

Julius Emig, Dipl.-Ing. | Fraunhofer Italia IEC

BIM2FEM: From Building Information Modeling to Finite Element Analysis

An open-source-based workflow

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Fraunhofer Italia – Innovation Engineering Center

Fraunhofer Italia

Innovation Engineering Center

- **Applied research** for public and private stakeholders all sizes and economic sectors
- Institute **founded in 2010** in Bolzano, since 2017 at NOI Techpark

Head of Institute

Univ.-Prof. Dr.-Ing. Dominik Matt

Unit: Process Engineering in Construction

- **Digitalization and sustainability** in construction industry
- Concepts and software prototypes
- BIM methodology and extraction, manipulation and analysis of data related to construction processes



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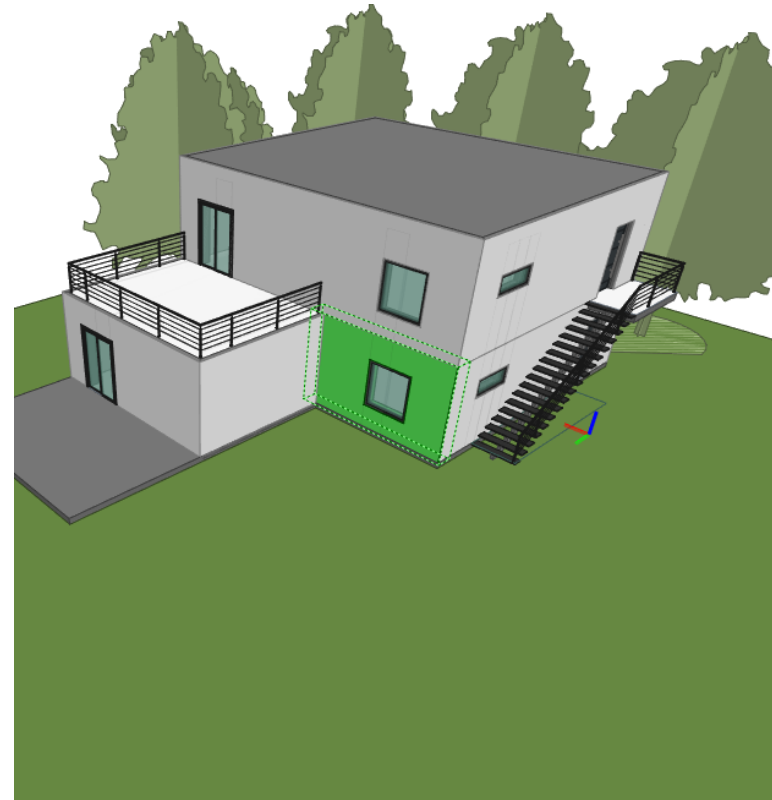


BIM2FEM – Background & Motivation

Background

Building Information Modeling – BIM

- Methodology to model and exchange information about construction projects / processes
- Open file-format IFC



IFC Structure		
Active	Type	Name
<input checked="" type="checkbox"/>	Project	Project Number
<input checked="" type="checkbox"/>	Site	Surface:513505
<input checked="" type="checkbox"/>	Building	
<input checked="" type="checkbox"/>	Building Storey	Level 0
<input checked="" type="checkbox"/>	Walls	
<input checked="" type="checkbox"/>	Wall	Basic Wall:EXTERNAL
<input checked="" type="checkbox"/>	Wall	Basic Wall:EXTERNAL
<input checked="" type="checkbox"/>	Wall	Basic Wall:EXTERNAL
<input type="checkbox"/>	Material layer	Plaster
<input type="checkbox"/>	Material layer	Insulation EPS
<input type="checkbox"/>	Material layer	Sand-lime-brick
<input type="checkbox"/>	Material layer	Plaster
<input checked="" type="checkbox"/>	Opening	Window_Basic Shape

Properties	Location	Classification	Relations
Name	Value		
Element Specific			
Guid	1MglAB4PP41wEp9aHc2iYE		
IfcEntity	IfcWall		
Name	Basic Wall:EXTERNAL WALL_BRICK:317128		
ObjectType	Basic Wall:EXTERNAL WALL_BRICK		
PredefinedType	NOTDEFINED		
Tag	317128		
Analytical Properties			
Absorptance	0,7		
Heat Transfer Coefficient (U)	17		
Roughness	3		
Thermal Mass	32,256		
Thermal Resistance (R)	0,058824		
Constraints			
Base Constraint	Level 0		

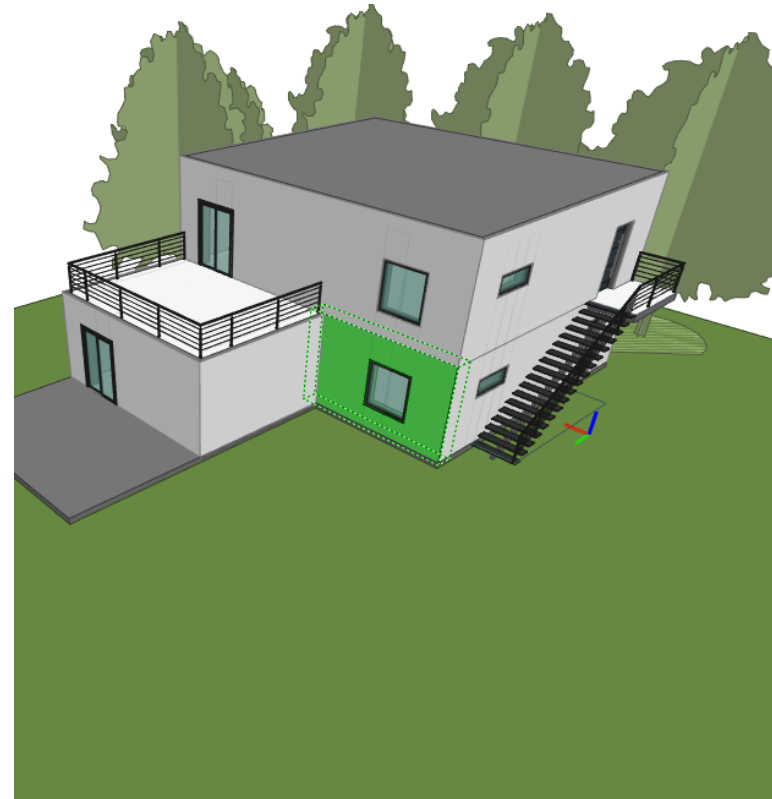
Background

Building Information Modeling – BIM

- Methodology to model and exchange information about construction projects / processes
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Finite Element Method – FEM

- Numerical simulation method to model physical behavior of objects
- Applied in AEC-sector e.g. for structural and thermal analysis of buildings / building parts



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Motivation

Lack of interoperability for BIM and FEM software

- Proprietary solutions
- Open-source solutions lack robustness

Motivation

Lack of interoperability for BIM and FEM software

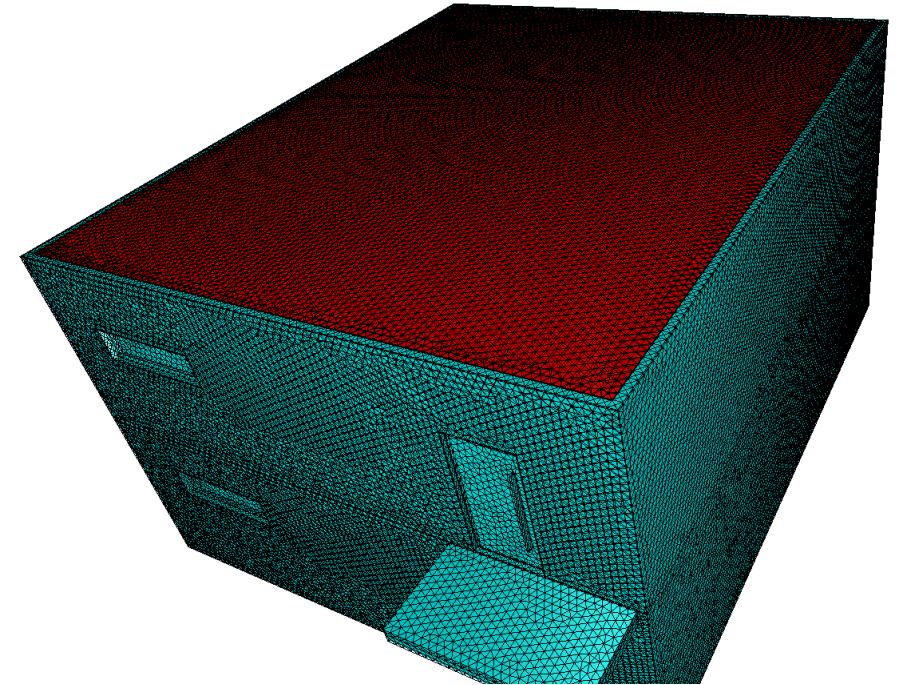
- Proprietary solutions
- Open-source solutions lack robustness

Thermal analysis of buildings

- Low degree of automation
- Manual input of thermal bridges, materials, boundary conditions

➔ Enable simulation-based planning with high degree of automation

Object	Value
Boundary 1113	
Boundary 1114	
Boundary 1115	
Boundary 1116	
Boundary 1117	
Boundary 1118	
Boundary 1119	
Boundary 1120	
Boundary 1121	
Boundary 1122	
Boundary 1123	
Boundary 1124	
Boundary 1125	
Boundary 1126	
Boundary 1127	
Boundary 1128	
Boundary 1129	
Boundary 1130	
Boundary 1131	
Boundary 1132	
Boundary 1133	
Boundary 1134	
Boundary 1135	
Boundary 1136	
Boundary 1137	
Boundary 1138	
Boundary 1139	
Boundary 1140	
Boundary 1141	
Boundary 1142	
Boundary 1143	
Boundary 1144	
Boundary 1145	
Boundary 1146	
Boundary 1147	
Boundary 1148	
Boundary 1149	
Boundary 1150	
Boundary 1151	
Boundary 1152	
Boundary 1153	
Boundary 1154	
Boundary 1155	
Boundary 1156	
Boundary 1157	
Boundary 1158	
Boundary 1159	
Boundary 1160	
Boundary 1161	
Boundary 1162	
Boundary 1163	
Boundary 1164	
Boundary 1165	
Boundary 1166	
Boundary 1167	
Boundary 1168	
Boundary 1169	
Boundary 1170	
Boundary 1171	
Boundary 1172	



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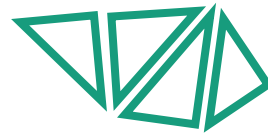
BIM2FEM - Workflow

BIM2FEM - Workflow



Extracting geometry and materials from BIM-model

BIM2FEM - Workflow



Extracting geometry and materials from BIM-model

Meshing extracted geometry

BIM2FEM - Workflow



Extracting geometry and materials from BIM-model



Meshing extracted geometry



Thermal FEM-simulation

BIM2FEM - File Formats and Software

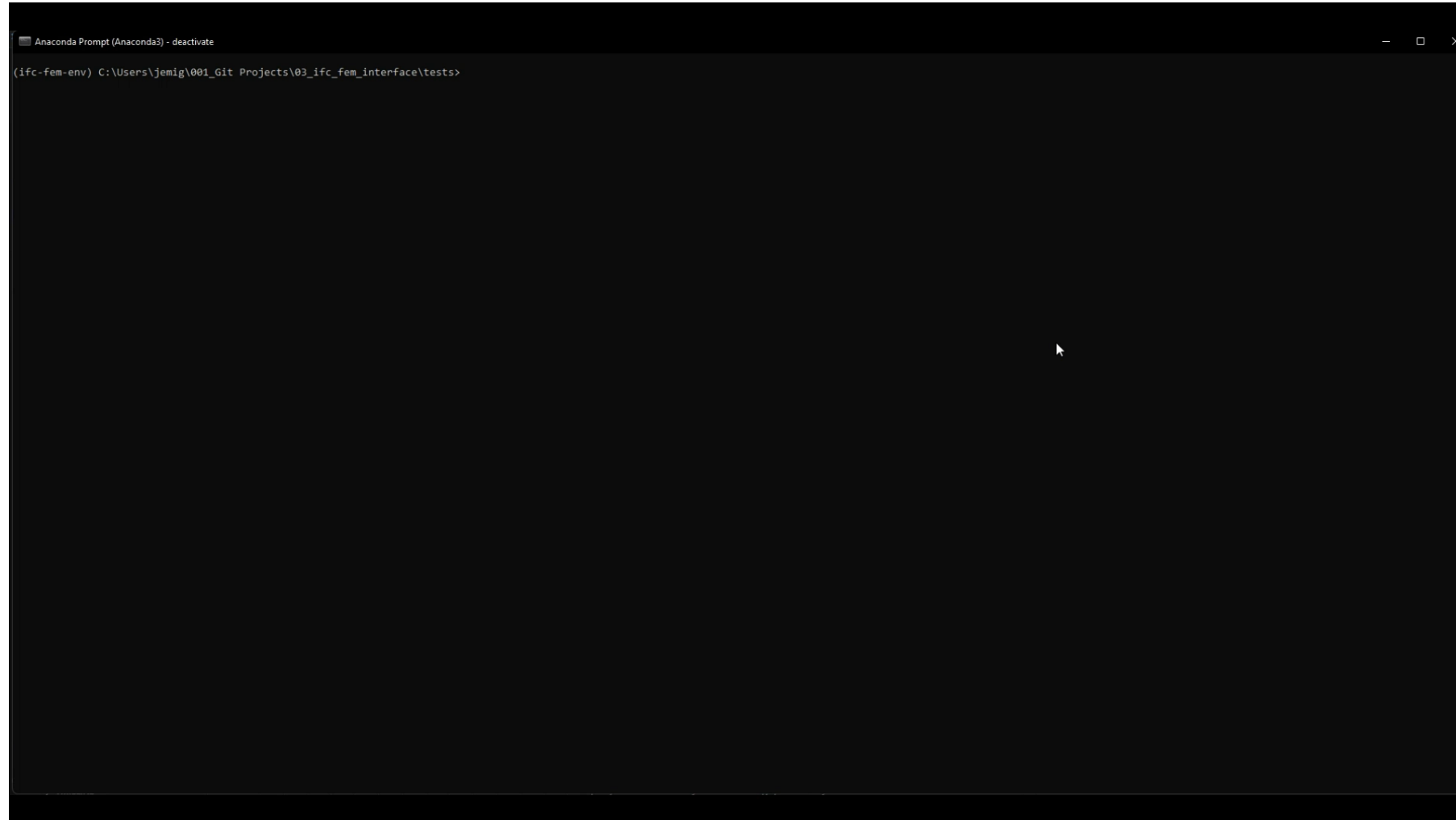


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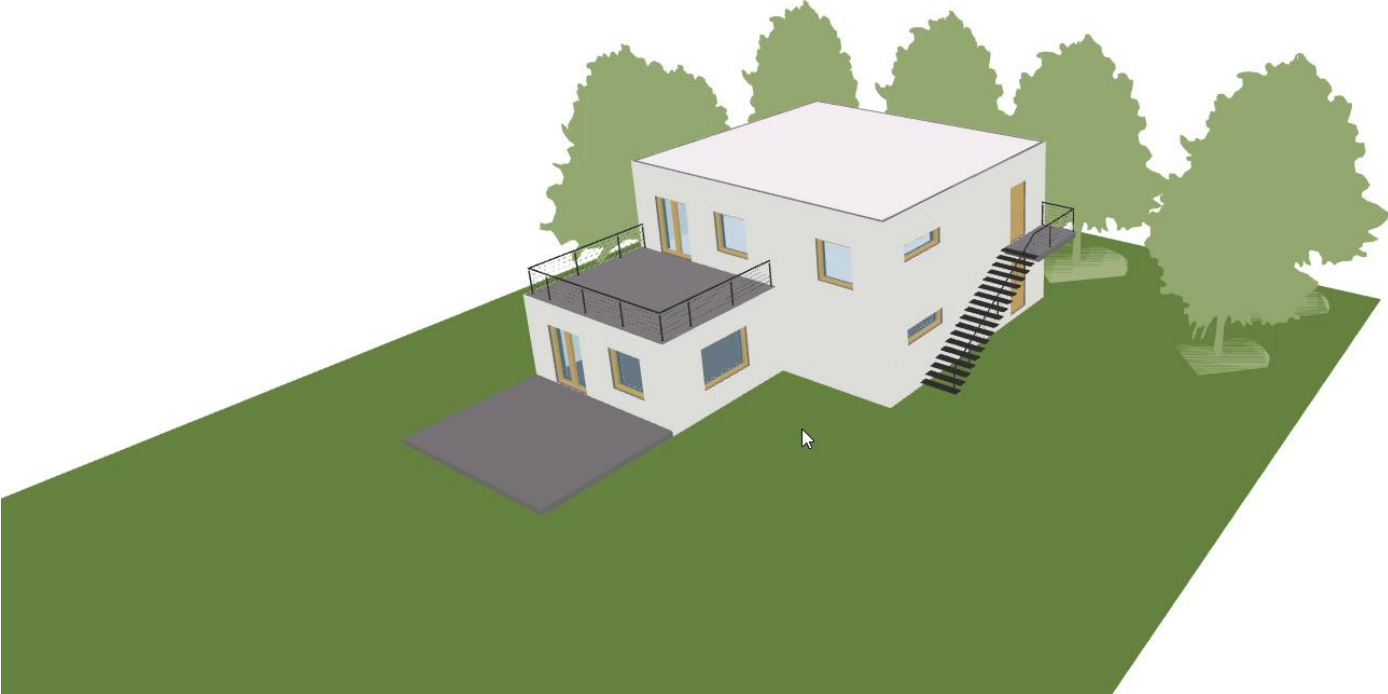
BIM2FEM - Demonstration

Video: 2D-Prototype



```
Anaconda Prompt (Anaconda3) - deactivate
(ifc-fem-env) C:\Users\jemig\001_Git_Projects\03_ifc_fem_interface\tests>
```

Video: 3D-Enhancement



Contact

Julius Emig, Dipl.-Ing.

Research Associate

julius.emig@fraunhofer.it

Fraunhofer Italia Research

Via A. Volta 13a

39100 Bozen

www.fraunhofer.it