Simplification & Visualization of BIM models through Hololens

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About Me

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- Thesis (Nov – Now)
- Tensing

Outline

- Introduction
- Motivation / Problem Statement
- Literature Review
- Methodology
- Implementation - Results
- Conclusion
- Future Work

Improving & Modernizing Construction

❏ **Construction projects** [1] :
  ❏ **40%** are late
  ❏ **50%** over budget
  ❏ **30%** fail to meet expectations

❏ **Rework** [2] **(construction errors - design discrepancies)**:
  ❏ costs **5%** to **20%** of the contract value
  ❏ contributes to **52%** of the cost growth
  ❏ increases the schedule overrun by **22%**

50% due to design changes

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Delft University of Technology

Demand for Visualization of the Final Outcome

❏ Error Reduction

❏ Time Efficiency
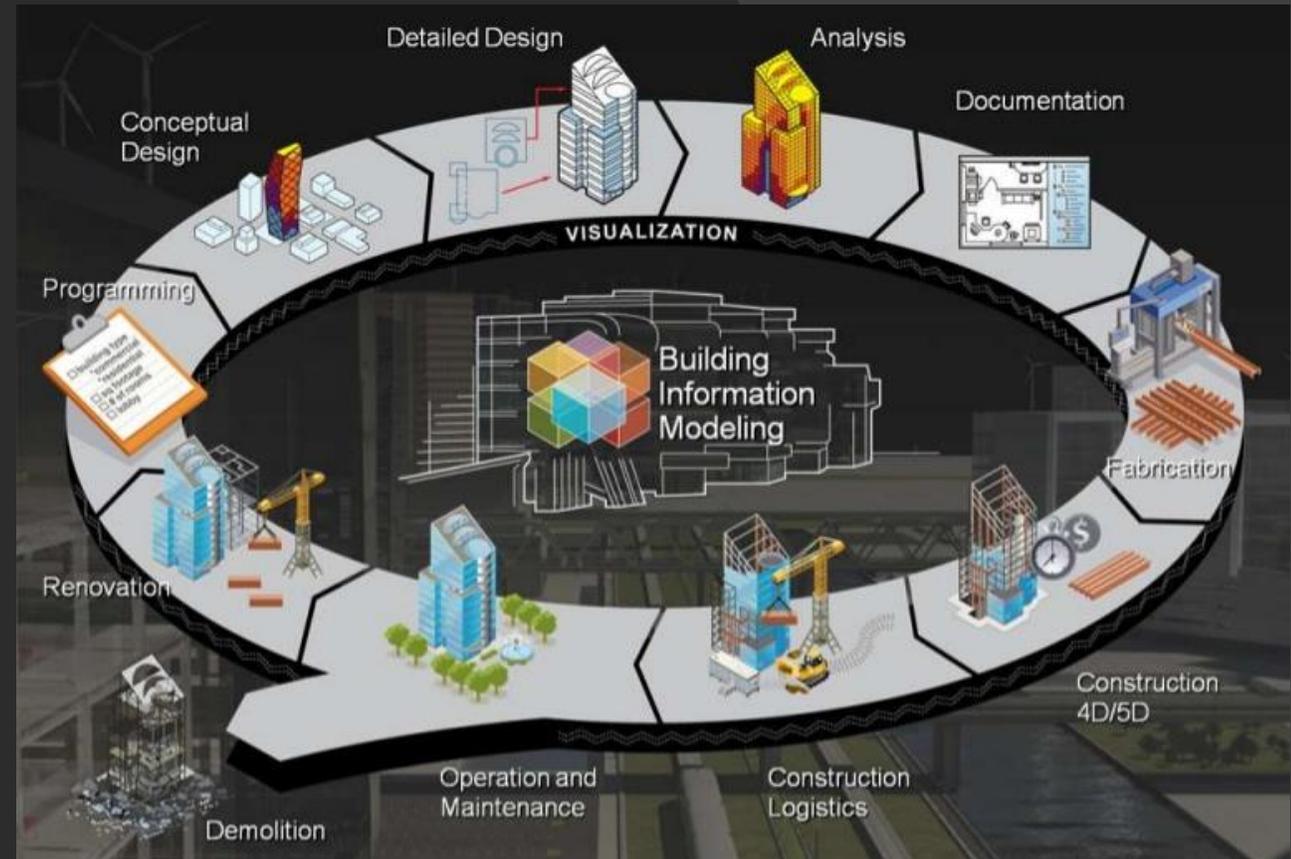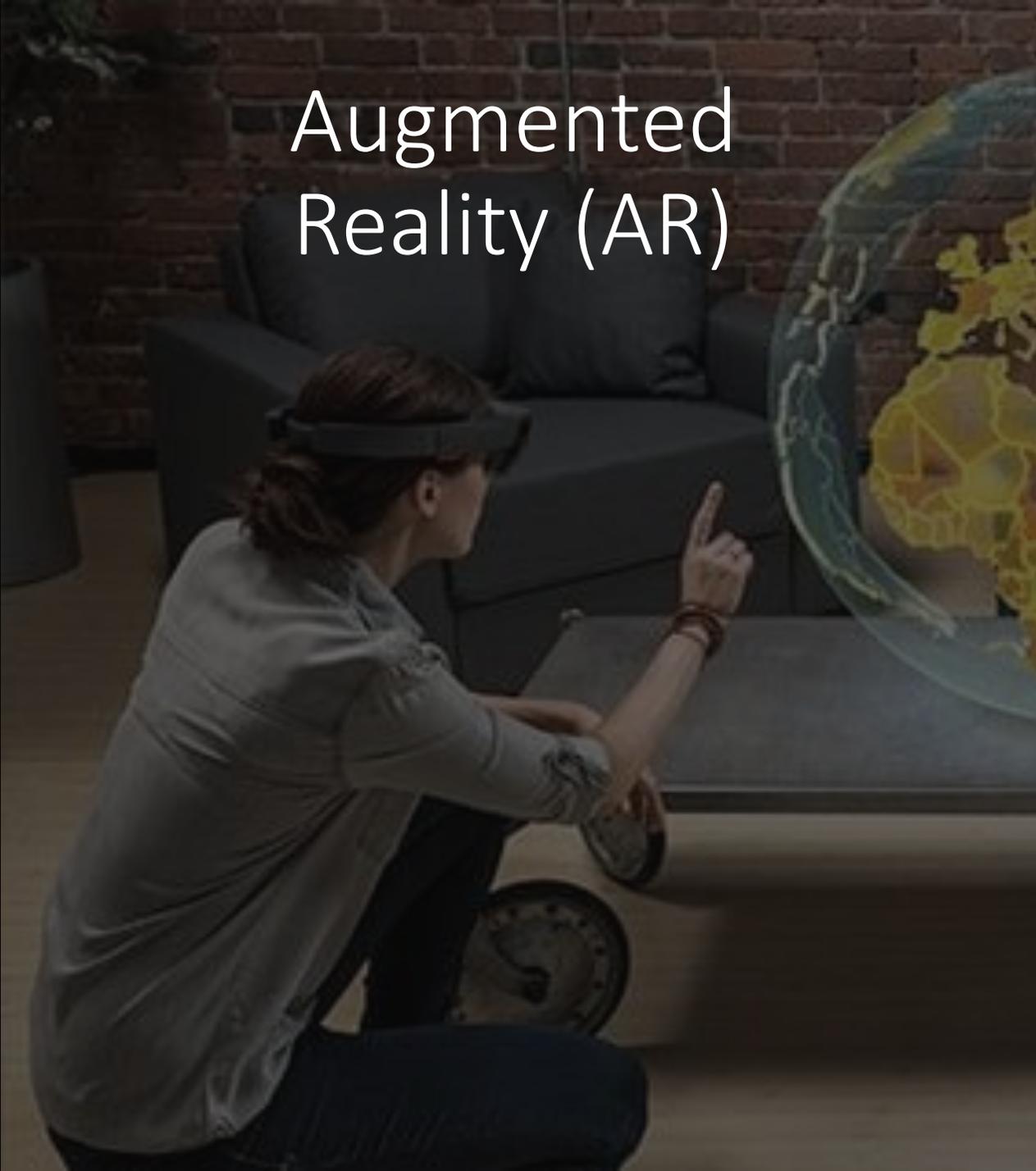
❏ Cost Reduction

❏ Customer Satisfaction

Building Information Modelling (BIM)

Benefits:

- Improved coordination

- Clarity in task requirements

- Reduction in inconsistencies

Augmented Reality (AR)


Benefits for Architecture :

- Improved collaboration among the actors of a design project

- Natural interaction with the design

- Reduction of cognitive load to evaluate design solutions

Microsoft Hololens

- Head-Mounted Display (HMD) unit or a Wearable Windows 10 computer

- The user can interact with holograms using gestures or voice commands

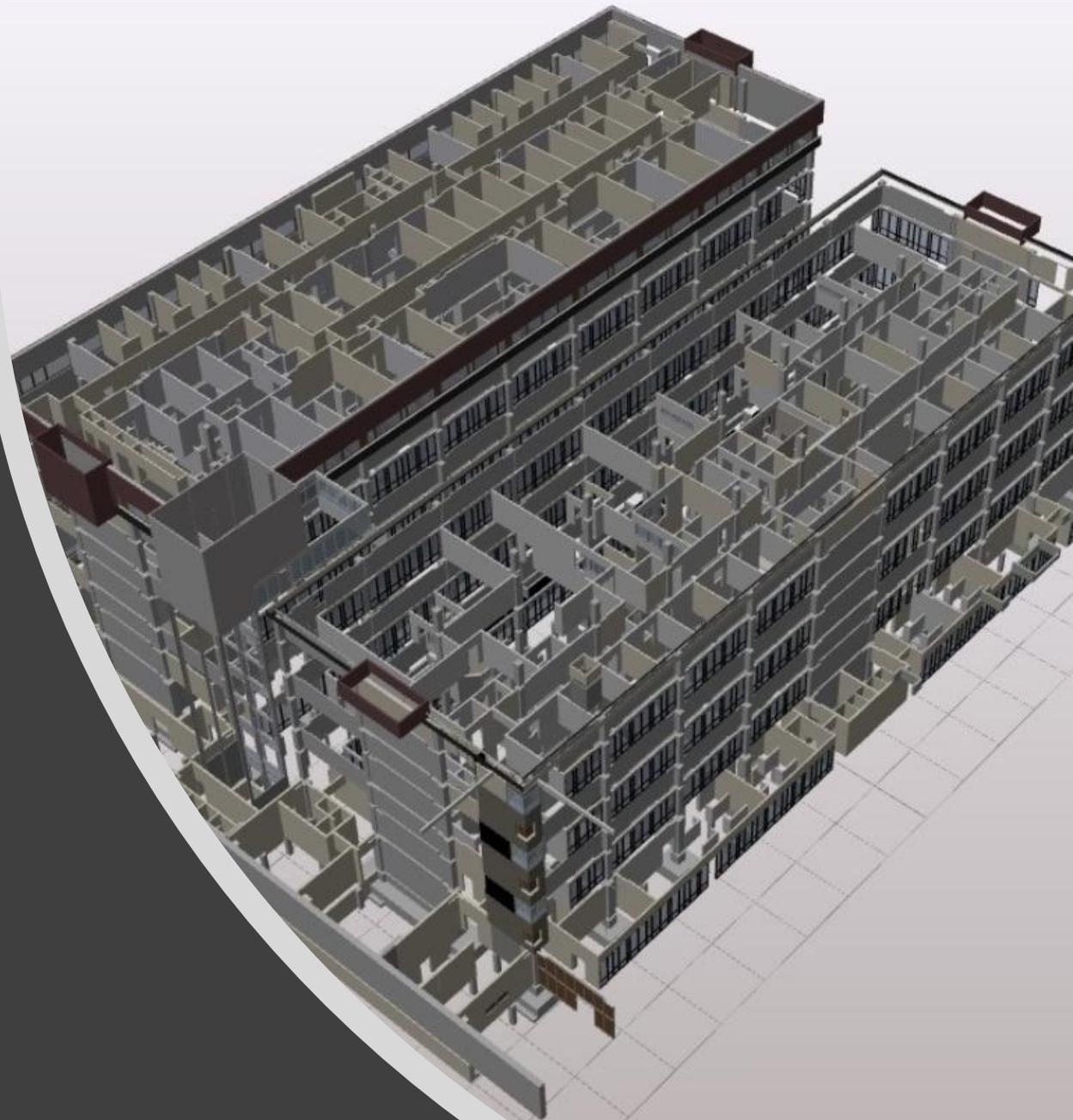- Creates a 3D model of the surrounding environment
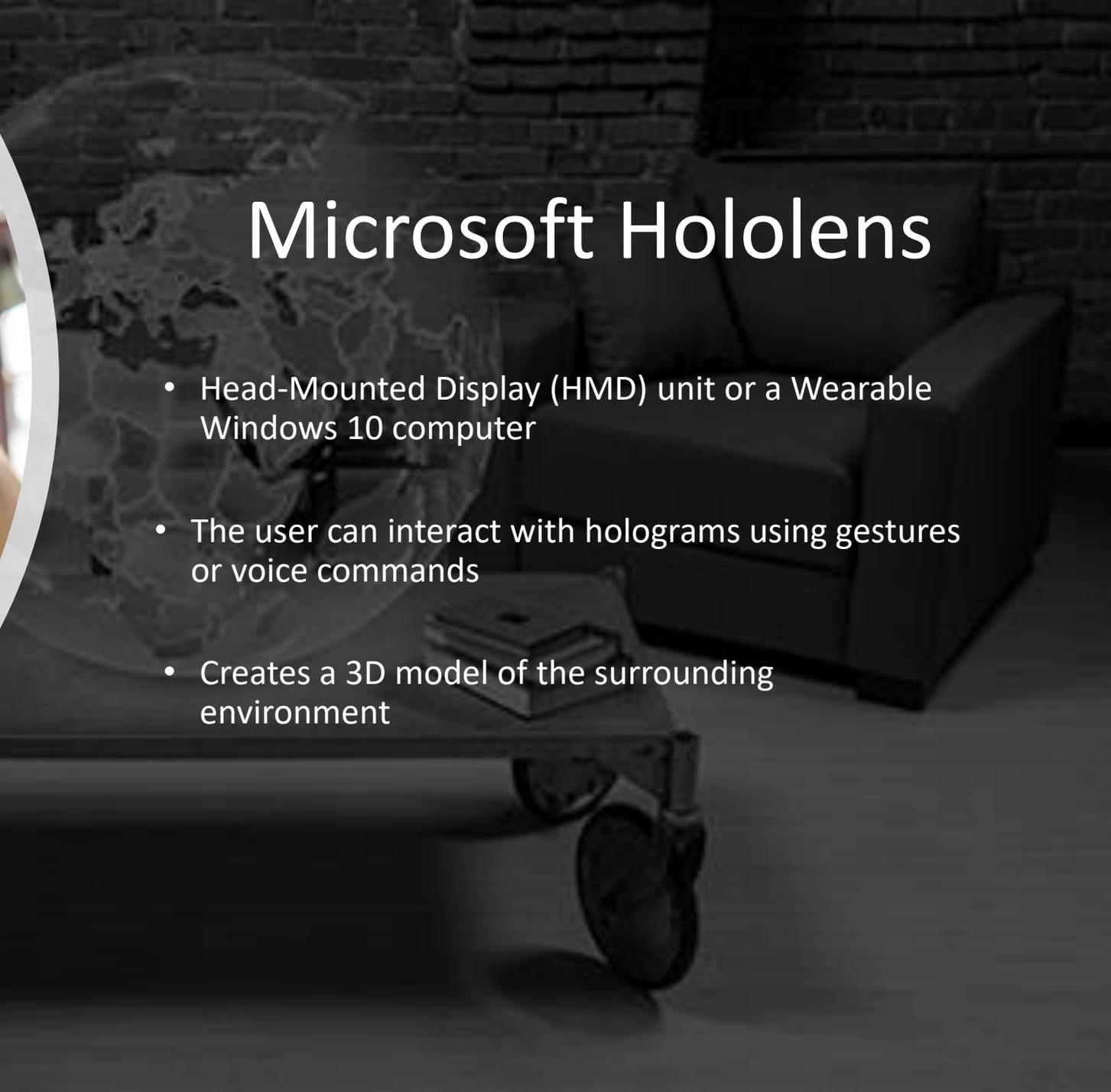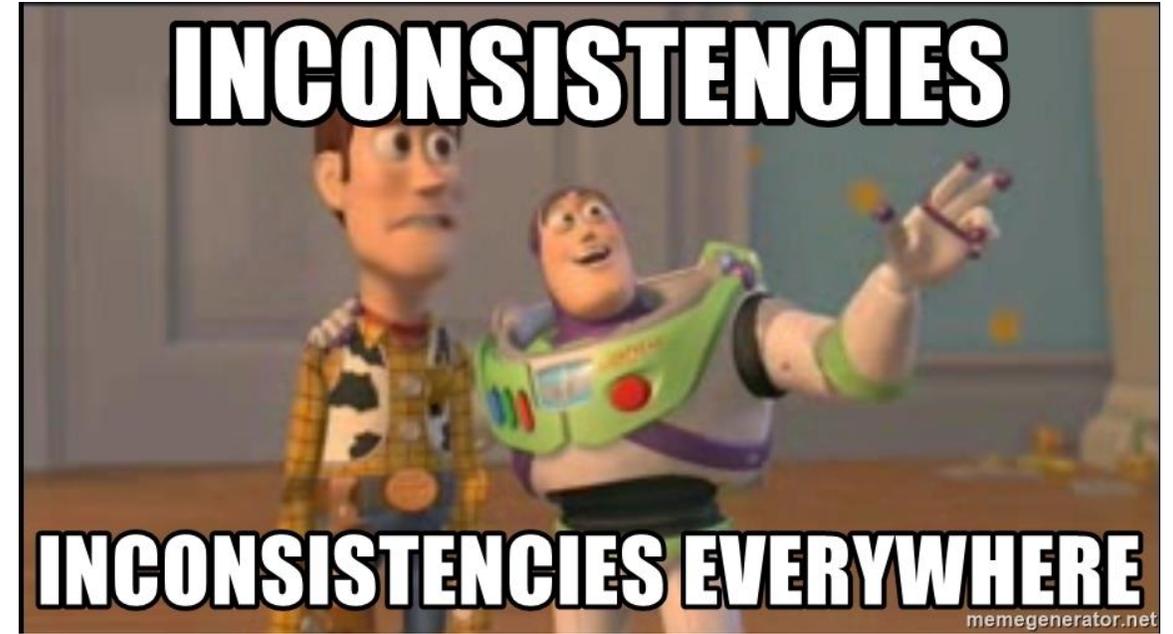
Motivation

Problem Statement

- Exterior envelope

- Isolation of every floor

- Creation of Holograms

Use Case (AMC)

- 127 MB

- 778.000 faces

- Extensive U shape

Related work: Simplification of IFC

- **Benner et al**. (2005)

- **Nagel et al**. (2007)

- **El-Mekawy et al**. (2011)
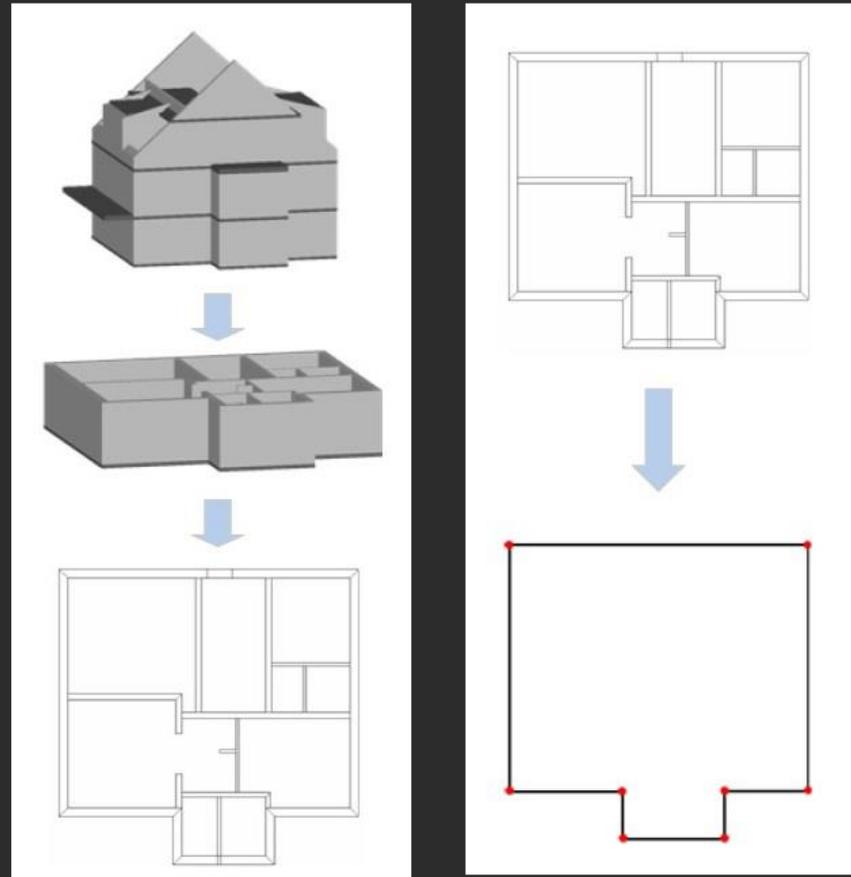
Simplification steps (Nagel et al., 2007)
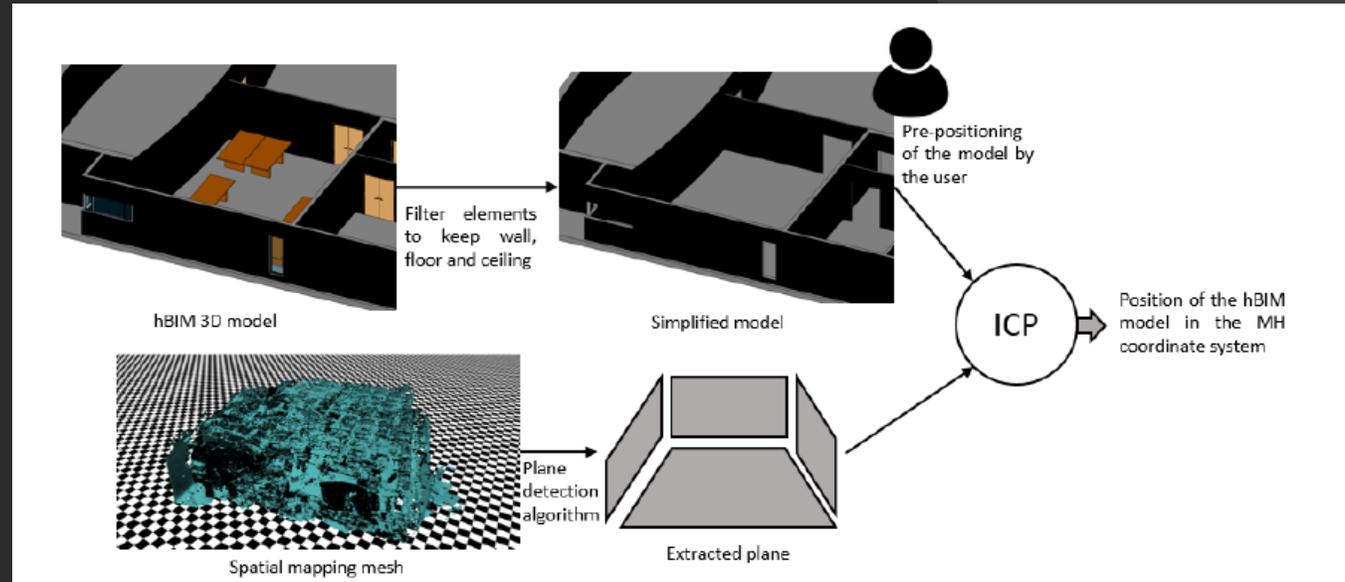
Related work: Simplification of IFC

- **Diakite' et al**. (2014)

- **Donkers et al.** (2016)
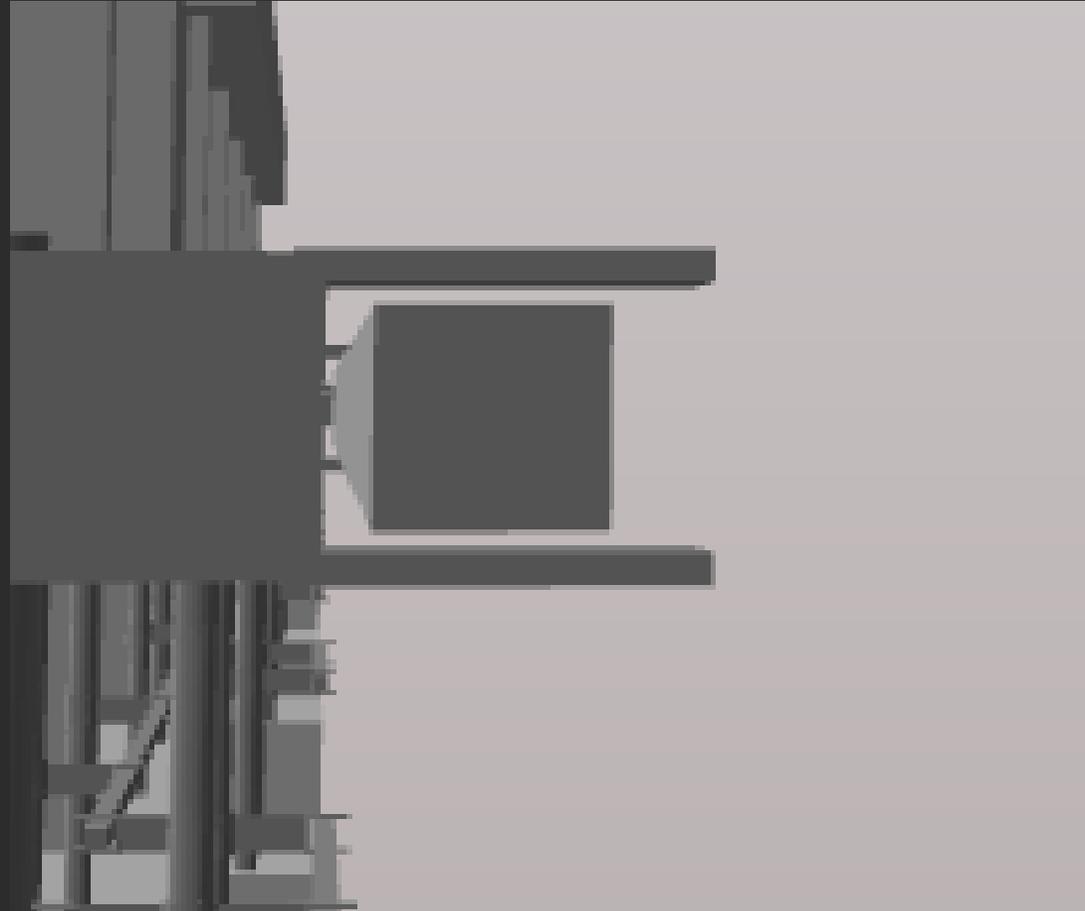
Related work: AR Visualization

- **Kopsida and Brilakis** (2016)
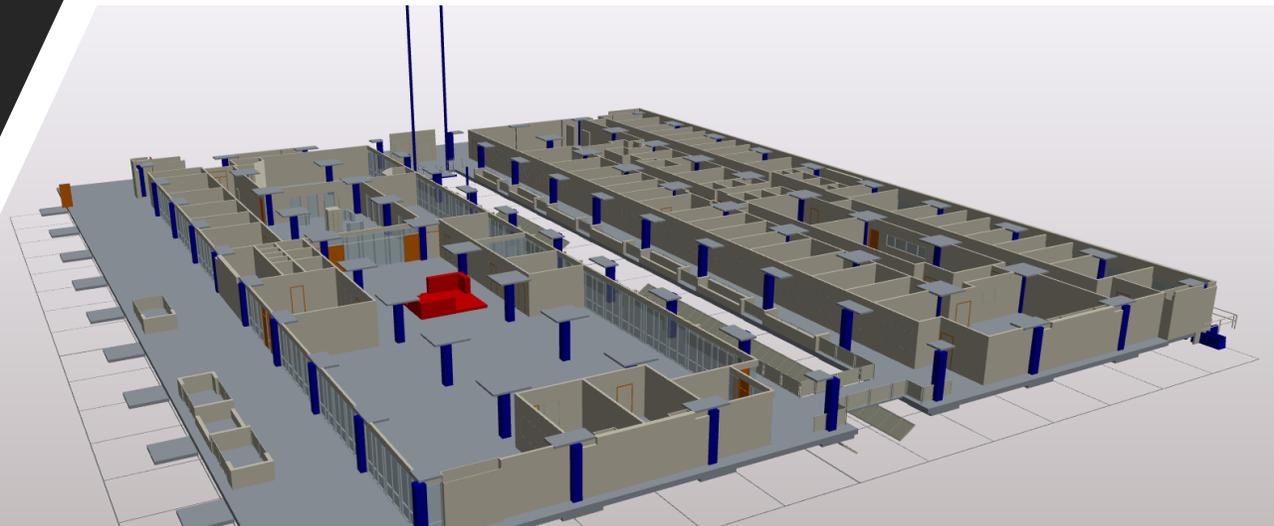

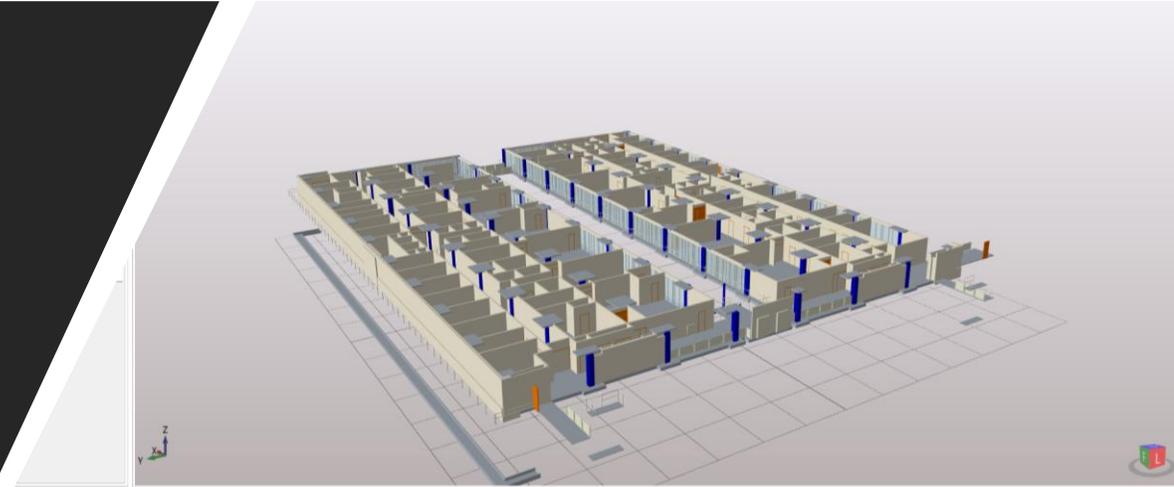- **Fonnet et al.** (2017)

- **Cardoso et al.** (2017)

Methodology
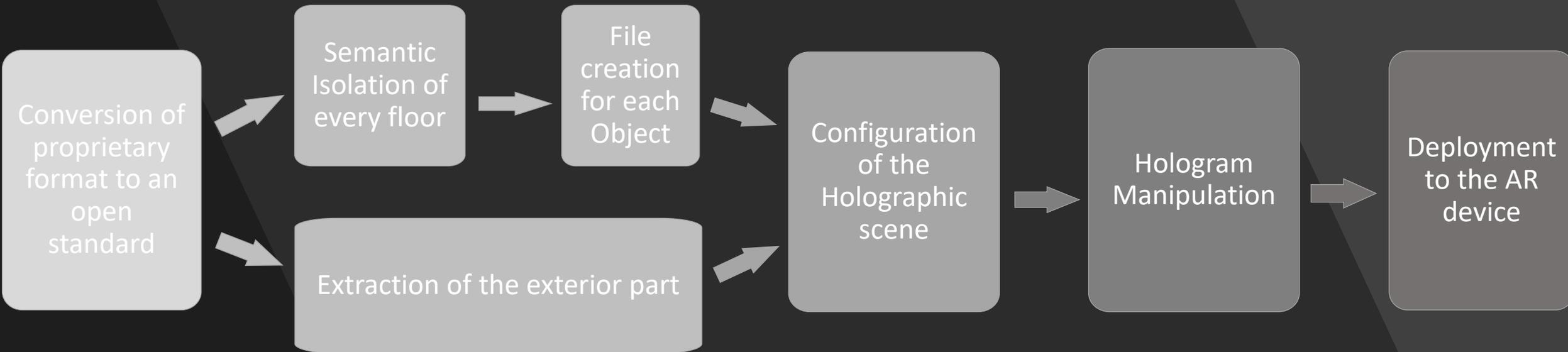
Conversion of proprietary format to an open standard

- NOT human readable

- NOT script adjustable

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Semantic Isolation of Every Floor

- Iterative process
- Identification of relationship among entities
- Grouping of them
- Writing in a new .ifc file

Object Creation for Each Element

- New file for every element
- File's name as metadata

Name	Date modified	Type	Size
IFC_TYPE=IfcBuildingElementProxy__ID=0P3C_WSYL1E9MMSKD73OCO__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:05	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=0ST37ZVTJDWX0TERZBFZTV__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 11:55	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=1O$97DCXB6T9RV6FB1SL4P__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:05	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=1PQTRI815CAEQIWK49WTP6__NAME=66_GM_Lift Assembly__lift 2042x2663__.obj	12-Mar-18 12:11	3D Object	9 KB
IFC_TYPE=IfcBuildingElementProxy__ID=1QLR0LZT56ORCE2CJRV8W5__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:04	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=2FDURLESH0GHGST$L8DGWC__NAME=66_SE_personenlift__1000x880mm__.obj	12-Mar-18 12:11	3D Object	36 KB
IFC_TYPE=IfcBuildingElementProxy__ID=2FULEMLTL71GPM6OP5SYIE__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:05	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=2Y9$ADSQF8TGHSTN5W6YJL__NAME=66_GM_Lift Assembly__lift 2042x2663__.obj	12-Mar-18 12:11	3D Object	9 KB
IFC_TYPE=IfcBuildingElementProxy__ID=3BP1FVP8JEKWD7XSLRVG__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:04	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=31K3CQW$VFSVQVEIWEFFZG__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:04	3D Object	2 KB
IFC_TYPE=IfcBuildingElementProxy__ID=35WU2NFFD8EHJYGXX_SSTJ__NAME=65_SE_brandslanghaspel in kast__3D__810 x 215 x 915__.obj	12-Mar-18 12:05	3D Object	2 KB

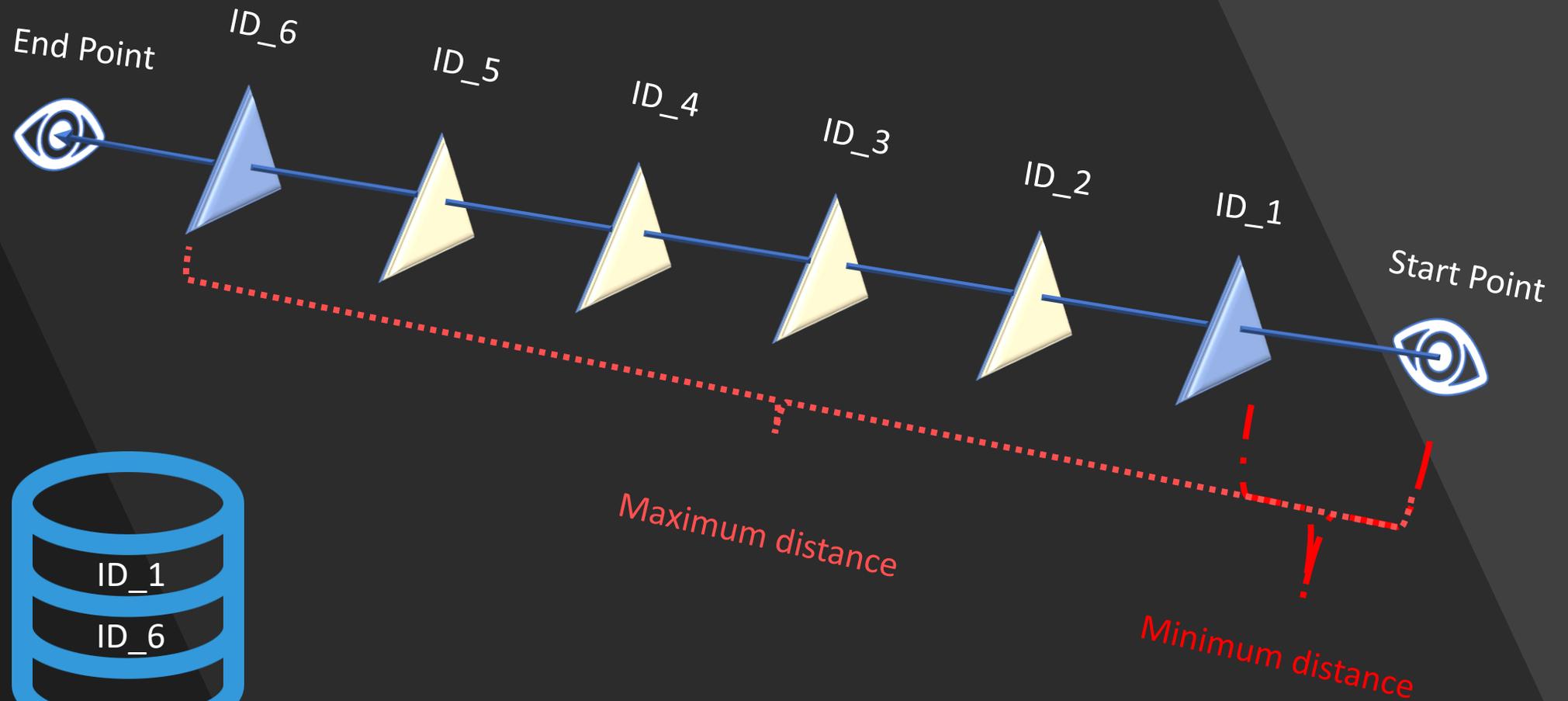TU Delft — Delft University of Technology
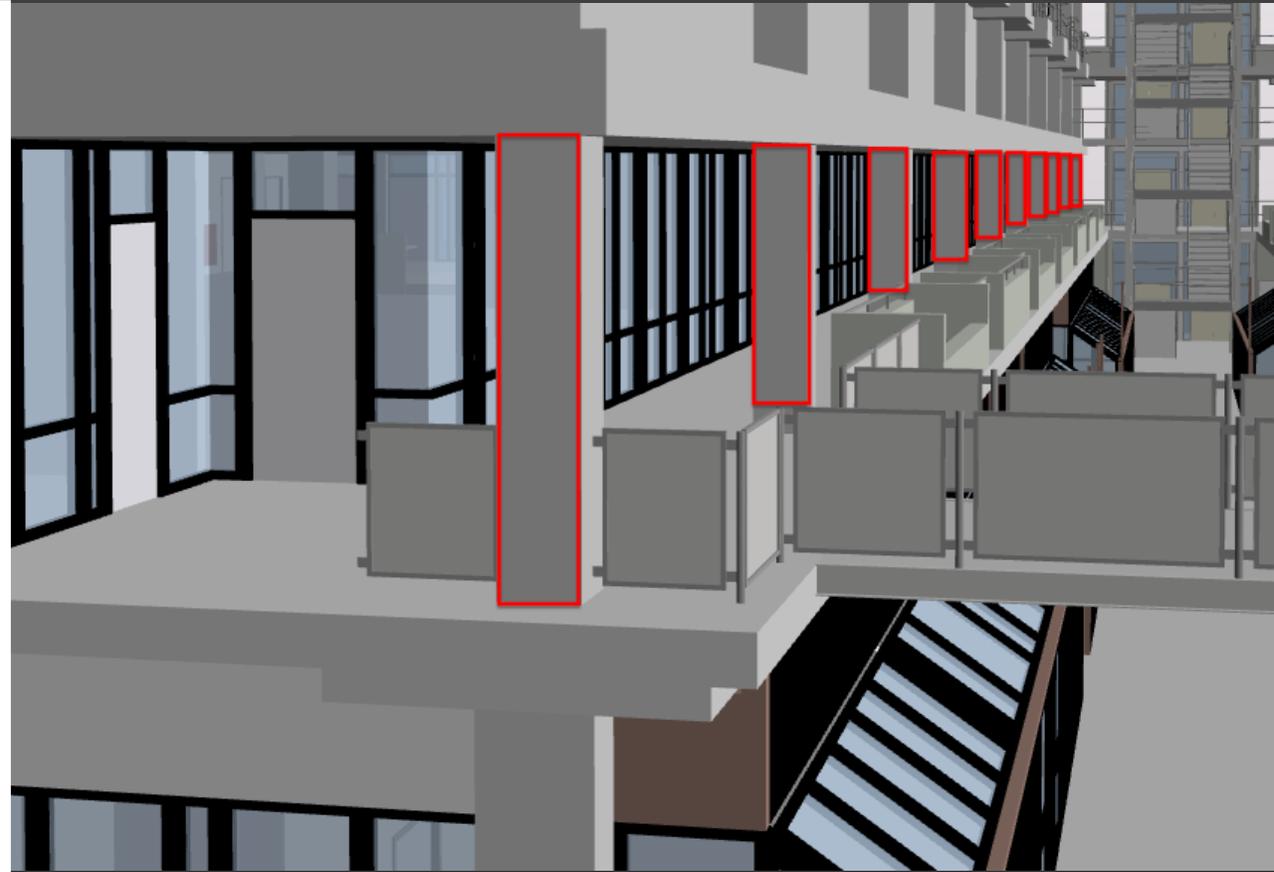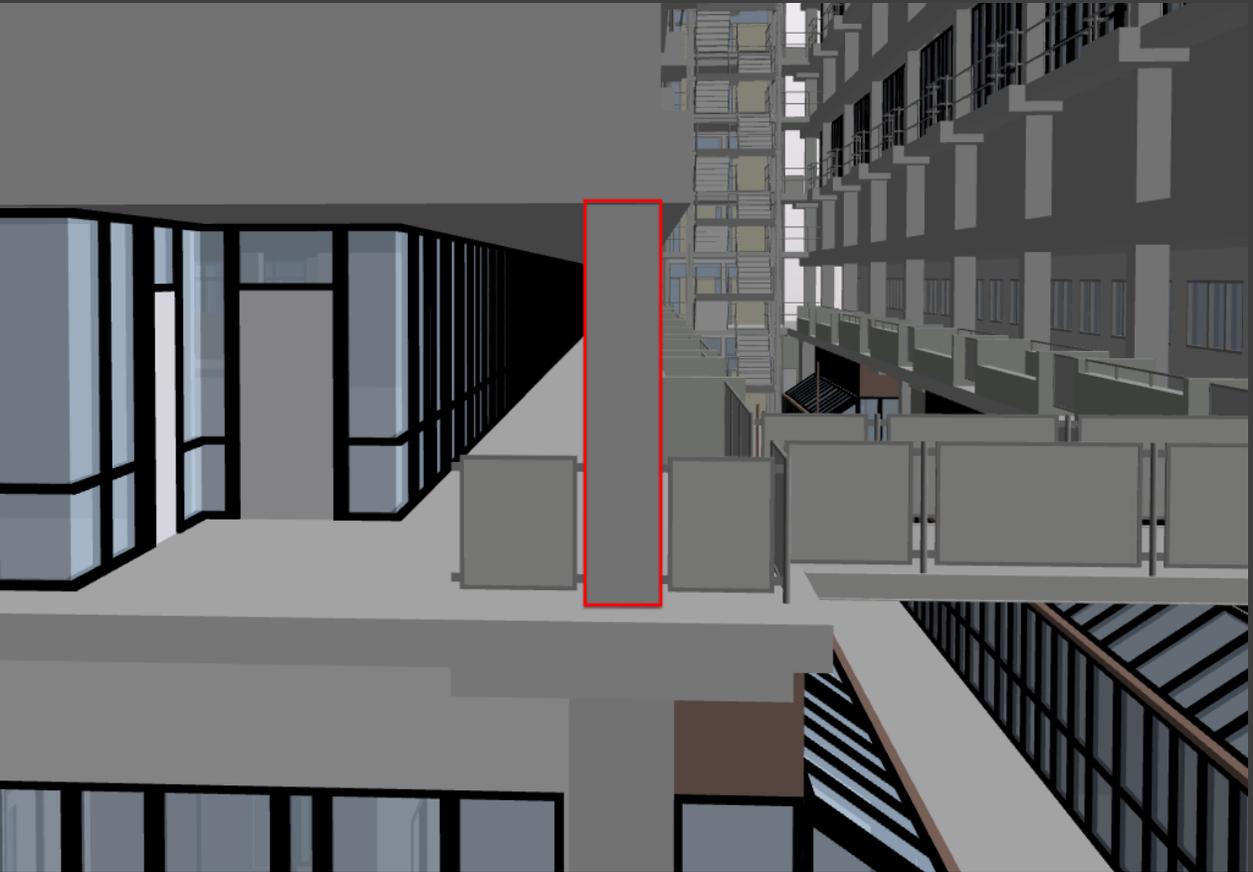
Extraction of the Exterior Envelope
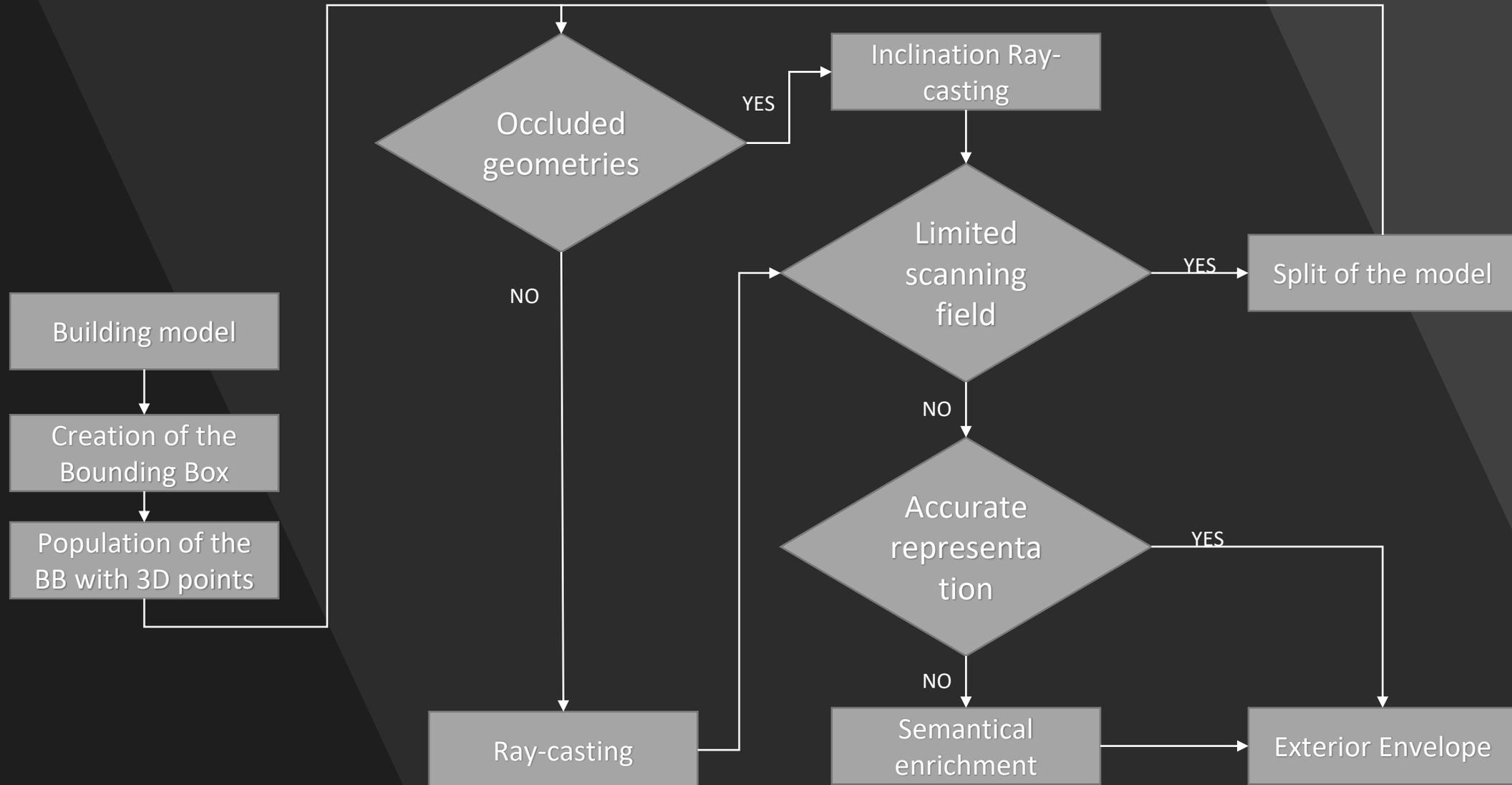
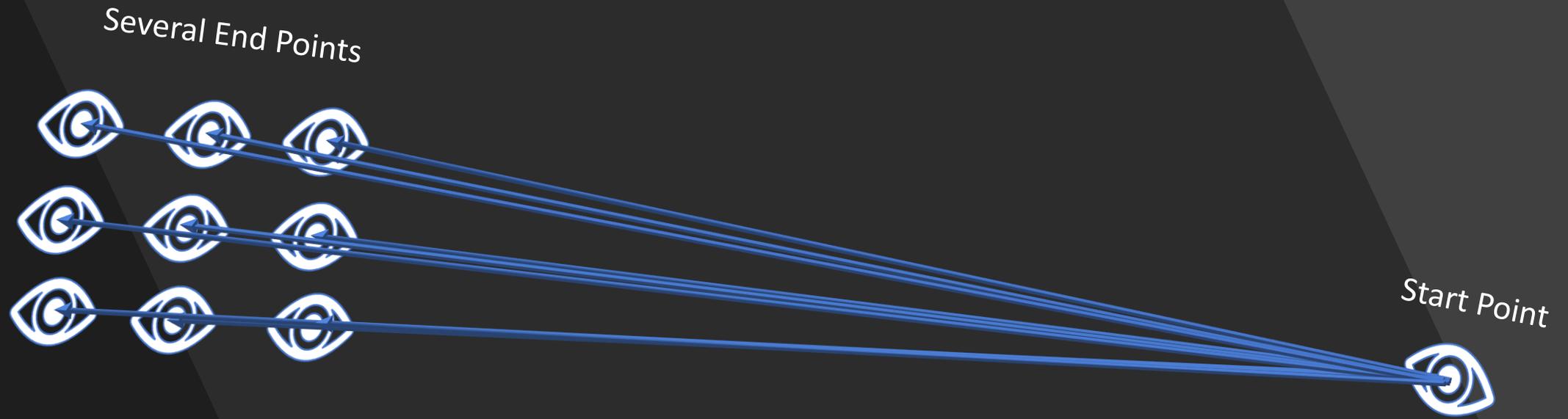# Exterior Part: Bounding Box & 3D Points
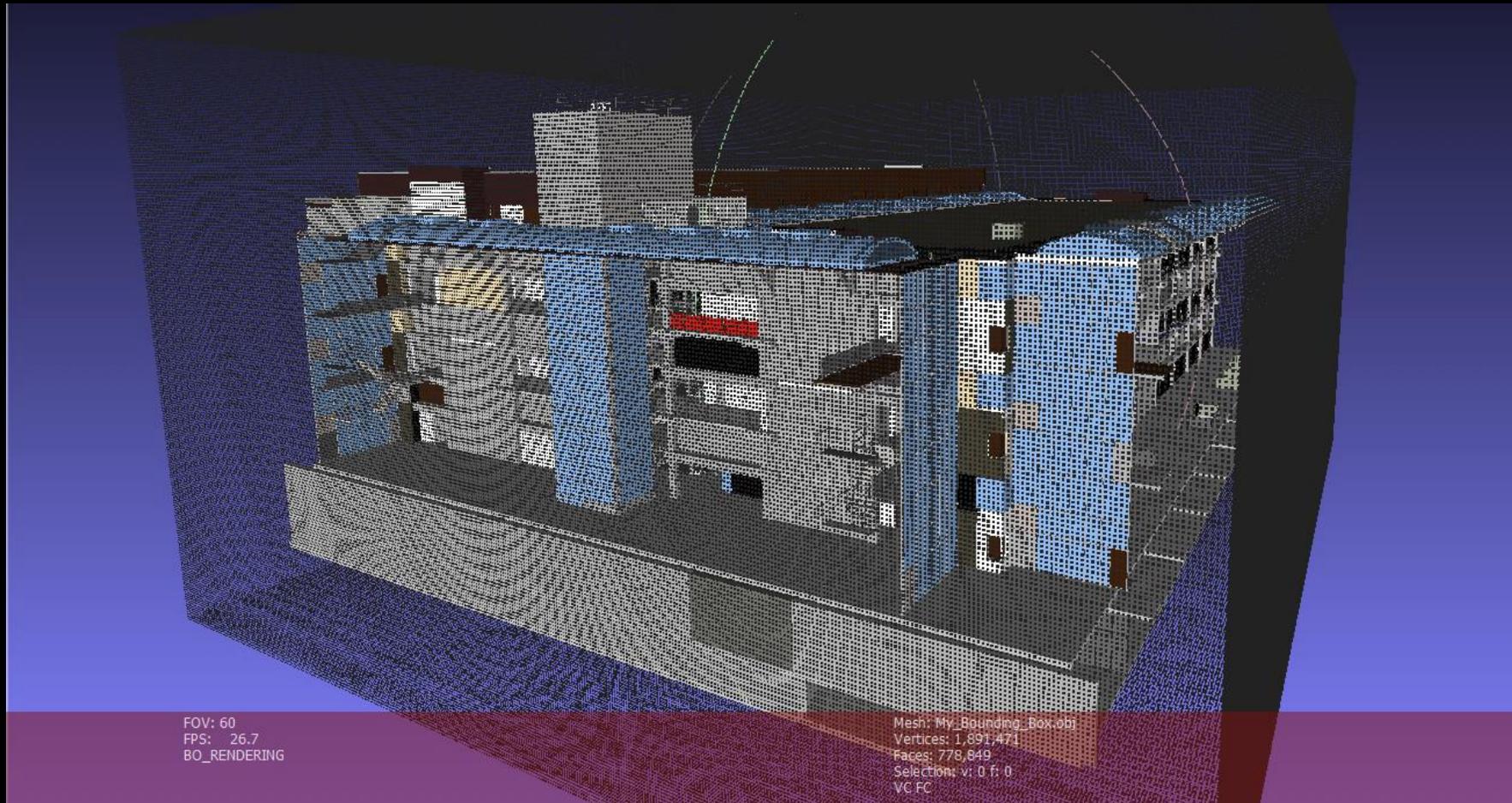
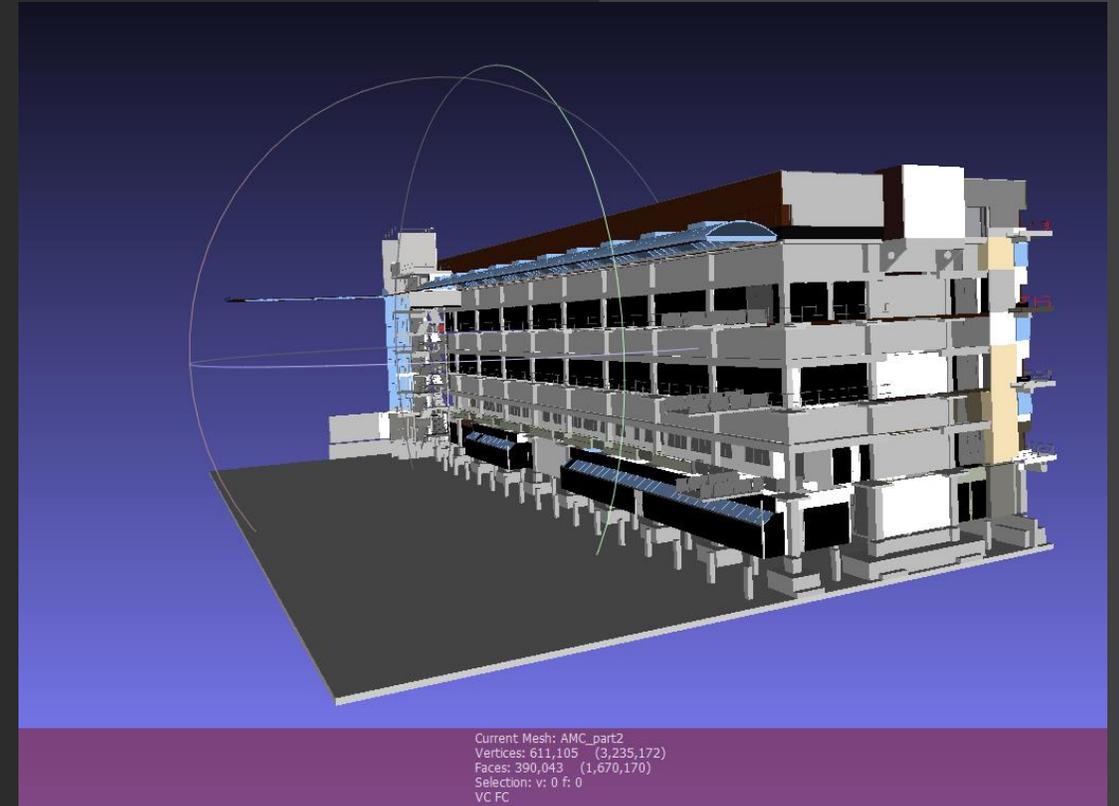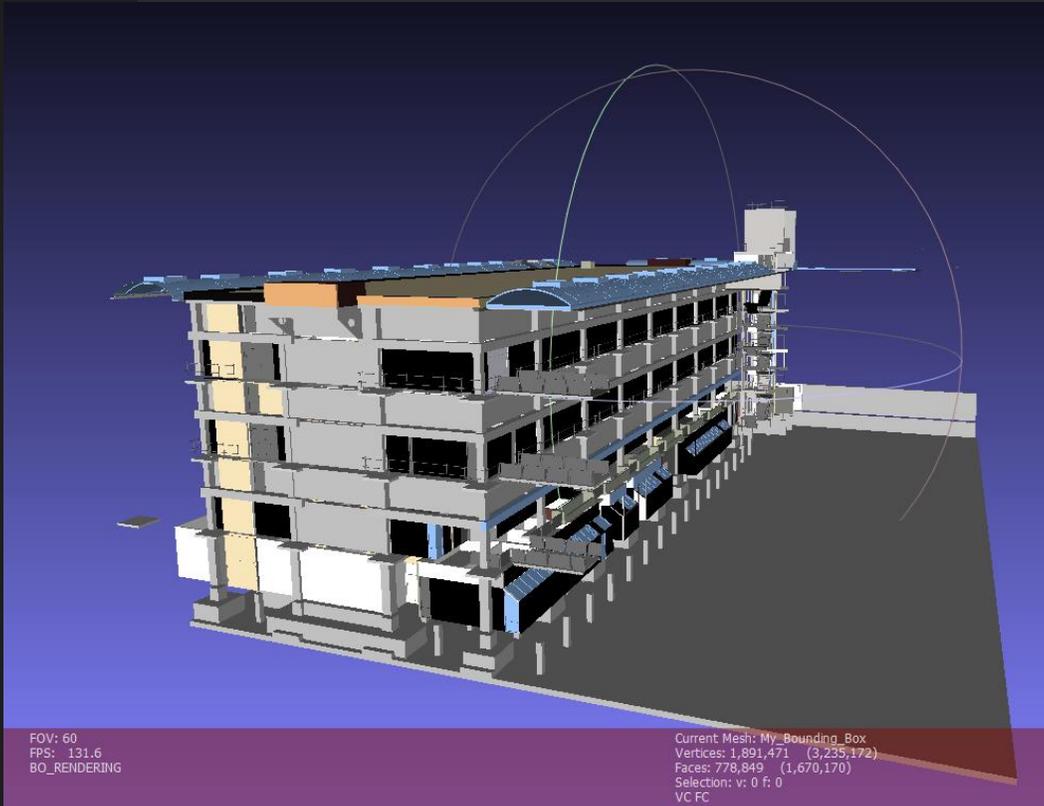# Exterior Part: Raycasting
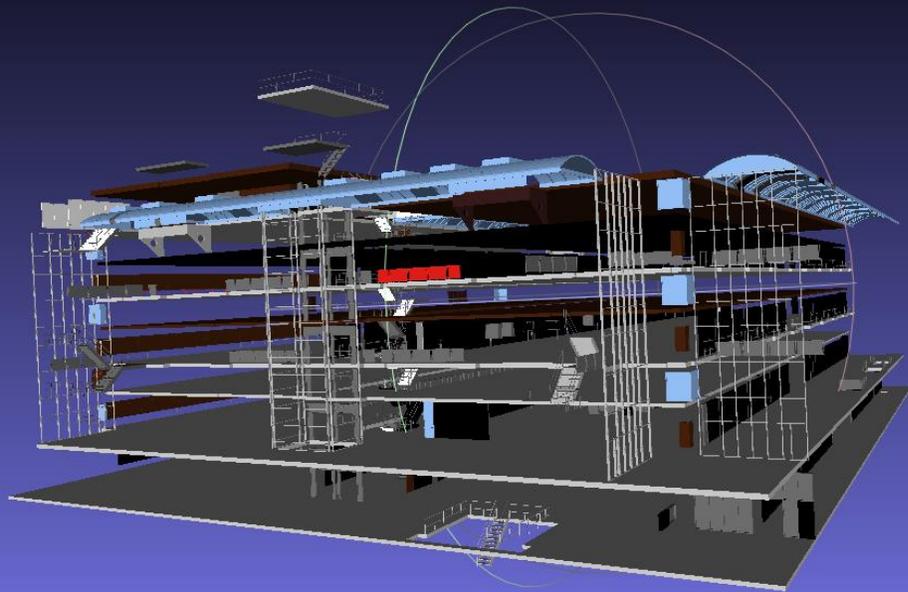
Exterior Part: Inclination Raycasting

Exterior Part: Inclination Raycasting

Exterior Part: Split of the Model

Exterior Part: Semantical Enrichment

Objects Isolated Semantically
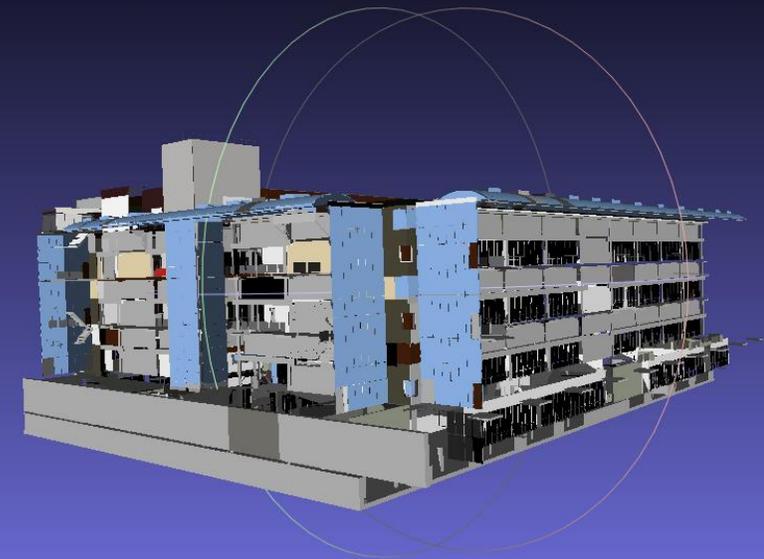
Exterior Obtained by the Algorithm

Configuration of the Holographic scene

- Project Settings

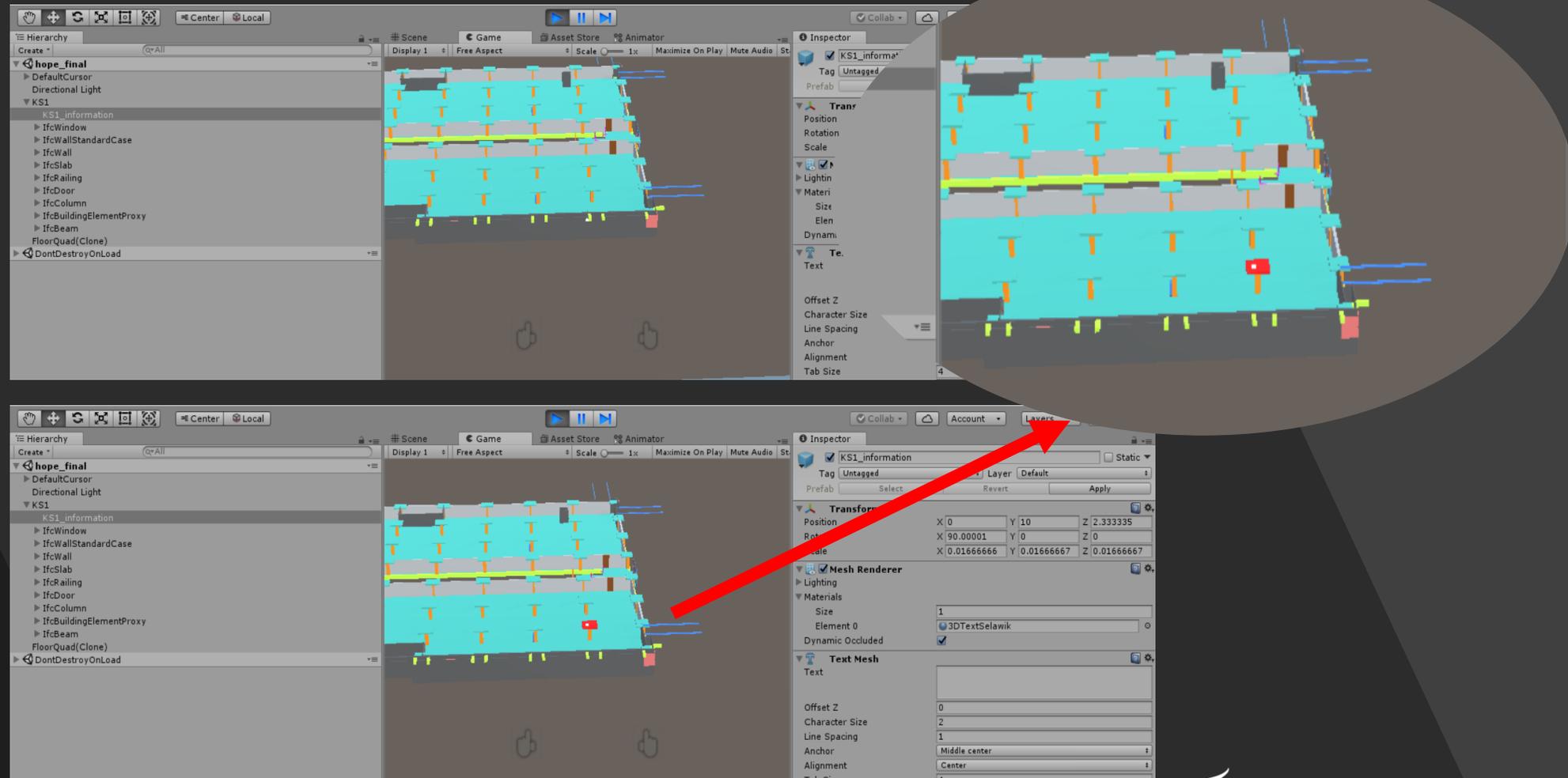- Apply Augmented Reality Scene Settings

- Spatial Perception Capability Settings
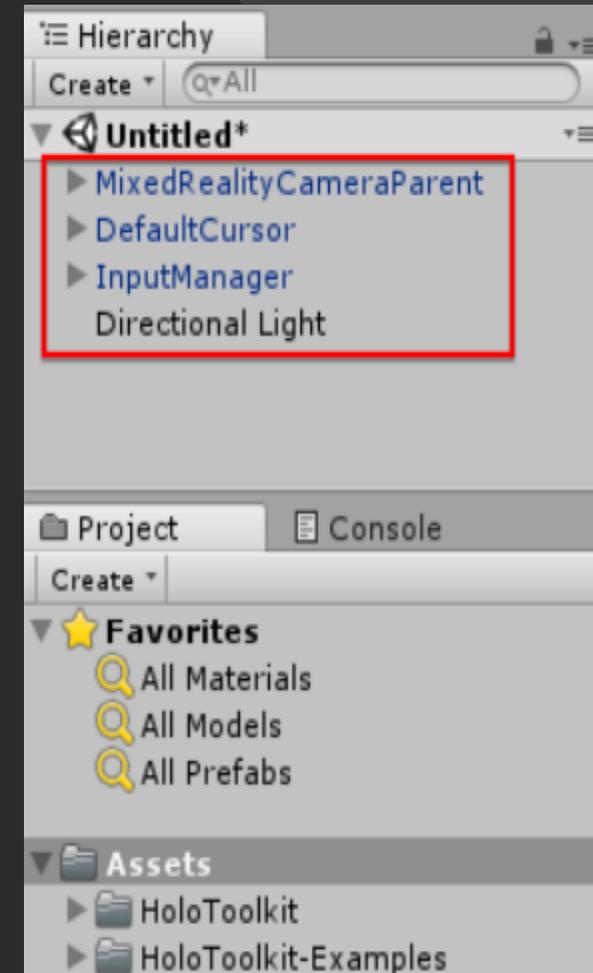
Hologram Manipulation: Material Creation & Assignment

Materials:

- Different material for every group of object
- Holographic textures
- As simple as possible (no reflections, hover light, etc)
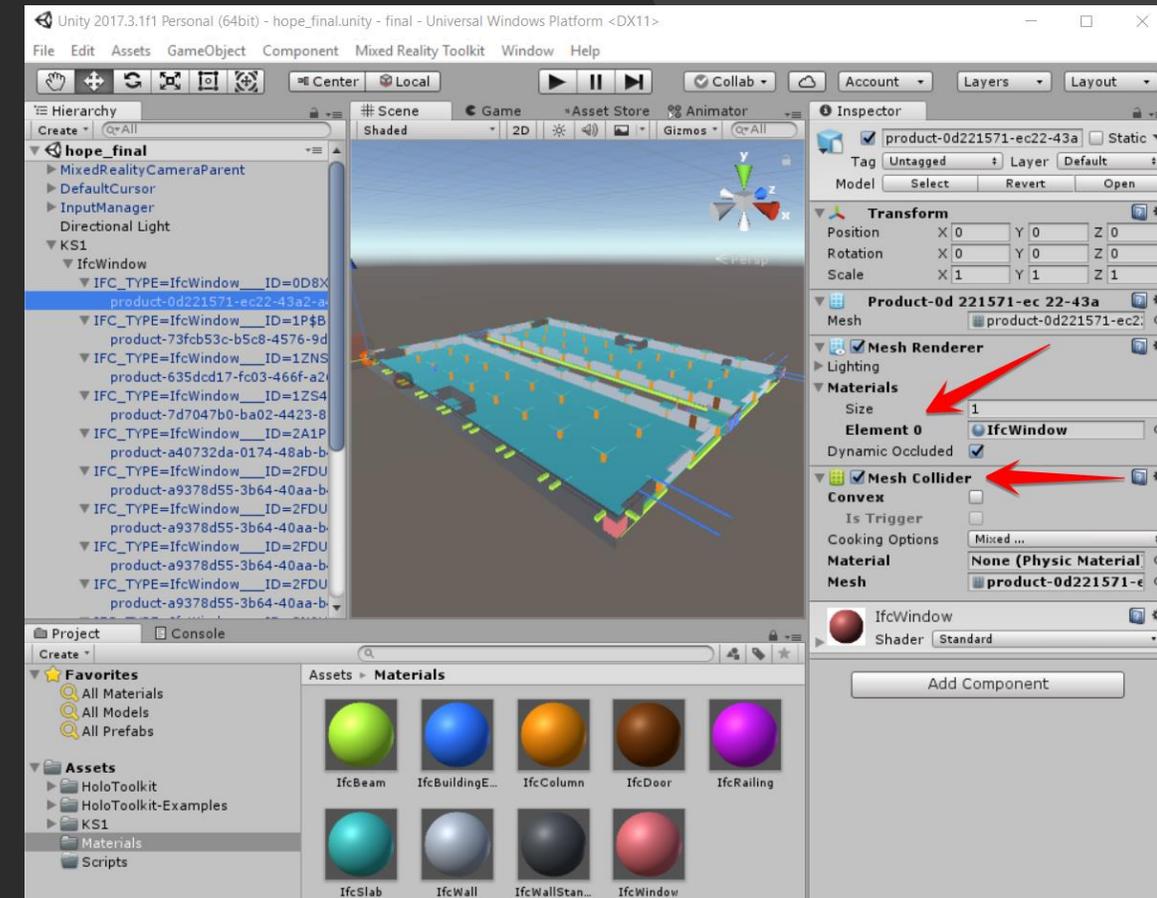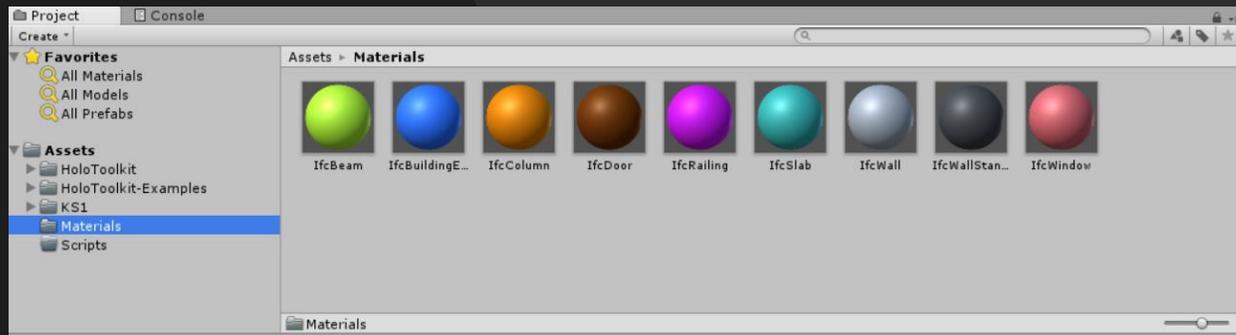
Hologram Interaction: Color Highlighting on Focus
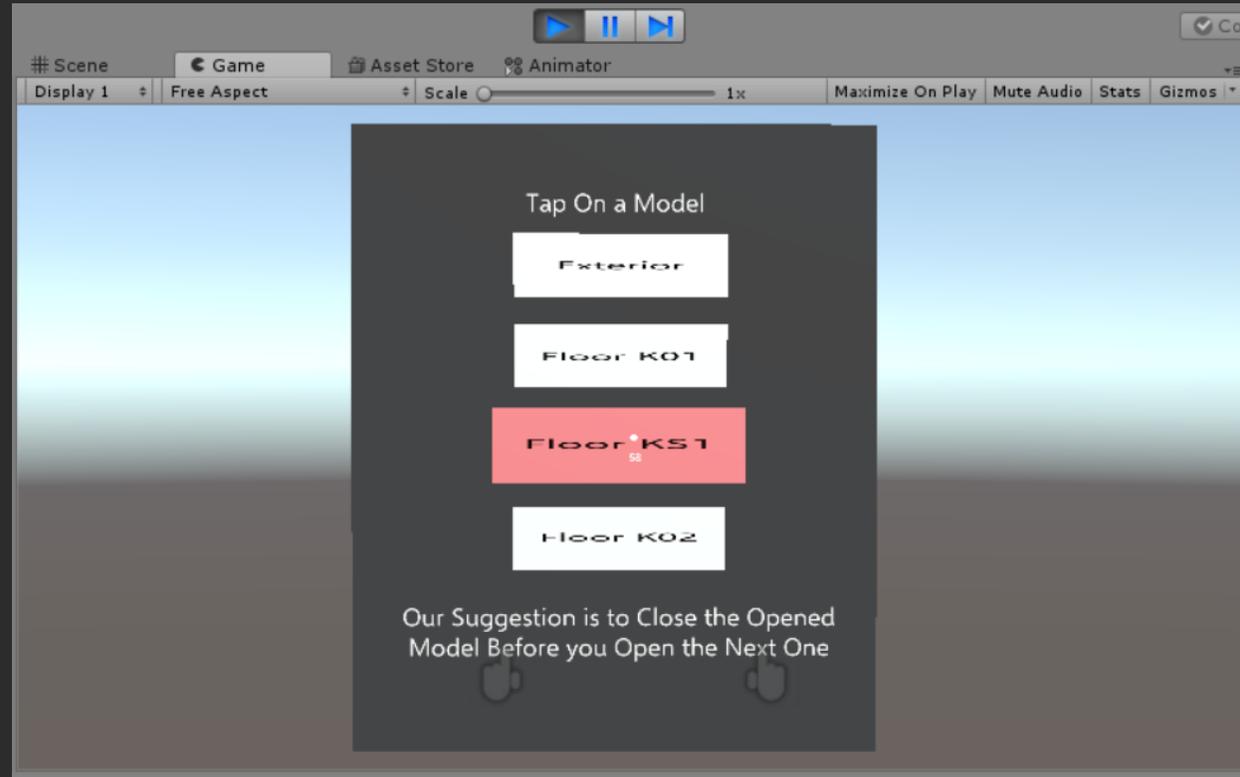
Hologram Interaction: Metadata Visualization
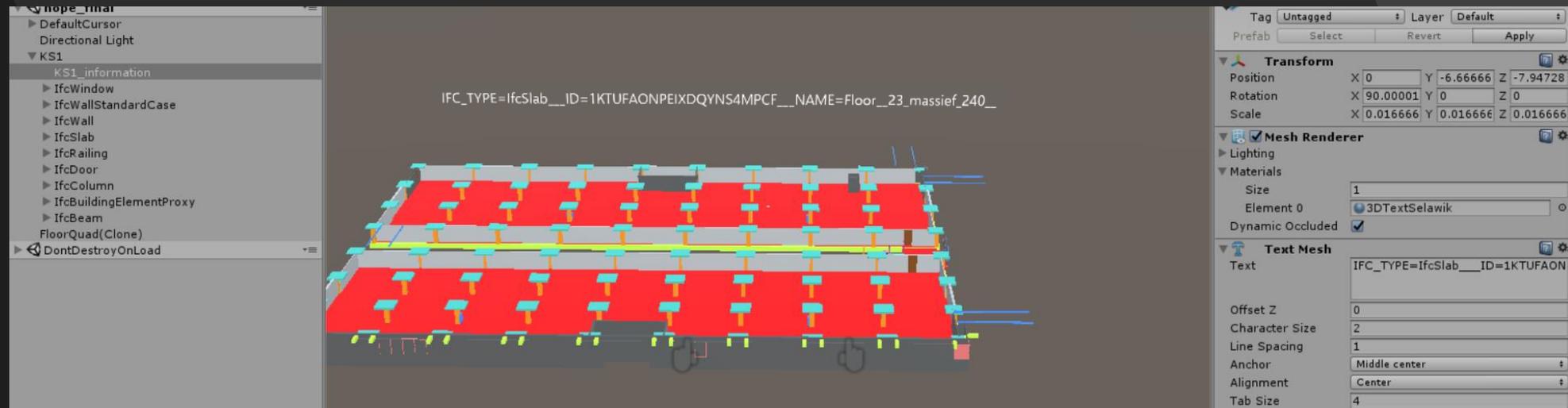
Hologram Interaction: Grow-Shrink-Rotate
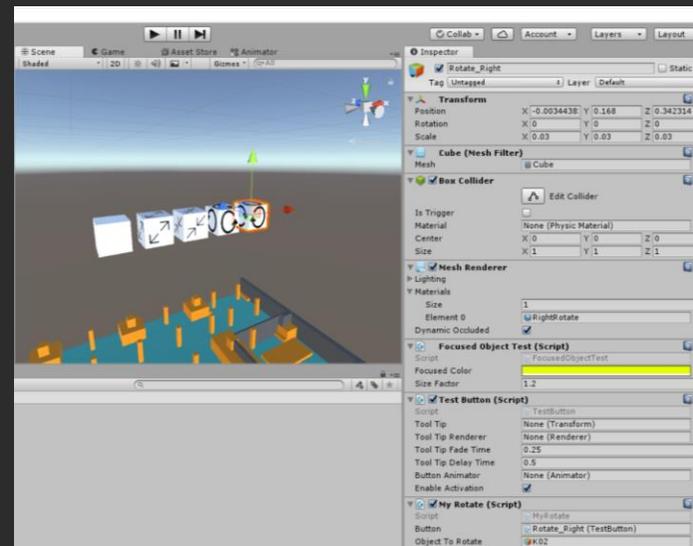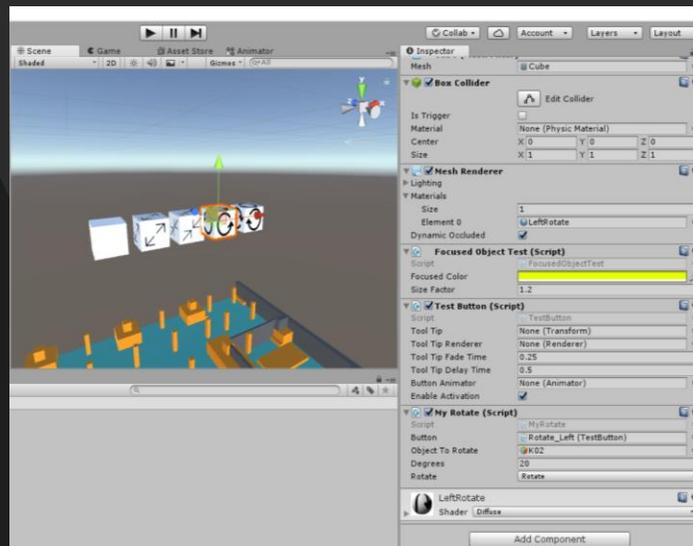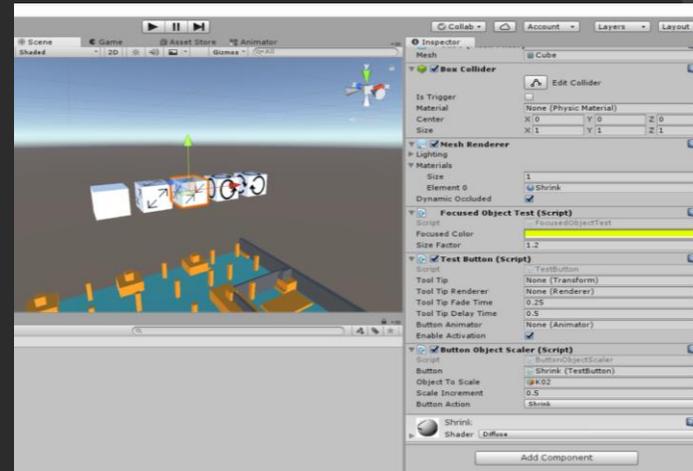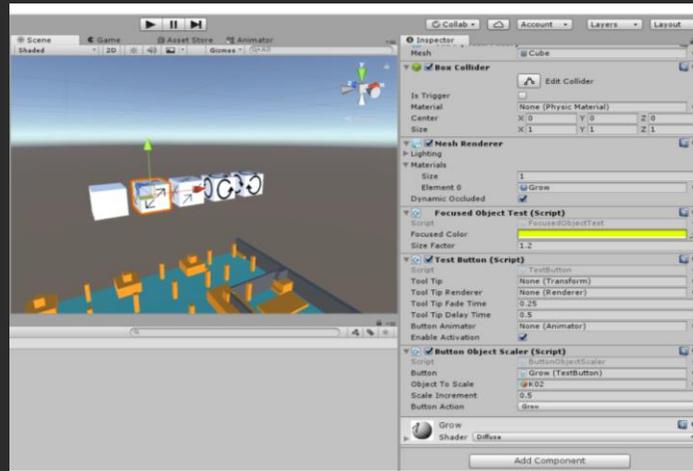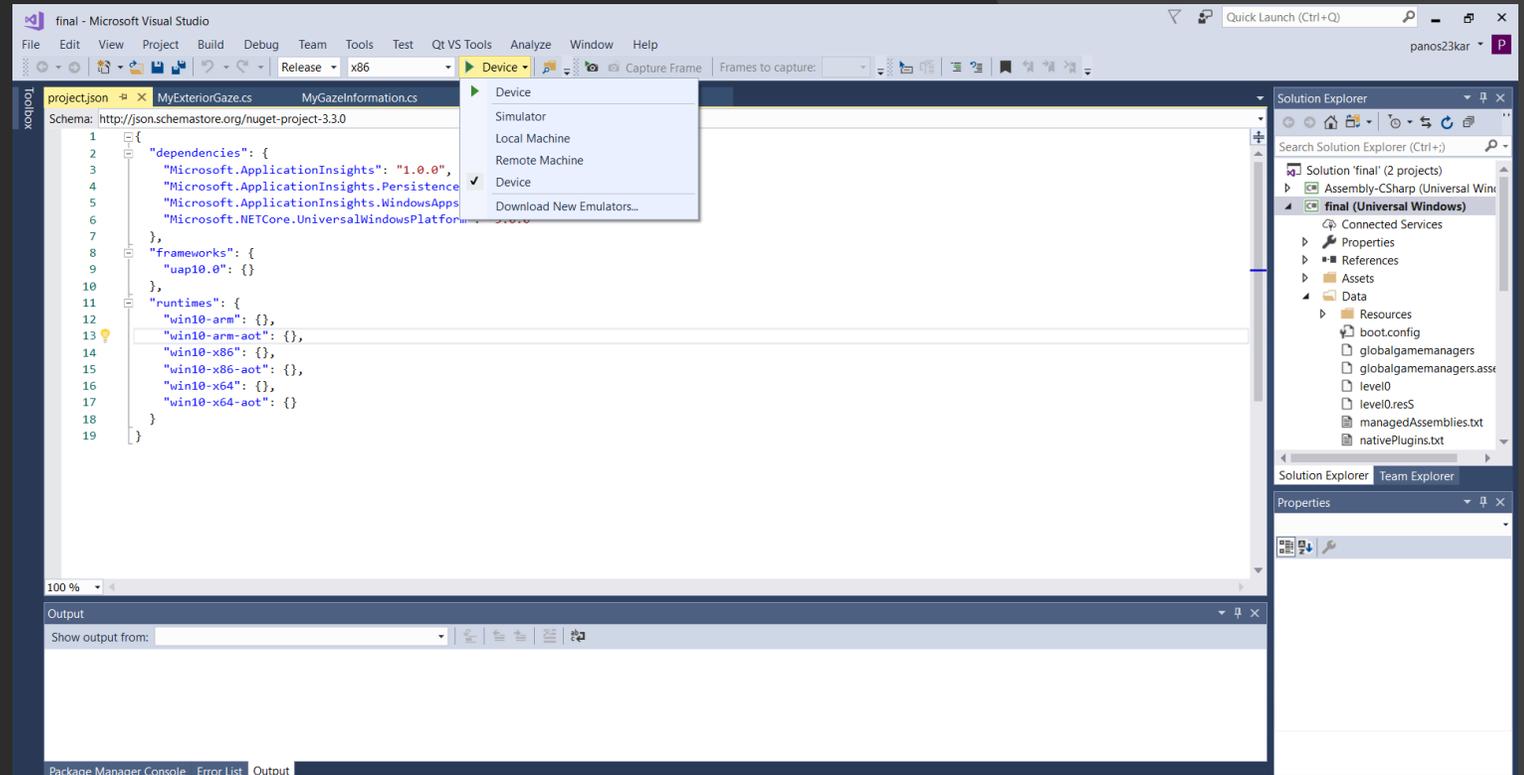
Hologram Interaction: Model Positioning
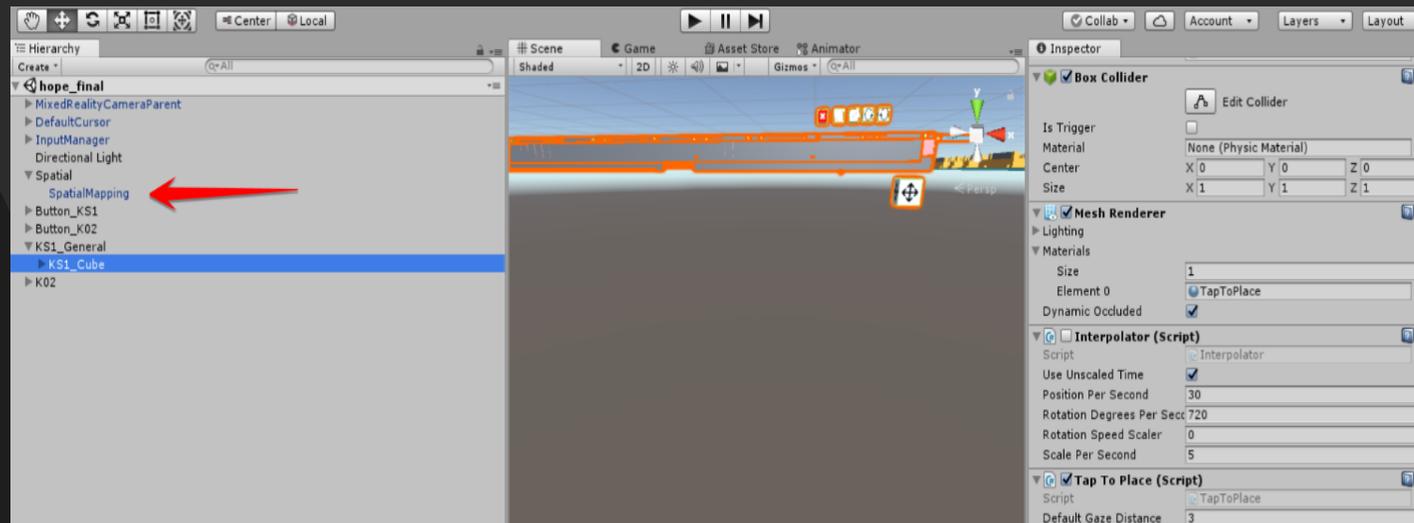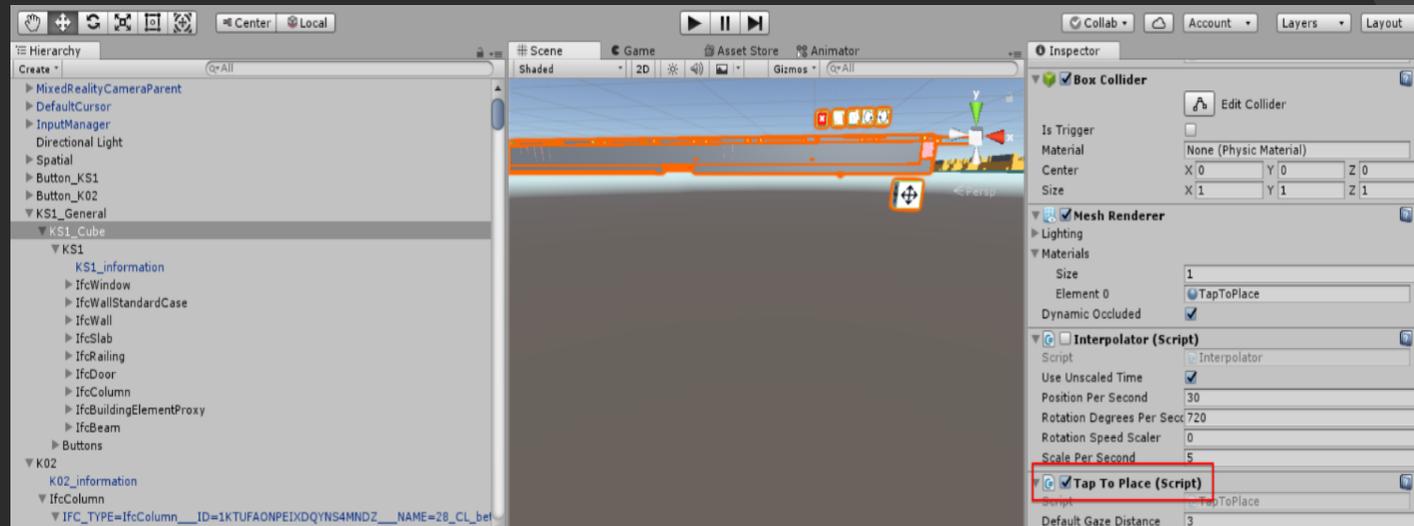
Hologram Interaction: Menu Creation

Deployment

- Deployment to the AR device
- Deployment to a simulation environment

Implementation Tools
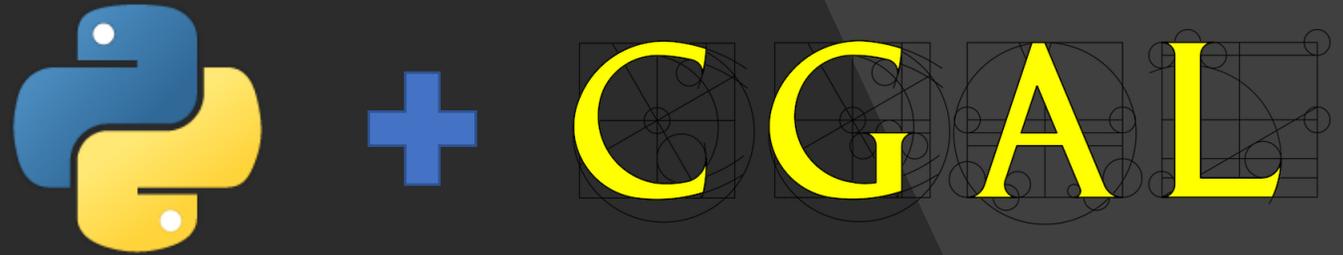
File Conversion

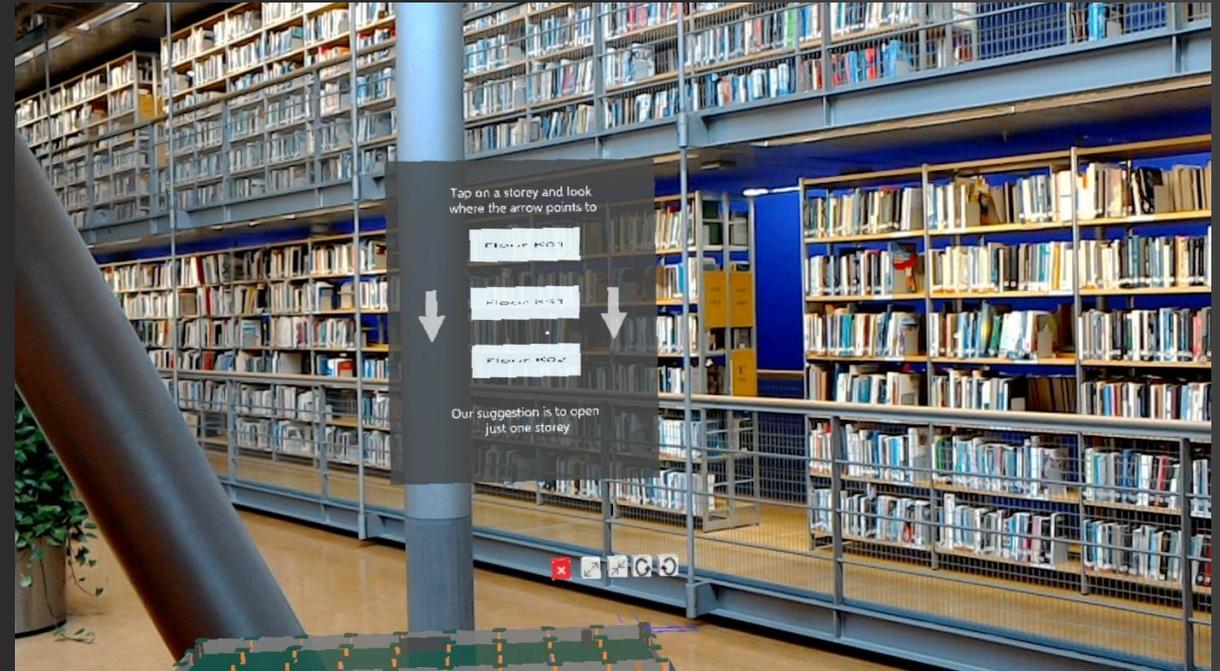IFC Visualization

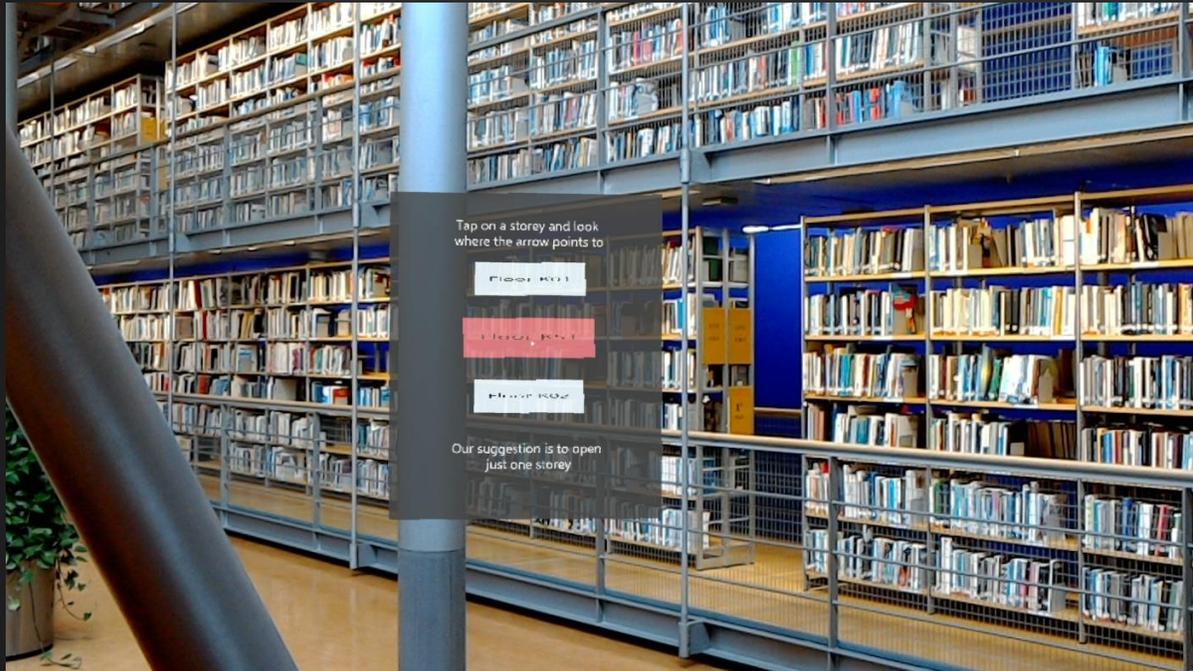Semantic Isolation

Implementation Tools

Exterior Extraction

Scene Configuration
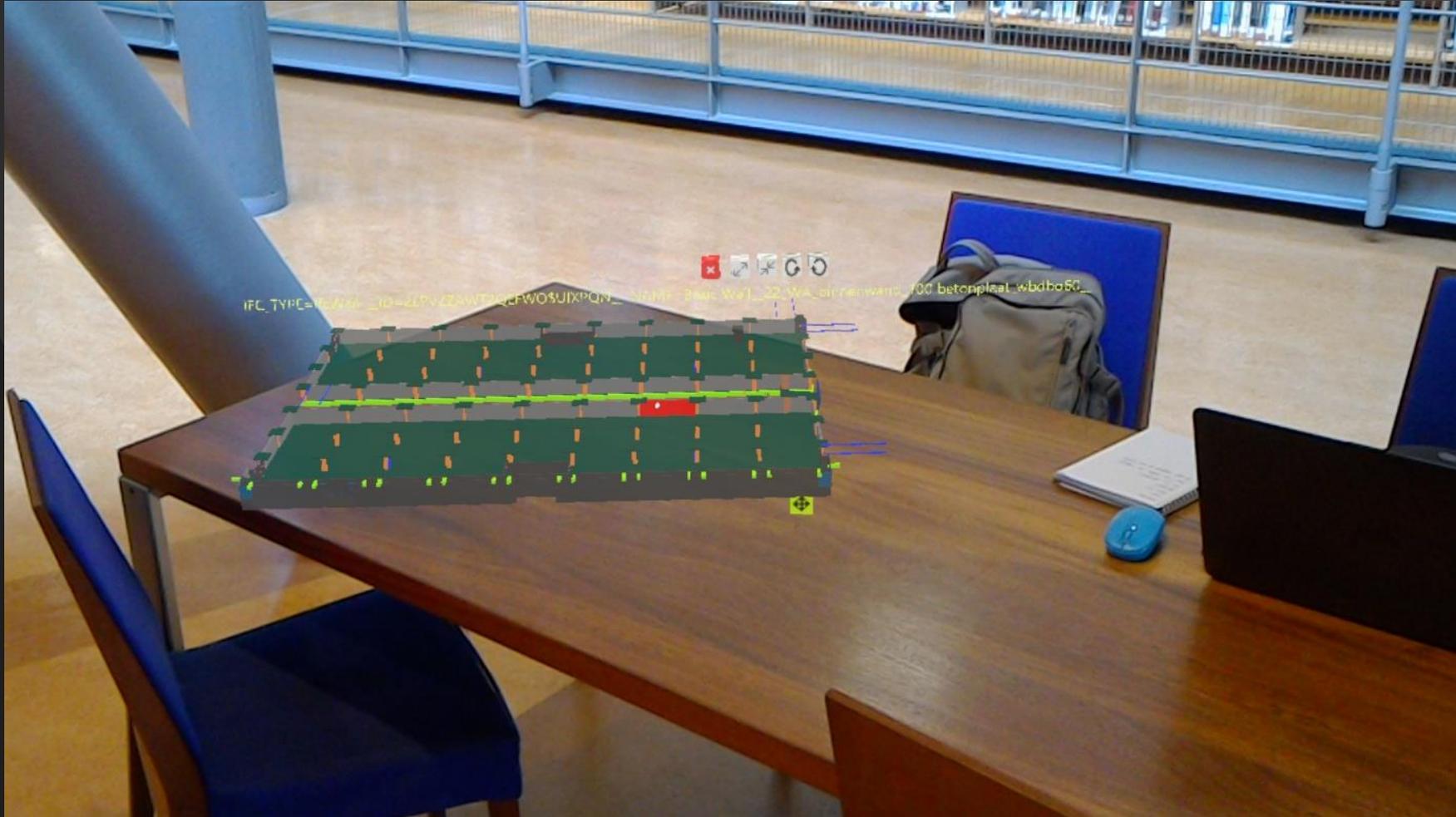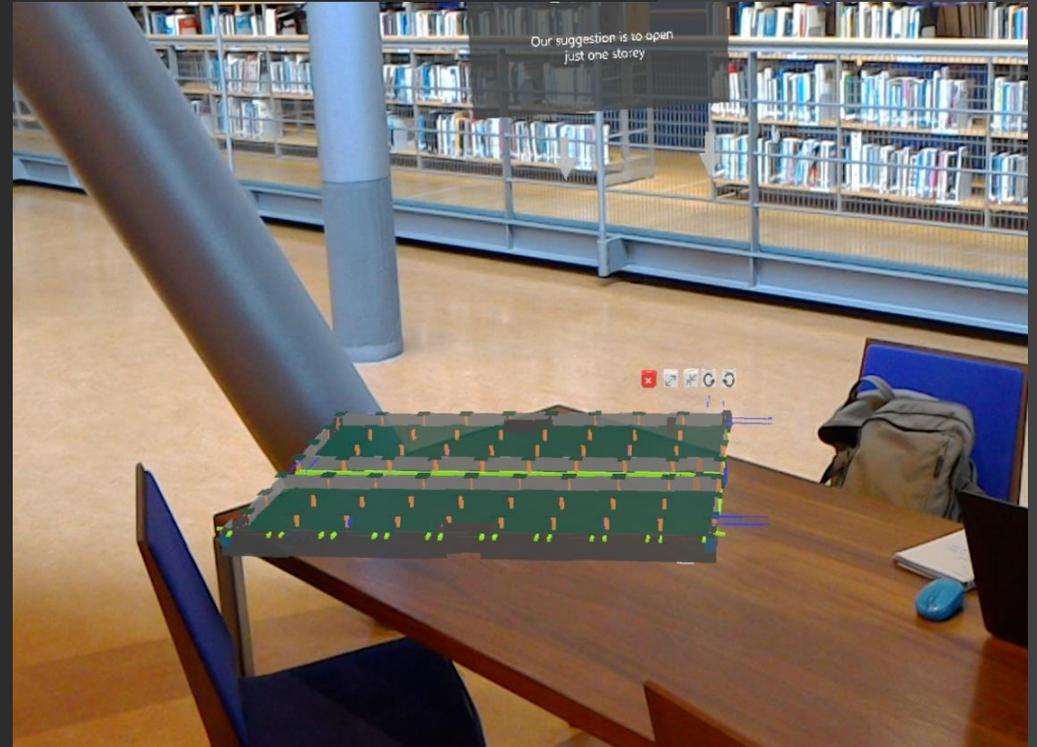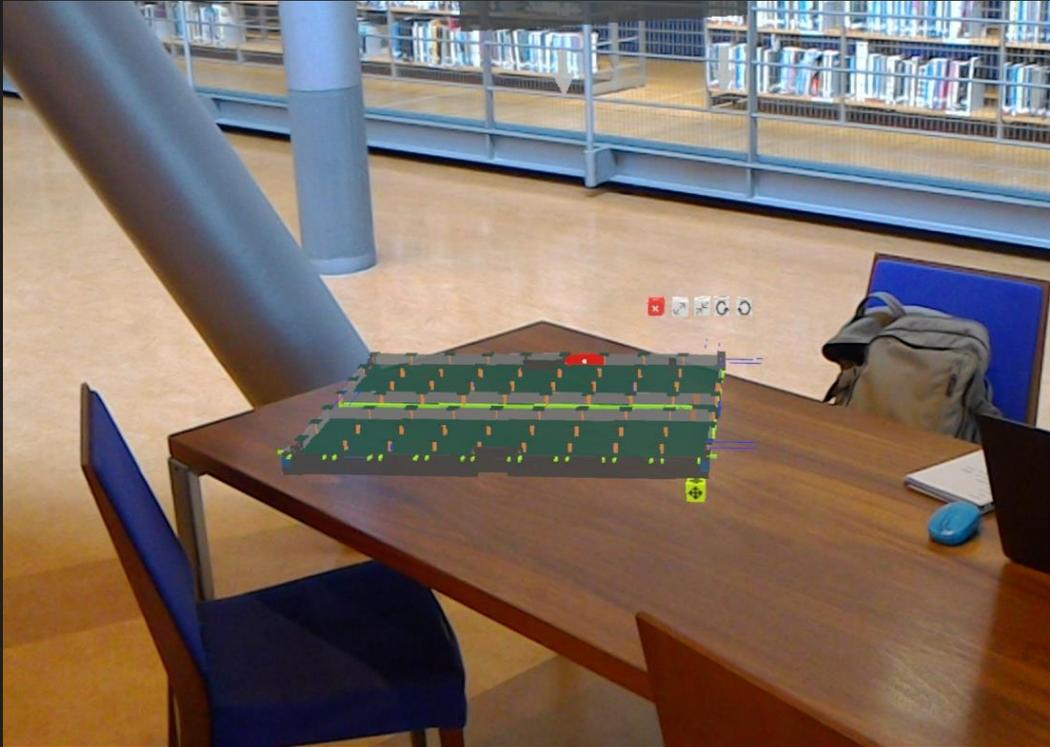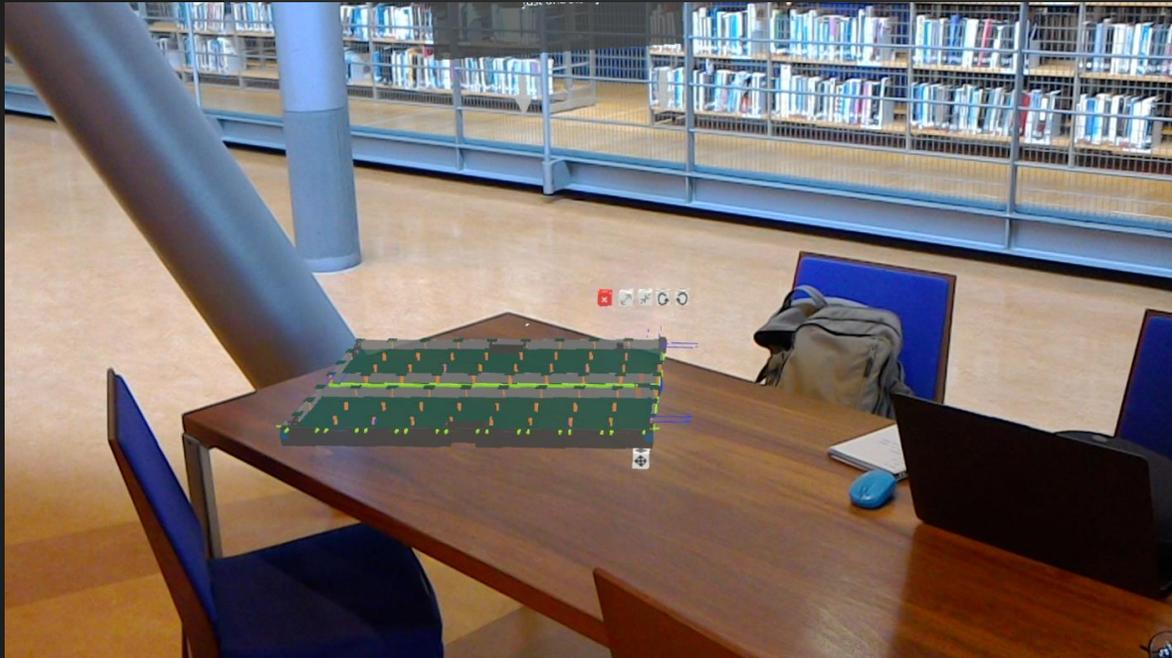Hologram Manipulation

Deployment

Results
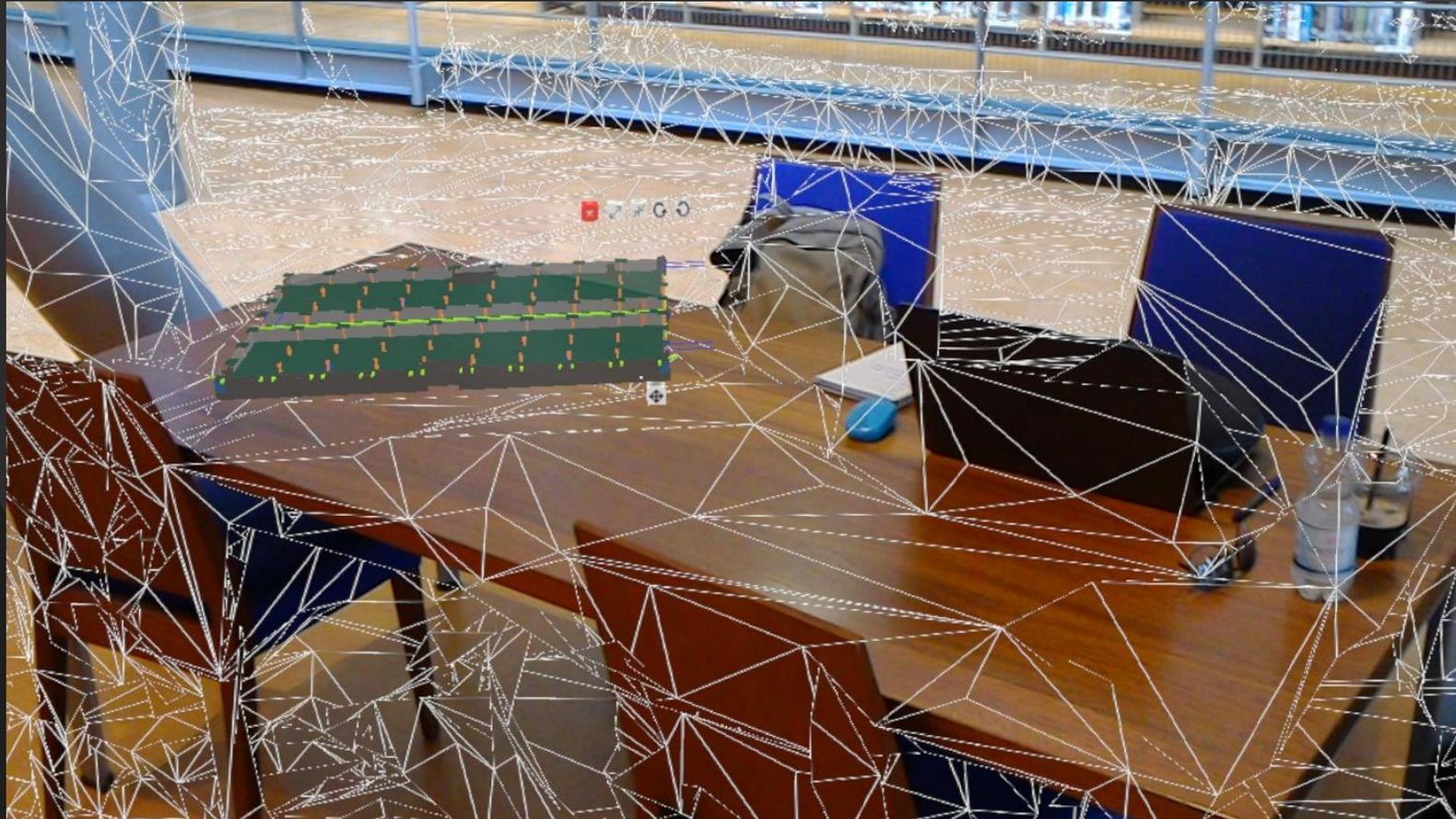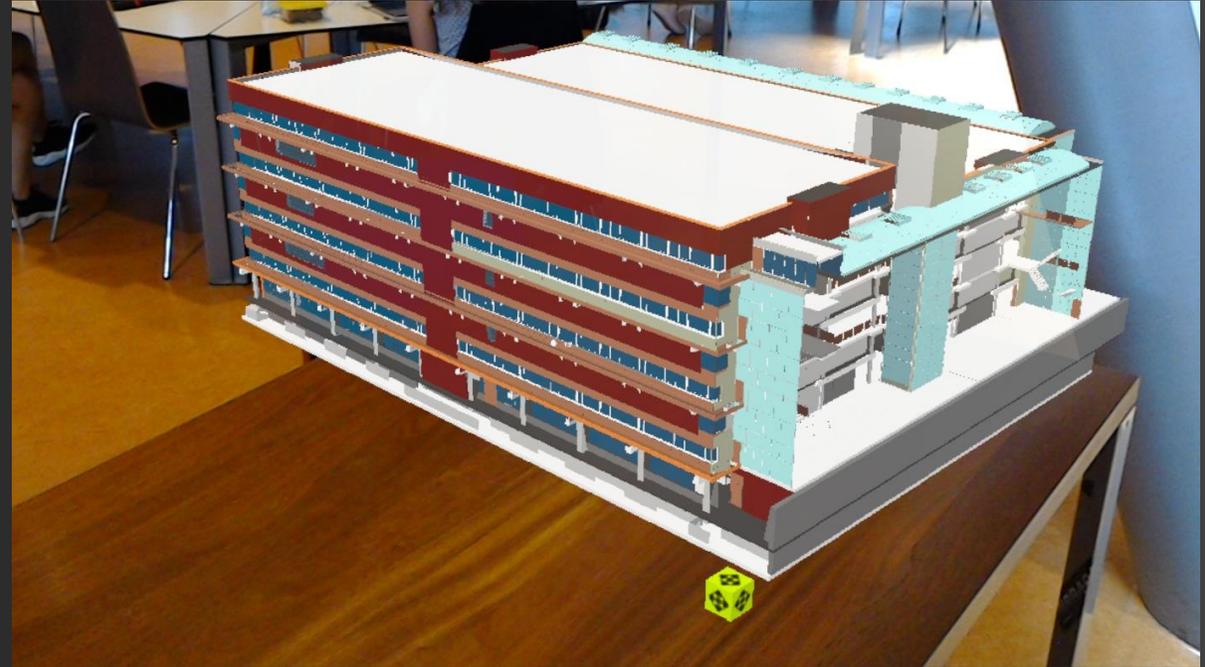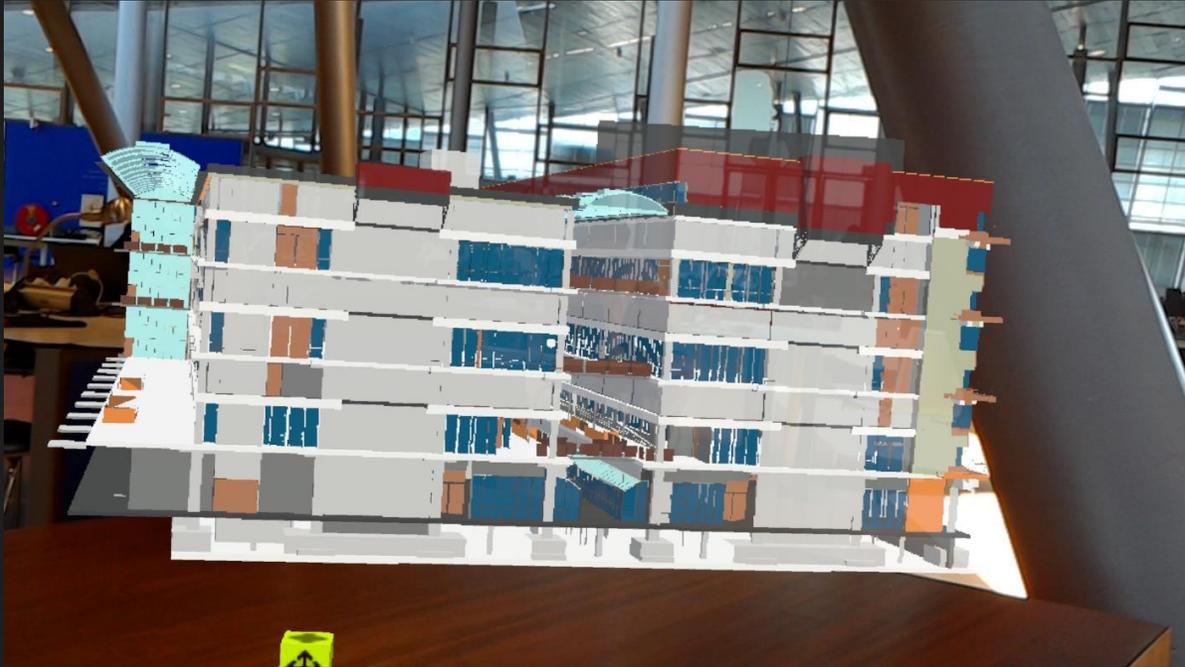
Results
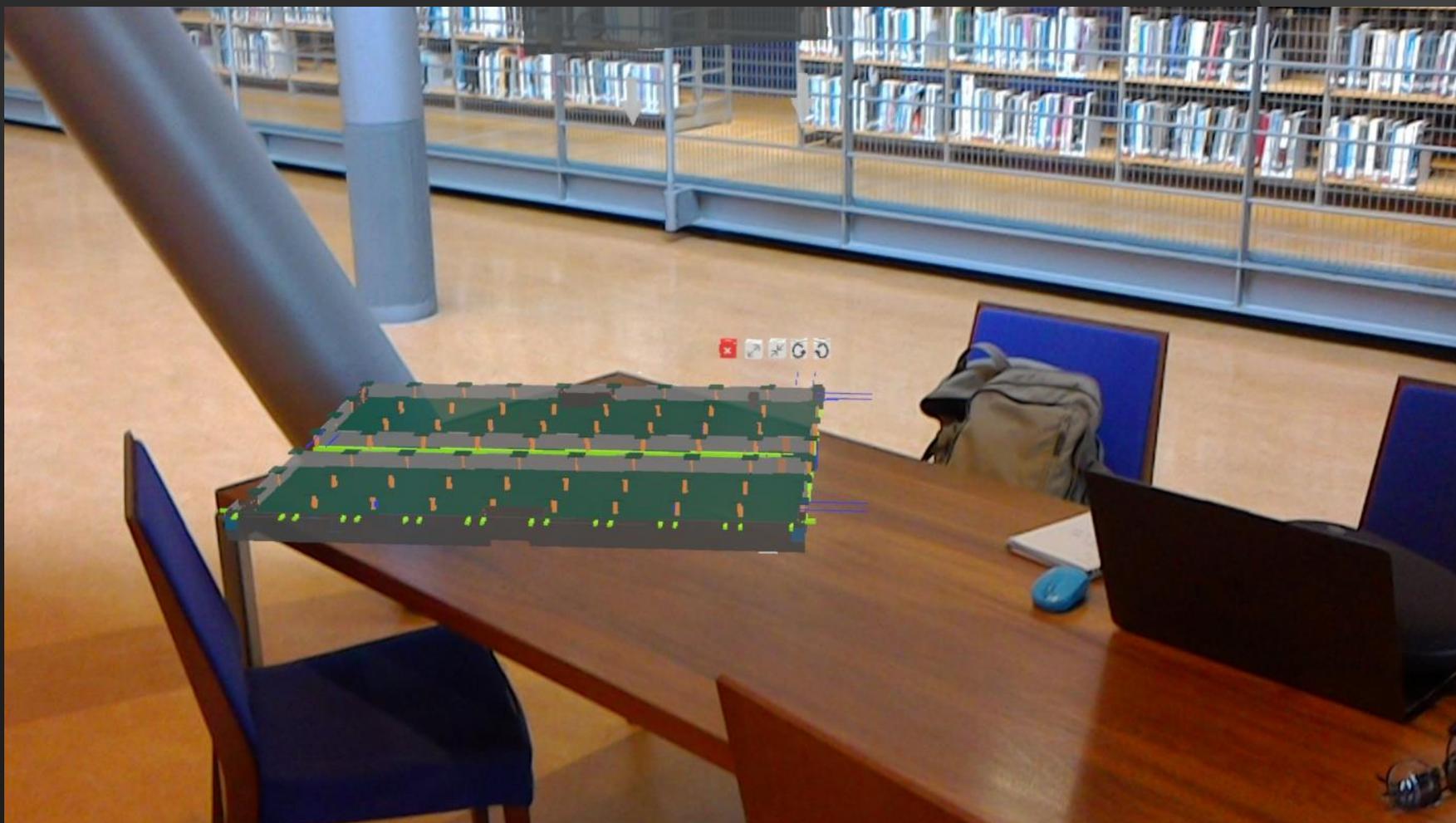
Results

Results

Results
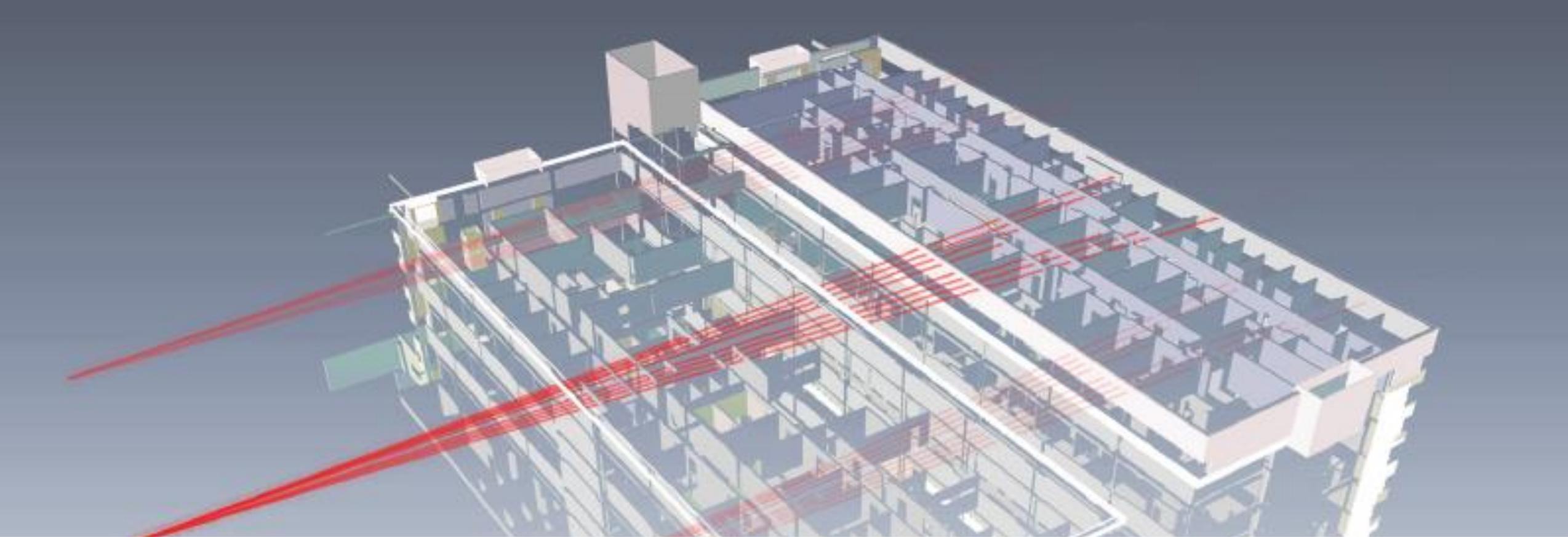
Results

Results

Results

Conclusions

- Intuitive perception of the design

- Precision of the exterior shell depends on the number of points, rays & cores and complexity of the model

- Inclination raycasting facilitates the exterior extraction

- Dynamic interaction with holograms is possible (resizing, rotating and positioning the model)

- Hololens still has certain limitations

Recommendations / Future Work

- Use of the interior / exterior attribute

- Use of PyCuda for the extraction of the exterior

- Dynamic occlusion of geometry (prepared caches)

Thank You