

# Virtually Handcrafted

An Investigation of Immersive Architectural Design Processes

ARCI 593 MArch (Prof)

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How can virtual reality be an effective tool for architectural design ideation?

## Abstract

Architects use a variety of media to test and understand their designs. These media are frequently scaled for convenience and reduced to two dimensions for clarity; however, in relying on these methods, the direct and visceral experience of inhabiting space is neglected. Phenomenologists such as Juhani Pallasmaa point out that this problem is exacerbated by the picture plane which acts as an impenetrable window, excluding the viewer from a truly embodied appreciation of the design's spatial qualities.

This research investigates the use of virtual reality (VR) as a tool for conceiving architecture without alienating the designer from the user's perspective. It is suggested that the holistic and subjective approach of immersive media is a necessary complement to the more abstracted and objective views of architectural tradition: plan, section, and elevation. The recent availability of consumer-grade VR allows the testing of this opportunity without many of the side-effects which hindered research done in the 90's. Looking forward, this research aims to describe tendencies of VR design and thus guide the incorporation of immersive technologies into contemporary practice.

To study these impacts, a real-time engine is used to develop an interactive program which allows the modelling of conceptual designs while immersed within them. Its efficacy is studied with three groups (architecture students, architects, and members of the public), from which quantitative and qualitative data is collected. By identifying the unique benefits of such tools, it is proposed how each group could make good use of the technology and extend the abilities of their existing workflows.

*This Thesis Is:*

Research about design  
An exploration of virtual design tools.  
A demonstration of the limits of current representation techniques (manual & digital).  
An argument for the unique benefits of immersive technologies and a VR-integrated design process.  
Experimental evidence of designers' interaction and engagement with the VR medium.

*This Thesis Is Not:*

Research through the design of a single building  
An exploration of VR as a hyper-realistic presentation device.  
Suggesting that VR is the ultimate medium or that it should replace traditional methods.  
Just a piece of software

the case for  
*Immersive Design*

Phenomenology  
+  
Drawing Literature  
+  
Immersive Media Research

“A picture is not like perceiving.”

p. 280. Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.



“If we are to understand what the experience of our designs will be like, and hope to improve that experience, we must perceive our design drawings as environments.”

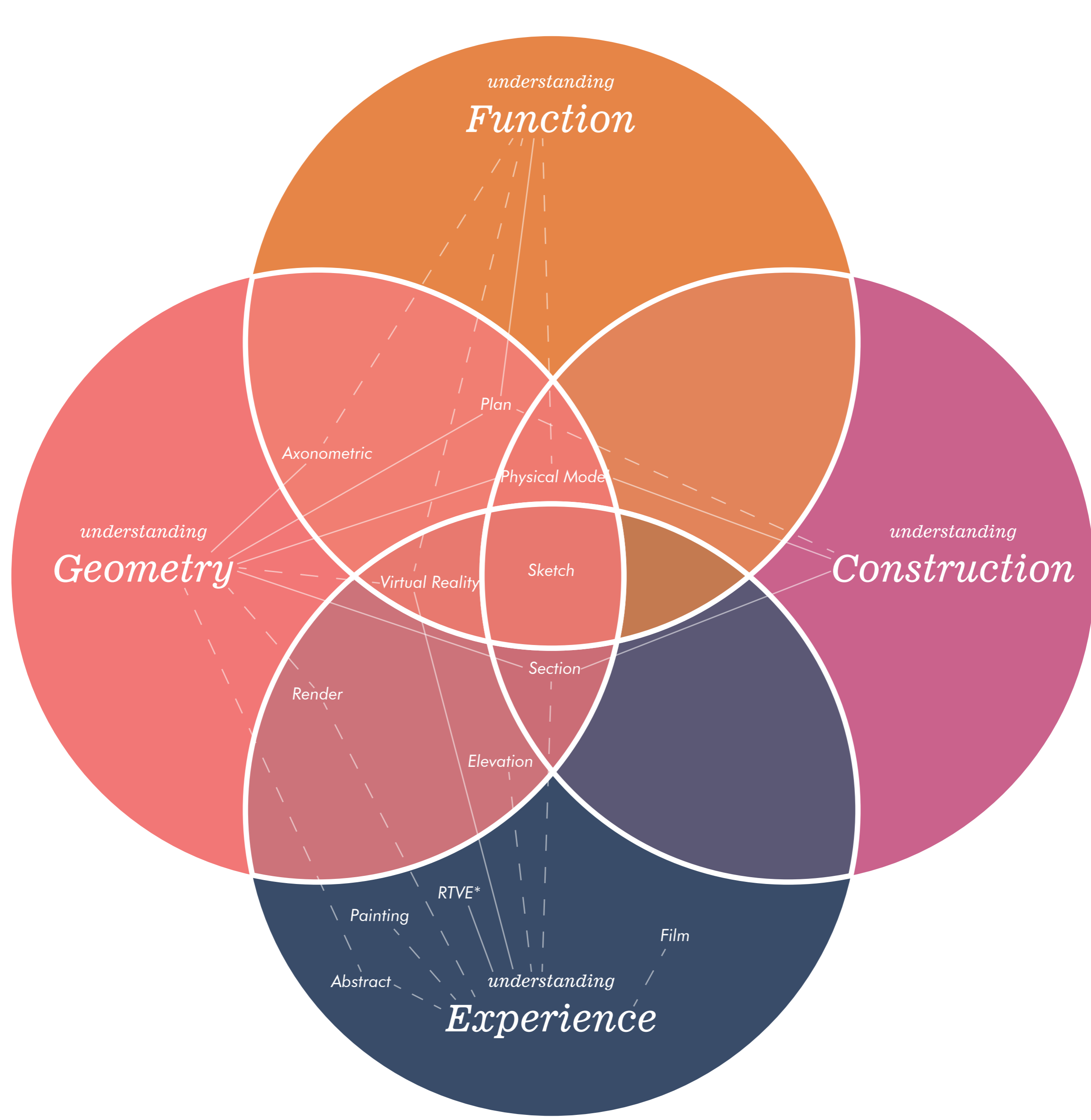
p. 33. Lockard, W. K. (1982). *Design drawing* (Rev. ed.). New York: Van Nostrand Reinhold Co.



“Virtual reality offers a unique capacity for real time feedback to be provided in a very intuitive form.”

p. 286. Kim, M. J. W., Xiangyu; Love, Peter ED.; Li, Heng; Kang, Shih-Chung, (2013). *Virtual Reality for the Built Environment: A Critical Review of Recent Advances*. *Journal of Information Technology in Construction*, 18, 279-305.

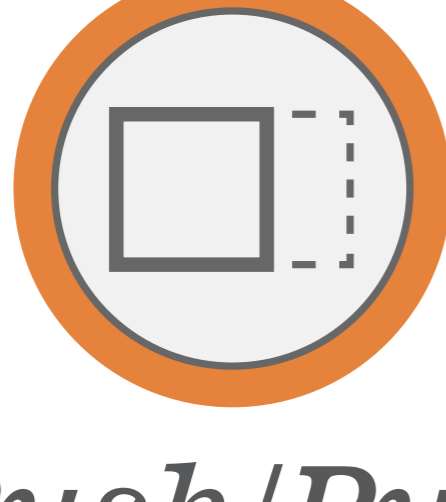
the purpose of  
*Architecture Representation*



\*Real-time Virtual Environment

# Sketchspace Tools

## Assumptions, Limitations, and Tendencies



### Push/Pull

- Intuitive method of design
- Useful for adjusting sizes
- Tends to promote extrusion



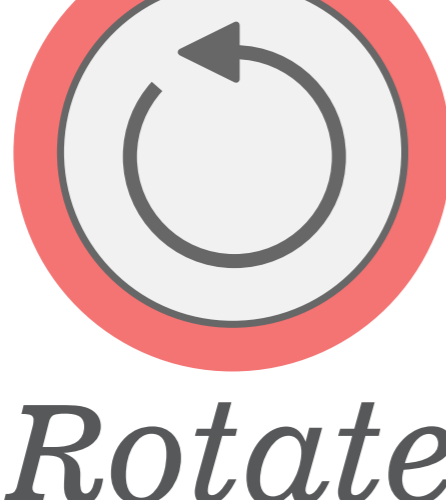
### Add

- Initially only cubes introduced
- Produces a distinct aesthetic
- A 2-point method is chosen



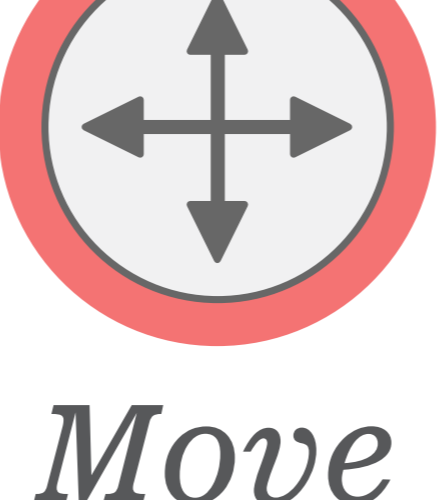
### Delete

- Assumes certainty of the designer - undo required
- Single click method



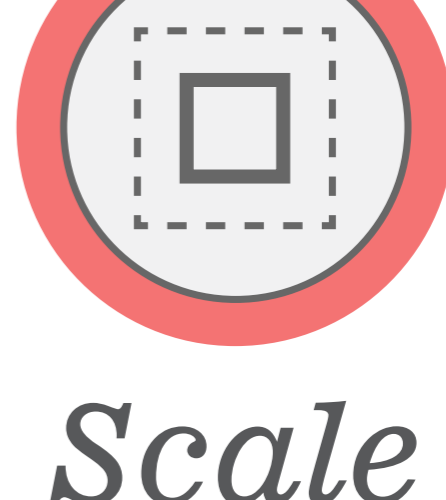
### Rotate

- Plane of rotation required
- Difficult to define in VR
- Breaks away from the grid



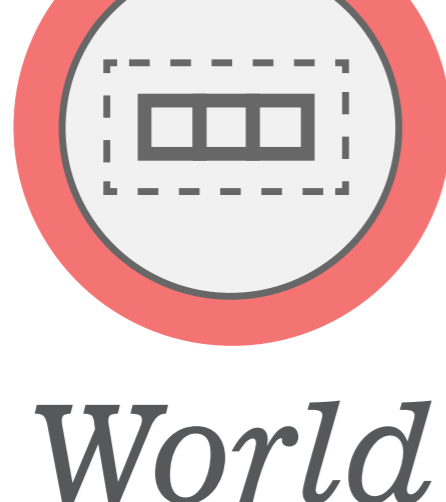
### Move

- Defaults to axial movement
- Pulls in direction of face
- Free move option lacks control



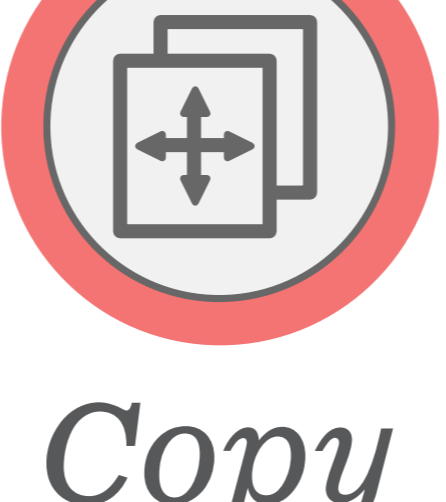
### Scale

- Has great relevance in VR
- Origin defaults to base
- Danger of over-scaling



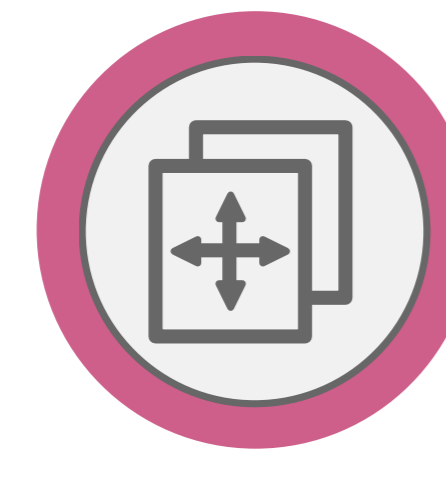
### World

- Changes world scale
- Later removed to encourage 1:1 modelling



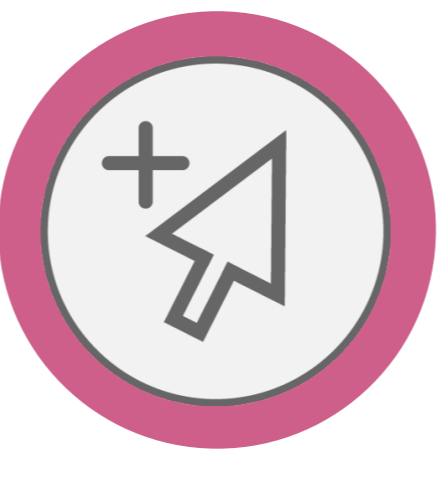
### Copy

- Copies establish pattern
- Repetition evokes architectural qualities
- Similar mechanics to 'move'



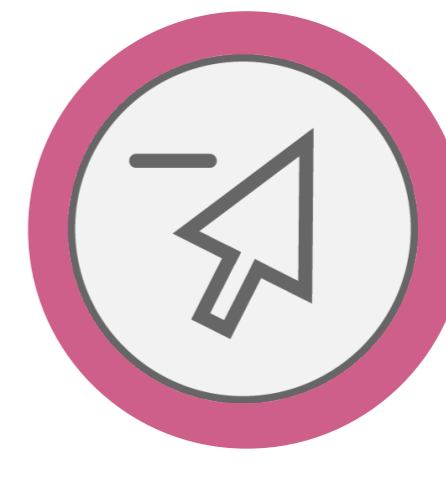
### Array

- Easily makes complex patterns (i.e. parametricism)
- VR gives array dimensions greater human significance



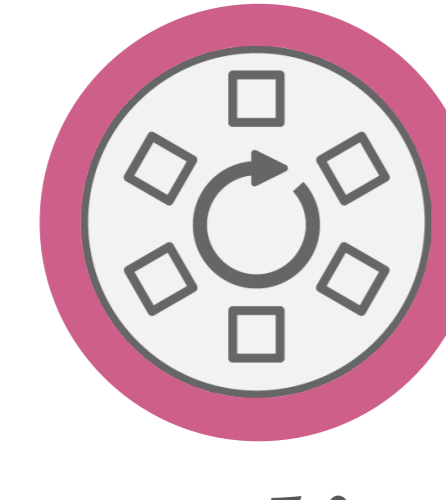
### Group

- Allows different levels of detail
- Nesting groups quickly increases complexity
- Discrete objects (e.g. furniture)



### Ungroup

- Useful for custom manipulation of array elements
- Paired with 'group' tool



### Radial

- Rotational copy and array
- Tends to produce geometries with less functional purpose
- 'Alien' appearance when not careful

## Review #01 Reflection:

#### Key Feedback:

- Don't ask "what wins?" - ask "under what circumstances is this good in?"
- Explore how different modes of creation produce different aesthetic tendencies
- What is the role of a tool like this in the world?

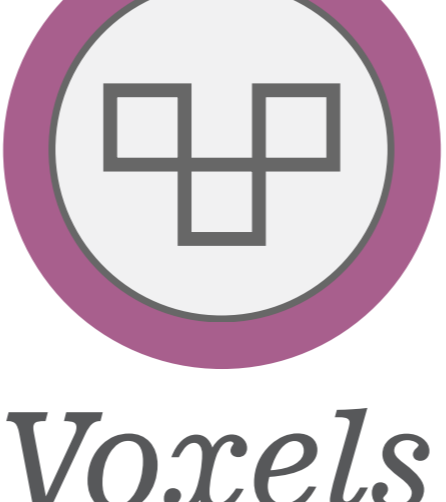
#### Response:

- Thesis goals are revised to focus on the specific conditions it is effective rather than overall quality
- Tools such as 'voxels' and 'morph' test adding more ambiguity and a varied aesthetic into the process



### Shapes

- Allows more diverse geometries
- Tends to prompt the design
- Unusual results when combined with the 2-point creation method



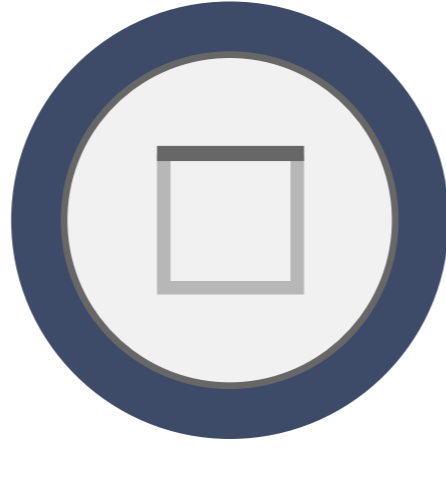
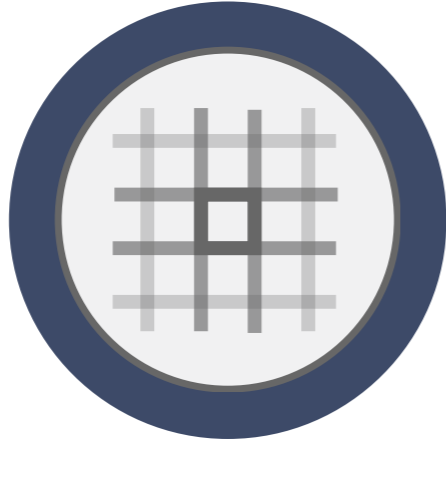
### Voxels

- (A.k.a 3D pixels)
- Acts as a drawing tool
- Becomes an effective volumetric massing tool at larger sizes



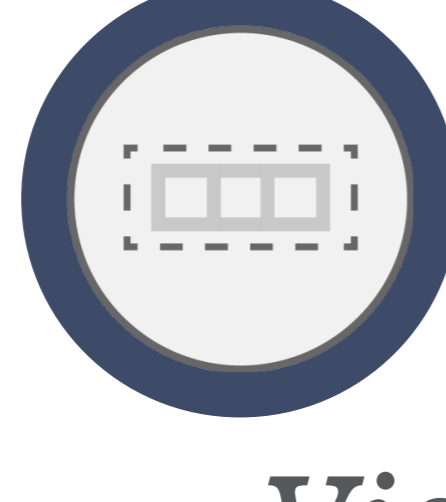
### Morph

- Random scaling of a group of objects
- Shuffles shape size for inspiration
- Not useful for more detailed design



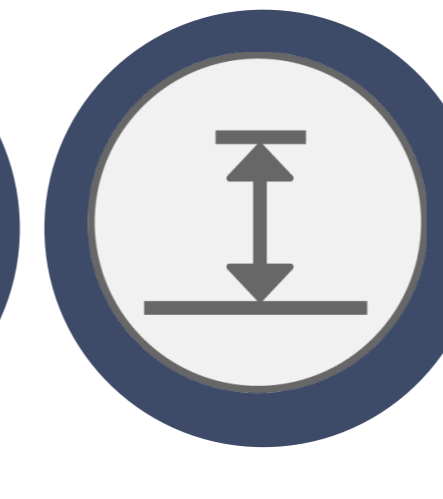
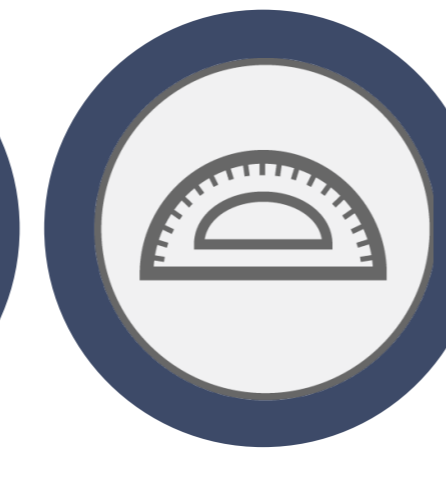
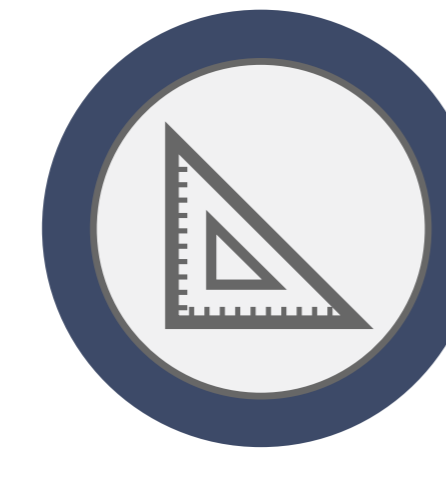
## Snap Settings

- Very powerful settings for a more controlled design experience
- Allows the precise alignment and organisation of objects
- Important for anticipating construction requirements later



## Visibility Settings

- Control over the interface is standard in industry, however it was under-utilised in the context of the concept design environment.
- Typically not used when creating in a playful and unfocused way
- Contrast of views is important for deeper understanding, yet users tended to stick with the default.



## Evaluation Tools

- Useful for intuitively evaluating site properties
- Not frequently used, possibly due to the perceived lack of a need to be precise during the concept design stage

## Review #02 Reflection:

#### Key Feedback:

- Don't overstate what will be solved with this tool.
- Materiality is a significant part of our understanding of scale
- Renders are done for people who don't understand our grammar
- "Is interactive VR an effective tool for engaging the non-architect in the design process?"

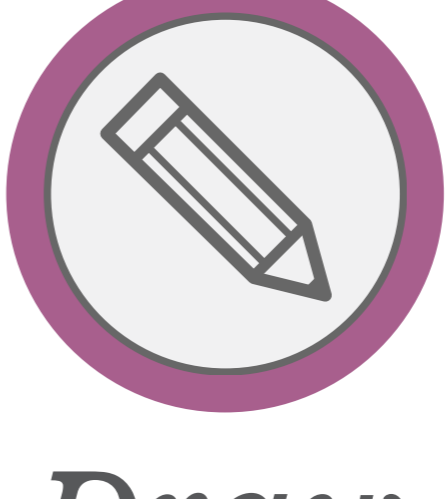
#### Response:

- A more critical and realistic view of the tool's potential was taken
- Refined the tool to include material manipulation
- Draw tool added to give the public a quick way to express ideas in 3D
- Completed an urban design experiment in Karori with the local residents



### Material

- Gives geometries a more realistic context
- Increases model detail
- Improves sense of texture

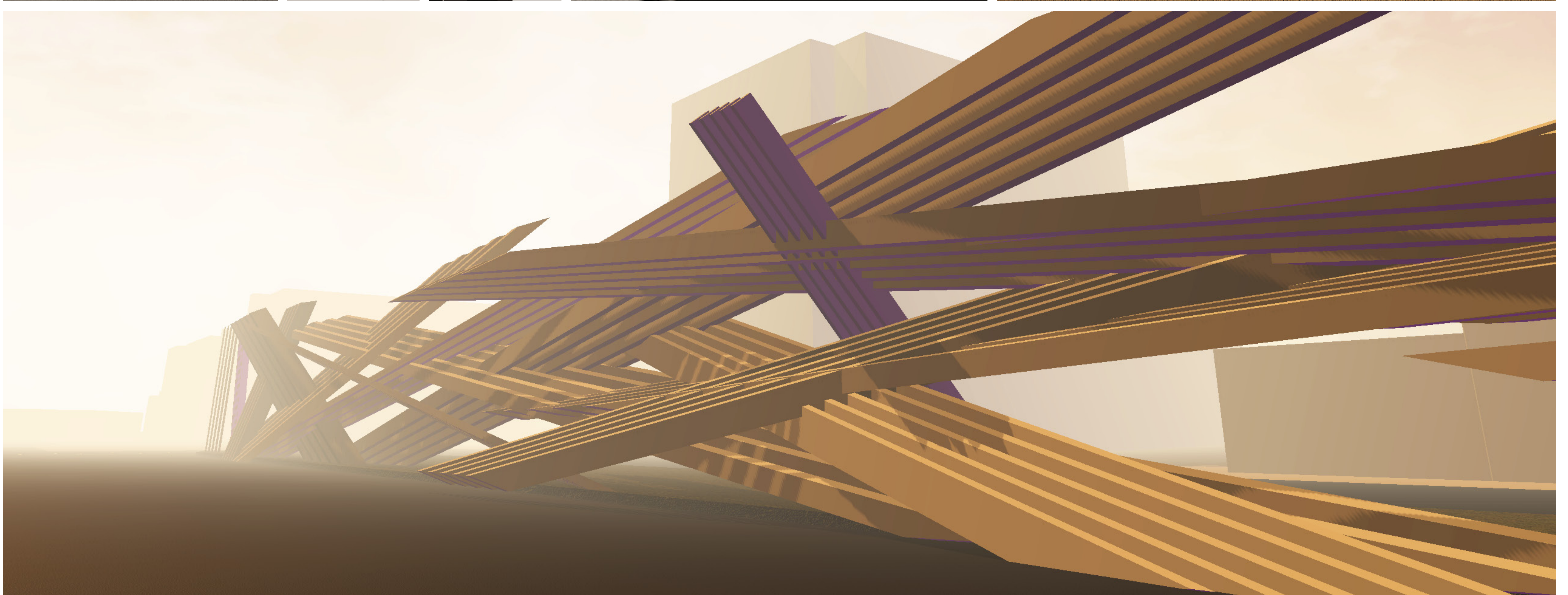


### Draw

- A 'sketch' tool with greater ambiguity
- Tends to be defined by sphere at arm's length



# Iterations



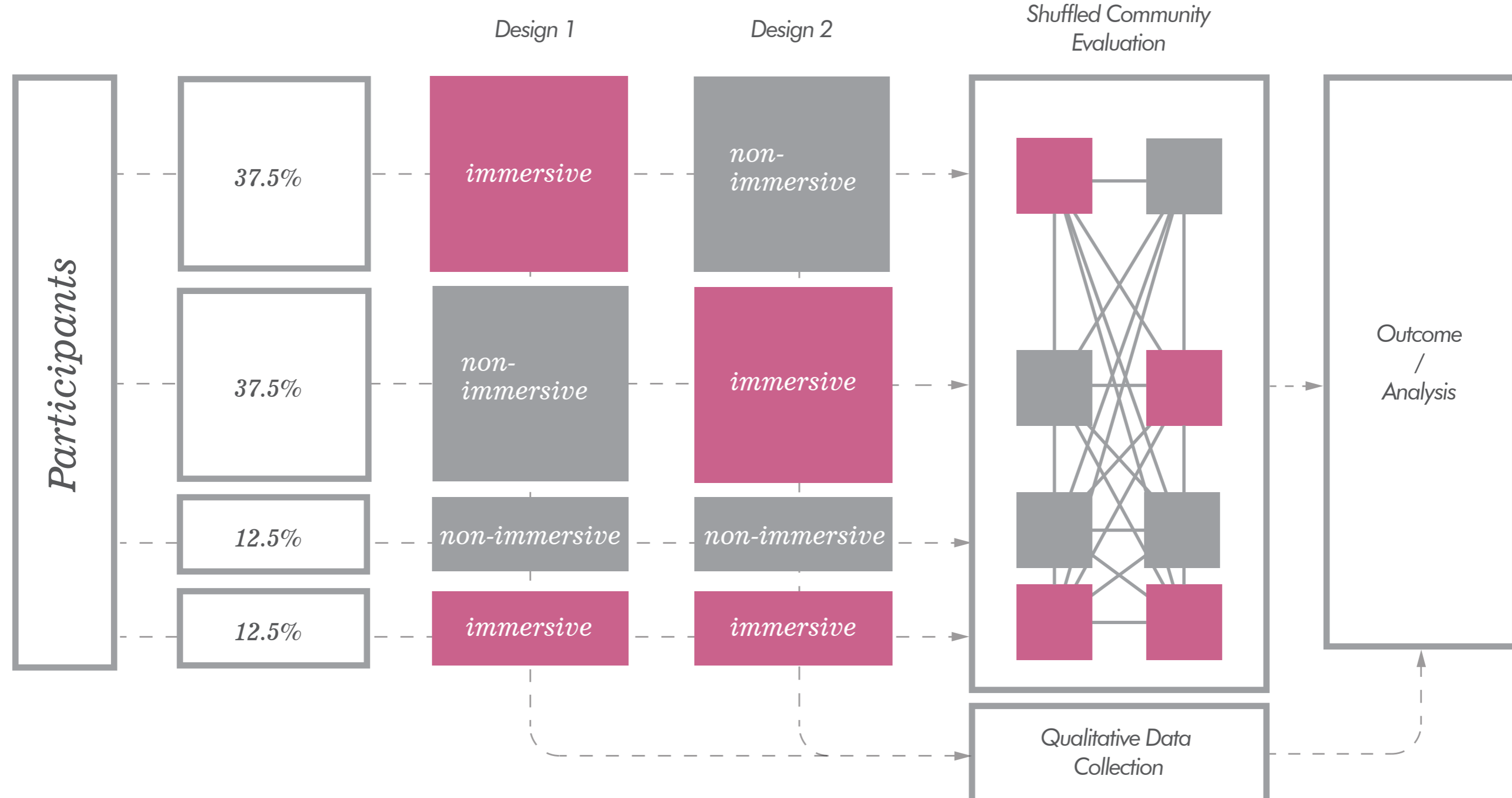
# Sketchspace Testing

Q Is VR effective as design tool for...

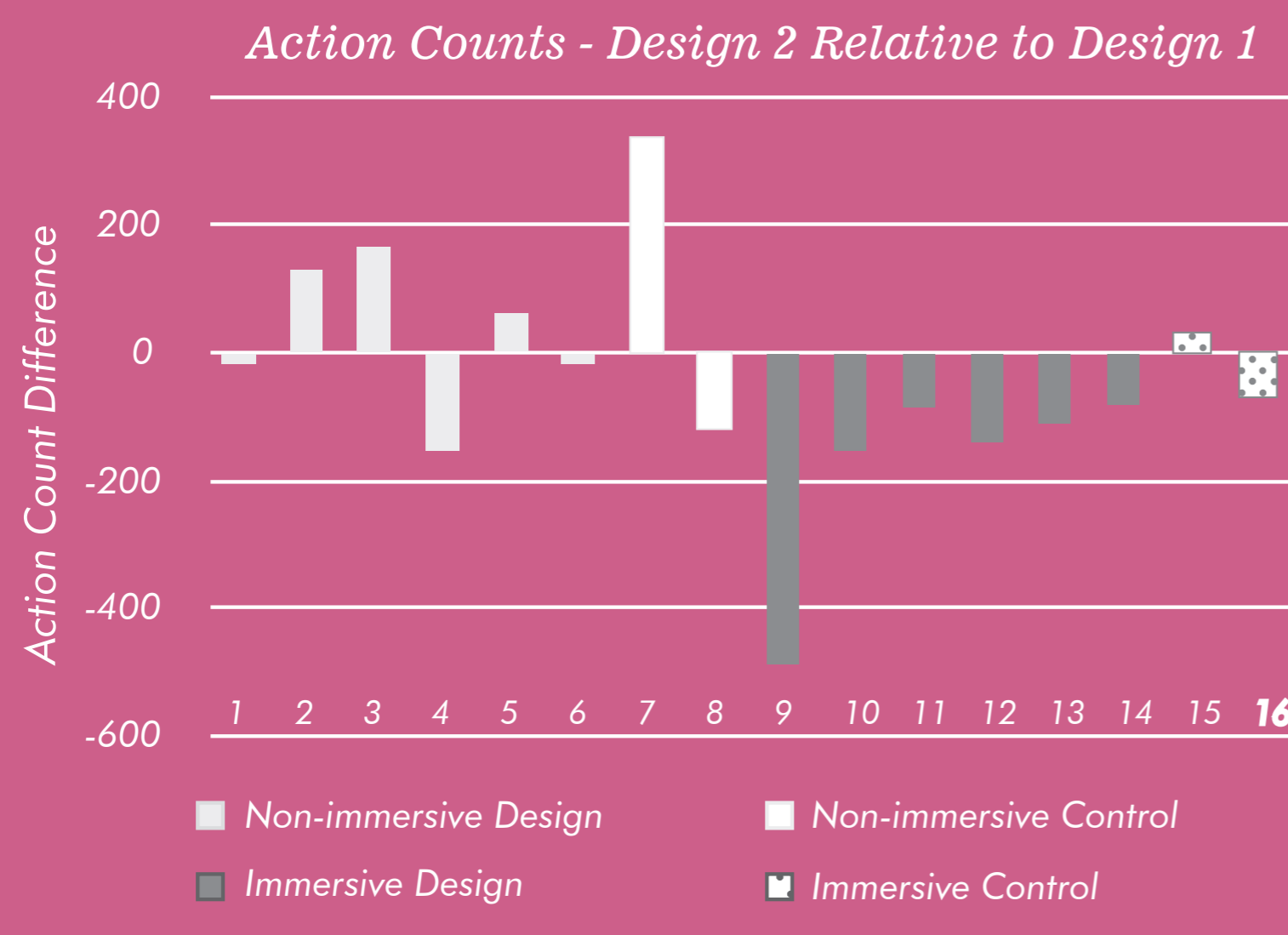
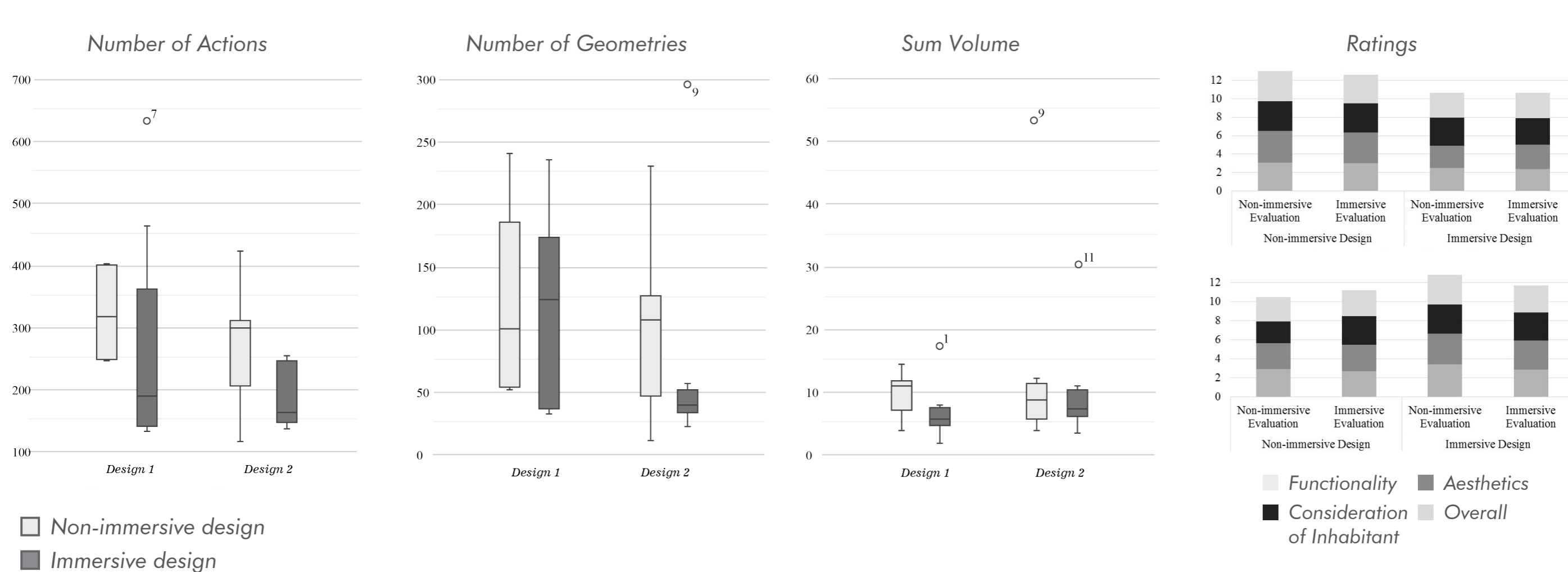
...architecture students?

## Experiment #1

'The Competition'



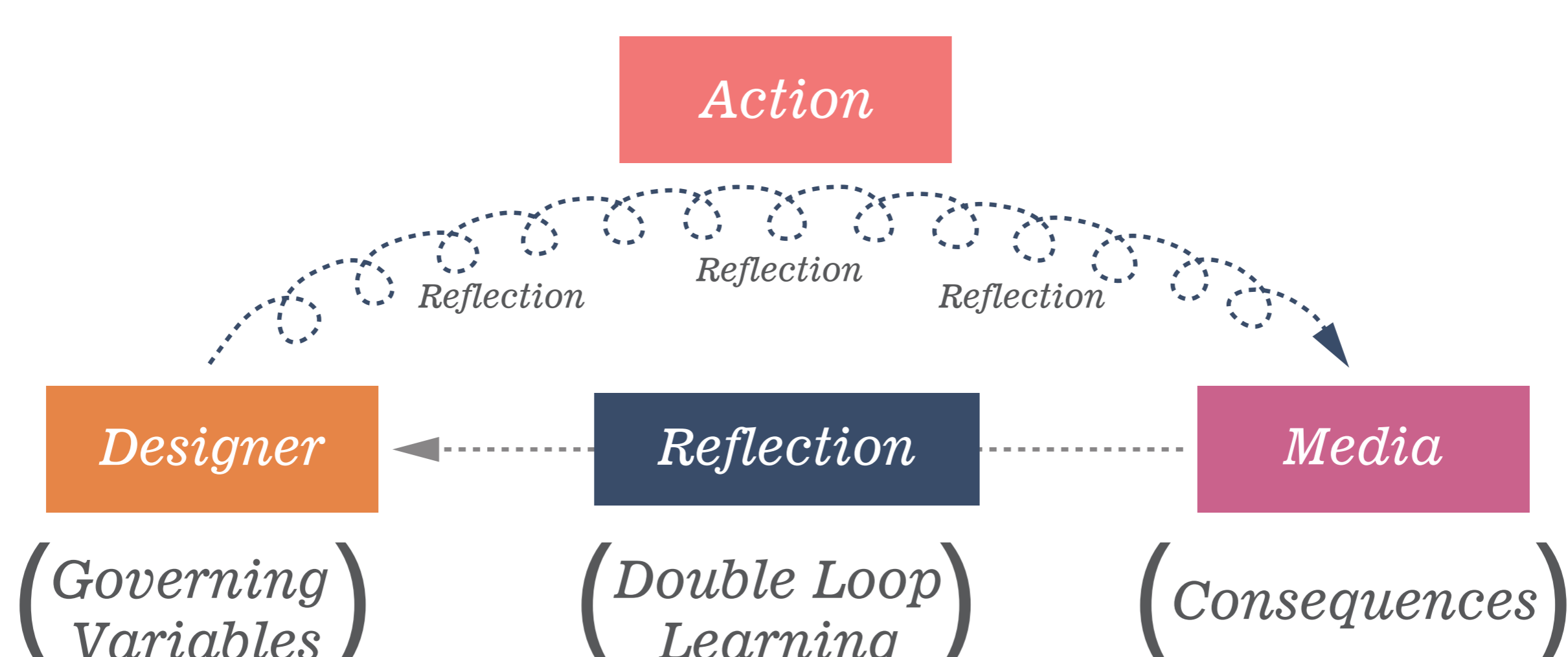
## The Results



Designers make significantly fewer actions when designing in virtual reality to produce similar results

## Reflection-in-Action in Virtual Reality

(Adapted from Donald A. Schön's (1995). The Reflective Practitioner: How Professionals Think in Action. Aldershot, Hants: Ashgate.)



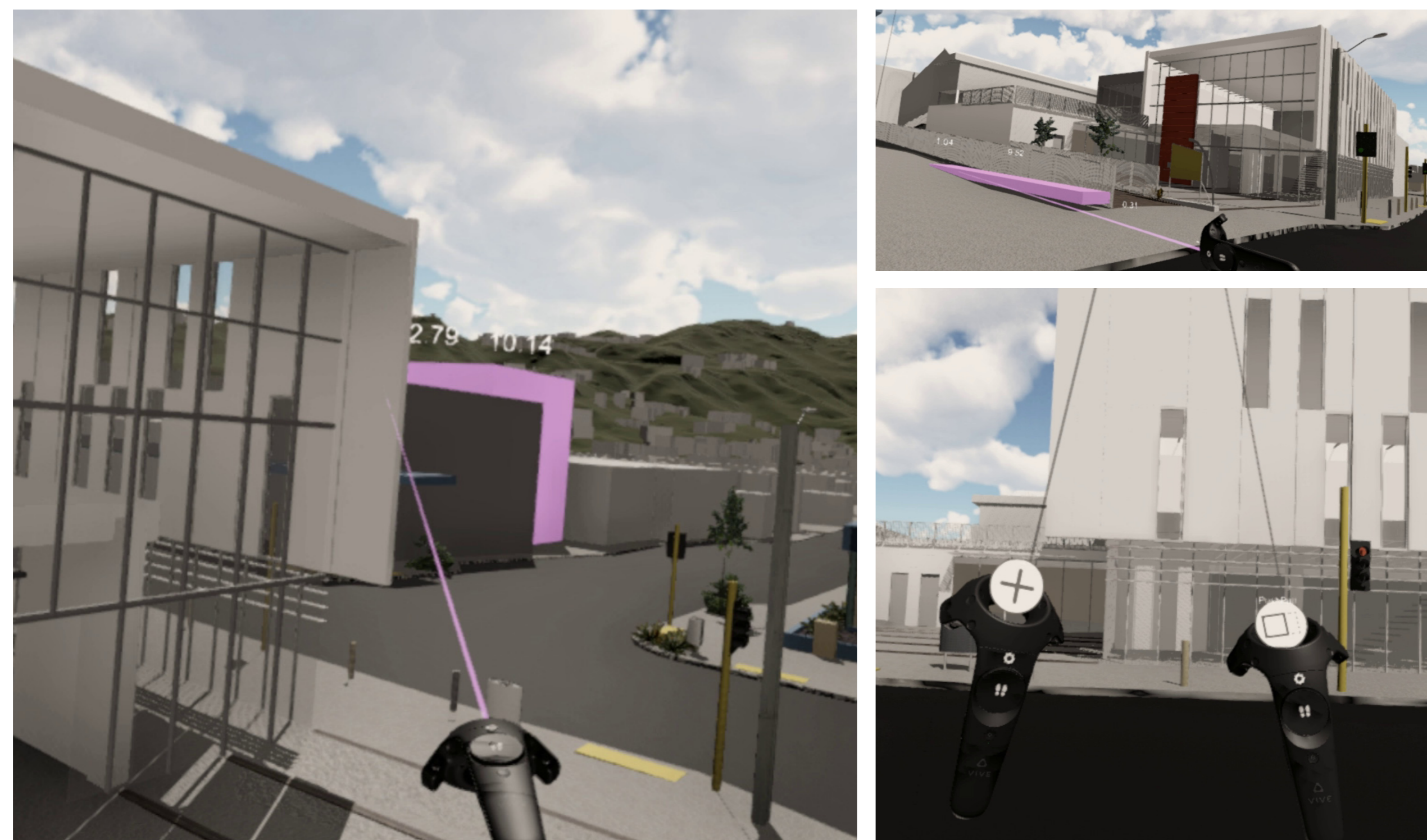
...members of the public?

## Experiment #2

'The Public Engagement'

“ Given their unequalled potential visualisation, immersive simulation, and interactive feedback, digital technologies could greatly enrich these traditional tools for publicity and participation in design. ”

p. 115. Carpo, M. (2011). The Alphabet and the Algorithm. Cambridge, Massachusetts: MIT Press.



Residents of Karori were invited to participate in an urban design exercise.

## The Results:

- The 'Add' function represented 82% of all actions
- Model detail was rated the most significant factor for scene comprehension
- No significant difference in action speed was measured

Participants understood the scene well and were able to appreciate the spaces and building scales effectively

Participants found 3D ideation difficult and needed further training to use the tool to its full potential

# Potential Workflows



When is VR an appropriate tool to use during the design process?

Based on Karl Aspelund's. (2010). The Design Process (2nd ed.). New York, NY: Fairchild Books.

## Inspiration / Conceptualisation



### Context-driven

The tool renders the landscape accurately, an advantage when site is unable to be accessed in person.

Demographics  
Sun path

### Observation

Visiting precedents virtually could be valuable; however, it is not explored in this thesis

Precedent  
Biomimicry  
Structural

### Intellectual

The tool isn't strictly necessary for this category of inspiration.

Theoretical  
Visual

### Randomness

The 'morph' tool uses randomness to create dynamic inspiration for concepts. It is one option for architects.

Manual  
'Morph' tool

## Exploration



### Geometry

Design of geometry is only benefitted by the VR program insofar as it influences a user's perspective

Pedestrian View

### Function

The tool is inherently viewpoint-oriented, and so can quickly reveal sightlines, etc.

Planning

Wayfinding  
Privacy  
Sightlines

### Construction

Projects focused on construction needs have tight parameters and are less likely to benefit from the subjective design methods described

Structure

### Experience

Such a tool is ideal for reflecting on the experience of a design. It communicates a sense of scale, drama, and atmospheric qualities

## Concept VR Evaluation

## Refinement

### Function

This tool lacks the depth of development for effective ideation at this level; yet, it is highly effective as an evaluation and adjustment tool.

Services  
Performance

### Experience

This tool is best positioned for this side of the design refinement - e.g. adjusting dimensions, sense of progression, daylighting.

## Definition

### Construction

This investigation suggests that VR is not ideal for construction documentation because of the technical intricacies involved. It is outside the scope of the tool's capabilities.

### Experience

A controlled 'add' mode is a useful way to mock-up and assess details visually.

## Communication

## VR Visualisation

# Conclusions

- The developed interface excels at conveying and manipulating experiential qualities of a design.
- It has limited purpose in more detailed areas of the design process.
- Architecture students were able to use the tool to express conceptual ideas efficiently.
- Participatory VR design with the public requires close guidance to maximise engagement.