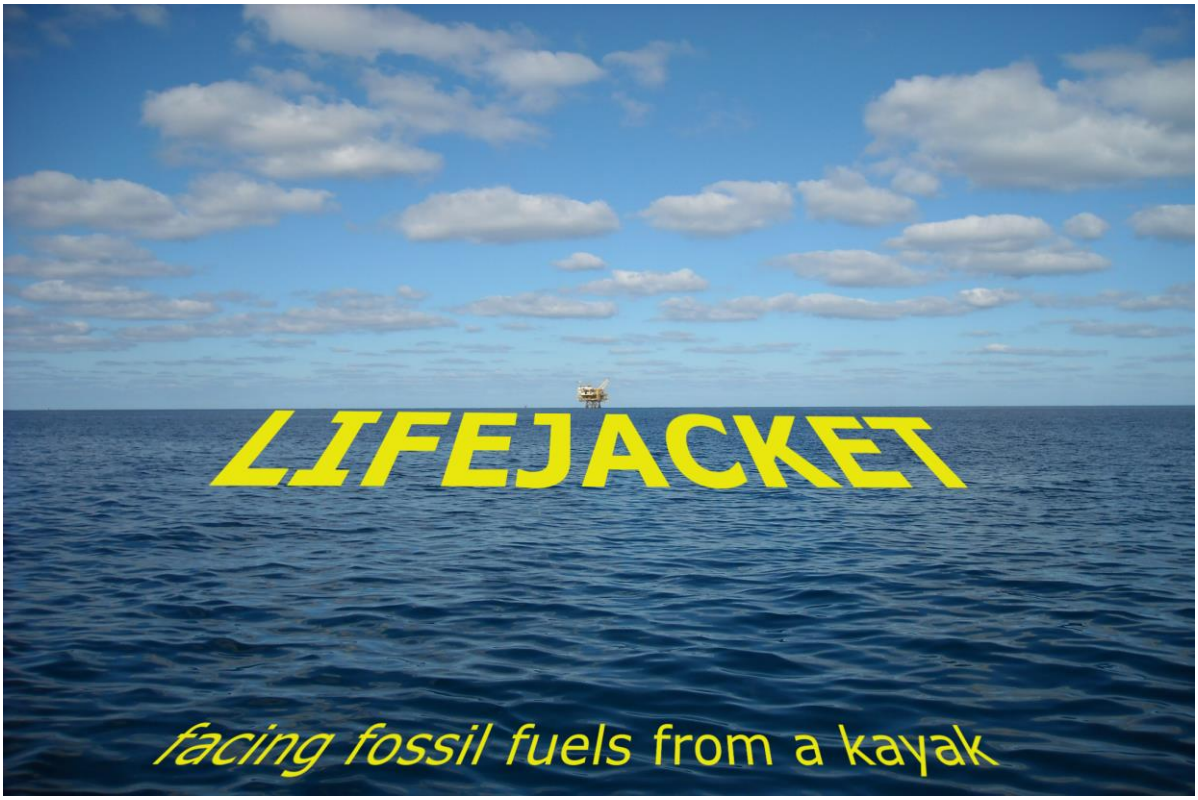


Figure 7 - Lifejacket: A sample website using PresentWP

Kayak4Earth http://kayak4earth.com is a WordPress site that records the kayak journeys of Steve Posselt: climate warrior and kayaker who has travelled the world in his kayak, Old Yella, raising awareness of Climate Chaos.

Figure 8 - kayak4earth.com is the original website copied and reinterpreted using PresentWP

The content has been repurposed to demonstrate some uses of PresentWP

This home page, http://lifejacket.ebono.com.au, introduces the background to the

Figure 9 - The home page of Lifejacket

content, showing an image of the proponent paddling past the Statue of Liberty in New York on his way to the Climate Summit in Paris in 2014. We can zoom in on the statue using our mouse, or drag the images across the screen. This is a dramatic introduction to the section of the journey up the Mississippi heading for New York.

The next page animates the most gruelling section of the journey, up the Mississippi in full flood, with a support crew unprepared for the dangers they face.

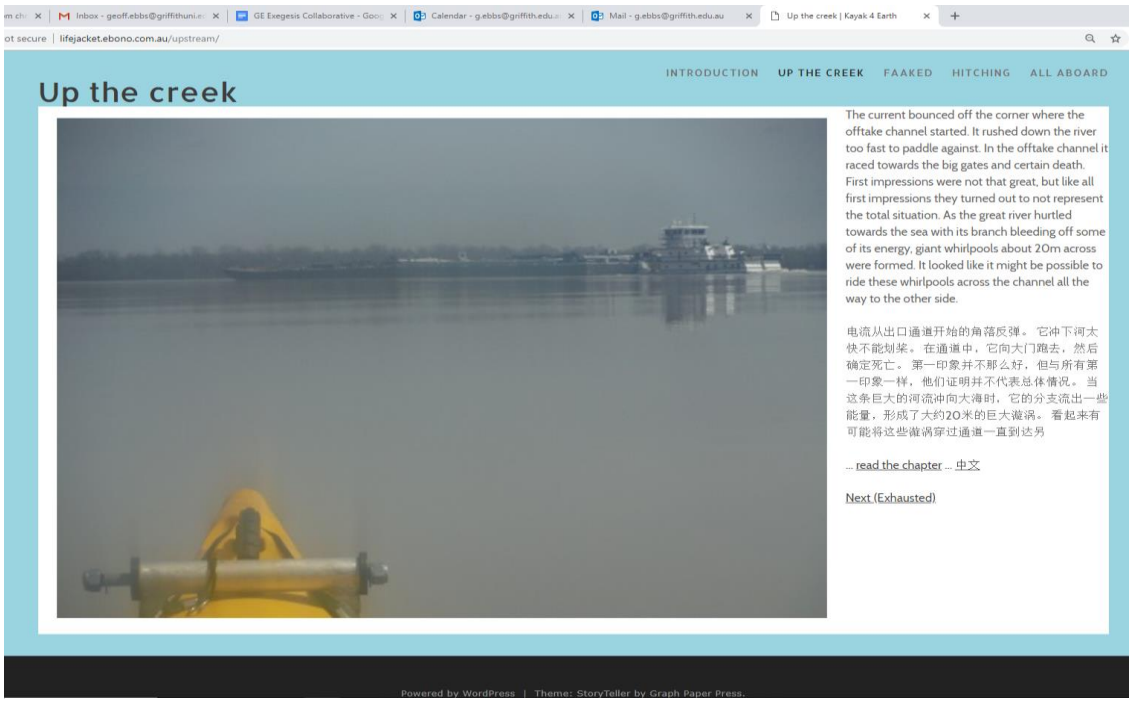


Figure 10 - An animation of the gruelling paddle upstream

As we read the text describing the gruelling experience, we see the story unfold first hand. This is a simple subset of the image library, a short section of the story selected chronologically with no other curation.

The experience was totally exhausting. Steve writes “The river had won. Shattered, deflated, tired, emotional, downright buggered really, I conceded defeat.”

In this collage, the images from the previous animation jostle for position over the background of Steve’s total collapse. By allowing the user to pan through the images, the administrator gives the user the opportunity for an additional insight into the impact of each image.

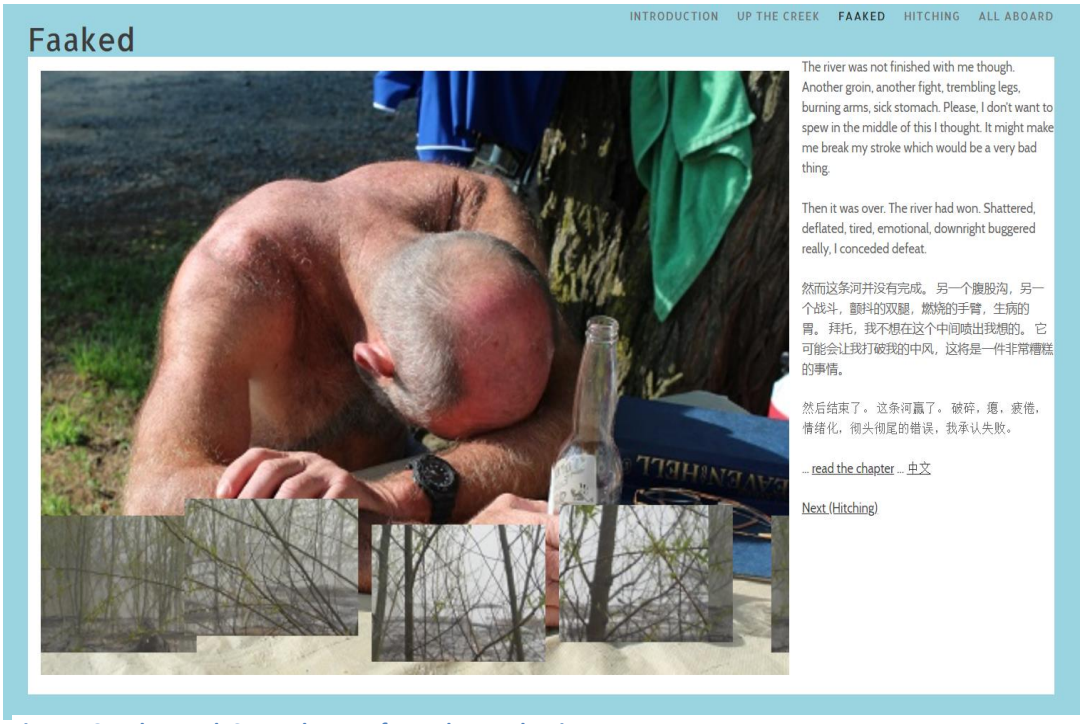


Figure 12 -Exhausted, Steve slumps after a day on the river

To make it past this impossible section of the river he chose to hitch a ride on one of the Mississippi barges. This, again, is a simple animation. In this case, though, the administrator has given the user the possibility of controlling the animation, stepping backward and forward through the sequence and speeding it up. These simple controls are familiar to most of us from operating video equipment or online sites such as YouTube.

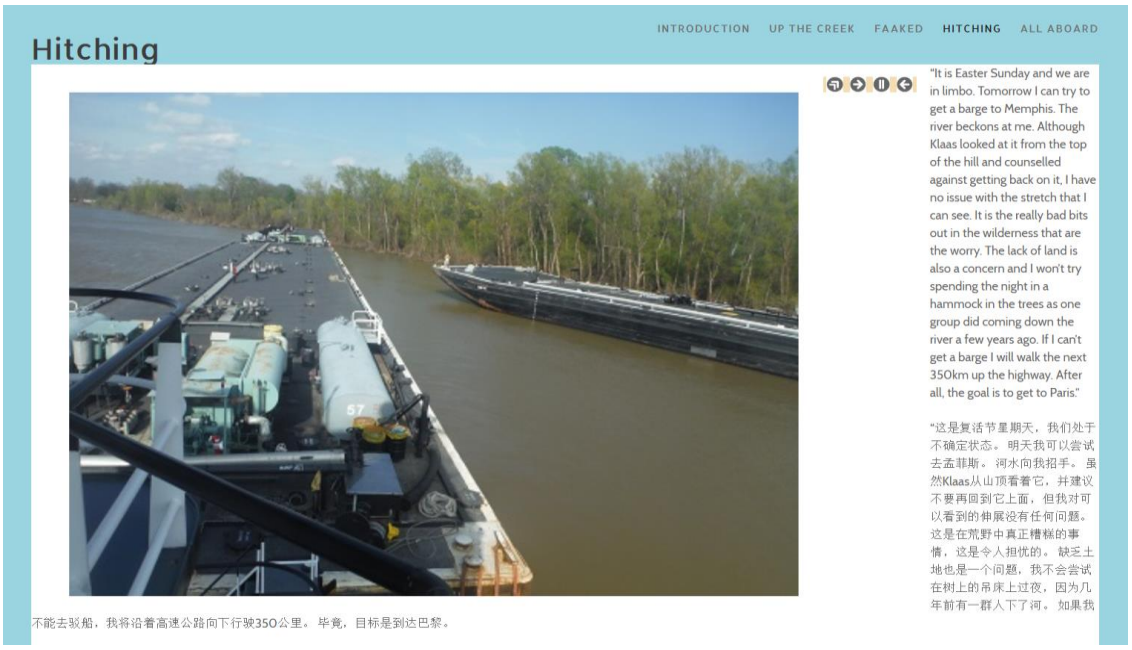


Figure 11 - The animation of the barge allows users to manipulate the display

FInally, for this site, we leave Steve to get back on the water to paddle to New York, catch an ocean liner across the Atlantic and paddle across the UK, the English Channel and down the French coast to Paris.

Figure 13 - Old Yella ready to board the Queen Mary II in New York

Lifejacket is a short example of the implementation of PresentWP to reveal the contents of a site.

It is also installed at http://thegenerator.news and http://ebono.com and offers users the same features.

2.2 PresentWP

Figure 14 - PresentWP.com describes and delivers the plugin

The site PresentWP.com shows off the features of the plugin and explains how to use these features as it walks us through the available visualisations.

The home page shows swimmers moving through the open sea. The swimmers jostle for position, attempt to dominate the space and then have to defend it against interlopers. The visualisation itself, then, tells a story in its own right. Random factors are at play but the administrator places limits on the scenario to constrain the possible outcomes.

We can influence this automated positioning by using the mouse. Moving left or right moves the frames. We can examine the characters and control certain aspects of their behaviour.

The links in the main menu at the top of the PresentWP site walk the visitor through each of the visualisations and how to use them. The final page describes the plugin, allows the visitor to watch a nine minute movie that walks them through the plugin

and download it for installation on their own WordPress site. The banners at the top promote aspects of the tool.

Figure 15 - A promotion for the animation visualisation

The second page in the site introduces the starting point for an administrator to begin to manipulate their image library. The **Field of Images** is a grid that contains all the images in a WordPress site, displayed here in chronological order.

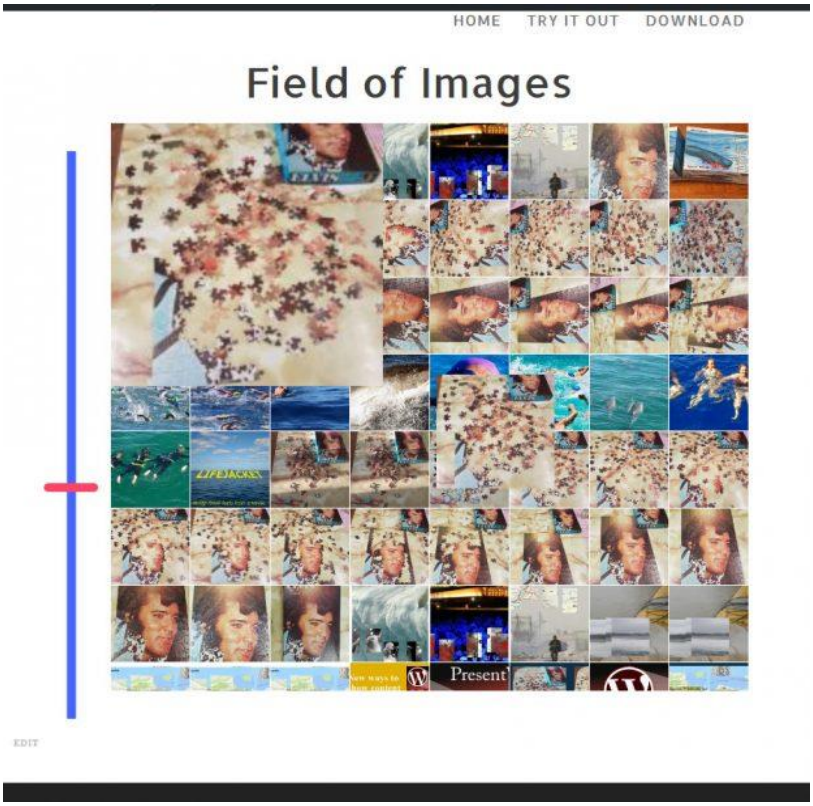


Figure 16 - The field of images displays all the images in a given WordPress site

We can explore the field of images using a mouse or, if it has been revealed to us by the administrator, a slider that performs the same function. Revealing the images as we roll over them, allows us to make an informed selection.

Clicking on an image displays it at the maximum possible resolution on the screen so that we can examine it in detail.

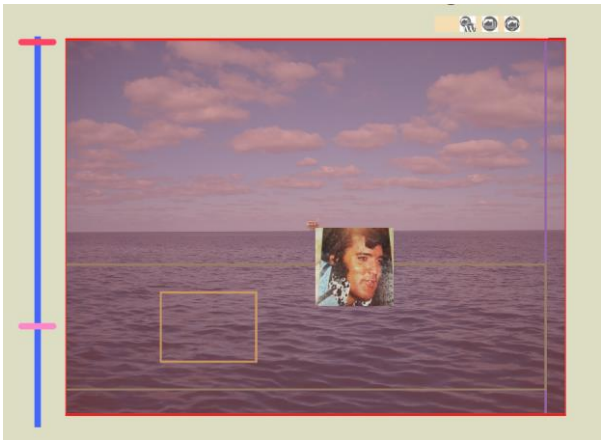
Alternately we can step through all the images in a site, or any subset of them, to explore them at our leisure or to tell a story based on a section of the chronology or any other sort criteria we have established.

Figure 17 - The controls specific to the animation tool

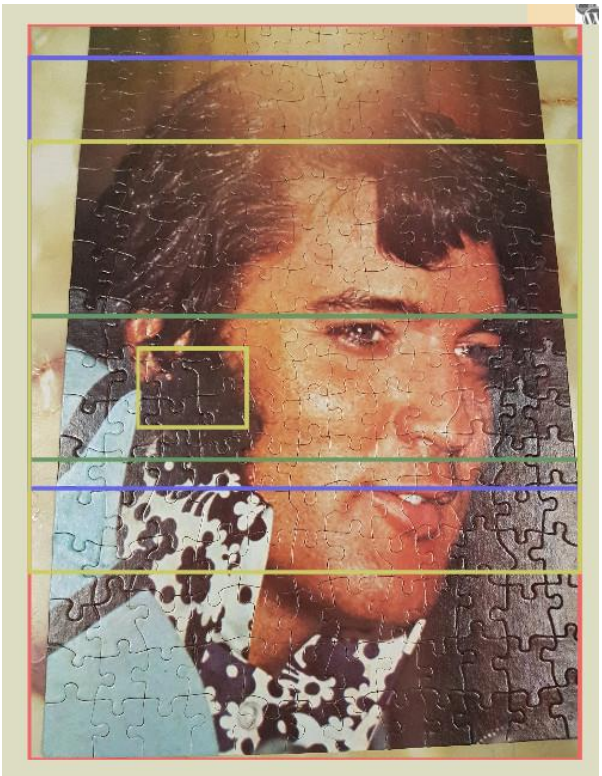
The administrator can provide simple tools on the interface so that the user is in control of the animation.

These controls mimic the controls provided on most video playing hardware and software. (see discussion of research into timelines in the Appendix for more details)

When we start working with more complex visualisations, those on screen controls provide the user with a much richer and more nuanced way of integrating the images.



The float visualisation, for example, allows us to select the background image (above)



define which portion of that image we would like to display, (right)

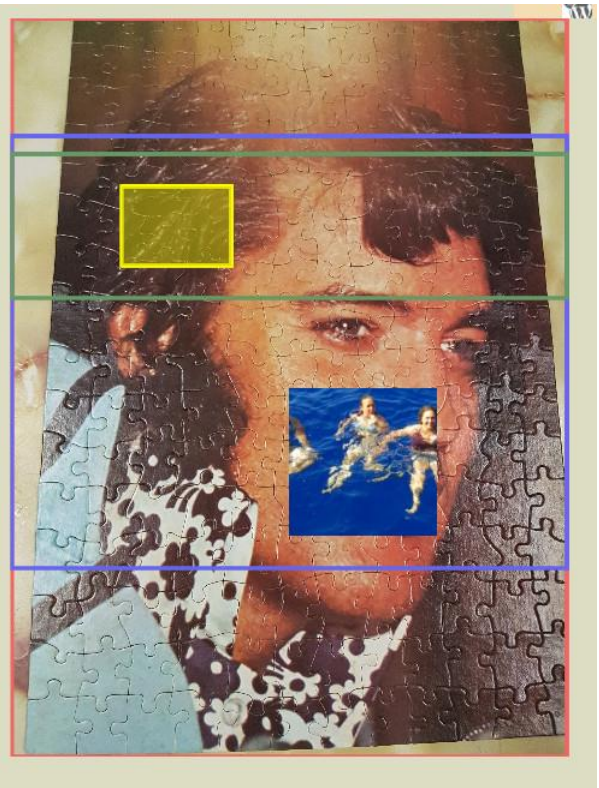
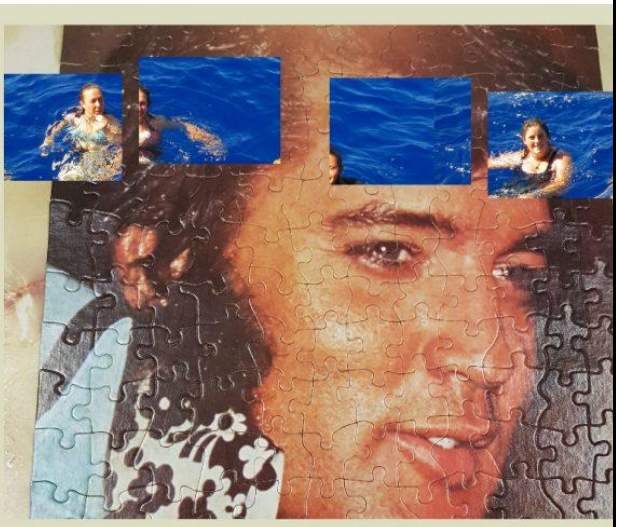


Figure 18 - The float visualisation provides controls to establish the details of the display



where we want the floating images to appear and what images should appear in the floating frame. (left)

The final result is Elvis with Girls on his mind.

Administrators can also use a single click to save the selected visualisation as a WordPress page and then incorporate it into the site.

Thus, the WordPress plugin PresentWP enables a WordPress site administrator to:

1. Manipulate the image library using metadata based navigation and selection tools
2. Capture the results of those manipulations as Wordpress pages
3. Expose these tools to the user so they can personalise the content themselves.

The plugin is currently visible to the general public on the two sites described here and is available to be downloaded for installation on any WordPress site.

Other visualisations and controls are in various stages of development and have been left out of the product as presented for the sake of polishing and bug-fixing.

The structure of the application and the code from which it is built is described in detail in the Appendix. It includes a section explaining why the files in the product PresentWP are named Metadex, after the underlying infrastructure on which they are built.

3 Development of the work

The work began as a visual design project describing an interface that allows you to fly through a set of categories to navigate a complex data set. This work was based on a literature of interfaces in general, interfaces involving metadata, and the use of metadata in digital story telling. This process is summarised in PresentingMetadex.mp4

Figure 19 - A space-travel metaphor for a metadata based navigation system applied to a pathology knowledge base

A discussion of the research into the current importance of metadata is attached in Appendix A. That research was conducted with reference to what I had learned building an early content management system for the web in the 1990s (Proton). Proton was the third iteration of a database to web-engine I had built and was founded

on a metadata indexing system I created specifically for the purpose (Metadex). A detailed discussion of the development of Metadex is attached in Appendix E.

A high-level review of academic literature about interfaces in general revealed that a number of factors determine whether an interface is considered effective. Jiun Jhy-Her, for example, identified that Incentive, Transfer, Accessibility, Play and Challenge are all important elements of an engaging and useful interface. (Her 2014) Other authors use different but complementary frameworks. For example, Keptelinin, Nardi and Macaulay studied the role of context in activity theory and identified that "the subject, intent, artefacts and sociocultural rules" all influence the nature of interactivity. In these frameworks, familiarity emerges as a component of usability. Her's Accessibility and Kaptelinin's artifacts and sociocultural rules all incorporate the user's ability to grasp the concepts as they are presented. Kaptelinin's observation that "underpinning this are two driving principles. One is that the human mind only exists in context of its relationship with the real world. The other is that activity is socially and culturally determined." (Kaptelinin, Nardi et al. 1999). We see that metaphor is an important element of creating an accessible interface.(Laurel 1997)

Figure 20 - The controls of a car - Learners License SA http://learnerslicencesa.co.za/LLSA/index.php/car

One interface familiar to most of us is the automobile dashboard and controls. An interesting aspect of the automobile interface is that is quite complex in that it has many elements to it and its use involves thousands of decisions per minute across independent disciplines. We control the mechanical operation of the vehicle, the navigational needs of reaching our destination and the responsive needs of staying safe in the environment. In Mental Workload while Driving, Recarte et al examined the complexity of mental activity while driving to study the impact of various distractions. The rules of the road, the navigation in physical space and the safety requirements are all quite independent spheres of knowledge and activity and yet they are seamlessly intertwined in the act of driving. (Recarte and Nunes 2003) The automobile interface therefore represents a familiar paradigm for navigating quite complex and independent areas of knowledge.

A more specific investigation of navigational interfaces included the development of radar, the emergence of 3D holographic interfaces and innovative technical approaches to presenting large volumes of information effectively to users of technology. A surprising outcome of that research, though somewhat obvious in hindsight, is that the navigation tools available on the modern smartphone involves the most advanced combination of interface design, artificial intelligence, geospatial mapping and network theory.

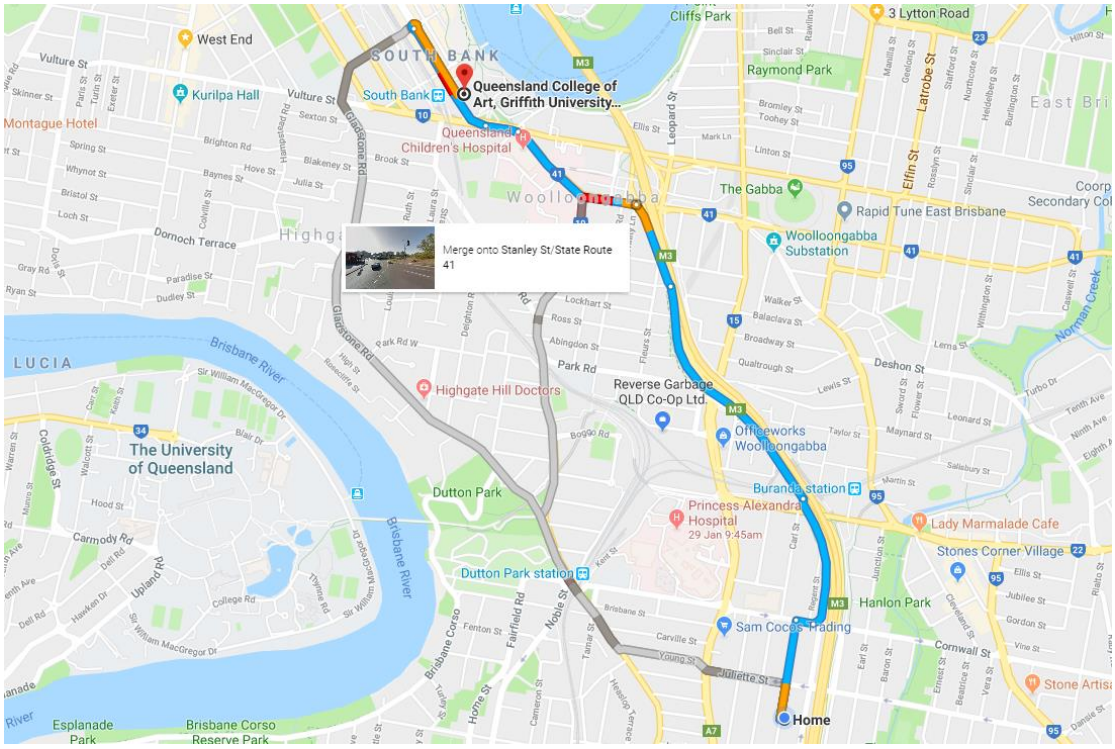


Figure 21 - Google maps provides directions, travel time, traffic conditions, driving instructions and neighbourhood information updated in real time

The capacity to respond in real time to traffic conditions and calculate the most effective route automates some aspects of the intelligence required to drive effectively outlined above. In a study of 1,181 drivers using in-car navigation, Park and Kim write, “perceived processing speed and locational accuracy of car navigation systems as key psychological constructs” (Park and Kim 2014) The perceived integrity of the interface and the real world is a major driver for human satisfaction. Of course, that automation has evolved to the point where driverless vehicles are now commonplace in many industries and an emerging reality in our daily lives.

Again, it is true that the most familiar interface happens to be a highly advanced example of the simplification of incredibly complex fields of knowledge into a simple representation that most people can readily identify.

The initial field of practical exploration then, was to consider methods of applying the approach of navigating complex data sets in a geographical manner by applying the principles of a vehicular interface to the controls used in that navigation.

3.1 Overview

3.1.1 Organisation of PresentWP

The concept of a visual interface to navigate complex data sets using metadata was developed as an exercise for the Visual Design subject as part of this Masters Degree and used a request from a client seeking a solution for presenting a knowledge base about pathology to assist people to read pathology results holistically.

This section starts with an overview of the conceptual framework and then examines how that framework relates to the underlying principles of the Metadex.

The notion was based around a DNA column on which a rotating plane of meaning appears. As you move up and down the column the categories that identify the meaning spin and re-organise themselves. Thus your position on the main column determines what categories are relevant and, so, available. Selecting a particular category (at any given position) makes it the primary category and, so, reorganises the surrounding categories based on their relevance to that selection.

The combination of position on the main column and the selected category determines the visible content. That content is displayed as a geographical map based on a hierarchical arrangement of galaxies, solar systems, planets, continents and local features.

As well as the related set of categories, an independent set of parameters are presented as alarms, or controls, that influence the content that can be viewed. In the pathology universe pictured above, the selection of **Iron** means that inflammation and age are significant.

The interface thus uses a space travel metaphor in which the controls given to the user allow them to leap through space to arrive instantly at a particular destination where the content that interests them is arranged in a hierarchy controllable by the user.

This provides a means of visually representing an n-dimensional matrix, which may be sparsely populated, in a readily understandable form. While the nature of the interface must be learned, the abstraction of relationships and the structure of the hierarchy are visceral not intellectual.

3.1.2 Underlying conceptual organisation

The consideration of an interface that combines a vehicular paradigm with a geographical representation of complex knowledge begs an important question: How might we map complex knowledge bases?

In discussing this in The Psychology of Human-Computer Interaction, Card and Moran wrote, “Prior styles of interaction between people and machines—such as driver and automobile, secretary and typewriter, or operator and control room—are all extremely lean: there is a limited range of tasks to be accomplished and a narrow range of means (wheels, levers, and knobs) for accomplishing them. The notion of the operator of a machine arose out of this context. But the user is* not an operator. He does not operate the computer, he communicates with it to accomplish a task. Thus, we are creating a new arena of human action; communication with machines rather than operation of machines.” (Card., Moran et al. 1983)

Creating a driverless car uses advanced technology and mathematics to solve a real world problem. Ultimately it provides a real world solution to a real world problem using that technology to operate a machine through a conceptual representation of a real world space. The vehicle is an arbitrary (though highly evolved) device and the map is an arbitrary (though highly evolved) abstraction of physical reality.

When it comes to the representation of knowledge, however, we have an entirely arbitrary representation of abstract concepts. We develop most of these representations based on real world paradigms (files and folders, for example) mixed with abstract concepts (tables, lists, alphabetic and numerical sorting). The use of metaphors to organise data is an application of the need for familiarity in interfaces as discussed above.

The problem of representation of abstract knowledge and finding methods for navigating it has been a long term area of study for me, and that work led to my development of the metadex in the mid-nineties. A detailed discussion of that work appears in the background to the work, below.

3.1.3 Background to the work

The basis of this research is the use of metadata to engage with content. This section of the exegesis explores the concepts underlying that field and the nature of my engagement. It traverses the work that led to my understanding of the role of metadata, and what the research for this project revealed about the current state of activity in those areas I wished to explore.

The underlying emphasis on metadata as a tool for navigation in my approach is based on the power of metadata to operate as an index for content. The challenge of finding verifiable, meaningful and relevant content in relationship to any particular topic increases with the variety and volume of the content itself. Metadata describes and defines content. Searching the metadata, then, is less onerous and more productive. Because we can sort, filter and organise content based on its metadata we can develop protocols for automating the sharing and delivery of content so that it is immediately usable and useful at the client. Research into the usefulness of metadata as a search tool generally reports it as useful. “Despite the unfamiliarity and power of the interface … 90% of the participants preferred the metadata approach overall, 97% said that it helped them learn more about the collection” (Mateas and Stern 2005)

I have first hand experience through my roles as a programmer in the early eighties creating information retrieval systems. On one hand, extracting statistical information from census data revealed the power of elegant data structures, specifically sparsely populated, n-dimensional grids, for storing and extracting meaningful information. On the other, creating systems for cataloguing unstructured content revealed the major challenges organising and cataloguing information for retrieval and delivery. I had experimented with tagged databases such as Pick (used by IBM as U2 in the operating system of the S38 aka Silverlake) and The Corporate Retriever (a Queensland product developed in the late 80s).

Figure 22 - Dick Pick releasing a PC version of his software in June 1984. Modern derivations include OpenInsight and D3.

Databases built before 1995 were designed to tabulate and report on information filtered by specific values of the content. The tabular nature of computer screens and applications such as spreadsheets complemented and supported the tabular view of business information systems commonly in use in most mainstream computer systems. While the visual interfaces of modern computing devices remain generally tabular in nature, we live in an increasingly visual world that requires more flexible responses. (Taylor and Benford 1997) My interest in the constraints and power of the tabular view is discussed in detail under X.2.3 Reflections on grids in Chapter X Development of the work.

I built on that experience for Sean Howard of OzEmail in the early nineties, researching different methods of organising unstructured data, with a view to creating a retrieval system for a major content repository. At the time Sean Howard was investing the money he made when he "sold his publishing business to Kerry Packer while keeping the intellectual property [MicroTex] that allowed OzEmail to continue" (Budde 2002) OzEmail later became Australia's largest internet service provider and sold to WorldCom for $512 million.

My research for him resulted in the development of the text searching tool Isys. Sean concluded from my research that text searching was the most effective way to retrieve data from large content repositories. This was later vindicated by the rise of Alta Vista and then Google as the world's favourite tools for navigating the web. Until those web search tools introduced the public to text searching as the standard method of finding items in large data sets people had not find that intuitive, either. Isys was purchased by LexMark in 2010.

My conclusions were somewhat different. While text searching enables the rapid retrieval of content it does nothing to verify sources, create context or to link meaning.

I set out in 1994 to build an indexing system for metadata, known as Metadex, to facilitate the meaningful organisation of the unstructured data distributed across the web.

Figure 23 - The Metadex Group was a small web development company in Sydney.

From 1993 - 2003 I built web applications: connecting the web to databases; pioneering content management systems; developing a metadata index that could be distributed across websites; applying those principles to publishing and e-commerce systems.

In 1996 the Metadex Group delivered the web based content management tool Proton as proof of concept of the application development platform powered by Metadex. I stopped work on that project following the dot com crash in 2000. It remained in commercial use until 2006.

I had designed and built Metadex to create a distributed index for content that allowed it to be shared in a secure, verifiable manner as the basis for workflow and document management environments. Proton was the third iteration of a web-based content management system I had built in the early nineties and the design of Metadex was based on that earlier experience with content management as well as my previous experience in research content retrieval and extraction systems.

The problem that Metadex set out to solve is how to organise the browsing of complex categories in an API that allows a range of applications to be built on it. Most online databases offer a search and a browse function. Users tend to use the search function for two reasons.

A. they are familiar with the concept of text searching
B. the browse function generally exposes a hierarchical tree of categories that may or may not suit their particular approach.

The problem, then, is to allow flexibility in the organisation of categories to cater for independent categories (as opposed to hierarchical) and those with many to many relationships.

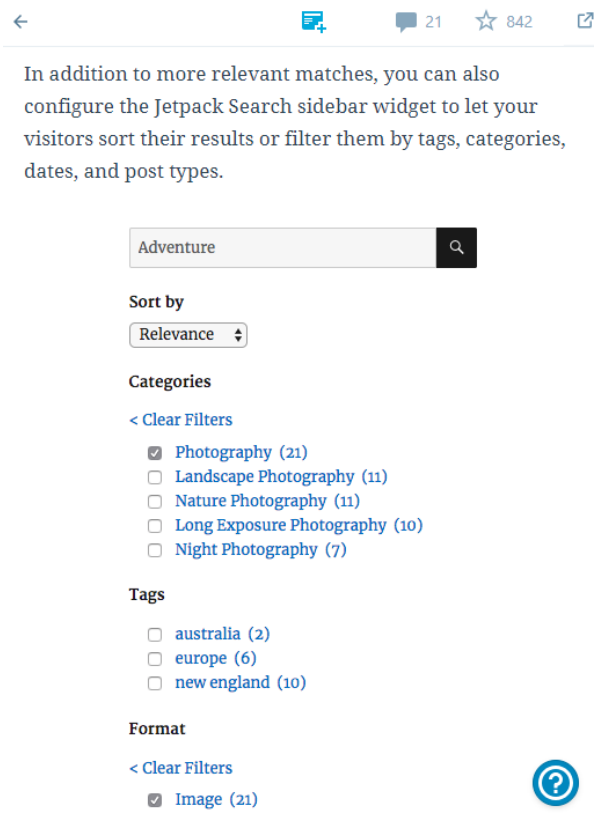


Figure 24 - Even the latest browsing and filtering tools force the content manager to expose the user to a primitive tree

That problem continues to plague software developers. WordPress for example, recently released its JetPack search tool to WordPress Business customers, promoting it with the claim "Jetpack Search provides a more engaging experience for your visitors: it relies on modern search algorithms that take phrase matches and the recency of your content into consideration, which in turn produces better search results." (Brown 2018)

Figure 24, however, reveals a classic tree structure, forcing the site administrator and the end user to familiarise themselves with the categorisation tree and understand which categories are hierarchical and which are independent.

3.1.4 Key concepts

This Masters project set out to explore methods of building on that previous work to address similar issues in the visual, streamed environment of the Web 2.0 by developing a visual interface for navigating that metadata.

The key concepts explored in my initial research, then, are

- the role of metadata as an organising framework,
- the use of metadata in the art of storytelling and
- the structure of metadata in existing content management systems (WordPress).

3.2 First prototypes

3.2.1 LabMap

A quick prototype was developed using HTML5 Canvas and JavaScript to categorise various posts and to establish the relationships between those categories. This prototype is visible at http://labmap.net

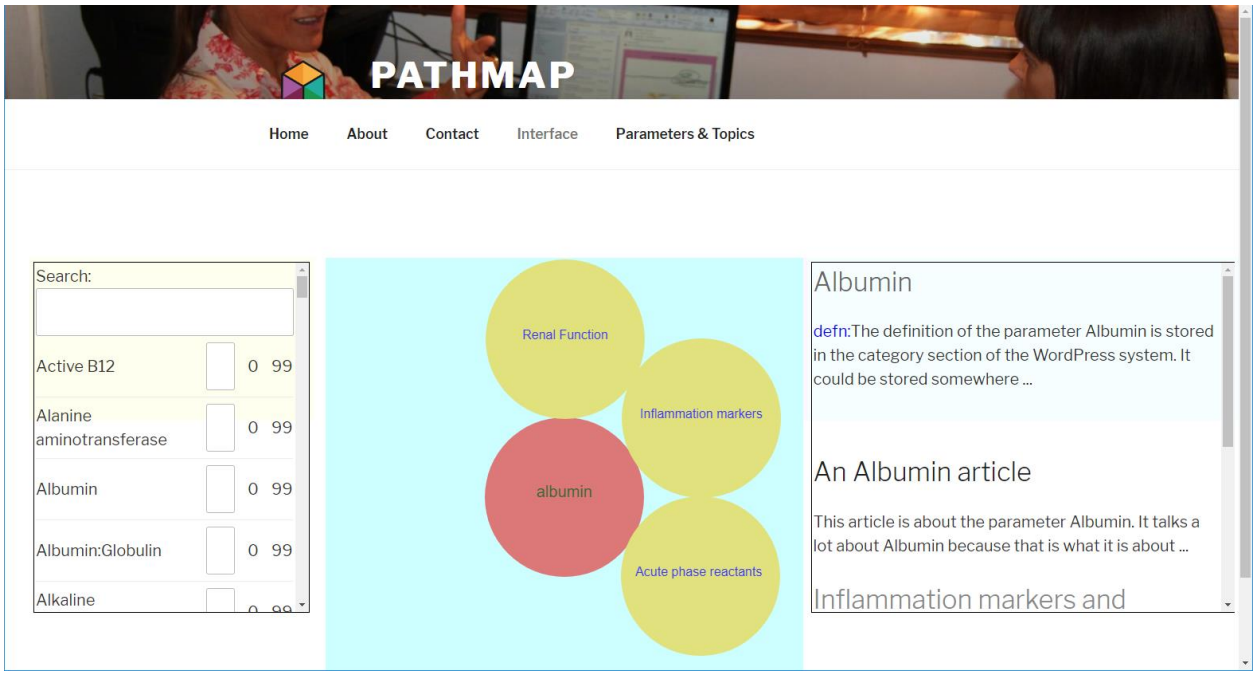


Figure 25 - A basic wireframe website with a 2D version of the proposed navigation system - Winter 2017

The initial prototype was simply an HTML Canvas and javascript interface that accessed WordPress posts and categories. It was then integrated into a WordPress site as a page.

This system extracted all the categories from the WordPress wp_postsmeta table identifying the categories by type. This list is the initial search criteria and determines the user's position in the primary selector. The application then related those categories by looking at which posts they had in common and displayed those as coloured circles in the categorisation canvas. That represents a two dimensional view of the categorisation field in response to the position on the primary selector. The user is thus navigating the metadata visually and can alter their selection by clicking on the metadata in the categorisation canvas.

Hovering over a category in the display, highlighted the posts categorised using that category. If there is an entry in the comment field of the category (on the wp_posts table) that is displayed first, as a definition of the category.

3.2.2 Storylines

The system was then rebuilt as a WordPress theme that incorporated the framework for the routines to operate the canvas. That project was called Storylines and was used

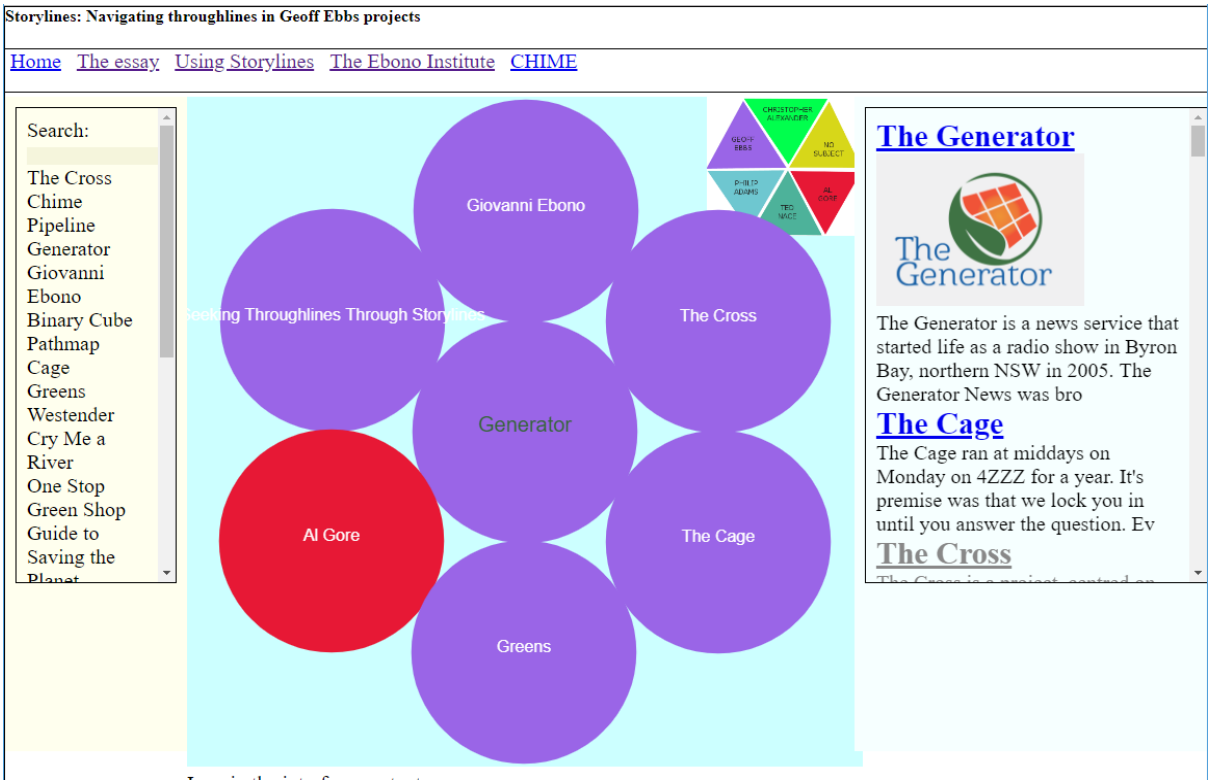


Figure 26 - Colour coding adds a layer of richness to the interface – T2, 2017

to discover and present throughlines in my creative work. It was my submission for a project for the Interactive Media Theories course as part of this Masters degree and is visible at http://storylines.ebono.com.au Operationally, the system is identical to LabMap with the exception that it was integrated into WordPress as a child theme to explore the integration of the interface with the WordPress development environment and to ensure that it could be implemented by an average WordPress site owner.

The initial selection from the list on the left establishes the related topics which are colour coded based on their relationship to a predetermined (independent) category. This is an example of adding depth to the controls using visual clues.

Interestingly, the project revealed some aspects of my earlier worked that influenced the development of PresentWP in unexpected ways. I include those reflections here, because they were later instrumental in the decision to focus more on the interface and less on the back end aspects of the tool.

The challenge for me in completing this particular project was that I had never identified as an artist, or detected a particular creative theme or driving force in my work over a diverse career that has spanned a lot of computer programming, a huge amount of writing, speaking and media as well as management, sales and marketing. The challenge set by my Interactive Media Theories lecturer, David Harris, was to begin to categorise my work and to seek throughlines by tracing common categories.

3.2.3 Reflections on grids

One of the most interesting things that emerged from this process was the discovery that I have had a lifelong interest in grids. My first programming project was a Fortran program designed to create a jigsaw puzzle with multiple solutions. I used 2 ½ hours of computing time on the Melbourne University CDC Cyber 60 computer before the program was switched off and I was warned against creating open ended programs in the future. The interest in grids reappered in a crossword solver written in Basic for the Amiga 64, a tool to collapse Census data written in Wang VS Cobol and went on through activities as diverse as reporting on the development of SQL and the hobby of developing patterns for wall tiles.

Interesting to me was that some of this work was deliberately exploring the limits of grids and the relationship between grids and more complex data. My long-term love of crosswords and early programming work designing puzzle creators seemed relevant here. Discussing the professional identity of cruxiverbalists with Richard Fidler on the ABC Radio show Conversations (at 30 min) - cyrptic crosswork setter David Astle described the results of a Buckinghamshire study https://www.frontiersin.org/articles/10.3389/fpsyg.2016.00567/full of 800 capable crossword solvers using the RIASEC measure that revealed cryptic crossword enthusiasts tended to work in intelligent fields such as mathematics and engineering. Astle added his anecdotal observations in his discussion with Fidler, “Cryptic

crosswords are popular amongst code creators because they know how to look past the surface of the patterns ... another group is musicians because [music is a language that] combines logic and art."

The work that I had done collapsing census data from the sparsely populated matrices in which it was stored revealed the power of n-dimensional matrices to me, which was revitalised when I reviewed and then promoted Lucid 3D, the spreadsheet that separated business rules from data and stored the data in an n-dimensional cube. The spreadsheet was widely used by the Australian Bureau of Statistics, even after it was bought by Lotus and shelved by IBM in an attempt to save Lotus 123 from the onslaught of Microsoft Excel.

My fascination with grids, and their shortcomings, led to me deciding to use the Pick database (a non tabular, tagged database) to build a repository for the output of the Computer Magazine Section of Australian Consolidated Press in 1988. I had already built the database for the Directory of Hardware and Software in dBase III Plus and created a publishing system in Ventura 1.0, so had a good handle on the requirements of content repositories and the shortcomings of categorisation systems in tabular databases.

At the time the SQL standard was emerging and there was considerable debate about the approaches to storing and retrieving many to many relationships in a tabular database system. I wrote a number of articles at the time for PC Week on the topic. It was this work that led to the research for Sean Howard, director of the Computer Magazine division of Consolidated Press, on means of creating a large content repository for online retrieval. At the time he was establishing the internet provider Ozemail.

It was interesting to me that these reflections on creating methods for categorising content emerged in Storylines, a visual tool for navigating those relationships. This also sharpened my view about the relationship between the interface and its capacity to construct meaning. I realised that if the purpose of the interface was to lead the user on a journey rather than to force them to think overtly about the category choices

they were making, then the interface needed to be more or less invisible. The power of text searching is precisely that it allows the user to find things without thinking too much about how they approach their search.

3.3 Exploring the visual

3.3.1 Art based on metadata

Having identified that visualisation of online content using metadata was one way to explore this field, a wide range of digital artwork was examined to identify those artworks that use metadata as a primary tool for navigation.

3.3.1.1 The Whale Hunt

This work is entirely metadata based. It represents nine days spent in an Inupiat community in Barrow Alaska by Brooklyn artist Jonathan Harris in March 2007 (Hennessy 2008). He took a photo automatically every 5 minutes as well as whenever he saw something that interested him. The time of the photo, its hue and the names of

Figure 27 - WhaleHunt provides a means of stepping into and through a visual story

the characters in it are the only data used to navigate through the gallery. Of that, only

the character identification required curation by the artist, the rest of the metadata is inherent in the system information about the content itself.

The number of photos in any given time period increases in line with his interest in the activity around him.

“ In moments of high adrenaline, this photographic heartbeat would quicken (to a maximum rate of 37 pictures in five minutes while the first whale was being cut up), mimicking the changing pace of my own heartbeat.” (Harris 2007)

Thus the actual account of the whale hunt and, to a significantly lesser extent, his record of getting dressed to go hunting on the Arctic ice represent clearly defined periods of additional activity.

Given the striking and unusual use of metadata as a sole means of navigating a set of photos, this was the first series of visualisations implemented as a “dirty” prototype usable on any WordPress site to test the concept.

3.3.1.2 Prison Valley

This is a good example of the current state of the art in interactive documentary. Developed by French television studio Arte TV. “ARTE offers high-quality programmes to 70% Europeans in their own language. ARTE programmes are broadcast in French and German 24 hours a day in HD quality on all screens. … This is a unique experience

Figure 28 - Prison Valley is an interactive documentary that makes use of metadata driven interfaces

cofinanced by the European Union since 2015 "to foster EU integration through culture by providing new subtitled versions of selected TV programmes across Europe". (Arte TV, 2018)

Prison Valley examines an area of the US with 17 different prisons, including the largest high-security prison in the USA. The local economy is totally dependent on the prison economy. The documentary allows the viewer to explore the material gathered by the documentary maker in a variety of ways, using the paradigm of a motel room as the basis of their journey of exploration.

In addition to the editorial curation of the content to provide a narrative there are a number of elements based entirely on the metadata generated by the user as they navigate the content.

Figure 29 - Souvenirs use metadata generated by user activity

The example studied for this project is the use of souvenirs, such as postcards, brochures and tickets, used to identify those areas of content that have been explored

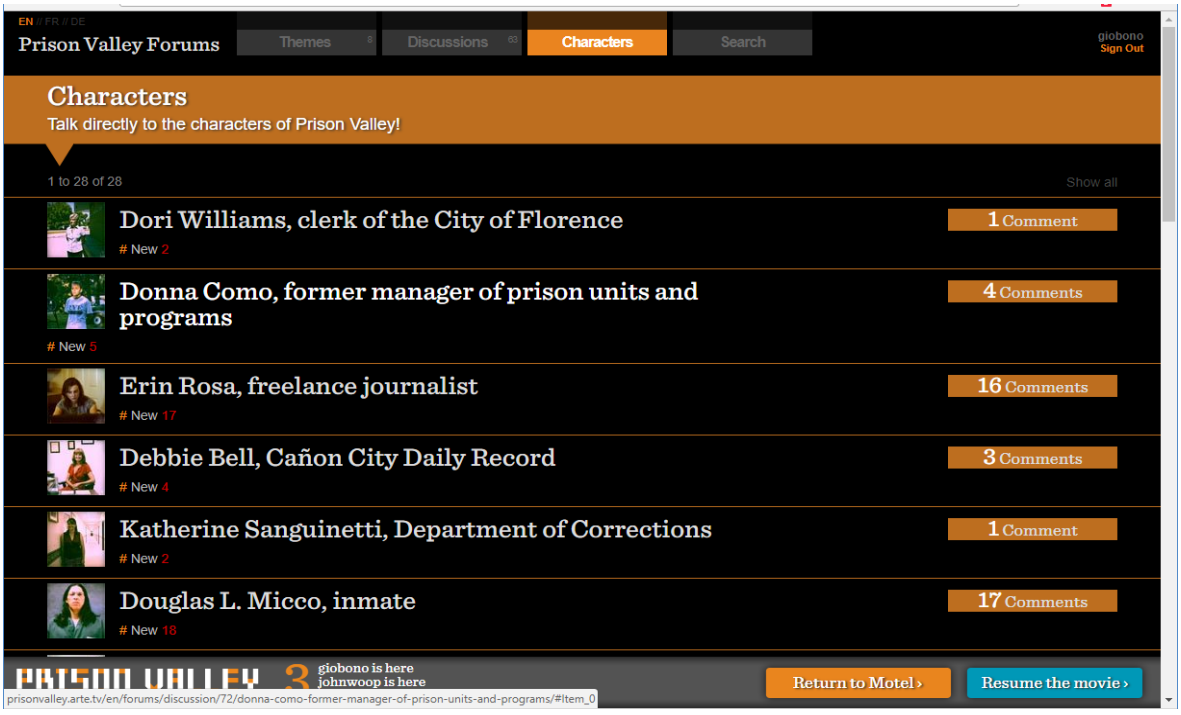


Figure 30 - Metadata is the basis of most communication interfaces

by the user. This is an example of user-generated metadata (username, date, features

visited) and system generated metadata (featured image filename, link to content) being employed to enhance the user's future experience.

Another feature allows viewers of the documentary to leave messages for characters in the documentary. Like most chat features, the content (the message itself) is managed by the metadata (username, charactername, location of character image, date of last message).

3.3.2 Examples of visualisation based on metadata

Another way of analysing the usefulness of metadata in aiding comprehension is to examine the role of metadata in different visualisations. The following examples all deliver visualisations of data that contain many examples driven by metadata.

3.3.2.1 10 data visualisations that changed the world

The British Library exhibition in February 2014 documented ten major uses of data visualisation in human history. One of the interesting things about a number of these visualisations is that the results are important because they are surprising. It was the new knowledge they revealed that makes them significant. In many cases the new knowledge was revealed by detecting patterns in data that was not central to the matter under examination.

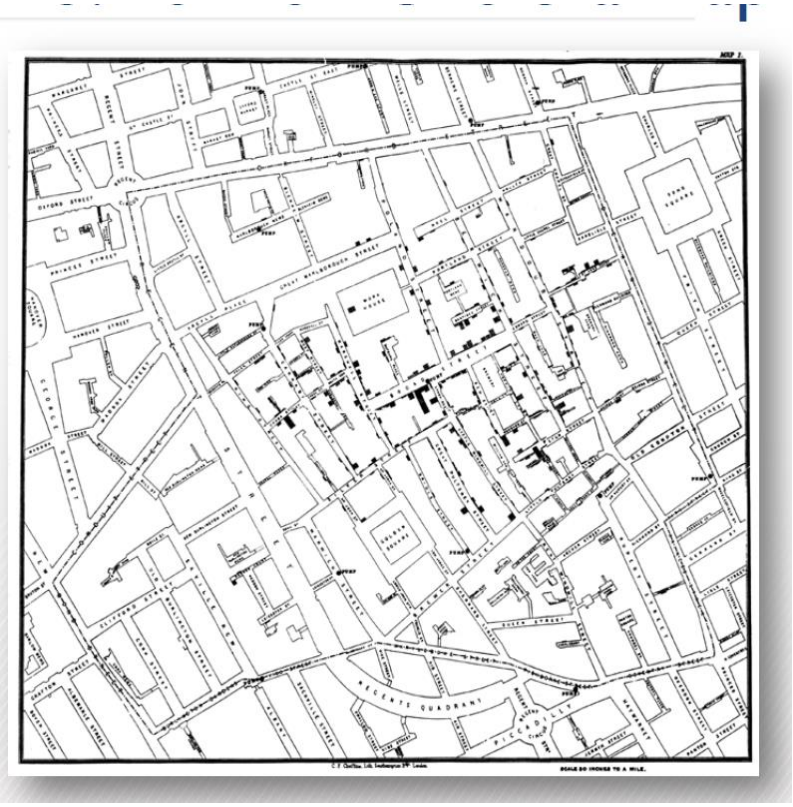


Figure 31 - The home addresses of cholera victims was an early example of using metadata to solve a data analysis problem

For example, the identification of drinking water as a source of cholera in nineteenth century London was determined simply by mapping the address

of the deceased against sources of drinking water. The proximity of the deceased to a particular well identified it as a likely source of contamination and thus launched the drive for sanitation that underpins the improved health of humanity to the present day. This is well before the understanding of microbial infection or the work in identifying particular microbes and the vectors that deliver them.

Significantly for this project, the address of the deceased is the sole piece of data used to create the visualisation that revealed the connection between cholera and drinking water. That data is peripheral to the illness or the health of the deceased. One may argue about whether the address of the victim is actually metadata as opposed to a different category of data but, for the purposes of this exercise, the important thing as that access to visualisation of data that may be peripheral to the area of content under examination, may reveal patterns that have meaning. In this case, the pattern of addresses revealed proximity to a certain well as a factor in death, identifying the water supply as the source of cholera and so solving a major medical challenge.

3.3.2.2 D3 JS

This site documents a wide range of visualisation tools that the author has determined as interesting or valuable.

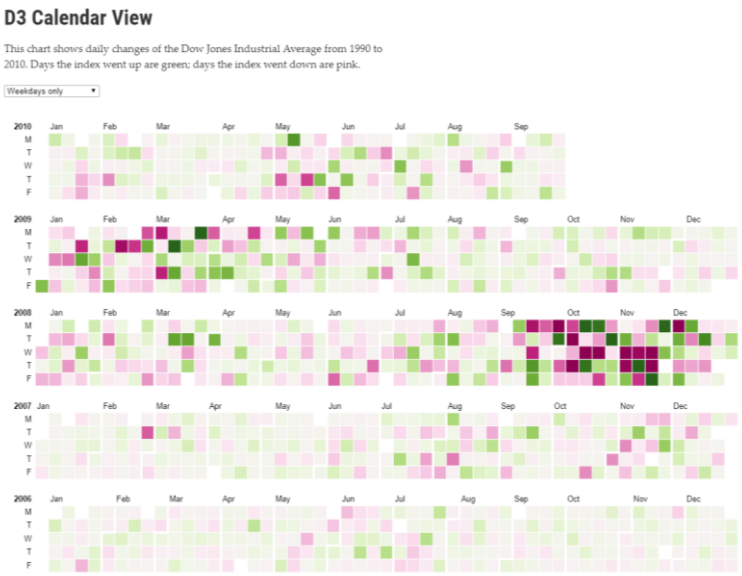


Figure 32 - the D3.JS library contains hundreds of data visualisations

Some of them provide new insights on existing news. Many of them represent news stories of a particular period that use different or remarkable approaches to visually representing the data. The D3 Calendar View is a graphical representation of the movements of share prices on the Dow Jones Industrial Average over 2010 and is an example of this category of visualisation. https://beta.observablehq.com/@mbostock/d3-calendar-view

Other items are simply the rendering of mathematical functions in JavaScript and may or may not have use in displaying data.

The spherical spirals for example, is simply a representation of a beautiful form that many of us admire and most of us would not know how to approach. https://www.jasondavies.com/maps/sphere-spirals/ Most importantly for this project, the library is built on a framework known as Observable, offering a method of rapidly developing visualisations using JavaScript. It was originally the intention to integrate the Observable framework into the PresentWP framework and facilitate the rapid integration of the library of visualisations already available within D3.JS. The limitations of time available in the Masters project preclude the completion of that. Regardless, the identification of such a library highlights the range of visualisations available, the interest which such visualisations may generate and a forward development path that may have commercial and academic value in the future.

Figure 33 - Not all D3 visualisations relate to navigation

3.3.2.3 Voyant

The Voyant set of tools voyant-tools.org is described as “a web-based reading and analysis environment for digital texts”. (Voyant, 2018) It is thus a *content* analysis tool

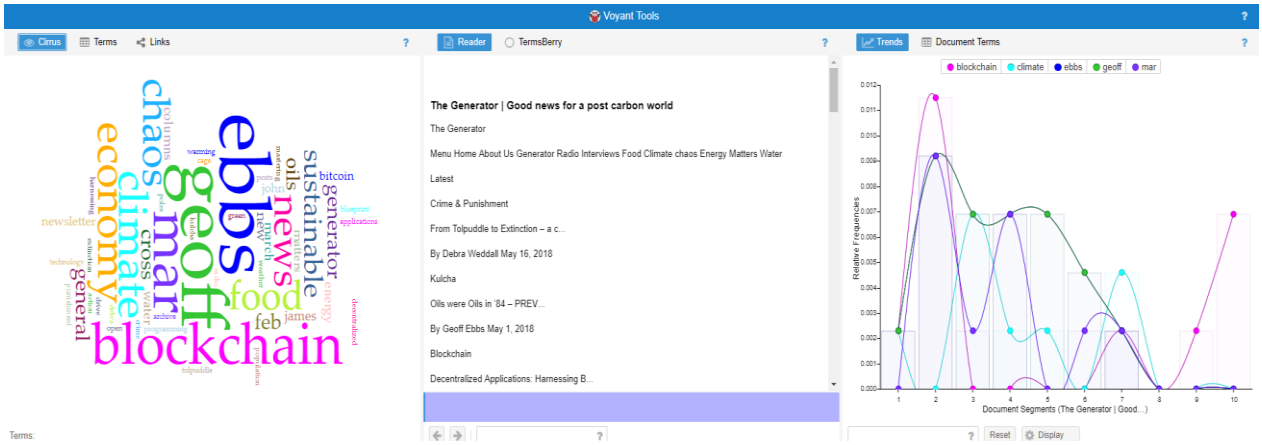


Figure 34 - Voyant tools can be run over any website, document or library

rather than a metadex visualisation tool. Because its visualisations are generally based on metadata generated as a result of the analysis of text it falls into the category of “automatically generated categorisation metadata” as outlined above.

At its most basic you can give Voyant a URL and it provides an immediate overview of word frequency overall and by segment. This same approach can be applied to a

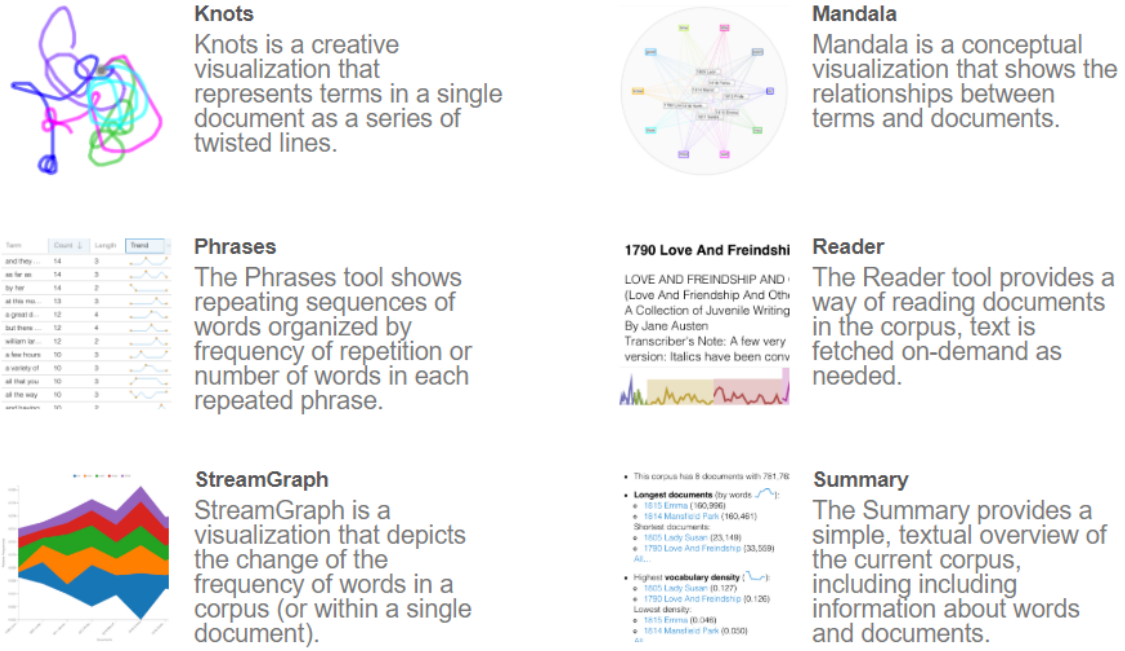


Figure 35 - the wide range of Voyant tools indicates the inherent power of the approach

specific text, or to a pair (or group) of texts for comparison.

The wide range of visualisation tools makes it useful for a range of purposes. The toolkit itself is “a scholarly project that is designed to facilitate reading and interpretive practices for digital humanities students and scholars as well as for the general public.” (Voyant Tools, 2016)

The project is developed as an Open Source project, available on GitHub by Attribution. Similarly to the visualisations presented in D3, it was originally envisaged that the Voyant toolset could be incorporated into the PresentWP framework to strengthen the underpinning objectives of demonstrating the power of metadata as a means of visualising underlying patterns and thereby navigating content. Voyant has a backend JavaScript framework called Trombone, which could be used to provide the integration of Voyant visualisations with WordPress. Again, the scale of the work required to achieve that integration is beyond this Masters project and is included here as a potential application of the PresentWP framework and a possible path for future development.

3.3.3 Conclusions from practitioner survey

An exploration of the use of metadata by artists, visual story tellers and software developers indicates that it does offer a powerful means of navigating content and that there are many approaches that are already well developed.

On the other hand, there is little focus on the role that metadata plays, as opposed to the source content, or on the link between these visualisation tools and the formal frameworks using metadata as a means of organising content (Semantic Web, Dublin Core).

These conclusions confirmed the validity of the question and research and offered a variety of possible approaches to exploring solutions. It was thus a significant step in reaching the most convergent point in the first “diamond” of the double-diamond approach to design. The outcome of that phase is a restatement of the problem based on the research carried out to date.

In this case the problem was redefined as how best to use existing visualisation tools to demonstrate the power of a visual representation of metadata as a navigation system for content stored in WordPress sites. The overall problem remains the same but the field of enquiry has been limited to re-use of existing approaches as opposed to a broader exploration of interfaces in general and the selection of WordPress as a subset of the broader web, given its relatively simple and well structured metadata.

The next step is to start exploring different approaches of implementing solutions to the freshly defined problem.

3.3.4 Exploring visual prototypes

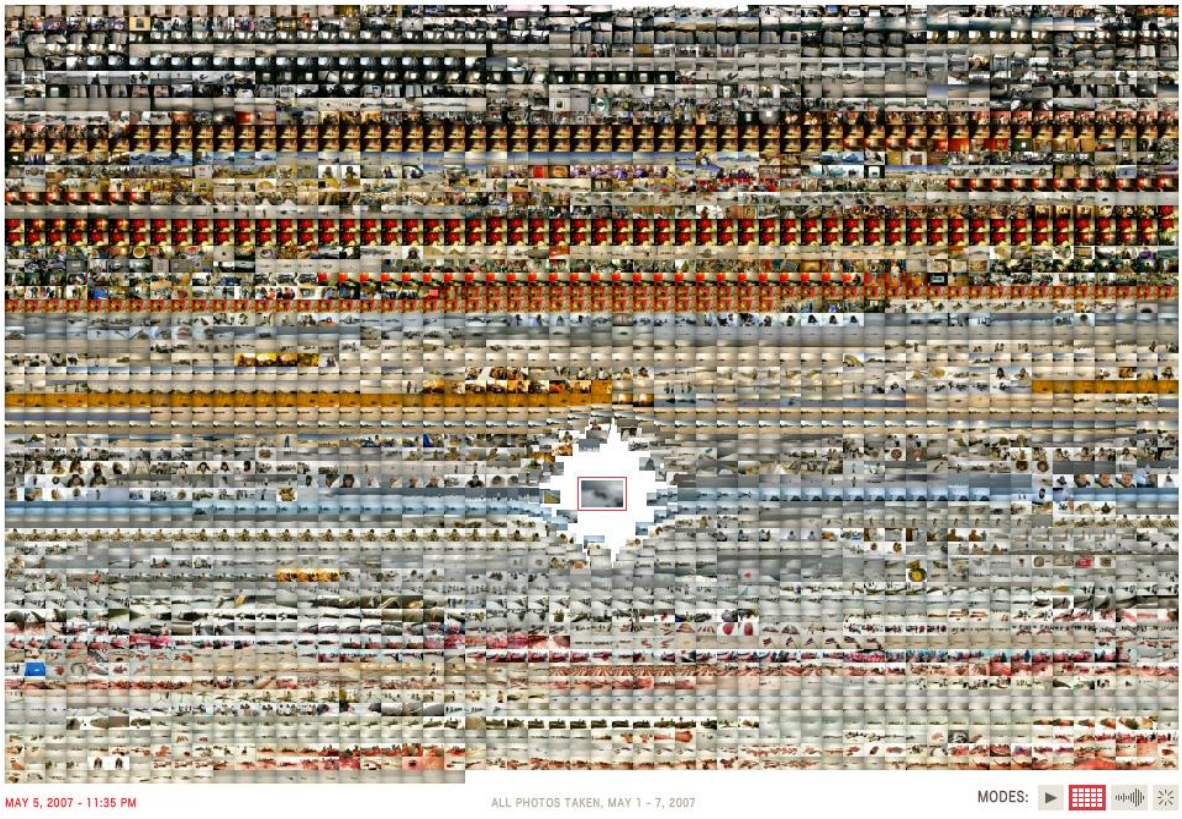


Figure 36 - The Whale Hunt provides an example of a totally metadata driven interface

The Whale Hunt interface provided a powerful paradigm for examining a field of images in a variety of ways without much explanation. It switches between a display of all images and an individual image and allows the user to step through the individual images as an animation.

Figure 37 - A prototype was added to the Storylines theme

In addition it allows for the selection of a subset of images based on metadata, such as the name of character in the images.

A quick prototype was developed and the author of that project Jonathan Harris approved the notion of making his approach available to WordPress site owners. That interface was then incorporated into the existing Storylines interface. As part of the commitment to WordPress the code was also rewritten as a WordPress theme so that it could be installed into an existing site by any owner.

That approach appears to coincidentally be consistent with and complementary to an approach developed by Nguer and Spyratos in Portugal in 2008. (Nguer and Spyratos 2008) Initial feedback was informal and anecdotal and included feedback from the content producer and subject of the blog at lifejacket.ebono.com.au, Steve Posselt.

> *Even though I paddled every inch of the journey and took the vast majority of the photos, I was amazed how much the timeline view surprised me. There were about a third of the photos that I had forgotten taking and quite a few I used the back button to go back and have a second look. (Posselt, 2018)*

The implementation at http://storylines.thegenerator.com.au is an example of that approach.

A second visualisation was incorporated into the same framework based on a project I had completed for a Coding for Interactive Media course 7155QCA as part of this

Figure 38 - The swim visualisation as originally presented in T2 2017

degree that floated still images of swimmers over a background image.

This project had been developed in response to a brief to display of historical photographs of swimming competitions for the Commonwealth Games held in Queensland in April 2018. As a partner to the Commonwealth Games, Griffith University encouraged students to submit assignments for course work that met various briefs provided by the Commonwealth Games committee, GOLDOC. That original project is visible at http://ebono.com.au/7155/ by selecting Week ten in the left hand menu.

The incorporation of two distinct visualisations required a good deal of thinking about the separation of each individual visualisation from the underlying framework provided to the user. That became a major focus of the development and the need for generalising the controls across visualisations for consistency.

3.3.5 Integrating the visual and the Metadex

To complete the process of exploring different prototypes in the Develop phase of the second diamond in the Double Diamond approach an attempt was made to integrate the diverging modes of operation. As part of this process the ability to make an initial selection defining the subset of content under examination was improved and the categories were sized based on the number of stories that used that category.

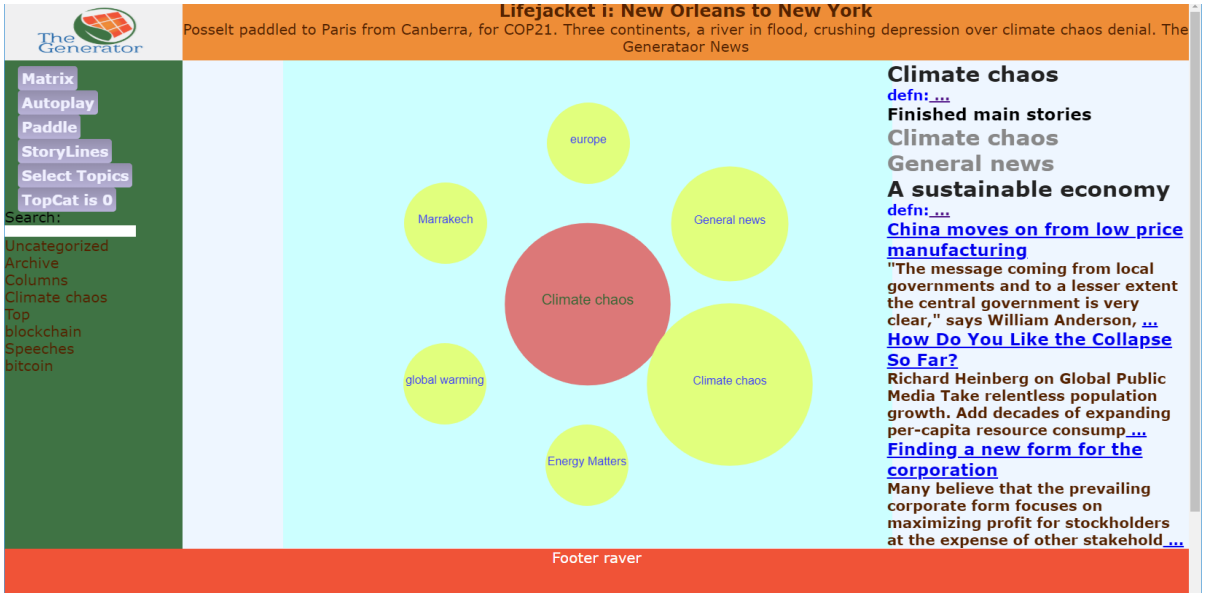


Figure 39 - Improvements to the categorisation interface did not help the integration

In Figure 37, previous page, the field of images is presented in the second panel, where the categories had been visually displayed in the earlier prototypes. It was quickly realised on demonstrating the interface and in discussion with mentors and industry experts that the images are content, equivalent to the posts in the earlier prototypes and belong in the visualisation panel, whereas the representation of categories is actually part of the selection process (the controls visible to the user as a pilot navigating the content) as shown in Figure 39, above. The initial selection from a list at left was also deemed to be equivalent to but different from the timeline provided by the slider from the Whale Hunt interface.

Those discussions also revealed that the interface was far from intuitive and failed to lead the user to an obvious conclusion and so the project needed to be narrowed down to a subset of the initial scope. There were two reasons for this. One reason was

to ensure the scope of the project was sufficiently contained to be delivered within the timeframe of the Masters degree. The other reason was to ensure that the final interface was relevant to the scope of the degree itself, that is to deliver Interactive Media as an artwork that could be exhibited. Given the complexities of integrating a drop down list and a slider, and creating equivalence between text based posts returned by AJAX and visual images retrieved by JavaScript it was decided to focus exclusively on the more recent visual prototypes.

This narrowing of the scope is consistent with the convergent nature of the delivery phase of the Double Diamond approach and so a revised brief for final development was created, focused on the polishing and presentation of the visualisation tools at the possible expense of the categorisation interface.

4 Future directions

This project is an investigation into the power of visualising metadata and its usefulness as a means of navigating content. The manipulation of a library of images is a very specific subset of content and this implementation is specifically focused on the appearance of the selection being made rather than the context or meaning of that selection.

This section of the exegesis explores a possible development path for expanding the current project to realise a greater part of the original intent. This is a gradual step by step path based on organic growth from the current project to the stated intention. A more effective path, should suitable investment be available, would involve a major study of the existing field and a serious examination of the most effective development path to implementing the core ideas into existing software.

This proposed path assumes that the creation of relatively simple storytelling tools may lead to widespread adoption and so prove the underlying power of metadata to a wider audience.

Future pathways might include integration into data visualisation frameworks like Voyant or D3, content management or representation frameworks such as WordPress, search and retrieval frameworks such as the Semantic Web. The approach outlined here broadens the scope one step at a time to provide a realistic pathway for future development.

The initial adoption of an Open Source model of software development maximises the chances of it going in multiple directions and achieving widespread use. The recent purchase of GitHub by Microsoft and the closure by Google of FreeBase which it purchased eight years ago are examples of the limitations of the Open Source approach as a means of keeping software “free”. It may therefore be desirable to partner with a major commercial or academic organisation to develop the framework in a proprietary mode. That decision requires significant consideration.

It is most likely, then, that PresentWP will be made Gutenberg ready, have a small number of additional visualisation tools added, go through initial user testing and interface refinement then be released as an Open Source product with commercial support. It is expected that an early upgrade of this tool will be as a mobile phone app, designed to build mobile phone friendly views of existing sites. Steps involved in this process include:

- Better separation of the administrator and end user functions will allow site owners to better control what users can and cannot do.
- The refinement of the API to allow developers to integrate their visualisations and toy makers to offer interfaces to their manufacturing systems will enhance the value of PresentWP to site owners and the development community at large.
- The capacity to use the visualisations created in PresentWP as widgets and Gutenberg blocks in addition to the current capacity to create WordPress pages.
- The system currently stores key/value tuples in the wp_postsmeta table which is not consistent with Gutenberg. Migration of the metadata storage to a

Gutenberg friendly structure will influence future development plans for the separation of the metadex.

The next steps would reintegrate the display of posts and images in the interface, allow content to be shared across sites and, then, across content management systems. An outline of what is involved in these steps is provided separately below.

The integration of posts and images into the PresentWP interface reposition the framework as a holistic storytelling tool. More important for the long term development of the project it also exposes the categorisation aspects of the metadex and the power of the interface to deal with categories. Steps involved in completing this process include:

- Determining the method of displaying posts that is consistent with or complementary to the field of images
- Determining the manner in which lists of topics, characters or other text based data are made equivalent to a slider representing a timeline, a range of hues, or aspect ratios.
- Refining the interaction between the use of the slider/list and the categorisation interface

The separation of the metadata to provide an index to the content allows a number of directions for development that are not possible without it. First the application can easily move to the client, with relatively minor synchronisation required on the client to update the metadex before commencing work on the application. This may be important for the development of the phone app. Second, the metadexes can then be aggregated to allow the next major phase to begin which is the creation of a tool that can navigate content from all participating sites, rather than simply one site. This steps involved in achieving this will probably include:

- a detailed analysis of Gutenberg storage of metadata for blocks
- Analysis of performance depending on client and server responses under various approaches.
- Research into current mobile application frameworks for WordPress and other tools

- That judgement will involve selection between WordPress compatible and CMS agnostic approaches

The aggregation of metadexes and the subsequent ability to navigate content from multiple sites is consistent with the work being done by Automattic with Wordpress.com.

An analysis of the search functions for WordPress.com and the REST API used by each WP site to communicate with WordPress.com

The implementation of a system for displaying the field of posts, in a similar way that PresentWP currently displays the field of images would go someway to addressing this. The exposure of the tags and categories used to organise posts along with the generation of metadata based on content analysis as demonstrated by Voyant would highlight and promote this to a much greater extent.

4.1 LabMap

LabMap is a specific application that makes use of the metadex architecture and the storytelling opportunties it delivers to navigate from a specific set of laboratory results into a rich knowledgebase. The intention of the application is to shift the focus of the user from a traffic light interpretation of lab results to a holistic understanding.

The holistic interpretation of lab results is a challenge for pathology, forensic, environmental and water testing laboratories. The integration of knowledge databases to support meaningful relationships between lab results requires the capacity for navigating complex metadata.

A proposal to apply metadex to link lab results to knowledge-bases has been developed and interest has been expressed by laboratory owners. The most likely investor is waiting to see market reaction to and support for PresentWP before they decide whether to proceed.

4.2 Beyond WordPress

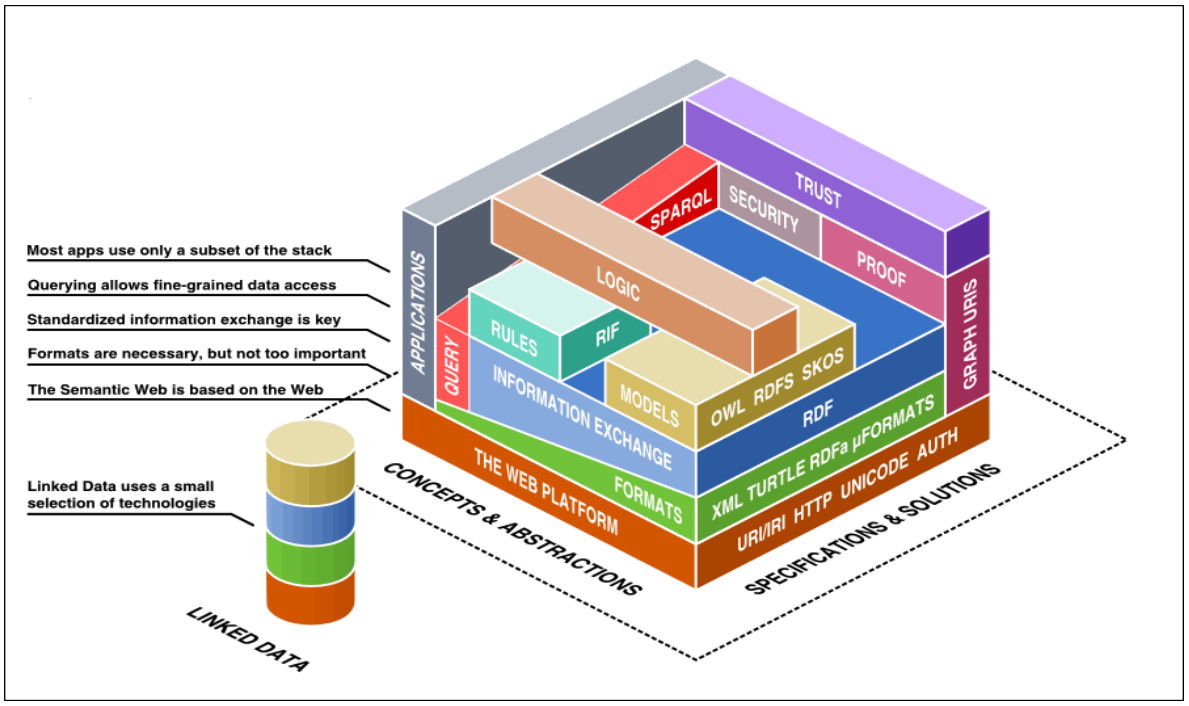


Figure 40 - The Semantic web stack only goes as high as application logic

The implementation of Semantic Web protocols to integrate the WordPress/Metadex ecosystem with the broader efforts of the Semantic Web development will enhance the usefulness and applicability of both Metadex and the Semantic Web. By integrating databases such as dBPedia and major news services already committed to the Semantic Web we see the potential to create a means of establishing credibility, verifiability and meaning in search and browse on the web.

4.3 Beyond the Web

Given that the vast majority of our content is now streamed and that it is increasingly visual and audible rather than text based, the published web is decreasingly important as a primary source of data. Extending the principles developed in WordPress and expanded to the Semantic Web into social media and streaming services offers a powerful system of organising content and integrating streams.

4.4 Verifiable, meaningful content

Metadex sets out to provide a system for organising the context of content such that it can be found, sourced and delivered. PresesntWP and its derivatives set out to provide an interface for visualising that context and discovering the content within it.

The use of blockchain as a means of maintaining the integrity of the provenance of data will become an increasingly integral part of any system and will provide a significant element of the backbone for the content management systems of the future.

5 Conclusion

The use of aggregated, distributed metadata as the basis of searching large knowledge bases has been an active area of research for decades, made more urgent by the invention and widespread adoption of the World Wide Web and formalised academically by the Semantic Web project launched by Tim Berners Lee. Metadex is an indexing system for web searches based on separable, distributed metadata and developed by the author in 1995.

PresentWP is a tool (or toy) for WordPress owners with visual content that lends itself to novel presentations. In its current form, the tool is simply proof of concept and requires further work to make it commercially viable. PresentWP represents, however, an example of a product that can be created using the metadata organisation principles outlined here and underpinning the earlier development of Metadex.

PresentWP is a very limited implementation of the original vision of a vehicular interface for the Semantic Web, or even the revised vision of a 2D version for WordPress metadata. Even so, it tests the theory that metadata extracted from existing sites can be used as the basis of a visual interface. In fact, the interface for storylines.thegenerator.com.au as shown in figures 37 and 39 is much closer to the original vision than the final project. The fact that the task list required to get that version of the prototype ready for presentation was too long for the available timeframe is an indication of the large scale of the original idea.

One of the major findings of this research is the vast scope of this field, the enormous amount of work already being undertaken in the area and the scale of the undertaking required to achieve the vision that emerged from the initial research. On the other hand, it reveals the diversity of the gaps in the existing work and so the opportunities to create new ways of navigating knowledge.

The forward plan presented here is an iterative path for organic growth from the current project toward the original vision. A far more effective path would involve the investment in a major survey of the semantic web, mobile app development for Wordpress and interface development tools in general, before embarking on any development at all.

Metadex is a metadata generation, storage and sharing protocol for providing a consistent layer of metadata for use by navigation and visualisation tools such as PresentWP. It is intended to link the rigorous but relatively shallow field of WordPress metadata to the richer but arcane information structure of the Semantic Web.

The original works created for this prototype and the new implementations of existing works may in themselves offer value to WordPress site owners and users. It is hoped that those works stand in their own right despite their genesis as components in a larger project.

It is also hoped that the underlying concepts of the Metadex and a visual navigation tool built upon it are of value in some areas of academic research and commercial software development. The author is certainly dedicated to furthering their development by whatever means are available.

6 Bibliography

Berners-Lee, T. and M. Fischetti (2001). Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web by Its Inventor, DIANE Publishing Company.

Brown, G. I. (2018). "New in the WordPress.com Business Plan: Jetpack Search." Retrieved 20/09/2018, 2018, from https://wordpress.com/read/blogs/3584907/posts/40675.

Budde, P. (2002). A decade of life with OzEmail. Sydney Morning Herald. Sydney Australia, Fairfax Media.

Card., S. K., et al. (1983). The Psychology of Human-Computer Interaction CRC Press.

Choudhury, N. (2014). "World wide web and its journey from web 1.0 to web 4.0." International Journal of Computer Science and Information Technologies **5**(6): 8096-8100.

Ga˘sevi´c, G. H. D. (2012). "Semantic Web User Interfaces: A Systematic Mapping Study and
Review." Semantic Web Journal **3**.

Ghoshal, I. (2017). "The Metadata Economy—The Future of Trusted Data Sharing." scribbleData. Retrieved 10/9/2018, 2018.

Google (2014, 18-10-2018). "Data Dumps: The Freebase API has been shut down." Retrieved 20-October-2018, 2018, from https://developers.google.com/freebase/.

Harris, J. (2007). "The Whale Hunt." Retrieved 12/05.2018, 2018, from http://thewhalehunt.org/statement.html.

Hennessy, K. (2008). "The Whale Hunt (Harris)." Museum Anthropology Review **2**(2): 134-135.

Her, J.-J. (2014). "An analytical framework for facilitating interactivity between participants and interactive artwork: case studies in MRT stations." Digital Creativity **25**: 12.

Kaptelinin, V., et al. (1999). "Methods & tools: The activity checklist: a tool for representing the “space” of context." interactions **6**(4): 27-39.

Koller, A. (2009). SKOS Thesaurus management based on linked data with PoolParty. Third annual European semantic technology conference, Vienna, Citeseer.

Laurel, B. (1997). "Interface agents: Metaphors with character." Human Values and the design of Computer Technology: 207-219.

Liu, X. and H. Ferhatosmanoğlu (2003). Efficient k-NN Search on Streaming Data Series, Berlin, Heidelberg, Springer Berlin Heidelberg.

Mateas, M. and A. Stern (2005). Structuring Content in the Façade Interactive Drama Architecture. AIIDE.

Nguer, E. M. and N. Spyratos (2008). A user-friendly interface for evaluating preference queries over tabular data. Proceedings of the 26th annual ACM international conference on Design of communication. Lisbon, Portugal, ACM**:** 33-42.

Park, E. and K. J. Kim (2014). "Driver acceptance of car navigation systems: integration of locational accuracy, processing speed, and service and display quality with technology acceptance model." Personal Ubiquitous Comput. **18**(3): 503-513.

Pollock, R. (2012, October 2013). "Javascript Timeline Libraries: A review." Retrieved 22 May 2018, 2018, from http://okfnlabs.org/blog/2012/12/04/javascript-timeline-libaries-a-review.html.

Recarte, M. A. and L. M. Nunes (2003). "Mental workload while driving: Effects on visual search, discrimination, and decision making." Journal of Experimental Psychology: Applied **9**(2): 119-137.

Rice, I. (2018). "Improved data visualisation through nonlinear dissimilarity modelling." Pattern Recognition **73**(Jan 2018): 12.

Rudomilov, I. and I. Jelínek (2011). Semantic P2P search engine. 2011 Federated Conference on Computer Science and Information Systems (FedCSIS).

Tanon, T. P., et al. (2016). From Freebase to Wikidata: The Great Migration, International World Wide Web Conferences Steering Committee 1419-1428.

Taylor, I. and S. Benford (1997). Exploration of the requirements in a visual interface to tabular data, Berlin, Heidelberg, Springer Berlin Heidelberg.

Upshall, M. (2014). "Text mining:Using search to provide solutions." Business Information Review **31**(2): 91-99.

W3Techs (2018, 10/09/2018). "World Wide Web Technology Surveys." Retrieved 10/09/2018, 2018.

7 Table of figures

Appendices

Appendix A: Metadata: navigation and visualisation

The fact that there is now a metadata economy presents striking evidence of metadata's value. Writing in scribbleData, Indrayudh Ghoshal separates " the 'data brokerage' industry, where companies exist to shadily collect consumer information and sell to any Johnny, the mashing of a company's data with public records and *symbiotic businesses buying and selling their data from and to each other"* to examine the economic implications of the latter. (Ghoshal 2017)

The value of metadata as an organising principle stems from their usefulness as a means of identifying a relevant subset of content without examining the content itself. It is thus faster and more efficient as a mechanism for searching and navigating content.

A key component of this project is the exploration of possible us of metadata as a means of enhancing or enabling navigation. In addition to its organising role, metadata can be used to establish the authority and the veracity of sources. By understanding where content is sourced and how it is filtered we can verify, or quantify, its reliability and its relevance to a particular enquiry.

The Semantic Web was established in 2000 by Tim Berners-Lee - the inventor of the World Wide Web - and set out to create a metadata-based catalogue for the World Wide Web. The Semantic Web is not the first attempt to create a framework based on metadata. It is also the basis of schemas such as the Dublin Core which is the basis of a range of Open Source software including the GNOME desktop. <citation needed>

Despite their long academic credentials and integration into many applications these metadata frameworks have failed to materialise as a commercial product or substantial component of major search tools. That partly seems due to the effort required to create the metadata itself. Mike Tung CEO of DiffBot notes, "a long line of

history (ranging from RDF/microformats/RSS/semantic markup) has shown that requiring human annotation is never going to scale in terms of economic incentive and accuracy to all of knowledge." (Anadiotis, George, 2018) DiffBot is an AI based web-crawler that crawls the web, automatically extracting Metadata from web-pages and enabling semantic queries. He made that comment while being interviewed by George Anadiotis of ZD-Net's *Big on Data* in August 2018.

A number of commercial tools have been developed based on Semantic Web principles but these are high level corporate tools and have not captured the public imagination. This includes the query language SPARQL , commercial applications such as Pool Party (Koller 2009) and academic explorations such as YACY (Rudomilov and Jelínek 2011). The most commercial of these is Pool Party, a corporate tool that requires significant planning and consultation to establish the metadata models required for implementation.

Figure 41 - Pool Party is a corporate tool built on Semantic Web protocols

Perhaps the most successful Semantic Web implementation was Freebase, purchased by Google in 2010 and switched off in October 2018. "Freebase [uses] the Metaweb Query Language (MQL) … designed to facilitate the creation of collaborative, Web-based data-oriented applications." (Bollacker, 2008).

App A.1 - Automating metadata generation

To interact meaningfully with the volume of information available to us, we must have a means of navigating it. That navigation system needs to respond intuitively to the character of the metadata which it reveals. "The use of automatic indexing tools, known also as text mining, or semantic content enrichment, has been for thirty years or more the subject of intense research and development," (Upshall 2014)

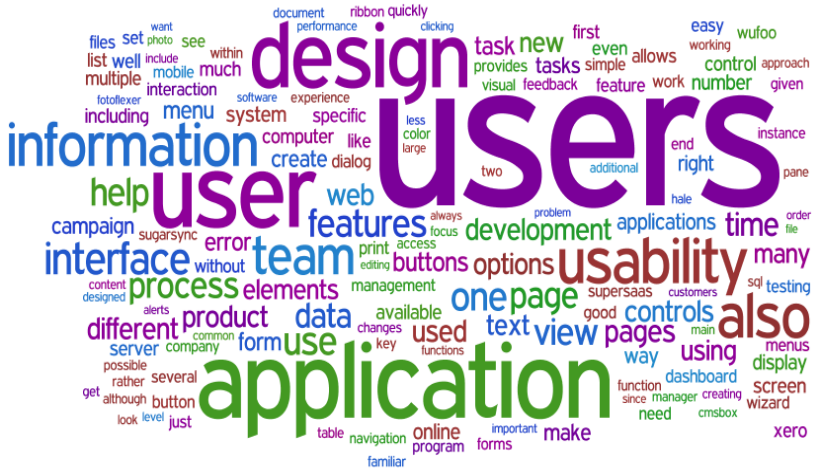


Figure 42 - WordCloud is a WordPress plugin based on the same principles as the Voyant visualisation

Because of the expertise, concentrated effort and time required to properly categorise data a range of semi-automated tools have emerged to analyse data and generate metadata specifically to enable content analysts to perceive patterns in content which may assist them in their analysis. DiffBot, mentioned above, is a web-scale example of such a tool, many others, though, are available for end users to apply to individual documents, websites or libraries.

The Voyant tool-set includes components such as the WordCloud that provide such tools for text content. In contrast, D3.js provides a variety of visualisation tools for visualising data generally. These toolkits and their contemporaries can be described as content analysis tools that generate metadata to assist in the visualisation and analysis of the data itself.

These approaches that generate metadata are complemented by AI that, for example, analyses images to identify faces and thereby allow the automated creation of links between visual content to create stories in your phone's gallery or to track people's movements in CCTV footage for security applications.

Independently of, and in contrast to, both the manual and automated categorisation approaches metadata generated by users as we traverse cyberspace has become an incredibly important commercial commodity, often gathered by offering free content and services to attract users. Our phones now use this type of metadata to examine what content interests us, to authenticate us and to determine our physical state.

App A.2 - Types of metadata used in this project

The field of metadata is therefore growing rapidly, is changing and evolving as it expands and is moving well beyond the categorisation role defined in Dublin Core, for example. This project specifically deals with the metadata used to organise content but is not limited to metadata that is created by humans for the purpose of categorisation (category, tag, visibility in the case of WordPress). One such type is generated by the system to store the content (date, filesize, author). A second, related, type is generated by an algorithm to assist in the sextraction of certain subsets of data (hue, aspect ratio, most common words - such as described by Voyant).

This project then uses that metadata to provide the user with the tools to select a subset of content and display that subset in one of the provided visualisations.

The tool examined in this exegesis, PresentWP, allows the end-user to create novel visualisations of the content in online databases and thus curate that content themselves. This specific challenge was identified as one aspect of the broader field that was sufficiently constrained so as to be able to be addressed within the framework of this Master's degree. Those constraints and the development path are discussed under Development of the Work, below.

Appendix B: Reasons for selecting WordPress

The second wave of research involved exploring ways that an interactive media project might employ the principles of using metadata that had been discovered in the first wave.

Figure 43 - The WordPress logo

An exploration of the tools developed to implement the Semantic Web revealed that the field was far too wide to get very far within an individual Masters project. Rather than tackling the problem of organising the entire web and constructing a framework for navigating the entire Semantic Web API, it was necessary to select a subset of the web that presented a limited range of problems.

The decision to use the WordPress content management system as both a source of content and a framework for the delivery of the visualisation was based on both ubiquity and rigour.

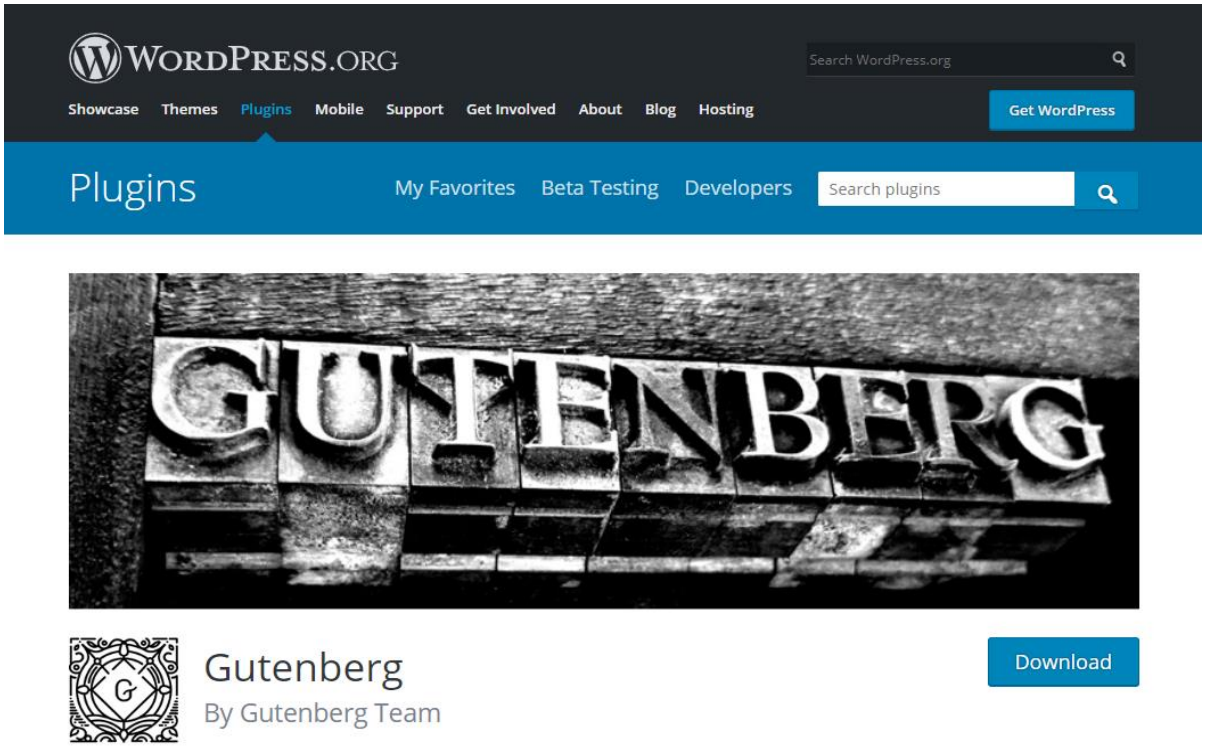


Figure 44 - WordPress is undergoing major structural change with Gutenberg

With 32% of the URLs on the public web being WordPress sites, it is by far the most popular and widespread content management system in use. That does not make it the source of the majority of content, as many sites (such as newspapers, encyclopaedia, government agencies for example) are much larger than most WordPress sites. Nevertheless, this huge variety of content sources, makes WordPress an attractive environment for exploring this concept.

In addition to the volume of content, the rigour of the WordPress development environment provides a consistent and accessible source of metadata that is able to be mined. While it does not employ the Semantic Web protocols used by specifically Semantic Web friendly sources of information such as dbPedia it is consistently

formatted so that it is possible to examine the metadata structures of any WordPress site without the engagement of the owner or a curator.

This underlying structure will undergo significant changes in 2019 with the introduction of Gutenberg as the new underlying structure for WordPress content . The version of PresentWP delivered with this exegesis predates Gutenberg and is compatible with Wordpress up to 4.9 (the current version at the time of submission). A development plan for Gutenberg compatibility has been prepared and will be undertaken before commercialising PresentWP. Significantly it separates the concept of a block of content from the concept of a page. That should enhance the flexibility savailable to utilise a PresentWP visualisation within a WordPress website. It requires, however, that the metadata is stored at the block level, rather than at the post level.

App B.1 - Existing visualisation and metadata generation tools for WordPress

Plugins such as InfoGram, Venngage, CM BlogCloud and its siblings generate metadata and visualise it in exactly the way described above under the heading *Automatically Generating Metadata*. While they offer specific outcomes to WordPress owners they lack any overarching framework or theory about the extended use of metadata. The ready availability of these tools offers the possibility of incorporating them within the proposed framework. Conversely, it also encouraged the choice of novel visualisations as the chosen field of endeavour for this project.

Ultimately the choice to focus on visualisations instead of a framework was influenced by the need to present the final work visually as an artwork, rather than conceptually as a back-end software application.

App B.2 Plugins, themes and front ends

The popularity of WordPress means there is a vibrant developer community engaged in development of the WordPress ecosystem. These include people working within the rigorously controlled WordPress environment and those that seek to extend it with

one eye on the “next big thing” that may replace WordPress as the major content repository on the web.

This includes layout frameworks such as BootStrap, page-builders such as Elementor and ecommerce engines such as WooCommerce (WordPress specific) and Magento (CMS independent).

Before defining the value proposition and hence design parameters of PresentWP it is important to examine these existing offerings. While a comprehensive study is beyond the scope of this project, it is important to develop an overview to determine where Metadex is likely to fit.

App B.3 - Wordpress development

At least as important as the third party developers are the tools and frameworks provided and planned by Automattic, the owners and developers of WordPress itself. Automattic’s major website, WordPress.com provides a centralised storehouse of tools and an integrated system for managing WordPress content. Recently the emergence of WordPress search as a tool for searching across participating WordPress sites indicates a vision on the part of Automattic to establish a centralised (or centrally visible) content repository.

Clearly, such ambitions are complementary or competitive to the notion of an independent distributed index such as Metadex. The history of software development is littered with great ideas that were pushed out of the way by less elegant solutions with market dominance. Right now, the page-builder Elementor is fighting a rearguard action to survive in the face of Automattic’s new core editor Gutenberg.
www.templatemonster.com/blog/elementor-gutenberg

It is clear then, that the development path of this project must incorporate and complement the core development path of WordPress rather than competing with it.

The JetPack toolkit is provided by Automattic to WordPress developers as a means of securing, backing up and analysing WordPress content and constitutes the gateway

between each WordPress site and the central WordPress.com services. Again, an examination of the operation of JetPack and its potential use as a delivery mechanism for publishing and sharing the Metadex is an important consideration of the overall project.

Discussion of this possibility with Automattic reveals that the starting point of development in this area is the REST API, with specific reference to the related_posts and wp_search modules of that API.

Appendix C: Structure of the work

The work is a single-page web application that is driven out of one php file. Metadex.php.

That page simply adds an HTML Canvas onto a standard Wordpress page in the content area.

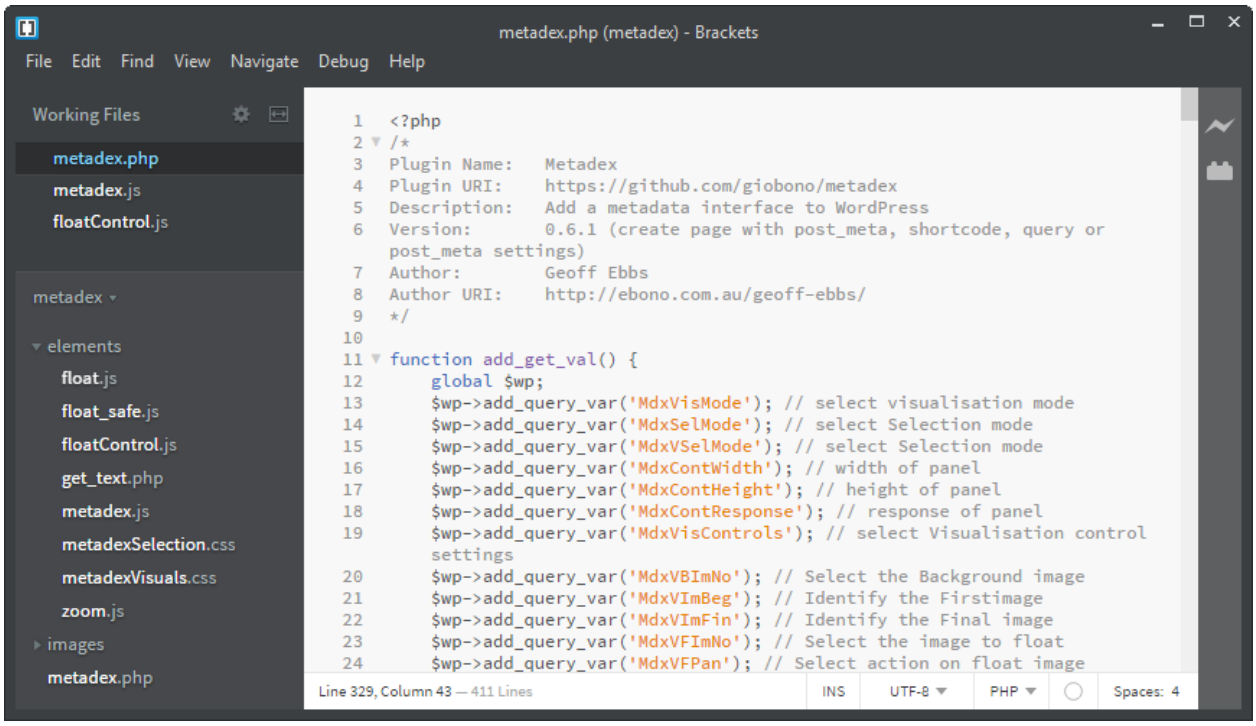


Figure 45 - Opening lines of metadex.php with file structure shown on left

The entire application is then run out of the JavaScript library (primarily metedex.js) until such time as the users wants to save the current configuration back to WordPress at which time the server is called and the page refreshed.

The files provided with this exegesis, and the minimum files that form the plugin are

/metadex.php

/elements/metadex.js

/elements/float.js

/elements/floatControl.js

/elements/metadexVisuals.css (formatting of the basic visualisations)

/elements/metadexSelection.css (formatting of the controls)

/images/<icons and controls>.png

Other files available on the GitHub site https://github.com/giobono/metadex are:

- zoom.js - JavaScript for viewing the zoomer visualisation
- getText.php - AJAX code for retrieving HTML of selected stories (see Storylines - below)

The internal structure of the code itself is explained in the internal documentation. The operation of the application has been described above. This section describes the on-screen layout of the application as well as the file and code structure and the conventions.

App C.1 Layout

PresentWP consists of a large visualisation canvas with some optional controls surrounding it. The control areas consist of a slider, the metadex, the visualisation

selector and the controls for each visualisation. If any of the controls are turned off then the system responsively expands the visualisation area to fill that space.

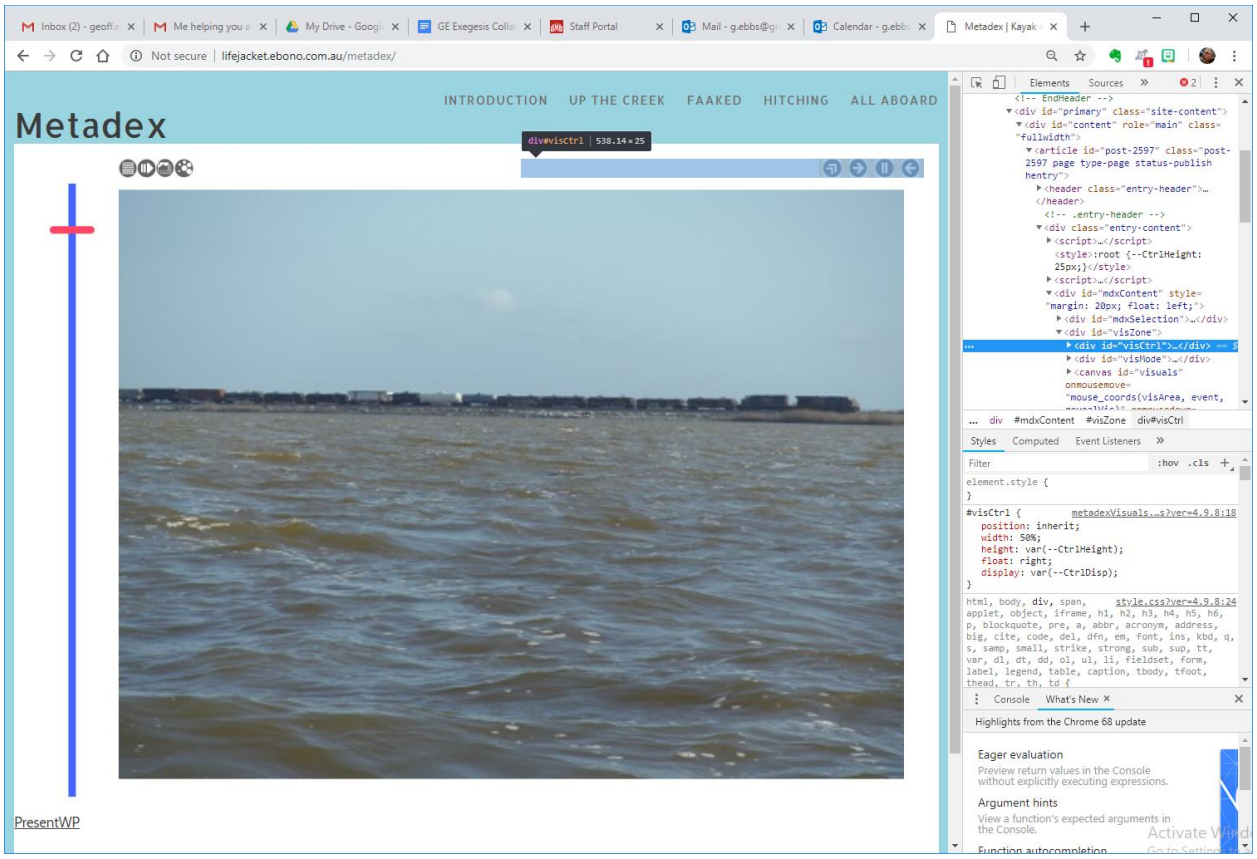


Figure 46 - Inspecting the tool with the VisCtrl div selected

The slider and visualisation canvas have been turned on, the metadex selector is off.The shape of the canvas generally is responsive to the device on which it is viewed and that responsiveness can be manipulated using variables set by the administrator.

Generally speaking the application occupies the entire area available in the wordpress content area, generally defined by a . This is a wordpress convention that allows the application to work within any WordPress theme.

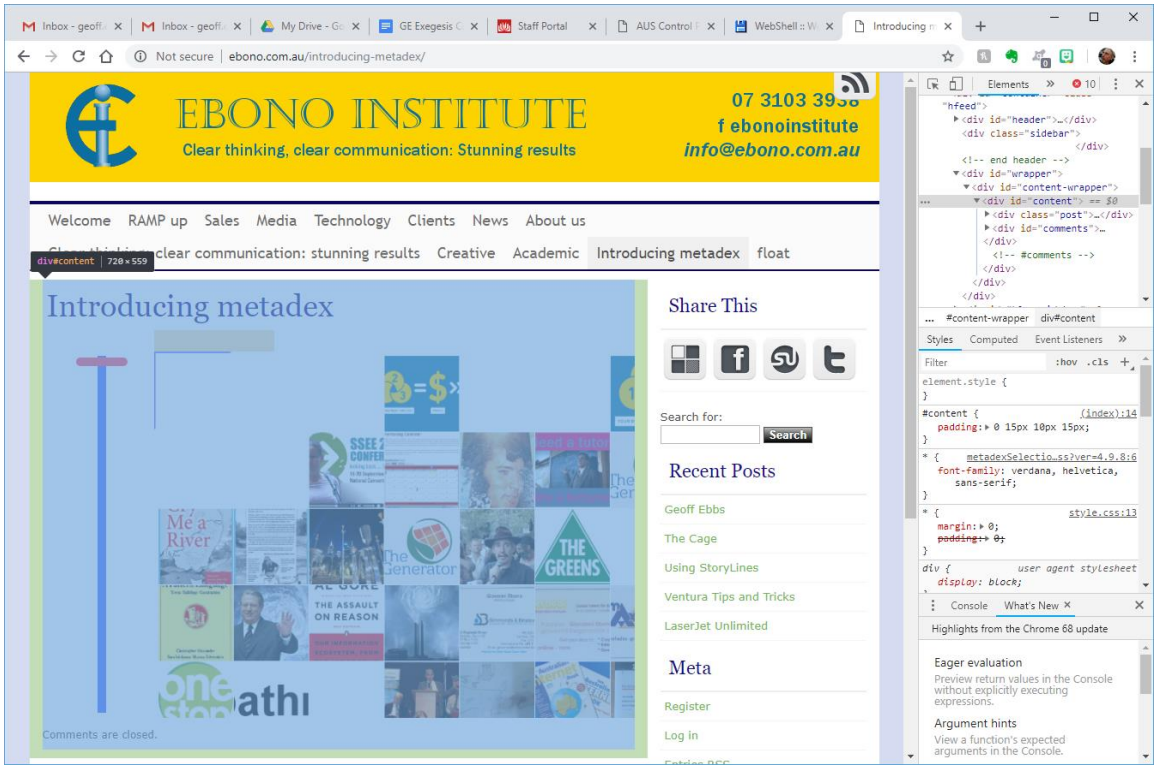


Figure 47 - The application responsively sizes the canvas to fill the available space

If the page is set to be responsive then the application will take the shape of the available onscreen area unless that forces it to go outside predetermined parameters. In that case the shape of the canvas will take on the shape defined by the administrator and the remainder of the content area will be occupied by the rest of the content on that page.

Figure 48 - The administrator has predetermined the shape of the canvas and so it responsively sizes itself and allows other content to flow beside the canvas.

Figure 49 - This shows the slider, visualisation selector and controls switched on in animation mode.

If **the slider** is switched on, it occupies a vertical slice one tenth the width of the available space. **The metadex**, when it is used, occupies three tenths of the available space. **The visualisation selector** takes the left half of a band at the top, one twentieth of the height of the available space. **The visualisation controls** take the right hand half of that same band.

The visualisation controls differ for each visualisation. The visualisation selector switches from one visualisation to another.

For those visualisations that give the user control over the visualisation the canvas becomes a formatting platform that allows the user to select images and segments of those images for display.

The format step in the float visualisation mode displays the background image selector box (red) the background segment (blue) foreground float zone (green) and the foreground float selector (yellow).

When an image selector is activated (by clicking on it) the box is highlighted and shaded and the current image is displayed centre screen. The slider is used (drag and drop) to display an image for selection.

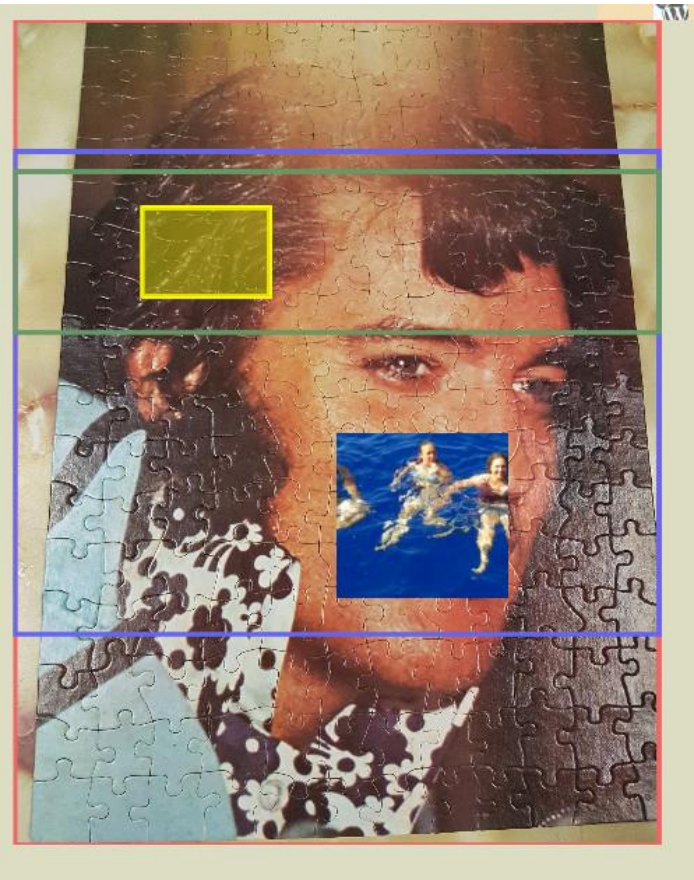


Figure 50 - The formatting step in the float visualisation shown in the process of selecting an image for the foreground (yellow box)

When a segment is being identified, the relevant box is highlighted when selected and moved (drag and drop) to the required location.

After each selection has been made, the application returns to the visualisation itself to display the impact of the selection.

In the current implementation, those items that have not yet been built into the front end interface can be edited using the custom fields of the WordPress page.

These values can also be overwritten by typing values into the URL. For example the slider can be revealed on any page by adding ?MdxSelMode=on to the end of the URL. The security implications of that mean that it will be turned off for any commercial release of the application.

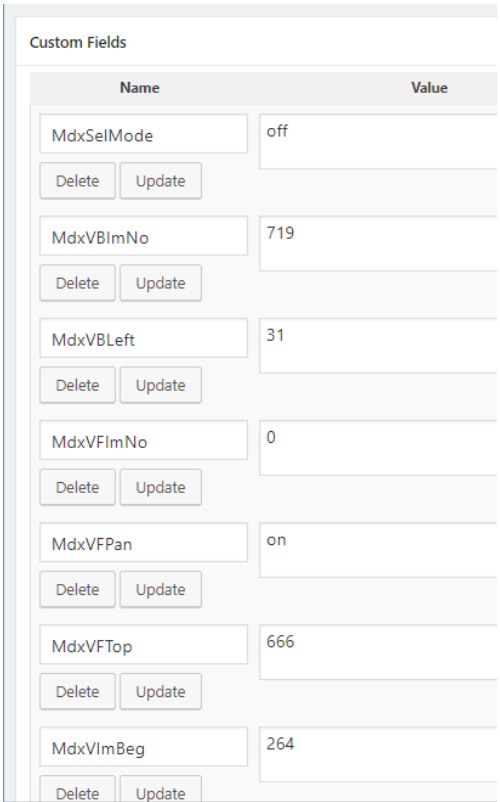


Figure 51 - The name value pairs used by the JavaScript application to store values in WordPress for correctly initiating the display on loading the page

App C.2 File and Code Structure

As a one page application, there is one file (metadex.php) that is placed in the wordpress/wp-

content/plugins/metadex folder that performs all of the WordPress operations to set up the page. Plugin installation functions, generation of background metadata required for future visualisations and other activities not directly related to the operation of the application will be broken out into separate files.

The JavaScript and css for the application are stored in a sub-directory called elements.

The files metadex.js and metadexVisuals.css contain the code required to run the basic visualisations and set up the API for individual visualisations. This is designed to be the "PresentWP lite" application which allows viewing of pages that have been created.

Currently the only other files are:

- metadexSelection.css - formatting for the controls
- float.js - JavaScript for viewing the float visualisation
- floatControl.js - JavaScript for the formatting step of the float visualisation
- zoom.js - JavaScript for viewing the zoomer visualisation
- getText.php - AJAX code for retrieving HTML of selected stories (see Storylines - below)

App C.2.1 – Metadex.php

While metadex.php "simply" adds a canvas to the standard wordpress page it has become quite long to accommodate the preparation required on first accessing the page and in the event that the settings made by the end user are saved to WordPress.

Most of this additional code is involved in reading external variables from WordPress or the URL to determine the settings to apply when initialising the application.

Another significant slice of code reads the screen dimensions and dimensions of the so the appropriate size of the canvas can be calculated. These calculated variables must be synchronised across PHP, JavaScript and CSS and so cannot be isolated to one single block of code. CSS variables are used to pass the values into the CSS file and a generated block of JavaScript code captures the calculated variables for use on the canvas.

There is a small section of code that reads the image thumbnails required to set up the Document Object Model to form the HTML page. This has additional code for dealing with those images that do not have thumbnails stored on the WordPress server.

The controls to select visualisation mode and control the displayed visualisation are presented in the DOM and so declared in metadex.php although they are controlled from metadex.js

App C.2.2 - Metadex.js

This is the code that does most of the work in driving the application

The internal functions break down into three main sections

1. the management of the state of the application
2. the operation of, and response to, the mouse
3. The presentation of images on the canvas

The **state management functions** track which visualisation is currently employed, set its initial state, establish the appropriate response to mouse actions and communicate with the DOM.

function selectCtrl(thisCtrl), for example, is called when the mouse is clicked on one of the control positions. The mouse passes in a number (thisCtrl). Depending which visualisation is currently displayed (VisMode) and which control position has been clicked, function selectCtrl calls the relevant routine. For example the fourth visualisation control in the animation mode speeds up the animation by adjusting the interframe delay.

DispDelay = DispDelay/2;

That routine enacts the mouse clicks. It is the practical opposite of function SetVCtrl which sets them up.

Function setVCtrl(rhisMode) writes to the DOM to display the button that the user will click. To place the speed up button in the fourth control position when displaying an

animation visualisation, function setVCtrl writes the HTML to display the image SpeedCtrl.png into the DOM element VC4.

109 document.getElementById("vC4").innerHTML = "<img src='" + document.getElementById("speedCtrl").src + "' height='" + CtrlHeight + "' width='" + CtrlHeight + "' alt='Speed Up' title='Speed up the animation'>";

The **mouse response functions** are driven by `function mouse_coords(c, e, doFunc)` which reads the current position of the mouse on the canvas and then passes control to `doFunc(mouse_pos)`.

This means that the system is constantly responsive to mouse movement, the position of the mouse and the canvas over which it is moving. The function currently named in the variable `doFunc` is passed the current contents of the variable `doFunc`. For the main visualisation canvas, the function `revealVis` in metadex.js takes care of this step. The "state" of the canvas is also a factor in the response to the mouse and is dealt with in detail below.

The **image display functions** fall into two groups, those that manipulate the image array and those that manipulate the image itself. In most cases the mouse action will call a routine (sending the mouse position) that manipulates the image array depending on the position which will then in turn call a similarly named routine that manipulates the image itself.

This pattern allows routines to directly manipulate an image (if the image is known) or if only the number of the image is known the application can o to the image array to retrieve the image itself before passing control to the function that will manipulate it.

Thus the field of images is driven by the `function revealImage(mpt)` which is a two line function that a/ lays down the field of images and b/ displays the full thumbnail for the image under the mouse by calling the image to redraw the image after identifying which image it is.

456 redrawImage(detectImage(mpt));

In this case `redrawImage(imNo)` is a function that manipulates an image based on the number passed to it. The function `detectImage(mousePos)` returns an image number based on the position of the mouse. The function `redrawImage(imNo)` retrieves the image from the image array and then redraws it at a position on the screen determined by the Visualisation mode that has been selected and the current mouse position. So, in the field of images <`MdxVisMode = 'matrix'`> the thumbnail is redrawn under the mouse (and influenced by the proximity of the edges of the canvas), where as in the format view of the float visualisation <`MdxVisMode='float'`> and <`MdxVCMode = 'format';`> the thumbnail is positioned centre screen.

Recording **the "state" of the canvas** allows the development of more sophisticated functions that involve multiple steps. In the example above, `MdxVCMode = 'format'` indicates that he format features of the float visualisation are active. As it happens this is a sophisticated function and so the state of the canvas is taken into account to determine whether the mouse is "identifying", "moving" or "selecting" an image or image segment.

The file floatControl.js uses a major function `formatFloat(mP, mode)` to manage this process. That function identifies what 'zone' the mouse is in and then based on the existing state of the canvas and the current mouse function what action should be taken. MdXVCMode is used to determine what operation we are performing and the variable 'mode' is used to determine what step of that operation we are up to. So "clicking" in the red box that identifies the background image switches MdxVCMode to "FBSelect". While we are in that mode the system is only responsive to the slider for the selection of an image unless someone clicks on the canvas and goes back to the general operation <`MdxVCMode = 'format'`> and <`mode='reveal'`>

These are descriptive examples of the 1179 lines of JavaScript that make up the canvas manipulation functions. A full list of functions their parameters and operation appears in the appendix. The detailed operation of each of these functions is described in the code itself.

To assist developers in navigating the code an overview of some of the conventions may be helpful.

App C.3 Conventions

This section describes the naming conventions used within the code for PresentWP

Global Variables are CamelCase with inital cap.
local Variables are camelCase with no initial cap.
local functions are camelCase() with no initial cap
functions are prefixed by the js file in which they belong: Mdx, MdxV etc

Metadex.js is the high level support tools that provide the framework for the Metadex library
And the prefix for components in this file is Mdx
is called by mdxVisualisation.js library -- MdxV -- for visualisation of content
is called by mdxSelection.js -- MdxS -- for selection of content
is called by various visualisations eg float.js -- MdxVF for float visualisation
... and thus floatControl.js -- MdxVFc -- for control of float settings

Metadex Visualisation library loads images into the DOM object as im1 -- im<NumImages>

i.e. Metadex data is built in the client from information based on a download from wordpress posts and postMeta tables. In the long term the metadex will be built and maintained on the server (or an aggregator) and downloaded directly instead of calculated and extracted on initial page load.

The DOM object is set up in PHP after content is loaded - this localises naming of canvases etc

Appendix D: Detailed research into the interface - Timelines

The second version of the dirty prototype provided a basic timeline that indicated what image or item was under the mouse. That item would then become active when clicked. This behaviour was adopted from The Whale Hunt.

Because it is the requirement of an information navigation system that we can filter by selecting ranges of data, the selection of a single item is only a small part of the puzzle.

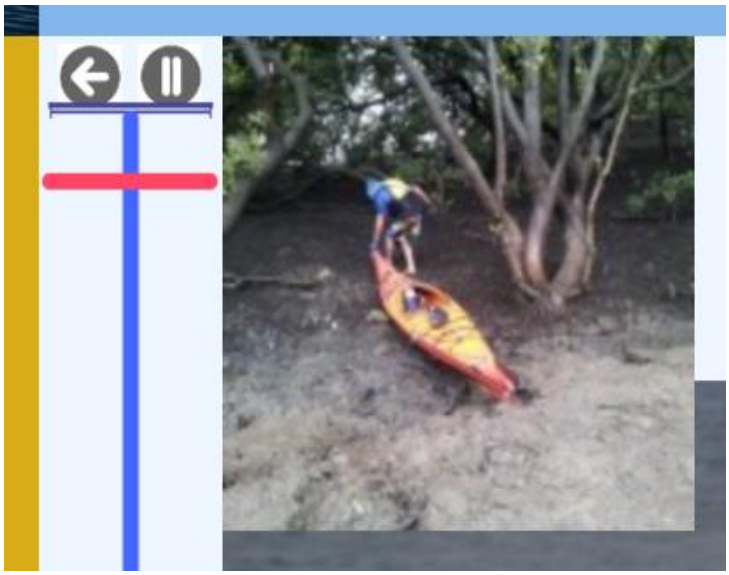


Figure 52 - The slider as an animation control

The requirement to adjust the range of the timeline as well as the image, led to the addition of selectors at the top and bottom of the timeline which required much more complex analysis of the mouse position, the storage of states and so on.

To avoid the timeline becoming a major development project distracting from the overall project and it was decided to carry out a literature and context review into timeline libraries using JavaScript.

This relatively simple component, thus became the test bed to define and refine the research approach.

1. Prototyping defines a requirement.
2. A context review refines the requirement and suggests solutions
3. A literature review explores the available solutions and means of achieving them
4. Usability studies determines the efficacy of available solutions
5. The data analysis suggests an approach
6. Prototyping implements the results and the cycle starts again … or moves onto the next component.

AppD.1 Currency charts

The selection of a date within the available data is live (mousover) and responds with useful information (date and closing price as subtitle - reflecting the dot at the peak in chart 1). The selection of the range is via external buttons. The range in chart 1 is one year. Note the capacity to arbitarily adjust the range using the slider at the bottom in chart 2.

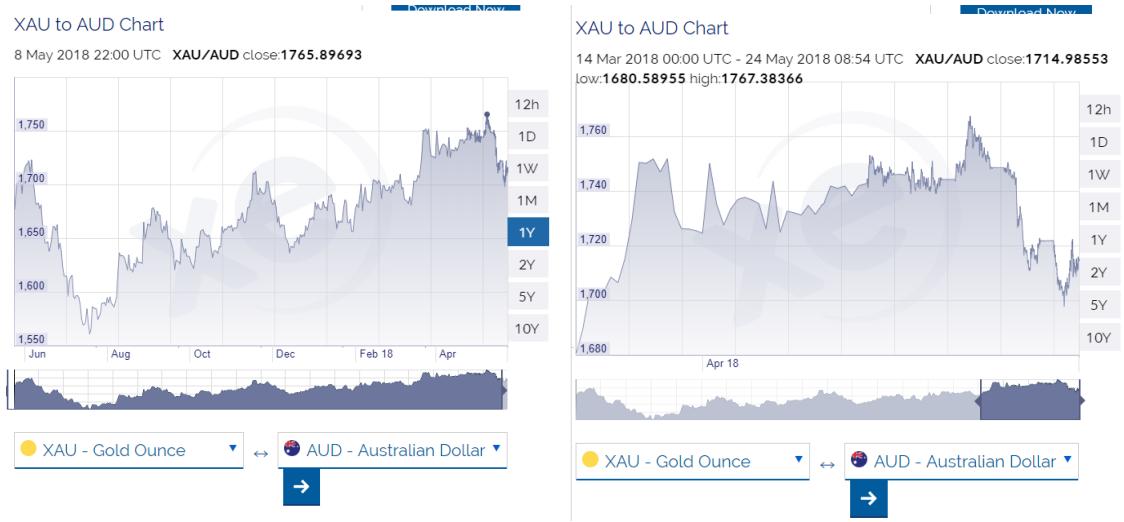


Figure 53 - Sliders to select a subset of data are common

AppD.2 Timeline libraries

Ray Pollock wrote a review of JavaScript timeline libraries in 2012. His major finding was that they are too complex and not modular enough.

I want to start with a general comment. Timeline libraries consist of various components:

- Data loading
- Date parsing
- Band (timeline) rendering
- Showing render info on individual items

For me a timeline visualization library need only be the second of these but most that I've come across do more.

In fact a major issue in my opinion with most libraries is that they are *under-componentized* - they don't separate cleanly into these different components and end up doing everything.

To take one example, the Verite timeline (in my view is one of the best libraries out there) has a whole bunch of its own custom date parsing built in inside an internal utility library which are hard to override or replace and also has a large chunk of code just for loading from google docs and other data sources. (You can of course somewhat solve this somewhat – as I do in Recline by parsing the dates directly and then submitting in a standardized form).

In my view, even if library authors do want to include these sorts of things, it would be good to do it in a way that allowed for a clean separation so that you could just use the parts you wanted (and/or over-ride parts more cleanly). (Pollock 2012)

AppD.3 Chronoline.js

One of the lines reviewed by Pollock that appeared to have potential for this project is chronoline.js

Hovering over datapoints depicted on this timeline reveals useful data, indicating that making them into live links is trivial.

There appear to be no controls to adjust the scale (ie size of the range) though the line can be slid using the controls left and right that appear when you hover over the timeline.

Like most of the timelines reviewed by Pollock this is more concerned with data representation than

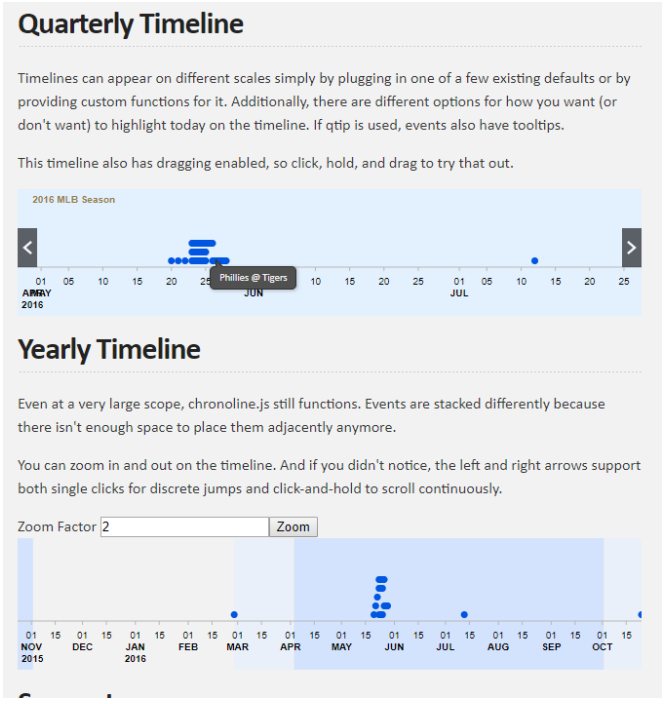


Figure 54 - Timeline scales can have embedded intelligence

navigation. The gap between the existing operation of the component and the requirement, combined with the observation that the components lack modularity determined that alternative approaches be sought.

AppD.4 HTML 5 video players.

Given the relative simplicity of the basic requirement and the common appearance of HTML5 video it was decided to review the available code libraries.

While there are a large number of HTML5 video players, they concentrate on interacting with a video file, not providing a framework for a series of still images. In the long term it may be worth separating the interface from one of these players from the file control but it is a small component of the overall project and so was deemed out of scope for this report.

Appendix E: The Development of Metadex

AppE.1 - A word on naming

Before describing the structure of the application it is important to explain the naming of the files. Although the application is named **PresentWP** and featured at PresentWP.com most of the files and technical references refer to **Metadex**.

The reason for this is that PresentWP is the first experimental step to test the viability of a visual interface for navigating large content repositories by metadata. That approach was first explored by this researcher in the 1990s as a means of organising and delivering content across the web using a pioneering content management system, Proton.

The prototyping carried out as part of this research created two divergent tools, one focusing on the categorisation of text based posts, the other on visualisations of images. In the end the name PresentWP was chosen for the visual tool and it was decided to focus on polishing that and delivering it as the final work for this project. Despite this it remains part of the overall Metadex toolkit as described in future development below.

An additional consideration was the amount of time and effort involved in renaming filenames, global variables and prefixes of all variables. An earlier experience of changing the name from Storylines to Metadex indicated that there was insufficient time to undertake a second name change in the final month before presentation.

It was also apparent that metadex domain names were already well established and so the name and brand PresentWP was developed.

That earlier experience involved a transition from the original name **Storylines** based on the larger aim of creating a framework for digital storytelling. Early versions of the application (including http://storylines.ebono.com) use that name for the plugin (then a JavaScript front end accessing WordPress databases but bypassing WordPress itself.)

This occurred in the second phase of development, after the initial research and the

Figure 55 - Cover image from **http://storyline.ebono.com.au**

first prototype had been completed and I was narrowing the scope of the project.

At that stage I decided to focus on the indexing of metadata as a subset of the more general problem of creating a framework for digital storytelling and as a useful

addition to the broader Semantic Web research. There was also a copyright issue as I had actually developed a (now defunct) site for Storlines in Alice Springs.

The process of renaming the entire code base from Storylines to Metadex took over one week and it was many weeks before all the bugs and references to Storylines were removed.

Given that earlier experience that revealed the effort involved in a fundamental renaming, the name Metadex has been retained at a technical level for the purpose of submitting this work in time and so I could focus on polishing and presenting the work as it is.

AppE.2 - Metadex overview

AppE.2.1 – Metadex background

Metadex is a system for indexing metadata as a means of organising distributed content. It was initially developed in 1995 and was the basis of a content management system (Proton) delivered to publishers and industry organisations. The first online newsletter editable over the web in Australia was launched by IDG Communications in 1996 using Metadex. The magazines ComputerWorld, PC World, MacWorld and Family PC used the system from 1996 until they switched to the system used by the parent company in the US. The regulatory body of the Australian Communications industry (then ACIF) used Proton/Metadex to manage their documents, meetings and conferences from 1998 until ACIF was replaced by http://www.commsalliance.com.au/ in 2006.

Metadex development. I developed Metadex based on my experience with converting Census data from n-dimensional, sparsely populated datasets into datasets usable by statisticians, research into early search engines and non-tabular databases. I was acutely aware of the limits of text searching as a means of navigating the, then nascent, web and the need to provide a categorisation framework that did not require librarian style skills to implement.

Metadex was the driving force and basis for an early content management system built initially in (UConstruct an in-house scripting language based on Perl then C##) , Cold Fusion and Microsoft ASP. When Cold Fusion appeared we dropped our own scripting language and launched the content management system Proton, which was re-coded as Mambo (without the Metadex) and then later forked to become Joomla. The code base for Joomla was rewritten in Joomla 2.0 though the data structures remained largely the same. A patent for Metadex was applied for in 1999 but did not proceed as the company collapsed in the dot com crash of 2000.

AppE.2.2 – Organisation of the Metadex

The implementation of Metadex in the content management system Proton addressed the needs for both hierarchical and independent categories by use of a sparsely populated, n-dimensional matrix. A data dictionary defined the role of each dimension in relationship to other dimensions.

The system provided for three types of metadata.

Primary metadata was common to all entries and was used to define the field of content visible to a given user prior to browsing. Thus security, censorship rating, visibility and domain are available to an application accessing the metadata as a primary consideration and only that content relevant and appropriate to the user are included in any lower level searches.

The primary metadata was used to control access to content and set user roles. The settings of the user were binary ANDed with the settings of the content to filter the content and establish the environment in which the user operated. These were not visible to the user and so do not clutter the interface or allow the user to hack into the backend of the application.

The primary metadata included the following: In this list those entries that are dimensions of the sparsely populated matrix are described as (a dimension …)

- Url: The actual address of the item within a domain

- Domain: The URL of the site (in most applications but conceptually could be varied)
- Creation date:
- Type: The type of content eg company, person, event, file, text, image, movie, meeting (a dimension …)
- Owner: email address (but could be a unique id in a system such as facebook)
- Security level: Intended access to the content in the domain (a dimension …)
- Visibilty: The intended reach of the owner for the content (a dimension …)
- Rating: The censorship level of the content (a dimension …)
- Location: latitude and longitude (but could be other locator in different applications)

Type metadata: This is generally metadata extracted from the content and accessible to the metadex to assist the user. The start and end date of an event, for example, is important at the browse level and needs to be visible in an aggregated view of the data.

This data needs to be exposed to the user so they can select the subset that interests them. Once the user makes that selection then the selection needs to be removed from the browse function but remain accessible for the user to edit. On the other hand, if the administrator has restricted the field of data that selection would appear as primary metadata and be invisible to the end user. This allows applications to expose only the relevant categories.

So, for example, in an application managing events, only events would appear in the application and start date would be an initial selection field - see below. Once the user selects a range of start dates that interest them, the field of content visible to them is restricted to that subset.

Categorisation metadata: This is the most complex field of metadata to organise (especially in applications that aggregate content across sites) and has a number of layers.

Within any given field of data, some categories may be hierarchical and others may be independent. Proton exposed the top level category for each independent set of categories and allowed the user to drill down within the hierarchy for that set. So, for example, the document management and workflow application developed for ACIF, allowed the user to see all documents relating to any of the subcommittees of which they were members, but then select an individual sub-committee if that was a filter they wished to apply. Independently of that they could select the document type they were interested in for example, forthcoming meetings, meeting minutes, documents requiring their approval and so on. The administrator could therefore expose a user to all meetings, documents or notices that required their attention upon logging in and then allow them to broaden or narrow their view from that point.

Aggregate applications, such as those collating material across different magazines for a publisher, require a means of organising different categorisation schema. To this end, Proton used a local thesaurus to map categories. The user could then select a category using any english word and the thesaurus would collect those categories synonymous with those words and expose content in those categories as a result of that selection.

At the time that development stopped, work was being undertaken on a universal thesaurus to provide greater aggregation but that is a major project that was not completed.

AppE.2.3 – Relationship of PresentWP to Metadex

The DNA column represents the initial selection criteria. The strands of the DNA represent different selection criteria that may be selected as the main organising principle. In the case of an application to reveal items from a pathology knowledge base, the initial selector is the pathology parameter being examined. It could equally well be a symptom or a nutritional element.

The primary selection has already been determined by the application. Thus doctors may see different options to nutritionists, patients or staff. The primary selection is not visible to the user while using the interface.

The hexagonal blocks represent the categorisation metadata. In this case the hexagons represent related parameters or factors influencing the pathology result. So, for example, when examining the knowledge base for articles relating to an Iron result, the available categories include Liver test results, which should be read in conjunction with the results of the iron test to ensure a proper interpretation.

The images displayed on the globe depicted at the right of the screen represent the articles available for that particular view of the knowledge base. The image of Rachel Arthur on the globe indicates that the Universe of data currently selected is those articles provided by Rachel Arthur Nutrition (a preselected subset of the knowledge base that may or may not be editable by the end user)

To test the viability of this approach a small Wordpress site was created containing a small set of articles categorised by the parameters suggested by the client. That is discussed in the next section.