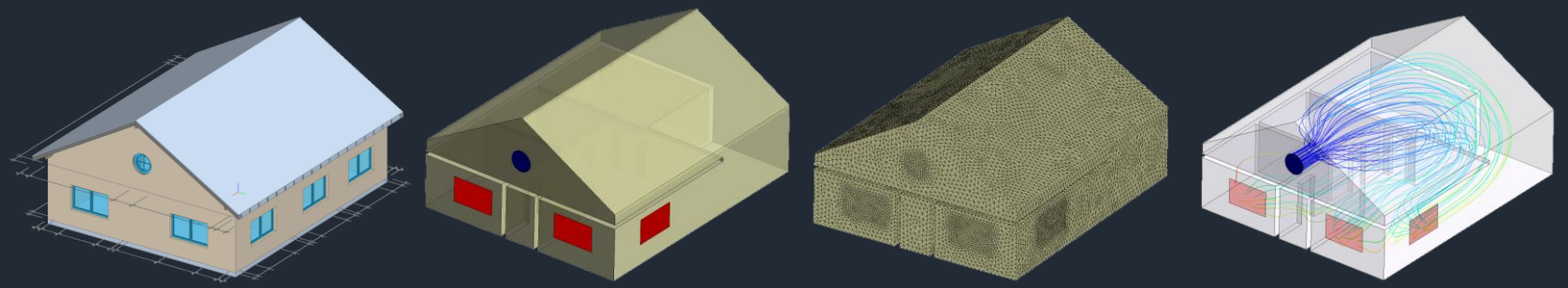
IBPSA Project 1 - WP 2.2: Building Information Modeling

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



IBPSA Project 1

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Third Expert Meeting, Aachen, Germany

3rd and 4th April 2019

Introduction to BIM2SIM

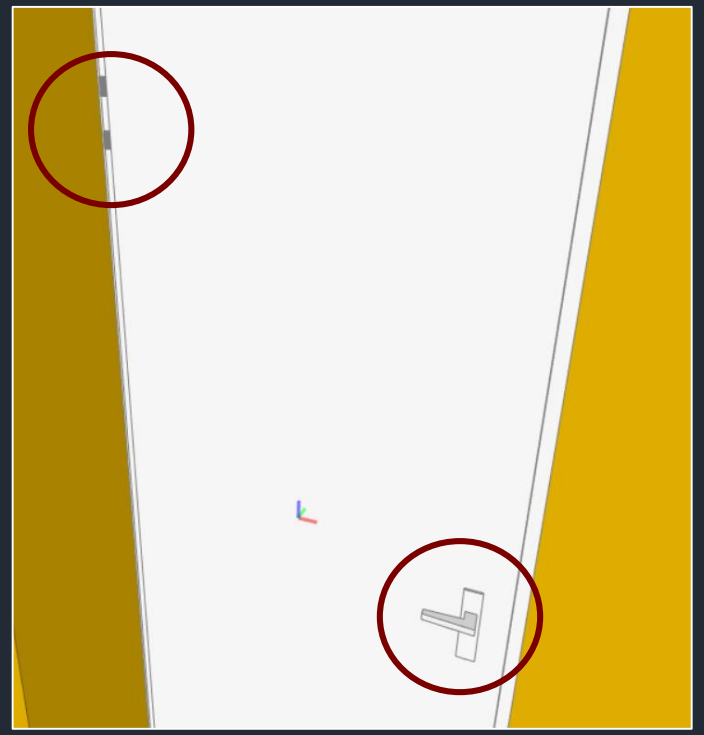
Usage of FZK-Haus ;)

Motivation

Survey among CFD engineers

Answers

- “IFC? We get PDF!”
- “We don’t know how to handle IFC”
- IFC models too complex (several 100MB)
- IFC models are faulty (e.g. watertightness)
- IFC models are incomplete (geometrically and boundary conditions)
- Details are unnecessary (embrasures, handles, …)
- Getting IFC models ready takes too long
- **It’s easier to build the model by themselves, IFC model as comfortable blueprint**



Goals of BIM2SIM

IFC (Industry Foundation Classes) to CFD (Computational Fluid Dynamics)

ANSYS FLUENT

OpenFOAM

Properties of IFC

- High information density
- High level of detail and geometry
- Design errors (often at export from proprietary to open data format)
- Diverse design approaches of different disciplines

Requirements of CFD

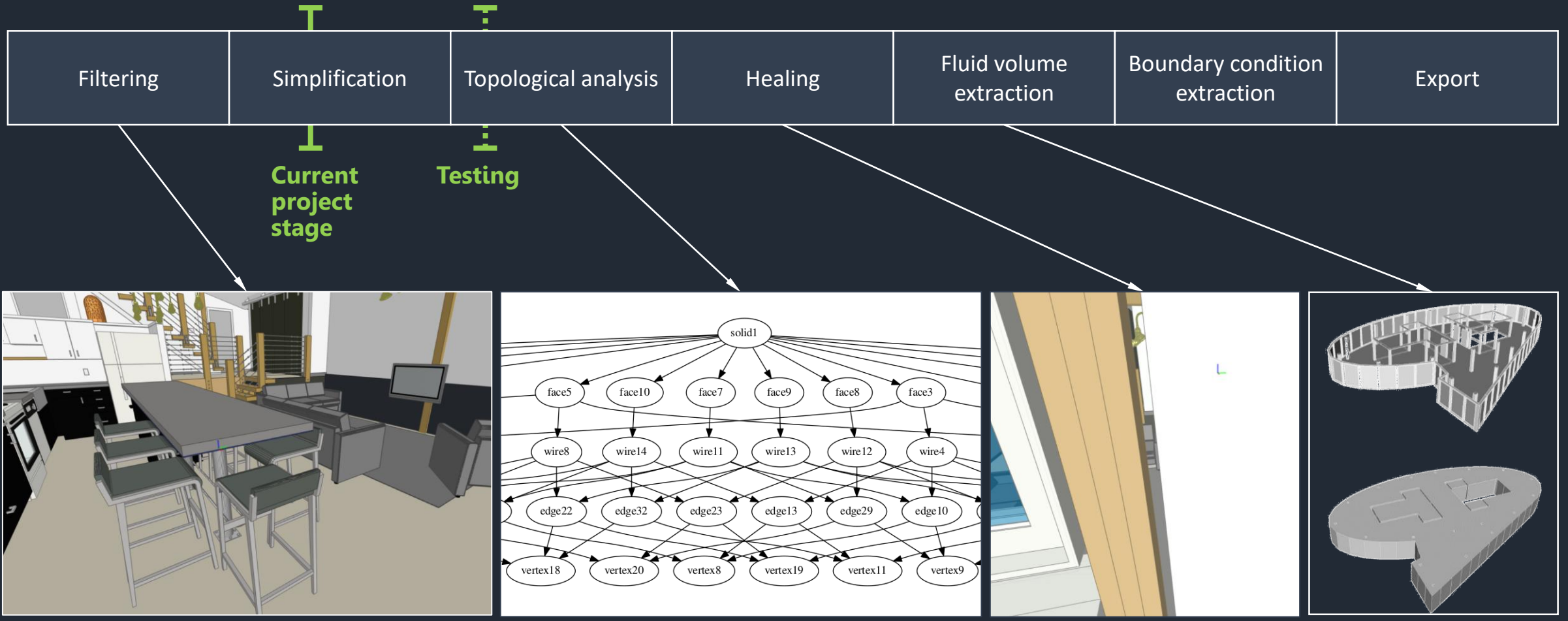
- Subset of building geometry
- Simplified geometry (angles, cell area)
- Extraction of fluid volume to simulate
- Watertight geometry

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

Current status of BIM2SIM

Tool chain

- Tool chain ≙ Project schedule



Filtering

Challenges

- Incorrect or difficult assignment (e.g. storey), creation of holes (HVAC)

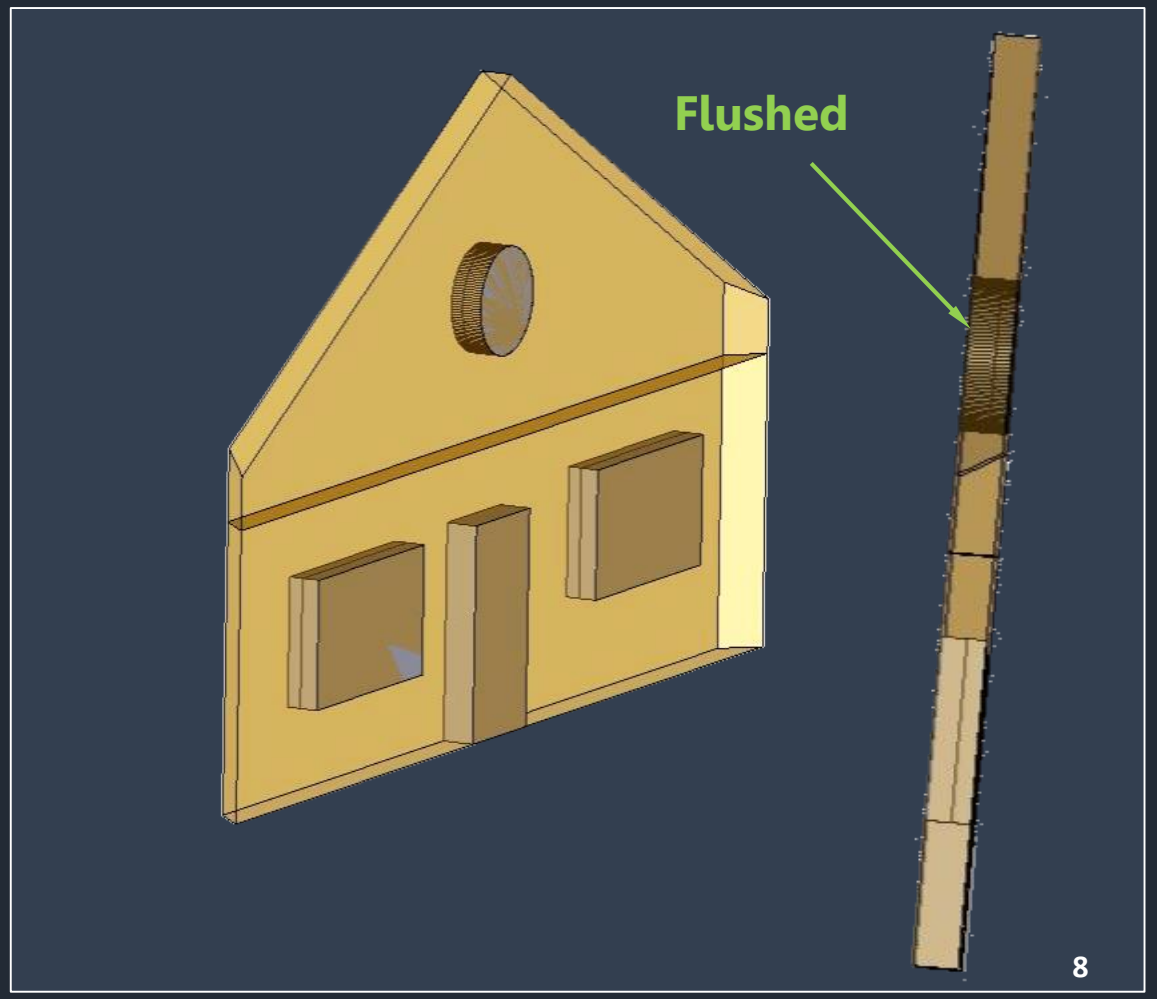
Impact

- Reducing effort for BREP creation

Simplification – „Semantical“ Simplification

Challenges
- Best solution is „flushed“ object into wall, robustness

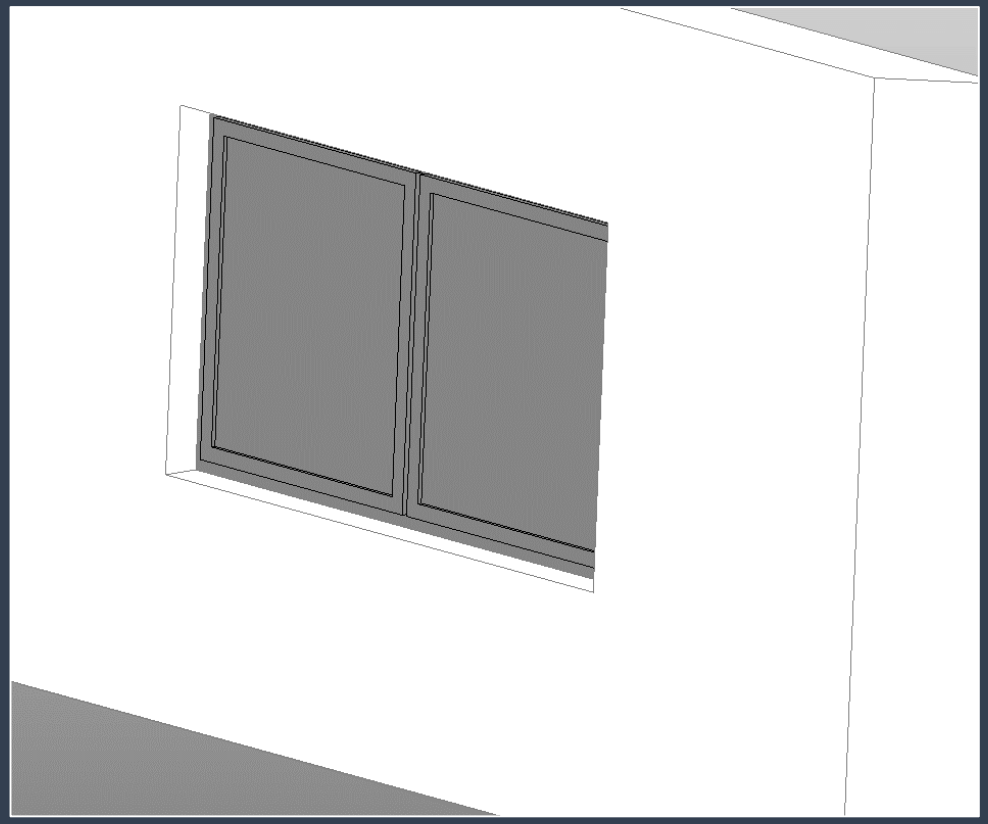
Impact
- Strong reduction of complexity, detailed BREP creation not necessary anymore

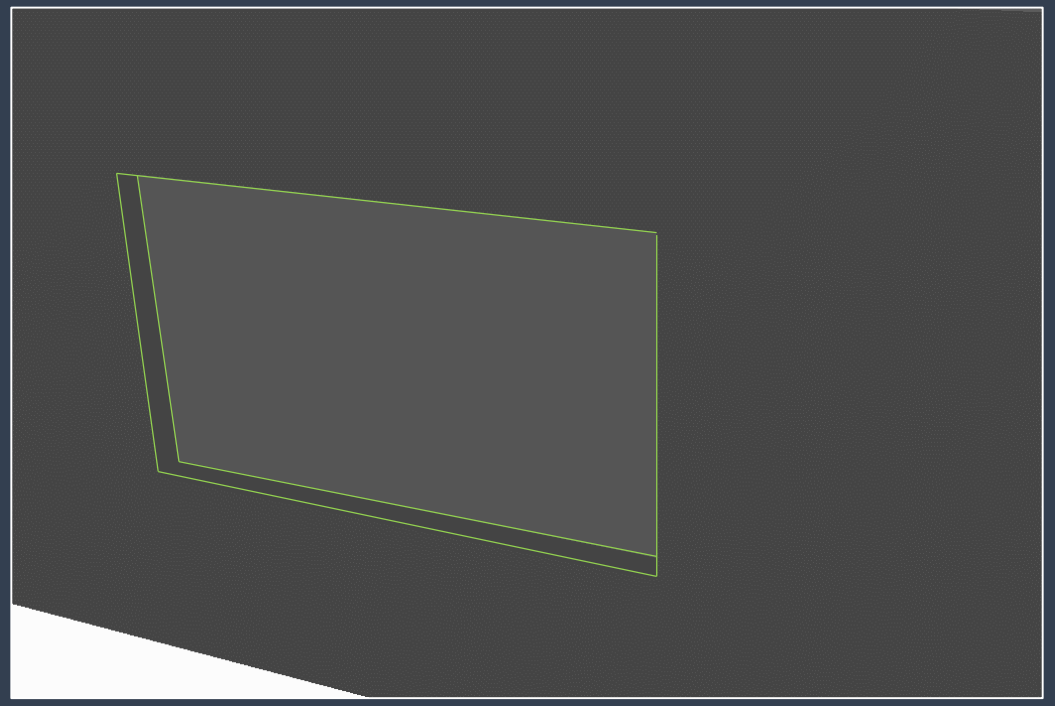


Simplification – Bounding Box

Challenges
- Robust algorithm

Impact
- Strong reduction of complexity

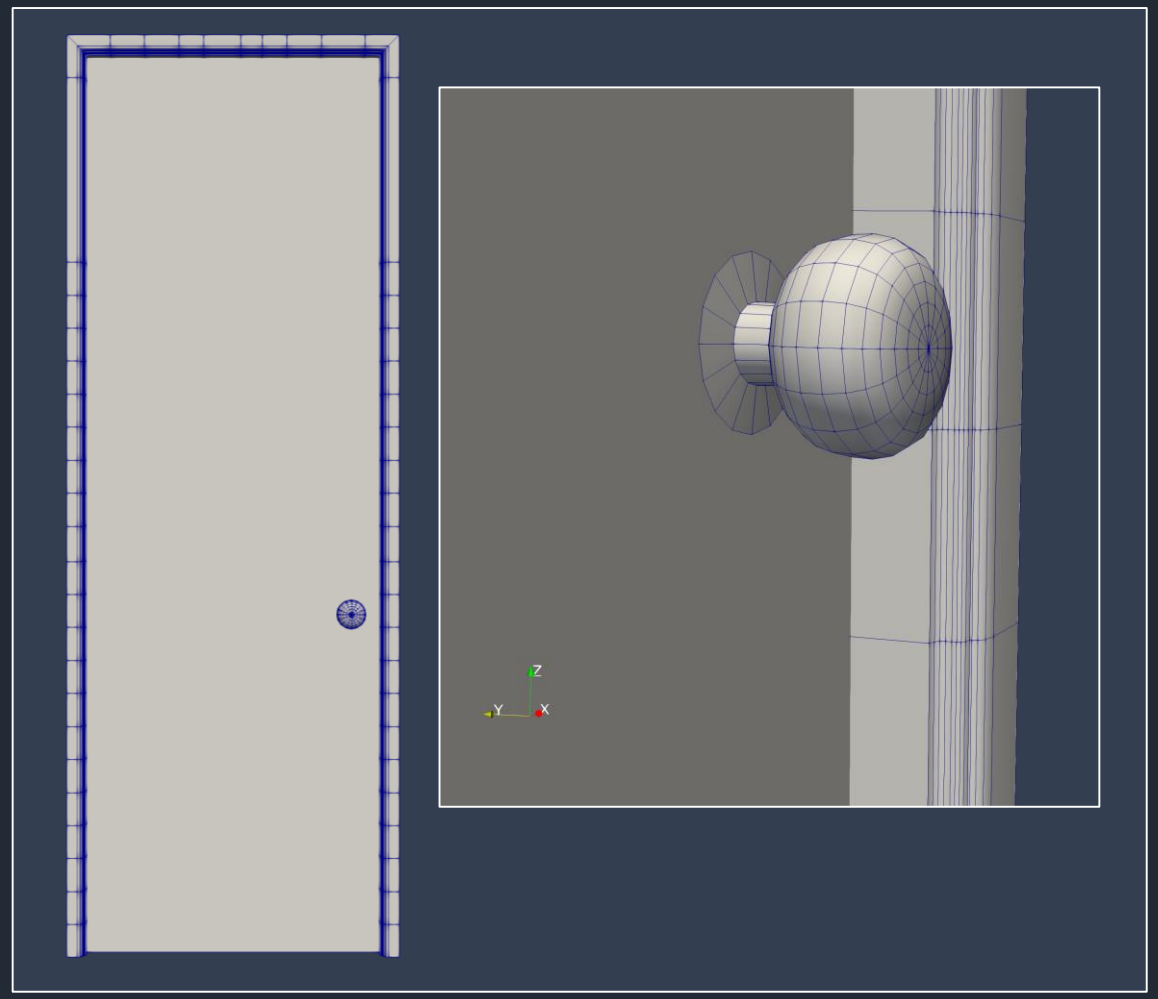


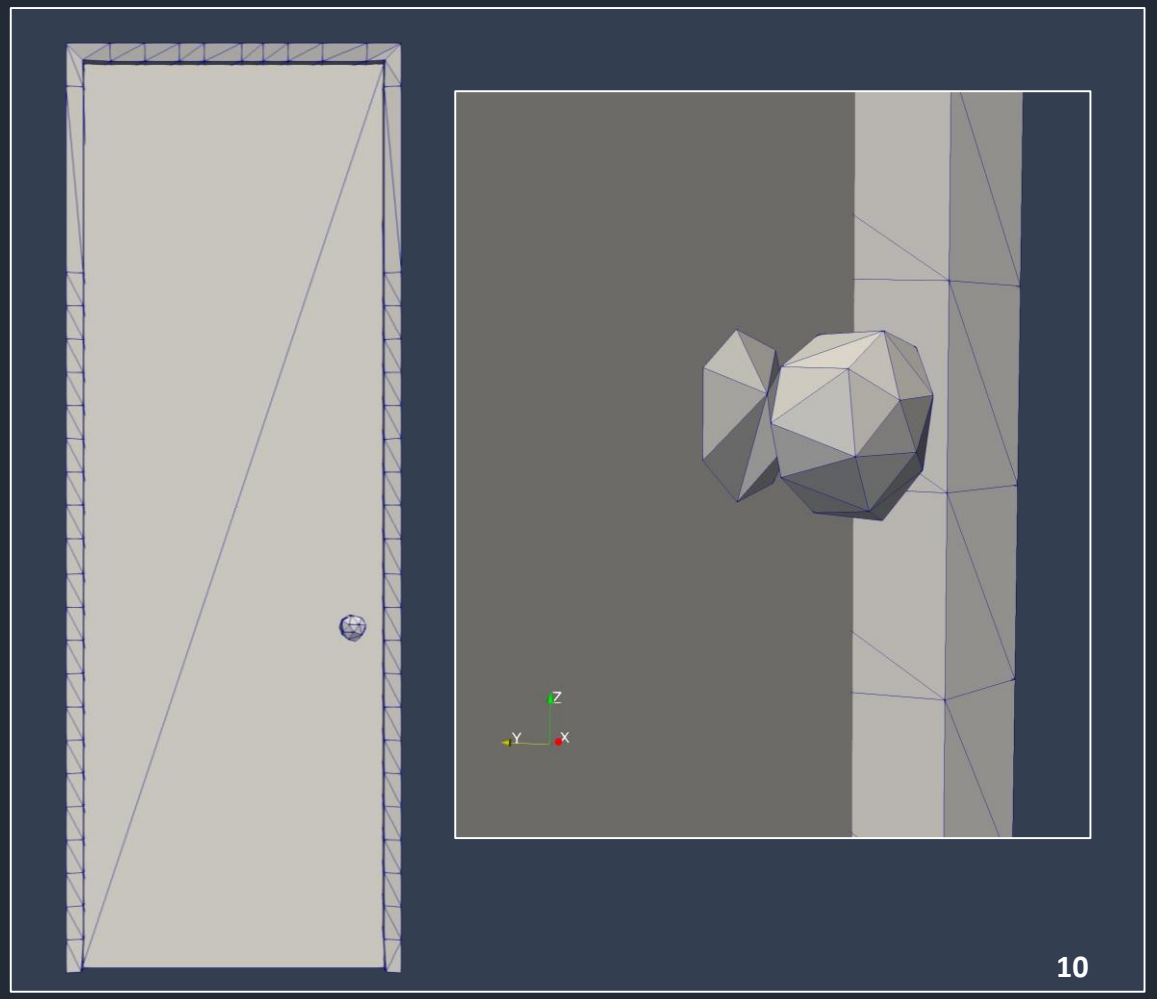


Simplification – Mesh Decimation

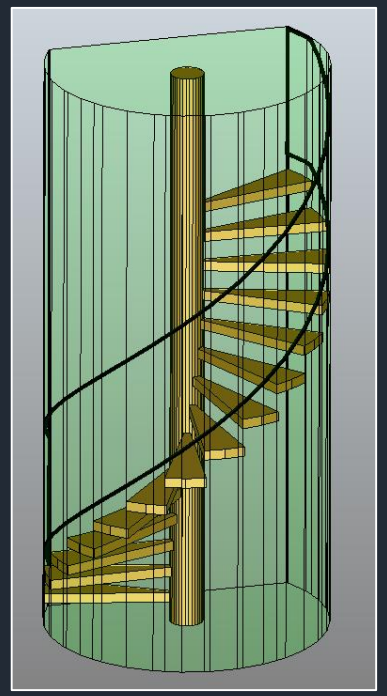
Challenges
- Preserving of features (creation of holes), strong case dependency

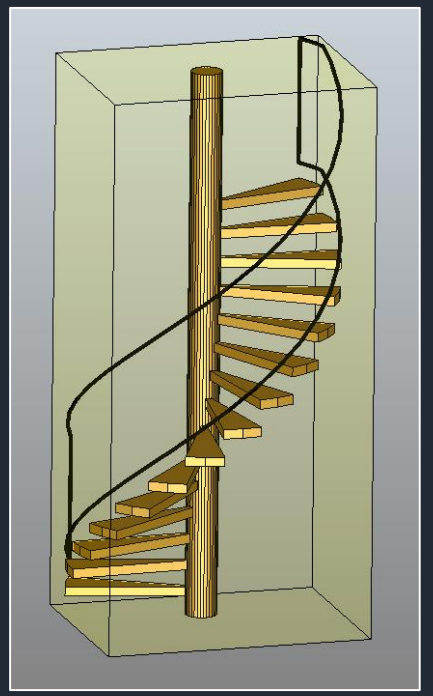
Impact
- Reducing effort for eventual geometric algorithms (e.g. topological analysis)

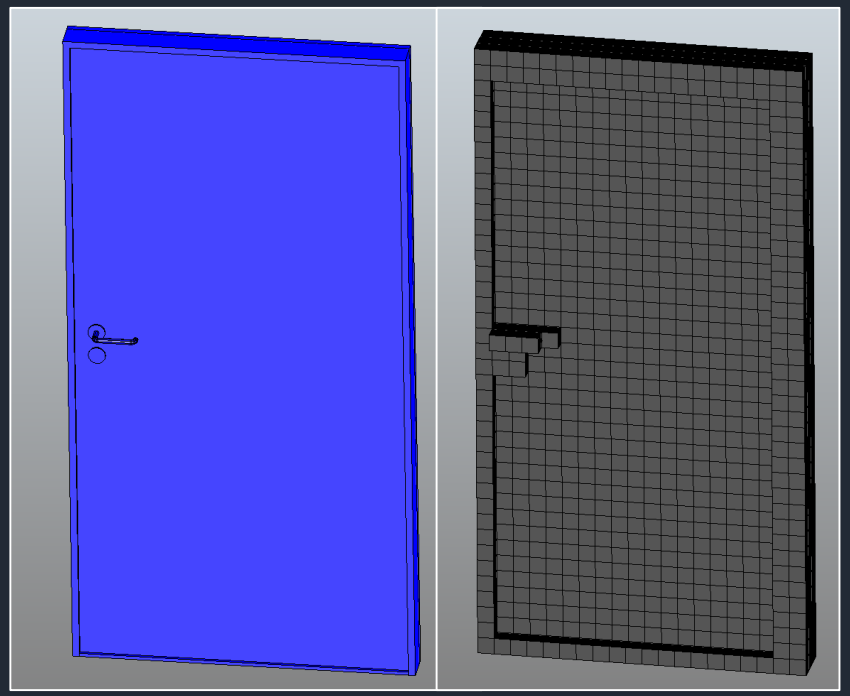




Simplification – More on …



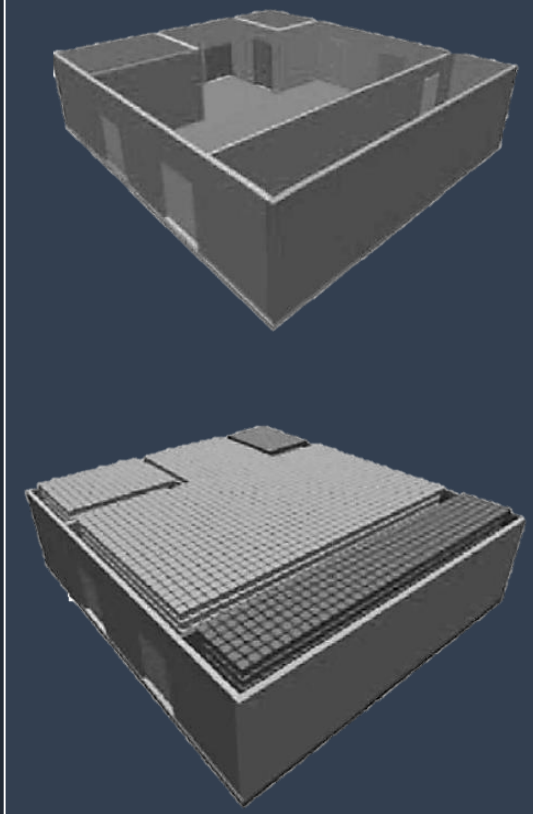


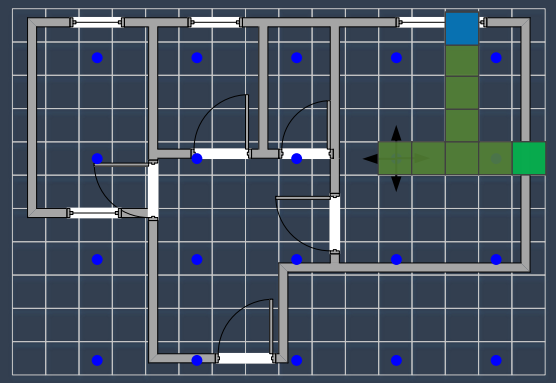


Future work of BIM2SIM

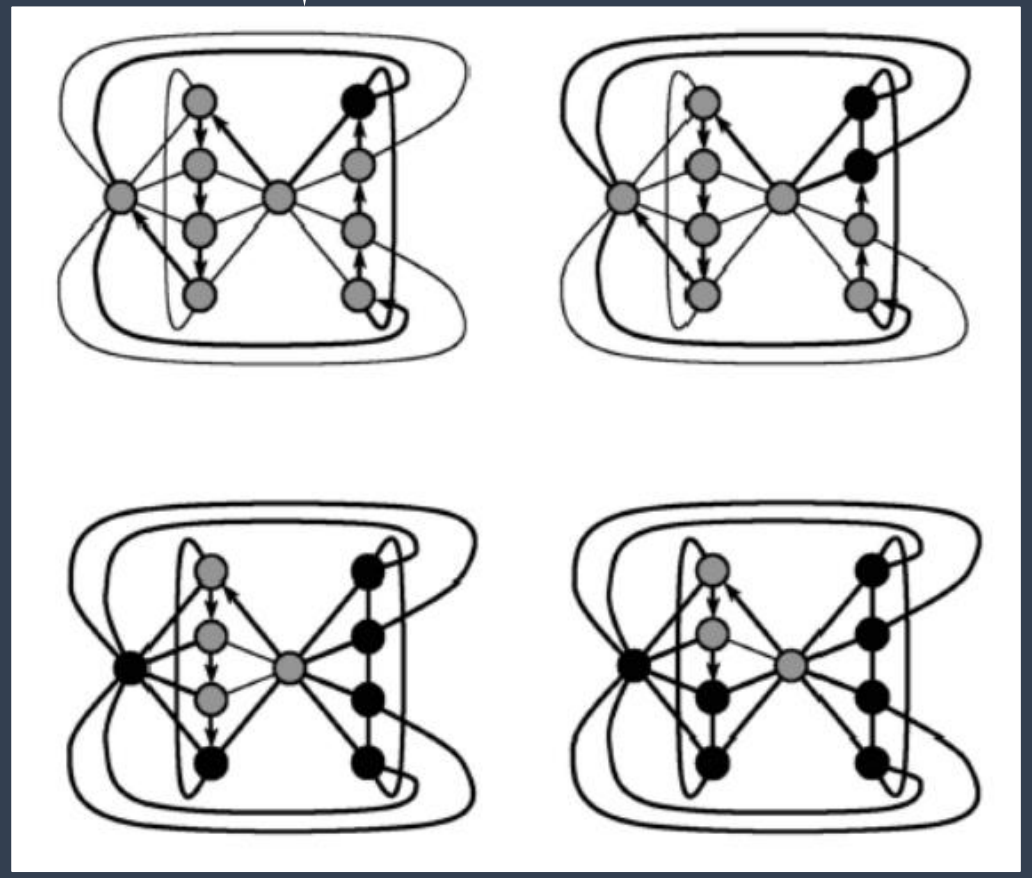
Coupling Model

- Simplification chapter shows: full control over geometry and topology
- Extracting of fluid volume and check for watertightness
- Discrete approaches (e.g. flood fill) vs. Topological approches (recursive face search)





Images by Jiarui Lin

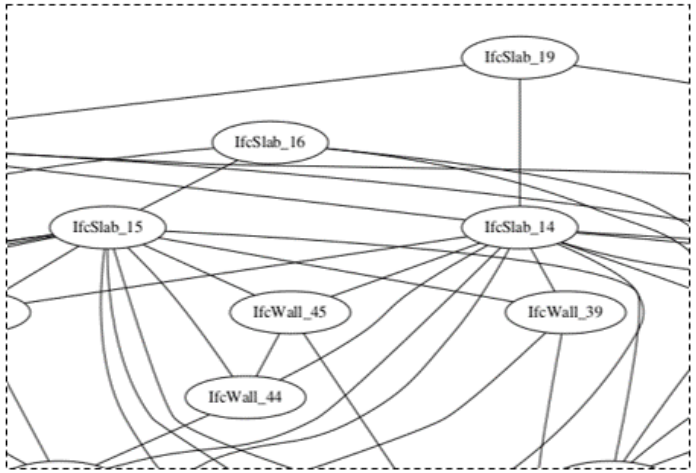


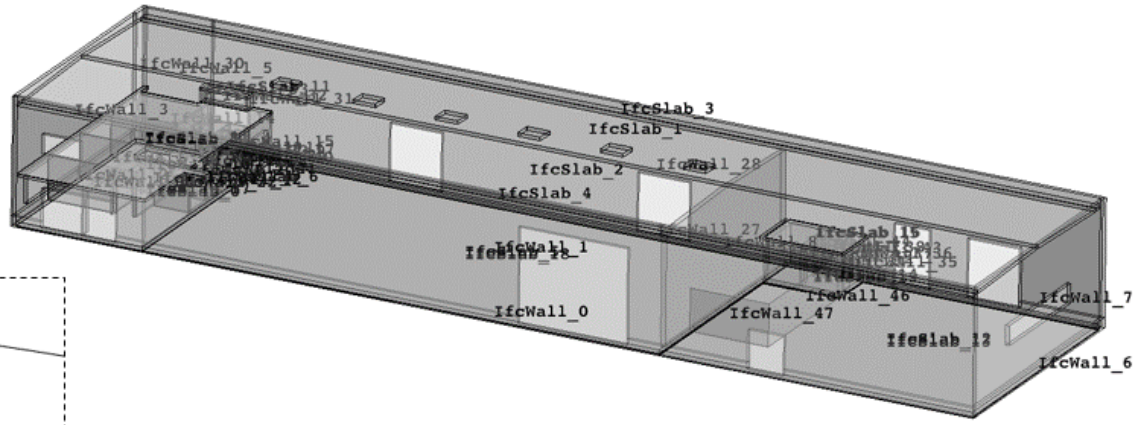
Coupling Model - Review

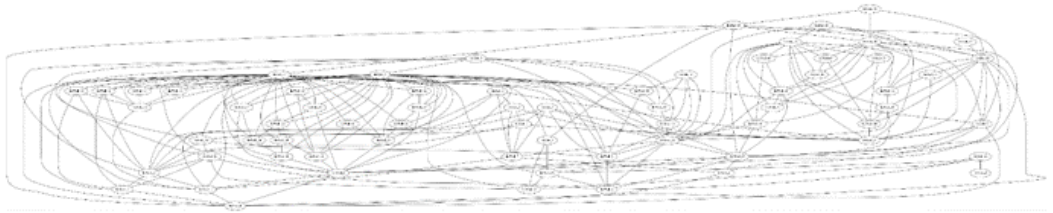
- Brute Force Boolean Operation for coupling model

Tests

- Connection between building elements using *fuse* and check for *intersection*

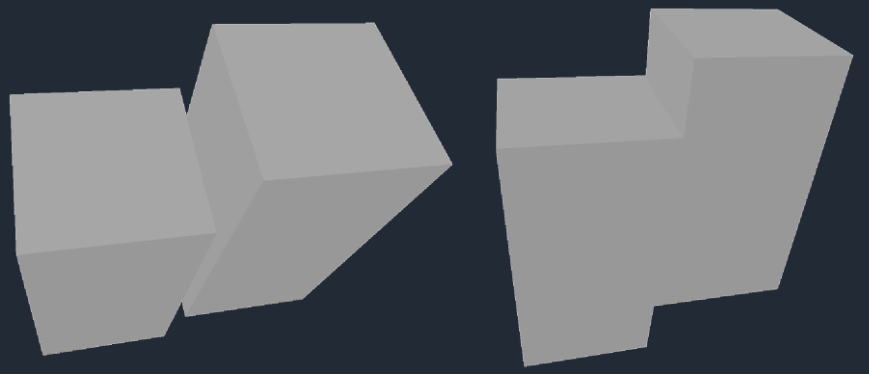


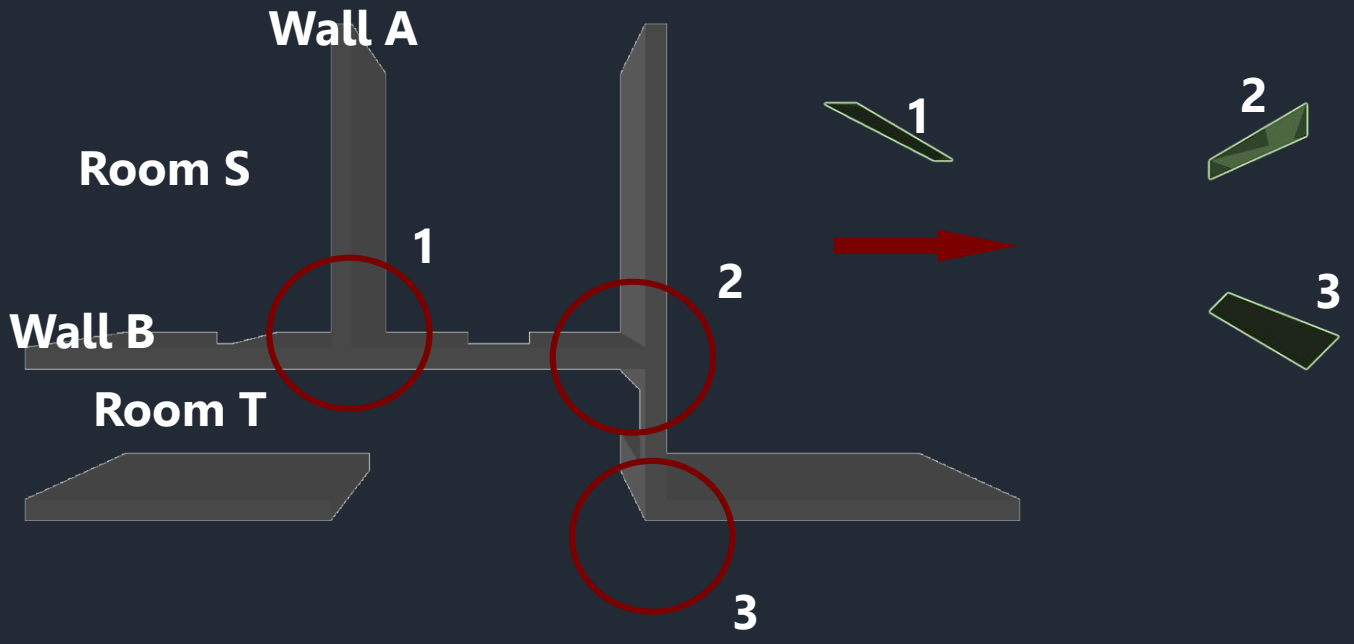


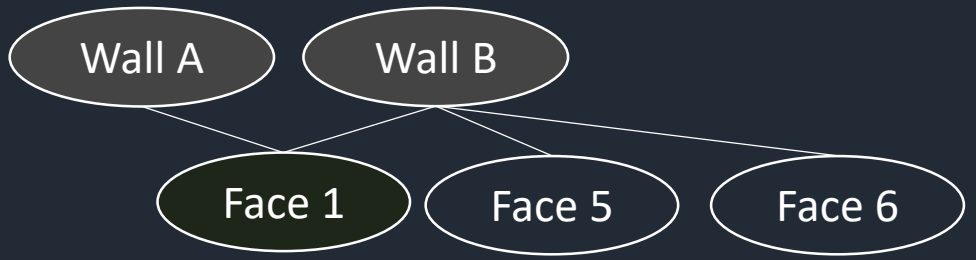


Coupling Model – A test

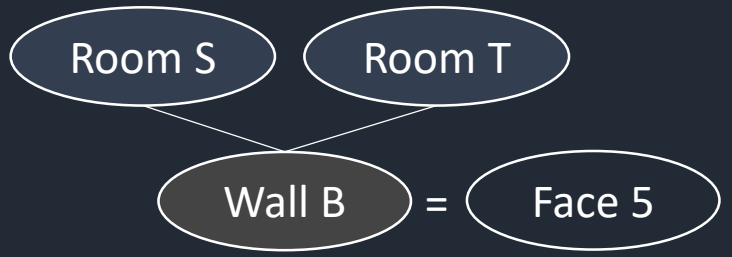
- From Volume to Faces
- Closing gaps while analyzing
- In CFD, Space Boundaries are not relevant







After recursive search



- Difficulty: Reduce calculation time, e.g. by spatial partitioning

Synergies – IBPSA Project 1 and BIM2SIM

Coupling Model – A test

- Two neighbouring rooms are separated by clearly defined faces
- CBIP algorithm by Lilis et al. (DOI: 10.1016/j.autcon.2016.08.044):
  - Identification stage
  - Boundary Surface Extraction stage
  - Common Boundary Intersection stage
  - Boundary Intersection Projection (BIP)

IfcSpaces

Filtering	Simplification	Topological analysis	Healing	Fluid volume extraction	Boundary condition extraction	Space Boundaries	Export

Feel free to contact me.

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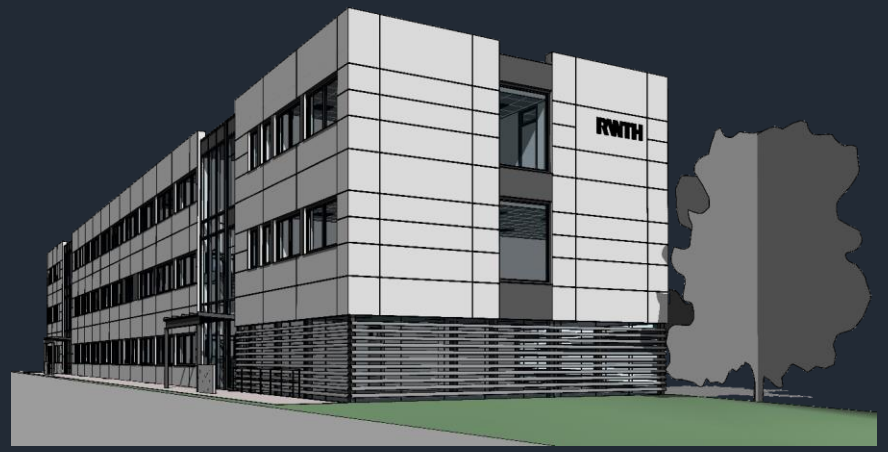

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