Week 12
VR/AR/MR IN ARCHITECTURE

This week we will be looking at available VR/AR/MR technology for architects which might improve our design processes.

Photo by Vinicius "amnx" Amano on Unsplash

Outline

01

VR/AR/MR

What are they and how do they fit into our current design ecosystem

02

VR application in architecture

Going through some commonly available tools

03

AR application In architecture

Going through some examples

Photo by Tobias on Unsplash

Aims and objectives

- To **explore capability** of VR/AR/MR technology in relation to architecture
- By presenting **potential uses** in the context of architectural education and practice
- Gathering young architects (you!) thoughts on untapped uses of VR/AR/MR in design and architecture

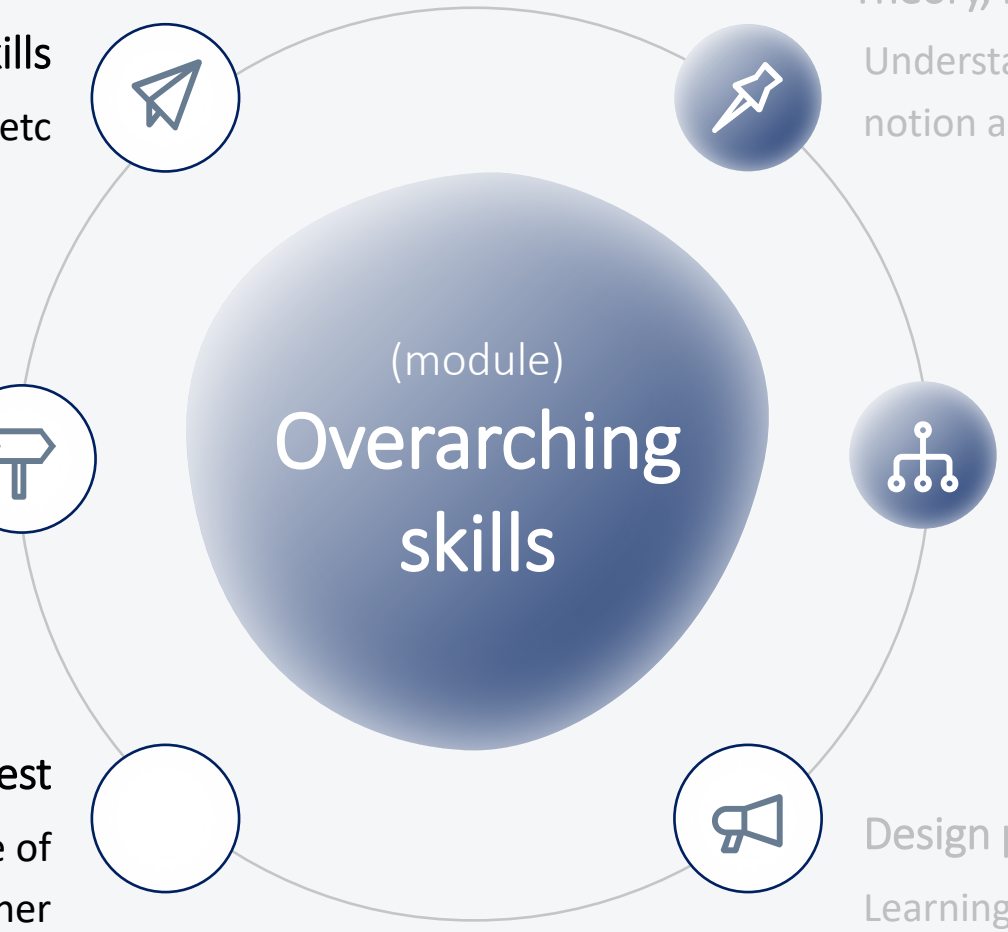
Learning outcomes

Students will be able to..

Gain understanding on available VR/AR/MR tools.

Contextualise the tools with our existing design software ecosystem

Understand the required skills needed to build our own virtual or augmented environment



Software skills

Rhino, Grasshopper, etc

Theory, history and current debate

Understand historical background of this notion and relevant debates.

Research skills

Designing through extensive research

Important concepts

Digital fabrication and construction
Digital design cognition
Human-computer interaction
Digital craftmanship
etc

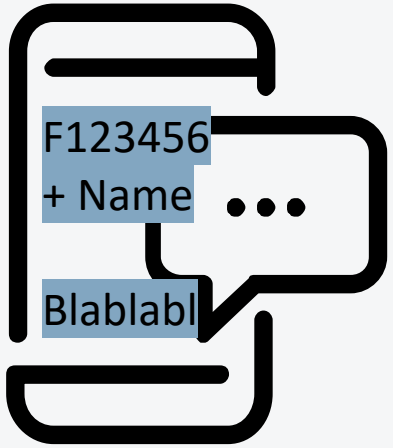
Personal interest

Exploring a preferred scope of design to be developed further

Design precedents

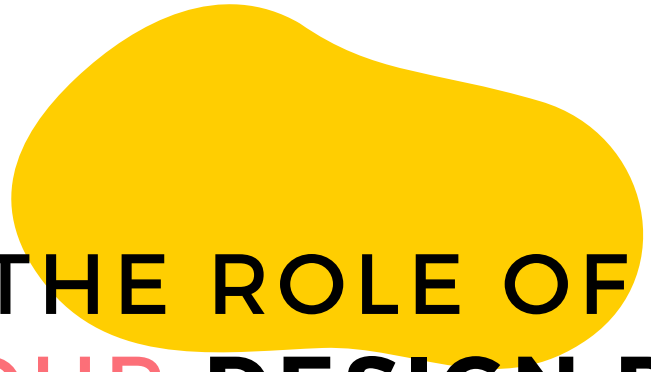
Learning through analysis of completed project

In-class Observation



1. How would you incorporate VR/AR/MR in your current design process?
2. Any particular design function you can suggest (which are not yet available in the market)?
3. What are the advantages of VR/AR/MR for architects?
4. What are the disadvantages?

https://miatedjosaputro.com/2022/04/02/dg-week-12-2/



WHAT IS THE ROLE OF **TECHNOLOGY** IN YOUR **DESIGN PROCESS**?

(ANALOGUE) DESIGN COGNITION

1. Sketching: pen-and-paper or other mediums
2. Physical model making
3. Paintings
4. Photo montages
5. Texts

And so on..

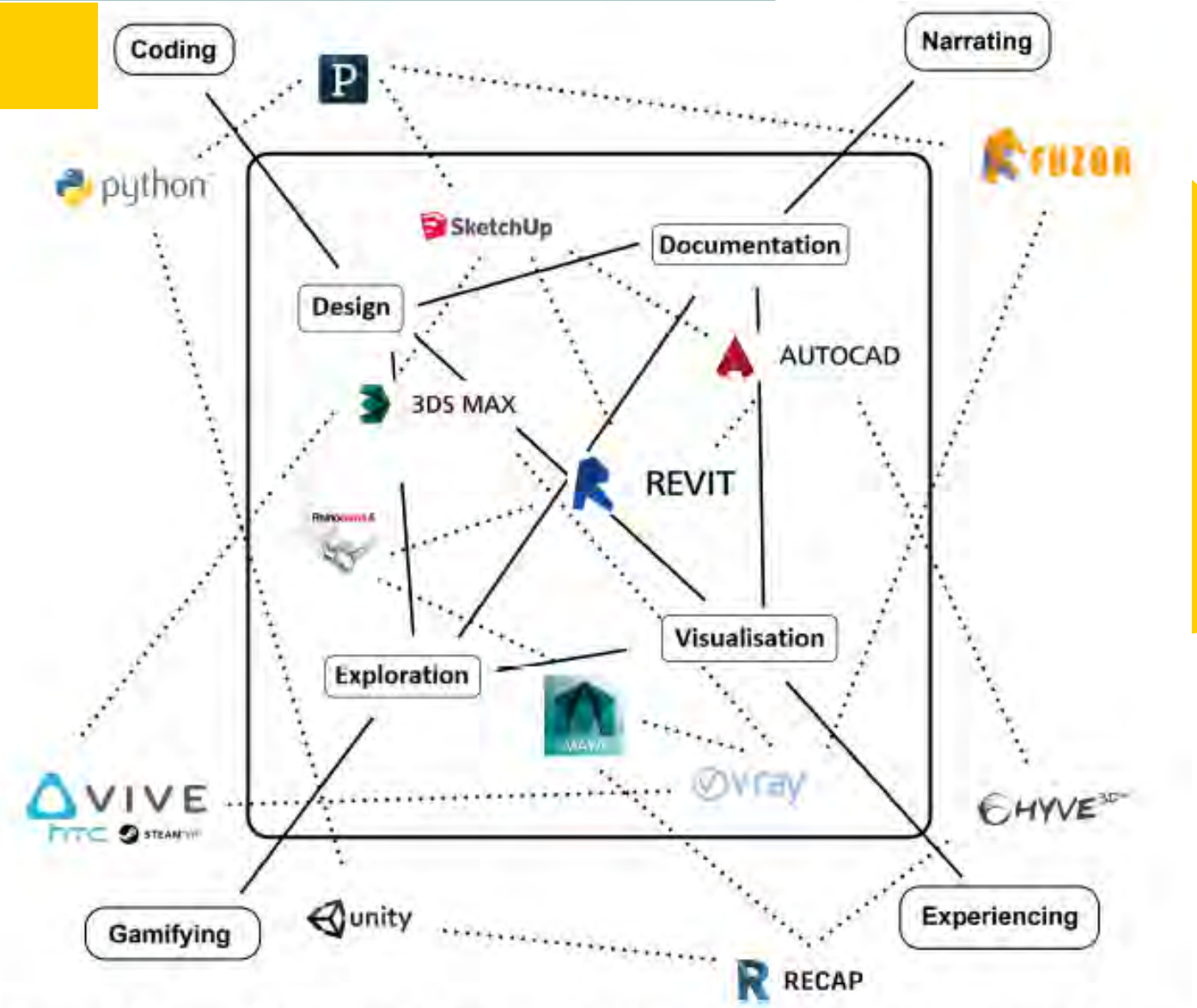


Figure 4. Dynamic Eco-system of the design process expanded from the conventional design process.

DIGITAL DESIGN ECOSYSTEM

How VR and AR are placed within the ecosystem

Schnabel, M. A. & Lo, T. T. (2018). Virtual & Augmented Studio Environment (VASE). In: Fukuda, T., Huang, P., Janssen, P., Crolla, K. & Alhadidi, S., eds. Learning, Adapting and Prototyping. Proceedings of the 23rd International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) 2018, 2018. Hong Kong, p. 443-452.

01

SECTION.ONE

VR/AR/MR

Sensorama (1957)

Morton Heilig

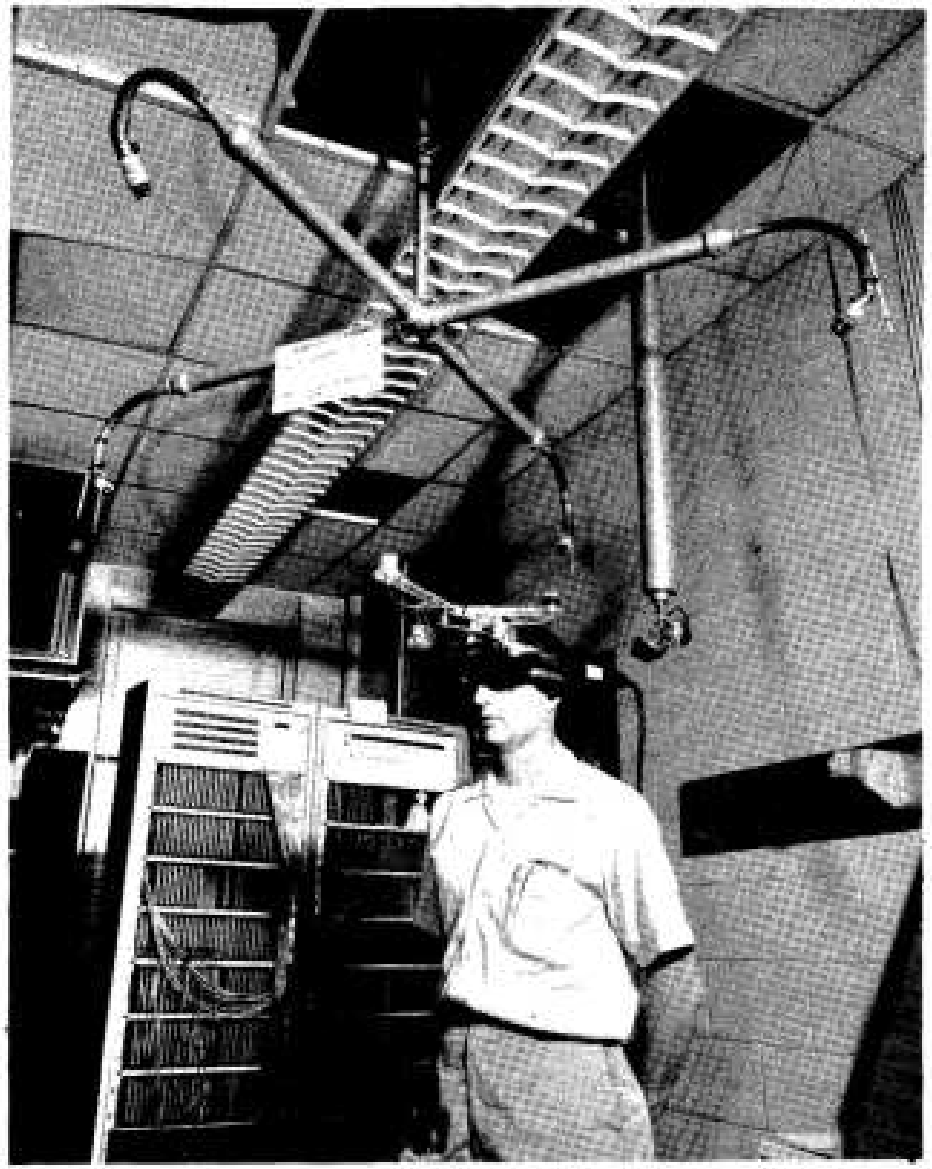
Arcade style cabinet for an immersive movie watching experience, stimulating all the senses

https://www.i-programmer.info/history/people/329-ivan-sutherland.html?start=1

Remote Reality (1966)

Ivan Sutherland and
Bob Sproull

Pioneering:
Virtual Reality,
Although the name was
not invented by them



https://www.i-programmer.info/history/people/329-ivan-sutherland.html?start=1

What are VR/AR/MR?

- “Virtual Reality” (VR) creates a digital environment that replaces the user’s real-world environment
- “Augmented Reality” (AR) overlays digitally-created content into the user’s real-world environment
- “Mixed Reality” (MR) is an experience that seamlessly blends the user’s real-world environment and digitally-created content, where both environments can coexist and interact with each other

VR, AR, MR Defined, Finally. The Consumer Technology Assn seeks to… | by Charlie Fink | Medium

VIRTUAL REALITY (VR)

Fully artificial environment

Full immersion in virtual environment

AUGMENTED REALITY (AR)

Virtual objects overlaid on real-world environment

The real world enhanced with digital objects

MIXED REALITY (MR)

Virtual environment combined with real world

Interact with both the real world and the virtual environment

[VR, AR, MR: Which Reality Technology to Choose for Your Business in 2020 (rubygarage.org)]

02

SECTION.TWO

VR APPLICATION IN ARCHITECTURE

Potential uses and benefits of virtual reality techniques to aid design processes

VR+AR

VASE

IMMERSIVE DESIGNING IN STUDIO SETTING

- An alternative approach that moves out of conventional design approach
- VASE is Virtual and Augmented Studio Environment
- ***Other potential: design crits***

Figure 1. (left) The Virtual Environment Lab at Strathclyde University (Maver et al., 2001) (right) The VR Lab at Victoria University of Wellington.

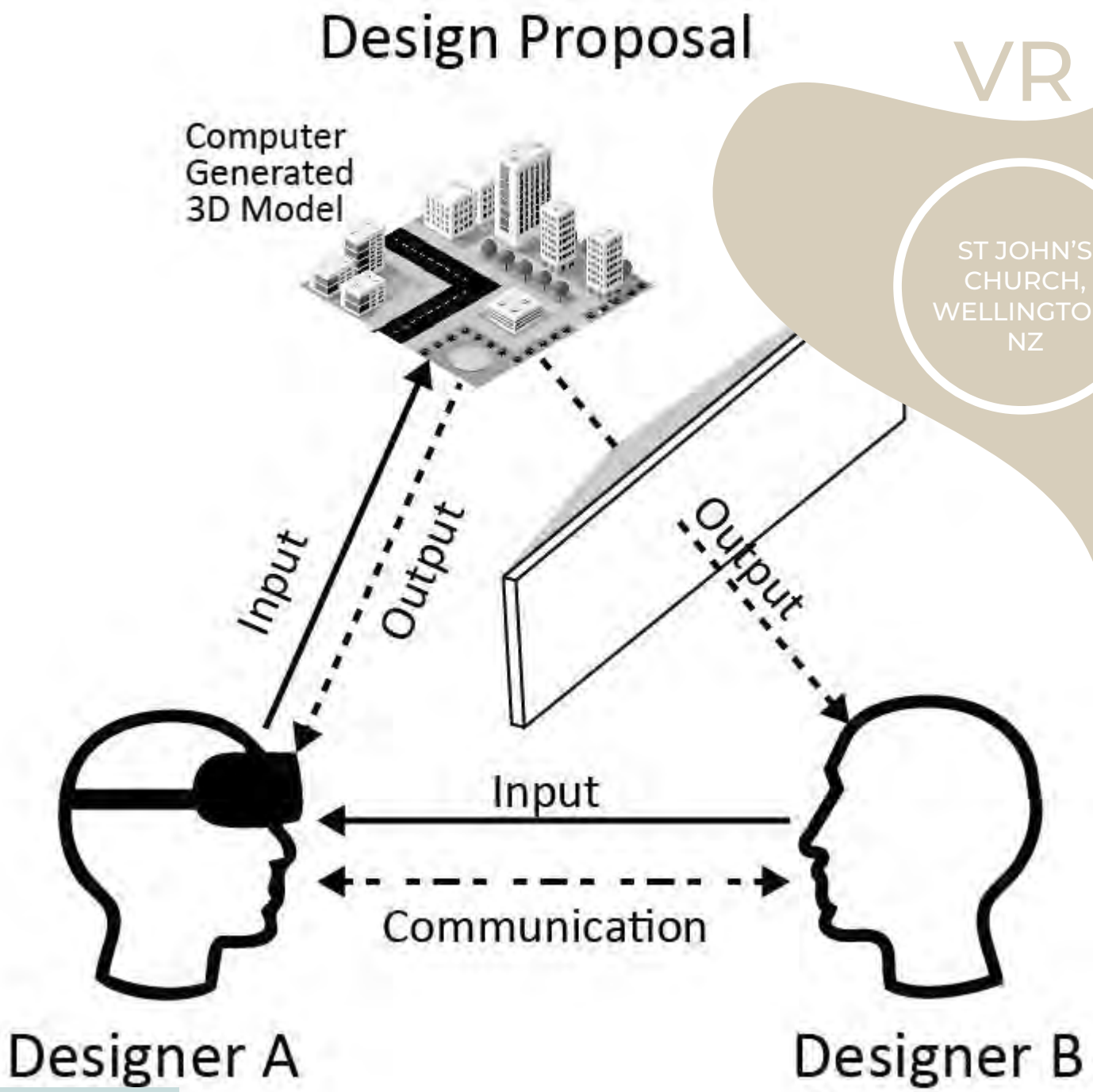
Schnabel, M. A. & Lo, T. T. (2018). Virtual & Augmented Studio Environment (VASE). In: Fukuda, T., Huang, P., Janssen, P., Crolla, K. & Alhadidi, S., eds. Learning, Adapting and Prototyping. Proceedings of the 23rd International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) 2018, 2018. Hong Kong, p. 443-452.

PARTICIPATORY URBAN DESIGN

- Social VR instrument
- Real –time generation and visualisation
- IVE instrument SketchPad

VR

ST JOHN'S CHURCH, WELLINGTON, NZ



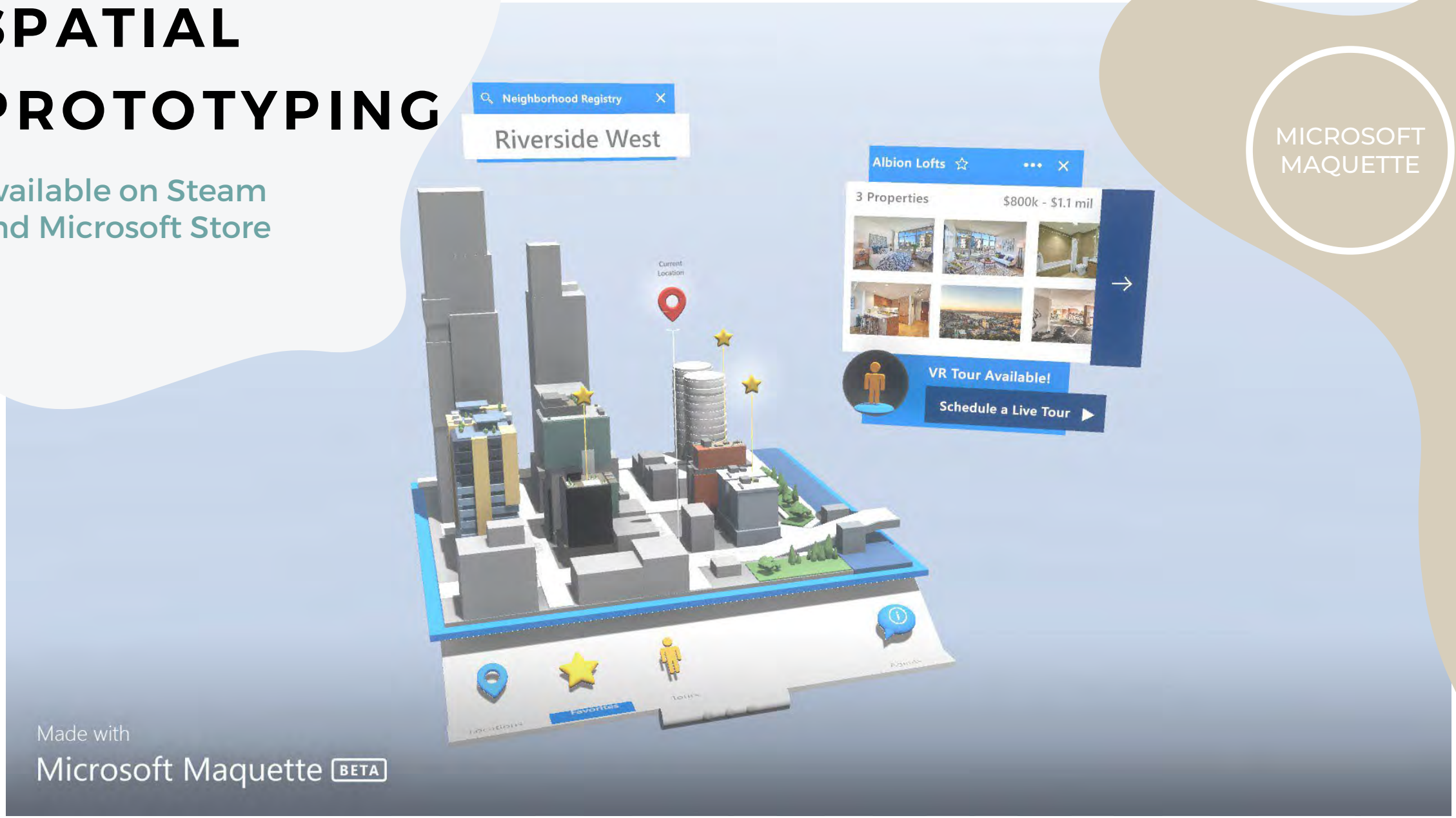
Chowdhury, S., & Schnabel, M. A. (2020). VR Unmatched-Leveraging Non-experts as Co-Urban Designers.

VR

SPATIAL PROTOTYPING

Available on Steam
and Microsoft Store

MICROSOFT
MAQUETTE



VR

9 CUBE VR

DESIGNING IN REAL-WORLD SCALE

For foundation year students

Was built in zSpace

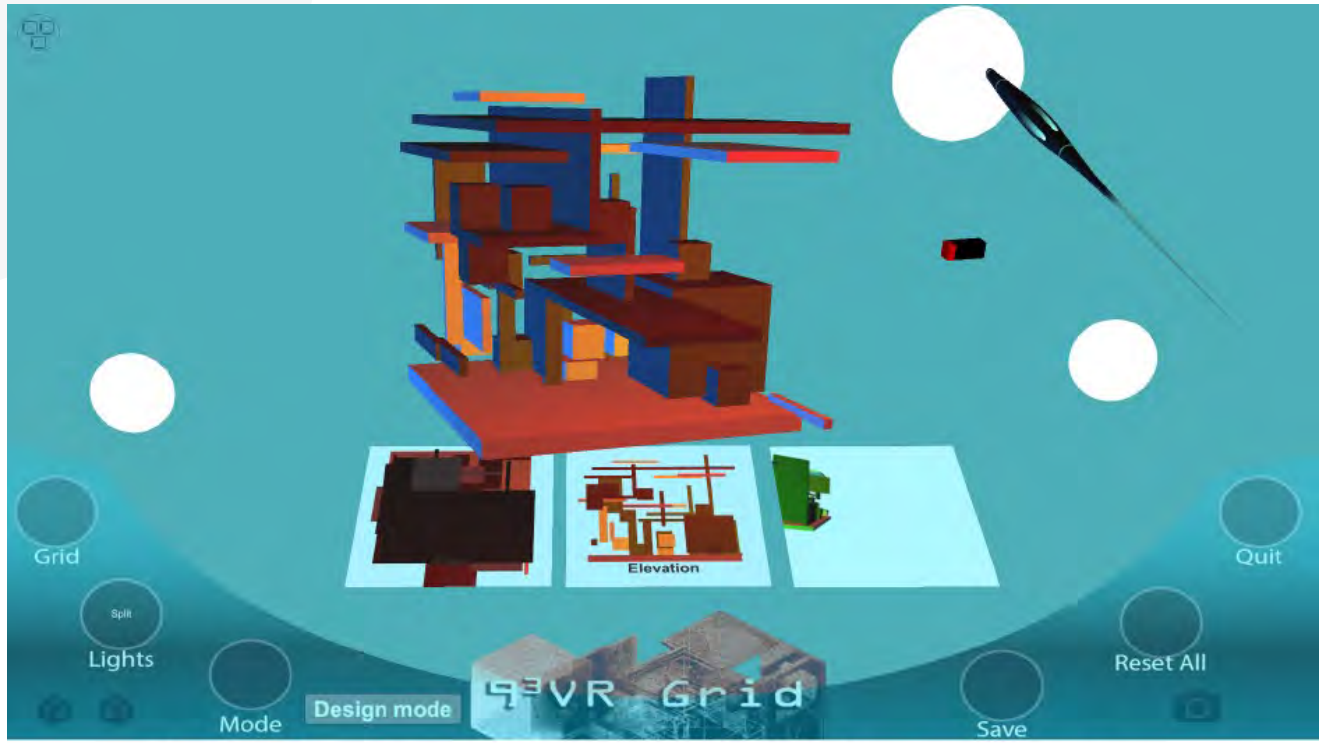


Figure 4. Working model showing split RGB lighting experimentation.

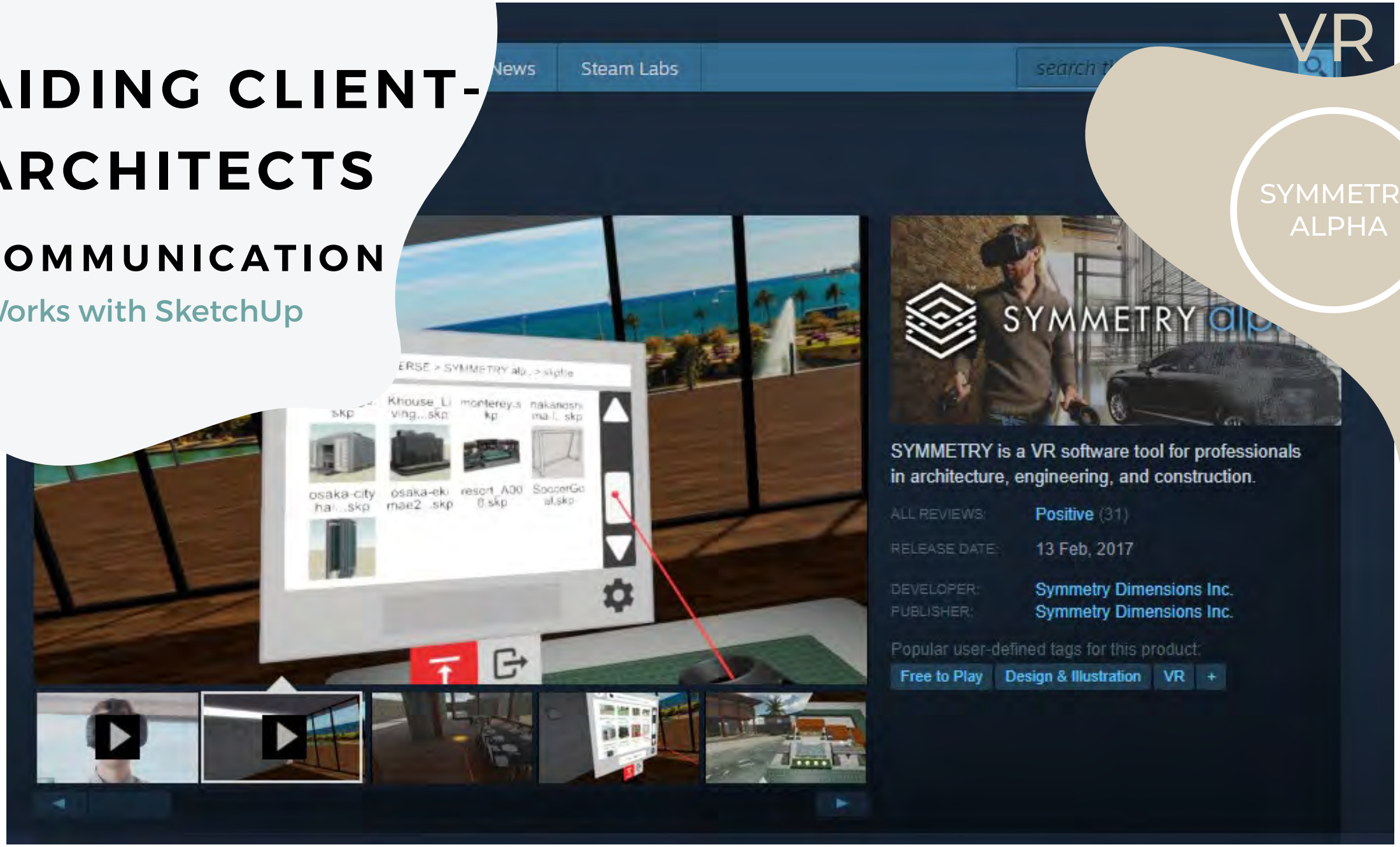
Hopfenblatt, J. & Balakrishnan, B. (2018). The "Nine-square Grid" revisited: 9-Cube VR- An Exploratory Virtual Reality Instruction Tool for Foundation Studios. In: Fukuda, T., Huang, P., Janssen, P., Crolla, K. & Alhadidi, S., eds. Learning, Adapting and Prototyping. Proceedings of the 23rd International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) 2018, 2018. Hong Kong, p. 463-471.

AIDING CLIENT-ARCHITECTS

COMMUNICATION

Works with SketchUp

SYMMETRY ALPHA



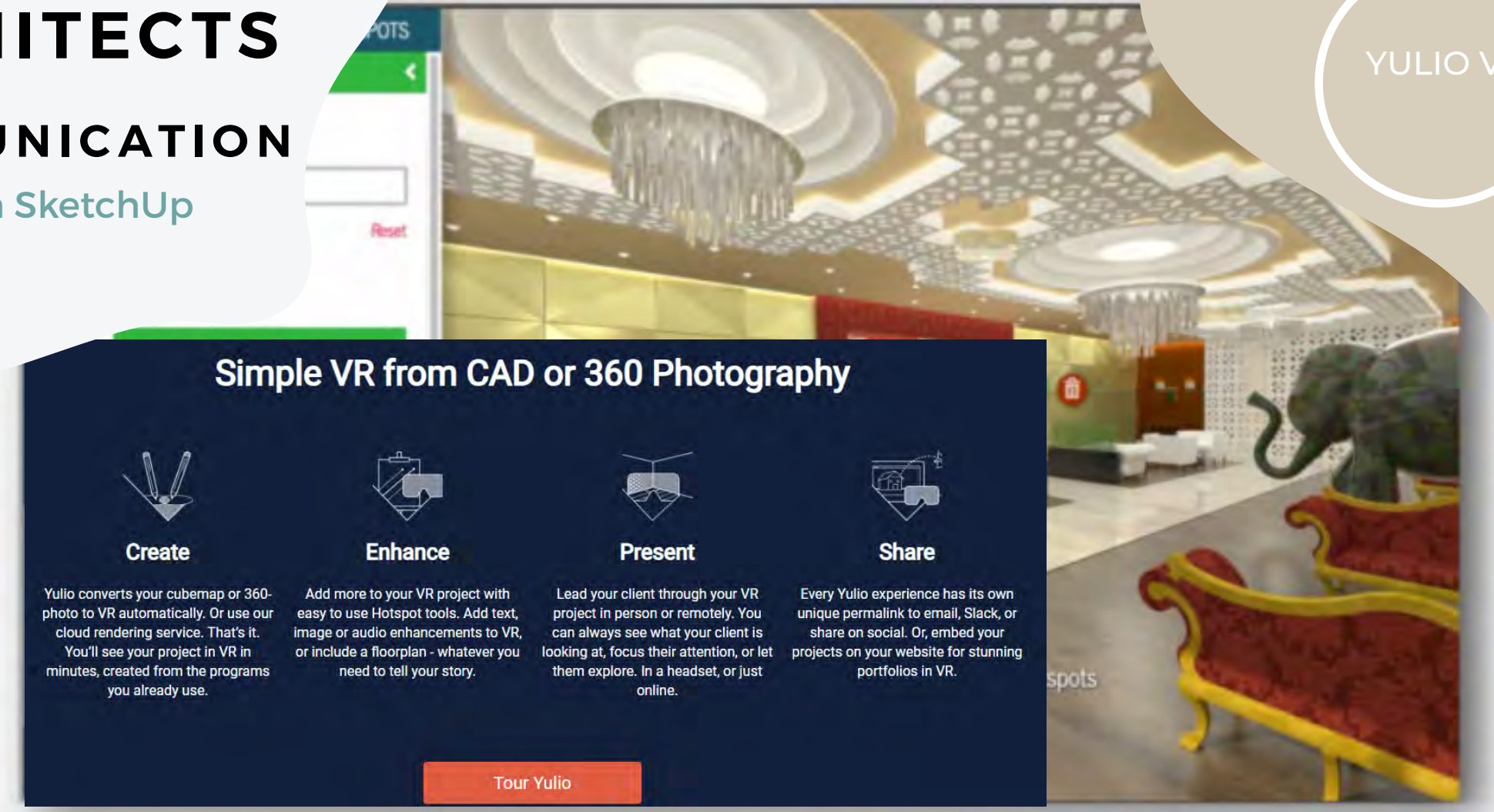
VR

AIDING CLIENT-ARCHITECTS

COMMUNICATION

Works with SketchUp

YULIO VR



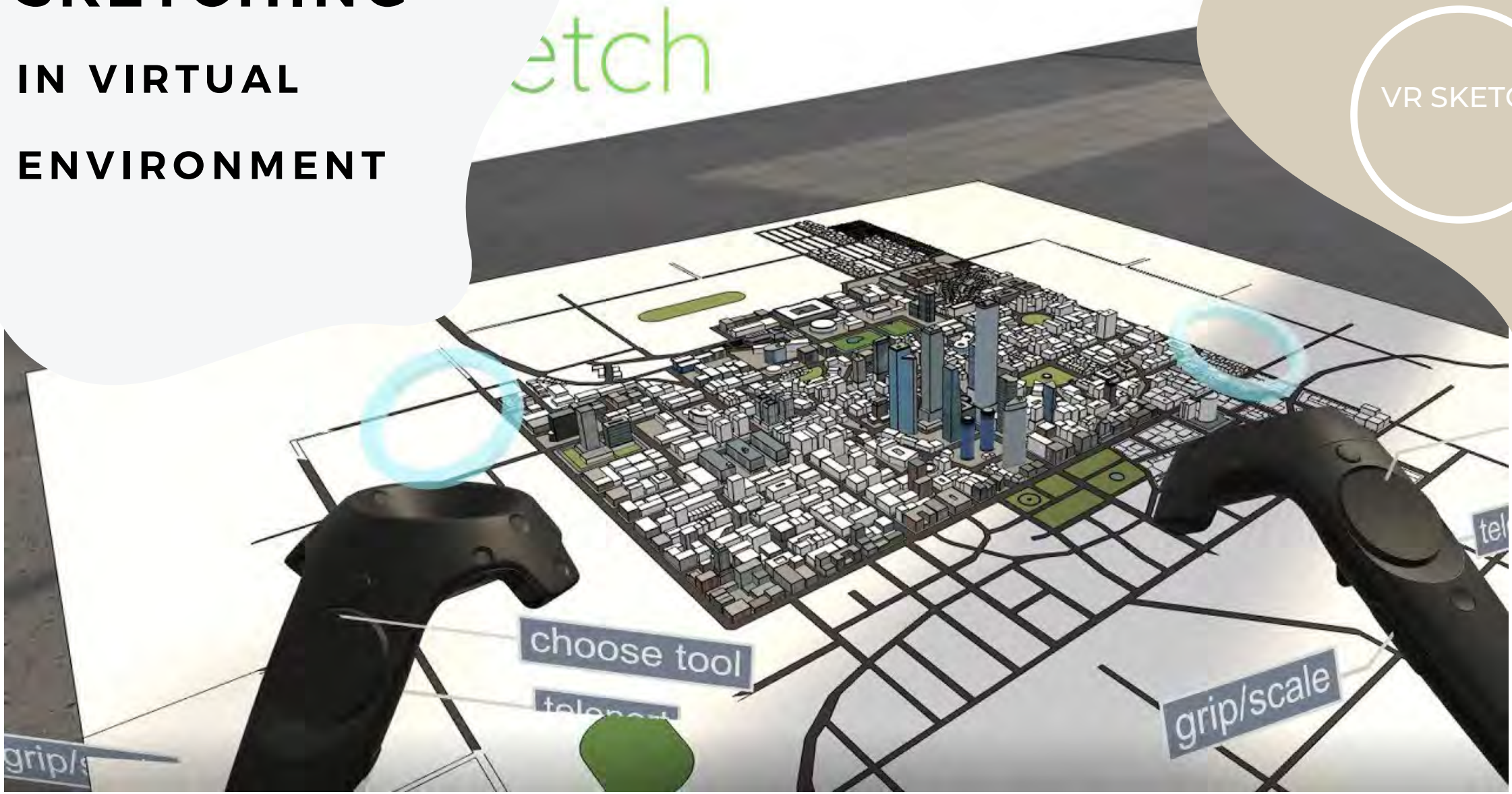
SKETCHING

IN VIRTUAL

ENVIRONMENT

VR

VR SKETCH



SKETCHING

IN VIRTUAL

ENVIRONMENT

https://youtu.be/W1-iBLGC9i8

Duration: 2 mins

VR

VR SKETCH

VR

REMOTE SITE VISIT

THE RIO STUDIO, BRAZIL

- Introducing IE (Immersive Experiences) in architecture and landscape studio
- Virtual design studio in education setting
- Comparison between approaches: WebVR, mobileVR and head-mounted display (HMD) desktop VR.

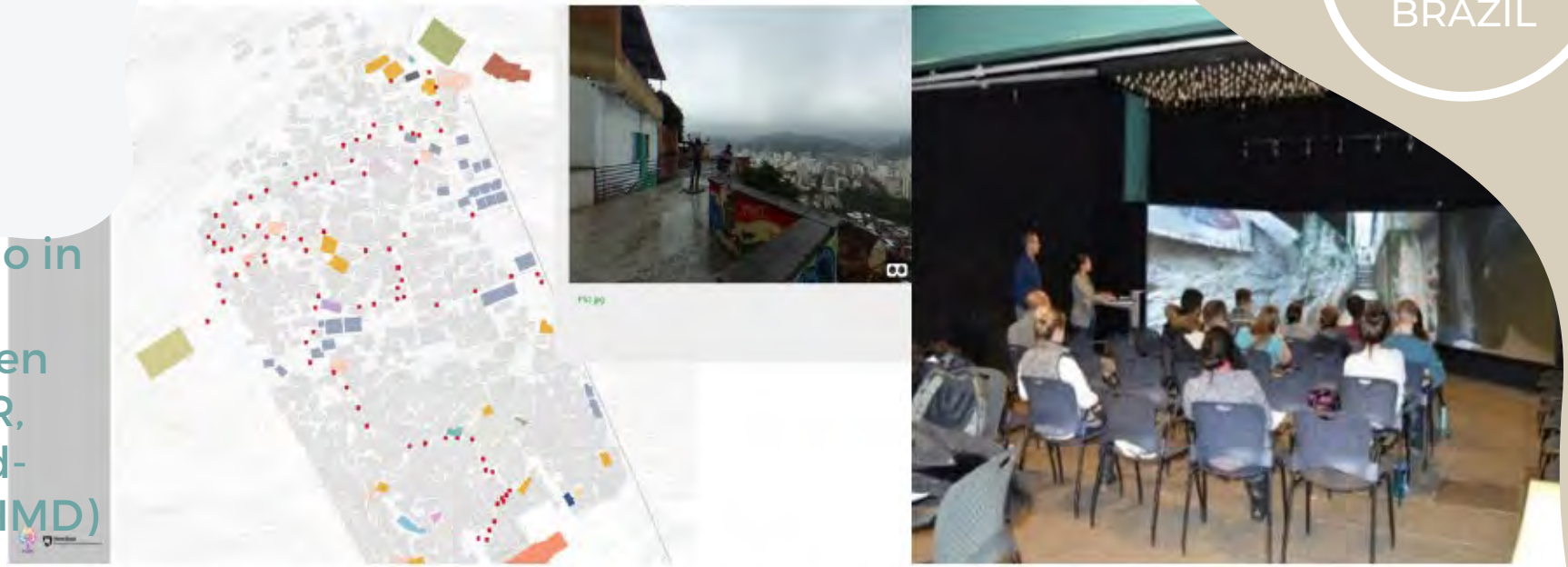


Figure 1. WebVR website with the 360° images and display in the IEL.

Oprean, D., Verniz, D., Zhao, J., Wallgrun, J. O., Duarte, J. P. & Klippel, A. (2018). Remote Studio Site Experiences: Investigating the Potential to Develop the Immersive Site Visit. In: Fukuda, T., Huang, P., Janssen, P., Crolla, K. & Alhadidi, S., eds. Learning, Adapting and Prototyping. Proceedings of the 23rd International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) 2018, 2018. Hong Kong, p. 422-430.

VR

YONSEI UNIVERSITY, KOREA

UNDERSTANDING SPATIAL EXPERIENCE

- Understanding spatial experience in retail environments
- Visual merchandising cognition
- VR system integrated eye-tracking
- The ability to analyse visual attention.

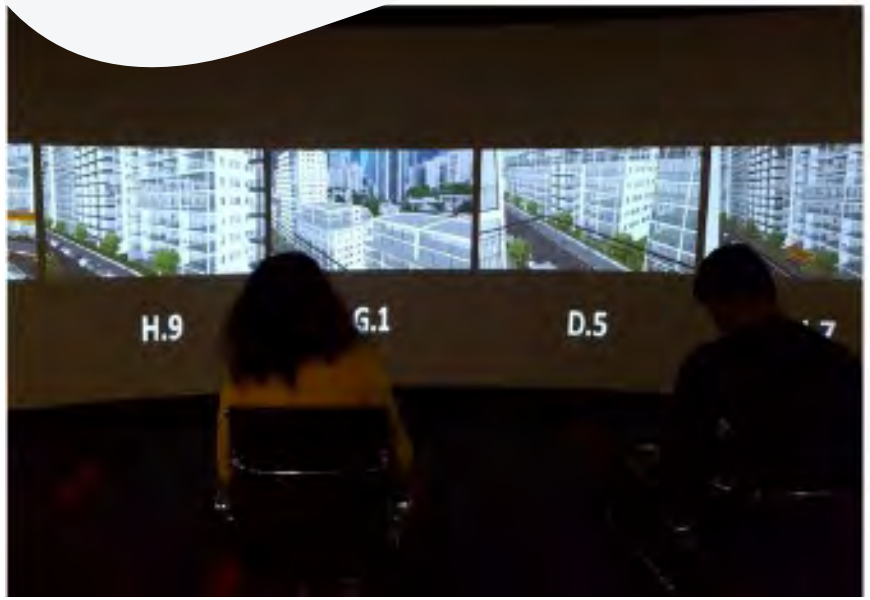
Kim, N., & Lee, H. (2020). Visual Attention in Retail Environments-Design Analysis using HMD based VR System Integrated Eye-Tracking.

VR

VisLab in Technion

A RESEARCH TOOL

- To examine impact of urban environment and the sense of wellbeing.
- 24 virtual urban environment to simulate pedestrian movement
- ***Other research example: perception of built environment***



Haifler, T., & Yaala and Fisher-Gewirtzman, D. (2020). Urban Wellbeing, As Influenced by Densification Rates and Building Typologies-A Virtual Reality Experiment.

03

SECTION.THREE

AR APPLICATION IN ARCHITECTURE

Potential uses and benefits of augmented reality in architecture: using different AR systems (mobile, HUD, holographic displays, etc)

AUGMENTED CO-DESIGN STUDIO

AR

UNI OF MONTREAL

- Improving tutor and student experience
- Hyve3D allows social interactions within VR

IS. Shown partially opened for student presentations in this project

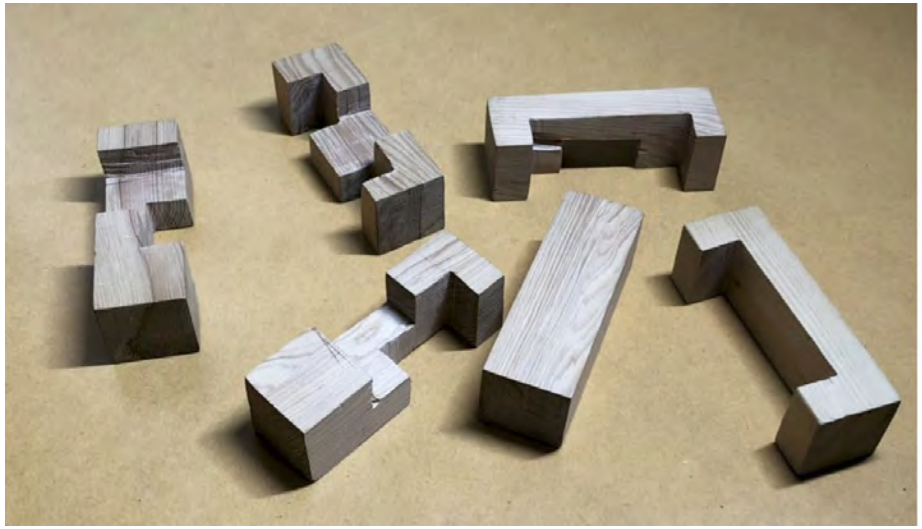
Dorta, T., Kinayoglu, G. & Boudhraâ, S. (2016). A new representational ecosystem for design teaching in the studio. Design Studies, 47, p. 164-186.

AR

HOLONAVI

ASSEMBLY GUIDANCE SYSTEM

- Preserving Japanese timber joinery.
- Instructions:
  1) Construction in correct order
  2) Assembly in correct direction
  3) Selection of correct component
- Development: multiplayer, scaling up and navigation



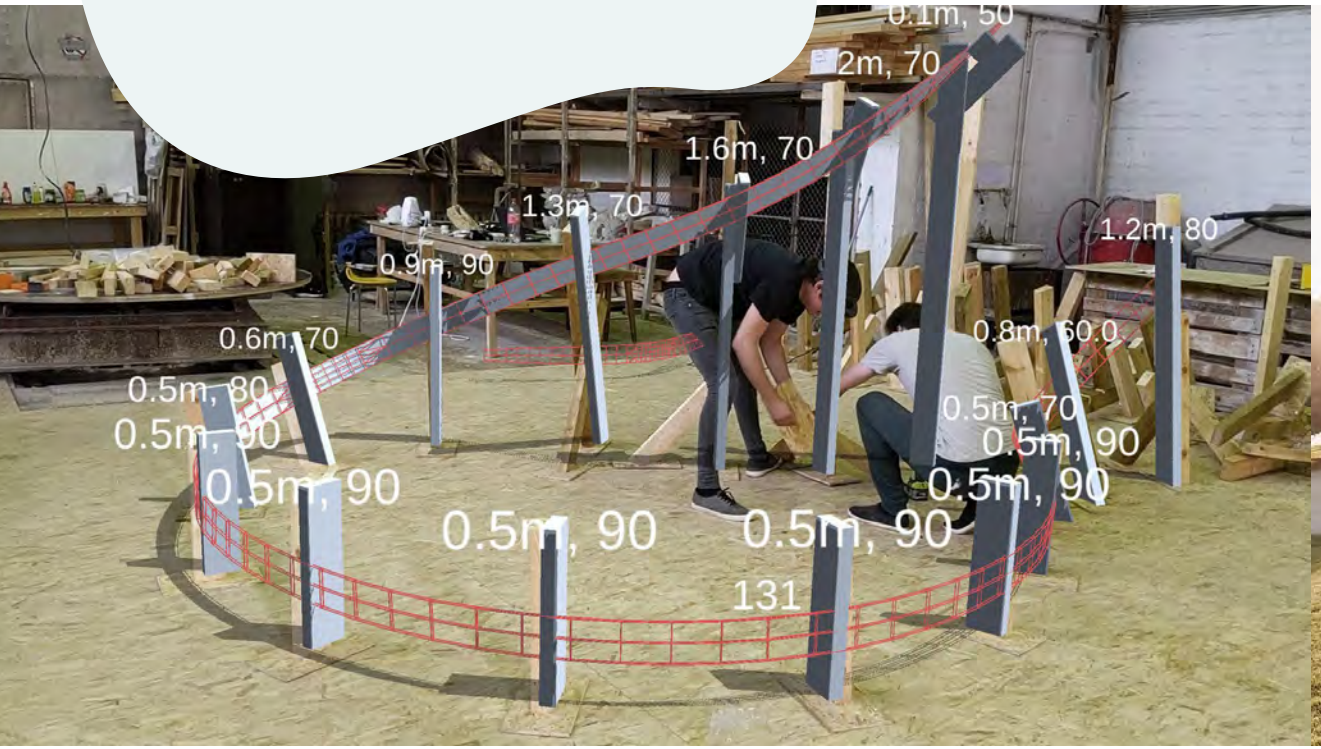
Suzuki, T., Ikeda, H., Takeuchi, I., Matsunaga, F., Sumitomo, E., & Ikeda, Y. (2020). Holonavi: A study on user interface for assembly guidance system with mixed reality in a timber craft of architecture. In 25th International Conference on Computer-Aided Architectural Design Research in Asia, CAADRIA 2020 (pp. 691-700). The Association for Computer-Aided Architectural Design Research in Asia (CAADRIA).

DIGITAL FABRICATION

Fologram
Steampunk pavilion
(Soomenhamn Design)

AR

FOLOGRAM



AUGMENTED GROUND

Augmented Timber Assembly
Tongji University, Digital Futures 2019

AR

DIGITAL FUTURES 2019

AR

TRIMBLE

AIDING ON-SITE DISCUSSION

BIM using Trimble, for example

SITE RELOCATION

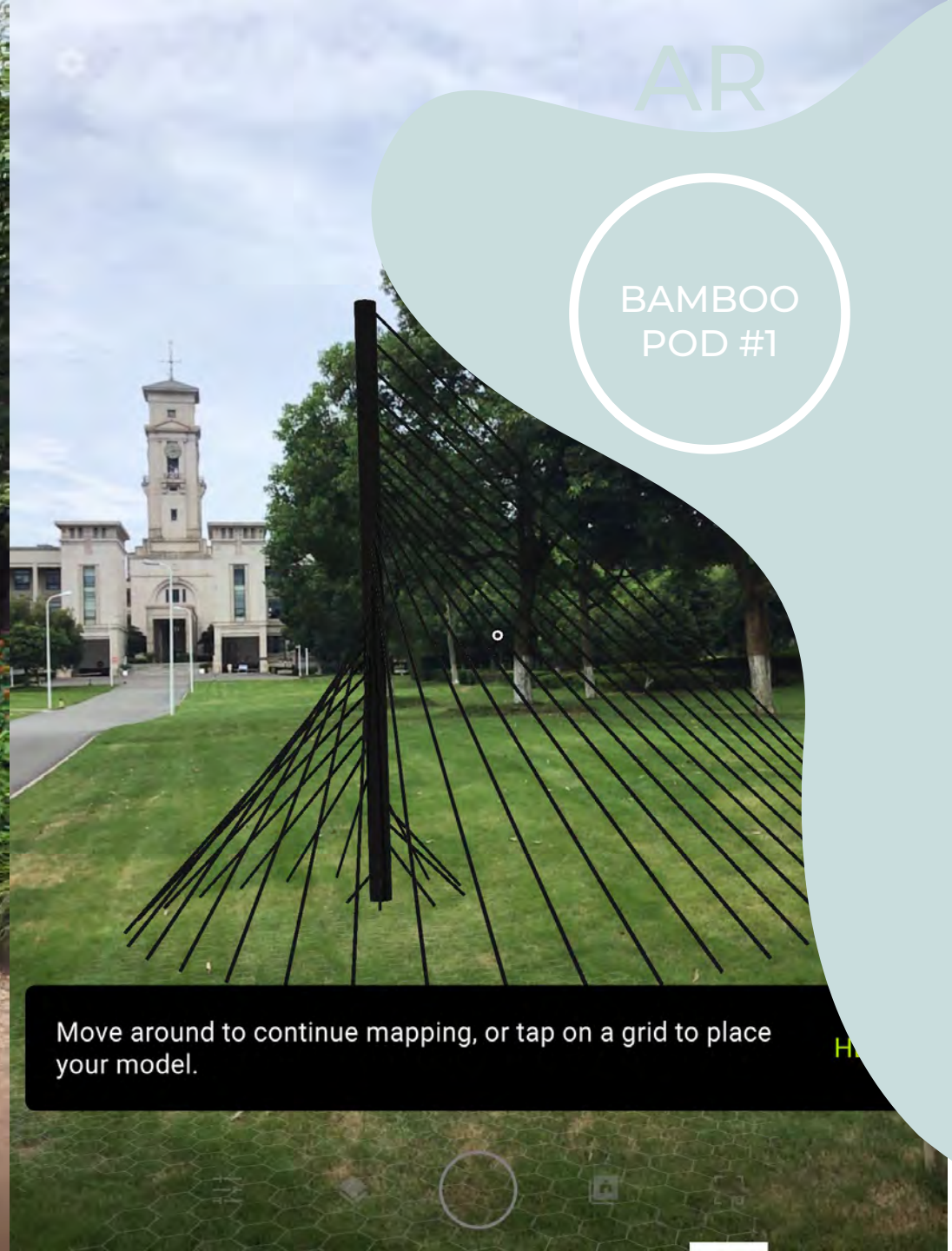
Bamboo Pod #1

Fologram

Hololens 2 problem

AR

BAMBOO POD #1



SITE SELECTION

Bamboo Pod #2

Fologram on mobile

AR

BAMBOO
POD #2

AR

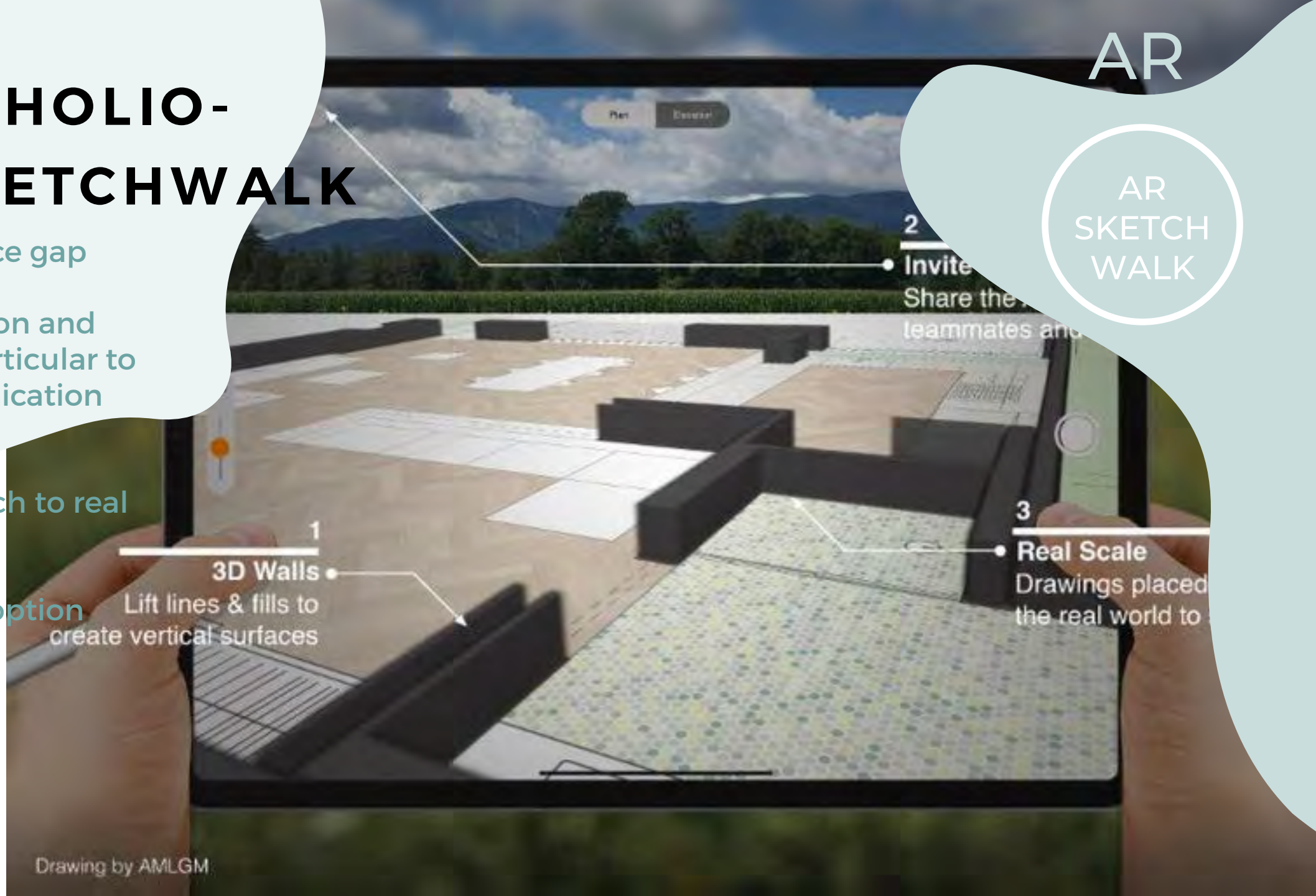
MORPHOLIO-AR SKETCHWALK

AR SKETCH WALK

Aim to reduce gap between representation and reality, in particular to aid communication with clients.

Placing sketch to real world.

Multiplayer option



AR

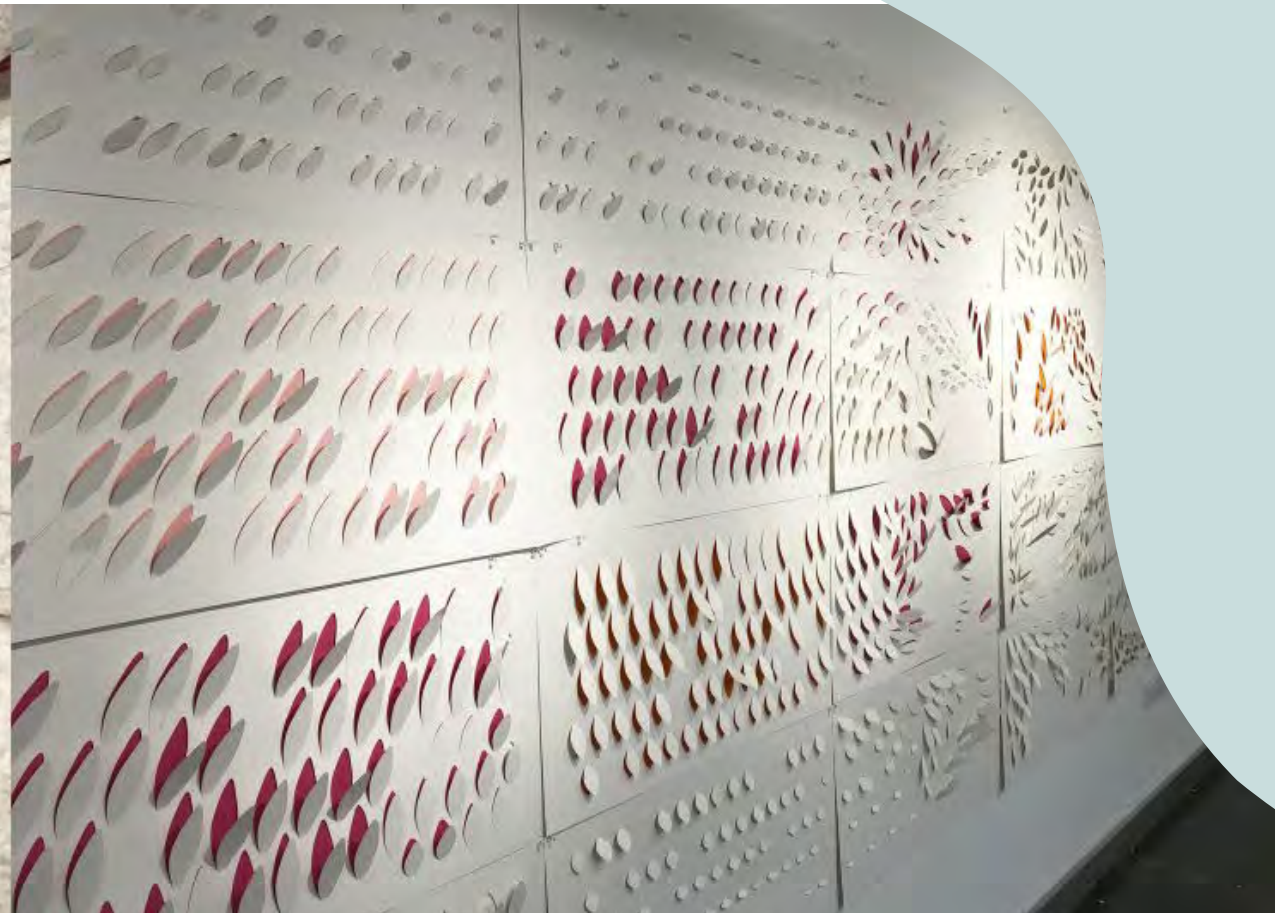
PROJECT NAME

HUMAN/ MATERIAL PERCEPTION

Relationship between technology and human sensory experience.

Wearable emotion sensors to evaluate human experience. Mood bracelet.

6.5m long of tactile surface with salt.



FARR, M., & MACRUZ, A. MULTI-SENSORY MATERIALITY.

AR

GAMIFICATION EXPERIENCE & MUSEUM GUIDE SERVICES

Gamification is the application of game-oriented design approaches.

Figure 5. User testing of museum guide system in the exhibition.

Chen, Z. R. (2020). The Guidance System of Gamification and Augmented Reality in a Museum Space.

AR

REMOTE COLLABORATION

CLOUD BASED DIGITAL TWIN OF CONSTRUCTION SITE

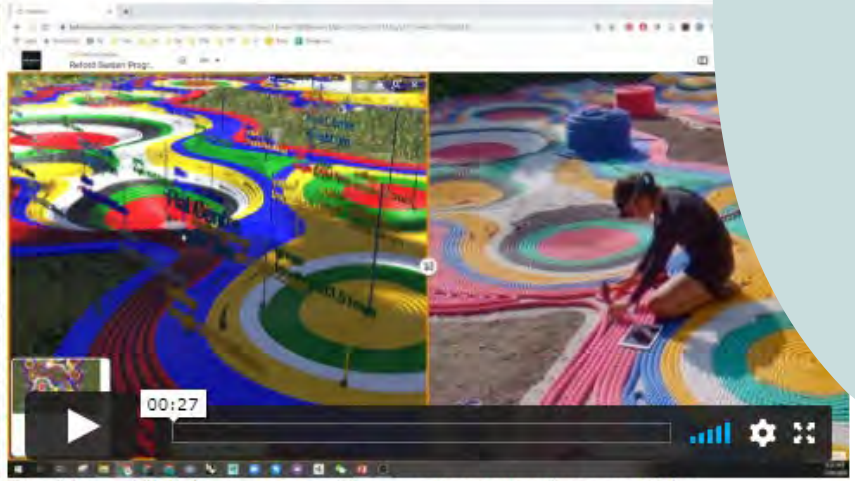
AUGMENTED GROUND

Manual crafting process
Augmented human builders using AR device

Marking the height of the heals using AR.

Snapshots of the construction process.

Mixed reality perspective through AR devices.



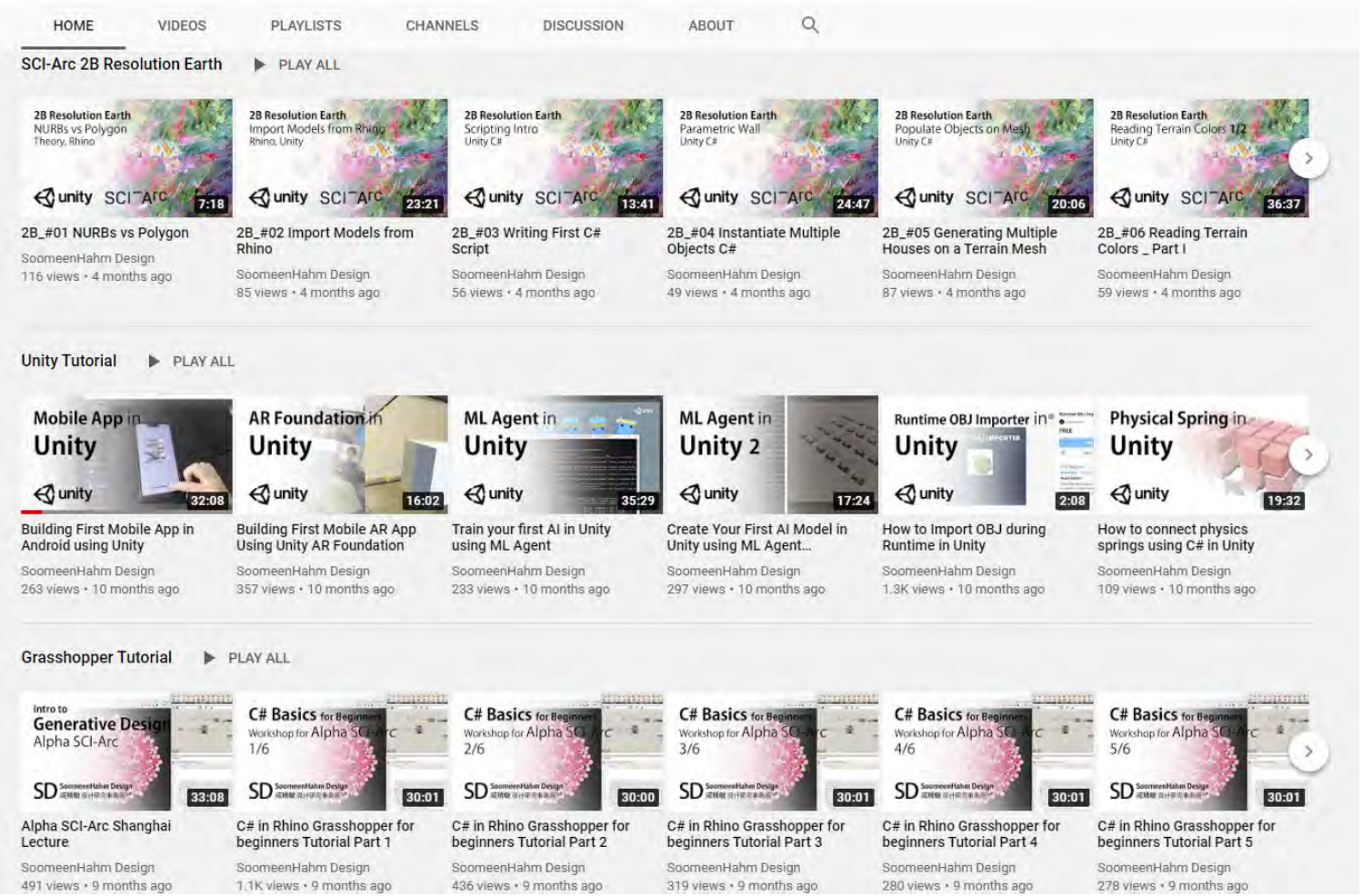
Cloud based digital twin was used for remote construction supervision.

https://soomeenhahm.com/portfolio-item/augmented-grounds/

SOOMEENHAHM DESIGN

RESOURCES

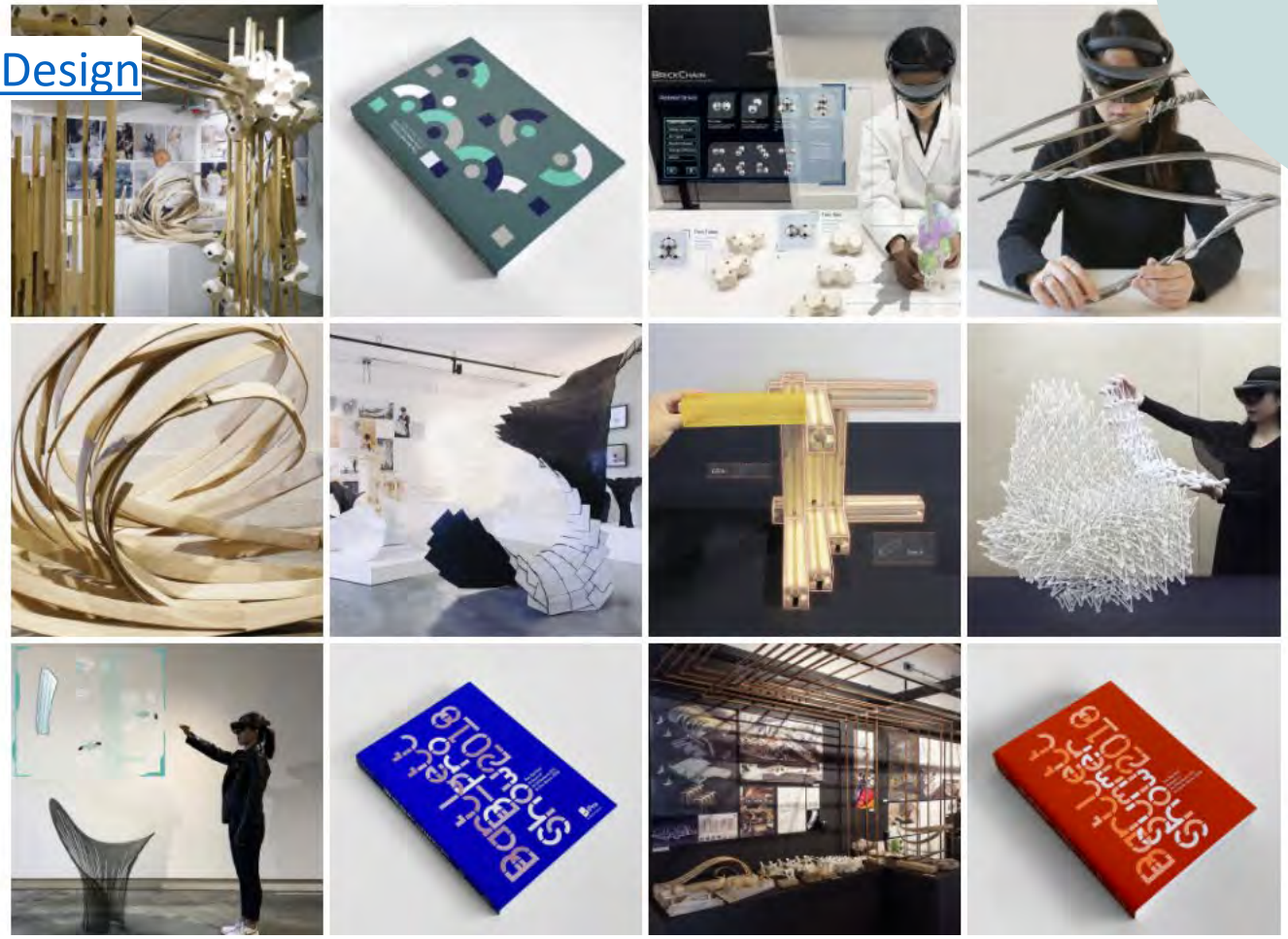
[(230) SoomeenHahm Design - YouTube]



SOOMEENHAHM DESIGN

RESOURCES

[Bartlett – SoomeenHahm Design]



AR

NO-CODE PLATFORM

TO CREATE AND SHARE AR/VR EXPERIENCES

MINSAR STUDIO

Minsar App:
https://youtu.be/VpWbXUPpODI

Review and example of use:
https://youtu.be/8FkR3-E0XqM

AR APPROACH

ON DRAWING

https://youtu.be/AJDf_HRNo54
https://youtu.be/awHhe00V_1s

AR

SketchAR

04

SECTION.FOUR

TAKEAWAYS

ADVANTAGES

DISADVANTAGES

TAKEAWAYS

1 | Design ecosystem

An expanded and dynamic view of design ecosystem beyond design, exploration, documentation and visualisation.

2 | Availability

Knowing what are available for architects to use. Do not need to re-invent the wheels.

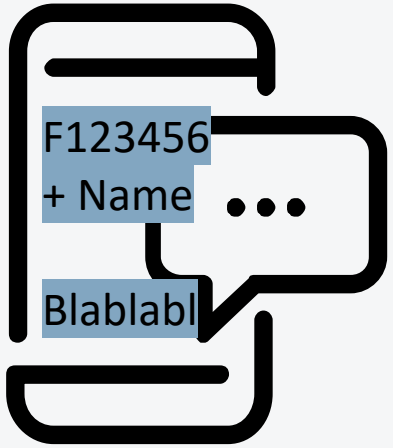
3 | Open to ideas

Multidisciplinary collaboration
Networking outside architecture field.

4 | Seek guidance

Related to point no 3, seek guidance in early stage. Engage in collaborations as much as you can.

In-class Observation



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