Virtual Venues:
Using VR to facilitate more accurate and innovative lighting design.

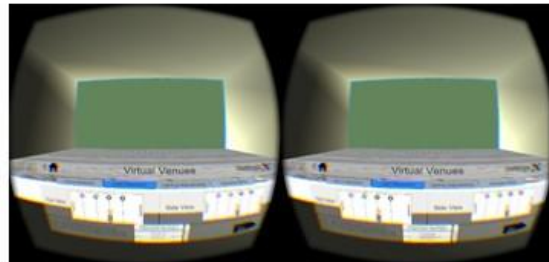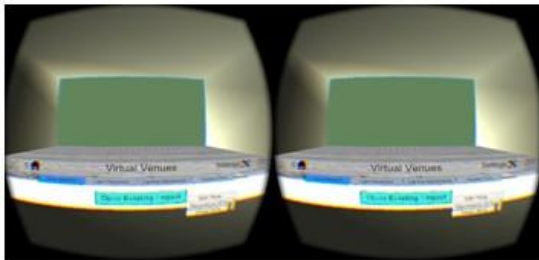| **Tyler Sorensen**	**Aashna Mago**	**Aaron Furrer**
Development	Design	Team Manager
	User Testing	Documentation

PROBLEM AND SOLUTION

Across musical genres, many artists utilize laser light shows synchronized to their songs to enhance the audience's experience at major concerts. Creating and rehearsing light shows can be much more cumbersome than planning the musical performances that they accompany. Currently, setting up equipment, tweaking settings, and rearranging lighting can be very tedious, especially 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 using our platform, Virtual Venues, work with 3D models of venues and perform tasks related to lighting design while being fully immersed. Tasks include lighting placement within the virtual venue, synchronization of cues with music, and testing the show from various positions within the venue. Our solution takes two cutting edge technologies - the Oculus Rift and the Leap Motion - and tries to do what has never been done before. By attaching a leap motion to the front of an Oculus Rift, users can use both of their hands to interact with a 3D world. Initially, users move their hands to select a venue and lighting placement. Then they are viewing a concert venue from the perspective of the audience. The venues lights can be programmed by the user through a virtual touch screen that appears right in front of them. Finally, with the tap of a virtual button, their light show masterpiece can be viewed from start to finish, as if they were viewing it in real life.

TASKS

Lighting Placement (simple): After the lighting project has been started and the venue selected, the user will begin the lighting placement. The placement portion of Virtual Venues features a unique drag-and-drop functionality that allows the user to easily place the desired lighting fixture within the venue. The option to choose a lighting fixture is new to our medium-fi prototype-- in the low-fi prototype, the user could select hanging positions within the venue, but couldn't choose specific fixture types, a missing feature that was noted by multiple users who were used for usability testing. In this portion, the screen is represented by two 2D maps, one from a birds-eye perspective and one side view that allows the user to see light towers. The user can also group similar lighting fixtures together at this stage in order to make adjustments to all of them at once.

Virtual Venues — Settings

Venue Selection | Light Placement | Lighting Adjustments | Visualize Show
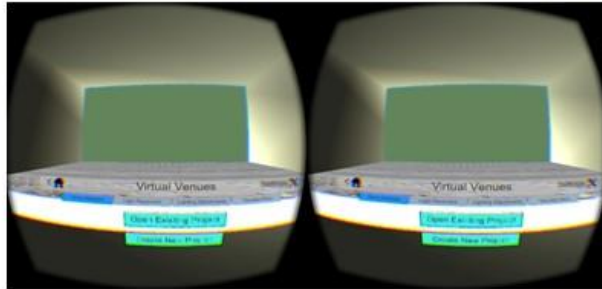
Open Existing Project

Create New Project

Virtual Venues — Settings

Venue Selection | Light Placement | Lighting Adjustments | Visualize Show

Create New Project

Amphitheater
Stadium
Auditorium
Tent

Virtual Venues — Settings

Venue Selection | Light Placement | Lighting Adjustments | Visualize Show

Open Existing Project

EBF Party
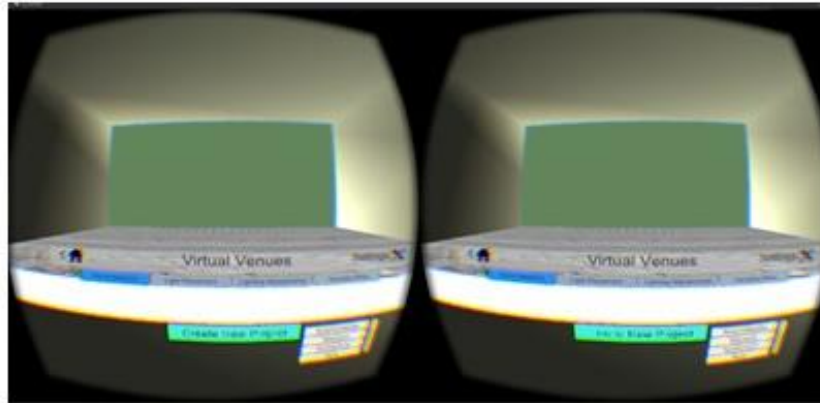Mausoleum 2014
Diwali 2014
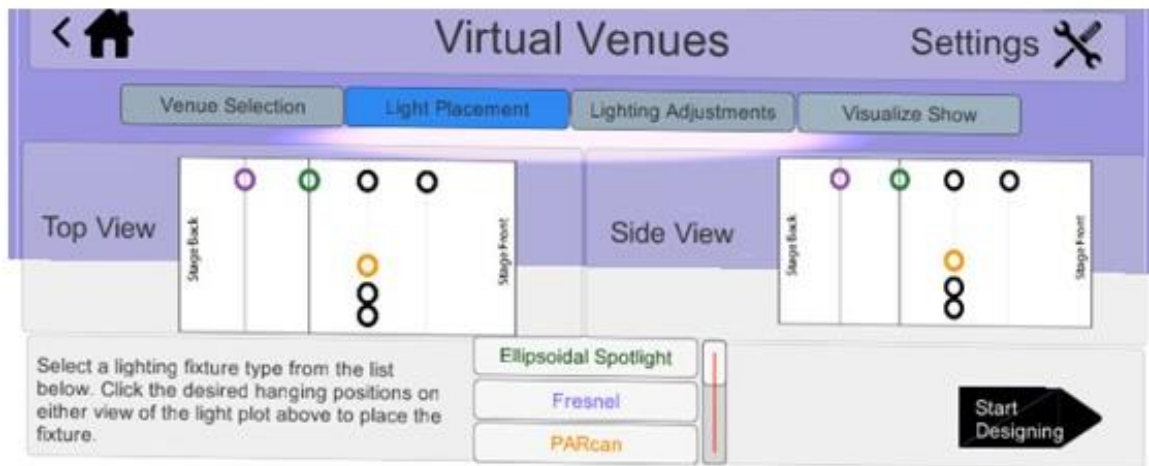
Figure 1. Storyboard walkthrough of Task 1: Lighting Placement. First, users select their venue. Then, users place lights onto the 2D map of the venue.

Lighting Adjustments (medium): Once the lights have been placed, each one can be individually selected, adjusted, and tweaked using the virtual light board, or groups of lights can be adjusted together. To minimize the clutter and overwhelming number of controls on a standard lighting board, Virtual Venues will allow the user to tab through desired controls. This feature helps guide the inexperienced user through creating a light show as only the tools for one option are shown at a time (e.g., color, brightness, movement, etc.). Based on previous feedback, there is a larger focus on new and novice users, which led us to decrease the number of options and controls present. Another key feature is preset cues which allows the user to select from pre-programmed lighting options for various standard venues and make small changes to those if desired to better align with the music.
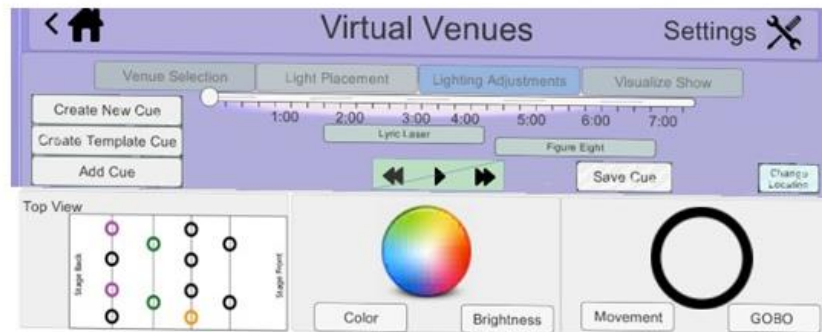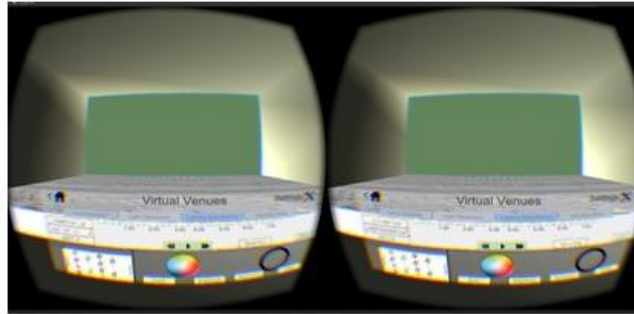
Figure 2. Task 2: Lighting Design. Users use this interface to design lighting cues, and add them to the list of cues for the show. To create a cue, first you would select "Create New Cue" in the top left. Then you would select a light from the 2d map in the bottom left. Then you would change its color, brightness, movement, or GOBO shape (if it is a GOBO light) using the panels in the bottom right. Then you would press "Add Cue", and it would show up in the middle of the screen.

Visualization (complex): Finally, at the end of adjusting and synchronization, the user can experience the light show that was just designed from a variety of locations throughout the venue. Although this is the most complex task in our application, it has the simplest user interface. The complexity comes from the underlying mechanics of producing dynamic lighting in virtual reality to match the light fixtures and cues that were just assigned to them. The user interface, however, merely consists of a direction pad and standard playback buttons (play, pause, fast forward, and rewind).
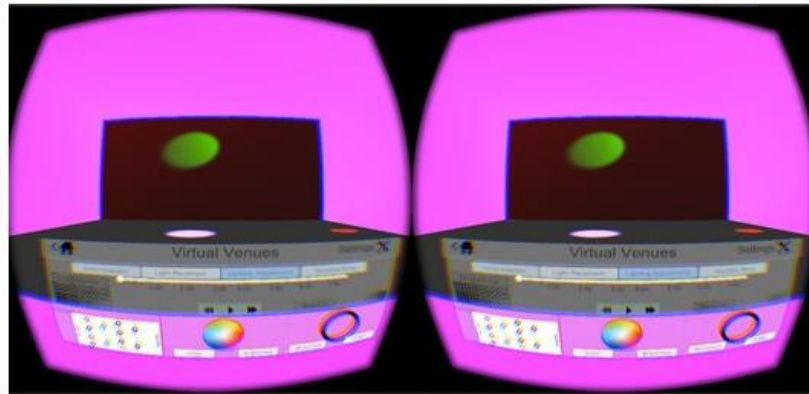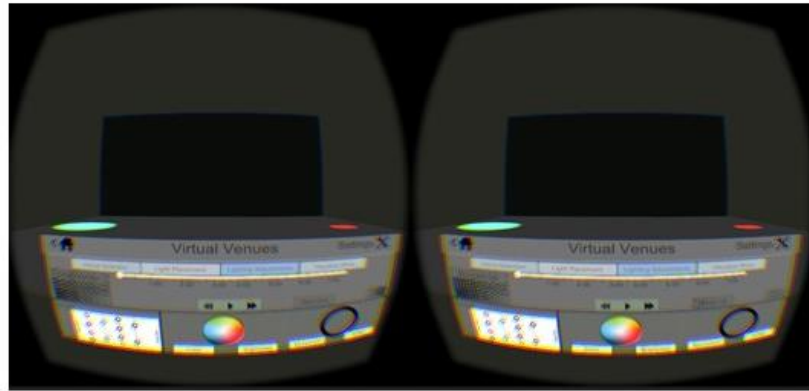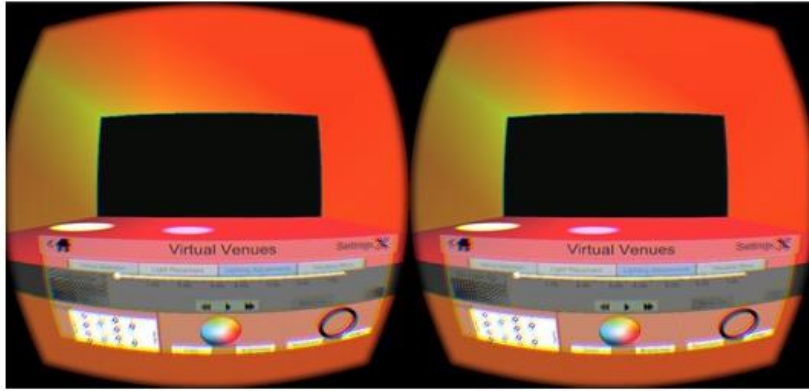
Figure 3. Task 3: Visualization. By pressing the play button in the center of the virtual light board, the light show plays in the virtual world.

MAJOR USABILITY PROBLEMS ADDRESSED

<u>Severity 4:</u>
1. <u>Violation:</u> No navigation bar, breadcrumb bar, progress bar (help locate within lighting planning process).
   <u>Fix:</u> Insert breadcrumb so that users know where they are in the process and there is easy navigation between screens. **(Figure 4)**
2. <u>Violation:</u> On fixture selection screen, diagrams poorly labeled (both have "Front" and "Back").
   <u>Fix:</u> Label which floor plan is the top view and side view to distinguish what set of lights the user is looking at. We also labeled the diagrams with "backstage" and "frontstage" to be clearer. **(Figure 4)**
3. <u>Violation:</u> Light design screen-- Bar keeping track of time doesn't have units.
   <u>Fix:</u> Add time units to cue progress panel. **(Figure 5)**
4. <u>Violation:</u> Back button always goes to very first screen … should go to previous screen and home screen should go all the way to beginning.
   <u>Fix:</u> This was due to a limitation in the prototyping application that was used. In the high-fidelity prototype the back buttons function properly due to the ability to keep track of previous pages. **(No Image - not screen specific)**
5. <u>Violation:</u> Throughout initial screens, buttons get smaller and smaller and underutilize screen space-- In "new project" Screen, "Amphitheater" and "Private Venue" are small and very close to each other… user might pick the wrong one (Fitt's Law).
   <u>Fix:</u> Keep text and buttons the equivalent and size and cut unnecessary options so the start-up process is more streamlined. **(Figure 6)**
6. <u>Violation:</u> Light show design page-- no information about where you are in the show … add a progress bar, top bar could fill up with a different color.
   <u>Fix:</u> The show is as long as the user wants it to be and progress in the show is measured by the timing of the cues therefore no fix was implemented. **(No Image - no fix)**
7. <u>Violation:</u> Light show design screen different from visualization screen, makes optimization cumbersome. Some simple preview should be available in lighting design screen to streamline design process and make it continuous instead of segmented.
   <u>Fix:</u> We eliminated the visualization screen because we realized that it was unnecessary. Our lighting design screen had always had the option to view the show and make changes simultaneously, but our evaluators may not have realized this due to the fact that the medium-fi prototype was on an iPad interface rather than in a virtual world. **(Figure 5)**
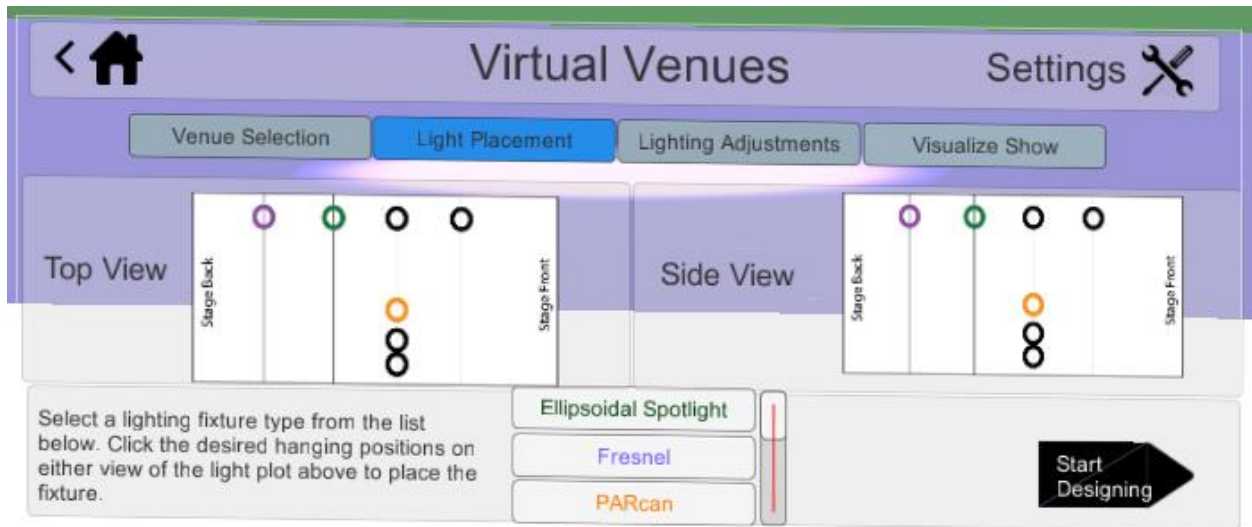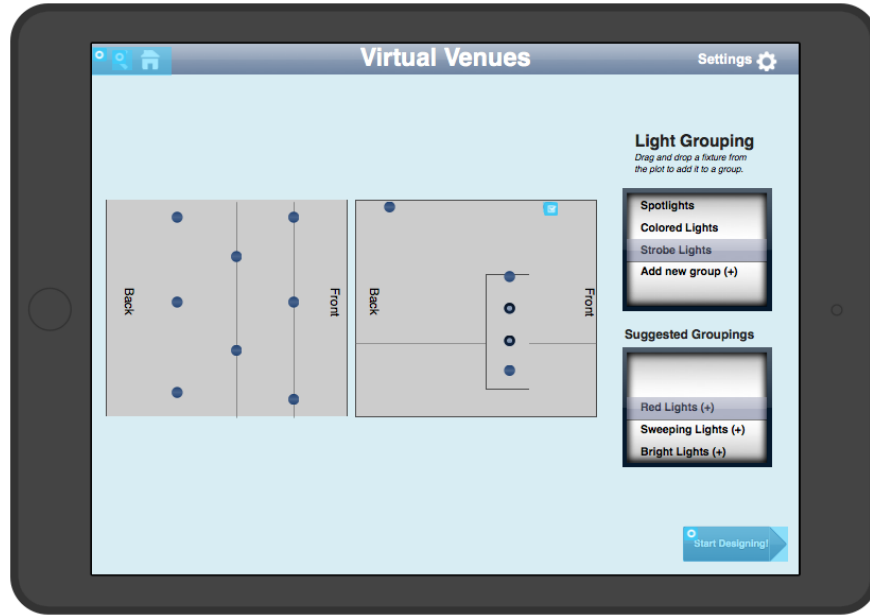
Figure 4. The fix to violation 2 can be seen above between the medium-fidelity and high-fidelity prototypes. The lighting plots are each labeled with "Stage Back" and "Stage Front." We also added a navigation bar to each screen to help the user see where he/she is in the lighting design process.
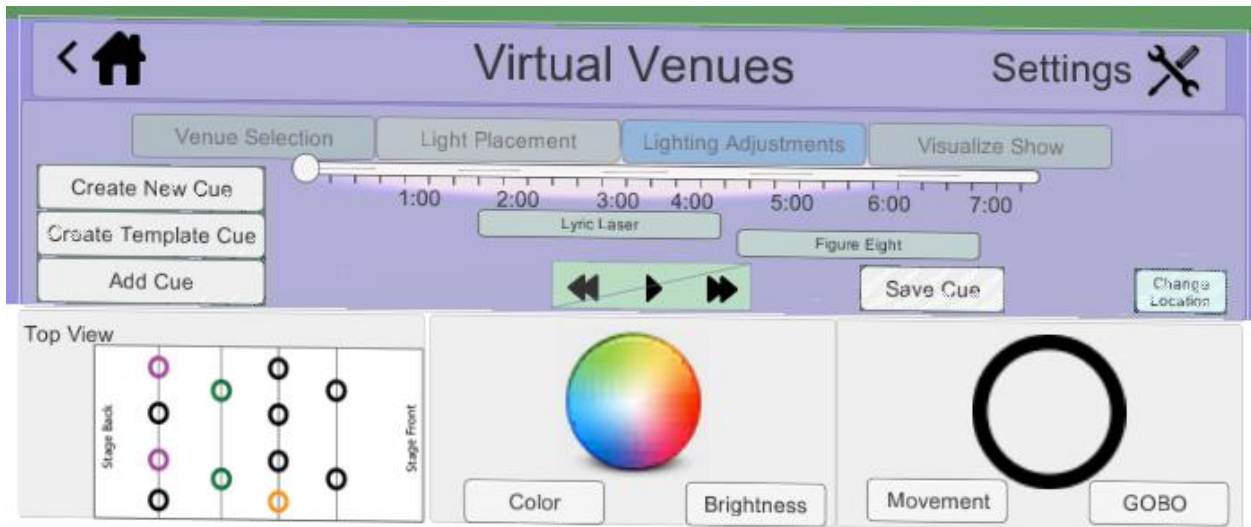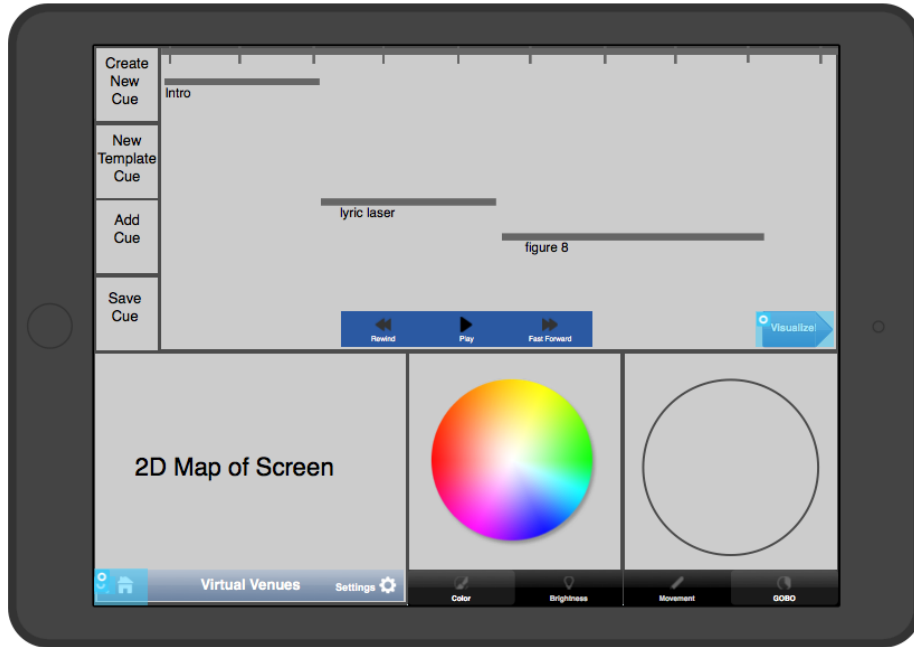
Figure 5. Above can be seen the fixes to both violation 3 and 7 from the heuristic evaluation of the medium-fidelity prototype.

Figure 6. The above image is the fix to violation 5, however, due to prototyping application complications (we no longer have access to our proto.io account), there is no available medium-fidelity comparison.

Severity 3:

1. Violation: Navigation feels slow because every option must be read & understood… few icons other than Home and Settings… may be difficult to understand technical terms
   Fix: We eliminated some of the unnecessary screens and complicated instructions, but for the most part, we didn't understand what it meant to include more "icons." **(No specific image is relevant to this violation)**

2. Violation: Instructions small and not noticeable.
   Fix: Use screen space to our advantage and increase text size and adjust positioning. **(Figure 7)**

3. Violation: Lighting fixtures are difficult to distinguish once their hanging position has been selected and they have been placed.
   Fix: Differentiate lighting fixtures by color of the ring that forms around hanging position when they're selected. **(Figure 8)**

4. Violation: Light grouping page: rewrite instructions or overhaul entire task methodology because the instructions are complex to interpret for novice users.
   Fix: We ultimately chose to eliminate the light grouping stage because the functionality and convenience of this feature were outweighed by the confusion it introduces. **(Figure 8)**

5. Violation: Instructions accompanying Dpad and play controls feels unnecessary because intuitive controls.
   Fix: Remove instructions for a cleaner interface and only included play controls on lighting design screen -- got rid of visualization screen

6. Violation: Light grouping screen-- unclear what "+" means… shows up once in top box and next to everything in bottom box. Confusing how the two boxes interact and if you need to select one from both for each lighting group. Adjust names and instructions above boxes

Fix: As mentioned previously, we ultimately eliminated the light grouping screen from our final prototype. **(Figure 8)**

Other changes:
When we eliminated the visualization screen, we added a "change position" button onto the lighting design screen so that the user could still move around in the venue and view the show from different vantage points. In response to a lower severity violation, we moved the "Save Cue" button to a different part of the lighting design screen (see Figure 2) because it didn't thematically with the buttons that were all related to adding new cues.
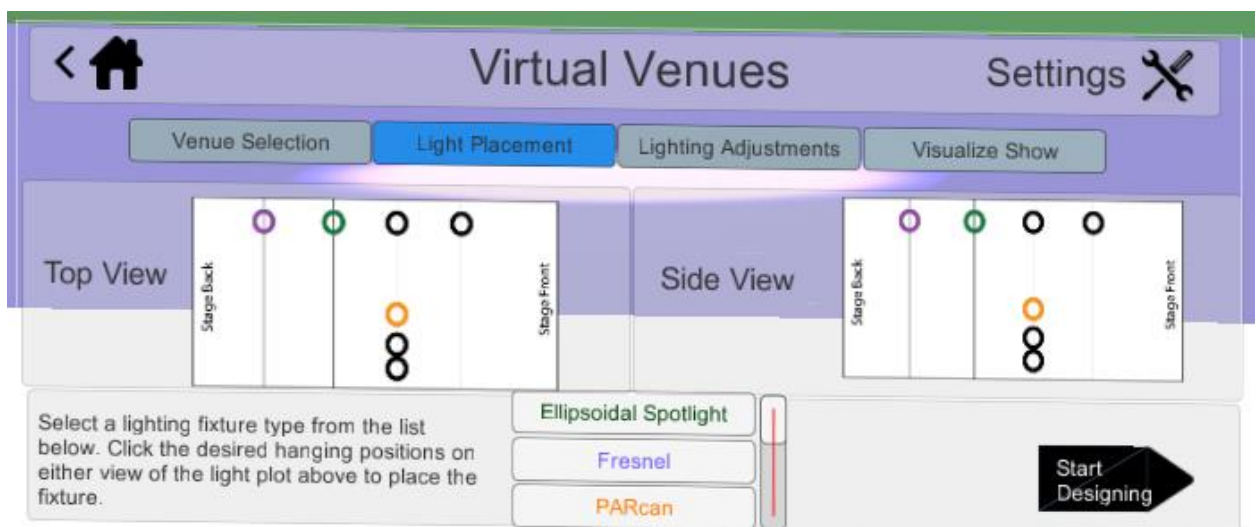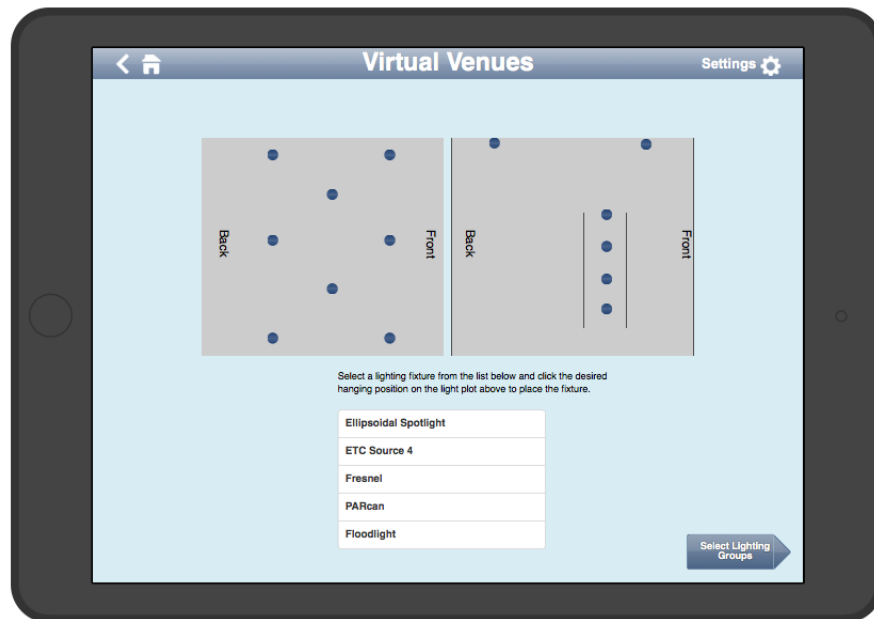

Figure 7. Between the screens above the fixes to violations 2 and 3 can be seen in the evolution of the prototype versions.
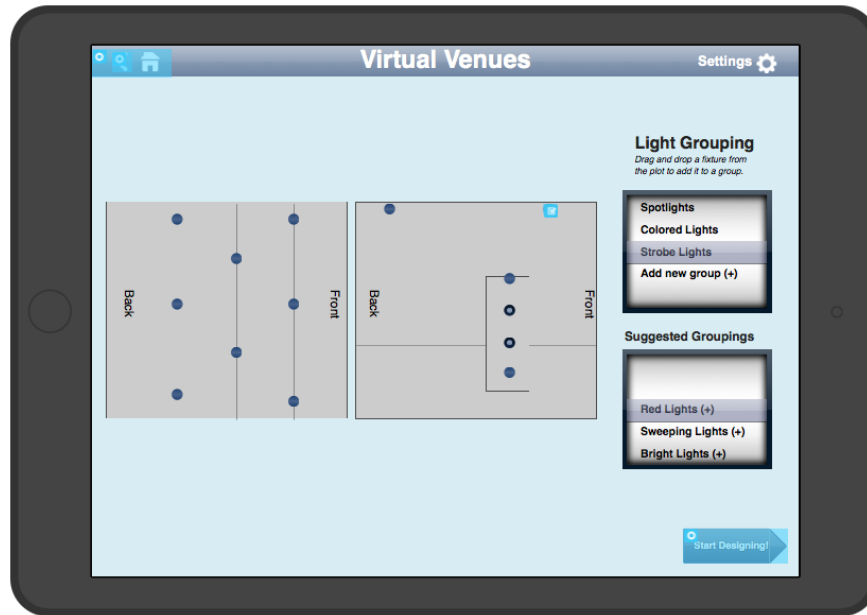
Figure 8. The above screen is from our medium-fi prototype and contains the heuristic violations (#4 and #6) that we alleviated by removing the light grouping screen.
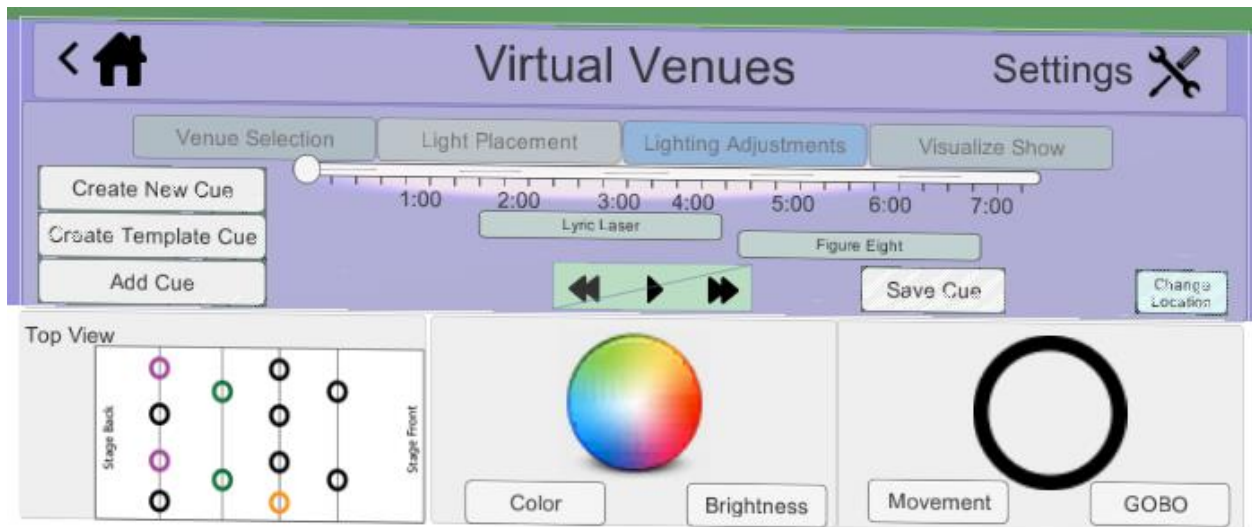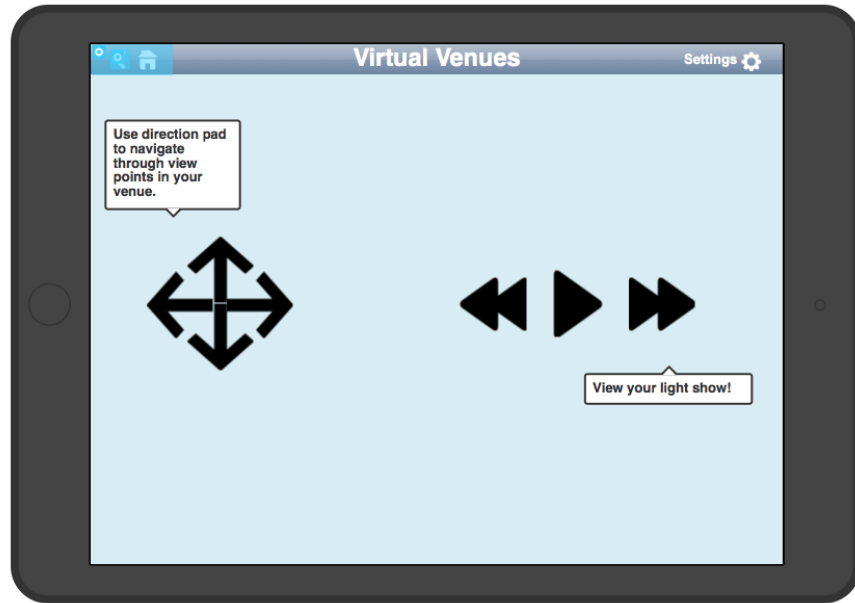
Figure 9. The visualization screen presented our team with many design problems because it just seemed too simple. Here is the fix to violation 5 and our visualization screen problems.
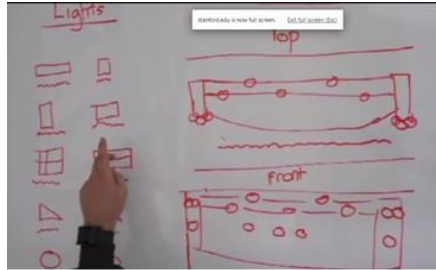

DESIGN EVOLUTION

Virtual Venues changed quite a bit throughout the course. Initially, as evidenced in our video **(Figure 10)**, we imagined that the user would sit in a chair with three tables around him: one on the left, one in front, and one to the right.

Figure 10. Initially, we imagined Virtual Venues would be used in a special studio with three flat surfaces surrounding a chair.

We imagined that each table would be used for each of the three tasks: light placement, light design, and visualization. However, we decided to make everything happen on one surface in front of the user, for a couple reasons. First, while we were filming the video, we realized how clunky it was to switch between surfaces constantly, and how often it would needed to be done. Second, during our usability testing, an employee at a lighting store told us that we should focus our product towards inexperienced lighting designers who don't normally use lighting design software. Thus, we wanted out software to be simple, and not require a studio built specifically for Virtual Venues.

The lighting placement screen did not change too much throughout the process (**Figure 11).** The most changes were made from the medium-fi prototype to the hi-fi prototype. From the heuristic evaluations, we learned that we needed to re-label the two 2D maps of the venue so that the user could understand their purpose and differences. The heuristic evaluation also convinced us to remove the grouping functionality all together, since it is confusing, and not likely to be used very much. Lastly, the heuristic evaluation persuaded us to color-code the types of lights.
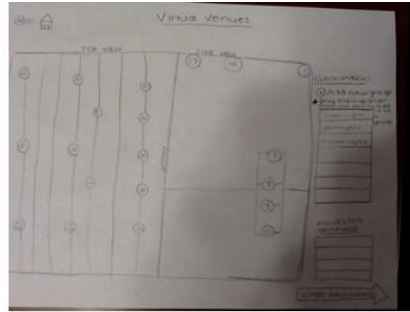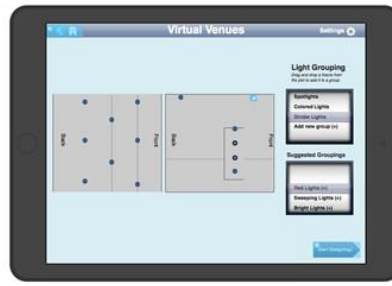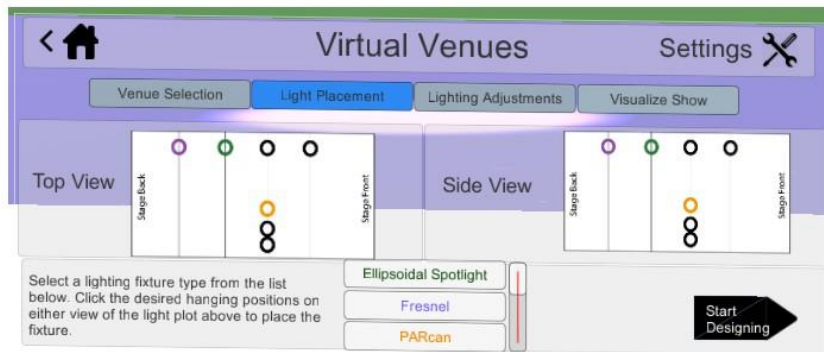
Video Prototype   Lo-Fi Prototype
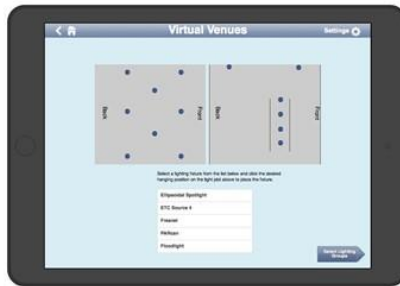
Medum-Fi Light Placement   Medum-Fi Light Grouping

Hi-Fi Light Placement

Figure 11. The design evolution for the light placement screen.

The next task, lighting design, experienced constant redesigning throughout the class **(Figure 11).** We learned through usability testing that the lo-fi prototype was very cluttered and difficult to understand, especially the cue list. For the medium-fi prototype, we streamlined the cue list by removing the pictures of each cue. We also rearranged much of the screen to make it more obvious how various parts of the screen interact. For example, all of the cue-related buttons were placed to the left of the cue list timeline. We also were inspired by garage band and redesigned the cue list to look more like a timeline. The heuristic evaluation had us move the "save cue" button, to distinguish it from the three other cue buttons that all functionally create a cue in some way. We also added a "change location" button so that this screen could adopt the
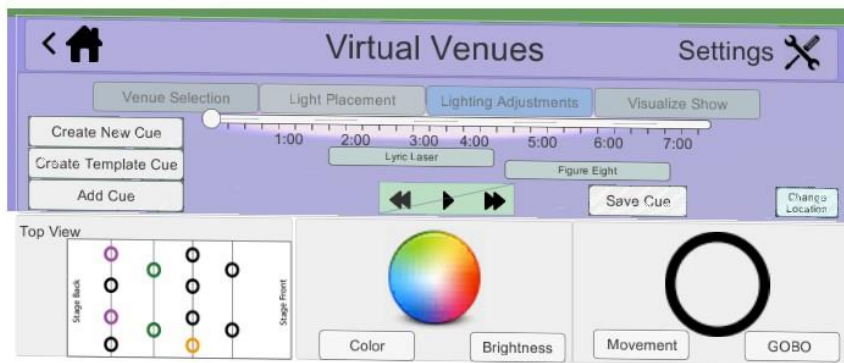
functionality of the visualization screen. By pressing this button, a d-pad would pop up that could be used to move around the venue.
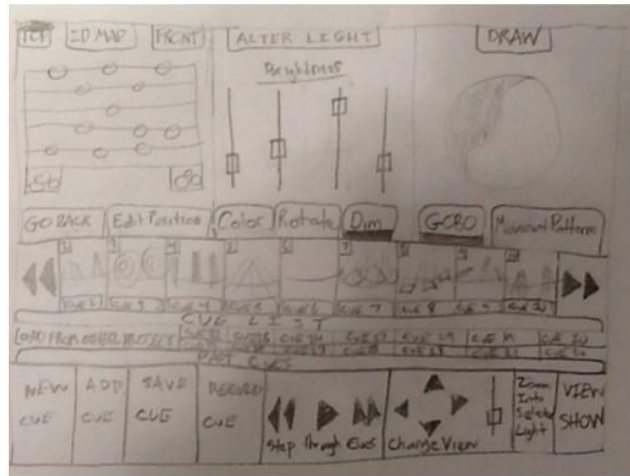
Lo-Fi Lighting Design
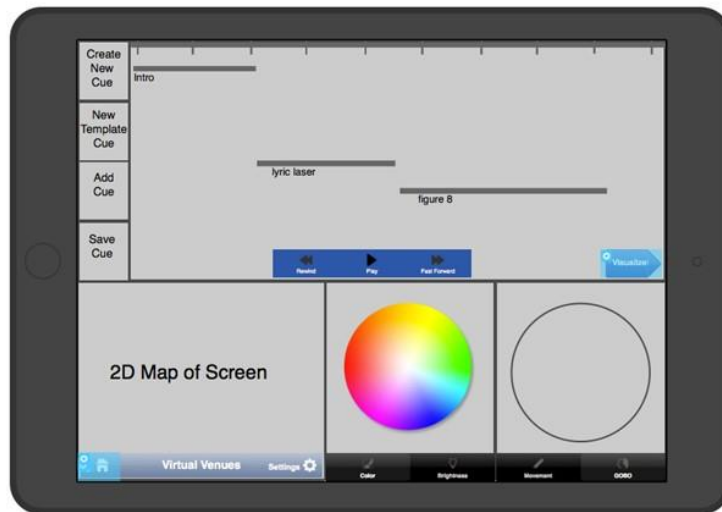
Medium-Fi Lighting Design

Hi-Fi Lighting Design

Figure 12. The design evolution for the lighting design screen.

Finally, the visualization screen did not change much throughout the design process, until it was removed for the hi-fi prototype (**Figure 13).** We removed it at the advice of our heuristic evaluators. They pointed out that having to go to a separate screen to view the show is too much of a hassle. They argued, and we agree with them, that users will constantly view the show while designing and tweaking cues. Now, users can simply press the play button to view the show. Additionally, users can press the "change location" button, explained above, to change their vantage point.
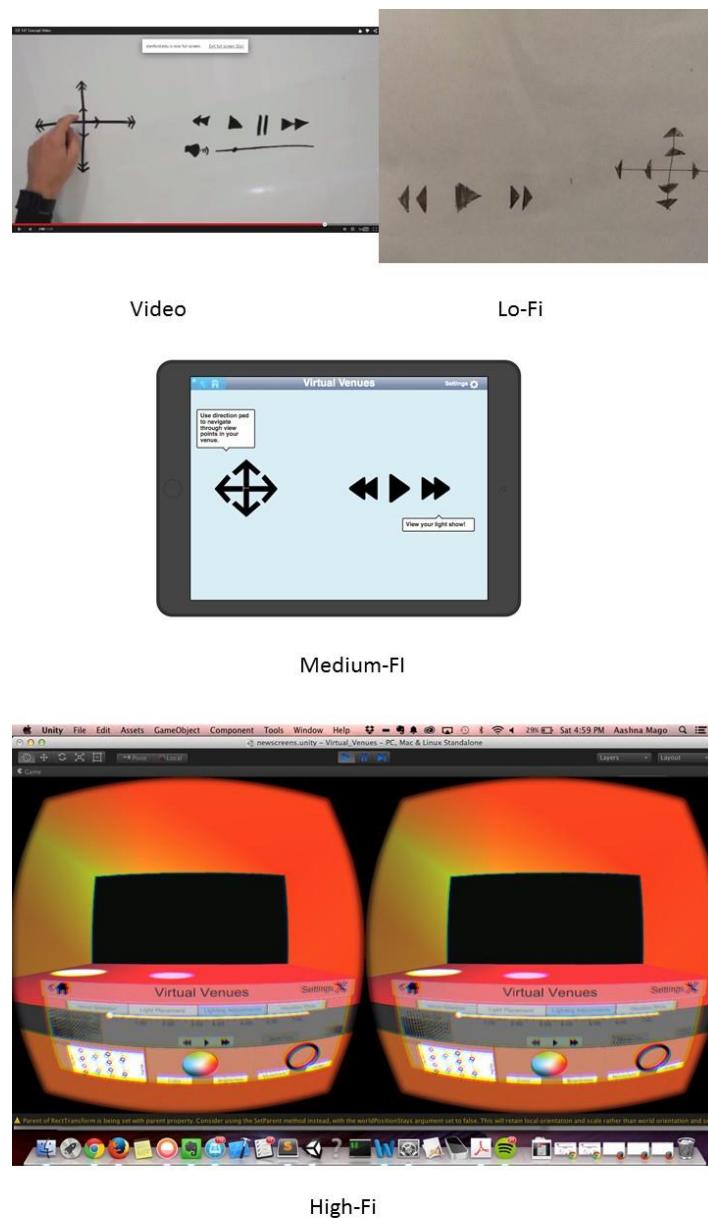

Video   Lo-Fi

Medium-FI

High-Fi

Figure 12. The design evolution for the visualization screen.

PROTOTYPE IMPLEMENTATION

We built our prototype using Unity 3D, which is a game engine frequently used to create virtual worlds. Luckily, the latest version of Unity included built in UI elements, which we were able to take advantage of. This made it easier to construct a 2D screen within a 3D world. We designed a virtual world for the Oculus Rift and used an integration with the Leap Motion. The Leap Motion, which uses infrared sensors to detect a user's hands, was mounted onto the front of the Oculus Rift so that the user could be in the virtual world, see the light board and the stage, and interact using his/her hands. We also used Adobe Illustrator to draw the lighting plots so that they would be 2D objects. Originally, we made them in Unity, but then the circles, lines, and background were on three different planes, and wouldn't align properly if the user didn't look at them head on. This was one disadvantage to building a 2D user interface in a 3D virtual world.

We built each screen as a separate object and then linked switching between the screens to key-presses and used Wizard of Oz control. This is because it was difficult to detect collisions between the virtual hand and specific buttons on the screen and we were under time constraints. When giving demos, we mirrored the Oculus Rift display onto a laptop display so that we could see what the user was seeing. When it looked like the hand was pressing a button, we would manually use key-presses to trigger a change in screens. Since users were fully immersed in the head-mounted display, they often didn't realize that we were using Wizard of Oz control.

In our high-fi prototype, we had a hard-coded light show-- we weren't storing any of the interactions from the user, so the lights, timing, etc. were all predetermined. A key-press triggered the start of the light show, and each user saw the same show. Also, our UI wasn't fully interactive, which is something we would change in the future. Again, due to time constraints and the added difficulty of building in virtual reality, there were certain features (like actually moving the color picker around) that the user couldn't interact with. We had to verbally direct users to the features that *were* interactive.