Imagine. Design. Create.

Design within Virtual Reality

Powered by

AUTODESK®

OUR TEAM

PHAN LEE

INTERN SOFTWARE DEVELOPMENT, AR/VR

CARNEGIE MELLON UNIVERSITY

MASTERS OF ENTERTAINMENT TECH

DAVE YAN

INTERN SOFTWARE DEVELOPMENT, AR/VR

UNIVERSITY OF SOUTHERN CALIFORNIA

MASTERS OF INTERACTIVE MEDIA AND GAMES

ETHAN ARNOWITZ

INTERN AR/VR UX DESIGNER, CG GENERALIST

CORNELL UNIVERSITY

MASTERS OF HUMAN ENVIRONMENT RELATIONS

JOHN SCHEELER

INTERN AR/VR UX DESIGNER, CG GENERALIST

CORNELL UNIVERSITY

BACHELORS OF ARCHITECTURE

MANAGERS

HANS KELLNER & BRIAN PENE

IMAGINE
DESIGN
CREATE

INTRODUCTION

Designing within Virtual Reality

Autodesk is a company that empowers innovators by providing the tools they need to need to imagine, design, and create a better world. Since it's foundation in 1982, this has primarily been done through Computer Aided Design (CAD) on a 2D monoscopic computer screen. With the development of sophisticated, low cost Virtual Reality (VR) hardware and novel spatial interfaces, the medium for which designers use to create will radically change.

As part of OCTO's Emerging Technology Team at Autodesk, our role is to understand how future innovators will use future hardware to imagine, design, and create. Now that VR is first becoming realistic at an enterprise scale, the desire for integrating VR into the design process is continuously growing. VR offers an increase in immersion, spatial awareness, and interactivity, that can allow a more efficient design process.

This booklet outlines multiple research experiments centered around UX/UI in virtual reality. The most successful UX/UI elements were used simultaneously in two demos including "ModelVR," and "World Builder VR," centered around the theme of "Designing within Virtual Reality."

HARDWARE

HTC Vive

Room Scale Virtual Reality

In 2016, a number of high powered- low cost VR headsets become available for the first time. Our team used the HTC Vive as our VR hardware. The Vive is the only headset on the market that offers complete room scale tracking. While exploring UX/UI elements in VR, accurate and 360° tracking is essential. Design decisions were made based off the design of the Vive controllers, but the knowledge learned is generalizable to additional hardware and 3D interface devices.

SOFTWARE

Maya | **3DS Max**

3D Modeling

Maya and 3DS Max were used as the modeling tools to develop our projects. All UX creation was developed in Maya, and environment and asset creation were created in both Maya and 3DS Max. Both of these modeling tools have a direct work-flow connection to Stingray, making editing models and updating assets in Stingray seamless.

Stingray

Game Engine

Stingray was used as the primary game engine. Level flow was used as a visual coding language within Stingray.

Fusion 360

CAD, CAM, and CAE

Fusion 360 is Autodesk's design and digital manufacturing tool. Fusion 360 was used to convert sketches from *ModelVR* into physical prototypes.

Lua

Coding Language

Lua is the main programming language in Stingray.

PROCESS

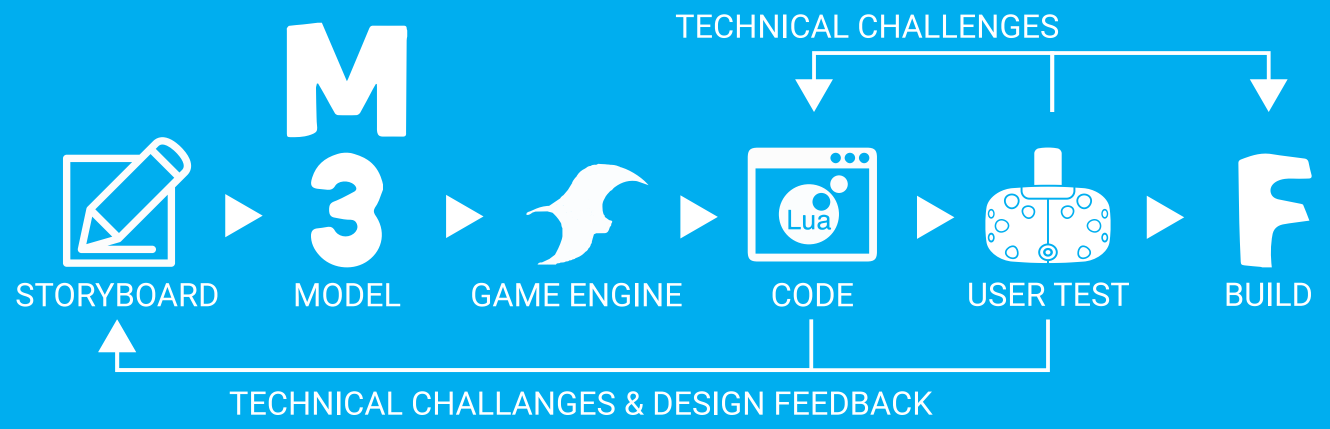
USE TESTING TO INFLUENCE DESIGN

UX TEST/ COMPONENT PER WEEK

FINAL PROJECT COMBINES UX COMPONENTS

This booklet was created as part of an 11-week internship program at Autodesk in their San Francisco office. Each week our team would develop a rough UX/UI prototype and test it with subjects. This allowed us to rapidly develop ideas and receive instant feedback. Toward the end of our internship, we took the most successful design components and merged them into two demos centered around the theme of “Designing within Virtual Reality.”

The first step in our design process is to come up with an idea and sketch it out. Drawings are often crude, but outline the core functionality. After the storyboard mock-ups are generated, they are used to create interaction flow-charts. This is a critical step for the designer to communicate the workflow to the programmers. The programmers heavily rely on these flow-charts while writing the code. Next the designers generate 3D menu assets. Since VR enables the user to interact with 3D space, the menus, icons, controllers, and windows all need to be digitally modeled. UI designs are created and applied to the 3D model as a material texture. These assets were brought into Stingray where the programmer would code the functionality. After a working prototype was created, subjects would come try it and provide feedback for next iterations.



1

VR UX/UI
EXPERIMENTS

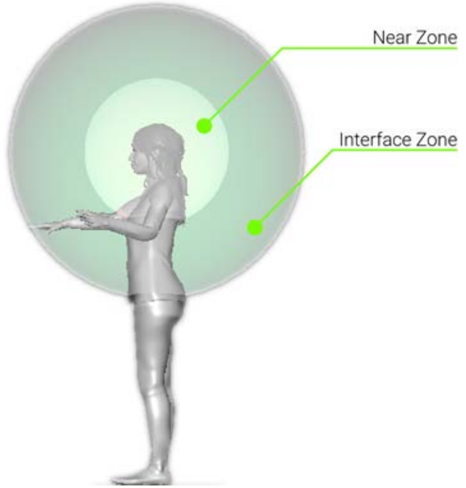
WINDOW MENU TEST

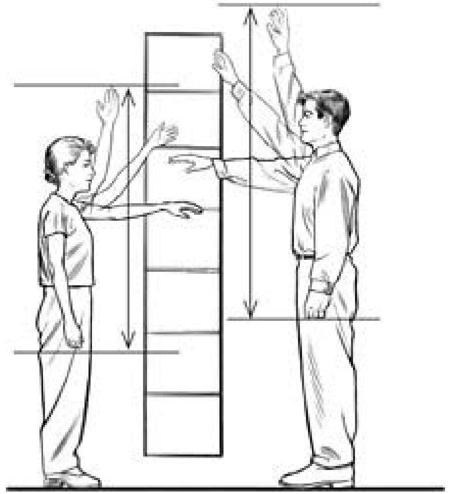
This test explored various window options in VR. Although attaching menus to the controller is good for a clear set of tools, it’s not scalable as options increase exponentially. Instead, we propose to have menus that are placed into the scene that the user can interact with directly. Like computer software, there are many different types and functions of windows. Although standards exist for 2D interfaces, 3D window interfaces still have a lot of unanswered questions including:

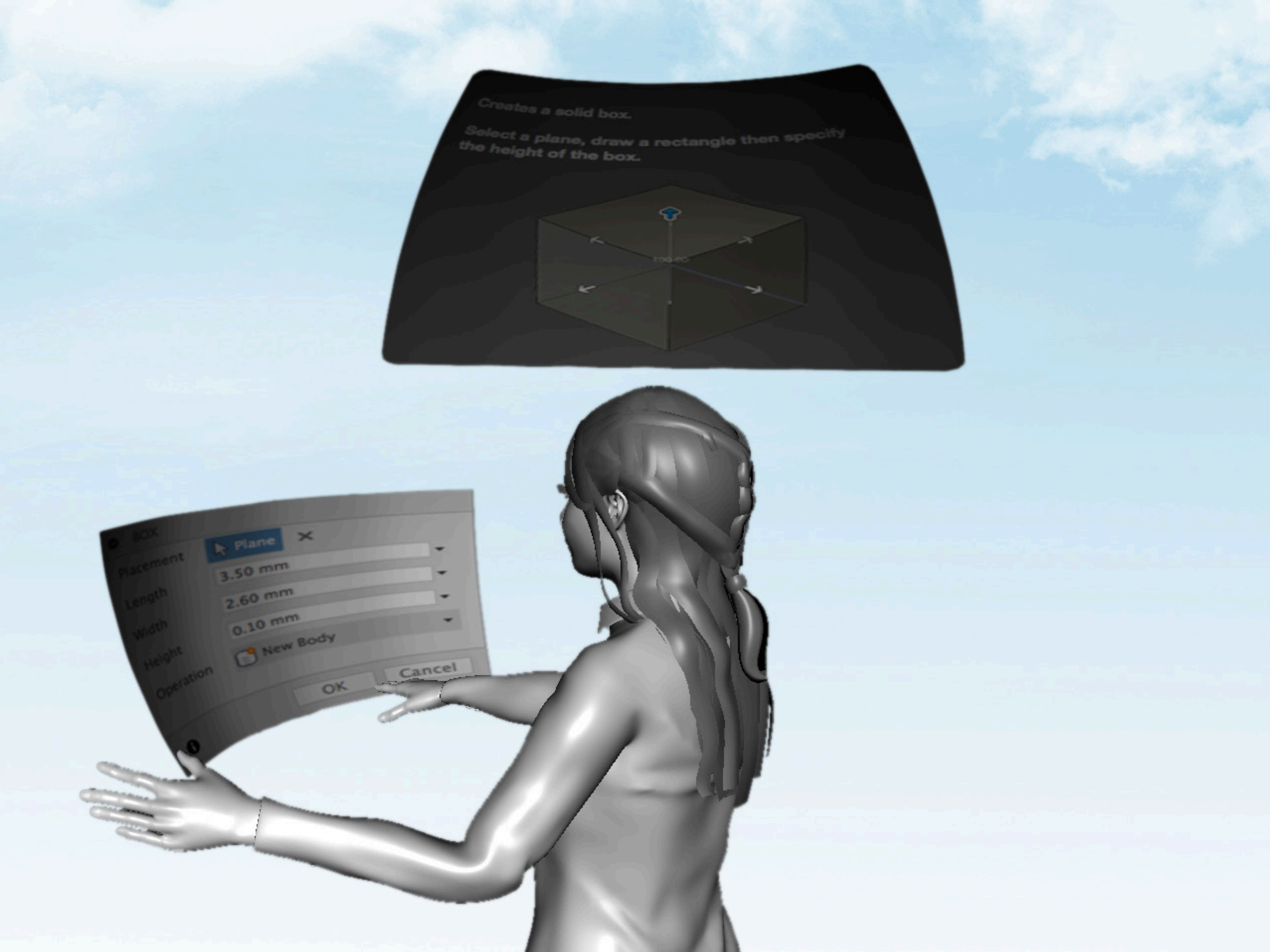
- How curvy should they be?
- How far should they be?
- How large?
- Should they be head locked? Body locked? World locked?
- Can the user drag and re-position menus?
- Is text readable?
- Do windows cause eye strain?

Using Stingray, we explored these questions by creating multiple window variations. Users indicated that large sightly curved displays further away work best for menus with a large set of options. Small world-locked windows work best for notifications, and spherical windows work best for removing the user from the environment.

Dimensions were taken from anthropometric diagrams to inform reach and stretch zones. This page highlights the spherical window design. This design encompasses multiple windows within reaching distance of the user. The spherical window can block a users view, so contextual integration is critical to its' success. Since this study was done in a blank environment, further testing within contextual environments is needed to address potential occlusion problems.







LASER DISTANCE TEST

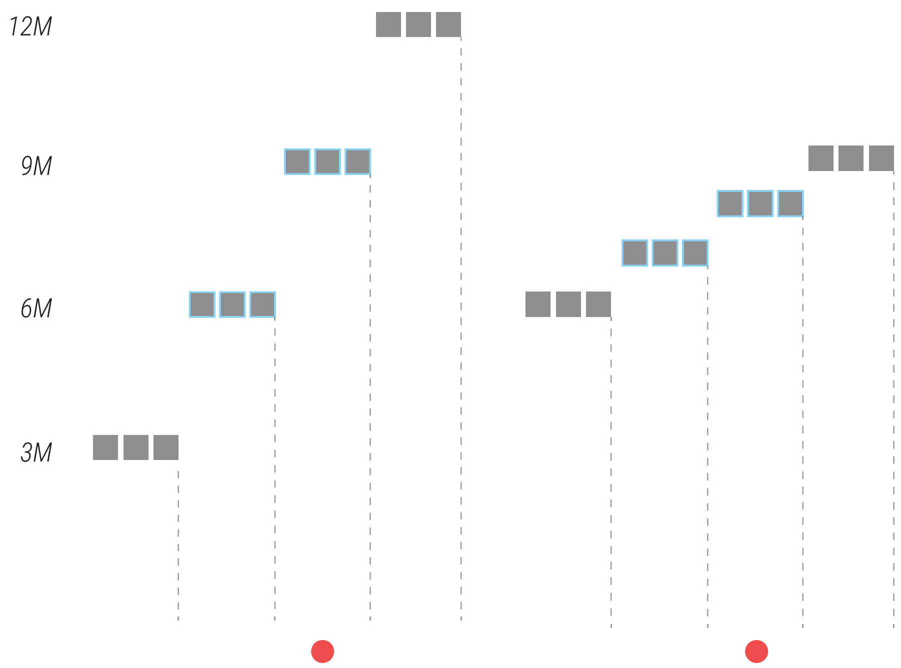
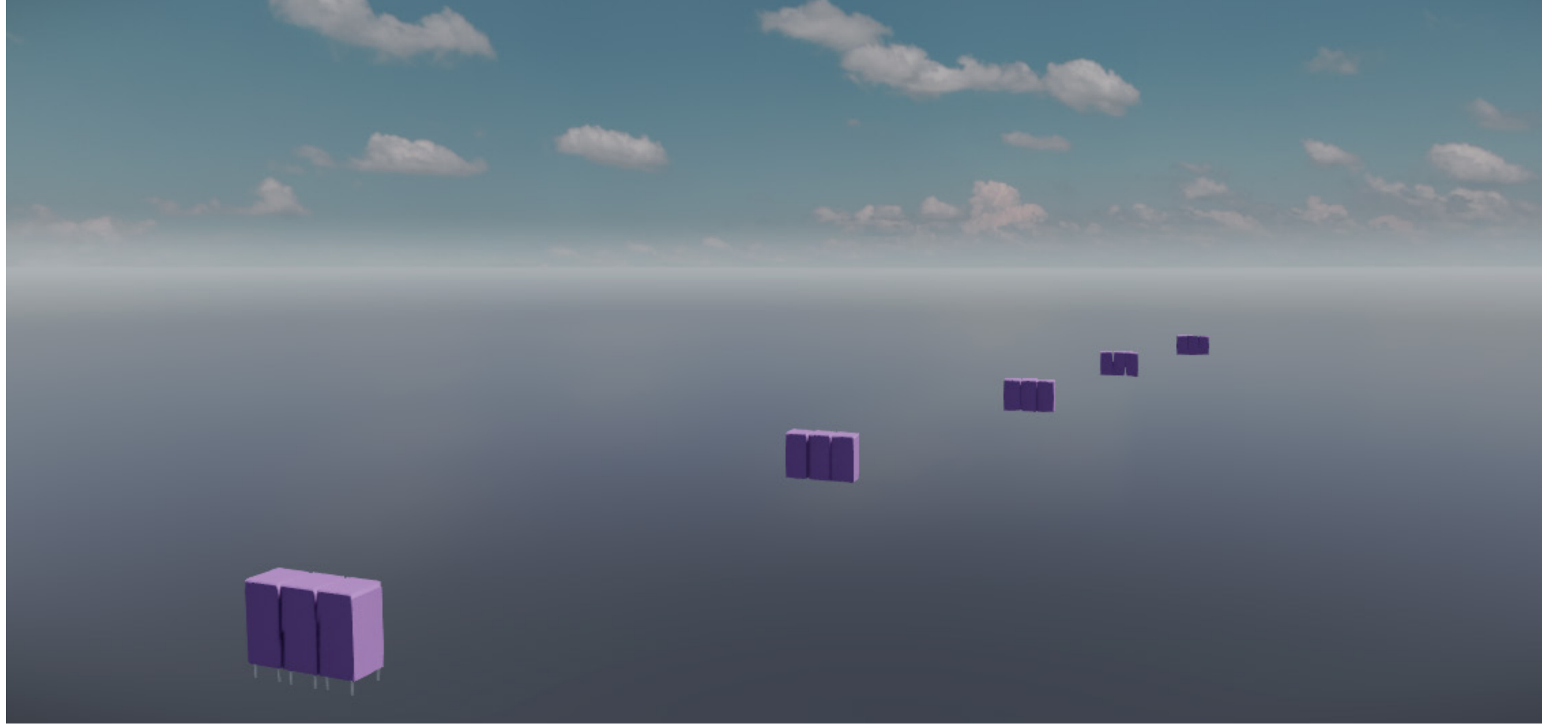
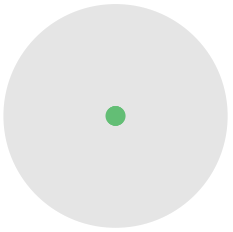


Fig. A. 10 Meter Interval Test **Fig. B.** 2.5 Meter Interval Test

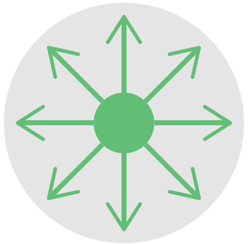


Common interactions within VR involve the use a virtual laser pointer. Because human hands naturally vibrate, this test explored the maximum distance a user can accurately use a laser pointer within VR. In the initial test, boxes were placed at intervals at 3m. Users were asked to select the middle box at each interval. Results showed that users were not able to accurately select objects starting at 9m (Figure A). An additional test with intervals of 1m was then conducted to get more specific distances. Results show that users could not accurately select objects starting at 8m (Figure B). Because of these finding, the laser pointer on the controller was limited to 8m. Beyond this distance objects would not be selectable.

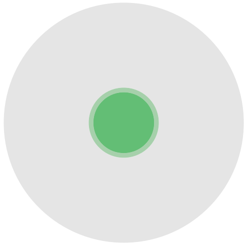
VR Touch Pad



Finger Position: Marks the starting point

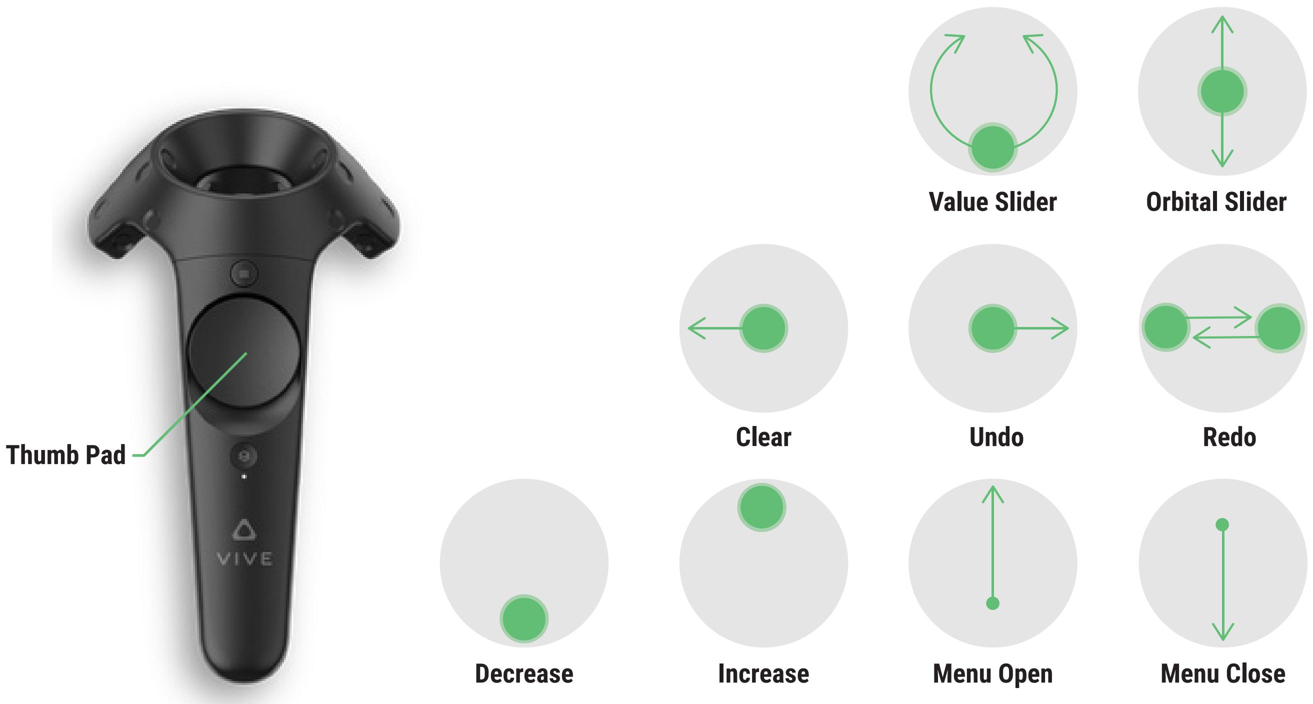


Swipe Direction: Movement path required by gesture



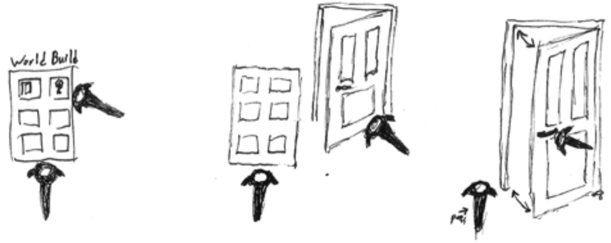
Pad is Pressed: Serves as trigger to activate/start gesture

Vibration: Tactile feedback for gesture recognition



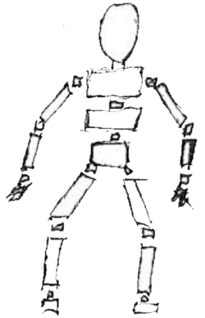
Currently the Vive controller is limited to four click-able buttons. One of those buttons is the thumb pad, which is both touchable and click-able. Because of the limited number of buttons, we explored how to utilize the thumb pad for additional functionality. We tested this by giving users the vive controller and asking them to perform a swipe gesture when given a specific command. We analyzed the results to look for patterns. The most common gestures are shown above. In each gesture are four input modalities including touch, swipe, click, and tactile feedback.

VR Interaction

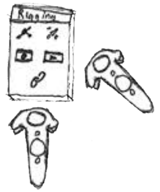


Currently designers can migrate their designs from a 3D modeling software into a game engine, allowing them to experience their designs in VR. Unfortunately, this creates static projects that require codding to enable any interactions within the environment. By adding simple interactivity within VR, virtual environments can mimic a persons expectations from the real world, thus creating a more satisfying and intuitive experience.

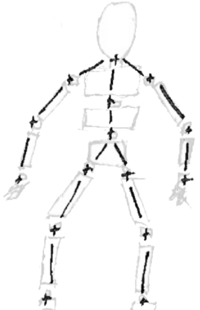
Through the implementation of the VR interaction tool, it is possible to add complex interactions simplistically and intuitively. This demo allows users to enter a static VR scene and quickly rig and animate different objects such as a door, character, or car.



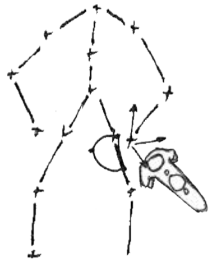
1)IMPORT MODEL



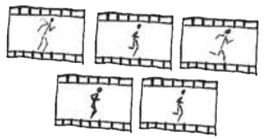
2)SELECT RIG TOOL



3)RIG MODEL



4)ADJUST SKELETON



5)CAPTURE FRAMES

VR Marquee

Menu 1

Menu 2

Menu 3

Interface standards have been deeply explored on 2D screens, but VR provides an opportunity for 3D interactive interfaces. *VR Marquee* explores this by using depth to switch between menus. The interface features a radial design with three main menus, each with 8 tiles. Once the marquee menu is opened, the user can push the controller back to switch between different main menus. Within each main menu are relevant sub menus.

Depending on the specific case use, the menu can be adopted to satisfy more or less functions. The original design was adopted from the popular marquee menu used in applications such as Maya and Fusion 360. Understanding how to translate 2D to 3D interfaces is a critical step in developing novel VR experiences.

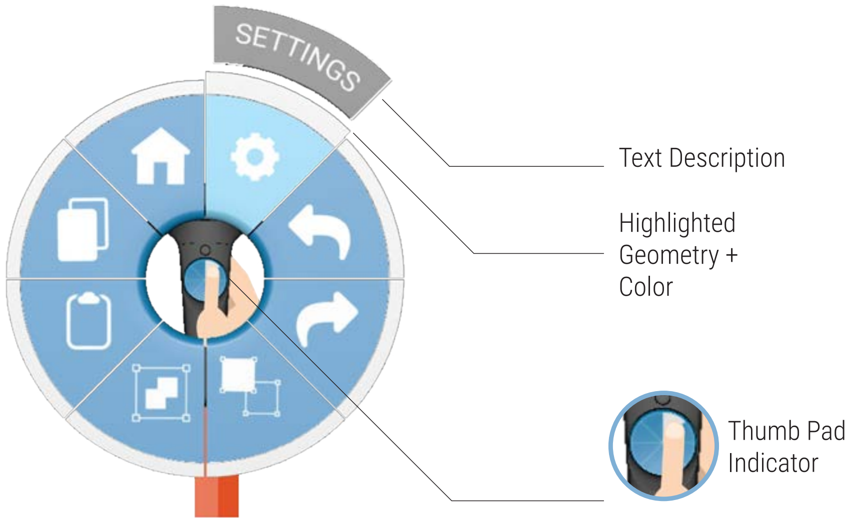
VR Marquee - User Interface

Touching the pad highlights over a specific tile. While highlighting a tile it expands, changes color, and a text description appears.

The user can press the pad to select a button. Buttons will either select a tool and exit, or open up a sub menu.

To switch between main menus, the user moves the controller away or towards them.

If the user presses the trigger, this will lock it on the corresponding menu. If the controller is locked, moving the controller toward and away from the body does not change the menu.



VR Marquee - Submenus

TILES **COLOR PALETTE** **RADIAL**

Buttons on the main menu can lead to corresponding sub-menus. Three types of sub-menu designs were created including ***tiles***, ***color palette***, and ***radial***. The tiles option is similar to the main menu design, and features up to 8 tiles each with a different option. Seen above is the font style sub-menu. The color palette sub-menu provides a spectrum of color options. This sub-menu can also be incorporated with depth if additional tints are desired. Additionally, the color palette can also be integrated as a material palette. The final sub-menu design is a radial. This can be used for value sliders such as sound, size, opacity, etc.

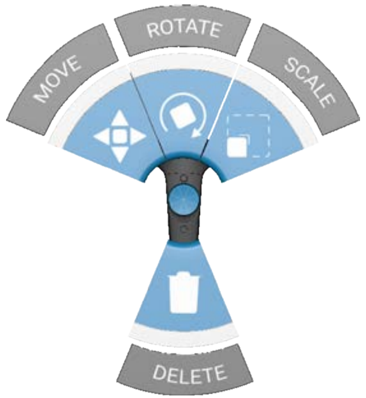
OBJECT SELECTION

Unlike the real world where a user has to approach, touch, and lift an object, VR provides opportunities for non-realistic interactions. For this test we explored three methods of selecting and moving an object.

In version 1 the user would first select an object, and then use the controller to indicate whether to move or rotate the object. In version 2 the user would select an object. This would activate a menu over the object that would allow the user to choose whether to move or rotate the object. The final version involved direct manipulation with the object. Using one controller, a user can select and freely move an object, while using two controllers allowed the user to rotate an object.

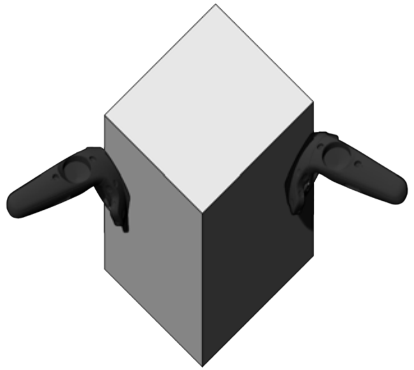
Version 1 proved to be too many steps for users to quickly manipulate objects. Additionally, some users didn't realize functionality was on the controller because it was out of sight. Version 2 proved successful for far away interactions and for locking specific axes. Since the user was already looking at the object when selecting it, placing additional UI locked to the object was successful. Version 3 felt the most realistic, and was best for up-close direct manipulation. Understanding how users interact with objects from multiple distances takes advantage of capabilities only available in the virtual world.

CONTROLLER
Version 1



HEADS UP DISPLAY
Version 2

HEADS UP DISPLAY
Version 3



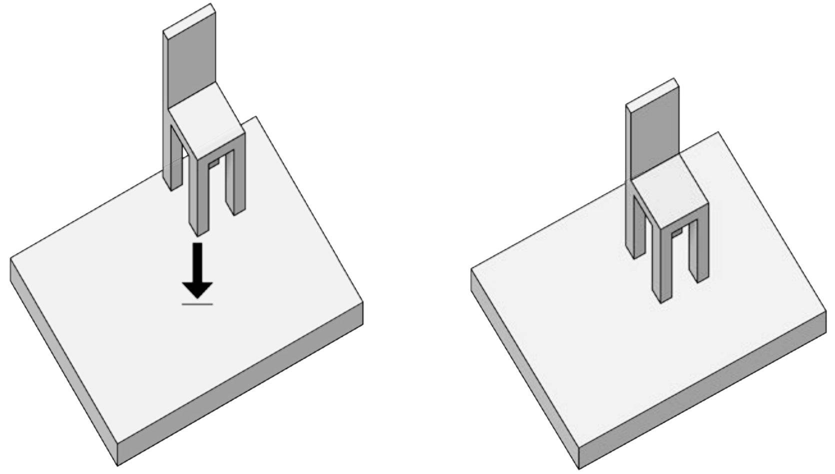
GRID SNAPPING

When moving an object that isn't constrained along a specific axis, users still want control over fine movements. The snap and ground tools allow users to freely move objects with specific constraints.

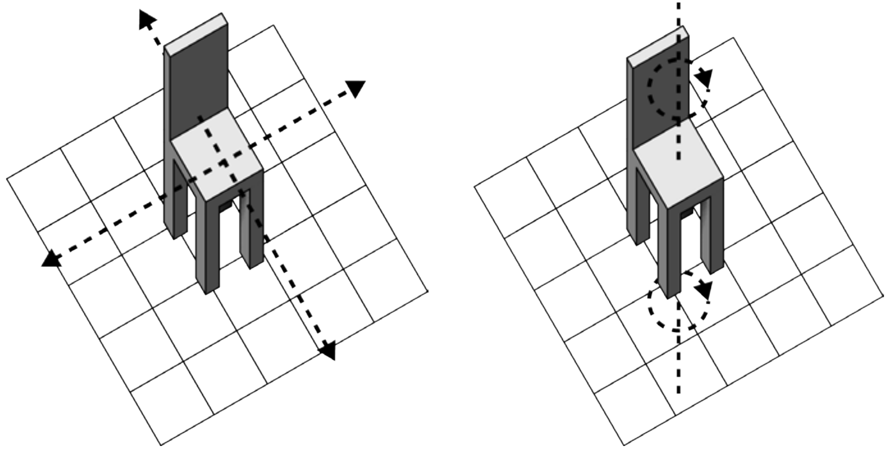
The ***ground tool*** will take any object and place it on the surface below. This can vary depending whether an object is floating above a table or floor or other surface. The ground tool will also reset the rotation of an object.

The ***snap tool*** allows users to move an object by snapping it to the ground or rotating it by 15° intervals. The snap tool can be toggled on and off.

These tools are critical in allowing fine movement of objects. After users place assets within the environment, these tools allow them to carefully tweak their designs.

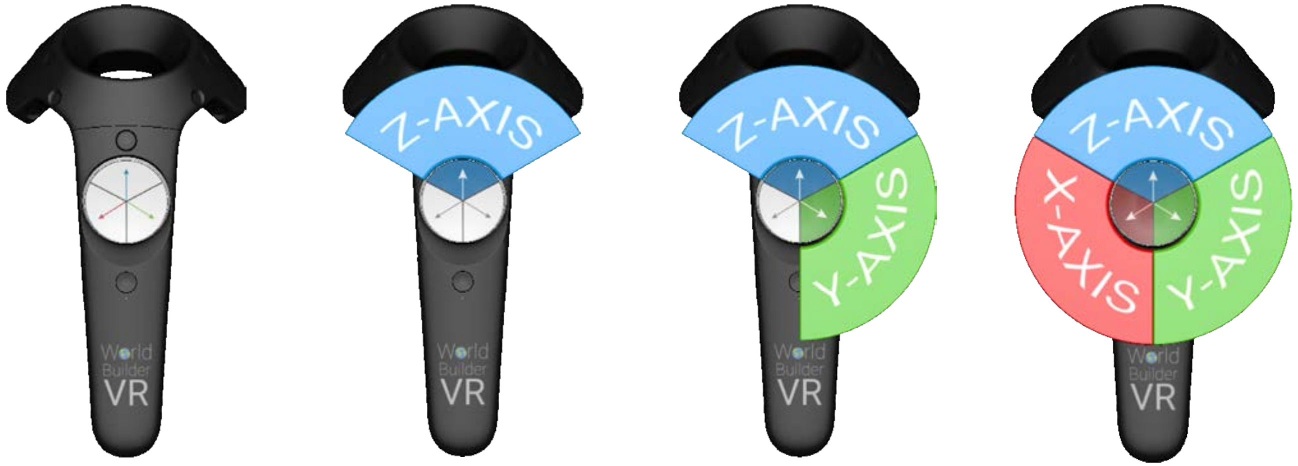


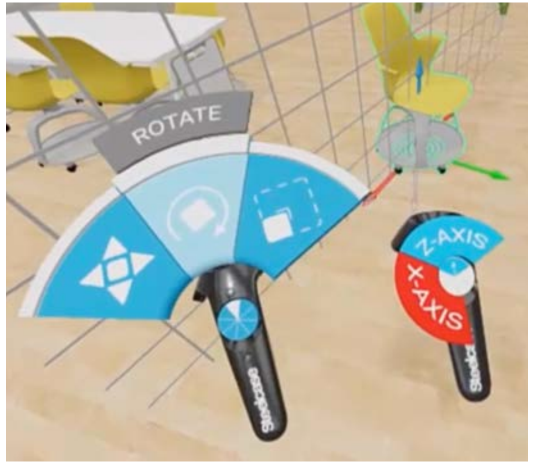
Ground Tool

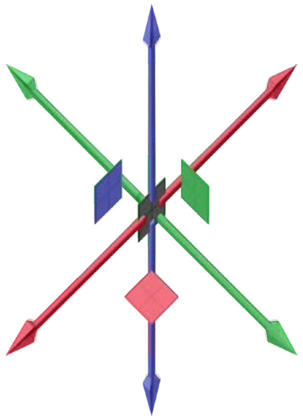


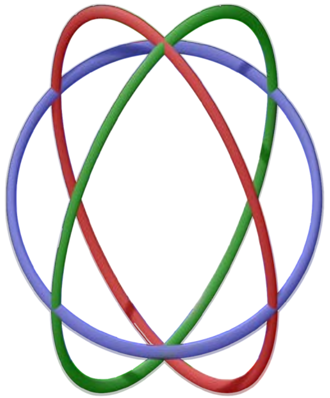
Snap Tool

AXIS LOCK AND GIZMO





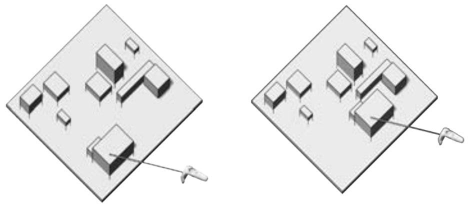




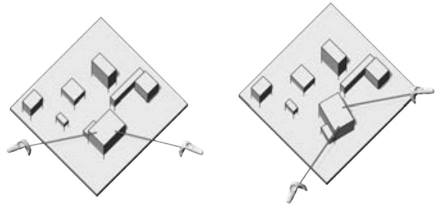
Traditional modeling tools allow users to constrain objects using a XYZ Gizmo. This prototype explores how to constrain an object along a specific axis or plane using the Vive controller. After users select an object, they can constrain the object using the controller pad. Each axis can be toggled on/off, allowing the user to constrain along one or all 3 axes. After selecting an object, the pad defaults to moving it in the XY direction and rotating it in the Z direction. Besides the pad, our team explored direct manipulation of the Gizmo via a laser pointer. Users found grabbing a specific axis, especially from a distance, too difficult with the laser.

MINI MAP

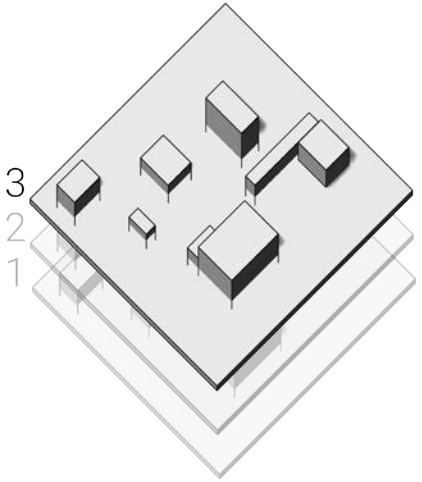
VR provides opportunities to perform tasks in a non-realistic way. This UX prototype takes advantage of this by allowing users to layout a virtual environment from a bird's eye view. When the mini-map is turned on, a miniature model of the environment is generated in front of the user. The user can use the Vive controllers to directly manipulate objects. Objects can only be moved along the ground surface and rotated along the Z axis. As the user make changes to the mini-map, the virtual environment adapts accordingly. This provides an opportunity to edit a large space without teleporting. The mini-map features a model of a person with a "You are Here" GPS pin. This allows the user to orient themselves on the mini map. When the mini-map is turned on, a spotlight is placed over the it and the environment lighting is dimmed. Multiple prototypes were created exploring how the walls should be represented, manipulation of miniature objects, and lighting of the map.



Move



Rotate



Level Change

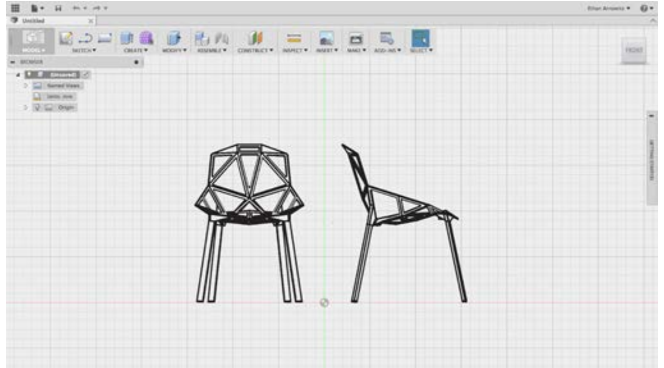
2

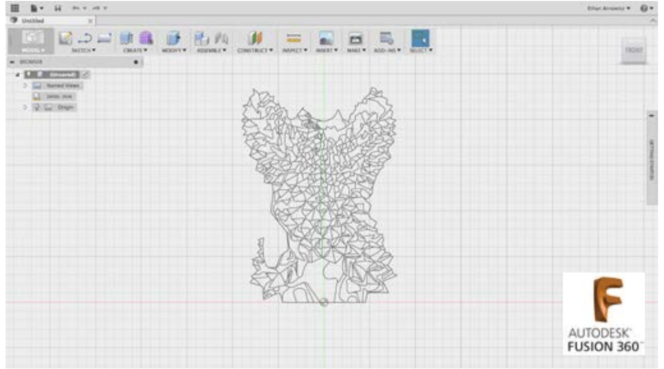
DESIGN IN
VIRTUAL REALITY
DEMOS

ModelVR

Select a Base Object

Sketch in Virtual Reality





Convert Sketch into Fusion 360 File

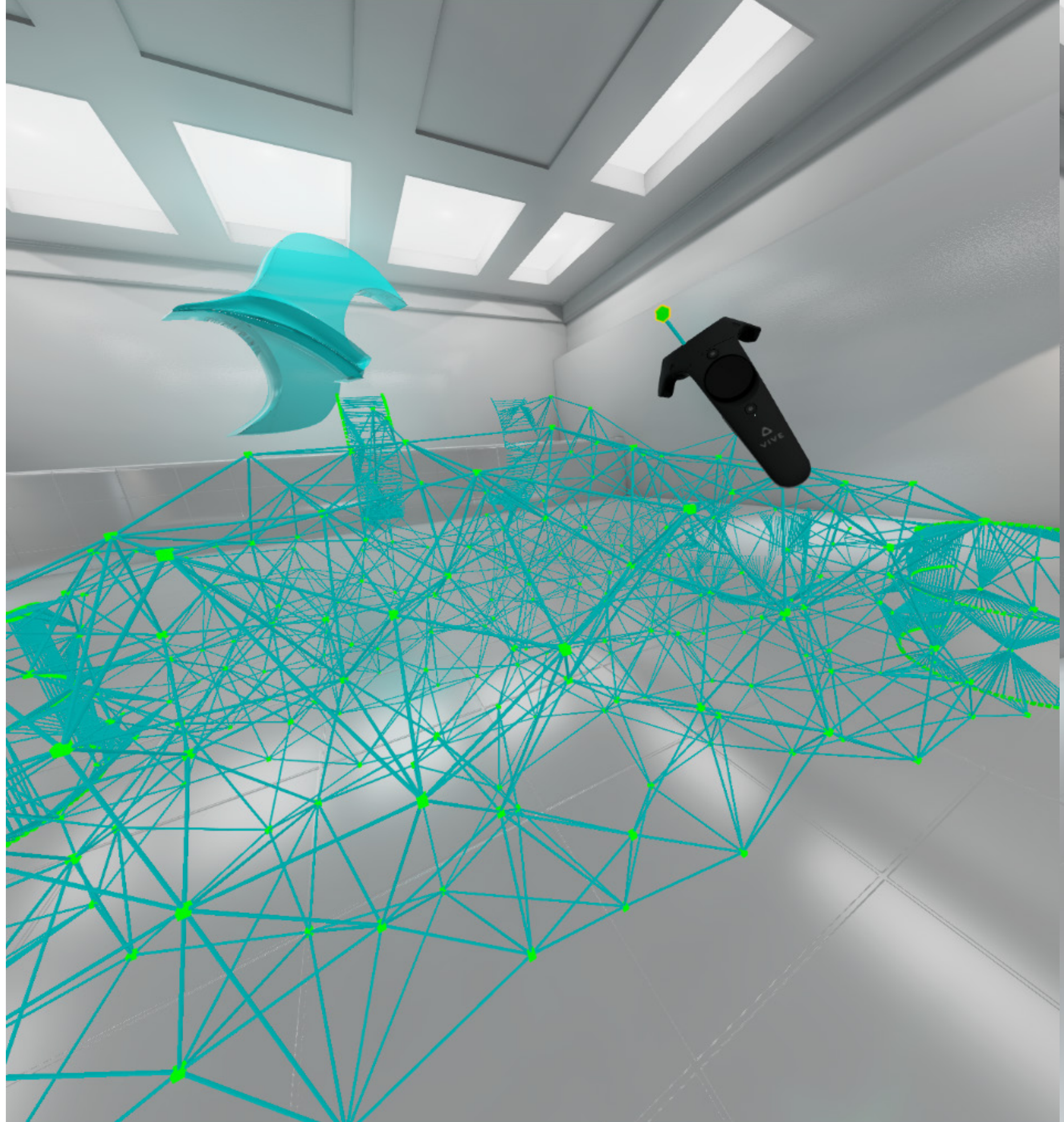
Convert files into physical prototypes

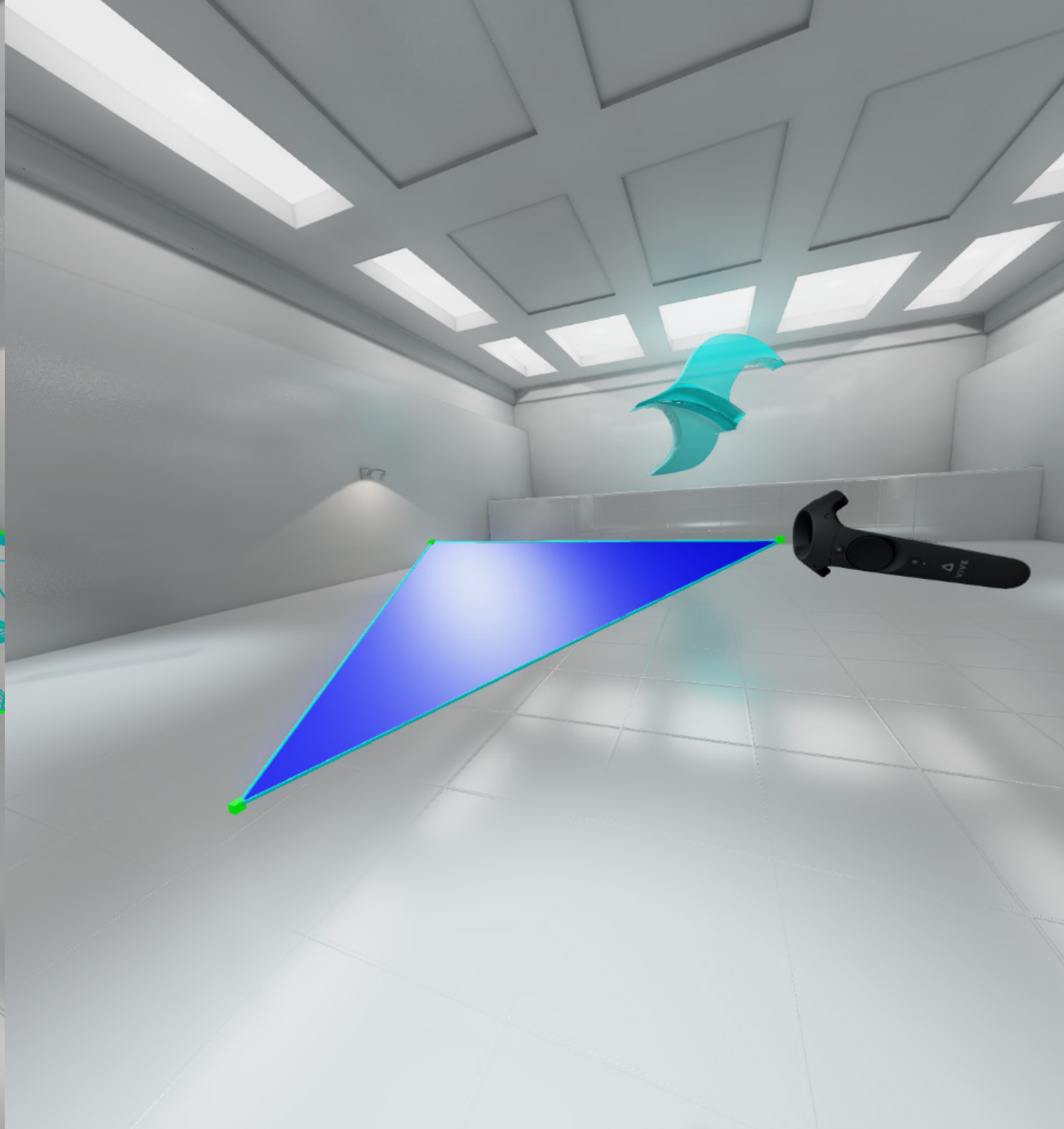
Final Product

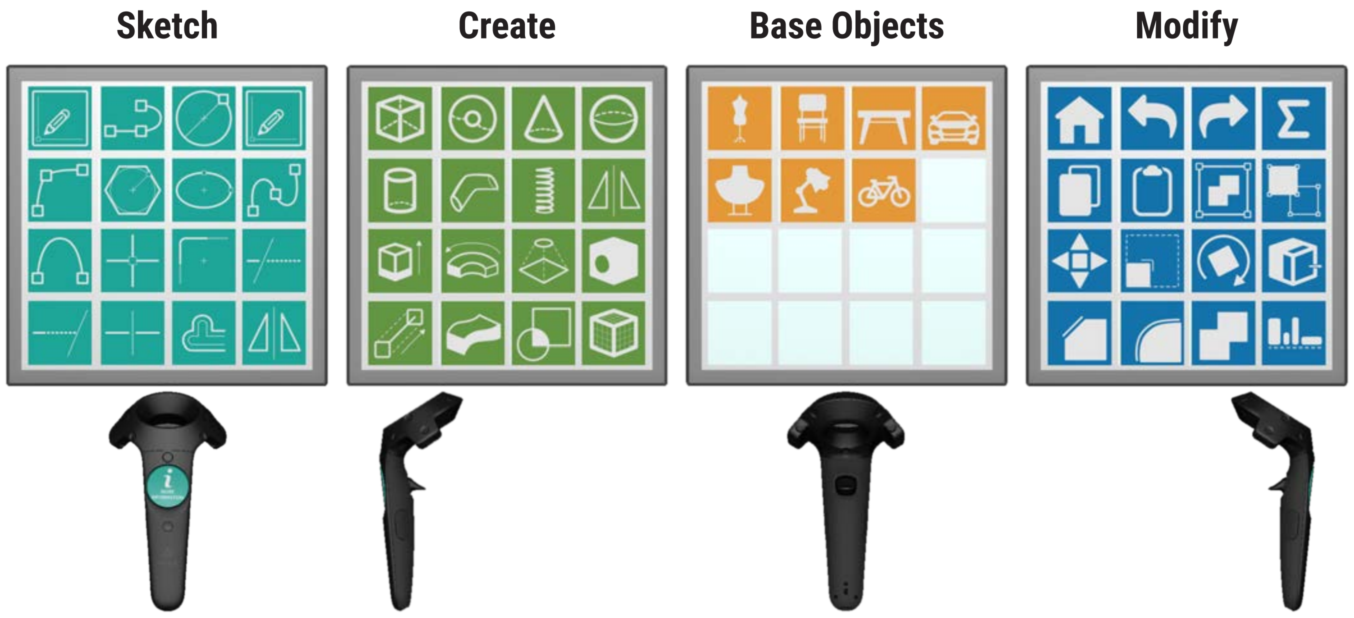
ModelVR
to Fusion 360

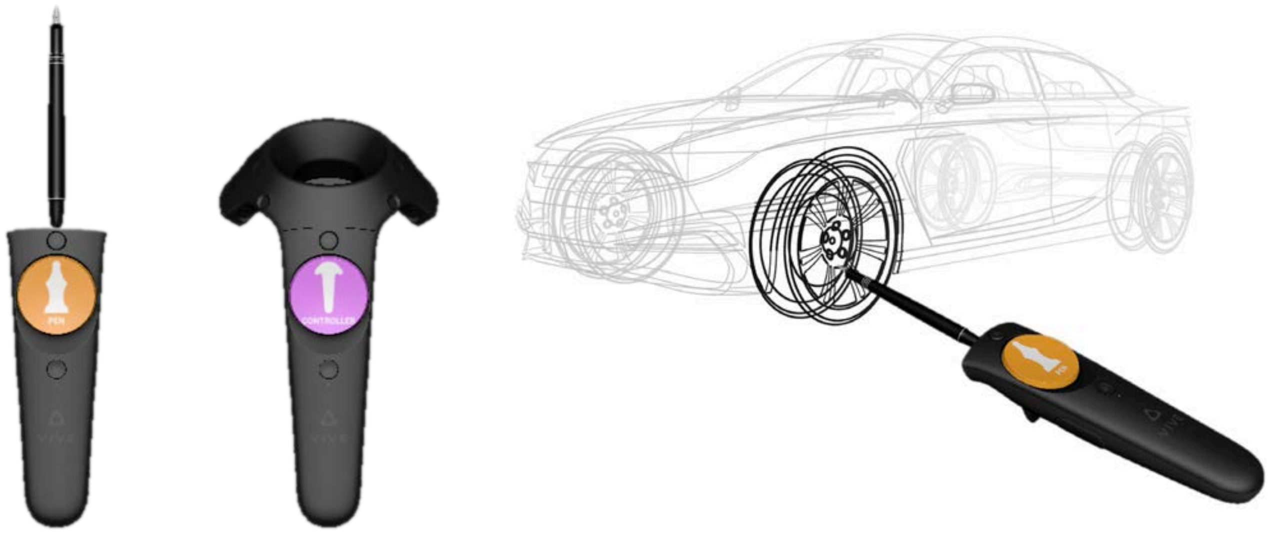
In Fusion 360, you can create objects by using the sketch, create, and modify tool sets. Each of these tools start by selecting a specific plane to draw off of. Once you have a primitive object, you can convert it to “create form.” This allows the user to add edges, create subdivisions, and have complete control over the model form.

Similarly to Fusion 360, *ModelVR* will allow the user to sketch, create, and modify forms. They will do this by selecting a plane to draw the objects off of. If the user wants complete control over the modeling process, they can “create form.” This will allow additional modeling options, similarly to modeling in Maya or 3DS Max.







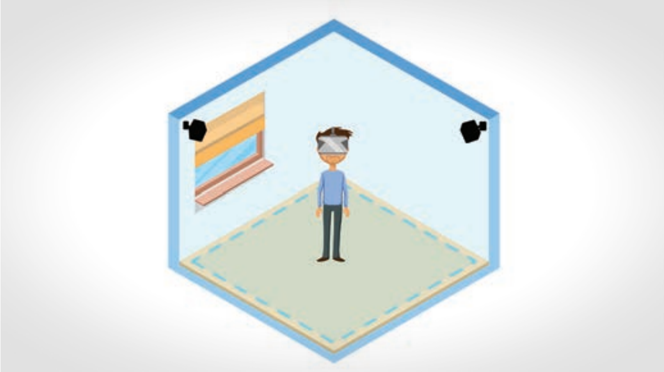


Controller 1 contains a static cube menu. These buttons contain the essential tools to sketch in VR and are organized, similarly to Fusion 360, into sketch, create, and modify. The forth side of the cube contains "base objects." These objects are basic forms as a frame of reference.

Controller 2 will be used as the drawing utensil. The user will have the option to switch between different kinds of drawing utensils, such as a quill or pen, that provide a different grip, orientation, and drawing style than the controller.

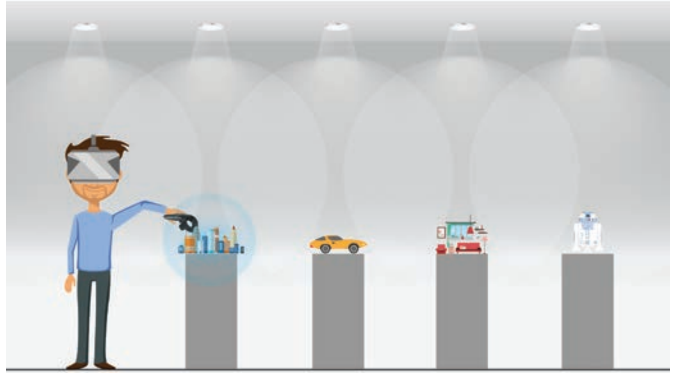
World Builder VR

Enter Vive Headset



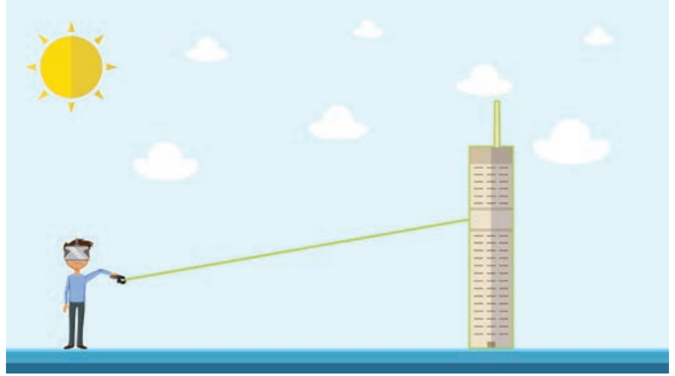
Launched into Gallery

Select Level



Enter Blank Environment

Spawn Assets



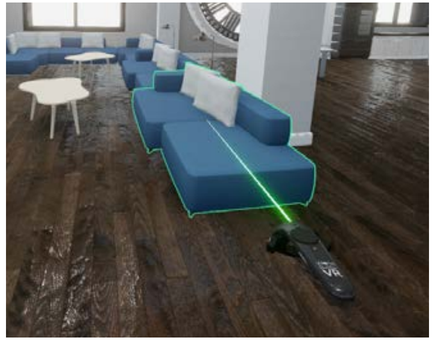
Build Dream World!

World Builder VR allows users to design their dream world. First the user will enter a gallery room where they can choose from a variety of environments to build. Once an environment is selected, the user will be launched into a blank version of the environment. Inside this blank environment, users can spawn objects from an asset menu and dynamically manipulate them until they've finished their design.

When the user first enters World Builder VR, they will be launched into a gallery room. As seem above, this gallery room features different environments a user can select from. Options include interior design, film design, city planning, architectural design, and car design. A user can enter a level by teleporting to an object and selecting it with the Vive controller.

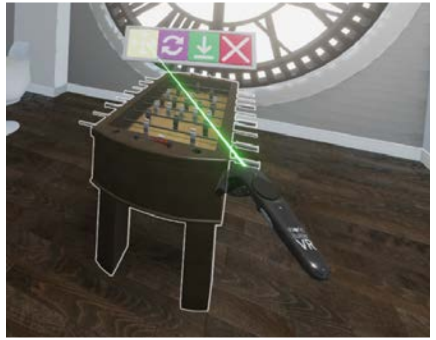
User Interface

SELECT OBJECT

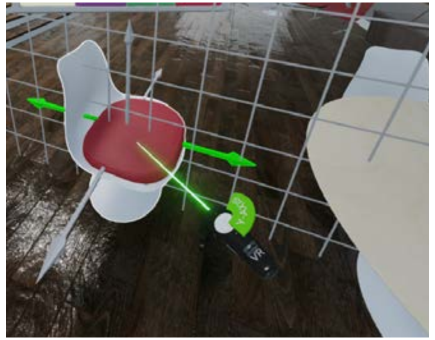


First the user hovers over an object and selects it via a laser. Then the user either freely moves the object, or activates a Gizmo via the heads up display. If the Gizmo is activated, a supplemental XYZ pad will appear on the controller. In free move, users can use the snap tool to constrain the object on the ground surface.

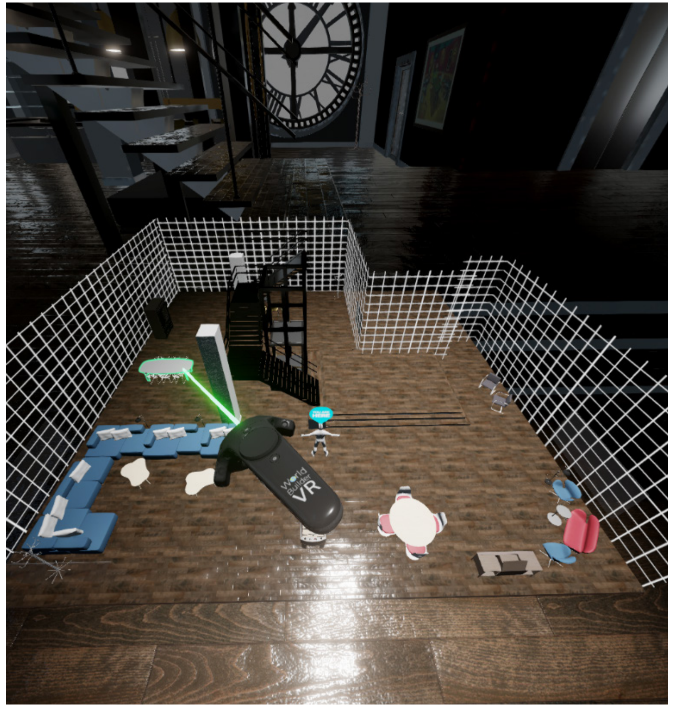
SELECT TYPE OF MOVEMENT



CONSTRAIN MOVEMENT



MINI-MAP



The mini-map allows user to spawn a miniature version of their environment in front of them. When user move or rotate objects on the mini-map, the corresponding object will move in the virtual environment. This gives users a macro-view over the entire apartment at once.

ASSET MENU

The asset menu allows users to add objects into an environment. Depending on the level, different types of assets will appear. Users can choose from a variety of categories, or even upload custom assets. The menu is flat images, but show a 3D preview when hovering.

Steelcase

Classroom Environment

This Active Learning VR Classroom was designed as a demo to showcase to a team of employees from Steelcase furniture manufacturer including members of the industrial design, visualization, and research team. After using the demo, Steelcase employees provided feedback that was used to further refine World Builder VR. The classroom features multiple products from Steelcase including the Node Chair, SW_1 Chair, the Brody, and modular whiteboard displays. Within the demo, the user can move objects and rearrange the classroom to different pedagogy styles. This concept proves the power of product visualization and space planning tools within VR.

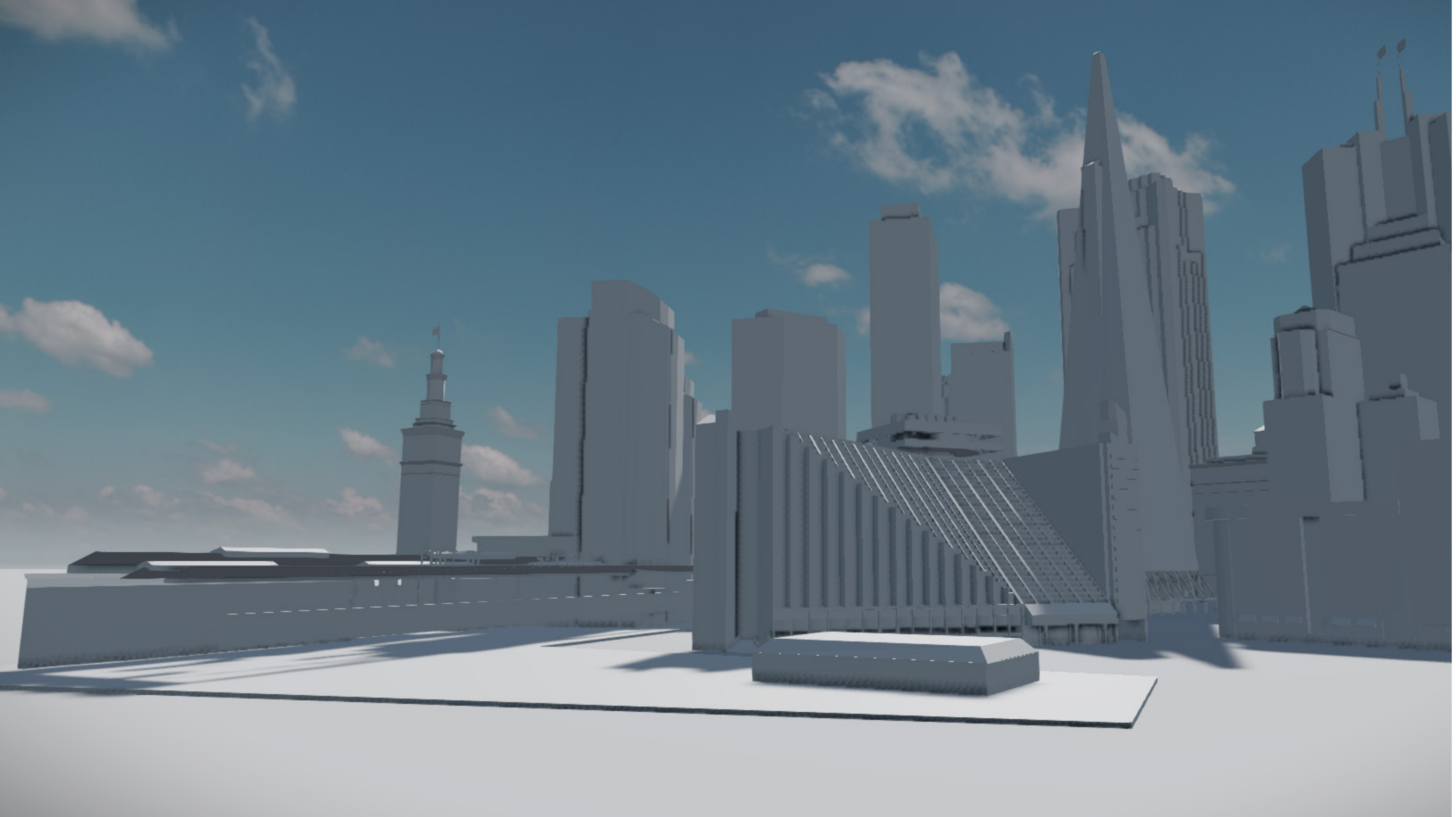
The node chair is a prime example of product visualization within VR. With a variety of options and configurations, a designer can go within the virtual environment and swap out different options. This allows rapid prototyping before ordering any physical products.

Node Chair by Steelcase

Apartment Environment

Another example of an interior design environment is the Clock Tower Apartment. This apartment is based off of the Clocktower Lofts Owners Association Building located at 461 2nd St, San Francisco, CA 94107. This apartment features a pent-house style interior featuring three sprawling stories. Users can rearrange furniture throughout the house including in the open kitchen, living room, dinning room, entertainment room, and four bedrooms. This apartment shows how any consumers, regardless of design expertise, can use World Builder VR to design their future home or office.


POWERED BY
STINGRAY
POWERED BY
STINGRAY



City Environment

The city environment is a prime example of using VR technology to perform tasks that are impossible in the real world. In this environment users can move buildings around to create the perfect city layout. Assets include iconic buildings from around the world. This provides opportunities for city planners to dynamically understand the impact of their layout on the city as a whole. Additionally, the user can scale themselves up or down to experience the city from multiple perspectives.

STINGRAY LIMITATIONS

DOCUMENTATION
- Minimal pictures
- No detailed information
- No public tutorials
- No documented workflows

TIME
- Packaging is incomplete
    - Unreliable for "level flow"
- No components
- No community
- No shared marketplace

VR OPTIMIZATION
- Minimal performance tab
- Nothing VR specific
- Minimal performance settings

NO REAL TIME EDITING
- No access to mesh properties
- Physics lacking
    - Can't replace animation
- Lacks common parameters

NEXT STEPS

COMPONENT LIBRARY
- Curated by Autodesk
- Adds VR Standards
    - UX/UI
    - Tools

OUTPUT
- View work created in VR
    - 3D file output
    - Digital Fabrication
    - Images

VR INTERFACE SPEC
- Consistency
- Lower barrier to entry
- Improved UX
- Consolidate research

NEW HARDWARE= NEW SOFTWARE
- New VR software
    - Design
    - Develop
    - Review


Powered by
AUTODESK