

# The Westwood Experience: Connecting Story to Locations Via Mixed Reality

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Figure 1: Some of the components of the experience. From left to right: the mayor character, the game played in the theater, the panorama effect in front of Yamato, details of the set at the brewery, Marilyn Monroe's grave.

## ABSTRACT

The Westwood Experience is a location-based narrative using Mixed Reality effects to connect participants to unique and evocative real locations, bridging the gap between the real and story worlds. This paper describes the experience and a detailed evaluation of it. The experience itself centers around a narrative told by the “mayor” of Westwood. He tells a love story from his youth when he first came to Westwood, and intermixes the story with historical information. Most of this story is told on a mobile computer, using Mixed Reality and video for illustration.

We evaluate the experience both quantitatively and qualitatively to find lessons learned about the experience itself and general guidelines for this type of experience. The analysis and guidelines from our evaluation are grouped into three categories: narration in mobile environments, social dynamics, and Mixed Reality effects.

**Keywords:** Location Based Experiences, Mixed Reality, Linear Narratives, Mobile Devices

**Index Terms:** H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, augmented, and virtual realities; J.5 [Computer Applications]: Arts and Humanities—Literature;

## 1 MOTIVATION AND CONTRIBUTION

Traditional forms of media such as movies and television are very effective at telling compelling stories. However, such media are designed to completely replace the real world and make no use of

contextual information, such as who the audience members are or where they are viewing the content. A different, but also powerful form of experience is to actually visit locations where famous or important historical events occurred. Tour guides take visitors to such sites and attempt to explain their importance through stories and other media, but since such locations often look very different than they did in the past, the impact of the experience is limited by the ability of the tourists to imagine it in a different time period.

Powerful mobile devices now allow us to combine traditional media-based storytelling with location in a way that was not possible before. Mixed Reality effects, along with video and images on the device, allow stories to be told on location while also giving creators the ability to visually build a historical or fictional world that is linked to the real world around the user. This can enhance the narrative by using the power of certain locations that resonate with users. It can also enhance an otherwise modest location by adding a compelling story, and most interesting of all can make the combination of story and location more interesting than either would be individually.

This paper describes The Westwood Experience, a production we built to explore and evaluate combining traditional media and real locations via MR. The experience is told primarily through a Nokia N900 mobile computer. The story involves the honorary mayor of Westwood who introduces himself and then virtually leads participants on a tour of Westwood in 1949. The historical tour quickly becomes something else when his memories of 1949 lead him to tell a story of a young actress he met in Westwood at that time. While participants walk around Westwood, he describes the key events of their brief but intense relationship at the actual spots where they occurred. The woman eventually leaves and he never sees her again in person, but he reveals she later became a famous actress. The tour concludes when he takes the participants to actually meet her in person. After entering a hidden cemetery,

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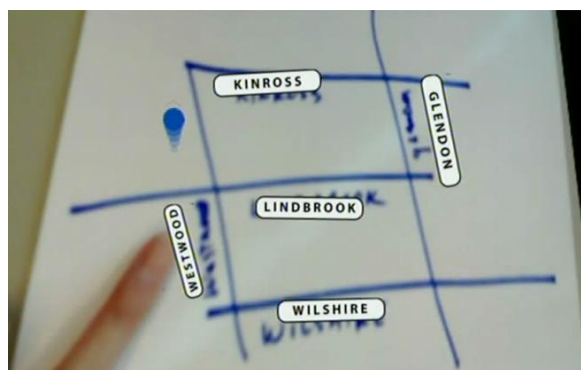


Figure 2: This figure shows the final recognized, rectified, and annotated map. The map was hand drawn by the mayor, who had his finger on the map when this picture was taken.

the participants discover the crypt of Marilyn Monroe.

The contribution of this paper comes both from the experience itself and from the detailed evaluation of the experience. What makes the experience itself unique is the combination of three things: 1) Tightly tying story elements to unique and powerful locations, to the degree that we could not move this experience to another location without completely changing the story; 2) Telling a simple, linear story (rather than being a game, a marketing event, or a puzzle hunt) at such locations; and 3) Incorporating different MR effects to combine real and virtual to tie the narrative to the real locations. We also conducted a thorough evaluation of the experience, combining a quantitative online evaluation with 56 users and a qualitative interview based evaluation with 16 users. Through these evaluations we learned many lessons about this project, and many we think apply more generally to this new form of media.

In the rest of this paper we both discuss the project in more detail and our analysis of what we learned. Section 2 describes other location-based media experiences and how our project compares to them. In Section 3 we further describe both the narrative and technical effects that were used to enhance the storytelling experience. Section 4 presents the techniques we used to evaluate the project, and Section 5 discusses these results. Finally, Section 6 presents final conclusions.

## 2 RELATED WORK

The Westwood Experience has elements of location tours, narrative-based experiences, and location-based experiences. We describe a representative sample of related work. Tour guides that use both AR and location awareness have been well explored in outdoor settings, and even more so in controlled museum settings. Two early location-aware tour guide systems are the Cyberguide system by Abowd et al. [4], and the GUIDE system created by Cheverst et al. [9]. These works presented information on a handheld device that was relevant to user location but did not use AR to enhance the experience. There are many examples of using AR to enhance a museum experience, though. Both Fockler et al. [12], and Schmalstieg and Wagner [19] used AR at specific museum installations to enhance user understanding. Schmalstieg and Wagner's work was also integrated into a game played throughout a museum. Similarly Miyashita et al.'s [16] work both enhanced individual exhibits in a museum through the use of augmented reality and provided users with a virtual tour guide to aid navigation. Stapleton et al. [22] describe several MR-based museum experiences. Schmeil and Broll [20] also created a virtual anthropomorphic AR guide who worked as a personal assistant, as well as having some knowledge of the real world surroundings to guide physical and virtual interactions. Vlahakis et al. [24] and Papagiannakis et al. [18] also used virtual



Figure 3: The static AR view of the effect at Peet's Coffee. The user takes a picture of a building which is recognized and an image containing parts of the illustration is aligned with captured image.

actors in their outdoor effort to bring ancient Olympia and Pompeii back to life respectively. While some of these works integrated features beyond simple tourist guides, none were built to be a single experience structured around a narrative.

There have been a number of location-based narratives however, including some that use MR. Both Tony and Tina's Wedding [3] and Accomplice [5] are location-based theatrical performances where the audience must follow the show to different locations, although neither uses MR. Stapleton et al. [21] discussed the effects of adding MR to narrative-based experiences. Both MacIntyre and Bolter [14] and Dow et al. [11] have created indoor narrative-based AR experiences. Both take place in a single room though, rather than a large outdoor space. Cheok et al. [8] incorporated live actors into an MR experience.

Location-based experiences on mobile devices are the closest to our experience, although to our knowledge none use the same combination of MR effects and narration. Representative examples include REXplorer, a project by Ballagas et al. [6], which is both an outdoor location-based tour guide and game. Time Warp, by Herbst et al. [13] is a similar experience that has characteristics of both tourism and gaming. Dow et al.'s The Voices of Oakland [10] interweaves physical location and narrative, but does not have any visual effects. The Kim Possible World Showcase Adventure [1] at Epcot enables visitors to trigger physical effects at various locations via a mobile phone. Montola et al.'s book [17] includes some of these and several more location based experiences, primarily focused around gaming.

## 3 PROJECT DESCRIPTION

### 3.1 Setup

The experience takes place in Westwood, a neighborhood in western Los Angeles. Most of the experience takes place on the streets of Westwood, primarily Westwood Blvd. and Glendon Ave, with some components indoors in both the Crest theater, and a room rented from the Westwood Brewery. Participants had to walk approximately 1.1 miles during the experience, and all interaction and narration was done at stationary locations. The entire experience was 75 minutes long. The experience was run for one day in Dec. 2009 and four days in January 2010 with three runs each day for a group of 6 to 8 people at a time. A total of 89 participants went through the experience. While participants went through the experience in groups, most of the experience was not synchronized, so users could advance at their own pace. Groups were only synced at the beginning of the experience at the theater, and in the middle of the experience when they entered the brewery. On the street, all interaction was through a Nokia N900. This involved viewing and interacting with images, videos, and MR effects on the screen, and listening to narration via headphones. The N900 was





Figure 4: Four of the images used for navigation. Users would view these pictures, and then try to find the corresponding object in the real world.

augmented with an external sensor box providing rate gyroscopes for a panorama effect (described in the next section). This sensor box communicates with the N900 over Bluetooth.

### 3.2 Narrative and Experience

The Westwood Experience begins in the historic Crest theater in Westwood, then progresses as a walking tour of the city. However, the core of the experience is the narrative. This story begins as the honorary 'mayor' of Westwood (who can be seen in Figure 1) bursts into the theater to tell the audience about himself. After giving a monologue in the theater, the actor playing the mayor waves goodbye to the users, saying he will guide them on a mobile tour of the city, not in person but virtually through their devices. The rest of the story is then narrated by him at various stops in Westwood. Initially, these stops tell only about the history of Westwood, specifically the year 1949. But after two stops, the narration takes a quick turn when he remembers a beautiful blond girl he met in a nearby diner. He quickly abandons the historical tour to tell the story of how they met and fell in love in that diner. It continues as they spend a magical evening together at the woman's studio (she is an aspiring actress), after which he is ready to propose. He buys a ring, but before he can return to the studio to propose the woman leaves. He catches up to her, but is spurned. The woman knows that her life as an actress will not be an easy one, so she wants to spare him from that life. She says, "I can't be with a man like you, because of what I mean to be, and have to do to be it. You'll find a real woman. She'll be happy and so will you." The narrator then skips through time, finishing the love story by describing how he first met another woman he later married after first mistaking her for the woman who had left him. The story concludes with the narrator taking the participants to meet, in person, the woman who broke his heart. She became a famous actress, as famous as many other celebrities buried in a hidden cemetery that the participants enter. The users are guided to a specific crypt and memorial bench that reveal the mystery woman was Marilyn Monroe. The experience ends with a video clip of Marilyn Monroe's coffin being put into the crypt that the users have found.

This experience uses a variety of effects, both on and off of the device, to make the story more compelling. The rest of this section describes these components and their place in the narrative.

The experience begins in the Crest theater where the mayor introduces himself in an extended monologue. He introduces the users to the devices (Nokia N900s) they will be using throughout the experience, as well as the application that will guide them through it. The application breaks the experience up into discrete chunks, and the users are told to touch the icon for the next section when they



Figure 5: A user holding an N900 and aligning a static outline of the building with the real building behind. This calibration step is used to start the effect at Yamato, and as a backup to start the effect at Peet's.

are at the appropriate place. The first component is a multi-player game that is played on the screen of the theater. The N900 touchscreen becomes a remote control, allowing each user to position a cursor on the movie screen. Each user moves his or her uniquely-colored cursor to collect flying polygons of the same color. Once the game is over the mayor leads the users out of the theater and into the lobby.

In the lobby, the mayor tells the users he will not accompany them on the rest of the experience in person, but rather virtually through their devices. To help them find their way through Westwood, he hand draws a map of the streets they will walk. Then he invites each participant to take a picture of the hand-drawn map, at any angle. Our custom computer vision algorithm recognizes the map, rotates it to an upright view, adds the names of the streets, and animates a cursor showing the route, as seen in Figure 2. The captured map then becomes a custom help screen the user can call up later to help them if they become lost. Capturing something from the real world that becomes a core part of the user interface was intended to delight users and to introduce them to effects based on computer vision that they would encounter again.

Next, the mayor bids participants farewell and the experience continues on the streets of Westwood. An assistant takes them to the location of the next effect, where they are asked to take a picture of a building across the street. This building is currently a Peet's Coffee & Tea, but in 1949 this was a Ralphs grocery store. Once the user takes a picture, we use SURFTrac [23] to recognize the building and the camera's pose. If recognition succeeds, we create a "static AR" effect by covering the Peet's logo and adding a virtual Ralphs sign and other items to change the building's appearance to the year 1949, as seen in Figure 3. After several seconds, the image dissolves to a completely virtual painting showing the building in 1949. If recognition fails, the user is given an outline of the building and told to line up the actual building with the outline (similar to what is shown in Figure 5). Once lined up, we simply dissolve to the completely virtual painting without attempting recognition. Since the computer vision recognition did not work in all illumination conditions, we needed a fallback that would always show the painted illustration even if users did not take a good picture of the correct building. The Peet's effect reinforces the narration at this spot that describes the Ralphs, transporting the users to 1949.

After the Peet's effect, users are guided to the next stopping point by a series of images. They are shown an image of something further down the street that is visible, but not obvious. Figure 4 shows some of these image clues. Following these clues becomes a simple treasure hunt for participants as they try to find the correct path



Figure 6: One of the illustrations used in videos to illustrate the narration.

through Westwood. This navigation technique is used throughout the experience to guide users from one stop to the next.

Users reach the Yamato restaurant, in a historic building that used to be a Bank of America. This point is the heart of Westwood and offers views in all directions. The narration at this stop again focuses on the history of Westwood describing what the area around the user looked like. To take advantage of the view from this location we built a panoramic illustration of what the view looked like in 1949. Users view this panorama by lining up an outline with the Yamato building (as seen in Figure 5). Users can then turn around to view the illustration aligned with the real world. The tracking for this is done using gyroscopes in the sensor box attached to the back of the device. As discussed in Section 5.3, users found this a very immersive effect as they could look in any direction and directly compare the way a building used to look to the way it looks now.

After the Yamato effect, the narrative changes focus from historical Westwood to the love story. To begin this change in focus, users listen to a narrative component where Pete (a sailor in 1949 who would later become the mayor) describes meeting Marilyn in a diner across the street. This meeting is also illustrated as a still picture (the entirety of which can be seen in Figure 6) which is slowly panned over in a video to complement the audio. Users are then guided further down the street where another video is shown while Pete talks more about falling in love.

Users are then led into a room above what is now a brewery, but in 1949 was a rehearsal studio. This stop is completely different from the previous effects because users do not use their devices. Instead, this effect relies upon a physical set, set up half as a studio apartment, and half as a photography studio as can be seen in Figure 8. Within this space we hear only Marilyn's voice talking to Pete as they flirt and become intimate in the room. Her voice comes from different parts of the room as she walks around via spatialized audio. The physical set combined with spatialized audio creates a very immersive experience.

The next several stops are presented via audio and video again and chronicle Pete's impulsive decision to propose and Marilyn's rejection. As the user proceeds down the street, the first stop is at a jewelry store where he buys an engagement ring. The user proceeds further down the street and stops at the Profeta coffee shop where Pete proposed to Marilyn, and stops again on a street corner where Marilyn got into a car and left. The last stop as users continue down this street is at the restaurant where users watch Pete meet a different woman who became his actual wife.

Users are then guided to a cemetery for the finale of the experience where they are led to Marilyn Monroe's crypt, which can be seen in Figure 7. This was the climax of the experience for many users, partly because it ties the narrative to a unique and powerful



Figure 7: The crypt where Marilyn Monroe is buried.

location, and partly because for many people it was a surprise. Before this point, the woman's identity was not disclosed. At the crypt, the experience finishes with an epilogue featuring video footage of Marilyn's actual burial.

#### 4 EVALUATION APPROACH

The goal of this project was not just to build a new mobile narrative experience, but also to evaluate different parts of the experience to guide future projects. There were three areas we were most interested in studying: how a narrative based story could be told effectively in a mobile and location-based setting, how social dynamics could be used to enhance the narrative experience, and how technical, and especially visual, effects could both enhance the narrative and more tightly couple it to the real world. To evaluate the experience in these areas we used two methodologies. We had 56 users fill out an online questionnaire after completing the experience to get some quantitative results, and we conducted a focused interview-based qualitative study with 16 users (9 women and 7 men, between 18 and 60 years old) who had experience with smart phones, but not with mobile media.

The online questionnaire asked very general questions about the experience. Essentially the goal of the survey was to determine broad trends. The majority of the questions focused on general themes like which part of the experience users liked best. There were also several chances for free response from users allowing them to elaborate on the rationale behind their responses. The respondents to the online survey were invited guests to the experience, and were primarily experts in fields related to mobile media. Many had previous experience with similar types of experiences, and most were 30 or older.

For the interview-based component of the evaluation, we recruited participants from the general public who had experience with smart phones but were not experts in any related field. Participants were divided into groups of three and sent through the experience as parts of larger groups with other invited guests.

After participants completed the experience, we conducted semi-structured group interviews. These interviews lasted approximately 30-45 minutes and were audio and video recorded. Interviewing participants in a group using the semi-structured interview method facilitated conversation about the experience amongst the participants. This approach helped us to glean insight into the parts of the experience that resonated with the participants and the parts that did not.

We used a modified form of narrative analysis/grounded theory [15] to analyze the interview data. We reviewed the audio and video recordings, "noting" interesting direct quotes onto post-it notes.





Figure 8: Two views of the set designed to look like a 1950s studio. Users entered this room and were told part of the story via spatialized audio from various hidden sources around the room.

We then sorted the post-it notes according to natural patterns and themes (affinity clustering) in order to determine the most salient research insights. After clustering the data into themes and determining the research insights, we then synthesized the insights into a set of design implications – directives that clearly communicated both things we did well or poorly in this experience and general guidelines for future similar experiences. In the next section we will use direct quotes from recruited users that support the overall insights that we gained from both the interviews and online questionnaire. Any numbers that are used to support our findings are taken from the questionnaire results rather than the interviews. We found little to no contradiction between the two evaluations suggesting that the experience appealed to a broad range of people.

## 5 EVALUATION / DISCUSSION

Participant response to the experience was overwhelmingly positive. In our online survey we asked users “Was this an entertaining experience?” On a seven point Likert scale with 1 being strongly agree, and 7 strongly disagree the average response was 2.05 (standard deviation 0.83). Overall responses by participants we interviewed were equally positive.

During the evaluation process there emerged several insights that were strongly reinforced by multiple users that went beyond how well they liked the experience. We refined these insights into design guidelines that we think apply generally to location-based narrative experiences as well. To better discuss how we arrived at these insights we have broken the discussion into three sections. We first discuss our insights in telling a narrative in a mobile environment. Next, we discuss the social dynamics of the experience, followed by a discussion of the MR techniques we used.

### 5.1 Narration in Mobile Environments

We were interested in evaluating the narrative from two different but interrelated view points: How well received it was as a narrative, and how well it worked in the mobile environment. The key guidelines we formed from this evaluation were:

- Distractions are inherent in a mobile environment. Interruptions from the real world must be taken into account both in character development and in deciding the timing and flow of the narration.
- The narrative must be carefully tailored to the environment. It is obvious when location is shoe-horned into the story.

To evaluate the narrative we examined all the user comments related to it and grouped them by the part of the experience they related to as well as by the tenor of the comments. This gave us a clear picture of what worked well in the experience and what didn’t, as well as comments with enough detail that we could extract the underlying reasons why users liked one part better than another. As

can be seen in Figure 9, there were some parts of the experience that users found much more engaging than others. There are naturally a variety of reasons for the different levels of interest, but the story itself definitely played a large part in some user assessment of experience, as well as how well the environment around the user was linked into the story.

#### 5.1.1 Narrative Evaluation

Overall users thought that the narrative itself was good but not great. When asked about the narrative the most common response was something like “it was a cute story,” but it was also described as not being “impactful; [the user] got caught between history and story.” Although the overall response to the story was fairly positive, there were several users who also found particular elements of the story and experience aggravating.

In creating the experience, one design choice we had to make was whether to concentrate on a narrative driven by character or to have the focus be more of a historical narrated walk. We chose a hybrid approach, starting with more historical information, narrated by the mayor, and then switching to a personal story from the mayor’s past. This was a stylistic choice, but also one proven by our dramaturgical expertise and insights. We felt a story concentrating on the main character’s life and its high points would be more interesting than a simple guided tour. Although our narrative focused on the mayor, he was not a well developed character which made it difficult for many users to identify with him. In the beginning, when the exposition of a show is supposed to be powerful and emotionally extensive enough to make the participant care about the mayor, we focused on the factual side of our experience, giving users information about the experience, rather than developing the mayor’s character. Therefore, later in the experience when the mayor started his love story, people did not relate to him as much more than the narrator. This made it more difficult to keep participants engaged, which led to two problems. First, when the experience switched between focusing on historical information and the mayor’s love story, the mayor was the primary bridge. Because he was not well developed, there was less of a connection between the two parts of the narrative. Likewise, because users did not identify with the mayor they were less likely to become re-engaged with the narrative after walking from one story location to the next.

#### 5.1.2 Distractions

Presenting the narrative in discrete chunks in a mobile setting makes it difficult to keep participants in the flow of the story. When walking between parts of story, a user’s connection with the narrative is often weakened as they instead focused on the real world. In a standard setting, like a theater, it is easier to maintain user attention because a great deal of effort is put into eliminating distractions outside the screen, and the story is told continuously. In a mobile setting where real world distractions are unavoidable though two

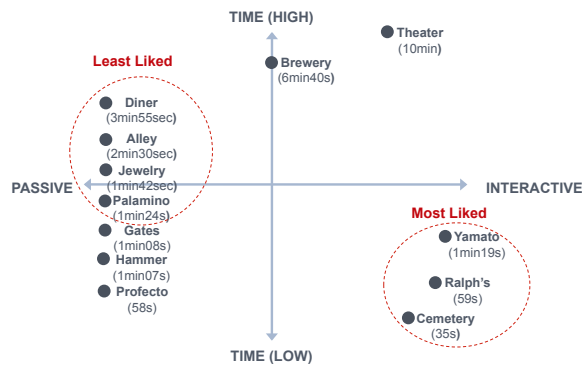


Figure 9: This chart depicts in two dimensions the type of experience people most enjoyed in a street environment, and the type they did not enjoy. The most like components of the experience were short, and interactive, while long passive components that did not fit well with user's expectations of a street activity were not well liked.

different approaches could be taken to maintain user interest in the story. Either the narrative could be told more continuously as it is in some audio walks [7], or in cases where this is not possible because of things like safety concerns, more effort should be made to incorporate the real world into the narrative. In this case the fictional world would have to be tied very closely to the real world; in essence, the narrative would have to be written around what already exists in the real world, making the real world part of the narrative, instead of simply a place where the narrative is located.

### 5.1.3 Tailoring Content to the Environment

We attempted to do this, but because the narrative itself was the focus, not all of our ties between narration and location were equally strong. When the link wasn't as strong users definitely noticed it and were less interested in those parts of the experience. For instance one user said: "I hated that part in front of the Palomino. It wasn't relevant." That component of the story was not crucial to the central narrative (it was where Pete met his wife), but it was also the weakest location. In the story, the meeting takes place in the same diner where the mayor met Marilyn, but the users are in a different physical location. In contrast, the cemetery was the peak of the experience for many users (the ratio of those who called it their favorite to least favorite part of the experience was 94:6) primarily because of the strong tie between narrative and location, as well as the strength of the location itself.

A powerful location is not necessary to have a compelling location and narrative-based experience though. In retrospect, one opportunity that we missed was at the jewelry store. We showed a video of Pete buying a ring, while the users stood in front of a real jewelry store. We could have tied the story to location much more tightly by having him talk about a ring that was in the actual store, maybe describing how the ring he bought was similar. By doing this the story would be the same, but the connection to place would be much stronger, which would have likely increased user engagement. An instance where we were much more successful at tying the story to an unremarkable location was at Peet's Coffee. This was an ordinary spot where we talked about history, how the building used to be a Ralphs grocery store. On its own this is not an interesting fact, but the effects we used, and the way it was tied into the story made it interesting and for some people even hit an emotional cord since they grew up in the same neighborhood.

## 5.2 Social Dynamics

When we built the Westwood Experience, the social dynamics of users were not a high design priority. Instead the focus was primar-

ily on the narrative and effects. However, we were still interested in the social dynamics since it is such a new type of experience and asked people about their social experience. From this we synthesized the following guidelines:

- In a novel experience it is important to give users coherent social cues. There are no established norms on how to behave in this type of social experience.
- Users are more comfortable when the experience matches their social expectations for a particular environment. In other words, the same experience won't work well both on the street and in someone's home.

### 5.2.1 Evaluation of Social Dynamics

We found the above results in part because we led users into several different types of social interactions throughout the experience. Participants went through the experience in groups, but not all aspects of the experience were group based. To evaluate the social component of the experience we asked users several questions including if they even wanted this type of experience to be a social group activity.

Throughout the experience, users were put into a variety of social situations. At the beginning in the theater, they played a multiplayer game that was social, whereas on the street there was no requirement for interaction and people were wearing earphones which partially cut them off from each other. Users also took off their headphones in the middle of the experience when going into the studio room in the brewery, but no interaction was required.

One question we asked every group during the evaluation was if they felt it was a social experience. The responses to this were quite mixed. Some people felt it was, some felt it could have been with friends, and others felt it was not. In general, people were confused about the social dynamics throughout the experience. This confusion was due to design decisions (discussed further below) and the fact that some events required the entire group to participate but most did not. The lack of synchronization often led to the group members separating and being unable to talk to each other.

### 5.2.2 Importance of Social Cues

One of the primary causes of social confusion throughout the experience was that we gave users conflicting cues on how they were supposed to act. In a normal experience that might not matter as much, but because users do not have established social rules for this type of experience they need to be made more explicit during the experience. We gave some cues that it was a social experience, starting with having people go through it in a group. Users also interacted at the beginning of the experience in the theater, and had a chance to interact at the brewery. However, we also gave many cues that it was an individual experience. Users wore headphones for much of the experience, which one user pointed out act as a 'do not disturb' sign. Much of the experience was also an audio-based linear narrative that was not synchronized across users (since they could go at their own pace), which also lead to isolation.

Another way to look at this is that we did not provide consistent social cues, or guidelines, on how people were supposed to act. Many popular location based applications like foursquare [2] use very specific verbs, like check-in, to describe your activity. We had a large number of verbs that describe different parts of the activity, and many of them suggest different social scenarios. For instance some verbs that could describe the more individual parts of the experience are match, listen, and view, while other parts of the experience could be described with verbs like find, follow, and explore. This second set could describe both group or individual activities.

The essential guideline to take from this: It is important to build the system to have consistent verbs and social cues in cases, like this, where there are not established social norms. These cues don't

have to be made explicit verbally, and can just as easily be built into the system to guide users in a consistent manner, but without consistency users will be socially confused, and it will likely detract from the rest of the experience as well. In our case we should have thought more about the social aspects of the experience while designing it, since those aspects will exist whether designed for or not, and made more informed decisions, like to use headphones less, to match the type of social experience we wanted.

### 5.2.3 Meeting User Expectations

We found that it is also very important to tailor the experience to the physical environment. This is in many ways an obvious statement, but we found the level of connectedness necessary to convince users was higher than we expected. Many of the components of the Westwood Experience were well tailored to the environment, like the panorama at Yamato, but some pieces did not work as well. This was particularly true for some of the videos. Some users thought the individual video clips were too long: “Parts of the story, like the jewelry store, the diner, and the alley [all video clips] were so long that it took me out of feeling present on the street. They were just too long and drawn out. I was like, alright already. Let’s get going.” Others were irritated by what they felt was unnecessary content: “I didn’t understand the point of the part about the dogs [in the alley]. It shouldn’t be like reading from a book - we’re there.” Both of these cases illustrate how those particular video clips were not well tailored to the environment they were delivered in. We tried to tailor the clips to the environment by keeping them relatively short, but we did not fully appreciate the importance of this. The longest video clip, of the diner, was 3:55 minutes. Other video clips ranged from just over one minute to 2:30 minutes. These would all be considered relatively short for a desktop setting, but when forced to stand on the street and watch them many users got anxious. We feel this is in large part because people are not used to spending time standing still on the street, unless they are waiting for something like a bus. Forcing them to stand and watch a video outside of this context felt unnatural.

The spatialized audio at the brewery also caused anxiety among some users. The subset of users were again uncomfortable with the way the content merged with the environment. Although, in this case it was the social environment, being surrounded by six strangers in a small room with spatialized audio, that caused the problem. Users were surrounded by spatialized audio of the actors becoming intimate in the room they were in, causing some people to feel very uncomfortable: “The brewery was really creepy and it felt like it went on forever. They started making out and you wanted to close your eyes and ears, but you couldn’t.” The room was designed to make users feel very immersed in the story, which it succeeded at. Unfortunately, it also, in succeeding, made some users uncomfortable because they were experiencing the content in a novel way and felt confined by room itself, and because they were uncomfortable being in an intimate setting with strangers.

## 5.3 Mixed Reality Techniques

Throughout the experience we used several MR based effects. The goal of these effects was to enhance the experience both by giving the user more information and by making them feel more immersed in the narrative. Asking the study participants particularly about the effects, and the general experience when effects were used and not used led to the following guidelines:

- Mixed Reality effects can work very effectively at joining the real and fictional worlds.
- Interactive, user steerable effects are more compelling than static ones.
- Technical effects do not have to have perfect registration to be effective if user attention is not drawn to these inaccuracies.

### 5.3.1 Effectiveness of MR effects

The three MR effects that we used in the experience are described in Section 3.2. They comprise the map recognition effect in the theater near the beginning of the experience, the building recognition and image combination at Peet’s, and the 360 degree viewable panorama at Yamato. Of these three effects the map effect was primarily used to delight participants, although the map itself was used as a help function, while the other two effects were used to enhance the story. An added benefit of doing the most technically challenging image recognition problem at the beginning was that we established user confidence in the technical effects. This allowed us to fake image recognition later on, particularly at Yamato, without it being obvious.

In both our online survey and in person user study the effects at Peet’s and Yamato were very well received. In the online survey the Yamato effect was the second favorite part of the experience (the ratio of those who called it their favorite to least favorite was 92:8), trailing only the ending of the experience at the cemetery. Both effects also received praise from our interview subjects who said things like “Ralphs and the Yamato were really genius technology ... brilliant, really brilliant” and regarding Yamato, “I’ve always wished I could do that. Stand on a corner and go back in time.” In general users seemed to like the effects in part because of the novel technology, but many also felt that the effects enhanced their feeling of being in the story. The effects were used during the opening part of the experience where most of the content was trying to set the stage for the love story by immersing the users in historical Westwood. The narration also supported this by describing what Westwood used to look like, but the visual effects were what really made it interesting to users. One user commented “It was cool to immerse yourself in another decade,” while many other users expressed excitement and amazement at seemingly trivial details, like the fact that a building that now contains a Peet’s Coffee and Tea used to house a Ralphs grocery store. Because this detail was presented visually, users felt connected to that detail, rather than seeing it as trivial fact. In some ways we were actually too successful with the Peet’s and Yamato effects. The narrative during those effects primarily described the historical environment, and then shortly thereafter quickly transitioned into the love story where MR effects were not used. This left some users confused and longing for more of the historical information. One user stated: “The story started out great, then it kind of became really slow and less interesting. I enjoyed the history more than the story.”

### 5.3.2 Interactive effects

While both the effects at Peet’s and Yamato were well liked, the panorama effect at Yamato was, as previously mentioned, the highlight of the whole experience for many people. While not completely unexpected, this was still interesting to us because unlike the map recognition and Peet’s effects there was no image recognition. Instead, users were asked to manually line up the building to the outline, and then the orientation was updated with data from gyroscopes. So although the effect was judged to be the most immersive it was not the most technically advanced. It was immersive because it gave users control, allowing them to see what they wanted to see in the same location it was in the real world. One user commented that because of the extra control “it wasn’t just a picture, it was like standing there back in time.” Enabling users to hold up their device and see a historical (or fictional) view of the world around them in-situ changes the paradigm of the mobile experience. Typically a user looks *at* their mobile device, and the visual interface consumes their attention. By changing the device into a magic lens, we enable users to look *through* the device instead (if only figuratively). This gives what is viewed on the device a much stronger location based connection, and enhances the immersiveness of the experience. It also makes the device less visually greedy. A normal smartphone

application demands the user's full visual attention. By having the application on the device be location aware the world around the user becomes part of the interface, particularly in the case of MR.

### 5.3.3 Overcoming Registration Errors

Another benefit that we found in presenting the user with a virtual panorama was that orientation tracking did not actually have to be very accurate to convince the user that it was accurate. By asking the user to start the effect by manually lining up an outline of the Yamato building with the actual building, we ensured accurate initialization. But by the end of the effect, accumulated orientation error from integrating gyroscopic data could reach ten degrees or more. Surprisingly, not one user mentioned this tracking error in our evaluation feedback. It is likely that most did not even notice it. We found this very interesting because in many MR scenarios, particularly AR ones, this amount of error would render the system almost unusable. We think there are two reasons why the tracking error was not a problem. These reasons are primarily related to human perception. First, the panorama used an interaction metaphor already familiar to users. Most digital cameras today have the user look at a screen on the back of the device that shows the view through the camera. The image displayed is what the camera detects, not what the user would see if the display were a transparent frame over the real world. Therefore, users are used to seeing images on the display that do not accurately line up with their direct, first person view of the real world. That may explain why orientation errors were not noticed or bothersome. It is difficult to hold the device so its orientation lies exactly along the user's gaze direction, so users may have manually and unconsciously rotated the device to correct small orientation alignment errors. Second, the previous two effects (the map recognition and the Peet's effect) did provide accurate registration. By the time users got to the Yamato effect they had already seen two accurate image alignment effects and may have assumed the Yamato effect was also accurate, rather than scrutinizing it carefully. Combined these factors allowed us to have a very compelling effect with fairly inaccurate tracking.

## 6 CONCLUSION

The Westwood Experience broke new ground telling a linear narrative in a location-based experience. Combining the linear story with MR effects and unique, powerful locations enabled us to immerse the users more deeply into the story in multiple ways. Our evaluation found many interesting and specific strengths and shortcomings of this experience, from which we inferred general guidelines to follow when constructing this type of experience in the future. Many of the guidelines can be summed up by saying that the location itself must be key to every part of the experience. When designing everything from the narrative, to the way it is presented, and the way people go through the experience it is critical to keep the location in the loop and design for it rather than around it.

### ACKNOWLEDGEMENTS

The authors would like to thank Duy-Nguyen Ta, Owen Vallis, and Jordan Hochenbaum for work on this project.

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