

**INTERACTIVE MAP AND TIMELINE APPLICATION  
FOR THE KNIGHTS! EXHIBITION AT WORCESTER ART MUSEUM**

Interactive Qualifying Project Report completed in partial fulfillment  
of the Bachelor of Science degree at  
Worcester Polytechnic Institute, Worcester, Massachusetts

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## Abstract

The purpose of this project is to enhance the visitors' experience by creating interactive media to supplement the *Knights!* Exhibition in the Worcester Art Museum. The result is an informative web-based Map and Timeline Application. The application launched at the opening night of the *Knights!* Exhibition on March 28<sup>th</sup> 2014, in the *Knights of the Round Table* section, showcasing the chronological and geographical relationships of the twelve helmets on display. It replaced the extended wall labels which contained the detailed information about the helmets in the section. In addition, it transformed the exhibition into a more interactive space, expanding the museum's visitor demographics. The application was highly regarded by the Worcester Art Museum and its visitors. By the time the project concluded, the museum had also adapted the application for use in other galleries.

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## Executive Summary

The Higgins Armory Museum, located in Worcester, Massachusetts, was once the only museum in the United States devoted solely to armory collections (Edgers). Due to insufficient funding, it permanently closed on December 31<sup>th</sup>, 2013. Its arms and armors collections were partially moved to the Worcester Art Museum, the second largest art museum in New England, to retain the public access to the artifacts. The *Knights!* Exhibition displays a small portion of the migrated armory collection, along with existing artworks from the Worcester Art Museum. The exhibition, curated by the Worcester Art Museum director Matthias Wascheck, opened on March 28<sup>th</sup>, 2014. The *Knights!* Exhibition is the first phase of the armory migration which will last five years. The Worcester Art Museum's long-term plan is to display more artifacts from the armory collection using its current library space.

The Worcester Art Museum anticipated this exhibition to attract more family visitors and expand its audience demographics which consisted mainly of seniors. However, most of the interactive media from the Higgins Armory Museum, which played an important role in attracting family visitors and enhancing visitor experience, were not moved to the Worcester Art Museum. The goal of this project was to help the Worcester Art Museum shape an interactive *Knights!* Exhibition by developing supplementary interactive media, which should also enhance the visitor experience at the museum.

The team started the development process by creating different design ideas that could be applied to the museum, among which the Map and Timeline Application was selected. The purpose of the application was to illustrate the chronological and geographical relationships of the twelve helmets in the *Knights of the Round Table* section in the *Knights!* Exhibition. The

*Knights of the Round Table* section displays twelve helmets from Europe and Asia, dating from 550 B.C.E. to 1,800 C.E.

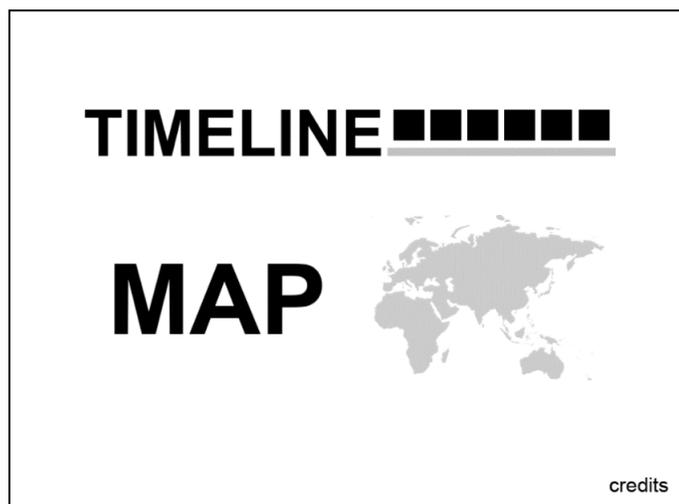
To understand the Worcester Art Museum's experience with interactive exhibitions, the team conducted research and interviews regarding the [remastered] galleries, an experimental interactive exhibition at the museum. The team studied online examples of similar applications to generate design ideas, and carried out technical research to explore technological options for the application development.

The Worcester Art Museum established a set of requirements and expectations for the application. The application needed to be run on iPads without Internet access. In addition, it must be able to display images and texts provided by the museum. Furthermore, the application should be flexible enough to be used for other exhibitions and on the museum website. While the main target audience of the application are adults, the application should be designed to accommodate visitors of all demographics. The application needed to have a simple grayscale interface to complement the colorful *Knights!* Exhibition.

To ensure the usability of the application, the team followed a set of design principles with emphasis on the layout consistency, flexibility and information organization of the application. The application must be able to convey the chronological and geographical relationships between the helmets as well as the detailed information of the helmets. To accommodate users of all demographics with different levels of experience with touch-screens, the application had a simple navigation system. Careful considerations were given to the graphic designs and other visual elements on the interface.

There were three major stages in the development of the Map and Timeline Application: the initial interface design, the first prototype and the final design. The final design combined the

first prototype and the interface designs suggested by the museum. The final design consists of a homepage (Figure 1), a map feature page and a timeline feature page. Both map and timeline feature pages are linked to the object information pages which contained detailed information of the helmets, and their respective help pages.



*Figure 1: Homepage in the Final Design*

In the development process, the team created the structure of the application using HyperText Markup Language (HTML). JavaScript added dynamic effects and fabricated the interactive map and timeline features. Cascading Style Sheets (CSS) defined the look of the interface. The application incorporated a separate datasheet developed using Extensible Markup Language (XML), allowing the contents of the application to be changed easily.

The Map and Timeline Application was delivered to the Worcester Art Museum and with a few modifications, the application launched on the *Knights!* Opening Party on March 28<sup>th</sup> 2014. The team members attended the evening and noted that the application was widely used by visitors of all demographics (Figure 2). Renowned art critic Sebastian Smee wrote in the Boston Globe that the application was “admirably lucid and straightforward to use” (Smee, Worcester Art Museum’s show of armor shines, surprises).



*Figure 2: Group visitors using the application in the Triumphal Arch*

To evaluate the application, the team gathered feedback from the museum, the users and a user interface design expert. Opportunities for improvements on text usage, graphic designs and page layouts were identified. The team also suggested several possible additional features to be developed, and potential future uses of the application. For example, colorful interfaces could be implemented to substitute the simple, greyscale interface. For another example, other types of media, such as 3D pictures, videos and games, could be added to the application to provide various experience for the users.

The Map and Timeline Application has several impacts on the *Knights!* Exhibition and the Worcester Art Museum. The application conveys the chronological and geographical relationships of the helmets in the *Knights of the Round Table*. In addition, the application serves as a substitute for the extended wall labels in the section, uncluttering the gallery space. The application is highly regarded by the museum and its visitors. The museum adapted the timeline feature in the application for use in the *Triumphal Arch* section of the *Knights!* Exhibition. At the time the project concluded, the museum was preparing it for use in the [remastered] galleries.

## 1. Introduction

The Higgins Armory Museum was a museum devoted exclusively to armory collections. The museum was located in Worcester, Massachusetts and closed on December 31<sup>st</sup>, 2013 due to deficiency in funding. The majority of its collection was moved to the Worcester Art Museum to maintain its access to the public. However the interactive media, which plays an important role in attracting younger visitors, were not transferred.

Interactive exhibitions widen the age groups that museums appeal to. In addition, they encourage the physical participation of visitors and allow the visitors to be actively involved in the exhibition. For these reasons, Worcester Art Museum has been slowly transforming its galleries into more interactive spaces. Recently, the museum re-designed the [remastered] galleries. The galleries aim to balance the opportunities for quiet contemplation with the new interactive and experimental program. With the success of the experimental program, the museum is looking to transform more of its gallery spaces into more interactive exhibits. This is partly to compensate for the interactive media not transferred from the Higgins Armory Museum, to attract younger visitors and expand the visitor demographics.

The purpose of this project was to create interactive media to enhance the visitor experience at the Worcester Art Museum. The result of the project is an informative web-based application that aims to help visitors understand the geographical and chronological relationships of the objects in the gallery. The application was launched on the opening night of the *Knights!* Exhibition in the *Knights of the Round Table* section to aid the twelve helmets on display. In addition to making the exhibition a more interactive space, the application replaced the extended wall labels in the section. This reduced the cluster in the exhibit and gave the visitors an optional access to the in-depth information of the helmets.

*Knights of the Round Table* is one of the five sections in the *Knights!* Exhibition. The *Knights!* Exhibition displays a combination of existing artworks from the Worcester Art Museum and the arms and armor collection obtained from the Higgins Armory Museum. Worcester Art Museum hopes that this collection will attract more family visitors, which will expand its audience demographics. For the first five years, the exhibition will only display a small portion of the collection. After that, the museum plans to put the whole collection on an open storage style exhibition in the current library space (Stacy).

The research that the team conducted provided the essential background knowledge on the skills desired to develop the application as well as on existing interactive media designs. A variety of design interfaces were developed and analyzed. In the development process, the team considered the requirements and expectations from the Worcester Art Museum as well as the user interface design principles. There were three main stages in the development of the application: the initial interface design, the first prototype and the final design. The application was designed to run on Kiosk Pro and to function offline.

The application consists two main features: the map page and the timeline page. The map feature page highlights the countries that the objects are from, showing the relationship between the helmet and its country of origin. The timeline feature page displays the objects in the chronological order, showing the relationship between the helmet and its time of origin. Both feature pages link to the object information pages which contain more detail information about the objects.

The application can be modified to be used in other exhibitions and on the museums' website. The timeline feature of the application were modified to be used in the *Triumphal Arch* section in the *Knights!* Exhibition. When the project concluded, the museum was preparing to

use it in the [remastered] galleries. Opportunities for improvements were identified and recommendations for further developments are outlined in this report.

The application has met all the requirements given by the museum and has received positive feedback from both the museum and its visitors. The team believes this application has benefited the *Knights!* Exhibition and improved the visitor experience at the Worcester Art Museum. It will also be valuable to the museum in the long run for it can be used for future exhibitions.

## 2. Background

To prepare for the development process, the team conducted background research in several topics, ranging from the migration process, to examples of interactive application design, to technical knowledge needed for the development process. The details of these research discoveries will be discussed in this section.

### 2.1. Migration from Higgins Armory Museum to Worcester Art Museum

The Higgins Armory Museum was the only public museum devoted solely to arms and armor collections in the United States (Edgers). However, due to funding issues, the museum permanently closed after the year 2013 and the collection was moved to the Worcester Art Museum. The Worcester Art Museum houses artworks that represent cultures from all over the world, dating from antiquity to the present day. It is a museum committed to collecting, caring and preserving art.

There are two phases of the migration. First, from March 2014 to 2019, the collection will be displayed in the *Knights!* Exhibition in the Worcester Art Museum. In this phase, a small portion of the collection will be displayed and the rest will be kept in storage. The museum plans to put the entire collection on display in the second phase of the migration by utilizing an open storage style exhibition in the current library space.

With this migration, the Worcester Art Museum hopes to expand its audience demographics. Currently, its visitors comprise of mainly senior citizens. The museum hopes to attract more family visitors with the migration (Stacy).

### 2.1.1. The *Knights* Exhibition

The *Knights!* Exhibition deploys a new framework, breaking away from the traditional installations in the Worcester Art Museum, combining the existing artworks from the Worcester Art Museum with the armory collection obtained from the Higgins Armory Museum. The *Knights!* Exhibition comprises of five main sections: *Courtly Pursuits*, *The Dance of Love and War*, *Knights of the Round Table*, *Triumphal Arch*, and *The Corridor of Good and Evil*. The exhibition also has a children section called *Helmutt's House*.

The first section is *Courtly Pursuits*. This section displays five portraits of Italian, Spanish and Dutch noblewomen wearing filled collars, broadened shoulders and puffy sleeves of the respective eras they are from (Bergeron). To go with the portraits, the section also displays five armored knights which are gazed down on by the women in the paintings.

The second section is *Dance of Love and War*. This section demonstrates the relationship between Venus, the Roman goddess of Love and her lover Mars, the Roman god of war. The objects displayed in this section are meant to suggest the conflicts buried within the idealized relationships between the knights and their fair maidens (Bergeron).

The third section is *Knights of the Round Table*. The section consists of twelve helmets and a life-size figure of Batman, wearing the original black armor from the 1989 film. The twelve helmets are fashioned in an oval and displayed in glass cases while the Batman figure is at the tip of the oval, facing the helmets. *Knights of the Round Table* is modeled after King Arthur's Round Table. King Arthur's Round Table, according to Arthurian Legends, has no head, implying that everyone on the table is of equal importance. Helmets from different times and cultures are displayed to represent the many worlds that meet in a museum (Worcester Art Museum). The section also displays rare shaffrons, which are armors worn by horses.

The fourth section is *Triumphal Arch*. The arch in this section is built to resemble the Arch de Triomphe in Paris which was visited by Adolph Hitler and Charles de Gaulle. This section illustrates how victory symbols can suggest war's futility and human costs.

The fifth section is *The Corridor of Good and Evil*. The section showcases different types of lethal weapons ranging from samurai swords and Indian daggers to firearms. The section also includes a screening room, displaying photos titled "Guns without borders in Mexico and Central America". These photos illustrate the darker side of the beautiful craftsmanship of weapons.

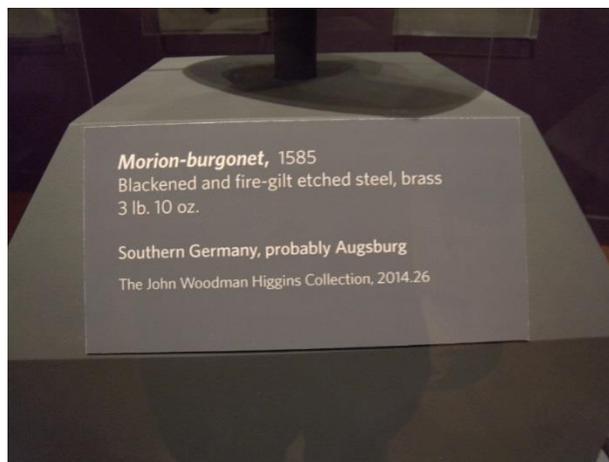
*Helmutt's House* is designed to help attract younger museum visitors. The section is a sitting area with different activities relevant to the *Knights!* Exhibition for children to enjoy.

#### 2.1.2. *Knights of the Round Table*

The Map and Timeline Application is used to display the relationship of the helmets in the *Knights of the Round Table* section. The section displays shaffrons and helmets representing a variety of historical periods, places, and cultures (Worcester Art Museum). According to the legend, King Arthur's knights would feast, joust and dance without serious fighting. (Worcester Art Museum). The twelve helmets from different regions are placed in an oval shape to signify that no helmet is more important than another (Figure 3), just as in the legend. The eight shaffrons represent the horses on which knights traveled to this reenactment of King Arthur's Camelot (Worcester Art Museum). The batman suit is also displayed in this section. There are four iPads located at the back of the helmet arc to display the Map and Timeline Application.



*Figure 3: Knights of the Round Table Layout*



*Figure 4: Example of a Helmet Label*

The helmets are from different regions in Europe and Asia. More specifically, three helmets are from Asia (Japan, Persia, and Turkey or Caucasus), and nine helmets are from Europe (France, Italy, Italian Peninsula, Germany, Greece, Russia).

Time-wise, most of the helmets originated from 1500 -1800 C.E. Three others were from before 200 B.C. E. Between the two time periods, there is a gap of 1700 years without any helmet.

## 2.2. Interactive Exhibition

Worcester Art Museum hopes to expand its audience demographics by creating more interactive exhibitions. Interactive exhibits allow visitors to be actively involved in the exhibitions. The definition of an interactive exhibition is “those in which visitors can conduct activities, gather evidence, select options, form conclusions, test skills, provide input, and actually alter a situation based on input. (Allen and Gutwill)” Interactive exhibits engage individuals – keeping them interested as they control their own museum experience (Sparacino, Larson and MacNeil). Reaction and connection are essential in this process – a visitor “acts on the exhibit” and obtains responses accordingly from interactive exhibits (Allen and Gutwill).

Interactive exhibits are educational facilities that enhance studies on the exhibited objects. Children are more interested in playing with colorful games than observing objects behind glass barriers. Adults learn better by manipulating instruments and analyzing the process than by solely observing and reading. Everyone will “gain some understanding [of science and technology] by controlling and watching the behavior of laboratory apparatus and machinery” (Archer, Kimberly and Thomas).

Interactive exhibits widen the age groups that the museum appeals to. For example, games can attract kids, who otherwise might not be interested in the exhibits. A good interactive exhibit will be highly regarded by visitors, and will bring in more visitors. However, interactive exhibits may be considered intrusive (Robertson). Some interactive devices may disturb other visitors. Moreover, interactive exhibits sometimes have high development and maintenance costs and are delicate and prone to breaking (Robertson). Furthermore, the interactive exhibits may exclude older generations and people who visit the exhibitions to enjoy and appreciate the art.

### 2.2.1. Examples of Interactive Media at Worcester Art Museum

Worcester Art Museum has a moderate level of experience in interactive exhibitions. The museum had Discovery Gallery in which visitors can touch parts of the exhibition. It is currently undergoing renovations to improve the experience of its visitors.

The most recent change to their permanent collection is the [remastered] galleries. The goal of the [remastered] galleries is to balance opportunities for quiet contemplation – the “traditional” museum experience - with the new interactive and experimental program. Two iPads are placed in front of the paintings as a part of the [remastered] gallery. The iPads are used to share reflections and responses from visitors. The two highlighted paintings change every month. The iPads also provide information about the highlighted paintings and provide reflections from notable individuals and museum visitors.

An art history project team from the Worcester State University carried out a study in the [remastered] gallery on how the absence of wall labels enhanced the visitor experience with the artifacts. As a precursor of interactive exhibition study in the Worcester Art Museum, the students conducted several surveys to the visitors of the [remastered] galleries after the museum had replaced all the labels in the gallery with label booklets in September and October of 2013. The students assisted the audience, of different ages and background, in adapting to the new design of the exhibition. They then observed the audience reactions and asked for feedback from the audience regarding the innovation. They drew the conclusion that “no labels on the wall” eliminated the distraction from reading labels, and made the audience focus on the artifacts. (Wilcox-Titus and The Worcester State University Students)

### 2.2.2. Examples of Interactive Media at Higgins Armory Museum

Higgins Armory Museum had a large amount of interactive media. Its two online databases are examples. The public online database linked from the museum website was the most updated online database that the museum offered to the public (Figure 5).

This database displayed “Artifact of the day” on its homepage. On the side of the homepage, users could “Search the Higgins Collection” by typing in the desired keyword or search by time period, which went up in 100 years increments. The canned search included “browse by accession number”, “On display at the Museum” and descriptions of objects including accession number, origin, measure, weight, a brief description of the artifact and a picture. Overall the banner looked professional but the homepage could have been more organized and contained more general information about what the database had to offer.



Figure 5: Public Online Database Homepage

The second database was an older, student-programmed database called the Virtual Armory (Figure 6). The homepage included the highlights of as well as a little introduction to the website. The Fun section included games, video combats, and personalized tours. The personalized tours included a multiple-choice quiz. After the users took the quiz, the program generated a map that highlighted in red the areas that users would be most interested in. The

Learn section had a virtual tour where the objects could be accessed by the armor type. Different forms of media were used to present information such as sound clips and Flash media. Under the Higgins Armory section, the users could to search under the following categories: accession number, artifact type, date and origin.



*Figure 6: Virtual Armory Homepage*

### 2.2.3. Online Examples of Map and Timeline

The Map and Timeline Application was to showcase and help visitors understand the geographical and chronological relationships of the objects in the exhibition. Thus, the team conducted research on a variety of similar applications to generate design ideas. Two examples of such applications are discussed below.

#### *2.2.3.1. TimeMap of World History*

Website *TimeMap of World History* illustrates the events that happened world-wide from 3900 B.C.E. to 2100 C.E (Figure 7). The interface is divided into two parts: a world map showing the locations of the events and a timeline with colored bars showing the time periods that the events occurred in (TimeMap of World History).



*Figure 7: TimeMaps Webpage<sup>1</sup>*

The world map is colored with different colors and labeled with pins that allow users to hover over to see a brief description and a small image of the event. Details are displayed when the user clicks on the pin. The timeline can be dragged from 3900 B.C.E. to 2100 C.E. It shows the time intervals and locations of the events.

The website uses white background, which provides contrast with the colorful contents. The web page is made more appealing because of the simplicity of the interface (Rosen and Purinton) . The team utilized this design idea in the development of the application.

The pins on the map serve to direct the users to a more detailed level of information (Lawrence and Soheyla). The team adapted the hovering function on this website, and designed the pop-up boxes that contain the object list in the region. The iPad does not allow hovering, but the idea of showing a brief overview before offering users all the information is showcased on our application.

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<sup>1</sup> <http://www.timemaps.com/history/japan-750ad>

### 2.2.3.2. Heilbrunn Timeline of Art History

The *Heilbrunn Timeline of Art History* displays the art collections from the Metropolitan Museum of Art. The collections contain objects created from 8000 B.C.E. to the present, originated from all around the world (Heilbrunn Timeline of Art History).

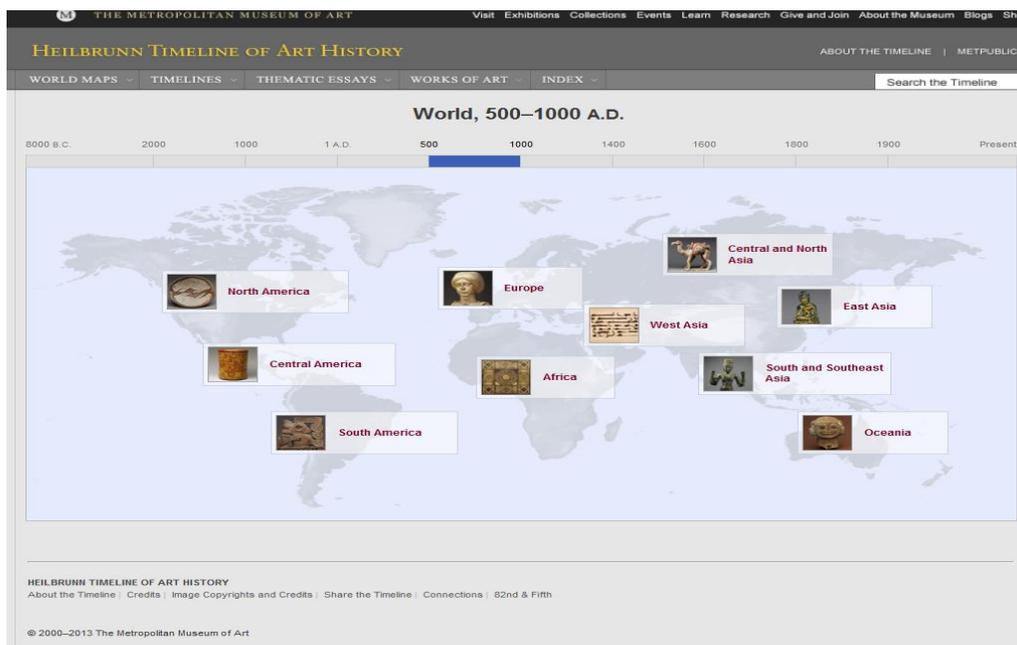


Figure 8: Heilbrunn Timeline of Art History Webpage<sup>2</sup>

The regions in the world map are labelled with region names and images of their representative artifacts. When a region is selected, the world map zooms in to show only the region. The regional map is labeled with sub-regional names and images of the artifacts. A detailed list of the names of the countries in the region is displayed next to the enlarged map. A description of the sub-region will appear when the label of it is clicked. The description includes an overview, a list of key events, works of art, and other related contents.

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<sup>2</sup> <http://www.metmuseum.org/toah/world-regions/#/05/World-Map>

## 2.3. Technical Research

In preparation for the development of the application, the team researched a variety of programming languages and tools as well as interface design practices. Understanding the interface design practices helps make sure the users' positive experience. An in-depth knowledge of the related technology is important because their capabilities and limitations can impact the implementation of the designs.

### 2.3.1. Programming Languages

HTML, CSS, JavaScript, and XML are examples of the most commonly used languages for application development, more specifically for web application development. HyperText Markup Language, or HTML, is defined by World Wide Web Consortium, or W3C<sup>3</sup>, as “the language for describing the structure of Web pages” (HTML & CSS - W3C). Cascading Style Sheet, or CSS, is a language that describes the appearance of web pages, for example, colors, layouts, and fonts (HTML & CSS - W3C). JavaScript is the most common scripting language used in web pages. Scripting, in the web development context, usually refers to program code that is executed by web browsers in response to users' actions (Hazaël-Massieux). The team also used Extensible Markup Language or XML, which is commonly used to represent structured information such as tables and configuration, especially for web pages (Quin).

### 2.3.2. Software and Services

There are countless software and services designed for application development. These tools range from environments for application development to project managers and backup

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<sup>3</sup> W3C is an international community that develops open standards to ensure the long-term growth of the Web.

services. Examples of such software and services are Eclipse, EGit, Adobe Dreamweaver, and GitHub. The descriptions of these software and services can be found in Appendix A.

### 2.3.3. JavaScript Libraries

A JavaScript library is a collection of pre-written JavaScripts that provides resources web pages. JavaScript makes web pages dynamic and interactive. Examples of JavaScript libraries are jQuery, jQuery UI, jQuery UI Touch Punch, Hammer.js, jVectorMap, and Colorbox.

Descriptions of these JavaScript libraries can be found in Appendix B.

### 2.3.4. Interface Design Preparation

In successful interfaces, users can immediately notice the important elements (Garrett). In addition, a well-designed interface recognizes the course of actions that are most likely to be taken by the users. In short, the best practices for interface design are to keep the interface simple, to create consistency by using common user interface elements, to be purposeful in the page layout, to strategically use colors and texture, to use typography to create hierarchy and clarity, and to make sure that the system communicates what is happening (User Interface Design Basics).

#### 2.3.4.1. Navigation Design

Users should be able to tell the purpose of every page on the interface and know where they can go. The interface navigation design should aim to accomplish three main goals (Garrett). The user must be able to get from one point to another on the site without having to navigate through multiple pages. In addition, the navigation should be appropriately labelled so that users build a sense of familiarity faster (Morville and Rosenfeld).

#### *2.3.4.2. Information Design*

The key to information design is to group similar elements together and consider how users relate each set of information with each other (Garrett). To achieve this, the developer should have a clear understanding of the sites' content, processes and purpose. The interface design should aid the actual contents in communicating the information to the users. The information presented to users should be organized in a way that makes users want to work through them (Ta'eed). Large sets of information should be organized in levels and each given level should have four to eight options. The page has to be designed with consideration that users may be scanning, skimming, and jumping through the interface. Thus, key information should not be concentrated in one area and should be emphasized either by breaking them up with headings, subheadings, and bullet points or diagrams (Ta'eed). Texts on the interface, emphasized or not, should be easy to read. In order to design readable texts, the following factors have to be considered: font sizes, contrast between text and background color and font type. Moreover, the design of the interface should not be too complicated. There should be a balance between the visual elements on the page and the level of complexity of the interface.

### 3. Methodology

After the background research, the team started to solidify and implement the idea of developing supplementary interactive media through a series of moves. The first step was to generate design ideas, among which one was selected and further developed. The second step was to gather the project requirements and expectations from Worcester Art Museum, the project sponsor. This was to ensure that we understood the project concept properly and we knew what should be achieved in the end. Then the development process could be divided into two main parts: interface design and implementation. After the application was fully developed, it was launched and the team conducted evaluations to understand its impact and to find opportunities for improvements. This section will discuss in detail the stages that the team went through and the rationale behind them.

#### 3.1. Design Ideas

The project started with a theme of “interactive media design” for the Worcester Art Museum, with the ultimate goal to enhance the visitor experience. The specific design idea was formed later in the process. First the team needed to choose a media platform. The museum had experience with iPad applications and developing them was feasible for the team. Thus iPad was selected to be the medium for the design. Then the team researched and brainstormed different types of applications that can be run on iPads. Four ideas were established and are briefly described below:

- Exhibition Extension: the application displays information of items in storage.
- Global Map and Timeline: the application combines and presents the geographical and chronological information of the objects on display.

- The Higgins Armory Memorial: the application exhibits materials related to the Higgins Armory Museum such as its history, migration process, and images.
- Floor Map: the application shows an interactive map of the Worcester Art Museum.

The team constructed evaluation criteria and utilized a decision matrix to rate the four alternatives (Appendix C). The conclusion was made that the global map and timeline was the most valuable idea among all. The biggest weighing factor in the decision matrix was the sponsor's opinion, for that ultimately the product was developed for the sponsor. The sponsor was most interested in the map and timeline option, and hoped to have it for the armory collection newly migrated from the Higgins Armory Museum. Therefore the team decided to design and create a Map and Timeline iPad Application for the armory exhibition.

### 3.2. Requirements and Expectations

After the team and the sponsors narrowed down the different choices of project themes to the map and timeline option, the museum provided the team with specific requirements and expectations for the application. These terms were important to the team and served as guidelines throughout the development process.

In terms of the operational environment, the application needed to be run on an iPad. This limited the options to a native iOS application and a browser-based application. The sponsor further suggested that the application might be used on their website, thus the team opted for the browser-based application. The application should also be able to run offline therefore its contents and functionalities would need to display and operate independently without Internet access.

The contents of the application, including texts and images, would be provided by the sponsor. The museum expected to use application to replace the wall labels in the exhibitions.

Furthermore, the application should be flexible and scalable so that it could be used for other exhibitions in the future. Thus, the information and images of specific artifacts should be easy to change.

With regards to the user interface, simplicity was highly recommended by the sponsor. It was explained that the artifacts in the armory exhibition would be colorful and vibrant, so everything else needed to be mute and complimentary. Grayscale would be used as the main theme color for most iPad applications in the exhibition. The application was to target at adults while also taking into consideration seniors and children. The interface design should reflect this consideration.

Last but not least, the application should be fully developed and delivered well ahead of March 28th, the opening date of the exhibition. This would leave sufficient time for the museum to make necessary adjustments.

These requirements and expectations from the sponsor formed an important knowledge base for the design of the application. In order to understand the best design practices, the team then explored the established design principles. This was to ensure that the user experience of the application would contribute to the visitor experience as a whole.

### 3.3. Design Principles

In general, an application contains a series of interrelated pages with different features and functions. These dynamic pages are the user interfaces (UI). The quality of the user experience of an application is dependent on the quality of its UI. A good UI design, according to *User Interface Design and Evaluation*, “encourages an easy, natural and engaging interaction between a user and a system, and it allows users to carry out their required tasks” (Stone, Jarrett and Woodroffe). In this project, the team followed a set of design principles adapted from the

book *User Interface Design and Evaluation* (Stone, Jarrett and Woodroffe 90-98), more specifically the four Psychological Principles and the three Principles from Experience. These protocols served as important guidelines in the creation of the prototypes and the final design.

### 3.3.1. Four Psychological Principles

Each of the Psychological Principles below will state the principle first, followed by the implications of each of them in the UI design. Then brief explanations are given next to each implication.

1. Users see what they expect to see.

*The principle of consistency.* This principle says that consistency should be maintained throughout the design, across many aspects including color, layout, font, etc.

*The principle of exploiting prior knowledge.* Screen metaphors are one way to allow the users to utilize their prior knowledge in the use of the application.

2. Users have difficulty focusing on more than one activity at a time.

*The principle of perceptual organization.* Grouping things together properly can help the users to focus on the right things.

*The principle of importance.* Important messages should be positioned in a prominent place on the screen to attract the attention from the users.

3. It is easier to perceive a structured layout.

*The law of proximity, similarity, closure, continuity, symmetry.* This principle discloses critical considerations that should be taken into the graphic design, including but not limited to the contrast between background and figures.

4. It is easier to recognize something than to recall it.

*The principle of recognition.* This principle calls for the explicit display of options on the screen. Having the manipulation choices displayed on the screen is a big advantage for the inexperienced users.

### 3.3.2. Three Principles from Experience

The principles below will include citations from the book, followed by further explanations for each one of them.

1. The Principle of Visibility: it should be obvious what a control is used for.

When users want to carry out a specific task, they should be able to find the way of doing it easily. This calls for carefully-designed graphics, layout and texts.

2. The Principle of Affordance: it should be obvious how a control is used.

This principle, more specifically, means that there should be “strong clues to the operations of things” in the graphic design. For example, a button is to be pressed and a bar is to be dragged.

3. The Principle of Feedback: it should be obvious when a control has been used.

Feedback can be very helpful in letting the user know he has made the manipulation he wanted to make. This can be done by offering the right indication after an operation is carried out.

Studying these design principles helped the team gain a theoretical comprehension on the UI design standards. They apply to not only the interface design, but also the implementation because the interface design is achieved by implementation. Specific conceptions that were carried out will be discussed in the next sections.

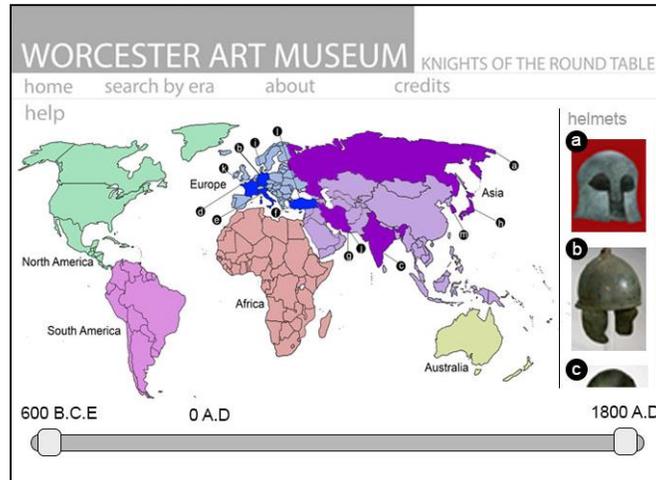
### 3.4. Initial Interface Design

Several interface designs were created in sketch forms. Strengths and weaknesses of the designs were analyzed and discussed; one base design was selected. Appendix D illustrates the base design selected.

The base design was further developed using Adobe Photoshop to create a clear visual representation of the expected outcome. Different graphics for the banner and navigation pane were created and different layout options were explored. The initial design followed the best interface design practices (User Interface Design Basics).

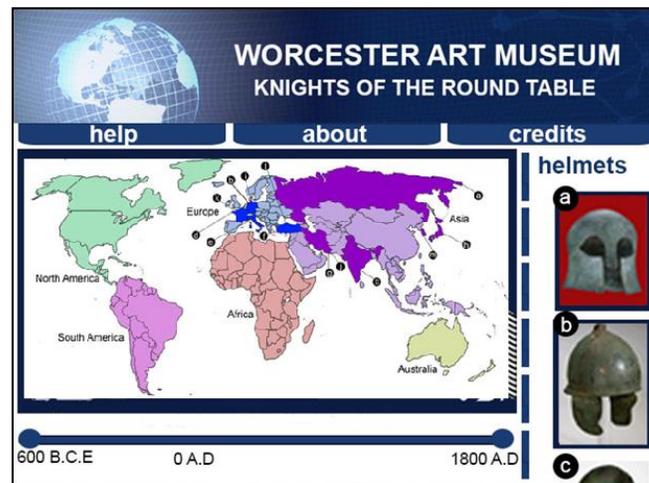
The interface was kept as simple and visually clean as possible. Worcester Art Museum uses font type Arial for all their displays and therefore font type Arial was applied to all the texts used on the interface. The principle of consistency was followed. In addition, spatial relationships between items were considered. Analysis were put into the placement of each feature and figure.

Two main themes were proposed. The graphics for the first theme were in grayscale with minimal patterns to keep the interface as clean as possible (Figure 9). The design was based on the banner from the existing Worcester Art Museum website banner (Appendix E). The only features on the interface that were not in grayscale are the map and object images. This was so that the users could direct their attention towards the subject of the application. This theme was also used to explore other layout options (Appendix F).



*Figure 9: Initial Interface Design 1*

The second theme was the more colorful and bold of the two designs (Figure 10). The color palette for the theme was blue. Only one color palette was applied to the design so that the users' attention would be directed to the more colorful map and object images.



*Figure 10: Initial Interface Design 2*

The team along with the sponsor decided to develop the application from the first theme. The sponsor wanted an interface design as simple as possible. This meant that the graphics, patterns and colors used should be kept at a minimum. The grayscale was chosen so that it would not create a contrast with the color scheme of the *Knights!* Exhibition.

### 3.4.1. Map Options

The visual representation of the map was one of the primal issues that the team considered. Not only should the map be visually pleasing for the users, the team must also be able to implement it. The team focused on finding interactive maps that can be used offline, since the application was required to run offline. After exploring the different options, the team decided that the interactive map generated by jVectorMap was the best option.

Different map display options were explored (Appendix G). The selected map option highlights the countries with objects being presented in the same color and the remaining countries in gray (Figure 11). This map display option was chosen because the sponsor wanted an application with simple colors and displays. This corresponded well with the color palate of the overall interface design.



*Figure 11: Map Display Option Selected*

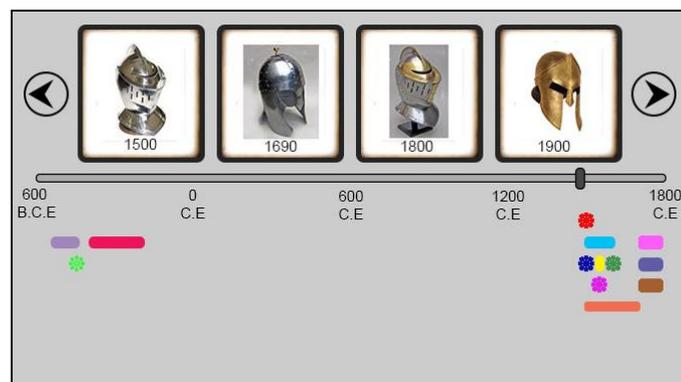
Another issue considered was which portion of the map should be displayed. Since the objects were all from Eurasia, showing the whole world map would be inefficient. In addition, the aspect ratio of the world map and that of the space allocated on the interface for the map were different. The width to height ratio of the world map was much larger than the width to height ratio of the allocated map space. This resulted in unused space left in the vertical direction. For the above reasons, the team decided to only show the part of the world map with

the objects, in this case Eurasia. Displaying only a certain section of the world map meant that the ratio of the map image can be adjusted to fill the whole section allocated to the world map. Moreover, the countries are larger on the interface which reduced the issue with the marker sizing, which is discussed in the later section “3.6.3. Markers in Map Page”.

Lastly, the issue on country borders were considered. Since the objects being displayed are from ancient times when the country borders were different, the team had to consider political concerns. However, due to technological restraints, the modern world map was used.

### 3.4.2. Timeline Options

The timeline displays the time the objects were present relative to each other (Figure 12). The object images were arranged in chronological order, and more images can be viewed by clicking on the arrows or by scrolling on the timeline. The rectangles and the flower icons represent the time period the object was present for.



*Figure 12: Selected Timeline Design*

### 3.5. First Prototype

The first prototype was developed based on the designs selected from the initial interface design. The map feature page acts as the homepage (Figure 13). On the right hand side is a

scrollable bar that displays the object images in the chronological order. Refer to Appendix H for a screenshot of the about page.



*Figure 13: Homepage of First Prototype*

The gray bar on the bottom of the page says “slide to see timeline”. Users can slide the bar up to see the timeline feature page (Figure 14).



*Figure 14: Timeline Page of First Prototype*

### 3.6. Final Design

The final design of the interface was a combination of the designs provided by the sponsor and the team’s first prototype. This design corresponds with all the other iPad

applications developed for the *Knights!* Exhibition, and complements the exhibition itself. The designs given to the team can be found in Appendix I.

In the design provided by the sponsor, the map and timeline features are completely separate entities and the homepage is a simple image link to the two features. The banner spans across the bottom of the iPad, instead of across the top as in the prototype. Based on the designs provided, the team created the necessary graphics to match the vision.

One of the most important principles followed was the principle of consistency. The general layout of the banner on the timeline and map feature pages, the layout and the graphic type of the help pages were kept consistent. Grayscale designs and Arial font type were applied to all the pages on the interface.

The team followed the principle of perceptual organization when considering the layout of all pages. Since users may have difficulty focusing on more than one activity at a time, each feature was kept as straightforward and simple as possible. This principle keeps the design interface clean, which is one of the requirements from the sponsor.

In addition, the principles of visibility and affordance were considered. Each feature and function was designed so that it is obvious what it is used for. For users with less touch-screen experience, the help pages are readily accessible on both the map and timeline feature pages.

While the team considered general design decisions to create a satisfactory user interface for agreeable user experience, specific considerations were given to a number of issues. These issues are examples of the design decisions the team faced during the development process. Each of them will be discussed below.

### 3.6.1. Object Information Page

The team aimed for a simple interface. Therefore, zooming and scrolling were avoided where possible. The size of the object information page should be reasonable in relation to the amount of information it needs to hold, while remaining visually pleasing. After several adjustments, the team decided to set the width and height of the object information page to 80% of the width and height of the screen. Since the aspect ratio of the iPad is 4:3, the aspect ratio of the object information page is 4:3 as well.

The object information page has two major components: the image and the texts. The team decided that vertically splitting the page into two equal parts was visually pleasing for the users. The contents also turned out to fit well into their divisions.

### 3.6.2. Image frame

The team received images of the helmets in the *Knights of the Round Table* Exhibition from the sponsor. However, the images did not have a common aspect ratio. The team needed to adjust them to have a common aspect ratio. The aspect ratio of 3:4 was chosen because the aspect ratio of the space for the image is about 7:10, which is very close to 3:4—one of the most common aspect ratios. Other common aspect ratios did not apply well on landscape object images.

### 3.6.3. Markers in Map Page

Markers are one of the key elements of the map page because they show users the locations of and geographical relationships between the objects. Thus, markers must be clearly visible to users and accurately mark the locations. There are essentially two problems with the markers: marker size and marker locations.

The issue with the marker size is related to the precision of the human touch. Small markers are hard to select on a touch screen with fingers. Large markers are easier to select, but they fit poorly with the map and are not visually appealing, especially when several markers appear on a small country. To solve this issue, an intermediate page was created between the map page and the object information page. This page shows a list of objects in or nearby the area selected by users. Users can then select an object from that list to view the object information page for that object. This page allows markers to be relatively small, while giving access of the object information page to users.

The team could not determine the precision of the locations because the information in the application would be provided by the sponsor. Moreover, since the objects are centuries old, it is not possible to pinpoint the exact locations of their origins. Some objects are from countries that no longer existed, for example, the Ottoman Empire. The team came up with specifications on where the marker should be placed considering two factors, which were the areas of origins and the number of items in the areas.

The regions of the objects' origin designates where their corresponding marker will be. If the object came from a country which is known and still exists, its corresponding marker will be placed on that country. If the object came from a country that no longer exists or is from a region that covers several countries in the modern time, its corresponding marker will be placed on the country that best represent the country or the region geographically. For instance, the Roman Empire will be represented by Italy.

The number of objects in the countries determines how the markers are aligned. If there is only one marker in the country, the marker is placed at the center of the country. If there are more than one marker, the markers are grouped near the center of the country. The team decided

to limit the number of objects per country to four to keep the interface clean and visually pleasing.

#### 3.6.4. Country Borders

Country borders change throughout time. Since the objects displayed are from ancient times, some of the regions no longer exist. For instance, the Roman Empire, which was once one of the largest civilizations in the world, had fallen centuries ago. Some country borders changed and some countries have conflicting borders. For example, the United States bought Alaska from the Russian Empire in 1867. Therefore, it is difficult to select a map that can illustrate every country, kingdom, and civilization in the past, present, and future. In addition, due to technical limitation and time limit, generating maps for jVectorMap was not possible for the team. Therefore, the team decided to use the version of the world map provided by the author of jVectorMap.

### 3.7. Implementation

The application has to be executable on an iPad. Thus two development options are a native iOS application or a browser-based application.

Native iOS applications are applications that run “natively” on iOS which is a series of operating systems used by all iPads. This kind of applications do not require any other intermediate applications to run on. However, iOS applications can only be developed on OS X which is a series of operating systems available only on Apple products. In addition, iOS applications are not flexible and can only be run legally exclusively on Apple products.

Browser-based applications, also known as web-based applications, are applications that run within web browsers (Ziff Davis, LLC. PCMag Digital Group). Examples of browser-based

applications are web sites and offline web pages. This kind of applications are executable on any machines that have a web browser<sup>4</sup>. Browsers-based applications can be developed on most, if not all, operating systems such as Windows, OS X, and UNIX. Moreover, several web developer communities provide free resources such as tutorials and examples.

The browser-based application was chosen for three reasons. First, browser-based applications are feature-rich and flexible. Second, the team had discovered several resources that would fit into our design. Third, Worcester Art Museum had experience with browser-based applications. Lastly, browser-based application allows the sponsor to use the application on the museum website.

### 3.7.1. Programming Languages

The team used HTML, CSS, JavaScript, and XML as main languages to develop the application. HTML was used to create the foundation and the main content of the application. HTML allows the team to create and organize the application interface following the design principles stated previously. For instance, every main page was created to have consistent layout. CSS was used to customize the appearance of HTML elements. More specifically, CSS allows the team to customize each HTML element, for instance, fonts, alignments, and colors, according to the design principles. JavaScript, written or imported, was used to add dynamics to the application. For example it was used to generate page layouts and contents, create feedback to users' actions, and add effects and animations. Lastly, the team decided to store object contents as a separate XML file because it is easy to edit without any programming knowledge. In

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<sup>4</sup> Except for web pages containing Flash media, which may not be runnable on iOS.

addition, storing object information as a separate file increases flexibility of the application by allowing object information to be switch in and out easily.

### 3.7.2. Software and Services

The team used Eclipse and Dreamweaver as the main application editors. Git was also used to allow the team to access the older versions of the application. More specifically, the team used EGit, a git plugin for Eclipse, and used GitHub as an online repository. This allowed the team members to have their own copies of the application to work on, while keeping the “official version” clean and functioning.

### 3.7.3. JavaScript Libraries

The team utilized the following JavaScript libraries in the application: jQuery, jQuery UI, jQuery UI Touch Punch, Hammer.js, jVectorMap, and Colorbox. jQuery was used to accommodate other JavaScript functions and libraries. jQuery UI was used to create the slider bar in the timeline page. jQuery UI Touch Punch was used to ensure that the slider bar created by jQuery UI work properly on touch screens. Hammer.js was used to support touch screen gestures on other elements such as swiping the timeline. jVectorMap was used to generate the interactive map in map page. Colorbox was used to display popup pages on every page in the application.

### 3.7.4. Implementation Process

After creating a set of requirements, the team implemented the application based on the final prototype. Iterative and incremental development paradigm was used to ensure a deliverable application at the end of the development process.

For each week, the team started by processing comments from project advisors and sponsor and adjusting the requirements. Then, possibilities and priorities of each requirement

were re-computed. The goals of the current iteration were set according to the new requirements. The team then started implementing according to the goals. Finally we tested and presented the application to the project advisors and sponsor, who provided comments for further development.

Iterative and incremental development paradigm allowed the team to focus on a set of smaller goals such as adding features or fixing defects. This allowed the team to dynamically adjust the plan and make major changes without causing significant delays. Also, this paradigm ensured that at the end of each iteration, the team would have a working, and possibly deliverable, application.

### 3.8. Evaluation

The importance of a good user interface was emphasized in section “3.3. Design Principles”. In the UI design process, evaluation is also very important. A good product must entail usability, which is defined by ISO 9241 as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (Stone, Jarrett and Woodroffe). In deciding the usability of the product, evaluation plays a key role. Due to the time frame of the project, it was not practical to conduct complete iterative evaluations during the development process, but having it after the launch of the application is also useful. Evaluation later in the design cycle can generate a set of recommendations for the sponsor as well as future project groups.

#### 3.8.1. Expert Review

Given the resources available on campus, the team believed that an expert review would be helpful to our project. With this evaluation method, an expert “uses a product or web site and

assesses its usability against a set of principles or best practice guidelines” (Travis). Conducting an expert review gives fast results under the time constraints and has low cost. The details of the expert review that the team conducted will be discussed in the later section “4.3.2. Expert Review”.

### 3.8.2. Feedback from Users and Worcester Art Museum

The feedback from the users was of unique value to the project because however valuable the expert review was, it could not replace the users’ voice. The users’ opinions were essential in understanding the usability of the product. In this project, the sponsor was to decide the value and use of the product. Thus it played an equally important role as of users in deciding the product’s success. For these reasons, the team gathered feedback from both the users and the sponsor, by both talking and observation. The specifics will be discussed in the later section “4.3.3. Feedback from Users and Worcester Art Museum”.

## 4. Results

The Map and Timeline Application was launched on March 28, 2014, on the opening night of the *Knights!* Exhibition, in the *Knights of the Round Table* section. Worcester Art Museum also modified it for use in the *Triumphal Arch* section. The application received positive feedback from the museum visitors. In this section, the results of the project will be discussed, as well as the feedback that the team gathered from the design expert, the museum, and the users.

### 4.1. Description of the Results

The result of this project is a web-based application that has two major interfaces, the map and the timeline. The map is marked with markers that are linked to the helmet's information page; the timeline displays a scrollbar and the images of the helmets which are linked to their information page. Both pages have links to their respective help pages.

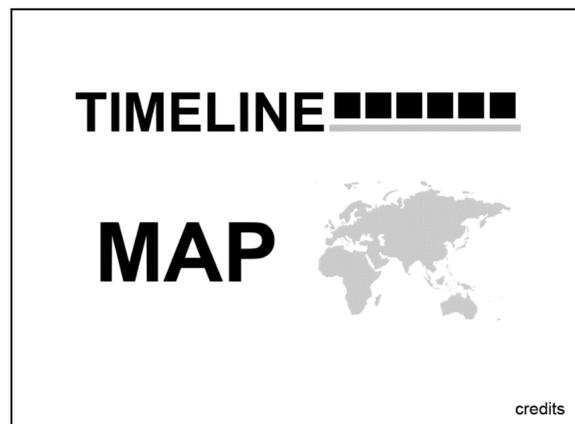
#### 4.1.1. Homepage

The timeline and map icons were created based on the design given by the Worcester Art Museum; the credits button was added to the homepage. There are three links on the homepage: the top link is an image link to the timeline feature, the middle link is an image link to the map feature and the link towards the bottom right hand corner leads to the pop-up credits page. Each icon was designed so that it is obvious what the control is for – the name of the feature is next to an image that mimics the interface that the users can expect after tapping on the icon.

The homepage (Figure 15) is a great example of how white space is used throughout the design of the final interface. The background is white and empty to help define the features that the user's attention should be directed towards (Turnbull). The design of the homepage is similar

to Google’s homepage (Appendix J). Both designs utilize white space to display a clean design and direct the users’ attention to the main aim of the webpage (Turnbull). The structured layout of the homepage makes it easy to perceive. Moreover, the list structure allows more features to be added during future developments, increasing the flexibility of the application, which is one of the expectations from the Worcester Art Museum.

The application was designed to run on Kiosk Pro which has a feature to command the application to automatically return to the homepage whenever the interface is idle for more than a specified time period.



*Figure 15: Final Homepage Design*

#### 4.1.2. Banner



*Figure 16: Final Timeline Design*

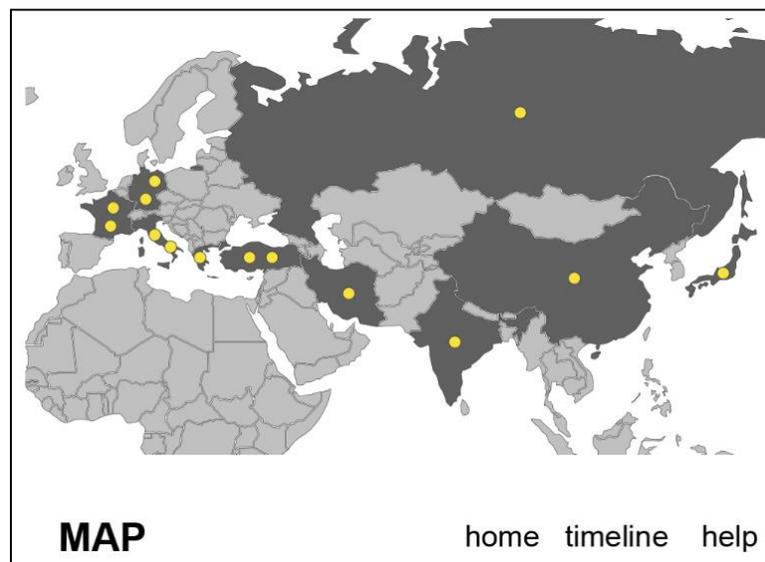
Consistency was one of the principles followed during the design of the interface. Thus, the banner (Figure 16) which is located across the bottom of both the timeline and map feature pages is in the exact same position with the same design. The banner acts as the main navigation tool in the application. The name of each page is named after the feature it displays and is

located on the left hand side. This follows the feedback principle that signifies the user when a control is used.

The text for the title is larger than the text for the navigation system. It is also all in upper case while the text for the navigation system is all in lower case. This is so that the users can distinguish between the title and navigation. The banner allows users to navigate from the map feature page to the timeline feature page and vice versa. The banner also allows the user to navigate back to the homepage from every page in the application. The help button on the banner is linked to a popup page which displays the help section for each respective feature.

#### 4.1.3. Map

The map, which can be viewed from a link on the homepage as well as the timeline feature page, displays a portion of the world map, specifically Eurasia. The countries with objects on displayed are highlighted in a darker shade of gray, whilst the rest of the map is in light gray (Figure 17).

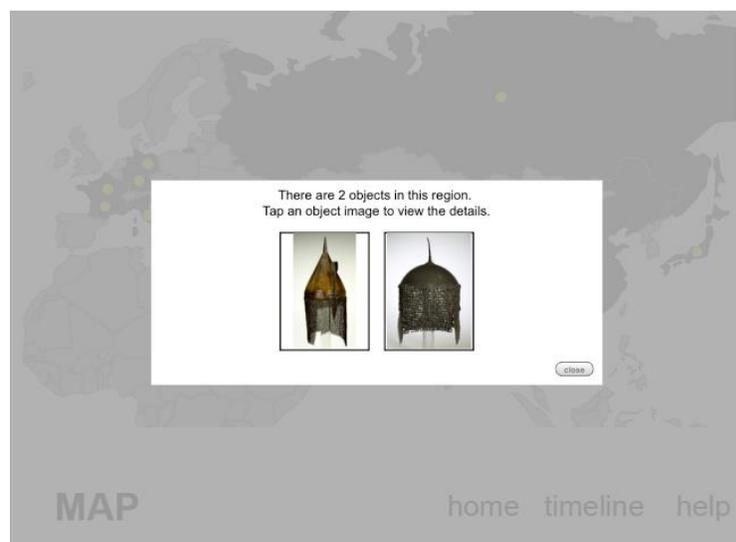


*Figure 17: Map Feature of Final Design*

The yellow markers on the countries represent the items in each country. The darker shade of gray and the markers are to make obvious what part of the interface the user should be focusing their attention on.

The countries with objects were highlighted in a darker shade of gray than the countries without objects as people will be attracted to the darker regions on the lighter background. Negative space is left between the map and the banner on the bottom to separate the two entities. The lack of content is to influence the user's attention to the main content.

For countries with one item on display, the user can tap on either the yellow marker or anywhere on the country to view the object details and image. For countries with more than one item on display, the user can tap on the yellow marker to directly view more information. The user can also tap on the country to view the object list in each particular region. A popup page will appear displaying the images of the objects in the region and the user can tap on the image to view more information about the objects (Figure 18). Each country is able to display four objects because it is the maximum number of images that can be displayed whilst also maintaining clean and simple visual aesthetics.

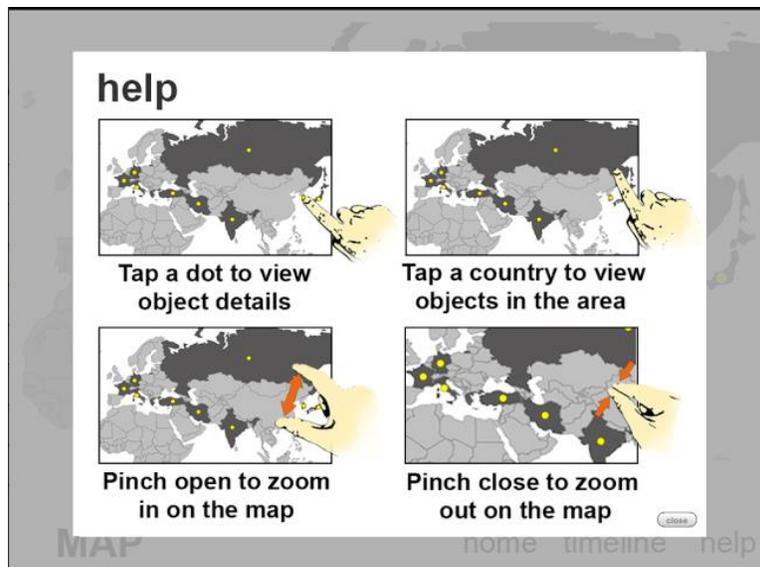


*Figure 18: Pop-up page from map page*

The map and timeline features are on separate pages because users may have difficulty focusing on more than one activity at a time. Moreover, the separate features allow for more options to be added to each respective feature and makes the layout of the interface more structured.

#### 4.1.4. Help page

The help page (Figure 19) for the map feature can be accessed from the map page by tapping on the “help” button on the banner. The help page is divided into four sections, each with an image that displays the action that can be taken and a text description of the course of the action.

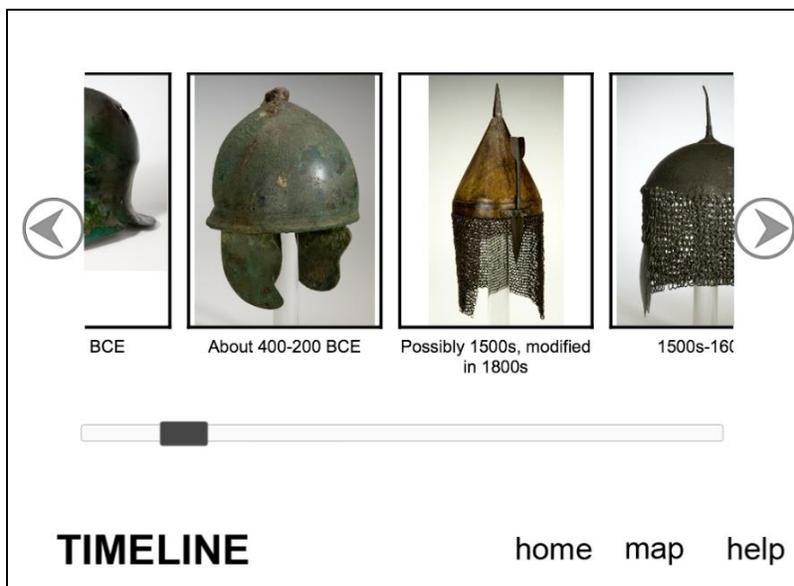


*Figure 19: Map Help Page*

The four main actions that can be taken on map page are: tapping on the marker to view object details, tapping on a country to view objects in the area, pinching open to zoom in on the map and pinching close to zoom out on the map.

#### 4.1.5. Timeline

The timeline feature page can be accessed from the homepage as well as the map feature page by tapping on the timeline link on the banner. The final design of the timeline feature is a combination of the design envisioned by the Worcester Art Museum and the design from the team's first prototype.



*Figure 20: Timeline feature of Final Design*

The same principles from the design of the map feature page were followed during the design of the timeline page (Figure 20). For consistency, the same grayscale design was used in the homepage and the map feature page. This was done to keep the interface visually clean.

The timeline page displays the images of the objects and its corresponding time period in chronological order across the interface. This was done to follow the principle of perceptual organization. Objects from all regions were grouped into one timeline instead of having a separate timeline for each region so that there is only one activity for users to focus on, since some users may have difficulty focusing on more than one activity at a time.

The principle of affordance was considered in the design of the functions of the page. The scroll bar on the bottom of the page allows users to navigate through the images by scrolling left and right. Tapping on the arrows on either side of the page will also move the objects in the respective directions. Although not as obvious as the arrows, users are also able to navigate through the images by swiping left or right. This option is added to serve more experienced touch screen users. Swiping the images and tapping the arrows, either to the left or to the right will move the images across in the respective direction.

#### 4.1.6. Help page

Identical to the help page for the map feature, the help page for the timeline feature (Figure 21) can be accessed through the ‘help’ button on the banner. Following the same layout as the map feature help page, the page is divided into four sections each with an image to illustrate the action and a text description to explain the course of the action.

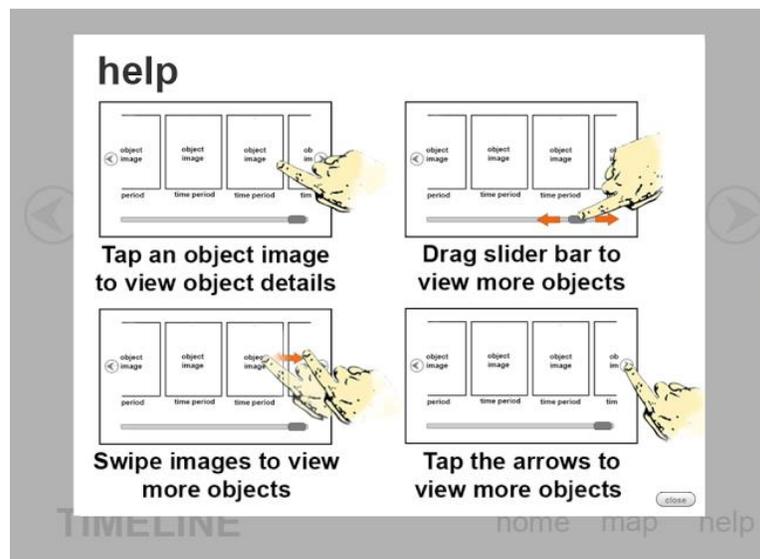


Figure 21: Timeline Help Page

The four main actions that can be taken on the timeline page are: tapping on an object image to view the object details, dragging the slider bar to view more objects, swiping images to view more objects and swiping images to view more objects.

#### 4.1.7. Object Information Page

The page displaying the object information is a popup page (Figure 22). The page displays the object information on the right hand side in text form and the image of the object on the left. The image of the object is recommended to have a 4:3 ratio, but is not required. The font size of the title of the object is larger and is bolded for emphasis. The details of the objects are broken into different categories and the category names are also bolded. The order and categories that are displayed can be changed in the application's database. The text description of the object is divided into two main parts: the first part is for basic details such as the date of origin and the weight of the object, all of which have short answers, and the second part is the text description which outlines a brief history of the object. When the text content for this category is too long to be displayed, the section automatically becomes a scrollable page.



Figure 22: Object Information page

#### 4.1.8. Instruction for Future Uses

The application was designed to be flexible and easy to edit without programming knowledge. In order to edit the content, developers need only to change contents.xml and add the new images, if any. The instruction manual for the application can be found in the Appendix K. In addition, the code of the application can be found in Appendix L as well as [https://github.com/tpatikorn/WAMIQP\\_public](https://github.com/tpatikorn/WAMIQP_public).

#### 4.2. Examples of the Worcester Art Museum's Adaption of the Application

Worcester Art Museum modified the code of the Map and Timeline application for other exhibitions. Helmutt and the *Triumphal Arch* section are examples of further developments. In addition, the museum plans to use the application in the [remastered] galleries as well. This shows that the application can be applied on paintings and sculptures. For future use in the Worcester Art Museum, the Map and Timeline Application can be applied on paintings and sculptures.

##### 4.2.1. Helmutt

Helmutt is the mascot of the *Knights!* Exhibition that the Worcester Art Museum adopted from the Higgins Armory Museum (Figure 23).



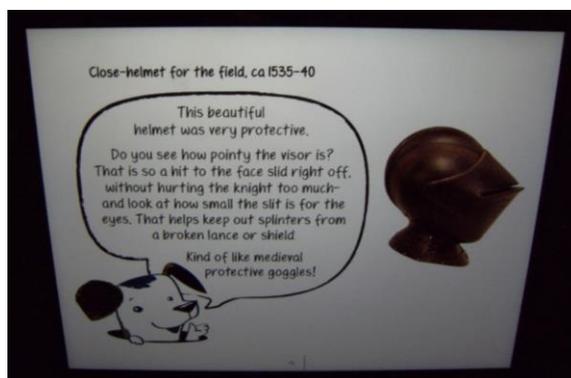
Figure 23: Helmutt's House section in the Knights Exhibition

The Helmutt section was added onto the application by the Worcester Art Museum when it was launched in the *Knights!* Exhibition. Helmutt's image is on the homepage of the application. When selected, it directs the user to a children version of the application. It mainly consists of the selected object images and their modified descriptions. This section is more colorful and children-oriented.



*Figure 24: Helmutt introduction Page*

Helmutt's content in the Map and Timeline Application was developed by the Worcester Art Museum. The integration of the original features and the Helmutt feature is an example of using contents from other sources.



*Figure 25: Helmutt detail helmet description*

#### 4.2.2. *Triumphal Arch* section

In the *Knights!* Exhibition, the *Triumphal Arch* section (Figure 26) is located next to the *Knights of the Round Table*. The exhibition in this section focuses on front plates, boarding swords, and miniature cuirass artifacts. The Worcester Art Museum adapted the timeline feature of the Map and Timeline Application to display the labels and information of the artifacts in this section (Figure 27).



Figure 26: *Triumphal Arch* Section



Figure 27: *Interface of the Timeline Feature in Triumphal Arch*

### 4.3. Feedback and Analysis

#### 4.3.1. The *Knights!* Opening Party

The *Knights!* Exhibition was open to the public for the first time during the *Knights!* Exhibition Opening Party on March 28, 2014. The team members joined the celebration and took the opportunity to observe the iPad users.

Visitors that attended the Opening Party ranged from teenagers to the elderly, both males and females. The application that the team designed was placed on four iPads at the *Knights of the Round Table* section. The iPads seemed to attract the interests from people of all demographics. By observation made during the first two hours after the public opening, at most one iPad out of the four was not occupied at any time. Users seemed to be able to operate and navigate through the application well. Most users browsed through to read at least one extended label. There were some group visitors who used the application together. Those users were able to read at a distance and from different angles.



*Figure 28: Child User at Knights of the Round Table*

The team also noticed that several other iPads used in the exhibition seemed to attract the same amount of attention from visitors as the team's application did. The two iPads used in the

*Triumphal Arch* displayed the Timeline part of the application created by the team. The flexibility of the application allowed the museum to modify the timeline feature to be used alone.



*Figure 29: Senior User at Triumphal Arch*



*Figure 30: Group Users at the Knights! Exhibition*

#### 4.3.2. Expert Review

For the expert review on the application, the team consulted with Professor David C. Brown in the Computer Science Department of Worcester Polytechnic Institute, who specializes in Artificial Intelligence and Interface Design. The team believed that Professor Brown is an invaluable resource for the critique of the application.

Professor Brown provided general comments on the UI design. The criticisms were mainly concerned with text usage, graphic designs and page layouts. The assessment encompassed both positive feedback and suggestions for improvements. However, this section focuses on the critical suggestions for improvements.

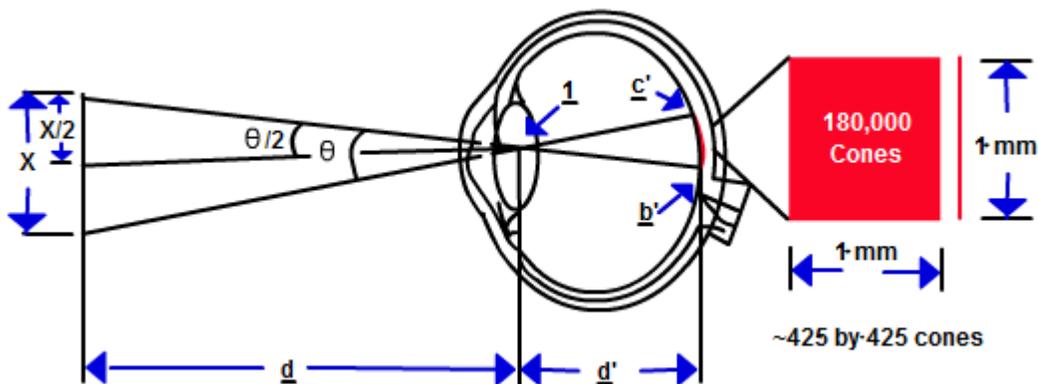
In general, the team should know the other iPad displays at the museum, and keep consistency and the university design principle in mind when designing the application. To make the application accessible to as many visitors as possible, the team should take into consideration the font sizes, audio functions and the height of the display.

On the homepage, the Professor pointed out that the titles “MAP” and “TIMELINE” could potentially discourage the use of the application for being too vague. Rather, “map of helmets” and “timeline of helmets” might give the users a clearer idea about what the application is about. The term “home” used on the navigation bar on both map and timeline pages is most commonly used on websites. “Start” might be a better fit here. In addition, lower cases may be used for the titles at the bottom left corners of both map and timeline pages, to be consistent with the lower-case uses on the navigation bar. The help page of the map page contains some potentially confusing terminologies, such as “pinch” and “zoom”. “Pinch close” is not a commonly-used phrase, and “zoom in” may be replaced by “enlarge”.

The homepage may also encourage more use of the application by including some kind of indication for “touching”. For example, a pointing hand image or a “Touch me” logo can be used. The timeline image on the homepage might better convey the idea by including timeline symbols, such as an arrow. The timeline image may be gray, instead of black, to be consistent with the map image. On top of that, there is no indication of the touch-sensitive areas -some users may not know how to proceed. This can be improved by adding borders to the areas.

Moreover, the “map”, “timeline” and “help” buttons on the navigation bar can utilize the round box shapes to indicate that those are page links. Using the round box shape for buttons is a conventional practice on many other interfaces and thus it is likely familiar to the users. On the timeline page, the slider under the timeline can better communicate its sliding function to the users by having a grapple, and adding arrows to its ends. This reflects the “Affordance” design principle. The “close” buttons on the object information pages are too small and thus difficult to tap on. The other way to exit these pages is to tap on the gray area outside of them. However, Professor Brown suggested that the implicated use of the gray areas is not intuitive. Additionally, the homepage should also have a help page.

Professor Brown also provided a calculation method to find out the minimum font size the application should adopt. For people with normal visual acuity, their visual angle is  $1/60$  of a degree (Figure 31). That means  $\theta$  is  $1/60$  of a degree. If the distance between the eye and the object ( $d$ ) is provided, then the minimum size ( $x$ ) of the object, in this case fonts, can be calculated using the triangle relationships.



*Figure 31: Visual Ability of the Bare Eye (Visual Acuity of the Human Eye)*

Overall, the UI of the application can be improved through providing clearer instructions and indications for the users. This can be achieved by: refining the word usages, adding hint

graphics, and utilizing design conventions. The usability of the application shall be further inspected through a user testing.

#### 4.3.3. Feedback from Users and Worcester Art Museum

The team observed and talked to several users of the application at the Worcester Art Museum. During the conversations, the users generally appreciated the information the application provided and how clean the design looked. One of the users the team talked to said “the app is very useful and teaches a lot about the different helmets in the exhibition. I enjoyed learning more about the individual helmets in such an interactive way.” By observation, the younger generations especially had fun playing with the application. The use and functions of iPads seemed very intuitive to them. Among the older generations, including adults and seniors, while many of them tried their hands on the application, they seemed to be more careful and conservative about exploring some of the functionalities. This might be caused by the higher level of familiarity with iPads of the younger generations. It may also indicate that more instructions or indications on the application could be utilized to encourage its use.

The sponsor spoke highly of the application. Tim Furman, the Web Design Coordinator at Worcester Art Museum, made the remark that it was easy to use and smooth. The codes were clean and he was able to easily make adjustments to it. He also emphasized that the application achieved a very important aspect which was flexibility. He was pleased of the result and was preparing to use it for some other exhibitions. He also had some suggestions on possible additional features. One was that a continuous display function could be added on the timeline, so that the pictures of the objects would scroll like a slide show.

#### 4.4. Impact of the Application

Recently, the Worcester Art Museum is experimenting with different methods to replace the wall labels of some artifacts. This is to enhance the visitor experience and expand its audience demographics. The Map and Timeline Application displays the extended information of helmets on a screen device, offering “great potential for deeper exploration” (Smee, Worcester Art Museum’s show of armor shines, surprises). Consequently, extremely text-rich wall labels were eliminated from the *Knights of the Round Table* section. According to the study conducted by the Worcester State University students, which has been discussed in the section “2.2.1. Examples of Interactive Media at Worcester Art Museum”, the removal of wall labels help the visitors focus their attention on the artifacts. Thus, the application enhanced the visitor experience by providing them with optional access to more information. If they prefer appreciating the helmets alone, there will not be wall label distractions; if they like to know more about the helmets, the information is at their fingers on the iPads.

## 5. Recommendations

The Map and Timeline Application satisfied all of the requirements from the Worcester Art Museum. However, further development possibilities can be applied to make the application more informative, entertaining, and appealing.

The application can be used in other galleries in the Worcester Art Museum to display other artifacts, paintings, and sculptures. The Worcester Art Museum already used parts of it in the *Triumphal Arch* section of the *Knights!* Exhibition.

Museums other than the Worcester Art Museum can also apply the Map and Timeline Application in many kinds of exhibitions with additional features, such as 3D-Map, videos, and games.

The XML file of the application allows it to be used for other exhibitions with minimal modification. Exhibitions of paintings and sculptures are good examples of where the application can be used in future. Since the map and timeline features were independently coded, each of them can also stand alone or be incorporated into other applications with different functions. To adapt it to other exhibitions, refer to Appendix K.

The application was designed to support regular web browsers in addition to the Kiosk Pro used in the exhibition. The application can also be used on the Worcester Art Museum website without any modification for informative and marketing purposes. In fact, any web browsers that support JavaScript and CSS will be able to display the application.

The flexibility and the clarity of the code allows the application to be applied in other exhibitions and other museums. Due to the time frame and technological obstacles faced by the team, the application has its own limitations and areas that can be improved. The application can be modified to accommodate different needs by implementing more functions or features, which

may better serve exhibitions other than the *Knights!* Exhibition. For future uses, other museums can add the features they need just as the Worcester Art Museum did with Helmutt.

In other exhibitions, the objects need to have similar focuses such as time and location to be able to utilize this application. Adapting the Map and Timeline Application to other exhibitions – such as of paintings, handicrafts and historical memorials – would not take excessive effort. Take a sculpture exhibition as an example: the high resolution pictures of the sculptures can be integrated into the picture boxes on the object information pages, accompanied by the story, history, and expert view of the sculptures. The location and the era information can be shown respectively on the map page and the timeline page. Sculpture exhibitions can use the modified Map and Timeline Application to enhance the visitor experience.

However, the application may not fit well with some exhibitions. If there are too many or too few objects in the exhibition, the application may not convey the relationships well. For example, if there are thousands of objects, the map will be covered by markers and the timeline will be endlessly long. Moreover, if the purpose of the exhibition does not entail displaying the chronological and geographical relationships of the objects, then the application may not be used to its maximum. For example, if all of the objects come from the same location, then the map feature would not tell any additional information.

### 5.1. Interface Modification

The interface in the Map and Timeline Application was designed in grayscale to complement the colorful *Knights!* Exhibition. The layout, graphics and contents were also kept simple. When used in other exhibitions, the interface can be modified to match the needs of the particular exhibition.



*Figure 32: Colorful Design 1*

In some exhibitions, a more colorful interface may be desired under the certain exhibition environment. The developers may change the background of the application according to the needs. Markers on the map can be changed to other icons, such as arrows, pins, or even small object images and other symbols (Figure 32). Furthermore, the layout of the pages can be change. For example, the map feature and the timeline feature may be combined into the same page as the team had in the initial design (Figure 33).



*Figure 33: Colorful Design 2*

Any modification to the interface should be carefully thought through as little alterations may drastically change the users' experience of the application. The developers must consider the goal of the application and the exhibitions before making any modification. Adding more contents and features to a page may make the application more informative, but also harder to learn and navigate, especially for novice users. Combining several functions and features under

one page may reduce the frequency that the users have to navigate to a new page. However, when there is a large amount of contents, the space on one page may be insufficient. The crowdedness of contents will make it hard for users to touch, drag and navigate through.

The developers should also be careful about adding colorful elements onto the interface. A colorful design can be more visually appealing to some, but it may conflict with the overall tone of the exhibition. The color choice may be hard to satisfy all the visitors. Color blind visitors may have difficulties in viewing the colorful contents. Thus the application will need a special color arrangement to facilitate the visitors with specific needs.

## 5.2. Filter Function

For larger amounts of artifacts, a filter function will enhance the efficiency of the application by allowing searches for certain artifacts. In the original design, the team had Search by Era and Search by Location pages. But the functions were later eliminated for simplicity reasons. Other examples under the filter function include ‘Search by Materials’, ‘Search by Artifact Type’, ‘Search by Artist’, and an ‘Advanced Search’ that combines a number of filtering criteria. When the contents become abundant and more operations are allowed, the filtering function can be valuable to the users.

The filter function also helps in understanding the relationships of the artifacts. In a list that is arranged by some certain criteria, related artifacts can be compared to each other for similarities and differences. However, for a small amount of objects, the filter function is redundant and not very useful. Under this circumstance, creating pages for filtering functions will cause inefficiency.

### 5.3. Virtual Tours, 3D pictures, Games and Other Media Forms

Besides providing the map and timeline features, the application now serves as a digital booklet to replace the traditional labels on the walls. Its functionality can be furthered by incorporating more forms of media, such as 3D pictures, games, etc. Notably, a compatibility test should be conducted before implementing the other media forms, to ensure that they can run smoothly on iPads.



*Figure 34: Virtual Tour example<sup>5</sup>*

Figure 34 shows a virtual tour example from the National Museum of Natural History. It provides a 360° perspective view of the gallery for audience outside the museum, if the application is available online. Combined with other functions in the application, a virtual tour enables the audience to experience the museum at home.

Visual tours may also function as a map, helping visitors find their interests and directions in the museum. However, it is redundant for visitors who enjoy walking around and exploring the exhibition. Moreover, a virtual tour usually consists of 360° pictures that can be rotated and moved by the users. Some visitors may be not used to this way of displaying.

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<sup>5</sup> <http://www.mnh.si.edu/vtp/2-mobile/008.html>



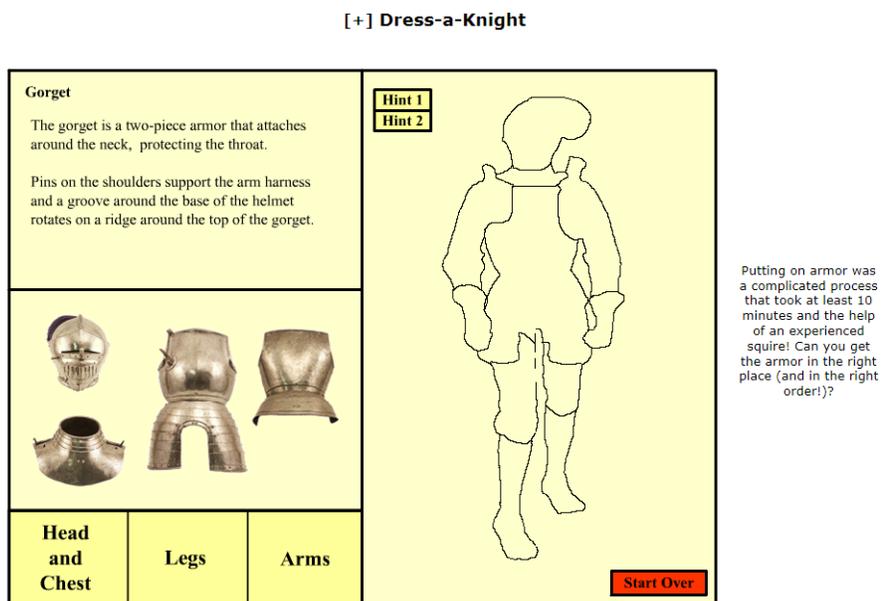
*Figure 35: 3D picture example<sup>6</sup>*

Figure 35 is a 3D picture example that could be used in the Map and Timeline Application. Details of the objects from all angles can be shown clearly using the 3D pictures. However, 3D pictures on web sites are usually implemented as Flash media, which cannot be displayed on iPads. Moreover, 3D pictures may slow down the performance of iPads.

Figure 36 is an example of a game that can be integrated into the Map and Timeline Application. This game, called Dress-a-Knight, is from the Virtual Armory website of Higgins Armory Museum. Games like this may attract child visitors. However, games may distract the visitors' attention from the exhibition itself and may slow down the running speed of iPads similarly 3D pictures.

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<sup>6</sup> <http://hampson.cast.uark.edu/artifact.php?IDart=10>



*Figure 36: Game example<sup>7</sup>*

Other than the ones mentioned above, other media forms can also be integrated into the application, such as videos, sound tracks, slide shows, etc. However, careful considerations should be taken before realizing the functions. For example, in an area supposed to be quite, sounds should be avoided. In an exhibition that mainly targets at senior visitors, children-oriented games are not necessary.

#### 5.4. Timeline Scroll Animation

The scrolling functionality of the timeline feature can be improved. The current scrolling functionality does not work well in some conditions. An example of such condition is that when users repeatedly swipe the timeline several times in a short time, the scrolling animation may stop or be significantly delayed. In addition, the current scrolling functionality does not scale

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<sup>7</sup> <http://users.wpi.edu/~virtualarmory/dressaknight.html>

well with the number of objects. For instance, if there are more than 50 objects, one swipe will move around five objects.

### 5.5. Timeline Object Ordering

The current version of the application does not automatically arrange the objects in the timeline by the dates of origin. Instead, the objects are ordered according to how they are manually ordered in the XML file. The team did not implement the automatic ordering function because most of the helmets are from overlapping periods of time. In addition, some of the dates of origin are unknown. The team decided to leave it unimplemented to allow expert judgment when the time period are overlapping or unknown. Nevertheless, the application may be improved by adding this feature with an option to turn it off.

Automatic ordering of the objects in the timeline will allow for easier and faster adaptation of the application in other exhibitions. This feature will provide accurate arrangement and eliminate possible human mistakes. However, the function should have the option to be turned off since, in some exhibitions, objects arrangement is hard to define due to overlapping time intervals. In this case the automatic arrangement may not be ideal.

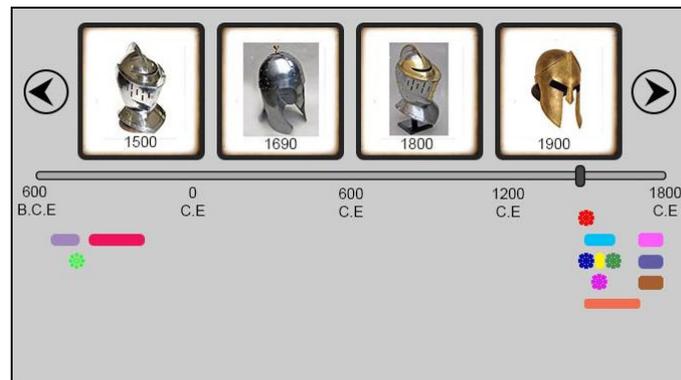
### 5.6. Alternative Map Options

The application can also be improved by expanding the map options, for instance, the map of the United States or the map of the ancient civilizations. This allows the application to be used for exhibitions of different themes. In addition, if the application has Internet access, many more map options are available, for example, Google Map Chart and Google Map. Internet Connection also allows users to obtain more information about the objects, for examples, historical events that happened when object was created.

Different types of exhibitions may need different map options. Implementing different map options to the application will allow the application to be utilized in more exhibitions. Before selecting an alternative map option, the content of the exhibition must be considered. If the exhibition is more history-related, an ancient map may be used in the application for better illustration. In an exhibition about the Seven Wonders, Google Map, which is excellent at displaying specific locations, may be used to display the locations of the Seven Wonders.

### 5.7. Timeline Time Stripe

The timeline page can be improved by including “time stripes” similar to the feature previously detailed in the *TimeMap of World History* and the initial interface design. This feature will provide users with a clearer picture of the chronological relationship among objects. However, this feature might confuse users with less experience with interactive application and become a distraction.



*Figure 37: Time Stripes in Timeline Page*

The time strip timeline helps dealing with overlapping time intervals since each of them is listed separately (Figure 37). For an exhibition with many objects from overlapping time intervals, each object requires a separate row to display, taking up a large portion of screen

space. Thus, this feature might not optimal for devices with small screens such as iPads or smart phones.

### 5.8. Quick Response Code (QR Code)

With the increase use of smart phones, the use and popularity of the application can be further expanded by adding a Quick Response Code (QR Code). Quick Response Codes are two-dimensional machine readable codes that hold data. Users can use their smart phones to read the code that can direct them to a webpage that contains the application. With this, users are able to move around in the museum and use their phones to view objects' information while viewing the objects. This will give users more flexibility and may increase the time spent on the application.

If a QR Code is used, the museum should provide detail instructions for the visitors. In addition, some visitors do not have a smart phone which means that they are unable to utilize this function. Thus, the museum should provide alternate ways for visitors who are unable to access the application using QR codes.

## 6. Conclusion

In this Interactive Qualifying Project, our team successfully produced an interactive Map and Timeline Application for the Worcester Art Museum. Designed for the *Knights of the Round Table* in the *Knights!* Exhibition, the application was also adapted and used in the *Triumphal Arch* in the *Knights!* Exhibition. The Boston Globe wrote the application was “admirably lucid and straightforward to use,” in the review of the *Knights!* Exhibition (Smee, Worcester Art Museum’s show of armor shines, surprises). At the time when the project concluded, the museum was preparing it to be placed in the [remastered] galleries.

Overall, the application was highly regarded by the museum. Operation-wise, the application is able to run on iPads, and requires no Internet access. Meanwhile, it can be easily reused on the museum website with minimal adaption. Performance-wise, the user interfaces were based off the prototype provided by the sponsor, with enhanced features. They were kept as simple and clean as possible, while help pages offered necessary user instructions. These elements all contributed to the usability of the application. The flexibility of the application themes and implementation allowed the sponsor to make use of it in other exhibitions. In addition, the team implemented the application in a clear and logical format, complemented by essential documentations. This offered future development possibilities for the application. The application as a whole achieved the functionalities required by the Worcester Art Museum and expanded beyond the requirements.

Opportunities for improvements were identified by both inside and outside the team during the evaluation process. The current user interfaces can be enhanced with better text usage, graphic designs and page layouts. The team also suggested several possible additional features to be developed, and potential future uses of the application. With proper modifications, the

application should be able to accommodate a certain range of other exhibitions. These suggestions should be used as recommendations for the museum and future development teams.

## Bibliography

- Allen, S. and J Gutwill. "Designing with multiple interactive: Five common pitfalls." *Curator* (2004): 199-212. 47(2).
- Archer, Katie, Morin Kimberly and Jessa Thomas. *ESIGNING AN INTERACTIVE CHILDREN'S MUSEUM EXHIBIT*. online. Worcester: WPI Project Center, 2000. Web.
- Bergeron, Chris. *Go Bold, Brave Knights: Worcester Art Museum transforms Higgins Collection*. 23 Mar 2014. 01 April 2014.  
<<http://sharon.wickedlocal.com/article/20140323/Entertainment%20&%20Life/140328771>>.
- Edgers, Geoff. *Higgins Armory Museum to Close*. 08 Mar 2013. 14 Dec 2013.  
*EGit*. 2013. 27 March 2014. <<https://www.eclipse.org/egit/>>.
- Furfero, Devid. *jQuery UI Touch Punch - Touch Event Support for jQuery UI*. 2013. 27 March 2014. <<http://touchpunch.furf.com/>>.
- Garrett, Jesse James. *The Elements of User Experience : User- Centered Design for the Web and Beyond (2nd Edition)*. New Riders, 2010. Book.
- Google. 24 Mar 2014. <<https://www.google.com/>>.
- Hazaël-Massieux, Dominique. *JavaScript Web APIs*. 2013. 27 March 2014.  
<<http://www.w3.org/standards/webdesign/script>>.
- Heilbrunn Timeline of Art History*. 3 April 2014. <<http://www.metmuseum.org/toah/world-regions/#/05/World-Map>>.
- HTML & CSS - W3C*. 2013. 27 3 2014. <<http://www.w3.org/standards/webdesign/htmlcss>>.
- jQuery*. 2013. 27 March 2014. <<http://jquery.com/>>.
- jQuery UI*. 2013. 27 March 2014. <<https://jqueryui.com/>>.

- Lawrence, Dave and Tavares Soheyla. *Balanced website design: optimising aesthetics, usability and purpose*. Springer, 2006. Web.
- Lebedev, Kirill. *Home*. n.d. 27 March 2014. <<http://jvectormap.com/>>.
- Moore, Jack. *Colorbox - a jQuery lightbox*. n.d. 27 March 2014. <<http://www.jacklmoore.com/colorbox/>>.
- Morville, Peter and Louis Rosenfeld. *Information Architecture for the World Wide Web*. O'Reilly Media, Inc. , 1998. Book .
- Quin, Liam R. E. *XML Essentials*. 2013. 27 March 2014. <<http://www.w3.org/standards/xml/core>>.
- Robertson, S. *The Disadvantages and Advantages of Interactive Media*. 10 Dec 2013. ehow.
- Rosen, Deborah E. and Elizabeth Purinton. "Website Design: Viewing the Web as a Cognitive Landscape." *Website Design: Viewing the Web as a Cognitive Landscape*. (2004): 787-794. Web.
- Services", "U.S Department of Health and. *User Interface Design Basics*. 14 March 2014. <<http://www.usability.gov/what-and-why/user-interface-design.html>>.
- Smee, Sebastian. *Worcester Art Museum's show of armor shines, surprises*. 10 04 2014. 03 05 2014.
- . "Worcester Art Museum's show of armor shines, surprises." 10 April 2014. *The Bistib Globe*. News. 5 May 2014.
- Sparacino, F., et al. *Technologies and Methods of Interactive Exhibit design: from Wireless Objects and Body Tracking to wearable computers*. 2000. MIT.
- Stacy, Katrina. *Labels on the wall* Jingtian Kuang, et al. 16 April 2014.

Stone, Debbie, et al. *User Interface Design and Evaluation*. San Francisco: Morgan Kaufmann Publishers, 2005.

Tangelder, Jorik. *Hammer.js - A javascript library for multi-touch gestures*. n.d. 27 March 2014. <<http://eightmedia.github.io/hammer.js/>>.

*TimeMap of World History*. n.d. 3 Apr 2014. <<http://www.timemaps.com/history> >.

Travis, David. *Usability Expert Reviews: Beyond Heuristic Evaluation*. 16 April 2007. Web. 10 April 2014.

Turnbull, Conno. *Using White Space (or Negative Space) in Your Design*. 19 Jul 11. <<http://webdesign.tutsplus.com/articles/using-white-space-or-negative-space-in-your-designs--webdesign-3401>>.

*Visual Acuity of the Human Eye*. n.d. Web. 10 April 2014. <<http://www.ndt-ed.org/EducationResources/CommunityCollege/PenetrantTest/Introduction/visualacuity.htm>>.

Wilcox-Titus, Catherine and The Worcester State University Students. *Interview with the project team with interactive exhibition experience* Jingtian Kuang. 22 November 2013.

Worcester Art Museum. *Knights of the Round Table*. Worcester: Worcester Art Museum, 2014.

—. "Knights! Exhibition Takes New Approach to Examining Arms and Armor Throughout History." 9 Jan. 2014: 2.

Ziff Davis, LLC. PCMag Digital Group. *browser-based application definition*. 2013. 3 May 2014. <<http://www.pcmag.com/encyclopedia/term/61816/browser-based-application>>.

## Appendix

### Appendix A: Examples of Software and Services

There are countless of software and services designed for application development.

Examples of such software and services are shown below.

Eclipse is an integrated development environment used for software development. The Eclipse community provide a variety of plug-ins for software projects, including web development.

EGit is a plugin for Eclipse. It provides developers working in a team with a full copy of every revision of the code for the project<sup>8</sup>. Thus, it allows faster and more versatile collaboration between developers (EGit).

Adobe Dreamweaver is a software primarily used for web design and development. It provides tools and resources for web development with easy-to-use interface.

GitHub is a web-based hosting service for software project that use git version control system. In layman's term, GitHub is an online hub that connect each developer in a team together, while maintaining the properties of git version control system.

---

<sup>8</sup> Also known as git version control system or distributed version control system.

## Appendix B: Examples of JavaScript Libraries

A JavaScript library is a collection of pre-written JavaScript that provides resources of some kinds to web pages. To illustrate the capabilities of JavaScript, examples are shown below.

jQuery is a JavaScript library developed and maintained by The jQuery Foundation. jQuery provides an easy way to manipulate web pages such as document traversal and animation (jQuery).

jQuery UI is a JavaScript library developed and maintained by The jQuery Foundation. jQuery UI provides several common user interface interactions, widgets, and effects (jQuery UI). Examples of jQuery UI widgets are jQuery UI tab (Figure 38) and jQuery UI Slider (Figure 39).

### Tabs

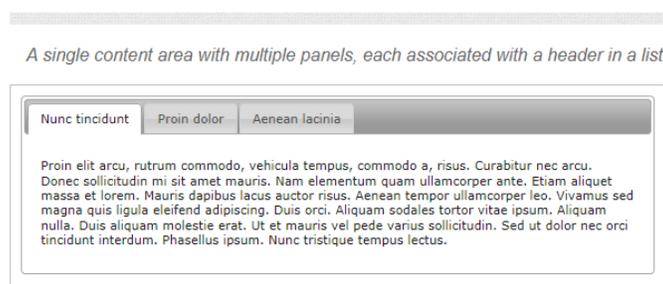


Figure 38: an example of jQuery UI (jQuery UI Tabs)

### Slider



Figure 39: an example of jQuery UI (jQuery UI Slider)

jQuery UI Touch Punch is a small JavaScript library created by David Furfero. jQuery UI Touch Punch allows jQuery UI to support touch events from touch screens such as swiping (Furfero).

Hammer or Hammer.js is a JavaScript library developed by Eight Media. Hammer provides easy-to-use interfaces for touch screen multi-finger gesture controls, such as swiping and pinching in and out (Tangelder). For example, a web page can change when users swipe or drag the screen (Figure 40).



*Figure 40: examples of hammer.js: swiping and dragging gestures*

jVectorMap is a JavaScript library developed by Kirill Lebedev. jVectorMap provides a convenient way to create an interactive map (Figure 41). Main features of jVectorMap are: zooming, dynamic area coloring, and map markers. jVectorMap also allows additional interactions when areas or markers are clicked (Lebedev).



*Figure 41: examples of jVectorMap*

Colorbox is a JavaScript library plugin for jQuery developed by Jack Moore. Colorbox provides an interactive in-page pop-up (Figure 42) that can display various kind of contents from images to web pages (Moore).

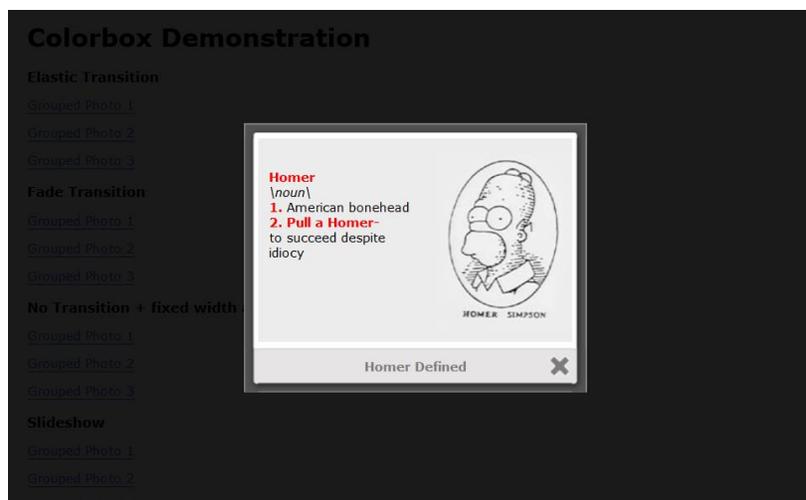


Figure 42: an example of a popup generated by ColorBox (Moore)

## Appendix C: Criteria & Decision Matrix

### Evaluation Criteria

The evaluation criteria detailed in this section are deemed important in the selection of the project. The criteria are listed in no particular order.

- How the proposed idea aligns with the timeline for the migration from HAM to WAM has to be considered because some ideas may not be possible if it does not align with the time of migration.
  - The timeline should align to the migration
- Repetitiveness is also an issue.
  - The project aims to create something that is innovative and different
- Maintenance includes cost of maintenance as well as programing related maintenance.
  - An interface that requires a lot of maintenance is not desirable.
- The time restriction the group has to work with is considered. There are two terms left to work on the proposed idea
  - The project has to be able to be completed in two terms
- Since the project is sponsored by WAM. The core of the objective is to satisfy their need. WAM staff's opinions are considered
  - WAM staff have to agree with the feasibility and idea of project
- The level of engagement that the interface is expected to offer is considered
  - Interface should be as engaging as possible.
- The expected cost of development is also an important factor to consider.
  - The cost should be as low as possible

- The ease of use from the user's perspective is important because the actual value of the interface is directly related to the user experience.
  - The interface should be as easy to use as possible

### Rank ordering the evaluation criteria

Cross's method of rank ordering design goals is adjusted and is used to rank order the evaluation criteria. A row-criteria is given a value of 1 if it is more important than a column-criteria; otherwise, it is given a value of 0. If the two criteria are considered to be of equal significance, each is given a value of 1/2.

	Tim eline	Repetiti veness	Mainten ance	Time restriction	WAM's opinion	Level of engagement	Cost	Ease of use	Total
Timeline	1	1	1/2	1/2	1	1	1/2	5.5	
Repetitiveness	0	1	0	0	0	1	0	1	
Maintenance	0	1	0	0	0	0	0	1	
Time Restriction	1/2	1	1	1/2	1	1	1/2	5.5	
WAM's Opinion	1/2	1	1	1/2	1	1	1/2	5.5	
Level of Engagement	0	1	1	0	0	1	1/2	3.5	
Cost	0	0	1	0	0	0	0	1	
Ease of use	1/2	1	1	1/2	1/2	1/2	1	5	

Figure 43: rank ordering the evaluation criteria

### Assigning Weighing Factors to criteria

The values of the weighing factors is assigned to each criteria. The weighing factors were assigned in three different sections. The first step is to determine which criteria was considered critical, important and optional. Next, the criteria that were deemed critical were assigned a weighing factor and the criteria that were deemed optional were assigned its respective weighing factor. The last part was to assign the criteria considered important a value that fits between the values assigned to criteria considered critical and optional.

Critical	100	WAM's opinion
	90	Time restriction
	80	Timeline
	70	Ease of use
Important	60	Level of Engagement
	50	
	40	
	30	Repetitiveness
Optional	20	Maintenance
	10	Cost
	0	

*Figure 44: assigning weighing factors to criteria*

#### Rating the alternative Designs – Decision matrix

A decision Matrix was used to determine the ability of each idea to satisfy the criteria.

The first number in the table is the rating factor and the second number is the decision factor. The decision factor is the weighing factor multiplied by the rating factor. The total column represents the decision factor total.

Rating factor scale:

10 = completely satisfies criteria

5 = moderately satisfies criteria

0 = does not satisfy criteria

Design Alternatives	Opinion Of WAM	Time Restriction	Timeline	Ease of use	engagement	Repetitiveness	Maintenance	Cost	Total
	Weighing factors								
	100	90	80	70	60	30	20	10	
Exhibition extension	5-500	8-720	9-810	8-560	6-360	6-180	7-140	8-80	3350
Global Map Timeline	10-1000	8-720	8-720	9-630	7-420	5-150	7-140	8-80	3860
Higgins Armory Museum Memorial	3-300	7-640	3-270	5-350	7-420	6-180	7-140	8-80	2380
Floor map	2-200	9-810	9-810	9-630	4-240	2-60	5-100	9-90	2940

Figure 45: decision matrix

Appendix D: Base Design

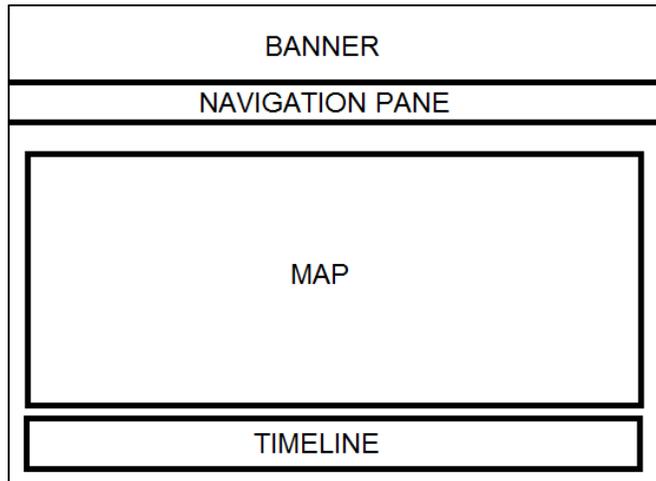


Figure 46: Initial Base Design Homepage

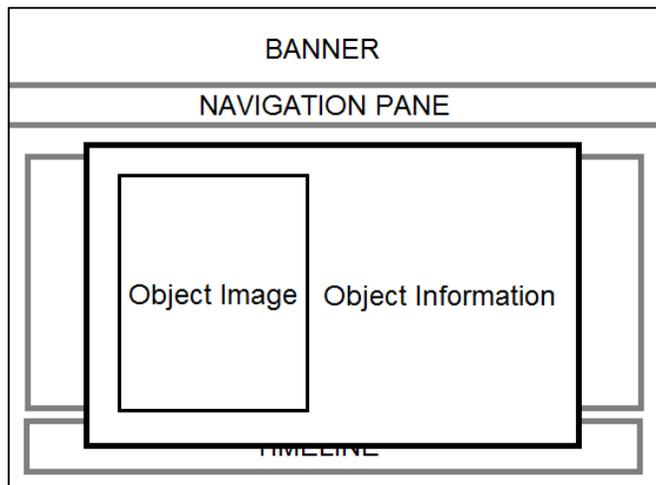
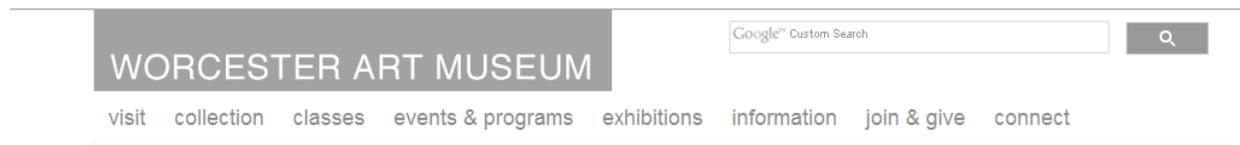


Figure 47: Initial Base Design Object Information Screen

## Appendix E: Banner of Worcester Art Museum Website



*Figure 48: banner of the Worcester Art Museum Website*

## Appendix F: Other Display Options

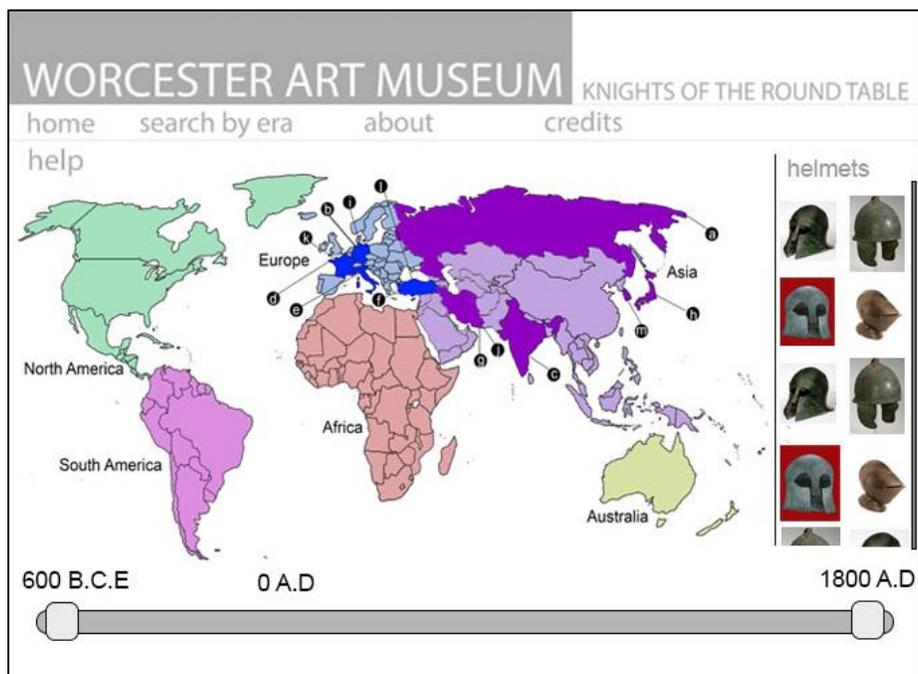


Figure 49: Other Display Option 1

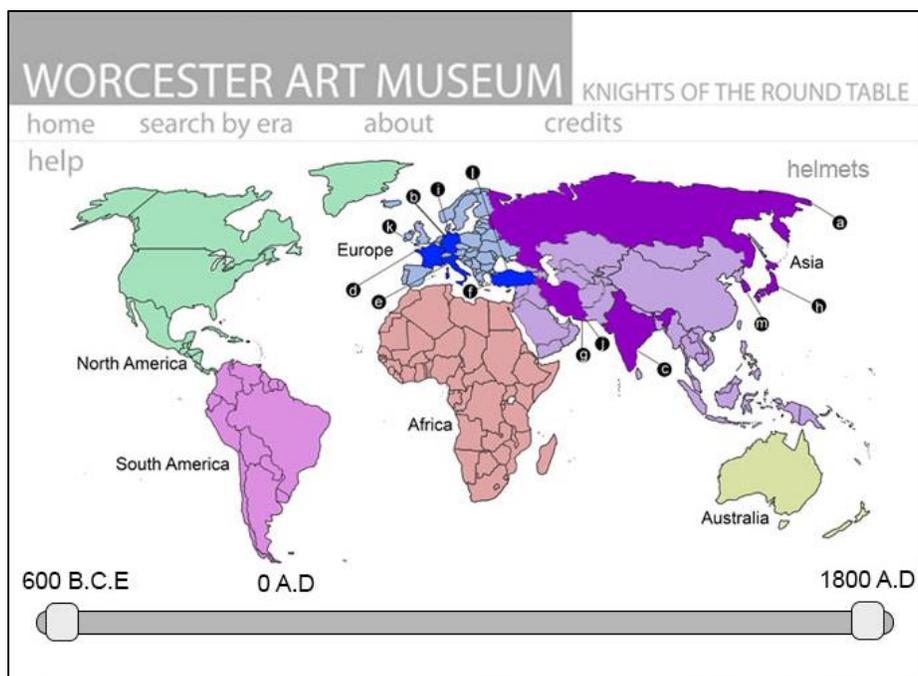
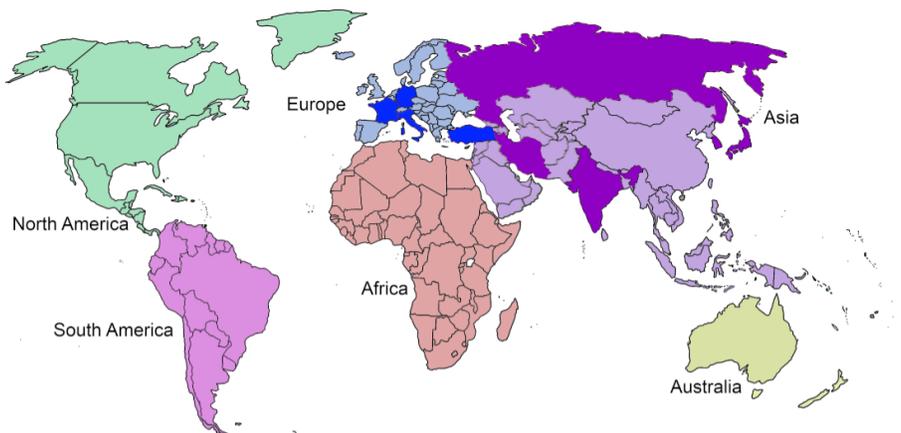
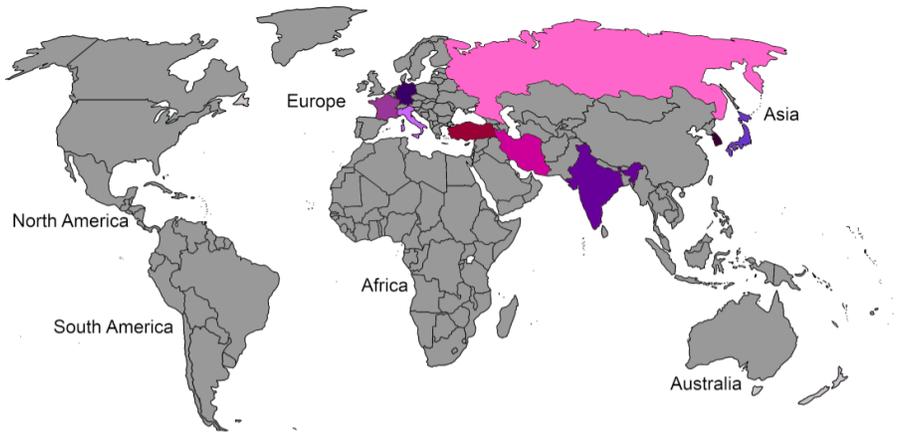


Figure 50: Other Display Option 2

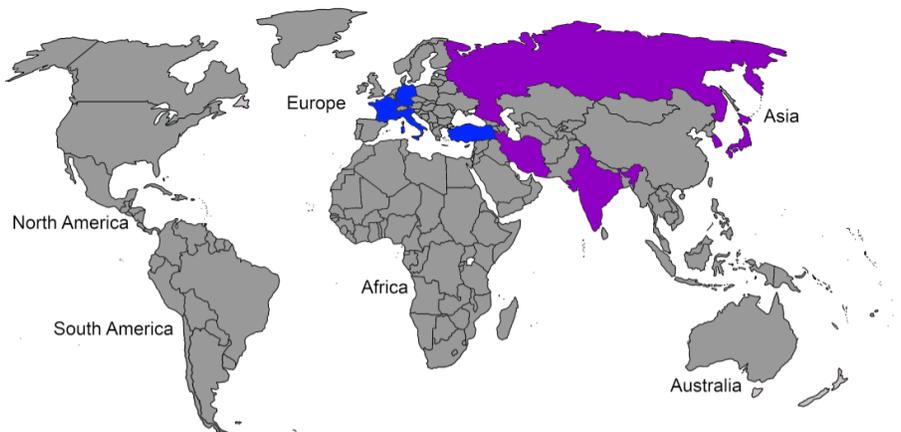
### Appendix G: Map Options



*Figure 51: Map Option 1*

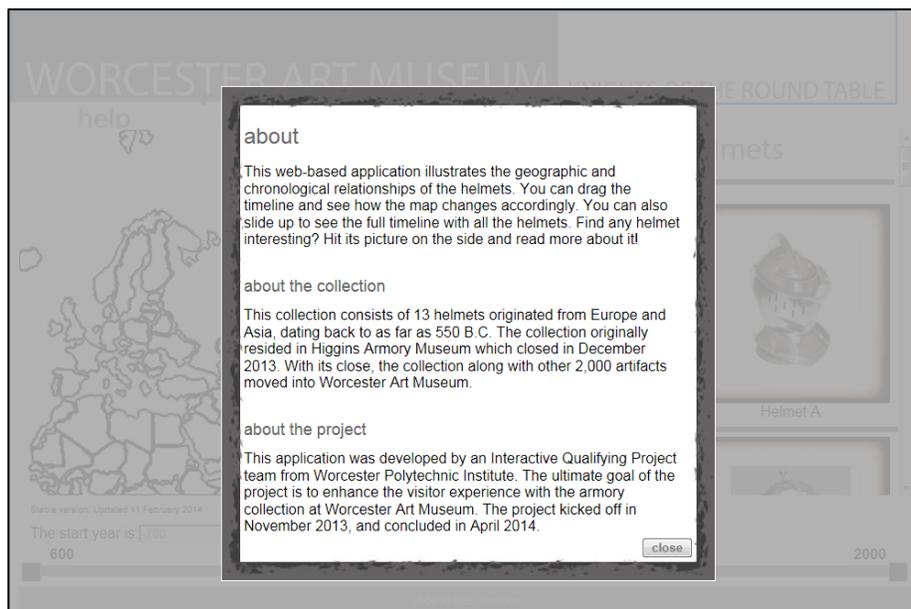


*Figure 52: Map Option 2*



*Figure 53: Map Option 3*

## Appendix H: About Page



*Figure 54: About Page*

Appendix I: Design from Worcester Art Museum

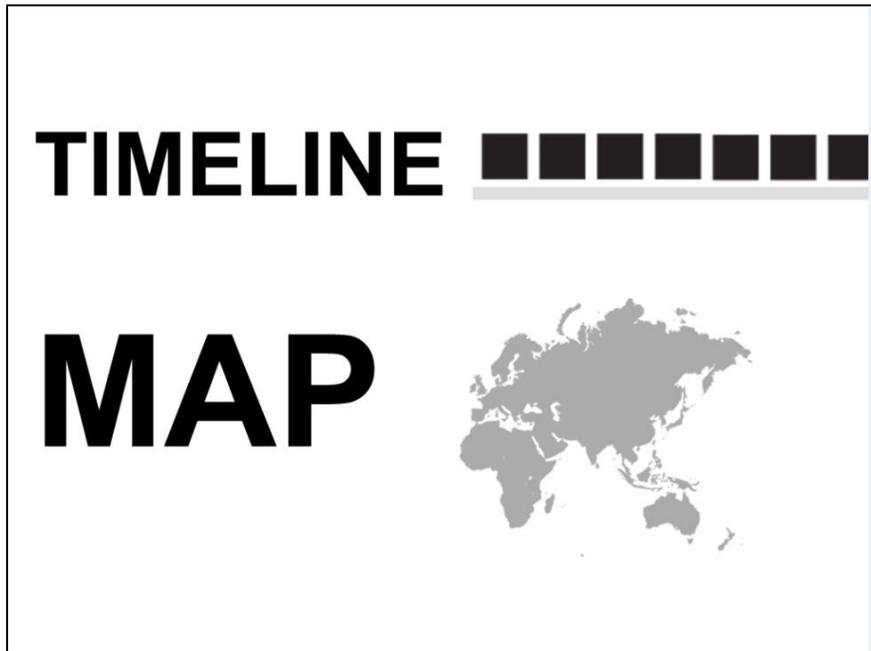


Figure 55: Design from Worcester Art Museum: Home

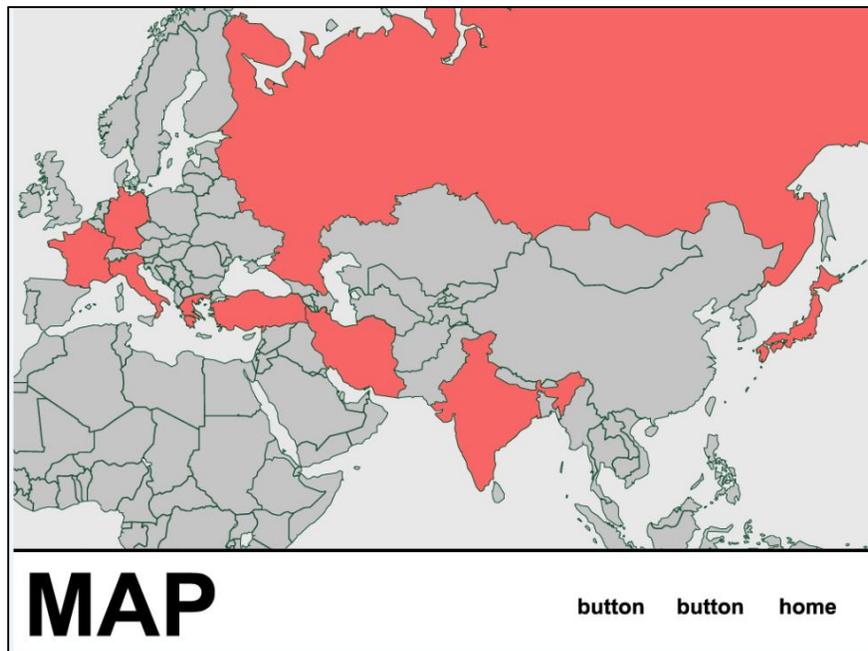


Figure 56: Design from Worcester Art Museum: Map Page

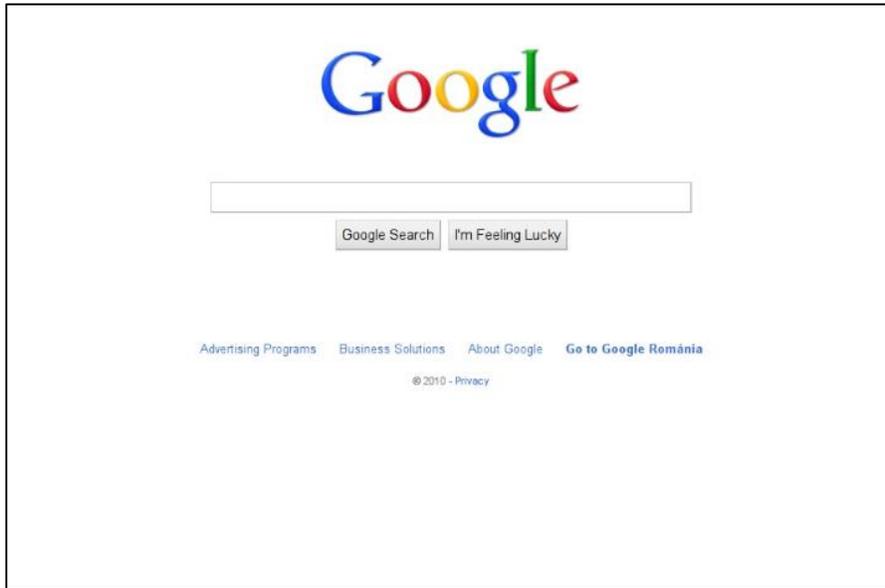


Figure 57: Design from Worcester Art Museum: Timeline Page



Figure 58: Design from Worcester Art Museum: Information Page

Appendix J: Google Home Page



*Figure 59: Google Homepage (Google)*

## Appendix K: Instruction Manual

The application was designed to be flexible and easy to use even for those who do not know how to create web pages. In order to edit the content, developers need only to change contents.xml and add the new images, if any.

### 1. Adding an object

To add an object, developers need to add an Object tag inside the Object\_List tag. Inside the Object tag, several attributes are required, including Title, Date, Credit, Description, ID, Picture, Latitude, Longitude, and Country. There are a few restrictions:

- ID needs to be a positive integer and must be unique among all objects.
  - Picture must be the file name of the image under contents/object\_images corresponding to the object, including file extension. For example, if the file is contents/object\_images/none.jpg the attribute should be
- ```
<Picture> none.jpg </Picture>
```
- Latitude and Longitude are the real Earth coordinates corresponding to the location of the marker representing the object.
  - Country is identification of the country of the object according to ISO-3166 standard.

Also, attributes specified by Display\_Attributes must be included as well. All the stated attributes cannot be empty.

Here is an example of contents.xml with a minimal object:

```

<Object_List>
  <Display_Attributes></Display_Attributes>
  <Object>
    <Title>[N/A]</Title>
    <Date>[N/A]</Date>
    <Credit>[N/A]</Credit>
    <Description>[N/A]</Description>
    <ID>0</ID>
    <Picture>none.jpg</Picture>
    <Latitude>0</Latitude>
    <Longitude>0</Longitude>
    <Country>US</Country>
  </Object>
</Object_List>

```

Note: the attributes inside Object tags are not limited to the required attributes and attributes specified by Attributes.

## 2. Removing an object

To remove an object, developers can simply remove the entire Object tag corresponding to the object that needs to be removed, including anything inside the object tags.

## 3. Choosing attributes to display in object information page

Developers can choose any attributes to display in object information page by changing the Display\_Attributes tag. Inside the tag are the names all attributes that will be displayed in object information page. For example,

```
<Display_Attributes>Date</Display_Attributes>
```

If there are more than one attributes, the names must be separated by commas without any spaces. For example:

```
<Display_Attributes>Date,Weight,Region</Display_Attributes>
```

With this Display\_Attributes tag, the minimal contents.xml file with a minimal object should look like this:

```

<Object_List>
  <Display_Attributes>Date,Materials,Weight</Display_Attributes>
  <Object>
    <Title>[N/A]</Title>
    <Date>[N/A]</Date>
    <Materials>[N/A]</Materials>
    <Weight>[N/A]</Weight>
    <Credit>[N/A]</Credit>
    <Description>[N/A]</Description>
    <ID>0</ID>
    <Picture>none.jpg</Picture>
    <Latitude>0</Latitude>
    <Longitude>0</Longitude>
    <Country>US</Country>
  </Object>
</Object_List>

```

#### 4. Changing from Eurasia to the entire world

To make the application show the entire world map, there are a few steps. First, find the following line:

```
<div id="world-map" style="width: 2160px; height: 1280px; position: absolute; top: -230px; right: -260px">
```

And change it to:

```
<div id="world-map" style="width: 990px; height: 580px">
```

The marker size also needs to be changed by changing a variable called `marker_radius` from 8 to 4. To change the map back to Eurasia, developers can simply revert this process.

## Appendix L: Source Code

This is the organization of the files:

- object\_images
      - contents.xml
    - resources
      - colorbox
      - hammer
      - images
      - jQueryAssets
      - jvectormap
      - touch-punch
      - colorbox.css
      - content\_selector.html
      - content.html
      - credit.html
      - help\_map.html
      - help\_timeline.html
      - home.html
      - map\_timeline.css
    - map\_timeline.js
    - map.html
    - timeline.html

File/Folders	Description
map_timeline	The root folder of the application
o_scontents	All object-relation files are in this folder
o object_images	The folder containing all object images*
o contents.xml	The folder containing all object information*
o resources	The folder containing resources
o colorbox	The folder containing ColorBox(imported)
o hammer	The folder containing Hammer(imported)
o images	The folder containing interface images in application
o jQueryAssets	The folder containing jQuery and jQuery UI(imported)
o jvectormap	The folder containing jVectorMap(imported)
o touch-punch	The folder containing jQuery UI Touch Punch(imported)
o colorbox.css	The file containing ColorBox-related CSS code
o content_selector.html	The html file of intermediate page
o content.html	The html file of information page
o credit.html	The html file of credit page
o help_map.html	The html file of map page's help
o help_timeline.html	The html file of timeline page's help
o home.html	The html file of home page
o map_timeline.css	The file containing common stylesheets (CSS)
o map_timeline.js	The file containing common JavaScript
o map.html	The html file of map page
o timeline.html	The html file of timeline page

\* Please refer to Appendix K: Instruction Manual for details

## File: colorbox.css

```

    #cboxTitle, #cboxSlideshow
    #cboxCurrent{position:absolue; bottom: 25px; left: 25px; font-weight:bold;
color:#7C7C7C;}

    #cboxCurrent, #cboxPrevious, #cboxNext, #cboxClose, #cboxSlideshow
    #cboxCurrent{position:absolue; bottom: 10px; right:10px; font-weight:bold;
color:#7C7C7C;}

    #colorbox, #cboxOverlay, #cboxWrapper{position:absolute; top:0; left:0; z-index:9999;
overflow:hidden;}
    #cboxWrapper {max-width:none;}
    #cboxOverlay{position:fixed; width:100%; height:100%;} /*size of background (click-to-
exit) */
    #cboxContent{position:relative;}
    .cboxIframe{width:200%; height:200%; border: 0px; margin: -10px}
    #cboxLoadingOverlay, #cboxLoadingGraphic{position:absolute; top:0; left:0; width:100%;
height:100%;}

    #cboxOverlay{background:#aaa;} /* background color overlay */
    #colorbox{outline:0;}
    #cboxContent{margin-top:32px; overflow:visible; background:#fff;} /* what to show,
while loading */
    #cboxLoadedContent{background:#fff; padding:1px;} /* what to show, background */
    #cboxLoadingOverlay{background:#fff;} /* what to show, while loading */

```

## File: content\_selector.html

```

<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<link href="resources/jqueryAssets/jquery.ui.core.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.theme.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.slider.min.css" rel="stylesheet"
type="text/css">
<link href="resources/colorbox.css" rel="stylesheet" type="text/css" />
<script src="resources/jqueryAssets/jquery-1.8.3.min.js" type="text/javascript"></script>
<script src="resources/colorbox/jquery.colorbox.js" type="text/javascript"></script>

<link href="map_timeline.css" rel="stylesheet" type="text/css">
<script src="map_timeline.js" type="text/javascript"></script>
<meta charset="utf-8">
<title>Content Selector</title>
</head>
<style type="text/css">
.thumbnail {
    max-width: 120px;
    max-height: 160px;
}
.picture_border {
    width: 120px;
    height: 160px;
    float: left;
    display: block;
    border:2px solid black;
    text-align: center;
    margin-left: 10px;
    margin-right: 10px;
    font-family: Arial;
}
</style>
<body>
<div id="overall" style="height:260px;width:600px;margin: 10px 12px 0px 12px;text-
align:center">
    <script>
        var url = location.toString();
        var countryCode = url.substring(url.indexOf("=") + 1);
        var objectList = getObjectListFromXML();
        var wantedObject = new Array();
        var i = 0;
        for (; i < objectList.length; i = i + 1) {
            var objectCC =
objectList[i].getElementsByTagName("Country")[0].childNodes[0].nodeValue;
            if (objectCC === countryCode) {
                wantedObject.push(objectList[i]);
            }
        }
        var len = wantedObject.length;
        var objectText = "There";
        var expected_width = 144*len;
        document.write("<p style='font-size:18px;font-family:arial'>There
are ");
        document.write(len+" objects in this region. <br>");
        document.write("Tap an object image to view the details. </p>");
        document.write("<div style='height:260px;width:"+ expected_width
+"px;margin: auto; text-align:center'>");
        if (len == 0) {
            //This should not appear
            document.write("There is no object in " + countryCode);
        } else if (len == 1) {
            var ID =
wantedObject[0].getElementsByTagName("ID")[0].childNodes[0].nodeValue;
            submitId(ID);
    </script>

```

```
        } else {
            for (i = 0; i < wantedObject.length; i++) {
                var idNum =
wantedObject[i].getElementsByTagName("ID")[0].childNodes[0].nodeValue;
                var picname =
wantedObject[i].getElementsByTagName("Picture")[0].childNodes[0].nodeValue;
                document.write("<div class=\"picture_border\"
onclick=\"submitId(\"+ idNum + \" )\">");
                document.write("<img src=\"contents/object_images/\"+
picname);
                document.write(\" \" class=\"thumbnail\"/> </div>");
            }
            var content_div = document.getElementById("content_div");
        }
        document.write("</div>");
    </script>
</div>
</body>
</html>
```



```

20px;text-align: left\>");
document.write("<table id='attr_table' style=\"margin-left:
var i2 = 0;
var url = location.toString();
var id = url.substring(url.indexOf("=") + 1);
for(;i2<attr_list.length;) {
    var tagname = attr_list[i2];
    var data = getDataFromAccessNumber(id, tagname);
    document.write("<tr>");
    document.write("<th>" + tagname + "</th>");
    document.write("<td>" + data + "</td>");
    document.write("</tr>");
    i2 = i2 + 1;
}
document.write("</table>");
</script>
<strong style="margin: 10px 10px 0px 20px">Description</strong>
<div id="item_labelbox">
    <div id="item_label" style="margin: 0px 10px 0px 20px;
height: 360px;background-color:white"></div>
    </div>
</div>
</div>
<script>
var url = location.toString();
var index = url.substring(url.indexOf("=") + 1);

var newttl = getDataFromAccessNumber(index, "Title");
document.getElementById("item_title").innerHTML = newttl;

var newimg = "contents/object_images/" + getDataFromAccessNumber(index,
"Picture");
document.getElementById("item_image").setAttribute("src", newimg);

var newtxt = getDataFromAccessNumber(index, "Description");
document.getElementById("item_label").innerHTML = newtxt;

var newcre = getDataFromAccessNumber(index, "Credit");
document.getElementById("item_credit").innerHTML = newcre;

var size_title = document.getElementById("item_title").clientHeight;
var size_table = document.getElementById("attr_table").clientHeight;
var size_label = 520 - (size_title + size_table);
document.getElementById("item_labelbox").style.height = size_label+'px';
//alert(url);
</script>

</body>
</html>

```



## File: help\_map.html

```

<!doctype html>
<html>
<head>
<meta charset="utf-8">

<title>Credits</title>
<link href="resources/jqueryAssets/jquery.ui.core.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.theme.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.slider.min.css" rel="stylesheet"
type="text/css">
<link href="resources/map_timeline.css" rel="stylesheet" type="text/css" />
<script src="resources/jqueryAssets/jquery-1.8.3.min.js" type="text/javascript"></script>
<script src="resources/jqueryAssets/jquery-ui-1.9.2.slider.custom.min.js"
type="text/javascript"></script>
<script src="resources/colorbox-master/jquery.colorbox.js"
type="text/javascript"></script>

</head>

<body>
<div id="page">
<div id="content" style="height:660px; width: 860px; padding:10px">

</div>
</div>
</body>
</html>

```

## File: help\_timeline.html

```
<!doctype html>
<html>
<head>
<meta charset="utf-8">

<title>Credits</title>
<link href="resources/jqueryAssets/jquery.ui.core.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.theme.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.slider.min.css" rel="stylesheet"
type="text/css">
<link href="resources/map_timeline.css" rel="stylesheet" type="text/css" />
<script src="resources/jqueryAssets/jquery-1.8.3.min.js" type="text/javascript"></script>
<script src="resources/jqueryAssets/jquery-ui-1.9.2.slider.custom.min.js"
type="text/javascript"></script>
<script src="resources/colorbox-master/jquery.colorbox.js"
type="text/javascript"></script>

</head>

<body>
<div id="page">
<div id="content" style="height:660px; width: 860px; padding:10px">

</div>
</div>
</body>
</html>
```

## File: home.html

```

<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1">
<title>Home</title>
<script src="resources/jqueryAssets/jquery-1.8.3.min.js" type="text/javascript"></script>
<script src="resources/colorbox/jquery.colorbox.js" type="text/javascript"></script>
<link href="colorbox.css" rel="stylesheet" type="text/css">
<link href="map_timeline.css" rel="stylesheet" type="text/css">
<script src="map_timeline.js" type="text/javascript"></script>
<style type="text/css">
.large_image {
    width: 800px;
    height: 250px;
}
</style>
</head>
<body>
<div id="page" class="page_all" style="position: relative;">
<div id="links"
style="width: 800px; height: 500px; padding: 100px; padding-top:
50px">
<a href="timeline.html"> </a> <a
href="map.html">

</a>
</div>
<div style="position: absolute; bottom: 25px; right: 25px;">
<a href="#">

</a>
</div>
</div>
</body>
</html>

```

## File: map\_timeline.css

```
@CHARSET "ISO-8859-1";

div, p, h1 {
    font-family: Arial;
}

div.page_all {
    width: 1010px;
    height: 750px;
    background-color: #ffffff;
    overflow: hidden;
    font-family: Arial;
}

img.menu_image {
    height: 40px;
    padding: 30px 0px 30px 30px;
    float: right;
    border: 0px;
}
```

## File: map\_timeline.js

```

/**
 * author Thanaporn Patikorn
 */

var xmlFileLocation = "contents/contents.xml"; /* the location of the content xml file */

/**
 * Display a ColorBox popup of the specified page
 * with specified height and width
 * @param page the page to display
 * @param height the height of the popup
 * @param width the width of the popup
 */
function popUpPage(page, height, width) {
    var urltext = page;
    parent.jQuery.colorbox({
        iframe : true,
        innerWidth : width,
        innerHeight : height,
        initialWidth : 0,
        initialHeight : 0,
        scrolling : false,
        top : 0.5 * (690 - height),
        left : 0.5 * (1010 - width),
        href : urltext
    });
}

/**
 * Display a ColorBox popup of an object
 * with specified (internal) item id
 * @param item_id the item id of the object to be displayed
 */
function submitId(item_id) {
    var idtext = "itemId=" + item_id;
    var urltext = "content.html?" + idtext;
    popUpPage(urltext, 640, 880);
}

/**
 * Retrieve the list of objects from the XML file
 * @returns the list of all objects in XML file
 */
function getObjectListFromXML() {
    if (window.XMLHttpRequest) {
        // code for IE7+, Firefox, Chrome, Opera, Safari
        xmlhttp = new XMLHttpRequest();
    } else {
        // code for IE6, IE5
        xmlhttp = new ActiveXObject("Microsoft.XMLHTTP");
    }
    xmlhttp.open("GET", xmlFileLocation, false);
    xmlhttp.send();
    xmlDoc = xmlhttp.responseXML;

    return xmlDoc.getElementsByTagName("Object");
}

/**
 * Find an object with Accession_number and
 * return the data of tagname
 * If tagname === "Object", the whole object is returned instead
 * @param Accession_number the accession number of the object
 * @param tagname the name of the tag
 * @returns the data from specified tag name
 */
function getDataFromAccessNumber(Accession_number, tagname) {
    var objectList = getObjectListFromXML();

```

```

        for (i = 0; i < objectList.length; i++) {
            var idNum =
objectList[i].getElementsByTagName('ID')[0].childNodes[0].nodeValue;
            if (idNum === Accession_number) {
                if(tagname === "Object") {
                    return objectList[i];
                }
                else {
                    return
objectList[i].getElementsByTagName(tagname)[0].childNodes[0].nodeValue;
                }
            }
        }
        return false;
    }

    function CSVparser(CSV) {
        var retArray = new Array();
        var index = CSV.indexOf(",");
        while(index > -1) {
            var val = CSV.substring(0,index);
            retArray.push(val);
            CSV = CSV.substring(index+1);
            index = CSV.indexOf(",");
        }
        retArray.push(CSV);
        return retArray;
    }

    function is_touch_device() {
        return !!(('ontouchstart' in window));
    }

```

## File: map.html

```

<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1">

<link href="resources/jqueryAssets/jquery.ui.core.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.theme.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.slider.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jvectormap/jquery-jvectormap-1.2.2.css" rel="stylesheet"
type="text/css" media="screen" />
<script src="resources/jqueryAssets/jquery-1.8.3.min.js" type="text/javascript"></script>
<script src="resources/jqueryAssets/jquery-ui-1.9.2.slider.custom.min.js"
type="text/javascript"></script>
<script src="resources/colorbox/jquery.colorbox.js" type="text/javascript"></script>
<script src="resources/jquery.ui.touch-punch/touch-punch.min.js"
type="text/javascript"></script>
<script src="resources/hammer/hammer.js" type="text/javascript"></script>
<script src="resources/jvectormap/jquery-jvectormap-1.2.2.min.js"></script>
<script src="resources/jvectormap/jquery-jvectormap-world-mill-en.js"></script>

<link href="colorbox.css" rel="stylesheet" type="text/css">
<link href="map_timeline.css" rel="stylesheet" type="text/css">
<script src="map_timeline.js" type="text/javascript"></script>
<title>Map</title>

<style type="text/css">
.jvectormap-region {
    stroke: #000000;
    stroke-width: 0.2px;
}
</style>

</head>

<body>
<div id="page" class="page_all">
<div id="content" style="width: 990px; height: 630px; padding: 10px">
<div id="mapbox"
style="width: 990px; height: 580px; overflow: hidden;
position: relative; background-color: #ffffff">
<div id="world-map"
style="width: 990px; height: 580px;">
</div>

<script>
function generateListsOfIds() {
    var objectArray = getObjectListFromXML();
    var listofid = new Array();
    for (var i = 0; i < objectArray.length; i++)
    {
        listofid[i] =
objectArray[i].getElementsByTagName('ID')[0].childNodes[0].nodeValue;
    }
    return listofid;
}
</script>

<!-- This is the script that call jVectorMap (make the map)
Editable variable (see comment):
content_selector_width,
content_selector_height,
marker_radius -->
<script>

```

```

the content_selector popup */
the content_selector popup */
*/

var content_selector_width = 620; /* the width of
var content_selector_height = 280; /* the height of
var marker_radius = 4; /* the radius of the marker

var Id;
Id = generateListsOfIds();
var markers = [];
var i = 0;
var len = Id.length;
var countryData = [];
for (; i < len;i = i + 1) {
    markers.push({
        latLng : [

getDataFromAccessNumber(Id[i], 'Latitude'),

        getDataFromAccessNumber(Id[i], 'Longitude' ] ,
            name : Id[i]
        });
        var countryCode =

getDataFromAccessNumber(Id[i], 'Country');

        countryData[countryCode] = 1;
    }
    $(function() {
        $('#world-map').vectorMap({
            map : 'world_mill_en',
            series : {
                regions : [ {
                    values : countryData,
                    scale : [ '#a0a0a0',

'#606060' ],

                    } ]
            },
            onLabelShow : function(e, el, code) {
                el.html(el.html() + '

                +

            },
            hoverColor : false,
            markerStyle : {
                initial : {
                    fill : '#F8E23B',
                    stroke : '#383f47',
                    r : marker_radius
                }
            },
            regionStyle : {
                initial : {
                    fill : '#C0C0C0',
                    stroke : '#383f47'
                }
            },
            backgroundColor : '#FFFFFF',
            markers : markers,
            onMarkerClick : function(events,

                var item_id =

                submitId(item_id);
            },
            onRegionClick : function(events,

                if(countryData[countryCode] >

index) {
markers[index].name;

countryCode) {
0) {

        popUpPage("content_selector.html?countryCode="+countryCode,
        content_selector_height,content_selector_width);
    }
}

```

```

},
/**
 * On touch devices, onMarkerOver and
 * will be automatically enabled a
 * (no need to change anything when
 */
onMarkerOver : function(events,
                        if(is_touch_device()) {
                            var item_id =
                                submitId(item_id);
                        }
},
onRegionOver :
    if (is_touch_device() &&
function(events, countryCode) {
countryData[countryCode] > 0) {
    popUpPage("content_selector.html?countryCode="+countryCode,
    content_selector_height,content_selector_width);
    });
});
</script>
</div>
</div>
<!-- Bottom menu -->
<div id="menu" style="width: 990px; height: 100px; padding: 0px 10px 20px
10px">
    <div id="page_name" style="width: 100%; height: 100%">
        
        <a href="#"> </a>
        <a href="timeline.html">
             </a>
        <a href="home.html">
             </a>
    </div>
</div>
</div>
</body>
</html>

```

## File: timeline.html

```

<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1">

<link href="resources/jqueryAssets/jquery.ui.core.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.theme.min.css" rel="stylesheet"
type="text/css">
<link href="resources/jqueryAssets/jquery.ui.slider.min.css" rel="stylesheet"
type="text/css">
<script src="resources/jqueryAssets/jquery-1.8.3.min.js" type="text/javascript"></script>
<script src="resources/jqueryAssets/jquery-ui-1.9.2.slider.custom.min.js"
type="text/javascript"></script>
<script src="resources/colorbox/jquery.colorbox.js" type="text/javascript"></script>
<script src="resources/touch-punch/jquery.ui.touch-punch.min.js"
type="text/javascript"></script>
<script src="resources/hammer/hammer.js" type="text/javascript"></script>

<link href="colorbox.css" rel="stylesheet" type="text/css">
<link href="map_timeline.css" rel="stylesheet" type="text/css">
<script src="map_timeline.js" type="text/javascript"></script>

<title>Timeline</title>
<style type="text/css">
.thumbnail {
    max-width: 240px;
    max-height: 320px;
}
.picture_div {
    width: 250px;
    height: 400px;
    float: left;
    font-size: 22px;
    display: block;
    margin-right: 20px;
    text-align: center;
    font-family: Arial;
}
.picture_border {
    min-width: 240px;
    min-height: 320px;
    display: block;
    margin-bottom: 10px;
    border: 4px solid black;
}
</style>
</head>
<body>
<script>
/**
 * Generate timeline, including links, images, etc.
 * (The middle thing)
 * Generated content depends solely on contents.xml
 */
function generateTimeline() {
    var objectArray = getObjectListFromXML();
    for (i = 0; i < objectArray.length; i++) {
        var idNum =
objectArray[i].getElementsByTagName("ID")[0].childNodes[0].nodeValue;
        var picname =
objectArray[i].getElementsByTagName("Picture")[0].childNodes[0].nodeValue;
        var date =
objectArray[i].getElementsByTagName("Date")[0].childNodes[0].nodeValue;
        document.write("<a href=\"#" + ">");

```

```

onclick=\"submitId(\" + idNum);
picname);
date + \"</div>\";

document.write("<div class=\"picture_div\"
document.write(\"\\\"> <div class=\"picture_border\\\">");
document.write("<img src=\"contents/object_images/\" +
document.write(\"\\\" class=\"thumbnail\\\"/> </a> </div>\" +
}
var box_inside = document.getElementById("timelinebox_inside");
document.wanted_width = objectArray.length * 270;
$(box_inside).css('width', document.wanted_width);
}
</script>
<script>
/**
 * This function moves the location of the scrollbar to
 * specified location.
 * Note: location is the location you want, not the distant
 */
function changeScrollbar(location) {
    location = 0.001 * location * (document.wanted_width - 750);
    $("#timelinebox_outside").scrollLeft(location);
};
/**
 * This function slide the slider by amount.
 * Positive value = to the right
 * Negative value = to the left
 */
function changeSlider(amount) {
    var val = $("#timeline_slider").slider("value");
    val = val + amount;
    changeScrollbar(val);
    $("#timeline_slider").slider({
        value : val
    });
};
/**
 * This function slides both slider and scrollbar
 * "smoothly" by total_amount.
 * Positive value = to the right
 * Negative value = to the left
 */
function slideScroll(total_amount) {
    var baseval = 10;
    var amount = baseval;
    if (total_amount < 0) {
        amount = 0 - amount;
    }
    var timeout = baseval * 20;
    var times = total_amount / amount;
    var i = 0;
    for (; i < times; i = i + 1) {
        setTimeout(function() {
            changeSlider(amount)
        }, timeout);
        timeout = baseval * i;
    }
}
</script>
<div id="page" class="page_all">
    <div id="content" style="width: 990px; height: 630px; padding: 10px">
        <!-- Your work space is 900px by 450px -->
        <!-- example box is just to demonstrate the size and location of
your space -->
        <!-- feel free to change/delete it if you want -->
        <div id="timelinebox"
            style="width: 990px; height: 430px; overflow: hidden;
position: relative; padding-top: 80px; ">
            <div id="sidebox_left"

```

```

padding-top: 150px;border:0px">
                                style="width: 80px; height: 250px; float:left;
                                
                                </div>
                                <div id="timelinebox_outside"
                                style="width: 830px; height: 400px; overflow-x:
hidden; float:left">
                                <!--this is the actual box-->
                                <div id="timelinebox_inside"
                                style="height: 100px; background-color:
#ffffff">
                                    <script>
  generateTimeline();
                                    </script>
                                </div>
                                <div id="sidebox_right"
                                style="width: 80px; height: 250px; float:left;
padding-top: 150px;border:0px">
                                    
                                </div>
                                <div style="width: 990px; height: 100px; margin-top: 20px">
                                <div id="timeline_slider" style="margin-left: 75px"> </div>
                                </div>
                                </div>
                                <!-- Bottom menu -->
                                <div id="menu" style="width: 990px; height: 100px; padding: 0px 10px 20px
10px">
                                    <div id="page_name" style="width: 100%; height: 100%">
  
  <a href="#"></a>
  <a href="map.html"></a>
  <a href="home.html"> </a>
                                    </div>
                                </div>
                                </div>
                                <script>
                                function setArrows(state) {
                                    var arrow_right = document.getElementById("arrow_right");
                                    var arrow_left = document.getElementById("arrow_left");
                                    if(state=="leftOnly") {
  arrow_left.setAttribute("src",
"resources/images/arrow_left.png");
  arrow_right.setAttribute("src",
"resources/images/blank.jpg");
                                    } else if(state=="rightOnly") {
  arrow_left.setAttribute("src",
"resources/images/blank.jpg");
  arrow_right.setAttribute("src",
"resources/images/arrow_right.png");
                                    } else {
  arrow_left.setAttribute("src",
"resources/images/arrow_left.png");
  arrow_right.setAttribute("src",
"resources/images/arrow_right.png");
                                    }
                                }
                                $(function() {

```

```

$("#timeline_slider").slider({
    min : 0,
    max : 1000,
    step : 5,
    value : 0,
});
$("#timeline_slider").css('height', '20px');
$("#timeline_slider").css('width', '820px');
$("#timeline_slider").css('background', 'rgb(250,250,250)');
$("#timeline_slider .ui-slider-handle").css('height', '30px');
$("#timeline_slider .ui-slider-handle").css('width', '60px');
$("#timeline_slider .ui-slider-
handle").css('background', 'rgb(70,70,70)');
$( "#timeline_slider" ).slider({
    slide: function (event, ui) {
        var val = ui.value;
        if(val >= 1000) {
            setArrows("leftOnly");
        } else if(val <= 0) {
            setArrows("rightOnly");
        } else {
            setArrows("appearAll");
        }
        changeScrollbar(ui.value,
$("#timelinebox_outside"));
    }
});
$( "#timeline_slider" ).slider({
    change: function (event, ui) {
        var val = ui.value;
        if(val >= 990) {
            setArrows("leftOnly");
        } else if(val <= 10) {
            setArrows("rightOnly");
        } else {
            setArrows("appearAll");
        }
    }
});
});
$("#timeline_slider").draggable();
</script>
<script>
    var toggle = document.getElementById('timelinebox_inside');

    Hammer(toggle).on("dragend", function(event) {
        event.gesture.preventDefault();
        event.gesture.stopDetect();
        var dx = event.gesture.deltaX;
        if (dx >= 20) {
            slideScroll(-180);
        } else if (dx <= -20) {
            slideScroll(180);
        }
        else {
            return false;
        }
    });
</script>
</body>
</html>

```

## File: images

Several images are used in the interface of the application (Figure 60). For a better quality images, please get it from the repository.

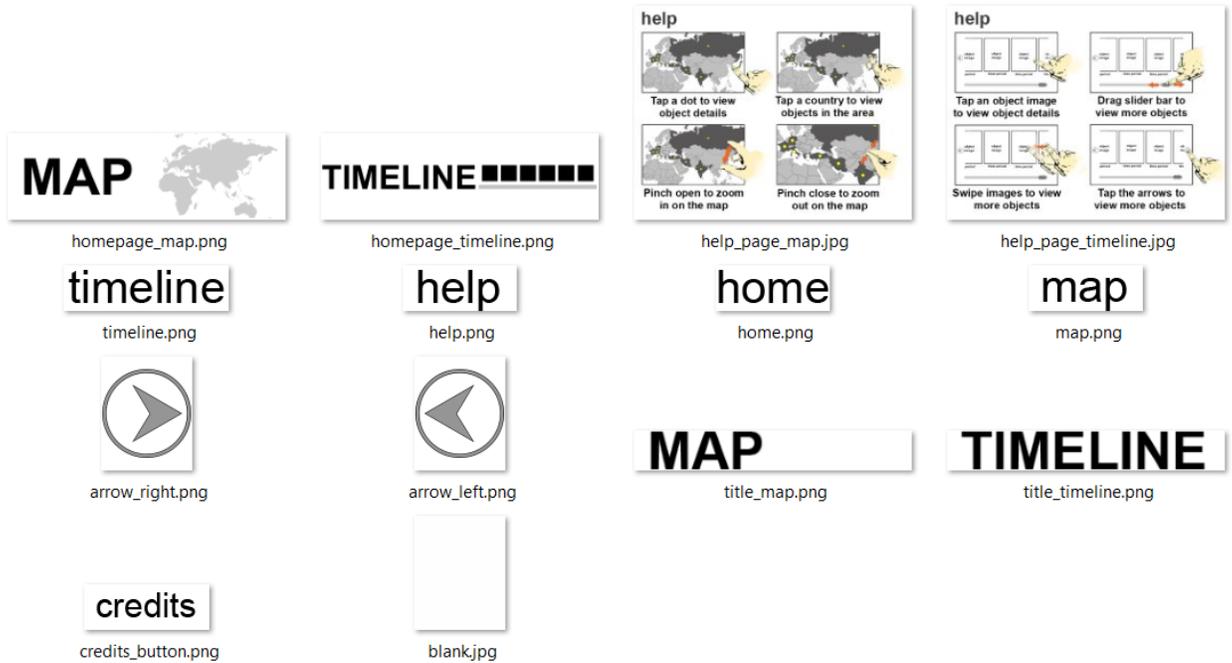


Figure 60: Images used in the application