Designing Digital Rails to Foster Scientific Curiosity around Museum Collections

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Abstract

The objective of this paper is to investigate how interactive technology can be used to foster visitor curiosity and engagement around the authentic artifacts and specimens within museum collections. In this preliminary collaborative project between The Field Museum of Natural History and Northwestern University, we have been investigating an interactive technology that we call *digital rails*, which are interactive computer displays mounted on exhibit case railings that serve a similar function to traditional static labels. The original digital rails were redesigned to highlight questions about the objects as a way to foster curiosity. Results indicate that the redesigned versions that highlighted questions on the home screen led to greater capture rates than the original, but the dwell times were equivalent.

1 Objective

The objective of this paper is to investigate a persistent question facing modern natural history museums, namely, how to understand the role of interactive digital technology in the visitor experience. More specifically, how can interactive technology be used to foster visitor curiosity and engagement around the authentic artifacts and specimens that make up museum collections?

Recent research suggests that digital technology can create engaging and effective opportunities for learning in museums (Roberts et al., 2014). Despite these opportunities, supporting intuitive interaction that goes beyond superficial levels of engagement is still deceptively challenging (Block et. al., 2012). In addition, interactive displays have been studied as exhibits in their own right, but little work has been done on the use of interactive displays to help learners interpret and appreciate authentic artifacts on display.

In this preliminary collaborative project between The Field Museum of Natural History and Northwestern University, we have been investigating an interactive technology that we call *digital rails*. Put simply, digital rails are interactive computer displays mounted on exhibit case railings that serve a similar function to traditional static labels (Figures 1 and 2). For example, when visitors approach an object display case, they can select from a menu of options to learn more about the various objects in front of them. They can also see contextual information such as maps, timelines, or conceptual diagrams as well as examples of similar objects not on display. The central design tension in this research is to explore how to harness the power and engagement of interactive digital media in a way that enhances

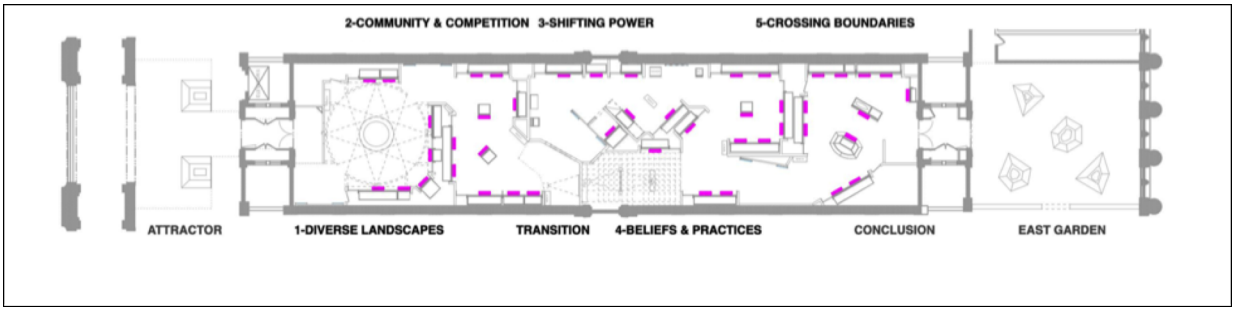

Figure 1. Floor plan of the exhibit with locations of digital rails shown in magenta.

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(rather than detracts from) visitor appreciation and understanding of the authentic artifacts on display. The focus of this research is a 7,500 sq/ft exhibit on China that showcases 350 artifacts from prehistoric times to present-day China. The exhibit is divided into five themed galleries (see Figure 1).

The exhibit includes over 45 digital rails spread throughout the hall (represented in magenta in Figure 1). These are custom-formatted touchscreen surfaces that are similar in size, shape, and position to the traditionally printed "reading rails" often placed in or outside of a museum display case (see Figure 2). The headline and block of text to the far left (A) describes the overall theme of the display. There is a menu with around six items or objects to choose from (B). The three brief phrases at the center of the screen (C) are the prompts about a selected object: visitors can select any of the prompts. When they tap one of the prompts, they then see, at near right (D) a story. The image and caption at the far right (E) carries additional information in the form of photos, video clips, scientific illustrations, or manipulable digital models of objects.

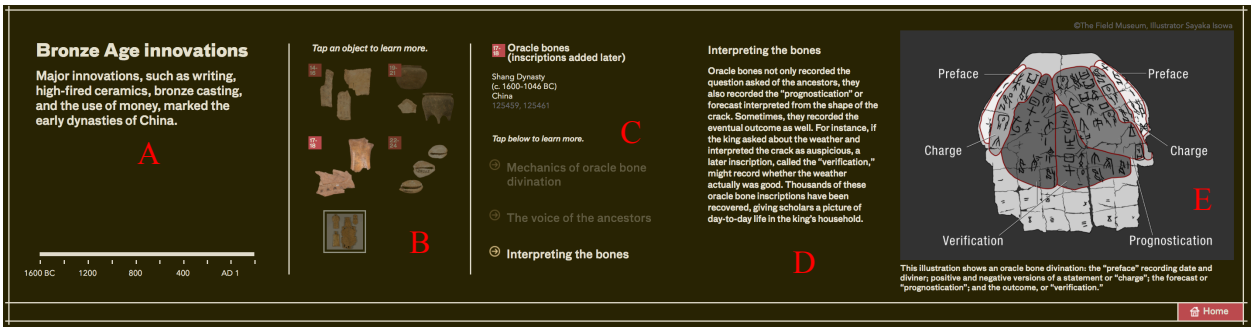

Figure 2. Screenshot of a digital rail describing a 3,000 year-old Shang Dynasty oracle bone.

2 Theoretical Framework

In this research, we explore the role of digital rails in fostering visitor curiosity, operationalized as visitor engagement around exhibited objects. Curiosity has been studied as a psychological construct across a variety of domains. However, little work has been done on translating that research into museum contexts to cultivate visitor engagement. Loewenstein (1994; Golman & Loewenstein, 2013) has posited a theory of curiosity as an information gap between what an individual knows and what an individual is interested in finding out. Curiosity increases when an individual becomes aware of an information gap and has a desire to narrow that information gap because doing so will bring satisfaction. Curiosity decreases once the information gap is closed when an individual learns the information that was unknown. Loewenstein compares curiosity to hunger, which creates a desire for food. But once the food is consumed hunger goes away. The information gap model outlines situational characteristics of curiosity-inducing stimuli that offer direction on how we might use the digital rails to cultivate visitors' curiosity about unfamiliar museum objects, like Chinese artifacts. By highlighting unknown, but knowable ideas, museums can cultivate curiosity and increase the drive to seek out information about the museum collections.

Museum collections provide concrete objects that can stimulate curiosity. Objects can spark questions, such as "what is that," and can serve as a stepping stone to critical thinking (Paris, 2002). The challenge for exhibition developers is cultivating visitors' curiosity to explore beyond the features of the object and how it is made so that visitors delve into explorations of the significance of an object within the broader context of the exhibit of which it is a part. In this project, we investigated the role of questions in fostering curiosity.

The original format of the digital rails primarily uses declarative prompts as a means to access information. For example, in Figure 2, the visitor tapped on "Interpreting the bones" to access further information. Alternatively, posing questions confronts visitors with missing information, which can

directly contribute to curiosity by highlighting what is unknown, but knowable (Loewenstein, 1994). According to a study by Berlyne (1954), when questions are novel or surprising, individuals are more likely to process and remember the information that answers those questions. Unfortunately, Berlyne did not continue that line of work so as to articulate the characteristics of the questions that invoked curiosity. More recent research (Jant, et al., 2014) found that questions about museum objects are also valuable for stimulating conversational elaboration among groups of visitors. This project builds on the paradigm of Ask Systems (Jonassen, 2011). Within the Ask System paradigm, a rich database of cases or stories are organized according to both common questions people have in the domain as well as questions that users should be asking, but may not think to ask. The questions become the means to access the information in the database. Likewise, we replaced the declarative prompts with questions as the means by which visitors received additional information about the objects (see Figures 3 and 4 below).

3 Alternative Digital Rail Interfaces

A baseline timing and tracking study was conducted over 3 weeks in December 2015-January 2016 (Roberts, Banerjee, Matcuk, McGee, & Horn, 2016). When a group of visitors entered the main door of the China exhibit, a researcher used a tablet application to record behaviors such as looking at an object case or rail, touching a rail or element, speaking with a companion or a docent, or taking a photo. In addition, Google Analytics data from all digital rails were pulled for the entire 3-week period of the timing and tracking study, totaling over 200,000 unique events logged. This baseline study identified which objects had the highest and lowest capture rates for both viewing objects as well as interacting with the digital rails.

This preliminary study revealed that a particular case in the 2nd gallery that had been identified by the curators as one of the most interesting and important cases for understanding one of the exhibit themes was one of the least frequently visited by visitors, both in live tracking and Google Analytics. The case contains three sets of objects demonstrating Bronze Age innovations: oracle bones used by kings for divination, high-heat ceramics that instigated the growth of craft districts in large cities, and cowrie shells that served as early currency. Because of the mismatch between the importance of the objects and visitors' attention to those objects, we felt this case would be an interesting focus for investigating the potential for curiosity-inducing questions.

In our first design, we used questions as the means by which visitors accessed information. We kept constant all of the story information about the objects in the case. Each object in the case is accompanied by three stories. We developed questions for which the stories were the answers. We then used those questions as prompts for the information in place of the declarative prompts of the original digital rail. We modified the home screen by selecting one story for each object and presented the associated question on the home screen. These main questions were presented one at a time on the home screen and rotated every six seconds. When a visitor tapped on the question, the digital rail displayed the story as an answer to that question. A list of questions about the object is shown next to the targeted story along with an menu of other objects in the case. When a visitor leaves the digital rail, the rail returns to the home screen after several minutes and begins rotating the main questions. See Figure 3 for a screen capture of the main screen and the story screen, which contrasts with the original interface in Figure 2. We refer to this version as the Big Questions version.

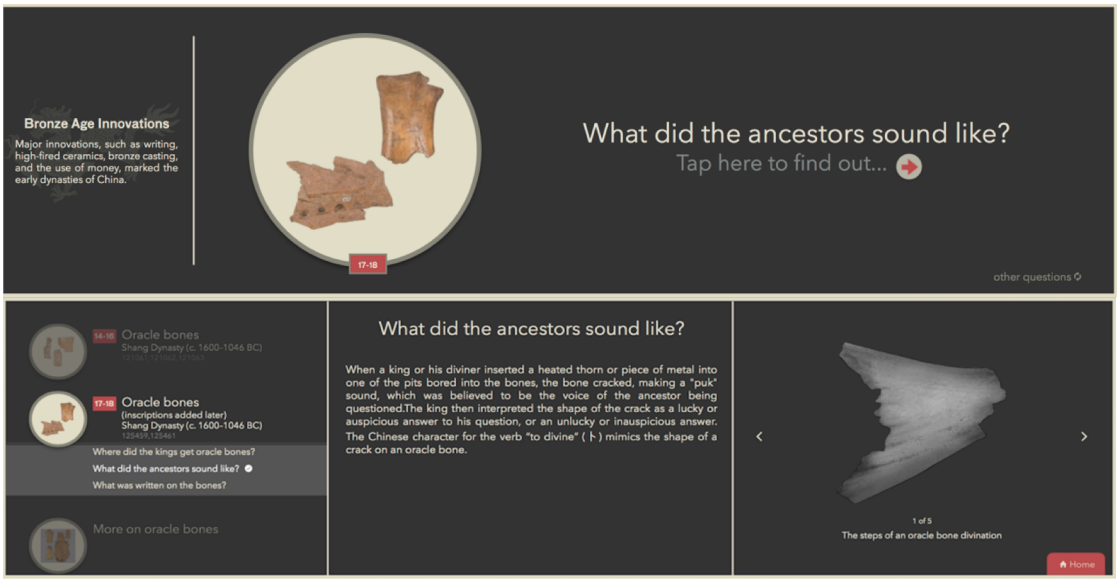

Figure 3: Screenshot of the revised home screen and story screen for question-oriented interface

As part of the analysis of the Google Analytics of digital rail use during the same timeframe as the timing and tracking study, we noticed that there was a slide show attached to one of the stories about oracle bones that was the most popular object in the digital rail content for that case. The slide show contained a timeline of the changes in Chinese characters for specific words. Given that the content was attractive to visitors, we created a second alternative interface that brought the timeline to the home screen and made it interactive (see Figure 4). As the visitors dragged a handle on the timeline, it showed the date and highlighted the characters that were active during that time frame. Also, the visitors could tap on a character and the timeline would highlight the dates that the character was active. The prompt for the timeline was phrased as a question. Similar to the Big Questions interface, when the visitor tapped on the question to find out more, they were taken to the story that answered the question along with a list follow up question prompts related to the object.

We also modified the original version to replace the declarative prompts with the same questions used in the Big Questions interface. The home screen of the original version remained the same, with thumbnails of the objects in the case. When a visitor tapped an object thumbnail in the original version, the rail would display the list of questions. When a visitor tapped a question, the digital rail would display the answer to the question. We referred to this version as Original+Q. Therefore, the main comparison in this study was the means by which visitors accessed information from the home screen. In two of the versions (Big Questions and Timeline), the home screen contained questions as prompts to pique curiosity. In the third version (Original+Q), the home screen contained thumbnails of the objects as the

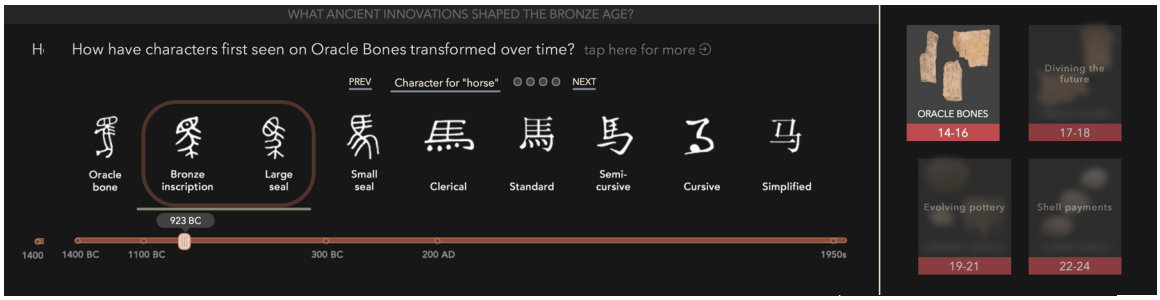

Figure 4: Screenshot of the revised home screen slide show interface

means to pique curiosity. Once a visitor's curiosity was piqued and the visitor tapped a question or the thumbnail of an object to explore the answer, the three versions all provided a similar means to explore other questions related to the object. Thus, we hypothesized that the home screens that highlighted questions would be more attractive to visitors than the original home screen that highlighted objects, but the level of exploration past the home screen would be similar. To investigate the effect of these revised interfaces, we alternated displaying the Original+Q, the Big Questions and Timeline interfaces as detailed below.

4 Data Sources

The three redesigned case interfaces—original design with question prompts ("Original+Q"), rotating big questions on the attract screen ("BigQuestions"), and interactive timeline slider ("Timeline") were observed during summer and winter of 2016. A total of over 40 hours (2,437 minutes) of observations were conducted by three researchers. During observations, a video camera was mounted on a stanchion focusing on the oracle bones digital rail, and a microphone was mounted to the digital rail to augment audio recordings. A sign was posted next to the case indicating that recording was in progress. No other consent was gathered, as no personally identifiable information was collected about participants. During observation periods, a member of the research team sat on a bench near the oracle bones case to record visitor groups entering the "zone" of the targeted case. The zone was defined by both physical proximity (i.e. did their path go past that case, which is in a corner) and visitor gaze. Visitors walking by the case but not looking at the case were not counted as entering the "zone." A timestamp was created when the first visitor in a group entered the zone, and a closing timestamp delimited when the last member of that group left the zone. The group composition was recorded using simple letter codes for perceived gender and age (M = adult male; m = child male; F = adult female; f = child female), and researchers took brief notes on the interaction. Notes included information about fluidity of group composition, such as whether a visitor started interacting and called a companion over to see something, after which the first visitor left but the companion kept interacting.

These observational notes were used to help segment and categorize interactions in the video files using the qualitative data analysis software MaxQDA. Each zone visit was categorized according to visitor behavior. Visitors who entered the zone (went near the case and looked at it) but didn't stop were recorded as "passby." Visitors who stopped were categorized as "interaction" if at any point they used the digital rail touchscreen or non-interaction if they didn't. To "use" the screen they had to engage in a deliberate action, e.g. select a story, move the timeline, etc. Random touching (common with young children) was not counted as an interaction. Some visitors gestured toward the screen or seemed to be looking at it but did not touch it. These visitors were also labeled as non-interaction.

As noted above, fluid groupings of museum visitors were common around this case, with visitors coming and going at different intervals. Interactions were segmented from the time the first visitor in a group entered the zone to the time the last person in that group left (Atkins et al., 2009). The entire interaction was categorized according to the most inclusive category. That is, if a visitor was alone during his entire time in the zone it was coded as a solo interaction, but if a companion joined him for even a few seconds at any point, it was coded as a group session and then coded according to whether they talked about the rail or case content (coded "substantive talk") or they didn't talk at all or only about other subjects, like what to have for dinner (coded as "no talk"). Visitors speaking a language other than English were coded as "foreign language." The most commonly spoken foreign languages were Spanish and Mandarin. These sessions are being translated by native speakers and will be included in ongoing dialogue analysis.

	Original+Q	Big Question	Timeline
Total number of visitor groups in the zone	292	273	316
Total number of visitor groups who stopped at the case	228	224	237
Case capture rate	78%	82%	75%
Dwell Time for visitor groups who did not interact with digital rails	19 sec	22 sec	20 secs
Total number of visitor groups who interacted with digital rails	94	115	129
Digital Rail capture rate	32%	42%	41%
Dwell Time for visitor groups who interacted with the digital rail	79 secs	78 secs	83 secs

Table 1: Distribution of the number of visitors across the three conditions

5 Results

This study focuses on the extent to which the different versions of the home screen were attractive to visitors and the length of time of interaction as indicators of curiosity. Future studies will examine the nature of the interaction with the digital rails as well as the nature of discussion that occurred around the digital rails content. Table 1 shows the results of the visitor counts across the three conditions. Roughly three-fourths of the visitor groups who entered the zone stopped at the oracle bones case. Based on a chi-square test of independence, there were no statistically significant differences between the conditions on the percentage of visitor groups who stopped at the case ($X^2(2,881) = 4.28$, NS). Roughly forty percent of all visitors who entered the zone interacted with the digital rails. Based on a chi-square test of independence, the different test conditions had a statistically significant effect on the likelihood that a visitor group would interact with the rails ($X^2(2,881) = 7.15$, $p<0.05$). Visitors were more likely to interact with the two digital rail interfaces that highlighted questions on the home screen versus the original interface that highlighted objects on the home screen.

We also examined the dwell time of visitor groups under the different conditions. Those visitor groups who did not interact with the digital rail content spent about twenty seconds on average in front of the oracle bones case. Based on a one-way ANOVA, there was no statistically significant difference between the conditions in terms of time spent in front of the oracle bones case by those who did not interact with the digital rails ($F(2,348) = 0.73$, NS). Those visitor groups who did interact with the digital rails spent about eighty seconds on average in front of the oracle bones case and interacting with the digital rails content. Based on a one-way ANOVA, visitors who did interact with the rails spent about the same amount of time at the case, regardless of which of the three revised formats they encountered ($F(2,335) = 0.19$, NS). However, there was a statistically significant difference between the visitor groups who did or did not interact with the digital rails ($F(1,687) = 248.57$, $p<0.001$). Those visitor groups that interacted with digital rails spent four times as much time in front the oracle bones case as those visitor groups who did not interact with the digital rails.

6 Conclusion

These results provide preliminary evidence about the benefit of using questions as a means to access information about museum objects, as suggested by the information gap model. Overall, the digital rails were attractive to a large segment of visitors. Roughly half of the visitors who stopped at the oracle bones case interacted with the digital rails. Regardless of how the information was presented on the home screen, visitors were highly likely to engage with the content. However, the two home screens that

highlighted questions as the means to access the information were more attractive to visitors as evidenced by the higher rate of attraction to those digital rails. These results suggest that there is a segment of visitors for whom questions pique curiosity more than a menu of objects.

Once visitor groups were attracted to interact with the digital rail content, they were likely to spend more time at the case than visitor groups who did not interact with the rail content. For those visitors that tapped the digital rails to find more information, they spent an equivalent amount of time exploring the content across the three conditions. These results are consistent with the fact that all three versions used questions to organize information at the story level. In future analyses, we will explore in more detail the manner in which visitors interacted with the content in the digital rails as well as the nature of the conversations that occurred as visitors interacted with the digital rails content.

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