Virtual Venues:

Using VR to facilitate more accurate and innovative lighting design and stage control.

Tyler Sorensen
Development

Aashna Mago
Design
User Testing

Aaron Furrer
Team Manager
Documentation

PROBLEM AND SOLUTION OVERVIEW

Across various musical genres, many artists utilize laser light shows synchronized to their songs to enhance the audience's experience at major concerts. Musicians can compose and rehearse songs relatively easily, but the same cannot be said for the corresponding light show. Finding a venue, bringing and setting up the proper equipment, and tweaking all aspects of the lighting display can be extremely tedious. Rearranging lighting is also often necessary, which is a hassle and must be done within the time constraints set by the venue. Lighting design would be much simpler if it were possible to test and create lighting shows on a personal device wherever and whenever one wanted.

Artists could implement Virtual Venues using virtual reality headsets to design and test light shows in advance of their performance. Rendering a 3D version of the venue in which they would be performing, the artist can begin the design process. Using the interface to navigate the venue, the artist can place their chosen style of lights in locations within the virtual venue. After synchronization and light layout are complete, the artist can test the display. To test the display, the artist can play his/her songs along with the light show, assuming different positions within the venue to observe the show as the audience would. Designing light shows using virtual reality could greatly reduce the time and error involved with set-up and testing at the physical venues.

CONTEXTUAL INQUIRY CUSTOMERS

April Yang is a Stanford undergraduate (20-25 years old) who has experience with theater production. In the past, April has assisted with lighting for the Stanford Shakespeare Company. She has worked alongside lighting designers and is familiar with industry standards for lighting design and software that is commonly used. We chose to interview April to get the perspective of someone who actually works with lighting for performances to better understand what key tasks are and how they are currently performed. To help better understand some of these techniques and lighting design we had April walk us through basic lighting while answering our many questions along the way.

Figure 1. April Yang, one of our interviewees.

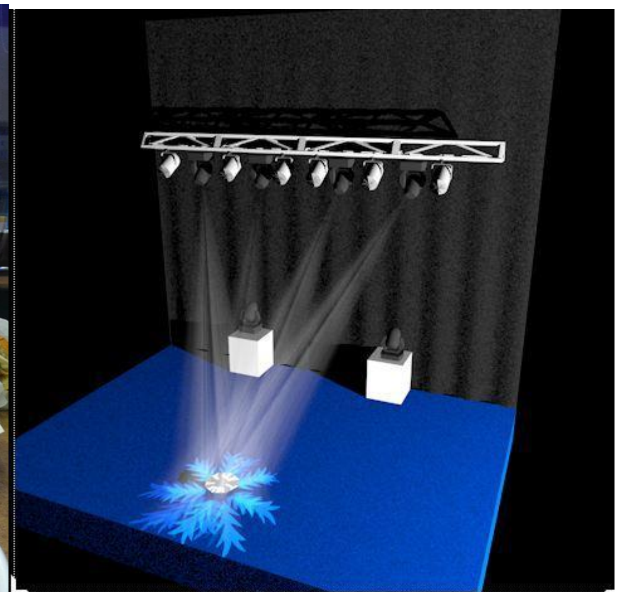

Figure 2 (left). April told us about a program called Vectorworks that is commonly used by lighting designers at present to visualize their lighting placement. The software can be complicated to understand.
Figure 3 (right). April is involved in productions put on by the Stanford Shakespeare Company.

Harrison Wray, a Stanford graduate student (20-25 years old), is a DJ in his free time. We approached him to learn more about what DJs do and the kind of preparation (or lack thereof) that takes place before a performance. We interviewed him about the various venues at which he has performed, most of which are on Stanford's campus. He gave us insight into how artists plan for performances, some of the challenges they face, and what some of the distinguishing features between different venues tend to be.

Figure 4. Harrison Wray, one of our interviewees.

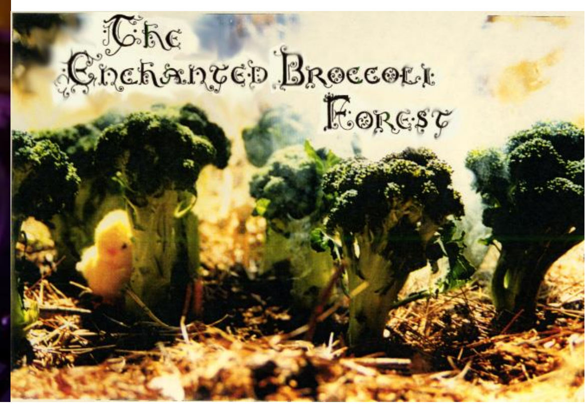

Figure 5 (left). Harrison is a DJ who performs at events on campus.
Figure 6 (right). Enchanted Broccoli Forest, a co-op on Stanford's campus, is one of several venues at which Harrison performs. EBF is an example of a venue that we could potentially virtualize using our application.

Thai Phan is a development engineer at the MxR lab in Los Angeles, CA (30-40 years old). The lab is affiliated with the University of Southern California's Institute for Creative Technologies and does cutting edge research regarding virtual reality and human-computer interaction. Thai has been working at MxR for about four years and is involved in many of the projects at the lab, including work with multitouch user interfaces, creating mobile viewers for iPads, iPhones, and Android devices, and creating virtual reality experiences and devices for the US Army and Navy. He was involved in mentoring Palmer Luckey, founder of Oculus VR, who first started at MxR and did much of the early work developing his revolutionarily cheap and accessible head-mounted displays at the lab several years ago. Thai gave us valuable advice regarding the technological feasibility of our device and directed us to resources that would help create virtual representations of physical venues and realistically render dynamic lighting in virtual worlds.

Figure 7. Thai Phan, one of our interviewees.

Figure 8. *Crescent Bay,* the latest prototype of the Oculus Rift. This head-mounted display features LEDs on both the front and back to allow for positional tracking even if the user is turned and not directly facing the camera that Oculus provides.

CONTEXTUAL INQUIRY RESULTS

Our interviews definitely confirmed our assumptions about our original problem: planning and setting up light shows is currently a tedious process that often has disappointing or incomplete results. This is due in part to the current software available for lighting designers to lay out and visualize their designs -- applications with busy and non-intuitive interfaces. April, who has experience with production and lighting design, gave us insights into the details of the experience. She told us that professional lighting designers can connect their personal computers to the venue’s systems via USB and their shows will load up with all of the preprogrammed cues, but they still have to do patching, which consists of connecting lights to the appropriate numbers on the lightboard) and double-check all of the cues. These designers only get two chances to do run-throughs, which leaves little room for error and few opportunities to do any redesigning once they are at the physical location.

Interviewing Harrison also led us to address some of the assumptions within our original proposal. For example, talking to him highlighted the existences of distinct use cases: actually preparing for a concert at a specific venue, actually nailing down timing and exact positions of lights, or creating an initial design for a reusable light show. He suggested that we learn about how variable lighting can be from one venue to the next in order to choose between these two concepts. For the latter, he pointed out that we could create virtual representations of archetypal venues so that artists could get a general idea of how their shows would look without having to pay for custom virtualization of a specific venue. From his own experiences, he noted that he primarily performs at indoor venues and that acoustics and his position relative to the crowd tend to be the main distinguishing factors between venues. The major insight that we gained from Harrison is that as a DJ, he doesn't know his audience beforehand, and he thinks that "feeling the crowd" and improvising is key to a successful show. He doesn't do much planning beforehand, and we began to realize that artists like him may not either. To an extent, our original proposal rested on the assumption that lighting designers for shows similar to Harrison's would be interested in an application that allowed them to realistically plan lighting shows ahead of time. We now realize that the kind of application we originally discussed would probably be targeted to more prominent and professional artists who are going on national or international tours, performing on large stages with complex lighting and laser shows, and who can afford the time and effort required to extensively plan lighting ahead of time. Artists like Harrison, on the other hand, are more drawn to the idea of an app that allows them to play around with different sounds and lighting for the purpose of creation. He was excited when we suggested a VR application that simulated the experience performing in front of an audience in order to make improvisation feel easier and more natural. He is a DJ whose work focuses on music and acoustics, but he expressed interest in a sync feature that would allow him to see lights (perhaps auto-generated) while he made beats.

Thai was most helpful to us in regards to the virtual reality aspect of our project. He provided us with additional information about head-mounted displays and the theme of creation in virtual reality. From our interview with him, we realized that virtualizing venues and rendering dynamic lighting would be two of our majors tasks. He gave us advice on how to make or obtain 3D models of venues -- for example, he directed us to some professional companies that laser scan venues and provide meshes that can be imported into virtual worlds. In fact, the MxR lab at which he works is in the process of creating a virtualized version of the lab facilities. We realized that the process of laser scanning venues would be complex and expensive and decided that it might be most practical to offer users with five or six popular venues as options in our application rather than creating virtual versions of any venue from scratch. Ideally, we would want users to be able to photograph their venues quickly and get virtual representations outputted, but it is very difficult to stitch photos together to create 3D models, and current technology would not allow for this feature. An important point that we discussed with Thai is that we may not have hardware powerful enough to actually light up our venues dynamically. We determined that dynamic lighting *is* a necessity since synchronizing lighting shows with music and perfecting timing is an essential feature for our application. He offered some suggestions of ways to simulate lighting without overly taxing the CPU. This would especially be a concern if we used the iPad as our platform instead of the Oculus Rift. We decided together with Thai that the iPhone is most likely not a potential platform due to its limited processing power.

TASK ANALYSIS QUESTIONS

Who is going to use this system? Virtual Venues can potentially be used by a variety of customers involved with lighting and light design. The main focus will be on DJs and musical artist to aid in efficient show set-up while on tour and performing at a variety of venues. For artists who design and synchronize light shows in advance it will enable them to get a feel for and essentially rehearse at the venue remotely.

What tasks do they now perform? Currently setting up lighting displays can be very expensive and time consuming. Artists need to scout venues in order to determine potential lighting placement to begin the design process. There is currently software that aids in the design process to give approximations of lighting within the venue. After design and synchronization with the music the displays must be tested. Set-up and testing can be a very tedious task moving all the lights into position and determining whether or not the proposed display is effective within the venue.

What tasks are desired? Virtual Venues will play a key role in designing and testing light shows in a multitude of venues. The process starts with a 3D rendering of the venue itself. Using this representation of the venue the artist or designer can navigate the environment to determine placement of the light and view the stage from perspectives within the audience. Using the interface lights can be virtually placed within the venue to be synced with the artist's performance. Finally the show can begin allowing the artists and designer to view the dynamically lit venue to achieve the most realistic experience. Overall this will streamline the set-up process at the physical venue and enhance the quality of performances.

How are they learned? The user interface will streamline the light placement and testing process with a clean and clear display allowing the user to easily navigate lighting options. Largely the interface will be self-explanatory with easy to use drag and drop controls. Artists will be able to select from the available styles of lights dragging and placing them in the venue with the desired orientation. Once the lights have been placed the artist can adjust light timing according to the tracks being played. Upon completion the user can immerse them in the virtual venue to enjoy the masterpiece that they created.

Where are the tasks performed? At present, lighting designers can do some design and planning on their own computers using software, but a great deal of lighting design has to be done physically by actually going to venues, scoping out the space, and testing out multiple configurations there. If the Oculus Rift were used as our platform, it is possible that the device would have to be used on a motion capture stage to facilitate positional tracking. This is especially true if we implement data gloves or require tracking for anything other than the head, because although the Oculus Rift DK2 comes with built-in LEDs for tracking and a small camera, other body parts and objects cannot be tracked.

What's the relationship between customer & data? Customers would use our interface to view virtual representations of venues, test out lighting placement, and create new light shows. Our customers themselves probably would not have access to 3D models or blueprints of the venues at which they wanted to perform, but we could custom make virtual representations of venues or obtain models from architectural firms whenever possible (as suggested by Thai). We will most likely provide customers with an interface that indicates predetermined locations within each venue at which it is possible to install lights as well as the range of possible light types. It would be up to the customer to choose the actual placement, lighting types and colors, and timing and synchronization with music and performances.

What other tools does the customer have? Currently, artists and lighting designers use software like Vectorworks, LX beams, Visual, and AGi32 to visualize virtual representations of what their lighting will look like in the real world. As April emphasized, however, these programs have relatively complicated interfaces. They are also viewed on normal computers, and thus, cannot provide the same level of realisticness that virtual reality can. Users still have to physically go to venues to really see what their lighting will look like in the space. Customers also make use of other equipment including lightboards, DJ lighting, and other lighting fixtures like profiles, Fresnels, and spotlights. As we move forward, we are aware of the fact that iPhones, iPads, and other mobile devices are widely prevalent, while most of our potential users don't currently have access to head-mounted displays and motion capture stages. We discussed this with Thai, and we do ultimately believe that the Oculus Rift and our application for that platform could be a powerful tool.

How do users communicate with each other? Our users could potentially use our platform to share designs and shows with other users. One major benefit to facilitating communication and sharing amongst users is that we could minimize the amount of effort spent on creating virtual representations of venues from scratch. Customers could borrow virtual worlds utilized by their peers and easily obtain 3D models of different venue types. They could also draw on other artists' lighting shows and designs for inspiration, and because we would enable them to view these shows in such an immersive way, the experience would be more powerful and valuable than just seeing lighting on a diagram.

How often are the tasks performed? This depends on the main use-case of the application. If Virtual Venues is used to fine-tune venue specific shows, then the tasks would be performed before a concert involving a new venue, song, or light show design. If the main use case is to explore general light show design concepts to be used at various shows and venues, then the tasks would be performed as often as the user is interested in doing so. Designing lights shows today using software such as Vectorworks is very time consuming, so we expect using Virtual Venues to be time-intensive, but less so than Vectorworks or LX Beams.

What are the time constraints on the tasks? If the user is designing for a specific concert, he or she has the time between when he or she decided to do the concert at the specific venue, and when he or he needs to set up the light show. This time frame can vary a lot. Major artist sometimes announce their tours a year or more in advance. Smaller performances such as DJing at a small party are organized on a shorter notice, but they also take less time to plan.

What happens when things go wrong? If the assumed lighting positions are not actually possible, then some lights will have to be put in a different location, or removed entirely. This can worsen the aesthetics of the show, or brightness of the venue. if the heights of lasers and lights are not properly considered, they could be set up to injure peoples' eyes. Potentially, if using Virtual Venues does not work for the user, he or she could design and practice the light show in person, if he or she has time to do so. Again, this may result in a worse show, and also a waste of time.

MAJOR TASKS

Lighting Placement and Testing (Simple)

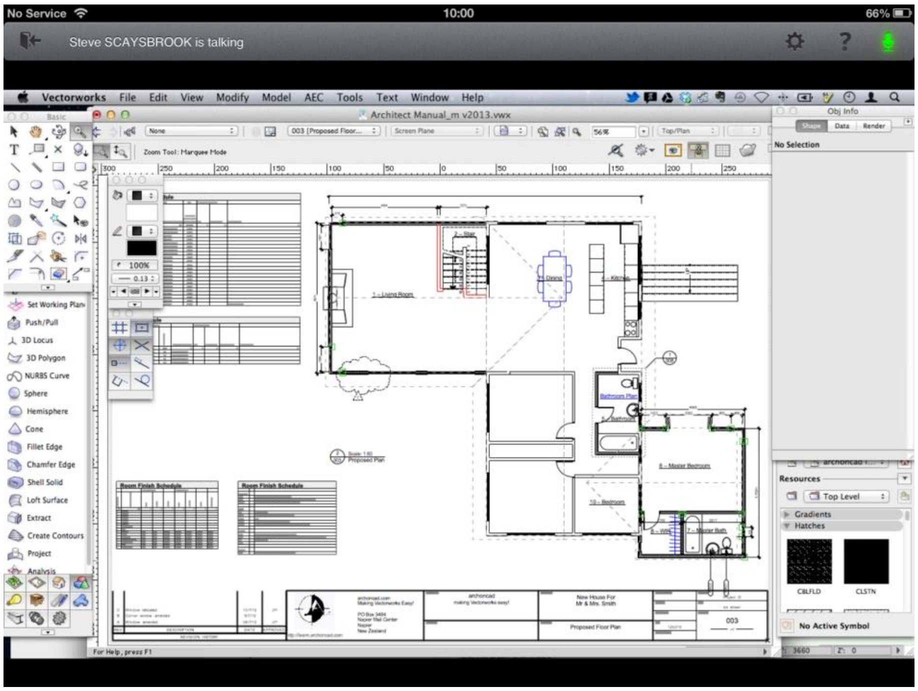

Figure 9. Vectorworks, the current industry standard for lighting designers. The software has a complicated interface that is clearly intended for experts and is not particularly user-friendly. This software involves a learning curve and still makes testing lighting a tedious process.

As seen above in the image of popular lighting software Vectorworks, there are an overwhelming number of options. To the beginner or untrained eye this is a convoluted mess of buttons and menus with no hope in sight for finding the options desired. Even for an expert, having the sheer number of menus it takes significant time to navigate each one to get the desired result. Using Virtual Venues the user will be able to interact through touch, picking which type of lights they wish to place. Upon placement of the light within the 3D venue they will be able to select the light to fine tune angles and direction of movement. After placement is finalized synchronization software can be used to integrate the light display with the music being performed.

Evaluation of Light Show (Moderate)

Figure 10. After designing their laser/light show, users will evaluate it by watching the 3d representation of the show from start to finish. Users will be able to visualize the show from various vantage points within the venue.

This task is admittedly the most fun, and also the task that benefits the most from using new virtual reality technology. We believe that the experience of doing this task will really separate Virtual Venues from other options such as Vectorworks. By immersing the user in the realistic virtualization of the venue, the user has the ability to understand depth, and appreciate how the appearance of the show looks from vantage points of various seats. In addition to providing a more realistic experience, doing this task in 3d makes it much more fun. People spend a lot of time and pay of lot of money to go to concerts. But by using our application, you can feel like you have magically been teleported to a concert, that is playing exactly the songs you want to hear, and with the exact laser/light performances you want to see. And all of this can be done in a very quick and simple way, whenever you want. Additionally, watching shows designed by yourself or your friends will make the experience even more fulfilling than watching a show whose designer is not known to you.

Virtualizing the Venue (Complex)

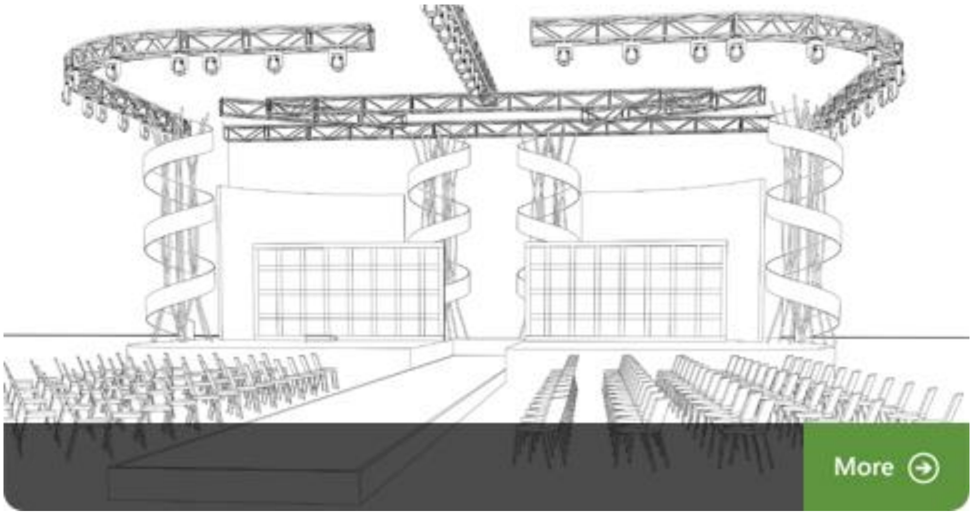

Figure 11. We plan on creating virtual representations of the venues at which our customers perform, either using 3D models of the venues, blueprints, or using laser scans of the physical venues to create 3D meshes.

Virtualizing the venue is the most complex of our tasks but also the most important one of the three. The concept of our product revolves around being able to navigate through the venue virtually in a remote location. The exact methodology of the 3D rendering is still unclear although we have several options to consider the answer will most likely result from a combination of them. Using the blueprints and architectural data on the venue will help to give accurate dimensions to the building. Even though the technology is not reliable enough currently a 3D representation could ideally be rendered from pictures using depth sensing technology. This combines both internal design of the venue and the dimensions. Lastly and the most feasible is using 3D laser measuring systems to render spatial representations. Overall, Virtual Venues will provide the user with both building dimensions and internal design to most accurately develop lighting displays.

APPLICATION IDEAS

Oculus Rift Interface

Oculus Rift is the most popular virtual reality headset, and a consumer version is expected to be released next year. The biggest advantage of using something like an Oculus Rift is that it is much better suited to dynamically render realistic lights, than an in iPad or iPhone. According to interviewee Thai Phan, “real” dynamic lighting on the Rift or iPad is not possible, but “fake” dynamic lighting could be done well on a rift. He was very skeptical of the ability of an iPad or iPhone to render even “fake” 3d dynamic lighting realistically. When creating an application for a virtual reality headset, special attention must be paid to how the user interacts the application. One common solution is to use a xbox controller that can communicate with the headset. This would certainly be feasibly, and probably pretty intuitive since many people have used an xbox controller.

Non-touch Touch User Interfaces

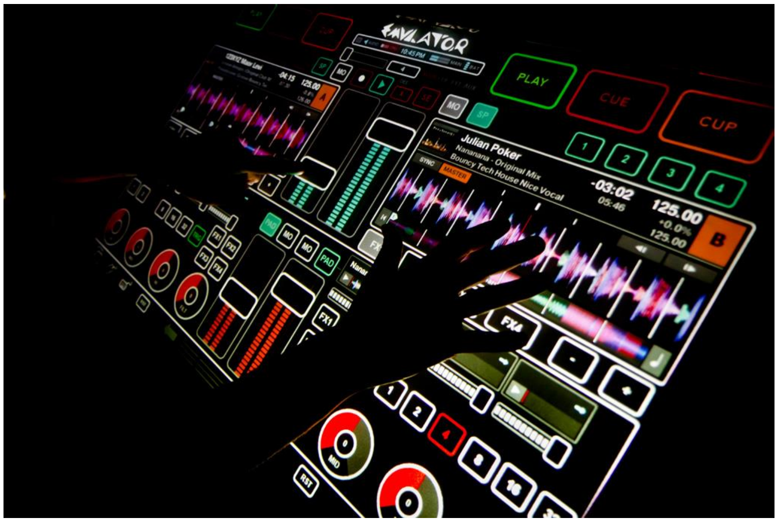

Figure 12. This is the Emulator Pro user interface. Emulator allows DJs to use a touch interface to make music during live performances. Although the interface is still cluttered and a bit complex, this is evidence that performers are migrating to touch interfaces and digital tools from traditional analog tools. Unlike our proposed application, this one runs on an actual touch screen.

Combining the use of virtual reality headsets and data gloves can allow the user to directly control the virtual environment from within the virtual environment itself. Having everything contained within the virtual environment provides the unique advantage that any space can become your workspace. It would be optimal to have flat surfaces (white board, plywood, table, etc…) for the tactile feedback of using an actual screen. This all encompassing system would also increase the ease in which lighting adjustments can be made from any point of view within the virtual venue. Artist will be able to dynamically interact with their displays and receive instant responses to create the best possible lighting combinations.

iPad interface

It is also possible to experience virtual reality with an iPad screen by attaching a simple set of goggles to the top portion of the iPad. The benefit on an application on an iPad is that it would accessible to a wider audience, since more people have iPads than Oculus Rifts. Another benefit of the iPad is that it has a large touch screen that the user can use to interact with the application while immersed in the virtual world. While it is true that the iPad has less processing power than a Rift, it may be that the simple touch interface of an iPad, combined its greater adoption, is worth the less realistic visuals.

DESIGN SKETCHES

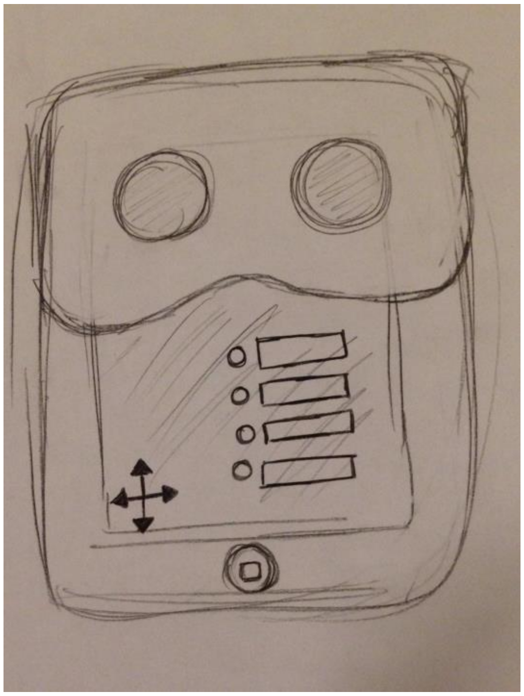

Figure 13. An iPad app that allows users to view 3D virtual representations of their venues using a 3D printed viewer that attaches to the iPad. This interface would include a digital/virtual joystick on the touch UI that allows the user to move around the virtual world, as well as a touch interface involving lighting options and placement. (*drawn by Aashna)*

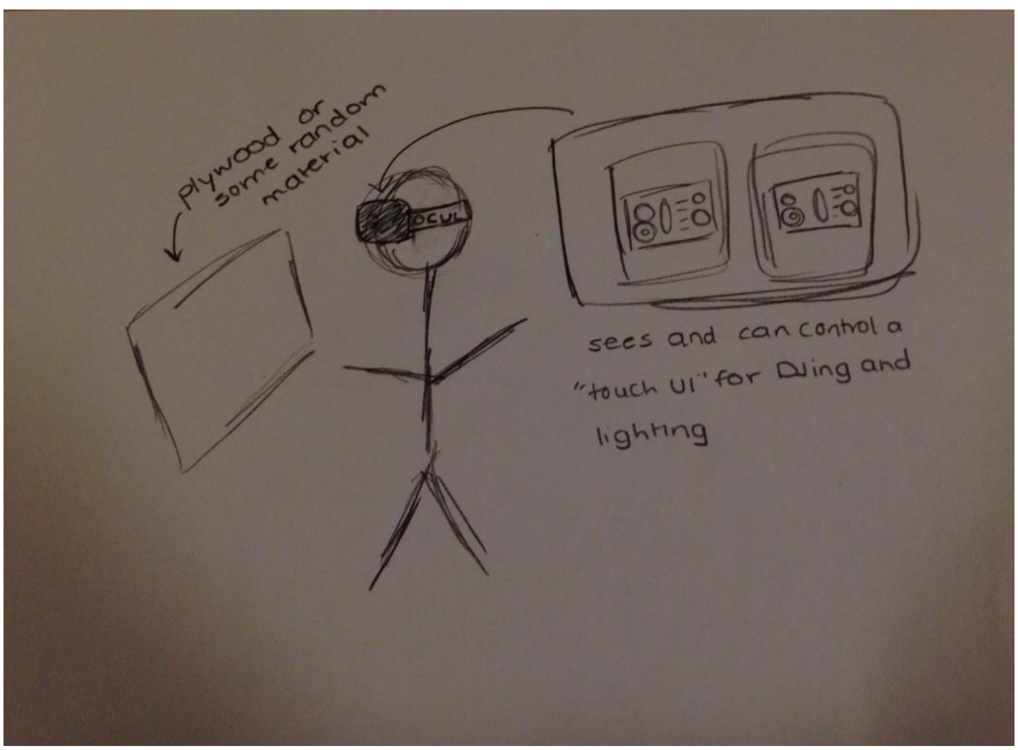

Figure 14. Using the Oculus Rift or any other head-mounted display creates a completely immersive experience for the viewer. He/she can see a touch screen in the virtual world and control lighting options (and potentially DJ controls) but it is not necessary to have a corresponding physical touch screen. A much cheaper and simpler option is to use any flat surface in the physical world, like a piece of plywood or plastic, so that the user feels something under his/her hands but sees a "touch screen" that he/she is controlling. *(drawn by Aashna)*

Figure 15. Standing in a circular room and using projectors to create the virtual environment the user can achieve the same interactivity as oculus rift without the need of a headset. The user can have physical control panels in front of them to manipulate lighting and movements through the venue which the projector is displaying. *(drawn by Aaron Furrer)*