

# THREADS: A digital storytelling multi-stage installation on industrial heritage

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**Abstract.** Storytelling enables us to connect through narratives that create reflections on our experiences. When storytelling concerns cultural heritage, it brings forth tangible and intangible assets that characterize activities and events of the past, which may sensitize visitors of a cultural site. In this paper, we present our cultural storytelling project THREADS, a four-station installation that narrates a story of a worker in a textile factory. The system comprises: (a) a welcome station (an animation on public display) that explains the main story and challenges to visitors, (b) the fabric design station (multi-touch display) where the visitor can create a simple fabric for production, (c) the punched cards station (Arduino mechanism), where the visitor codes their initials to binary form and receives a punched card, (d) the Jacquard production station (gesture-based interface with Leap Motion and Unity), where the visitor uses the card to repair a mechanical loom. THREADS has been installed in an abandoned building of a textile industry, which operated between 1914-1986, and it is now renewed and open to visitors. A preliminary empirical evaluation of THREADS revealed that it is not the variety of technologies that engages users, but a storyline flow that retains their attention and interest.

**Keywords.** Digital storytelling; Heritage tourism; Industrial heritage; Digital cultural heritage; Textile.

## 1 Introduction

Storytelling has been associated with cultural heritage since the beginning of time, from folklore narration to carrying on a society's cultural identity. Tales of parents, grandparents, and historians about who they/we were, what they did, and how they did it bear the identity of the referred social group. This identity, along with historical artifacts, shapes our own dynamic set of ideas, principals, and beliefs (a culture), and links us to a legacy. To preserve and effectively embrace and pass on cultural heritage, storytellers need inspiring means to capture their listeners' attention and empower their retention. To trigger emotions and experiences, people should be exposed in a rich environment according to the desired context and be allowed to step away from everyday reality [3, 13]. The narration of a story, especially of past events, can be more memorable to the

listener if it occurs in a relevant environment with visual impressions [7]. The enriched environment, when complemented by digital media, is able to better communicate cultural heritage related content, providing a more holistic approach [15]

In this paper we present THREADS<sup>1</sup>, a multi-stage installation for digital storytelling about industrial heritage, which has been installed in a renewed as a cultural space, previously abandoned textile industry building<sup>2</sup>. The aim has been to assist the soon-to-be-opened venue which will hold a permanent exhibition of textile machinery, products, and employment artifacts, and will promote heritage tourism. Our main design focus has been to raise cultural heritage awareness about the textile firm's past significance.

THREADS utilizes basic storytelling techniques to inform and sensitize visitors regarding the cultural heritage of the textile firm. It takes the visitor on a brief journey on site and narrates basic textile principles, technologies and fabrication processes. The four-station system is installed **across from** the physical artifacts, allowing a mental connection with the digital plot points and challenges. The storyline starts with the visitor entering the (virtual) factory (station 1) and being welcomed as a candidate worker. The challenge is to go through the production steps (next 3 stations) for the employer to see which is the most appropriate for them to get hired for. The stations challenge the design, coding and repairing abilities of the user, referencing a fabric's design process (station 2), its break down to binary code (station 3), and the repairing of a weaving machine (Jacquard Loom) (station 4). Through role assignment, visitors are encouraged to learn key historical facts in an engaging manner, making it possible to emotionally connect with the textile factory's behold cultural heritage.

## 2 Related Work

### 2.1 Related interactive systems

A number of systems utilize multitouch technology to let visitors learn through interacting with the digital content. For instance, the Walls of Nicosia interactive application allows the user to have a virtual tour through the fortifications of Nicosia throughout the centuries [11]. The target audience (children) come across a virtual world application running on a multi-touch table. Such interaction is highly effective for learning performance, combining education and entertainment (edutainment).

An experiential approach is having users take up an active role in the story and participate using natural interactions. Such is the Cycladic sculpture application [19] where users become sculptors and progressively create a statue using the appropriate tools. The application is based on bare hand interactions supported by Leap Motion. Users found the experience positive and engaging, with no significant differences in performance between adults and children [10]. This encourages the use of the Leap motion controller for public gesture-based interactions.

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<sup>1</sup> THREADS [Promo video](#)

<sup>2</sup> Zissimatos Textile Firm of Hermoupolis, Syros island, Greece

Also, the recent hybrid approach trend combines virtual and physical interactive means, offering a mixed reality environment. The Loom [4] project is such an example, comprising a simplified small-scale loom model and a multi-touch screen for digital content and feedback, installed at an industrial museum. Museum visitors can experiment, play and gain awareness about the weaving process by interacting with the loom model whilst observing their “product” on screen. Additionally, a multimedia interface presents information about the loom exhibits of the museum and the textile industry.

Prototyping platforms of other interactive systems were met in the Museomix hackathon, the Holoint installation, and an AR physics puzzle. Museomix aims to create digital artefacts for museums for a personalized visit [16]. Holoint is a gesture-based VR environment designed for a museum setting [5]. It offers users advanced and engaging interactive opportunities while navigating through ancient Rome (using Leap motion). The AR physics puzzle simulates Newtonian physics according to the placement of physical markers, in a game context [1]. Each marker represents a visual virtual 3D piece of stationary. The user manipulates virtual objects to witness their Newtonian behavior.

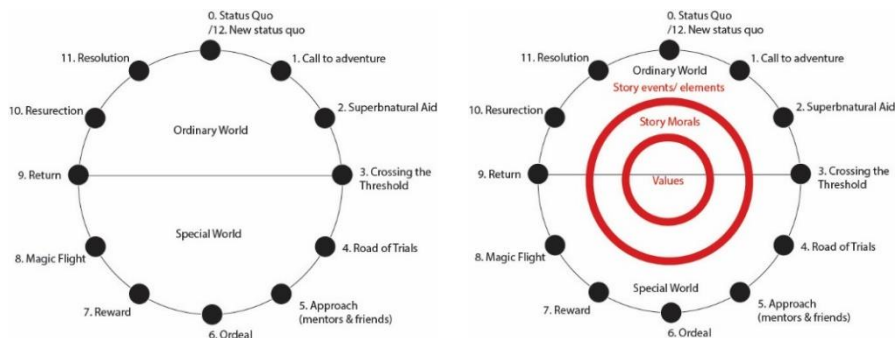
The aforementioned technologies served as bases for either the technological or design means that we used in THREADS. Alike technologies and types of interaction, such as the Leap motion sensor, VR environment, the mixed reality and role assignment have been incorporated in our project to attain similar results and experiences. More specifically, we borrow the role assignment from the Cycladic sculpture app, the edutainment and mixed reality approaches from the Walls of Nicosia and Loom projects respectively, the VR and Leap motion elements from the Museomix, Holoint, and AR puzzle systems.

## 2.2 Overview of two approaches for storytelling

A fundamental formula for story structure has been proposed as “A Hero’s Journey” (Archplot or Monomyth) by Joseph Campbell [3]. The pattern is spotted in myths across cultures and follows twelve steps to complete the storyline [3, 18], regarding the hero:

0. Status quo: Resting in their home culture.
1. Calling to adventure: An outside figure calls the hero into action.
2. Supernatural aid: Is given tools to help him in his quest.
3. Crossing the Threshold: Embarks on a journey to the unknown.
4. Trials: Is tested in his new surroundings and passes trials to continue.
5. Approach: New mentors and companions help the hero.
6. Ordeal: Experiencing a near death adventure, plunging down into an abyss.
7. Reward: Surviving the darkest moment and getting knowledge/ treasure/ power.
8. Magic flight: The hero flees from the enemy.
9. Return: Returning to the real world.
10. Resurrection: Arising transformed to the real world.
11. Resolution: Facing the final quest and using all the “rewards” gained to succeed.
12. New Status quo: The hero now rests in a new (self)culture.

To examine a modern perspective of storytelling, we analyzed the branding and marketing implementation of [3] by J. Sachs [17]. Sachs' contrasts the passive story encountering of people due to broadcast media of the past century, with the active story sharing through social media. In this post-broadcast era, as referred to, people have more control over what ideas they encounter and communicate, hence experiencing a digitally empowered version of oral storytelling. The classic story elements of [3] are defined as symbols for morals illustrated as values of the brand. The hero is the target audience, whereas the brand embodies the mentor or caller figure. Ultimately, storytelling is used in this manner to connect audiences with deeper values.



**Fig. 1.** On the left: classic model of storytelling (Campbell). On the right: modern approach for storytelling in branding and marketing (Sachs).

The preceding systems tested technological capabilities, whereas our development level is preliminary and serves the purposes of the creative and cognitive aspects. We found our design for storytelling approach on well-established theories, easily grasped by non-storytellers. Creativity is difficult to mold, yet we attempt to showcase how developers can structure their thinking process in order to bring technology and design in the same grid.

### 3 Digital Storytelling Approach

#### 3.1 Storytelling approach in THREADS

To relate the historical importance of the factory to people of the present, we needed to correlate key facts of the industry's historical status and events with current standards. We framed the necessary information on a story path to help visitors understand, recall and better relate to the context. The story form is based on a universal pattern of a protagonist-focused tale (Campbell's model) [3] and on Sachs's framework on storytelling in the post-broadcast digital era [18]. By combining Campbell's classic model with Sachs's framework, we came up with our basic storytelling approach for creating short story-based interactive systems.

To help visitors engage and immerse in the story, the narrative revolves around meaningful content, or else the principal tangible or intangible assets of the cultural

site. By combining the classic and modern approaches, along with the idea of real world metaphors, we adopted a simplified approach for creating interactive systems based on storytelling. According to resources and knowhow, design ideas can be prototyped using appropriate technology by addressing key questions about storytelling, cultural content and design elements. The **key storytelling questions** include:

1. Who is the hero?
2. Who is the caller?
3. What is the core value you want to communicate?
4. What are the main artifacts/ key touch points?
5. What is the (main) challenge?
6. What is the level of emotional involvement you want for your users?

The **cultural content** includes the main artifacts on site, various visual elements, testimonials, observations of people and the ‘character’ / mood / essence of the site. The cultural content is identified through contextual research including field visits, observation and interviews. The selection, documentation and curation of cultural content results to the **design elements**. These may be physical or digital and they are about the selected items that are going to appear in the designed system(s). These may include: human figures or characters, physical and digital objects, tools (including interactions and manipulations), scenery, sounds, etc.

On applying these principals, we recorded content and design elements for THREADS. Our story’s “hero” is the venue’s on-site visitor regardless of age, and the core value in discussion is industrial heritage found in the venue’s and peoples’ identity. The main artefacts include weaving tools, machinery, and people presence evidence. The greater challenge is to learn about the factory’s history and function. Finally, the emotional involvement affects immersion, visitor experience and learning process, thus we wanted to keep it at a medium level, avoiding nostalgic references [6].

**Table 1.** Storytelling approach in THREADS.

<b>Question</b>	<b>Cultural content</b>	<b>Design elements</b>	<b>Notes</b>
Who is the hero?	<i>Venue visitors</i>	<i>On-site user</i>	<i>Any visitor</i>
Who is the caller?	<i>Factory owner</i>	<i>Virtual character</i>	<i>Avatar and animation</i>
What is the core value you want to communicate?	<i>Industrial heritage</i>	<i>Identity of place and people</i>	<i>About factory and industry</i>
What are the main artefacts/ key touch points?	<i>Textiles (fabrics, towels), looms, threads, shuttles, working stations, ...</i>	<i>Character of factory owner, punched cards, towels and initials, Jacquard loom and gesture manipulations</i>	<i>It is prohibited to touch artifacts; the exhibition area is separated from visitor pathway</i>
What is the (main) challenge?	<i>Learn about factory’s history and works</i>	<i>Three interaction stations (design, code, repair)</i>	-
What is the level of emotional involvement?	<i>Medium</i>	<i>Intriguing, fun, interesting, learning</i>	<i>Beware of nostalgia effect</i>












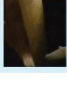
JOURNEY													
USER	User approaches the installation / touches the screen to start	User is assigned the Role of a potential employee / is challenged to perform following tasks	User moves to next screen/ chooses background color and pattern for his towel design	User chooses his initials to sign the towel	User moves to next station	User inserts blank card into the punching box	User presses button to start punching mechanism/ waits for green light to turn ON (end of punching)	User takes punched card	User moves to next station	User watches "How the Jaquard loom works" video/ is instructed how to fix it	User passes shaft through loom (fixes loom)	User is hired by the employer	
SYSTEM	System turns on	System plays Introduction video	System hosts Windows App in multi-touch display				System turns on Arduino mechanism / Green light lights up when punching mechanism is finished			System plays Jaquard video footage/ and interaction tutorial	System uses Unity and Leap motion for game control	System plays hiring video	
PRODUCTION PHASES		Welcome phase/ role assignment	Order Phase	Order Phase		Order Phase	Order Phase	Order Phase		Weaving Phase	Weaving Phase	Hiring Phase	
HIGHLIGHTS	The system is aligned across from the real corresponding artifacts	Animation character as the factory owner / employer	Personalization features	Personalization features			Punched pattern is the initials' form in Binary (0 1) (user initials from previous station)			Emphasis on one artifact		Achievment	

Fig. 2. Swim lanes illustrating the visitor journey.

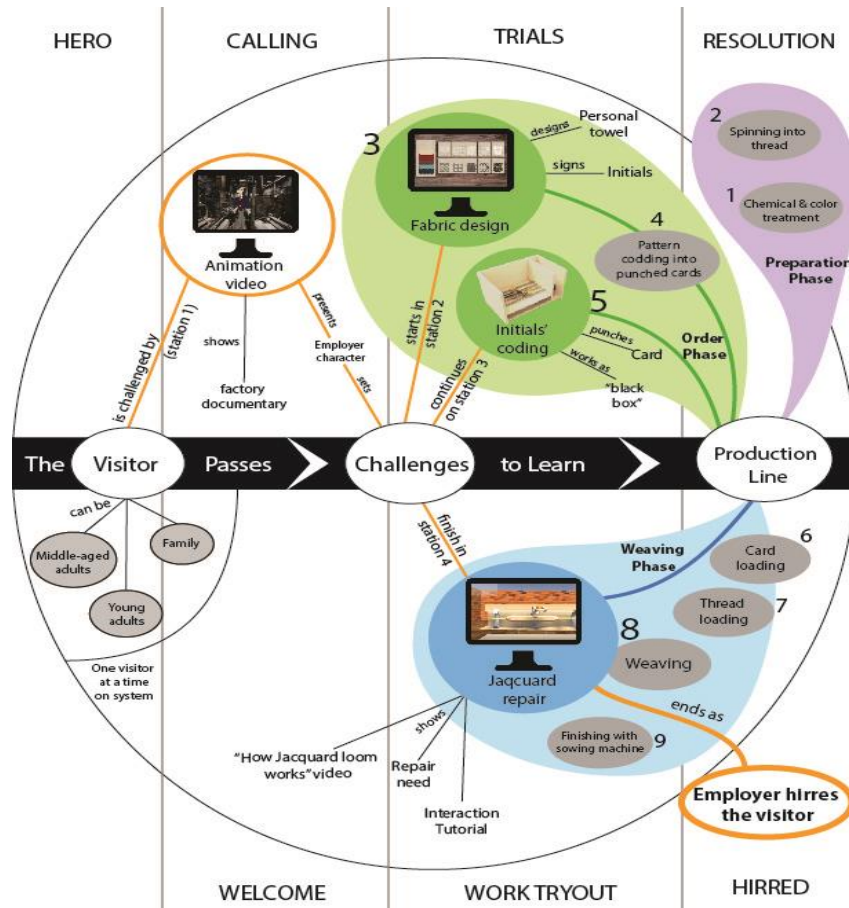


Fig. 3. The THREADS conceptual model.

## 4 Concept design

### 4.1 Pre-design, research methods

We employed several research methods to gather sufficient context insight including, desktop research, literature review, field visits, observation, interviews and contextual inquiry [8]. These pre-design, research methods provided us with insights on the history, function and socioeconomic importance of the factory, and helped us distinguish key points of interest of the factory's past function. Since the physical artefacts are not always approachable by the visitors, we opted to place digital artefacts in parallel to the real ones. Stepping into the visitors' shoes, we observed the venue and traced the usual routes one may take through the exhibition. The findings have been analyzed and recorded as a set of preliminary design goals regarding the nature, context, layout and placement of the system. Related to the overall user experience these include:

1. The user should experience the significance of the factory for the local community during its operation.
2. The user should interact with the system while viewing the exhibits.
3. The user should have a playful and engaging experience while learning.
4. The user should comprehend the basic stages of the textile production process.
5. The user should participate in the story as it unravels.

#### 4.2 THREADS conceptual design

The THREADS system represents a simplified simulation of the textile production process. When using the THREADS installation, the visitor of the factory needs to pass several challenges to learn about the textile production line. The first welcoming stage along with three remaining challenges comprise four stages of interaction, each representing a different working station: (1) role assignment, (2) fabric design, (3) punched cards, (4) Jacquard loom repair. The user goes through the process and learns at each station the corresponding action that would occur. The information is conveyed through varying media and gestural interactions [6] to keep the user engaged. Physically, the user interacts with three touch screens and a wooden box (which contains an Arduino-powered mechanism for creating the punched card).

THREADS is standalone installation located at the main area of the factory and is independent to the other audiovisual or assistive museum devices visitors' might potentially carry. The system does not interfere with the guided tours' content and it encourages visual contact with the actual physical artefact (exhibits) of the factory.

### 5 System prototyping

The **first station (Welcome and Role Assignment)** works as an introduction to the forthcoming process (Figure 4). An animated host character welcomes the user in the factory and narrates a brief history of the textile industry in Syros and its social impact. The host assigns the role of a potential worker in tryout for a job position to the user. As such, the user is required to pass through all the working stations. The character explains the required interaction in the following steps of the process. The first station operates in a 23'' inch touch monitor. A live action video introduces the visitor to historical facts about Industrial Syros, and the context of the system, and the host character performs over the video footage, narrating the story to the user. Animation has been used as a narration means since it facilitates learning and helps the user immerse into the presented fictional world [12, 13].



**Fig. 4.** Animation screenshot.



In the **second station (fabric design)** the visitor is asked to design a towel fabric. By choosing a background color and a design pattern, he generates a virtual prototype of a towel, and then is invited to sign it with his initials. Finally, he is instructed how to use the next station. The App is designed as a Windows Application and runs on Universal Windows Platform, in a 23'' inch touch monitor. There are 5 UI scenes in total:

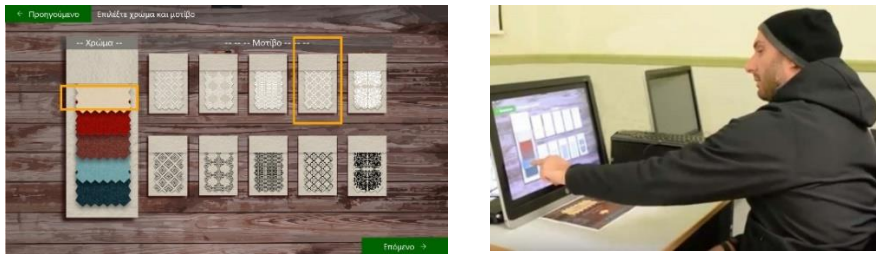
SCENE 1: “Welcome” screen, featuring the brand Logo and the “Start” button.

SCENE 2: Fabric design - color and pattern selection.

SCENE 3: Name initial and font selection.

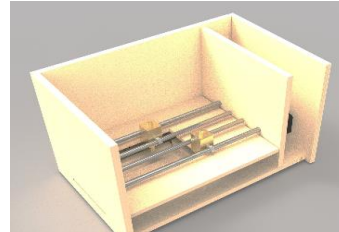
SCENE 4: Fabric preview.

SCENE 5: QR code corresponding to fabric design. Printing of QR code. The initials' information gets stored as a variable sequence (code following).



**Fig. 5.** The fabric design multi-touch app (second station).

In the **third station (punched cards)** the user interacts physically with the system to make a punched card. The punching mechanism is hidden inside a wooden box, with an insertion slot in the front, a start button and a LED light on top. As instructed, the user takes a blank card from a stack in front of the box, inserts the card in the slot and presses the button. Once done, the LED lights up to indicate that the card is ready and can be removed. The user takes out the punched card and proceeds to the next station. In the card punching station an Arduino board controls two stepper motors, two solenoids, a pushbutton, and one LED light bulb.



**Fig. 6.** 3D model of the card punching box.

In the **fourth station (Jacquard repair)** the user needs to repair the Jacquard loom. He is introduced to the basic concepts of the Jacquard loom and is instructed to repair it by repassing the shuttle through its track. Upon completion he is hired as a worker, marking the end of his journey. Animated footage explains the function of a typical Jacquard loom. The user is introduced to a Unity environment with a simplified, virtual loom model, with an empty shuttle path. The user manipulates the shuttle (dragging along a path) via gestures (pinch) over LEAP motion (Figure 6). The fourth station operates in a 23'' inch touch monitor.



**Fig. 7.** The loom repair app (fourth station).

THREADS borrows from the Monomyth key plot points for the sake of story flow, immersion, and engagement, as well as Sachs' point of view on the target group embodying the "hero" and the system/ brand/ venue featured as the "caller". The system introduces the visitor and his role assignment by the animated character as a "hero" character called into adventure by an outside figure (Monomyth steps 0, 1). It features the factory setting and the production line work stations (fabric design, punched cards station, Jacquard repair) as the "new unknown world" and the road of trials (3, 4). Finally, it finishes with the visitor successfully going through the work stations, and being hired as a factory worker, as a correlation to the Reward, and Return (7, 9). Cognition and experience wise, the visitor has learned about the industrial heritage of the factory and gained a piece of its culture (Monomyth's Resurrection 10 and New Status quo 12).

## 6 Evaluation

We conducted formative evaluations [9] to test the usability of THREADS and gather data for future redesign. There were eleven participants in total, seven students, three academic staff members and the factory's owner. Users have been briefly introduced to the context of the system and then let alone to pursue the steps themselves. Members of the design group made clarifications, when needed. The users have been asked to think-aloud about their experience. At the end of the test, they have been requested to provide answers to a 6-item online questionnaire (Figure 9). The evaluation has taken place at the university's computer lab. The station apps have been installed on different PCs to simulate the visitor's navigation along the stations.

Most users found the system engaging and relatively easy to use especially at the first two stations. Users reported some concerns regarding their interactions with the Arduino mechanism, which has been a black box to them. Future work in this respect will involve the placement of the mechanism into a plexiglass material. Additionally, some reported usability issues in gesture interaction via Leap motion. Most understood the historical facts (answers to questions 5 and 6). Overall, the users engaged successfully with the system and have had a satisfying experience. They have been able to learn and follow the storyline with no serious problems. Further prototyping and implementation work is expected to smoothen the problems of interacting with mid-air gestures.

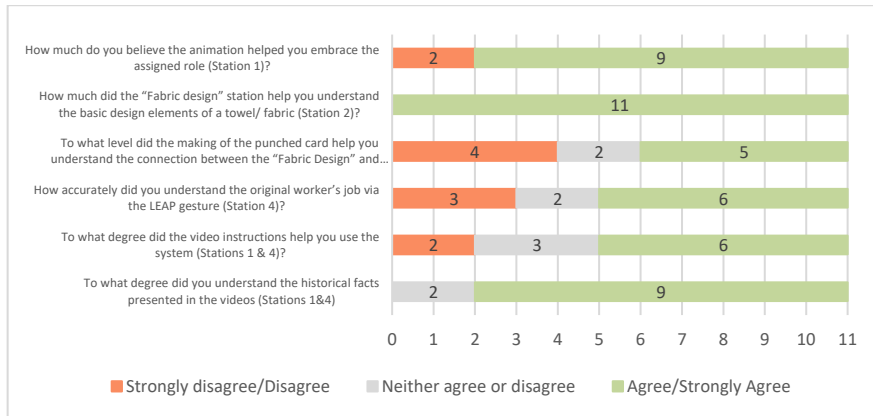


Fig. 8. Participant answers on questions about their experience in THREADS.

## 7 Conclusions and future work

This article introduced THREADS, a four-stage installation and interactive prototype for conveying the cultural heritage of a textile industry. The approach for the design of THREADS has been informed by several approaches on storytelling. The system comprises four stations of various interactive technologies: animated characters, live action footage and animation, multitouch screens, Arduino-powered mechanisms and gesture-based interactions. We investigated to what extent these different technologies could be effectively combined and keep the user interested as the story unfolded. Further work is underway to improve functionality and usability. Passive information passing needs to be simplified and present only the essentials (station 1). Interaction phases need to provide better feedback (station 2), and transparency of events (station 3). Lastly, virtual objects and environment need characteristics of realism to assist the user during the interaction.

The design process is a creative one and can be limited by technological factors. However, by filtering out information and clarifying the essential pieces, it was easier for us to find connecting points, form an information flow and define a user journey. By prototyping and testing the system, we concluded that the variety of technologies and exciting features alone is not what engages the users. Humans retain their attention and interest by following a flow; a storyline. Therefore, despite the technological flaws encountered, users have been able to perceive the context and enjoy the storytelling experience.

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