

Digital Presence of the Edwin Morgan Scrapbooks: Exploration and Development

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DECLARATION

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(Akmal Rizki Putra)

ABSTRACT

This document serves as a dissertation report of an MSc Design Informatics project. The project aims at the development of a prototype that gives a digital presence of an archive; Edwin Morgan Scrapbooks. In addition to this objective, we also stress on the exploration processes that happen during the project.

The final prototype is an interactive data visualisation in a 3D environment based on eight scanned pages from the collections. Accessed through a web browser, this prototype is designed to accommodate the user in exploring the dataset. We conduct several evaluation sessions based on the think-aloud protocol to assess the prototype. While it achieves the objectives, we find that the usability score is inadequate.

The processes include exploration using Computer Vision techniques to create an alternative artistic representation of the clippings and Eye Tracking Experiments to compare different gaze behaviours on the original images with the renderings—line detection and colour circles, as well as detailed cropped images.

We find that the line detection and colour renderings play complementary roles in term of dwell time and the number of fixations. The fixation maps show that the line renderings resemble the originals while the colour circles yield different hot spots.

The detailed cropped images do provide new information to the participants, as they spend significantly longer on the detailed ones compared to their respective Interest Areas.

Keywords: *Edwin Morgan, scrapbooks, data visualisation, colour extraction, eye tracking*

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CHAPTER I INTRODUCTION

1.1 Motivation

Have you seen Edwin Morgan Scrapbooks?

Unless you are in English or Scottish Literature, chances are you have never even *heard* of it.

Edwin Morgan is one of the most highly esteemed Modern Scottish Poets. However, besides poems, his works have a very wide range of the literature spectrum. He is also appreciated for his varying interests in social, politics, and science and technology; not to mention his sense of humour. While based in Glasgow, he loves to travel places and write about them.

His scrapbooks, now preserved at the University of Glasgow Library, are his autobiography, sources of subjective historical records, and insights to his views of the world. There is a cultural and artistic richness of these special collections, and there is always something for anyone inside. The downside is that they are books—old, analogue scriptures.

On the other hand, today's authoritative digital culture diminishes even further the chance that you know the existence of the scrapbooks and like archives—unless they are somewhat represented online. This is where this project originally comes in; to explore the options in developing an online representation of Edwin Morgan Scrapbooks.

More specifically, we are interested in exploring the principles, techniques, and technologies that can assist in this project. In the long term, we would like to look at applying them to similar problems.

1.2 Objectives

Our primary objective is to develop a prototype that digitally represents a subset of the scrapbooks. In addition, we aim that this prototype will induce users to be interested in the real scrapbooks—thus successfully giving them a digital presence. We approach this using data visualisation discipline as the primary framework. Computer Vision and Eye Tracking Experiments serve as tools that help us explore the problem and provide options to include in the proposed solution.

Due to the complex domain problem, the project proceeds in a more exploratory and prototypical manner. To this end, our secondary objective is to explore the problem and options and gather as much insight as possible as valuable inputs for future related projects.

1.3 Challenges

Digitisation of scrapbooks has been a challenging problem due to the complexity of the contents and the materiality, as well as external problems such as copyright. In this project, we explore the contents using Computer Vision and Eye Tracking Experiments. We also have gathered some descriptive metadata associated to the clippings as an attempt to provide alternative information that is free of copyright.

Data visualisation is a multidisciplinary topic that requires an understanding of related topics, such as visual design, statistics, and programming. However, we are not specifically trained in data visualisation. This inflicts a new challenge in that we need to learn to combine the different disciplines to develop a successful artefact.

1.4 Outline

This document is structured into six chapters. These are:

- 1) Introduction. This chapter introduces the motivation, objectives, and challenges of the project. This chapter also outlines the structure of this document.
- 2) Context and Background. This chapter describes the general and specific problems discussed, disciplines that are used, methodology, and insightful related works.
- 3) Design and Implementation. This chapter explains the explorations of the domain problem, data visualisation, and computer vision. It also describes the development of the prototypes.
- 4) Evaluation. This chapter describes the evaluation of the prototypes.
- 5) Eye Tracking Experiment. This chapter explains the eye tracking experiments on the scrapbook pages and the results obtained.
- 6) Discussion and Conclusion. This chapter reflects on our processes, explains future works, and concludes the report.

CHAPTER II

CONTEXT AND BACKGROUND

In this chapter, we present literature regarding the general and specific problem domains, as well as techniques and disciplines that we have considered throughout the project. We also present the design methodologies in use and several projects in the past that have inspired our design decisions.

2.1 Digital Presence of Scrapbooks as An Archive

In its traditional meaning, an archive is a collection of documents of rare or historical importance or the location they are preserved (Web.archive.org, 2017). Consequently, access to archived collections is more restrictive and publicity is much less compared to other kinds of collections.

However, as the technology advances, some of these special collections may have a digital representation—or at least, presence—as well. Project Gutenberg, started by Michael Hart in 1971 (Hart, 1971) is an example of a digital archive aiming to provide electronic access to books through the internet.

Nowadays, where digital content creation is overflowing, digital archives where the contents are originally and/or mostly in digital format have also flourished (Gilster and Gilster, 1997). Internet Archive is an example of this type of archive, providing access to free books and e-books, movies, software, music, websites, and others (Archive.org, 2017).

However, not all forms of traditional archives can be easily digitised. Scrapbooks, due to their complex materiality is especially difficult to digitise. Merely delivering the scanned pages of the scrapbooks such as in Heritage Scrapbooks (Crstudio.org, 2017) will diminish this special quality of scrapbooks.

Scrapbooking has been a very common practice throughout cultures and eras (Kaulbach and MacKay, 2006); even though its technicalities have shifted along with the advance of Information Technology (e.g. (Good, 2013), (D'Amore, 2016)). It is utilised both as a pastime hobby and a way of subjectively documenting one's life, with the intention to share the artefact with others.

Accommodating different materials—papers, photographs, and other ephemera—and extremely flexible in layout, thus wealthy in historical and biographical values, scrapbooks are in itself a form of an archive. Additionally, some items affixed to the pages of scrapbooks are there due to their rarity, which, even if it is subjective to the authors, can offer insight to the surrounding cultural and historical contexts. Thus, scrapbooks as archives suggest as one of essential research resources.

Unfortunately, the richness in materials contained in scrapbook makes it challenging to transfer them into digital media with a comparable level of complexity. Flatten pages found in published scrapbooks might, in fact, maintain nothing more than its visual values.

However, it is possible to mine rich data from scrapbook clippings, the way it is performed on other kinds of archives; through metadata. While not exclusively looking at digitising

scrapbooks, projects such as Bohemian Bookshelf (Thudt, Hinrichs, and Carpendale, 2012) and Past Vision (Glinka et al, 2016) is looking at utilising metadata of the archives to present an alternative digital representation. As opposed to trying to substitute the archives digitally, these projects present complementary artefacts that firstly entice public interest to then ultimately enrich the interaction as a whole.

2.1.1 Uninitiated Users

This project specifically aims to deliver an experience of exploring the scrapbooks through their digital representation to *uninitiated users*, in the hope that this will establish and/or strengthen the engagement with the actual artefacts.

We define uninitiated users, specific to our context, as users who have some interest in Edwin Morgan, his works, the scrapbooks, Scottish poems, and such but not yet academically stimulated. We vision that the digital representation of the scrapbooks then might play the role of a *catalyst* that intensifies their interest to Edwin Morgan Scrapbooks.

2.2 Specific Problem Domain

This project is based on the scrapbooks of one of the most prominent modern Scottish poets, Edwin Morgan. To appreciate the complexity that is involved in the project we need to understand who Edwin Morgan was, his works and worldviews, as well as one of his most important legacies, the scrapbooks.

2.2.1 Edwin Morgan

Edwin George Morgan was one of the most celebrated Scottish poets (Calder, 2017). He was born on 27 April 1920 in Glasgow and died 19 August 2010. Brought up in Glasgow, he enrolled in the University of Glasgow in 1937 to study English literature (BBC, 2017). In the university, he also learned French and Russian and taught himself “a good bit of Italian and German” (Crown, 2017).

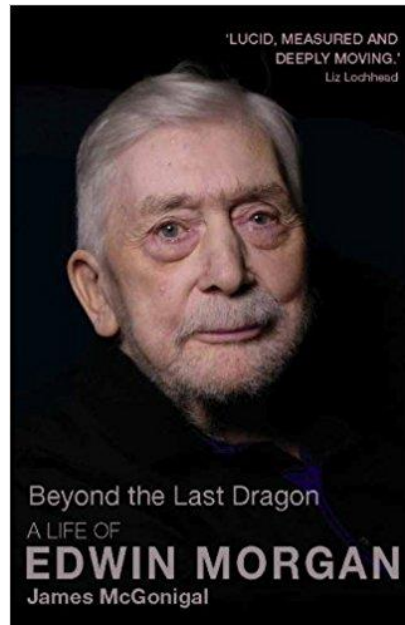


Figure 1 Edwin Morgan photograph on the cover of the book *Beyond the Last Dragon* by James McGonigal (McGonigal, 2010)

After serving as non-combatant personnel with the Royal Army Medical Corps during the World War II from 1940 to 1946, he returned to the University and graduated in 1947. Declining a scholarship to Oxford, he taught at the University of Glasgow until retiring in 1980 as a full professor. Morgan was the first Glasgow Poet Laureate (1999-2002) and named the Scots Makar in 2004 (Scottishpoetrylibrary.org.uk, 2017).

Throughout his life he had produced a very wide range of work—essays, sonnet, opera libretto, poems, and translations are a few examples. Hamish Whyte, a friend, publisher and bibliographer, has compiled the most comprehensive collection of Morgan's work and established the Edwin Morgan Archive in the Scottish Poetry Library (Edwinmorgan.spl.org.uk, 2017). Together with Robert Crawford, he also narrates the various roles The Scots Makar has taken throughout his life in the book *About Edwin Morgan*; adding critics and teaching into the list above (Crawford and Whyte, 1991).

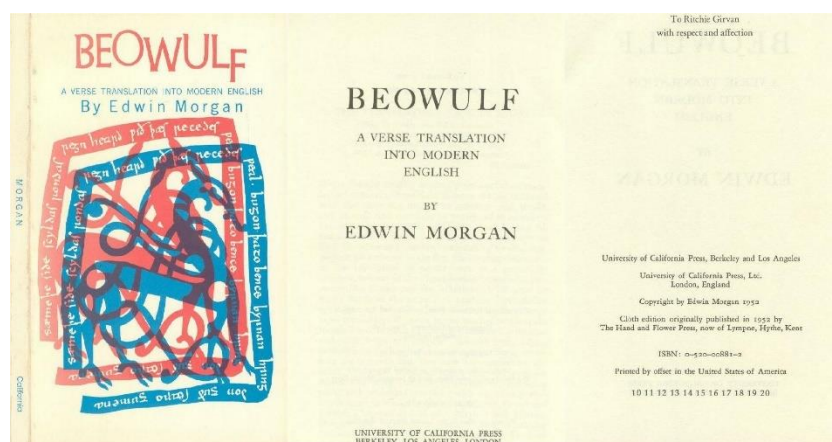


Figure 2 Modern English Translation of Old English epic *Beowulf* by Edwin Morgan (Morgan, 1962)

Arguably, one kind of his most celebrated works is concrete poems. Conceived as started by Brazilian artists in the 1950s (Clüver, 2017), it has been an international post-war avant-garde art & literary movement. While Weaver establishes that concrete poetry can refer to visual, audio, and kinetic (Weaver, 1966), concrete poetry is generally considered loosely defined and hence the various artefacts. Despite the difficulty in definition, Ellen-Scott argues that one fundamental aspect of concrete poetry is reduced language, and sometimes this extends into the substitution of language with non-linguistic materials (Solt, 1970).

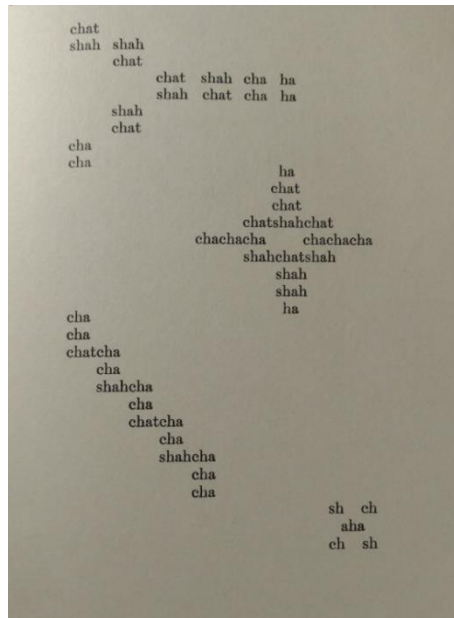


Figure 3 An example of Morgan's concrete poem, *French Persian cats having a ball* (April 1964) (Morgan, 1968)

Along with Sylvester Houédard and Ian Hamilton Finlay, Morgan was among the first British poets embracing concrete poetry. Morgan exploration and experimentation with concrete poetry usually resulted in the serendipitous humorous arrangement of words and letters (Solt, 1970). Attempting to blend tradition with innovation, he also sought to find new ways of utilising the visual and phonic aspects beyond common written or spoken forms (Cockburn and Finlay, 2001).

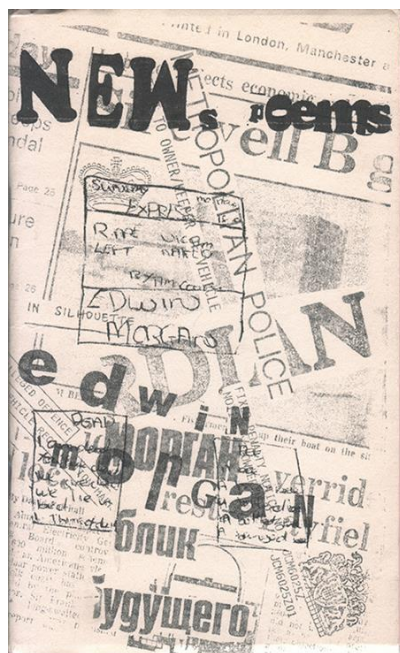


Figure 4 Another example of Morgan's concrete poem, *Newspoems*, published in a London's Magazine *WACY!*, in an edition of 58 (1987) (Edwinmorgan.scottishpoetrylibrary.org.uk, 2017) [1]

2.2.2 Edwin Morgan Scrapbooks

Considering Morgan's contribution to concrete poetry, it is hard not to suspect the probable connection with his scrapbooks. Compiled between 1931 to 1966, the collection spans across 16 volumes, of approximately 3600 pages. While there are half-full and empty pages in the last volume, they clearly signify meticulous and tenacious curatorial work. Hepworth and McGonigal suggest that the scrapbooks might be a prelude to Morgan's poems, both intrinsically and visually (McGonigal and Hepworth, 2012).

Describing them as "partly documentary/historical, partly aesthetic, partly satirical, and partly personal" (Edwin Morgan's letter to Christy and Moore agency, June 1953) (McGonigal and Hepworth, 2012), he sought them published twice (1953 and 1988); though this never happened due to high costs involved in printing and copyright clearance (Patterson, 2017). The University of Glasgow bought the scrapbooks in 1980, and they are now in the Department of Special Collections of the University's library.

The scrapbooks embody a very wide range of topics and materials. They reflect Morgan's ideas of being able to travel and explore the world as much as possible and yet still have a place to come home to (Morgan and Whyte, 1991). Skimming through the pages, one will appreciate Morgan's interests in—among other things, science and technology, social, cultural and political issues, as well as comedy and art in a very broad sense. They also boast wealthy materiality, ranging from newspaper and magazine pages, stamps, photographs, to "two halves of a pound note", which was put only to "show that it could be done" (*Letter from Edwin Morgan to his publisher Michael Schmidt, 15 December 1988*).



Figure 5 Edwin Morgan Scrapbook 11 (1953 to 1955), page 2146 & 2147 (Flickr, 2017) [1]

Hepworth and McGonigal further argue that one of the most important aspects of the scrapbooks is its surrealism. Morgan relies on the juxtaposition of clippings and annotations to convey his messages. On the other hand, it is inevitable that a sense of non-structure might strike the readers (McGonigal and Hepworth, 2012). To his defence, Morgan states that a kind of randomness that is not sequential and where characters recur casually is something to which he is indeed attracted. And that while he was serving in the Middle East, non-structure in poetry is as if a “structural idea in itself” (Morgan and Whyte, 1991).

Clearly, as a subject to a data visualisation and artistic representation problem, Edwin Morgan scrapbooks pose as extremely complex, challenging, yet exciting materials. However, due to the prototypical nature of the project and the importance of the scrapbooks as preserved archives, we only have access to 8 pages from 2 volumes of the collection. While this significantly minifies the richness of topics and materiality of the scrapbooks, we believe that these pages are still very valuable in demonstrating some ideas Morgan had shared within.

2.3 Related Disciplines

Looking at utilising metadata to create an alternative representation of the scrapbooks, this project considers several different disciplines. Interactive data visualisation poses as the main framework of the work as we are trying to design and develop an explorative visual representation. We also attempt to incorporate the principles of the generous interfaces to attract and encourage initial user interaction.

From technicality viewpoint, eye tracking experiments offer the opportunity to tap into users’ reactions and behaviour when looking at the scrapbook pages. This provides us with invaluable information that is influential to the user experience design. Finally, we resort to computer vision techniques in image and image feature extraction.

2.3.1 Interactive Data Visualisation

In this section, we will start with the discussion about data visualisation then proceed to interactive data visualisation.

While there are various definitions of data visualisation, we choose to follow Andy Kirk's concise definition because this comprises every universal aspect of data visualisation. He defines data visualisation as "the representation and presentation of data to facilitate understanding (Kirk, 2016)." We also refer to the workflow he has established as the practical reference of this project.

He further explains data representation as an act of showing a visual form of data through mixed utilisation of visual cues: *marks* (visual entities—such as points, lines, and areas) and *attributes* (visual attributes—such as colour and size). On the other hand, data presentation sits in a broader layer and encompasses high-level design decisions such as the overall form and interactivity. Finally, he argues that while data visualisation projects are intended to convey particular understandings of the subjects (Brasseur, 2005), this is something over which designers have very little control—due to the viewers' (humans) complexity; thus, *facilitating* is the most that can be sensibly done.

Data visualisation, rooted from mathematics and statistics, has been in use for centuries, though researchers have faced difficulties in locating its exact beginning. Project Milestones have compiled a historical collection of known data visualisation artefacts, as well as maps and related technology (Datavis.ca, 2017) (Friendly, 2008). In the interactive graph presented on their website, the oldest artefact predates the 1600s.

Perhaps one of the most notable pre-digital data visualisation are the Scottish political economist William Playfair's line and bar charts, presented in his publication, *The Commercial and Political Atlas; Representing, by Means of Stained Copper-Plate Charts, the Exports, Imports, and General Trade of England, at a Single View*, issued in London in 1785 (Ioannidis, 2003) (Historyofinformation.com, 2017).

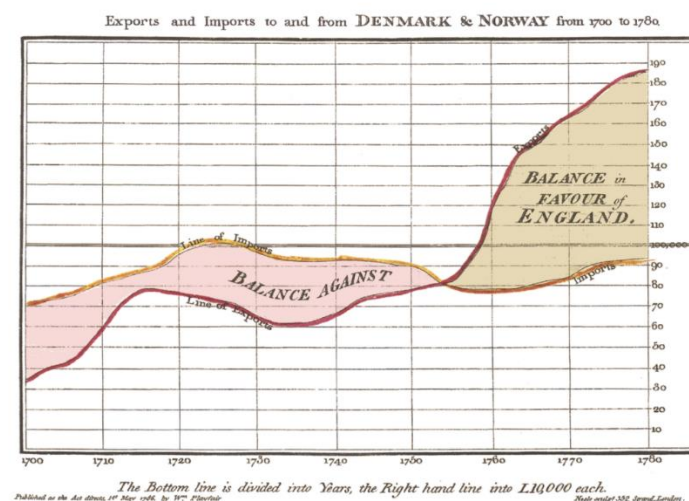


Figure 6 William Playfair's Time Series of Exports and Imports of Denmark and Norway (Brasseur, 2005)

Considering the multidisciplinary nature of data visualisation, Kirk further explains the four steps required in a data visualisation project: formulating brief, working with data, editorial thinking, and designing the solution.

Formulating the brief starts with curiosity about the dataset, either personal or collective, which then develops into the context. In this stage, designers need to consider several factors that may

affect the progress of the project as well as its outcome. These include stakeholders, challenges, consumption, deliverables, and resources. Designers should also define the purpose of the project, to which the 'Purpose Map' can be helpful.

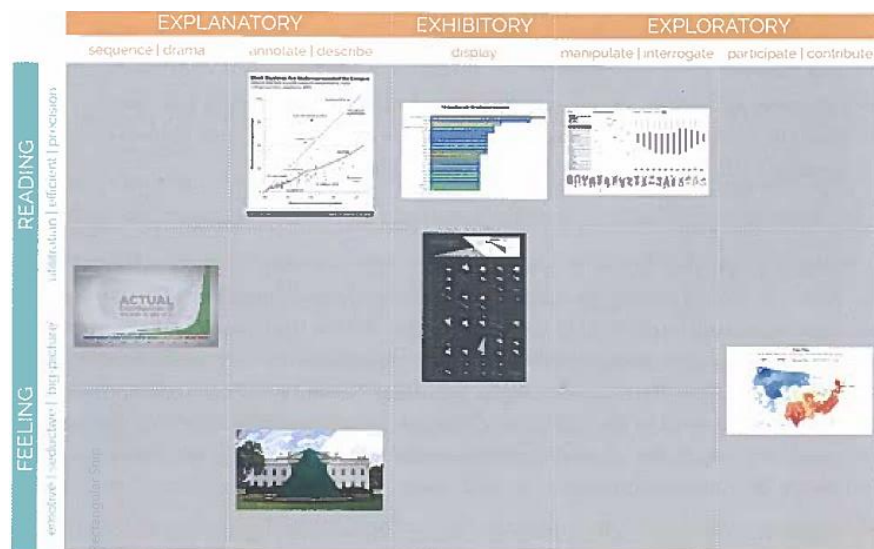


Figure 7 The Purpose Map (Kirk, 2016)

Activities in the second phase include data acquisition, examination, transformation, and exploration. Data acquisition can be performed by the designers themselves or by others. Data examination involves closely dissect the data to understand its properties (type, size, condition) and meaning. When enough understanding about the data has been garnered, designers may need to clean, convert, and consolidate the data. Finally, preliminary visualisation using statistical techniques is performed to gain insights about the dataset.

Somewhat a follow-through from the first step, developing editorial thinking concerns with choosing what angle, frame, and focus on the data the designers will show to the audience. Angle concerns with what inquiry is relevant to the audience or the broader context the visualisation is placed; framing looks at layering and choosing how much and/or which data to be included; and focus is about developing a hierarchy of importance in the visual space available, that is, drawing contrast of what specific feature, among the presented, more attention needs to be paid.

The final stage, the development of the design solution, is an iterative process that may differ from one project to another. Each cycle of the iterative process involves prototyping, testing, and refining; at the end of the last iteration, a launching of the solution occurs. However, rather than trying to achieve a flawless model, the focus is more towards optimisation, which naturally includes compromises and trade-offs.

Thus, the framework requires designers to possess three different mindsets throughout the project:

- 1) Thinking; this involves exploring the problem with creativity and curiosity, as well as logically make judgements and decisions.
- 2) Doing; this involves actualising ideas through sketches, performing research, and gathering and handling data.

- 3) Making; this involves *actually* designing and developing the solutions.

Kirk presents interactivity as a part of five layers of visualisation design. The other layers are data representation, annotation, colour, and composition.

He also suggests that the limiting factors (what *could* be done) be considered ahead of deciding what *should* be done. Then the interactivity features are divided into two options:

- 1) Data adjustments; this concerns with which part of the data is being displayed, involving framing, navigating, animating, sequencing, and contributing.
- 2) Presentation adjustments; this concerns with how the data is displayed, involving focusing, annotating, and orientating

2.3.2 Generous Interface

Complimentary to the data visualisation techniques and principles above, we also look at the importance of the principles of generous interfaces in the context of representing digital cultural collections.

While search boxes have been a *de facto* interface into digital collections, Whitelaw argues that these are *incomplete* for uninitiated users who usually are not yet inspired to look for any specific topic in the collection (Whitelaw, 2015). This argument is important due to a significant percentage of this type of user, for example, in museums (Fantoni, Stein, and Bowman, 2012).



Figure 8 Grid interface, *Discover the Queenslander* (Whitelaw, 2015)

Whitelaw further elaborates three characteristics of generous interfaces:

- 1) The intention to share and give information freely, even before asked.
- 2) Possible use of multiple, fragmentary interfaces to accommodate various kinds of inquiry.
- 3) Revealing relationships and structures that exist in the dataset.

Consequently, their implementation relies on reflective approaches that put emphasis on the process, user engagement, and experience, as opposed to merely the results.

2.3.3 Eye Tracking Experiment

While we understand that there are a lot of aspects—either measurable or not, relative to today’s techniques and technology—that are in play when users are interacting with an artefact, both physical and digital, we choose to focus on studying the eye movement. We believe that this is one of the most fundamental aspects of users’ interaction with either the scrapbooks or their digital representation because both are firstly graphical—then tactile; even though there are still differences in overall visual experience in that the latter is mediated by the computer screen.

Considering the point above, it was our original intention to run the eye tracking experiment with the actual scrapbooks. However, due to technical difficulties, we must be satisfied with the eight scanned images to which we had access.

The eye tracking experiment gives us access to *event types* such as fixations and saccades (Holmqvist et al, 2011) (Sr-research.com, 2017). It is also possible to view these event types in conjunction with the creation of several Areas of Interest (AOI).

A fixation refers to the state when the eye pauses at some point on the screen for a period of time. Fixation identifications are useful in understanding the “cognitive and visual processing behaviour” without having to dig into the more complex eye tracking data (Salvucci and Goldberg, 2000). Visualisation options for fixations include heat map and grey-scale look trough.

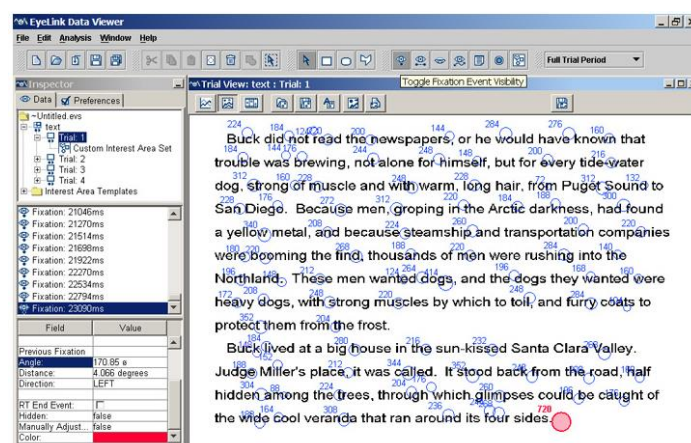


Figure 9 Fixations on the Eyelink Data Viewer © SR Research Ltd.

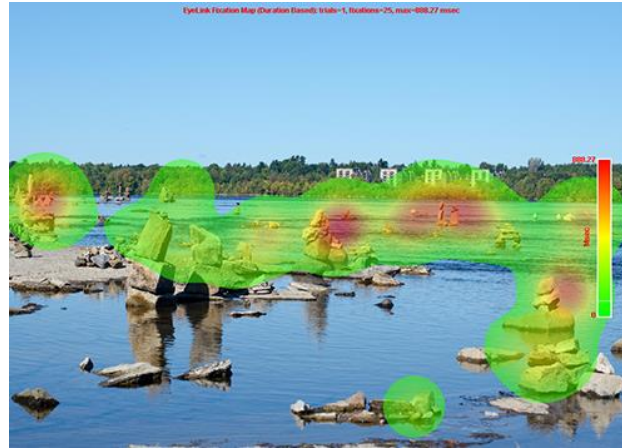


Figure 10 Heat map generated from the fixations © SR Research Ltd.

On the other hand, a saccade, denoted by a straight line between two fixations, is the very fast movement—which can take 30-80ms—of the eye between them; in this state, the eye is effectively blind. Combining fixations and saccades can give insights into the reading/scanning patterns of the user, denoting sequential, partial access to the object on the screen.

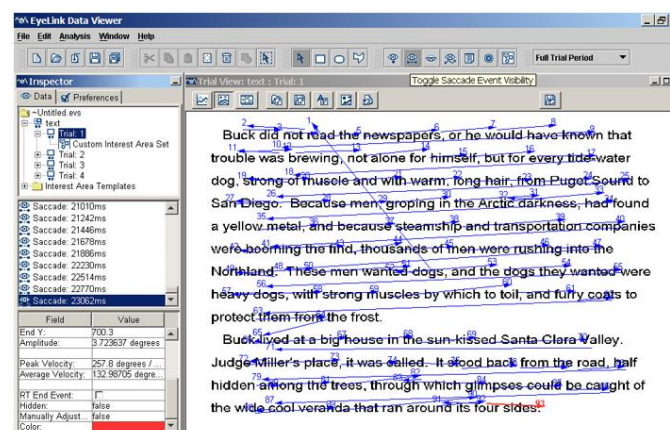


Figure 11 Saccades on the EyeLink Data Viewer © SR Research Ltd.

Optionally, we can specify several Areas of Interest to explain visual stimuli that present on the screen. Generally performed in a top-down manner, specifying AOIs require some knowledge and assumptions around the context of interaction between the user and the shown object (Drusch, Bastien, and Paris, 2014).

2.3.4 Computer Vision

Computer vision looks at technology and techniques that enable machines to *see* things as closely as possible as humans do; or even better in some cases. This field includes automatic extraction, analysis, and understanding of information from one or more images. Encompassed in this field is the development of both theoretical and algorithmic approaches to computer vision problems (Bmva.org, 2017).

To this extent, computer vision has a very wide range of application. A couple of examples include biometric, face, and automatic license number recognition, as well as robotics and medical image analysis.

Working with the scrapbooks that are graphically-dense, looking at computer vision techniques comes relatively naturally. We utilise these techniques specifically when dealing with image and image feature extraction; which will be further elaborated in Chapter III.

2.4 Design Methodologies

Throughout the project, we follow two main methodologies, namely The Double Diamond (Design Council, 2017) and Agile software development (Agilemanifesto.org, 2017). Each methodology has different yet complementary components.

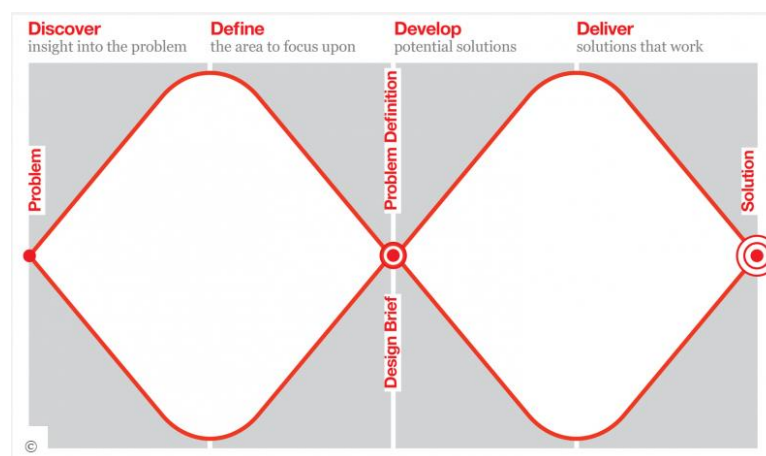


Figure 12 The Double Diamond Model © Design Council 2014 (Design Council, 2017)

The double diamond comprises four phases—discover, define, develop, and deliver. In the first phase, designers amass new information and look for insights. In the next phase, designers filter the relevant and useful information gathered to create a focused design brief that addresses the underlying design problem. The third phase involves iterative prototyping that helps designers improve and rectify their ideas. In the final phase, the design solution is developed and established.

On the other hand, agile manifesto appreciates the following values:

- 1) Individuals and interactions over process and tools
- 2) Working software over comprehensive documentation
- 3) Customer collaboration over contract negotiation
- 4) Responding to change over following a plan

Within the course of our project, we hold on above principles, and this is signified by, among others, the close and intense communication, extensive exploration of both techniques and domain problems, and production of sketches and prototypes.

2.5 Related Works

In this section, we present several works that are either conceptually or technically related to our project and have been sources of insights and inspiration.

2.5.1 Digitising the Edwin Morgan Scrapbooks

This project is established to look at the issues of rights clearance, risk, and how digital cultural collections can still be accessed under the copyright regime. It specifically aims to present the model of copyrights clearance process on Edwin Morgan scrapbooks; dividing risk levels into low, medium, and high (Digitisingmorgan.org, 2017) [1]. This project is a joint effort of CREATE and the University of Glasgow Library, supported by the Edwin Morgan Trust and the Queen's University Belfast (Digitisingmorgan.org, 2017) [2].

Its artefact, which can be accessed at <http://copyrightcentral.arts.gla.ac.uk/ema/> (Copyrightcentral.arts.gla.ac.uk, 2017), displays nine double-page scanned images from Scrapbook 12, that can be viewed using the drop-down menu on the left upper corner of the page. Each web page presents a double-page image where consisting of the segmented individual clippings. Users can filter these clippings based on their risk level and click on each clipping to view the catalogue information attached to it; the risk levels are low, medium, high, and the lower the risk, the fewer clippings are shown. Clicking on a clipping on the right panel achieves the same effect and hovering them will reveal where it is located on the double-page.

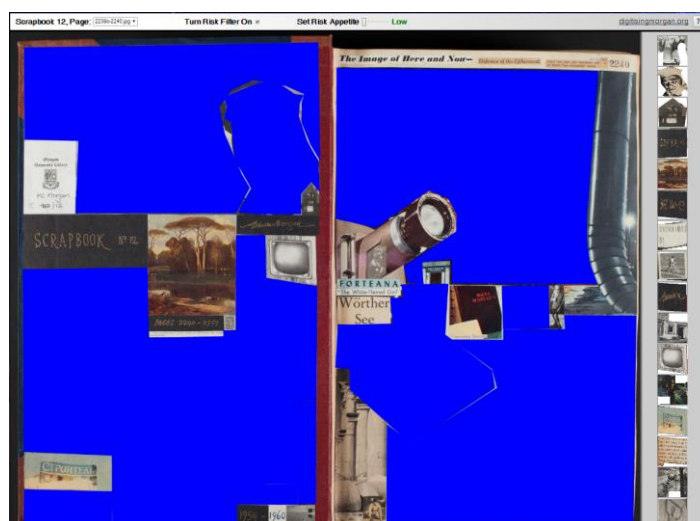


Figure 13 Sample page from the project website, showing only low-risk clippings. (Copyrightcentral.arts.gla.ac.uk, 2017)

While conceptually addressing a slightly different issue, this work also builds on the idea of presenting each clipping as a unique entity with attached metadata and retaining some of its visual attributes, such as its location on the page.

On a scanned page, the materiality is vanished, making it particularly challenging to tell apart different clippings. However, on this project hovering the clipping changes its overlaid colour, informing the user that it is indeed a separate object on the page. Furthermore, it also addresses the idea of networked objects, in that their risk level connects the clippings.

On the technical level, we are interested in the segmentation of the clippings from the page. While we could not find any written confirmation, paying attention to the speech on the project's launch event, we are inclined to believe that this was achieved by diligently drawing polygonal segments on each clipping by hand.

2.5.2 The Bohemian Bookshelf

This joint project by Alice Thudt, Uta Hinrichs, and Sheelagh Carpendale builds on the principles of serendipitous discovery (Thudt, Hinrichs, and Carpendale, 2012). Though it is a slightly different viewpoint, *serendipitous discovery* also departs from the inadequacy of search boxes in accommodating uninitiated users' requirements in collection exploration. Thus, it shares a few same principles with generous interfaces, in that it presents multiple representation—or entry points, with samples readily displayed upfront.

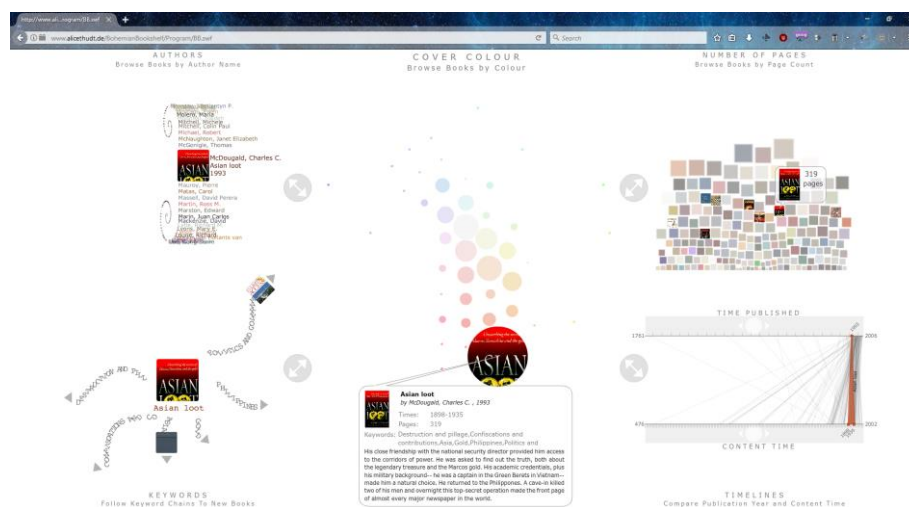


Figure 14 The Bohemian Bookshelf interface

The Bohemian Bookshelf is a data visualisation project based on book catalogues. It enables the user to browse, and serendipitously discovers books and display their information. To achieve these, five interlinked visualisations are presented:

- 1) Cover Colour; books are clustered based on their cover colours.
- 2) Authors; lists the authors in reverse alphabetical order.
- 3) Keywords; the chosen book links to others by keywords.
- 4) Number of Pages; sorts the books from the that with the greatest number of pages to the lowest.
- 5) Timelines; maps the timeline of the content of the books to their actual published time.

Every time a book is chosen on one of these interactive visualisations the other four also display the same item.

Placing explorability as the main driving concept is important in assisting common users to interact with the cultural collection such as books. On the other hand, even though the idea of interlinked visualisations is appealing, we choose to design an interface that enables the user to focus on one thing at a time. Finally, we understand that colour is inseparable from visualisations; hence this is one of the aspects we focus on in our project.

2.5.3 Past Visions

Built on another cultural collection, Past Visions is a data visualisation prototype based on 1492 drawings of the Prussian King, Frederick William IV (1795 - 1861) (Glinka et al, 2016) (Uclab.fh-potsdam.de, 2016). It is built as a part of the research project research project »Visualizing Cultural Collections« (Visualisierung Kultureller Sammlungen—VIKUS) at the University of Applied Sciences Potsdam, Germany.

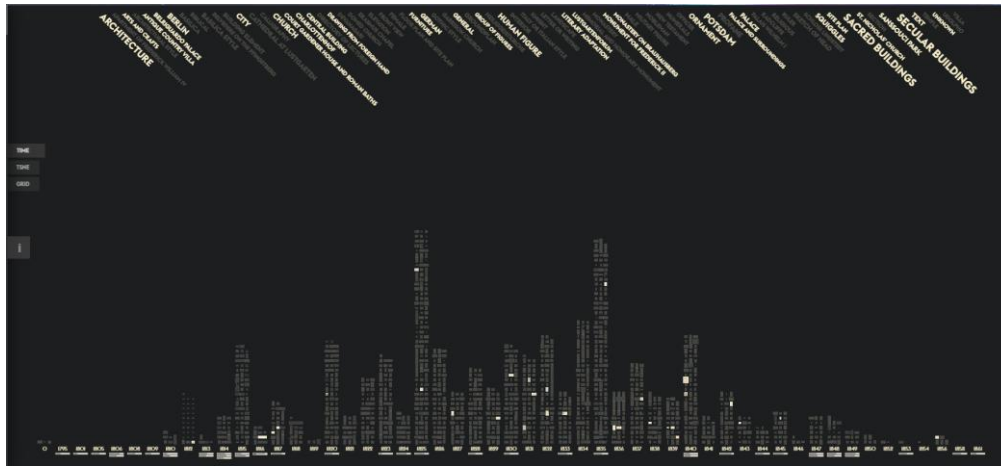


Figure 15 Past Visions primary interface

Not having to deal with copyright issues, it displays the original drawings arranged in three viewing modes with the chronological histogram being the primary. The main navigation mechanism in this system is filtering and zooming; Users can zoom in to see the detailed view of the drawing and zoom out to view its position within the overall collection.

Users can also filter the dataset by clicking on the keywords on top of the page. Relevant items will stay on the page while the others go below the imaginary horizon. The keyword acts as a kind of network connecting both themselves and the items. It starts by showing all possible keywords, but clicking on one of the keywords will reveal the relevant drawings as well as other connected keywords. Furthermore, it is possible to select multiple keywords to drill down the displayed items.

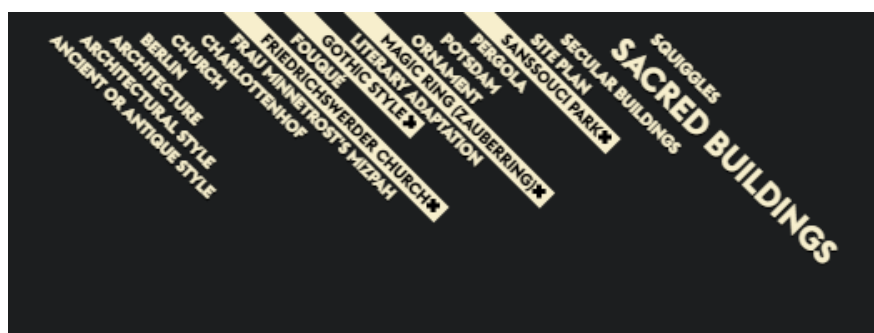


Figure 16 Multiple keywords are selected, displaying only a handful of relevant others

Looking at this project, we are interested in the ideas of zooming in/out while keeping the items in place as it is important to retain the information of where the item is placed within the whole

collection. The compound filtering is beneficial in illustrating the relationship between the items as well as between the keywords themselves.

2.5.4 Dear Data

Giorgia Lupi is an information designer based in New York, and Stefanie Posavec is a data designer based in London. They work together in a year-long hand-drawn data visualisation correspondences called Dear Data (Dear Data, 2016).



Figure 17 Dear Data is an analogue data visualisation project © Dear-Data.com

Strikingly different in terms of media from our previous digital data visualisation project, Dear Data is originally data visualisations drawn on postcards and sent through air mail. We came across and studied this project after it had been compiled into a 300-page book. This book contains all the one-hundred-and-four—fifty-two times two—postcards the designer duo has sent each other for each week during the year they were working on this project, as well as several comments and data visualisation how-tos.



Figure 18 Dear Data book covers © Dear-Data.com

Each postcard contains hand-drawn data visualisation and its legend (how-to-read) based on a topic they had decided previously. Each designer draws their own visualisation on the back of

the postcard and knows what the partner created only after it is delivered to them. The visualisations are typically based on a specific personal activity during the week. While the type of activity is a joint decision, the types of data, their properties as well as the visualisation design are all subjective.

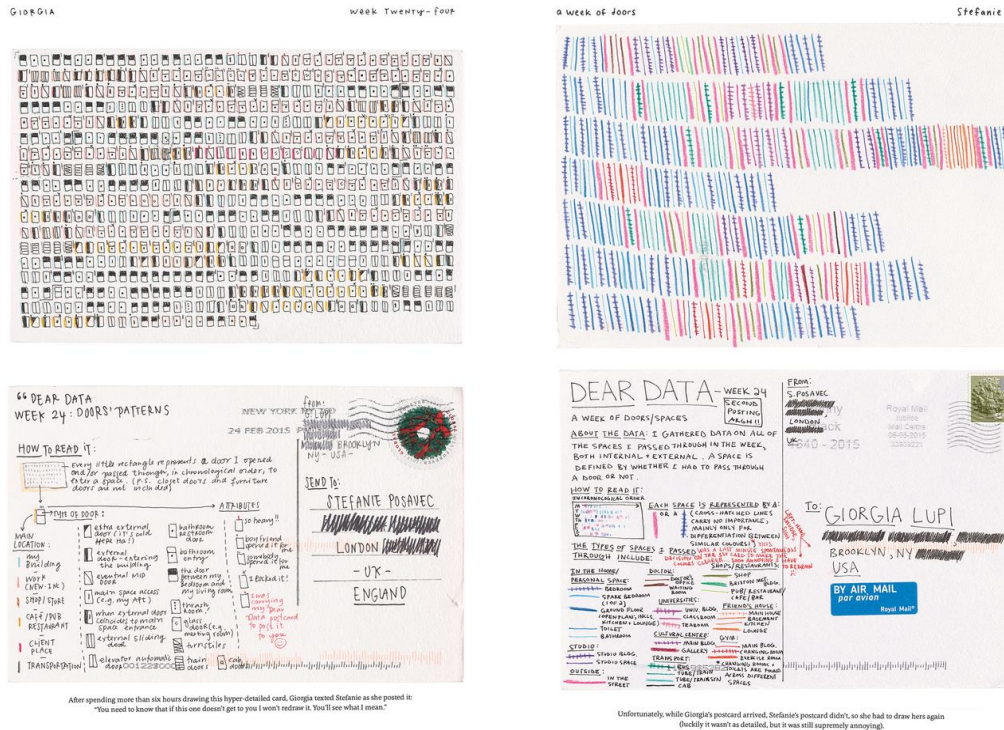


Figure 19 Some excerpts from the book, showing data visualisations of door patterns they had seen during the week © Dear-Data.com

Building from Kirk's theory on data visualisation, we find this project especially resourceful. Among the many things that become inputs to design considerations for our project are:

- 1) The consistency and relevancy of the overall form of the visualisation to the problem domain
- 2) The relationship between data point and attribute representation
- 3) The important and ubiquitous presence of time-based data/attribute
- 4) The importance of the balance between aesthetic and function of the design
- 5) The mechanism to decide categories and attributes from the dataset
- 6) How to look for kinds of data to collect

On a different note, this project is a significant contribution to the field of data visualisation as it inspires designers to look more closely at their own lives because our environments are a wealthy source of data. Furthermore, personal data visualisation is an exciting and essential reflecting tool as it may provide surprising insights and knowledge of ourselves that we might never notice otherwise.

CHAPTER III DESIGN AND IMPLEMENTATION

3.1 Exploration

The project begins with the discussion by Bridget Moynihan and me along with our supervisors about the project. Our initial aim was to create a digital interface that uses multimedia input and output channels to navigate the digitised scrapbook pages.

The initial proposal is as follows:

The artefact is a Digital User Interface that transcribes the scrapbooks of the Scottish Poet Edwin Morgan; a multimedia interface that encourages engagement between the reader and the book.

Possible media:

- a. Custom touch screen
- b. Consumer grade tablets and/or smartphones

Possible input elements:

- a. Touches, swipes, gestures
- b. Gaze, tracked by peripherals such as Eye Tribe, Microsoft Kinect, or even Webcam (Pygaze.org, 2015)
- c. Voice command

Possible output (feedback) elements:

- a. Graphics
- b. Texts
- c. Audio
- d. Haptic
- e. Video/Animation

Research topics:

- a. Usability

Usability is directly related to the original Digital Découpage project's objective. This area looks at how the final artefact can effectively assist its users to accomplish their goals.

- b. User engagement

This area looks at how effective the techniques in attracting and keeping users' attention as well as the possibilities of employing the same techniques in the "digitisation" of other types of books.

- c. Behavioural analysis

This area looks at how differently the users behave when interacting with the original scrapbook and its digital representation.

However, as we continue looking at the challenges, especially the fact that most of the clipping on the scrapbook pages are copyrighted, and it is immensely expensive or difficult to pursue clearances, we come to realise that our initial proposal depends entirely on original clippings being displayed. As this looks unviable, we move from the initial idea and explore new options.

We then start with looking at what materials we possess. We have four double-page scanned images of the pages 1519/1520, 2261/2262, 2407/2408, and 2423/2424; all at 6426 by 4912 pixels at 300 dpi. Another material is the dataset, that is the metadata about the eight pages of scrapbooks that Bridget has collected. This dataset concentrates on describing different clippings—written as Item in the database—of the pages. There are five tables in this initial database:

- 1) Item; contains clipping related metadata, both subjective (item_notes and item_description) and objective (other fields).
- 2) Item_Creator; contains information related to the creators of the clippings.
- 3) Item_Source; contains the source and place of the clippings.
- 4) Page; contains limited information about the pages of the scrapbooks.
- 5) Scrapbook; contains the years and limited description about the physical characteristics of the scrapbooks.

At this stage, the database is hosted on a personal computer, requiring data export, sending, and import every time changes are made.

The dataset is centred at the clippings (Item), with the other tables function as references holders to the main table. Thus, we start by looking at ways representing the pages with items as the main component.

As a consequence of the collaborative, prototypical nature of the project, we perform cycles of exploration at data visualisation and the domain problem throughout the project. Even though we present these two sections sequentially, these activities did not chronologically happen as sequenced here.

The process of collaboration and exploration involves a lot of meetings, discussions, observations, and sketching out ideas. It is a semi-structured process that encourages serendipitous research and ideation. Sometimes, exploration on one topic leads to another topic which in turn presents new options. However, we try to keep this within the contexts of the project.

3.1.1 Domain Problem Exploration

Included in this phase are a visit to see the real scrapbooks and looking at the Digitising the Edwin Morgan Scrapbooks.

We start the exploration about the scrapbooks by visiting the University of Glasgow Library. The scrapbooks are stored in the Special Collections department of the library and consequently are treated as archives.

This visit gives us insight to how the experience of *reading* the real scrapbooks is very different than reading the scanned forms. We note several aspects related to this experience.

Firstly, a scrapbook page invites touches—including tilting the pages. Touching the clippings is important in differentiating clippings in a collage and finding out their sources. These tasks are very difficult to accomplish with the scanned version. The first task is especially true for Morgan’s scrapbooks because he pastes the images very neatly to each other, making it difficult to tell apart different clippings. The second one applies more generally, where the materiality—how the material reflects light, how it feels—is lost in a scanned image. Therefore, the digitisation of the scrapbook pages often fails because it fails to maintain this characteristic.

Secondly, Morgan flips some clippings and use the other side as a page—where he pastes another clipping. Why it is hard to understand his original intention, we understand that he can save spaces by doing this.

Thirdly, as true with other scrapbooks, the clippings are connected in a way that they tell stories. These stories can be historical—several newspaper articles narrating an incident, conceptual, or even only visual. We admit, however, even when reading the original pages, it is sometimes still hard to discern some images or texts—when they are and how they relate to the other clippings.

Lastly, we notice several themes included in the scrapbooks. These are places, history, comedy, and technology. This finding shows that Morgan has very diverse interests, which then also appears in his other works. We realise that this means everyone can find something interesting to them; but the otherwise might also be true, especially with the very limited data-set that we have. We realise then that not everyone will find the themes and clippings present on our sample pages attractive enough to let them experience a personal connection with the prototype—and the scrapbooks.

Initial exploration also yields several aspects regarding the prototype, such as its intended user, content, navigation, medium, and involved elements. We also agree that given the restriction of the copyright issue, we are not developing a prototype that only serves as a digital copy of the scrapbooks. This means we are not pursuing a screen-mediated flat scrapbook page-viewing as in the Heritage Scrapbook (Crcstudio.org, 2017). We are looking to develop a platform that offers a distinct experience of exploring the scrapbooks given the capabilities and possibilities of the digital realm.

Focusing on the *main elements* of the *digital scrapbook*, we identify several items. While these are important, we give more focus to exploratory aspect because we want users to play and be engaged, so that they will develop more interest to the scrapbooks. The aspect of interactivity also gives a lot of choices. However, given the limited time, we later focus on implementing a minimum viable product incorporating elements that do not require a long time to develop.

Progressing on, we also look at the Digitising the Edwin Morgan Scrapbooks project we mentioned earlier in Chapter 2. Even though it is conceptually different than our project, we learn how the clippings become the primary components of the system. We also notice that the clipping segmentation might be needed.

One of the things that are important in this project is how the copyrighted materials are treated. Due to its nature of being non-commercial and research-led, they are permitted to reproduce these materials in accordance with sections 29 and 30 of the Copyright Designs and Patents Act 1988 (CDPA). The creators are also open to copyright owners contacting them in regards to their materials being used.

On the other hand, our project is especially looking at ways of representing the scrapbooks through aspects which are not under copyright. This is because at the very end of the project we want to make the artefact available for public access to accomplish our objective: creating an online presence of the Edwin Morgan Scrapbooks. Furthermore, we see that it is not feasible to perform the diligent search and copyright clearances for all the materials that we use due to the limited resources available.

We attended the Project's Launch Event on 20 January 2017 at the University of Glasgow Library. There we managed to have a short conversation with Sarah Hepworth, the Deputy of the Special Collection at the University of Glasgow Library, and James McGonigal, Professor of English in Education at the University of Glasgow and the writer of *Beyond the Last Dragon: A Life of Edwin Morgan*. Hepworth expressed her support for our project and was keen to have the real scrapbooks be involved in the eye tracking experiment (Chapter 4). McGonigal said that considering his interest in science and technology, Edwin Morgan would be pleased to know that his works, the scrapbooks, are materials of research in informatics.

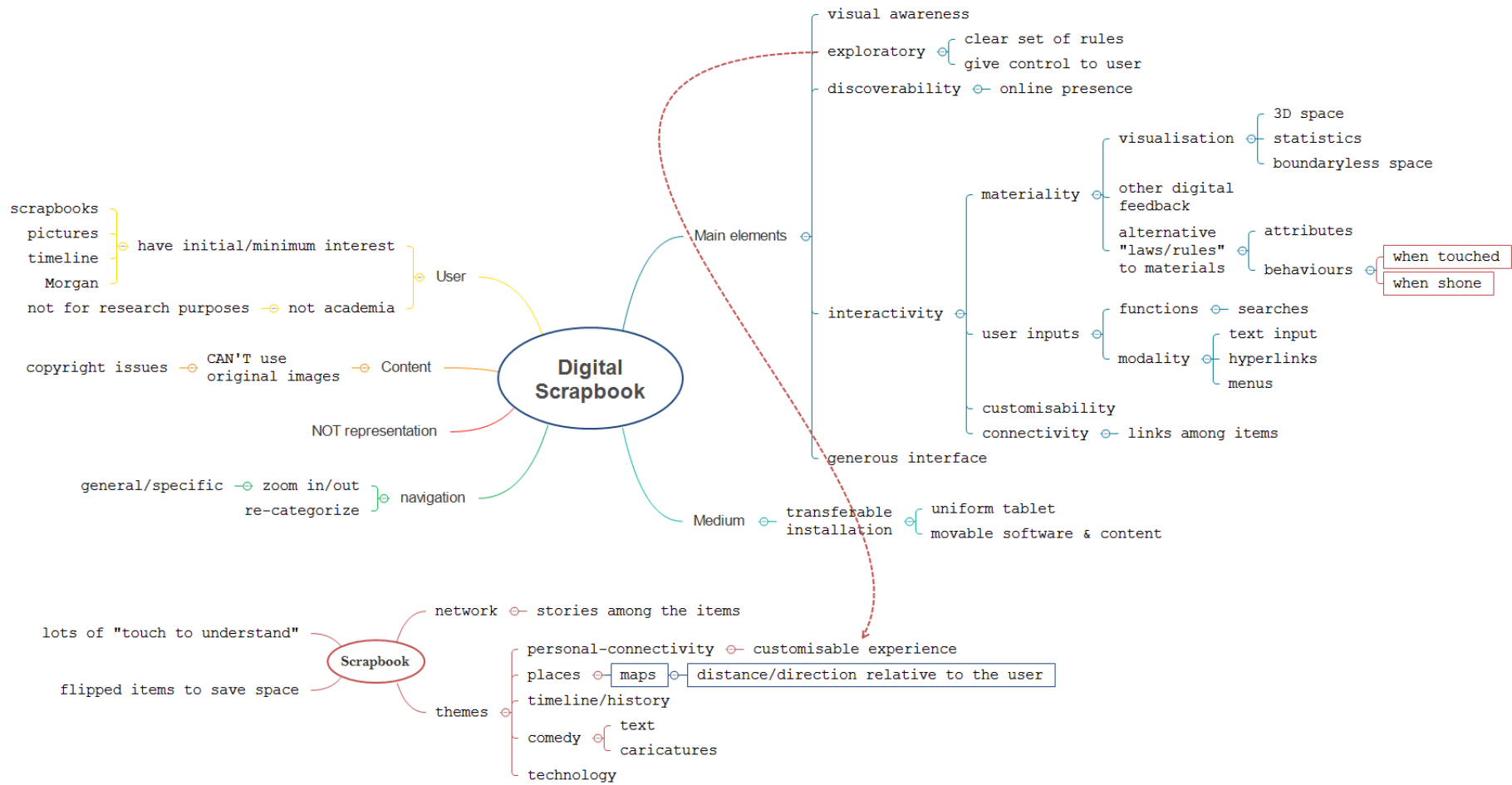


Figure 20 Mind map of the prototype and the scrapbooks

We also create several sketches in our attempt to understand the underlying problem better.

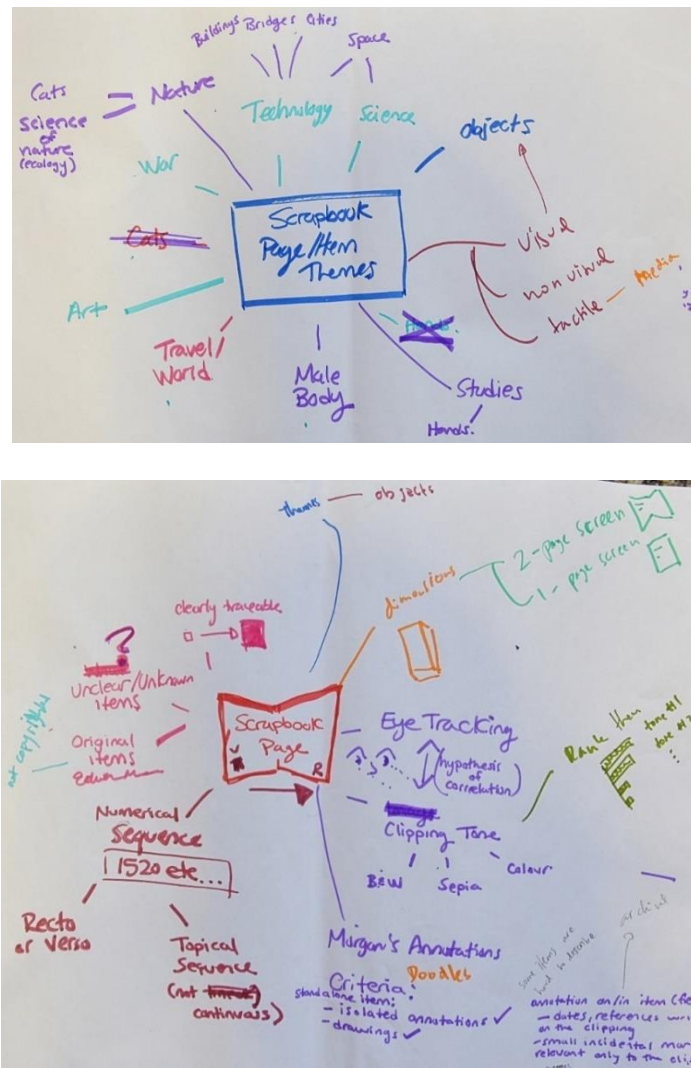


Figure 21 Sketches in domain exploration

3.1.2 Data Visualisation Exploration

This phase consists of discussions with Data Visualisation experts and practitioners and examination of literature and related data visualisation projects.

At the early stage of the project, we visited Dr Uta Hinrichs, a lecturer at the School of Computer Science at the University of St. Andrews, who has previously worked on several visualisation projects with Bridget. Even though we did not manage to discuss with her because she was giving a talk on another topic, we did receive a valuable advice: sketching ideas.

Moving on from the meeting with Dr Hinrichs, Bridget and I meet every week when possible to sketch our ideas regarding the visualisation of the scrapbook pages then discuss them.



Figure 22 Early sketches are revolved around the pages

Starting with page 1519/1520 we look at alternative ways to visualise the clippings by only reading the descriptions. These include segmentation of the clippings and a more abstract and artistic approach. However, we are still attached to the original idea of putting the items on their respective page.

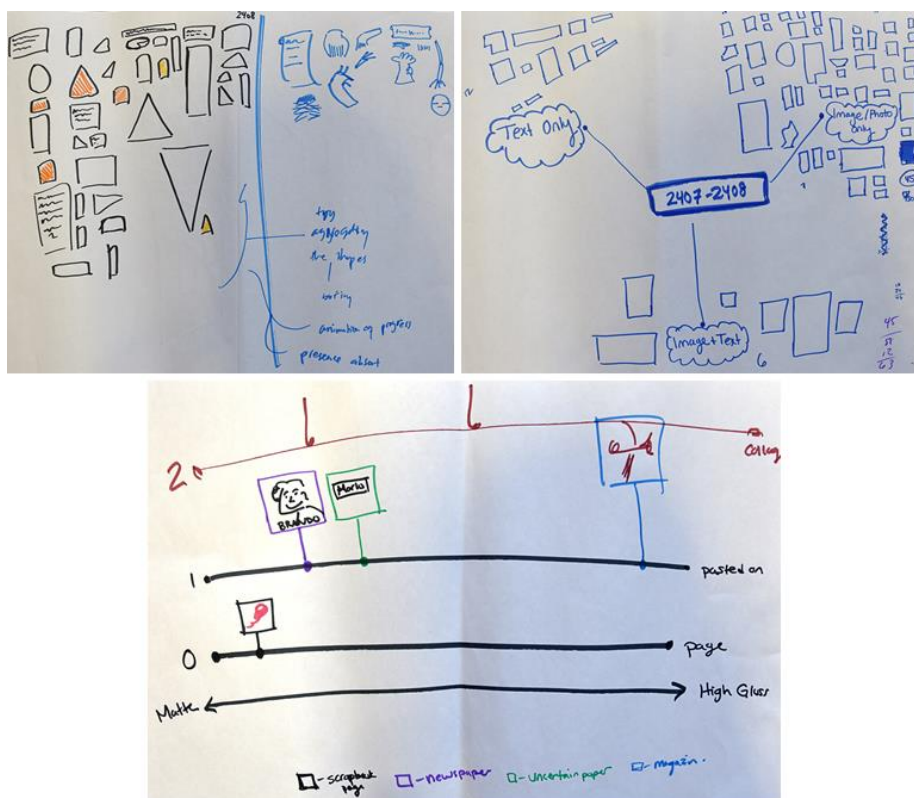


Figure 23 Sketches of the next iterations

In the few next iterations, we start looking to break away from the page arrangement and pursuing more aggregate views of our dataset. We think of grouping them by their other attributes, such as shapes, forms, materials and layering.

We also look at the Bohemian Bookshelf project (Thudt, Hinrichs, and Carpendale, 2012) cited in Chapter 2. We examine this project as an example of the implementation of the principles of generous interfaces. The examination of this project ascertains us that the element of explorability is of great importance in our project.

Besides Dr Hinrichs we also talk with Dr Julian Rawlinson, a lecturer at the College of Art at the University of Edinburgh. The talk with Dr Rawlinson opens a few new options or rather aspects, that might also be beneficial to our project: sonic. Indeed, *sound* is another essential element of an explorable interface, moreover if it is visually abstract. However, due to the limited resource—time and expertise—available, we decide to postpone the creation of any audio assets.

Dr Rawlinson also shows great interest in our project. However, due to his other involvement in other projects, he cannot offer technical support to us but is welcome to our questions and emails.

Nevertheless, there are several points that we can take from the discussion. One of these is that we start to think to create a virtual reality experience of exploring the scrapbook. We pursue the literal meaning of “explore” and aim to *put* the viewers *inside* the scrapbooks—or rather, the dataset that we have—and enable them to interact with the components as opposed to just *seeing* them.

Dr Rawlinson also informs us about a project called Bohemian Rhapsichord (Static.echonest.com, 2011). The creators use Echo Nest analyser to fragment the song Bohemian Rhapsody by Queen into fragments of quasi-stable musical events. What interesting from this project is the feature to arrange and rearrange the small components. Even though a little different, this inspires the grouping function in our project.

All other references we receive from Dr Rawlinson involve with sound. Therefore, even though these are important, we choose not to take them further for this project due to the limitation mentioned earlier.

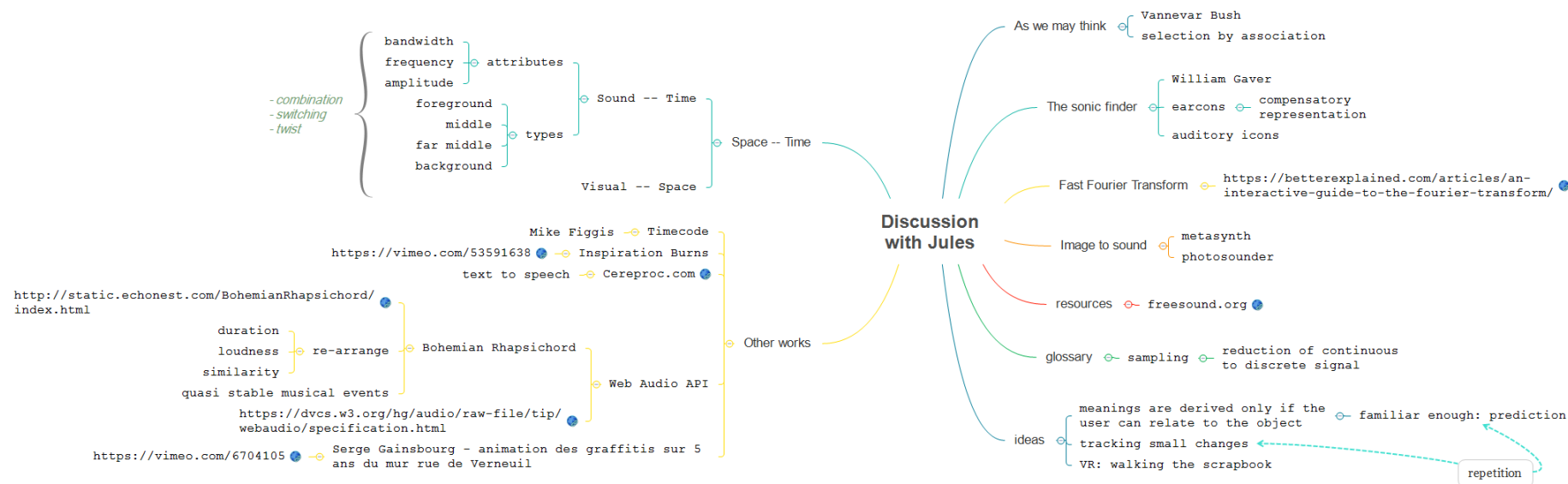


Figure 24 Mind map of the discussion with Dr Jules Rawlinson

Then we build a brief of our project based on Andy Kirk's exposition in his book (Kirk, 2016). The context of our project is creating an exploratory representation of Edwin Morgan's scrapbooks that aims to give visual awareness of the archive to uninitiated users. We are especially interested in Morgan's rationale when he was assembling the scrapbooks—though this very difficult to figure out, the themes included, and the relationships between different elements, especially texts and images. The aims of our project are to attract and hold users' attention as well as give a good impression and thus inspire further engagement with the materials on which it is based: the Edwin Morgan Scrapbooks. In regards to Kirk's Purpose Map, we decide to put our prototype between the Exhibitory-Exploratory and Reading-Feeling, as it contains aspects of these four categories.

	Explanatory	Exhibitory	Exploratory
Reading			
Feeling			



Figure 25 Our primary prototype on Andy Kirk's Purpose Map

The data handling in this project does not require specific activities due to the small size of our dataset. Other optimisation and enrichment to our dataset is explained in the next section.

In the editorial thinking, we develop a mindset to create a product that is both an art piece and interactive digital interface. The art piece element requires graphics as the main element attracting users' attention, while the interactivity includes rearrangement of the elements according to several categories.

Throughout the course of the project, we also look at a lot of other data visualisation projects—some of these are cited in Chapter 2, discuss whether the techniques or aspects implemented are relevant to ours.

From all other projects that we have examined, we want to mention Dear Data (Dear Data, 2016), both literature and a project closely related to ours. We are especially interested in how Giorgia Lupi, one of the authors, carefully define categories, identify data points, and decorate them with attributes.

One of the most important things that we gather from Dear Data is the existence of categories and attributes. These can be produced from the attributes of the data. However, they are distinct in that categories:

- 1) Must have no null values.
- 2) Must be a defining characteristic of the dataset.
- 3) Can be universal characteristics, so long it suits the context, e.g. time, days, hours, etc.

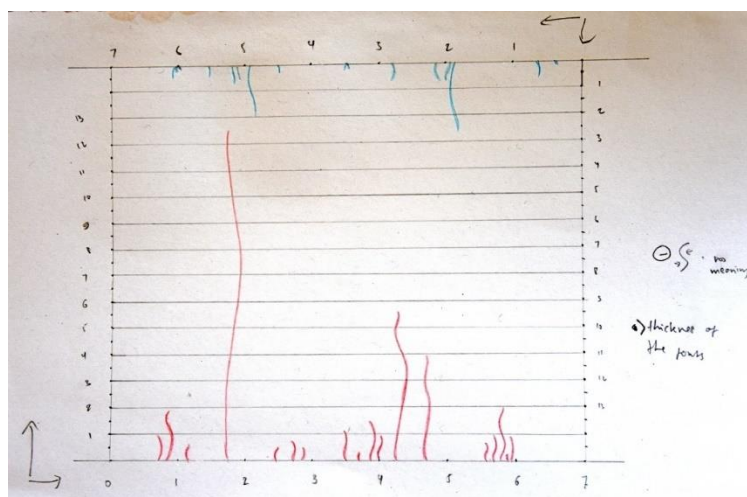


Figure 26 A sketch informed by techniques in *Dear Data*

3.1.3 Enrichment and Optimisation

Over time we look at optimising the dataset, for example, creating the `Item_Direct_Affiliation` table which holds the explanation of the possible connection between two items.

We also enrich the data by adding more information about the items, such as its location on the page. We initially do this by creating a uniform grid on each page, then determine the X-Y location of an item and its width and length using the grid. However, we find that this is too time-consuming without much benefit. We later resort to Computer Vision techniques to do this much more quickly.

Another information that we add related to an item's physical attributes is the z-index; that is the layer on which an item is pasted on a page. We use the term z-index in the same logic it is used in Cascading Style Sheet (CSS) (W3schools.com, 2017). For an item that is pasted on scribed on the page, we assign $z\text{-index}=0$; 1 for another item pasted on top of it, etc. The z-index is generally discrete. However, we assign $z\text{-index}=0.5$ for items that are pasted on the back of another item and flipped as seen on the page 1520 of Scrapbook 9.

Lastly, as we look at utilising eye-tracking experiments to gather more insights of the scrapbook pages, we realise that the eye may behave differently to texts and images. This means we need to isolate texts and images of the same item. Thus, we further break down the item into elements and create `Item_Element` table.

An item on the `Item_Element` table has a description, physical attributes, such as its X-Y coordinates, width and length, $z\text{-index}$, colour information. It is also defined by its medium, form, and status; all are a single value. The possible mediums of an element are Magazine/Periodical, Newspaper, Ink Drawing/Writing/Stamp, Postage, Original Photograph, and Uncertain Paper Source.

The forms are Published Photograph, Original Photograph, Handwritten Text, Published Image/Picture, Printed Text, Original Artwork, Uncertain Photo/Image/Picture Source, Stamped, and Postage Stamp.

While the form and medium seem to have similar terms, they refer to different things. The medium refers the source of the clipping, while the form refers to the material of the element itself.

And the statuses are Focal Image/Photograph/Picture, Marginalia/Annotation, Caption, Heading/Body Text, Supporting Image/Photograph/Picture.

Consequently, throughout the remaining course of the project, we switch the focus from the clippings (Item) to the clipping components (Item_Element) as the main component of our visualisation.

To ease the access to the database, we also move the database to Amazon Web Services (Amazon Web Services, Inc, 2017). This enables all team members to access and make changes to the data easily.

3.2 Artistic Alternative Representation of the Clippings

Edwin Morgan scrapbooks are a very visual and image-dense piece of work. While we are looking at ways to represent them without infringing the copyright through the metadata, we also realise that the visual element is essential. Focusing only on the metadata will strip the scrapbooks of its fundamental element. Therefore, we also visually examine the clippings and the components using Computer Vision techniques.

We use OpenCV (Opencv.org, 2017) for Python to perform the computer vision tasks in this stage. OpenCV is an open source computer vision libraries available for C++, C, Python, and Java. In addition to OpenCV, we also import scikit-learn (Scikit-learn.org, 2017) [2], a machine learning library for Python. Both are released under BSD License. Lastly, we also use two utility functions (Rosebrock, 2014) developed by pyimage-search. We choose to use python as it is the simplest and yet powerful language to perform the tasks that we need.

3.2.1 Component Extraction

The first thing that we try is extracting the clippings from their respective pages. This starts with applying Canny algorithm for line detection (Docs.opencv.org, 2017) to detect the lines (the boundaries) of the clippings. However, we quickly find a dead end walking this route. This is due to the irregular shapes of the clippings and the vague boundaries between them.

After looking at the Digitising Edwin Morgan Scrapbook project, we realise that the quickest way to perform the segmentation on a limited dataset is manual cropping. Thus, we proceed with manual extraction of the clipping components using an image manipulation software, GIMP (2017). As our focus changes from clipping to its components, we perform the segmentation on the component level. For example, a newspaper clipping is segmented into its graphic, caption, and article.

However, we acknowledge that this is not the most feasible method when applied to all pages of a scrapbook, let alone the whole collection. Thus, we suggest that another computer vision-specific project should look at this challenge in the future.

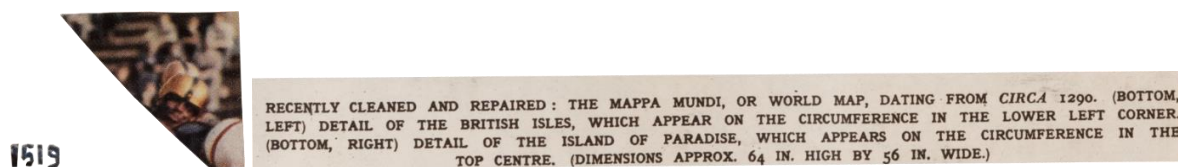


Figure 27 A few examples of the extracted components

3.2.3 Colour and Dimension Extraction

We use K-Means clustering algorithm (Scikit-learn.org, 2017) [1] to extract the colours from each clipping component. The algorithm read all values of the pixel of the image then cluster these pixels to the nearest centroid.

However, one of the disadvantages of K-Means algorithm is that we need to determine K—the number of clusters, for each image. We explored the machine learning techniques to determine K automatically, but the results are poor. Using Bayesian Information Criterion (BIC) to determine the K (Pelleg and Moore, 2000), we test the algorithm on a clearly colour separated image below. The highest BIC corresponds to the optimum K number.

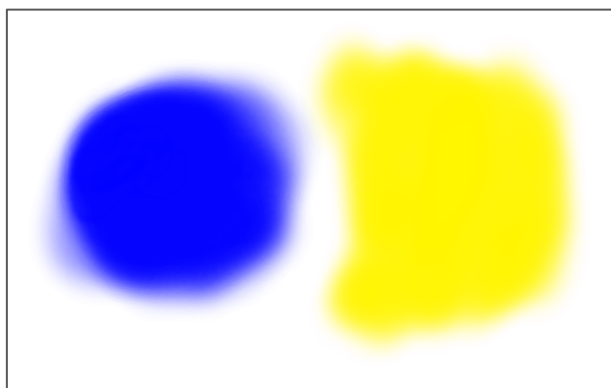


Figure 28 The original image of blue-yellow colours. The white background is transparent—no pixel

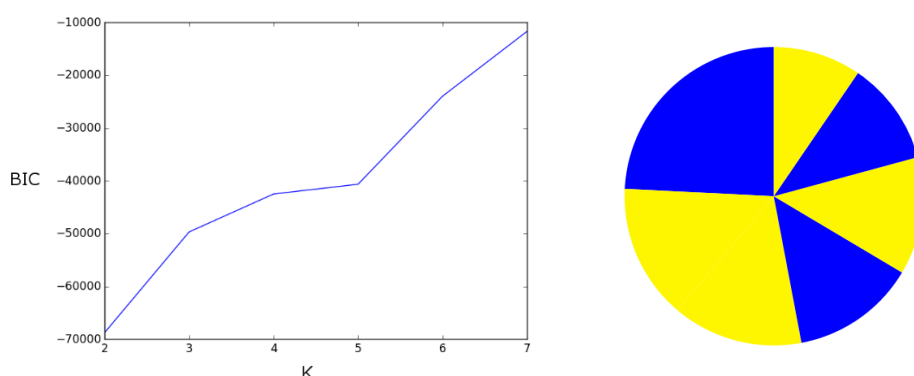


Figure 29 The line chart of BIC vs K and the resulted colour circle

Even though the image clearly has $K=2$, the algorithm gives incorrect results; $K=7$. Therefore, we choose to determine the K manually for each component.

As seen above, the results of the colour extraction are a colour array that is then input into the database and a colour circle. The format of the colour array is [HTML colour code : ratio, ...]. For example, a colour image of hand held in an Indian mudra position found on page 2408 of scrapbook 12 produces a colour array:

```
[ '#af5e3f': 0.15059779754115143, '#423c3f':  
0.1901156424431803, '#53535e': 0.10588316463246357, '#c1b39f':  
0.09007914251885088, '#775647': 0.1448045473564262, '#b6967d':  
0.1815804467234641, '#997863': 0.1369392587844635 ]
```

and the colour circle:



Another example is the pink doodle found on page 1520 of Scrapbook 9. The resulting array is

```
[ '#d98cb2': 0.25782601856221488, '#bb4f80':  
0.74217398143778512 ]
```

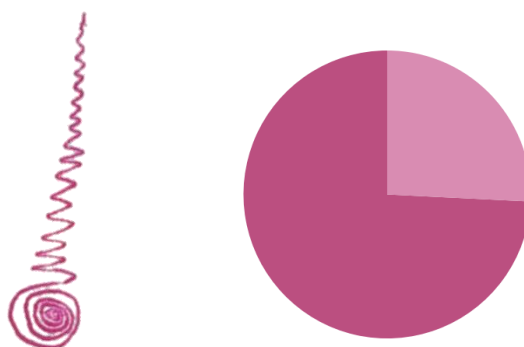


Figure 30 The original image of the pink doodle (p.1520/s.9) and the resulting colour circle

The dimensions are straightforward width and height of the individual image. From these metrics, we calculate the area. The area of the resulting colour circle corresponds to the area of the original image. While it is possible to create another representation of the colours, for example, a rectangle, we believe that circles are the simplest and most universal form.

3.2.4 Coordinate Extraction

Another manual work is involved in the coordinate extraction of the components, that is putting a small red dot on each component's supposedly centre. This is due to the difficulties faced

when trying to extract each clipping. There is no way to determine the centre if we cannot extract the clipping itself.



Figure 31 The red dots are put at the centre of each clipping component

We then clear the scrapbook page image, leaving the red dots on a white background. Next, we use Canny line detection and Contour detection (Rosebrock, 2016) from OpenCV to automatically find coordinates of the red dots.

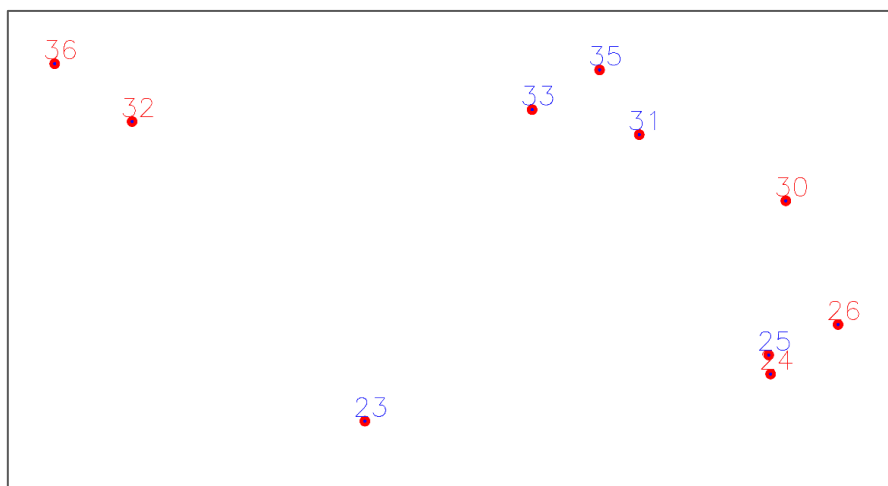


Figure 32 The algorithm finds the red dots automatically and assign a number for better readability

3.2.5 Creating the Colour Circle Renders

Combining the extraction of the colours and the coordinates as well as the creation of the colour circles we are able to create colour circle renders that we use in the eye tracking experiments explained in Chapter 5.

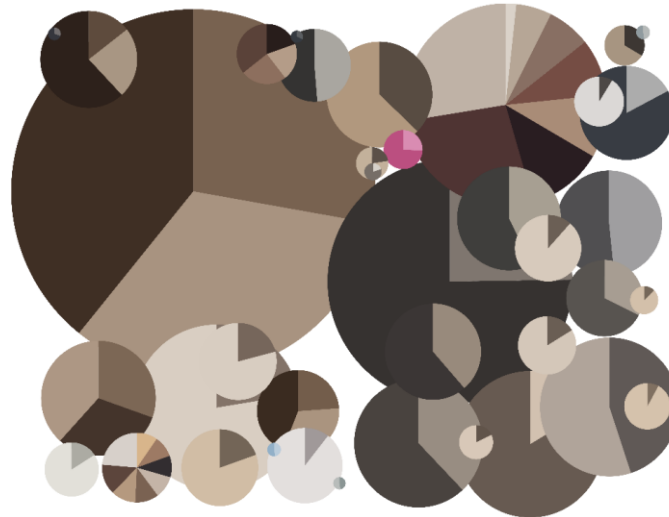


Figure 33 An example of the colour circle rendering: Page 1519/1520

3.3 Design and Implementation of the Prototypes

We proceed to the creation of the prototypes. Prototype 1 is our main pursue in this project, while the prototype 2 is the enhancement to the colour circle renders as we find that users are also interested in them.

3.3.1 Prototype 1

Before developing the prototype, we examine the columns in the table Item and Item_Element that are suitable for categories and attributes of the visualisation.

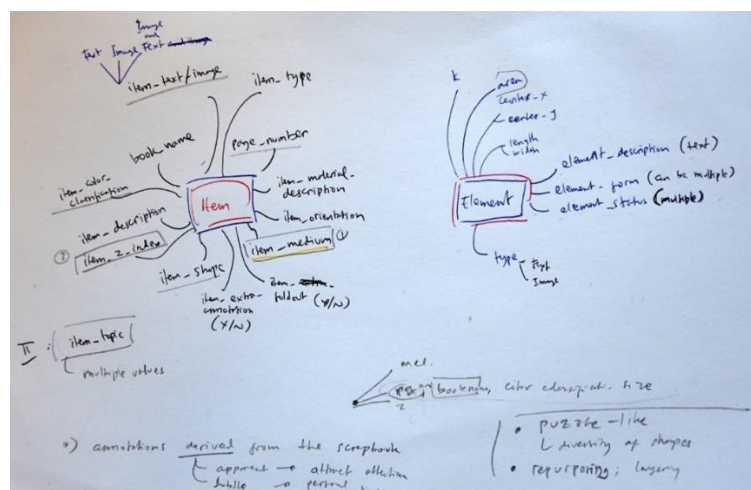


Figure 34 Columns of table Item and Item_Element

We find that the attributes that are suitable for a category are:

Item: item_medium, page_number, item_text/image, item_shape

Item_Element: element_z_index

After discussion, we decide to use `item_medium` as a filter and `element_z_index` as an initial category. We also consider `item_topic` as a category. However, it contains multiple values and thus more suitable for a word cloud.

The prototype departs from the idea of enabling the user to *explore the scrapbooks literally*. Initially, we imagine a jungle-like situation where the user makes his/her way throughout the forest of clippings. However, considering Morgan's interest in science and technology, we move to the idea of star constellations.

We also press the idea of breaking away from the organisation of the pages. This is because this artefact should work as a prototype of the *real dataset*—all the scrapbooks, but at the same time, we only have access to such limited dataset. By breaking away from the page arrangement, we try to make our small dataset looks larger than it actually is, hence represent the real dataset better.

While the idea starts as a Virtual Reality system, we revert to web browser-accessible visualisation because we want it to be widely available and easily accessible. However, it is still possible to fork the project and pursue the VR-mode in the future.

Architecture & Development

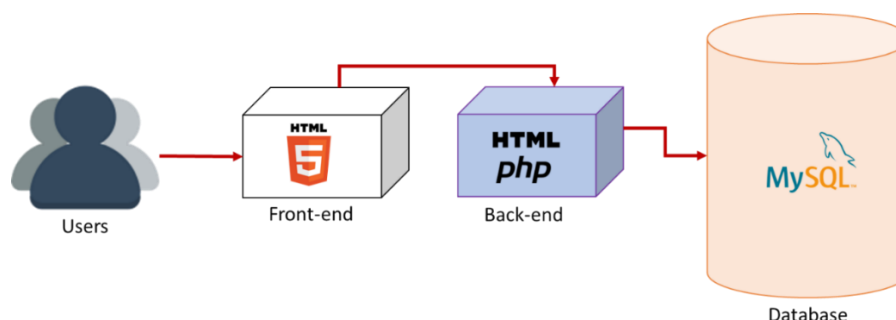


Figure 35 Architecture Prototype 1

We use the game development platform, Unity (Unity, 2017) to develop the prototype. We considered using Processing (Processing.org, 2017) as one of the most widely used data visualisation tools. However, it requires a steep learning curve compared to Unity. Furthermore, Unity is superior in building the 3D environment that we require. It is also capable of creating the VR environment we initially looked at.

The prototype is a multi-tiered system. Unity is capable of exporting the project into several platforms; WebGL/HTML 5 (The Khronos Group, 2017) being one of these. The front-end accesses a PHP (Php.net, 2017) back-end—that returns HTML responses, once at initialisation. At the time of the writing of this report, both front-end and back-end are hosted on the same machine at ECA Playground, College of Art, The University of Edinburgh. The PHP backend accesses the database on Amazon Web Services hosting a MySQL (Mysql.com, 2017) database.

Users visit the following URL to access the prototype:

<http://playground.eca.ed.ac.uk/~s1521283/morganshow/>

We use C# as the scripting language and write the codes in Microsoft Visual Studio (Crutchfield, P, 2017). While Javascript is available as an alternative, we are inclined to write in C# because we have developed more systems on the latter than the former.

Most of the 3D models are built using Sketchup (Sketchup.com, 2017), a 3D modelling software suitable for easily and quickly models simple shapes. Other models are available to use in Unity. The font we use in the application is Scotch Roman because it is the typeface of one of Morgan's most popular books, *The Second Life*.

Display

The clippings are the stars hanging in the sky while the user is standing on a platform, able to see 360° all around. The stars are put on the surface of an imaginary sphere around the viewer. The `element_z_index` dictates its elevation, but its placement within the belt is randomised. The angle of each elevation belt depends on the ratio of the items of that z-index to the whole items in the dataset—the more the element, the wider the angle.

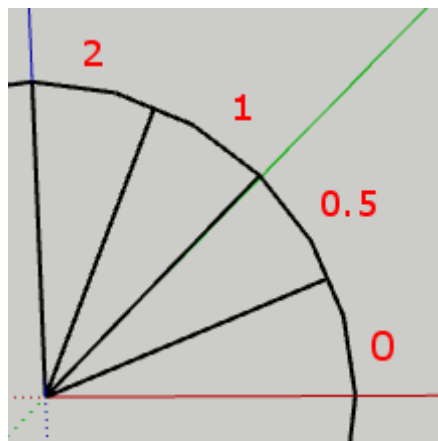


Figure 36 The elevation belt of a star is according to its z-index

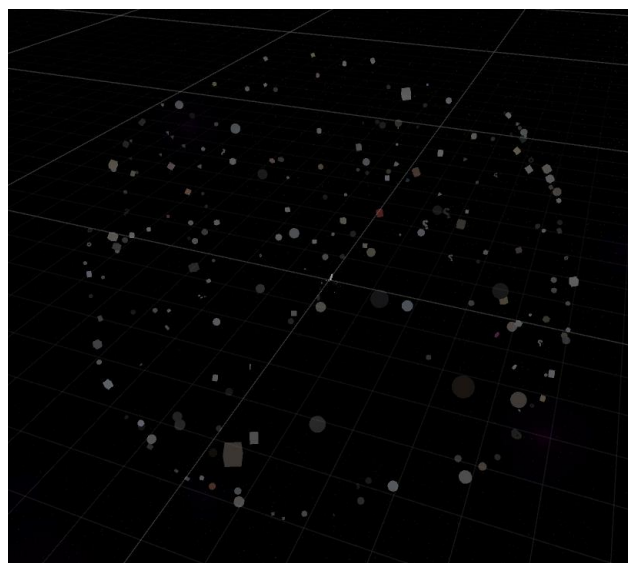


Figure 37 The stars are on a surface of a sphere around the viewer

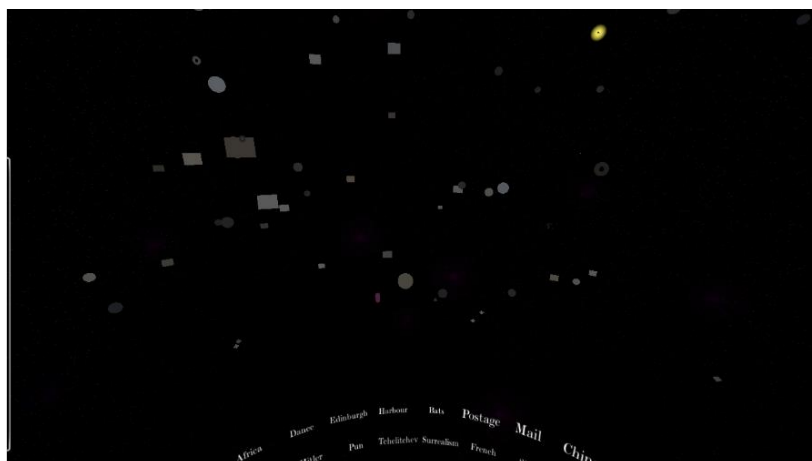


Figure 38 What the user sees on this prototype

Among the *stars* is a bright yellow dot serving as a guide so that the user can always find their way around.

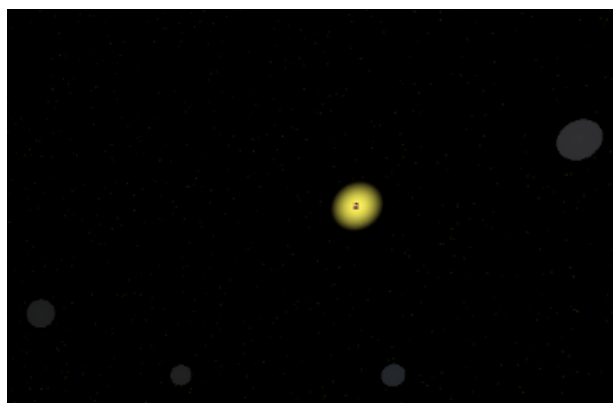


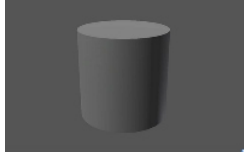

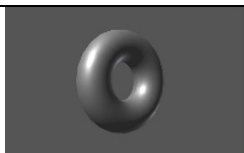


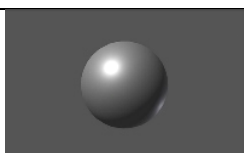


Figure 39 The yellow guide star

Each star is a data point, i.e. a record in the Item_Element table; a clipping component. It also rotates slowly to increase visibility. The shape corresponds to element_form. The legend is as follows:

Table 1 Legend of the shapes

	Original Artwork
	Printed Text

	Postage Stamp
	Stamped
	Original Photograph
	Handwritten Text
	Uncertain Photo/Image/Picture Source
	Published Photograph or Image/Picture

We realise that these shapes are detached to what they represent. We have discussed the possibility to create 3-dimensional icons that represent the different forms better. However, we also must accept that the time available does not allow for the creation of these icons. These shapes, then, serve as a placeholder which will be replaced in the future.

Nevertheless, we try to create some inferences with these basic shapes. For example, handwritten text and printed text are symbolised by shapes that do not have any spherical aspect; a pyramid and a cube, respectively. Similarly, we symbolise photographs and pictures with spherical shapes; a sphere and a torus.

The colour of the shapes is the most prominent colour extracted from its corresponding clipping component. For example, the pink doodle mentioned in section 3.2.3 is represented by a pink capsule.



Figure 43 Side-menus for Filtering (left) and Grouping (right)

Navigation

Navigation is performed using the mouse. The camera moves as the mouse moves. Clicking on a shape will cause the camera to zoom into the shape and enter zoom in mode. Clicking again on the shape in this mode will cause the camera to zoom out and return to its initial view.

When developed in Unity, we can move indefinitely using the mouse; thus, it is easy to navigate around. However, the web browser seems to cancel this ability. To alleviate this limitation, we provide a screen-freeze function. This function is activated and deactivated, as a toggle, by double-clicking or right-clicking anywhere on the screen. When used cleverly—freeze on one edge, unfreeze on another edge—the user can navigate anywhere around.

Functions

There are three main functions in this prototype:

1) Zoom-in/Zoom-out

As mentioned previously, this is accomplished by clicking on a shape. When in zoom-in mode, the shape is displayed bigger, and two information panels appear. The left panel contains identification of the clipping (component and clipping number, as well as page and scrapbook number) and clipping and component descriptions. The right panel contains the colour circle mentioned in Section 3.2.3, its medium, type, status, and topics. The bar charts of medium, type, and status are displayed as a ratio of that particular value to all other values.

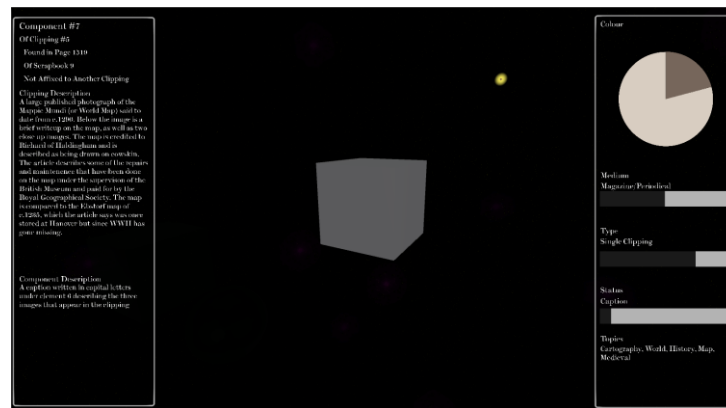


Figure 44 Zoom-in mode display



Figure 45 About half of the dataset are of medium Magazine/Periodical

Clicking on the shape again when in zoom-in mode will zoom the camera out to the default view; retaining any previous filtering or grouping.

2) Filtering

There are two ways the user can filter the elements: by Topic and by Medium. Filtering by Topic is accomplished by clicking on a word in the word cloud around the base panel. Filtering by Medium is accomplished by clicking a medium on the left side-menu. Both achieve the same effect: irrelevant elements fade out while the relevant ones stay, and the camera looks at the first element staying opaque. Resetting the filter is accomplished by clicking the Reset button on the left side-menu.

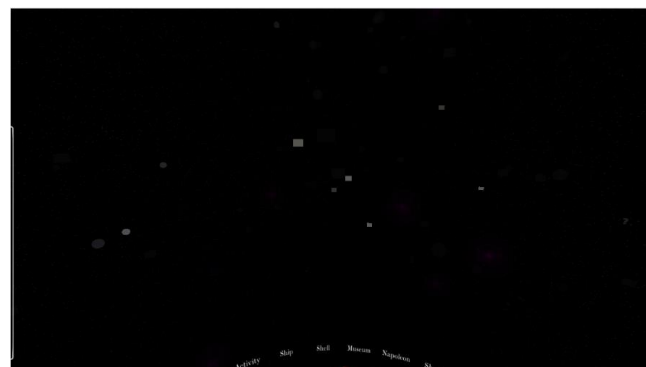


Figure 46 Filtering in effect

The filtering works exclusively, that is, the user cannot filter by medium and topic at the same time. Filtering by topic also works in the same way, respective to other topics. This means the user can only filter by one topic at a time.

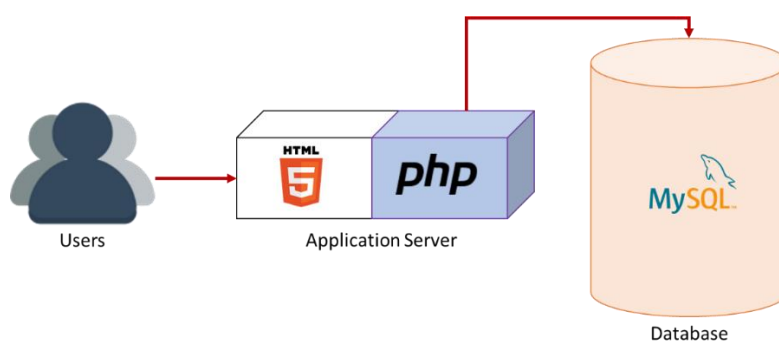


Figure 48 Architecture of Prototype 2

Slightly simpler than the primary prototype, this system has fewer components: a database and an application server. The application is written on PHP, HTML and CSS, accessing the same database as the first prototype.

Users visit the following URL to access the prototype:

`http://playground.eca.ed.ac.uk/~s1521283/morgan/circles/circles.php`

Display

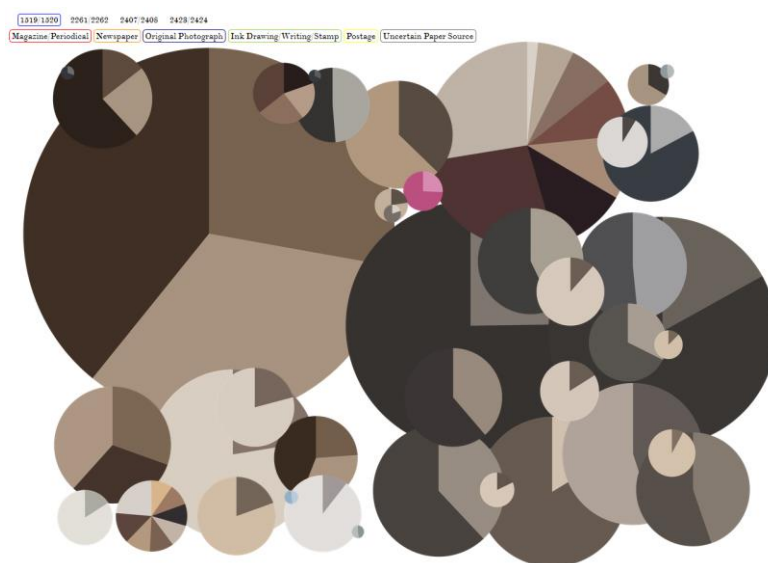


Figure 49 First page of the prototype

The initial display shows the colour circles on each double-page, links to other pages and legend of the medium on top of the page. Each circle is a clipping component. The size corresponds to the component's original area, and the coordinate reflects its centre's coordinate.



Figure 50 The legend explaining the different mediums of the clipping components

However, the layering of the circles does not reflect their original z-index. Here, they are arranged in such a way that the bigger circles are at the back, allowing the smaller ones to be visible.

Navigation & Functions

The navigation is performed using the mouse. The links at the top of the page take the user to the others pages.

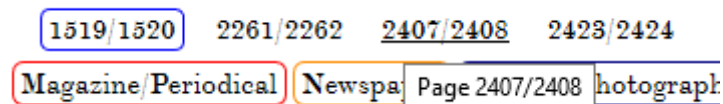


Figure 51 The links to other pages at the top of the page

When the mouse is hovering on a circle, a semi-transparent panel appears containing clipping and component descriptions. A colour border indicating the medium is also displayed.

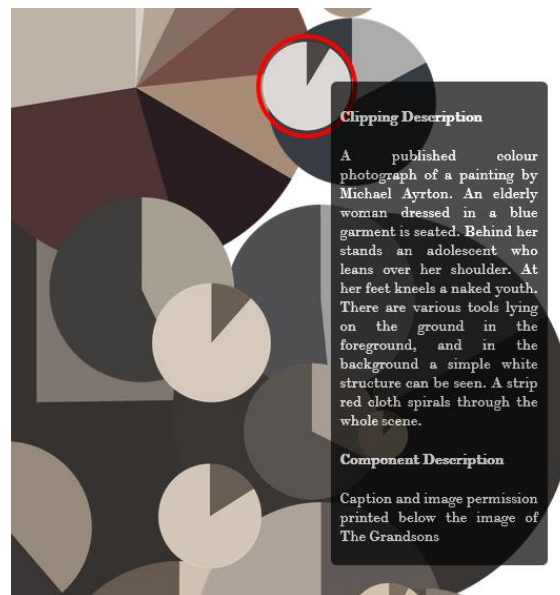


Figure 52 On mouse hover

When a circle is clicked, the description panel becomes opaque and stays on the screen along with the border. Also, the circle is brought forward. Clicking again on a chosen component will un-choose it.

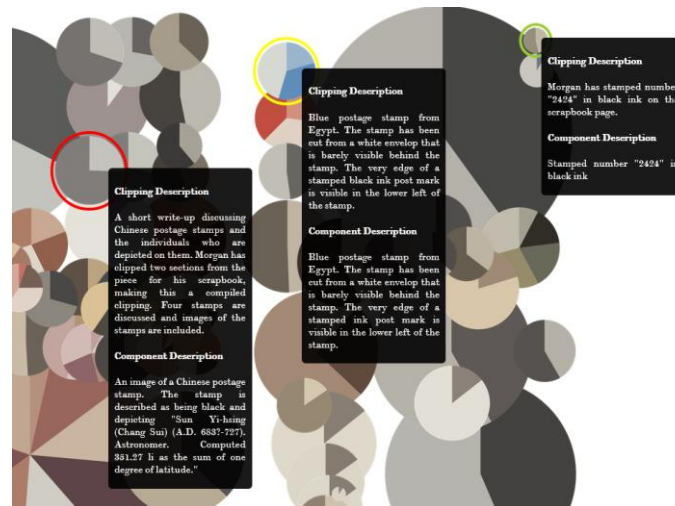


Figure 53 Several components are clicked

The Purpose Map

	Explanatory	Exhibitory	Exploratory
Reading			
Feeling			

Figure 54 The secondary prototype on the Purpose Map

Obviously, this visualisation is more exhibitory because it only shows the data as it is and lacks interfaces that encourage exploration of the dataset. The descriptions are annotations confirm its *reading* characteristic. However, users can still have a feeling of the data—by their colours, on each page.

CHAPTER IV EVALUATION

In this chapter, we present the qualitative analysis of the evaluation that we perform on both prototypes. While there are two prototypes to evaluate, each has different rationale and process, thus we do not intend to compare one to another.

We choose to conduct usability study on both prototypes to understand how easy they are to interact with and find out whether they stimulate the users' interests toward the original scrapbooks. We do this study using think-aloud protocol (Ericsson and Simon, 1984) and System Usability Scale (SUS) questionnaire (Usabilitynet.org, 2017) because these techniques are inexpensive and easy to perform while still offering reliable outcome (Nngroup.com, 2017) [2].

However, we understand that there several downsides to the think-aloud protocol. These mostly are related with the unnatural situation that the protocol may create. For example, it is uncommon for a normal person to utter words to himself/herself when performing a task. Furthermore, the participant might feel being evaluated rather than the artefact. This in turn can lead to he/she saying filtered statements instead of what he/she really thinks.

To alleviate these problems, we accompany the participants and ask questions every time they stop talking. We believe this will also minimise the chance they speak filtered statements.

Later we transcribe the evaluation interviews and think aloud sessions. We then perform content analysis on the transcription, looking for positive and negative comments, as well as suggestions on the prototype. We also make notes on some interesting behaviours that may help improve the prototype in the future.

Finally, we ask the participants to fill a SUS questionnaire to produce a qualitative overview of the prototypes' usability. SUS questionnaire is a dependable and affordable tool to quickly measure the relative usability of a system. It is 10-question document assessing the need for support, training, and complexity. Furthermore, the questions are formatted as such it encourages thoughtful responses.

4.1 Participants

As mentioned in Chapter 2, we look for participants that are not academically stimulated to Edwin Morgan scrapbooks as the domain of this project, but share minimum interest to aspects of the project. However, due to the limitation of resources, we cannot strictly look for only these types of participants.

On the other hand, we think that it is going to be useful that we receive feedback from designers. Thus, we ask our colleagues in Design Informatics to assess the prototypes. Furthermore, we also think that it is useful to invite people from other disciplines as a comparison.

Another limiting factor is that only one of the total of eleven participants is a native English speaker. We appreciate that this might affect their behaviour when interacting with the artefact because the language used in the interface and the dataset is English. Furthermore, this makes

transcription slightly harder as sometimes we do not clearly understand the participants' utterance.

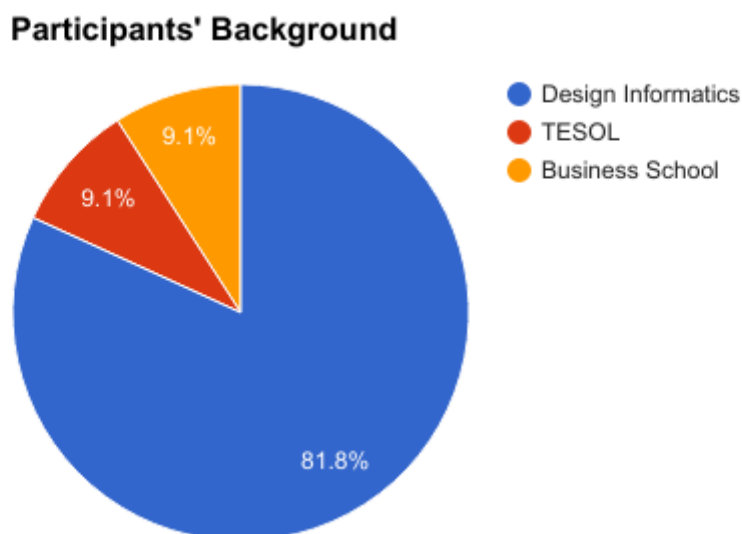


Figure 55 Academic Background of the participants of the evaluation

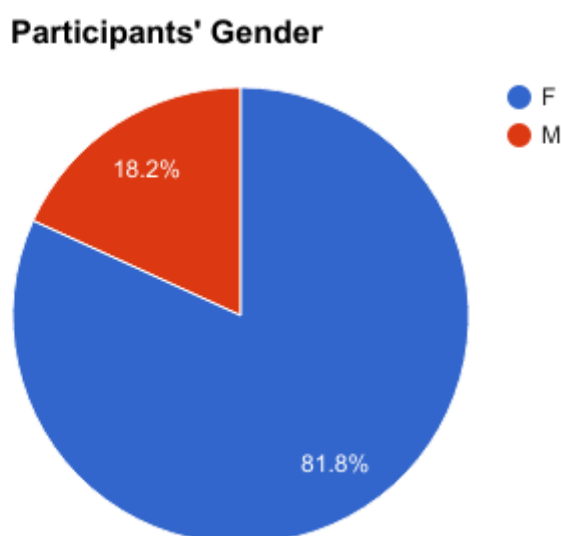


Figure 56 Gender of the participants of the evaluation

4.2 Setup and Procedures

The setup includes a 23.6 inch LED monitor on 1920 by 1080-pixel resolution, a computer mouse, and a sound recording device. The size and resolution are the minimum required to amplify the effects of the outer space representation.

Initially, we perform the sound recording using Zoom H1MB Handheld Recorder, which later was switched by a mobile phone when the battery ran out. We record the participant's activities during the think-aloud session using VSDC Screen Capture software, which also records his/her speech, even though in smaller volume.

Generally, we ask the participants to evaluate both prototypes. However, when time does not allow this, we prioritise Prototype 1 as it is our primary artefact in the project. The screen recording is also performed only on the first prototype because of the same reason. Each session runs as follow:

1. Explain the techniques used and train the participant to perform the think-aloud protocol when necessary. We use this prompt to train the participant:

Try to visualize the place where you live, and think about how many windows there are in that place. As you count up the windows, tell me what you are seeing and thinking about. (Willis, 2005)

We may also show a short video (Nngroup.com, 2017) [1] showing a usability study of a website using the think-aloud protocol.

2. Explain the background and context of the project. We prepare a short document describing the project background—Edwin Morgan scrapbooks, and the general rationale of the prototypes. When needed—for instance the participant does not know what a scrapbook is, we show the Edwin Morgan scrapbooks Flickr page (Flickr, 2017) [1].
3. Conduct the pre-test interview, asking:
 - a. What aspects interest you in participating in this evaluation?
 - b. Do you know about Edwin Morgan prior to attending this session?
 - i. How interested or not are you in his works?
 - c. Do you know about his scrapbooks prior to attending this session?

How interested or not are you in the scrapbooks?
4. Conduct the think-aloud session for Prototype 1. We prepare a short note explaining different shapes, navigation, and other visual cues. We ask the participant to say whatever he/she is looking at, thinking, doing, and feeling at each moment (Crawford and Whyte, 1991). We also ask him/her to speak loudly and clearly.
5. Conduct the post-test interview, asking:
 - a. This prototype is developed to make you be (or more) interested in the Scrapbooks. Is this successful or unsuccessful?
 - b. Do you have any further suggestions that may improve this prototype?
 - c. There is a limitation for developing this: the original clippings are subject to copyright. In representing the clippings without showing the original images/text, is this prototype successful or unsuccessful?
6. Ask the participant to fill the SUS questionnaire for Prototype 1.
7. Offer a small discussion regarding their previous experience and further explanation about the project.
8. Conduct the think-aloud session for Prototype 2.
9. Ask the participant to fill the SUS questionnaire for Prototype 2.



Figure 57 A participant is assessing Prototype 1

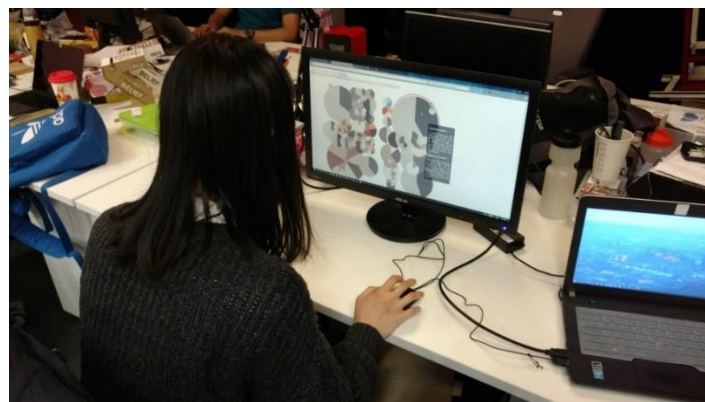


Figure 58 A participant is assessing Prototype 2

4.3 Results

4.3.1 Prototype 1

Pre-test interview

Most of our participants attend the session because they are either interested in the domain-related topics (Edwin Morgan, poetry, scrapbooks) or the theme of the project—Data Visualisation or both. However, three of them are interested in other topics, such as the eye tracking technology that is used before, or just curious about the project because this is new to them.

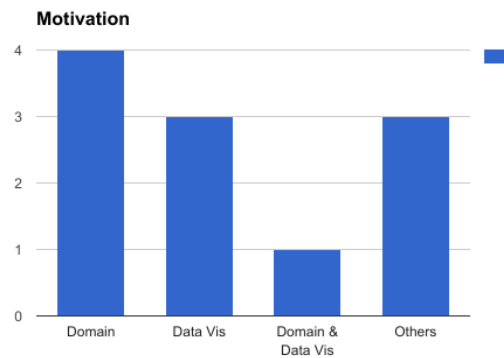


Figure 59 Participants' motivation for attending the evaluation

As we have explained previously, the participants have little to no knowledge of Edwin Morgan and his scrapbooks. However, some of them have attended the eye-tracking experiments previously, and thus have seen the scanned scrapbook pages. Furthermore, we also provide brief explanation about the project's context and background to the participant in the beginning of each session.

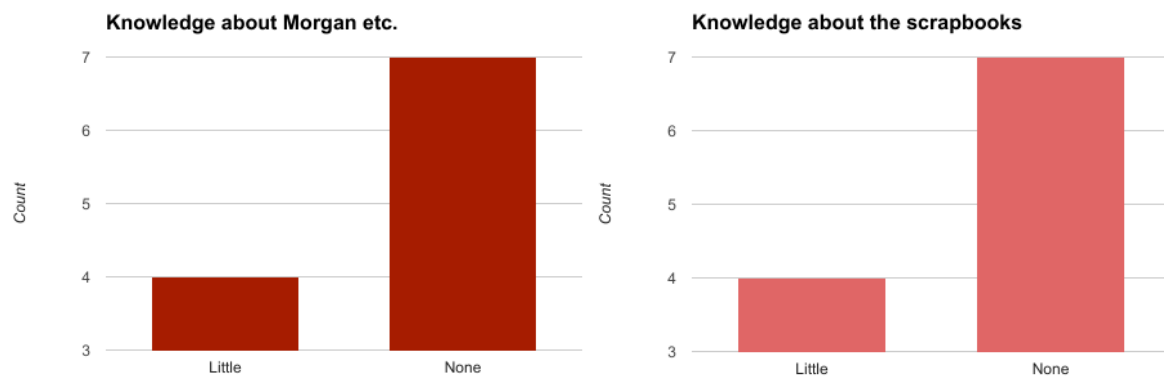


Figure 60 Participants' knowledge about Edwin Morgan and his works and the scrapbooks

Think-aloud session

On average, users spend about 15 minutes exploring the prototype. However, some users spend twice more or less time than the average.

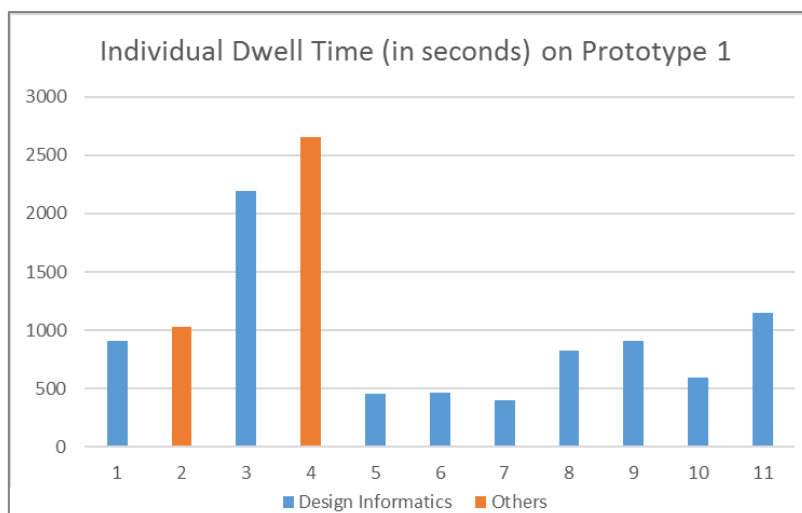


Figure 61 Individual Dwell Time (seconds) on Prototype 1

The descriptive statistics is follows:

Table 2 Dwell Time (seconds) on Prototype 1

	N	Minimum	Maximum	Mean	Std. Deviation
Dwell_Time_1	11	399	2652	1052.91	728.058

The following graph illustrates the overview of the time spent on Prototype 1. In general, Design Informatics participants spend less time interacting with the prototype. However, we understand that the size of the samples of the “Others” group is not enough to justify this difference.

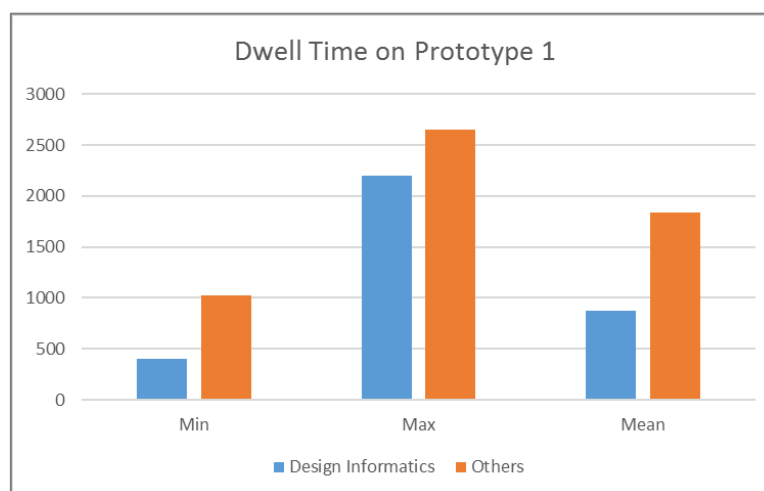


Figure 62 Dwell Time (seconds) on Prototype 1 per user groups

Positive remarks

Most participant says that the unusual interface is interesting, while the outer-space theme provokes imagination and makes them curious. At least four of them express their fond of the literal explorability characteristic of the prototype.

Some of them comment on the grouping feature. These comments are either related to its visual aspect—e.g. *they look like a sun, full of energy*, or that they find the feature gives them enough information regarding how the shapes (the different clipping components) connect to each other.

Two participants give positive remarks on the yellow star, saying that it helps them know their position and that it grabs their attention quicker than the other shapes. Another participant looks for element of consistency and says that she finds it quite consistent. After playing around for some time, she also expresses her comprehension of the prototype.

Negative remarks

There are more negative opinions than the positive ones, even though they are sparser. The one thing most of the participant criticise is that the shapes are not associative to the ideas they represent. This is expected, considering we use these basic shapes as a placeholder and plan to improve them in future iterations. Other comments regarding the shapes are that their colours are too dark and look similar and it is hard to remember the position of the shape. Thus, it is also difficult to look for a particular shape later.

Some participants seem confused about how the filter feature works. Some others find that the information on the right panel when zooming in is difficult to comprehend. Looking at the word cloud, one participant notes that some words are too either too cluttered or far away. It also seems that they feel that the descriptions are too long and boring, thus making the experience a little dull without the original clippings.

Regarding the navigation, the web-based characteristic seems limiting as it does not allow true borderless scrolling experience. It takes time for the participants to be used to the screen freeze feature, because sometimes they are stuck on a frozen screen and do not remember what happened or what action to take.

In the initial evaluation sessions, the camera does not stay after panning after a filtering event took place, and this confuses the participants. We have fixed this for the few last sessions, and we have not received any further complains on this.

Suggestions

Agreeing with some of the negative comments, most participants are concerned about how the shapes should make more obvious association with the clipping element's forms they represent. They also ask for the shapes to be more visually appealing through, possibly, the use of brighter colours. Furthermore, a lot of them wish that they could see the original clippings rather than just descriptions and a random shape.

Other suggestions include the inclusion of more feature and information to the current interface; more information to see and more options to click. One participant suggest adding values to some of the visual cues; for example the rotation of the shapes and the colour of the grouping lines. Another suggest that the legend should be incorporated into the interface and that more annotations may be needed to inspire actions, for instance, on the word cloud.

Other useful suggestions are the addition of visual cues to the objects with which the participant has interacted and the ability to unselect active filter or grouping, thus nullifies the necessity for the *Reset* buttons.

Notable behaviours

- Some participants seem to spend a lot of time trying to figure out what the word cloud represents. They keep theorising what connects them together.
- A participant tries to click everything; the yellow star, the EM initials, the charts on the zoom-in mode.
- They try to compare different shapes. And this is difficult because there is no direct way to find a particular shape.
- The fact that the filter works by fading out unselected elements does not seem apparent to the participants.
- The colour circle does not seem to be an obvious representation of colours. We think this is due to the lack of context where it is displayed.
- One participant says that she would like to see it in a Virtual Reality environment.

Post-test interview

Most participants agree that they are more interested in the scrapbooks after interacting with the prototype. Some of them see the lack of information presented as a reason to go and see the original archive. Slightly lower is the number of the participants who agree that the prototype is a successful alternative representation of the clippings.

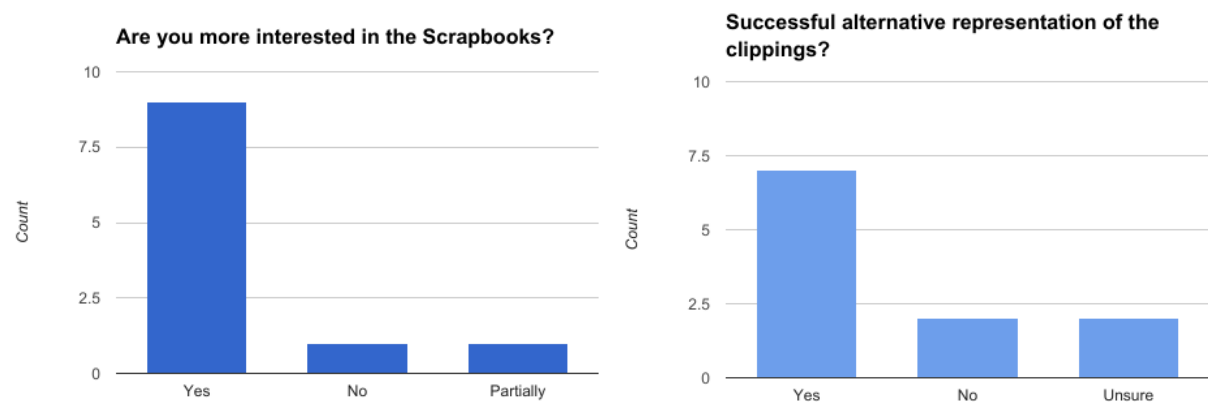


Figure 63 Post-test interview: How successful the prototype is

SUS Score

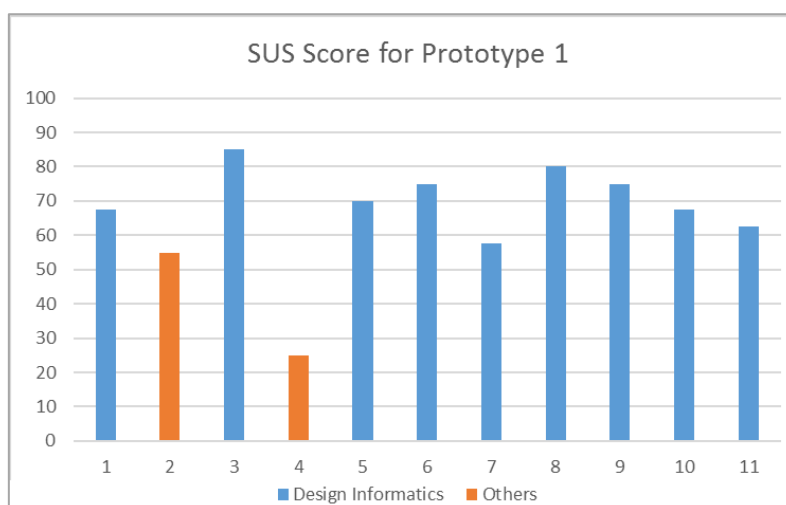


Figure 64 SUS score for Prototype 1

A SUS Score is between 0 to 100 and intuitively tells a system's usability overview. The average of SUS Score for this prototype is 65.45. All except Participant #4 gives a score higher than 50.

4.3.2 Prototype 2

The participants spend less time exploring the second prototype. We understand that this is because there is fewer features on this artefact in comparison the first. As seen from the graph below, we did not enrol participant 4 and 10 in this session due to the limited time available on their part.

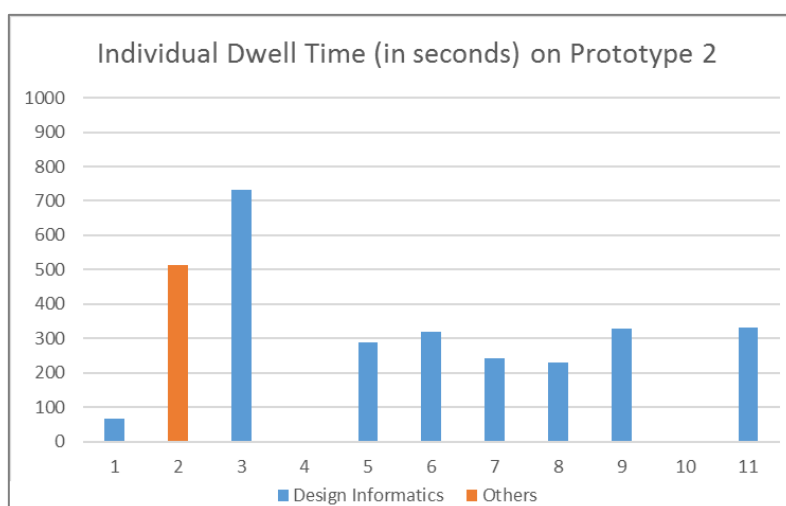


Figure 65 Individual Dwell Time (in seconds) on Prototype 2

The average time spent is around 5 minutes, three times less than the first prototype. The descriptive statistics is as follows:

Table 3 Dwell Time (seconds) on Prototype 2

	N	Minimum	Maximum	Mean	Std. Deviation
Dwell_Time_2	9	67	733	338.89	188.261

Positive remarks

The most obvious feature that attracts the participants is how colourful the interface is. One participant thinks the white background helps creating this effect. Another participant says that she is able to immediately see the colour of the page through this visualisation.

The simple navigation and mechanism make it easier for the participants to understand the interface and further retrieve information. A participant also thinks that it is useful to be able to bring a colour circle to the front by clicking on it.

Negative remarks

Amusingly, some participants think that it looks a little more cluttered. It is also difficult to understand how the different circles are connected. One participant says that the description box is too long, while another thinks that it is more static than the first one.

Suggestions

A participant suggests that it would be better if the user did not need to scroll down. Another participant thinks that it could be more interesting if the circles were not static, for example floating. Lastly, a few participants suggests that the legend needs to use different visual cues than the links to the other pages.

Notable behaviours

- One participant combine the information she gathers from the colours and the description to explain what an element originally is.
- She also compares what types of element is present on a page and not on others.
- A participant has a difficulty when attempting to unselect the circles.
- The participants who have never seen the scrapbook pages nor attended the eye-tracking experiments do not seem to notice that the circles are placed on certain coordinates following the original layout. Rather, they try to understand the connection between intersecting circles.
- A participant tries to drag the colour circles.

SUS Score

The average score for the second prototype is significantly higher at 80.

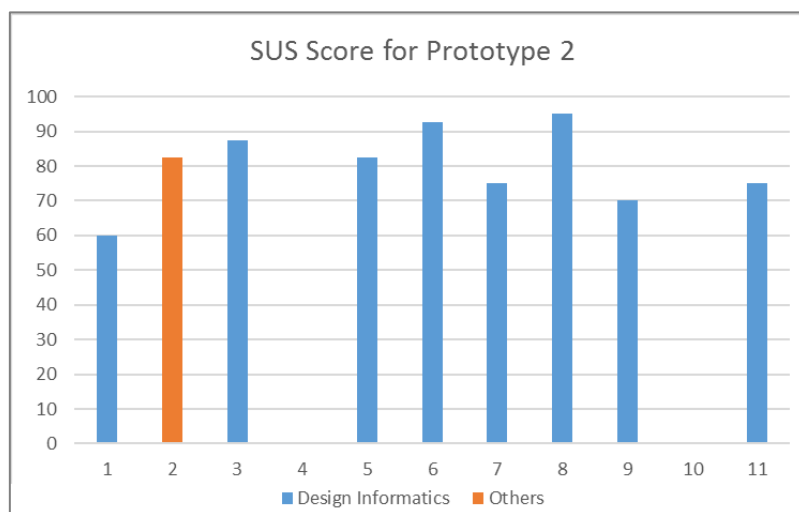


Figure 66 SUS score for Prototype 2

CHAPTER V EYE TRACKING EXPERIMENTS

5.1 Motivation

As we mention in Chapter 2, Edwin Morgan scrapbooks are quite complex materials from which to produce alternative representations. This statement remains true even for the sample eight pages that we possess. There are a lot of different aspects hidden in a simple page; colours, the juxtaposition of clippings, images, readings, topics, contrasts, etc. Therefore, in the attempt to uncover the key aspects of the scrapbooks we look not only at the pages themselves but also at how they are viewed.

The eye tracking experiments pose as a complementary method in attempting to extract the attributes of the clippings using Computer Vision techniques as discussed in Chapter 3. Through this experiment, we are trying to understand the visual aspects that are of the greatest importance to the scrapbooks viewers. We perform this by comparing the participants' viewing behaviours of the original four double-page scanned pages, two sample black-white line renderings, and four line-circle renderings.

In this project, we appreciate the viewing behaviour using the areas of focus, dwell time, fixation count, and fixation duration. While there are a lot of other metrics than we can measure, we find that these are the simplest to retrieve and understand, while still giving useful insight.

Initially, we also wanted to perform the eye tracking experiments to the real pages of the scrapbooks. However, this could not be done due to technical difficulties. The scrapbooks, like other archives, cannot leave the University of Glasgow Library where it is preserved. On the other hand, the eye-tracking apparatus that we use are not portable and cannot leave the laboratory in Informatics Forum, at the University of Edinburgh.

Also, we are also interested in investigating users' viewing behaviours when they are given the opportunity to zoom into certain parts of the scrapbook pages. This includes investigating whether they can obtain new information and comparing the time spent on the full image to the detailed image.

Finally, we also look at how the users are reading a few of Edwin Morgan's concrete poems as a corroboration to the argument that the scrapbooks may have certain similar visual properties to these poems.

5.2 Participants

As mentioned in Chapter 2, we are interested in uninitiated users, who might have interests, however slight, in Edwin Morgan, his scrapbooks, his works, or other things that are related to this project, but not looking to study these topics through the prototypes academically. Thus, we assume that whoever answers our calling to participate in the experiments do have some interests in the topics above.

We send the invitation through emails, social media (Facebook), and personal communications, asking people to participate. We initially set the target number of the participants to 20 to ensure the quality of the gathered data. However, our invitation seems to find its way to various groups and brings us a total of 27 participants, consisting of 9 males and 18 females, from diverse

academic backgrounds—Linguistics, English, Medicine, Business School, Informatics, are a few examples. All the participants are affiliated with the University of Edinburgh, either as students or staff.

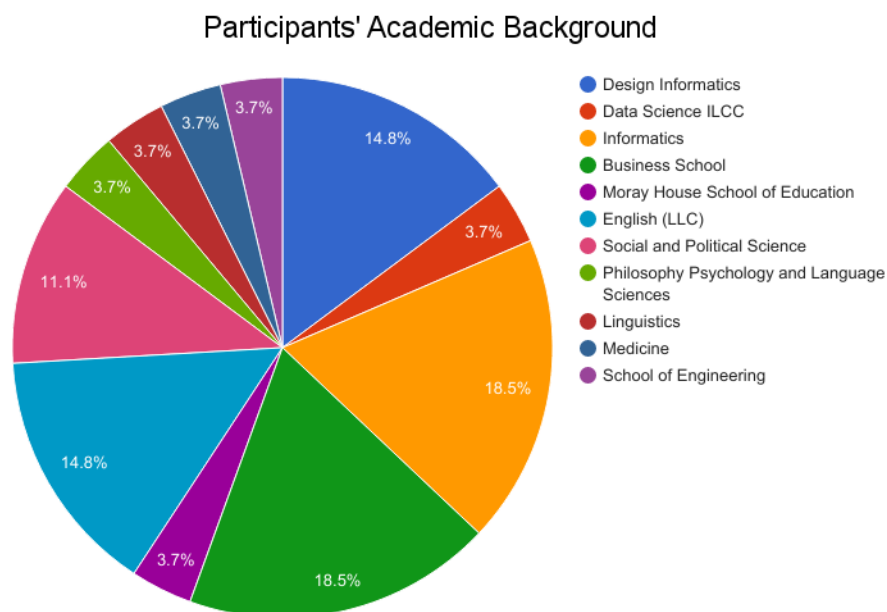


Figure 67 Eye Tracking Participants' Diverse Academic Background

As displayed in the pie chart below, more than a half of our participants are quite young and might not be so familiar with the idea of *scrapbooking* and probably more used to its digital alternatives, such as *bookmarking*, *blogging*, and *posting on social media*.

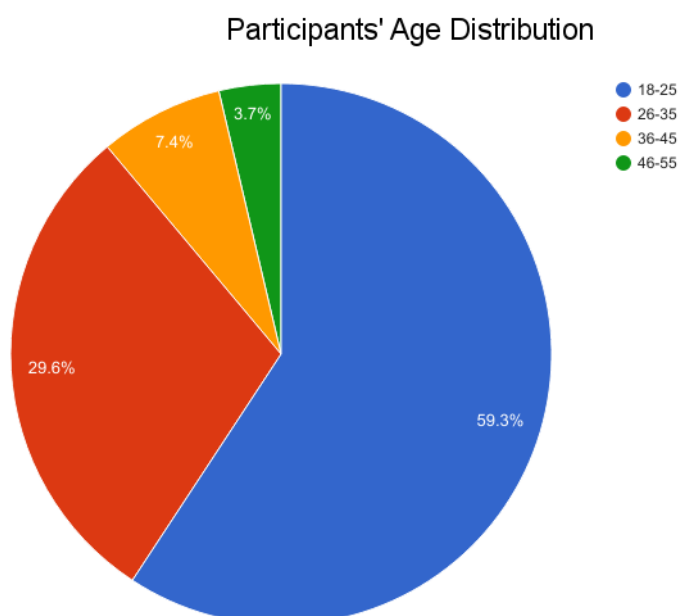


Figure 68 Eye Tracking Participants' Age Distribution

Two third of our participants are female as shown by the pie chart below.

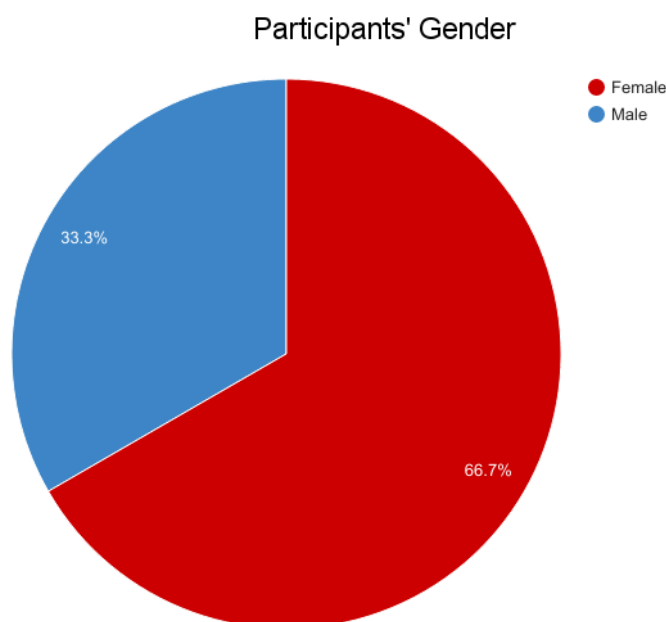


Figure 69 Eye Tracking Participants' Gender

All participants are required to sign a consent form—presented in Appendix, stating that there is neither known risk nor remuneration in participating in the experiment. Participants decide whether we may take their picture during the session. Some allow this, while the others do not. They are also allowed to leave at any given point during the session, but none does.

5.3 Setup and Procedure

In this section, we explain how we prepare the experiments material, the devices that are used, and the procedure of the experiments.

5.3.1 Material Preparation

We use a total of 23 screens in the experiment. These are:

- 1) Two training images. Both images are acquired from the University of Glasgow Library's Edwin Morgan album on Flickr. Both images are from Scrapbook 12 (1954-1960). The first image is the page 2251/2252 (Flickr, 2017) [3], and the second is 2243/2244 (Flickr, 2017) [2].
- 2) Four main original images. These are the four scanned double page images of the scrapbooks to which we have access. They pose as our main dataset, and we present them in Appendix. The order we show them is as follows:
 - a. Page 1519/1520
 - b. Page 2261/2262
 - c. Page 2407/2408
 - d. Page 2423/2424
- 3) Eight detailed cropped images. These are manually selected and cropped parts of the four double pages. Every detailed image belongs to a page from our dataset. Since they belong to the main dataset, we present them in Appendix as well. The order follows the main images.

- 4) Two line-detection renderings. We apply Canny line detection algorithm mentioned in Chapter 3 to page 1519/1520 and 2423/2424.
- 5) Four colour-circles renderings. These are the colour circles renderings that are results of our exploration in trying to create artistic representations of the clippings using Computer Vision techniques described in Chapter 3. The four renderings are based on the four original main images and are displayed in the same order.
- 6) Three concrete poems. The three concrete poems that we include in the experiments are Archives, Siesta of a Hungarian Snake, and Pomander.

As mentioned at the beginning of this chapter, the inclusion of these materials is to serve our objectives in the experiments:

1. Analysing participants' gaze behaviours on the scanned scrapbook pages.
2. Comparing participant's gaze behaviours on the original scanned images, the line detection renderings, and the colour circle renderings.
3. Comparing participants' gaze behaviours on the Interest Areas with the detailed cropped images.
4. Analysing participants' gaze behaviours on the concrete poems.

We include the first two training images to adjust the participants' viewing behaviour to view scrapbook pages. Unlike books or other ordinary pages, viewing a scrapbook page can be confusing and chaotic, especially when performed in an experiment. By training the participants using these images, we aim to make them more comfortable and used to viewing scrapbook pages.

We include the four original main images as the main object we ask the participants to perceive. We will then compare their viewing behaviours in regards to the two types of renderings. In addition, we also compare every Interest Area on each page to its respective detailed image.

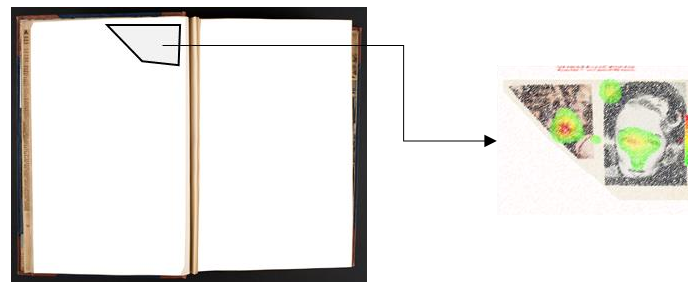


Figure 70 Comparison of an Interest Area (IA) to a cropped image

We include eight detailed images to compare the participants' viewing behaviours when they see the clippings in the large main image to when they are zoomed in and thus provide more details. The eight detailed images are:

- 1) Two small clippings on the top right corner of page 1519. The first clipping shows a rugby player wearing a gold-colour helmet which is quite obscured when displayed in the full-page image. We would like to see whether the participants can recognise this when zoomed-in.
- 2) The collage from page 1520 showing a head statue and a young man looking up, with the *glowworm* cave as the background, along with the captions. This collage is rotated

90° counter-clockwise to accommodate reading. We would like to see whether the participants read the captions.

- 3) Three medium-size clippings on the bottom right corner of page 2261. Page 2261 is quite text-heavy, causing these chosen clippings not receiving much attention. We would like to see whether isolating them would encourage the participants to pay more attention to them and thus bring about new information.
- 4) Four small image clippings on the top of page 2262. These images are difficult to see in the full-page image; thus, we want the participants to have a chance to look at them in more detail.
- 5) Three medium-size clippings and a small printed text “theories of Aristototele” from the bottom part of page 2407. Most of this cropped region is printed text containing the word “Shakespeare”, which we believe that most participants will recognise. On the other hand, there is a clipping of an image that is very difficult to comprehend. We are interested in understanding how the participants react to these contrasting parts.
- 6) Seven clippings from the middle-upper part of page 2408. This region contains mostly images of or related to hand, except the small clipping showing a doll’s head. We are interested to see whether the participants will pay attention to this tiny head.
- 7) 11 postage stamps, two black and white images, and a small blue-inked doodle from the middle region of page 2423. Arguably, this is the most colourful part of the page and thus supposedly attract attention. We would like to see whether the participants will benefit from the zoomed-in.
- 8) Seven small-size clippings including a short article from a newspaper from the middle region of page 2424. There is not much colour in this region, but there is some text that the participants can read. We would like to see whether the participants will read this text and how they will perceive its surrounding images.

We include 2 Canny detection line renderings to compare participants’ viewing the images of the scrapbook pages in more abstract and colourless renderings. There are only two renderings because we do not pursue artistic representation through this technique and are interested in them only as a comparison to the original images.



Figure 71 Canny line detection rendering of page 1519/1520

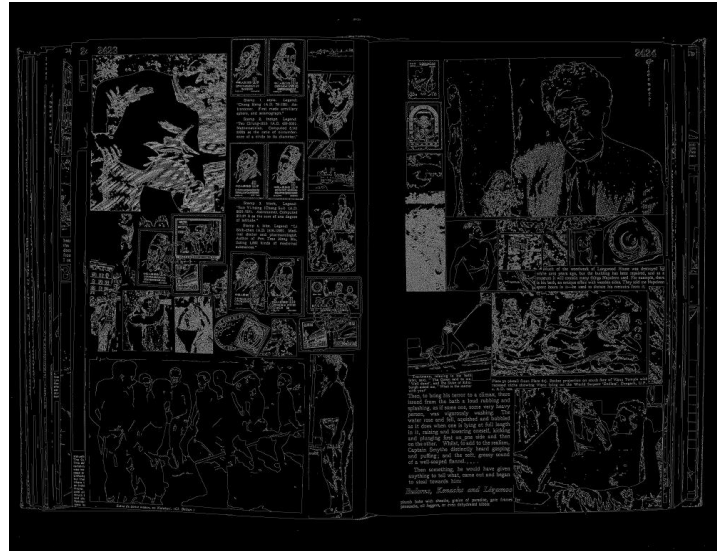


Figure 72 Canny line detection rendering of page 2423/2424

We include the four colour-circle renderings as the main comparison to the original full-page images. These are a result of our attempt to create alternative artistic representations of the scrapbook pages on the level of clipping's component.

As mentioned in Chapter 3, the colour circles are the representation of colours of each clipping's component. After creating a colour circle for each component, we reconstruct them based on their original location on the scrapbook page. However, in this form, we cannot maintain the original layering (z-indexing) because some colour circles are bigger than the others. If we insist on the original layering, some small colour circles will be covered by the bigger ones. Instead, we arrange the circles so that the bigger ones are rendered first, making sure all circles are displayed either wholly or partially.

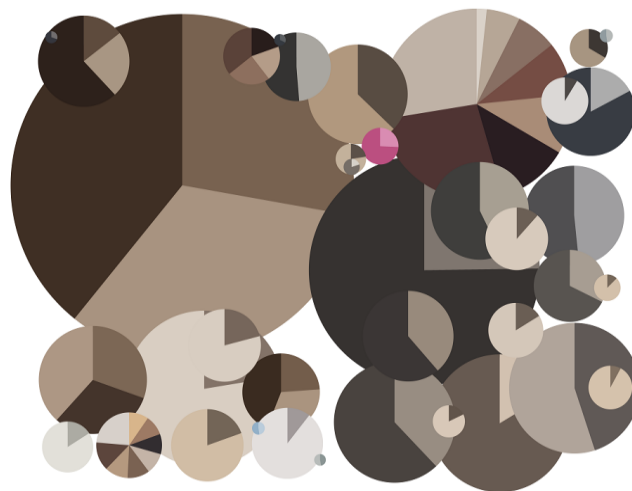


Figure 73 Colour-circle rendering of page 1519/1520

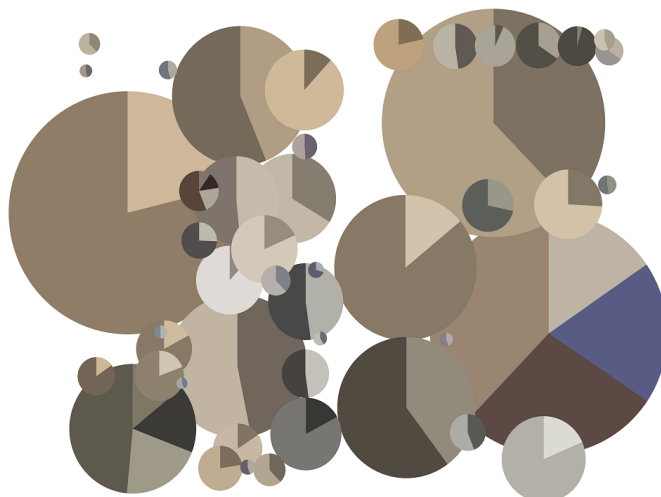


Figure 74 Colour-circle rendering of page 2261/2262



Figure 75 Colour-circle rendering of page 2407/2408



Figure 76 Colour-circle rendering of page 2423/2424

Finally, we include three sample Edwin Morgan's concrete poems as an extended interest that is not directly related to the scrapbooks—general viewing behaviour of the concrete poems, and as a comparison to the viewing of the scrapbook pages.

Archives

generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
generation	upon
gneration	upon
gnerat	n upon
gnerat	n p n
gerat	n p n
gera	n p n
gera	n n
ger	n n
gr	n n
g	n n
	n
g	

*Figure 77 Archives from Edwin Morgan Archive at the Scottish Poetry Library, Edinburgh
(Edwinmorgan.scottishpoetrylibrary.org.uk, 2017) [2]*

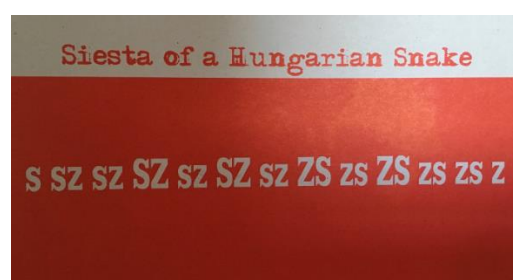


Figure 78 Siesta of a Hungarian Snake (March 1963) from a postcard from the Scottish Poetry Library

The last poem is Pomander (17 September 1964) from *The Second Life* (Morgan, 1968) and included in Appendix.

5.3.2 Apparatus

We use SR Research EyeLink 1000 and a chin rest. Participants sit in a chair, put their chin on the chin rest, and look at the images viewed on the monitor. A mouse and a keyboard are

provided for the participants to interact with the program during the experiment. The experiment is built on SR Research Experiment Builder and running on Microsoft Windows.



Figure 79 The setup of the experiment



Figure 80 EyeLink 1000 camera and infrared illuminator

We control the experiment—especially during calibration—through another set of computer.

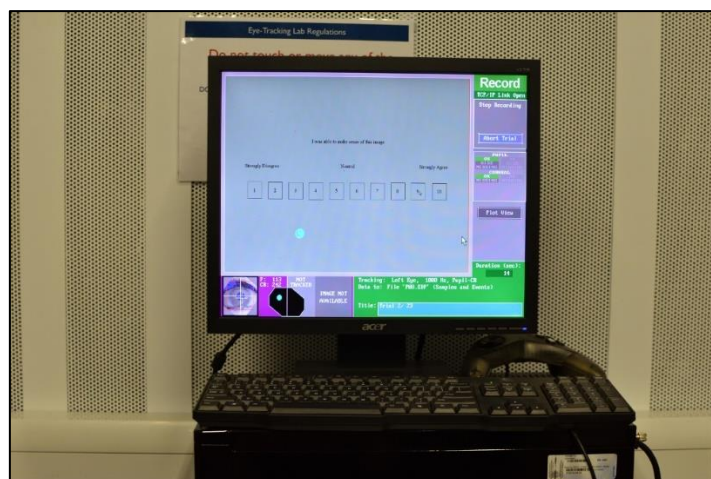


Figure 81 The computer we use to control the experiment

5.3.3 Experimental Procedure

Each session runs for approximately 35 minutes, depending on how long the participant is looking at each image. Each session runs as follows:

- 1) We explain the consent form to the participant, then he/she signs it if he/she agrees.
- 2) We explain the instructions to the participant.
- 3) We introduce a brief project's background to the participant.
- 4) When the participant is ready, we perform eye tracking calibration. This can include elevating or lowering the camera, adjusting the chin rest, and trying both eyes. We use whichever eye that works better.
- 5) When the gaze is calibrated, the participant can take a short break. When ready, the session continues.
- 6) The experiment begins. The participant is shown a total of 23 images as explained in the section 4.3.1, in that order. For each image:
 - a. The participant is asked to look at them normally and try to make sense of what he/she sees.
 - b. When finished, the participant presses any key on the keyboard to bring up the questionnaire page saying: *"I was able to make sense of this image."*
 - c. The participant uses the mouse to rate their agreement to the statement on the scale of 0 to 10; with 10 being most strongly agree.
 - d. After clicking on the number, a recalibration point will be shown on the screen. At this point, the participant can take a short break again.
 - e. When ready, the participant looks at the recalibration point for one or two seconds; then we manually press the space bar on the controlling computer's keyboard to continue the session.
- 7) At the end of the session, the participant is asked to fill a questionnaire asking their experience during the session.

After the participant fills the questionnaire, depending on the time available, we usually offer a small chat asking if he/she has any more questions. We do not record this conversation. However, we believe that this gives us more insight when reading their recorded responses and at the same time offers them a clearer explanation about the experiments.

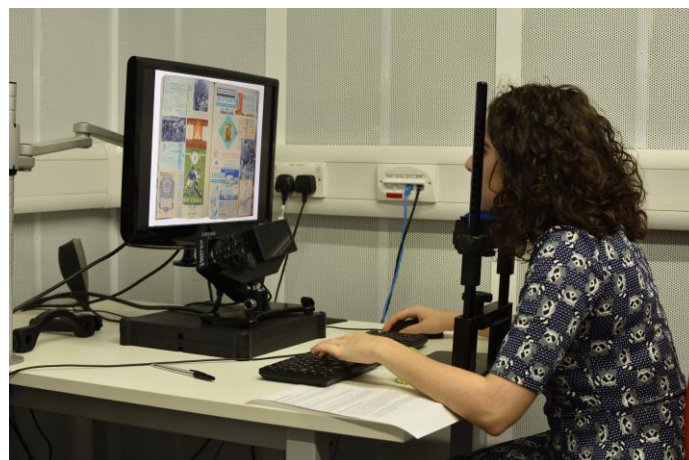


Figure 82 A participant of the eye-tracking experiment

5.4 Results and Discussion

While a lot of data has been recorded throughout the experiments, we choose to focus on the fixation maps in conjunction with the statistics of several main metrics (dwell time, fixation count, and fixation duration) to illustrate the results that we have gathered. In addition, we also display the sensibility rating that the participants give for each screen in the experiment.

A fixation map (heat map) is the simplest tool that shows the regions that hold participants' attention. While this kind of visualisation is devoid of temporal information that is essential for regression analysis, it does tell the researcher the general outcome of the experiment (Crcstudio.org, 2017).

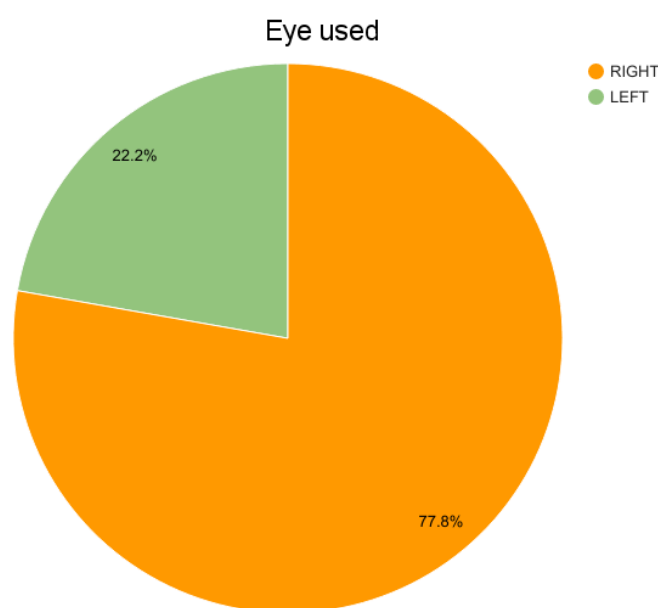


Figure 83 Eye used during the experiments

The full comparison of the fixation maps as well as the full table displaying aggregate values of Dwell Time, Fixation Count, and Fixation Duration of the scrapbook related materials can be found in Appendix. In this chapter, we present the charts showing the average of these metrics.

We can see from these charts that the original images are distinct in that they produce a much higher rate of dwell time and fixation count. This might be due to the amount of comprehensible unique information presented.

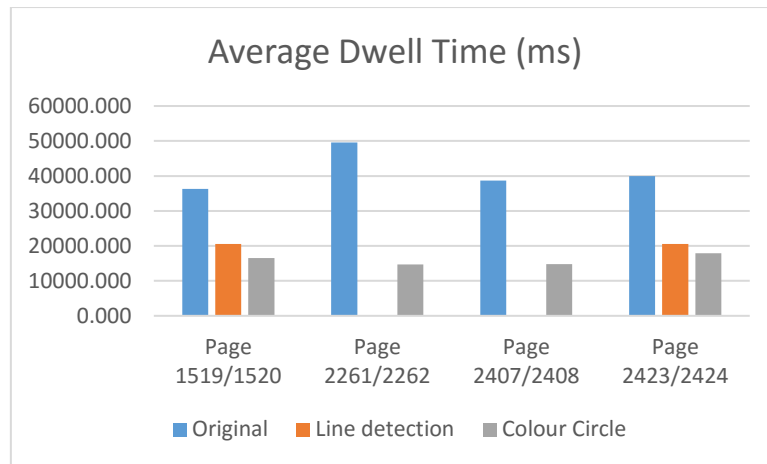


Figure 84 Average dwell time (ms) on the original, line detection, and colour circle images

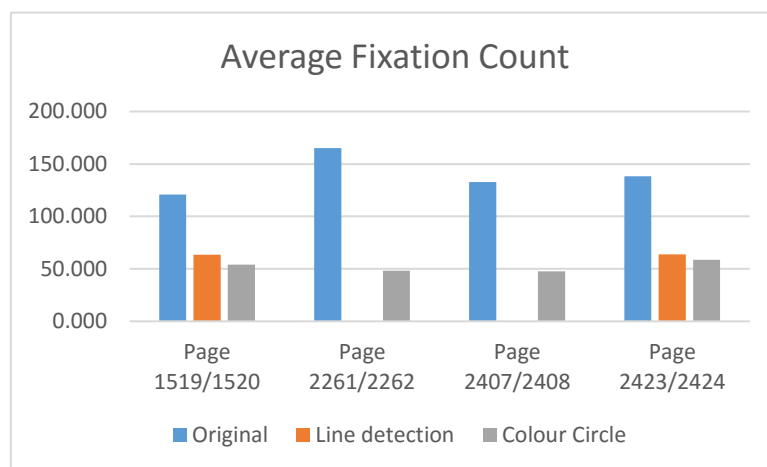


Figure 85 Average fixation count on the original, line detection, and colour circle images

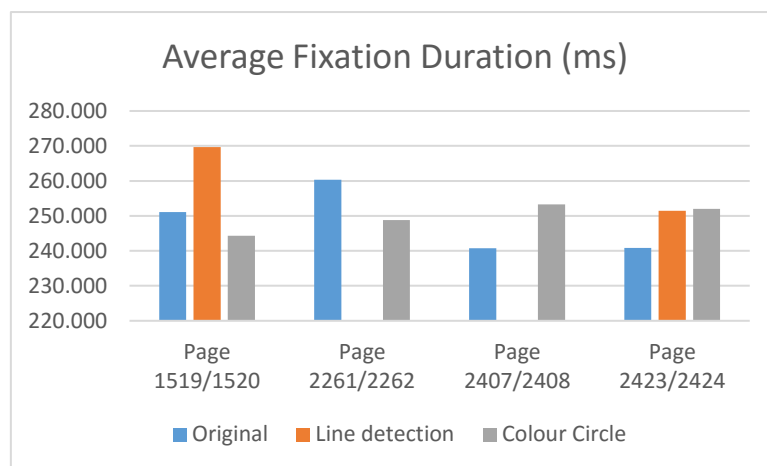


Figure 86 Average fixation duration (ms) on the original, line detection, and colour circle images

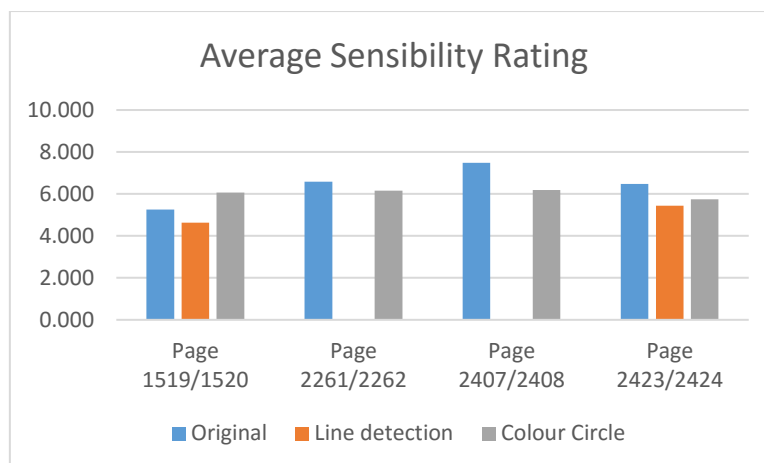


Figure 87 Average rating to the question “I was able to make sense of this image.”

Appreciating the maps, we come to understand that the line detection and the colour circle renderings play complementary roles in regards to the original main images of the scrapbook pages. The line detection renderings represent the visual structure, while the circle renderings represent the colours.

While we did not intend to pursue this direction, the line detection renderings produce relatively similar results to those of the original images regarding the areas that capture user’s attention. For example, the face of a man, painting, the stone head and a young man on the collage on page 1520 attract viewers’ attention in both the original image and the black-white rendering.

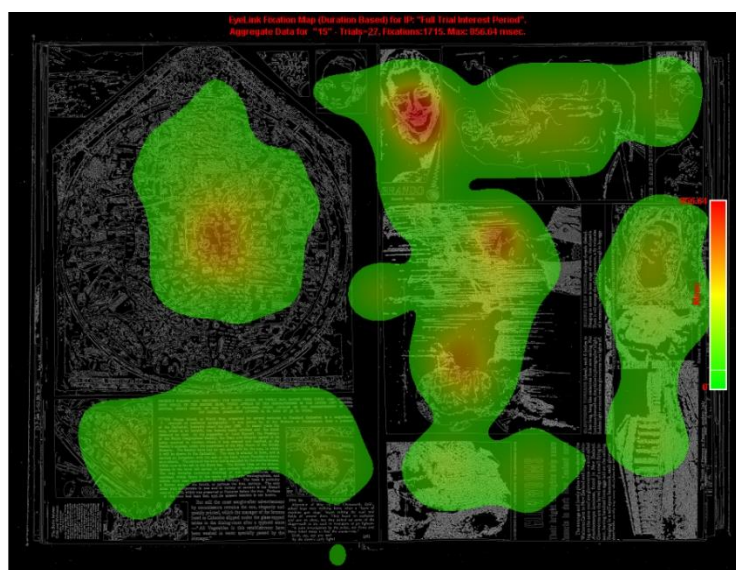


Figure 88 The fixation map of the line detection rendering of page 1519/1520

This is, however, with the exception of the regions containing text. The fact that texts are more overlooked in this mode is understandable due to their low readability in this colour scheme.

However, while the fixation maps look similar, there is a significant difference regarding dwell time. Users seem to spend much less time on the line detection rendering. They also seem to understand the original slightly better. Furthermore, referring to a few commentaries from the questionnaire, about one-third express negative comments to these renderings.

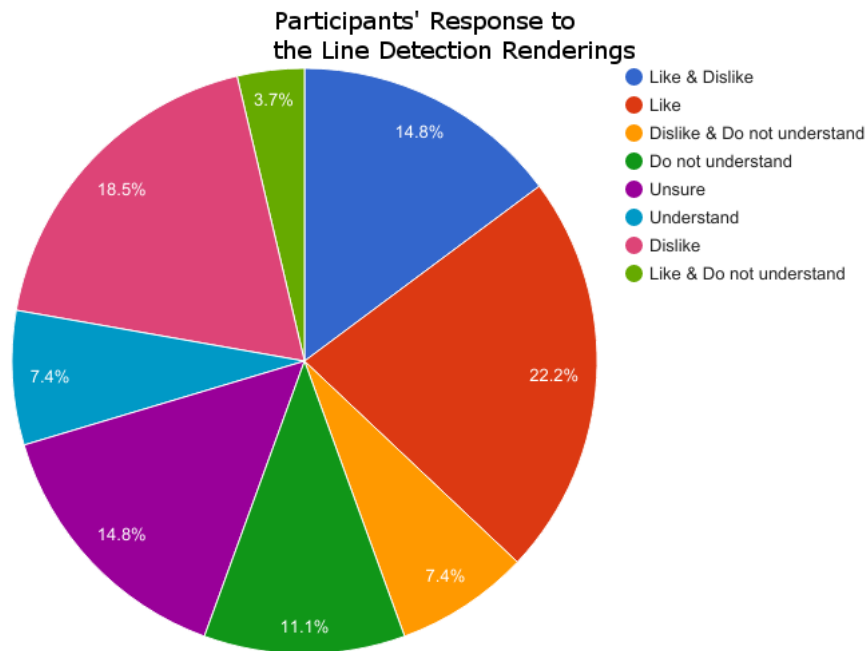


Figure 89 Eye Tracking Participants' response to the line detection renderings

On the other hand, the colour circle renderings produce quite different fixation maps compared to the originals. For example, the original pink doodle on page 1520 of the original image does not seem to receive much attention. However, the pink colour circle becomes the hottest spot on the alternative rendering. Similarly, the colourful circle of the Mudra hand on page 2408 receives much more attention compared to its original picture.

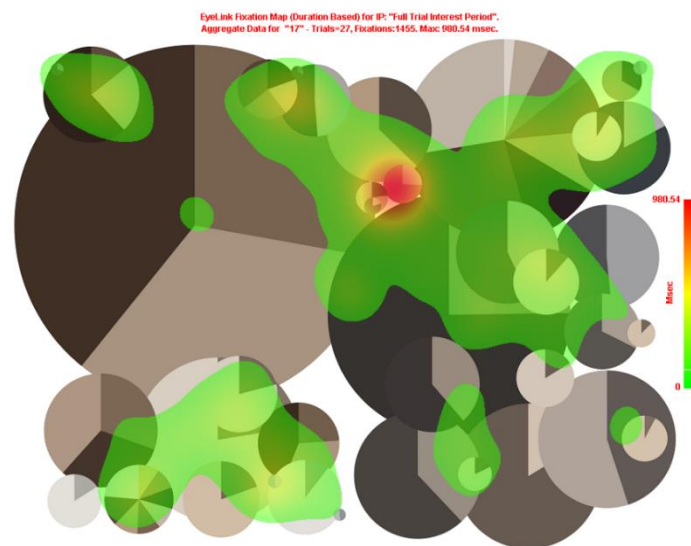


Figure 90 The fixation map of the colour circle rendering of page 1519/1520

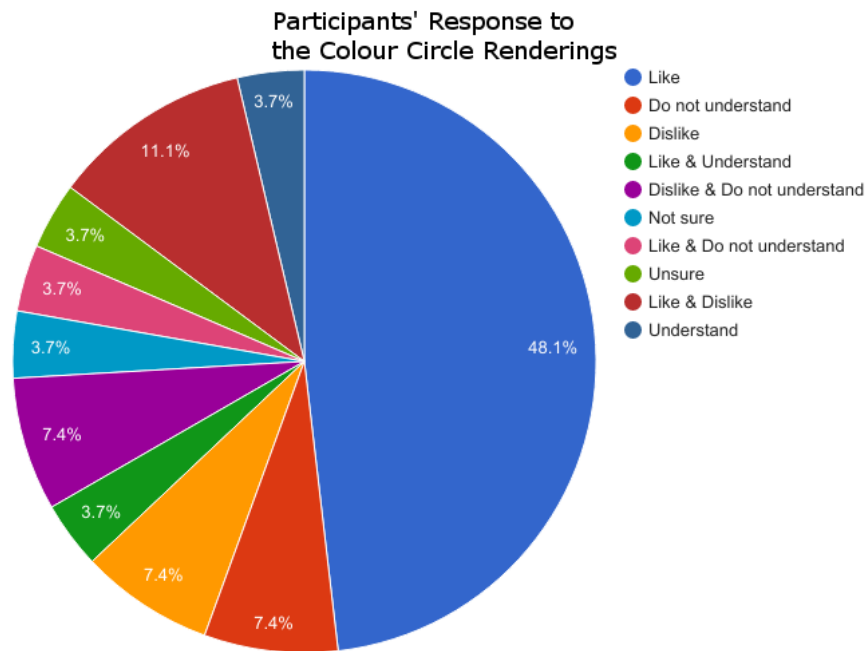


Figure 91 Participants' response to the colour circle renderings

From these results, we appreciate that visual structures capture attention in similar ways, regardless of colours. On the other hand, the display of the colours without the structure does give new insight to the viewers.

To perform the comparison on the detailed cropped images, we create eight Interest Areas—one on each page, that correspond to these images.

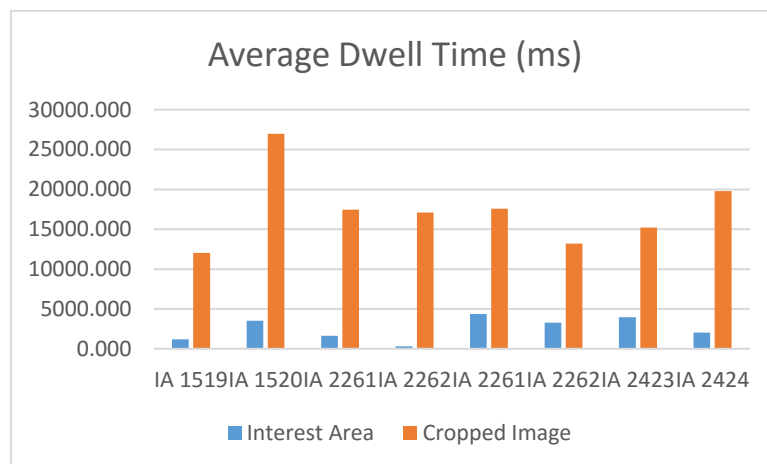


Figure 92 Average Dwell Time (ms) on the Interest Areas and the detailed cropped images

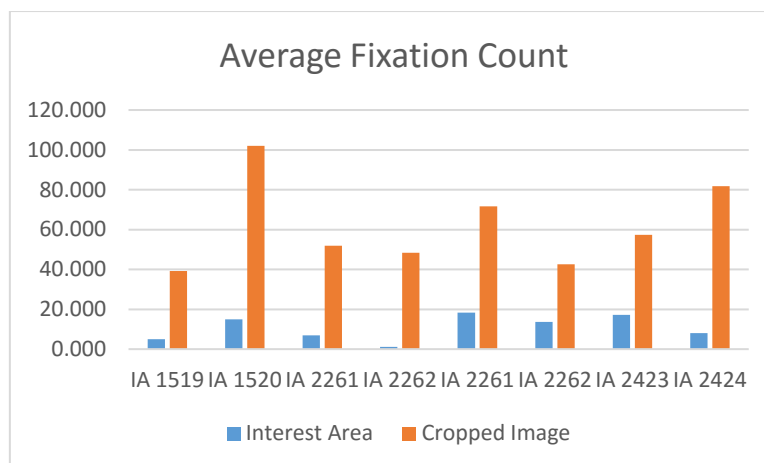


Figure 93 Average Fixation Count on the Interest Areas and the detailed cropped images

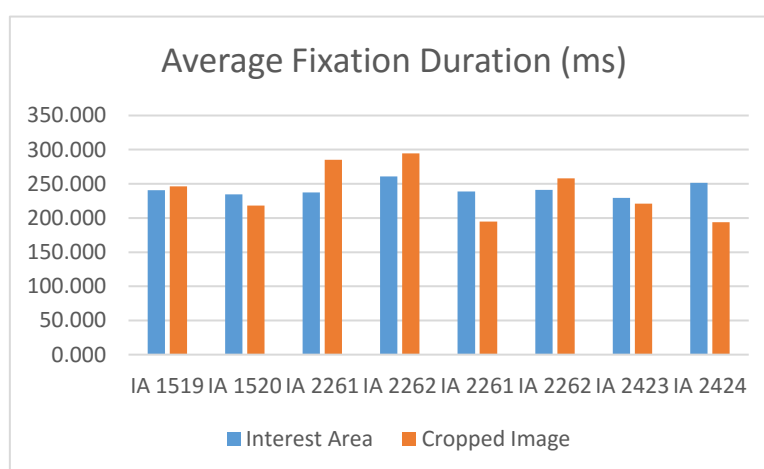


Figure 94 Average Fixation Duration (ms) on the Interest Areas and the detailed cropped images

Looking at the comparison table of the fixation maps (see Appendix), we understand that the cropped images function similarly to the colour circles, in that they give a chance to the viewers to notice new information. Regions that are not attractive enough in the full images receive significantly more attention in the cropped version. For example, the tiny rugby player's head wearing a yellow helmet on page 1519 creates a hot spot on the cropped version in contrary to the full image where it does not receive enough attention.

The rotation of some regions in the cropped version also makes it easier for the participants to see read texts. This happens for the glowworm collage on page 1520 where the participants start reading the description when its orientation is changed to landscape.

The dwell time and fixation count charts show that the cropped versions have a higher number of these metrics compared to their respective Interest Areas in the full images. More than 75% of the participants recognise that the cropped images are parts of the pages they saw before. On the other hand, while slightly lower, most participants agree that they learn something new from the cropped clippings.

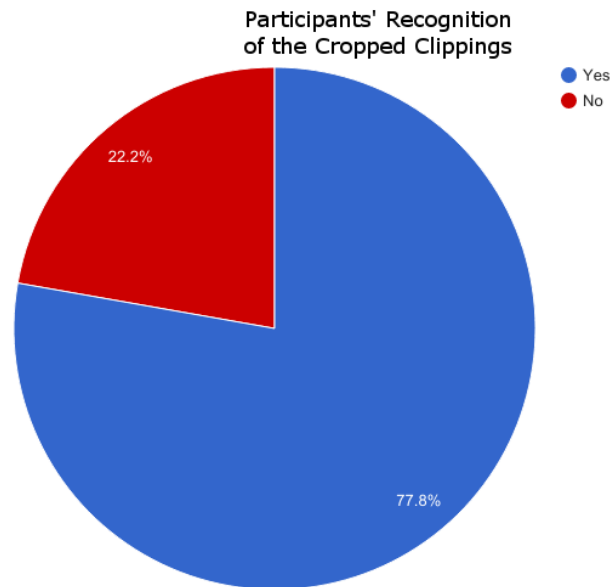


Figure 95 Most Eye Tracking participants managed to recognise the cropped images as part of the scrapbook pages

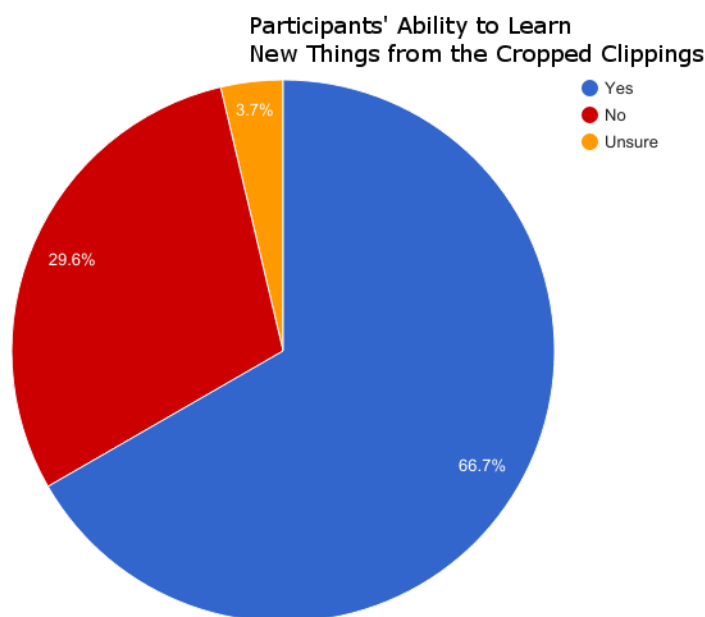


Figure 96 Most Eye Tracking participants are able to learn new things from the cropped images

Concrete Poems

Because the concrete poems are not our main pursue in this study, we will only look at the fixation maps of these poems, which nonetheless, give valuable insight.

Being composed of text, we understand that the participants treat them as they would treat other kinds of text: read. However, the concrete poems are more than common texts in that they have a visual structural element. We believe that this element attracts more attention than the textual characteristic itself. As shown in the two examples below that while the ordinary text—such as the first few rows of *Archive* and the title of the *Hungarian Snake* do attract attention, it is

the poems' visual elements—such as the letters that are falling apart in the former and the font size in the latter, that receive most attention.

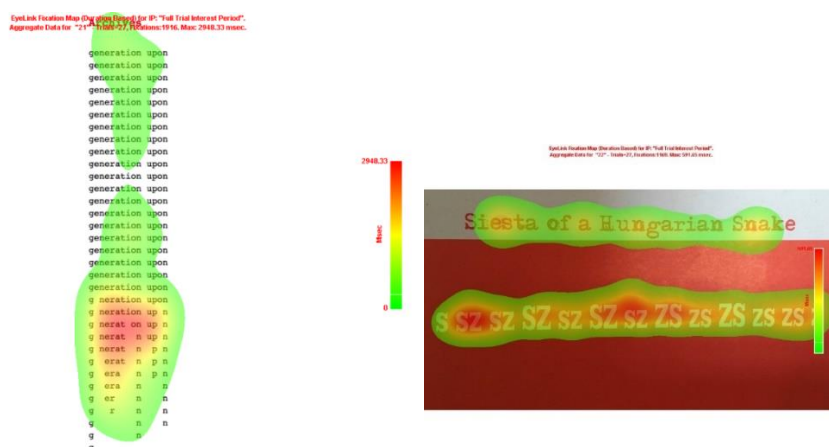


Figure 97 Average Fixation map of the poem “Archive” and “Siesta of a Hungarian Snake”

Conclusion

We find that the eye tracking study is very useful in the attempt to understand participants' visual behaviour on the scrapbook pages and some of their visual elements—structure and colour.

The visual structure gives comparable experience to the originals, but the colours encourage serendipitous finding.

We come to appreciate that when comprehension is only achieved through reading, the participants will do this. However, as soon as a striking visual structure is involved, people will move to from reading to analysing the structure.

Finally, our views that the segmentation of the clippings still stand, as this gives a chance to the viewers to inquire more and learn new information. However, while we understand that images and texts should be separated, further analysis is needed in deciding any more components should be extracted.

5.5 Future works

Due to the consideration that this study is not our main pursue in the project, we only perform very limited data analysis. It is clear, however, that there is still a lot of qualitative and quantitative analyses that we can perform on the results.

As mentioned previously, it will also be very valuable to conduct the experiments on the actual scrapbook pages as they contain richer information compared to their respective scanned images.

Finally, we are also interested in creating an artistic alternative visual representation of the eye tracking results themselves. One of the possible courses to take is to create a 3D object from the aggregate space-time cube (STC) using techniques discussed by Drusch and colleagues (2014).

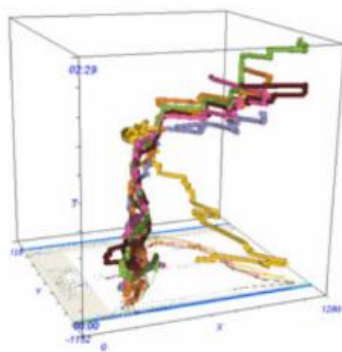


Figure 98 An example of the STC reproduced from (Drusch, Bastien, and Paris, 2014)

CHAPTER VI

DISCUSSION AND CONCLUSION

In this chapter, we reflect on the processes we have followed and the results we have obtained.

6.1 The process of collaboration

This project is unique in that it starts as a proposed project from the English Literature to the Informatics. Appreciating the exciting potentials of the project, we approach the original project initiator and inform them that we are interested in working collaboratively.

This means that there are different motivations and objectives involved in the project. It is a walk in the park when ours go hand in hand with other stakeholders', but the otherwise can sometimes arise. To alleviate problems related to conflicting priorities, staying true to the agile manifesto, we immensely value communication.

Both our counterparts and ourselves always try to communicate every idea that may be beneficial and every problem that may hinder the project. By keeping retaining good practice, we find that the project is always in a decent state, in that none of the project members loses motivation halfway.

On the other hand, an Informatics dissertation report is, up until the time we write this, individual work. This means that we still have to maintain personal motivations and objectives while working in a closely collaborative environment. Thus, we think that it is important to write and plan on these different lists and make sure they are stay aligned at every stage to ensure further progress of the project. Again, whenever discrepancies arise, we communicate them to the other project members.

In addition, the collaborative process also brings different viewpoints, ideas, and skill sets together. These varying viewpoints and ideas are very useful in assisting our critical thinking process, opening new options, and assessing new possibilities. In other words, they lead to creative explorations of the problem.

Different skill sets brought together is a fundamental point. Agreeing with one of Software Engineering's slogan, *do not reinvent the wheel*, collaborative processes let a job be done by the person who is best tailored for it. In terms of pushing the boundaries of the project, this concept is important because it saves resources that otherwise would be spilled on re-learning and re-training.

However, undoubtedly, there are potential downsides in a collaborative process. Two most essential issues are time and workload. Project members are not exclusively provisioned; resulting in a few difficulties finding time to hold meetings. While we keep communicating through emails, sometimes it is important to talk in person, especially when some real time activities—sketching, tutorials—are due.

Secondly, depending on the nature of the project, team members might find it difficult to offer help, thus distributing the workload better. This can be frustrating for all parties because some of them cannot contribute and the others feel overworked.

To these downsides, we admit that we could not promote any bullet proof solution. However, as mentioned previously, we value communication greatly and try to be as flexible as possible, so long the project guidelines permit.

6.2 The process of exploration

Previously we view that the different viewpoints and ideas existing in a collaborative project lead to creative explorations. In our case, academic backgrounds and involvements in previous projects are the fuel that keeps the creative processes running.

Our colleague's experiences from other data visualisation projects in the past as well as her viewpoints as English Literature are very useful in offering visualisation ideas and developing the prototypes critically.

On the other hand, our informatics background opens new technological options and possibilities for the project. We also ask questions that might be overlooked by a literature person but beneficial in shaping the prototypes' conceptual as well as technical framework.

However, we appreciate that this process can be too wild and time-consuming, especially when various disciplines come together to make the boundaries thinner. For example, there are times that we find it difficult to limit the extent of our technological exploration because all options seem promising.

Due to the limited time, we are also forced to give up a few very promising options—for example, asemic writing. While this might look as inefficiency, we believe that the process that we have performed will be beneficial in the future; if not for ourselves, for the readers.

6.3 Limitations of this work

Appreciating the explorative approach that we take in this project, we admit that this is not a pure data visualisation project. The time we have spent on learning data visualisation principles and techniques is very limited as a consequence of our explorations on other disciplines. Thus, we believe that there is much space for improvement in this regard.

This is also true for other related disciplines. After all, the trade-off is between depth and breadth, and we choose to take the latter in this project.

In the eye tracking experiments, we only included two line-detection renderings because we initially saw them only as an intermediary object in the clipping segmentation. However, they turn out to be very useful in describing the participants' gaze behaviours, as they retain the structures of the original pages, only colourless. Thus, we think that they should be included in future experiments.

Another limitation in the eye-tracking experiments is the order the images are shown. The original images are shown before the renderings. Thus, it is difficult to say that the results we gather on the renderings are not affected by the fact that the participants saw the original images earlier.

In the evaluation, we could not find the specific participants as we intended to have at the beginning of the project. Indeed, the scrapbooks' status as archive makes it difficult for the general public to appreciate its existence, let alone put some interest.

Another flaw regarding evaluation participants is that we only had one native English speaker. While the scrapbooks contain languages other than English, most of its contents, as well as the interface of the prototypes, are in English.

We think that it is essential that we invite the suitable participants in the next iteration to make sure the usability score is not so much affected by the language or cultural barrier.

6.4 Findings from the evaluation of prototypes

6.4.1 Prototype 1

While most participants agree that the visualisation is interesting and induce them to explore more, we admit that its usability is significantly lower than ideal—above 70. We view that there are two components that cause this and thus need to be improved in the future iterations. They are:

1) Appearance

- As we have expected, the basic shapes that serve as placeholders is not associated with the types they represent. We will create 3D models that represent better the types, or create alternative visualisations from other sources, e.g. the STC mentioned in Chapter 3.
- The overall brightness of the interface makes it hard for the user to see the objects. We will try adjusting the lighting or consider using a different background.
- We will include others attributes in the visualisation.
- We will revise the descriptions to accommodate better comprehension.
- We will improve visualisation of the word cloud and the charts on the zoom in the right panel.
- We will include the legend and annotation that explains some concept.

2) Interactivity

- We will smooth the interaction with both the right and left menu panels.
- We will consider removing the Reset buttons and develop toggle buttons.
- We will look at developing the feature to perform compound filtering and grouping.
- The web-based environment is more restrictive in terms of navigation, and moving around—which is one of the main fundamental features of the prototype, seems unintuitive. We are considering developing a flat screen mode where participants do not need to navigate the camera. This mode is activated when the user is looking to perform a certain task, for example, comparing the components or filtering.

Finally, we will also look at the possibility to step up into Virtual Reality Environment. We believe this will offer much more immersive experience and natural navigation.

6.4.2 Prototype 2

This prototype has better usability score because of its simplicity. Thus, we intend to keep this as simple as possible. The main visual aspects that we are looking to improve is the layout. For

example, we are considering to move the menu and the legend so that it is clear what they are (links and legend), and it gives more space to the visualisation.

One of the fundamental information that is not yet incorporated is the z-index. Another issue is that the connection between circles is not apparent. We will further investigate the ways we can improve these.

In the terms interactivity, we are interested in developing filters that will let users investigate the visualisation further. For example, the legend can be developed into buttons that will filter certain mediums.

While a few users give criticism that this is a static visualisation, we are not yet interested in developing a more *playful* version. This is because we believe that the first prototype has better potential in this term than the second one.

6.5 Future work in related disciplines

We believe that our exploration in different disciplines opens various research directions.

6.5.1 Computer Vision

As mentioned in Chapter 3, we believe that it is suitable for this field to look at ways to perform the segmentation of the clippings from its scanned page. Furthermore, while strict component segmentation might be required, we understand from the eye tracking experiments that it is essential to break up texts and images belonging to the same clipping.

Furthermore, we have only performed colour extraction from the images during the feature extraction stage. Future studies can look at other feature to extract, for example, lines and contrasts.

6.5.2 Eye Tracking

It is essential that we try to perform the eye tracking experiments with the real scrapbooks. Both Sarah Hepworth, and James McGonigal have expressed their interest in this idea. We propose to use portable eye tracker, such as Eye Tribe, which, even though is not as accurate as the apparatus that are used in this project, is portable and easy enough to operate.

6.5.3 Others

One of the seemingly most obvious technologies from which this project can benefit is Optical Character Recognition (OCR) because the scrapbooks contain quite a lot of textual material. Utilising OCR can help digitise the contents of an article, for instance.

Similarly, while some of the images are extremely hard to discern, researchers might find Image Recognition useful to tag some of the easily recognisable ones automatically.

6.6 Conclusion

In this document, we have explained our motivation, the underlying problem, and the methodology we used, the processes we followed, and the results we obtained. The problem at which we looked is the development of a digital prototype that represent a subset of Edwin Morgan Scrapbooks and promote the archives, as well as explore the problem and techniques, and report any findings that will be inputs for future research.

In response to the first objective, we have developed a prototype in a 3D environment that accommodates interactive exploration of the items in the subset of the scrapbooks. We have evaluated this prototype and obtained the result. Most participants agree that they become interested in the scrapbooks after interacting with the prototype. They also agree that the prototype is relatively successful in representing the scrapbooks.

In response to the second objective, we have explored computer vision as a technique to create an alternative artistic representation of the clipping. We have also run the scrapbooks and the alternative representations through a series of eye tracking experiments and presented the results.

Finally, we have reflected on our processes and suggested future improvements and research related to this project.

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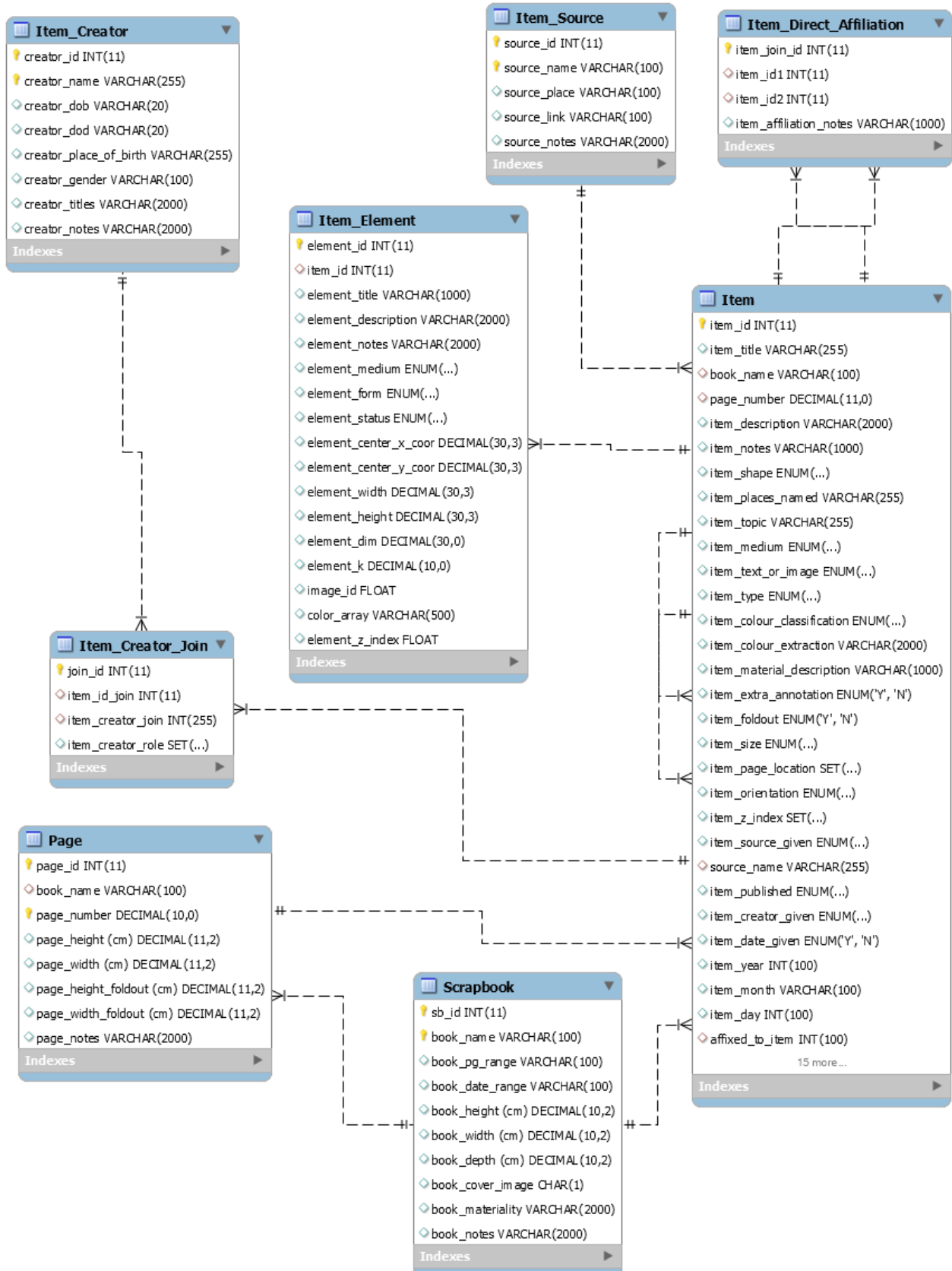
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APPENDICES

APPENDIX A

Diagram of the database



APPENDIX B

8 Original scanned pages of the Scrapbooks. Page 1519/1520.



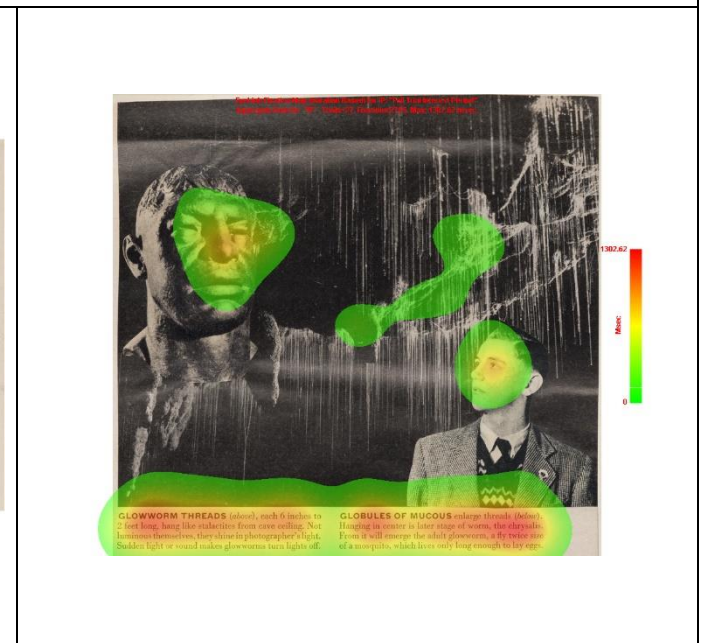
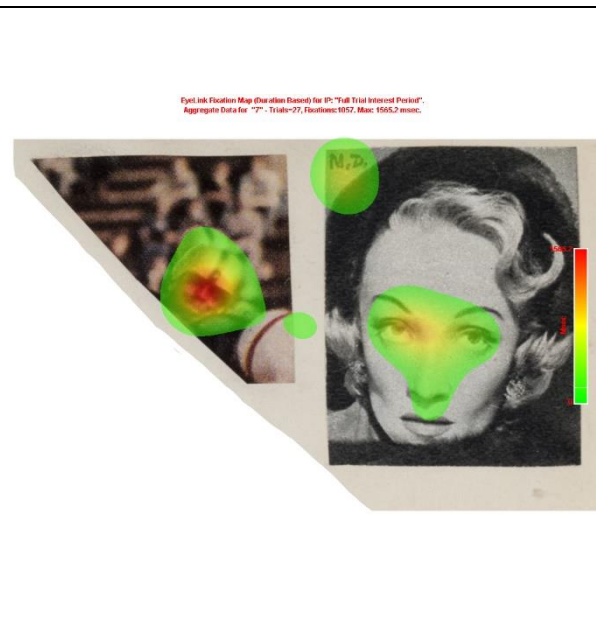
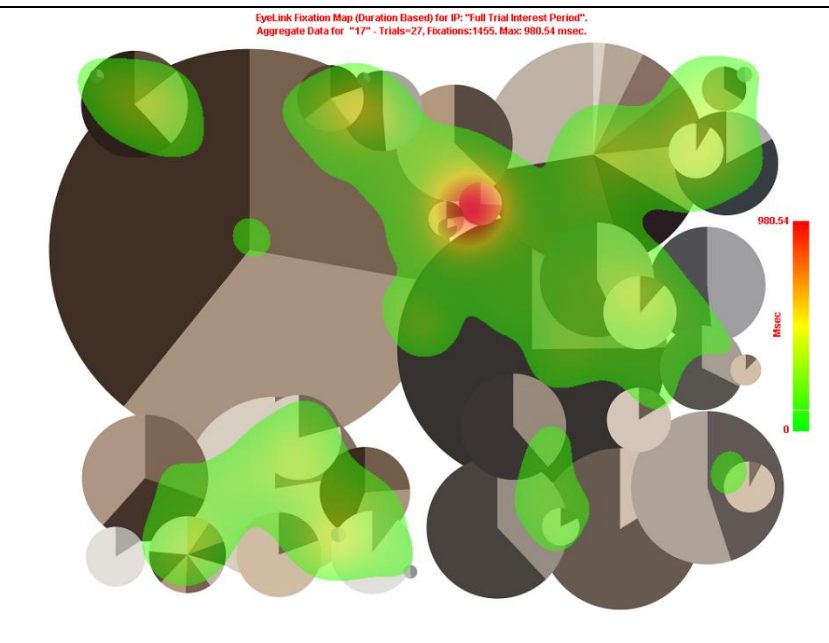
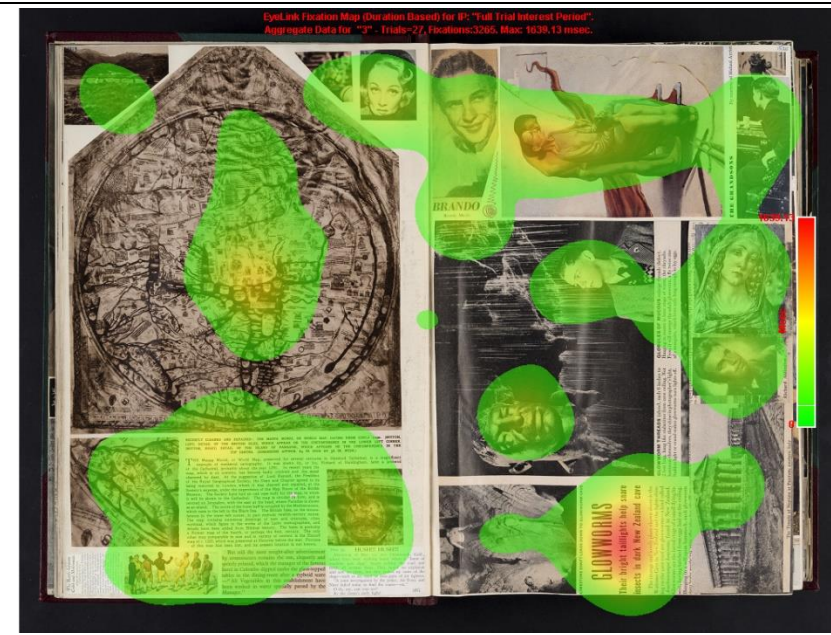
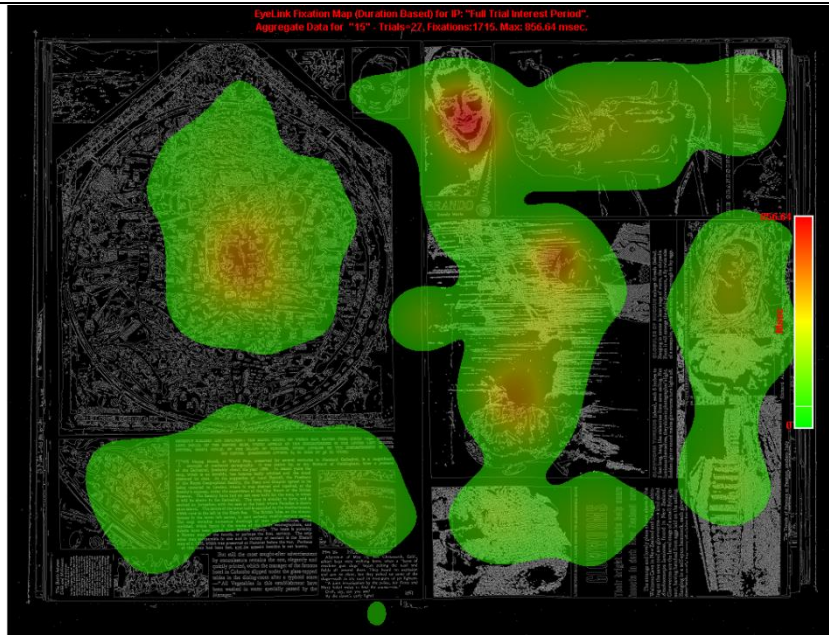
Page 2261/2262.

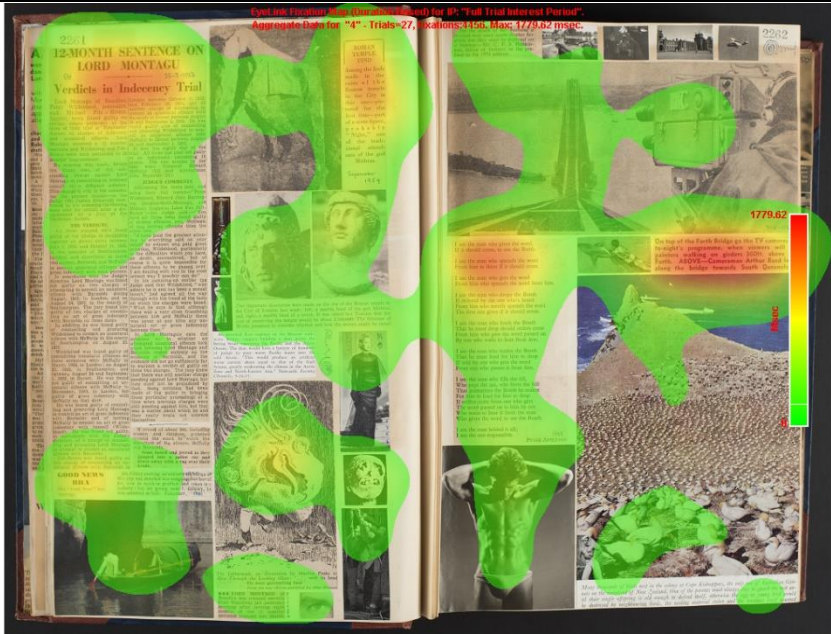




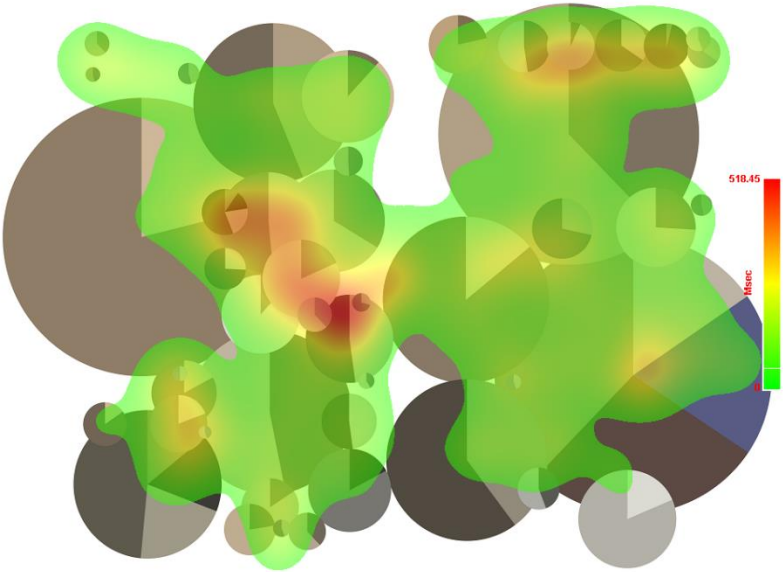
APPENDIX C Aggregate fixation maps from 23 participants of the eye tracking experiments.

Page 1519/1520

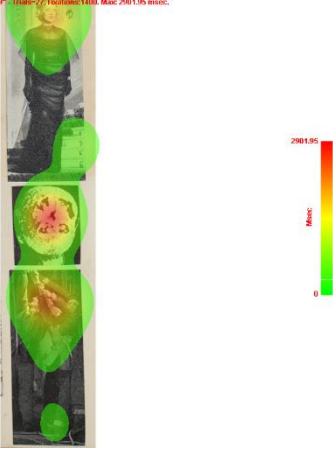




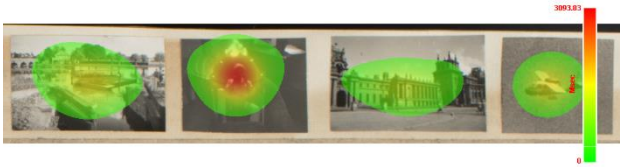
EyeLink Fixation Map (Duration Based) for IP: "Full Trial Interest Period".
Aggregate Data for "18" - Trials=27, Fixations:1302, Max: 518.45 msec.



EyeLink Fixation Map (Duration Based) for IP: "Full Trial Interest Period".
Aggregate Data for "9" - Trials=27, Fixations:1410, Max: 2081.95 msec.

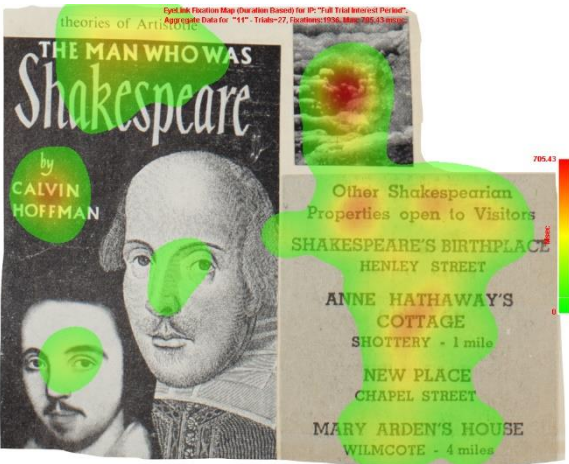
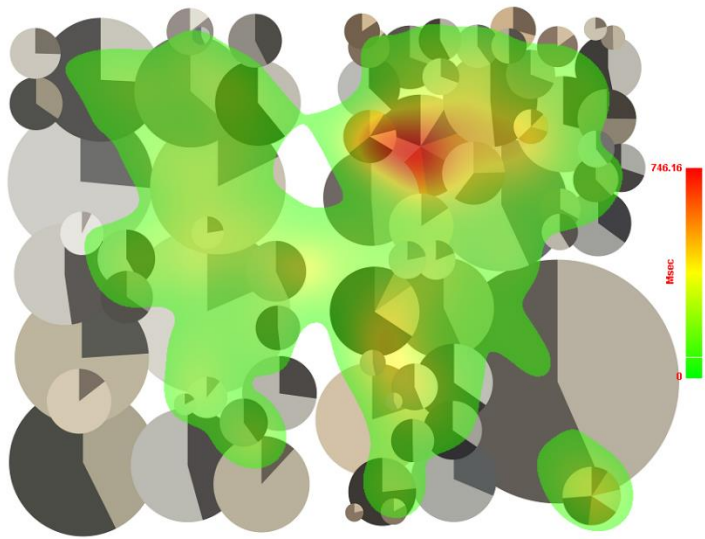


EyeLink Fixation Map (Duration Based) for IP: "Full Trial Interest Period".
Aggregate Data for "10" - Trials=27, Fixations:1307, Max: 3093.87 msec.

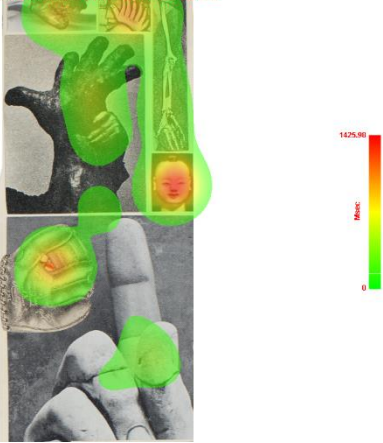


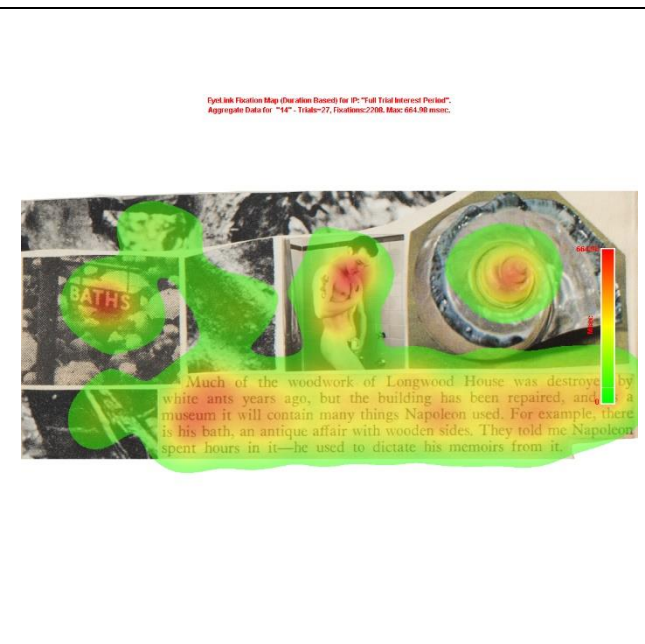
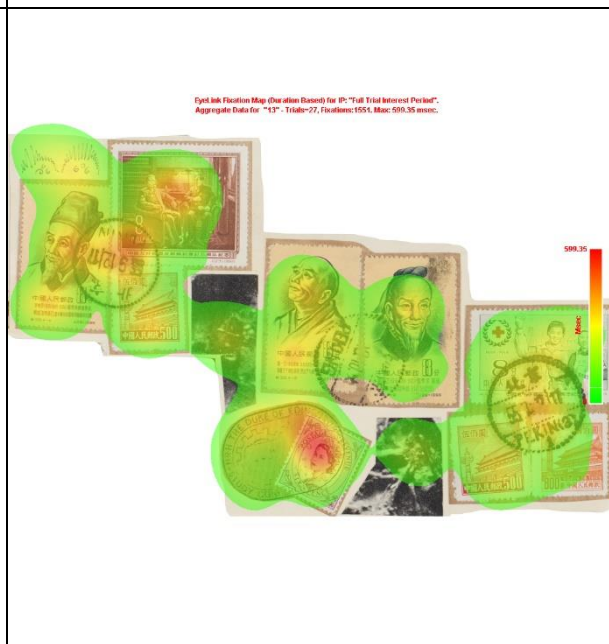
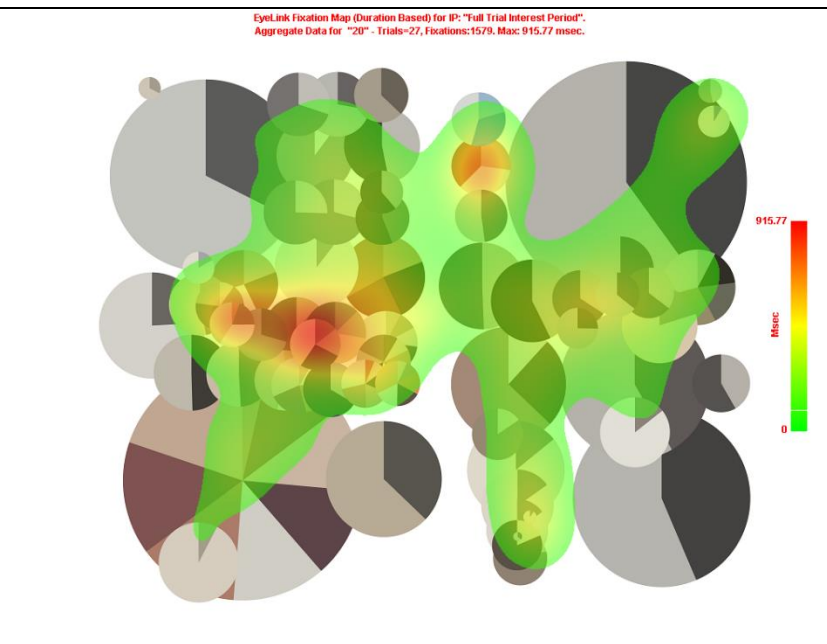
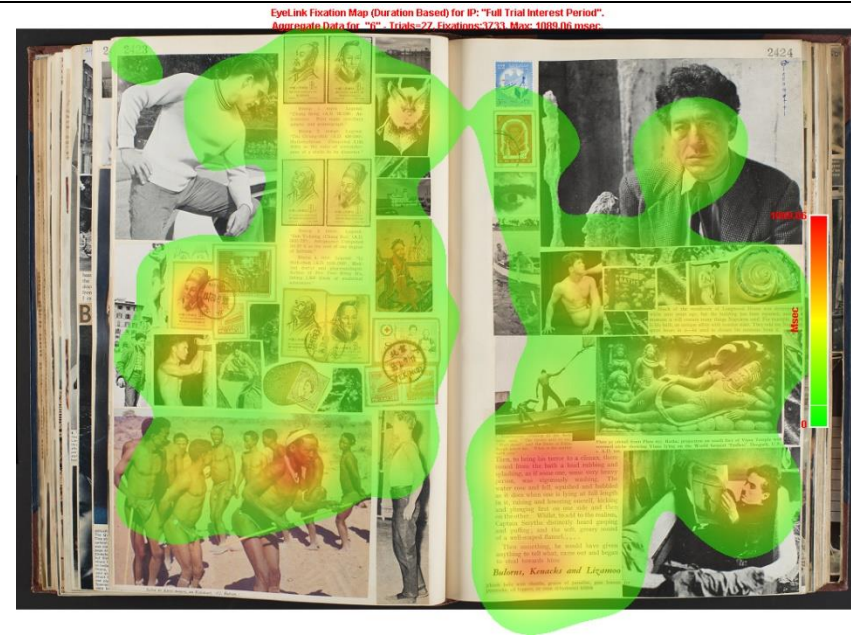
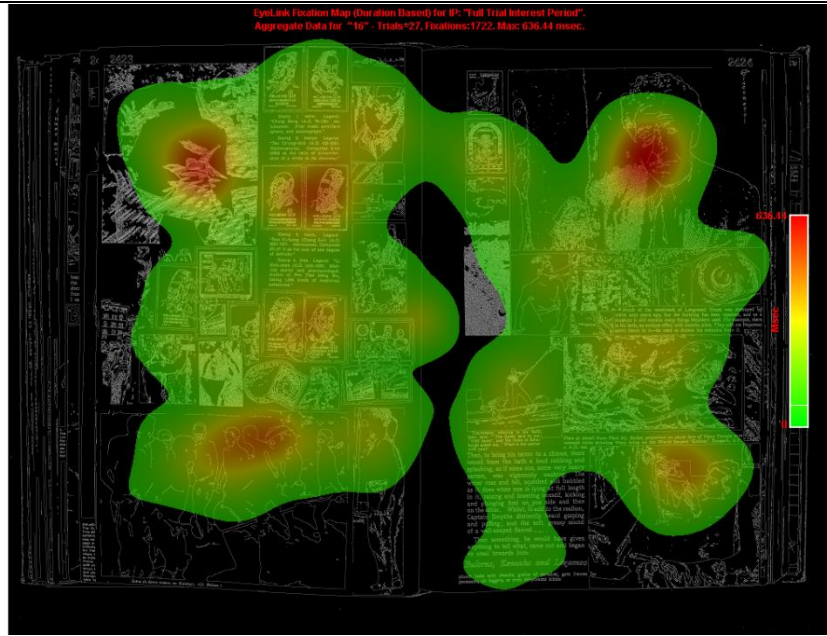


Eyelink Fixation Map (Duration Based) for IP: "Full Trial Interest Period".
Aggregate Data for "19" - Trials=27, Fixations=1284, Max: 746.16 msec.



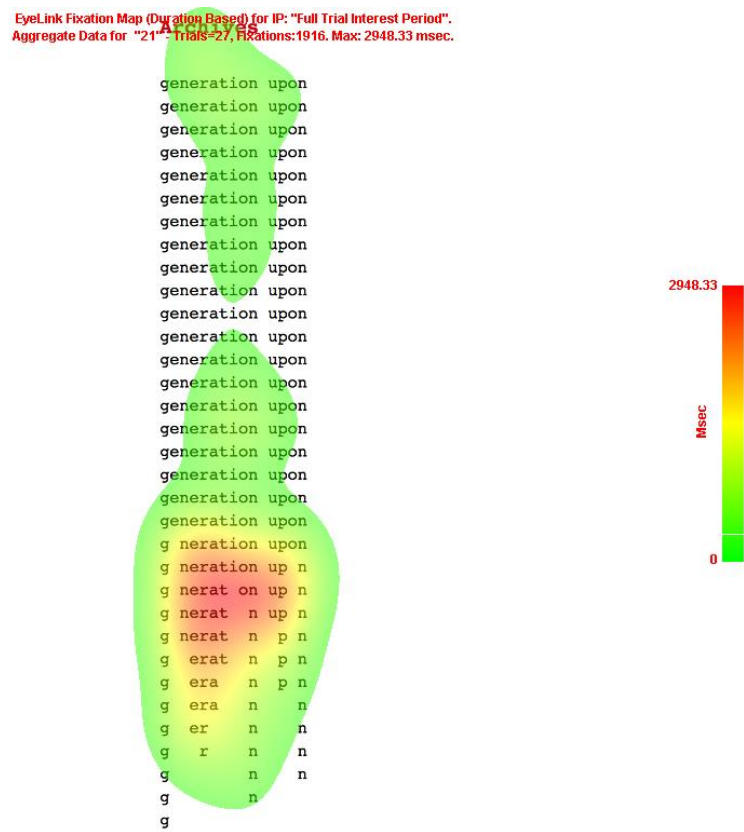
Eyelink Fixation Map (Duration Based) for IP: "Full Trial Interest Period".
Aggregate Data for "12" - Trials=27, Fixations=1431, Max: 1425.90 msec.



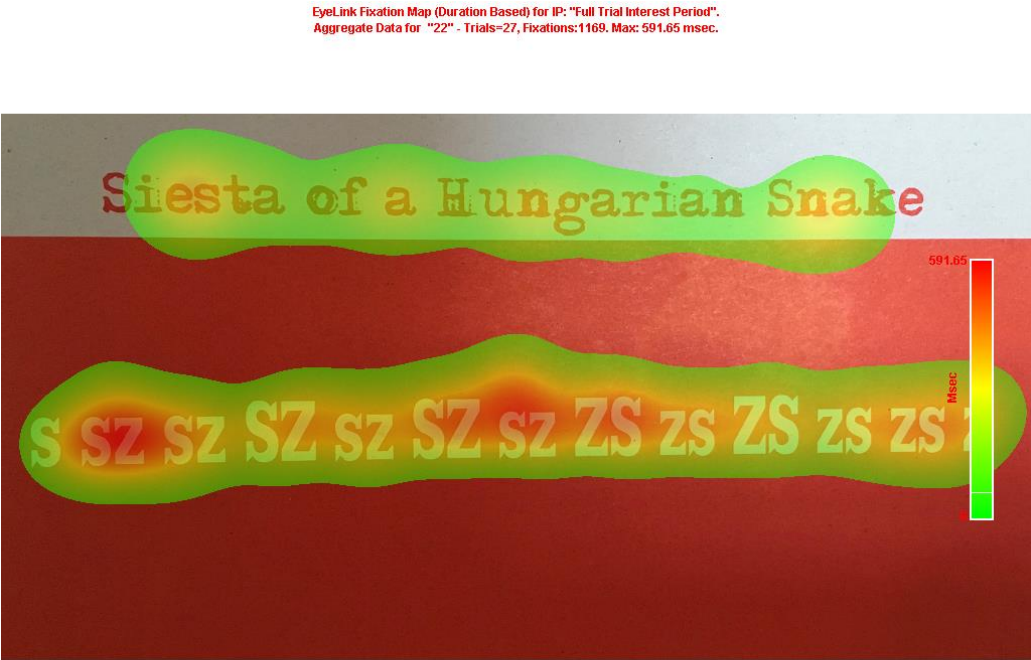


APPENDIX D

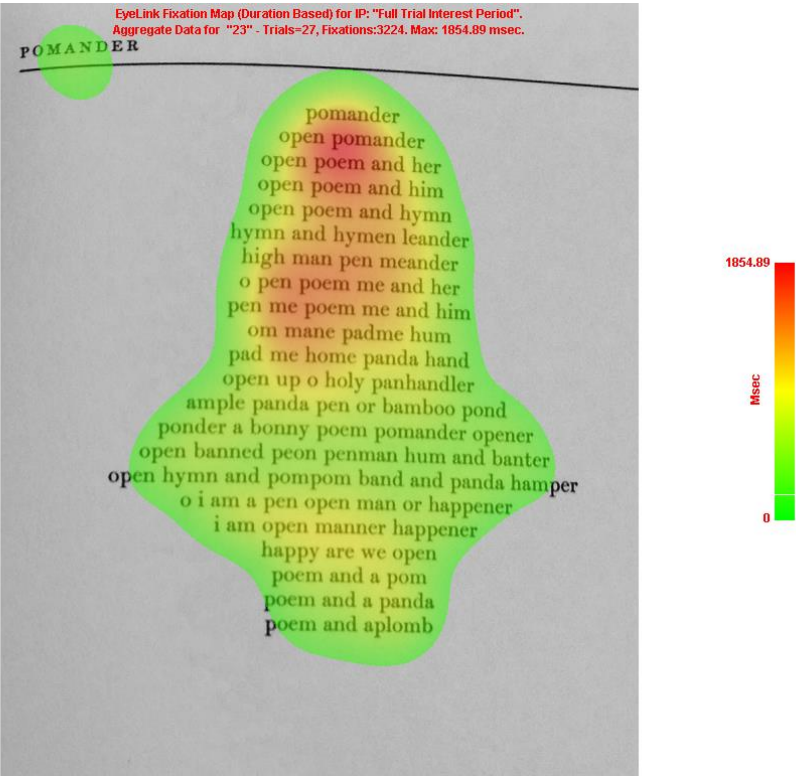
Aggregate (23 Participants) Fixation Map of the Poem “Archive”.



Aggregate (23 Participants) Fixation Map of the Poem “Siesta of a Hungarian Snake”.



Aggregate (23 Participants) Fixation Map of the Poem “Pomander”.



APPENDIX E

The 23 Screens in the Eye Tracking Experiment.

Type	Training		Main Original				Detailed, Cropped Clippings								Line		Colour Circles				Poems		
Screen	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Aggregate statistics of Dwell Time, Fixation Count, and Fixation Duration of the Eye Tracking Experiment for The Scrapbook Materials. The Median are shown only for completeness.

No	Item		Dwell Time (ms)				Fixation Count				Fixation Duration (ms)			
			Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median
1	Screen 3 (Page 1519/1520)		7639.000	81922.000	36290.450	29926.000	22.000	260.000	120.930	99.000	17.000	1445.000	251.080	217.000
2		IA 1a	0.000	3600.000	1203.560	1070.000	0.000	12.000	5.000	5.000	52.000	953.000	240.711	205.000
3	Screen 7 (Cropped 1a)		2659.000	33664.000	12036.780	9924.000	10.000	91.000	39.150	35.000	2.000	1406.000	246.250	219.000
4		IA 1b	267.000	10872.000	3515.520	2855.000	1.000	43.000	15.000	14.000	22.000	1246.000	234.368	202.000
5	Screen 8 (Cropped 1b)		2997.000	59336.000	26985.520	24874.000	13.000	222.000	102.040	98.000	15.000	956.000	218.270	202.000
6	Screen 15 (Canny 1)		2576.000	69646.000	20540.850	16695.000	8.000	211.000	63.520	57.000	22.000	11518.000	269.660	245.000
7	Screen 17 (Cricle 1)		3727.000	54191.000	16515.700	14489.000	13.000	159.000	53.890	50.000	20.000	2251.000	244.310	216.000
8	Screen 4 (Page 2261/2262)		5545.000	111051.000	49570.040	46226.000	18.000	372.000	165.040	155.000	17.000	2452.000	260.370	230.000
9		IA 2a	0.000	4225.000	1636.670	1649.000	0.000	17.000	6.890	8.000	22.000	750.000	237.581	203.000
10	Screen 9 (Cropped 2a)		4204.000	42767.000	17435.810	14198.000	17.000	115.000	51.850	45.000	21.000	2322.000	285.120	249.000
11		IA 2b	0.000	1351.000	289.810	0.000	0.000	17.000	1.110	0.000	129.000	758.000	260.833	237.000
12	Screen 10 (Cropped 2b)		4170.000	39283.000	17072.480	14119.000	16.000	108.000	48.410	42.000	16.000	1766.000	294.430	256.000
13	Screen 18 (Circle 2)		2435.000	37927.000	14667.070	12093.000	8.000	116.000	48.220	45.000	21.000	2594.000	248.760	221.000
14	Screen 5 (Page 2407/2408)		3792.000	145946.000	38709.260	34318.000	14.000	434.000	132.670	110.000	21.000	1264.000	240.780	216.000
15		IA 3a	261.000	13993.000	4369.700	3140.000	2.000	44.000	18.300	14.000	21.000	1057.000	238.830	215.000
16	Screen 11 (Cropped 3a)		4059.000	46041.000	17575.370	15663.000	18.000	183.000	71.700	67.000	22.000	1209.000	194.840	181.000
17		IA 3b	53.000	10167.000	3288.440	2660.000	2.000	44.000	13.630	13.000	22.000	1264.000	241.272	219.000
18	Screen 12 (Cropped 3b)		3165.000	29333.000	13182.850	11407.000	9.000	87.000	42.520	42.000	22.000	2475.000	258.160	229.000
19	Screen 19 (Cricle 3)		3082.000	42152.000	14750.700	12312.000	12.000	131.000	47.560	39.000	22.000	2488.000	253.250	229.000
20	Screen 6 (Page 2423/2424)		3111.000	114807.000	39988.480	32519.000	16.000	388.000	138.260	111.000	19.000	4581.000	240.820	213.000
21		IA 4a	0.000	15276.000	3951.000	3257.000	0.000	68.000	17.220	15.000	19.000	1012.000	229.413	201.000
22	Screen 13 (Cropped 4a)		2933.000	50553.000	15196.590	13682.000	12.000	181.000	57.440	53.000	21.000	927.000	220.900	203.000
23		IA 4b	0.000	10944.000	2020.330	996.000	0.000	45.000	8.040	5.000	51.000	774.000	251.378	228.000
24	Screen 14 (Cropped 4b)		2728.000	39106.000	19786.630	21564.000	10.000	155.000	81.780	87.000	21.000	944.000	193.890	176.000
25	Screen 16 (Canny 2)		5438.000	43816.000	20588.070	17524.000	19.000	133.000	63.780	49.000	21.000	852.000	251.440	233.000
26	Screen 20 (Cricle 4)		4055.000	69248.000	17904.220	14936.000	14.000	209.000	58.480	44.000	21.000	2095.000	252.020	230.000

Aggregate statistics of Sensibility Rating for The Scrapbook Materials from the Eye Tracking Experiment.

No	Item	Sensibility Rating			
		Min	Max	Mean	Median
1	Screen 3 (Page 1519/1520)	1.000	10.000	5.260	5.000
2	IA 1a				
3	Screen 7 (Cropped 1a)	1.000	10.000	6.070	7.000
4	IA 1b				
5	Screen 8 (Cropped 1b)	4.000	10.000	8.300	8.000
6	Screen 15 (Canny 1)	1.000	9.000	4.630	5.000
7	Screen 17 (Cricle 1)	1.000	1.000	6.070	8.000
8	Screen 4 (Page 2261/2262)	3.000	10.000	6.590	7.000
9	IA 2a				
10	Screen 9 (Cropped 2a)	1.000	10.000	5.560	5.000
11	IA 2b				
12	Screen 10 (Cropped 2b)	1.000	10.000	5.960	7.000
13	Screen 18 (Circle 2)	1.000	10.000	6.150	7.000
14	Screen 5 (Page 2407/2408)	2.000	10.000	7.480	8.000
15	IA 3a				
16	Screen 11 (Cropped 3a)	5.000	10.000	8.370	8.000
17	IA 3b				
18	Screen 12 (Cropped 3b)	3.000	10.000	8.110	9.000
19	Screen 19 (Cricle 3)	1.000	10.000	6.190	7.000
20	Screen 6 (Page 2423/2424)	1.000	10.000	6.480	7.000
21	IA 4a				
22	Screen 13 (Cropped 4a)	2.000	10.000	8.890	9.000
23	IA 4b				
24	Screen 14 (Cropped 4b)	1.000	10.000	8.190	9.000
25	Screen 16 (Canny 2)	1.000	10.000	5.440	6.000
26	Screen 20 (Cricle 4)	1.000	10.000	5.740	7.000

APPENDIX F

Consent Form for the Eye Tracking Participants

A Study of the Edwin Morgan Scrapbooks – Using Eye-Tracking Technology

Informed Consent Form for Experimental Participants

Project: A study of how people view, process, and understand the Edwin Morgan Scrapbooks using eye-tracking technology.

Experimenters:
Akmal Putra, Bridget Moynihan

Affiliation:
University of Edinburgh

Description:
You are invited to participate in a study that investigates how people view, process, and understand the Edwin Morgan Scrapbooks, as well as visualizations based on these Scrapbooks. In the experiment, you will be asked to look at digital images of the scrapbook pages, and of visualisations based on the scrapbooks. You are asked to make judgements on whether or not you were able to make sense of the image as rated on a 10-degree scale. You are also invited to complete an optional short, written survey about what you liked or did not like about the images.

Risk and Benefits:
A video-based desktop-mounted eye-tracking system will record data about your eye-movements. There are no known risks involved in this procedure. There is no remuneration being offered for participation, and there are no other benefits to participation.

Time Involvement:
Each experiment session will normally last for 35 minutes (including set up).

Subject Rights:
Participation in the experiment is voluntary and you may choose to leave the experiment at any point. You have the right to ask for your data to be removed from the study.
If you have any questions about this experiment, please email: s1521283@sms.ed.ac.uk or b.moynihan@ed.ac.uk for further information.

By signing the form, you confirm that you meet the following conditions:

- You are at least 18 years old
- You have normal or corrected to normal vision
- You have read the above consent form, understood it, and agree to it.
- You want to participate in the above-mentioned experiment

I give consent to be photographed during the study: Yes _____ No _____

Name: _____

Signature: _____ Date: _____

APPENDIX F

Consent Form for the Evaluation participants.

A Study of Digital Representation prototypes of Edwin Morgan Scrapbooks

Informed Consent Form for Experimental Participants

Project: A study of how people view, process, and understand the interactive digital visualisation prototypes based on Edwin Morgan scrapbooks.

Experimenters:
Akmal Putra

Affiliation:
University of Edinburgh

Description:
You are invited to participate in a study that investigates how people view, process, and understand two interactive digital visualisation prototypes based on a few pages from Edwin Morgan Scrapbooks. You will be asked several questions regarding your knowledge to Edwin Morgan scrapbooks and the prototypes, and required to say whatever you are looking at, thinking, doing, and feeling at each moment while using the digital artefact. Finally, you will be asked to fill a System Usability Scale questionnaire.

Risk and Benefits:
Your voice will be recorded during the study, especially in interviews and the Think Aloud session. There are no known risks involved in this procedure. There is no remuneration being offered for participation, and there are no other benefits to participation.

Time Involvement:
Each experiment session will normally last for 30 minutes (including set up).

Subject Rights:
Participation in the experiment is voluntary and you may choose to leave the experiment at any point. You have the right to ask for your data to be removed from the study.
If you have any questions about this experiment, please email: s1521283@sms.ed.ac.uk for further information.

By signing the form, you confirm that you meet the following conditions:

- You are at least 18 years' old
- You have normal or corrected to normal vision
- You have read the above consent form, understood it, and agree to it.
- You want to participate in the above-mentioned experiment

I give consent to be photographed during the study: Yes _____ No _____

Name: _____

Signature: _____ Date: _____