

Virtual Reality: Cool Tool or Design Detour

By



Steven M. Cox, AIA, NCARB

Jeremy Metz, AIA

Brian Brown, Associate AIA

Revised June 6, 2020

Recipients of 2019



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Abstract

The challenge of designing a building or space for users has always been one of communication. How do the designers transfer what they have envisioned to various medium that will allow owners, users, approving authorities, lenders, and contractors to know what is proposed to be built?

The issue explored in this study is how to make sure designers understand the best tool(s) to communicate with their clients. In other words, in addition to making sure designers understand the client's needs they must also understand the client's ability to comprehend and visualize the true intended design. Various options were explored to determine the effective presentation tools and techniques to maximize the clients understanding of what is being proposed.

If clients and users can be properly coached through the mental, physical, and technical barriers posed by new presentation technologies, they will have a better understanding of design concepts and therefore will be more engaged in review and approval of final designs.

HPC Architecture, Inc is a medium sized full service architectural and interior design firm located in the heart of Silicon Valley. The firm was founded in 1987 by Steven M. Cox, AIA. With a staff of eight the company provides services in the San Francisco Bay Area to the following client sectors: corporate, institutional, high-tech, healthcare, commercial developers, property managers, as well as design-build contractors.

Special Thanks to Contributors, Editors, and Staff:

*All focus group participants
Carolyn Clark Beedle, One Workplace
Amy Nieva, One Workplace
John SanGiovanni, Visual Vocal
Marina Alvarado, HPC Architecture
Robert Hartley, HPC Architecture
Kristin Espiritu, HPC Architecture
Thomas Freedman, HPC Architecture
Sherry Cox, HPC Architecture*

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Introduction – It's always about communicating with the client

The challenge of designing a building or space for users has always been one of communication. How does the designer transform what they envision into various medium that will allow owners, users, approving authorities, lenders, and contractors to fully understand what is being proposed for construction?

Architecture is the only art form where the designer never physically creates the final product. The sculptor forms the clay with their hands. The artist paints the painting. The musician plays the music. By contrast, the traditional architect completely relies on someone else's understanding in order to physically implement their design. This has always required the best means of communication; therefore, communication should be at the heart of architectural design. If a designer is unable to effectively communicate the design intent, there will always be a disconnect between designer, client, and builder.

The decision as to which medium or tool to use has changed dramatically in the last twenty years. For centuries designers have relied on the ability to draw as the means of communicating their design intent. Over the last two decades, there has been a dramatic shift toward other tools and software replacing the need for "pencil on paper." If architects are not careful in how they approach this shift, the technology may make it more about the tool and less about capturing and communicating the essence of the design.

Architecture and design should always be about the client and the user. Space and buildings should be programmed and designed to meet the required and intended use. With the advent of new architectural tools and presentation techniques it is critical that designers never forget the client while on that journey.

Computer Aided Design (CAD), Building Information Modeling (BIM), Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are recognized as efficient tools for the designer to create and manipulate spatial designs. Through an investment in time and equipment, many design firms have become proficient with these tools. As a result, experienced designers can now communicate faster and more efficiently with other skilled designers. The critical aspect of this collaborative design experience is to ensure the client is not overlooked as a participant of that process. This can happen by assuming the client has the same level of understanding of the medium being used as the design firm, when in fact we know it would only be the rare client who is schooled in using the latest design tools.

Therefore, the true issue to be explored here is how to ensure the designer fully understands which tools fit best with their client's level of communication skills. In other words, how do we maintain a designer's understanding of a client's project needs, while simultaneously addressing their ability to fully comprehend the complexities of the design being presented? This paper will explore the various presentation options available to effectively connect a designer's intent with a client's understanding of their design, in order to meet the project needs.

Firm history with software and hardware

Up until the start of the ONEder Grant research, the firm's adventure into 3D presentation techniques and level of experience with software and hardware was as follows:

- Hardware
 - Standard computer workstations
 - Standard monitors
 - Smartphone with VR glasses or smart goggles such as Oculus Go
- Software
 - Autodesk
 - Autocad – 2-dimensional CAD
 - Autodesk 360 – cloud rendering engine
 - Revit – 3-dimensional CAD
 - SketchUp – 3-dimensional modelling
 - Yulio VR – VR hosting platform
- Presentation Styles used with clients
 - Traditional “hard copy” 2D drawings or 3D renderings
 - Monitor presentations of 2D or 3D renderings
 - Fixed-point (3° of freedom) utilizing Yulio VR and smart phone or Oculus Go headset.
 - Walk-through (6° of freedom) utilizing Enscape software and the Oculus Quest headset.
- Staff Training Level and Experience
 - Production staff fully proficient with Revit through 2016 onsite 12-week training course conducted after hours through a State of California grant. (no cost)
 - Selected designers fully proficient with Yulio VR and Enscape through on-the-job training. (non-billable)

The internal observations at this point in time were extremely positive and led the firm to believe that full virtual reality was a powerful design tool for the design team. Opportunities were easily provided for designers to quickly share with other designers for discussion and final selection of architectural form, materials, and colors. Design changes and options were easily made in real-time.

Based upon the staff observations of client reactions to fixed point and walk-through techniques initially led to different results. Client presentations were awkward for a variety of reasons as indicated below:

- In larger meetings with multiple participants, not all individuals were willing or interested in watching the presentation if goggles were required.

- One-on-one meetings appeared to be better received. This was attributed to clients being uncomfortable or feeling foolish in front of their peers while using the tools.
- Female participants tended to be more reluctant, which was attributed to hair and makeup issues.
- Those that did participate often missed the design intent being presented. This was attributed to being “wowed” by the technology. Their reactions seemed as if they were playing a game rather than reviewing their potential building or space.

Shortly after these observations were made the firm was invited to apply for the ONEder Grant.

ONEder Grant Application Submittal and Award

In the application submittal it was stated that the study would research the impact new design tools have on a client’s understanding of the proposed design, and how they will use the space by asking the following questions:

- Do tools and technologies such as BIM, VR, AR, and MR allow clients to understand and become part of the design process or does the newness of the tool just provide a ‘Wow Factor’ or worse yet, a distraction?
- What are the obstacles to the full utilization of these technologies and how can they be overcome?
- Are clients interested in becoming more of an active participant in the design of their own spaces?
- Is there value in allowing the client to make real-time option choices utilizing BIM, VR, AR, and MR?
- Can architects, consultants, and vendors participate in active collaboration during the design process utilizing these virtual mediums?

In August of 2019 the firm became one of three recipients of the 2019 ONEder Grant. At the time of the award, Carolyn Clark Beedle, Director Audience Development for One Workplace was assigned to us as a coach. With her guidance we developed a specific thesis statement.

Primary Thesis Statement

If clients and users can be properly coached through the mental, physical, and technical barriers posed by new presentation technologies, they will have a better understanding of design concepts and therefore will be more engaged in review and approval of final designs.

Focus Group – Initial Technology Tools – Tested

 			
<p>VIDEO</p> <p>Chopper view of [PROJECT NAME] AU Drive view of [PROJECT NAME] AU</p> <p>Tech – Software: Twin Motion Hardware: TV monitor HDMI computer Youtube video (basically hit PLAY)</p>	<p>GLASSES</p> <p>Fixed Point VR – we are presenter Collaboration Code, Load project PASS OUT VeeR glasses, clip to smart phone Interior views of [PROJECT NAME] Satellite</p> <p>Tech – Software: Yulio Hardware: TV monitor HDMI computer Smartphone & VeeR Glasses 3 Point VR (can't walk)</p>	<p>GOGGLES</p> <p>Fixed Point VR – we are presenter Collaboration Code, Load project PASS OUT VeeR glasses, clip to smart phone Interior views of [PROJECT NAME] Satellite</p> <p>Tech – Software: Yulio Hardware: TV monitor HDMI computer Oculus Go VR goggles with smart phone 3 Point VR (can't walk)</p>	<p>QUEST</p> <p>Total VR – Walk around, follow on PC</p> <p>Tech – Software: Enscape Hardware: TV monitor HDMI computer Oculus Quest</p>

List of Focus Groups

- Civil Engineering Firm (Consultant)
- Healthcare Client (Client)
- University Engineering Students (Users - Santa Clara University)
- University Educational Facilities Planner (Client - UC Santa Cruz)
- Electrical Contractor (Client)
- Drywall Contractor (Contractor)
- Commercial Office Furniture Dealership (Consultant)

At the end of each session the participants were asked to fill out a Post-Meeting Survey in order to establish whether there had been a shift in perception and comfort level with the use of the tools.

Through the course of the Focus Group process the researchers gathered data which allowed for refinements to be made in these presentations.

Focus Group – Lessons Learned

1. 10/29/2019 Engineering Team
 - *Avoid all potential barriers (wifi, APP, glasses)*
 - *NO GLASSES – caused confusion and trouble*
 - *Smaller focus group size*
 - *Allocate time to give VR orientation*
2. 11/18/2019 SCU students
 - *Group size perfect*
 - *Really need to give VR orientation*
3. 11/08/2019 Client
 - *With VR orientation client can provide valuable feedback*
 - *Dove into details*



Focus Group – Final Technology Tools Tested



OCCULUS GO
\$150 - \$200



VR HEADSET
\$60



GOOGLE CARDBOARD
\$15



OCCULUS QUEST
\$400 - \$500

← 3' OF FREEDOM

6' OF FREEDOM →



TP-LINK NETGEAR DLINK
Wifi router to act as standalone node.
Isolate network bandwidth problems.
\$100 - \$150

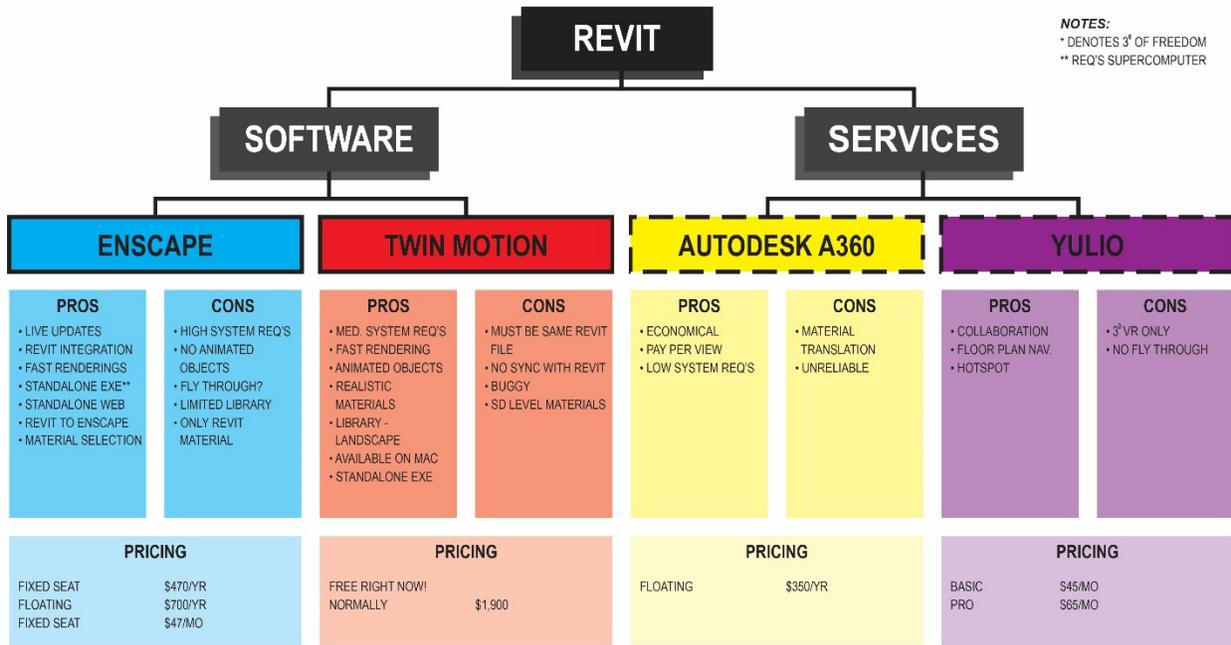


ENSCAPE REQUIRES EXPENSIVE GRAPHICS CARD
NVIDIA GeForce RTX 2070/Quadro RTX 5000 or AMD equivalent with 8GB VRAM

Razer Blade 15 Studio Edition Laptop
Intel Core i7-9750H - NVIDIA Quadro RTX 5000 - 15.6" 4K OLED Touch - 32GB RAM - 1TB NVMe SSD
\$4000



Focus Group – Software



ENSCAPE™



Twinmotion

AUTODESK® 360

YULIO^{VR}

RENDERING ENGINE

RENDERING ENGINE

RENDERING ENGINE

VR HOSTING PROGRAM

Adjustment Outcomes and Final Recommendations

It became apparent that one-size-does-not-fit-all. Presentation techniques need to be matched to the client's ability to understand and grasp the material being presented. This came as no surprise to the research team as this is common rule when presenting; know your audience and tailor the presentation to that audience.

Client Descriptors

This simple rule led the team to develop descriptors for different client types as it relates to their understanding and comfort level with technology. This identification helped to choose the level of presentation. Below are four types of client reactions:



- Stubborn Stanley – Reluctant to try new things, old school mentality, “no upgrades”.



- Adventurous Ally – Eager to learn, willing to try new things, “Show me.”



- Deep Dive Dave – “How does it work, bring it on”



- Ninja Ned – “More. Show me more”

The next take away was to establish a hierarchy for presentation styles or experiences from simple to complex. Below is the list with their descriptions:

Presentation Styles



Railway – This experience is used with either one individual or group. It utilizes a single monitor and the presentation is an aerial fly-through of the project generated by Enscape or Twinmotion software. The viewer experience is predetermined by the designer, resulting in a presentation similar to riding a train on the fixed path of the “railway”.



Anchored – This experience can either be presented to a single individual at a time, or to multiple individuals if the equipment is available. Each participant or user is typically alone within their observation of the experience. This style employs the fixed-point perspective (3° of freedom). It utilizes software like YulioVR or Visual Vocal, as well as a smart- phone or wireless Oculus Go headset for the hardware. This presentation allows the participant to see a 360° spherical view from a predetermined fixed point. As the viewpoints are fixed within an experience, the viewer cannot move around within the scene created, and feels as if they were “anchored.”

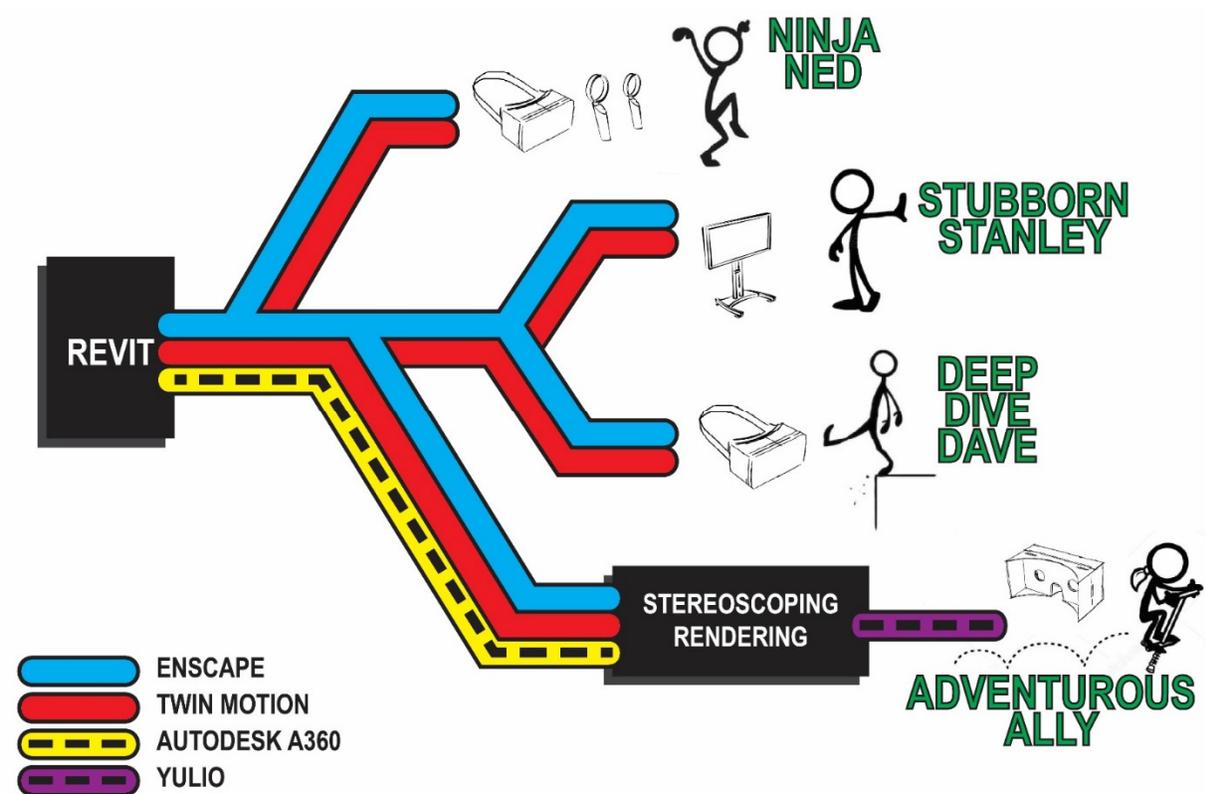


Teleport – Through this method, participants may either be alone in their virtual experience, or they can be linked to what others are seeing, depending upon the software and hardware being utilized. This style uses the walk-through mode (6° of freedom) utilizing Enscape or Twinmotion software and is presented wirelessly through the Oculus Quest headset. It is similar to the “anchored” experience in that it allows for 360° spherical view. However, this method goes further by allowing the user to freely move about within the experience. They can stand, stoop, walk, or click-to-jump from spot to spot within the scene. The walking function can be a little disorienting, so clients are encouraged initially to use the jump or “teleport” function to move about.



Carpool – The final experience is similar to the “teleport” style in that movement is free. The difference is this movement is controlled by the designer and the presentation is viewed on a monitor by an individual or group. The designer is free to take the user to any area of the building model they would like the client to see. In addition to an overall walk-through, this allows for the design to focus on an area or detail the client needs to review. The Enscape software allows designers to make real-time finish or material changes to provide the client more options.

Prescriptive Path



It was apparent, after observing multiple clients and focus groups, that a VR training procedure was lacking from the user experience, as the tools the subject was using were unfamiliar to them. When a participant was asked to put on a headset without any training in how to navigate through the design, they ultimately struggled to get past the “wow factor” of the technology. Inevitably, this effect would wear off, the user would lose interest, and move on from the experience. The result was a failed design-inclusion exercise and an aversion to the usefulness of the technology going forward.

Once this problem was identified, the team looked for a solution; a way to train users to work with the tools prior to looking at something where their input was needed. Several approaches were tested; one was to give verbal instructions for navigation while observing a participant use the tools; another went as far as demonstrating the tool in front of the client prior to their own attempt. Eventually, the team settled on a plan to develop a short instructional virtual reality experience utilizing a sequence of steps or actions, culminating in an objective “goal” for completion. The idea was that each consecutive step of the experience would demonstrate a new aspect of control available for the user to navigate their virtual environment. The hidden goal for the team was to develop a way to encourage the participants desire to go through the training process. They settled on having a brief experience that would appear more like a fun game, and less like a tedious training exercise.

At this point in the process, Carolyn Clark Beedle introduced the team to John SanGiovanni, CEO and Founder of Visual Vocal. His company is developing an advanced spatial computing platform for the design and construction industries for meetings, messaging, and mark-ups. John was incredibly helpful in providing an objective view of what we were trying to accomplish.

As our training tool evolved John offered several suggestions that were invaluable. He pointed out that what the team was creating with the training experience was an “orientation onramp” for clients and users. He also pointed out from his own experience that users in the walk-through (6° of freedom) or “Teleport” mode tend to become disoriented when provided the opportunity to virtually float around through a model. The issue being that by having the participant “float” through the spatial model without walking physically in real space leads to disorientation and nausea. This led the team to eliminate the floating function from the training tool.

Ultimately, the focus group testing of the “orientation ramp” tool proved that when properly trained and oriented users were far more engaged with the design than those who had not.

This was born out when working with clients as well. The more times a client was exposed to the use of virtual reality tools the better their feedback was with regard to design review and critique. Once the client became familiar with the tool it became more valuable in the conversation of preference and choice. The team had successfully found a method to bring the client into the design experience in a way that client had never done before, and the design process was more enriching and collaborative as a result.

One observation that came from this exploration was that the software and hardware systems that create and support the BIM, VR, and AR technologies are evolving rapidly. This industry is experiencing a season of expansion and development that many designers may struggle to keep up with. Changes, updates, and new products are added at an almost weekly basis.

Late in the research process the team was introduced to another startup company, Geopogo, founded by Dave Albert, FAIA. Geopogo’s team of architects and engineers has developed a product called ‘AR Instantly.’ The software provides a subscription-based solution to streamline design and construction. With AR Instantly, users can automatically convert BIM files on a PC into AR models at any scale from desktop in the office to full-size on site.

The team sees this and other AR tools like it as the next evolutionary step in the design process, as many industry leaders has considered VR to be a necessary stepping-stone towards total “mixed reality” experiences. While the technology is certainly promising, the current hardware used to host the AR experience may still have some development processes to get through before being adopted by the average design firm. But the team noted that given the speed this technology has been moving, it will be here before we know it. And given the incredible results from VR, the team cannot wait to see how AR transforms the design process even further.

Secondary Thesis Statement

If consultants and vendors can be coached through the mental, physical, technical, and cost barriers posed by new technologies, they will have a better understanding of design concepts and better prepared for the collaboration and the exchange of design ideas.

Two of the focus groups were conducted with consultants and vendors. In addition to the introduction to the “orientation onramp” and the use of the virtual reality tools, the researchers were able to have a dialogue about the value of these tools and how collaboration is enhanced. While no empirical data was collected during these discussions a better understanding of the value of the use of the tool was developed.

Conclusions

1. **Assess** client’s ability to understand software presentation style. We did this by creating a game for them to play using one of the tools. By doing this we were able to gauge their level of understanding.
2. **Match** presentation style to client’s ability.
3. **Create** an “Orientation On-ramp” to properly coach and orient. If clients and users are properly coached and oriented, the use of virtual reality tools can be an invaluable communication tool.
4. **Exposure** increases client’s capacity to make informed decisions. The more times a client or user is exposed to the use of virtual reality tools the value of their input increases. The more familiar clients become with the use of the tool the more they value the service this provides. The service is then easier to monetize. Providing clients, a shopping list of services allows them to choose the level of service.
5. **Disorientation** can occur in the “walk around function”. We noticed many users would become disoriented when allowed to use the walking mode in the Teleport style. It is still there but we encourage them to use the teleport function which allows them to move through the space by jumping from spot to spot.
6. **Multiple goggles** allow for a group experience and lessens resistance to using the tool. The feeling of being singled out was eliminated.
7. **Paper hygienic masks** for all users tends to lessen the resistance of some users to try the technology. We have set the protocol to wipe down each set of goggles and then provide hygienic masks.

8. **Portable router** allows for better connectivity particularly when working remotely offsite with a laptop computer. There is a lot of technology here so whatever can be done to minimize issues helps immensely.
9. **Virtual Reality** far outweighs traditional presentation techniques but Clients must be properly assessed and oriented to the appropriate tool.

Survey Response	Gender	Tech Devices	Software	VR Experience	Willingness
University Educational Facilities Planner	Male	Smart Phone, Laptop / Computer	Tolerate them	VR Goggles	5
Electrical Company	Male	Smart Phone, Laptop / Computer, Tablet	Understand the need for them	None	5
Drywall Contractor	Male	Smart Phone, Laptop / Computer	Tolerate them	VR Ride	4
Commercial Office Furniture Dealer	Female	Laptop / Computer	Tolerate them	VR Goggles, VR Movies	5
Commercial Office Furniture Dealer	Female	Smart Phone, Laptop / Computer, Tablet	Understand the need for them	VR Goggles, VR Ride	5
Commercial Office Furniture Dealer	Male	Smart Phone, Laptop / Computer	Understand the need for them	VR Games, VR Goggles, Other	6
Commercial Office Furniture Dealer	Female	Smart Phone, Laptop / Computer	Appreciate them	VR Goggles, VR Movies	5
Commercial Office Furniture Dealer -	Female	Smart Phone, Laptop / Computer, Tablet	Tolerate them	VR Goggles, VR Movies, VR Ride	5
Commercial Office Furniture Dealer	Female	Smart Phone, Laptop / Computer	Understand the need for them	None	5
Commercial Office Furniture Dealer	Female	Smart Phone, Laptop / Computer, Tablet	Understand the need for them	VR Goggles, VR Movies	5
University Engineering Students	Female	Smart Phone, Laptop / Computer	Understand the need for them	None	5
University Engineering Students	Female	Smart Phone, Laptop / Computer	Tolerate them	None	6
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer	Tolerate them	VR Goggles, Other	5
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer	Understand the need for them	VR Ride	5
Civil Engineer Firm	Male	Laptop / Computer	Appreciate them	None	6
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer, Tablet	Tolerate them	None	3
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer	Understand the need for them	None	4
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer	Understand the need for them	None	6
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer, Tablet, Game Console	Hate them	VR Ride	6
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer	Understand the need for them	VR Goggles	5
Civil Engineer Firm	Male	Laptop / Computer, Tablet	Tolerate them	None	2
Civil Engineer Firm	Male	Smart Phone, Laptop / Computer, Game Console	Understand the need for them	VR Ride, Other	4
Civil Engineer Firm	Female	Smart Phone, Laptop / Computer	Tolerate them	None	5
Healthcare Company	Male	Laptop / Computer, Smart Phone	Understand the need for them	None	6

Exhibit "1"
Pre-Survey – All Responses

Entry	Gender	Overall Experience Score	Type	Improvement	Most Loved	Disorientation	Disorientation B	Most interesting	Experience RW	Experience ANCH	Experience TEL	Experience CAR	Groups
University Engineering Students	Female	5	Passive	Clarity of the Quest could be better.	Anchored	checked	Teleport	Switching out finishes to see what looks more appealing (could save a lot of time and money for owner)	5	5	4		University Engineering Students
University Engineering Students	Female	6	♥ Promoter	Smoother video feed of what goggles/quest sees.	Anchored	checked	Railway, Teleport	Walking through walls/ to scale 3D so I could understand how it all physically worked together compared to me and my size.	3	5	4		University Engineering Students
Civil Engineer Firm	Male	5	Passive	Easier navigation with goggles as I got stuck in some places.	Teleport	checked	Anchored	Being able t see between walls and feel the size of the spaces.	4	5	5		Civil Engineer Firm
Civil Engineer Firm	Male	6	♥ Promoter	Glasses	Railway			The way everything is in detail.	6	4	6		Civil Engineer Firm
Civil Engineer Firm	Male	5	Passive	Video quality	Railway	checked	Anchored	Technology	6	3	3		Civil Engineer Firm
Civil Engineer Firm	Male	6	♥ Promoter		Teleport			Level of detail.	4	6	6		Civil Engineer Firm
Civil Engineer Firm	Male	5	Passive	Resolution of goggles less than model on screen	Railway			Detail level of models.	6	5	6		Civil Engineer Firm
Civil Engineer Firm	Male	5	Passive		Teleport	checked	Anchored	Real-time video	2	5	6		Civil Engineer Firm
Civil Engineer Firm	Male	6	♥ Promoter	More time to learn and get familiar.	Teleport			How all the models started in Revit.	3	5	6		Civil Engineer Firm
Civil Engineer Firm	Male	5	Passive	Larger viewport for goggles.	Railway	checked	Anchored, Teleport	That the changes to the model will change CDs	6	5	5		Civil Engineer Firm
Civil Engineer Firm	Male	4	Passive	Less jumpy	Teleport	checked	Anchored	Furniture removal	5	5	5		Civil Engineer Firm
Civil Engineer Firm	Male	5	Passive	More defined path you can travel in Quest.	Teleport			The Quest - interactive plus	4	4	6		Civil Engineer Firm
Civil Engineer Firm	Female	5	Passive	No changes needed.	Anchored	checked	Teleport	Video. Seeing how items can easily be removed and added.	6	5	2		Civil Engineer Firm
Drywall Contractor	Male	5	Passive	Clarity of images.	Railway			Being able to experience elevators	5	5	5		Drywall Contractor
Electrical Company	Male	5	Passive	Higher resolution with the Quest headset.	Railway			Ability to view from all angles.	6	5	5		Electrical Company
University Educational Facilities Planner	Male	6	♥ Promoter	Defined program for user so it is easy to go step by step	Anchored	checked	Teleport	"Feeling" the spaces with VR Entrepreneurs	3	5	5		University Educational Facilities Planner
Commercial Office Furniture Dealer	Female	6	♥ Promoter	Better WiFi	Teleport	checked	Railway, Anchored	The difference it makes to see a space and to actually be immersed in the space.	6	5	4	6	Commercial Office Furniture Dealer
Commercial Office Furniture Dealer	Female	4	Passive	Ok. Sensitive to movement.	Teleport	checked	Teleport, Carpool	Making changes immediately. Cost	4	4	4	4	Commercial Office Furniture Dealer
Commercial Office Furniture Dealer	Female	5	Passive	Anchored seemed like I was facing the wrong direction when using the cardboard and a pair of the goggles.	Teleport	checked	Teleport, Carpool	Teleport experience.	5	2	5	5	Commercial Office Furniture Dealer
Commercial Office Furniture Dealer	Female	5	Passive	Higher WiFi speed	Teleport			The discussion about the process and tools	3	3	5	6	Commercial Office Furniture Dealer
Commercial Office Furniture Dealer - Christaline Adrianti	Female	5	Passive	Maybe need to make sure the connection is fast enough	Carpool			How we can make changes real time.	6	5	5	5	Commercial Office Furniture Dealer
Commercial Office Furniture Dealer - Widya Soetanto	Female	5	Passive	This is amazing. I could not think of what needed to be improved.	Carpool			I have control to what I want to see.	5	5	6	5	Commercial Office Furniture Dealer
Commercial Office Furniture Dealer - Charles Imperial	Male	5	Passive	Better WiFi. Maybe presenting as you would a client	Teleport			Real time edits!	6	6	6	6	Commercial Office Furniture Dealer
Healthcare Company - Will Pollard	Male	6	♥ Promoter	more detail in model	Teleport	checked	Teleport	real time changes	4	5	6		Healthcare Company

Exhibit "2"

Post-Survey – All Responses

