Paleo Journey: An Interactive Paleolithic Cave Art Experience. Using the User Experience (UX) Design Process to Develop An Interactive and Immersive Paleolithic Cave Art Exhibit Suitable for Children Between Five (5) and Seven (7) Years Old.

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Paleo Journey:
An Interactive Paleolithic Cave Art Experience

Using the User Experience (UX) Design Process to Develop An Interactive and Immersive Paleolithic Cave Art Exhibit Suitable for Children Between Five (5) and Seven (7) Years Old.

By

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Using the User Experience (UX) Design Process to Develop An Interactive and Immersive Paleolithic Cave Art Exhibit Suitable for Children Between five (5) and seven (7) Years Old.


ABSTRACT

Most European caves containing Paleolithic cave art paintings (dating from approximately 10,000 – 50,000 years BP) are no longer accessible to the general public, and their visitor centers often require lengthy travel for tourists. In addition, the interactivity associated with these exhibits largely focus upon computer screens, and not a tactile interface. This Thesis project seeks to create a prototype of a tactile interface on a mock cave surface using projection mapping and motion tracking.

In developing this exhibit, the user experience (UX) design process was used as a methodology for defining, researching and co-designing for a particular user segment. While this Thesis only focuses on the users between the ages of five (5) to seven (7) years old, it can be used as a model for other user segments.

In researching and testing prototypes with children from this age cohort, it was determined that young children have visual-spatial development issues that hinder their ability to identify common animals in static cave art such as lions, rhinos and bison. After viewing the same cave art animals in motion graphics, 100% of all children were able to correctly identify the animal types.
INTRODUCTION

Museums can sometimes be difficult destinations for children. As parents, we want to expose our children to culture, art and history, but the exhibits often fall short of expectations of both parents and children. In an attempt to make the exhibits as widely accessible as possible, information is often watered down so that older children look at it as being, ‘for babies.’ Other exhibits go in the other direction, making exhibits so text and information heavy that younger visitors cannot engage with the material. Still other exhibits, in their quest to be more interactive, rely on interactive gimmicks that have little more educational material than a game of Pac-Man.

Poor exhibit design for children is everywhere if you only look for it. Some of the most common examples include: kiosks and displays that are too high or too low; material written at reading or interaction levels that are not suitable for children, and exhibits that don’t account for the vast range of developmental differences in children. It is as though these exhibits are talk down to children rather than treating them as equals.

When a critical analysis of museum exhibits is taken, it is clear that in many cases, the intellectual and emotional needs of the users are completely ignored. Exhibit designers often replace empathic analysis of user needs with their own biased ideas and presumptions. This violates one of the most basic rules of design stated by Frank Chimero, “People ignore design that ignores people.” (Lowdermilk 2013)

This Thesis seeks, in part, to add to the general conversation about the design process for exhibits and use methodologies and strategies employed in User Experience (UX) design. This goes beyond the requisite surveys and demographic analysis to include contextual inquiry, affinity diagrams, paper prototypes, digital prototypes and ultimately resulting in a collaborative co-design process with the intended user group.

PROBLEM STATEMENT

Due to their fragile nature, and the need for preservation, most Paleolithic Cave Art found in the caves of the Southern European continent (modern day France, Spain, Germany and Italy) are not accessible to the general public. As a result, models of the caves have been made into museum exhibits in locations near the original cave sites.
such as Lascaux in and Chauvet caves in France.

While this helps to bring these magnificent artworks to visitors, these exhibits are stationary, and most do not travel, thereby limiting access to an immersive experience only to those with the means to travel to Europe to visit the cave museums and visitor centers.

To help bridge this gap, many of these cave sites have online tours available, however they lack both immersive and tactile qualities that visitors, especially children, generally report as being the most preferred and engaging type of museum exhibits.

As an added complication, young children between the ages of five (5) and seven (7) have a wide range of developmental variability including visual-spatial limitations, abstract thinking limitations, and reading abilities which can inhibit their ability to appreciate the artwork or put the artwork into context. As a result, this segment of exhibit visitors would quickly lose any interest in the exhibit.

**SITUATION ANALYSIS**

Currently there are numerous ice age related museums and cave visitor centers located throughout Southern Europe. Cursory Internet research of existing museum and visitor center websites of this area include: Prehistory Museum (Liège, Brussels), Krapina Neanderthal Museum (Krapina, Croatia), Prehistory Museum of Soultre (Soultre-Pouilly, France), International Center of Prehistory (Les Eyzies-de-Tayac, France), Isturitz, Oxocelhaya and Erberua Caves (Saint-Martin d’Arberoue, France), The Museum of Neanderthal Man (La Chapelle aux Saints, France), Museum of Prehistory (Blaubeuren, Germany), Neanderthal Museum (Mettmann, Germany), Paläon Research and Experience Center (Schöningen, Germany), Archaeopark Vogelherd (Niederstotzingen-Stetten, Germany), Fumane Cave (Valpolicella, Italy), Espai Orígens (La Noguera, Spain), Museum of Human Evolution (Burgos, Spain), Museum of Altamira (Cantabria, Spain), Caves of Santimamiñe and Bizkaia Museum of Archaeology (Bizkaia, Spain), Chauvet Cave (Ardèche, France), Lascaux Cave (Montignac, France).

These museums and visitor centers all share this same problem of needing to restrict access to the
very thing that they are entrusted to make available to the public. A traveling exhibit showcasing some reproduction panels from Lascaux cave have been traveling around the world, however, the exhibit has had limited touring of only three (3) locations in North America, and a handful of other locations between 2013 and 2017. The majority of the cave exhibit consisted of installations of model cave panels and accompanying artifacts with a few interactive kiosk terminals. (Dowson 2017) (History 2013) The exhibit did use projection mapping to identify the outlines of artwork, however, it did not use projection mapping as a way to demonstrate animation in cave art nor did it use real time touch interactivity on the cave surfaces with projection mapping.

**THESIS PROPOSAL AND MODIFICATIONS**

The original Thesis proposal is included in this documentation as Appendix A. The initial proposal was to create exhibit interactions for a range of user groups. However, during the development phase of the project, it became clear that addressing the research and development needs for multiple user groups would become an overwhelming task better suited for a team of UX Designers rather than a single person. For this reason, the scope of the proposal was modified to focus on a single user group (children between the ages of five (5) and seven (7) years of age).

During the initial work children at the World of Inquiry School #58 in Rochester, New York (USA), it became apparent that children in the Kindergarten classes had unique developmental needs that were not observed in children from the 3rd and 5th grade classes. Subsequent literature review and interviews reinforced these as more than just anecdotal findings as children between ages five (5) and seven (7) years of age experience wide ranging and dramatic cognitive differences in brain development, particularly in the areas of spatial perception. Bezrukikh and Terebova point out in their 2009 study that, “All [Visual Perception] components rapidly developed between five and six years of age; considerable changes in visuomotor integration and visuospatial perception were observed between six and seven years of age.” (Bezrukikh and Terebova 2009)

**IDEA EVALUATION AND NEEDS ANALYSIS**

The needs analysis began with a review of existing visitor centers, traveling exhibits, and museum associations. Contact and discussions were also
initiated with Katrin Hieke of Ice Age Europe (http://www.ice-age-europe.eu), a non-profit network of European heritage sites, museums, visitor centers, and cave art replicas such as the Museum of Altamira, the Neaderthal Museum, and the Ekainberri museum.

Ms. Hieke stated that network members have access to traveling exhibits, and are always looking for ways to reduce expenses, improve portability, increase visitor engagement, and find new ways to improve exhibits. While Ice Age Europe was not involved in the development of this Thesis project, these constraints were used as a basis for development. (Parrillo 2016)

**SUBJECT MATTER RESEARCH**

The literature review produced a wealth of information about the history and controversies surrounding cave art discoveries, and the eventual authentication of the artworks during the late 19th and early 20th centuries. Renowned archeologist Jean Clottes focused his life’s work to Paleolithic art and archaeology and has two seminal treatises on the subject including a large full color book aptly titled *Cave Art* which covers both carved objects (portable art) as well as cave art (parietal art). (Clottes 2010) Now retired, Clottes summarized his lifetime of discoveries in a 2011 book recently translated from French to English and simply titled *What is Paleolithic Art?* (Clottes 2016)

**USER EXPERIENCE (UX) DESIGN PROCESS**

**Comparative Analysis**

In researching the existing museums and visitor centers of Europe specializing in Cave Art, there were none that offered a tactile interactive approach to the exploration of cave art. Most caves are under strict control, and are often owned and/or controlled by government agencies such as the Ministry of Culture, as is the case with both Lascaux and Chauvet caves located in France. (Ministère de la Culture et de la Communication de France 2010) (Ministère de la Culture et de la Communication de France 2016)

In most cases, separate reproduction models of the caves were constructed to provide visitors with the experience of exploring the art. However, these are expensive undertakings costing millions of Euros (Jones 2015) and requiring visitors to travel to often remote areas. In addition, many of the cave websites offer online video tours, but are difficult for users
to see details up close, and don’t allow for users to interact with specific art panels for additional information. (Ministère de la Culture et de la Communication de France 2010) (Ministère de la Culture et de la Communication de France 2016)

In addition, a small scale touring exhibition of Lascaux traveled the world to ten locations (Bordeaux, Chicago, Houston, Montréal, Brussels, Paris, Switzerland, South Korea, and Japan) between 2013 — 2017. However, the exhibit only featured a few reproduction panels and does not have any interactive components. (Dowson 2017) (History 2013)

Within this space, lies an opportunity to make art more accessible, more portable, and interactive through the use of projection mapping an interface onto a cave wall surface.

User Research

Debra Gelman has been working with children in developing interfaces since 1993. In her book Designing For Kids: Digital Products for Playing and Learning, she advises dividing user groups for children by age:

- 2 — 4 years old
- 4 — 6 years old
- 6 — 8 years old
- 8 — 10 years old
- 10 — 12 years old

Subsequent research and experience working directly with children viewing cave art in this Thesis Project has shown, however, that a refinement of these categories will be necessary in order to accommodate the unique visual-spatial developmental needs of children between the ages of 5 — 7 years old.

World of Inquiry School #58, Rochester, NY

The administration, faculty, parents and students of the 5th, 3rd, and Kindergarten classes at the World of Inquiry, School #58 in Rochester, New York agreed to participate in the process of researching and designing an interactive cave art exhibit.

Rochester Institute of Technology (RIT) and The Rochester City School District (RCSD) have a master agreement for students performing research, and proper documentation of this research was provided to the school administration from RIT.

All work, research and computer interface
testing was performed in the classrooms, and under the guidance and supervision of New York State certified teachers Meghan Delahanty-Reddington, Amy Martin, Elizabeth Dauksha, and Principal Sheelarani Webster. Per the agreement, students were not allowed to be video recorded or photographed, and no personally identifiable information was allowed to be collected. The participating teachers selected students that represented a broad representation of the classroom's socio-emotional, racial and ethnic backgrounds as well as educational aptitude.

During the initial information gathering and research phase of the project (January — May of 2017), students engaged in card sorting and were interviewed in pairs and presented with open ended survey questions so as to promote discussion between the students. This allowed for more open dialogue as the students would engage in conversation with each other rather than “performing” for an adult as suggested by Steve Portigal in his book, *Interviewing Users: How to Uncover Compelling Insights*.

### Initial Interview Questions and Developmental Discovery Informing the Direction of the Thesis

The initial survey and card sorting activities were designed to gauge awareness and interest in Paleolithic Cave art, interaction preferences, and preferences for museum environments. The children were asked to provide a level of interest using a Likert scale (ranging from 'Very Interesting' to 'Boring') for various types of exhibits typically found in a museum (Egyptian Mummies, Explore a Pawnee Lodge, Explore a Paleolithic Cave, Medieval European Armor, Traditional Native American Dress, and Tribal Masks of the Pacific Northwest). Children were also asked about their experiences visiting museums, zoos, and other cultural attractions. This followed traditional User Experience (UX) best practices. (Spencer 2009) (Buley 2013)

This survey fell directly in line with common known psycho-social child development patterns for children in this age cohort. (C. Wood 2007)

Younger children (Kindergarten) were interested in more concrete types of exhibits such as Egyptian mummies and Medieval armor. Older children (3rd
and 5th Graders) who have a more expanded view of the world and greater abstract thinking abilities were interested in the social and cultural exhibits. In general, positive interest towards potential exhibits varied depending upon exposure and familiarity with the subject matter. Many of these topics were chosen with the knowledge that some of the potential exhibits were previously studied in the school curriculum.

In discussing this anomaly with veteran current and former Kindergarten teachers Gail Garrett, Meghan Delahanty-Reddington, and Sheelarani Webster, all three agreed that their personal experiences working with children led them to believe that there are unique visual-spatial perception issues related to child development in Kindergarten age children.

Visual-Spatial Development Issues in Kindergarteners

In looking at the pictures of cave art with the children, some unexpected comments came up over and over with the Kindergarteners (all of whom were 5 years old) that did not arise at all with the 3rd (mostly 7 — 8 years old) or 5th graders (mostly 10 — 11 years old). The children in the Kindergarten often expressed great difficulty in deciphering the type of animals in the art (ie. rhinos, horses, bulls and deer). Instead, many children responded that they did not see any animals at all or else responded with incorrect answers. These stray comments would effectively change the course of this Thesis project and form the basis for the interface and interaction design patterns developed.

In the responses received from the Kindergarteners at World of Inquiry, it appeared that the specific perception issues related to the texture of the rock against the artwork as well as an understanding of the line art as a representation of a known object. In graphic design terms, this would seem to relate to the gestalt concepts of figure-ground and closure as well as dominance and priority.

With this new information, the focus of the Thesis project now included a new set of complications for
this specific user group. How do you teach children about Cave Art when their natural development limitats their ability to see the images?

**A Solution Within the Art Itself?**

At another point working with the Kindergarteners in the Spring of 2017 at World of Inquiry, the entire class of approximately 20 children were presented with 11” x 17” copies of a complex cave art scene from a cavern known as “The Sanctuary” of Trois Frères cave located in Ariège, France. The image is a disarming scene with different animals in various positions, and no discernible “up” or “down” to the scene.

Children were instructed to work together as a group and circle any identifiable images they saw in the reproduction drawing. Adult facilitators assisted by writing notes on the papers as to what type of animal the children found. Most children found this activity very difficult, however, often one child would identify an animal and point it out to other children. When the specific image was pointed out, other children would agree and could then make out the image.

This activity reinforced the assumption that complex scenes of static cave art would likely prove to be frustrating and ultimately futile in engaging young visitors.

While thinking about the issues of perception in the user cohort, additional research into cave art continued and and uncovered recent work by anthropoligists Marc Azéma and Florent Rivère, who theorize that many cave art images suggest an early attempt at animation on the part of the cave artists. Azéma and Rivère state in their writings that the flickering glow of torch lighting would provide an optical illusion that cave art images were in motion. This, they argue, is the reason why many quadrupedal animals were drawn with more than four legs extended in various positions of a walk / run cycle. (Azéma 2008) (Azéma and Rivère 2012b) (Azéma and Rivère 2012a)

This line of research led to an insight that perhaps the children would better respond to the artwork if it were animated. Perhaps an animation of the animals walking or running could force the perception and allow the children to see the artworks. It would also make an interactive cave exhibit more interesting to see animals in action rather than stationary images.
**Affinity Diagrams**

With the initial surveys performed and documented, Affinity Diagrams were created to help determine user sentiment. In this process, all comments were written on pieces of sticky paper and subsequently arranged and grouped so that particular ideas could be brought together and analyzed. In this way, unique ideas and concepts that initially seemed unrelated can be brought together and connections can be made. (Holtzblatt and Beyer 1998) (Holtzblatt, Wendell, and Wood 2005) (Holtzblatt and Beyer 2014)

**User Personas**

Following industry best practices, user personas were developed based upon previous research and surveys performed with children from the World of Inquiry, School #58. These documents helped to formalize and document the specific socio-emotional and cognitive needs and limitations of the user group. (Buley 2013)

**User Journey**

With the user surveys, affinity diagrams and personas completed, it is possible to develop a model for the User Journey. This is a graphical representation of the social, emotional and intellectual issues a particular user group faces during an experience. While typically this is used for user interfaces, it is also apt for experiential and exhibit design. (Lichaw 2016)

**Exhibit Design and Flow**

Design Solution: Creating an Immersive Environment With Projection Mapping

To best solve the needs outlined above, the final design solution proposed is to create a series of interactive surfaces using projection mapping. A version of this technique was previously employed by the Metropolitan Museum of Art to display the lost colors of hieroglyphics on Egyptian art. (Barone 2016) While this particular example was not an interactive display, the use of projection mapping provided visitors with a new appreciation and a new perspective on the artworks. By incorporating visual tracking software such as Kinect or Open CV, the exhibit could be made interactive. (Giorioebrrary, Inc 2013) (Segal 2009)

By using projection mapping onto a mock cave wall surface, users could interact with the cave images without concern for degrading the artwork. Use of motion tracking could also be used to determine movements within the exhibit. The exhibit could
be programmed to have animals follow visitors through the exhibit, and react to visitor movements. With the addition of other sensors and microphones, the animals could also react to quick movements and loud noises with herd dynamics such as flocking. This would create a dynamic experience for visitors and engage younger visitors with a kinesthetic experience.

**Interactive Cave Walls**

One of the most common problems with exhibits designed for children is that the touch points of interactivity are very often not located at heights accessible to small children. In some cases, it would seem as though exhibit designers have completely overlooked the physical needs of the specific group they are intending to design for.

In this proposed design solution, interactivity touch points would be designed at various heights and in accordance with the specific user needs. This would, for example, have interactivity areas for children between the ages of 5 – 7 years old at various heights that would be natural to that specific age group. This would mean that the design of the interaction patterns and reading levels should be in accordance with the specific user group, and distributed according to height. Specific usability accommodations such as a ramp should also be afforded for those in wheelchairs as well as persons of short stature. In addition, interactivity touch points should be designed to be dragged and moved up or down so that they may be shared.

**Framer Prototype Testing**

In December, 2017 a new group of Kindergarteners at World of Inquiry were asked to test a prototype interface built in Framer (framer.com). (n.d.) The prototype was divided into four specific sections: Cave Art Animals, Cave Art Animation, Making Paint and Hand Stenciling Techniques. Three of the sections included several animated GIFs of cave art in motion as well as explanations of the other related topics such as how to make of cave art paint. There was accompanying text explaining the images, however, none of the children were able to read. In all cases, the accompanying text was read to the children by the author.

The prototype was tested with fifteen (15) Kindergarten children all aged 5 years old. The prototype contained images of 9 different animals, with most reproduced from actual cave art. One part contained static animals including: a bear, a
In some cases deference was given if the child could describe the animal but could not remember the name, or where the identified animals were generally analogous (ie. tiger as opposed to lion).

In the ‘Cave Art Animation’ section, three different images were shown of a bison, horse, and rhinos respectively. First the static images were shown and then immediately afterwards, the images were shown with the animals running, walking, or with the head in motion. The bison and horse were drawn from modern photographs, and the rhinos were drawn from a painting at Chauvet cave in Ardèche, France.

For the ‘Cave Art Animation’ section, data was collected based upon animal identification accuracy for both the static picture, and the animated motion graphic. The average accuracy rate for the static images was 47% with a median score of 33.3%. The accuracy rate after viewing the animation was 100%.

While the sample size is small, these results give a very strong indication that the use of animation in complex and somewhat abstracted images significantly improves image perception in 5-year-old children. This discovery further bolsters the
argument for the use of moving images in any cave art exhibit where visitors include children between five (5) and seven (7) years of age.

**CONCLUSION**

The work of this thesis project demonstrates the power of the moving image, especially in children whose developing brains are still trying to properly interpret the world. This has far reaching implications for User Interface and Interaction Design as motion graphics has the ability to hold interest and communicate information to children in ways that some static images cannot.

The work done on this Thesis project presents some interesting possible lines inquiry by interaction designers, motion designers, as well as developmental and neuro psychologists. Some immediate questions for further study include:

What roles to color and texture play in the interpretation of graphics?

What role does figure-ground interpretation play in letter recognition of emergent readers?

What activities promote development of figure-ground perception?

How can animation be used to promote reading skills in emergent readers?

Can dyslexics improve reading skills through the use of kinetic typography?

These question have the potential for significant insight into social and brain development in young children, and can help promote early literacy and cognitive development.

**ANALYSIS FOR FUTURE IMPROVEMENTS**

Given that all the children in the testing could not read, the most significant improvement that could be made to the prototype would be the addition of audio reading the activities to this particular user group. This would comprise of recorded readings of the instructions or questions as the children participate in the activities and games.
BIBLIOGRAPHY


APPENDIX A: THESIS PROPOSAL
Thesis Proposal for the Master of Fine Arts

Paleo Journey: An Interactive Upper Paleolithic Cave Art Experience

by James J. Parrillo

Keywords: Interaction Design, Contextual Inquiry, User Experience, UX, User Interface, UI, Exhibit Design, Experiential Design, Environmental Design, Projection Mapping, Paleolithic Art, Parietal Art, Ice Age Art, Cave Art

Abstract
Most European caves containing Paleolithic and Neolithic cave paintings (dating from ~10,000 – 50,000 years BP) are no longer accessible to the general public, and their visitor centers often require lengthy travel for tourists. As a result, several interaction designers have created games and Virtual Reality environments to bridge this gap. Some earliest examples include an early Virtual Reality (VR) tour developed around 1996 for Lascaux cave, an interactive Ice Age hunting game for children via a large touch screen, and online virtual tours of caves accessible with a standard web browser. These tools, however, are largely solitary and not experienced in a group context, a critical component in spaces such as art galleries, museums, and during the development of cave paintings during the Upper Paleolithic period.

This Thesis proposal explores breaking away from solitary computer screens in an attempt to create a more immersive physical environment for participants to interact with the exhibit and each other as they explore and learn about the world of the Upper Paleolithic cave painters. To achieve this goal, this proposal includes some technical components to create the immersive environment, and an experiential exhibit design to create the interactive component, but are not the primary focus.

The design components proposed include a comprehensive interactive exhibit design focusing on educating the public about the Upper Paleolithic cave paintings and Ice Age people of Southern Europe.

The exhibit design shall include:

1. A motion graphics piece projection mapped onto a mockup cave exhibit wall demonstrating the interactive cave design.
2. A fully functional interactive display on a large touch screen highlighting various aspects of the information found in the exhibit. The display design shall be created to demonstrate the design of digital information within the exhibit that is presented in an interactive format. As part of the development of the interactive display, the design process and artifacts of ideation shall be documented including the user interface (UI) and user experience (UX) related items.

UI and UX documentation shall include:
- Contextual inquiry / user research.
- Development of user personas.
• Documentation of Affinity diagrams.
• Layouts and individual design elements from Bootstrap design elements such as forms, buttons, typography, headers.
• Development of a functional prototype, appropriate user testing and collection of results leading to the finalized deliverable.

3. Development of an exhibit branding guide that includes the exhibit logo and identity including examples of its usage, exhibit color palette for screen and print, exhibit typography choices and examples for both screen and print, layouts for screen and print materials, the exhibit wayfinding system as well as examples of how the exhibit branding can be used for items typically found in a museum or visitor center gift shop.

4. Finalized ideation drawings of the exhibit components and how they could potential be presented to the public within a museum or visitor center. Drawings shall be to scale and depict one potential layout for space. Specific information about the exhibit areas and exhibit subject matter will be included as well as required exhibit equipment such as touch screens, projectors.

**Problem Statement**

Due to previous vandalism and years of tourist visits, most of the fragile European caves containing Upper Paleolithic Ice Age art are now managed and controlled by government agencies to help protect and preserve the environments and artwork for future generations. The most significant and most majestic caves such as Chauvet, Lascaux, Altamira and the underwater cave of Cosquer are tightly restricted from the general public, and are only accessible to qualified experts such as archaeologists and anthropologists. Measures have even been taken to seal and control humidity so as to help preserve the delicate cave ecosystems from contaminants, and to prevent and reduce destruction of the artwork from organisms such as bacteria, fungi, and molds introduced from the outside. (Herzog 2011) Many of these caves do have visitor's centers, where cast models of the caves can be viewed and information about the cave art can be studied by the general public. However, these models are not portable, and can only be viewed on location in Europe. As an additional concern, non-profit and governmental organizations charged with educating the public about the caves have limited budgets, so creating physical exhibits can be an expensive endeavor. To bridge this gap, some organizations such as Ice Age Europe, a network of 14 cave visitor centers, museums, and cave protection agencies provide portable exhibits available for loan. (http://www.ice-age-europe.eu/engage/exhibitions-to-rent.html) However, no interactive immersive environmental exhibits currently exist for this purpose.

This Thesis seeks to explore the issues and develop a proof of concept prototype design solution for an interactive and immersive Upper Paleolithic cave art exhibit. This proposal could potentially add to the body of knowledge needed for further development of the concept of interactive environmental exhibits, and user feedback can be used to further develop future improvements and refinements to the design.
Review of Literature

Interaction Design

(Kourakis and Parés 2010)

In this paper, Stelios et. al. created an interactive game for children using a large eight foot by six foot touch screen, and a program written in ActionScript (Flash). The purpose of the game was to teach children about the collaborative nature of ancient hunting techniques as depicted in cave paintings. The developers animated characters from the Spanish cave paintings so that the hunters could run, shoot at arrows, hide and scare the prey with shouts. Children were provided no instructions, and would eventually learn via trial and error to work together in groups in order to ambush and capture prey. This paper provides an excellent example of a project that

http://www.hamiltonarts.net/lascaux.html

The LASCAUX Virtual Reality Art Installation by Benjamin Britton is an interior 3D model developed in 1995 for a “new computer graphics technique called virtual reality.” The exhibition was well received and traveled internationally for exhibitions as an early demonstration of the technology’s capabilities.

(Jacobson and Hwang 2002)

This article describes the CaveUT system developed at the University of Pittsburgh wherein a virtual reality space is created for use in a semi-spherical theater, such as those used in sky shows. The technology was aimed at creating an immersive experience even for environments such as an ancient Egyptian temple.

(Bullivant 2007)

This special publication by Architectural Design magazine showcases a number of interactive installation pieces and interviews artists. Though most of the articles relate to architecture, the coverage includes a number of both interior and exterior interactive environments.

(Keefe et al. 2001)

Keefe, et. al. developed a virtual painting program in 2001 using object tracking for paint brushes and buckets. The program would be projected onto walls and screens for artists to virtually paint scenes using gestures and mock brushes rather than a mouse (as was typical of that time).

(Stone 1998)

Stone discusses details in the use of Virtual Reality (VR) as a means of allowing the public to access
Stonehenge. In addition, the VR design allows users to witness the astronomical night sky as well as a sunrise to demonstrate Stonehenge’s connection to these astronomical events.

*(Holtzblatt and Beyer 2014)*

*(Holtzblatt, Wendell, and Wood 2005)*

These works spearheaded by Holtzblatt et. al. on contextual design form some of the earliest and most fundamental research done on user oriented interface and interaction design. The techniques put forth by the authors provide rigorously tested step-by-step methods for analyzing user needs and developing appropriate strategies for the development of accessible and suitable interfaces.

Upper Paleolithic Cave Art (Parietal Art)

*(Petzinger 2016)*

*(Petzinger 2009)*

Von Petzinger is a professor of Anthropology at the University of Victoria. This book is an extension of her Masters Thesis (“Making the Abstract Concrete”) and provides detailed information regarding the largely overlooked symbols found at the European caves containing Paleolithic Ice Age Art. Mrs. Von Petzinger and her husband painstakingly explored caves throughout Europe and documented 26 recurring symbols such as circles, zig-zags, crosshatches, hand prints, etc. that appear over and over in the various caves and compiling the information into a database. Both the book and her Masters Thesis provide regarding the signs found at approximately 140 different cave sites. This, along with other data such as known travel routes of that time, geographic distribution of the symbols, known historical migration patterns, etc. help von Petzinger make sense of disparate facts regarding the development of these symbols and their incorporation into the cave painting lexicon for approximately 20,000 years.

*(Clottes 2010)*

This book by the renown and authoritative Jean Clottes provides expansive details on the various cave art including wall scratchings and etchings, etched bone, simple bone flutes, fetish objects and the various cave paintings and engravings found at locations like Lascaux, Altarima, Rouffignac, Les Combarelles, Les Trois Freres and arguably the greatest, oldest and best preserved of the European caves, Grotte Chauvet.

*(Curtis 2007)*

This book provides a sweeping and exhaustive embattled history of various European caves containing Upper Paleolithic and Neolithic art. It provides great detail into how late 19th and early 20th Century amateur explorers upended long held conventions by scientists, archaeologists, anthropologists, sociologists, historians, and philosophers. Against a backdrop of academics and religious philosophers still coming to grips with evolution, a small band of non-academics pushed forward with excavations and research to help reframe what it means to be human and the origins of
European settlement.

(Herzog 2011)

Filmmaker Werner Herzog was granted access for several days to access Chauvet Cave along with another crew that was performing investigations and mapping of the cave. The documentary provides an in-depth narrative to the story of the cave’s discovery and history. Chauvet cave was discovered in the late 1990s and is the best preserved example of Upper Paleolithic Cave Art.

(Guthrie 2006)

Guthrie provides a detailed investigation of animal and human behaviors found in Upper Paleolithic Cave Art. As a zoologist, Guthrie explores the art in very different and controversial way from traditional perspectives.

(Clottes 2016)

Recognized as the world’s foremost expert on Paleolithic Cave Art, French archeologist Jean Clottes contemplates and explores the purpose behind Paleolithic Art. This is an excellent resource for base knowledge and understanding of Upper Paleolithic art.

http://archeologie.culture.fr/chauvet/
http://www.lascaux.culture.fr/?lng=en#/fr/00.xml
http://www.experienceardeche.com/page/the-chauvet-cave/56
http://www.donsmaps.com
http://museodealtamira.mcu.es/
http://font-de-gaume.monuments-nationaux.fr/
http://www.culture.fr/eng/Multimedias/Grands-sites-archeologiques/Collection/Prehistoire/La-grotte-de-Cussac
http://www.sculpture.prehistoire.culture.fr/en
http://cavernsduvolp.com/en/grottedestroisfreres
http://leseyzies-tourist.info/dordogne-caves-and-shelters/les-combarelles
http://www.pechmerle.com/english/introduction.html
http://en.museodealtamira.mcu.es/Prehistoria_y_Arte/la_cueva.html
http://cuevas.culturadecantabria.com
http://www.la-madeleine-perigord.com/

A brief list of websites dedicated the caves containing Upper Paleolithic Art. Most of the websites in this list are run by museums, visitor centers, governmental entities charged with the preservation of the caves, or tourism authorities. Some are run by hobbyists or academics studying the topic of cave art.
Lewis-Williams further develops his previously published theories regarding shamanic religion as the subject matter for rock art. Previously, Lewis-Williams had focused on the bushman rock art of Africa, but then teamed up with Clottes to explore the possibility that this theory would also apply to European cave art of the Upper Paleolithic Period.

Lewis-Williams pieces together fragments of various Upper Paleolithic societies of Europe to explore what is known about these cultures and how it influenced their production of portable and parietal art. He also contrasts how Homo Sapiens of this period, unlike our Neanderthal cousins, were able to think abstractly, understand the concept of something occurring in the future, develop complex plans, and their ability to produce representational symbols. The author also delves into issues relating to states of consciousness.

This book continues Lewis-Williams' exploration of the relationship between various states of consciousness, symbols, and how various Neolithic human societies came to understand their relationship with the Cosmos.

In this book, Lewis-Williams and Challis continue their research of the indigenous San people of southern Africa as well as other aboriginal peoples around the world. Using historical interviews and documentation from the 19th Century, the authors explore the development of thought patterns among hunter-gatherer societies. Using rock art, historical interviews and interviews with living tribal members, the authors are able develop specific meanings from various congruencies.

The 'Journey of Mankind' interactive timeline and map details the migration pathways of human populations throughout the world from 150,000 BP. This information is presented by the Bradshaw Foundation in collaboration with Professor Stephen Oppenheimer. Oppenheimer produced the map and timeline based upon DNA and Y Chromosome evidence as well as climatology, archaeology, and fossil studies.
Art & Aesthetics

(Consoli 2014)

Consoli’s article provides a detailed lineage of cognitive processes in the development of aesthetic perception in Upper Paleolithic society. He also theorizes that the development of aesthetic appreciation for art in painting, sculpture, music and dance was community-wide and instrumental in the development of an actualized self. He theorizes that development of aesthetic experience was a differentiator for mate selection, and development of a personal story. “Through the early artistic behaviors and products, individuals could learn the deep cultural narratives that allowed them to understand themselves and others, to organize their own experience, and to make sense.” This critical understanding points to an almost spiritual quality to Upper Paleolithic art, and potentially the precise point in time for the next two development stages in Maslow’s Hierarchy of Needs: Esteem and Self-Actualization. These points make clear the importance of this art within the story of humanity.

(Leder et al. 2004)

Leder et. al. develop a five stage cognitive process of abstract visual art (perception, explicit classification, implicit classification, cognitive mastering and evaluation). This paper also establishes that the context in which the art is viewed is important in aesthetic experience. This establishes a firm foundation for my development of a cave environment for viewing and experiencing Upper Paleolithic Cave Art. This view is also consistent with the findings of Cupchik and Laszlo (1992) and Goodman (1976). Although this paper is directed towards Psychologists as an outline for conducting future research into the aesthetic experience, it merits review and inclusion into the development of this project.

(De Smedt and De Cruz 2011)

De Smedt and de Cruz provide a cognitive approach to the background and symbolism of Upper Paleolithic Art. The authors discuss the background cognitive activity required for the development of aesthetic values for symbols and the use of symbolism in early art forms. This gets to the issue of whether is parietal art is actually art or not.

Technology of Interaction Installations & Motion Tracking

https://www.youtube.com/watch?v=kR-tcZplc-Y

Video of a low cost DIY multi-touch screen project, and demonstrating its use in projection displays.

http://unity3d.com

Unity is a game engine to create 3D environments. In this application, it would be used to create the “cave walls.” Participants would act as the game controllers, and the environment would be
In this tutorial, the author explains and demonstrates the use of OpenCV for tracking of multiple objects via a camera. This would be extremely useful in tracking visitors as they progress through an exhibit. Using this data, a game engine could perceive the participants as if they were in an environment and could trigger events as they pass through the environment. One example of this could be that as participants move through the exhibit, the lighting could change on the cave walls and illuminate the artwork and symbols.

This published code allows users unlimited rights for use in OpenCV object tracking.

(Dahms, n.d.)

Dahms provides a series of OpenCV tutorials along with downloadable open source code via his GitHub page.


Enox Software provides plugins to integrate OpenCV into the Unity game engine.

Cave Wall Design

(Kolatan and Sabin, n.d.)

Jenny Sabin is a professor of Architecture at Cornell University. She specializes in parametric design for architecture and recently exhibited an indoor pavilion at the Cooper Hewitt Design Museum. Her pavilion incorporated much of the same ideas presented in this Thesis proposal. While the focus of this proposal is not Architecture, it demonstrates that the ideas put forth in this proposal are achievable.

In the book she co-authored with Ferda Kolatan, she demonstrates the use of unusual yet natural forms and shapes in architecture that can be achieved by parametric design using computer algorithms. Many of her models of these structures are for pavilions and human scale interior structures created through the use of interlocking pieces. Much of Sabin’s design style of architecture resembles the morphology of caves.
Design Ideations

Analysis of Existing Solutions: VR & AR, Online Tours and Cave Models

A number of solutions to the problem of public access to the cave art currently exist. However, do not encompass all of the principles embodied in this Thesis. The following will discuss various ideations, and provide analysis of these potential methodologies. Explanations and reasonings will be provided for strengths and drawbacks of each.

In the late 1990s, when Virtual Reality (VR) was only a nascent technology, artist Benjamin Britton devised a VR tour of Lascaux Cave. (Nechvatal 2005), (Britton 2016) The exhibit was met with great success and considered a technological innovation. But like all VR technology of its time, it was limited due to technical limitations. (Williams 2015) (Wiederhold 2014)

Current VR technology has made significant improvements over the past two decades, with commercial quality systems becoming more widely available. VR is now capable of providing visually immersive experiences into existing and fictional realities. This provides a truly unique opportunity for presenting information and games in ways that were previously unavailable. VR technology would certainly solve the problem of providing access to virtual caves and interactivity with Paleolithic cave art. Many caves have been professionally scanned and mapped with lasers and then modeled in 3D software. High definition photography and video has also been taken for documentation and preservation purposes. (Herzog 2011) (Clottes 2010)

However, VR technology continues to have particular drawbacks to some users. In a chapter titled “Sickness in Virtual Reality” from Advances in Virtual Reality and Anxiety Disorders, Sarah Sharples, Gary Burnett and Sue Cobb provide a thorough history of physical and mental effects of VR use in therapeutic settings for treatment of phobias and anxiety disorders. In some cases, users became physically ill from extended use of VR. Symptoms were grouped into three categories that included nausea, visual fatigue, and disorientation and increased over time over a period of 25 minutes. In addition, the authors cite evidence that some user’s reactions to VR may be positive or negative depending upon the individual. One example cited is elevated heart rate; for some an elevated heart rate may be a positive effect from the visual stimulation, but for others, could have potentially negative health effects. (Wiederhold 2014)

During the ideation phase of this project, it became clear that the use of VR technology would present some potentially serious drawbacks to usability. While current VR technology has improved to a level of more widespread commercial availability and popularity, there exists a potential for segments of the population to be particularly vulnerable to the physically straining and anxiety producing effects of VR technology.

There also exists an interesting experiential component of exhibitions and museum installations that may be of particular importance to some visitors; the potential for social interaction with others about the subject matter. In some instances, visitors to museums and exhibits enjoy the social aspect of experiencing and discussing the exhibits. Parents, docents, guides and teachers will often take the
opportunity to provide additional explanations about the exhibit. Often these conversations may be overheard by others and initiate larger group discussions and exchange of ideas. Virtual Reality technology is a solitary experience where the user is largely alone in the virtual world. VR technology can be mesmerizing and visually overwhelming for some users to the point where their focus and attention is on the interaction more than the subject matter. As experiential designers it is important to consider the social aspects of exhibition design. Exhibitions are not just a means of communicating information to visitors, but also as a jumping off point for initiating conversations, facilitating conversations and fostering the development of new ideas and better understanding of the subject matter as well as each other.

As the internet became more widespread and download speeds increased, a number of caves including Lascaux and Chauvet developed online virtual tours. (Ministère de la Culture et de la Communication de France 2010) (Ministère de la Culture et de la Communication de France 2016) These websites allow for public access to the artwork, and provide some interactivity and in-depth information about the history of the caves and the people and animals who used the caves over thousands of years. However, due to the inherent nature of an online tour, viewing the exhibit on a small screen is not an immersive experience. Both do allow for the user to view the artwork, and research the topic, but both websites present potential drawbacks in terms of accessibility to users. Both sites are complex and could be difficult for some users to navigate. Both online tours are limited in terms of the available technology used during the development of the sites. Development for both sites were done in Adobe Flash, which is no longer widely used or supported. Another key component is that both are designed as pre-formatted tours that move the user through the caves at a pre-set pace. In this way, it is possible for viewers to miss specific cave art panels, become confused about the controls, or find the pacing of the tours as moving too fast (or too slow).

Perhaps the most important drawback of both online tours of Lascaux and Chauvet caves is that neither one allows the users to freely explore the caves at their own pacing. This makes both online tour experiences as potentially frustrating to users. While these site could benefit from improvements, any additional development using online virtual tours as thesis project would merely be repeating previous efforts. In effect, this would be merely providing a critique of past work and providing improvements and not rise to a level of work worthy of a thesis. Despite some technical drawbacks, both websites have been largely successful in allowing greater access to the general public. However, one of the most important drawbacks of using an online tour as a potential solution to this thesis project does lie with the technical issues, but rather with the fact that online tours do not provide an immersive experience.

In addition to the aforementioned technologies, many visitor centers have developed full scale walk-through physical models of the cave. The most recent being the elaborate Chauvet cave model. Visitors are immersed in the majesty of the cave itself as well as the elaborate art panels of rhinos, mammoths, lions and horses. (Ministère de la Culture et de la Communication de France 2016) This solution presents visitors with the truest representation of the various caves and cave art. The paintings have been recreated by artists in extreme detail and are accessible in exhibits designed to mimic the environment of the actual caves.

While certainly this is the most ideal way to allow public access to see the cave art, the accessibility to these exhibits present a challenge. Visitors must travel to Spain, France, and other parts of Europe in
order to see the cave replicas. The expense and time required to travel long distances for such a journey is out of reach for most people. The exhibits are very large permanent installations and cannot be moved as a traveling exhibit. In addition, production and fabrication of physical model exhibits are extremely expensive. It is estimated that development of the Chauvet cave replica exhibit cost approximately €55 Million Euros ($60.5 Million US Dollars) and was very time and labor intensive to produce. (Stewart 2015) The exhibits at Lascaux and Chauvet are static exhibits and do not have interactivity with the art panels.

Current Ideation: Idea Development and History
The original ideas around this project began in 2014 as part of an earlier Project Design and Implementation VCD course with Professor Nancy Ciolek. The framework surrounded the essential design problem of creating an exhibit that is accessible to the public, potentially portable, an immersive environment and interactive through the use of projection mapping.

These ideas have been incorporated from the original ideation, and the author has taken time to journal, review and discuss these issues in detail with various professors, fellow students and other design and software development professionals. The original ideas and understanding of the design problem has remained consistent, but the ideation of potential solutions has changed and evolved over time as the nuances of the problem has become more understood.

In returning to this project, the aspects of the problem and potential solutions were reexamined and a mind map was created (Figure 1) to assist in parsing out the various aspects of the project that would merit further review, analysis and development. In doing so, a deep analysis of the nature of the problem was conducted as well as a deep review of the work others have done to try and solve this problem.
The essential question about the problem involved researching and determining how this problem had been tackled in the past, and also looking critically at those previous solutions. It became clear after the research work that this problem, indeed does still exist at the present time. An important aspect of previous solutions is that the interactive solution designs put technology first instead of focusing on the experience of viewing and interacting with the artwork.

Both the VR and online tours satisfy the needs for interaction components, but fail to provide an immersive experience that uses any sense other than vision. In addition, the aesthetic experience of viewing art, such as at a museum is always best done with others as a collective experience. This allows the viewers to engage in a dialogue of ideas about the work, the concepts, and the ideas put forth by the artists. Viewing art can, of course, be done alone. However, the emerging field of Neuroaesthetics shows that the context in which the art is viewed can lead to varying levels of appreciation and understanding of the art being viewed. (Consoli 2014) (Leder et al. 2004) (Gerger, Leder, and Kremer 2014)

On the contrary, the physical models by their nature provide a much more immersive experience. The caves can be replicated to exacting specifications, and the artwork can be matched exactly with modern painting techniques. However, as with much of great art, a lack of understanding about the art can lead viewers to walk away with no real understanding about the nature and purpose of the art. Placards can be put in place, but there can be language barriers for international visitors. The development of an interactive system can also make it easier to provide updates to the exhibit information as new information becomes available. It is easy to find outdated museum exhibits with placards of old information that is no longer accurate.

Further analysis of the problem and development of the proposed project to address a possible solution proposed has shown the following:

1. The proposed solution, as outlined in this Thesis proposal is necessary and relevant. A gap currently exists between interactive technologies such as VR and online tours, and the immersive world of scale model environments. As outlined previously, interactive solutions provide access to more information about the exhibit, management of exhibit information is easier and can be done with relative ease, while physical fabricated environments provide a truly immersive experience of the caves, but are not as widely accessible as VR or online tours. However, physical environment exhibits are expensive, not portable, and potentially difficult to maintain.

2. The proposed solution, as outlined in this Thesis proposal is achievable and practical. With the development of better 3D scanning and digital photography, most cave visitor centers now have high quality images that can be used in exhibits. Development of an interactive exhibit would conceivably be less expensive to develop than creating cast models and hiring artists to painstakingly paint the models to perfectly mimic the cave environment. As an added measure, the proposed solution could be made in a modular format so that the exhibit could travel with less difficulty of packing and shipping than a full scale cave model.

3. The proposed solution, as outlined in this Thesis proposal is original and would contribute to
the design field. In the research leading up to this proposal, there exists no known solution to this problem that encompasses development of an immersive and interactive exhibit environment dedicated to Upper Paleolithic art. In addition, the proposed physical interface as outlined in this Thesis proposal seeks to address different user needs as based upon their cognitive abilities. While this is not entirely new, it seeks to foster greater engagement between adults and the younger visitors they bring to the exhibit. Based upon the writer’s previous personal experience with the shortcomings of exhibits that are intended for children, it is clear that contextual inquiry is a technique that is not utilized by professional exhibit designers. Utilizing contextual inquiry and the standard User Experience design process for development of an exhibit is likely to provide a new way of thinking for exhibit design.

Solution Development & Iteration

Previous work on this project led to an earlier iteration as shown in Figure 2. In this scenario, the exhibit consisted of only a screen, projector and computer software that would produce the interactive exhibit. Further review of this iteration revealed technological and physical issues that could not easily be resolved.

The first issue was that the screen would not be stable and sturdy enough for interactive purposes, and a more permanent style of structure would be required to accommodate interactivity and stability of the screen. The second issue is the placement of the projector. With the previous iteration, visitors could potentially block the projections if the light source was placed behind them.

To resolve these issues, further research and testing was done into the creation of projection touch screens. Research into this topic showed that software libraries and off-the-shelf components could
be used to create touch sensitive screens made from either fabric or Plexiglas. In these solutions, the computer screen is projected in reverse onto a semi-transparent surface (such as Plexiglas covered with a light diffusing film). An infrared camera is used to detect touch locations, and software is used to coordinate the user’s touch with the computer’s touch input system. (Segal 2016) (Karmon et al. 2009) These methods were successfully tested as a proof of concept, and were successful using the tutorials provided by Segal, Karmon, et. al.

During personal observation of exhibits designed for children at various museums and zoos, (a list that includes among others: Seneca Park Zoo, Brookfield Zoo, Buffalo Zoo, Field Museum of Natural History, Rochester Museum and Science Center, Adler Planetarium, National Zoo in Washington D.C., Adler Planetarium, and the Museum of Science and Industry) it became clear that environmental and experiential design teams often lose sight of user needs.

Specifically, two main problems have been observed in exhibits that are specifically designed with children in mind:

1. Text is often not written at age appropriate reading levels.
2. Physical exhibits are designed at height levels for adults rather than children.

Additional research revealed that UX and usability design for children is a widely studied area, and that children have specialized needs and requirements in order to create engaging and usable experiences. (Gelman, n.d.) (Gelman 2011) (Hanna, Risden, and Alexander 1997) () (Bala 2016) Although much of Hanna’s research is out of date, as it was done prior to the development of touch screens, her theories around user testing with children as it relates to child cognitive development remain relevant and have been supported by more recent studies. Research points to division of children into at least three main age groups for development of interfaces: Preschool (Ages 2-5), Elementary School (Ages 6-10) and Middle School (Ages 11-14).

With this information, and personal experience also informing the design, another design tenet has emerged that could make the experience more engaging for children. A fully developed exhibit could employ various levels of interactivity and reading levels based upon use height. In this way, younger (and typically shorter) visitors could participate in the exhibit with age appropriate experiences tailored for their needs. Younger visitors would then be engaged with material appropriate for their developmental abilities while adults would also find the exhibit engaging.

**Current Ideation: Sketch of Proposed Solution**

Figure 3 below demonstrates the current concept of the interactive cave environment. This sketch shows one iteration of a fully realized exhibit. Feedback on the design has revealed some issues with accessibility for people with physical handicaps. This will be addressed in future iterations and during the development process.
The ideation contains the following main concepts for the exhibit:
1. A physical touch screen interface integrated within the structure of the “cave.”
2. Touch screens are created via reverse projection of the interface onto the cave walls from behind.
3. Three interface designs for: children ages 6-10; children ages 11-14; adults aged 14+
4. Interface designs generally set at heights generally in accordance with the heights associated with the three age groups.

Methodological Design and Deliverables

Design Methodology
This Thesis project will encompass several design components that can work together to create an immersive and interactive experience. In a true full scale project, this would include other design, engineering and subject matter professionals such as architects, software engineers, programmers, art historians, archaeologists, anthropologists, and ethnographers.
In lieu of the time, budgetary and technical constraints required to complete this Thesis in one semester, many components of the proposed Thesis will be prototyped or simulated with accompanying documentation and explanation of how a final exhibit design could be achieved with the assistance other experts better suited in the related fields for specific elements such as exhibit fabrication, programming, and subject matter.

At the core of this project are the following elements to create an immersive and interactive educational exhibit about Upper Paleolithic parietal art:

- Development of a series of motion graphics demonstrating the interactivity and interfaces of the cave walls. These motion graphics should clearly demonstrate the type of interactions and micro-interactions, games, information displayed according to the user type.
- Interactive Cave Environment demonstration creation of a model cave surface for display of the motion graphics through projection mapping.
- Development of three (3) examples of the cave interactivity such as games, puzzles, information and interactions.
- Development of print and digital exhibit identity to reinforce the imagery of cave art.

**Target Audiences & Design Process**

In designing an exhibit for the general public, it is important to account for a wide range of ages, needs, and abilities. To best accommodate this, a standard contextual inquiry and user experience design process will be at the center of the design process.

The iterative process of the user experience design process requires designers to repeatedly design, develop, test and revise as follows:

- User Research & Contextual Inquiry
- Affinity Diagrams, Research Analysis & Persona Development
- Wireframing & Workflow Development
- Mood Board Development, UI Element System & Interaction Design System
- Prototyping
- User Testing and Results Analysis
- Design Revision and Iteration

**Target Audiences**

An exhibit about Upper Paleolithic Art would be typically targeted for families with children, school groups, and adults. In order to properly design an exhibit for such a wide audience, divisions may be made to accommodate the wide variation in education, literacy and ability to use technology.

There are two main target audiences for this project, however there will be distinct groups in order to properly accommodate natural developmental differences. The two (2) broad groups include School Children (ages 5 to 13) and Adults (ages 14+). These divisions are largely due to reading levels and interactivity needs. For the purposes of simplicity, and under the advisement of several educational
professionals including Meghan Delahanty-Reddington, Liz Dauksha, Amy Martin and Principal Sheelarani Webster, it was decided that the most representative cohort of children would be found in Kindergarten, 3rd and 5th Grade classrooms. (Parrillo, n.d.) (Parrillo 2016b) (Parrillo 2016a) (Parrillo 2016c)

School Children (Ages 5 to 13)
Due to their natural developmental needs, and rapid successive changes that occur in mental, physical, and emotional development in this group, it will be subdivided into three (3) sub-groups for the purposes of UX research and co-design iteration.

Early Emergent Readers (Kindergarten – Ages 4 to 6)
According to World of Inquiry School #58 teacher Meghan Delahanty-Reddington, kindergarten children are considered ‘Emergent Readers.’ These children have great variability in reading skills. Some children enter with superior levels of literacy and reading comprehension while others arrive not knowing a single letter of the alphabet. However, she asserted that almost all children arrive at the beginning of the school year with great understanding of touchscreen devices including mobile phones and tablets. Most are familiar with simple cause and effect and/or puzzle games such as ‘Angry Birds’ or ‘Where’s My Water?’ Many children have also had exposure to educational games from trusted sources like PBS Kids, which produces early educational television programs like ‘Sesame Street,’ ‘Word Girl,’ and ‘Sid the Science Kid.’ Developmentally, these children are only beginning to understand that there is a larger world outside of theirs. Although they are taught to remember their home address and phone number, most Kindergarteners could not be able to locate their home country on a map or globe. Kindergarteners have a simple understanding of cause and effect, as long as it is visible, as they are not ready for abstract thinking. This cohort of children probably most familiar with zoo exhibits, or perhaps exhibits about dinosaurs. (Parrillo, n.d.)

Elementary School Children (3rd Grade – Ages 8 to 9)
By Third Grade, children are beginning to learn about basic sentence structure and identifying topic sentences. Third Grade teacher Liz Dauksha explained how they are taught close reading and encouraged to underline important words for increased reading comprehension. These children have had exposure to topics like westward expansion into the New World from Europe, and have begun developing their abilities to think abstractly. By Third Grade, these children can usually locate the seven continents on the globe, and even locate where their home on globes and maps. The children have had lots of exposure to touch screens and operating PCs with a mouse and keyboard, and have a strong preference for touch screens. In terms of exposure to museum exhibits, these children have, at minimum, experienced a trip to a zoo, and many have also taken trips to other types of museums such as a science, natural history, art or children’s museum. (Parrillo 2016b)

Middle School Children (5th Grade – Ages 10 to 11)
Children in Fifth Grade have the ability to write in complete sentences and are beginning to write full paragraphs that include a topic sentence and supporting sentences. They are able to read chapter books and present full presentations to an audience, explaining topics such as the sinking of the Titanic, the effects of climate change, or the bombing of Hiroshima. By this age, children begin to lose interest in simple educational games, and start to explore first person role playing games requiring
planning and strategy for anticipated movements. The most popular educational games that capture the attention at this age are also first person role playing games that allow the user to develop their own anthropomorphic avatar, complete with choices for hair, skin and eye color, clothing and accessories. This personalization helps children to identify more with the character on an emotional level. Although the games may be around typically mundane topics like remembering math facts, the avatars often engage in battles where the victor is determined by speed of remembering multiplication tables, and the prize for winning can often be new accessories or points earned toward the purchase of new accessories. Users in this cohort may spend hours creating and modifying their avatars as a sign of social status between friends who also play these online games. Examples include ‘Animal Jam’ from National Geographic, (https://www.animaljam.com) ‘Wild Kratts’ from PBS, (http://pbskids.org/wildkratts/games/) and ‘Prodigy’ (http://prodigygamed.com) (Parrillo 2016a)

Adults (Ages 14+)
This age cohort has the largest span of ages and abilities in terms of exposure to technology and literacy. As this exhibit is most closely targeted towards families, the age range of parents would be expected to span from 20 to 50 years of age. However, this could also include elderly relatives that may join the family on the outing.

Therefore, some basic assumptions will need to be made to set a baseline in terms of familiarity with technology, and literacy. According to a Pew Research Center report published in February of 2016, 72% of all adults report ownership of a smartphone with a touch screen. (Poushter 2016) This represents a very high market penetration for these devices, and by all indications in the report, the trend will continue to increase for the foreseeable future. This indicates that an overwhelming majority of adults own a smartphone, so it can be safely surmised that the majority of adults in the United States have a firm understanding of touchscreen interfaces.

However, according to a 2009 report (on data collected in 2003) from the National Center for Education Statistics (a division of the U.S. Department of Education), 14% of adult Americans (have “Below Basic” prose literacy – meaning that they lack the ability to read simple prose such as grocery advertisements, product packaging or utility bills. Of this fourteen percent, 44% were below the poverty threshold, and 46% had at least one or more disabilities. (2009) Based upon these statistics, it is important to consider that even among adults, non-language based visual identifiers will need play a large role in informing visitors to the information and instructions.

User Research
During the user research portion, special attention will be paid to designing for families with children, grandparents and those with special needs. Attention will also be paid to cognitive issues such as usability and interaction complexity differences between children and adults, and reading levels of children.

To conduct the research with school age children, arrangements have been made with the Kindergarten, 3rd and 5th grade classes at the World of Inquiry School #58 in Rochester, New York. These grades were chosen in largest part because they correspond closest with the age groups
suggested by the research of Hanna, Risden and Alexander. (Hanna, Risden, and Alexander 1997) At the time of interviewing, the group Kindergarteners will typically have an emergent level of literacy – meaning that they will likely only have knowledge of letters, letter pairs, and simple sight words, (such as and, the, it, he, she, etc.) however there will likely be great variability in reading levels at this grade. The 3rd grade children will have greater fluency in reading, but are only just beginning to explore the outside world and how it has a direct impact upon our daily lives. (Parrillo 2016b) The 5th graders have increased reading comprehension, and a clear understanding of the outside world and societies different from their own. They also are beginning to understand complex social structures, the social roles within a society, social hierarchies, and conflicting values that can exist within a society. (Parrillo 2016a)

The principal and teachers of these classes have agreed to allow time in their schedules for interviews and collaborative work to define the needs of children visiting the proposed exhibit. During the interviews, collaboration and co-designing sessions, children will provide advice and direction to the design process and assist in providing ideas and feedback for the best ways for the information to be displayed and made interactive. Research and evidence clearly shows that involving children in co-designing activities provides for a better user experience. (Naranjo-Bock 2012) (Idler 2013)

While the Rochester City School District does not allow for collection of individual information about the children involved in the research, the teachers can provide an aggregate of data regarding the student cohorts to help assure that a wide spectrum of children have been included in developing the research data.

For adults, surveys and interviews will be conducted targeting parents with school age children. Surveys will be conducted online via a service such as Google Forms, and interviews will be conducted in person and via Skype.

**Contextual Inquiry Process**

Strong National Museum of Play and the Rochester Museum and Science Center have both been contacted regarding an opportunity for the author to observe and survey visitors in attendance. Direct observation within the context of the user interaction is at the core of research conducted by UX pioneers Karen Holtzblatt and Hugh Bayer. Their research bears out the importance of user research and inclusivity in order to develop the best products and interfaces. (Bayer and Holtzblatt 1998) (Holtzblatt, Wendell, and Wood 2005) (Holtzblatt and Beyer 2014)

Affinity Diagrams, Research Analysis & Persona Development

Within 24-48 hours following an interview, work begins on the development of an affinity diagram. All notes are translated into “I statements” in the voice of the user such as, “I like interactive displays to learn.” As the interviewee statements are gathered, they are written onto colored post-it notes. These notes can then be arranged on a wall. When all interviews are completed, various ideas will emerge from the statements and post-its can be grouped together into similar ideas. When this first round of grouping is completed, the larger concepts and sentiments can be determined such as, “I find museums intimidating.” This system of grouping and regrouping continues until no more
categories can be developed from the post-its. (Bayer and Holtzblatt 1998) (Holtzblatt, Wendell, and Wood 2005) (Holtzblatt and Beyer 2014)

The affinity diagram is a qualitative analysis of user sentiment and needs. It provides a way for designers to understand their user based on direct observation, surveys and interviews. Only after the affinity diagram is completed and documented can the development of personas begin.

Using the data gathered during the research phase, personas can be developed as a way to showcase the needs and desires of typical users. Personas are fictionalized characters that represent the typical user base. Often times personas incorporate ideas of personal style and discuss likes and dislikes, especially when designing for mobile, tablet, websites or desktop software.

Wireframes & Workflow Development
Once the data has been collected, reviewed, and organized, the work of developing an interaction design system begins. This commences with developing workflows to bring the user along the way. In the case of this Thesis, users will likely not have a direct pathway as is typically found in other task oriented software and websites such as an online merchant.

Since these users are in a more relaxed atmosphere where learning enjoyment is the goal, it is the author’s theory that users will have a stronger desire to meander through data and interaction at their own pace. This sentiment theory will be determined during the research process, but will have a direct impact upon the development of wireframes, navigation, and user workflows.

Mood Board, UI Element System & Interaction Design Patterns
Once the large picture of the site navigation, wireframes and workflows have been developed work can begin on the development of the mood board to provide an overall visual design direction of the site. This assists greatly in the development of a color palette, typography, layouts, and other visual elements.

With a clear direction from the mood board, common interface elements can be styled including form fields, navigation systems, buttons, search fields, etc. Individual interaction patterns can also be developed such as micro-interactions of individual UI elements.

Prototyping
Prototyping typically includes both paper prototypes and simplified digital prototypes using programs such as Axure, Principle, Framer, POP or Invision. The prototyping process is a critical component of the process as the designs begin to take shape and become ready for testing. Even before the prototype is ready for testing, the designs will often go through a series of micro-tests and refinements. It is commonplace for early design ideas to be shown as unnecessary, confusing or too complex for the various users.

User Testing & Results Analysis
Once the prototype has been refined to the point where no further obvious changes are necessary, groups of users can test the prototype and follow-up interviews can be conducted to gather feedback
about the designs. The results are then compiled and important ideas and developed about consistent problems with the prototype. Using these results, necessary changes can be determined and adjustments to the design can be made prior to finalization.

Each of the stages of the design process will work to keep the project focused on the needs of the users and ground the design in research and data.

**Interactive Cave Environment**

The interactive cave is a simulated cave environment where images are rear projected and mapped onto an interactive semi-transparent surface. Through the use of IR cameras, the surfaces can detect touches including swiping, pinching, drag-and-drop, and taps. (Karmon et al. 2009) (Segal 2016)

With this design change, the previous issue of visitors obstructing the projections is remedied. As technology improves, the use of touch screens via rear projection onto glass surfaces will become more widespread and the costs will decrease as the technology is more widely adopted. (International 2016a) (International 2016b)

The glass panels of the cave environment can be securely installed using a fabricated metal framework with hardware. Ideally, the installation framework should be designed and machined in a way so that the exhibit can be easily taken down for transportation. Additional engineering work would be necessary to ensure that the support structure can adequately support the weight load, has adequate stability for general public use, and has no sharp edges.

One important aspect of the design of an exhibit such as this is the accommodation and inclusion of as many segments of the population as possible. As this is an educational exhibit designed to be in a museum, an important part of the design is the accommodation of families with children and grandparents. With these factors in mind, the design often involves ways to bring the content to children in a way they can understand without talking down to them. The material also needs to be presented to adults in a way that is at their level, and not solely focused on children.

To resolve this issue, the use of physical interfaces provides in it an inherent solution. Interactivity can be divided by height to accommodate four major interaction and reading levels of visitors as follows:

1. Small Children (Early Emergent Readers – Ages 4 to 6) – lowest heights (between floor – 3 ft.)
2. Elementary School Children (Ages 7 to 9) – middle heights (between 3 ft – 4 ft.)
3. Middle School Children (Fluent Readers) – middle heights (between 4 ft. – 5 ft.)
4. Adults – highest heights (5 ft.+)

By dividing up exhibit according to height levels allows each visitor to interact with the exhibit in ways that are designed for their particular reading and interaction needs. In addition, panels can be designed to drag and drop information up and down between people so that younger visitors can still interact with panels that may be out of reach. This also helps to foster interaction between younger and older visitors.
In creating an environmental experience, attention will also be paid to lighting and sounds.

**Exhibit Identity Design**
Coupled with the design of the interactive displays (layouts, interaction design, typography, etc.) is the overall branding and visual design of the exhibit such as printed materials for exhibit cases, and explanatory posters that could also be included in the exhibit.

**Deliverables**

1. Four (4) motion graphics pieces demonstrating the interactive interfaces for each of the user persona categories: Small Children (Early Emergent Readers – Ages 4 to 6); Elementary School Children (Ages 7 to 9); Middle School Children (Ages 10 to 13); Adults (Ages 14+)

   The motion graphics will be created in Adobe After Effects and will be a minimum of 15 seconds each.

   Final documentation shall include storyboards for each motion graphic piece.

2. Construction of a mock cave wall surface a minimum of 3 feet long and 3 feet high which shall serve as a screen for projection mapping the Motion Graphics pieces demonstrating the cave interactivity. The mock cave wall shall be angled and shaped in a way similar to the reference concept drawings.

   As this will be a prototype, the projector will be front facing as opposed to rear facing as described in the final design. The mockup cave wall will be constructed from materials such as cardboard, paper, wood, string and/or tape.

3. A prototype of an interactive exhibit display on a tablet (or larger) touch screen providing one (1) example of interactive activities such as games or interactive learning panels for each of the four (4) user types (Small Children, Elementary School Children, Middle School Children, and Adults) as previously described.

   The four (4) interactive exhibit display examples shall be a functional prototype created in an industry recognized software such as Axure, Framer, Principle, Origami, Adobe XD, POP or InVision.

   As part of the final Thesis documentation, the design process and design artifacts shall be included. The following items will be compiled into an industry standard documentation report:

   - Contextual inquiry and user research notes and survey results
   - Development of two (2) user personas for each of the 4 user types as previously described – a total of eight (8) user personas
• Affinity diagram documentation and analysis of the affinity diagram
• Wireframes of the interaction designs including screen flows from one screen to the next, interactivity, animation and micro-interaction notes,
• User testing / survey results and feedback.

4. Development of an exhibit branding guide that includes the following:
   • Exhibit logo and its proper usage
   • Exhibit identity color palette for screen
   • Exhibit typography choices and examples for screen
   • Comprehensive digital design guidelines listing examples of individual interaction design elements such as screen layouts, forms, buttons, typography, table designs, information layouts, headers.

**Implementation Strategies**

As stated previously, the interactive portion of this Thesis project will use a standard UX Design process as follows:

- User Research & Contextual Inquiry
- Affinity Diagrams, Research Analysis & Persona Development
- Wireframing & Workflow Development
- Mood Board Development, UI Element System & Interaction Design System
- Prototyping
- User Testing and Results Analysis
- Design Revision and Iteration

The accompanying timeline shows how the research portion of this Thesis project will begin upon approval of the Thesis committee and continue through the end of 2016. This will require development of survey and interview questions for the various target users. Performing the interviews and surveys, development of the affinity diagram, and collecting the data into a report of findings along with development of Personas.

Development of the Visual Design elements will occur from December through the end of February of 2017, and will include the wireframes and workflows, interface design, interaction design, as well as the digital and print design elements.

Prototype development and User Testing should occur between February and April. Ideally, the prototype will be available for Imagine RIT in May where additional testing and feedback can be gathered from a wider public audience.

The development of the interactive simulation can only be completed once the assets from the interactive portion have been fully developed, and the prototype has undergone some level of user testing. This makes the interactive portion a critical path that must be accomplished quickly in order to proceed. It is estimated that the work on the motion graphics should begin around February or
March be near completion (or completed) by Mid-May for Imagine RIT.

Based upon previous experience, a project of this scale should take no longer than six months for one person to complete and document. In addition, during the process of developing and refining the interactive components, the exhibit identity portion will emerge from this research and work.

**Dissemination**

This project will be made available via ProQuest Theses, and my personal website with links to code repositories on GitHub.com. In addition, the following interactive and UX design conferences are available to submit this project:

Giant Conference: The Event For People Who Do Rad Work (Charlotte, NC)
http://www.giantconf.com/

ACM ISS (Interactive Surfaces and Spaces) – Academic and Application Papers can be submitted
http://iss2016.acm.org/

http://www.findexuevents.com/ux-conferences-2016/

IXDA (Interaction Design Association) Conference
http://interaction17.ixda.org/

AIGA Design Conference
http://designconference.aiga.org

Midwest UX Conference
http://2016.midwestuxconference.com/

Design Thinkers Conference
http://www.designthinkers.com/

Adobe Max, San Diego, CA
http://max.adobe.com
Evaluation Plan
At various points during the development of the Thesis materials, elements will undergo design iteration, review, testing, evaluation and revision. This includes the following:

- Co-design of interactive displays for children with students from the World of Inquiry School #58
- User Testing, Analysis, Evaluation and Revision
- Surveys and Interviews at Imagine RIT and the VCD

These strategies ensure that the proposed solution successfully meets the user's needs. As the data is collected, it is reviewed and analyzed in both quantitative and qualitative terms and compiled into documentation.

This is done at various stages of the development process, but most notably during the prototyping and user testing phases. With these results, the designs can be modified, revised and refined prior to final submission.

Additional evaluation and testing will be conducted during Imagine RIT when the general public will have an opportunity to review the various components of the project. Based upon the additional feedback at Imagine RIT, adjustments and improvements can be made prior to the final VCD Thesis Show.

Pragmatic Considerations
Due to the magnitude of the project, it will be necessary to adhere very closely to the very firm schedule that has been developed for the project.

Bibliography


Consoli, Gianluca. 2014. “The Emergence of the Modern Mind: an Evolutionary Perspective on
https://books.google.com/books?id=712zQgAACAAJ.
Poushter, Jacob. 2016. “Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies.”
APPENDIX B: ARTIFACTS OF PROCESS
Work in Progress Sketches

Initial Sketch of Interactive Cave Wall

Interaction Design Layout + User Journey Ideation

Typographic and Branding Color Study

Typographic and Branding Color Study

Cave Environment Sketch

Typographic and Branding Color Study
Card Sorting Results

Introductory WOIS Paleo Art Card Sort

Overview   Analysis   Downloads   Sharing
Participants   Questionnaire   Cards   Categories   Standardization Grid   Similarity Matrix   Dendrograms   PCA

Your Questionnaire

Pre-Study Questions

Question 1:
What is your age?

Radio button - required

<table>
<thead>
<tr>
<th>Age</th>
<th>%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>18.2%</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>18.2%</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>27.3%</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>4.5%</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>27.3%</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>4.5%</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

Question 2:
What grade are you in?

Radio button - required

<table>
<thead>
<tr>
<th>Grade</th>
<th>%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>36.4%</td>
<td>8</td>
</tr>
<tr>
<td>3rd Grade</td>
<td>31.8%</td>
<td>7</td>
</tr>
<tr>
<td>5th Grade</td>
<td>31.8%</td>
<td>7</td>
</tr>
</tbody>
</table>

Question 3:
If you were asked if you are a girl or a boy, how would you respond?

Radio button - required

<table>
<thead>
<tr>
<th>Gender</th>
<th>%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (Girl)</td>
<td>50%</td>
<td>11</td>
</tr>
<tr>
<td>Male (Boy)</td>
<td>50%</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Prefer Not to Answer</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>I Don’t Know</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>
### Question 4
What type of cultural institutions have you visited before? Choose at least one. Remember, these are places that you have actually been to.

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Museum</td>
<td>68.2%</td>
<td>15</td>
</tr>
<tr>
<td>Zoo or Aquarium</td>
<td>86.4%</td>
<td>19</td>
</tr>
<tr>
<td>Natural History Museum</td>
<td>45.5%</td>
<td>10</td>
</tr>
<tr>
<td>Children's Museum like the Strong Museum</td>
<td>72.7%</td>
<td>16</td>
</tr>
<tr>
<td>Art Museum like the Memorial Art Gallery</td>
<td>40.9%</td>
<td>9</td>
</tr>
<tr>
<td>National or State Park like the Adirondacks or Yellowstone...</td>
<td>27.3%</td>
<td>6</td>
</tr>
<tr>
<td>Historic Home like the George Eastman House</td>
<td>27.3%</td>
<td>6</td>
</tr>
<tr>
<td>Planetarium</td>
<td>31.8%</td>
<td>7</td>
</tr>
<tr>
<td>History Museum</td>
<td>31.8%</td>
<td>7</td>
</tr>
<tr>
<td>Cultural or Ethnic Museum, like the African American, ...</td>
<td>13.6%</td>
<td>3</td>
</tr>
<tr>
<td>Special Topic Museum like the Holocaust Museum</td>
<td>9.1%</td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

### Question 5
What type of cultural exhibit would you MOST like to visit?

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Museum</td>
<td>13.6%</td>
<td>3</td>
</tr>
<tr>
<td>Zoo or Aquarium</td>
<td>22.7%</td>
<td>5</td>
</tr>
<tr>
<td>Natural History Museum</td>
<td>13.6%</td>
<td>3</td>
</tr>
<tr>
<td>Children's Museum like the Strong Museum</td>
<td>31.8%</td>
<td>7</td>
</tr>
<tr>
<td>Art Museum like the Memorial Art Gallery</td>
<td>9.1%</td>
<td>2</td>
</tr>
<tr>
<td>National or State Park like the Adirondacks or Yellowstone...</td>
<td>9.1%</td>
<td>2</td>
</tr>
<tr>
<td>Historic Home like the George Eastman House</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Planetarium</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>History Museum</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Cultural or Ethnic Museum, like the African American, ...</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Special Topic Museum like the Holocaust Museum</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>

### Question 6
Think back about your experiences of visiting cultural institutions like museums or zoos. What type of exhibits interest you the MOST?

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibits with interactive displays (like touchscreens)</td>
<td>22.7%</td>
<td>5</td>
</tr>
<tr>
<td>Exhibits with computers</td>
<td>45%</td>
<td>1</td>
</tr>
<tr>
<td>Exhibits with rare objects (usually behind glass or roped)</td>
<td>9.1%</td>
<td>2</td>
</tr>
<tr>
<td>Exhibits that allow you to touch things</td>
<td>18.2%</td>
<td>4</td>
</tr>
<tr>
<td>Exhibits with an environment you can walk through jak...</td>
<td>31.8%</td>
<td>7</td>
</tr>
<tr>
<td>Exhibits with movies</td>
<td>13.6%</td>
<td>3</td>
</tr>
</tbody>
</table>
### Question 7

Have you ever been to a museum exhibit you could walk through, such as an underground bug exhibit, a real submarine or ship, or perhaps an old country village?

<table>
<thead>
<tr>
<th>Option</th>
<th>Yes</th>
<th>No</th>
<th>I'm not sure</th>
<th>I don't think so</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>682</td>
<td>227</td>
<td>91</td>
<td>0</td>
</tr>
<tr>
<td>Percentage</td>
<td>68.2%</td>
<td>22.7%</td>
<td>9.1%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Question 8

If you answered yes, what did you enjoy about it? What would you change about it?

<table>
<thead>
<tr>
<th>Participant</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I enjoyed the fact that you could actually enter the same experience as someone or something else. I would change the fact that not many things were interactive.</td>
</tr>
<tr>
<td>2</td>
<td>I like the pincher.</td>
</tr>
<tr>
<td>3</td>
<td>How everything is just like it was in the 1800s.</td>
</tr>
<tr>
<td>4</td>
<td>I liked it because it was so cool to have that experience to go in an underground tunnel.</td>
</tr>
<tr>
<td>5</td>
<td>I liked how you could see what the real deal was, and get to see historic exhibits.</td>
</tr>
<tr>
<td>6</td>
<td>That it had many things to do hands on.</td>
</tr>
<tr>
<td>7</td>
<td>I liked that there was a place where you could pet and feed all the animals.</td>
</tr>
<tr>
<td>8</td>
<td>I think they did a great job on how they set it up. It was cool.</td>
</tr>
<tr>
<td>9</td>
<td>I enjoyed that you can see different things. What I would change is adding real things to it. Especially live things.</td>
</tr>
<tr>
<td>10</td>
<td>I liked that it was nice. I liked that there was a puzelgameneto make a dinosaur. There was a touchscreen where you could make dinosaurs from puzzle pieces. They also had helpful facts about the dinosaurs. Standing-up exhibit with tablets on a kiosk.</td>
</tr>
</tbody>
</table>
### Post-Study Questions

#### Question 1
Which of the topics would you LIKE to learn more about? (Choose at least one)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Percentage</th>
<th>Count</th>
<th>Show More</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medieval European Armor</td>
<td>59.1%</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Egyptian Mummies</td>
<td>72.7%</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Tribal Masks of the Pacific Northwest</td>
<td>9.1%</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Traditional Native American Dress</td>
<td>13.6%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Explore a Pawnee Lodge</td>
<td>50%</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Explore Paleolithic Cave Art</td>
<td>54.5%</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

#### Question 2
Which topic would be MOST interesting to you?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Percentage</th>
<th>Count</th>
<th>Show More</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medieval European Armor</td>
<td>9.1%</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Egyptian Mummies</td>
<td>54.5%</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Tribal Masks of the Pacific Northwest</td>
<td>4.5%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Traditional Native American Dress</td>
<td>9.1%</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Explore a Pawnee Lodge</td>
<td>4.5%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Explore Paleolithic Cave Art</td>
<td>18.2%</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>CARD NAME</td>
<td>UNIQUE CATEGORIZATIONS</td>
<td>CATEGORIES</td>
<td>AVS POS</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------</td>
<td>--------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Egyptian Mummies</td>
<td>5</td>
<td>Not Interesting &amp; Boring</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boring</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interesting</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show 2 more</td>
<td></td>
</tr>
<tr>
<td>Explore a Pawnee Lodge</td>
<td>7</td>
<td>Historical museum</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Interesting</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Interesting &amp; Boring</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show 4 more</td>
<td></td>
</tr>
<tr>
<td>Explore Paleolithic Cave Art</td>
<td>5</td>
<td>Not Interesting &amp; Boring</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boring</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interesting &amp; Very Interesting</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show 2 more</td>
<td></td>
</tr>
<tr>
<td>Medieval European Armor</td>
<td>5</td>
<td>Not Interesting</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interesting</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interesting &amp; Very Interesting</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show 2 more</td>
<td></td>
</tr>
<tr>
<td>Traditional Native American Dress</td>
<td>6</td>
<td>Not Interesting</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interesting &amp; Very Interesting</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very Interesting</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show 3 more</td>
<td></td>
</tr>
<tr>
<td>Tribal Masks of the Pacific Northwest</td>
<td>6</td>
<td>Not Interesting</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boring</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Interesting &amp; Boring</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show 3 more</td>
<td></td>
</tr>
</tbody>
</table>
## Introductory WOIS Paleo Art Card Sort

### Your Categories

<table>
<thead>
<tr>
<th>Category Name</th>
<th>Unique Cards</th>
<th>Explore Paleolithic Cave Art</th>
<th>Tribal Masks of the Pacific Northwest</th>
<th>Egyptian Mummies</th>
<th>Medieval European Armor</th>
<th>Traditional Native American Dress</th>
<th>Agreement</th>
<th>Participants</th>
<th>Edit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boring</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>0.38</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Historical Museum</td>
<td>1</td>
<td>Explore a Pawnee Lodge</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Interesting</td>
<td>6</td>
<td></td>
<td>Medieval European Armor</td>
<td>1.3</td>
<td>3</td>
<td></td>
<td>0.37</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Interesting &amp; Very Interesting</td>
<td>6</td>
<td></td>
<td>Explore Paleolithic Cave Art</td>
<td>1.3</td>
<td>7</td>
<td></td>
<td>0.73</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Not Interesting</td>
<td>4</td>
<td>Tribal Masks of the Pacific Northwest</td>
<td>1.0</td>
<td>3</td>
<td></td>
<td></td>
<td>0.25</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Not Interesting &amp; Boring</td>
<td>5</td>
<td>Egyptian Mummies</td>
<td>1.0</td>
<td>1</td>
<td></td>
<td></td>
<td>0.42</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Very Interesting</td>
<td>6</td>
<td>Explore Paleolithic Cave Art</td>
<td>1.3</td>
<td>7</td>
<td></td>
<td></td>
<td>0.43</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Showing 1 to 7 of 7 categories filtered from 63 total categories.
Note: It is the author’s belief that there is some inherent bias in the children’s interest in Paleolithic Cave Art due to the fact that they were accidentally made aware of the topic before the study began. However, it is not believed that this had significant effect upon interest in other topics.
Thank you to Optimal Workshop (www.optimalworkshop.com) for granting me full access to a professional account for cards sorting and testing purposes.
## User Testing Results

### Cave Art Animals Section

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Animals Identified Correctly</th>
<th>Animals Identified Incorrectly</th>
<th>Notes</th>
<th>% Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>Was able to identify animals after animation</td>
<td>44.4%</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>Was able to identify animals after animation</td>
<td>22.2%</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>Animation had a negligible effect</td>
<td>55.6%</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>&quot;It was easier to see the animal with animation&quot;</td>
<td>55.6%</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>Was not able to identify the rhinos, but could see it with animation</td>
<td>66.7%</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>Was able to identify the buffalo and the rhino after seeing anim</td>
<td>44.4%</td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td>8</td>
<td></td>
<td>Was not able to identify the buffalo until he saw the animation.</td>
<td>11.1%</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>Was only able to identify the rhino after seeing the animation.</td>
<td>77.8%</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>5</td>
<td></td>
<td>Had a hard time identifying any animals.</td>
<td>66.7%</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>Had a very hard time identifying animals.</td>
<td>22.2%</td>
</tr>
</tbody>
</table>

**Average** 44.4%

**Median** 44.4%

### Cave Art Animation Section

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Animals Identified Correctly BEFORE Viewing Animation (Static Image)</th>
<th>Animals Identified Correctly AFTER Viewing Animation</th>
<th>Notes</th>
<th>% Accuracy BEFORE Animation</th>
<th>% Accuracy AFTER Animation</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>Was able to identify animals after animation</td>
<td>33.3%</td>
<td>100%</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>Was able to identify animals after animation</td>
<td>66.7%</td>
<td>100%</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>Was able to identify animals after animation</td>
<td>33.3%</td>
<td>100%</td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>&quot;It was easier to see the animal with animation&quot;</td>
<td>33.3%</td>
<td>100%</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>&quot;The cartoon makes it easier to see&quot;</td>
<td>33.3%</td>
<td>100%</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>Was not able to identify the rhinos, but could see it with animation</td>
<td>66.7%</td>
<td>100%</td>
</tr>
<tr>
<td>M</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>Was able to identify the buffalo and the rhino after seeing anim</td>
<td>66.7%</td>
<td>100%</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>Was not able to identify the buffalo until he saw the animation.</td>
<td>33.3%</td>
<td>100%</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>Had a hard time identifying any animals.</td>
<td>66.7%</td>
<td>100%</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>Had a very hard time identifying animals.</td>
<td>33.3%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Average** 47.3%

**Median** 33.3%
J’Quan Vicentes-Williams

Vital Stats

Age: 5 1/2
Grade: Kindergarten
School: St. Christopher’s School
Location: Columbus, Ohio
Favorite Subjects: Reading & Science
Reading Level: Sight word mastery
Favorite Places to Visit: Zoo, Children’s Museum, and Natural History Museum.
Knowledge of Cave Art: None

Important Facts About Me

I love animals! Especially my two dogs Rufus and Jack. They are a lot of fun.

I like school, and I’m a good reader. I know all my sight words. I also like recess and my friends Alyssa and Robert.

I especially like that our class has fish. Next week is my turn to take care of them.

When I get older, I want to be a veterinarian and take care of animals all day long. Or else I want to be a mailman so I can pet dogs.

Developmental Issues

Like many children his age, J’Quan has a short attention span with activities. He can stay focused for about 15 to 20 minutes.

J’Quan learns best by doing things such as counting using objects, drawing, and going on field trips.

J’Quan can’t connect with history and geography unless it’s happening in the present and or locally (i.e. current events, familiar places he’s visited).

J’Quan also likes to stand when he’s working, and likes to move around frequently to do things in the classroom.

Paleo Journey User Persona (Ages 5-7)
Vital Stats

Age: 6
Grade: Kindergarten
School: World of Inquiry, School #58
Location: Rochester, NY
Favorite Subjects: Math, Science and Art
Reading Level: Short Chapter Books
Knowledge of Cave Art: None.

Important Facts About Me

Science is very interesting to me, especially Astronomy. Someday, I want to work for NASA, so I work hard at Math.

My friends don’t like math very much, so I try and help them. I sometimes go for reading with the First Graders on Wednesdays.

My favorite thing to do is gymnastics and Brownies. I’ve sold more Thin Mints than anyone else in my Girl Scout Troop!

I have three cats at home, but only two of them are nice to me.

Developmental Issues

School comes easily to Jacinda, and if she is not challenged, she quickly becomes bored. Jacinda loves to learn. She absorbs, processes and retains information quickly.

Jacinda’s fine motor skills (i.e. writing) are better than her gross motor skills (i.e. gymnastics), which is common for her age.

Like other children her age, Jacinda does best with tangible and concrete subjects she can observe with her senses. Abstract concepts such as time are still very difficult for her to understand.

Jacinda also has a great interest in animals.
Georgia McDougall

**Vital Stats**

- **Age:** 6
- **Grade:** Kindergarten
- **School:** Martin Luther King Jr. Elementary
- **Location:** Brooklyn, NY
- **Favorite Subjects:** Art and Reading
- **Reading Level:** Learning Sight Words
- **Favorite Places to Visit:** Art Museum, Zoo, and the Botanical Garden.
- **Knowledge of Cave Art:** Has seen pictures.

**Important Facts About Me**

I want to be an artist when I grow up, like my Aunt. She makes very colorful sculptures, and I love them.

School is hard for me because I don’t like to read, but I am getting better. But I like my art and music classes very much.

The other hard thing for me is writing. My hands always hurt from writing so much in school.

My class is learning about all the different types of families, including animal families.

**Developmental Issues**

Georgia is learning to read at her own pace. Letters like ‘b’ and ‘d’ are hard to remember and often switch places in words. She uses ‘inventive spelling’ like ‘spce’ for ‘space.’

She has difficulty in copying from the board onto her paper because her brain is still developing its visual-spatial areas.

Georgia likes art because she feels she is ‘good at it.’ She likes to draw rainbows and rabbits but finds it difficult to try other things out of fear that it won’t be as good as her rainbows.

Paleo Journey User Persona *(Ages 5-7)*
Children aged 5-7 have a wide range of visual-spatial development abilities. This can limit their ability to see the art as images, or they may be visually confused.

Concrete and physical examples are made successful exhibits when physical objects such as mummies are used. Many in this group are not developmentally ready to comprehend complex and chaotic line art as forms or images.

Abstract concepts such as time, geography and history are difficult for children in this age range to understand. Understanding of abstract concepts develops with age as children’s worldview slowly expands.

Abstract topics such as Egyptology have made successful exhibits when physical objects such as mummies are used. Children in this age range enjoy repetition of topics as it reinforces knowledge and their understanding of the world.

Exhibits that are grounded in concrete and physical examples and allow children to touch and feel are most developmentally appropriate. 'Hands on' exhibits are particularly popular with children in this age range. Children in this age range often have short attention spans, are easily distracted, and like to move from one activity to the next.

Visitors aged 5-7 have a wide range of visual-spatial development abilities. This can limit their ability to see the art as images, or they may be visually confused. Understanding of abstract concepts develops with age as children’s worldview slowly expands.

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PALEO JOURNEY

An Interactive Paleolithic Cave Art Experience

Branding and Digital Style Guidelines

James Parrillo
MFA Candidate, Visual Communication Design
School of Design
Rochester Institute of Technology
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<td></td>
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</tbody>
</table>
Introduction

At its core, Paleo Journey is an exploration in the confluence of hands on exploration and interaction design.

The design philosophy is that the interactive design component must act at a supplement to the hands on and person-to-person experience. The interface interactions should not be an end unto themselves, but serve as a way to explore and experience the content in meaningful ways.

Upper Paleolithic Cave Art holds great mysteries about the development of human consciousness. Scholars from many disciplines including archaeology, sociology, ethnography, art history, and neuropsychology regularly add to this ongoing discussion to decipher the process, meanings and significance of this art left 50,000 — 10,000 years ago throughout present day Spain, France, Germany, England, and Italy.

This style guide aims to provide a framework for allowing the artwork to speak to new audiences in a systemic and simple manner.
The Paleo Journey brand combines the concepts of motion and individual exploration.

For many visitors it will be their first exposure to Paleolithic art, so it is imperative that the material is presented in a warm and friendly manner.

As an interactive exhibit, we strive to bring a fresh perspective to the subject matter, and engage younger visitors as well as their parents and caregivers.
The Paleo Journey logotype was developed using the typeface Brush Up. It is available via MyFonts or FontSpring.

The typeface has a large number of stylistic alternated for each letter, and care has been taken to ensure that repeated glyphs such as ‘O’ and ‘E’ are not identical.

The typeface is an all upper case brush lettering sans serif and was chosen for both its legibility, flexibility, and visual resemblance to painted strokes.

The logotype color should be chosen to either match or complement the dominant color of the spread using the approved palette.
The chosen logo is a stylized bison using the primary color.

The logo should be positioned with a slight angle, no more than a 5°—10° angle.

The logo may also be cropped to only show the head and face of the bison.

In all applications, when the logo is used, it must be accompanied by the logotype. However, the logotype may appear independently.
Clear Area and Minimum Size

The logo should be surrounded with a clear space of at least the height of a capital letter 'P' with some extra padding.

An obvious exception would be the right and left sides of the logo where it would be visually better to have the logo closer to the borders for aesthetic purposes.

In this example, the letter P is set in 50 pt type.
Any cave art photos used should have an overlay filter with an opacity between 55-65%. Colors should be chosen from the Color Palette, keeping in mind that some colors may work better than others relative to the chosen photo. In this example, the secondary and tertiary color opacities were reduced to 35% and 40%, respectively.

This is especially important when there is other text or the logo is used over the photo.

Photos should be the prominent feature of any spread, and chosen for clarity of the image.
The interaction and blending of colors (especially in a dark environment) is an important facet of Paleolithic Cave Art. Color interaction is also a large component of the Paleo Journey experience. Colors have been carefully chosen and tested for both screen and print. Careful attention must be paid to the interaction of colors to avoid color vibrations.

For screen applications, light colors such as grey-light and secondary-light are suggested for text against a base background for greatest legibility.

In other applications, base or primary-darkest should be used with lighter orange and yellow hues.
To provide visual contrast to the fluid painting style, elements should be organized on the grid using squares, rectangles and boundary boxes.

This is especially useful for collateral materials, environmental graphics and digital layouts.

Additional wayfinding and other international iconography symbols should be used.

Where possible, outline the stroke and treat use a standard charcoal pencil to give a rusticated effect.

Wayfinding in Brush Up with symbol treatments.

Critical Information
Signage in Adagio Sans for clear legibility.
While using standard iconography for signage and wayfinding, use a charcoal pencil or brush styling to the line quality to better match the brush script used throughout the exhibit.

When using a stylized typeface like Brush Up, it is important to increase the tracking for improved legibility.

Because of the low lighting in the exhibit area, signage must always be a dark background with light colored illumination.
We have chosen Adagio_Sans for the primary typeface. Adagio_Slab will be used for titles, headings, captions, and taglines.

Both typefaces have a large character set including full international characters with diacritics, true italics, and eight (8) weights: Extra Light, Thin, Light, Regular, Medium, SemiBold, Bold, Black and Heavy.

**Adagio_Sans**

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | - | = | ! | @ | $ | % | ^ | & | * | ( | ) | _ | + | | | | |
| ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā |

The quick brown fox jumped over the lazy dog

**Adagio_Slab**

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | - | = | ! | @ | $ | % | ^ | & | * | ( | ) | _ | + | | | | |
| ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā | ā |

The quick brown fox jumped over the lazy dog
Typography Hierarchy

**H1 Headline**  Adagio_Sans Bold 30pt

**H1 Small Text**  Adagio_Sans Medium Italic 24pt

**H2 HEADLINE**  Adagio_Slab SemiBold 24pt All caps

**H2 Small Text**  Adagio_Slab Regular Italic 18pt

**H3 Headline**  Adagio_Sans Light 24pt

**H3 Small Text**  Adagio_Sans Medium Italic 18pt

**H4 HEADLINE**  Adagio_Slab Regular 24pt All caps

**H2 Small Text**  Adagio_Slab Regular Italic 18pt

Body Text  Adagio_Sans Medium 14pt
Captions  Adagio_Slab Medium Italic 14pt

Using the standard conventions of CSS in web typography, the following formats are to be used in both digital and print.

Adagio_Sans and Adagio_Slab are both available for desktop and web applications through standard online font shops such as fontspring.com, and myfonts.com.

In digital applications, text should be in a light color with a base background color for best legibility.
Brand Architecture

When used in combination with a museum or visitor center, the Paleo Journey brand should be more prominent to call attention to the exhibit rather than the location.

This will help to generate interest in the exhibit.

As partner organizations will send collateral materials to their members and other frequent visitors, it is necessary for them to make the connection between Paleo Journey and the partner museum / visitor center.
Interfaces should have clear and consistent navigation using the brand typography and imagery.

It is encouraged that any type on screen should have a light background shadow or glow for improved legibility.

Light colored text with dark backgrounds are encouraged.

Avoid pure white (#FFFFFF) and Pure Black (#000000) where possible.
Cave art was a group activity.

Therefore, it's important to design the interactive portions so that they require group participation and "offline interactivity."

In this example, while this passage may be difficult for some children to read, it encourages caregivers to interact with the children.
Brand In Action — Print & Collateral Materials

Examples of the brand in action including a postcard, a sample advertisement and published exhibit book.
Exhibit Elevation Concept Drawing
Problem Statement

While replica caves help to make the artworks accessible, these exhibits are stationary, do not travel, and are not interactive.

Problem Statement

Online tours are available however, they lack both immersive and tactile qualities that visitors, especially children, report as being the most preferred and engaging type of museum exhibits.
Problem Statement
This thesis project focuses on the specific needs of children between the ages of 5 and 7 by using the User Experience (UX) design process.

Problem Statement
Children in this age group have visual-spatial developmental issues that can prevent their ability to see images in the artwork or put the artwork into context.
Design Solution: Tactile Surface Interface

Using projection mapping and motion tracking software, visitors can interact with cave art murals at specific interactive touchpoints.
Design Solution: Tactile Surface Interface

Using projection mapping and motion tracking software, visitors can interact with cave art murals at specific interactive touchpoints.

Design Solution: Tactile Surface Interface

The exhibit murals could also change based upon visitor movement or loud noises.
Screenshots from Final Interactive Prototype Built in Framer

Cave artists painted lots of different types of animals from the world around them.

Do you recognize this animal?

They also painted some animals that are now extinct such as this wooly mammoth...

...or these cave lions!
Usually when we think of the rhinoceros, we think of the African Savannah.

Did you know that rhinos used to live in Europe during the Ice Age?

This humped animal is a relative to one usually only found in today’s deserts of the Middle East and Africa.

Do you recognize this flying animal?

Do you have a hard time seeing the pictures of the animals?

Don't feel bad!

Lots of kids your age have this same experience!
Children between the ages of 5 and 7 often find it difficult to clearly see cave art. This is because the areas of their brains that control visual and spatial perception are still developing.

Animating the images makes it easier for children to see the animal forms.

Archaeologists believe that the earliest attempts at moving images can be found in the caves of France.

Azema (2008), Azema and Rivere (2012)
CAVE ART ANIMATION

It is believed that the flickering flames from torches gave the appearance of movement.

Azema (2008), Azema and Rivere (2012)

MAKING PAINT

There were no art stores in the Paleolithic period, so humans made paints by grinding colored rocks.

Red ochre was commonly used.

MAKING PAINT

Artists also used charcoal from fires to create black marks and shading.

MAKING PAINT

The dry materials were mixed with various wet ingredients including water, eggs, saliva, blood and urine.

Von Petzinger (2016)
Artists often made impressions of their hands with wet paint.

They would also make negative impressions by blowing paint onto the walls while they held hand steady.
THANKS AND DEDICATION

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