Augmented Reality Prototyping For Interaction Design Students

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Abstract
Technology never stops advancing. As such instructors in technology related fields must always be aware of new advancements, and prepare their students for industry. A prime example exists in Augmented Reality, a space of increasing popularity and scrutiny. However, to prototype a usable experience, students will need at the very least: 1) Programming experience, 2) 3D modeling experience, 3) an expensive AR headset. Can we create effective AR prototypes without spending a lot of time or money? In this paper we will explore a method for students to create prototypes of Augmented Reality designs that can be achieved through existing design methods.

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Augmented reality; prototyping; bodystorming; usability testing

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction
Augmented Reality is an emerging technology which allows us to view virtual objects as an overlay in our everyday environment[3]. As with Virtual Reality, the common mediums include smartphone apps, and

headsets. However, unlike Virtual Reality, users are not completely immersed in the virtual environment. Instead, they view their normal environment with a digital overlay. Being able to see the world around them is an important distinction for Augmented Reality and creates implications that will have to be thoroughly analyzed by designers. For example, the interface is no longer safely contained within a screen, but can exist anywhere and everywhere in a user's physical environment. Many AR experiences might not even offer an interface, or something completely unrecognizable as an interface to current users. This class of interactions without screens include VR, AR, and devices like the Amazon Echo and Google Home, and have been coined Faceless Interactions[2].

The current generation of design students, not to mention design professionals, must be prepared to grapple with these new interfaces, and currently, there are few tools to help them test their faceless designs. Designers have access to many tools to realize their screen-based designs. Sketch, Photoshop, and Illustrator can all create wireframes at various fidelities. And even without technical skills, designers can simply sketch with pen and paper. However, no equivalent currently exists for AR experiences. There is no dedicated tool that allows a designer to create a simple prototype of an AR experience. There are Sketch plug-ins that allow users to mockup their wireframes in VR, and for certain experiences might be usable for AR, but they can only be viewed in a VR headset, which does not allow the user to see their entire environment, which is an essential aspect of AR.

Producing an idea as a test in AR might not be a problem for a company with programming and 3D modeling resources, but it presents challenges in a classroom. For one, students need multiple skill sets before creating these experiences as mentioned above. Some interaction design students might have these skills before coming into the classroom, but it is hard to imagine Unity programming and 3D modeling fitting into a standard interaction design curriculum. Even in the case that the skill issues could be overcome, students would have to be provided with an expensive headset or smartphone AR system to realize and test their ideas.

In the Spring of 2016 our team, consisting of two interaction designers and one art historian focused on technology, found ourselves facing these issues and others as we attempted to design a system for museum professionals to take notes on physical artifacts and compare them to virtual artifacts in Augmented Reality. The system used a stylus pen as an interface device, which meant that a phone AR system could not be used, as our test subjects needed their hands free. In addition, we did not have access to any historical artifacts, and at this point in our process, we did not have an AR headset (we have since gained access to a Microsoft HoloLens).

In order to test this system, we had to be creative. In the next section, we will describe our solution.

Prototyping in AR

Without access to the materials or technology we would need to create the experience, we turned to traditional interaction design testing methods. The cheapest way to test a screen interface is through paper prototyping, in which the designers draw out their screens by hand, and have the user act as if it is real. Designers can

replace sheets of paper when the user moves to a different screen, or add overlays of new sheets of paper to simulate drop down menus or other changes in the screen. We asked ourselves the question: How might we create a paper prototype in 3D space? Paper is a fair way to represent screens, since they are both flat. This is obviously not the case with AR, which requires three dimensions. So the real question is, how might we translate the values of paper prototyping into a 3D medium, like AR? In this paper, we will propose a combination of various existing design methodologies including usability testing and bodystorming[5], to address this problem. We needed a test subject to see something representing a historic artifact, and be able to interact with it with the stylus pen we had designed. It was important for us to see how they would react to the artifact in space. How would they look at and touch the artifact? How would they work with digital models? Is a stylus pen an appropriate interaction method for this use case?

While we didn't have access to any historical artifacts, we did have access to many digital 3D models of historical artifacts, through one of our team members. To improve immersion, we selected the Crouching Aphrodite (Figure 1) statue as our representative artifact as we had a highly detailed model available. Our institution had 3D printers available, and we were able to produce a print around 12 inches tall. We also printed several other models at lower quality to stand in for digital artifacts in the experience.

For the stylus pen, we used the pen from a Microsoft Surface 3. This was also the stylus we used as a design exemplar for what our stylus should be capable of. This pen includes several buttons in locations that would

Figure 1: The Crouching Aphrodite, 3D printed from a detailed model

allow our participants to experiment with various functionality. This test was a combination of bodystorming and usability testing, but we also considered the Wizard Of Oz technique[5]. The designers could move objects around the room to simulate the user moving them, or add posters to the walls to simulate information boxes. Existing technology like televisions could be used to simulate video or animations that the user could see during the experience.

We reserved a large conference room, and placed the 3D printed artifacts around the room, with the Crouching Aphrodite as the centerpiece. This room was not ideal, as we originally envisioned a room with several small pedestals, and this room had a single large conference table. But the main interest was in a private space with tables, so this space was sufficient.

We had written a short script of tasks we would ask participants to complete. Some were specific, but most were open ended. We intentionally did not inform them of the interactions we had designed, so that we could see their natural attempts to solve problems with our system.

We invited art history academics, professors, graduate students, and a museum curator to test our design. These individuals all regularly worked with historic artifacts in museums and private collections.

Testing Results

Through the testing method described above, we gained knowledge not only on whether our design was usable, but also on what felt natural to these museum professionals. For example, we asked each participant to create a measurement of the artifact with the stylus. In our design, users would press a button on the pen, then select two positions on the statue. Most participants followed this method, but we discovered that the participants wanted to be able to make different types of measurements. We envisioned a measurement of the outside of the artifact, but we learned through testing that users also wanted a way to measure a line that intersected the artifact.

We also learned about environmental factors. One user asked what the lighting would be like in the room. Our design called for a brightly lit room. The user instead asked for modular lighting that he could control directly. We suggested this to subsequent users and got positive feedback.

While these findings are important, the most revealing results came from observing the relationship between the professionals and the historical artifacts. Each participant was aware that the Crouching Aphrodite was a plastic 3D model. But when they were told at the beginning of the scenario that the statue was to be treated as a real artifact, every participant was wary of touching it. The artifacts they work with are all unique, and priceless. Any mistake could destroy a key piece of the historical record. Every participant we tested took that responsibility very seriously. One participant began suggesting ways to make the system work without touching the stylus to the surface of the artifact. Another participant stopped our explanation and asked for reassurance that museum patrons would not be allowed to use this system.

In our initial testing concept, we planned to use whiteboard markers or push pins with strings to

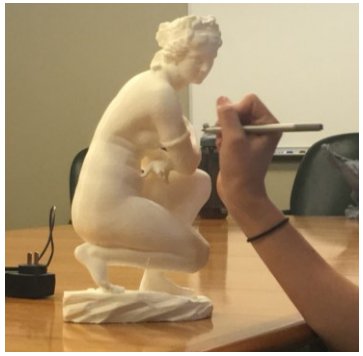

Figure 2: A user interacts with the artifact using the stylus pen.

represent the measurement lines that the system would display digitally, planning to remove them between test sessions. We assumed these lines would help users visualize what was happening. After learning how reverently our participants treated even these plastic artifacts, we realized that would have been a huge mistake. Drawing on the statue, or sticking it with pins likely would have horrified our subjects, and could have broken their immersion in the experience. Instead, we simply described what would happen in response to certain actions, and users were able to understand well enough to proceed through the test.

We selected a stylus pen even though gesture and voice controls are much more common AR control schemes[1,4] because we felt it would allow more precision in interacting with artifacts. Because of this, ensuring the usability of the stylus for museum professionals was a chief concern (Figure 2). In our testing, none of the subjects had an issue using the stylus, or questioned whether it would be good for their work. The only issue raised by the subjects was whether or not the pen might damage the artifacts. This is certainly a major concern, but further testing would have to be done to ensure the safety of historic artifacts.

Lessons Learned

Our initial question was "how might we translate the values of paper prototyping into a 3D medium, like AR?" While we initially thought that we'd have to come up with something entirely new, we learned that existing design research methods are robust enough to account for AR technology. In many ways, designs for Augmented Reality will be analogous to experience designs described by McCarthy and Wright[6]. This is because both experience designs and AR designs occur in the real world, not separated from it. Experience design argues that technology isn't just a tool we use, it is an active part of our day to day experiences[6]. Designers must take the users environment into account when designing an AR experience, just like an experience design. While AR designs aren't necessarily part of a standard design curriculum, experience design is (or at least should be). As a student designer learns the important aspects of experience design, including how to create an aesthetic experience for their user, they will also be learning how to build a strong AR experience.

When users put on an AR headset, the designer is able to alter and enhance any aspect of the world around them. To do this well, the designer must take into account the environment around the user and how the virtual objects will interact with the space. In some cases, this will mean designing both the space and the system, like we did. In other cases, it will mean making the system flexible enough that the virtual objects will integrate into a variety of physical environments. By applying experience design principles to an AR design, instructors can demystify this new technology for themselves and their students.

Does this method allow student designers to design and test their AR experiences without expensive hardware or specialized knowledge? For our testing, we did not have access to an AR headset of any kind, and we did not write any code to support our test. The test was completed entirely in a physical space making use of the user's imagination. One advantage we did have was that one team member was capable of 3D modeling, and we had access to an accurate representation of a

historical artifact. It is possible that we could have replaced the Crouching Aphrodite statue with something else, like a toy, clay model, or even a box. We don't know how this would have affected the testing, but like paper prototyping, as long as the participants can suspend their disbelief, it should theoretically work. More testing would have to be done with lower fidelity objects to know for sure.

Conclusion

Design principles are not tied to any single technology or platform. No matter what advancement occurs in the future, design instructors can find a theory or method to help their students understand how to create an effective experience. In this instance, we were able to apply the principles of paper prototyping to a new technology by replacing 2D paper with 3D models and leveraging research methodology.

We have focused on students and how they might cheaply and effectively test their AR designs, but professional designers could apply the same concepts. Just like professionals work with sketches, and then various fidelities of wireframes before building a product, the same could be done with AR experiences, following these methods or others. There are sure to be many more existing methods that will allow students and even industry professionals to design and test experiences effectively. For example, a method like business origami[5] could be used as a way to collaboratively design a model of how the system would work. Our process also included some aspects of participatory design[5], as we kept the design open-ended during the test, allowing users to help add their own take on the design. We will continue using this method and attempting to expand it, and we invite the community to do the same.

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