Taking Big Paper and Sticky Notes to the 360th Degree

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Abstract

The use of low-fidelity prototyping approaches has been a part of user-centered design and participatory/co-design for many years, dating back to at least the 1980s. However, the display experiences for which these were created (first desktops, then laptops, and later adding tablets and smartphones) are flat. The rise in interest about virtual reality (VR) headsets and other technologies that support the viewing of 360° spaces, as well as an increase in their availability, calls for updated low-fidelity prototyping approaches that still support co-design with diverse user populations. We present and discuss how to support collaboration between technical and non-technical design partners using supplies such as a consumer-grade 360° camera and tripod, along with common materials such as foam-core boards, basic metal easels, a standard color printer, paper, tape, and a variety of types of sticky note. The co-design is accomplished by creating, and then annotating during a design session, a basic representation of a 360° scene or experience using low-fidelity techniques, specifically a hybrid of the "big paper" and "sticky note" approaches, but taking them to the 360th degree.

Index Terms: prototyping, co-design, low-fidelity, design, virtual/augmented/mixed reality.

Introduction

With the recent surge of virtual reality technology, such as Google Cardboard, Google Daydream, Samsung Gear, and the Oculus Rift, moving towards ubiquity, the need for product research and design that explores what users want from these experiences becomes increasingly necessary. Product designers and developers from diverse segments of the industry will need to expand their understand of what will captivate users; not only to encourage and entice them into starting to own and use virtual reality technologies, but also to expand the ways in which they can use the technology in ways that are meaningful and valuable to them. Part of this challenge will be developing experiences that go beyond the traditional desktop or mobile metaphors, to set these experiences apart and realize the full potential of 360° experiences.

Dating back to its origins in the 1960s, co-operative (or participatory) design and inquiry has been shown to be a valuable part of user-centered design [6][12]. The ability to involve the end users in the design process, as well as the ability to engage in rapid prototyping, can be bolstered by the use of low-fidelity prototyping techniques [4][15]. Two such techniques are big paper [7] and sticky noting [13]. These are particularly effective when designing with children [5] but also apply to other age ranges and user groups. As new digital environment arise, these techniques need to evolve to suit them, such as when the ability to have multiple displays be a part of a single experience moved into the reality of affordability [1] and smartphones became ubiquitous[2]. We are there again, with 360° "VR" headsets as well as tablet and web-based experiences. Digital rapid prototyping using either special-purpose artistic and prototyping tools, such as Tilt Brush, proto.io, and instavr.co, or standard development tools such as Unity and WebVR, can require a higher level of technical comfort level as well as computing technology, and can lack some of the early design-idea benefits that a low-fidelity approach affords [14].

Given the real and perceived barriers to entry into the design process for virtual and augmented reality, such as time, costs, space, and resources, it is important to develop prototyping techniques that allow the quick and collaborative exploration of what users want in, and think about, a particular experience with minimal resources used. Consideration of this challenge is not new [8] but it is blooming as "everyday" access to VR/AR viewing technology rises [3][9] though the approaches discussed have overhead in the form of either artistic skills, such as being able to draw with forced perspective, or technology requirements that bring the techniques into the realm of medium-fidelity prototyping. This is where our new low-fidelity prototyping, "the 360th Degree" comes into play; it provides a method of prototyping that allows designers to explore and test overall concepts and features quickly and efficiently. While still debated in certain circles, the value of low-fidelity approaches has been affirmed time and again [16].

The 360th Degree Technique: Overview and Phases

First, we present the overview of this 360° prototyping technique and its phases, with images from an internal pilot use of the technique. In a later section we will present a different set of images from our first experimental application of the technique, as we discuss that design session.

Our approach to 360° experience prototyping is to provide a low-fidelity approximation of the look and feel of working on an immersive experience, while also supporting multiple design partners simultaneously without the need of an enormous working space or the disadvantages of cramped quarters during the main design phase. As one of our goals is to provide a technique that will have low entry costs, we accomplish this using no more than a consumer off-the-shelf 360° camera and tripod, along with common materials such as foam-core boards, simple metal easels, a standard color printer, paper, tape, and a variety of sizes and shapes of sticky notes.

Figure 1: A crop of a panorama to be tiled, printed, and attached to the foam-core art board octagon.

In this technique, the designer starts by taking the mid-region of a 360° photograph (Figure 1) and printing a tiled version of it. They will then connect eight foam-core art boards to each other with packing tape to create a working surface, and tape the individual tile sheets we printing onto that. This can then be spread out across a floor during our design session to allow everyone easy access to any part of the base image (Figure 2).

It is also a fairly simple matter to place them in an octagonal configuration on simple metal easels to produce a basic, somewhat-cylindrical, representation of a 360° scene (Figure 3). This will be used both to provide the design team a sense of the design space, and to allow them to experience their designs in-situ, as it were.

Figure 2: A view of the eight foam-core art boards with panorama taped to it, spread out across the floor, after a mock design session.

Due to the way in which the boards are attached to each other, the entire prototype can be easily folded together for portability or storage at the conclusion of the design session, to have available for later reference.

Before beginning the design session, the design/product team needs to select an appropriate scene on which to design and invite representative users to be a part of the co-design session. The tiling of the panoramic image, the printing of the sheets on a color printer, as well as the attaching of those sheets of paper to the foam-core boards with tape should be done in advance of the session. During the design session itself the final version of this technique contains six phases.

In Phase 1, begin by having all of the participants introduce themselves and answer a "question of the day" that is designed to help everyone begin to think about the day's design session. Then provide the design challenge/prompt and the details of this technique, including the types of sticky notes and the interaction feature that each type represents, and informing the team members that they should feel free to make use of online searching as part of the design process if the context supports that. Finally, divide your session's design participants into groups of three to four people (a combination of local designers and representative users) to work together in the next phases.

In Phase 2, arrange the boards in the octagon pattern on four metal easels and have the co-design groups take turns standing in the middle of it so that they can look around to get a sense of the scope and size of the design space environment.

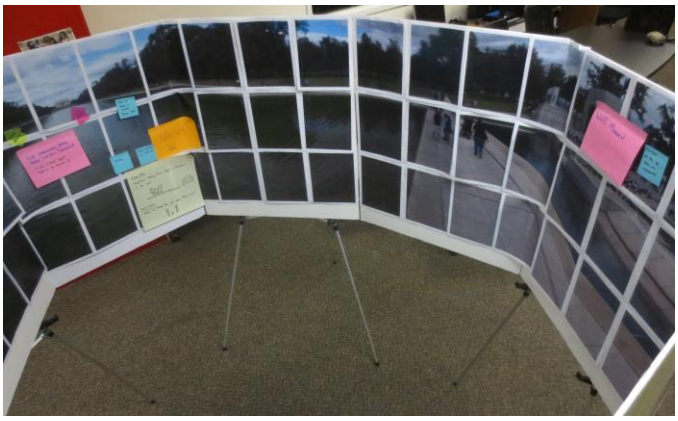

Figure 3: A view of part of the foam-core art board octagon set up on easels.

For Phase 3, you will take the octagon down and "unroll" it back across the floor to start the main design session so that everyone can easily move around it to add ideas, etc. The design partner groups can then brainstorm about things like points of interest, fun facts, questions about the space, etc. and add sticky note representations of these to the shared panoramic surface. It might be useful for one or more members of your core team to note things that are said during the design activities, or to record the session for retrospective review.

The length of time for Phase 4, the design activity phase, can vary, but 30 minutes is likely a reasonable target. Once the allotted time nears its end, or the generation of ideas appears

to be winding down, alert the groups that they have just a minute or two left, and then when they are done set the boards up on the easels either as a linear surface (Figure 9) or back as an octagon, and allow the design participants to see it at eye level (and to potentially make final tweaks or additions to it).

Phase 5 consists of having the design partners take turns pointing out one of the design elements that they added and explaining why they did so. If the final viewing was done as an octagon, "unroll" the boards back to being a linear surface. There can be multiple rounds of sharing this information. As the groups present, you can make a video recording of these presentations or have one member of your team write down what they each said in the form of bullet items and look for thematic patterns.

Finally, Phase 6 will wrap up the session by conveying the themes you have identified, and ask the participants whether you omitted anything. You can also ask where there are any final thoughts from them after having seen the final prototype.

Figure 4: An equirectangular image of the final mock design session artifact, ready for use in a VR viewing app.

At this point, the design team has both high-order themes as well as a detailed low-fidelity prototype (Figure 4) on which to base the next prototype iteration, which should be as a medium-fidelity prototype informed by this session, and expanding on it with domain knowledge of the product team.

Finally, the session leads reassemble the octagon to take a 360° photo for later use. To create an equirectangular image to use with VR headsets or other viewing mediums, simply place the boards back as an octagon on the easels, put a spherical camera in the center of the octagon on a tripod, and with the camera's height aligned to the center of the boards, step out of the octagon and either take the spherical photo on timer or via a remote control app.

One potential follow-up activity could be for each co-designer to view that 360° photo in a VR headset for immersion or in a web browser, to offer retrospective thoughts on the design.

The 360th Degree Technique: Logistical Details

Next, we present logistical details related to the construction of the prototyping surface, the selection of a location for the 360° foundation image, the creation of the panorama tile pages and the affixing of them to the prototyping surface, as well as further details about how the sticky notes are used.

Providing good conversation prompts when using co-design techniques to motivate brainstorming is important [11]. With the "360th Degree" technique, the panoramic photo used as the prototyping surface is a significant part of this prompt. It will be important for the image to contain multiple visuals targets. These could be items users might want to interact with or learn about or to which users might want to jump. However, they could also be items that serve as inspiration for related ideas. If the design target is a single 360° location, this should be the case by default. However, if the design session target is to be part of a larger set of connected locations or is meant to determine whether there should be a single or multiple locations, selecting it should take this into consideration. For example, in the pilot session that we will discuss, there are many locations on the National Mall from which we could have designed, but we selected one where there was at least one landmark visible in each direction in addition to the Mall itself to provide multiple design prompts.

Once you have selected the panoramic photograph to use, it needs to be cropped and tiled to be affixed to the foam-core art boards. The cropped region should be from the "middle" of the image, along the horizon. The aspect ratio of the cropped region should be as close to 36:5 as possible so that it leads to a good tiling when printing. The printing target is portrait-mode pages with ½" borders, 28 columns wide and 3 rows tall. An example of how to accomplish this is to open the image in Microsoft Paint, go under Print - Page Setup, and set the orientation to portrait and set the scaling to fit to 28 by 3 pages. The higher the resolution of the original image, the better the look of the printed image will be, but current commercial-grade spherical cameras such as the Ricoh Theta S or Nikon KeyMission360 provide sufficient resolution for the purposes of this technique.

To create the prototyping surface, we started with eight foam-core art boards, cut to be 36" by 28.5". The boards were connected to each other using clear packing tape along the 36" sides, leaving ½" spacing between them (to allow them to be folded on top of one another for storage). Once assembled, the 84 printed sheets need to be taped onto that surface. Each board will hold three and a half sheets across, where their borders are overlapped, and three sheets down. This can be done by having seven sheets span two boards, or, to make it easier to fold and unfold the surface without damaging the sheets, you can cut the 4th of every seven sheets of paper to allow it to span two adjacent boards (Figure 5). Start by placing the first 28 sheets, flush across the top of the foam-core surface and using clear tape to attach them to the boards. Then place the next 28 as a second row, aligned with the first so that the top of the sheets in the 2nd row touch the bottom of the sheets in the 1st row. Next, tape these down by lifting each corresponding sheet in the first row to tape the 2nd row sheet directly to the foam-core boards. Finally, repeat this process for the 3rd and final row. Depending on how many people are working on this stage, this preparatory work can take between 30 and 60 minutes.

Figure 5: Two of the eight boards seen with sheets affixed in 7 columns (3.5 and 3.5) by 3 rows.

One thing to note is that when arranging the boards into an octagon, the two end boards can be affixed to each other using something less sturdy, such as wide painter's tape, to make it easier to go from the octagonal arrangement to either the spread-out version, or to fold for storage. To elevate the octagon into place, use the four lightweight metal easels with plastic chart supports arranged with one behind every other board in the octagon. This will then take three or four people working together to lift the octagon up and slide the chart supports under the boards. The processed is reversed to spread the boards back out or to store them.

During our design sessions we used four types of sticky notes (Figure 6) where each style had a meaning and purpose assigned to it, with an explanatory sign. However, variations on this are easy to create by using more or different shapes and sizes and/or by assigning meaning to the sticky note color as well as its shape and size.

Figure 6: Image of the four sizes and styles of sticky notes we used.

Arrow-shaped notes represented portals the user could select in some way to jump to a different location or different VR experience. Their sign was, "**Portal: Jump to a 360° image at this spot in the distance.**" Standard 3" sized square ones represented fun facts that should be shown in some way. Their sign was, "**Fun Facts: Write down a single fun fact or bit of trivia.**" Medium sized 6" by 8" rectangular notes represented points of interest and a list of some of the interesting things about that location or object. Their sign was, "**Points of Interest: Name the location. List interesting things.**" Large square 12" notes represented a photograph that should be able to appear in some way and on which to sketch what should appear in the photo and to write a caption and/or blurb about the photo. Their sign was, "**Photos of Events: Sketch the image. Write a caption.**"

Pilot Design Session: Details and Discussion

To explore the technique in a realistic scenario, we worked with the Kidsteam intergenerational design team at Maryland's Human-Computer Interaction Lab [19] to prototype what we thought of as a 360° "annotated reality tour experience" for grade school and middle school children that would allow them to experience and learn a little about the National Mall. We selected a location on the Mall from where to photograph the 360° panorama on which we would design that would provide a clear point of interest in each direction (the Washington Monument, the Smithsonian Castle, the Capitol Building, and the Museum of Natural History) while also being at a location on the Mall where many events have taken place.

Figure 7: A middle-crop of a panorama with a 36x5 aspect ratio, ready to be tiled, printed, and taped to the foam-core art boards for the prototyping session.

Our "circle-time question" during the individual introductions was, *"What is something that you know about the National Mall in Washington, DC. If you don't know anything about it, what's a question you have about it."* The goal in asking this was to get everyone thinking about the design prompt that would come next, and to set the stage for potentially searching online for answers to questions they might have about the Mall, the answers to which they think the users of the annotated reality experience would find interesting.

For the design portion of the session the design team was divided into three groups, one with two children and one adult, one with 3 children and two adults, and a third one with 2 children and one adult. One additional adult was circulating between the groups and the foam-core board design surface during the session. Each group was based at a computer workstation around the periphery of the room where they could search for information. After each group's members had a turn to stand in the middle of the octagonal presentation of the design surface, the boards were taken down and spread out down the center of the room.

A table was prepared with the different types of sticky notes at the head of the room and the groups then spent the next 30-40 minutes brainstorming ideas and researching facts about and related to the part of the National Mall shown on the design surface. As they did, they added the appropriate sticky notes to that surface to represent features that they felt the experience should contain (Figure 8).

Figure 8: One of the child design partners placing one of her sticky notes onto the design surface.

Once the design portion was concluded, the boards were placed back up on the easels (Figure 9). At that point, everyone was given a few minutes to look at the design as a whole, and then each member of the three groups, both children and adults, took a turn telling the group about one of their design ideas.

Figure 9: The eight boards assembled vertically on the easels for the presentation of ideas.

The 7 children and 5 adults worked together for a little over 30 minutes and generated 52 sticky notes (by sticky note type, there were 11 portals, 25 fun facts, 8 points of interest, and 8 photos). The static and planar appearance during design did not stand in the way of suggestions regarding looking inside buildings or walking distance between locations that could be seen. While many ideas focused on basic facts (the number of windows in a building or the age of a tree) the participants also included things like historic facts (like that the Smithsonian had a sort of zoo on the National Mall in the 1880s) and images of the site (such as construction photos) and seasonal views in their design.

Physical to Digital

After the design session the ideas represented by the sticky notes that were generated were reviewed, and using a JavaScript library called hotspots.js [17] a medium-fidelity iteration of the tour experience was created, and we asked the children to try it out and offer additional feedback. As anticipated, the feedback that they provided here focused more on technical design aspects such as the quality of the 360° image, the fact that when you looked down you saw the head of the photographer who captured the 360° image, the quality of the regular images that appeared within the "photos of events" hotspots that were implemented, etc. This reinforces our belief in the need for low-fidelity approaches such as the one introduced in this paper to help support broader creativity from our co-designers in the earlier design stages, as well as our satisfaction with the outcomes of our design session.

Conclusions and Future Work

The overall results and observations of the session were encouraging. Using this low-fidelity prototyping environment that provided a moderate-resolution 360° viewing angle of the space showed itself to be effective in revealing the general layout of how the target experience should appear. The members of the team easily understood how to use the different types of sticky notes. Although the child participants were mostly unfamiliar with the details of the National Mall, the combination of the panorama as a design prompt, and the availability of workstations to search for additional information supported an active session leading to the generation of many design elements.

If we consider two of the purposes of a prototype being to serve as a sort of contextual "filter" through which we can see a design space, and to "manifest" the design ideas generated during a session in a concrete way [10], then "the 360th Degree" technique facilitates both of these with relatively low entry costs or technical requirements of the co-designers.

One idea generated by the children during the design of this "annotated reality tour" experience was that having access to an overhead map of the area was very desirable. This provided the design team geographic context for the location, which was important for choosing some of the "portal" destinations, as well as providing more information about where to "look" on the design surface for things the participants knew existed. As we look to utilize this technique in future design sessions with external partners we will also look to categorize the types of VR/AR experiences that it can best support, as well as the types of useful peripheral resources to recommend using during such sessions.

Additionally, this technique assumes the existence of a 360° "background" on which to design. We are exploring a technique called CubeDraw [18], through which non-technical co-designers will be able to express original, potentially blue-sky, ideas for a 360° world onto which they can then design an experience, using little more than drawing supplies and their creative vision to create a representation of those ideas.

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