Virtual Reality Interfaces for Product Design: Finding User Interface solutions for design creation within Virtual Reality

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Virtual Reality Interfaces for Product Design

Finding User Interface solutions for design creation within Virtual Reality

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Visual Communication Design

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Abstract

The focus of Virtual Reality has gone from research to widespread adoption in entertainment and practical directions, like automotive design and architectural visualization. With that, we have to take into consideration the best way to give in-experience control to the user and the interaction within the interface.

Recent studies explore the ergonomic considerations and zones of content for VR interfaces. But Virtual Reality interaction design has a long way to go and nowadays is done mainly like a projection of 2D screens, with planar interfaces in the 3D space, almost ignoring the immersive potential of the Virtual Reality medium (Alger 2015; Google Developers 2017).

Designers that work with 3D objects might find it difficult to make design decisions and validate their concepts based on context and empathy. To help with this, they often prototype, which can take a great deal of time and effort. Virtual reality can be a tool that improves the process and gives the designer an unconstrained and flexible canvas.

By reimagining interactions for Virtual Reality, this thesis aims to create interface tools that help designers explore shape and manipulate their designs.

Keywords

Gestures, user interaction, virtual reality, tracking, natural interface, diegetic interfaces.
Thanks to my advisors for their support and guidance for this thesis.

I dedicate this thesis to Mom, Dad, Fabio, Lilliam, Pedro, César, Xavier, Parsuree, Surudhakeerthi, and my VCD classmates. Thanks for believing in me, supporting me, and helping me to push forward.
Introduction

Industrial Designers might find it difficult to make design decisions and validate their design concepts based on context and empathy. To help with this, they often prototype, which can take a great deal of time and effort. Virtual reality can be a tool that improves the process.

Virtual Reality interfaces are currently mainly a projection of 2D screens, not exploiting the immersive potential of the medium. How do we use virtual reality to improve the design process of Industrial Designers?

The goal of this thesis is to create an interface that lets the user manipulate shape inside the virtual world, gives the recurring user a flexible canvas with their quick access tools at hand, and create a natural and immersive interface that translates current gestures and patterns to Virtual Reality.

Context

The focus of Virtual Reality has gone from research to widespread adoption in entertainment and practical directions, like the automotive design and architectural visualization. With that, we have to take into consideration the best way to give in-experience control to the user and the interaction within the interface in this new medium.

In screen-based games and interfaces, the UI is usually overlaid on top of the screen showing information like scores and health. That is what we know as non-diegetic UI, and we usually refer to as a Heads-Up Display. By contrast, in Virtual Reality, we are immersed in the environment, so interfaces need to be diegetic, part of the world. They can float freely on objects, appear over the user's body or as a fixed screen in the world that the user can interact with. (Unity Tutorials 2019; University of London 2017)

We live in a tridimensional world, but a lot of professionals and artists create and explore the tridimensional environments and products they want to build in a flat screen.

Industrial designers work with 3D shapes; they have to prototype and explore form, which can take a great deal of time and effort. Industrial designers, game designers, architects, 3D artists, and other design professionals would be benefited with a tool that aids their creation and evaluation process. In this project, my use case is an industrial designer working on furniture design.
Everybody has a different take on what Virtual Reality Interfaces can be, but this unconstrained playground can become a powerful tool for content creation. Giving the user the capability of exploring different shapes for a product and being able to turn it, scale it and edit it in real scale, see how it would look in the environment, and being able to show it to clients. This project wants to give the user an intuitive environment by exploring the possible ways they can interact with the system in virtual reality.

**Designing for Virtual Reality**

The approach of this thesis is based on research on interaction design, human cognition, and virtual reality guidelines.

Our memory is imperfect, and we have a poor peripheral vision. In a digital camera photosensor, the spatial resolution is constant across the entire frame, unlike the human eye: our peripheral vision is used to provide low-resolution cues to guide our eye movements to the exciting and crucial information, it is good at detecting motion. The primary characteristics of short-term memory are its low capacity and its volatility. That is why when designing interfaces it is good to show users their options and let them choose among them, rather than force users to recall their choices and tell the computer what they want. (Johnson 2010)

Giving the user contextually relevant information and arranging it by keeping it next to the context is essential; in 2D screens, you can anchor information to the edges or center of the frame, but in Virtual Reality, you should pin the context to the three-dimensional objects in the world. (Augmented World Expo (AWE) 2016)

Changing the conventions without defined reason is not advisable. Make the interface consistent with itself. Avoid having unimportant content in the interface: avoid clutter and excess of information. Take into consideration the navigation and information design to support wayfinding. (Garrett 2011)

People recognize pictures very quickly, and identifying an image also stimulates the recall of associated information, use photos where possible to convey function. Ex. Desktop or toolbar icons, error symbols, etc. Pictures that people can recognize from the physical world are useful and don't have to be taught, but users can also associate new icons and symbols with their intended meaning if designed correctly. (Johnson 2010)
The user should physically interact with the virtual world using their body so that they feel more engaged and present. In designing for VR, we should aim to minimize breaks-in presence. When present, the user doesn’t perceive the technology but instead recognizes the objects, events, and characters the technology represents. A break-in-presence is a moment when the illusion generated by a virtual environment breaks down, and the user finds himself where he indeed is—in the real world wearing a Head Mounted Display. A loss of tracking can cause that, a person speaking from the real, a real-world phone ringing, etc. (Jerald 2016)

Communicating more information through a different sense, like sound gives parallel input to the user. Audio can be used to make objects tactile, provides a physical sense: hollow, solid, soft, metal, wood, and a sense of touch. (Augmented World Expo (AWE) 2016).

**Design Process**

**Methodology for developing designs and validating concepts**

For developing the designs, I researched existing gestures; I surveyed the commonly used 3D software to come up with a list of the current tools for 3D product design; I also did interviews with design students and professionals, observed prototyping with clay, 3D printing, cardboard, and foam.

I interviewed a total of six industrial designers: four graduate students and two industrial design professionals, to find out what kind of problems they may face, one of them was the lack of confidence when picking a product solution based on empathy and requirements, other was the amount of time and energy that had to be put into prototyping.

These things might be solved by giving them a tool to explore shape and see their solutions in real scale and make real-time changes. I took into consideration the type of tools the user would use to prototype in commonly used 3D design software’s, to determine what kind of tools the user would like to use in the virtual space, which instruments should be gestures and which ones should stay part of the graphical user interface.

**Design Goals**

This project wants to translate the interactions that happen in a computer 3D software and the gestures people use every day in mobile devices into the virtual reality realm. It wants to give the 3D product designers an environment where they can explore shape and prototype, make changes and visualize their products.
It wants to expand what we currently know about designing for virtual reality. Complementing the two-dimensional and three-dimensional User Interface, with a translation of tools and gestures, make convergence of current knowledge and patterns and create an environment where the user can design freely, keeping them focused in their design, immersed in the reality.

**Audience**

Industrial Design professional and students, that want to make better design choices, explore shape in real time and communicate their design intent. To focus the design process to a single scenario, Monica’s persona was created.

![Figure 1 Use case, product designer prototyping in Virtual Reality](image)

Monica is an industrial designer designing a table for a coffee shop, and she has limited time to design and already has all her requirements. She puts on her headset and creates a prototype within minutes, she uses her hands to create shapes, rotates, scales them, zooms on the objects to see the details, and can see the different materials and colors. Her environment is immersive, and she can validate her design decisions by examining them in a 3D world, having the possibility to make changes and explore different versions.

This gesture-based idiomatic interface makes it easy for her to bring up her most used tools, get the tools she needs depending on the context and entities she is selecting and change the tools on her quick-menu. She can share this experience with coworkers and clients, who can see the product and give feedback.

**Existing Virtual Reality creation tools survey**

For content creation within Virtual Reality, there is Google Tilt Brush, Unreal VR Editor, Gravity Sketch, and Quill by Oculus to mention a few. Google Tilt Brush has some volumetric palette, and
gives the user creative freedom in 3D space. With Nissan Design tool the designer can walk around a car model and judge accurately. InsiteVR is an architectural tool that helps the user identify problems before construction. And Unreal Engine VR Editor lets them create a 3D world within 3D.

Most of the existing tools have 2D planar interfaces, the use of controllers is also a prominent recurring feature. They are used for visualization with minor creative power, or are art and experimentation focused.

From the VR tools researched, the Unreal Engine VR Editor seems one of the more natural to their current users. They can manipulate the objects with one hand, while in their other hand they have the existing content browser and editor they are familiar with as a palette. They can navigate the scene, grab it and move it around, scale the world; they can move, rotate, scale objects, and do teleportation. Most of the interaction is done with laser pointer interaction and controllers. (Unreal Engine 2016)

**Existing gesture interactions survey**

I researched about gestures in mobile, multi-touch trackpads, gyroscope gestures, hand tracking, gestures technologies and virtual reality controllers, this research was done au pair to doing my design ideation, and as the knowledge grew, my solution evolved with it.

**Multi-touch on Mac**

Mac trackpad offers a multi-touch function. The user can use from one to all 5 fingers to give the device a command. Tap to click, secondary click, zoom, scrolling, rotating, swiping or accessing specific screens and information, are available to the user by just dragging, moving, tapping, pinching and sliding their fingers.

**Leap Motion**

Leap motion device tracks the user hands with two cameras and three infrared LEDs. It can recognize the user's hands and retrieve where each segment is. The user can interact with the computer without needing to use invasive tools and controls.

Leap motion recognizes gestures like tracing a circle in space with a finger, swiping with a finger or hand, downward tapping with a finger in the air and forward tapping movement with one finger. To recognize the interaction with objects in the application the API provides information to the application based on the zone and the plane of the touch and then identifies if the user's finger is near to the surface or penetrating the touch surface. Leap Motion affirms that the developer can decide if there would be a UI element updated based on the position of the user, and simulate hovering and touching.
Their touch distance though doesn't represent a physical distance; it is an approximation of how close the software considers the UI to be from the forward-most finger.

Project North Star – Leap Motion
Leap Motion believes the essential input device will always be our hands. So they created an augmented reality head-mounted display with a hand-tracking solution that runs at 150 frames per second. It can accurately track your hands and fingers in real time everywhere in front of the user. In their Virtual Wearables demo, they show how they articulate every finger separately and aim to replicate the physics of picking up and moving objects and pulling up a virtual wrist display. Matsuda believes VR and AR have the potential to be the most straightforward and most natural interface. (Keiichi Matsuda 2018; Diaz 2018)

Moto Actions
Motorola smartphones use the Gyroscope in the device to help the user do things like turn on the flashlight, open the camera, put the phone on do not disturb mode. They also let the user remove the onscreen navigation icons by allowing them to use the fingerprint sensor to navigate, go home, go back and open recent apps. They allowed the user to customize their experience and let them opt out if they want to.

Project Soli – Google ATAP
Project Soli takes radar hardware and turns it into a gesture sensor; it interprets human intent from the radar signal received at a high frame rate with their gesture recognition pipeline. It can distinguish complex finger movements and deforming hand shapes within its field. They claim their radar technology can track micro motions with high positional accuracy, resulting in precise touchless gesture interactions. (Google ATAP 2015)

Microsoft HoloLens
HoloLens it's a frameless medium, you are within the content space, the holograms change based on the user's head position. Your body is the interface; the input can depend on where are you looking, your gestures and voice.

To do things with the HoloLens the user employs hand gestures, mainly the air tap gesture combined with gaze to experience something similar to a click, Microsoft calls it gaze-and-commit interaction. Their other essential gesture is Bloom, which takes you back to the Start Menu. HoloLens tracks the hands that are visible to the device. Other actions are made by combining gaze, voice and the air tap
gesture. Keeping the fingers that make the air tap gesture together the user can hold their selection and manipulate their environment. HoloLens ignores when hands are not in a pose it interprets. Its voice command input can improve the interaction but is not ideal when used in noisy environments. (“Gestures - Mixed Reality, Windows” 2018)

The display in the HoloLens, or mixed reality in general, is an additive display, so the whites are bright and the blacks transparent. The screen is see-through, so the content created will look different in mixed reality and other displays and devices.

The rules for using typography in Mixed Reality and virtual reality are the same: text should be readable, using bright and legible, medium or bold typography, building contrast and hierarchy for the user to understand the experience.

Microsoft mixed reality design documents also recommend the use of spatial sound, which will help guide the user attention, to direct the user gaze to some particular space, to help to keep the user immersed by indicating how those objects would sound like in the real world. The user also would expect to receive some sound feedback from the UI or when pressing a button. The more real the sound is, the easier it is for the user to locate it in the virtual or mixed reality environment.

**Design Ideation**

I went through different approaches when doing this project, exploring graphical and gesture-based interfaces concepts. Some of them were mainly GUIs: panels, radial, and volumetric interfaces; other were interfaces that used mostly gestures to interact with the objects in virtual reality.

![Figure 2 Initial ideation](image)
At first, I envisioned more of a previsualization tool, giving the user the freedom to change their point of view; editing objects they’ve already created in 3D software on the computer. But some similar tools exist for architecture and could be easily translated to Industrial Design, and I wanted to explore more about Interaction Design in Virtual Reality. I thought of letting the user explore shape and design their product within the virtual reality world.

Figure 3 Envisioning a previsualization tool

Figure 4 Ideation of a library of interactions
I started exploring the gesture-based tools, the translation of the gestures, and creating a library of interactions, debating between making all tools gestures, or including a menu system. Making them remember how to call every tool they need to sculpt their product would be a pain, and a menu system would help the user not be overloaded with gestures information.

A radial menu would be readily accessible, all options are at the same distance, so there’s an equal access time for all elements, but it is harder to scan, as it’s not in the world permanently. I decided it would be better for the user to have their commonly used tools at hand in a permanent menu.

A 2D panel menu works excellent in computer interfaces, but even with the favorable accuracy of hand tracking in Virtual Reality, the fast movements of a recurrent user on small flat targets would increase the interface’s error rates (The Interaction Design Foundation 2018).

Then I went for a volumetric menu with a more significant clickable area, which according to Fitts Law makes it easier for the user to interact, and separated the menu in Quick tools and a Launcher, so the user has their most used tools accessible at all times and makes timely choices. The more stimuli to choose from, the longer it takes the user to make a decision on which one to interact with. (Soegaard 2019)

![Icons designed for the tools of the interface](image)

After deciding on implementing both Graphical User Interface and gestures, I began investigating which tools were more likely to require some gesture or shortcut, and which utensil would be better accessed by a button in the User Interface.

I also had to explore the default workspace and the environment surrounding the user, the use of a grid, or changing the initial direction and going towards a mixed reality solution.
Pros and cons of gestures and hand tracking

Gestures are an idiomatic interface that the user can learn and master. They have become an interaction that the user intuitively does. Gestures are used extensively in the current time for day to day activities. Our mobile phones, tablets, and computers trackpad improve the experience of the user by utilizing gestures for their everyday tasks: rotating, scaling, moving, changing the screen, bringing up a menu, removing the clutter. This solution aims to let the user interact with the virtual world more intuitively.

By exploring the capabilities of bringing quick access tools to the designer’s hand, the recurring user would have an improved experience. This can be done by relying solely on hand tracking technologies, which are enhancing day to day, or mixing up the current Virtual Reality controllers with hand tracking.

However, an obstacle of using gestures and hand tracking in virtual reality is that the accuracy is limited, it is great to be able to select a corner by touching it, but how precise can a digital touch be?

Research on the Leap Motion device by Valentini and Pezzuti concluded that precision errors were around 4-5mm, vertical distances from the device did not make a relevant difference. When the hand is closer to the body, it is partially out of the range of view, and the Leap loses some recognition.

The researchers used a transparent plate with precisely measured points, to calculate the accuracy of the device relative to different hand locations. The results were somewhat accurate; the experiment evaluated the accuracy of pointing, the combination of fingers was not analyzed. (Valentini and Pezzuti 2017)

Virtual Reality can be a multi-sensorial, multi-dimensional experience where the physical and digital realms collide and let can engage the user with more than one sense and more than one kind of input. Gestures help the user explore freely in virtual reality with nothing external other than their body and headset.

In this project, Gestures are not meant to replace every tool, button, and Graphical User Interface. They are intended to complement them, like our mobile phones, trackpads, and Mixed Reality tools like the HoloLens. Introducing translations of our commonly used gestures into a Virtual Reality creation environment.
Gestures are currently used in a lot of mobile devices; users have learned to spread, swipe, pinch, pull down to refresh. Those gestures are linked with animations in the graphical user interface that help the user understand the interactivity, and actions that are occurring. Gestures have taken over the way we currently use our mobile phones and give the user the illusion that they are interacting with real tangible objects through the screen. (Cousins 2015)

The user still has to be reminded and given cues of which gestures are possible for them to do to interact with the digital world in this experience. Those gestures should not be too far from what they expect. (“Importance of In-App Mobile Gestures And How It Boosts App User Experience” 2016)

**Technical Issues and Troubleshooting**

In the beginning, deciding how to demo the interactions was complicated; I didn't know if I should use 360 videos or show just from one perspective. I pondered the possibility of using Premiere immersive tool, Mettle and After Effects, but by creating the storyboards it became clear that showing just one angle would be enough to show the interactions and gestures the user would be doing. My attention focused on the interaction instead of the 360 creative environments. Behind the user there won't be a lot going on, that is in the curiosity zone (Alger 2015) the user will be interacting with the objects they are creating and with the tools based on the context.

*Figure 6 Tridimensional representation of the move gesture tool before shading on the left, and after shading and changes on the right*
Some technical issues present in my design process was my limited knowledge in shading and other 3D rendering subjects. I had to reach to Visual Communication Designers from the motion and 3D digital design area to get suggestions on tools to do shading and rendering. After trying some render and shading software, I decided to go on with Pixar’s Renderman, which visual aesthetics aligned with my idea of the product.

Validation and Iterations

In the start of the project I interviewed six industrial designers, four graduate students and two industrial design professionals, to find out what kind of problems they face in their design process and give direction to the project.
Select vertex

Deselect

Rotate component

Rotate object

Move component

Figure 9 Digital storyboard of gesture tools
Mid-project I got feedback from 4 professors during my thesis defense; and showed my illustrations and animations to Industrial, Interaction and Visual Designers who gave me feedback and insights that helped my solution evolve.

At the end of the process I made a web prototype to explain the concepts and tools of the interface that included a tridimensional video representation, the design environment and tools, and illustrations of the gesture and contextual tools. The prototype was interactive, and the users could click around and learn about the interface and concept. I showed it to one Industrial Designer, two Interaction Designers and one Human Computer Interaction graduate student, to see if they understood the concept with the web prototype alone, without me explaining, and made changes based on their feedback.
Figure 12 Screen capture of the web prototype
Results

The user feedback throughout the design process helped in addressing needed modifications to the appearance of the environment, the menus, and interactions. Therefore, the final interface concept achieved the goals of this thesis by creating an interface that lets the user manipulate shape inside the virtual world, and use their bodies to interact with their designs. This thesis also gives the recurring user a flexible canvas and a rich experience and translates current gesture and interface patterns to Virtual Reality.

Based on the design ideation and user testing, the interface was revised to fit the thesis goals better:

- Create an interface that helps 3D product designers explore shape, manipulate their design, and visualize their products in the virtual world.
- Explore different ways the user can interact with the system in virtual reality, and give them a natural interface. Complementing the Graphical User Interface, with a translation of tools and gestures.
- Bring quick access tools to the designer's hand to give the recurring user a rich and immersive experience, using their body to interact with their creation.

Approach and features

The user has access to different types of tools: gesture-based tools, contextual tools, quick tools, and launcher.

![Figure 13 Two-finger moving gesture-based tool](image)

Gesture-based tools

Quick access tools and shortcuts in the designer hands, accessible through gestures and hand tracking technologies. Based on 3D software tools and research, the gesture-based tools in this concept are select, rotate and move.
The user can select the vertexes, edges, and faces with one finger, like tapping or clicking. They can select a component by placing their open hand on it since it is a bigger selection. The user will hold their selection by pinching the non-dominant hand while they continue picking entities with their dominant hand, and they can deselect by waving their hand.

To rotate the component the user will select the component first, and then do a three finger rotation, selecting and turning in the axis that they want, using a gizmo sphere. To rotate an object and change the view, the user will hold the object with both hands and turn it in an axis. Both kinds of rotations will be constrained, 15 degrees for the component rotation, and 45 degrees for the object rotation, those can be unlocked for free rotation in an axis.

The user will move the component by selecting it and using a two-finger gesture and dragging movement.

![Figure 14 Contextual tools in the user's non-dominant hand](image)

**Contextual tools**

Common action tools based on the entity the user is selecting. Accessed by opening the non-dominant hand while choosing an entity.

The contextual tools will vary depending on what you are selecting. For example, if the user is picking an edge, they will get chamfer and fillet, if they are choosing a face, they will see tools like extrude and shell, and based on a component selection they will have access to materials.
Quick tools and Launcher
Gestures are intended to complement the tools as they do on our mobile phones, trackpads, and Mixed Reality tools. They are not meant to replace every tool and Graphical User Interface. There is no need for the user to recall all the tools and gestures. They can have their most used tools within reach in the Quick tools menu, helping them create an individualized workspace, and the launcher is where the user can access all the tools that they will need to explore shape within Virtual Reality.

Benefits
This concept gives the user an intuitive environment by exploring the possible ways they can interact with the system in virtual reality. Give them a flexible canvas where they can explore shape and edit the objects, sculpting, mirroring, rotating, moving, etc.; this unconstrained playground can become a powerful tool for content creation.

Gestures can be fantastic to get some quick, repetitive actions done, keep the user aware of their space and give them control over it.

Evaluation & Discussion
This concept was evaluated throughout my design process to test if the interface fulfills the goals mentioned above. At the start of the project, I interviewed six industrial designers to find out the problems they face in their design process and their opinion on Virtual Reality. Some key points they mentioned were the time it takes to prototype, and the hard work required to make the models. They wanted an unconstrained and flexible tool that helped validate their design decisions and spoke a natural language. Nevertheless, they agreed that although this would be a great tool that improves their process, they would still need validation in the real world.
After showing my illustrations and animations mid-project, I got feedback from professors, Industrial, Interaction and Visual Designers. Most of the feedback was about the explanation of the concept, which directed me to create more animations and a web app prototype.

To conclude the project I observed participants using the web app prototype and asked them what they thought was the goal of the interface. To determine if they understood the concept without me explaining. The participants clicked around and learned about the interactions and concepts, they thought the animated illustrations were a great way to show the interactions, and the tridimensional video representation explained the look and feel of the Virtual Reality concept. Overall, they expressed interest in trying an interface like this.

**Solution Statement**

The exploration of gestures as part of the Virtual Reality environment, complemented with a graphical user interface, provides a rich experience for the user, who can focus on designing and exploring shape in Virtual Reality. The user feels engaged and immersed in the environment because of the use of their body to interact with their creation.

**Future directions**

This concept could be further developed by exploring new gestures to add to help the recurrent user interact with their designs, how the user would interact with real-world messages and notifications, and studying a translation of the product to a mixed reality environment.

**Exploring different senses**

Explore other areas of interaction design, not only graphical user interfaces and gestures. Examining voice commands, and using audio to make objects tactile, and provide a sense of touch. (Augmented World Expo (AWE) 2016)

**Gestures and controllers**

How would the user interact if they also had a controller at hand, preferably one flexible controller like the Pimax which mixes gestures and buttons; or using one controller in the non-dominant hand, changing the structure of the experience and the gestures but helping with the accuracy of the selection and editing tools.
Physics-based assistive grasping
In the virtual world, there's a one-way interaction, the user has frictionless contact, can't feel the object and there are interpenetrations between the hand and the object that want to be grasped. Some research has been done on assistive grasping; this system produces natural-looking grasps by predicting the users grasping intention and allowing the user to grab the object by closing their fingers around it. The system in that study also experimented with grabbing complex meshes and separate objects. These studies wherein a Leap Motion device and made with Unity Game Engine. (Nasim 2018)

Real world objects
Making the interaction more tactile by tying a real-world simple prototype structure made of a material like cardboard to the ever-evolving mesh in the virtual environment, or a mixed reality hologram, overlapping the render of the digital product to the physical object. With tools like the Vive tracker to provide the link.

Multi-user interaction
Giving users a multi-user interaction where they can explain their ideas to their clients within Virtual Reality, and their clients can comment and convey ideas, edit, and alternatively make contextual comments.

The researchers of the paper Towards gesture-based multi-user interactions in collaborative virtual environments were investigating gesture-based multi-user interactions, using a Google Cardboard as the Head Mounted Display, and a Leap Motion for hand tracking. The user could see each other's actions, the gestures coded were pinching, picking objects, pointing, highlighting an item, and measuring. The architecture of the experiment was based on Unity 3D 2017. This paper affirms that with the users being able to move and see each other in the VR environment they can think collectively by sharing their visualization. (Pretto and Poiesi 2017)
Conclusions

Virtual Reality can be a multi-sensorial, multi-dimensional experience where the physical and digital realms collide and let can engage the user with more than one sense and more than one kind of input. Gestures help the user explore freely in virtual reality with nothing external other than their body and headset.

By exploring the capabilities of bringing quick access tools to the designer's hand, the recurring user would have an improved experience. Complementing the two-dimensional and three-dimensional diegetic User Interface, with a translation of tools and gestures, this project makes convergence of current knowledge and patterns and creates an environment where the user can design freely.

Deciding how to demo the interactions and help the viewer understand the concept was a process. I went from wireframing for a 360 environment, to creating three-dimensional and two-dimensional animations, and designing a web prototype to explain the concepts and tools of the interface. The result was a gesture-based idiomatic interface concept that makes it easy for the user to bring up their most used tools, get the tools they need depending on the context and entities they are selecting, see their solutions in real scale and make real-time changes.
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Google ATAP. 2015. Welcome to Project Soli. https://www.youtube.com/watch?v=0QNiZfSsPc0.


**Source of Imagery**

All illustrations, vectors, icons and 3D models made by the author.
All photographs taken by the author.
The table used in the concept was inspired by Xavier Arvelo’s design.
Appendix: Interviews

Interview Questions

1 – Can you describe your current design process?
2 – What step of it do you find harder to work on?
3 – What tools or software do you use in your design process?
4 – What do you find the physical world have that you cannot see on a computer when designing products?
5 – Do you see Virtual Reality incorporated into your design process? How do you imagine it? Please explain.
6 – Would you use Virtual Reality as a product creation tool?
7 – Do you have worries about this kind of tool?

Interview 1 – Student

*Industrial Design Graduate student, Bachelor’s in Motion Pictures Science*

1 – Can you describe your current design process?
Identifying a Problem and meet with stakeholders. Understanding the needs benchmarking of technology, research around the context, ideating things that are not necessarily related. Aesthetics with reference images and I try to stay away from Pinterest. Then I show it to the stakeholders and client, and progress forwards, but is not a linear process.

2 – What step of it do you find harder to work on?
The beginning, what is the problem, understanding what the actual problem is, working with teams because not everyone understands what you’re doing and why you are doing it.

3 – What tools or software do you use in your design process?
Photoshop, illustrator, freehand sketches, Premiere, photography, video, Fusion 360, woodshop tools like welding, and video to convey the idea better and promotion.

4 – What do you find the physical world have that you cannot see on a computer when designing products?
No real tangibility, the computer tries to simulate it but sometimes it looks like a cheap simulator. I like the feeling of the dragging of the paper, I like feeling the texture, and I want it to feel real.
5 – Do you see Virtual Reality incorporated in your design process? How do you imagine it? Please explain.

If I model something and it looked real enough, contours that I can see and feel, walk around the product, feel the texture, respond to touch.

6 – Would you use Virtual Reality as a product creation tool?

I can see what’s out there how it will help me. I would like 3D modeling in free space, for example, click the tank and change color if it reacts to specular light of the environment, I can touch it, It maps the surface to create the image where the model is.

7 – Do you have worries about this kind of tool?

It’s hard to me, there’s the uncanny valley when you try to make real life. I would like it to map the surface in free space with virtual integrated into reality and not a separate entity you are designing real objects.

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**Interview 2 – Student**

*Industrial Design Graduate student, Bachelor’s in industrial design*

1 – Can you describe your current design process?

Research, Ideate, Refine

2 – What step of it do you find harder to work on?

Making the models. I hate foam and sanding foam: for example, last year I had to work doing a toilet it was so big and hard to model is there an easier way? it’s difficult to do models but it’s necessary to see how things will look like and how to interact.

Simulating the scenario, for example, the toilet. Simulating in the environment around it, the space around it the light.

3 – What tools or software do you use in your design process?

Brainstorming software, sketch by hand and then use illustrator, Fusion360 (used to use Alias but it’s not for organic shapes) and I also use Keyshot for rendering and Photoshop CAD and 3D printing.
4 – What do you find the physical world have that you cannot see in a computer when designing products?
It will be hard to imagine this; imagination is based on past things I think it will be to see how it will fit in the environment, show a scenario in my head to the other people. For example, display accurate pictures in my head in real space, real scale, 1:1 scale.

5 – Do you see Virtual Reality incorporated in your design process? How do you imagine it? Please explain.
I could imagine it in 3D space. How to interact with it, simple to use just dump it in and draw in the environment. Draw in 2D and then it changes to 3D, it will be a dream it will change things so fast.

6 – Would you use Virtual Reality as a product creation tool?
If you can make it, I would buy it.

7 – Do you have worries about this kind of tool?
The learning curve: for example, SolidWorks has a big learning curve, but Fusion360 is easy and intuitive, it speaks visual language and human language.

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**Interview 3 – Student**

*Industrial Design Graduate student, Bachelor’s in Industrial Design*

1 – Can you describe your current design process?
I research, define the problem. See what has been done before, what technology there is, define the user, interview the user, talk with the client, establish requirements. Ideation. Take the ideas to the client, make 5-6 concrete design concepts, 3D mockups that can be tested, test with the user. See what good and bad from the concepts, make more prototypes till I have one concept, which will have the aesthetics and functionality.

2 – What step of it do you find harder to work on?
The harder is finding users, they are not always available, talking with others sometimes is scary, and you can’t do it all by yourself. Prototyping the technology of the product and knowing if it will work is hard.
3 – What tools or software do you use in your design process?
Internet, Google Docs, Behance, Pinterest, digital and paper sketches, 3D modeling in SolidWorks, Fusion 360, prototyping with foam, wood, metal, CNC, 3D printing

4 – What do you find the physical world have that you cannot see on a computer when designing products?
Proportions, you can see the product, but you don’t see the proportion related to the environment. Tangibility, feeling the object.

5 – Do you see Virtual Reality incorporated in your design process? How do you imagine it? Please explain.
In VR you see things the scale they should be, but I think 3D sketching in the air might be strange. I imagine modifying a 3D product with AR, not necessarily something I already modeled on the computer, but modifying on top on an object. That way you’ll get feedback from the client: change this, do this, change it real time, in VR or AR.

6 – Would you use Virtual Reality as a product creation tool?
For example: if I have a simple prototype, but in VR or AR you can see it as I expect you to see it, even if you cannot touch it, you can see it.

7 – Do you have worries about this kind of tool?
It depends on how people use it, don’t just rely on it because tangible things will always have its importance and VR will be just a previsualization. It will help with materials, prototyping and time.

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**Interview 4 – Student**

*Industrial Design Graduate student, Bachelor’s in industrial design*

1 – Can you describe your current design process?
Research, design philosophy, ideation & research at the same time, prototyping and testing, time is limited.

2 – What step of it do you find harder to work on?
Research, I don’t know in which direction. How to approach people & do research.
3 – What tools or software do you use in your design process?
Things to record, laptop, Adobe software, Fusion 360, tools from the workshop, model making.

4 – What do you find the physical world have that you cannot see on a computer when designing products?
Tangible part. I can feel it instead of just visually. I can 3D print it and then go back to the computer and change and 3D print again.

5 – Do you see Virtual Reality incorporated into your design process? How do you imagine it? Please explain.
Trying to test it, visualize the environment, how it will be used, and for testing with users.

6 – Would you use Virtual Reality as a product creation tool?
Yes, if it’s available to me while making a model, models get made in the CAD also.

7 – Do you have worries about this kind of tool?
I’ve used VR twice, and once I got dizzy, I wear specks, it feels weird sometimes.

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**Interview 5 – Professional**

1 – Can you describe your current design process?
It’s flexible, changes. There are some different things, research, design, ideate. They can vary from time and depth depending on the project.

2 – What step of it do you find harder to work on?
Defining the design process, come to the clients, and what they say is not really the problem. I deal with different types of clients, sometimes of strange business, and I have to become an expert in their business.

3 – What tools or software do you use in your design process?
My favorite is pen and a piece of paper. After that, mainly illustrator from prototypes to presentations.
4 – What do you find the physical world have that you cannot see on a computer when designing products?
Real world provides more context. I can learn more about what I want to design. And also I can see how the user interacts with the product in a natural environment.

5 – Do you see Virtual Reality incorporated in your design process? How do you imagine it? Please explain.
Assist in the design process, most robust environment. Unconstrained, not limited to the monitor size. I wish I had 3 monitors and infinite artboards to work on. VR and AR to model similar solutions.

6 – Would you use Virtual Reality as a product creation tool?
Yes, I’m thinking of how I would use it. I have two monitors and a mouse, and I’m thinking of getting the new touch-sensitive Cintiq, I would like to work with my hands, manually and not be limited to the tools and controllers we currently have (mouse, etc.).
But, expert uses require Flexible tools, being able to customize your workspace (Ex: my illustrator panels, swatches, background color, location of everything)

7 – Do you have worries about this kind of tool?
Motion sickness

**Interview 6 – Professional**

1 – Can you describe your current design process?
Is really user-centered. It always starts by identifying user needs, not necessarily the problems that people have, but in what’s behind the problem. Behaviors, consequences that they create, and then design solutions. I like combining analog and digital experiences to identify what technologies work better.

2 – What step of it do you find harder to work on?
Making decisions is the hardest part, designers are used to ideation. You are celebrated when you come up with a lot of ideas, and they feel that’s enough. The challenge is to make decisions to pick the right one, and the execution: refinement, development.
3 – What tools or software do you use in your design process?
CAD: Autodesk Fusion 360, it has a lot of capabilities, modeling, simulation, rendering.

4 – What do you find the physical world have that you cannot see on a computer when designing products?
Direct interaction with objects around you. Something as simple Gravity, is it going to be heavy? tip over? You have to take it to the real-world test and validate.
I know you work with interfaces, I think the magic happens when you go from one state to the other, from one screen to the other, when you are processing, you see behaviors, sometimes it’s overseen by designers.

5 – Do you see Virtual Reality incorporated into your design process? How do you imagine it? Please explain.
I don’t use VR a lot in my current work, but I see a lot of potentials. For example, in human factors:
very easy to change the layout of a space, proportions of a product or an environment. Your perspective changes and you understand the changes depending on where you are in a room, depending on how short or tall you are. It’s also a powerful tool for communicating design intent. How space or solution might feel like. But it’s not a substitute for real-life experiences.

6 – Would you use Virtual Reality as a product creation tool?
I think so. I’ve played with some VR tools where you can create 3D lines, lay objects manipulate shapes or lines and turn into objects. I really like that there’s more connection with the scale. Designing furniture, on the computer, there’s no sense of height, depth, comfort. In VR there is a better understanding of those elements “This feel too high, this feels too far away”.

7 – Do you have worries about this kind of tool?
The worry is that people sometimes think that can be a substitute for physical tools. When CAD came out, at first people felt like they didn’t have to make physical mockups & models anymore. But you need to test and validate your ideas. It gives good direction and guidance, but you still need the validation in the real world.