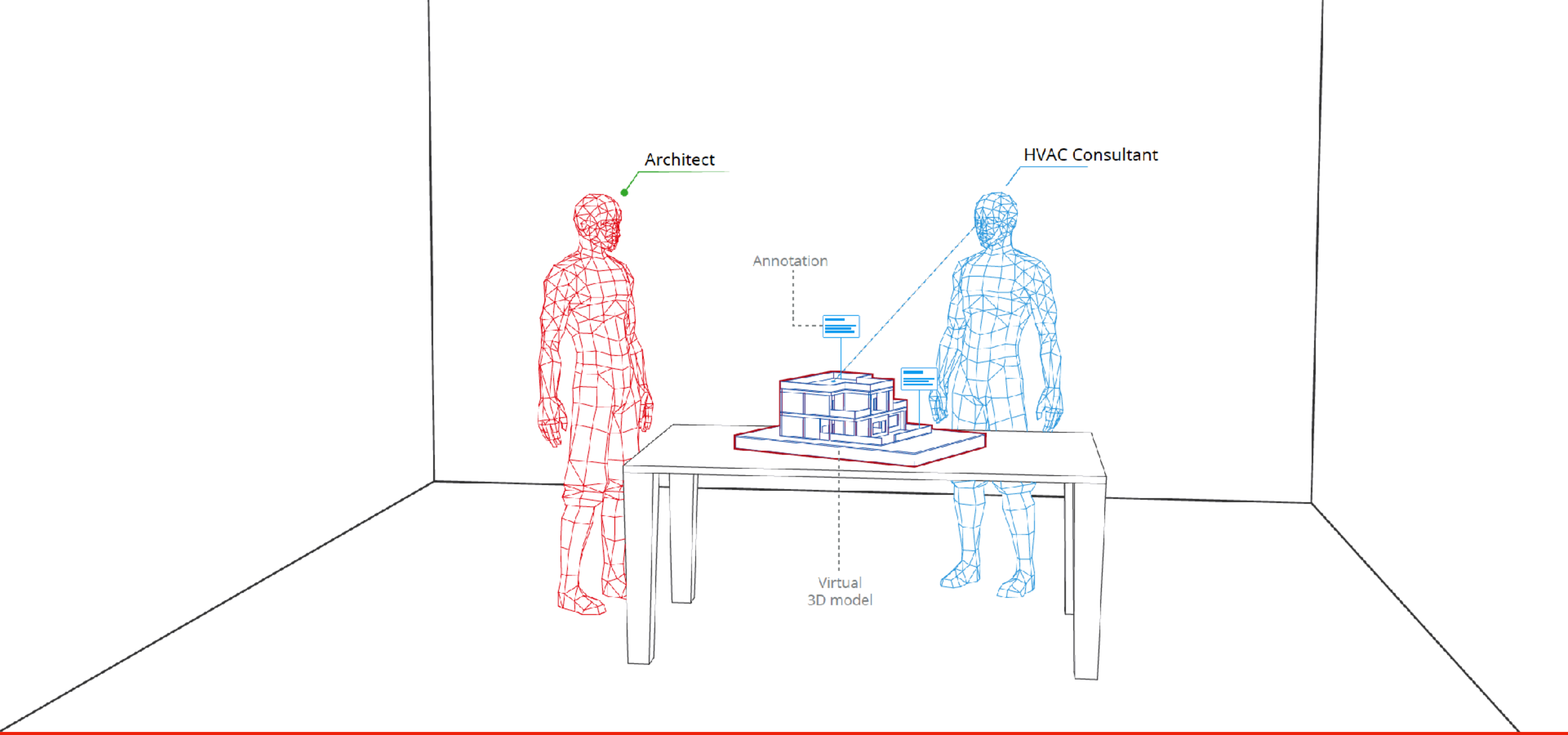


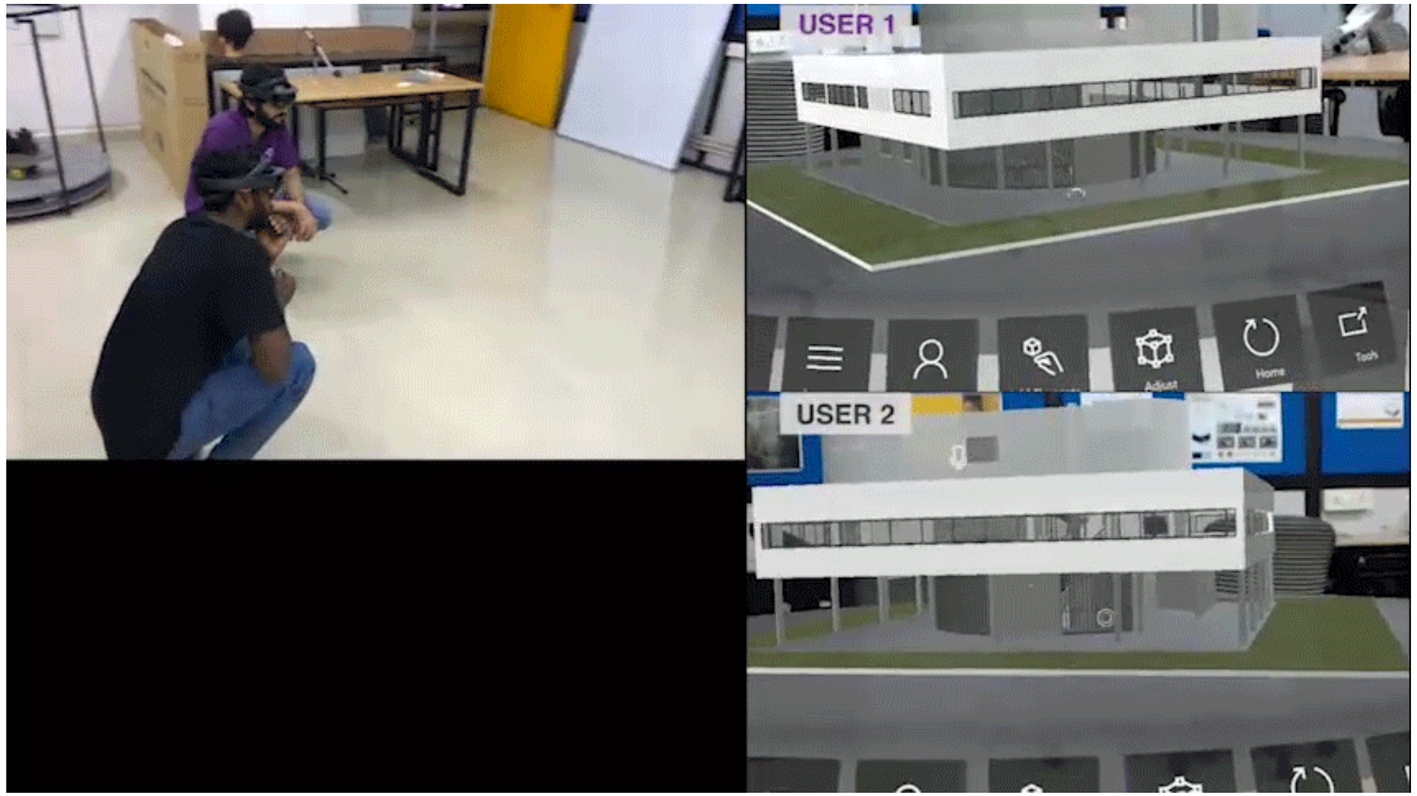
A collaborative mixed reality ecosystem for AEC Industry

Presented by - **Vineet Kamboj**

Guided by - **Prof. Jayesh Pillai**

Local Collaboration

Video from working prototype made in Project 2



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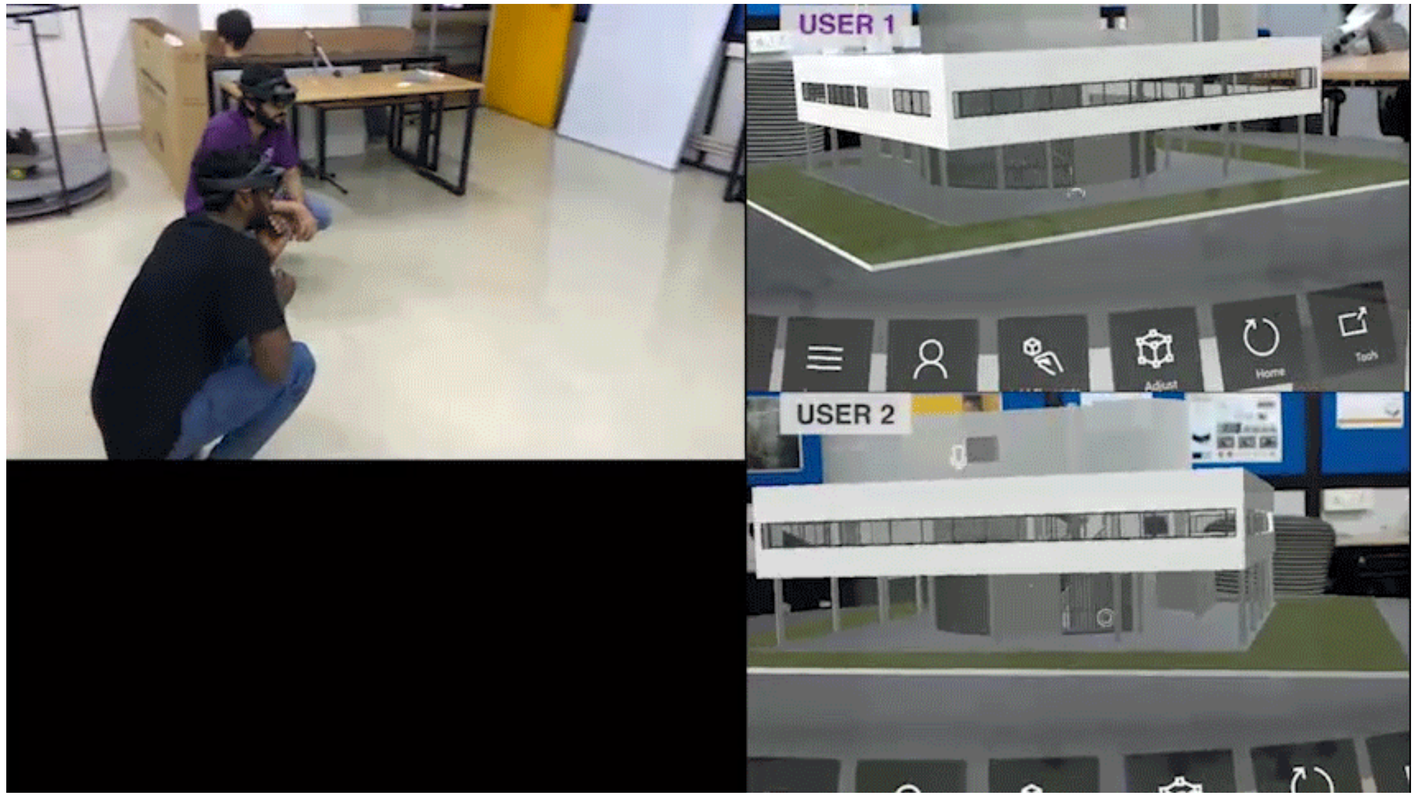
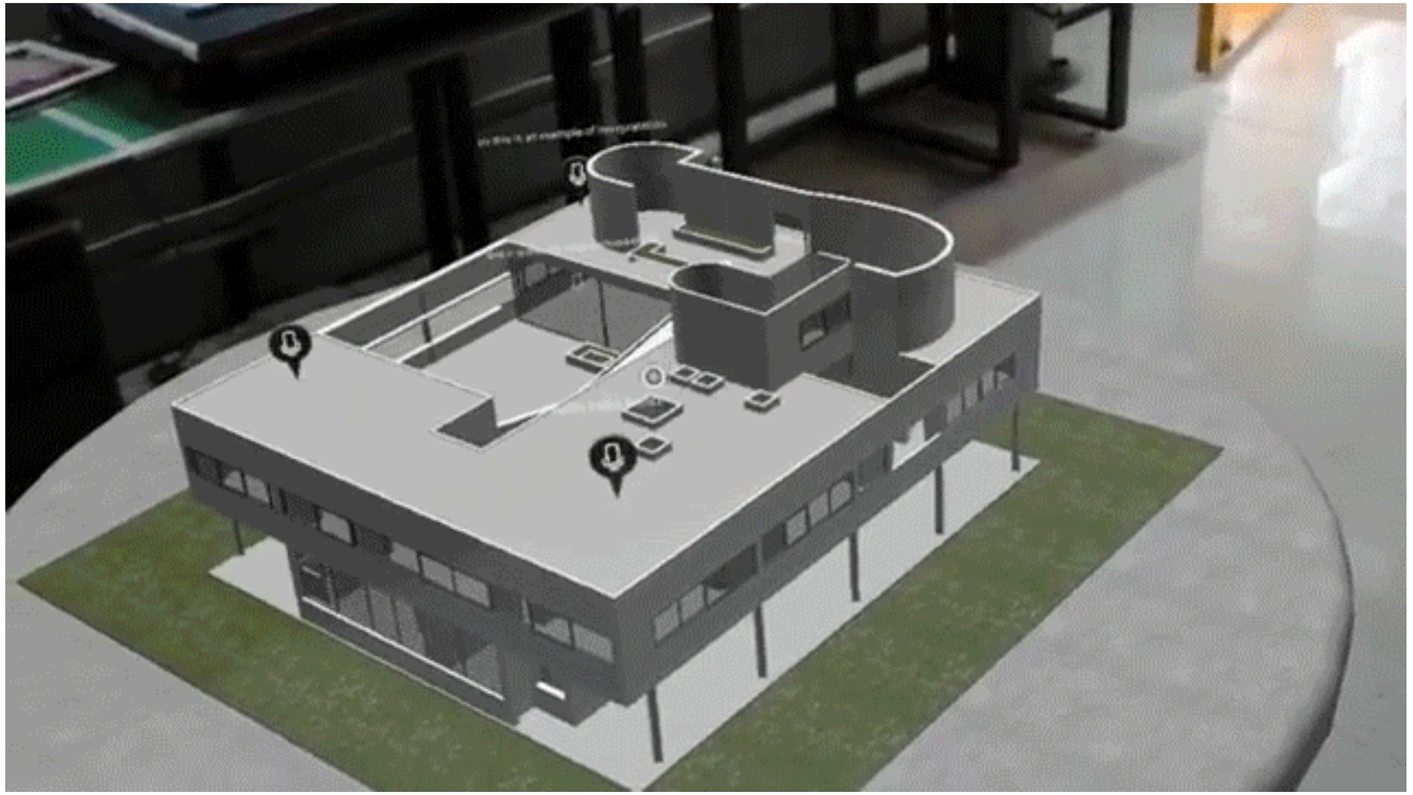
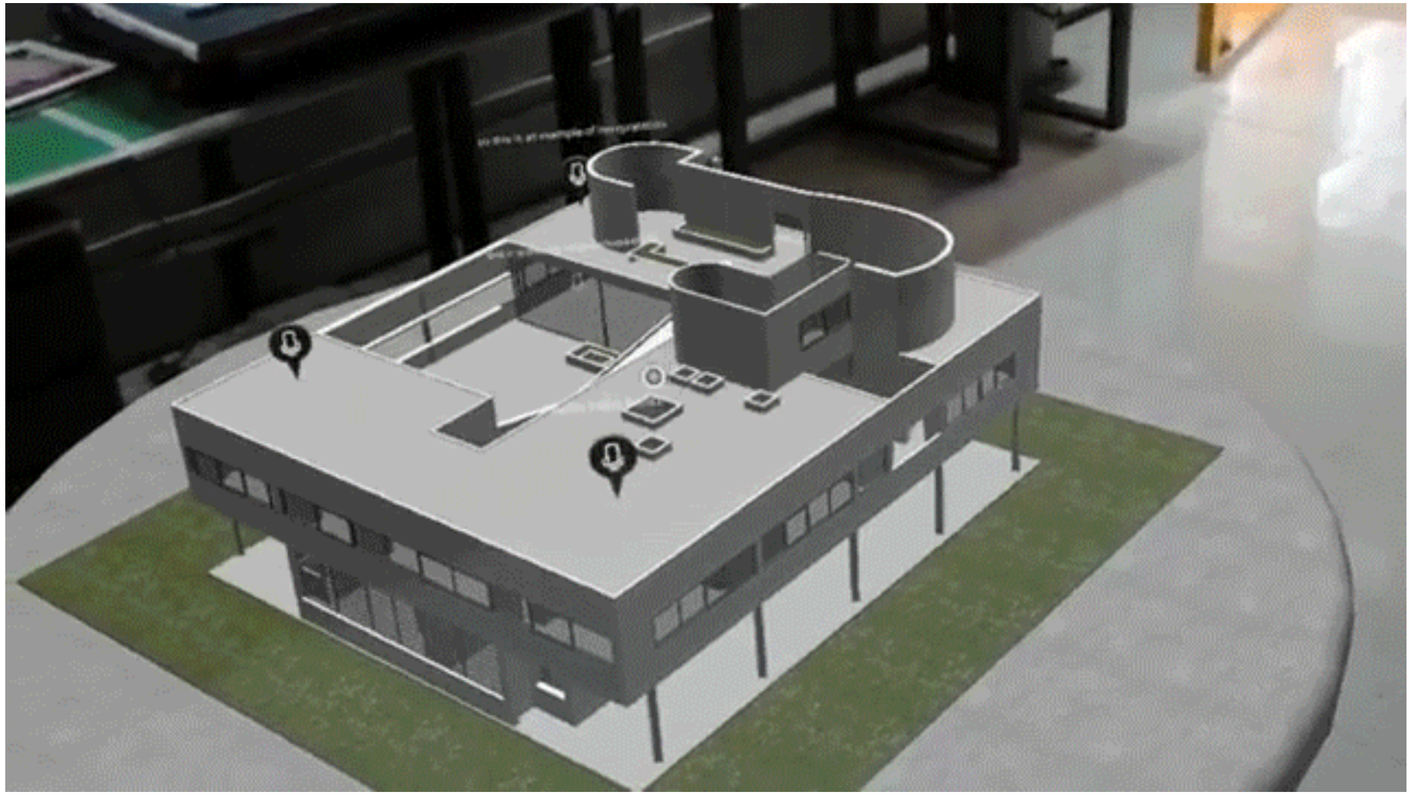


Remote Collaboration



Video from working prototype made in Project 2

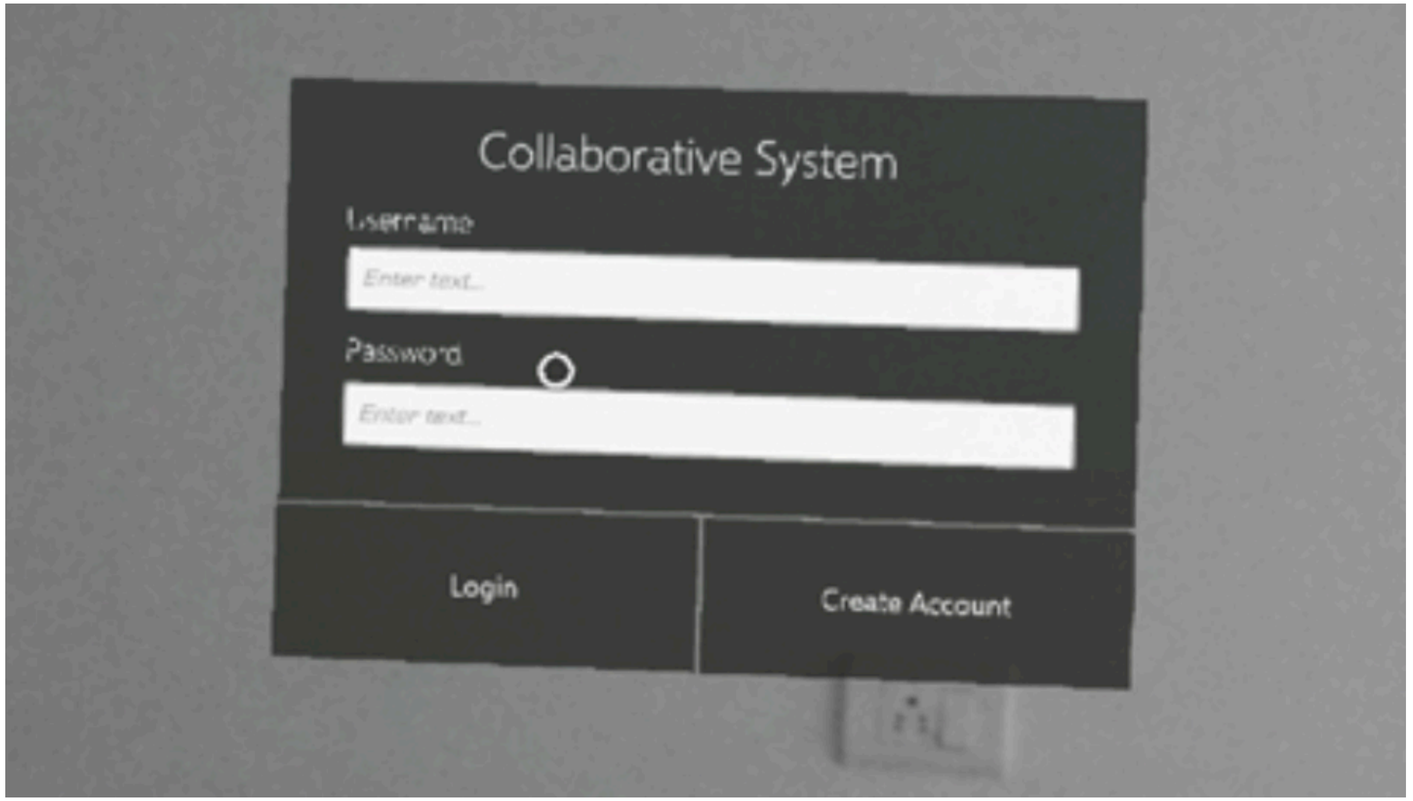
Remote Collaboration



Video from working prototype made in Project 2

Prototype

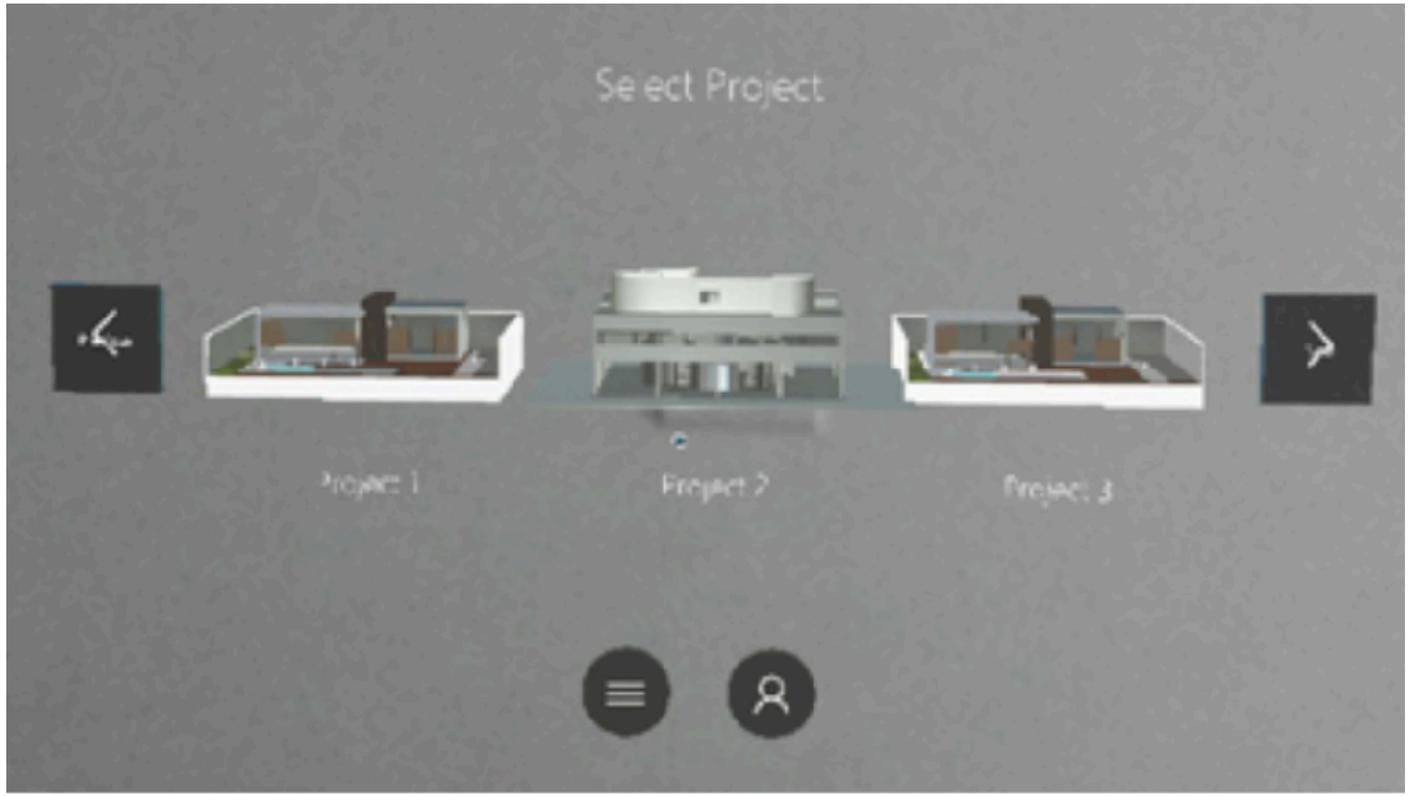
Stills from working prototype made in Project 2



Login Screen

Prototype

Stills from working prototype made in Project 2



Local Collaboration Scenario

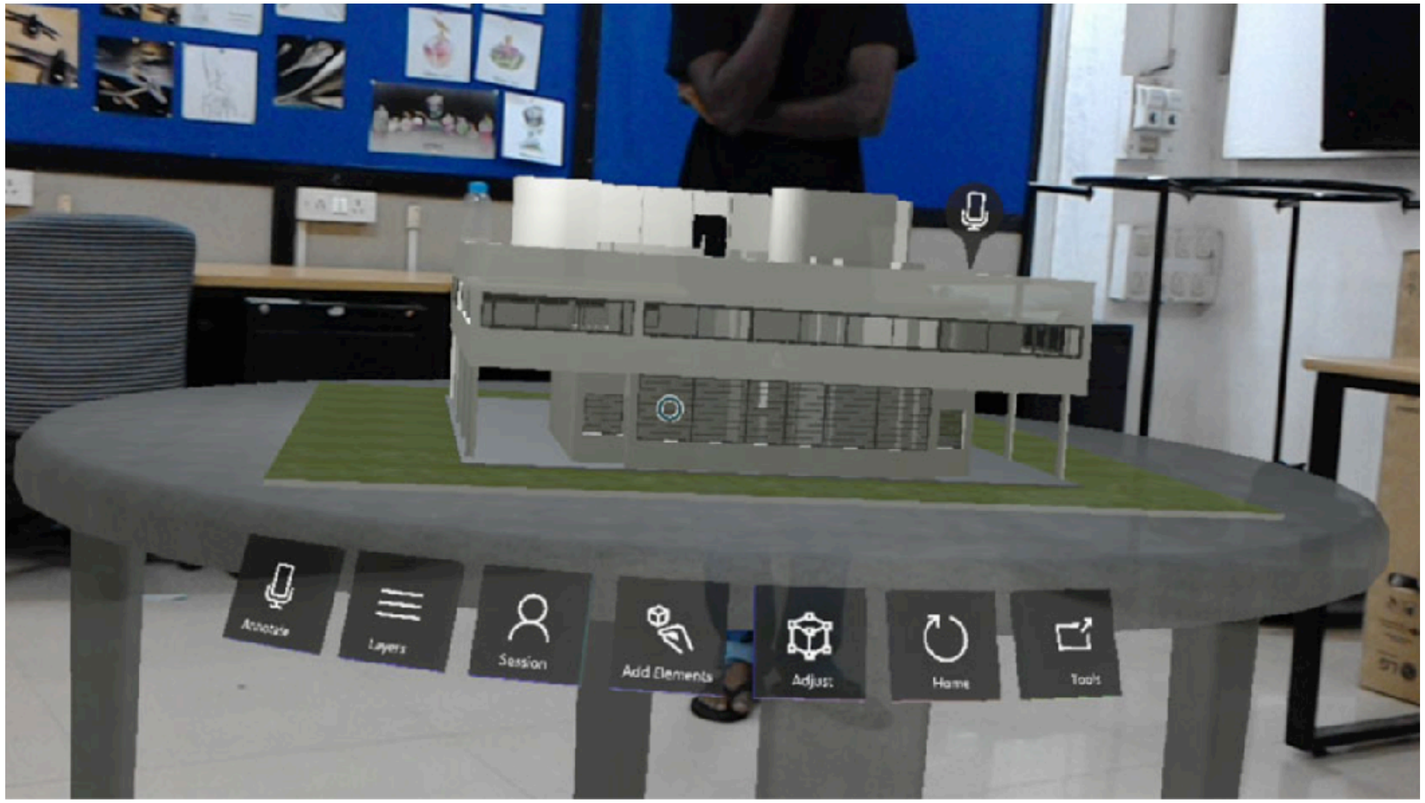
Prototype

Stills from working prototype made in Project 2

Placing the Disk

Prototype

Stills from working prototype made in Project 2



Collaboration Table

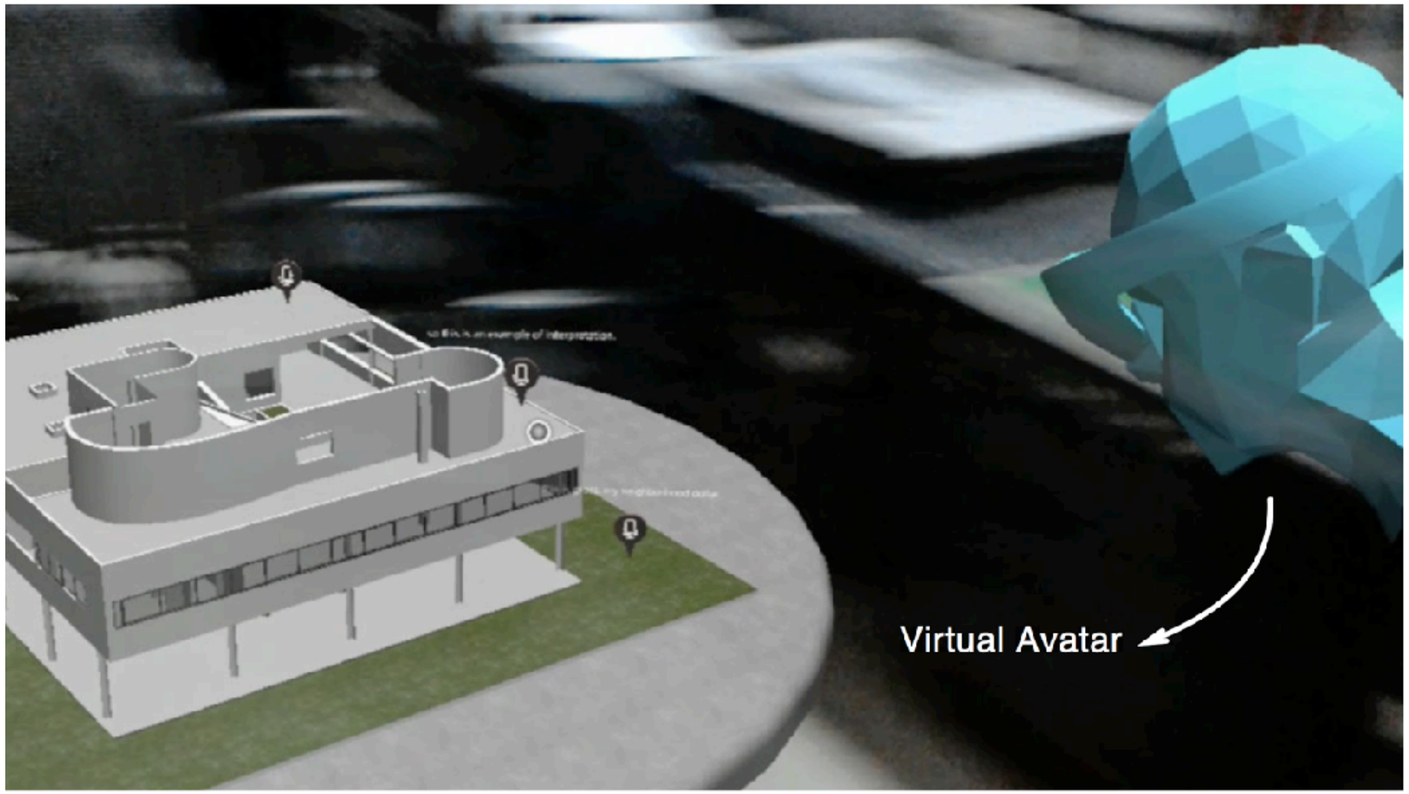
Prototype

Stills from working prototype made in Project 2

Local Collaboration Scenario

Prototype

Stills from working prototype made in Project 2



Remote Collaboration Scenario

*Collaboration happens when an **actor** performs an **activity** by using a **tool** which results in change, in state of a **resource.***

Cléver Ricardo Guareis de Farias, Luís Ferreira Pires, and Marten van Sinderen. 2000. A conceptual model for the development of CSCW systems. Proceedings of 5th International Conference on the Design of Cooperative Systems COOP: 189–204.

Architects
Structural Engineers
MEP Consultants
Interior Designers
others

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Collaborative Platform
on Hololens

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3D model of the structure

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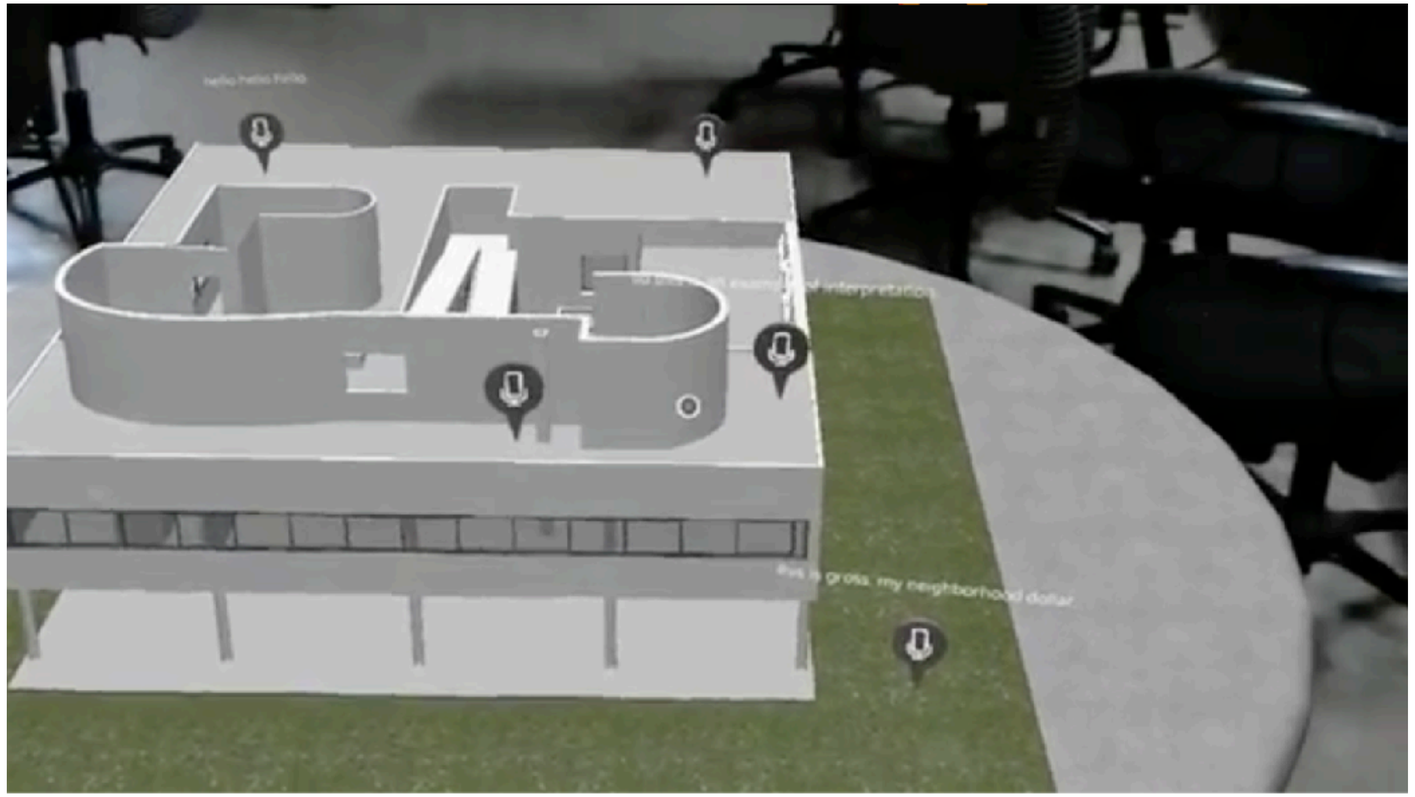
Collaborative Activities

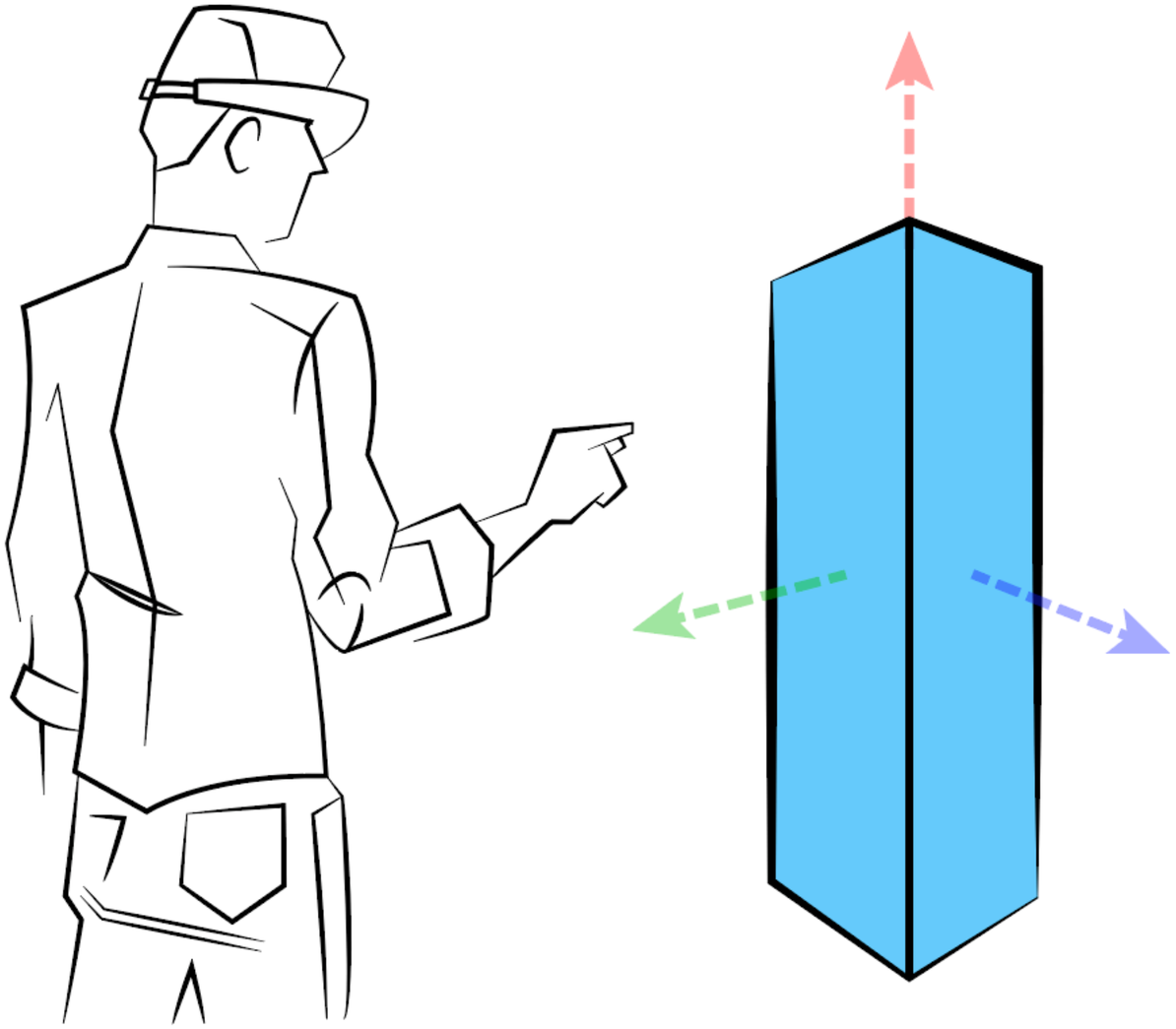
The only activity designed and prototyped in Project 2



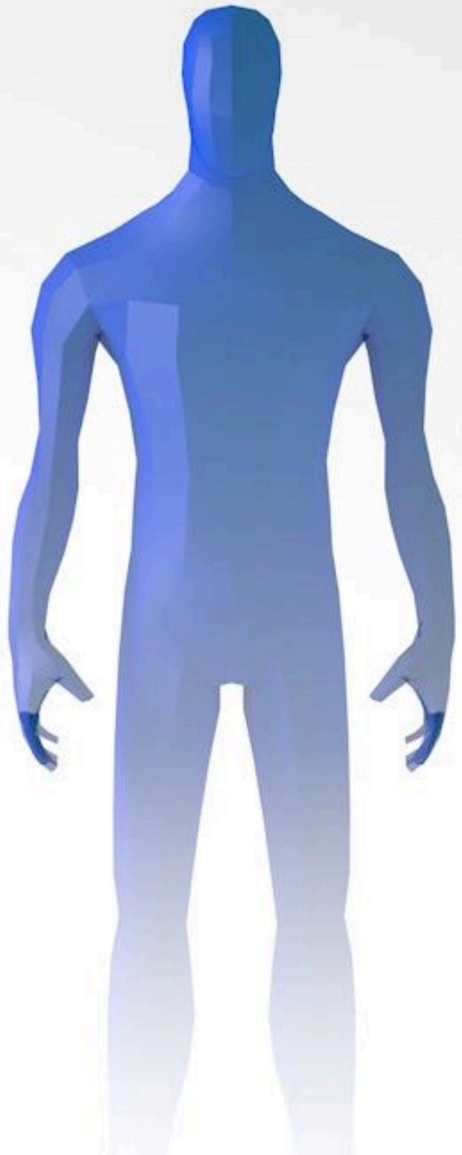
Annotations using Speech to text

Other Activities

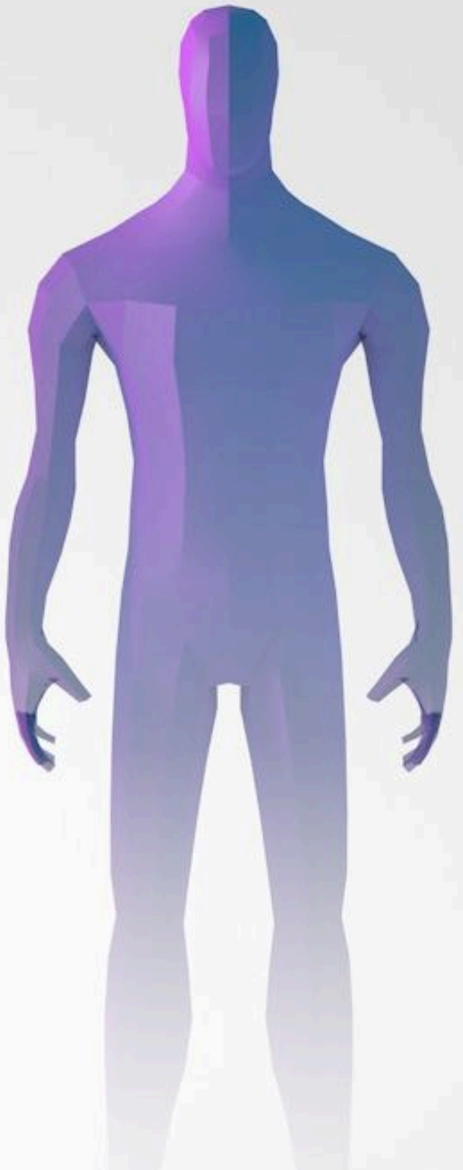
Scenario



Vivek
Architect



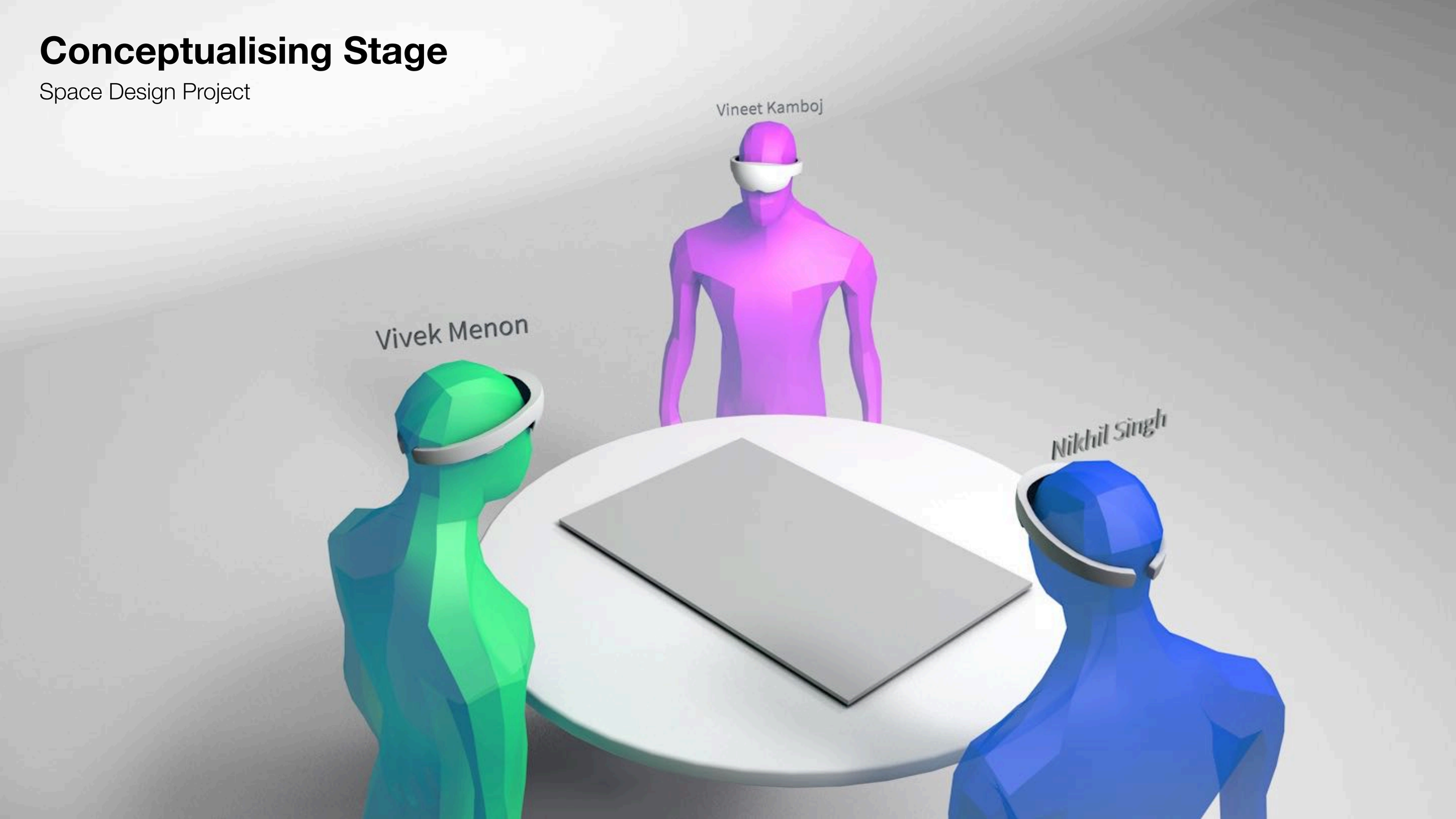
Nikhil
Structural Engineer



Vineet
HVAC Consultant

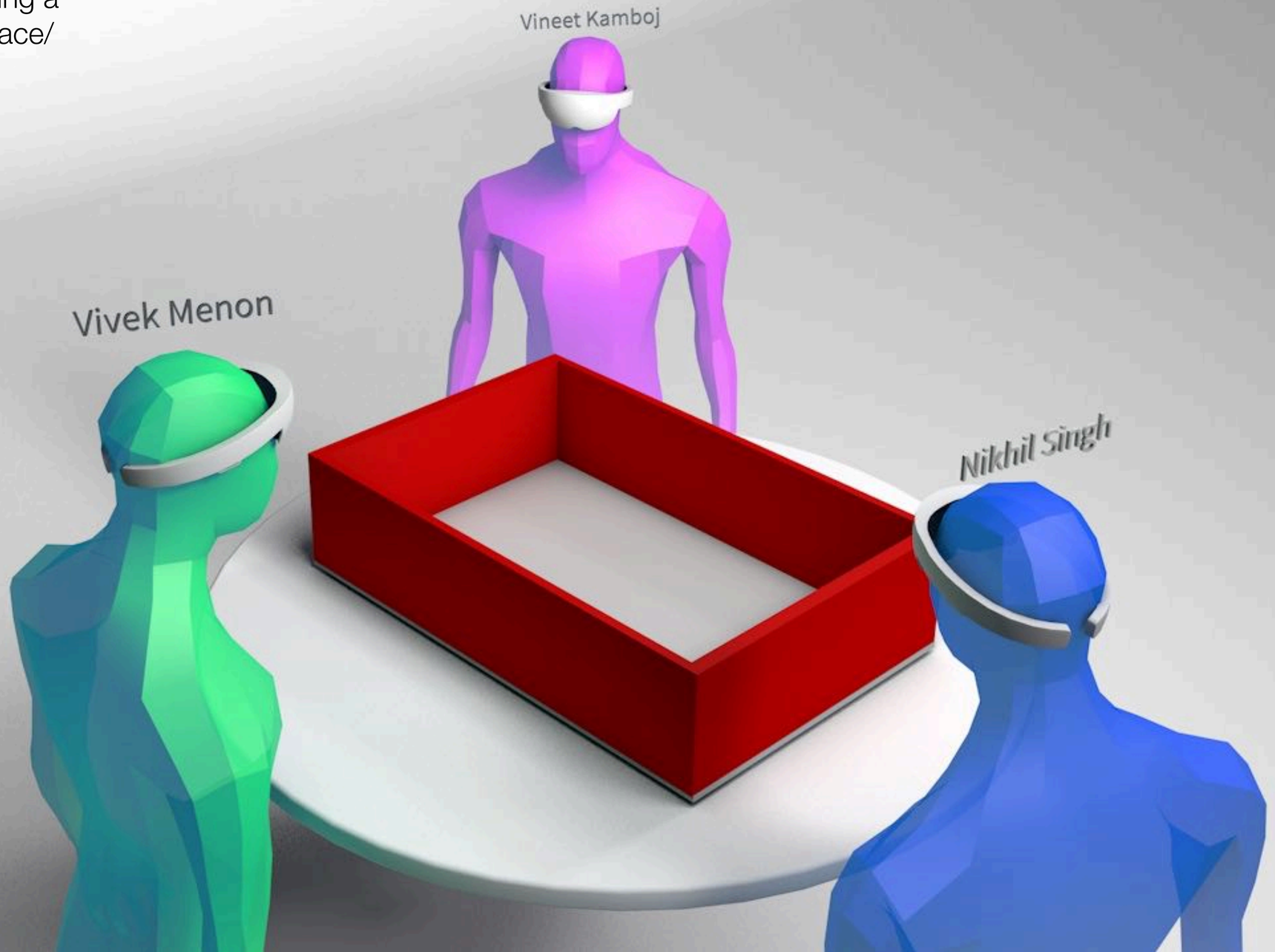
Conceptualising Stage

Space Design Project



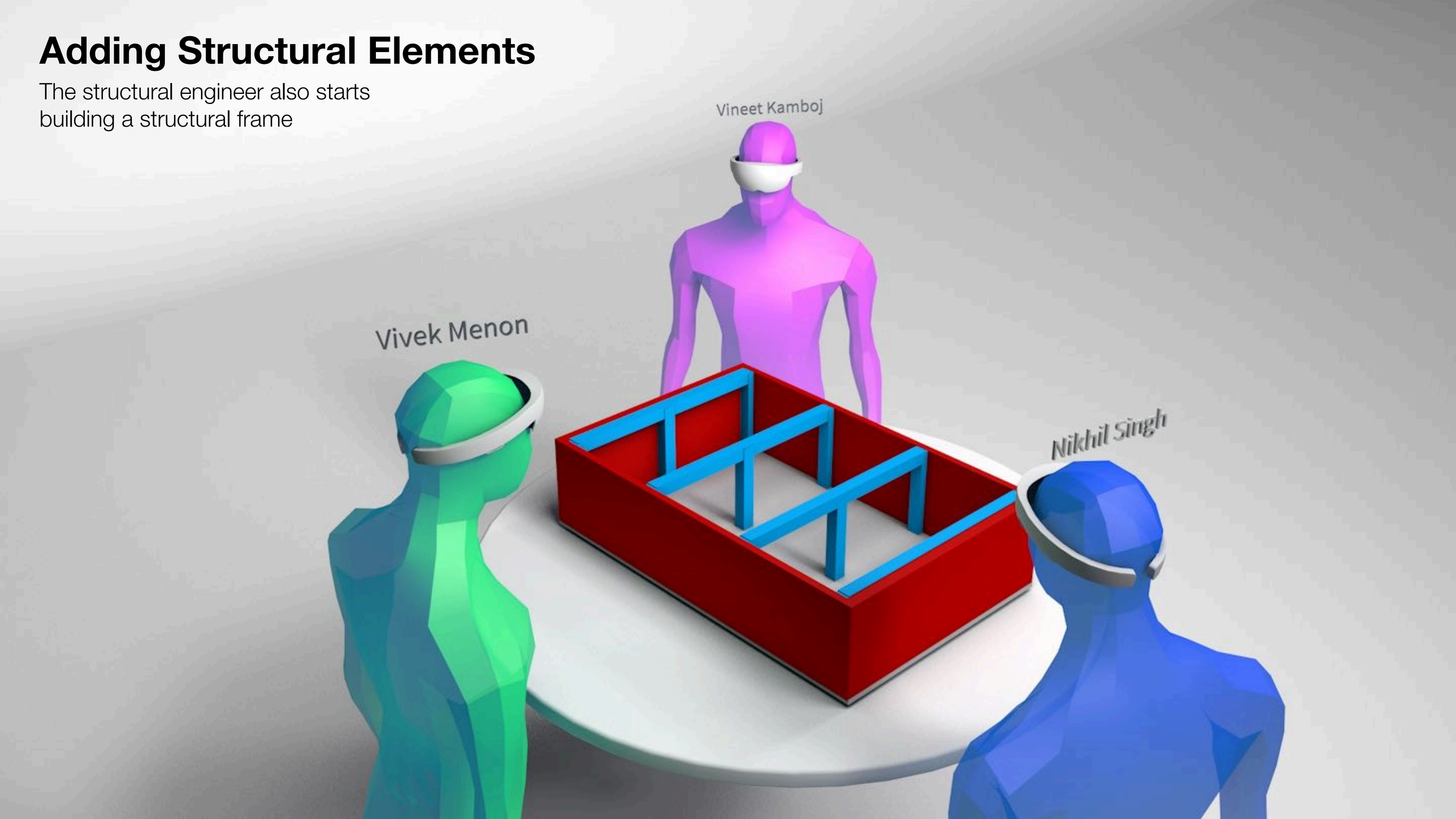
Adding Walls

The architect starts with adding a boundary wall around the space/ site

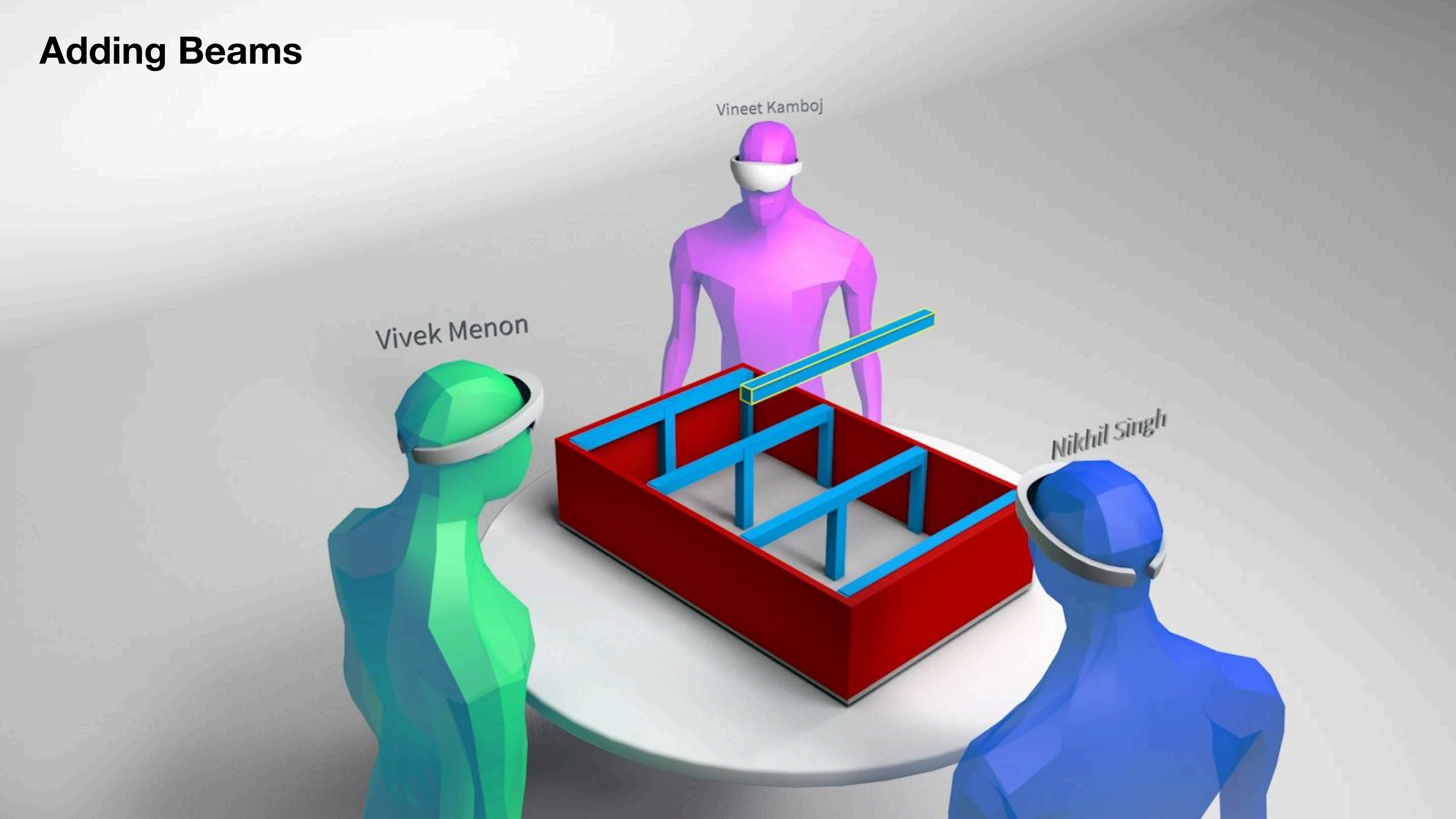


Adding Structural Elements

The structural engineer also starts building a structural frame

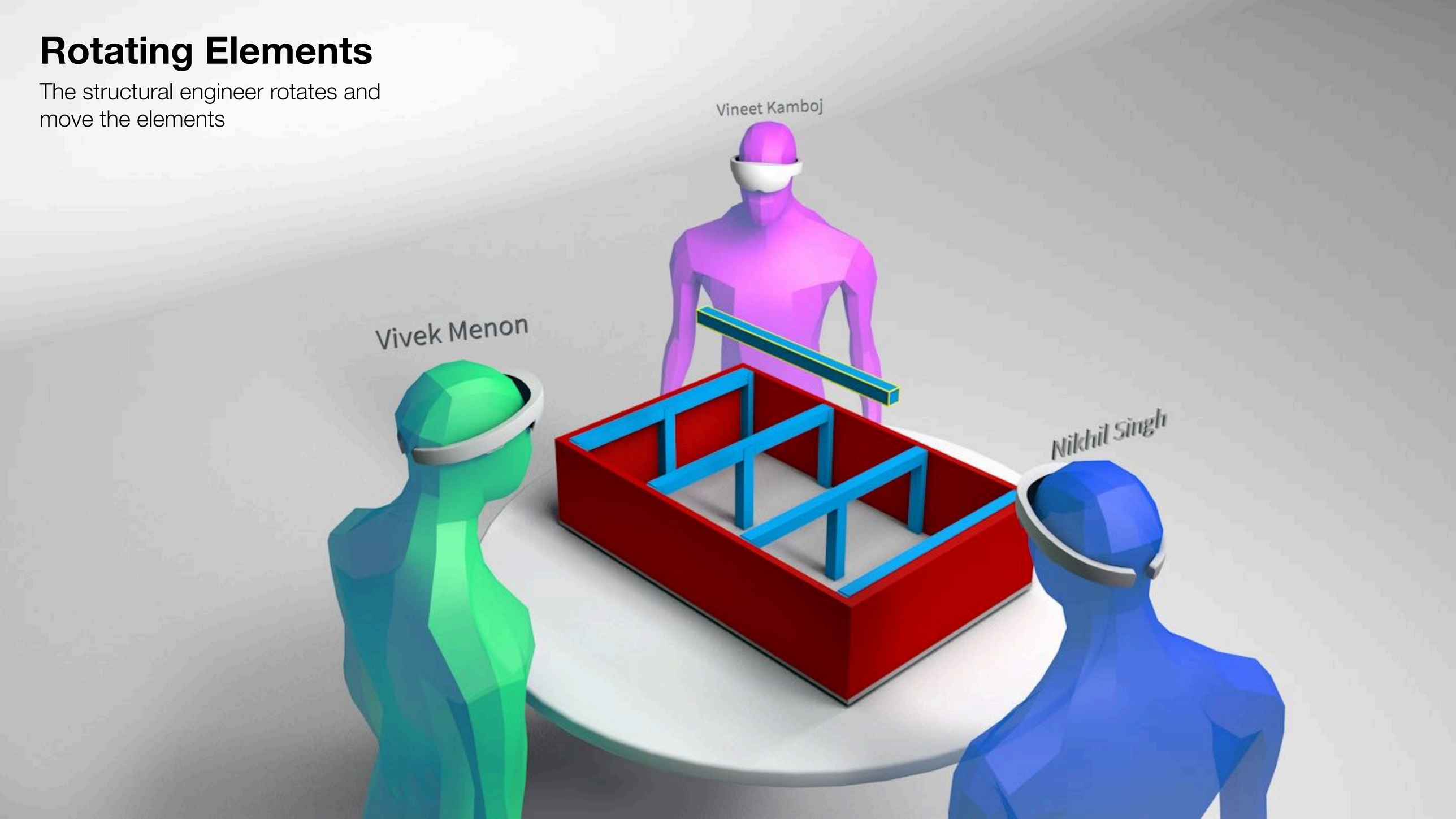


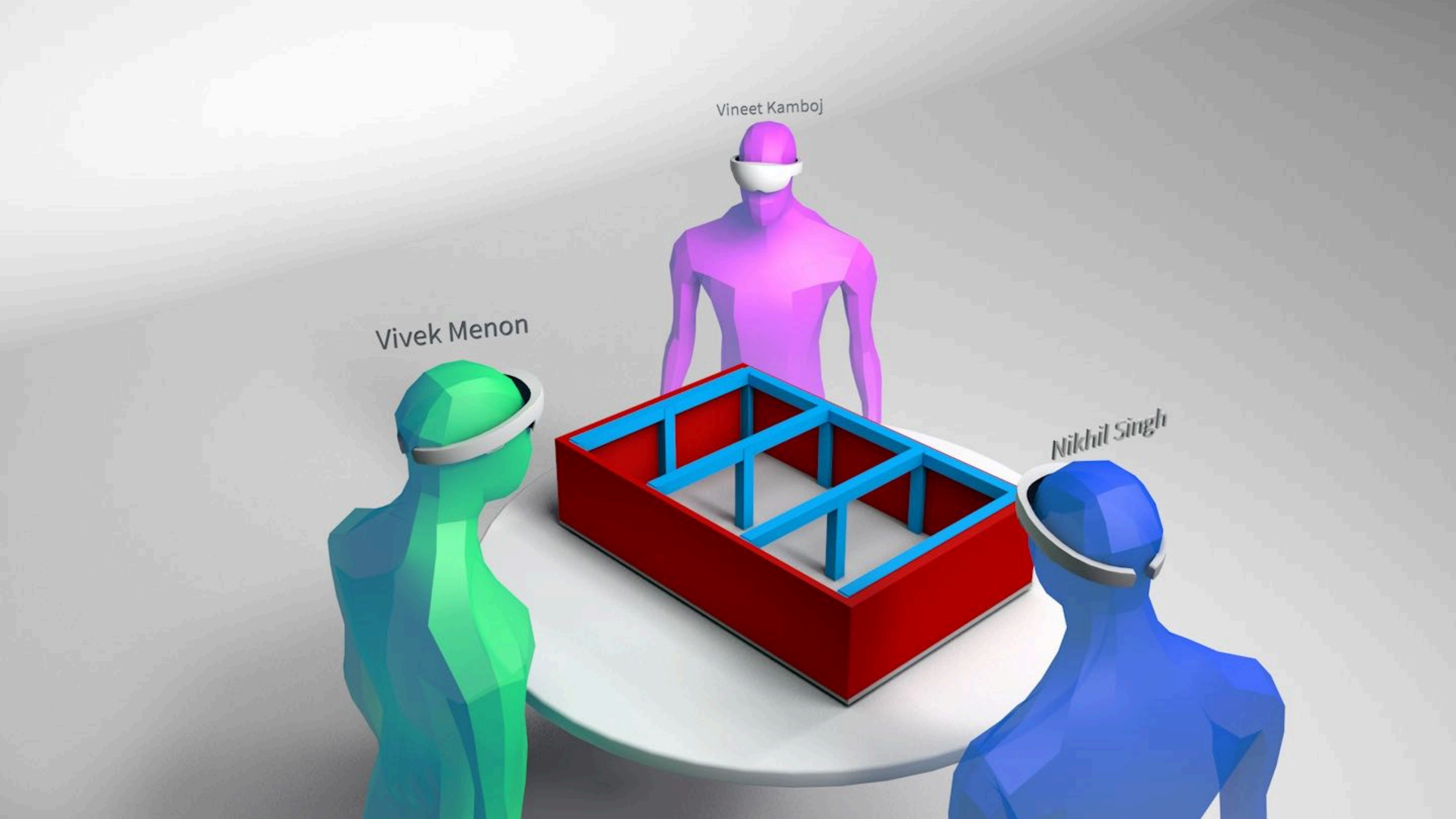
Adding Beams

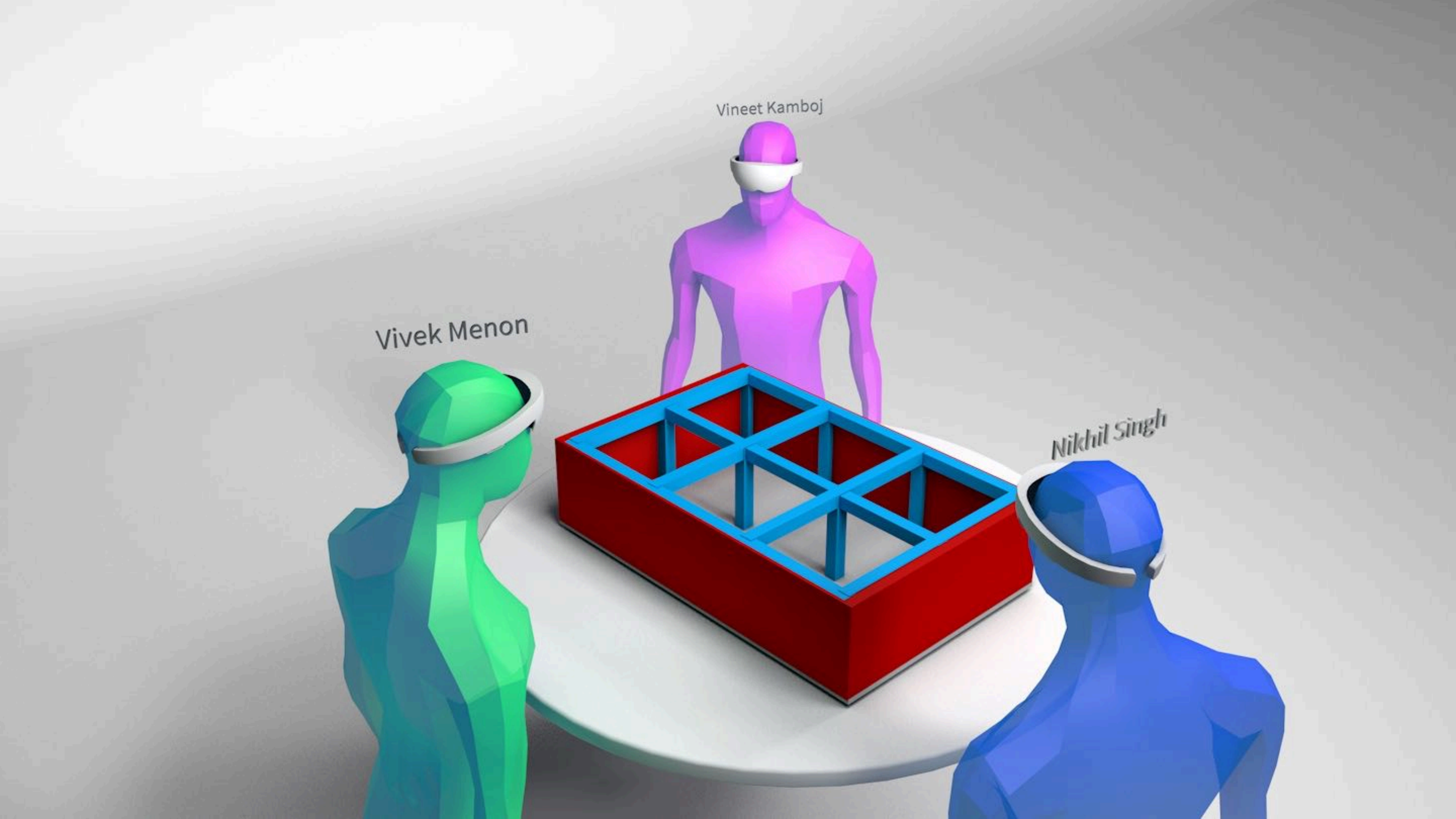


Rotating Elements

The structural engineer rotates and move the elements

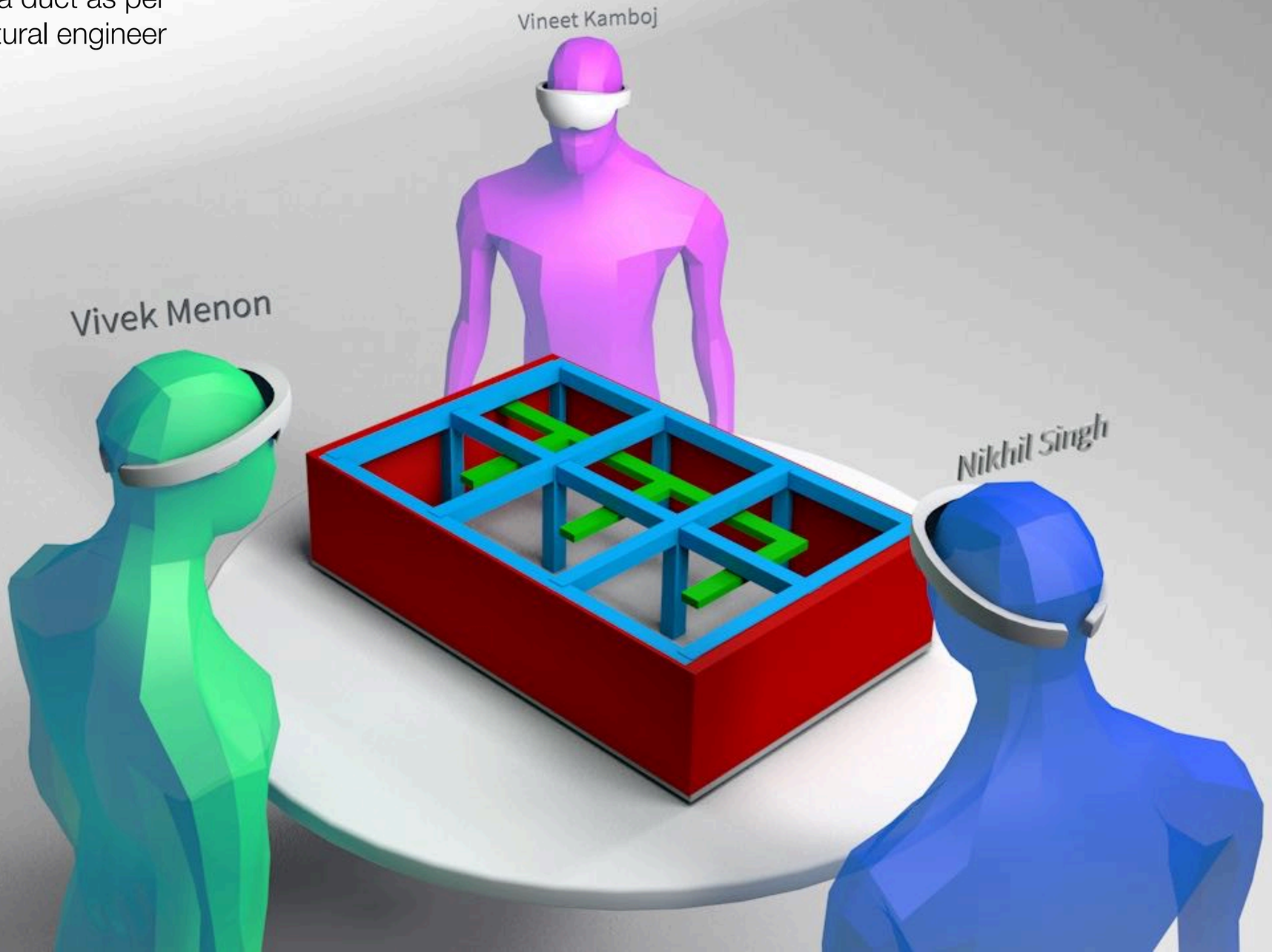



Vineet Kamboj
Vivek Menon
Nikhil Singh


Vineet Kamboj
Vivek Menon
Nikhil Singh

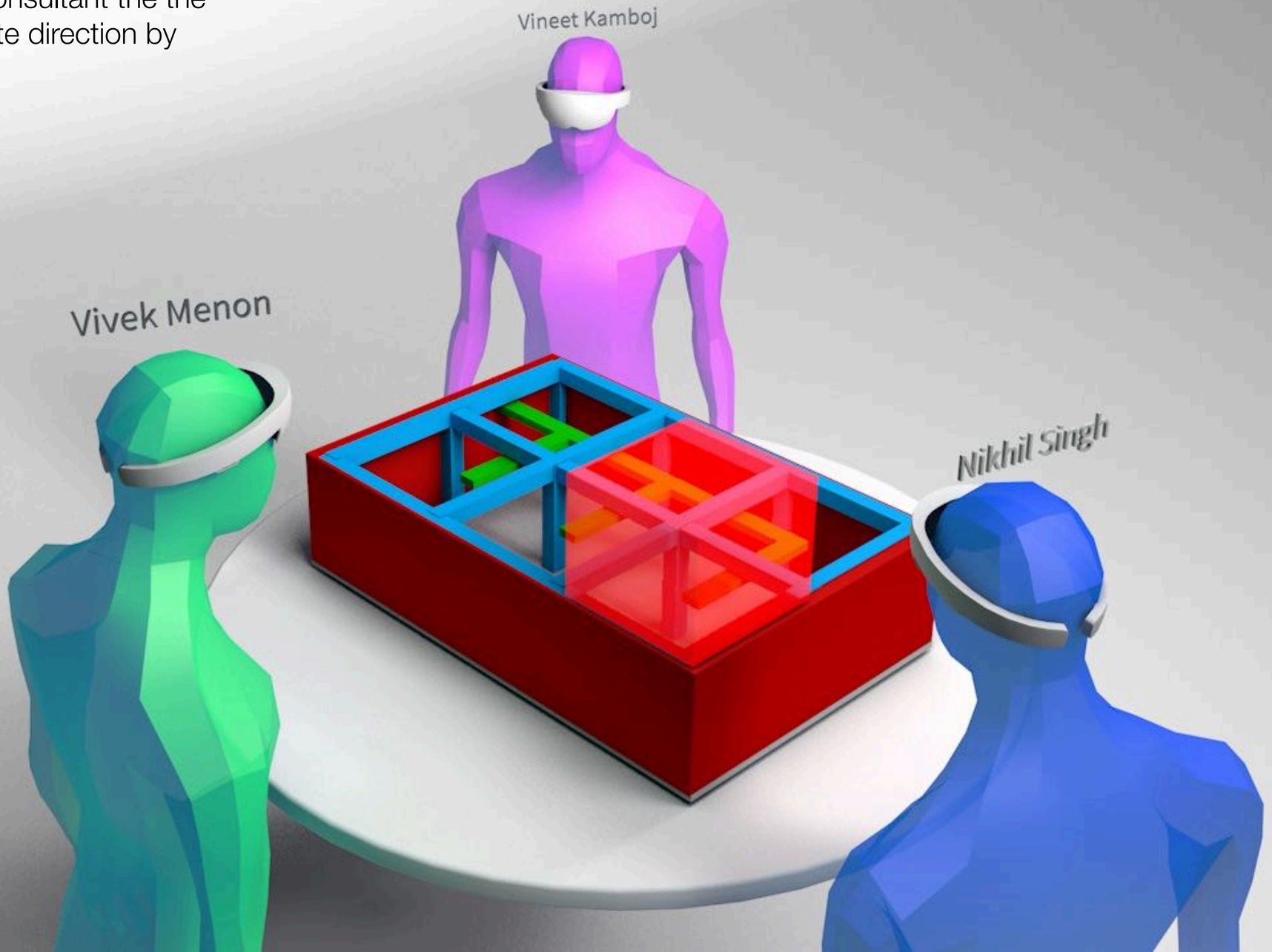
Placing HVAC ducts

The HVAC consultant builds a duct as per the frame made by the structural engineer



Change Placement

The architect indicates the consultant the the HVAC room is on the opposite direction by placing a cube.



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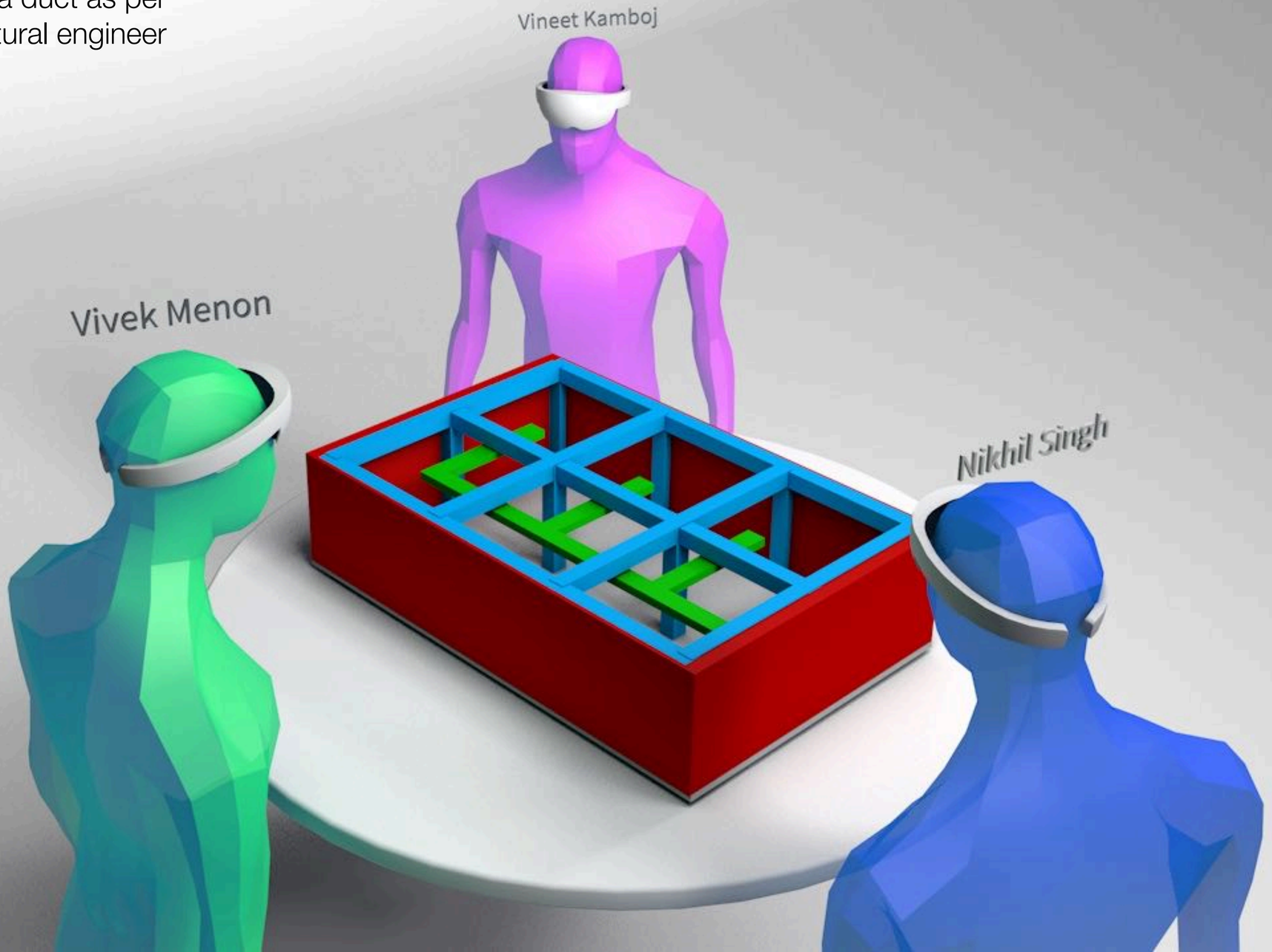
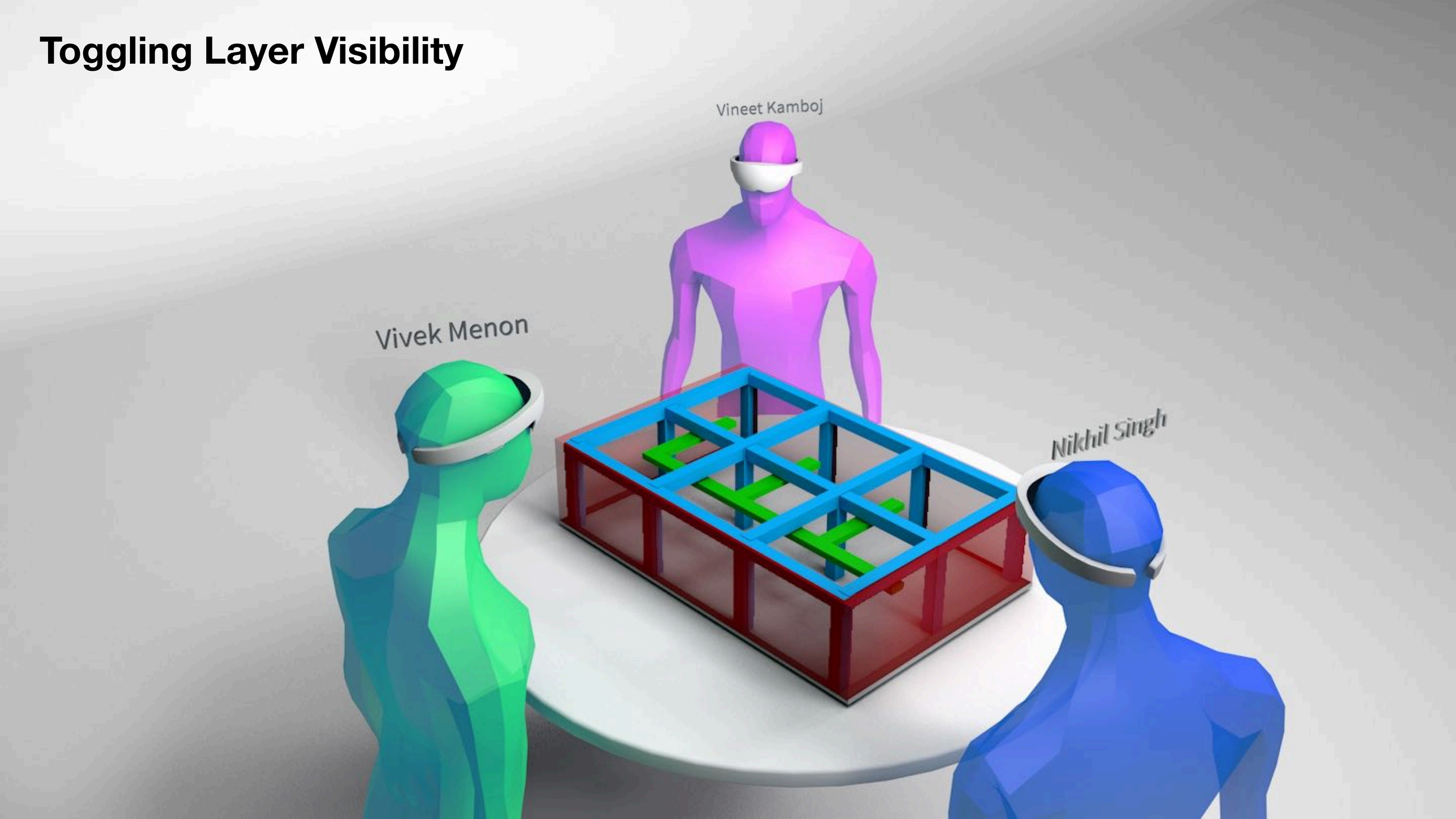
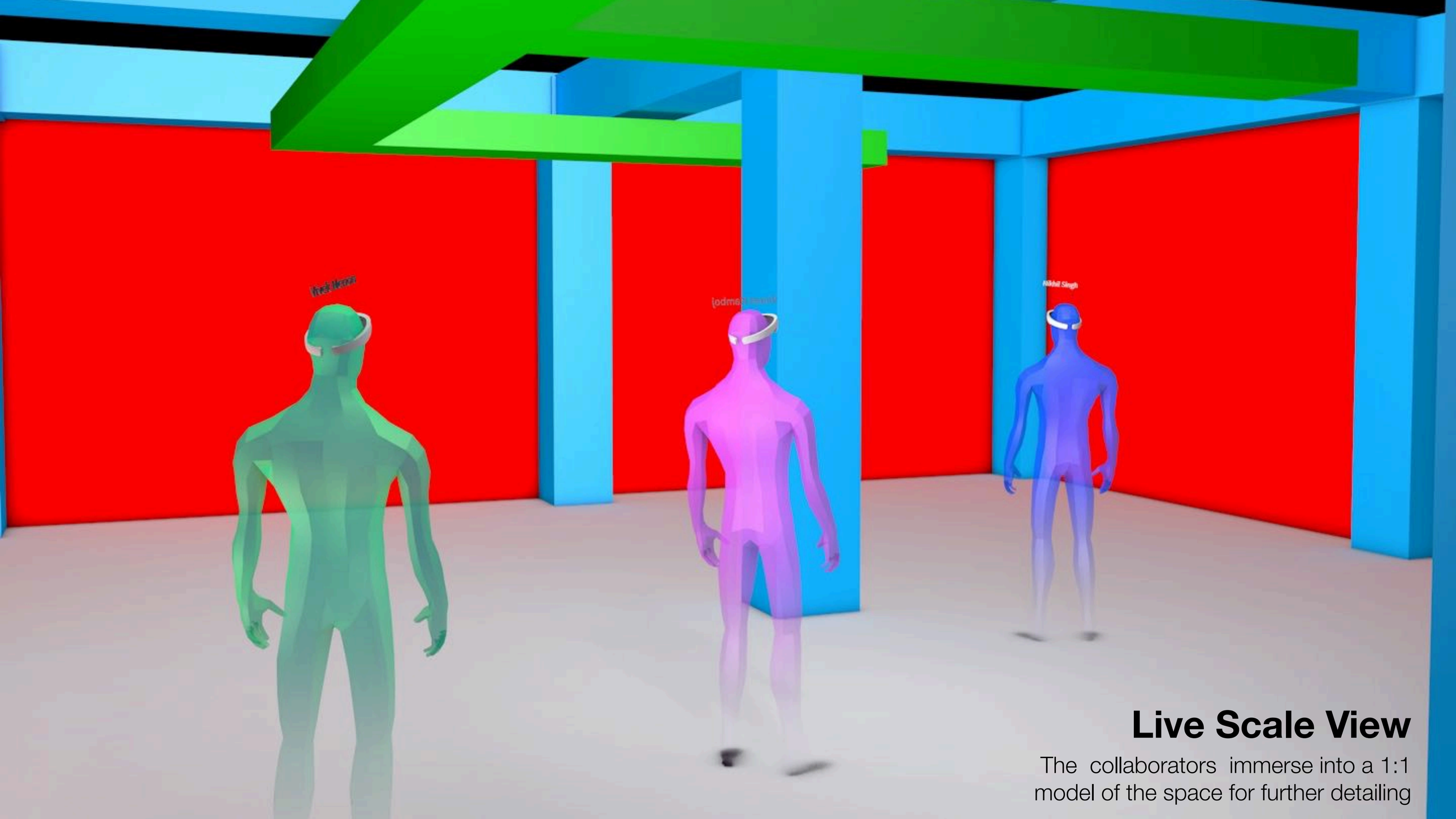


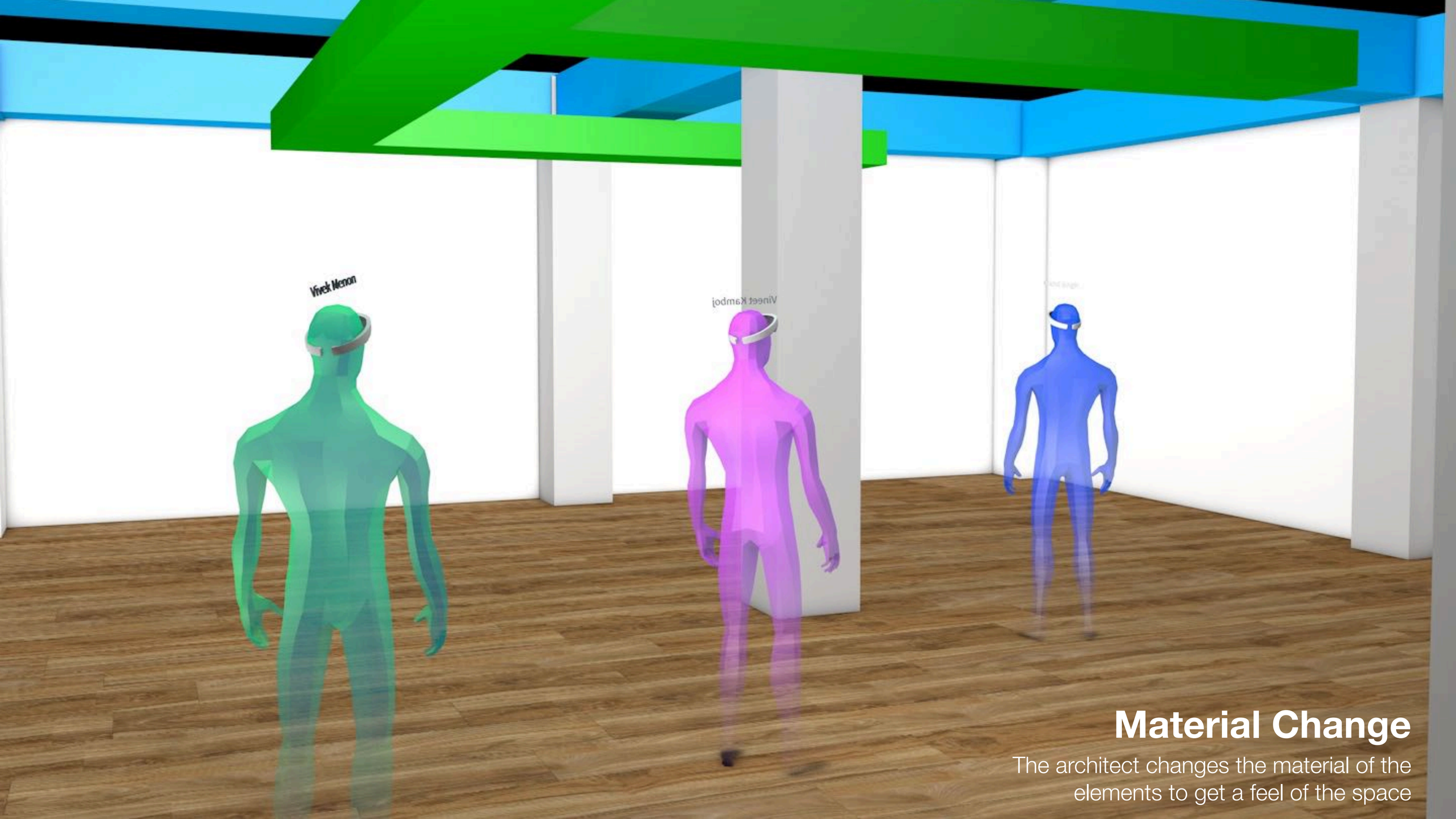
Toggling Layer Visibility





Live Scale View

The collaborators immerse into a 1:1 model of the space for further detailing



Material Change

The architect changes the material of the elements to get a feel of the space

Activities

Possible activities and interactions which would happen in similar scenario

Activities

Possible activities and interactions which would happen in similar scenario

Modification

Adding Elements

Deleting Elements

Move

Rotate

Scale

Change Colour /Material

Activities

Possible activities and interactions which would happen in similar scenario

Modification

Adding Elements

Deleting Elements

Move

Rotate

Scale

Change Colour /Material

View-ability

Layer Visibility

Layer Opacity

Model Scaling

Clipping /Section Plane

Activities

Possible activities and interactions which would happen in similar scenario

Modification

Adding Elements

Deleting Elements

Move

Rotate

Scale

Change Colour /Material

View-ability

Layer Visibility

Layer Opacity

Model Scaling

Clipping /Section Plane

Communicative

Annotations

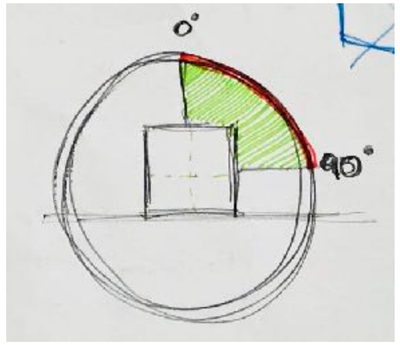
3D draw

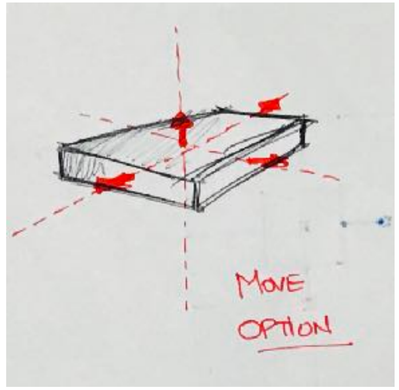
Selection

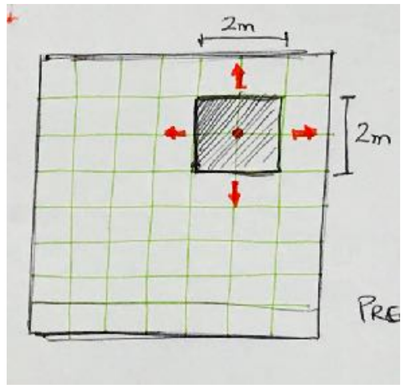
Adding photos/ videos /drawings

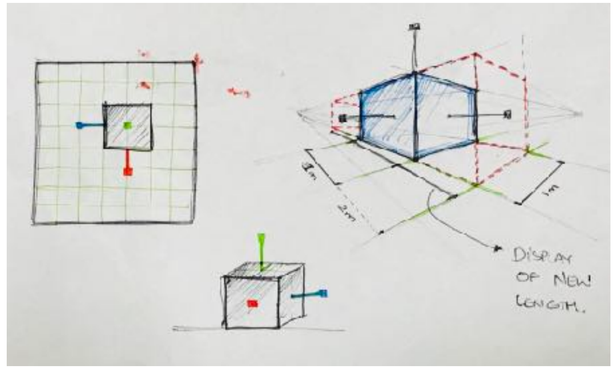
Interaction Explorations

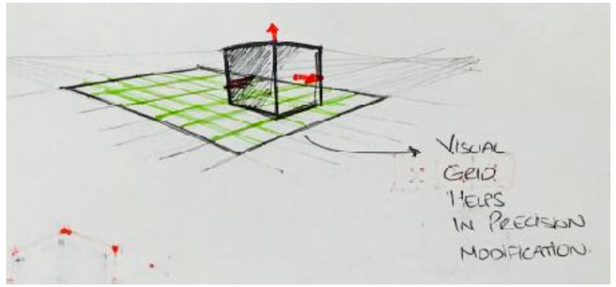
Exploration sketches for modification interactions

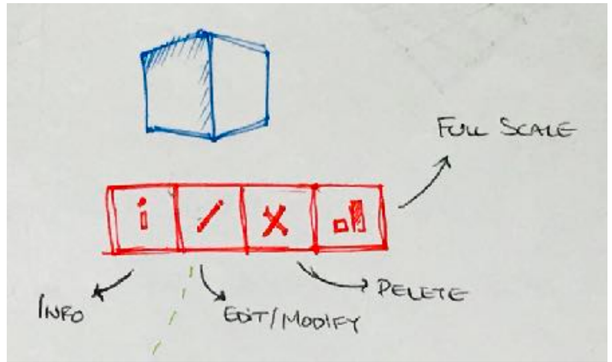


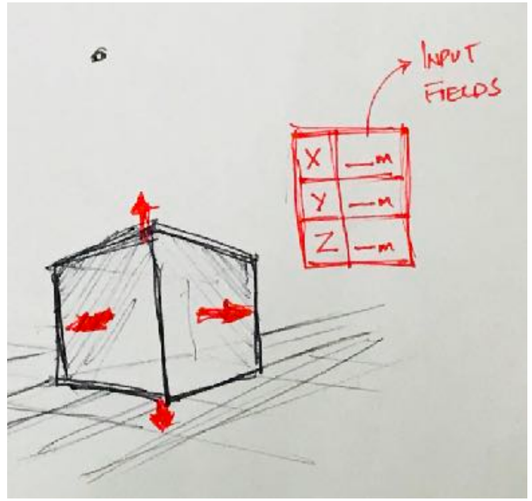


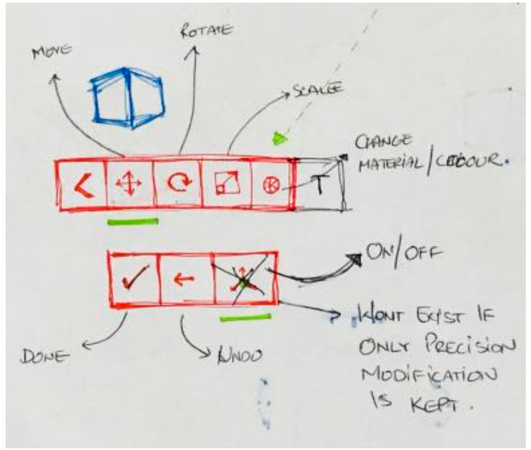


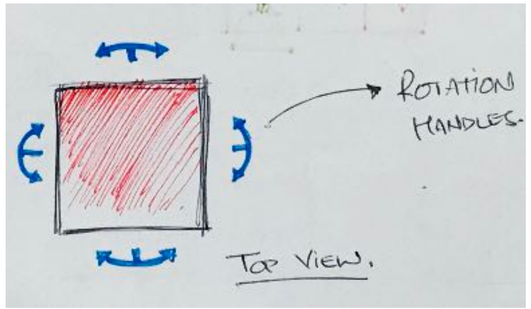






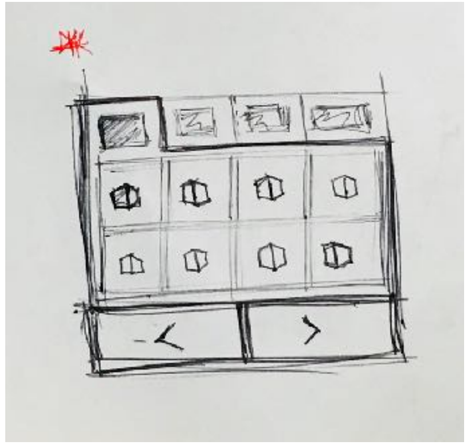


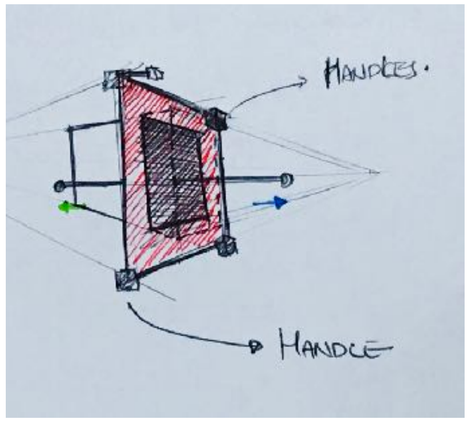


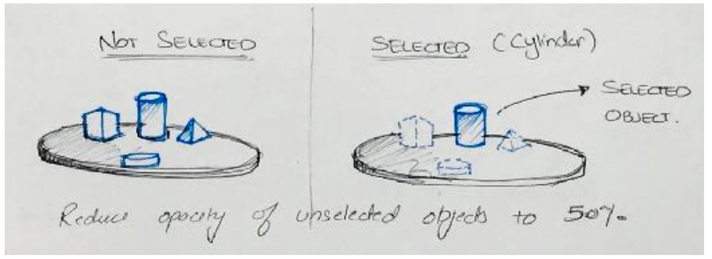


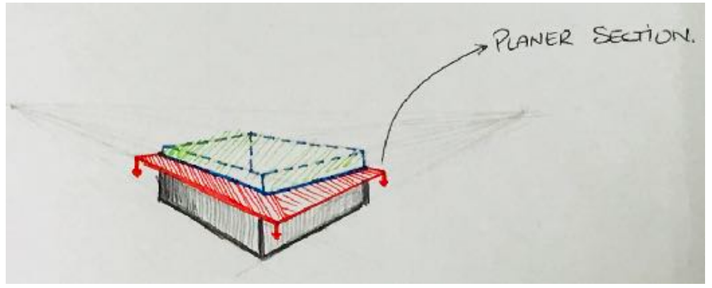
Interaction Explorations

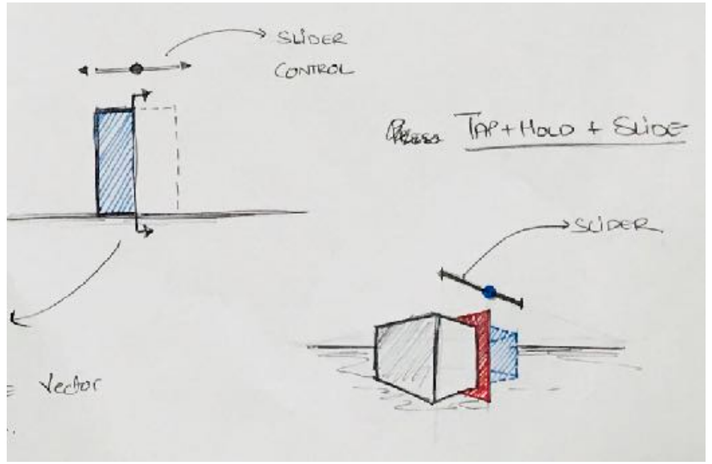
Exploration sketches for view-ability interactions

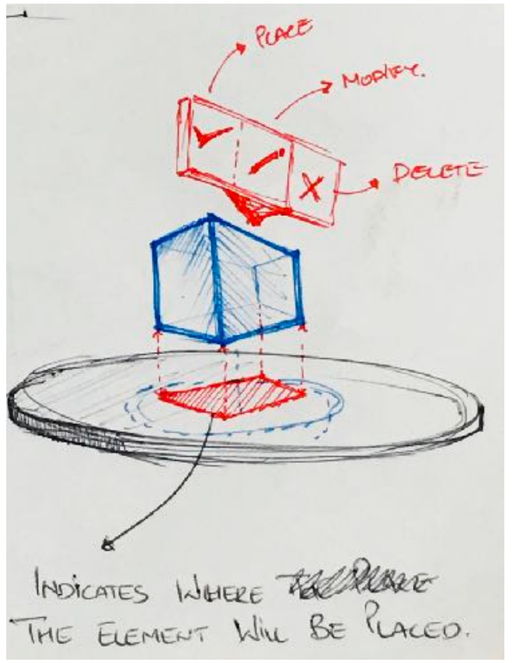


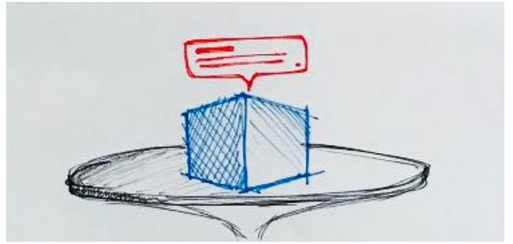


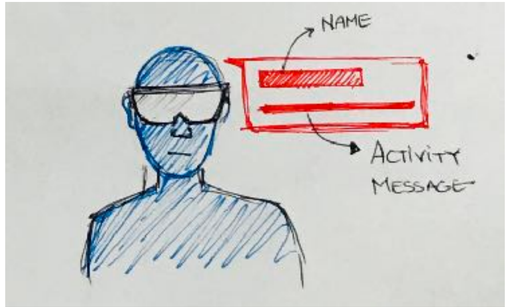






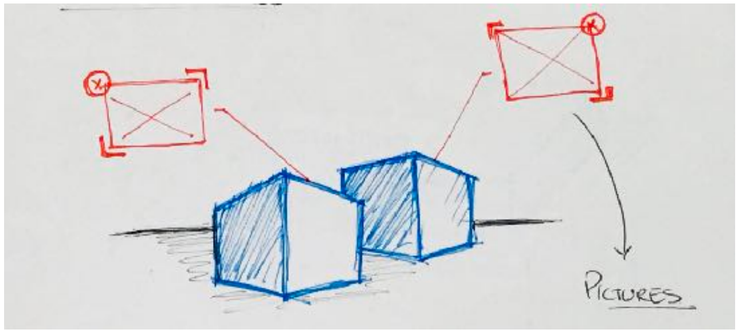


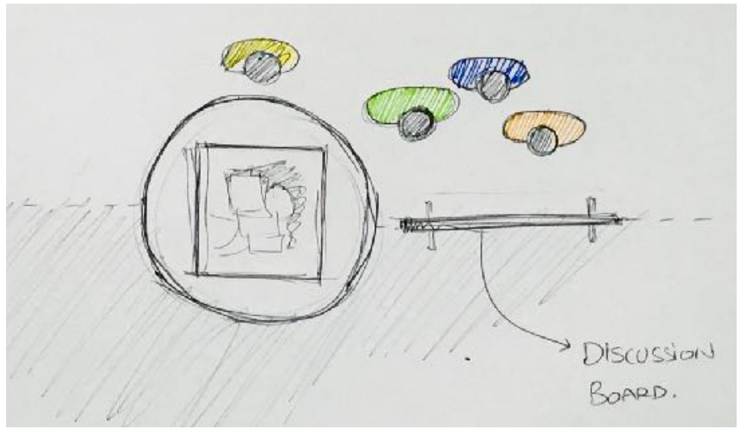


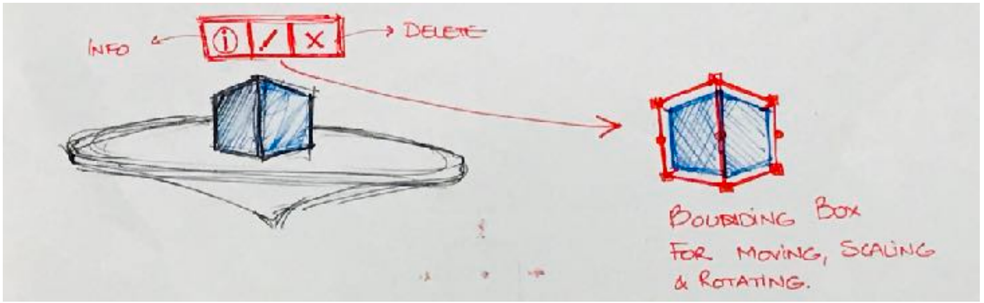


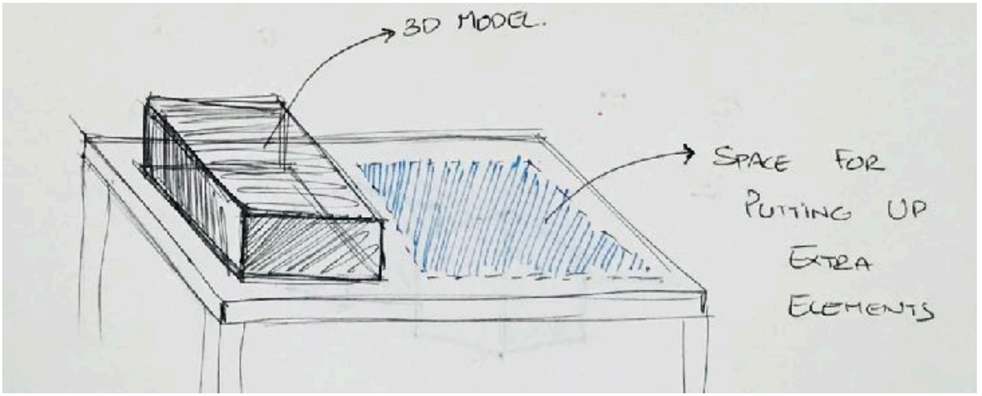
Interaction Explorations

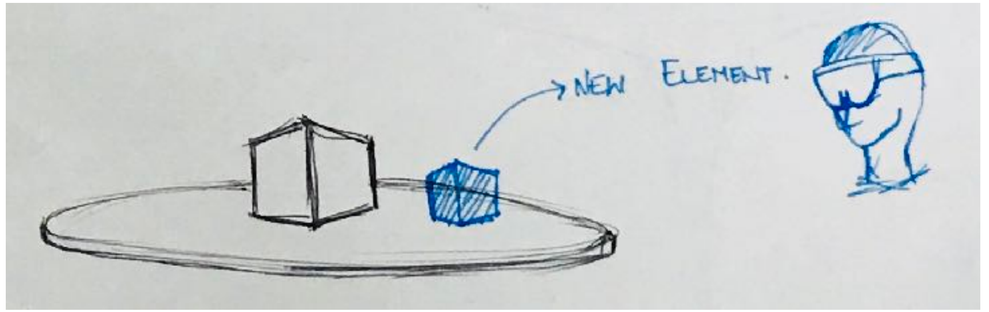
Exploration sketches for communicative interactions





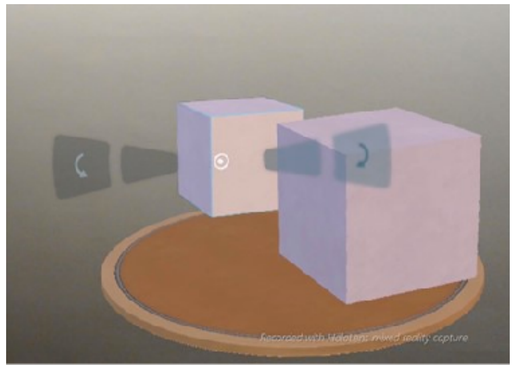






Case Studies

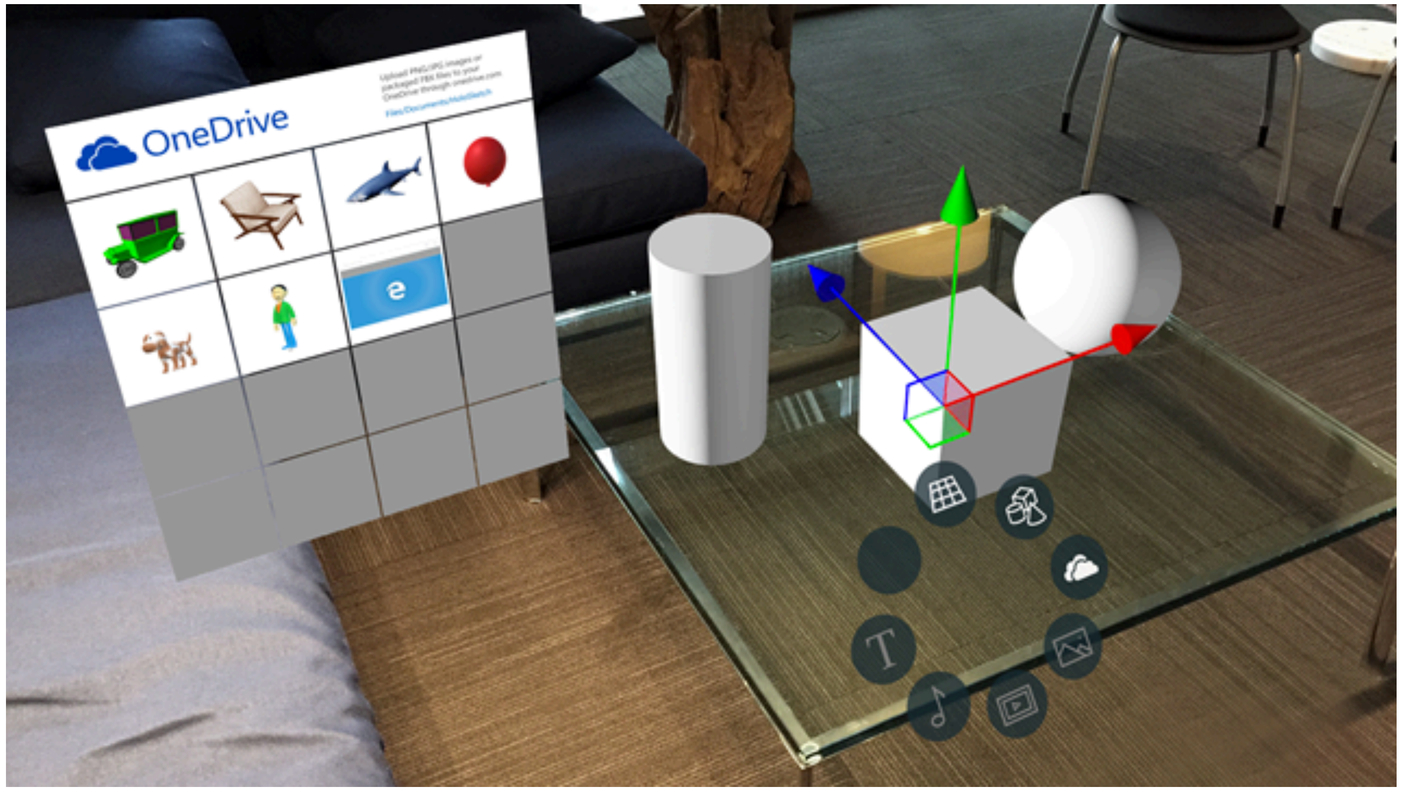
Case studies for Interface and Interaction design



Holo Studio - *Microsoft*

Case Studies

Case studies for Interface and Interaction design



Holo Sketch - *Microsoft*

Case Studies

Case studies for Interface and Interaction design

Lowe’s Kitchen - *Microsoft*

Gesture Inputs

AirTap

Gesture Inputs

AirTap

Gesture Inputs

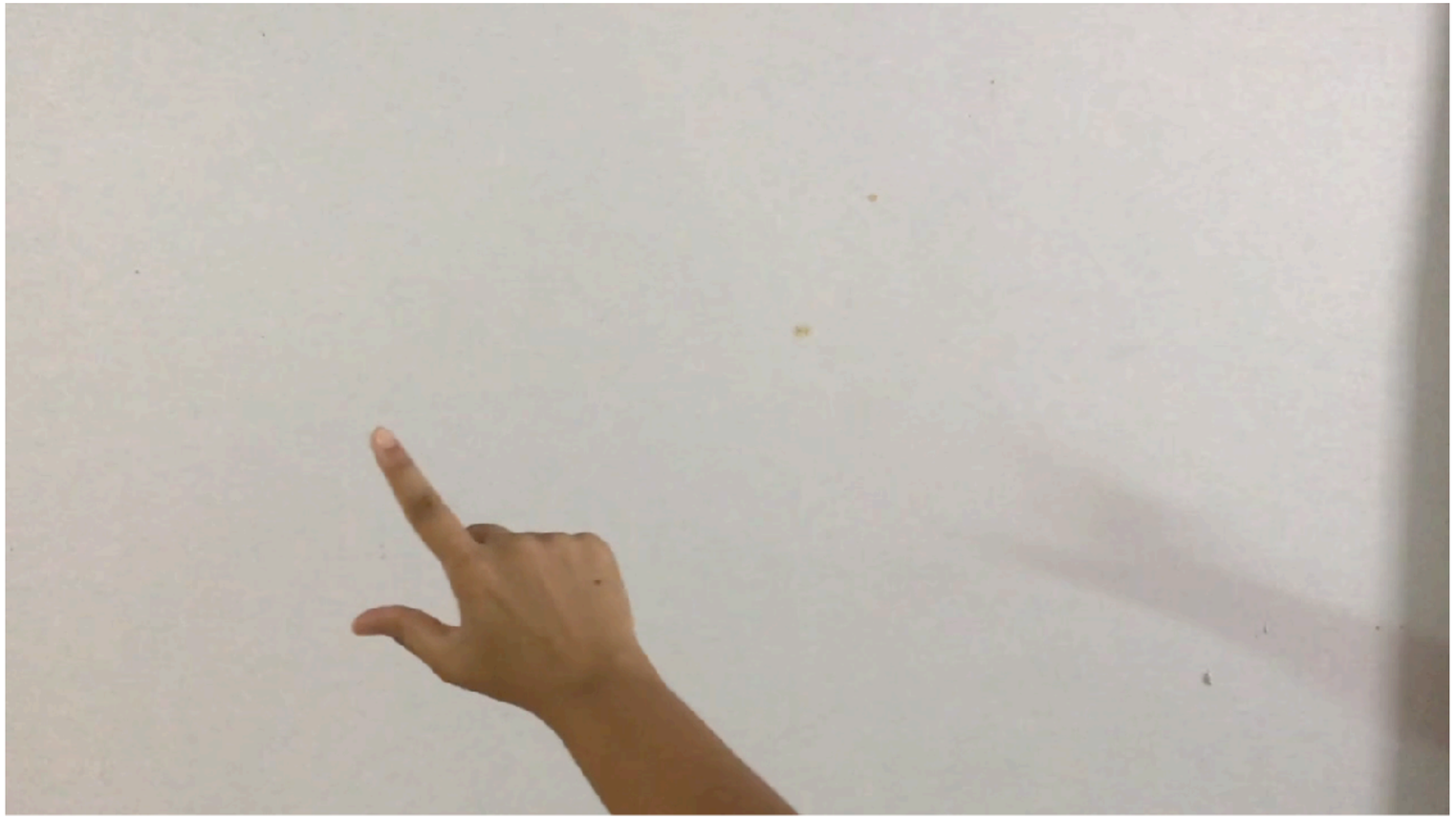
AirTap + Hold
Free Drag

Gesture Inputs

AirTap + Hold
Free Drag

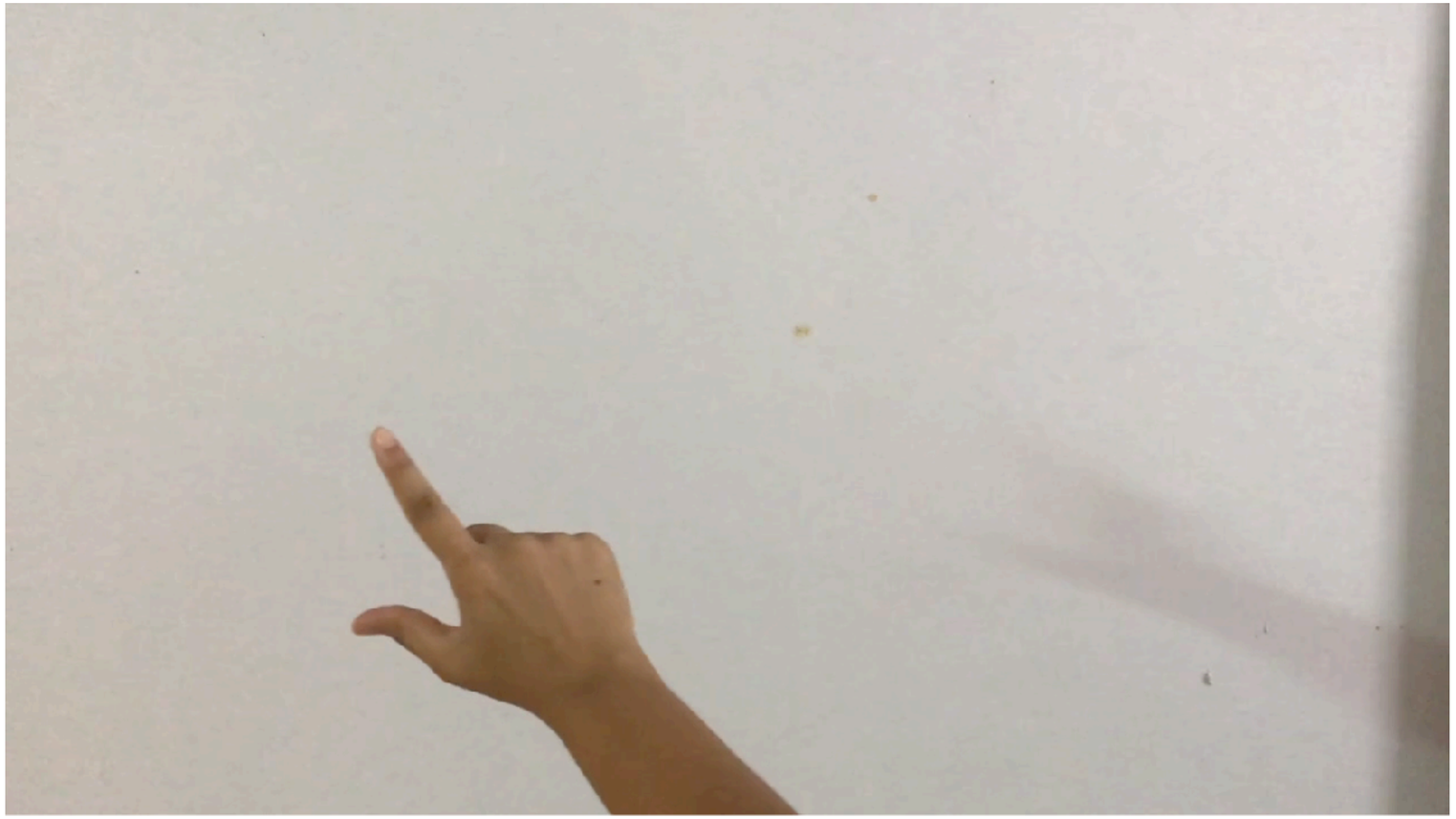
Gesture Inputs

AirTap + Hold Horizontal Slide



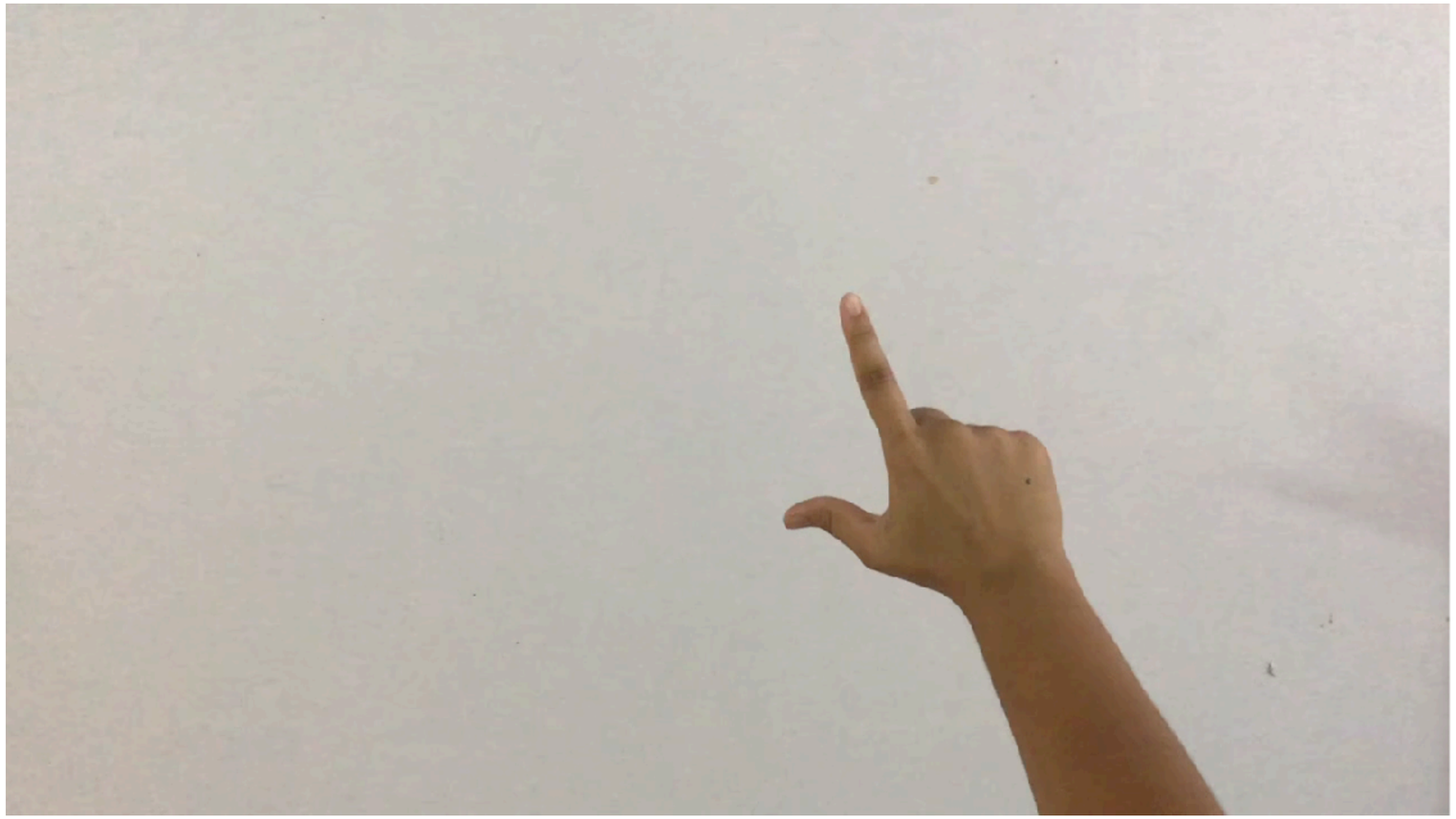
Gesture Inputs

AirTap + Hold Horizontal Slide



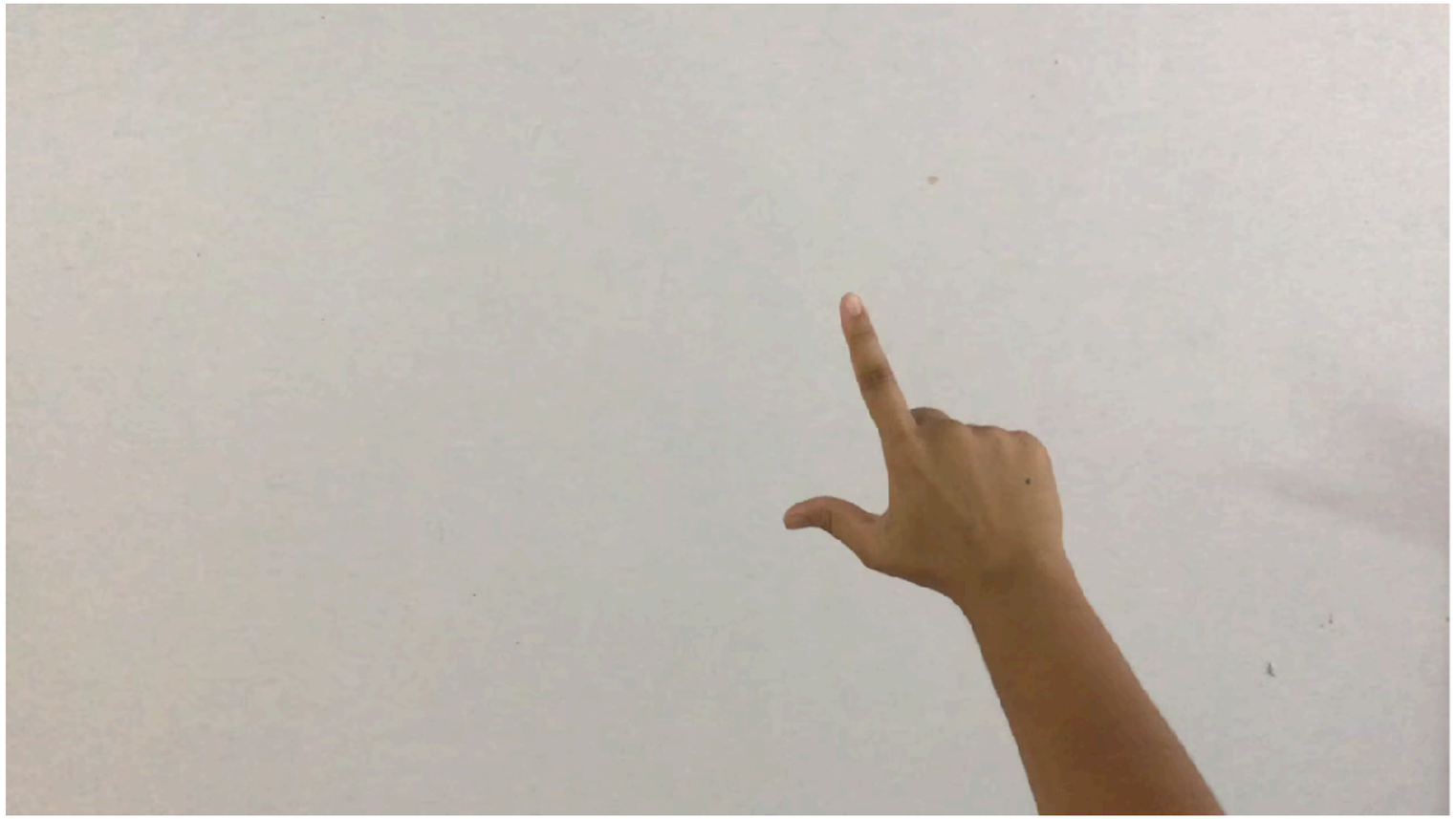
Gesture Inputs

AirTap + Hold Vertical Slide



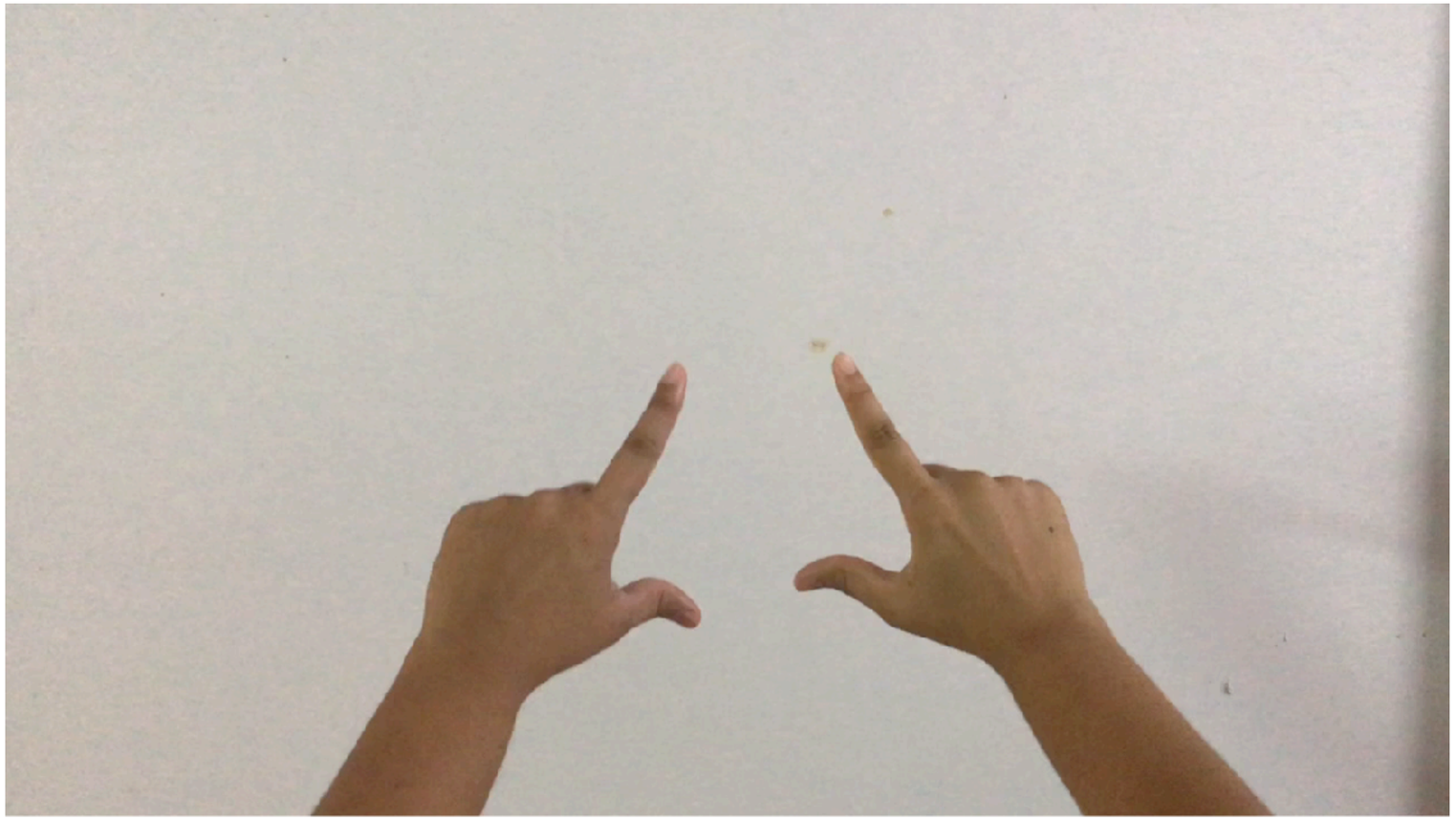
Gesture Inputs

AirTap + Hold Vertical Slide



Gesture Inputs

AirTap + Hold
2 hand stretch



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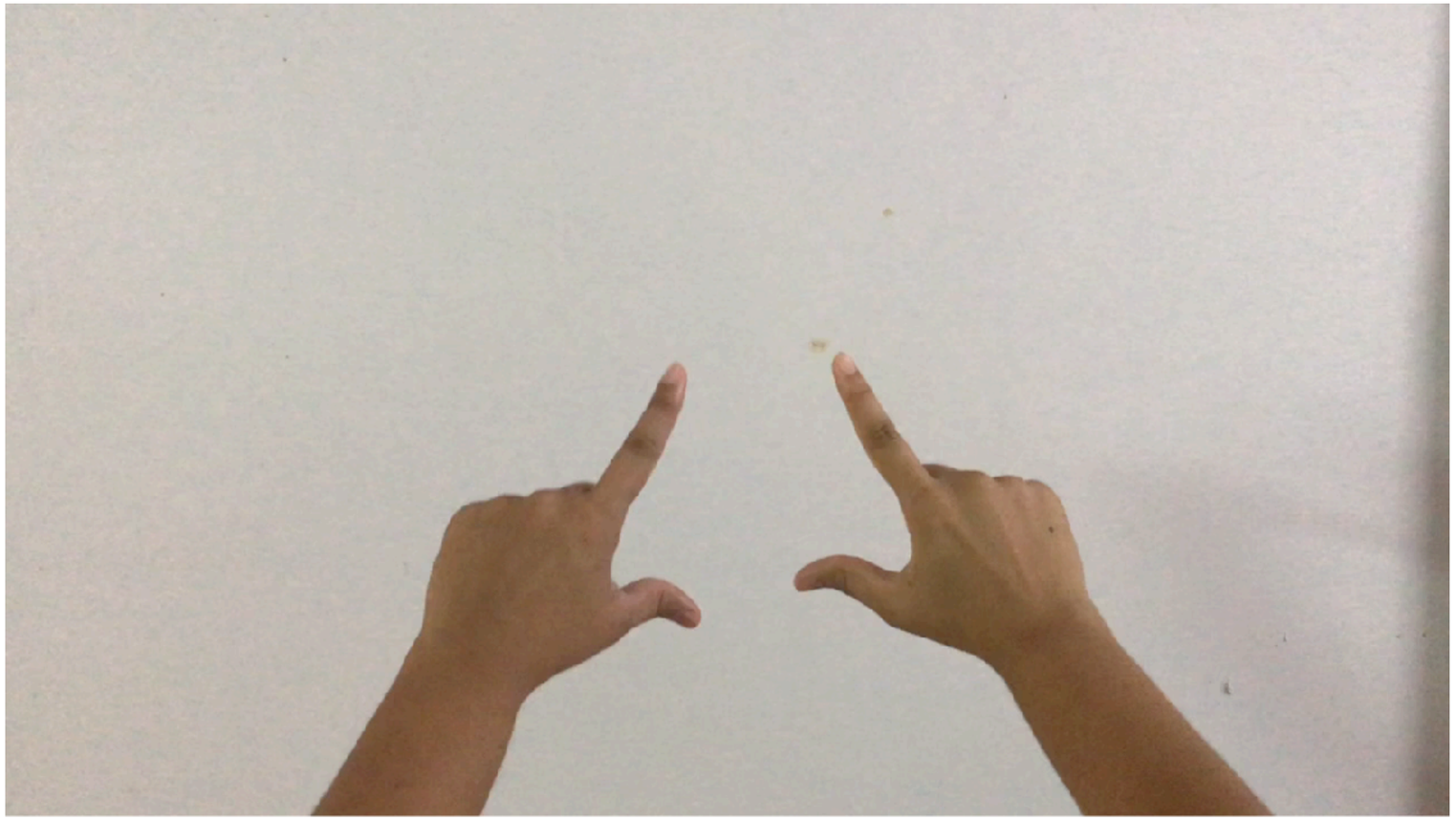
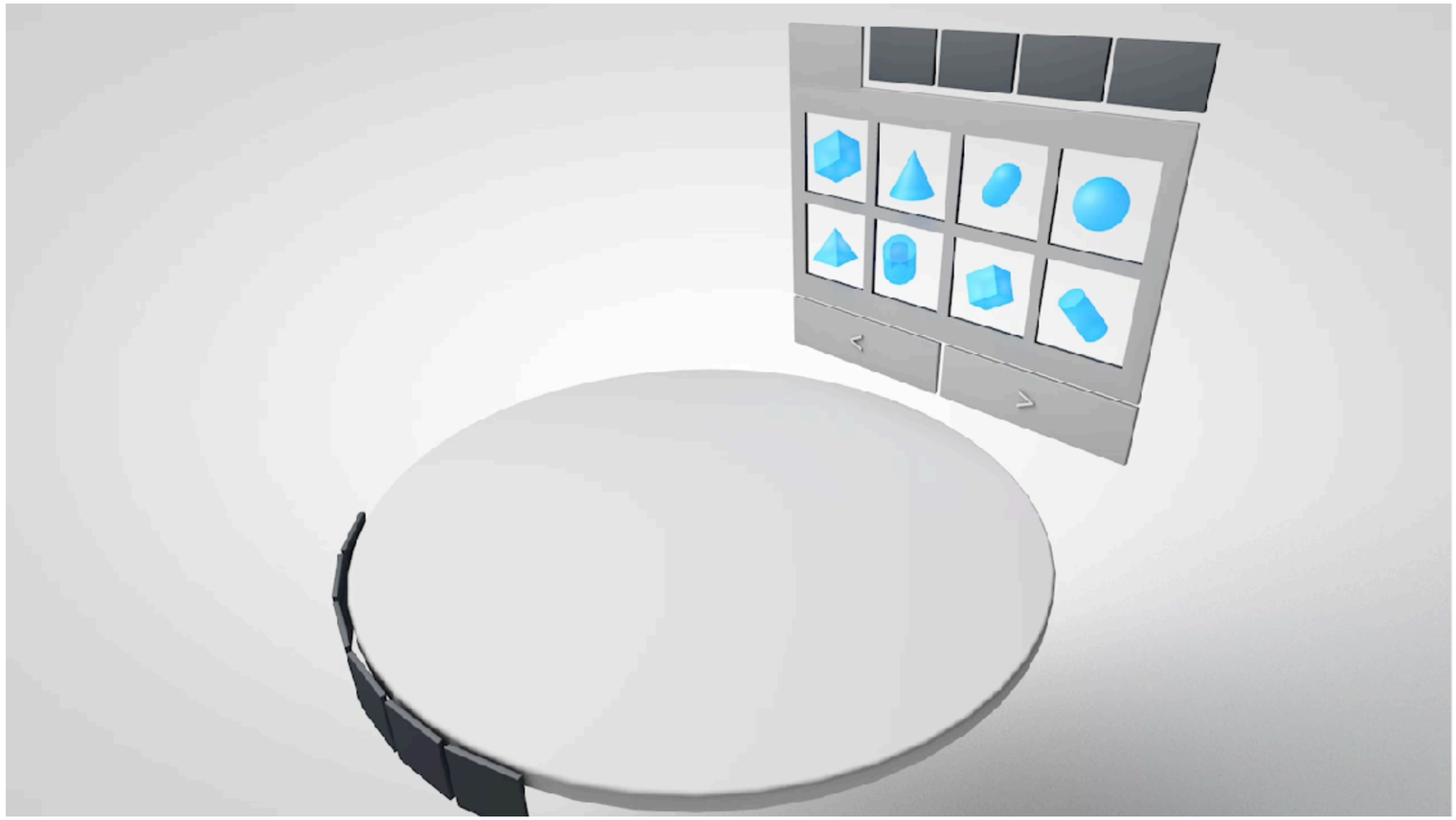


Modification Interactions

Adding Element

This interaction allows to bring in virtual elements in the scene



Gesture Used- ***AirTap + Hold + Free Drag***

Modification Interactions

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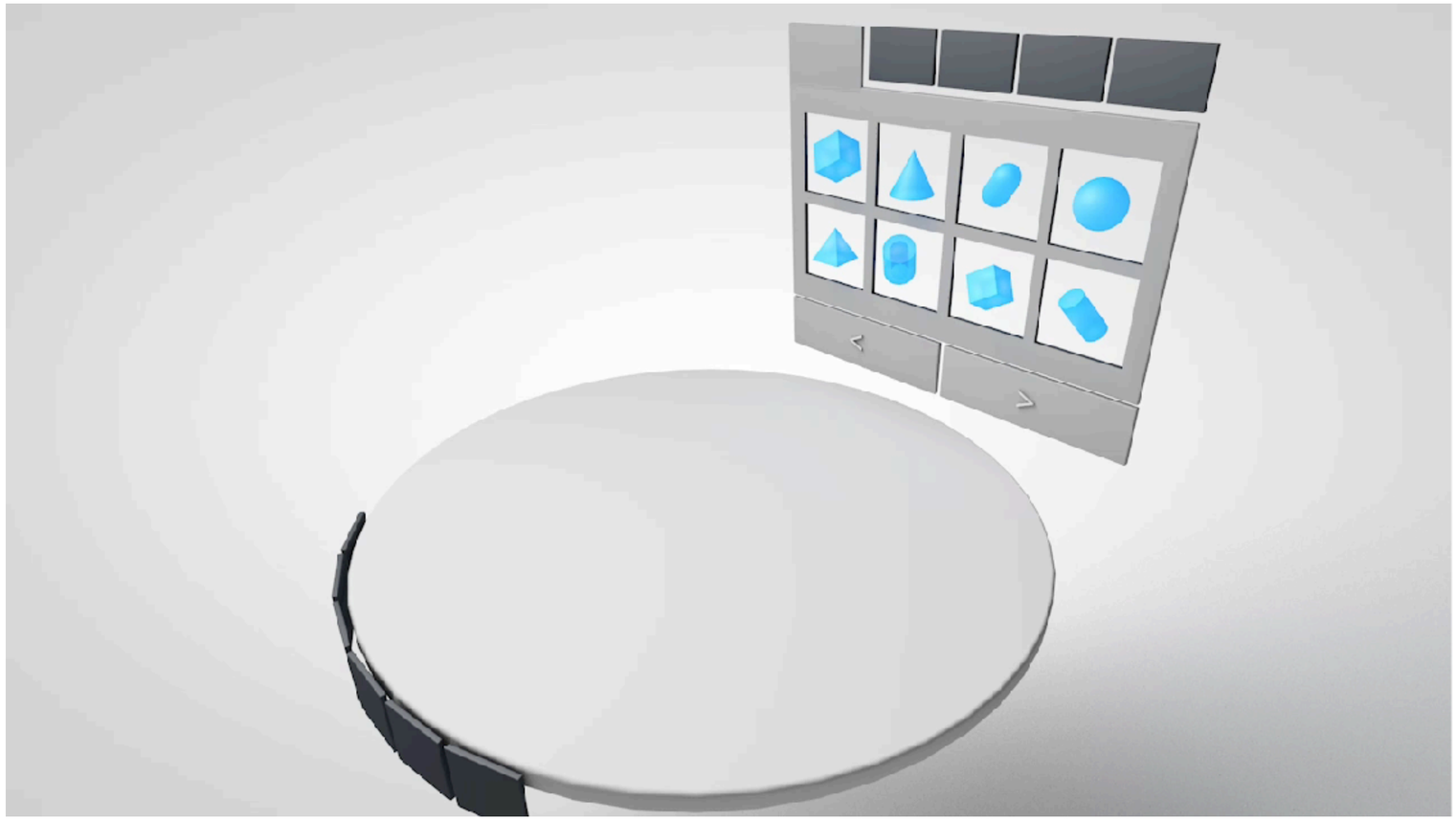
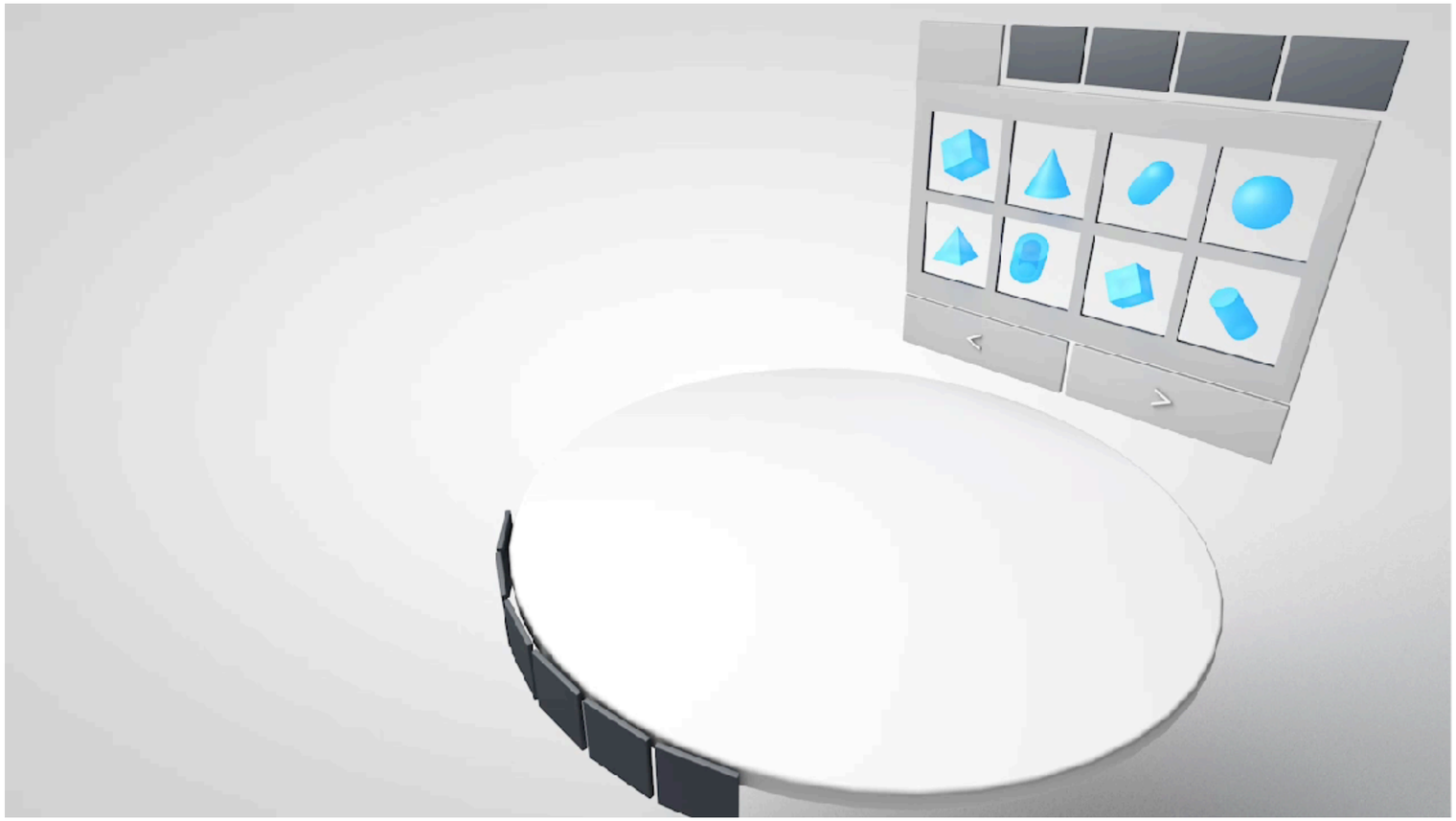


Gesture Used- ***AirTap + Hold + Free Drag***

Modification Interactions

Adding Element

This interaction allows to bring in virtual elements in the scene but in 1:1 scale for visualising the true scale of the element



Gesture Used- *AirTap + Hold + Free Drag*

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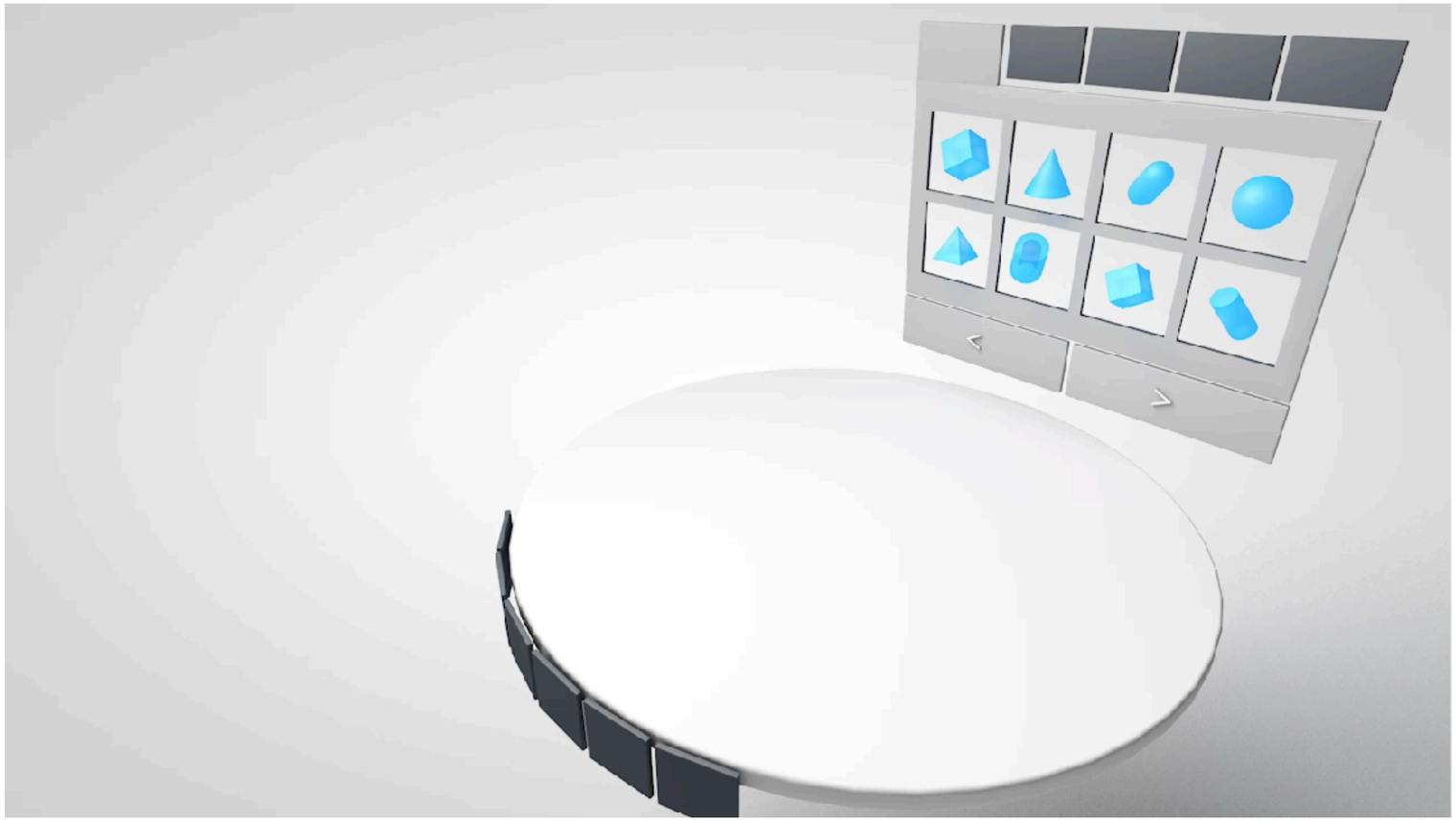

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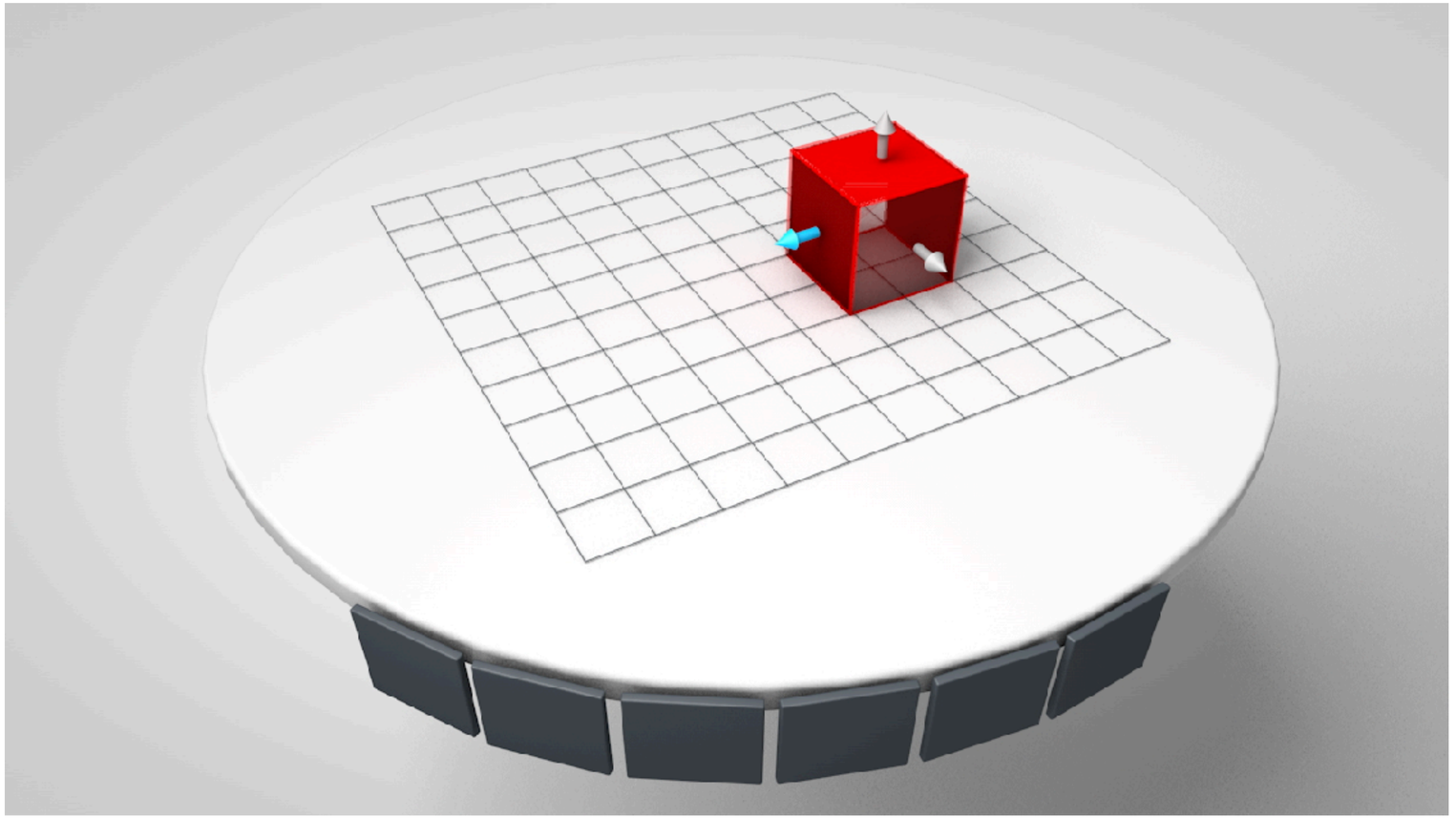
Modification Interactions

Moving Element

This interaction allows movement of 3D objects in X,Y & Z dimensions individually. The animation shows an example of grid for precision movement.



Gesture Used- ***AirTap + Hold + Horizontal Slide***

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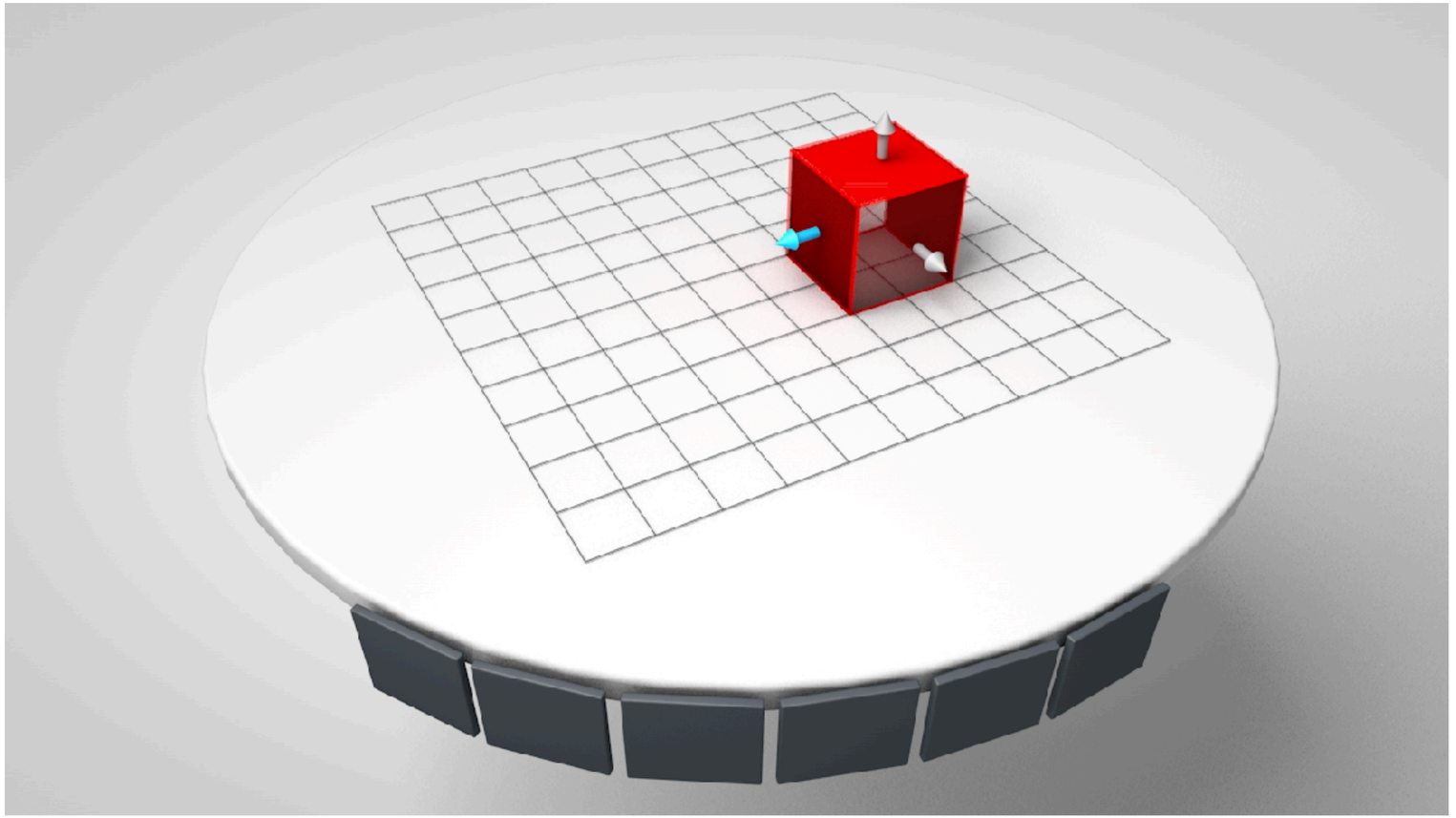
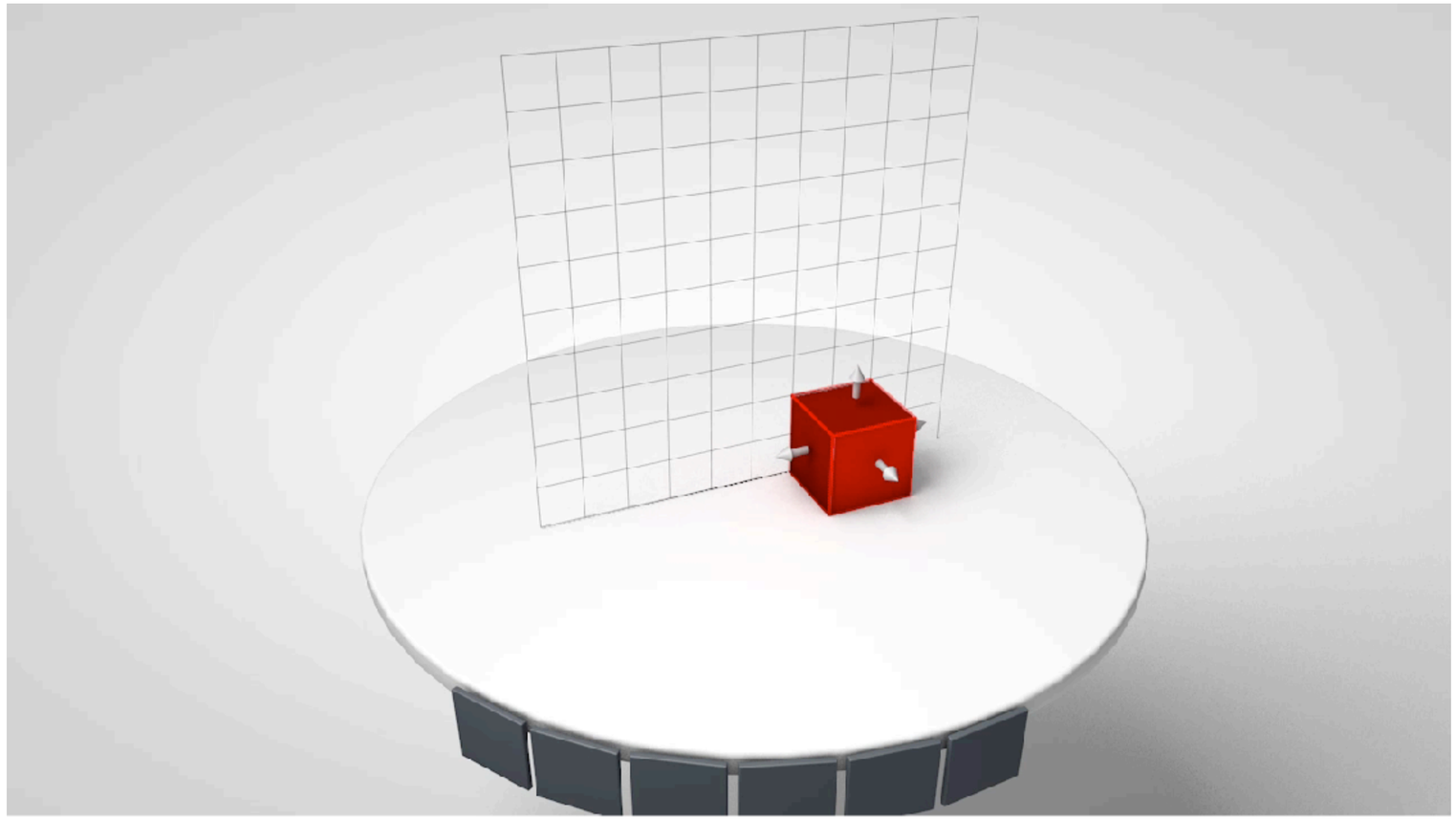


Gesture Used- ***AirTap + Hold + Horizontal Slide***

Modification Interactions

Moving Element

The grid rotates according to the selected dimension of movement.



Gesture Used- *AirTap + Hold + Vertical Slide*

Modification Interactions

Moving Element

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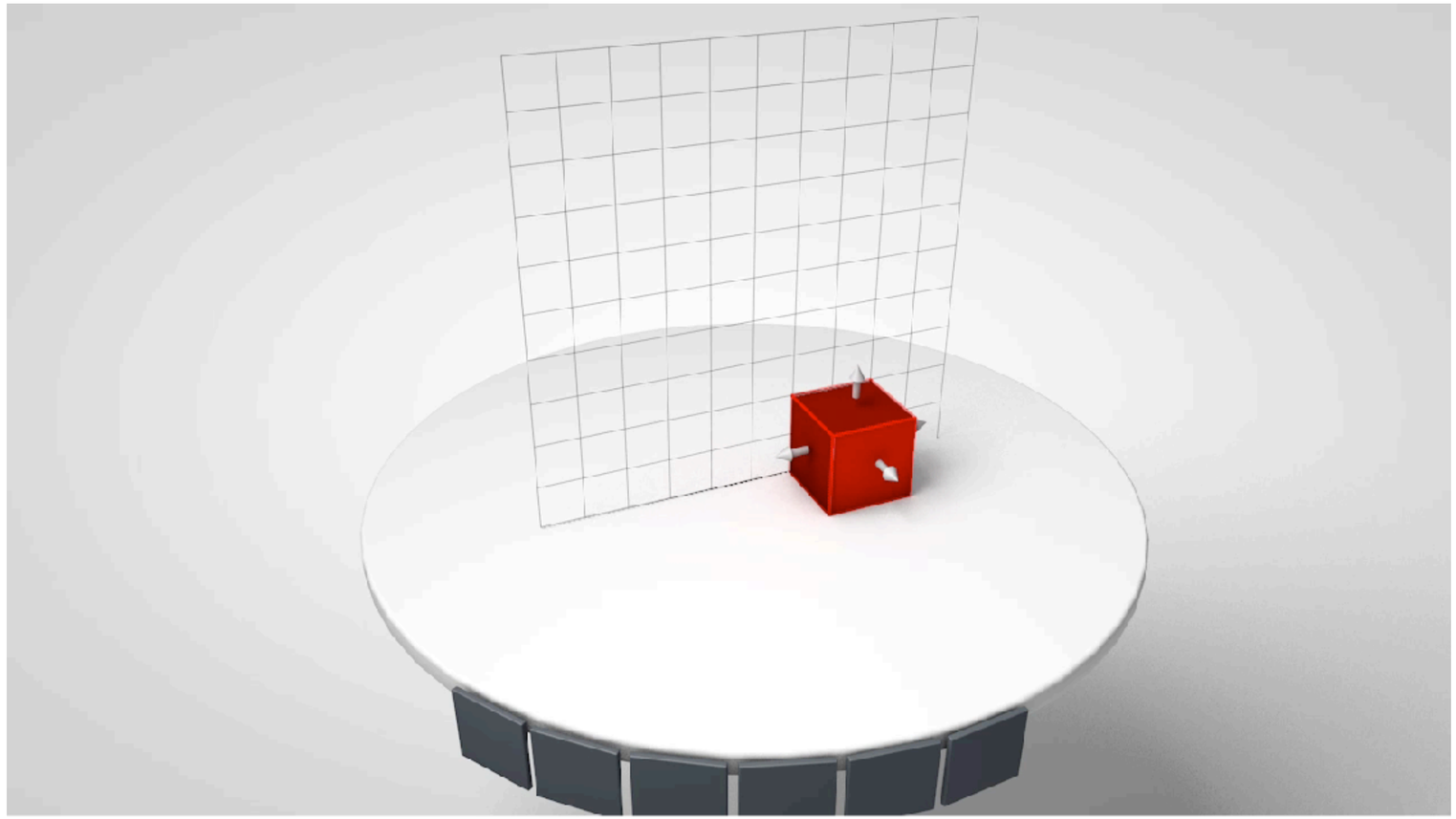
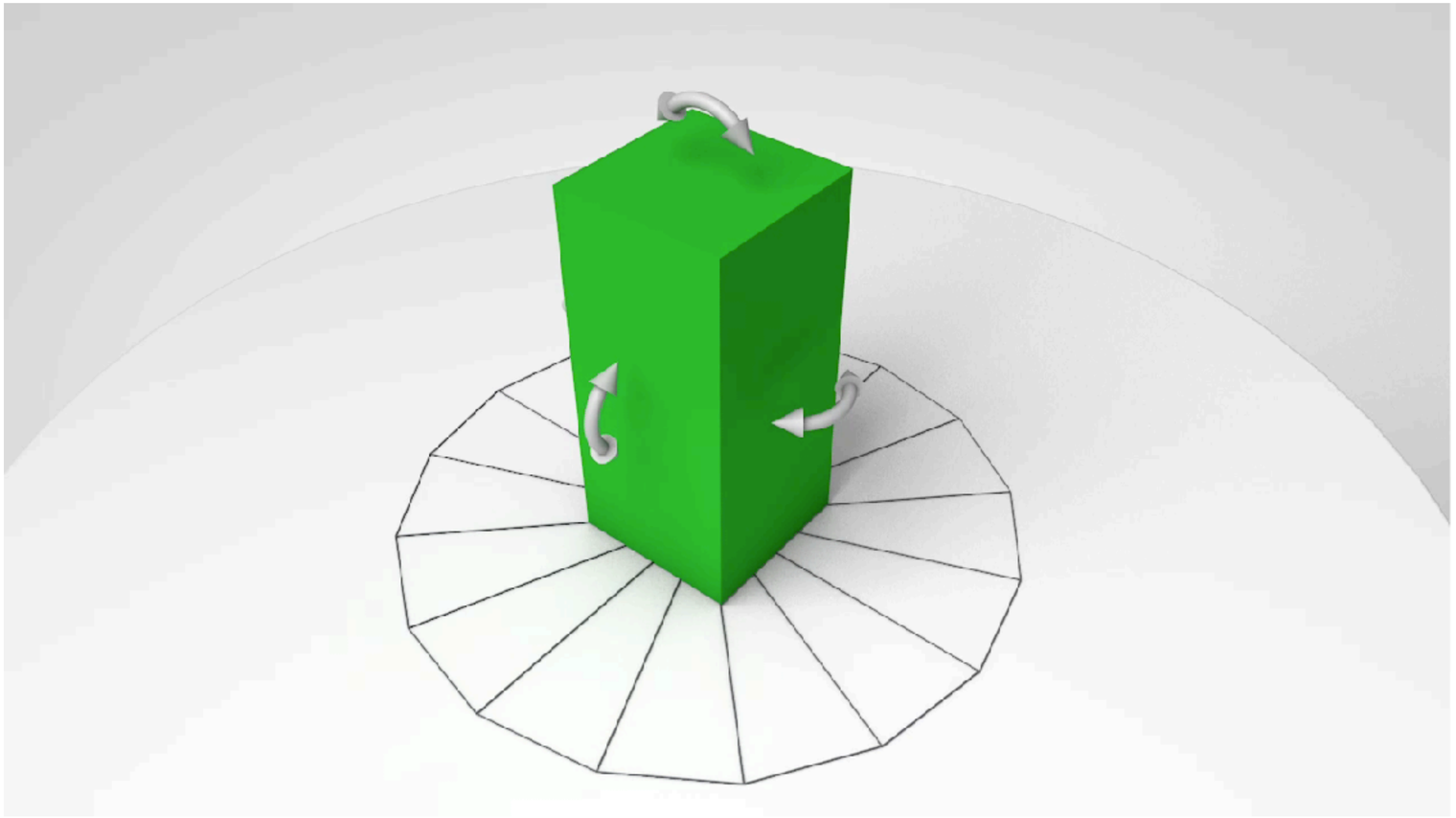


Gesture Used- *AirTap + Hold + Vertical Slide*

Modification Interactions

Rotate Element

The rotation interaction allows to user to rotate the 3D elements in all three dimensions individually



Gesture Used- ***AirTap + Hold + Horizontal Slide***

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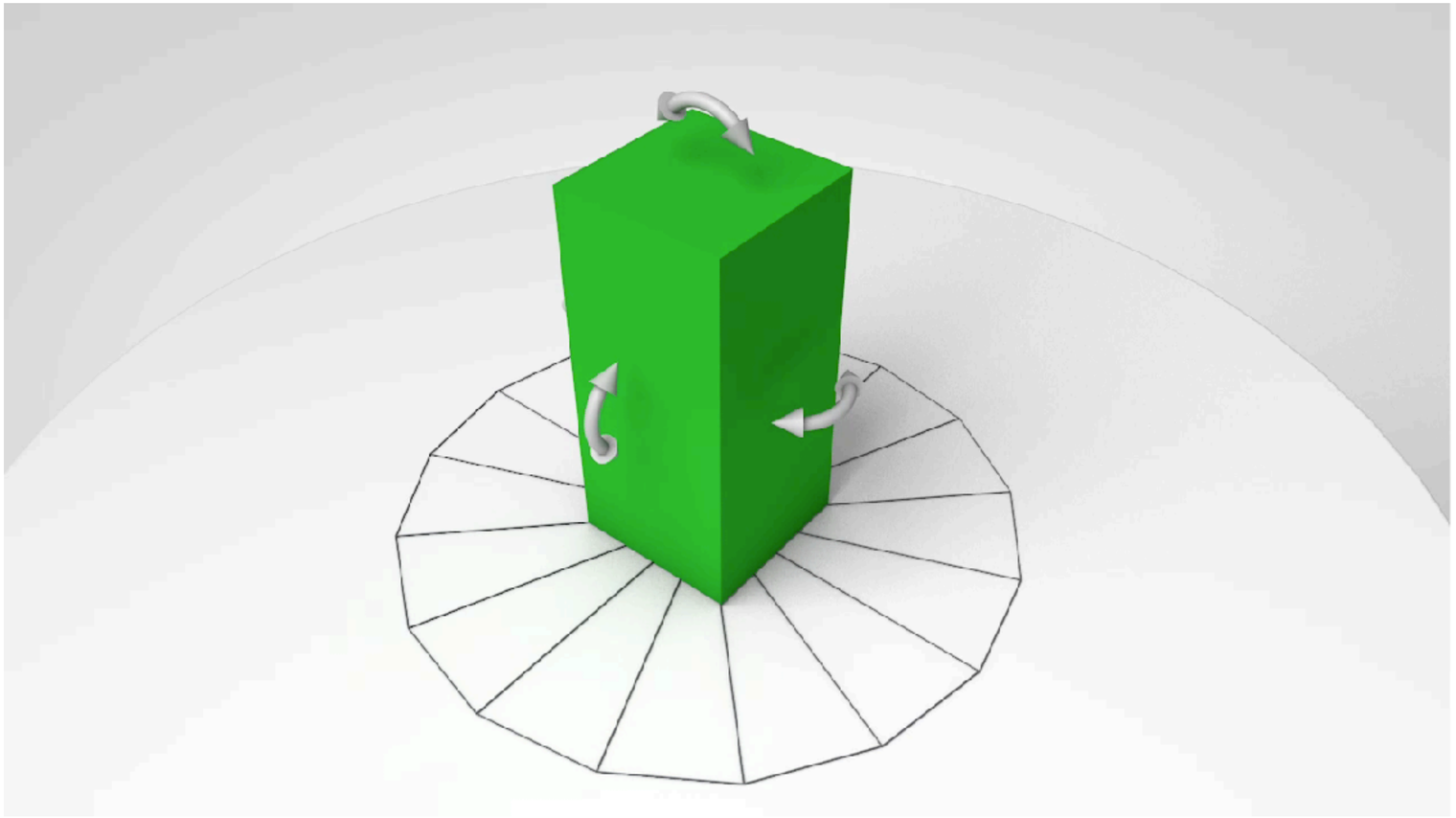
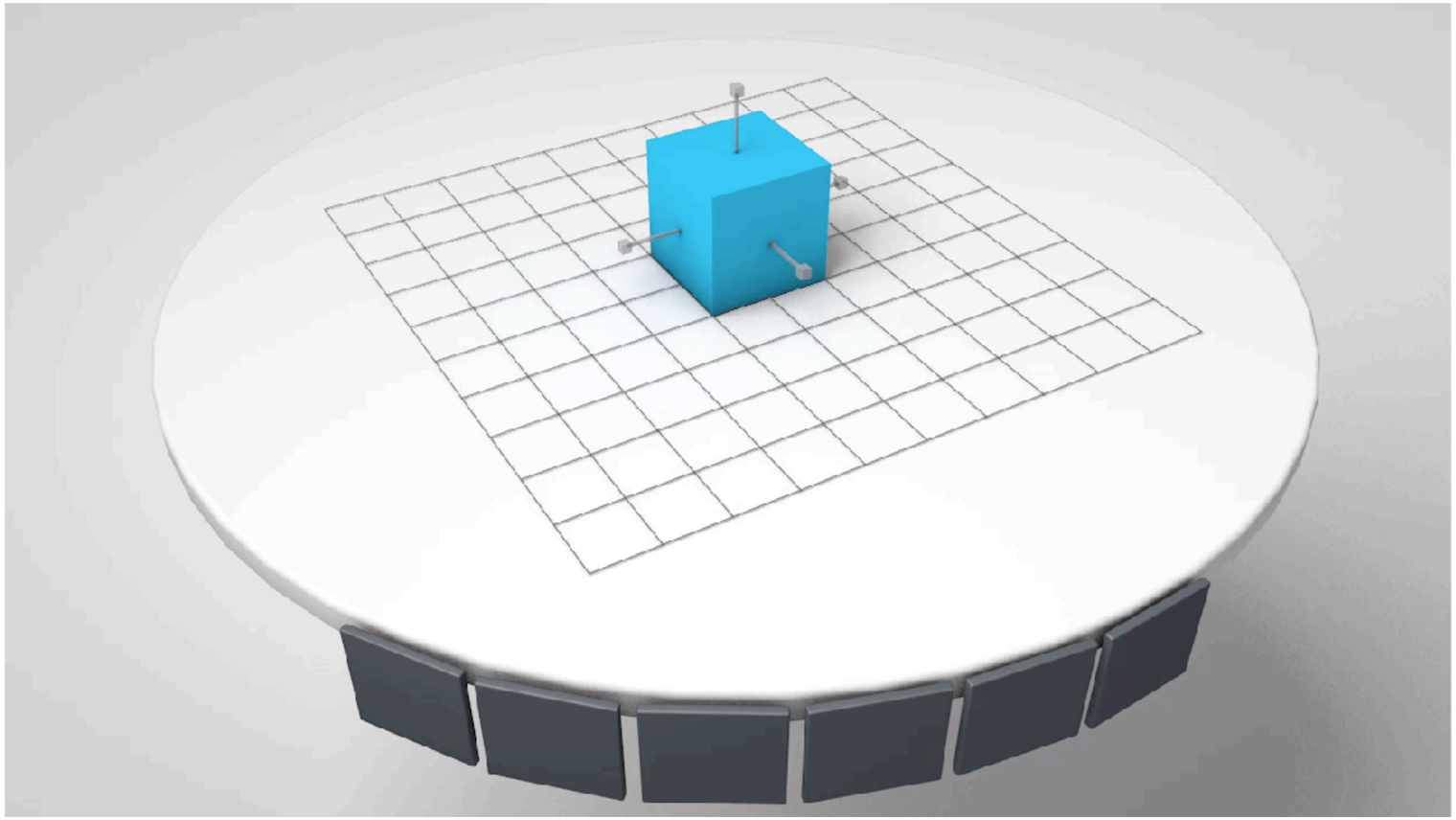


Gesture Used- ***AirTap + Hold + Horizontal Slide***

Modification Interactions

Scaling Element

The scaling interaction is kept more like stretching the elements. The user can stretch and scale in 1D



Gesture Used- ***AirTap + Hold + Horizontal Slide***

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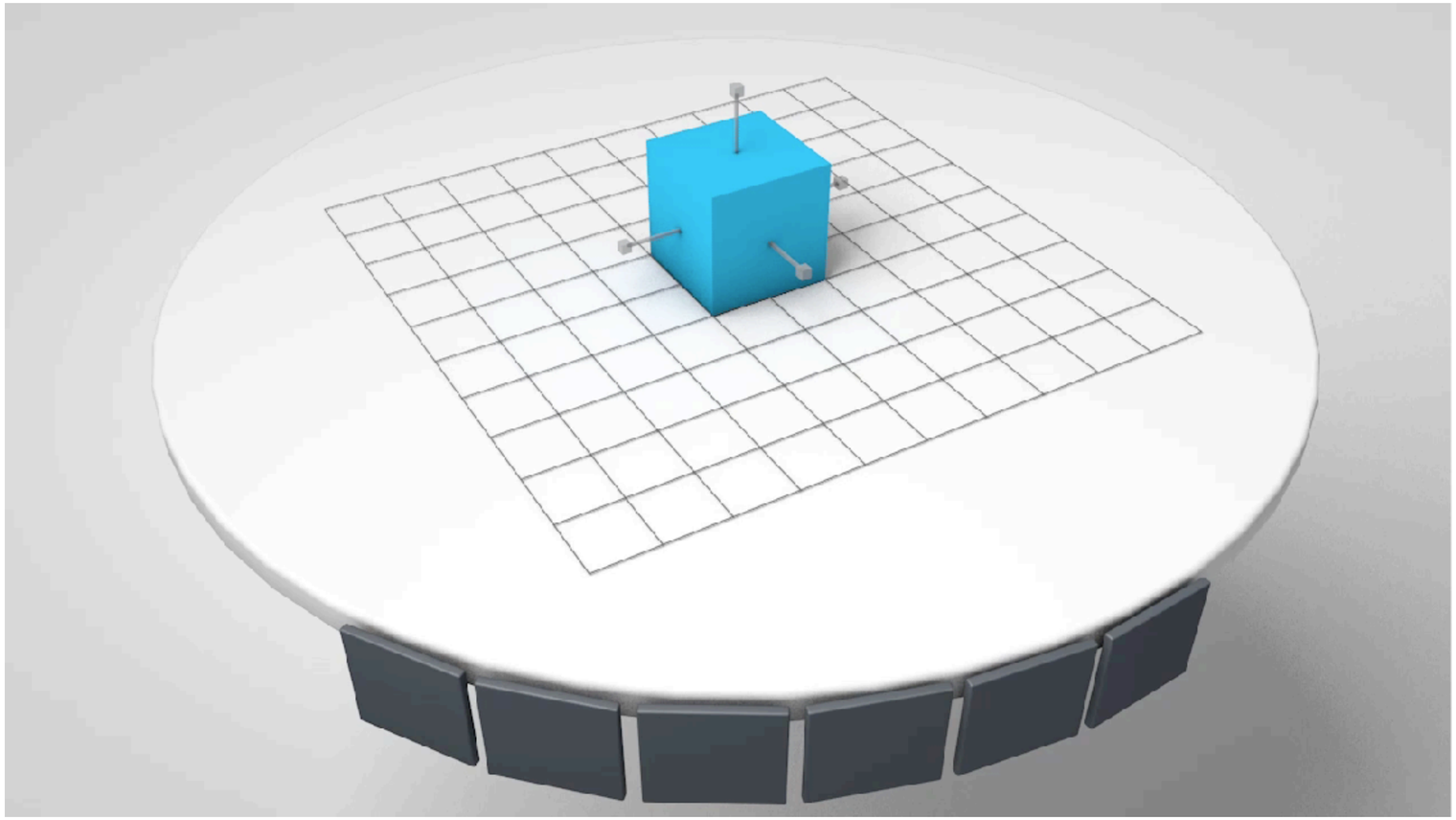
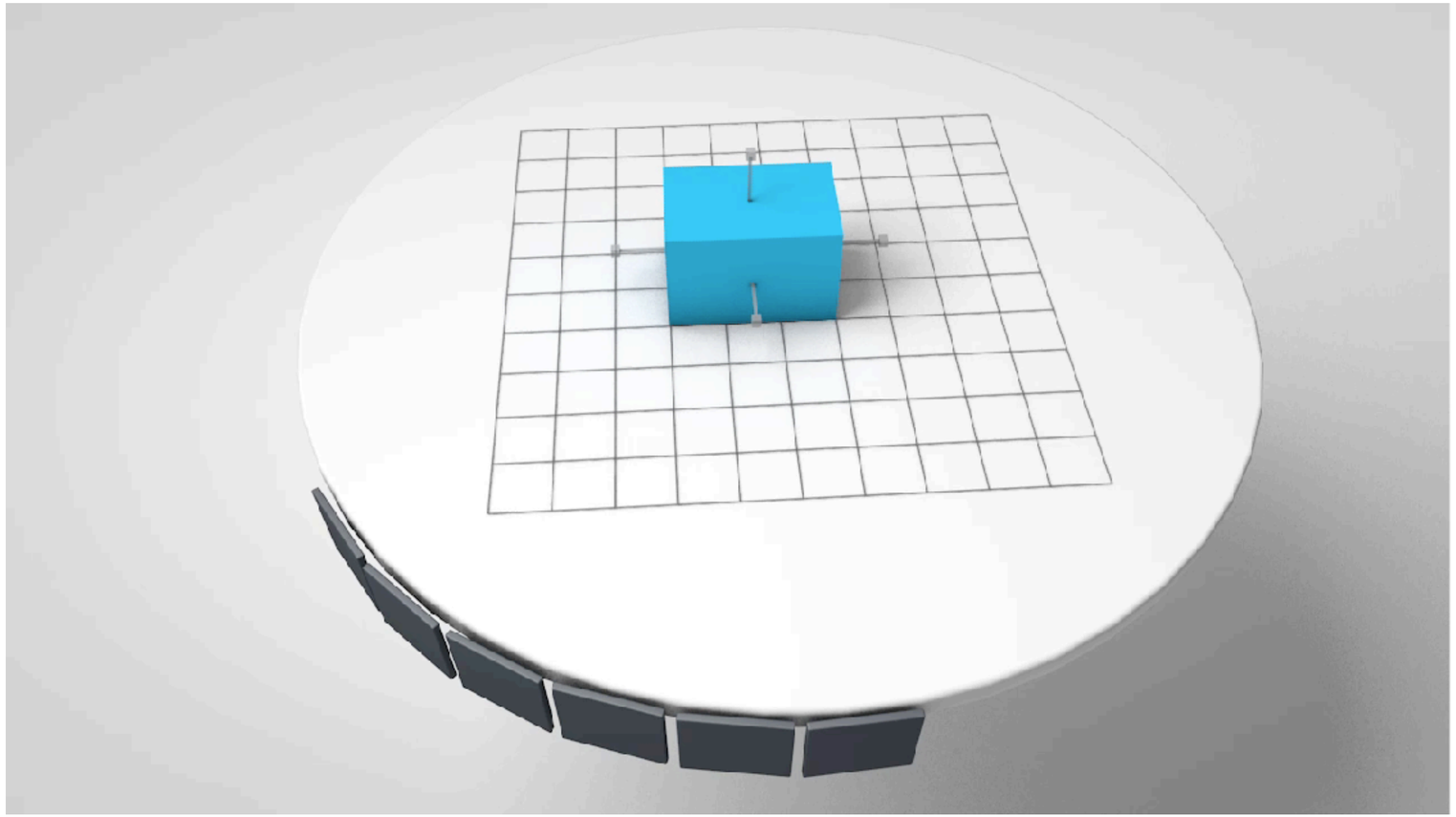


Gesture Used- ***AirTap + Hold + Horizontal Slide***

Modification Interactions

Scaling Element

The scaling interaction is kept more like stretching the elements. The user can stretch and scale in 2D's



Gesture Used- ***AirTap + Hold + 2 Hand Stretch***

Modification Interactions

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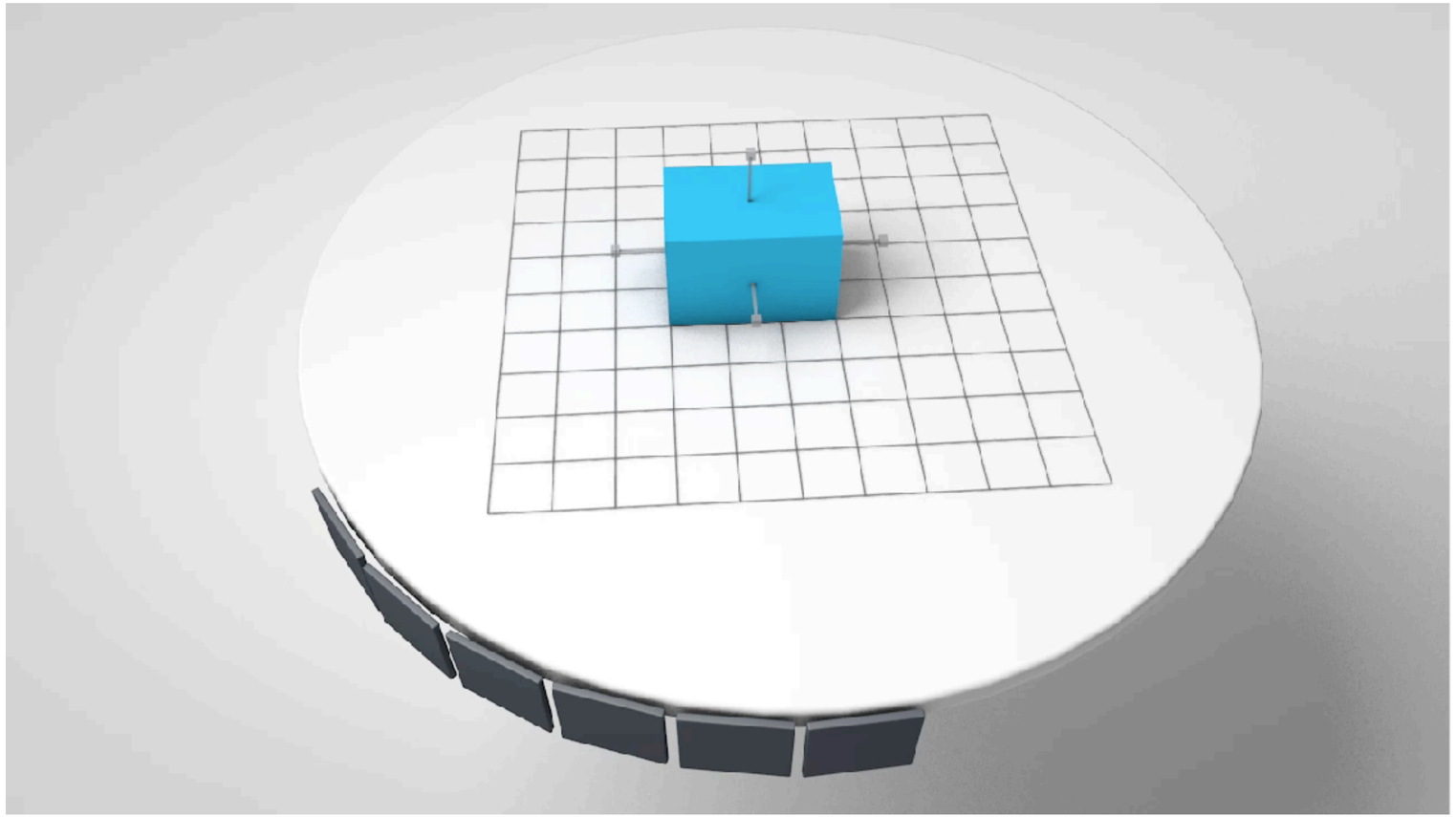
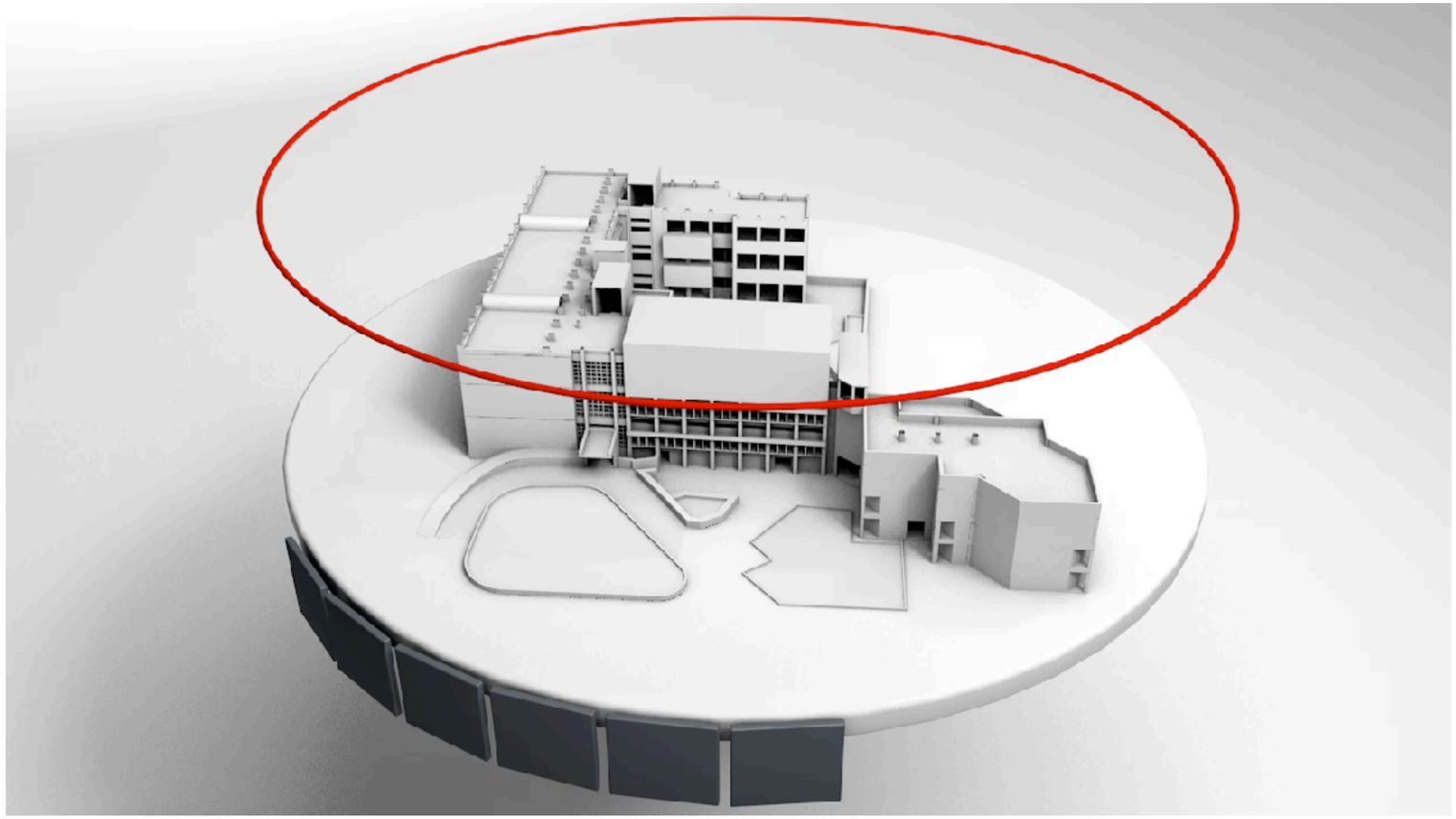


Gesture Used- ***AirTap + Hold + 2 Hand Stretch***

View-ability Interactions

Section Plane

Section planes or clipping planes can be turned ON or OFF and moved in a single vector direction at once.



Gesture Used- *AirTap + Hold + Vertical Slide*

View-ability Interactions

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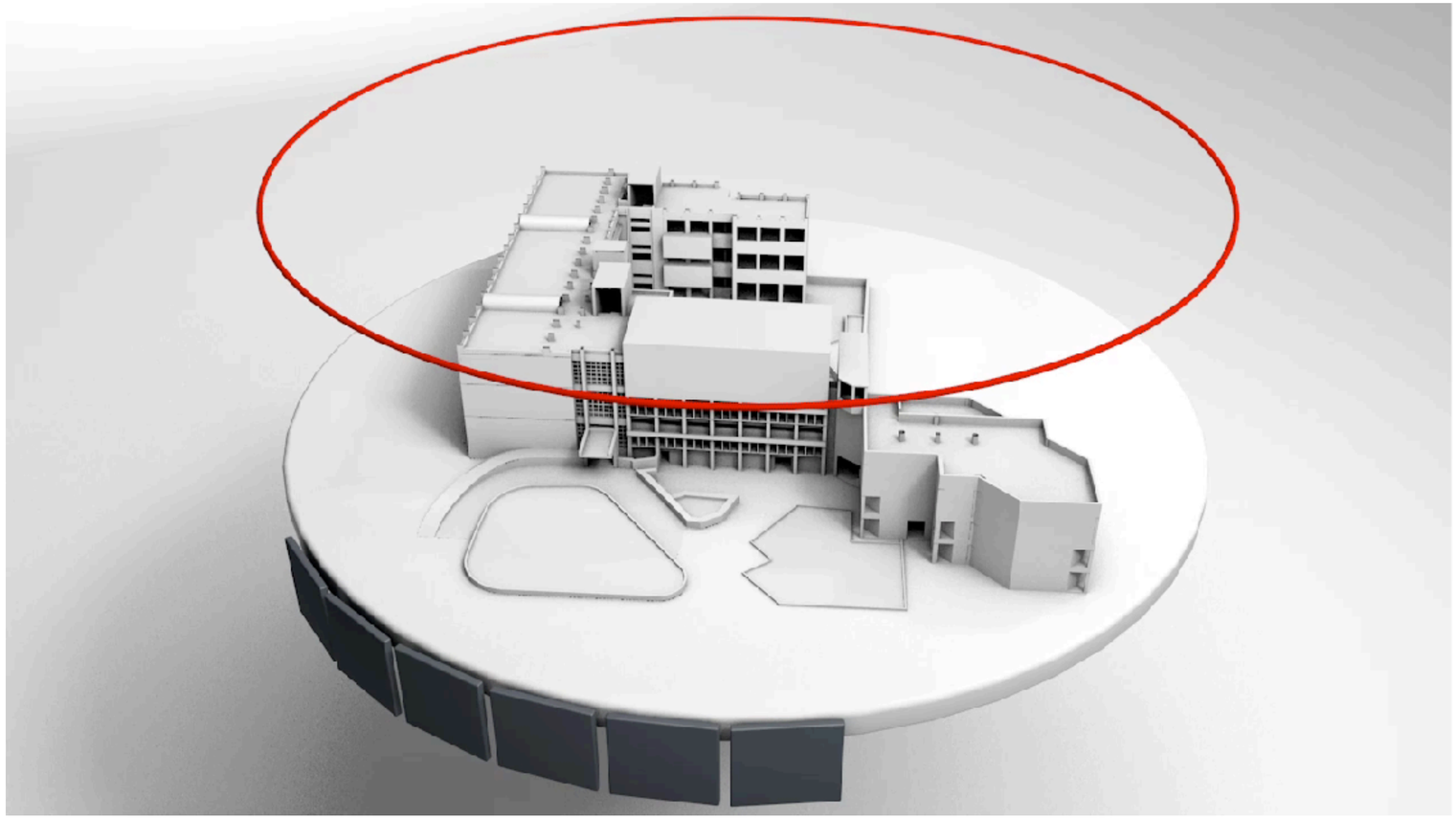

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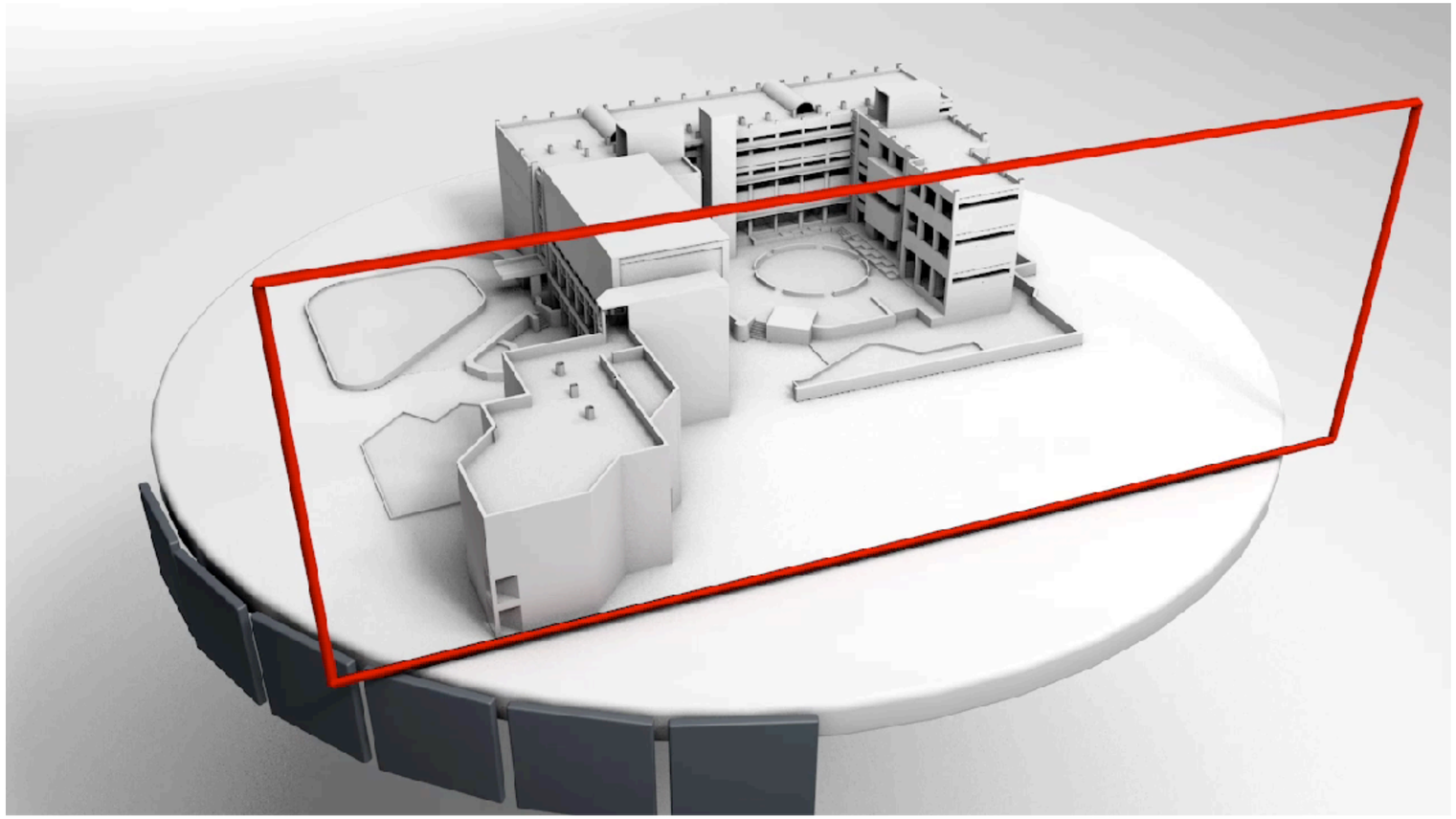

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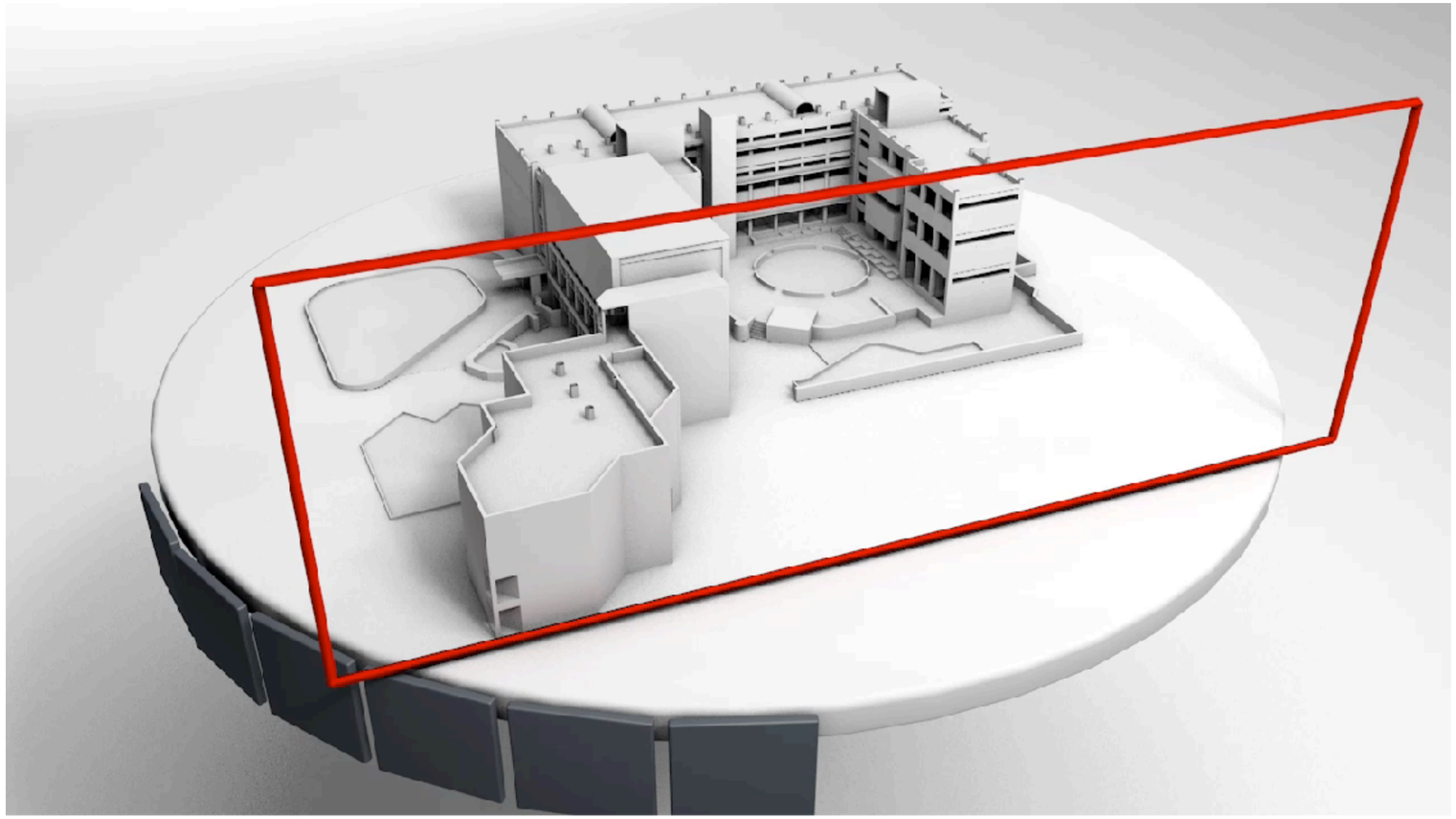
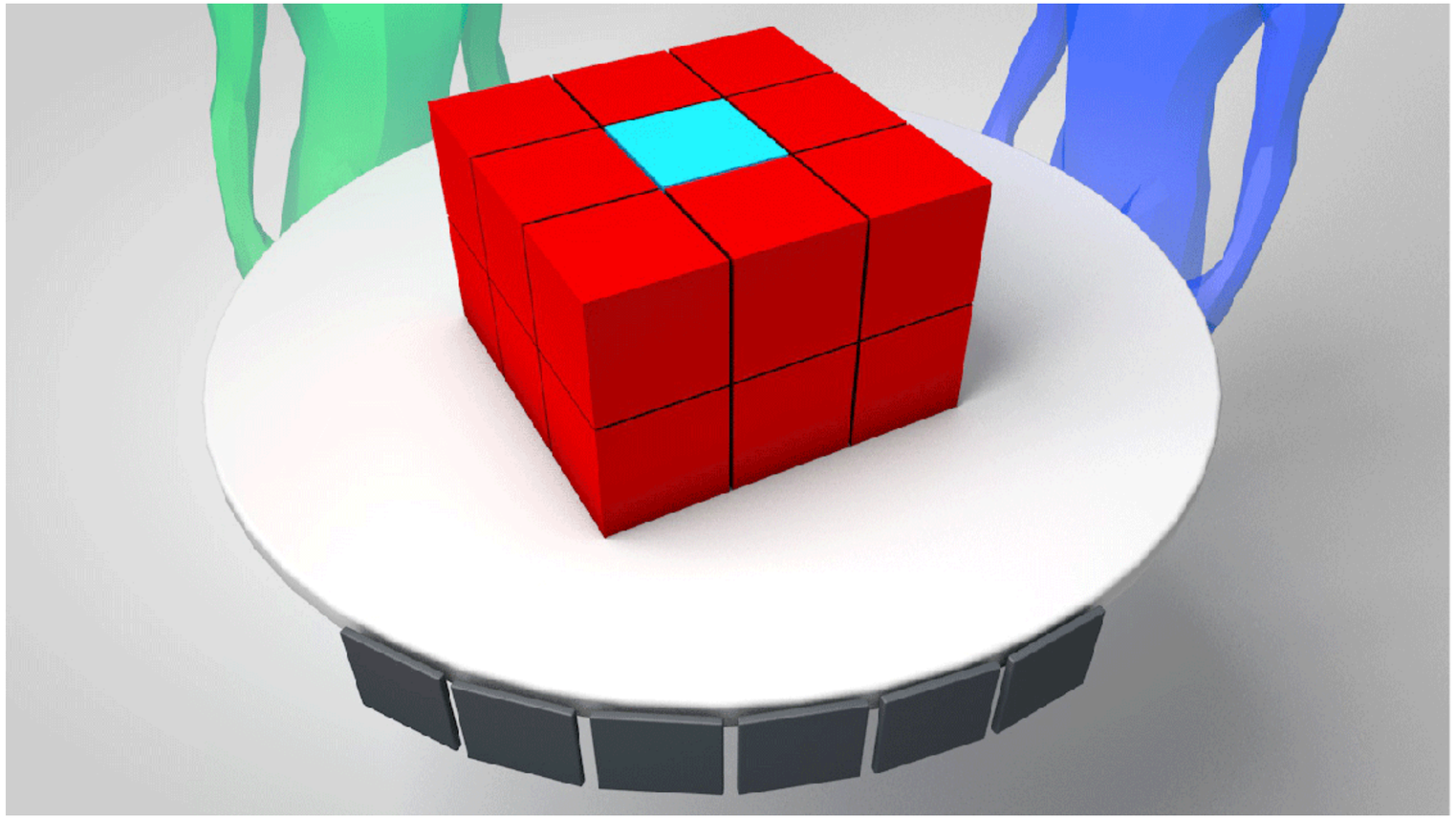


Gesture Used- *AirTap + Hold + Horizontal Slide*

View-ability Interactions

Layer Visibility

The layer visibility can be turned ON and OFF. The example shows blue layer in SOLO mode.



Gesture Used- *AirTap*

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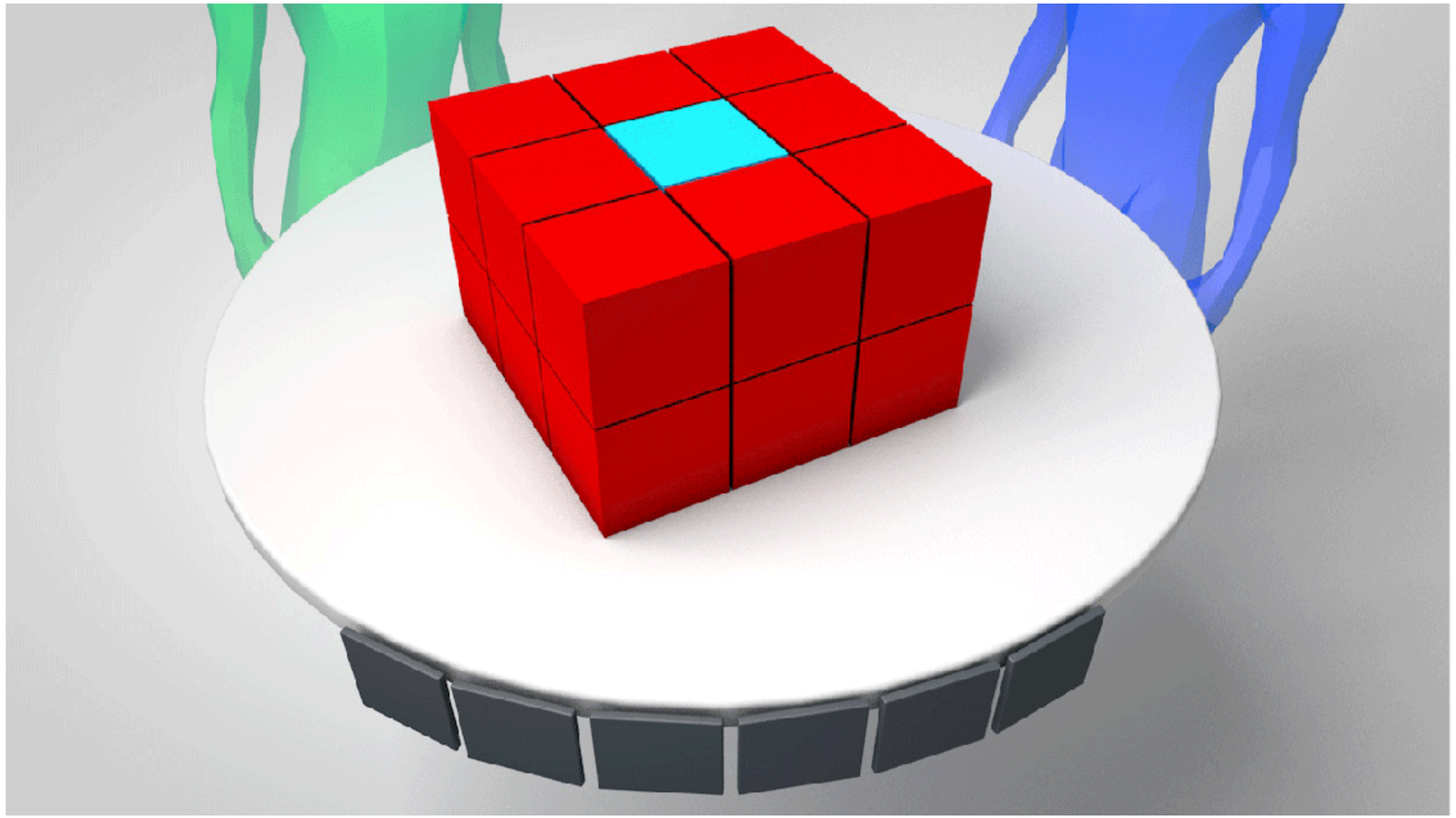

Gesture Used- *AirTap*

View-ability Interactions

Layer Visibility

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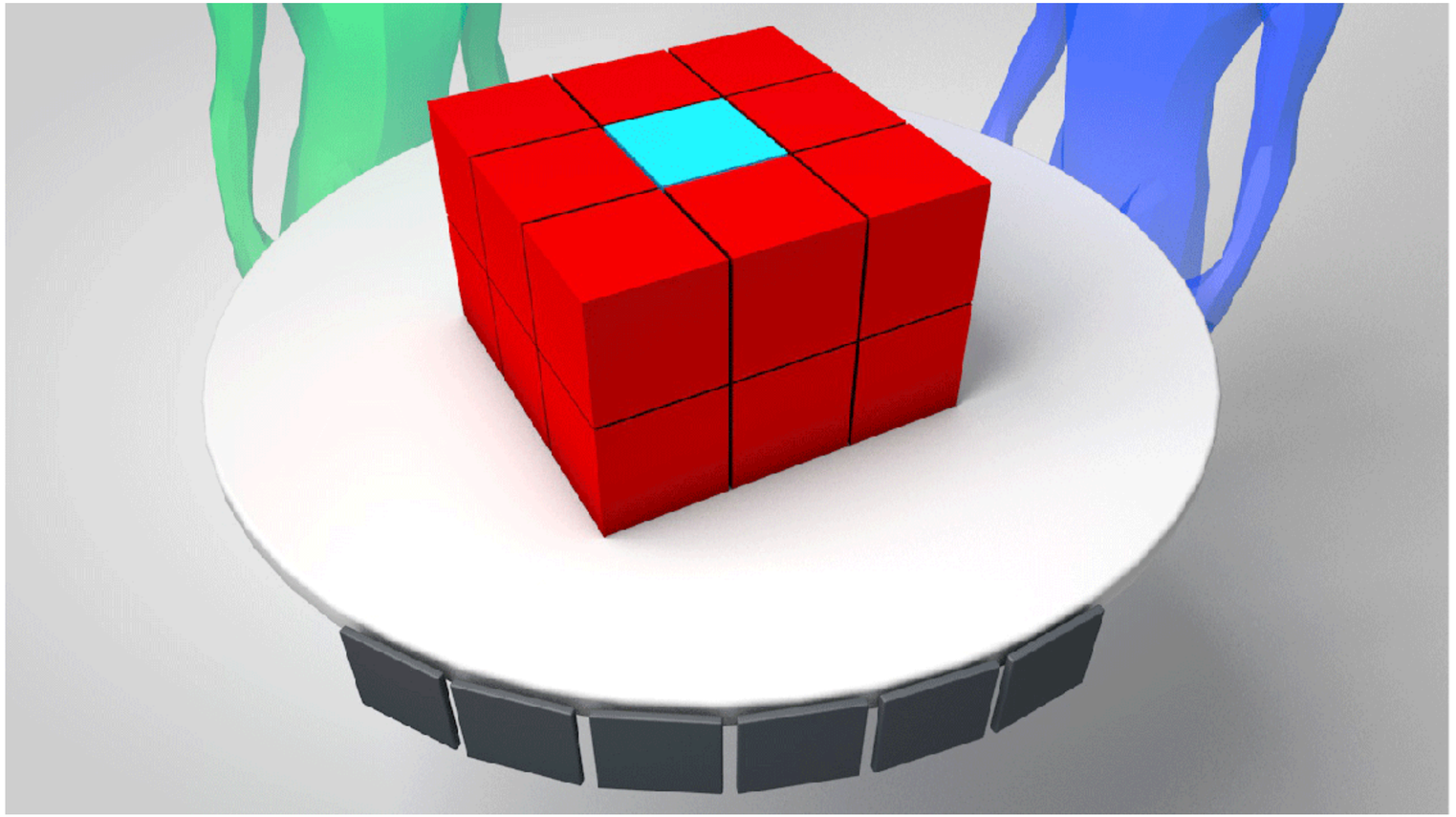

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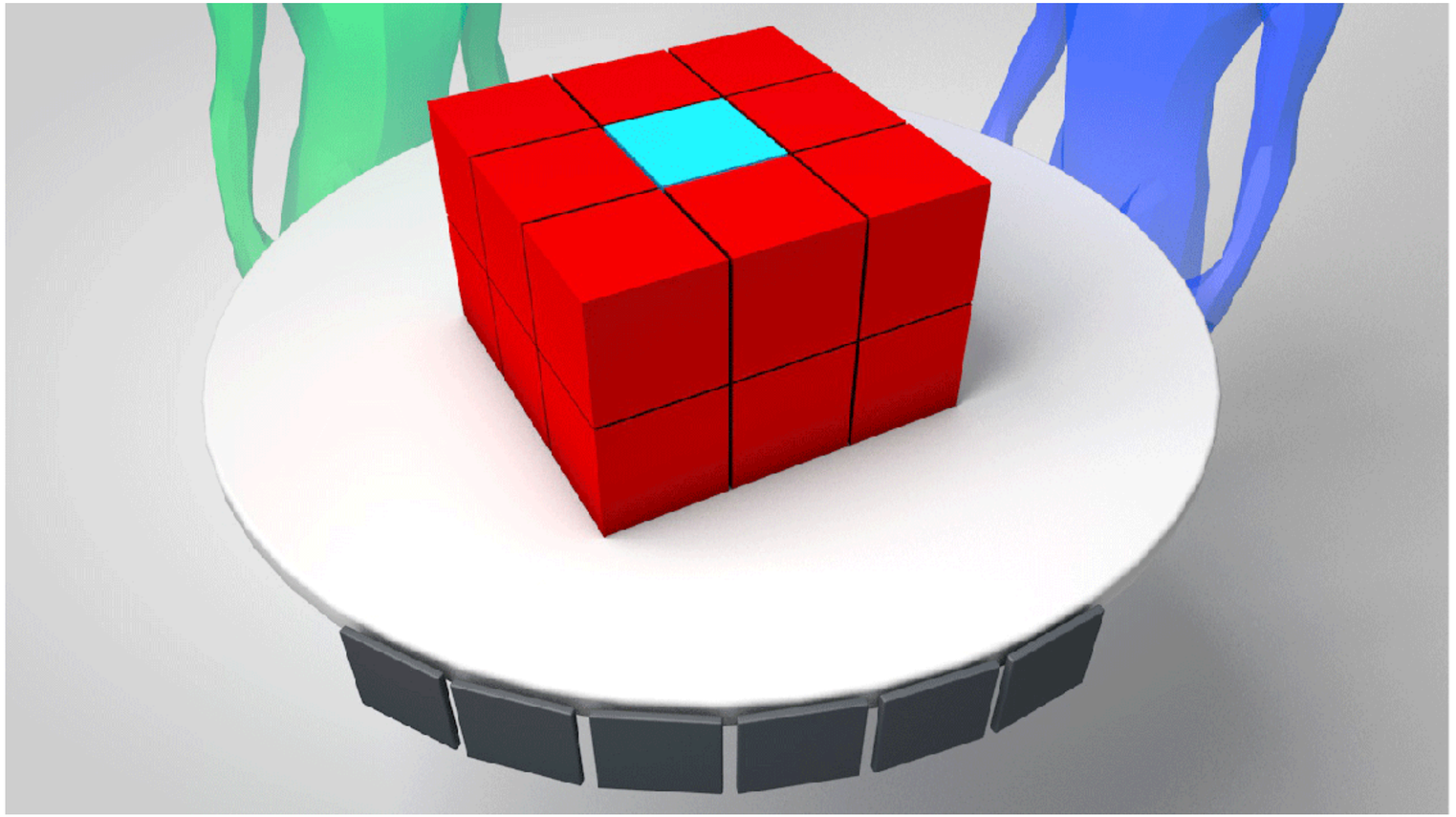
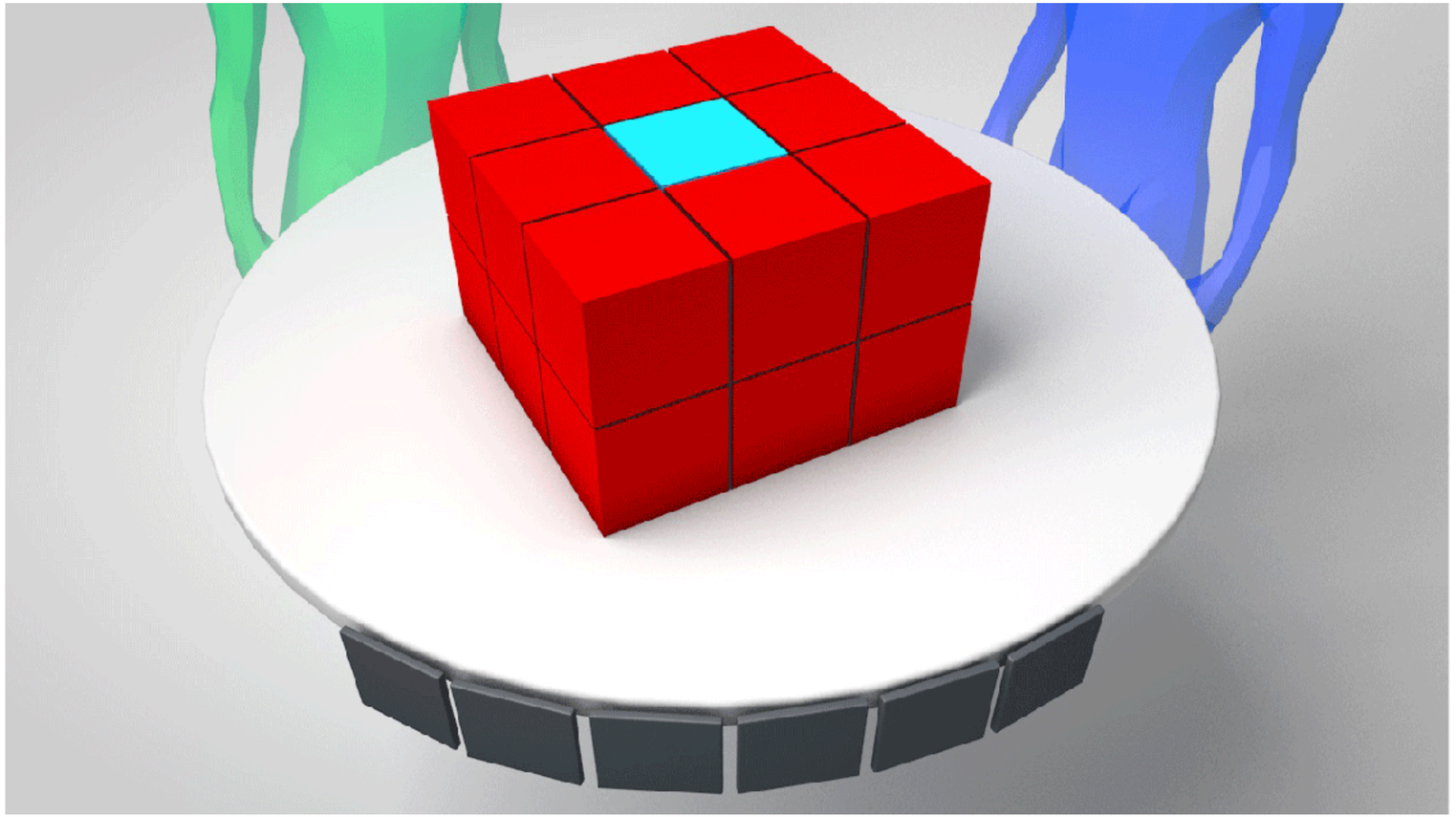


Gesture Used- *AirTap*

View-ability Interactions

Layer Opacity

The opacity function also works like Visibility function but does not hide the layer completely. The example shows turn opacity on all layers except BLUE



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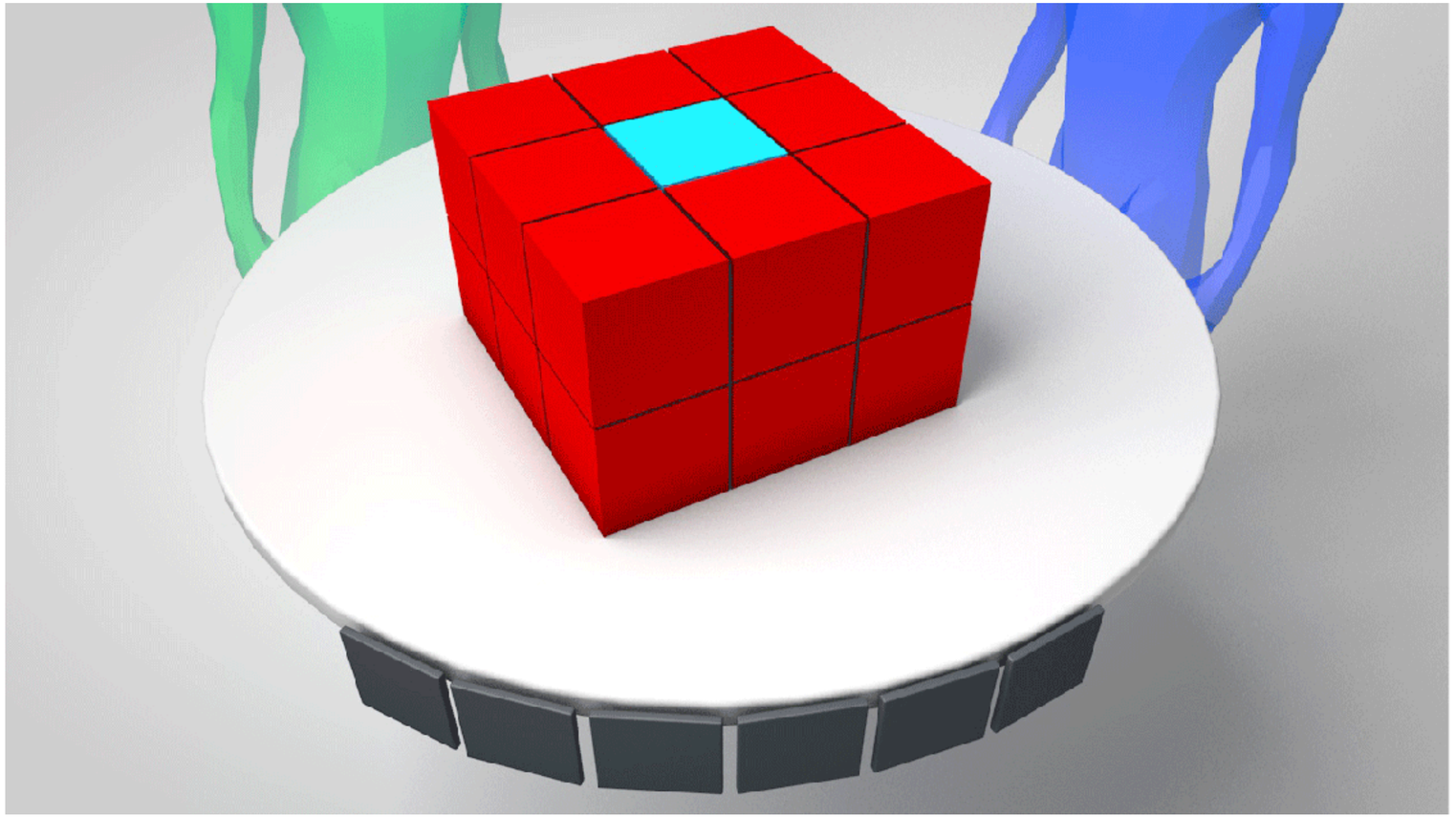
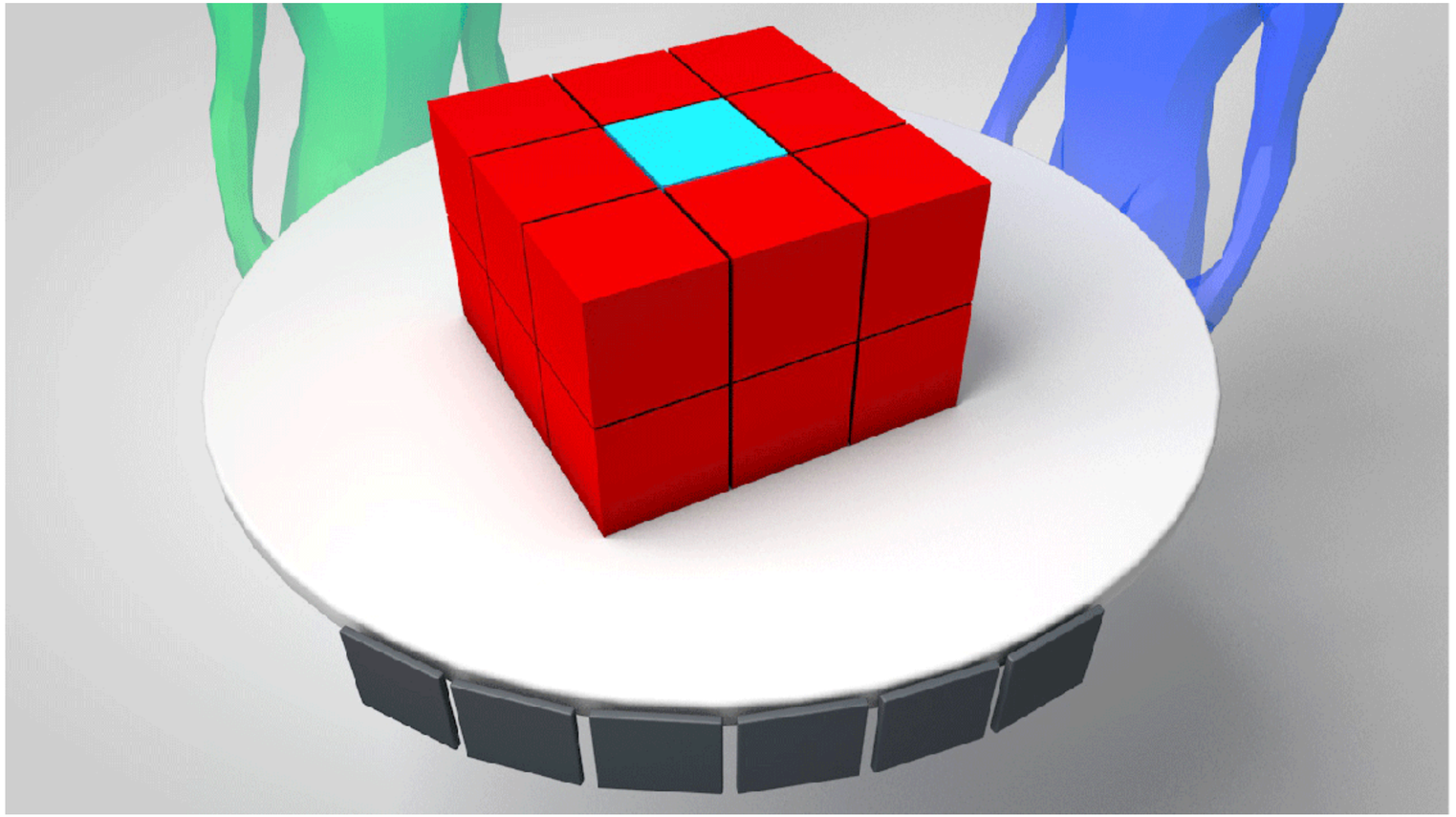


Gesture Used- *AirTap*

View-ability Interactions

Layer Opacity

This example is inverse of the last function.



Gesture Used- *AirTap*

View-ability Interactions

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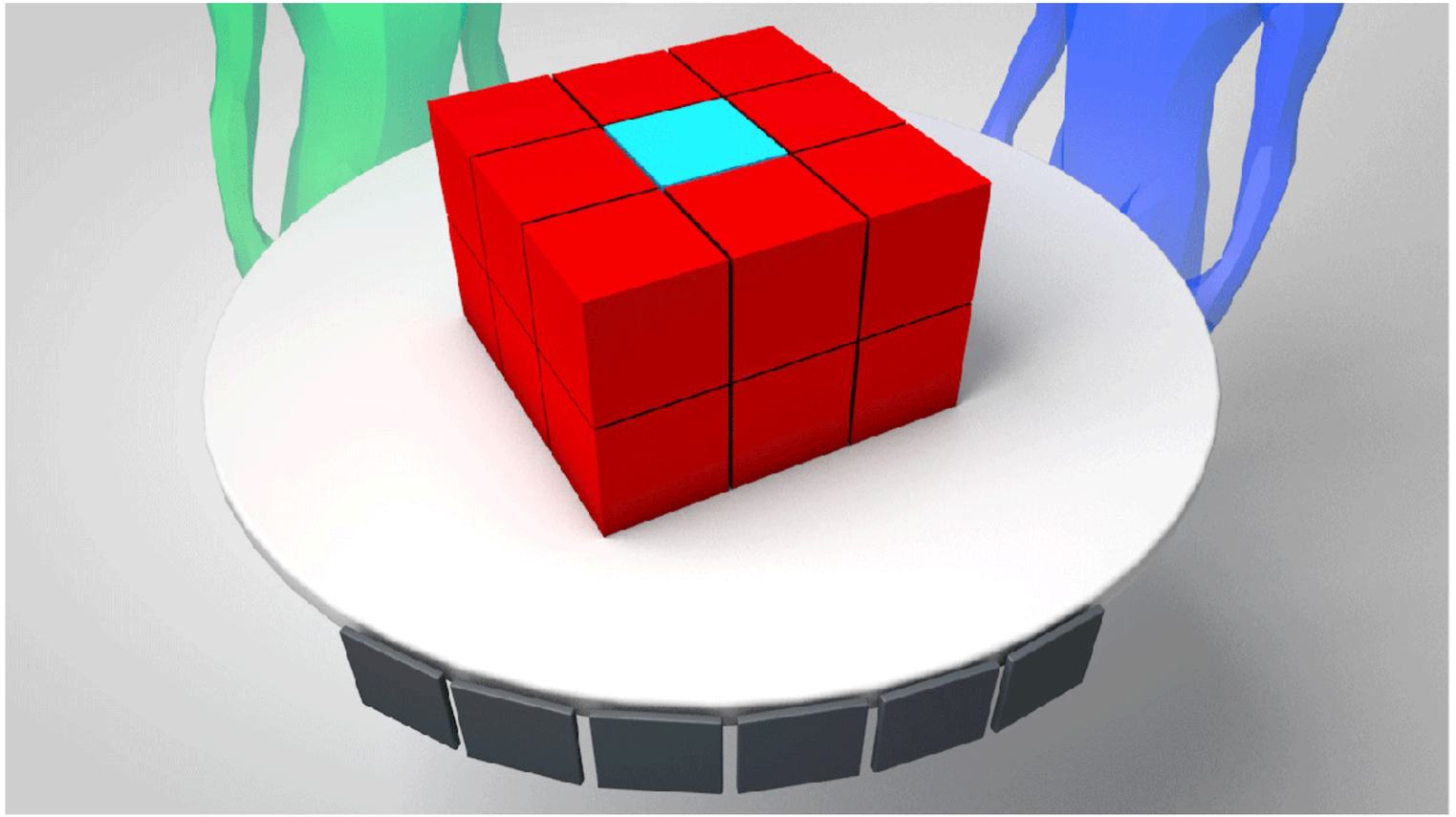
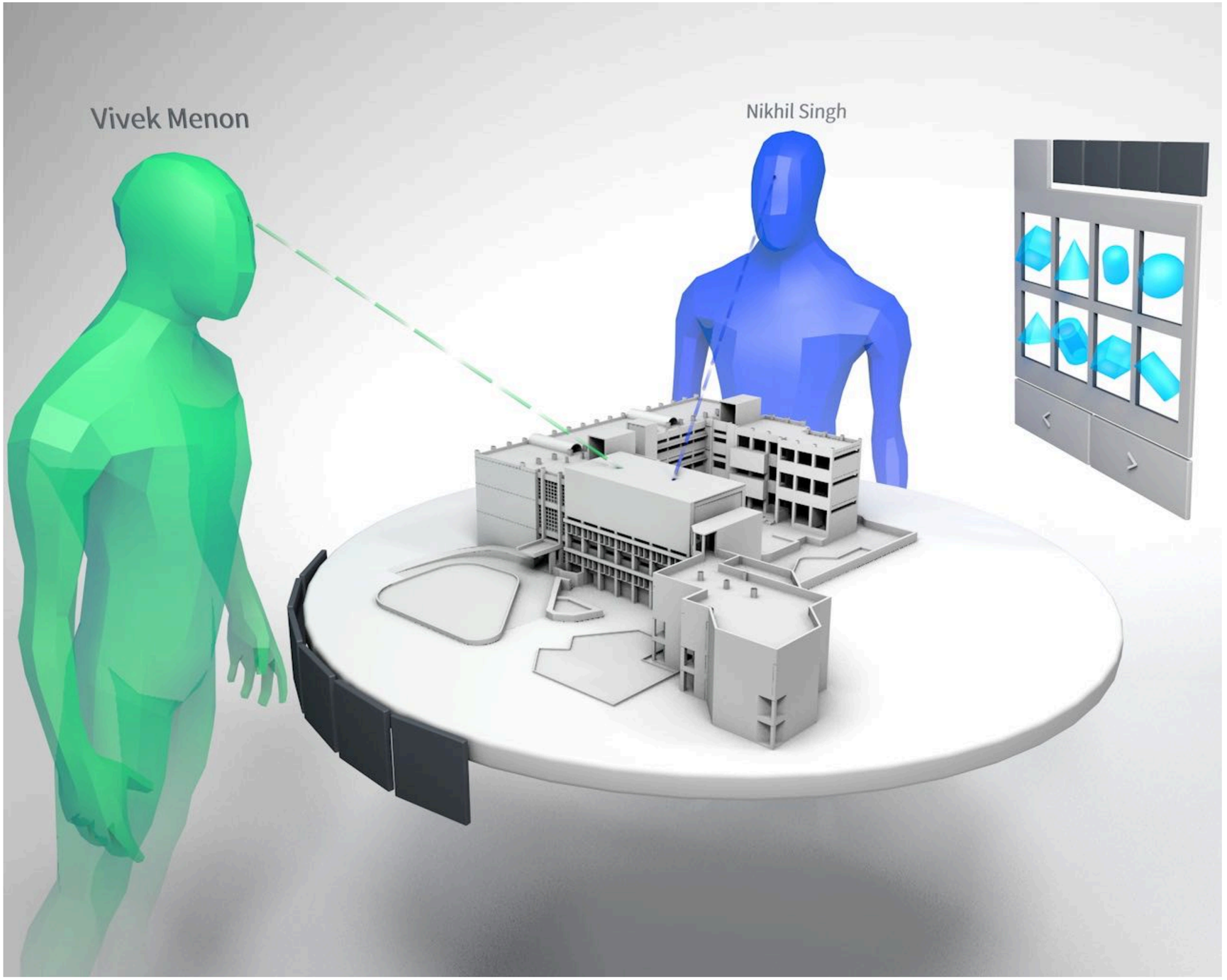


Gesture Used- *AirTap*

View-ability Interactions

Scaling Model

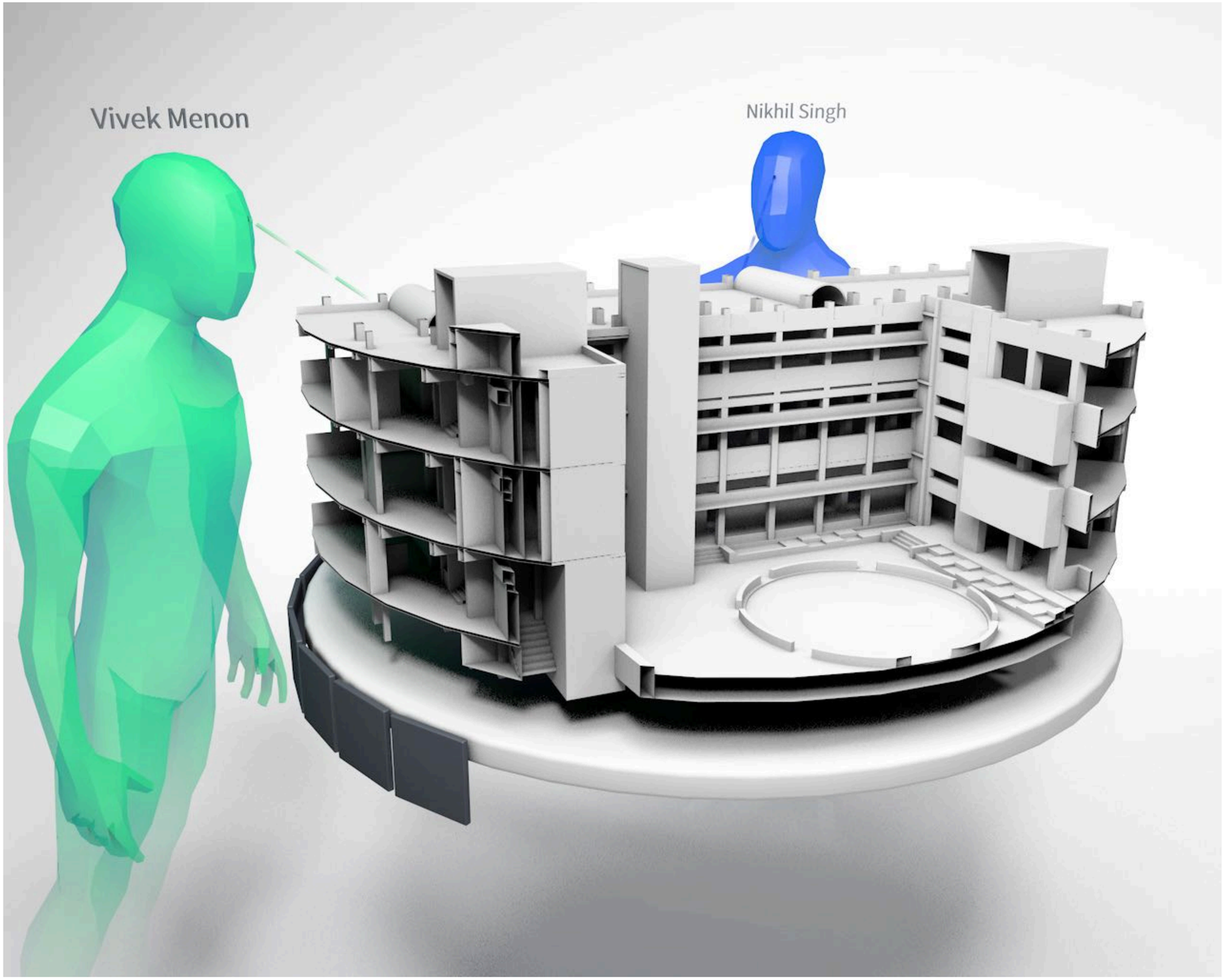
The collaborators view a scaled model on the table. The model can be scaled to any size on the table itself.



View-ability Interactions

Scaling Model

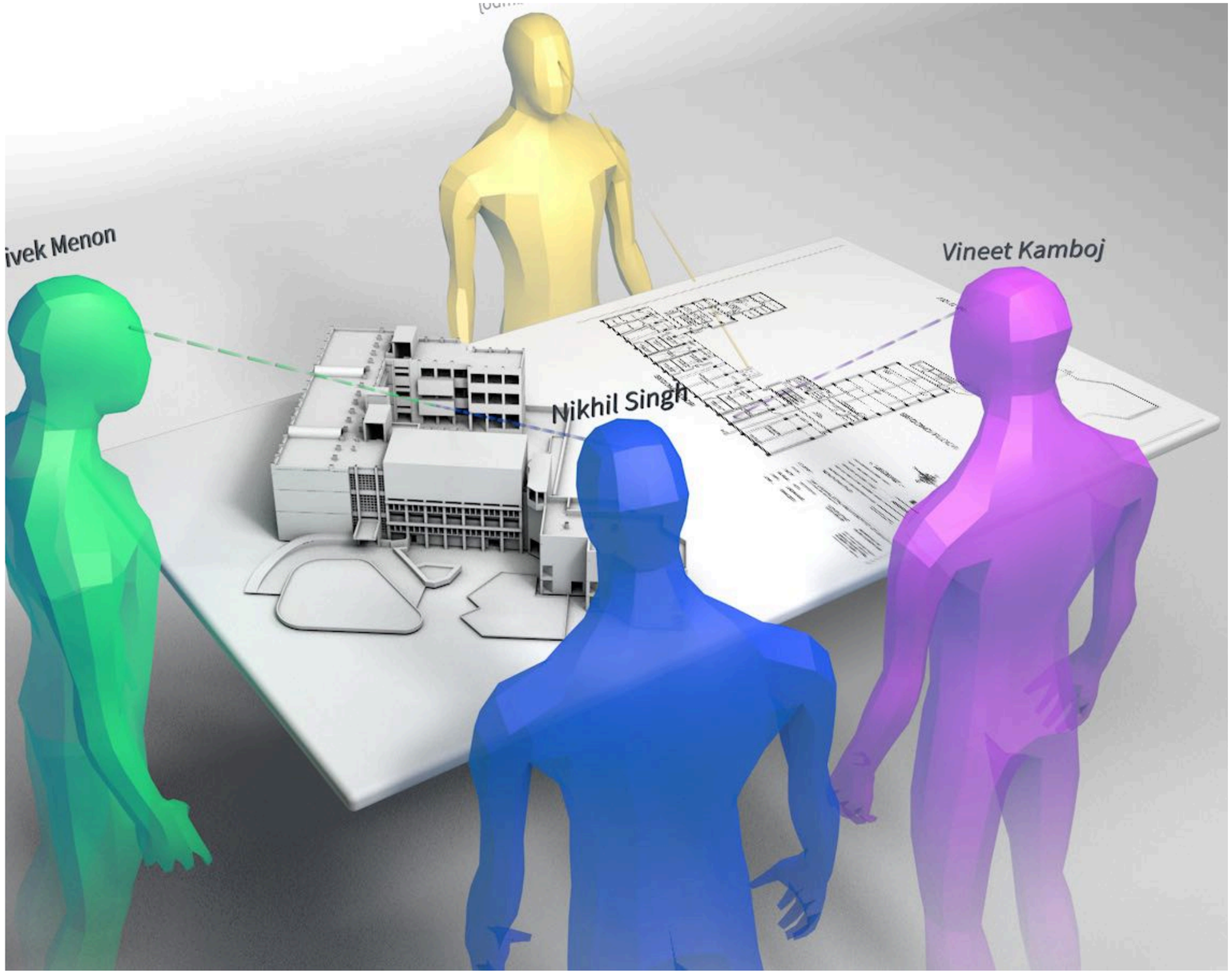
Upon resizing the model, it clips off around the edges of the table.



Communicative Interactions

Discussion Table

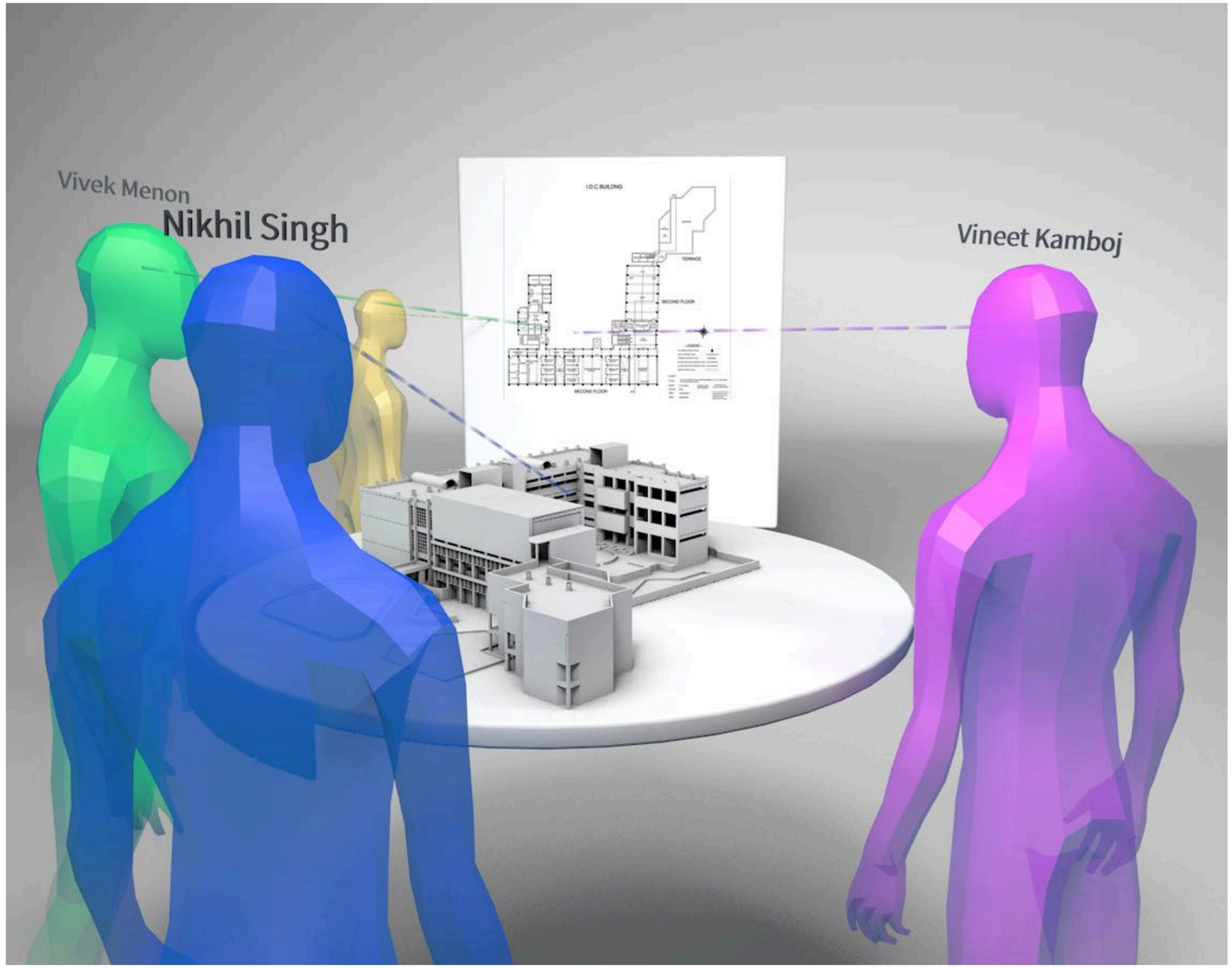
Another concept for putting up picture, videos and documents



Communicative Interactions

Discussion Board

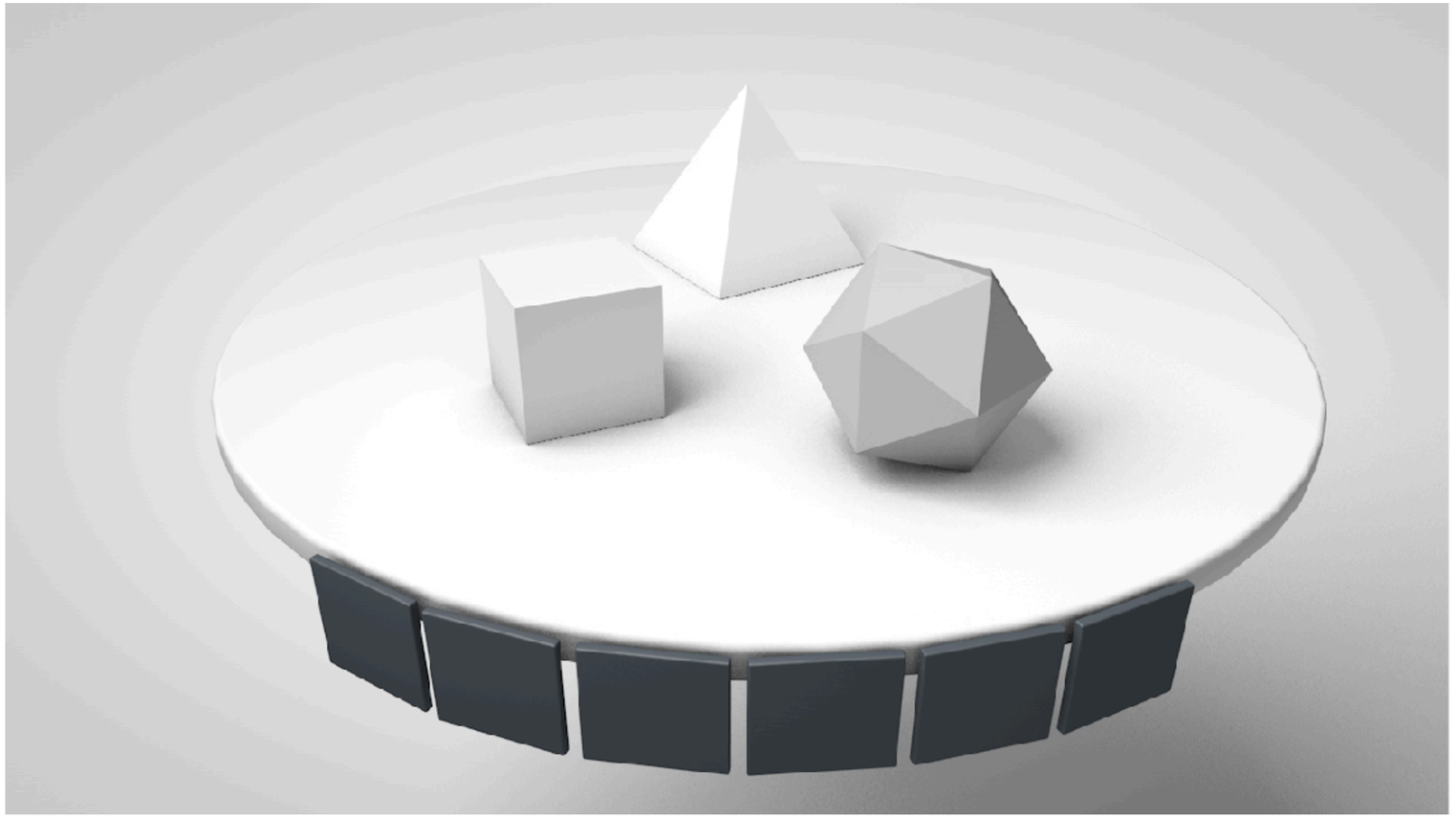
A discussion board for placing 2D drawings, photos or videos for discussion



Communicative Interactions

Selection

Whenever an element is selected by a collaborator, the colour of the element changes to the colour of collaborators virtual avatar perform the activity



Gesture Used- *Microsoft*

Communicative Interactions

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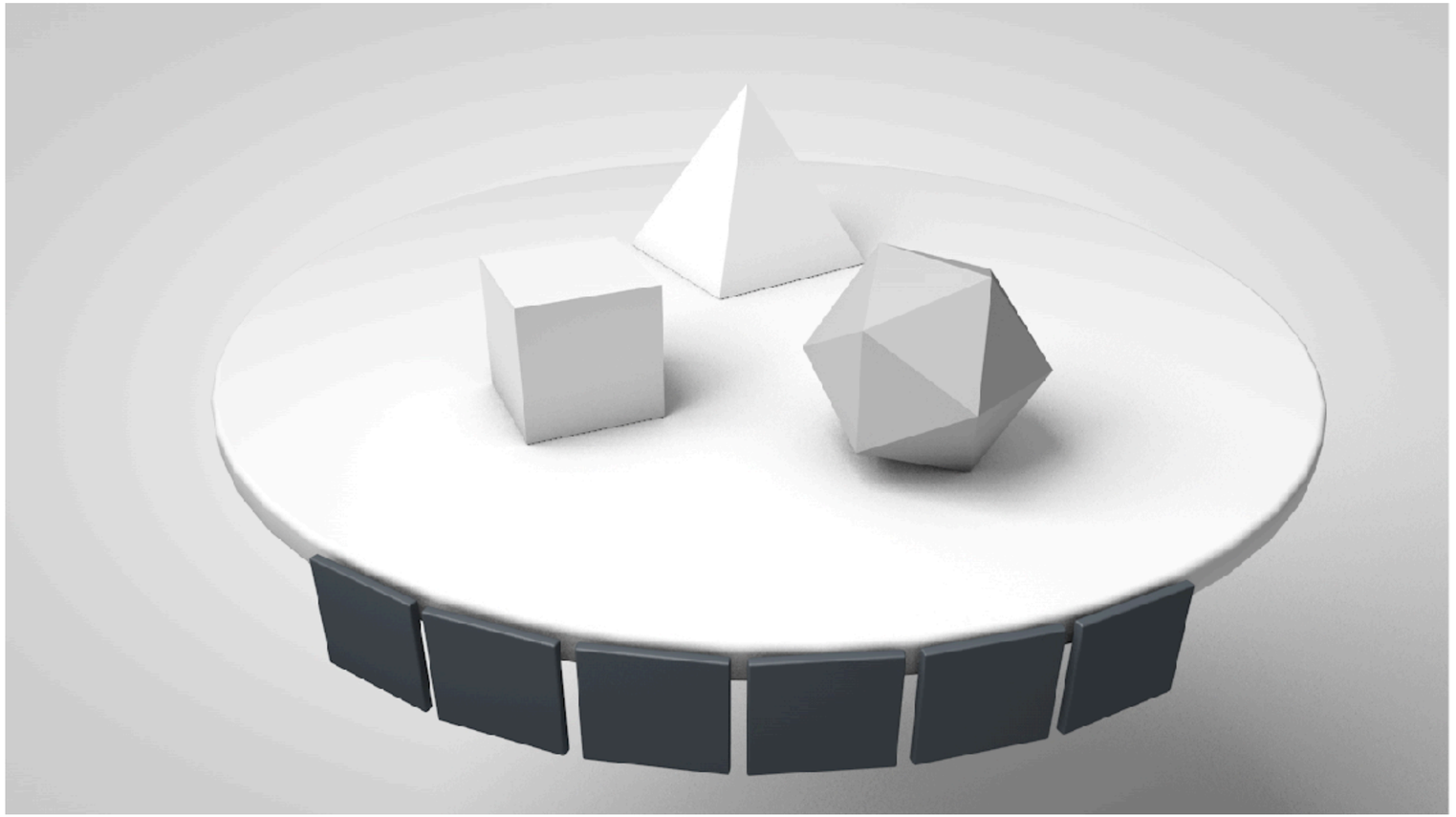
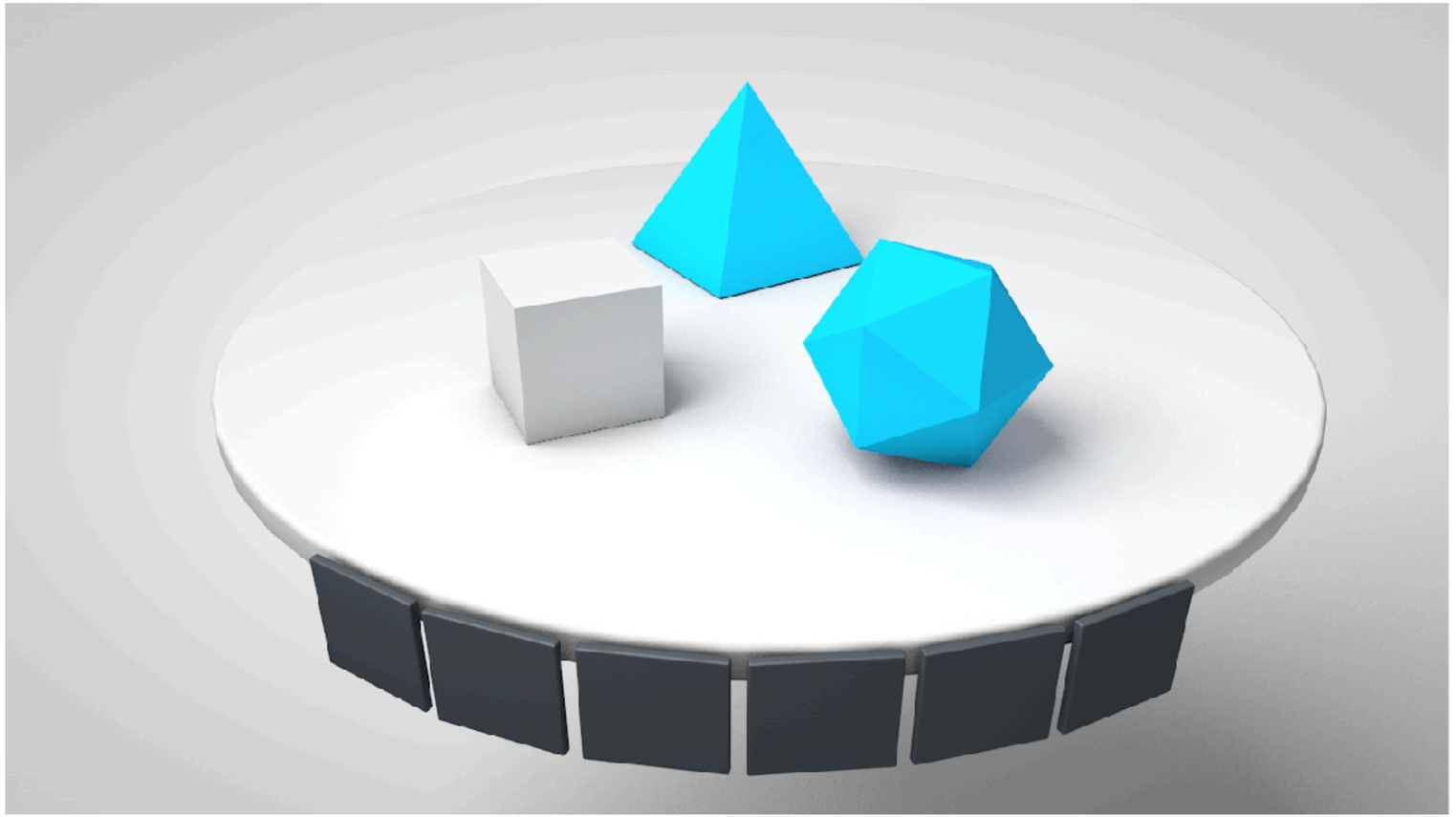


Gesture Used- *Microsoft*

Communicative Interactions

Selection

For making the the selection stand out, all other elements get translucent

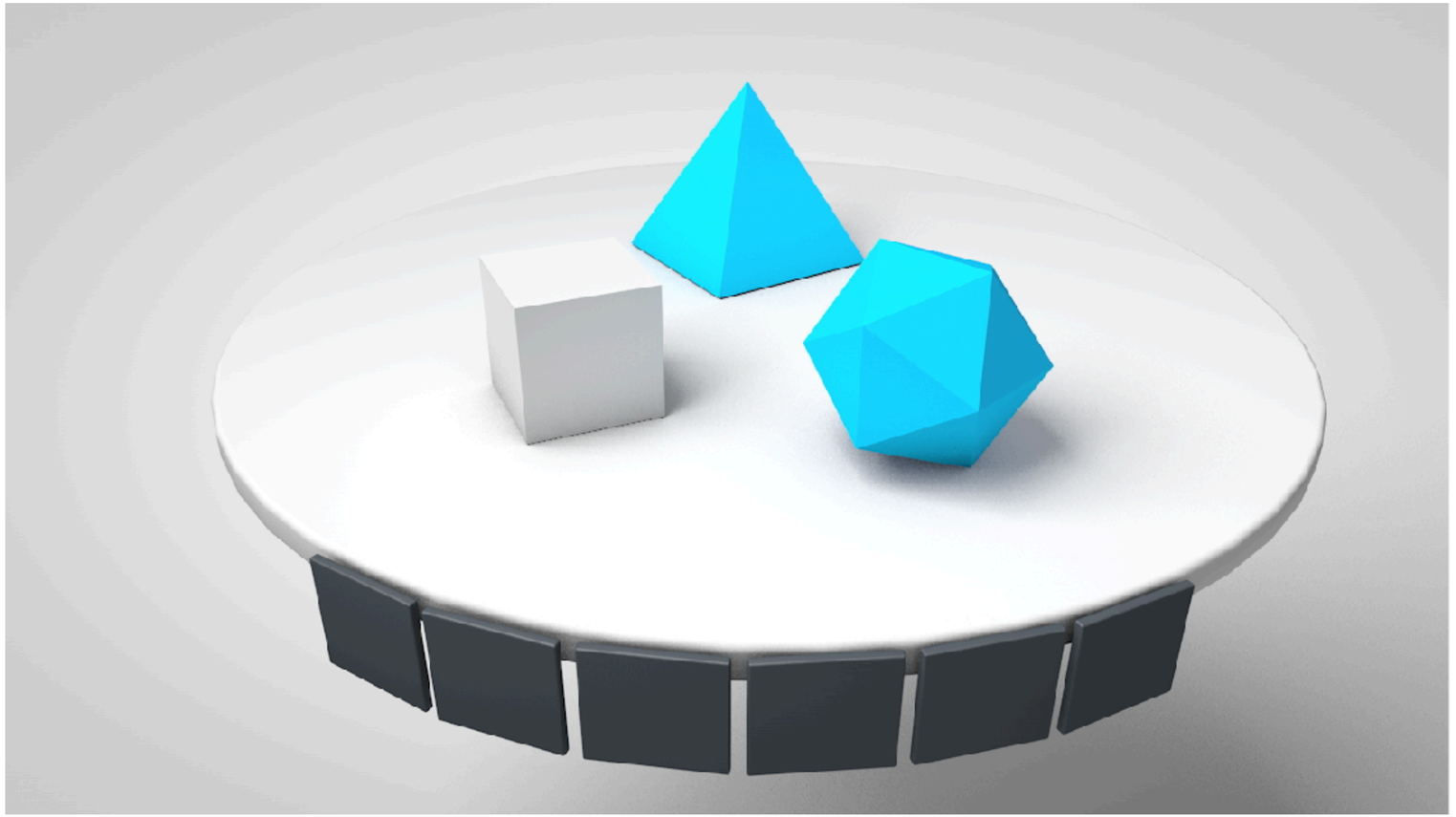


Gesture Used- *AirTap*

Communicative Interactions

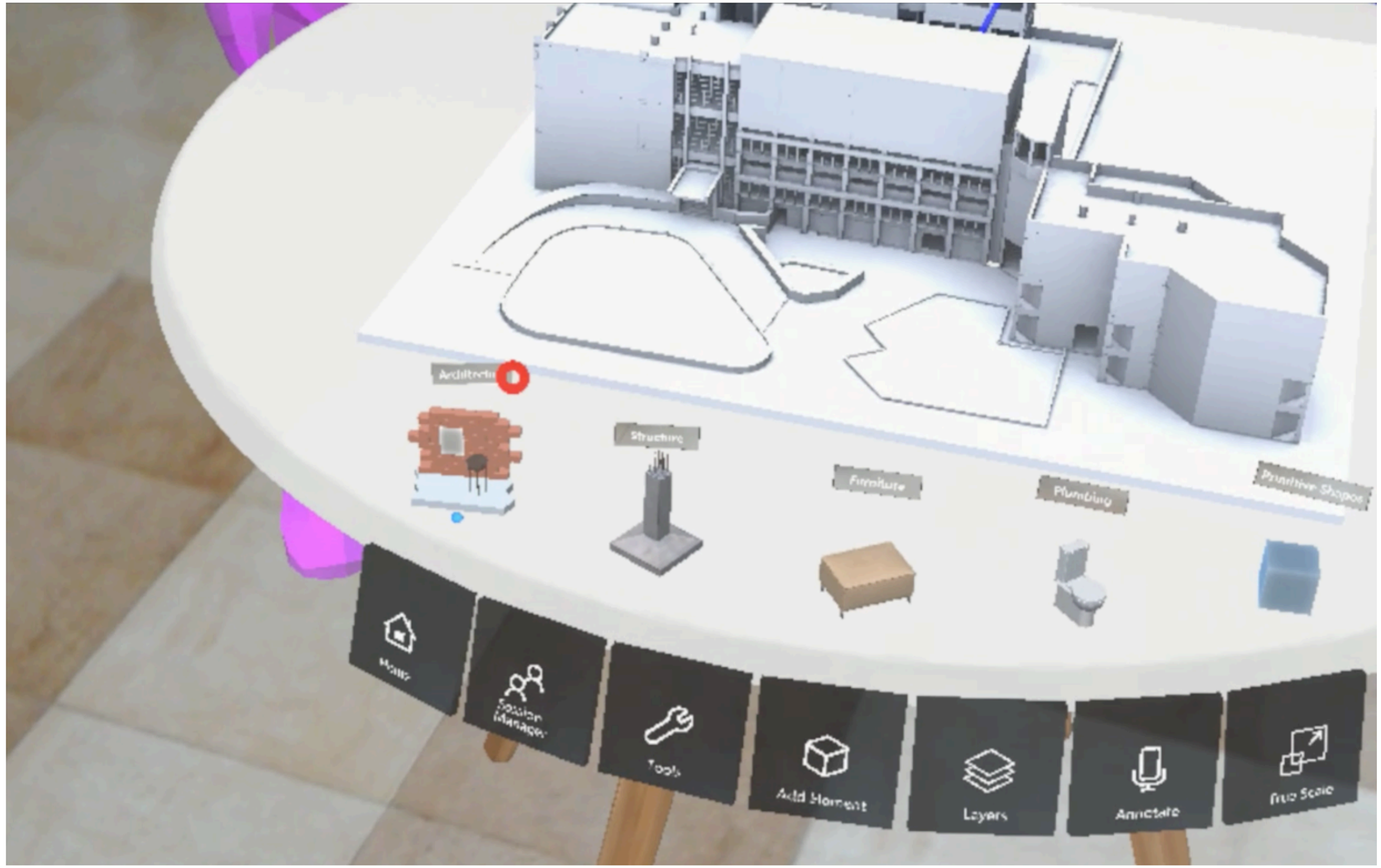
Selection

For making the the selection stand out, all other elements get translucent



Gesture Used- *AirTap*

Final Prototype



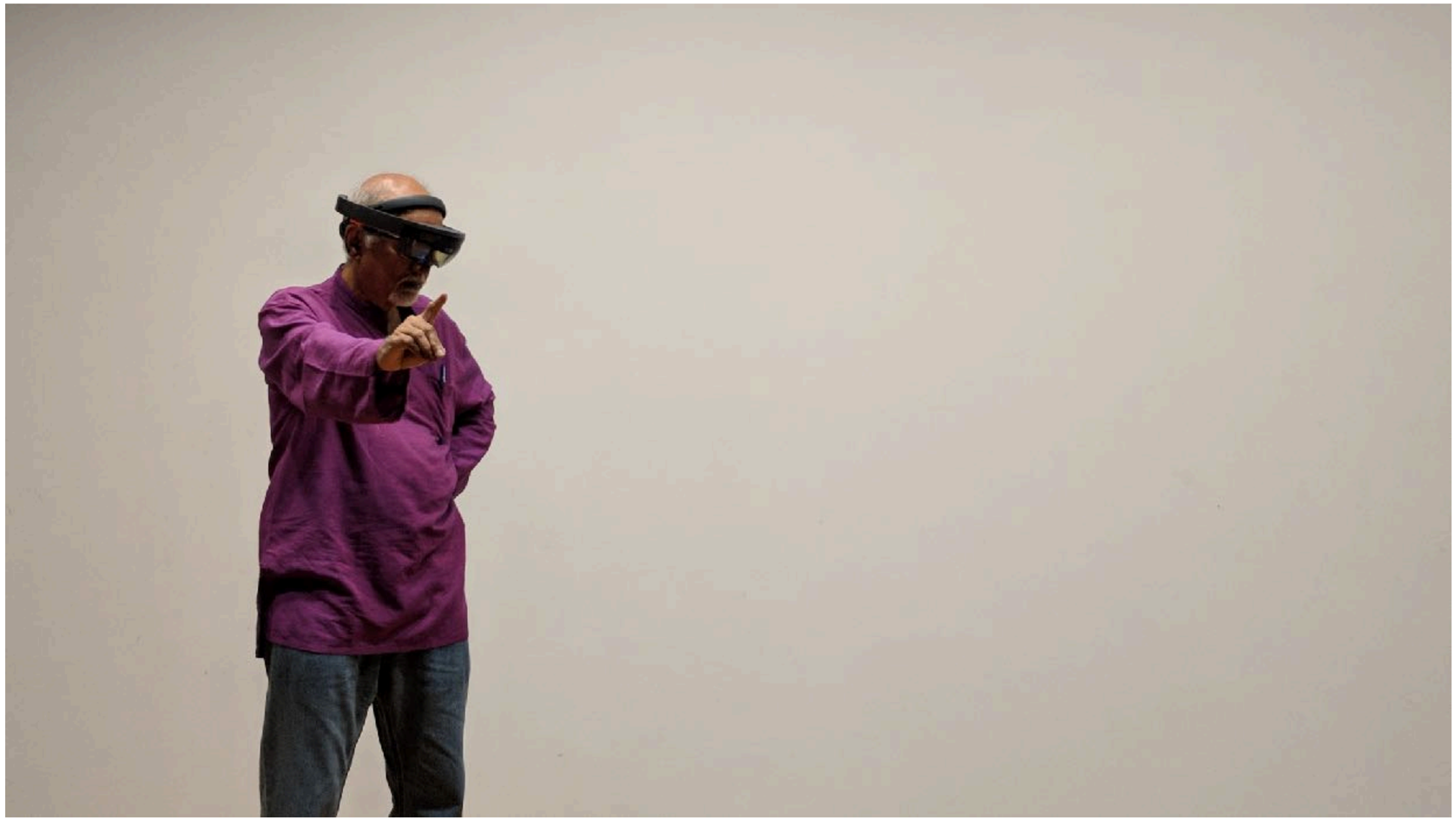
ArchDeck
DEMO

Evaluation

Formative Evaluation for spatial interface and activities

Evaluation

Formative Evaluation for spatial interface and activities



Evaluation

Formative Evaluation for spatial interface and activities

Issues

Physical Environment

Evaluator Issues

User Issues

Technical Issues

Issues with
Usability Methods

Evaluation

Formative Evaluation for spatial interface and activities

Issues

Physical Environment

Evaluator Issues

User Issues

Technical Issues

Issues with
Usability Methods

NASA TLX

Mental Demand

Physical Demand

Temporal Demand

Performance

Effort

Frustration

Evaluation

Formative Evaluation for spatial interface and activities

Issues

Physical Environment

Evaluator Issues

User Issues

Technical Issues

Issues with Usability Methods

NASA TLX

Mental Demand

Physical Demand

Temporal Demand

Performance

Effort

Frustration

Feedback

Device Specific

Interactions Specific

Interface Specific

Activity Specific

Functionality Specific

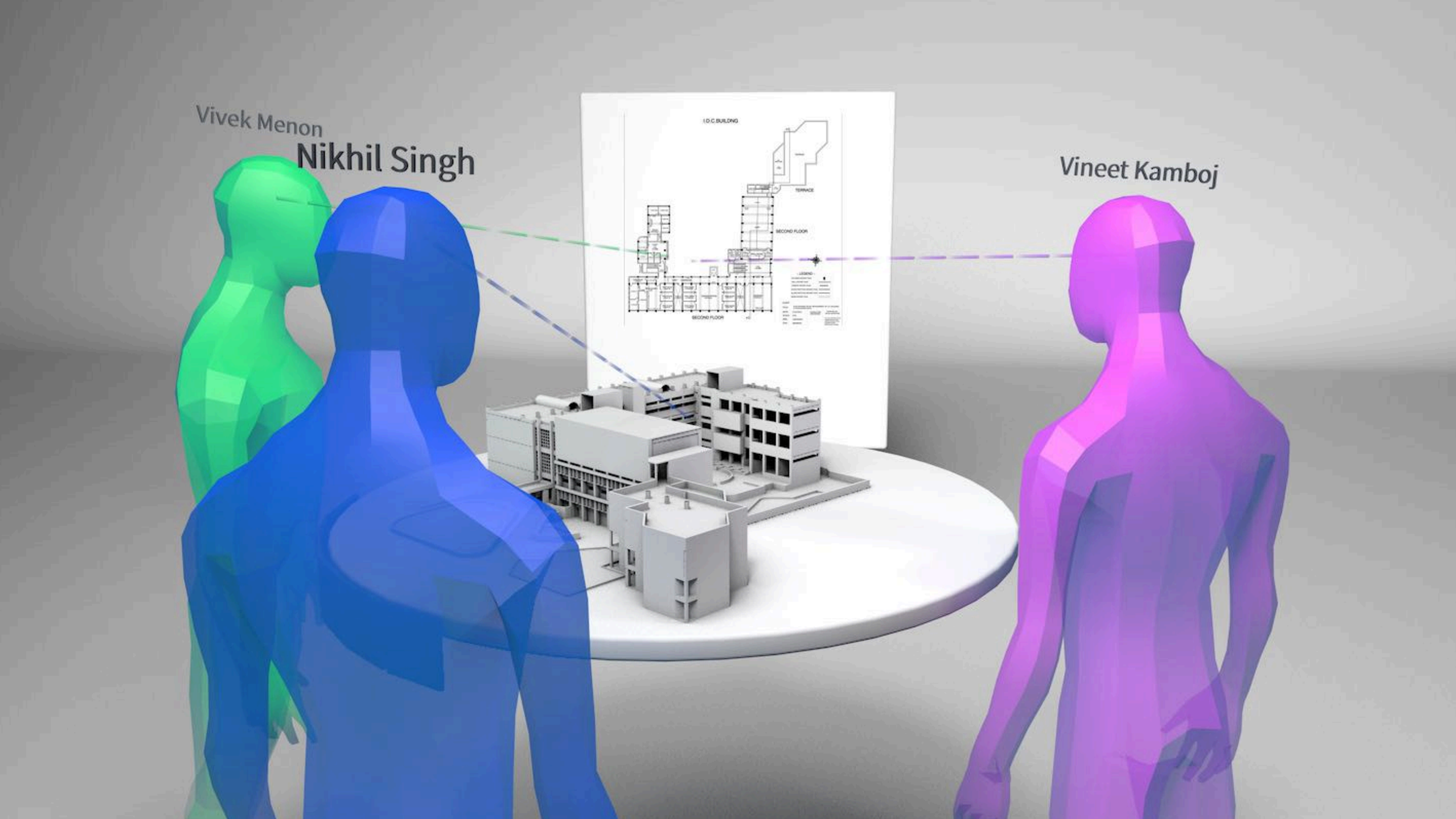
Development

Collaborative Ecosystem

Architect

MEP Consultant

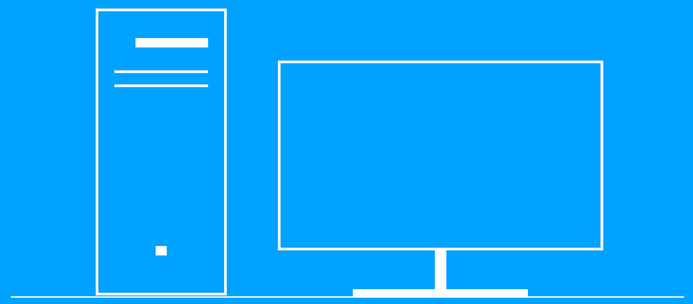
Structural Engineer


Vivek Menon
Nikhil Singh
Vineet Kamboj
I.O.C. BUILDING
TERRACE
SECOND FLOOR
SECOND FLOOR

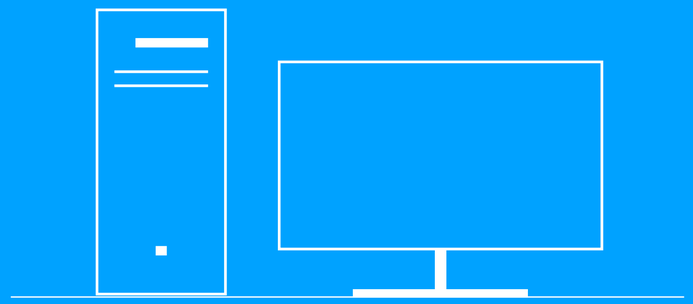
Architect

MEP Consultant

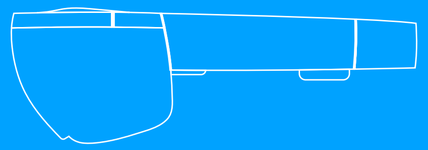
Structural Engineer



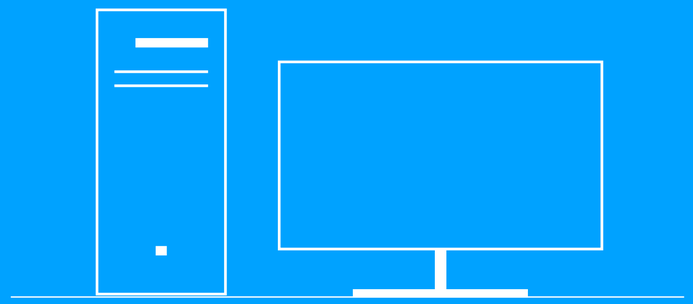
Build on desktop



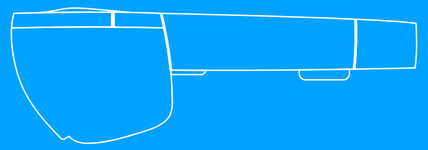
Build on desktop



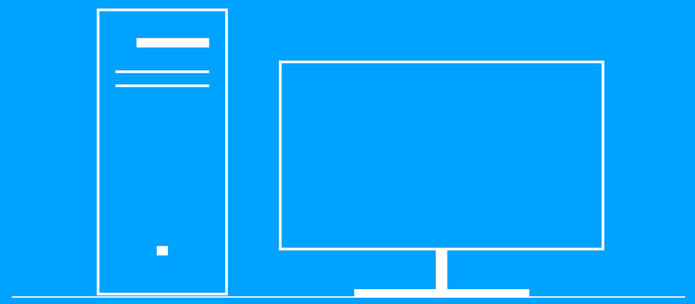
Collaborate in Mixed Reality



Build on desktop

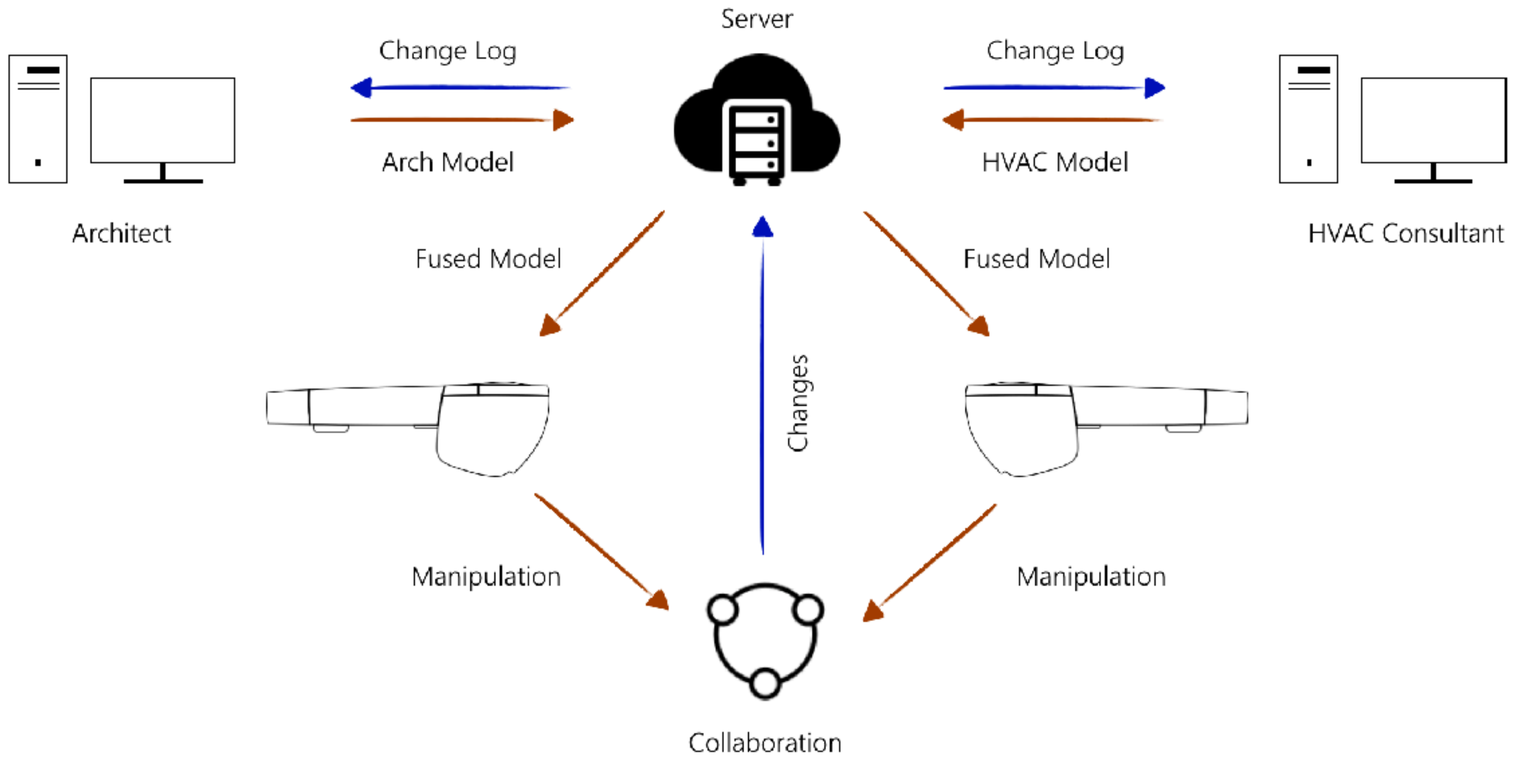


Collaborate in Mixed Reality

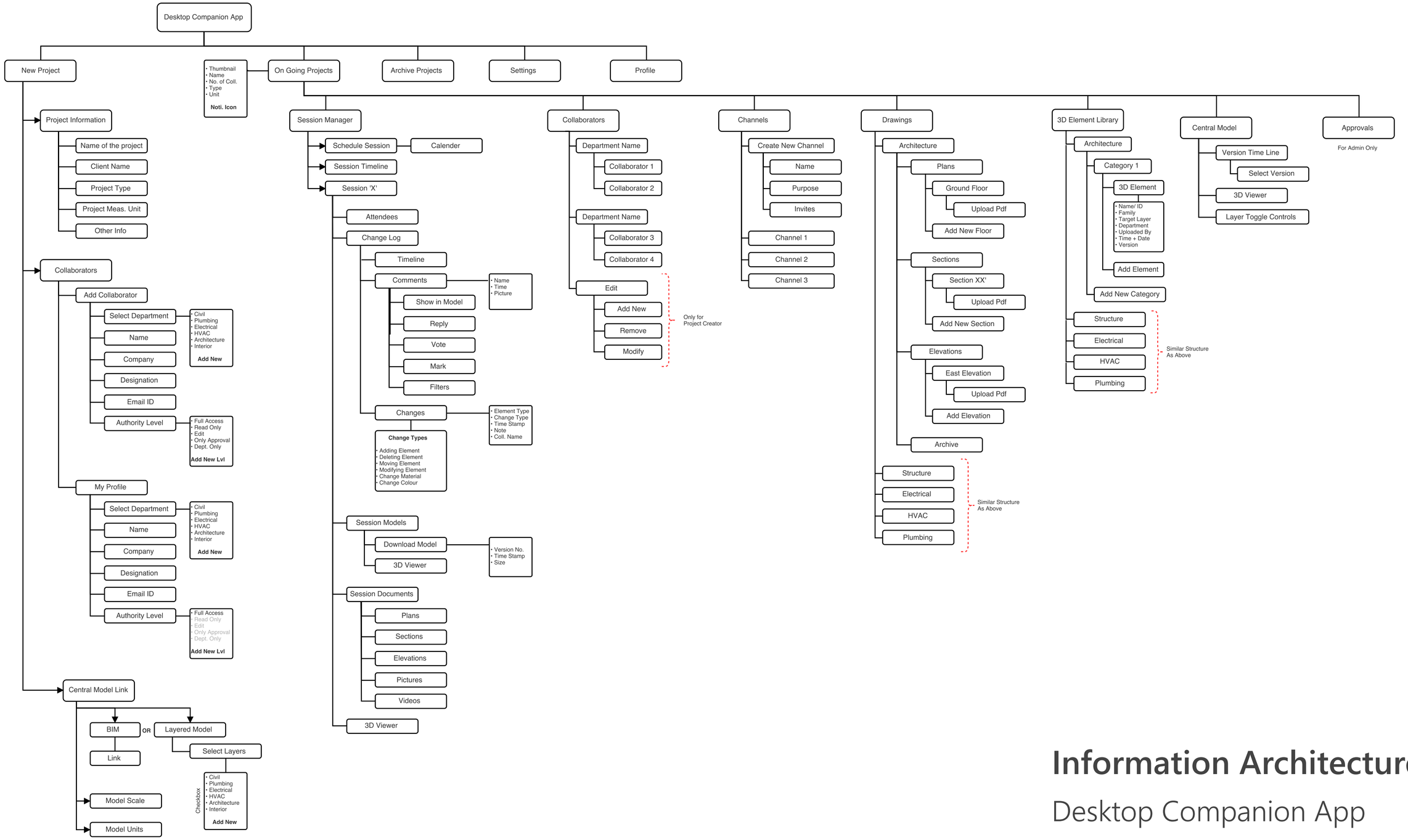


Take it back on desktop

Desktop Companion Application

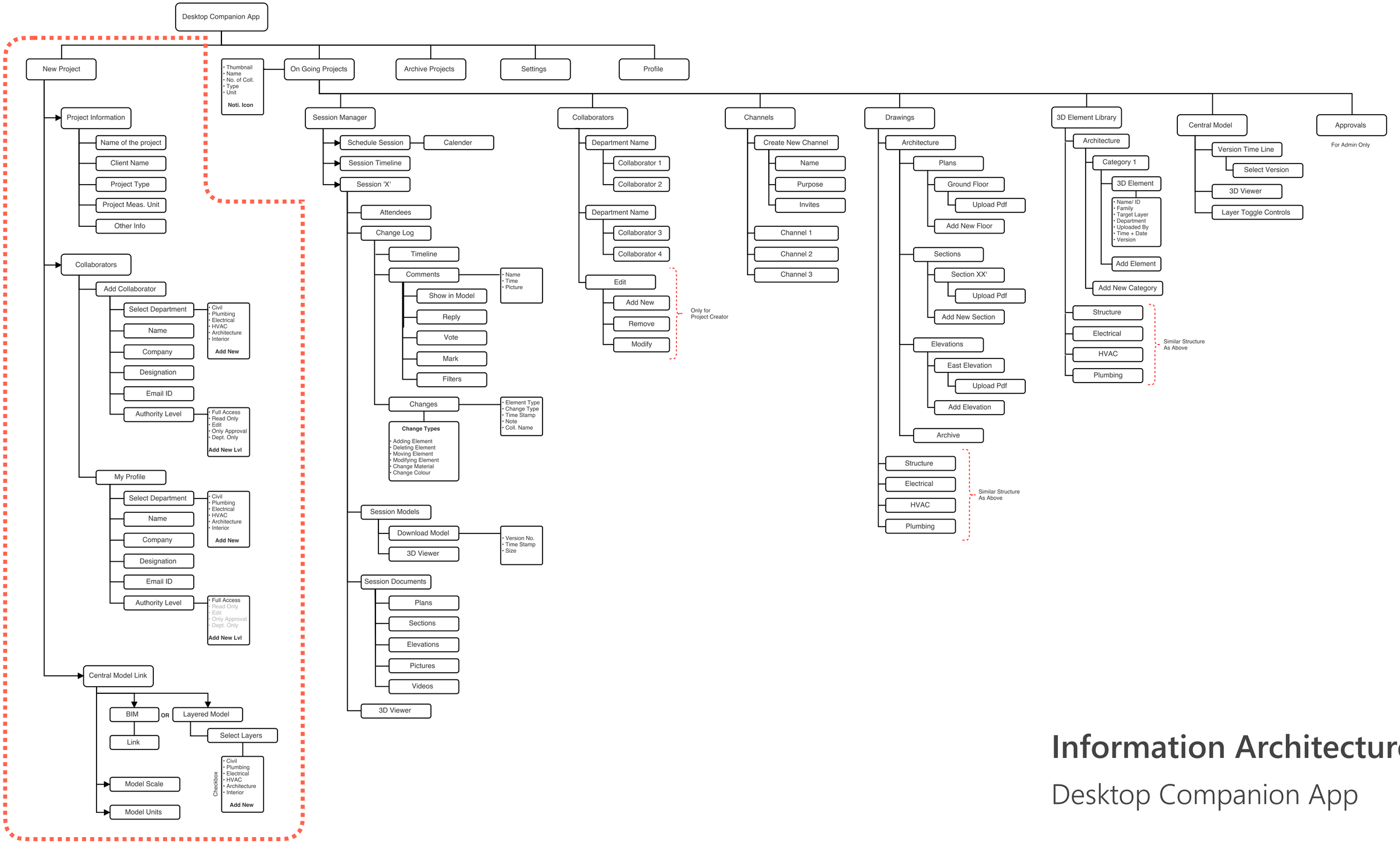


DCA allows exchange of data between Hololens application and workstation on which user work on



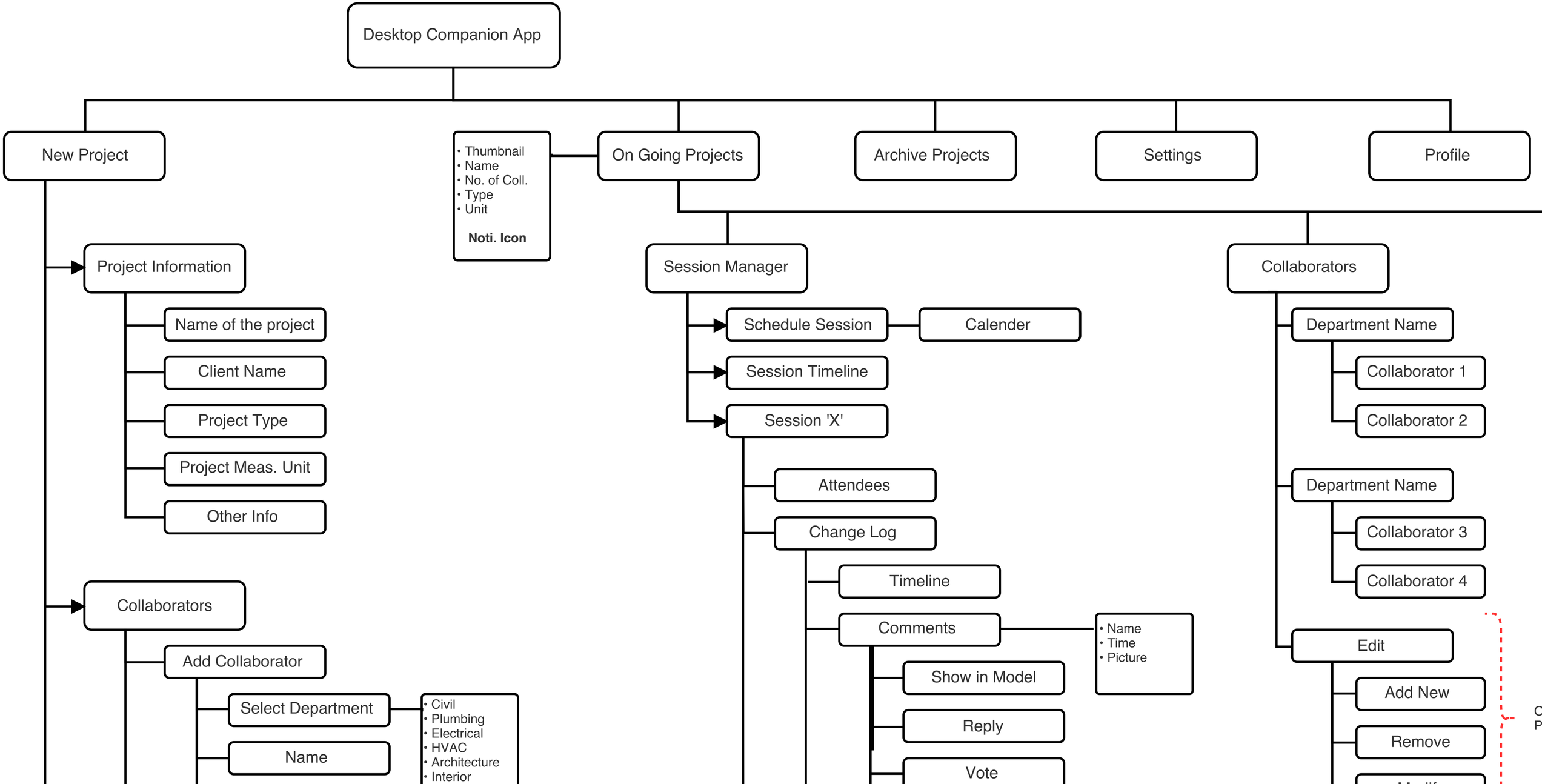
Information Architecture

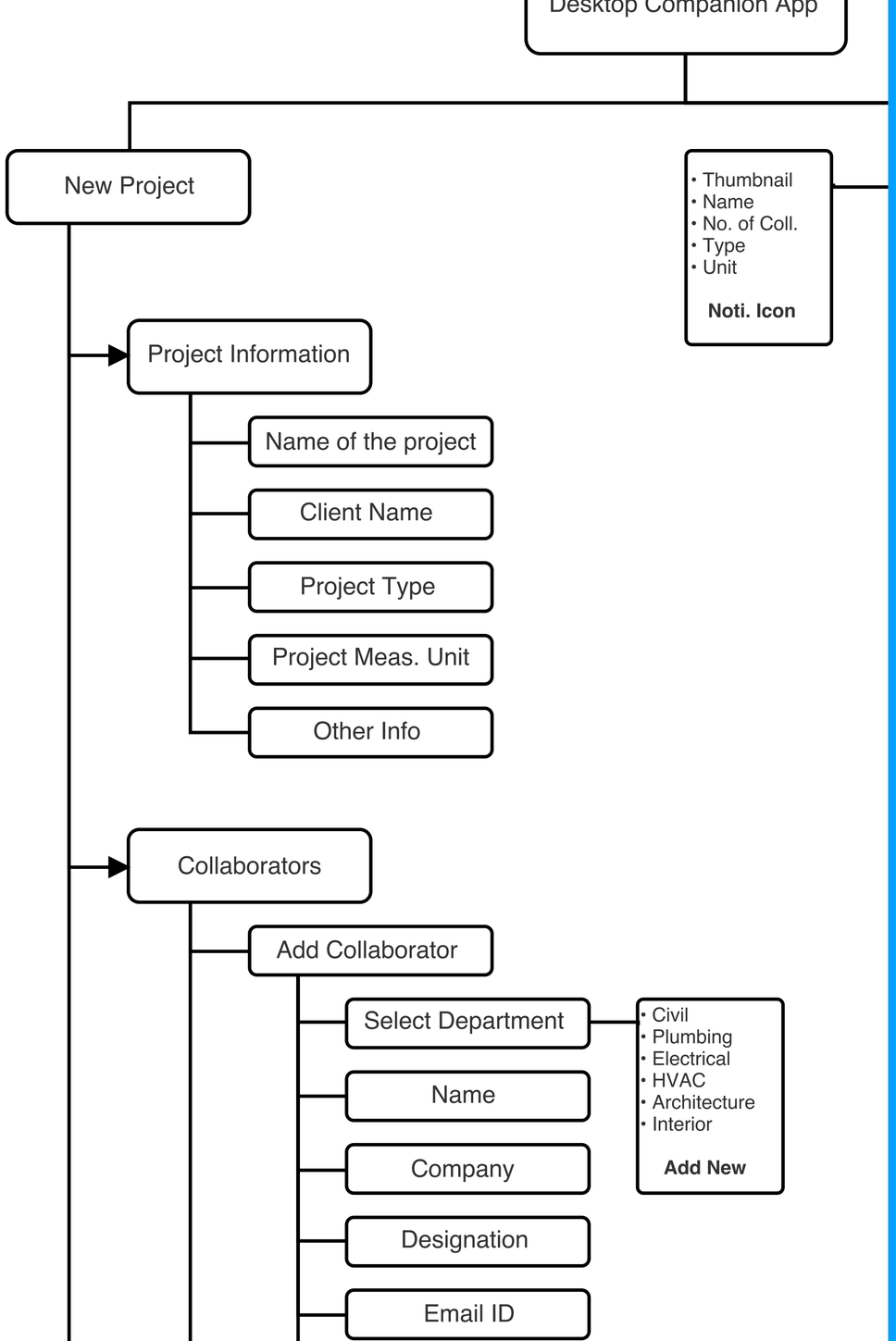
Desktop Companion App



Information Architecture

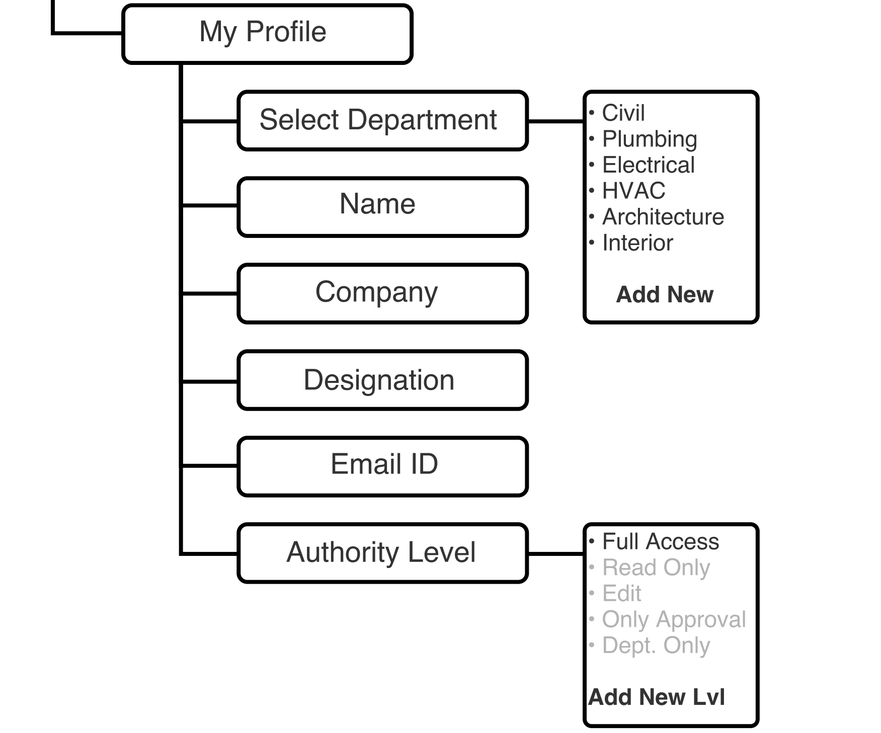
Desktop Companion App

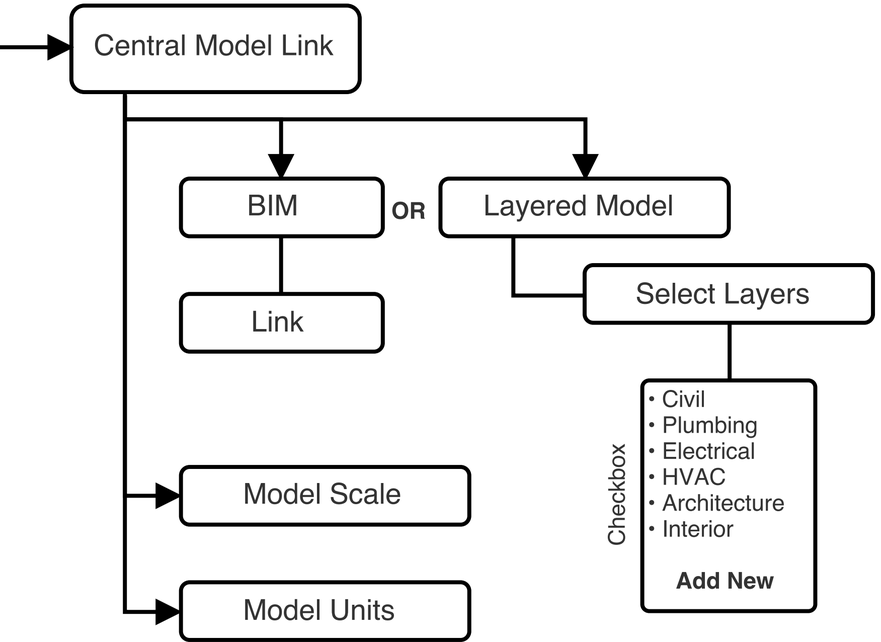

Desktop Companion App
New Project
• Thumbnail
• Name
• No. of Coll.
• Type
• Unit
Noti. Icon
On Going Projects
Archive Projects
Settings
Profile
Project Information
Name of the project
Client Name
Project Type
Project Meas. Unit
Other Info
Collaborators
Add Collaborator
Select Department
• Civil
• Plumbing
• Electrical
• HVAC
• Architecture
• Interior
Name
Session Manager
Schedule Session
Calender
Session Timeline
Session 'X'
Attendees
Change Log
Timeline
Comments
• Name
• Time
• Picture
Show in Model
Reply
Vote
Collaborators
Department Name
Collaborator 1
Collaborator 2
Department Name
Collaborator 3
Collaborator 4
Edit
Add New
Remove



Create New Project

- Project Information
- Adding Collaborators





Create New Project

- Project Information
- Adding Collaborators
- Setting Up Creator’s Profile
- Linking Central/Base Model

Desktop Companion App

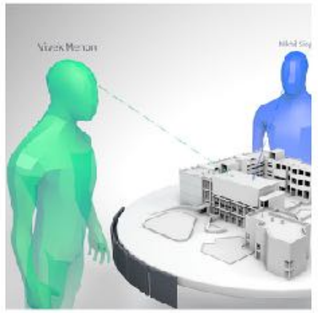
Projects

Username

Settings

Desktop Companion App

On Going Projects | Archived Projects | Create New Project



Name of the project
Project Type

Name of the project
Project Type

Name of the project
Project Type

Name of the project
Project Type

Name of the project
Project Type

Name of the project
Project Type

Desktop Companion App

Projects

Username

Settings

Desktop Companion App

On Going Projects | Archived Projects | Create New Project

Name of the project
Project Type

Name of the project
Project Type

Name of the project
Project Type

Name of the project
Project Type

Desktop Companion App

Projects

Desktop Companion App

On Going Projects | Archived Projects | Create New Project

Project Information

Name of the project

Enter Name

Name of Client

Enter Name

Select project type

Select Type

Select Project Units

Select Units

- Millimeters
- Meters ✓
- Centimeters
- Feet
- Inches

Next

Username

Settings

Desktop Companion App

Projects

Username

Settings

Desktop Companion App

On Going Projects | Archived Projects | Create New Project

Add Collaborators

Name of the collaborator

Enter Name

Company of the collaborator

Enter Company Name

Designation

Enter Designation

Email Id

Enter Email Id

Select Department

Select Department

Select Select Authority Level

Select Auhority Level

Add Another | Done

Desktop Companion App

Projects

Username

Settings

Desktop Companion App

On Going Projects | Archived Projects | Create New Project

Project Creator

Name

Enter Name

Company

Enter Company Name

Designation

Enter Designation

Email Id

Enter Email Id

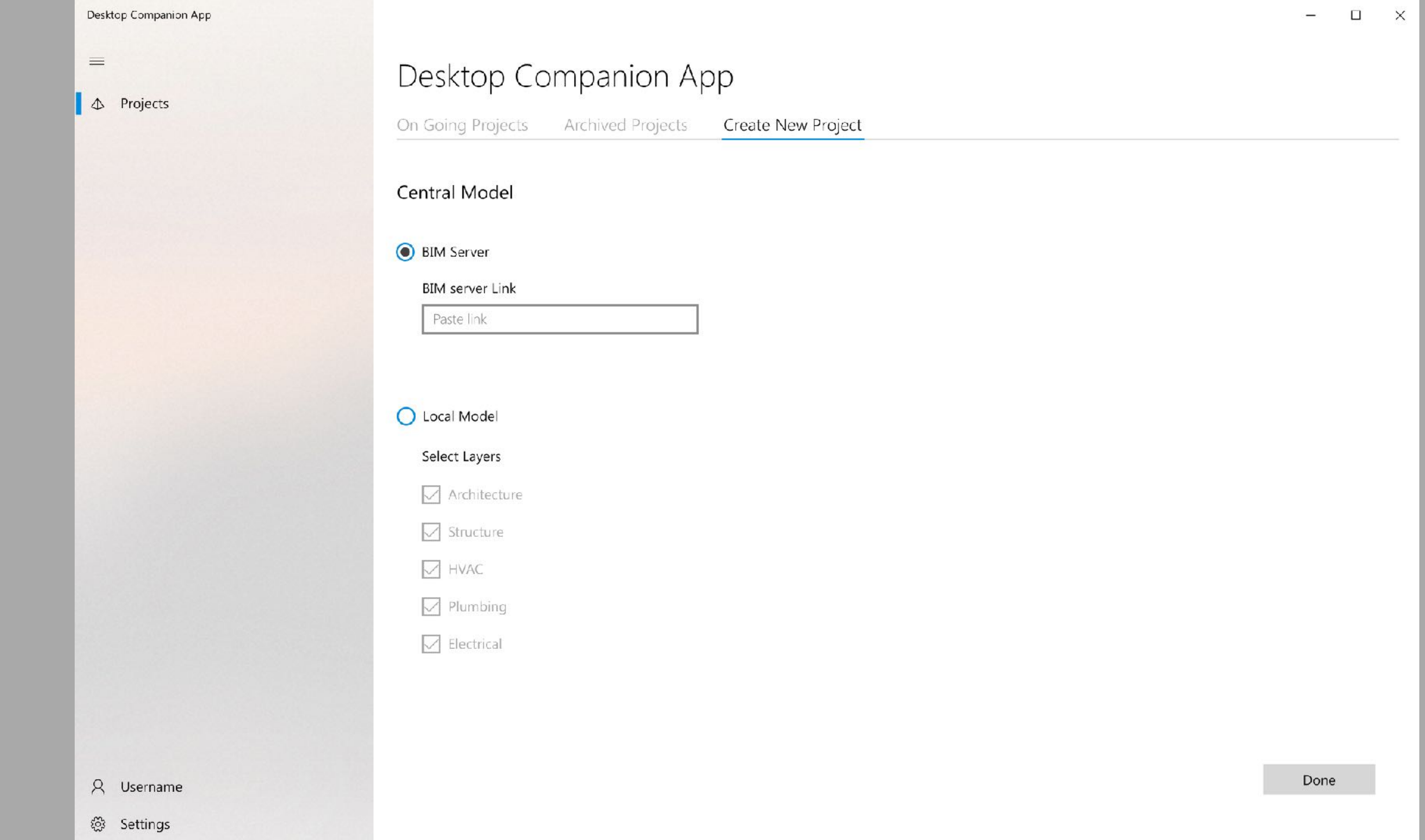
Select Department

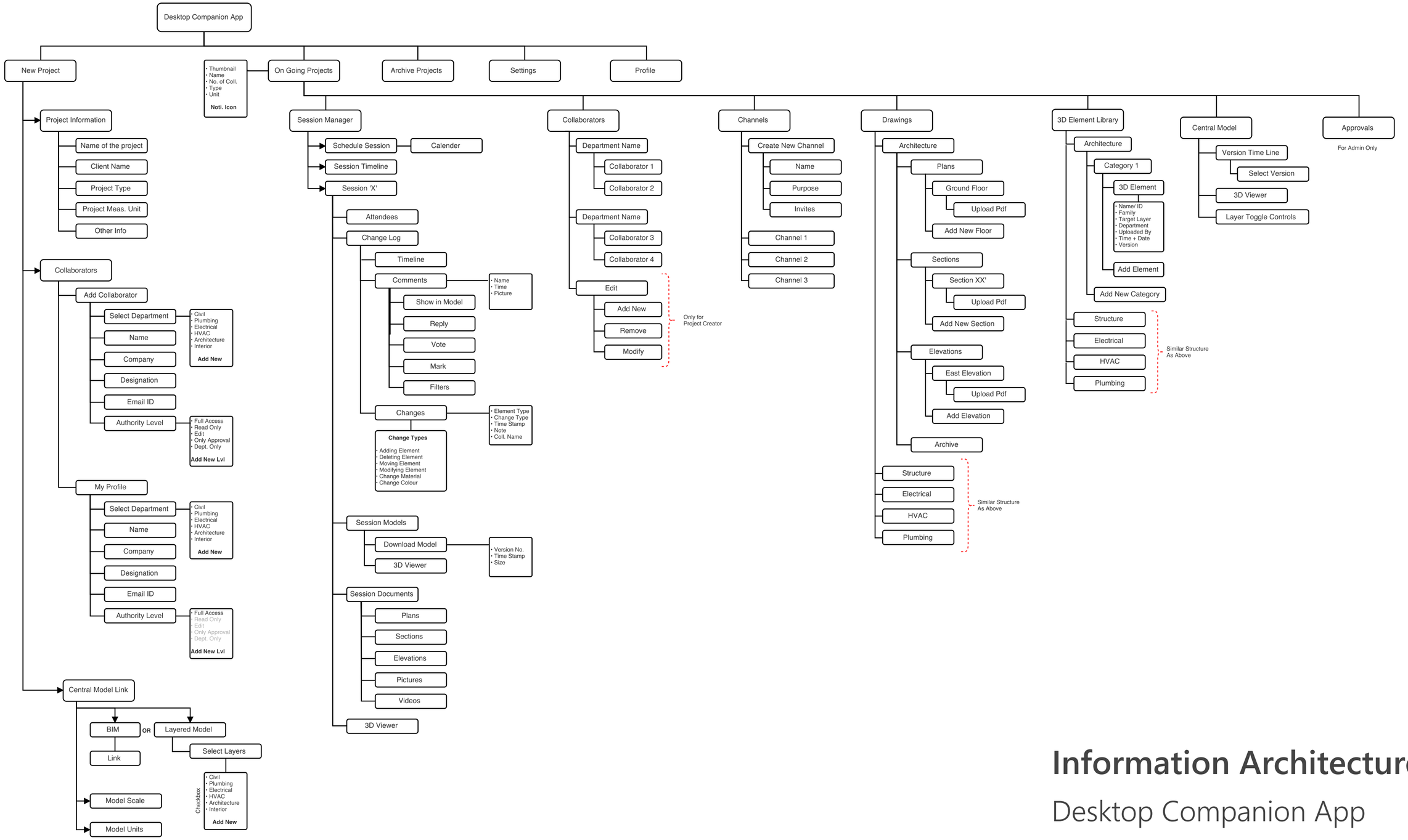
Select Department

Select Select Authority Level

Full Access

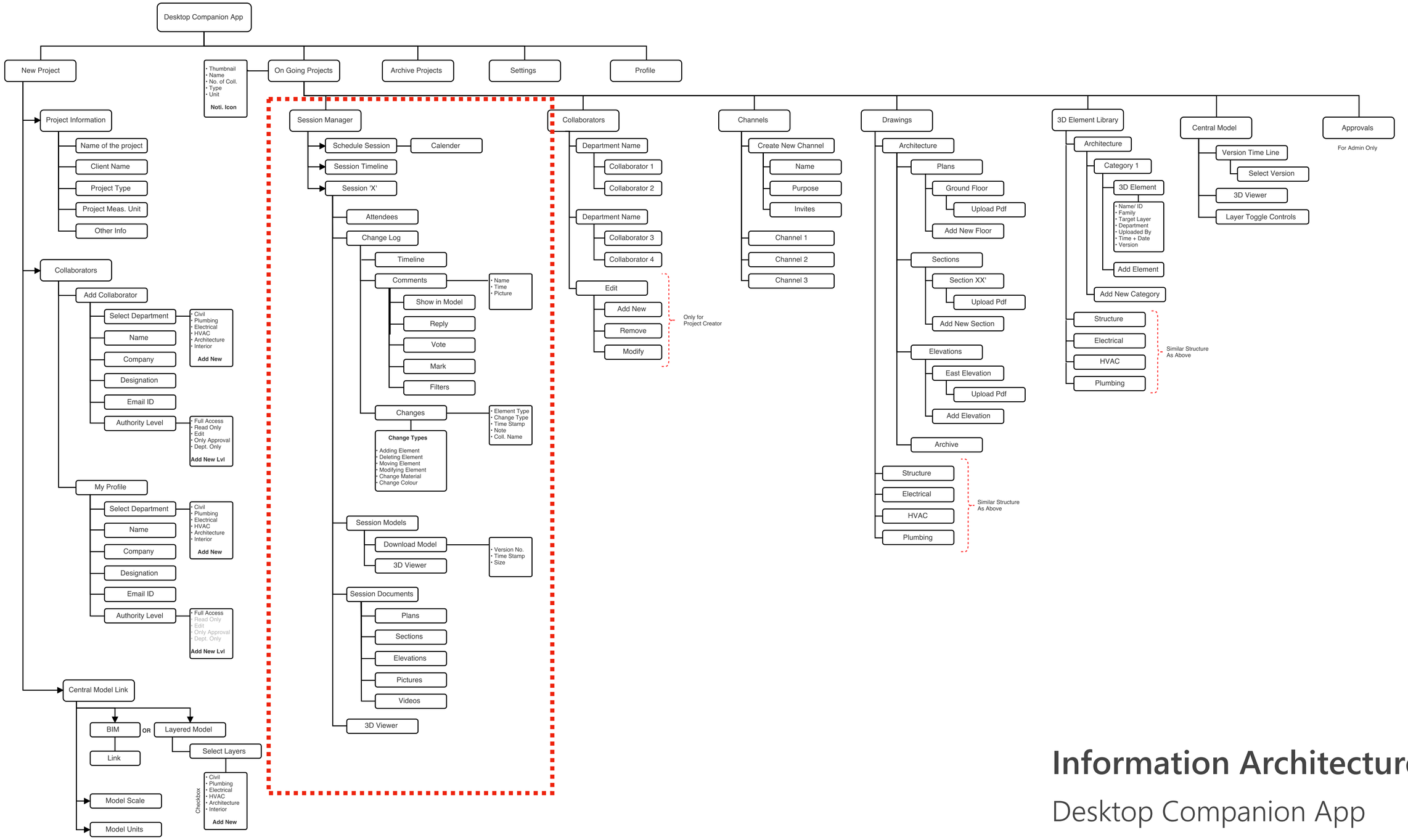
Next


Desktop Companion App
Projects
Desktop Companion App
On Going Projects
Archived Projects
Create New Project
Central Model
BIM Server
BIM server Link
Paste link
Local Model
Select Layers
Architecture
Structure
HVAC
Plumbing
Electrical
Done
Username
Settings



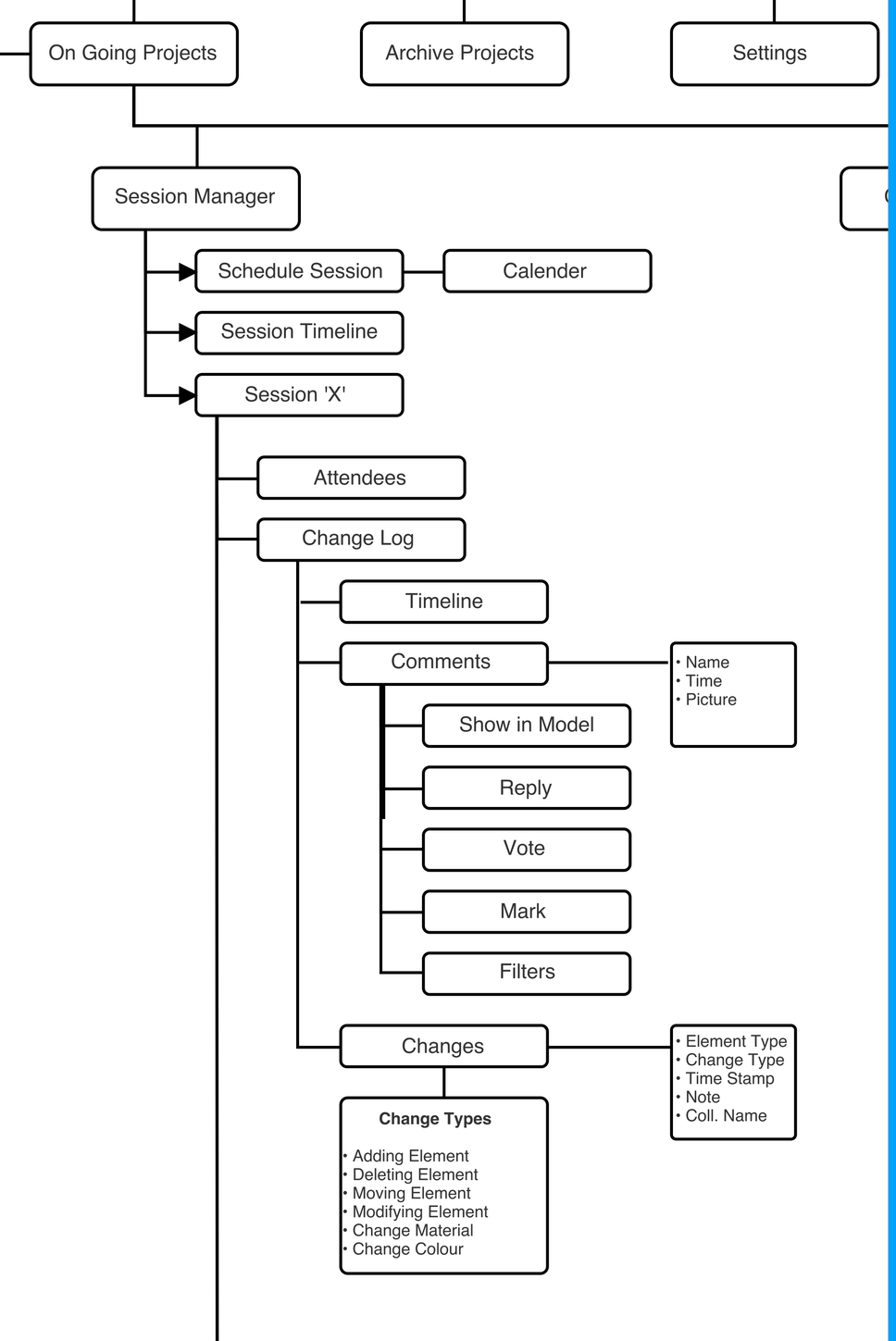
Information Architecture

Desktop Companion App



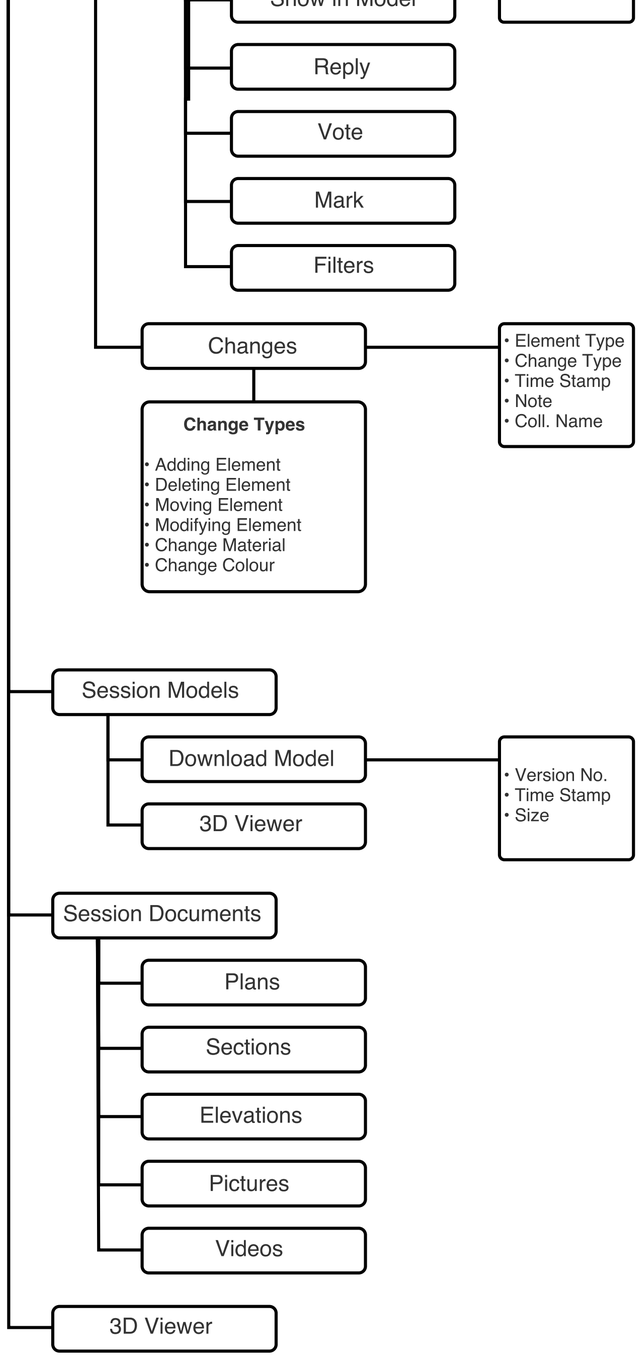
Information Architecture

Desktop Companion App



Session Manager

- All the details of collaborative sessions are stored here
- Change logs
- Comments



Session Manager

- All the details of collaborative sessions are stored here
- Change logs
- Comments
- Session 3D Model
- Session Documents

Desktop Companion App

- Home
- Session manager
- Collaborators
- Drawings
- Central Model
- 3D Element Library

- Discussion Channels
  - Channel 1
  - Channel 2

- Username
- Settings

Session manager

Sessions

Session Name
24/3/2018

Recent Updates

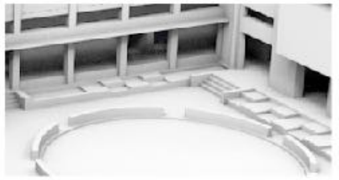
New Comment

Harold Nguyen 08:23 PM

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

Reply | View on model

3 New Changes



3 New Messages

Name of the Collaborator

Desktop Companion App

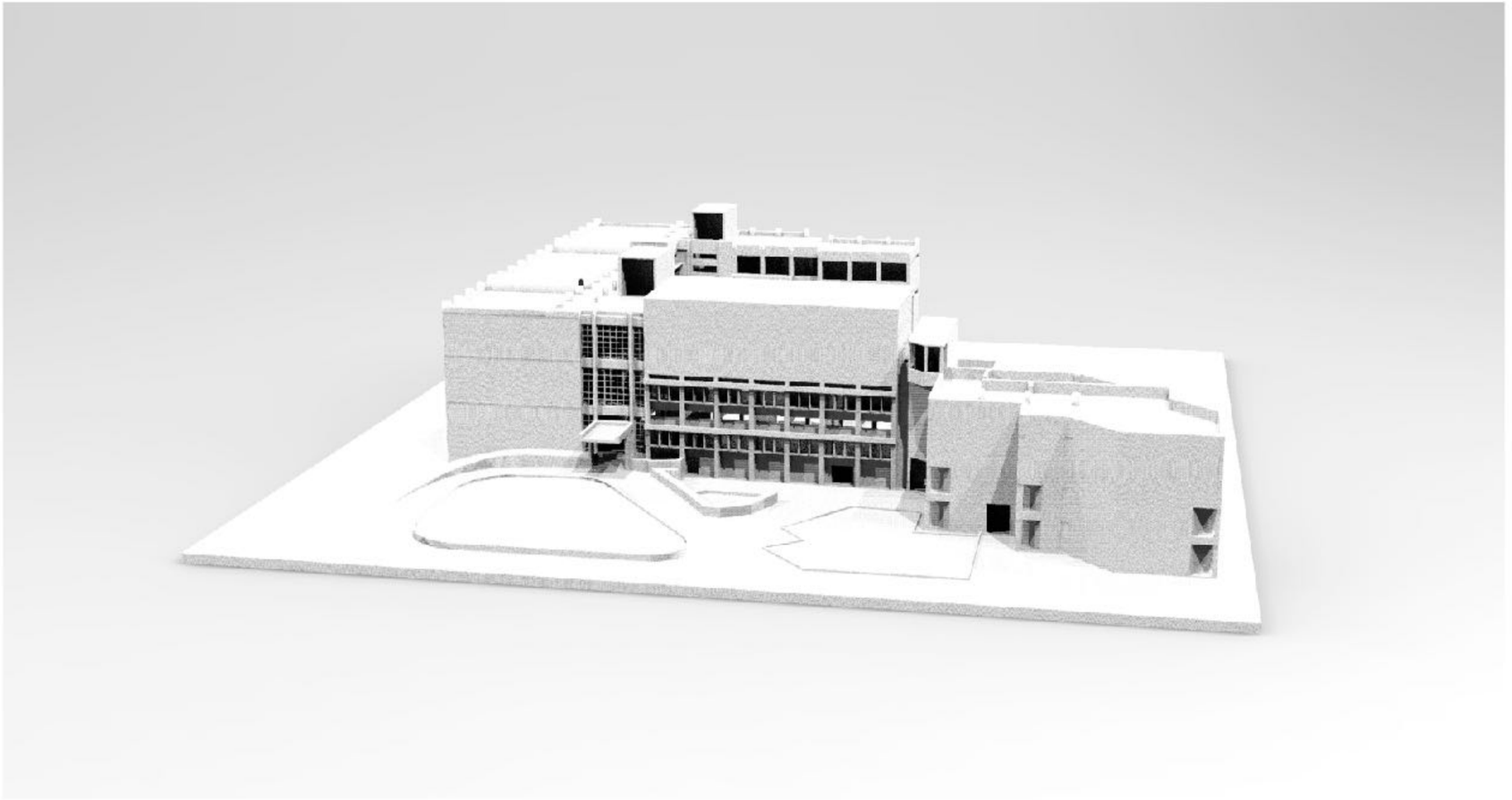
- Home
- Session manager
- Collaborators
- Drawings
- Central Model
- 3D Element Library

- Discussion Channels
  - Channel 1
  - Channel 2

- Username
- Settings

Session manager > **Session Name**

3D model | Change log | Comments | Documents | Attendees



Download Model Share Model

Desktop Companion App

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  - Channel 1
  - Channel 2

- Username
- Settings

Session manager > **Session Name**

3D model | Change log | Comments | Documents | Attendees

Changes

Added a wall 230mm
24/3/2018

Added 230mm wall

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout.

Added 230mm wall

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout.

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Session manager > **Session Name**

3D model | Change log | Comments | Documents | Attendees

Changes

Added a wall 230mm
24/3/2018

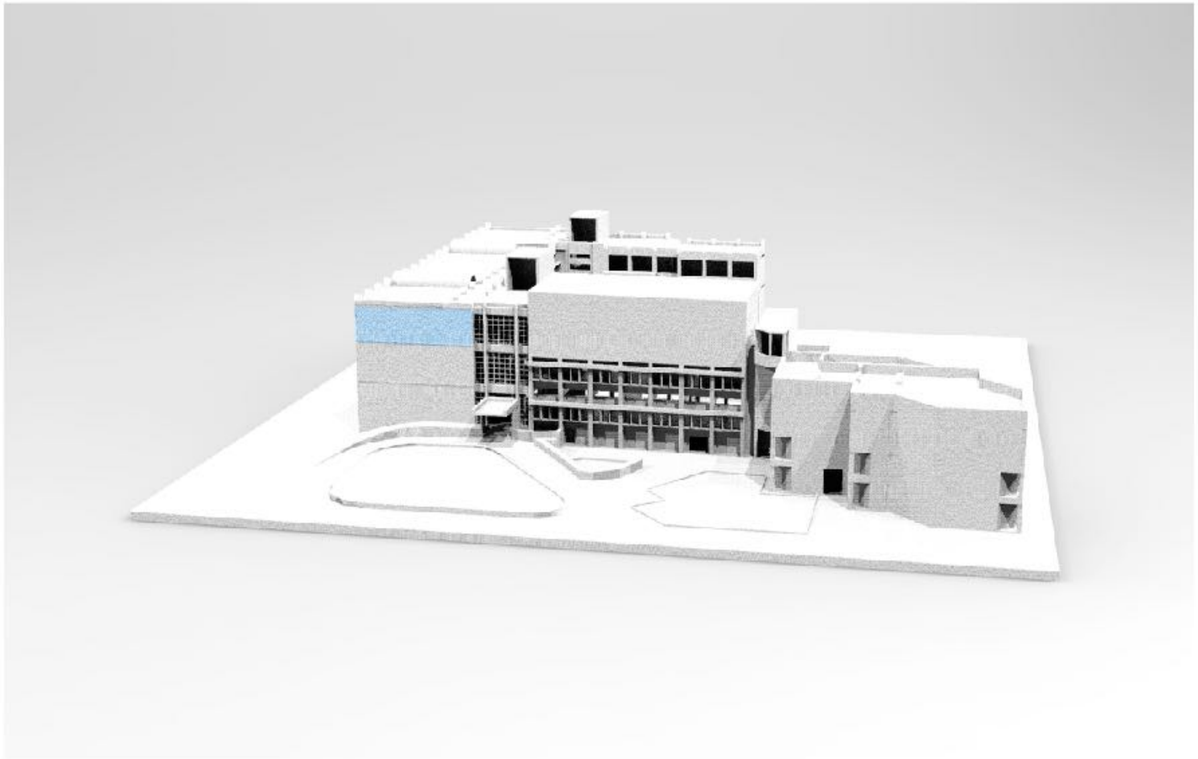
← Change No. 9

Added 230mm wall

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout.

Comment

Share



Desktop Companion App

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- Settings

Session manager > **Session Name**

3D model | Change log | Comments | Documents | Attendees

Harold Nguyen 08:23 PM

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.

Reply | View on model

Nathan Gutierrez 08:23 PM

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Willie Fields 08:23 PM

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Jeffrey Johnston 08:23 PM

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Justin Moore 08:23 PM

Desktop Companion App

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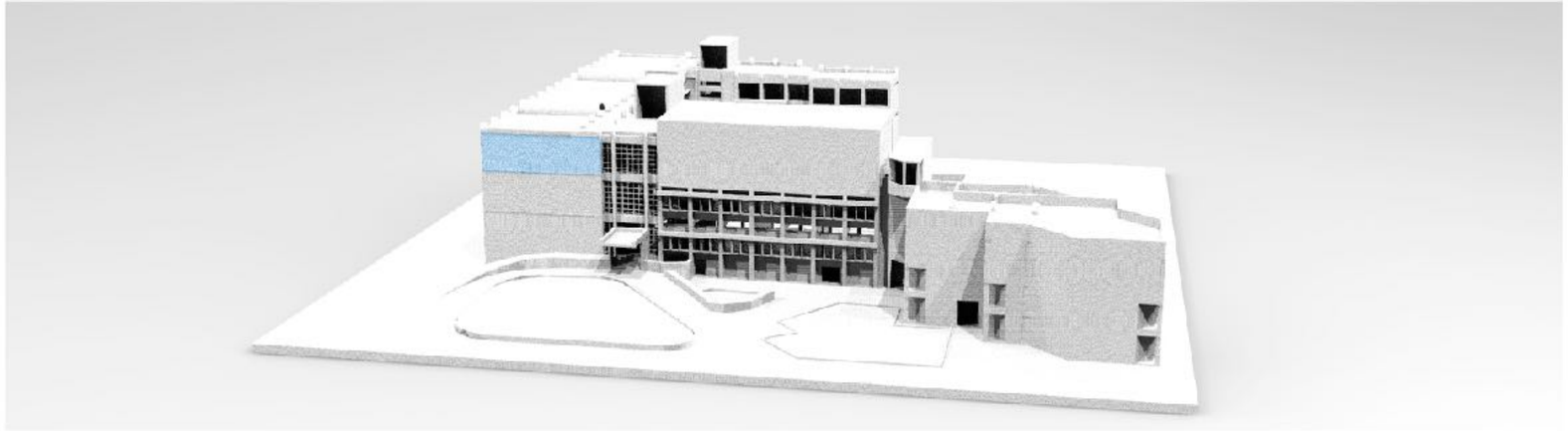
- Settings

Session manager > **Session Name**

3D model | Change log | Comments | Documents | Attendees

Harold Nguyen 08:23 PM

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.



Reply | Hide

Nathan Gutierrez 08:23 PM

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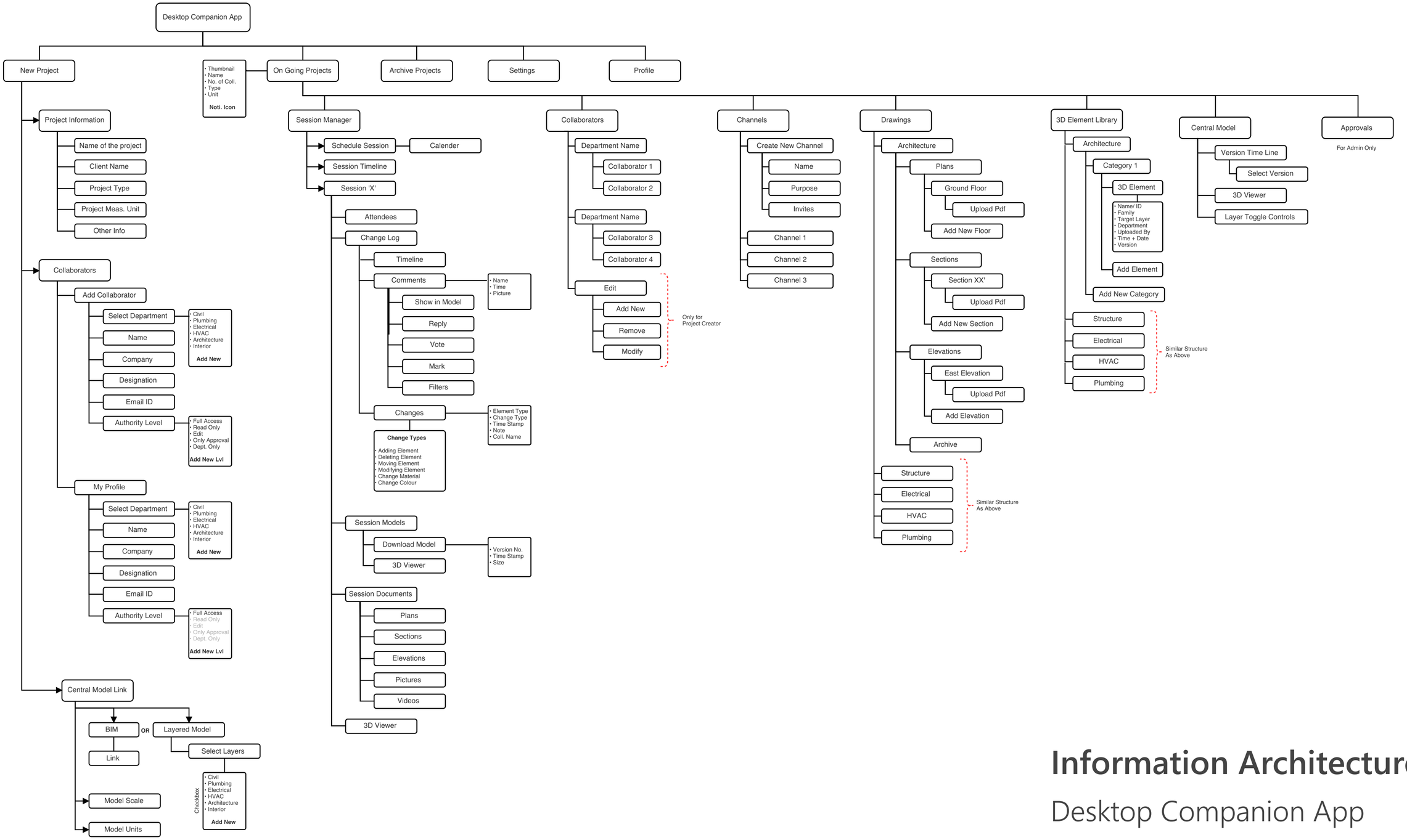
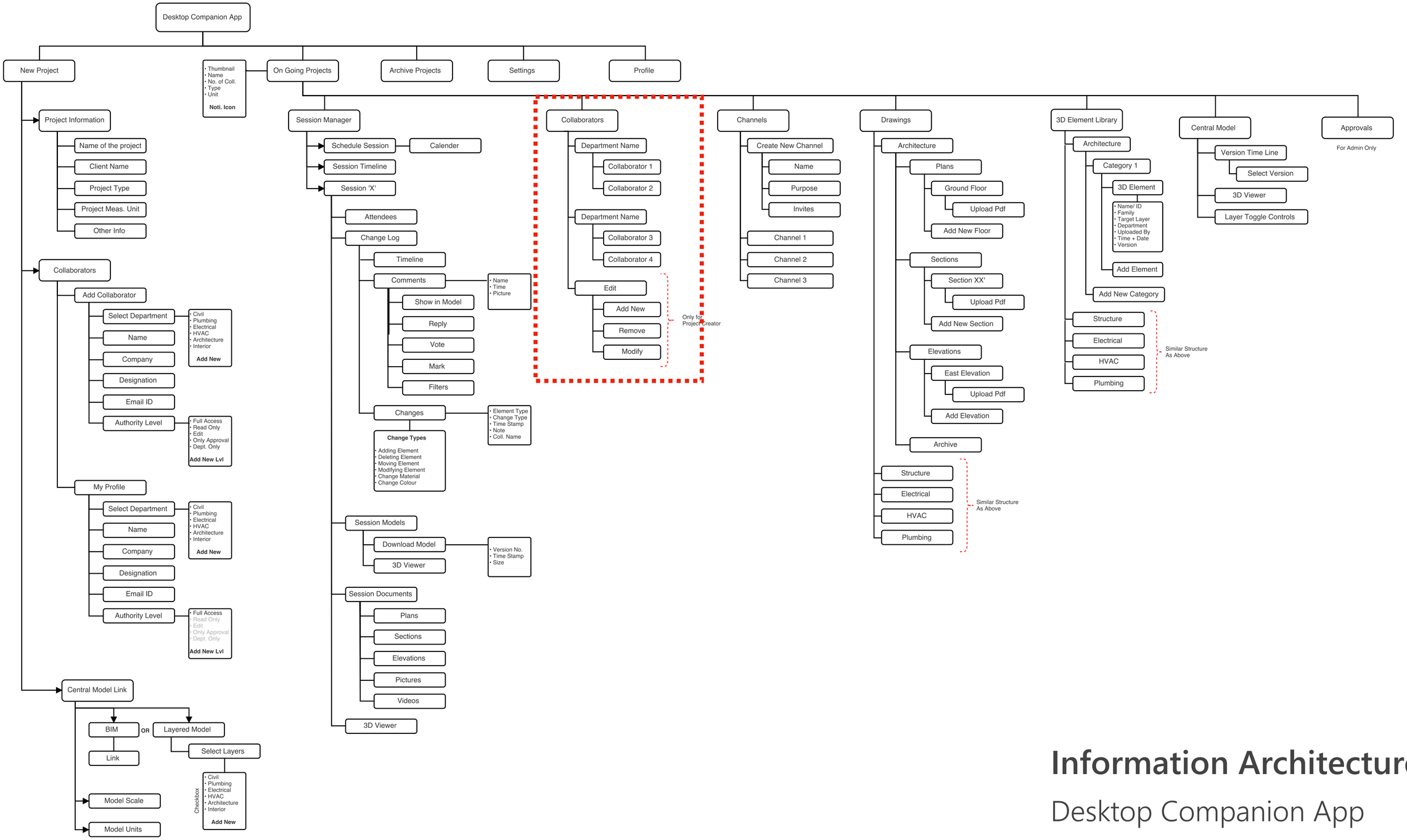
Willie Fields 08:23 PM

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad



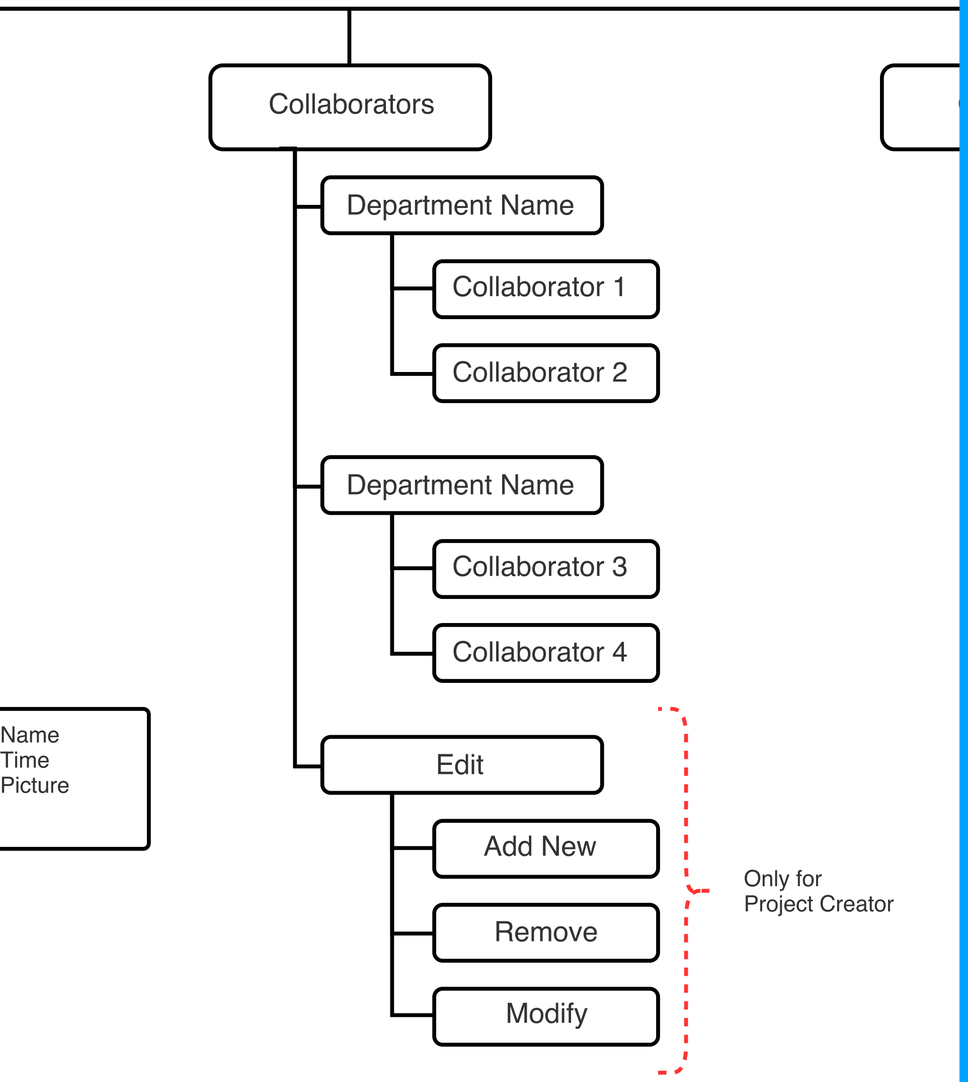
Information Architecture

Desktop Companion App



Information Architecture

Desktop Companion App



Collaborators

- Collaborator Details
- Allows you to go through collaborator activities

Desktop Companion App

- Home
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- 3D Element Library

- Discussion Channels
  - Channel 1
  - Channel 2

- Username
- Settings

Collaborators

Architecture | HVAC | Electrical | Plumbing | Structure | Interior

Mary Murray
Architecture
collaborator@outlook.com

Messgae Edit Remove

Virginia Gray
Architecture
collaborator@outlook.com

Messgae Edit Remove

Janet Scott
Architecture
collaborator@outlook.com

Messgae Edit Remove

Melissa West
Architecture
collaborator@outlook.com

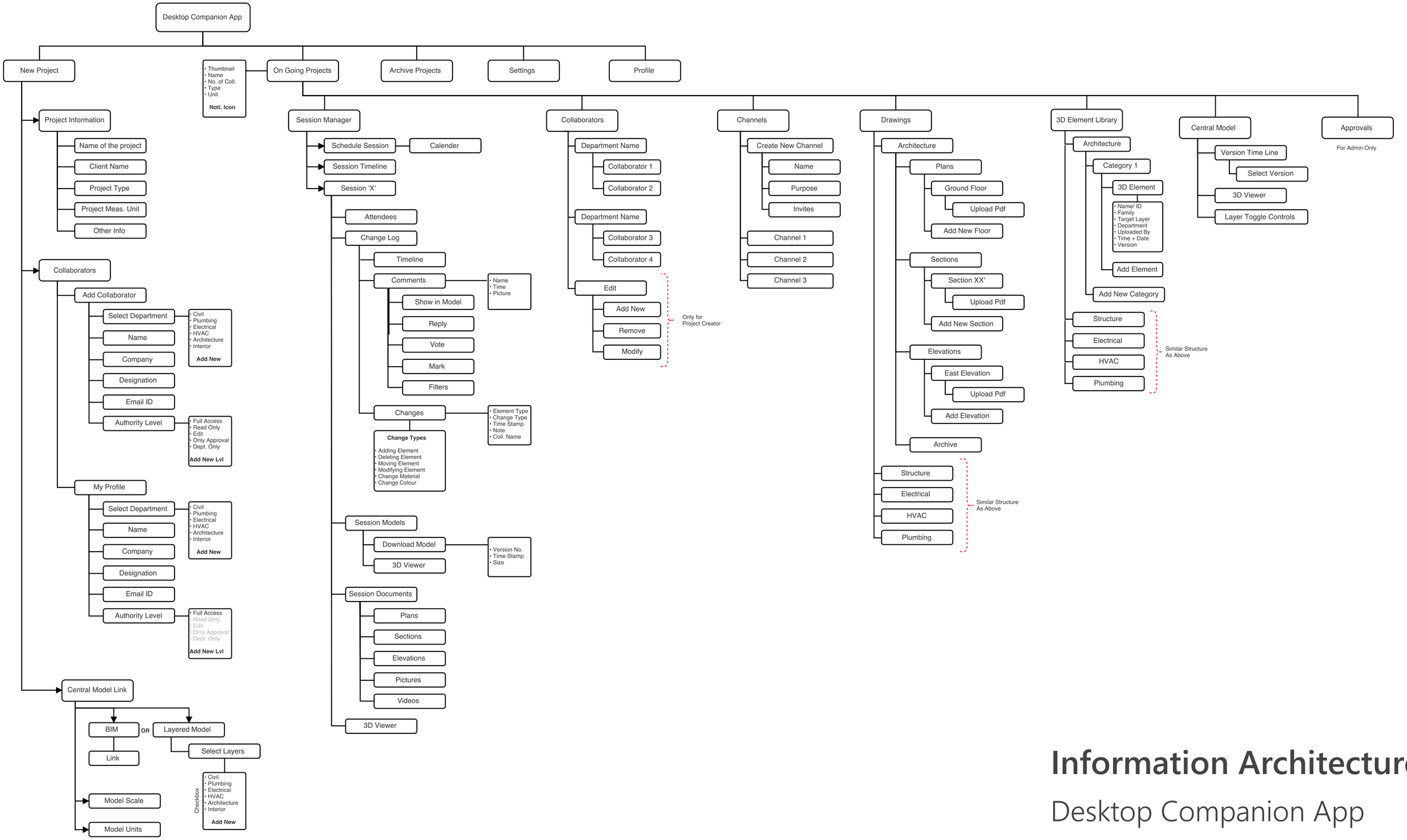
Messgae Edit Remove

Brenda Davidson
Architecture
collaborator@outlook.com

Messgae Edit Remove

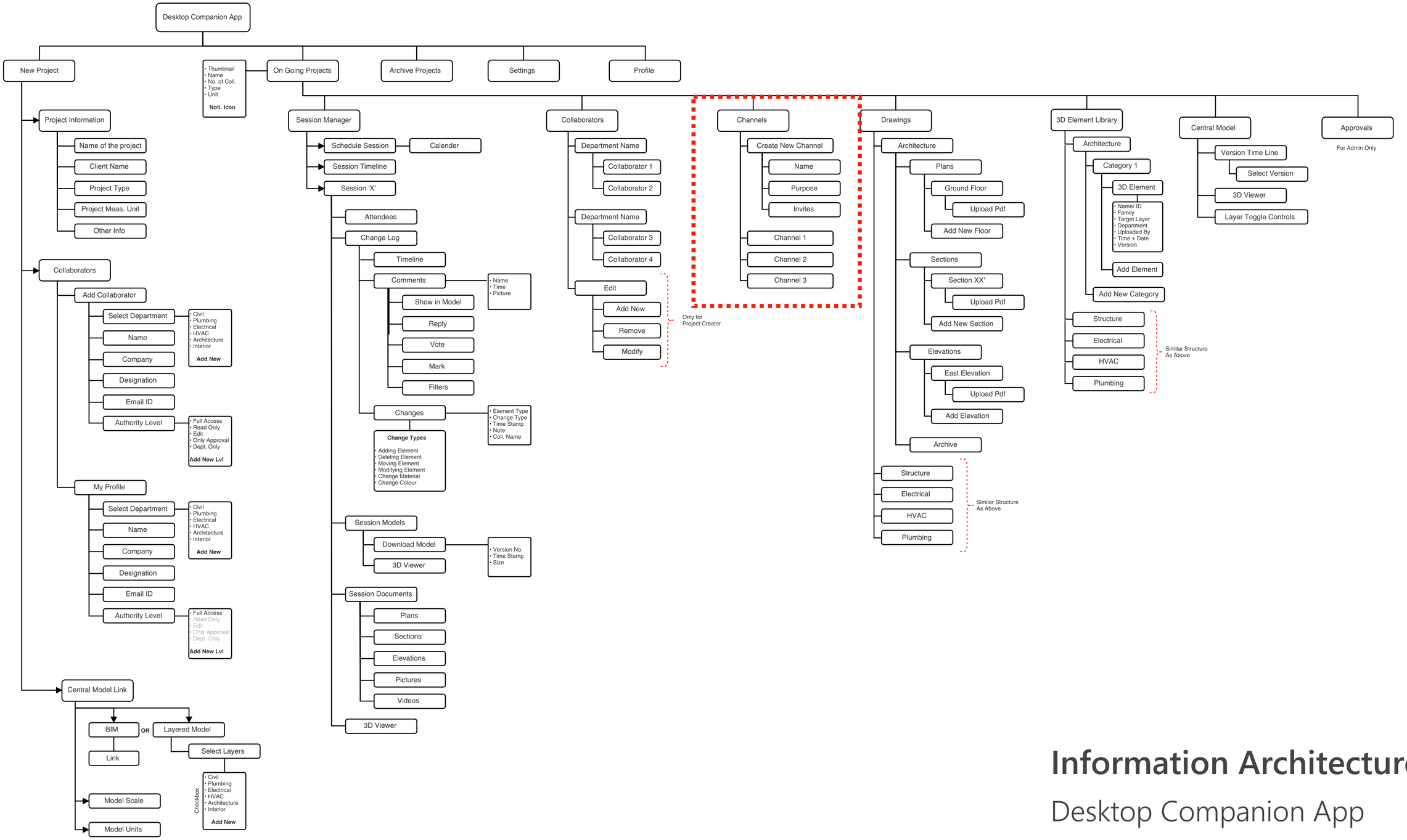
Douglas Brown
Architecture
collaborator@outlook.com

Messgae Edit Remove



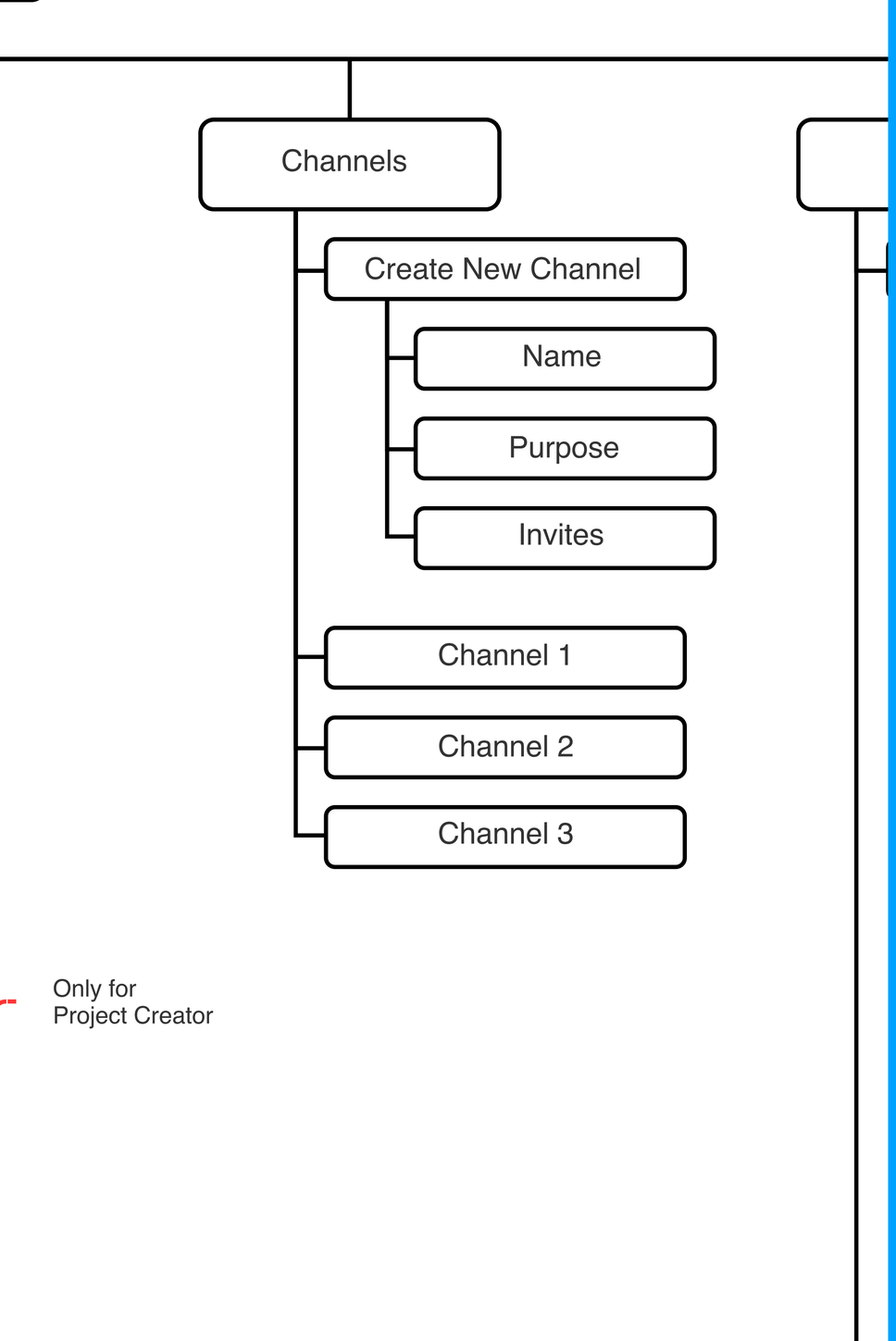
Information Architecture

Desktop Companion App



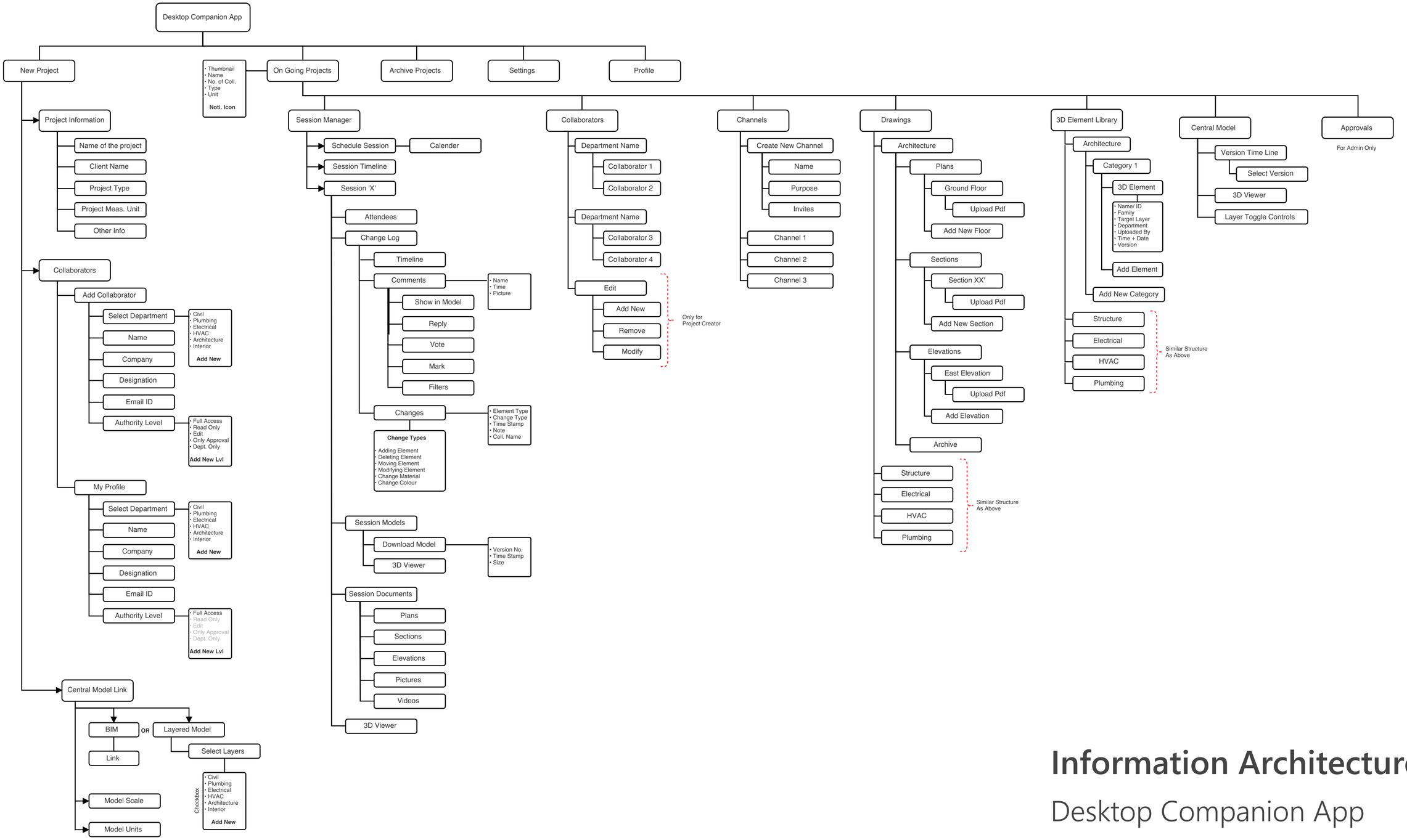
Information Architecture

Desktop Companion App



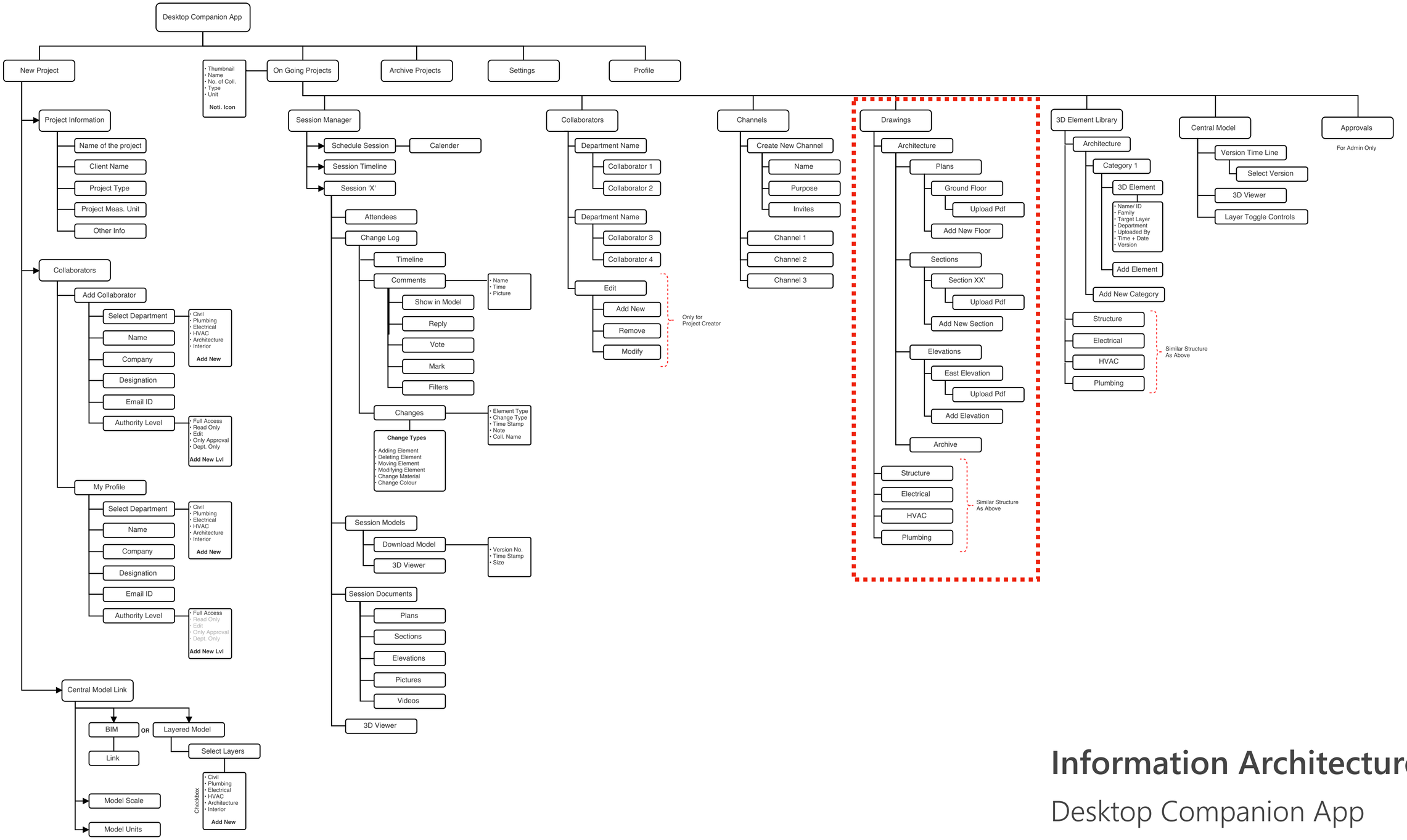
Discussion Channels

- Create discussion channels on specific topics
- Works like internal chatting platform
- Allows to form sub groups



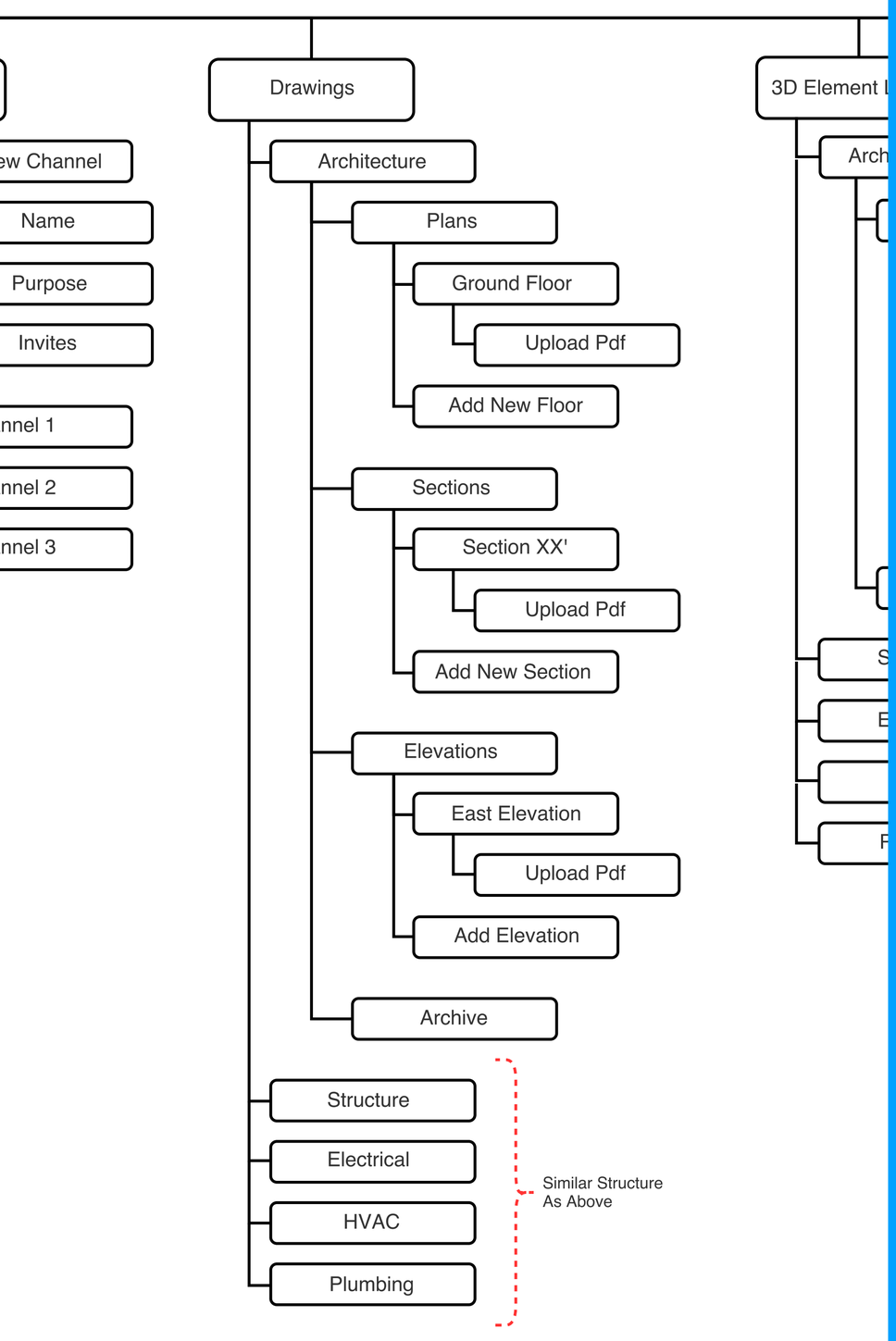
Information Architecture

Desktop Companion App



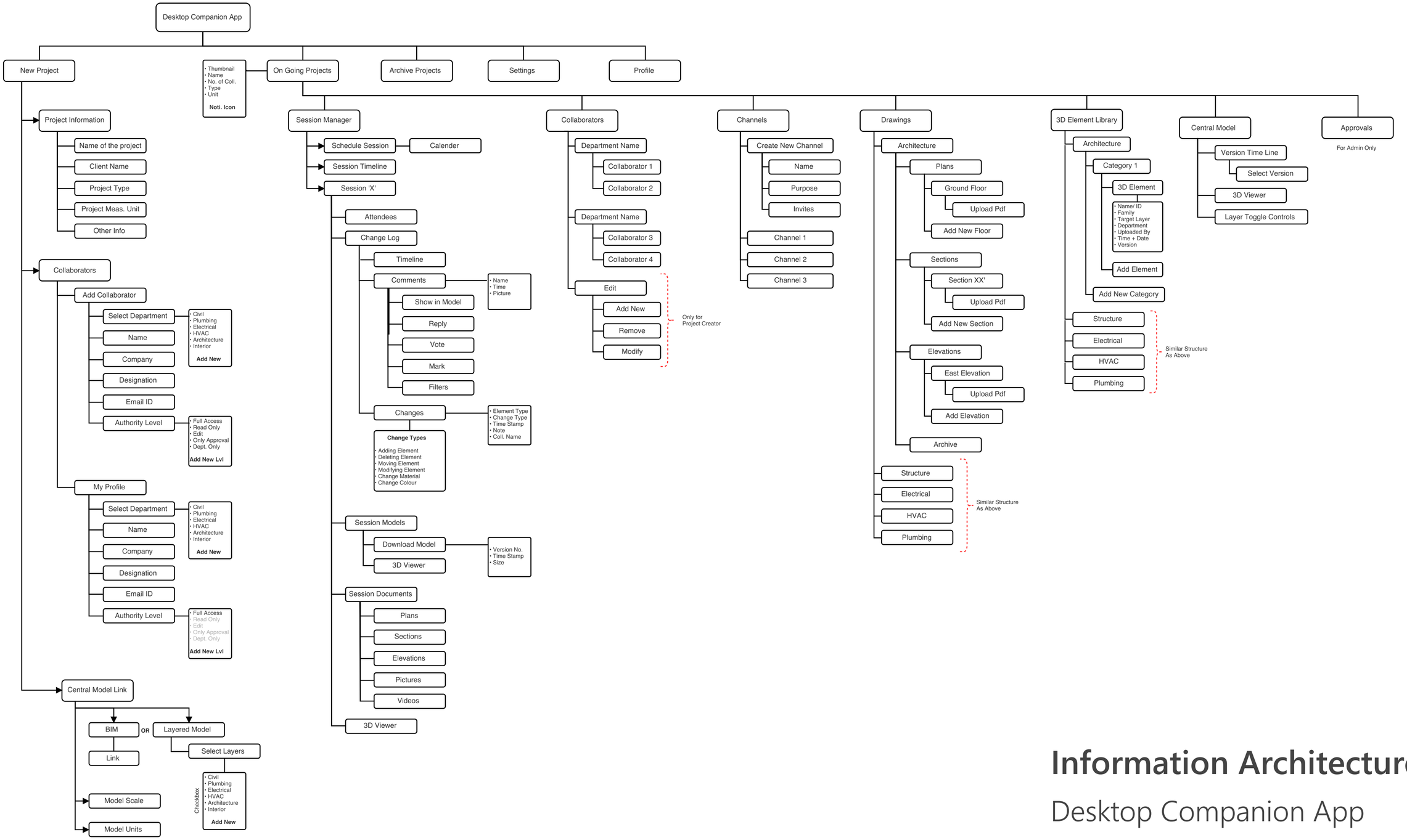
Information Architecture

Desktop Companion App



Drawings

- Repository of all the key drawings
- All documents segregated according to departments
- User can fetch these documents in collaboration session on Hololens



Information Architecture

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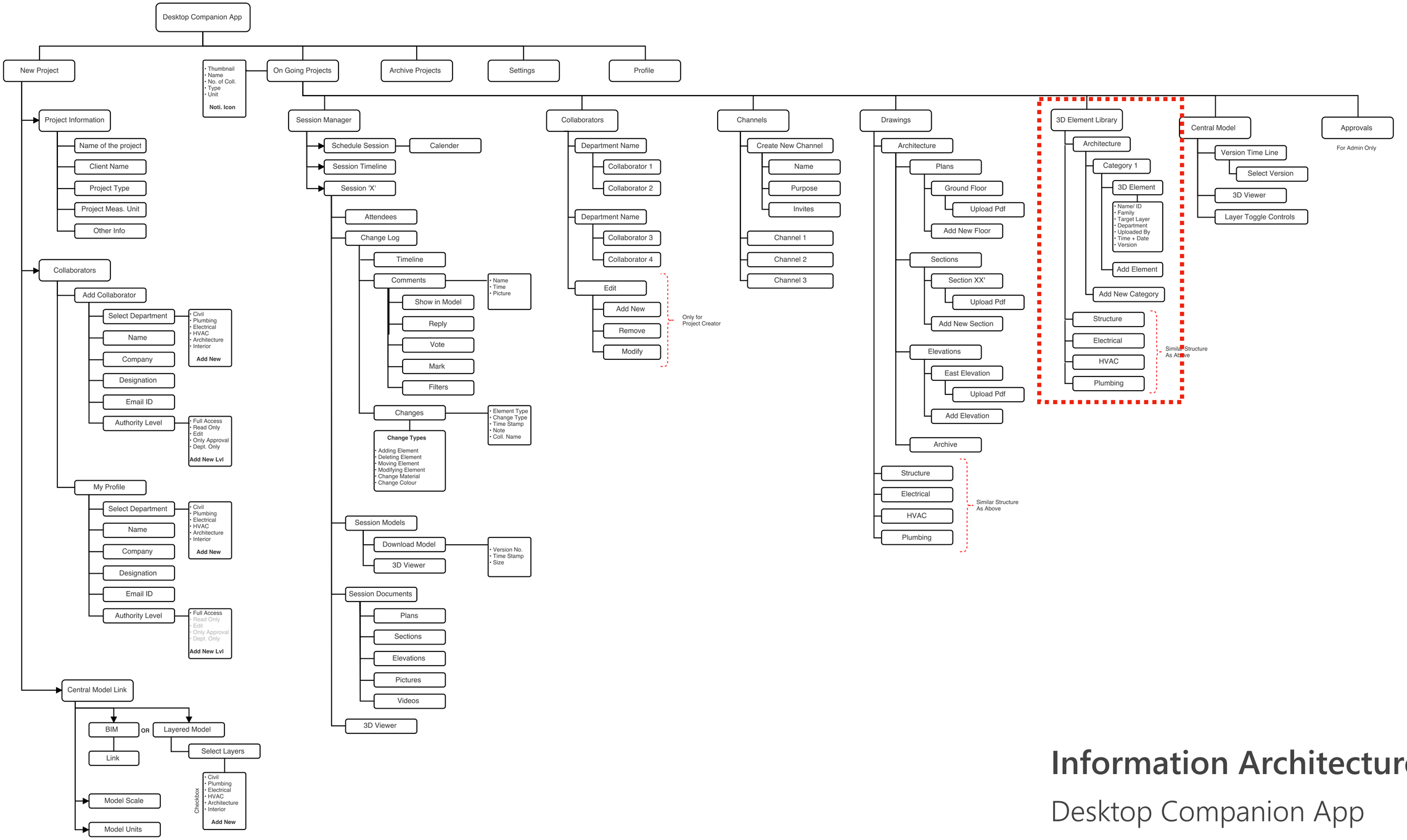

Information Architecture

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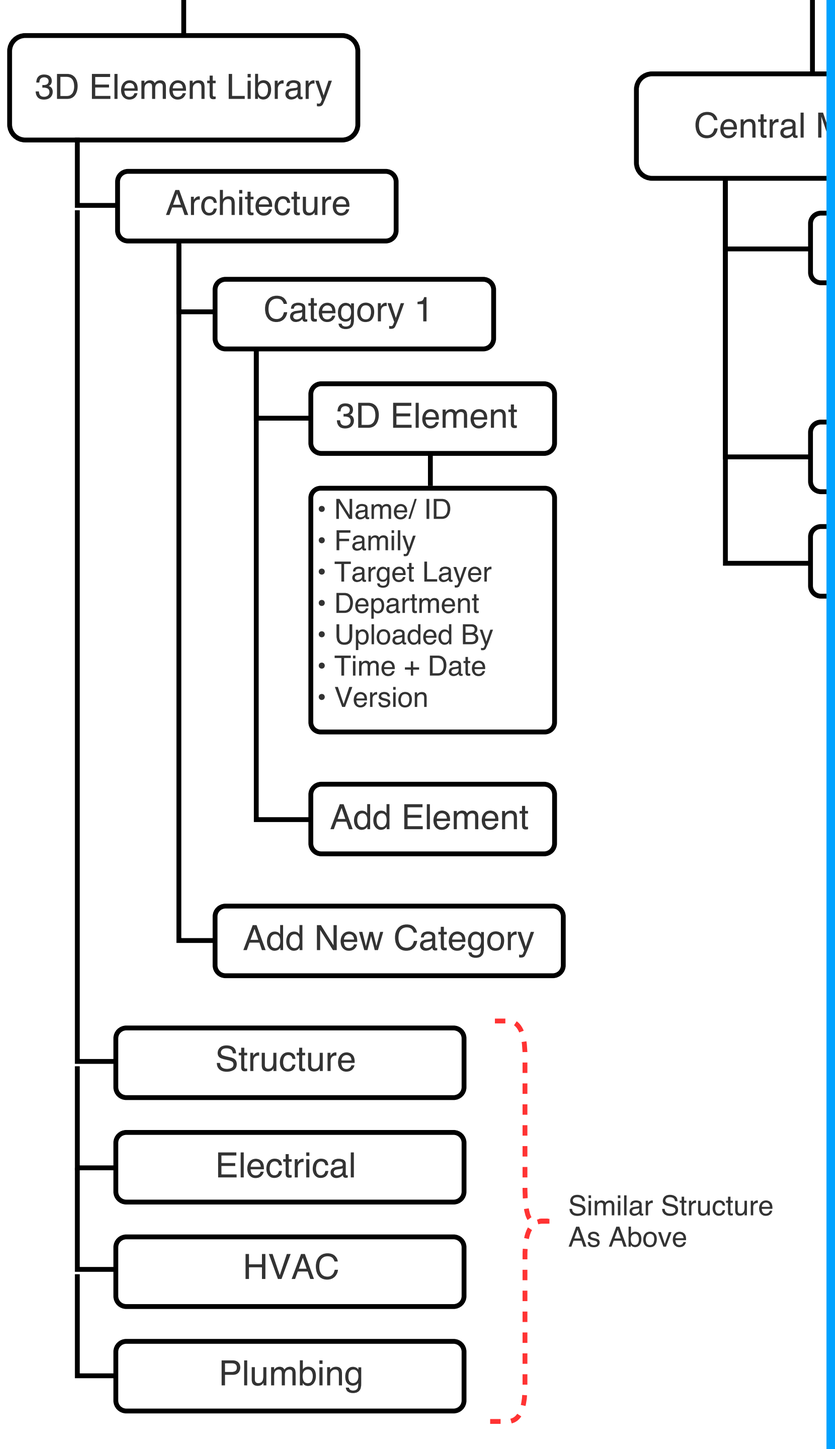
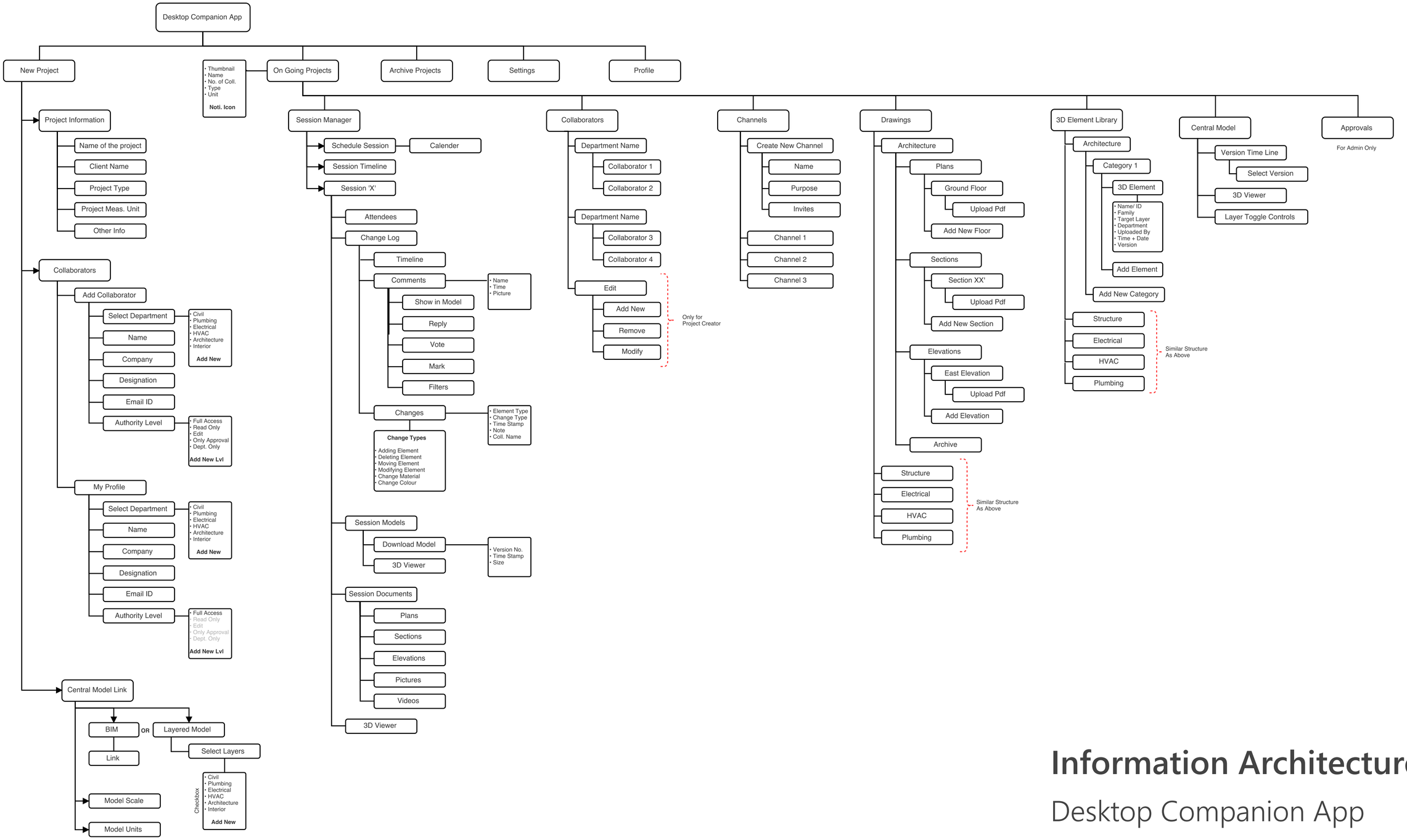


3D element library

- Pre addition of elements to be used during collaboration session
- Ability to define sets or categories of data for easy access



Information Architecture

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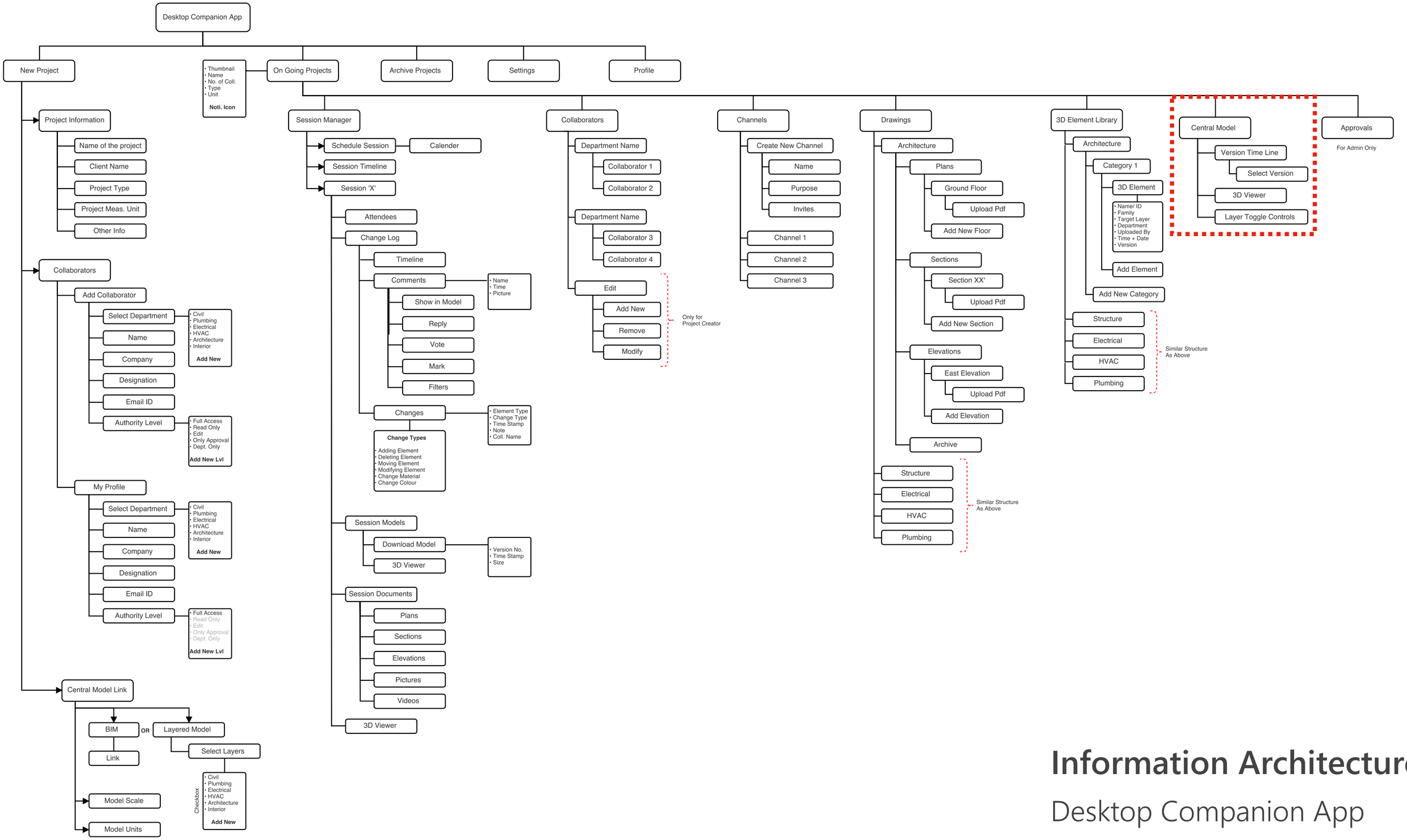

Information Architecture

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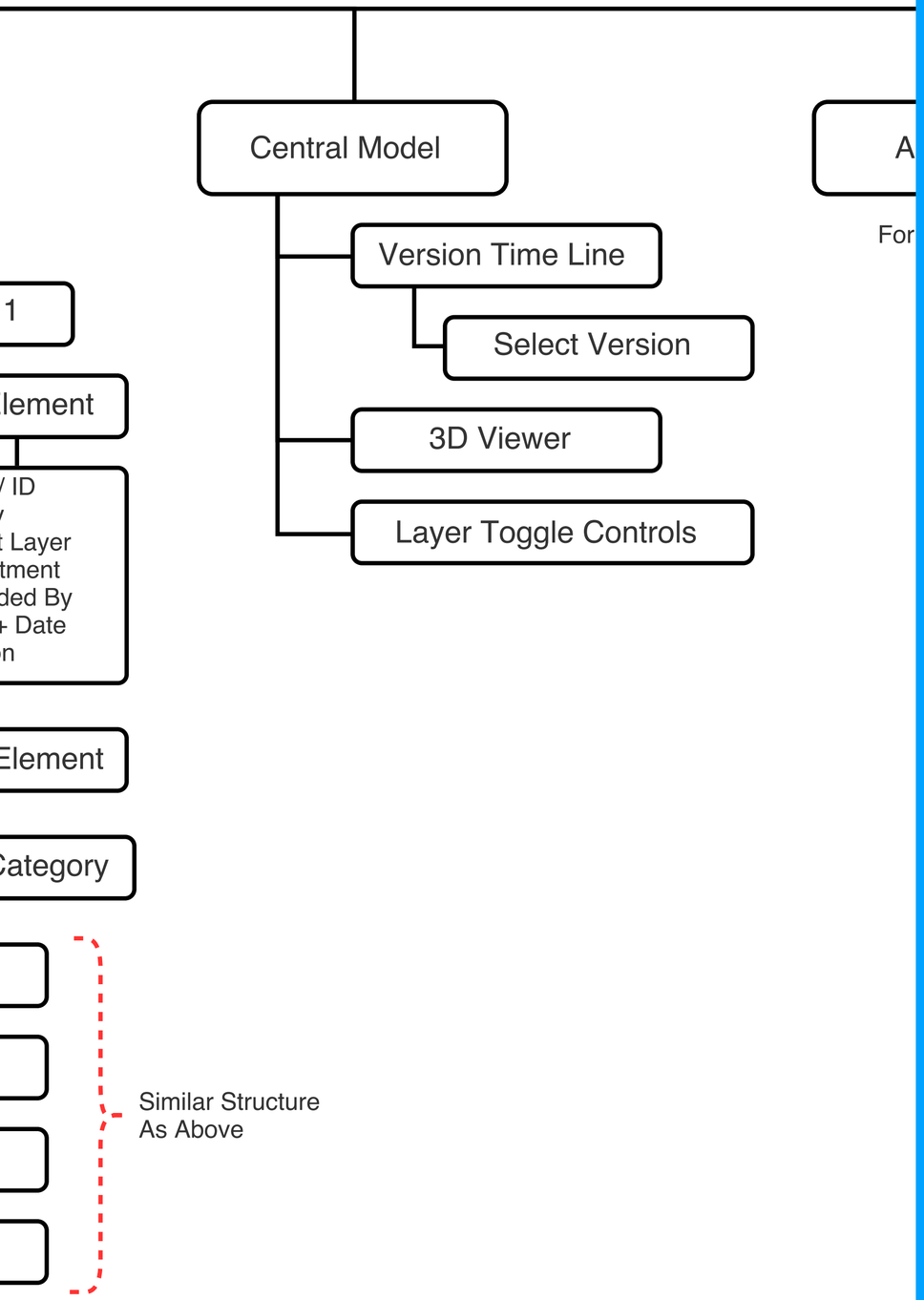

Central/ Base Model

- Allows the user to go through the latest model updates
- Version control allows to fetch older model to compare

Thank You