Goals for today

Creation of 2nd Level Space Boundaries from IFC

- Define input and output in a table
- Three presentation to algorithms and methods
- Create flow chart for the modular algorithms including responsibilities
- Planning creation of documentation including definitions, flow charts, method review, design error handling

Goals for Project

Input

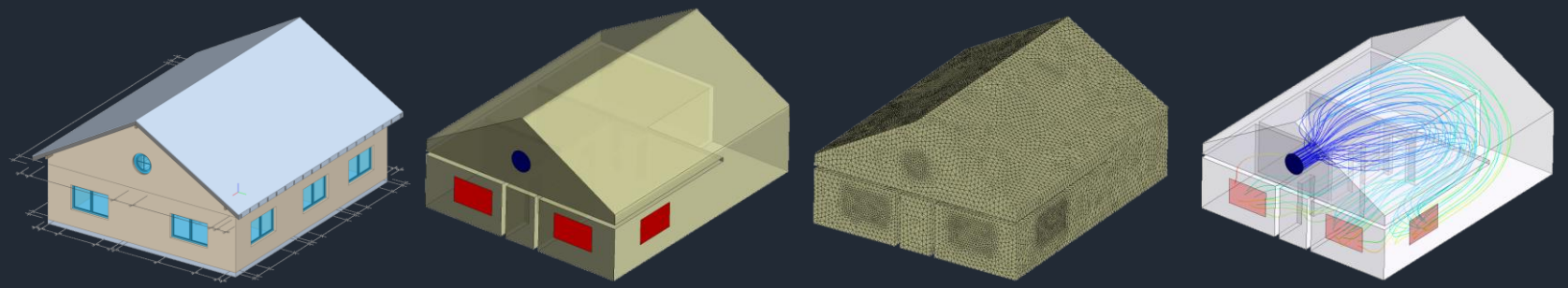
- IFC
- If existing: IfcSpaces, otherwise creation of air volume
- Planar faces only?
- Design Error or challenges handling:
  - E.g. hybrid modeling
  - Collisions
  - Gaps

Output

- 2nd Level Space Boundary (horizontal, vertical)
- IfcSpace
- IfcBuildingElement
- IfcRelSpaceBoundary
- IfcPhysicalOrVirtualEnum (physical, virtual)
- IfcInternalOrExternalEnum (internal, external)
- Geometry of Space Boundary according to one of the representation styles of IFC

IBPSA Project 1 - WP 2.2: Building Information Modeling

Current status of the project BIM2SIM – Part I: IFC to CFD



IBPSA Project 1

Eric Fichter

Lehrstuhl für Energie-effizientes Bauen

RWTH AACHEN UNIVERSITY

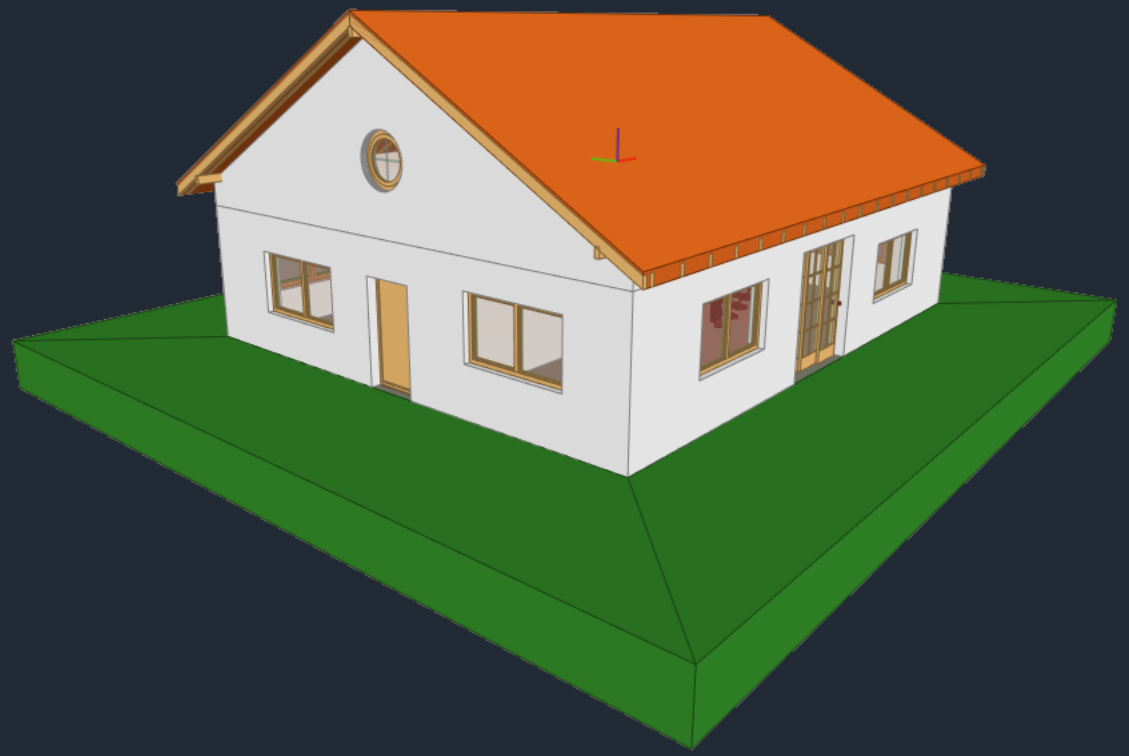
Fourth Expert Meeting, Rome, Italy

31th of August – 1st of September 2019

Test Building Model

Usage of FZK-Haus
as test building

Karlsruher Institut für Technologie

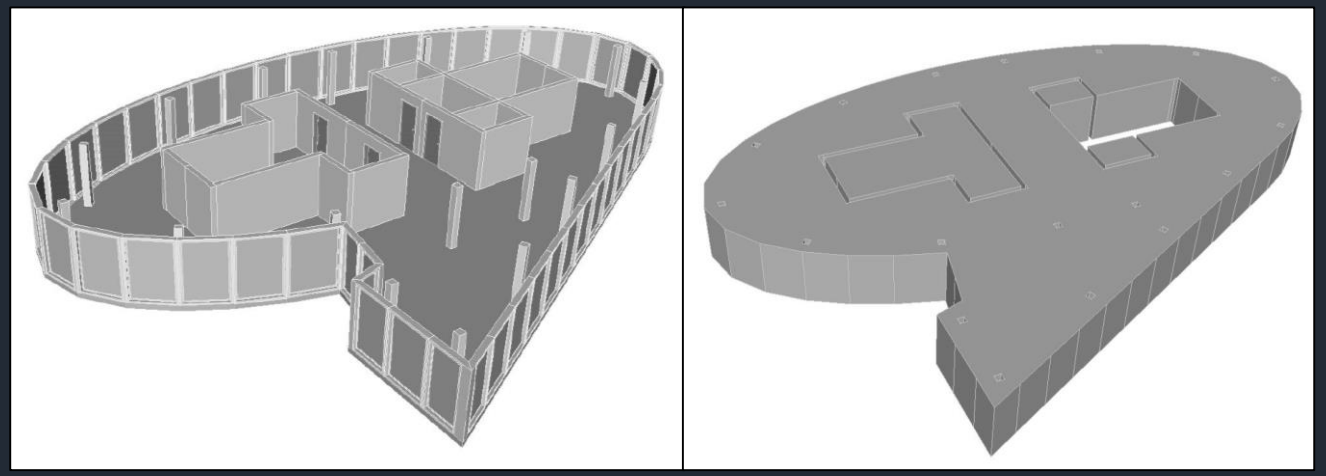


Goals of BIM2SIM

Goal: Providing some assistances to CFD engineers and show an example tool chain from IFC model to simulation model

Work Package 5:

- Topological investigations on IFC building models and extraction of air volumes as geometric objects

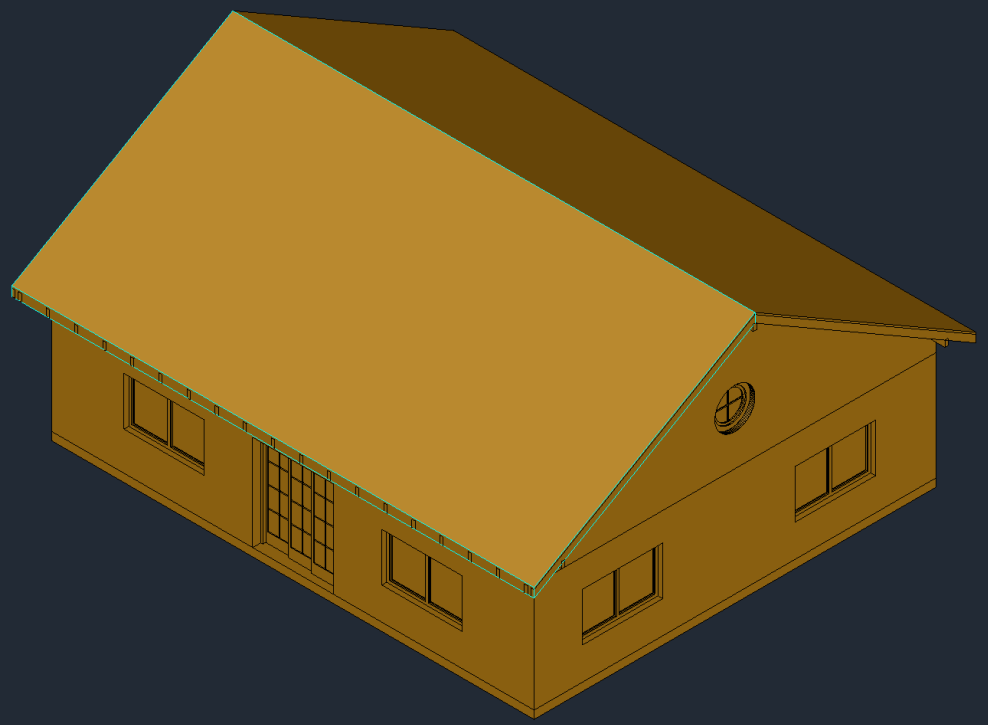


Christoph van Treeck: Gebäudemodell-basierte Simulation von Raumluftströmungen, PhD thesis

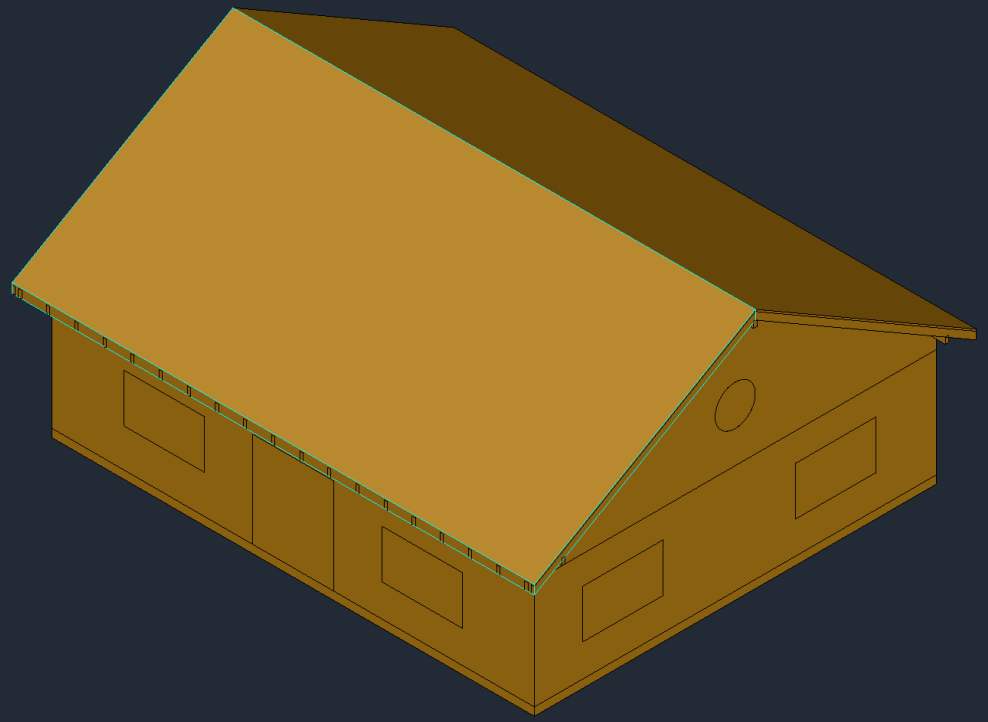
Current status of BIM2SIM

Step 1 – Extraction of Geometry

Boundary Representation

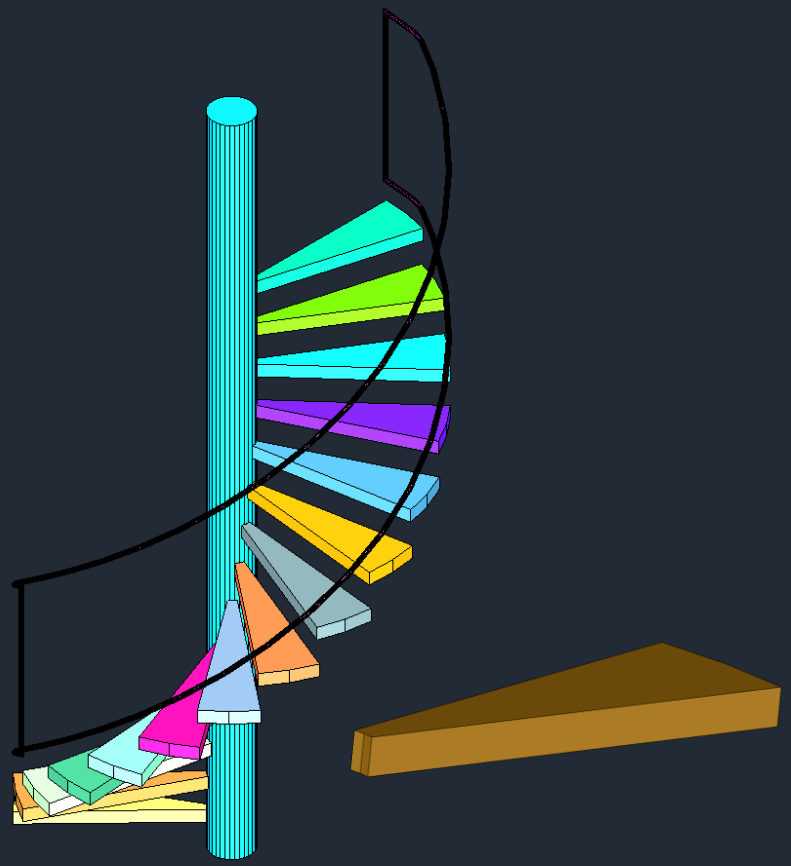


Boundary Representation with simplified openings



Step 2 – Merging Solids

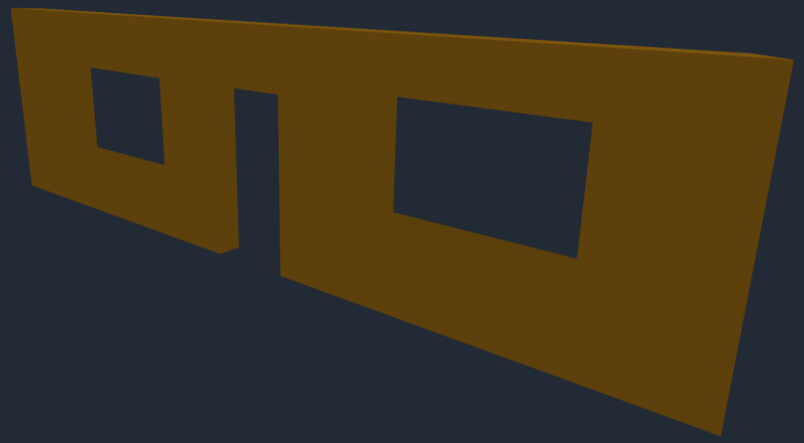
Compound

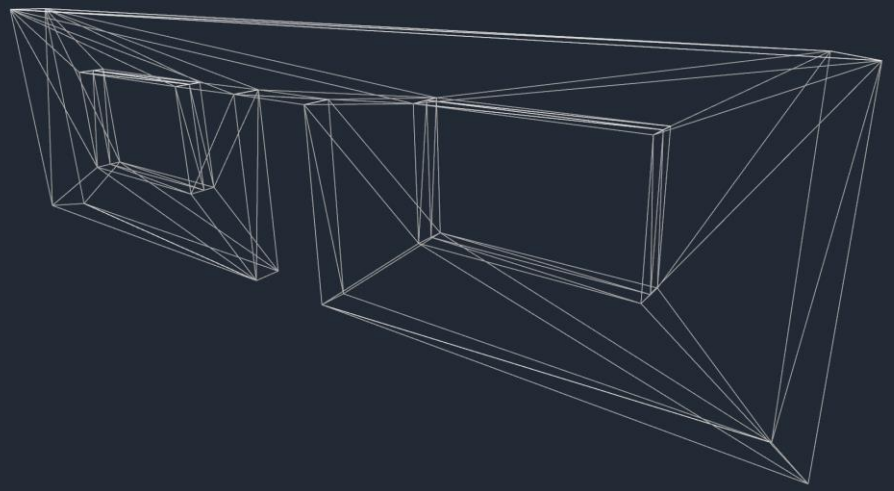


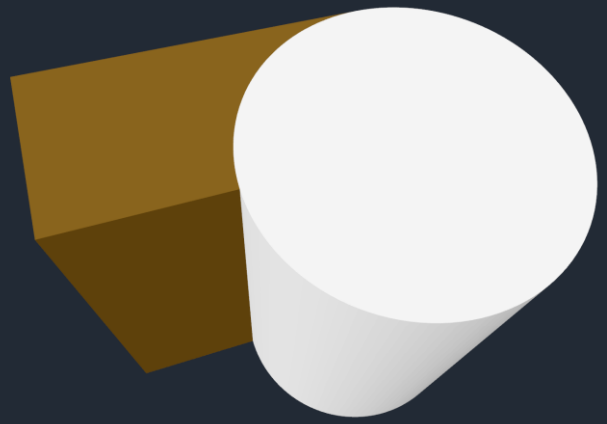
Solid/Shell

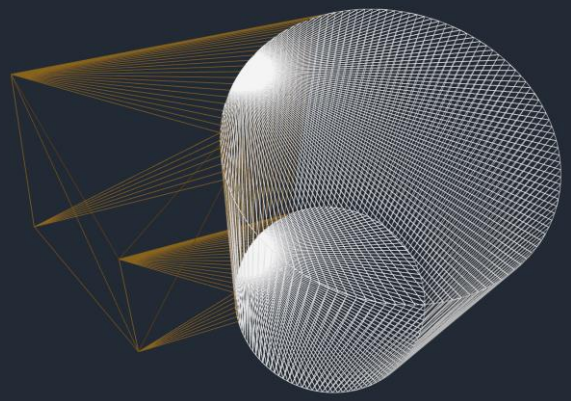
Step 3 – Tesselation

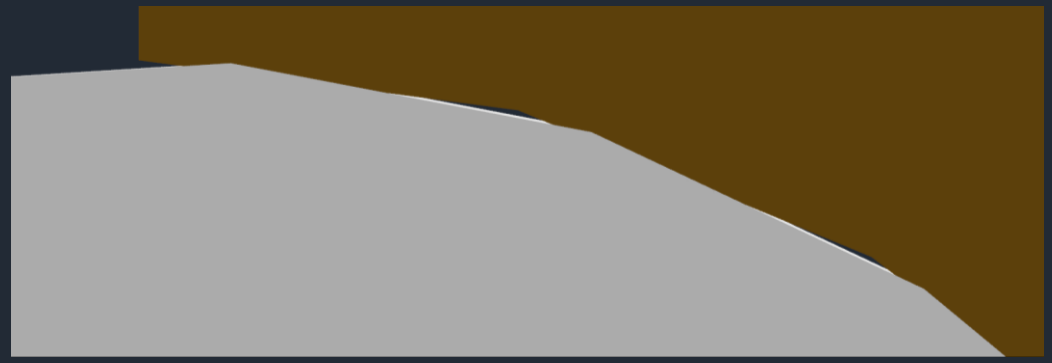
Triangulation









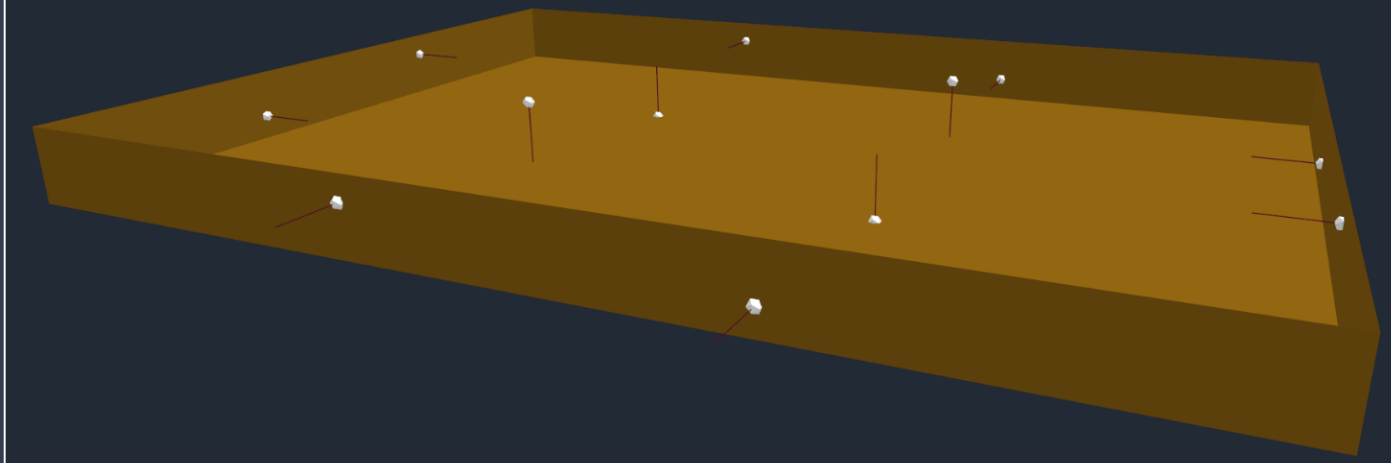


Step 4 – Shape Fixing

Typical problems (for both BREP and Mesh)

- Open shells (gaps), non-watertightness
  - Close shell
- Wrong orientation of shell's faces
  - Fix winding
- 2D-objects
  - Delete?
- Self-intersections (e.g. steps in stair column)
  - Merge
- Collisions between objects
  - Boolean Cut

✓ Fixed valid shapes



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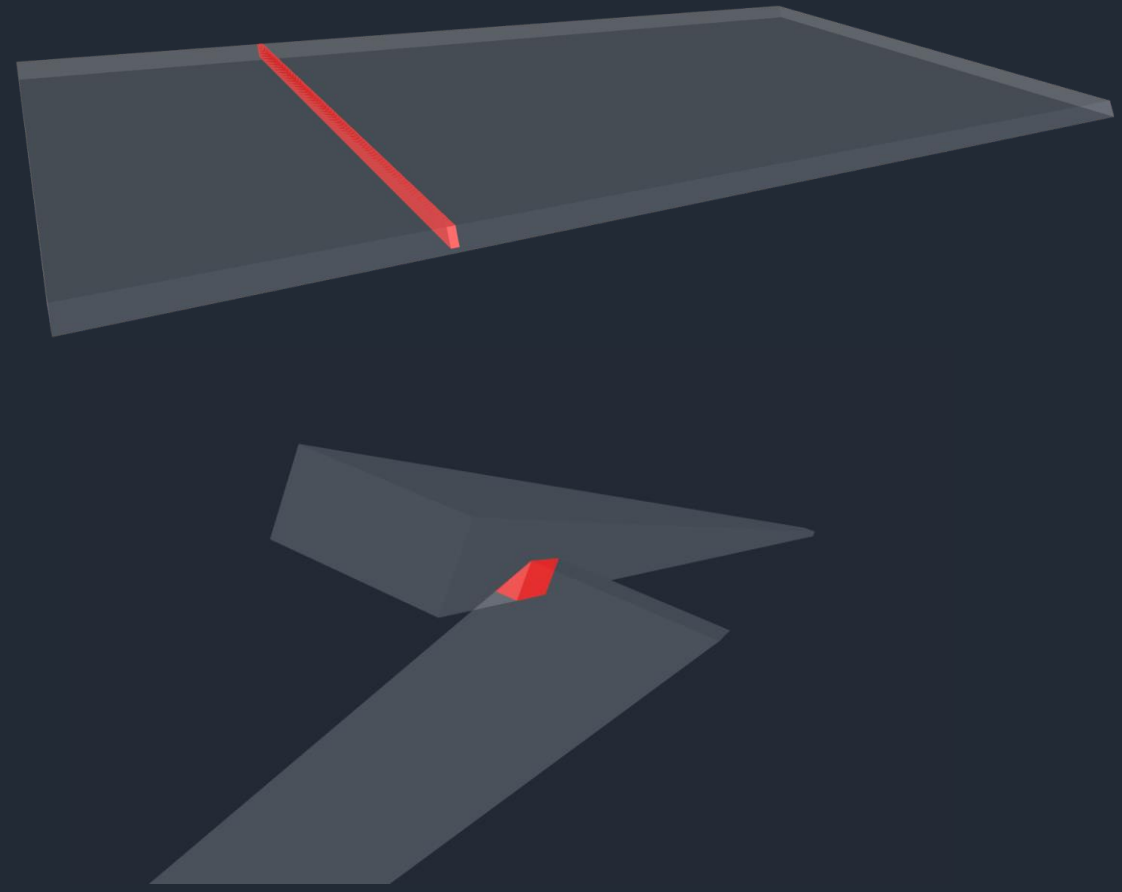
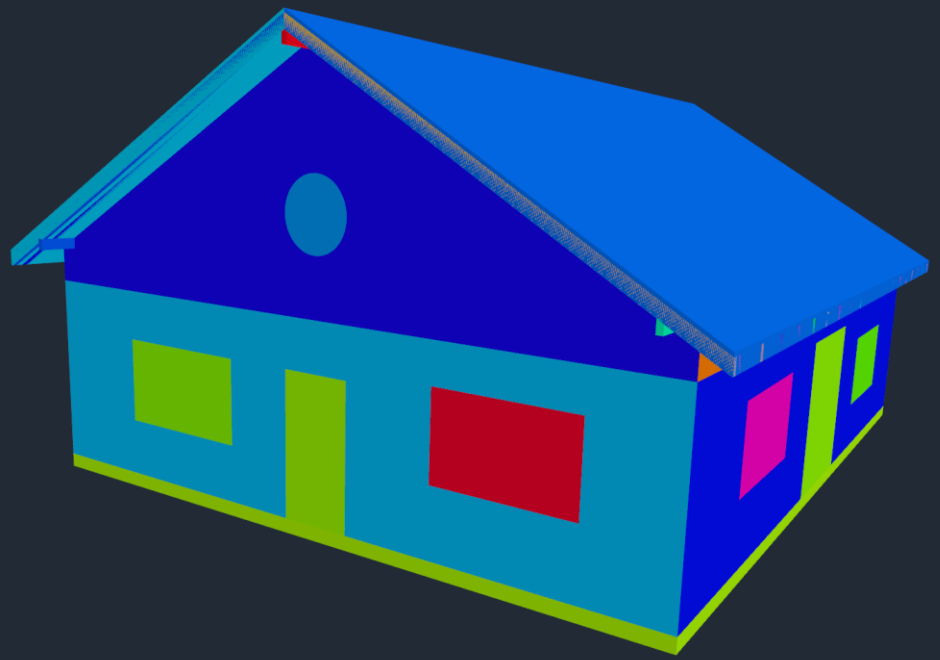
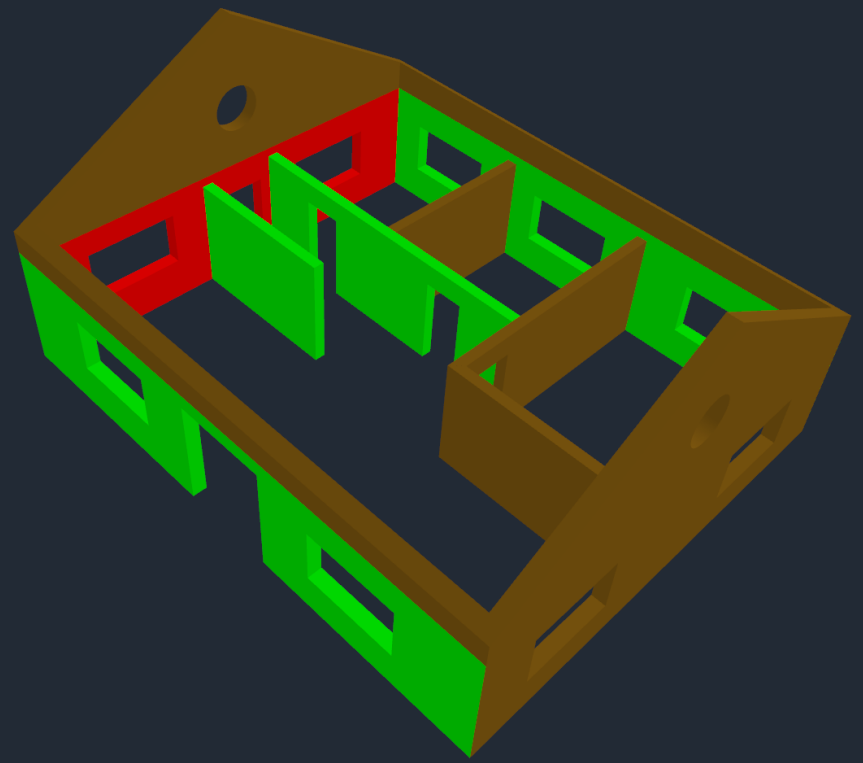


Step 5 – IFC Product Shapes and Relations

Shape - GUID

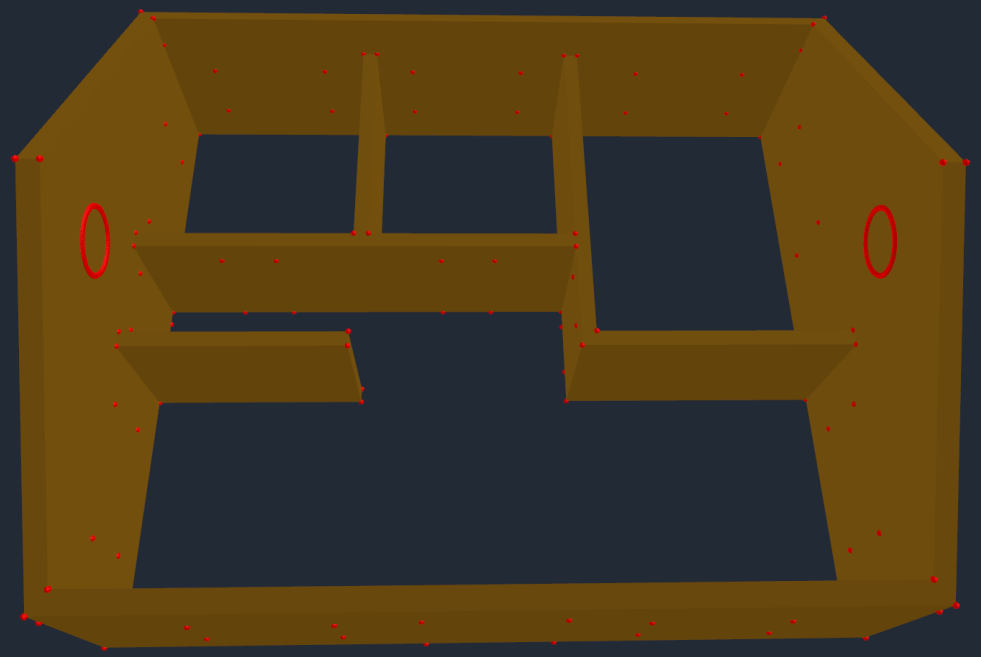


Shape (GUID) - Shape (GUID), Face – Face

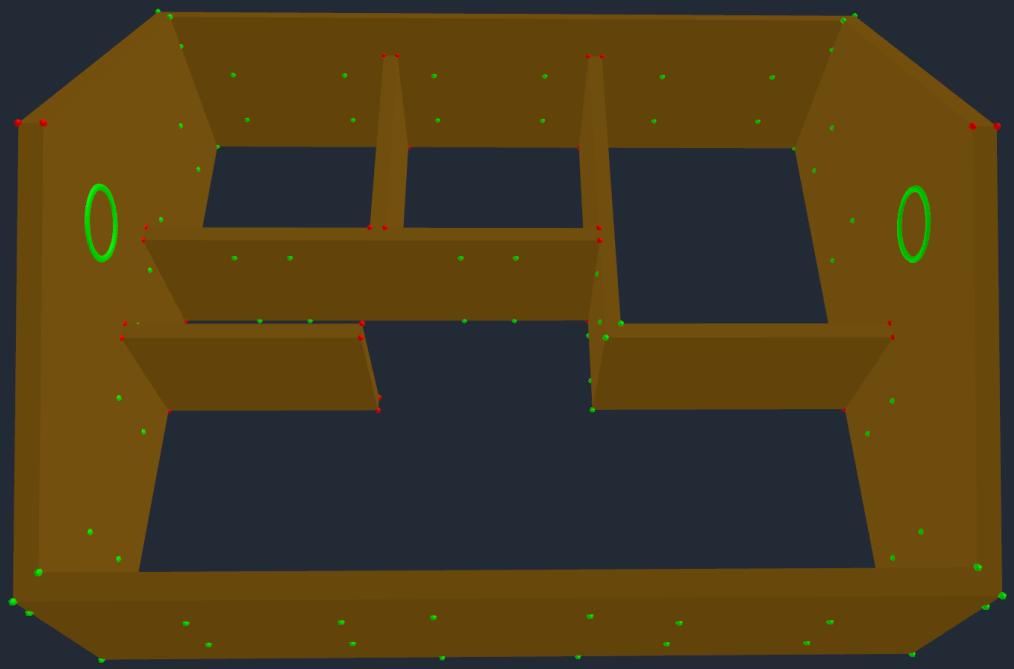


Step 6 – Creation of a merged model

Initial



Step 1

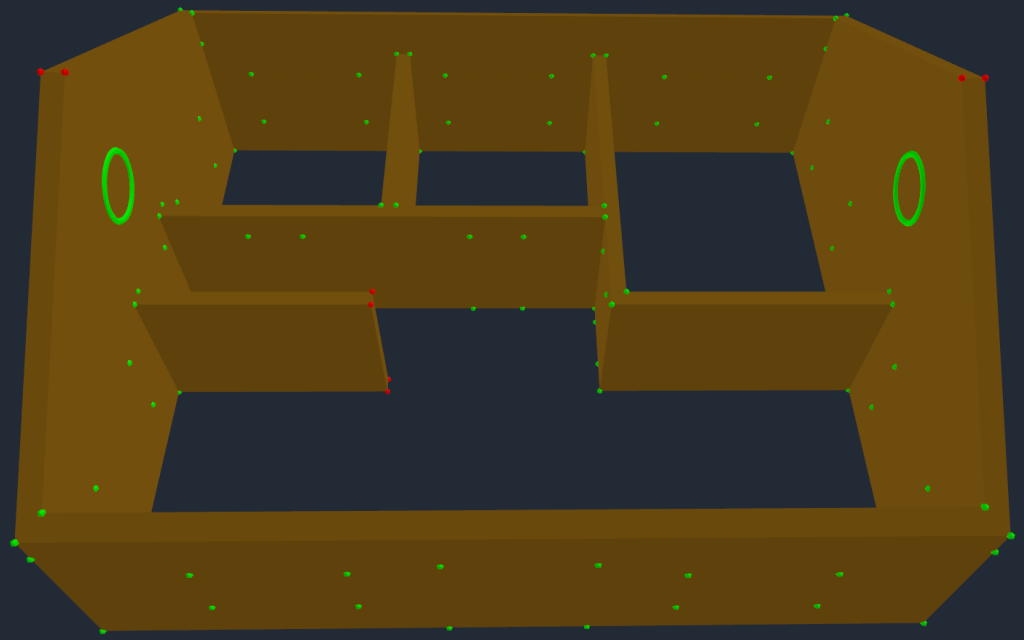


Unconnected Vertices (to other objects)

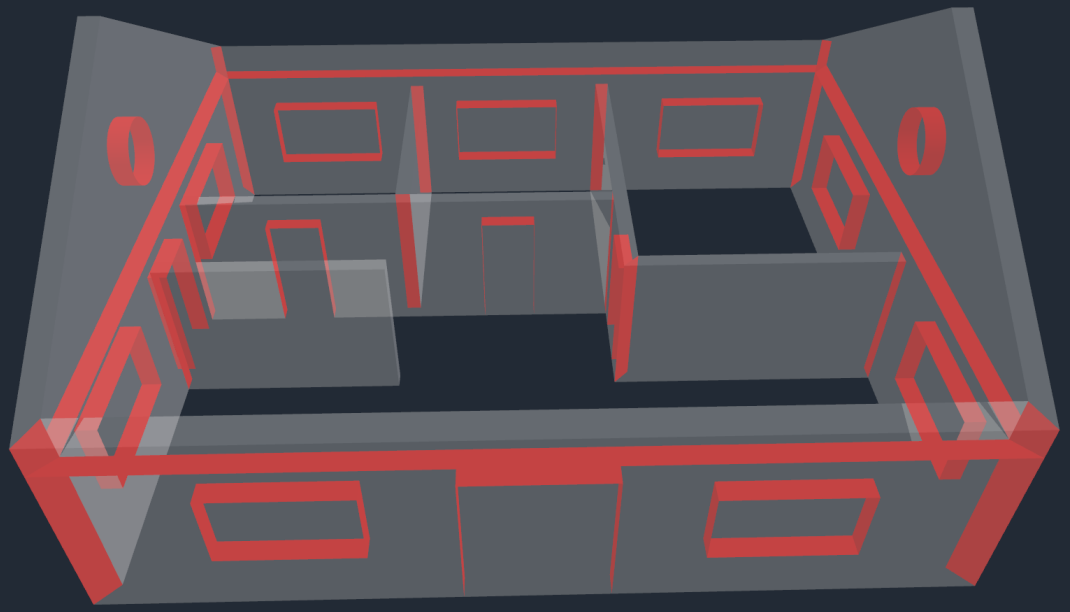
Connected Vertices (to other objects)

Step 6 – Creation of a merged model

Step 2



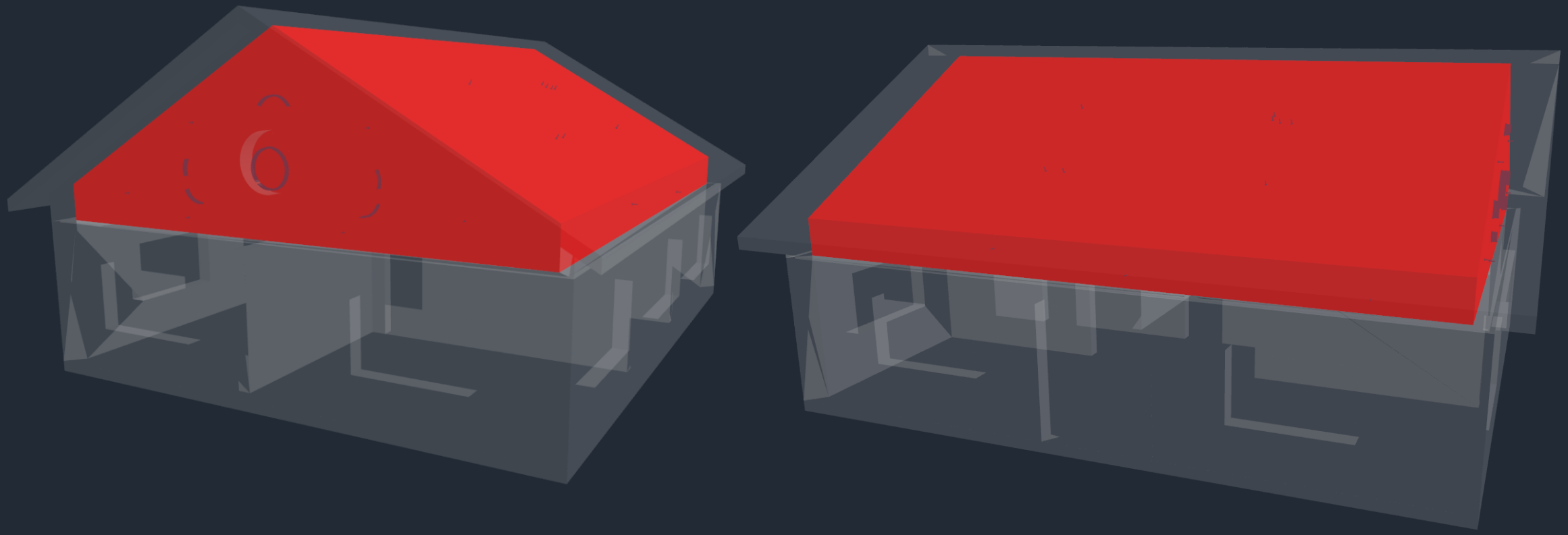
Step 3



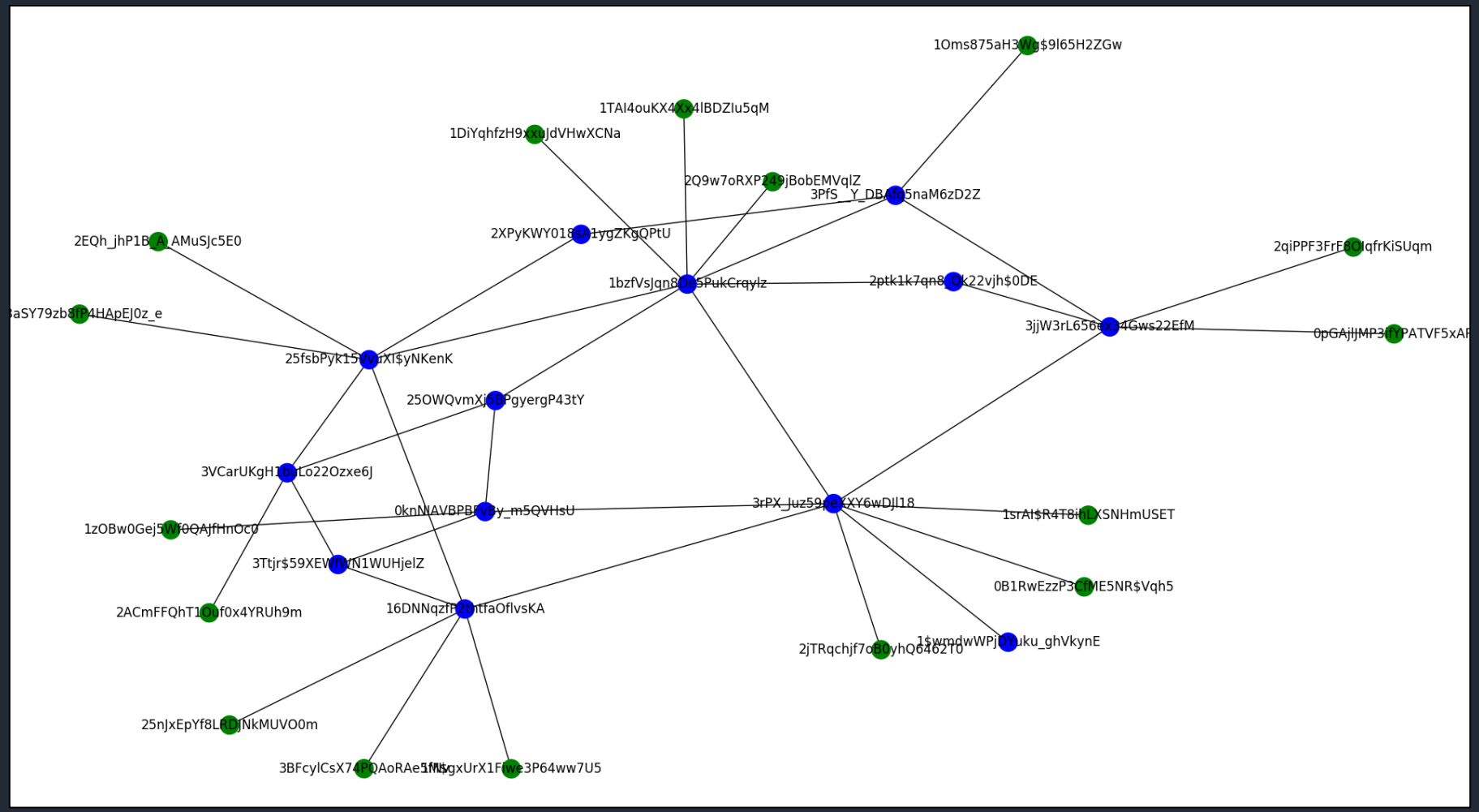
Unconnected Vertices (to other objects)

Connected Vertices (to other objects)

Step 7 – Extraction of Air Volumes



Step 8 – Graph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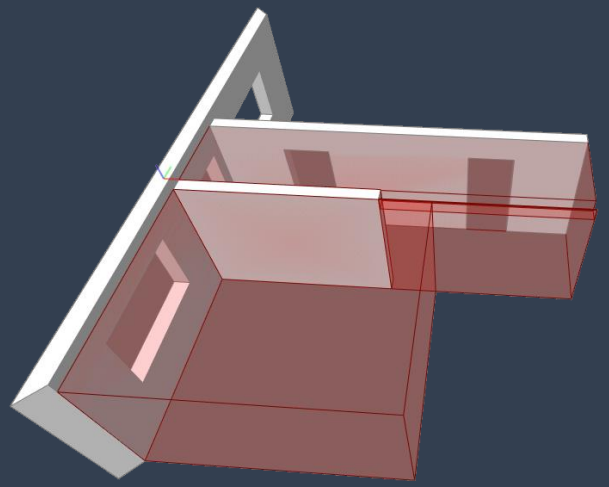
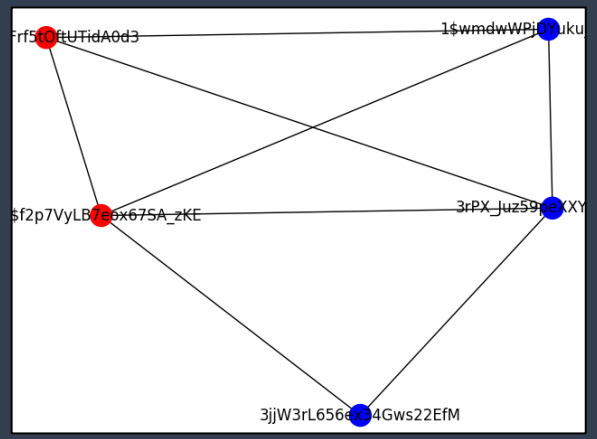
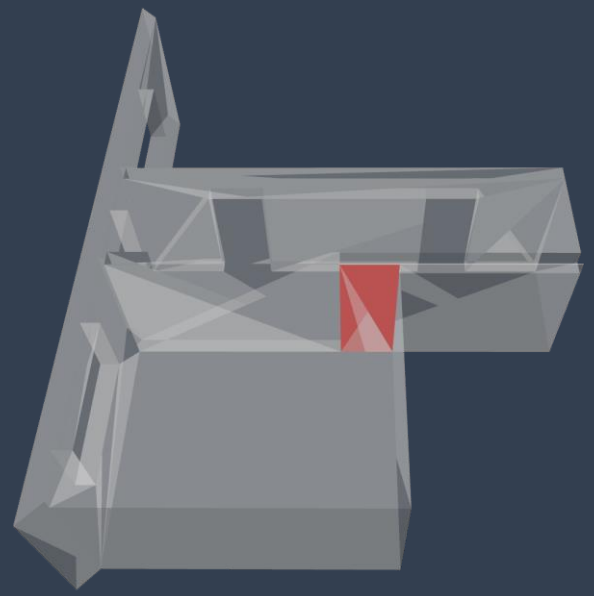
Second Level Space Boundaries

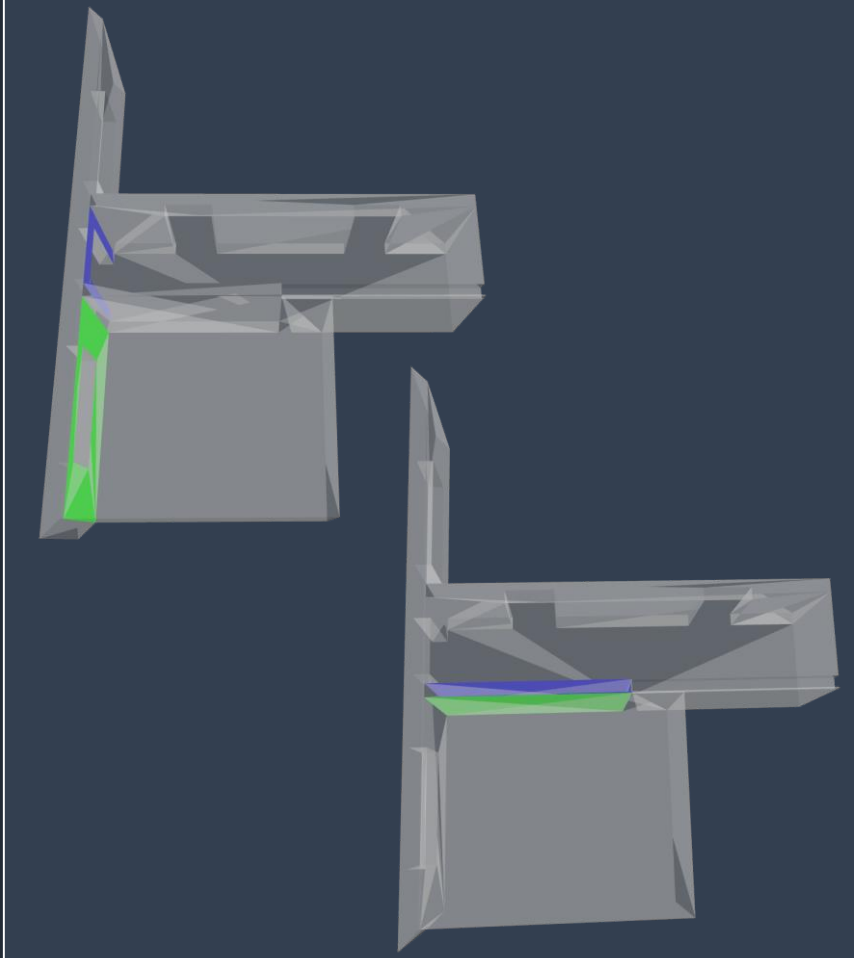




Virtual



Physical



Algorithm

Review

Air volume

- Connection model (topology)
- Flood Fill
- Ray Tracing

In last meeting decision to use IfcSpaces, if given. Air volume only when needed for algorithm

Space Boundaries

- **Van Treeck (2004)** - Volume-based
  - Boolean Operations (common, cut) between volumes
- **Jones (2013)** - Face-based
  - Raycasting, Boolean Operations (common, cut) between faces
- **Rose (2015)** - Volume-based
  - Boolean Operations (common, cut) between volumes
- **Lilis (2016)** - Face-based
  - Polygon Clipping between faces and Boolean Operations (common) between projected faces
- **Nytsch-Geusen (2018)** - Volume-based
  - Boolean Operations (common, cut) between volumes

Process Chart

Process Chart

MVDXML Check

Check for mandatory data

BREP Creation

OCC-Shape, .STEP, .BREP

BREPS linked to IFC GUID

OCC-Shape, .STEP, .BREP

Shape Checker

OCC-Shape, .STEP, .BREP

Are BREPS valid (one single watertight solid with correct face normals)?

OCC-Shape, .STEP, .BREP

Shape Fixer

OCC-Shape, .STEP, .BREP

Valid BREPS

OCC-Shape, .STEP, .BREP

Collision Checker

OCC-Shape, .STEP, .BREP

Find collisions between solids

OCC-Shape, .STEP, .BREP

Collision Checker

OCC-Shape, .STEP, .BREP

Solve collisions between solids

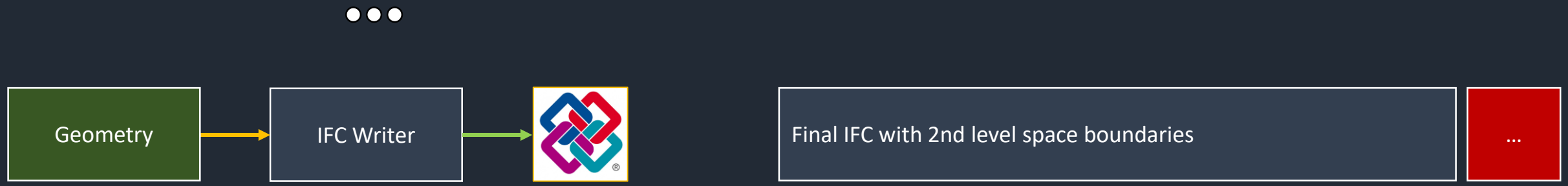
…

…

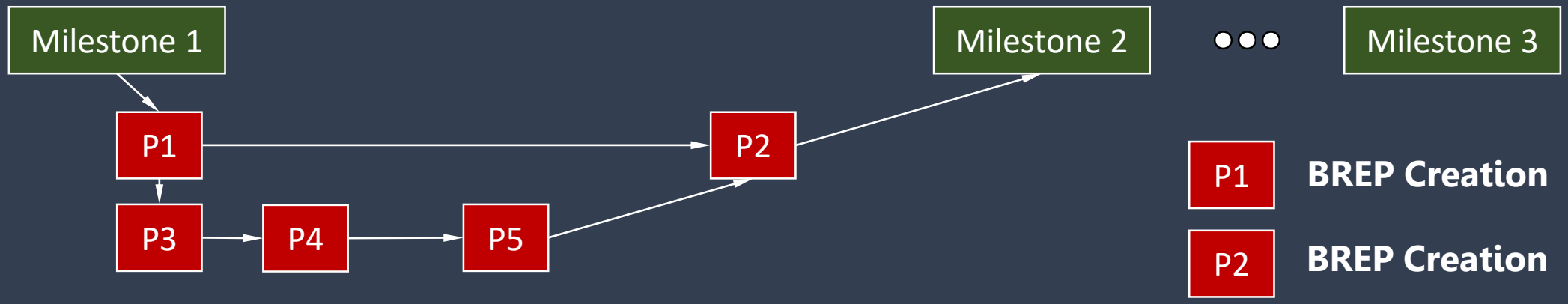
…

…

Process Chart



- **Definition of modular algorithms**
- **Implemented and provided by WP2.2 participants**



Documentation/Paper

Documentation

Content

- Review on algorithms
- Input geometry (modeling errors)
- Goal definitions, e.g.
  - Cut Geometry?
  - Curved faces?
- Process chart incl. responsibilities

Storage and editing

- Overleaf (LaTeX)
- Git
- Flow chart creation

Discussion in break-out group

Feel free to contact me.

Eric Fichter
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RWTH Aachen University

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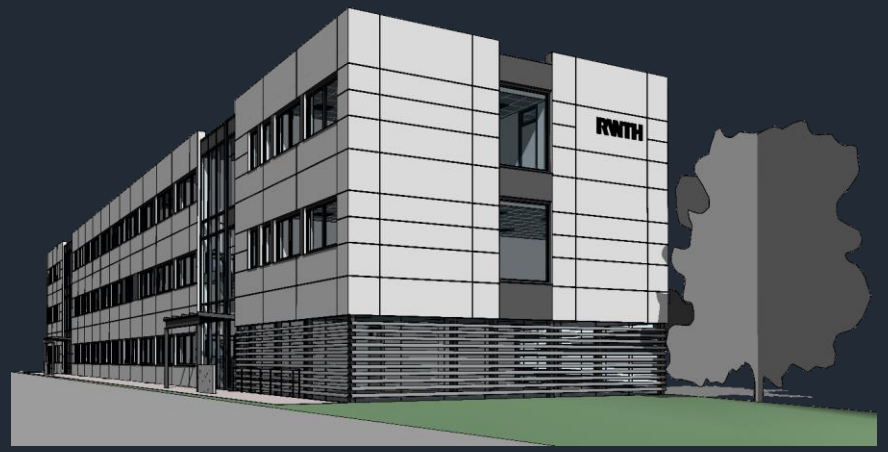
+49 241 80 25543



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