

White Paper Report

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(AI)2 Artificially Intelligent Artifact Interpreter
Western Reserve Historical Society, Cleveland, Ohio

Project Scope

The grant started in December 2009 and ended June 30, 2011. The abstract from the grant application described the scope of the work.

This project prototypes a virtual history museum docent to interpret historical artifacts to a general audience. Engaging visitors in exploring original historical artifacts is the key to successfully connecting them to human history. Traditionally artifacts have been presented in two ways. Either artifacts are displayed with graphic or media labels, providing a one-way avenue of information to the visitor, or a live docent interacts one-on-one with the visitor to explain and demonstrate the artifact. Using 21st century computer technology, including RFID tags and AI software, this project will create an Artificially Intelligent Artifact Interpreter that will respond to visitors' handling of artifacts, prompting the visitor with questions and offering the visitor information about the physicality of the artifact itself and its broader historical interpretation. This prototype is intended to be used in an introductory area at the museum entrance to welcome visitors or as the introductory gallery of a larger interpretive exhibit.

Creative Team

WRHS staff assigned to this project:

Ed Pershey, VP for Special Projects
Dean Zimmerman, Chief Curator
Janice Ziegler, VP for Education
John Grabowski, VP for Research

The main contractor is LogicJunction, a software/hardware development company in Beachwood, Ohio (an east side suburb of Cleveland), Mark Jowell, President. Evaluation was initially contracted to the Institute for Learning Innovation in Annapolis, MD, but after several personnel changes there the evaluation was handled by Kate Halely Goldman, Director of Learning Research and Evaluation National Center for Interactive Learning in Colorado.

Calendar of Work

The WRHS team met with LogicJunction twice in December and January, 2010. At the first meeting we established a series of milestone dates for work. This work plan was revised several times to adjust to three specific delays:

1. The hardware for the display of the software, intended originally to be a rear-projected image. Technical difficulties with that approach led the team to decide to use a standard large screen LCD-TV. The first unit shipped to WRHS proved to be defective and the second was damaged during set up at LogicJunction. By the time that a third unit was obtained, the project schedule was about 6 weeks delayed. All damages were covered by insurance at LJ at no cost to project.
2. Changes at the original evaluation contractor caused a few weeks delay as new evaluators were assigned and then, finally, the evaluation was subcontracted to a new organization (National Center for Interactive Learning)
3. Preparing scripts for the selected artifacts proved to be much more complicated than anticipated.

The final timeline at the end of the grant in June, 2011:

Project Kickoff	December 10, 2009
Requirements / Gathering data	December 09-February, 2010
Custom Character	January 15-March
Interface / Station design	February- March
Framework Programming (structure only, no content)	February 15-March 12
Final selection of artifacts	March 1
Testing	March 15-29
Framework Demonstration	March 30
Report to Advisory Board	April 1
Development of content	March-May
Integrate Final Content	end of May
Final Testing and Validation	end of May
Setup at LogicJunction	September
Prototype Demo with Advisory Board in Cleveland	September
Refinement of prototype	October-December
Delivery to WRHS	December
Evaluation with public	Jan-Mar, 2011
Review of evaluation and refinements	Mar-June
Grant period end	June 30, 2011

System Development

Hardware

The underlying hardware for the project was selected from readily available existing hardware components:

- Computer System: standard PC system with Windows software
- 60 inch Sharp Aquos LCD-TV
- 26 inch ELO touch screen monitor
- RFID reader (USB interface)

This hardware was initially set up in a controlled area of the museum using a readily available table and chairs. This allowed basic testing of the system and initial testing with limited numbers of visitors. Additional funds were sought for the building of a more stylized exhibit display unit that would allow the installation of the system into a more public area of the museum for extended testing of the system. Funds for that display unit were not forthcoming until late in the 21-month term of the NEH grant. The unit was not delivered until a week prior to the end of the deadline for this report, almost 90 days after the official end of the grant. Below is a photo of that stand still under fabrication at Gallo Displays (a local Cleveland firm) in August 2011:



Software

The underlying software for the project is a proprietary system developed by LogicJunction of Beachwood, Ohio, developed initially for interactive digital way-finding systems in large facilities such as large hospitals. Special graphic screens were designed as part of this project to create a digital “avatar” curator and recreate the look of a museum/library environment.

Using proximity sensors, the software comes to life when a visitor approaches the unit. The software then begins a standard greeting to the visitor, directing them to select an artifact from a small shelf of possibilities. Each artifact has an RFID chip attached which triggers the software via a RFID reader disguised as an “artifact analyzer.”

Designing the Avatar

The WRHS team met with Craig Knowles and Mark Jowell from LJ several times to discuss the development of the on-screen personality that will be the interface between the software and the museum visitors. This was one of the first steps in the software

development. The team originally had advocated that this avatar curator have the following characteristics:

- a human from some future (100 years+) time that has the responsibility for caring for a collection of museum artifacts relating to Cleveland history
- this character will be an environment that resembles museum open storage areas
- try to keep this avatar and surroundings relatively simple so as not to be too confusing or detract from the focus on the artifacts
- the avatar should try to emulate a fusion of current gender/ethnic/socio-economic types, e.g. an “every person” from world culture of 2100

After reviewing several different approaches, the WRHS team decided to model the avatar on an existing member of the WRHS curatorial staff. The resulting avatar appeared this way:



With the image of the avatar settled, the WRHS team chose the name “Clio” for this new digital member of the curatorial staff, after the Greek muse of history.

Graphic Environment

The graphical environment for the interactive system—essentially Clio’s “office” in a museum setting—was developed during the summer of 2010. LJ provided several different color schemes and backgrounds in conjunction with the WRHS team. A dark background of gold/brown/silver tones seemed to work the best with the avatar and with the addition of text and images that would appear throughout the presentation. Here is the main screen with Clio and an image of the first artifact for which a complete presentation was developed:



The LCD-TV selected for this image is a 60-inch model. At this screen size the avatar's image is a close approximation of full size when viewed from about 4 feet away.

The project budget for the development of this prototype was not sufficient to develop an audio response system that would allow visitors to query the avatar in with spoken questions. Instead a smaller 26-inch touch screen was selected for display on a table that would initially be used for the testing of the system with visitors. Here is a sample of the touch screen graphics:



Since the system cannot process open-ended responses from visitors, this touch-screen input system with a set menu is the best way to control the underlying script (see below). But the user interface does not use the best features of touch-screen systems that have come online since the award of the grant. Since the award was made a whole new generation of smartphones and tablets, and online apps for both have been introduced into the market. WRHS would like to explore a more elegant touch-screen approach in a future version of Clio.

Artifact Selection

The WRHS team selected artifacts from the collections that may be suitable for use in the prototype. At this point the staff did not apply strict selection guidelines as to physical suitability, but rather selecting objects that are compelling with a strong relationship to Cleveland history, as well as being inherently interesting. Two artifacts were eventually selected:

1. Section of strut from the Hindenburg airship salvaged after its crash in 1937
2. First map of the projected city of Cleveland prepared by Seth Pease in 1797

The Hindenburg strut was deemed an excellent choice for the project for several reasons. First it represents a popularly known historical event. Second, the artifact itself is very durable and can be handled easily without damage. Third, the artifact has local Cleveland connections to one of the companies that salvaged the ship and to the Akron-based Goodyear Company that held important U.S. patents for lighter-than-air ships. Fourth, a replica of this artifact would be very expensive and so only the original was available.

The Pease map original would not stand up to regular handling, and so in this case a color replica via digital reproduction at 1:1 ratio was deemed appropriate. The replication embodies the important visual information that was at the core of the original's value as a historical document.



These two artifacts were the focus for the early development of the system. Interpretive information about these two artifacts was generated by the WRHS creative team at a series of artifact analysis sessions which were audio recorded and then transcribed and summarized by the Primary Investigator, Dr. Pershey.

During the summer the WRHS team conducted a second “artifact analysis” session for additional items and selected a set of five color postcards, postmarked 1954-1955 from Dayton, Ohio, sent to Elliot Ness in Cleveland from an unknown person, taunting Ness over his failure to solve a series of murders in Cleveland in the late 1930s. This an

additional artifacts will be added in the fall of 2011 when Clio is further developed as a publicly-accessible exhibit in the WRHS History Center museum.

Scripting Clio

Using proximity sensors, the software comes to life when a visitor approaches the unit. The software then begins a standard greeting to the visitor, directing them to select an artifact from a small shelf of possibilities. Each artifact has an RFID chip attached which triggers the software via a RFID reader disguised as an “artifact analyzer.” Clio then comes to life, querying the visitor audibly and asking for responses via the touch screen in front of the visitor.

Clio prompts the visitor to pick up and handle the artifact. She asks specific questions about the artifact that the visitor should be able to answer by a close examination of the piece. There are essentially no “wrong answers” to any of these questions on the part of the visitor. Clio uses any response to guide the visitor on an exploration of the artifact to reveal an interesting historical narrative that the artifact illuminates.

The most difficult part of the development of the interactive system was the development of a script to drive the interaction between visitors and the system. The historical information and physical information about the artifact(s) needed to be prepared and uploaded to the computer software system. This included text, historic and modern detail photographs, and audio and video clips that Clio would call up from a small database.

Then this information linked to a script that the software would read to activate Clio’s voice and body, prompting visitors with queries and soliciting input from them. The script needed to be written in a way that standardized the cues and links. Here is a verbatim segment of the script for the Hindenburg strut. The bracketed items { } signal branches to other parts of the script.

{Clio Q3} So we know that is made of a special alloy of aluminum for strength and lightness. But more importantly the function of this artifact—that is, what it was originally made to do—has a lot to say about why it is so lightweight. Let’s think about this. Maybe it’s part of something larger? Can you tell from looking at it whether that’s the case?
{Goto Vis Q3}

{Vis Q3} Do the shiny ends mean that this was cut from a larger piece?
{Goto Clio Q3a}

Well, it doesn’t seem broken and it sure is strong for how lightweight it is!
{Goto Clio Q3b}

I'm done, goodbye!
{Goto Clio Q99}

{Clio Q3a} ^Cut away end of Hindenburg strut.jpg^ That is pretty good detective work on your part. This part seems to have been cut from a larger piece. ^Hindenburg construction 1.jpg^ Look at this photograph of a framework made up of longer pieces of structure similar to this one. Since this one segment is so lightweight, longer pieces put together create a large, but relatively lightweight framework. It appears to be made of metal that allows it to be both strong and lightweight. What would such a framework be used to build? {Goto Clio Q4}

{Clio Q3b} ^Strut made into table 2.jpg^ Look at how a similar structure to this one was used to make this end table. It certainly is strong enough to stand alone. ^Hindenburg construction 1.jpg^ But also look at this photo of a much larger structure made of many longer lengths of the same kind of structure as this one. Now the shape and lightweight of this piece begins to make sense. It appears to be made of metal that allows it to be both strong and lightweight. What would such a large, lightweight frame be used to build? {Goto Vis Q4}

The script branches and loops much like a computer program, which directs the output of the software that creates Clio on screen. All visitor response menus contain an option for the visitor to exit the program in a polite way—a feature usually lacking in museum interactive exhibits. The team felt that it was important to allow museum visitors to feel free to walk away from Clio and, at the same time, reset the software for the next visitor interaction.

One of the goals of the grant was to see if this script writing could eventually be done via a standardized “superscript” with fill-in-the-blank data entry by a curator or museum educator for a series of artifacts. That would ostensibly reduce the time needed to enter new artifacts into Clio’s system. As yet that goal has not been achieved. Script preparation remains a complicated and time-consuming. The WRHS team hopes to explore this simpler script generator with LJ over the next year.

AI2 Advisory Board Meeting

The WRHS team scheduled a meeting of the Advisory Board for mid-September to ensure that a working prototype would be available. Members of this advisory board:

Steven Lubar, Director, John Nicholas Brown Center for Public Humanities and Cultural Heritage, Brown University, Providence, RI
Megan Lykins Reich, Director of Education and Associate Curator, Museum of Contemporary Art Cleveland

Anne Helmreich, Director, Baker-Nord Center for the Humanities, Case Western Reserve University

The WRHS team and LogicJunction met with the Advisory Board on Sept 16 and 17, 2010. Discussions were held at WRHS and the demonstration of the prototype was done at LogicJunction's facility in Beachwood, Ohio, a nearby Cleveland suburb. The Advisory Board brought a critical eye to the project. They generated an action plan for WRHS team who used those ideas to further develop Clio.

Prototype

By July 2010 hardware was delivered to LogicJunction: 65" LCD HD TV and 26" touch-screen monitor for use in assembling the prototype. Digital graphics for the avatar curator and main screens for the software had been developed to static stage. LogicJunction assembled the hardware/software components into the first operable prototype system. This first assembly was ready by the end of August, in time for use in with an Advisory Board meeting in mid-September.

External Evaluation

During the summer staff changes at the Institute for Learning Innovation, the evaluator for this project, lead to a new contact at ILI being assigned to AI2. Kate Haley Goldman, a senior researcher at ILI, replaced Jess Koepfler who had been named in the grant. Kate was up to speed on the Clio project by July and attended the Advisory Board Meeting set for September.

Goldman prepared an evaluation instrument to be used by WRHS Museum Educators and trained them in its use. Issues such as visitor understanding of how the system works, clarity of Clio's speech, length of time for interactions, and intensity of visitor interest in the artifacts and in the interactive system are monitored by the evaluation. Notes regarding the use of the system by single visitors or small groups are also noted.

Presentation at Association of Midwest Museums Annual Meeting, Cleveland, Ohio

On October 8, 2010 team members Ed Pershey, Mark Jowell, Dean Zimmerman, and Janice Ziegler presented the AI2 project in a session at the annual meeting of the AMM. The team described genesis of the project and work to date. About 30 people attended this session held on Friday morning of the conference held Wednesday-Saturday, October 6-9, 2010.

Final development and evaluation with visitors

Delays in the final development of the prototype pushed its testing with visitors beyond the first of the year 2011. Testing was conducted in January, February, and March with museum visitors. The only available script was that for the Hindenburg strut. The

feedback from these tests indicated that the concept was viable. Visitors enjoyed interacting with software, but the physical set up was very limiting.

WRHS sought local foundation support to expand the project beyond the NEH funded prototype with exhibit cabinetry to allow display long-term in the WRHS history museum galleries. These funds were obtained very late in the NEH grant period and the new display unit will not be in place until around October 1, 2011. With that resource secured however, and with continuing involvement of LogicJunction beyond the NEH grant, *WRHS is committed to further development and testing of Clio over the next year.*

The prototype, when demonstrated for visitors and for the representative from the local foundation that funded the design and fabrication of the display unit, was well-received. The interaction between Clio and the individual is quite different from other forms of interpretation in a history museum. WRHS looks forward to more “professional development” for Clio to produce an exhibit component that would be a useful addition to a wide variety of exhibits in its History Center Museum.

WRHS will also explore variations of Clio on handheld devices including smartphones and tablets so that this avatar curator could follow the visitor through an exhibit be able to assist in interpretation of exhibit elements and collections of hands-on items within exhibits.

Results and Challenges

The working prototype “avatar curator” created in this digital humanities start-up grant was only partially successful. We faced and only partially solved some difficult development problems.

1. The final working prototype is based on the interpretation of 3 artifacts, rather than the 15-18 expected. This was the result of a more complicated scripting process that proved the biggest stumbling block. We had expected to develop a “plug-n-play/fill-in-the-blank” scripting language for the avatar, but that proved unattainable in the grant. Each of the three scripts produced so far and two more that will be finished after the grant period are essentially one-off productions. We did however create a scripting language and format.
2. The visitor-avatar interface relied on what is now a very rudimentary menu selection software-hardware setup on a touch screen separate from the avatar. Advances in tablet computers, which have become commercially available during the grant period, offer potential refinements to this interface.
3. The avatar itself is presented on a large screen LCD-TV, which was anticipated, along with a projected image, as the hardware environment for the avatar. Again, the advances in tablet computing suggest that the avatar could also interact with museum visitors via a hand-held tablet computer rather than a fixed exhibit kiosk.

In some ways the recent advances in hand-held computing suggest that it would be more effective and, perhaps easier, to have visitors take Clio around the museum rather than

bring the visitor to Clio in a fixed location. In fact, both approaches would easily work in tandem within a large museum exhibit environment.

Summary

This research project to develop a prototype “avatar” curator completed the technical portion of the project with the working unit that underwent limited testing with museum visitors in early 2011. Delays in the scheduling, even with an extension of the original grant period by 90 days, prevented extensive testing at the museum. The complexities of generating scripts for the artifacts limited the testing to one artifact and implementation of one additional.

The limited testing done with the version of Clio at the end of the grant period indicated that the idea warranted further testing and development. WRHS was able to secure local funding that will allow a more permanent exhibit stand for Clio and additional testing in the fall and winter of 2011. Additional artifact scripts will be prepared.

The museum’s expectations are to continue to develop Clio and integrate a modified version into exhibit plans at the museum over the next few years.

Prepared and submitted by NEH Principal Investigator, Dr. Edward Jay Pershey, VP Special Projects and Exhibits, WRHS, September, 2011.