Dynamo
+ Revit Systems Analysis
True BIM for HVAC

Sean Fruin
Director of Design Technology – Sigma AEC Solutions | @SeanFruin

Majd Makhlouf
Founder Manager – Building Information Researchers and Developers OÜ | @bird_tools
About the speakers

Sean Fruin

Sean Fruin is a Mechanical Engineer (EIT), design technologist, and innovator who has an ardent fascination with automation and the exploration of computational design solutions for the AEC industry. He has had the opportunity to learn many aspects of the design industry, having worked in manufacturing, MEP designing, and General Contracting. Sean started Sigma AEC Solutions to live his dream, having the opportunity to explore and implement the latest technologies to improve efficiency and increase quality in the AEC industry.
About the speakers
Majd Makhloof

Majd is a Mechanical Engineer and Design Technologist, with a Master of Science in Mechanical Engineering. He's an Autodesk Revit Certified Professional and a member of the Autodesk Developer Network. In January 2020, he founded Building Information Researchers and Developers OÜ, a software development company based in Estonia and providing services for the AEC sector worldwide. He specializes in BIM Management, Autodesk Revit and AutoCAD Add-in development, both public and custom developed, Forge web and cloud-based apps, Dynamo Zero Touch Node Packs, and mobile VR/AR applications.
“Because the quality of our tools has finally caught up to the scope of their vision – small groups of dedicated DIY innovators can now tackle problems that were once solely the purview of big governments and large corporations.”
Problem?
True BIM

VS.

R + P
True BIM
Learning Objectives

- 101 Revit’s Systems Analysis
- Streamline Revit Workflows with API
- Connect 2D schematics, 3D model & Analytical model
Revit Systems Analysis 101
Revit Systems Analysis

Energy Model – GBXML

- Location / Weather Data
- Building Geometry
- Thermal Properties
- HVAC Systems
Revit Frameworks
Energy Model – Weather Data
Revit Frameworks
Energy Model - Settings

How do these settings affect energy analysis?
Revit Frameworks
Energy Model – Material U value

Schematic Types

Analysis Properties:
By default, analysis properties are generated from information in Conceptual Types.
Properties of Schematic Types are used when override is selected.

<table>
<thead>
<tr>
<th>Category</th>
<th>Override</th>
<th>Analytic Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofs</td>
<td></td>
<td>4 in lightweight concrete (U = 0.2245 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td></td>
<td>8 in lightweight concrete block (U = 0.1428 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Interior Walls</td>
<td></td>
<td>Frame partition with 3/4 in gypsum board (U = 0.2595 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Ceilings</td>
<td></td>
<td>8 in lightweight concrete ceiling (U = 0.2397 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Floors</td>
<td></td>
<td>Passive floor, no insulation, tile or vinyl (U = 0.5210 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Sills</td>
<td></td>
<td>Un-insulated solid (U = 0.1243 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Doors</td>
<td></td>
<td>Metal (U = 0.6520 BTU/(h<em>ft</em>°F))</td>
</tr>
<tr>
<td>Exterior Windows</td>
<td></td>
<td>Large double-glazed windows (reflective coating) - industry (U)</td>
</tr>
<tr>
<td>Interior Windows</td>
<td></td>
<td>Large single-glazed windows (U = 0.6498 BTU/(h<em>ft</em>°F), SHGC = 0.40)</td>
</tr>
<tr>
<td>Skylights</td>
<td></td>
<td>Large double-glazed windows (reflective coating) - industry (U)</td>
</tr>
</tbody>
</table>

Shading factor for exterior windows: 0

OK  Cancel
Revit Frameworks
Spaces
Revit Frameworks
Spaces – Building/Space Type

Space Type Settings

Filter: Enter Search Words

Mall Concourse Sales Area - Retail
Mass Merchandising Sales Area - Retail
Medium/Bulky Material - Warehouse
Merchandising Sales Area - Retail
Museum and Gallery - Storage - Museum and Gallery
Nurse Station - Hospital/Hospitalcare
Office - Enclosed
Office - Open Plan
Office Common Activity Areas - Inactive Storage
Operating Room - Hospital/Hospitalcare
Other Televised Playing Area - Sports Arena
Parking Area - Attendant Only - Parking Garage
Parking Area - Pedestrian - Parking Garage
Patient Room - Hospital/Hospitalcare
Personal Services Sales Area - Retail
Pharmacy - Hospital/Hospitalcare
Physical Therapy - Hospital/Hospitalcare
Playing Area Gymnasium
Plenum
Police Station Laboratory - Police/Fire Stations
Public and Staff Lounge - Hospital/Hospitalcare
Reading Area - Library
Reception/Waiting - Hotel
Reception/Waiting - Motel
Reception/Waiting - Transportation
Recovery - Hospital/Hospitalcare
Restoration - Museum

Parameter | Value
---|---
Energy Analysis
Area per Person | 315.28 SF
Sensible Heat Gain per person | 250.00 Btu/h
Latent Heat Gain per person | 200.00 Btu/h
Lighting Load Density | 1.10 W/ft²
Power Load Density | 1.50 W/ft²
Infiltration Airflow per area | 0.04 CFM/ft²
Plenum Lighting Contribution | 20.0000%
Occupancy Schedule | Common Office Occupancy - 8 AM to 11 PM
Lighting Schedule | Office Lighting - 6 AM to 11 PM
Power Schedule | Office Lighting - 6 AM to 11 PM
Outdoor Air per Person | 5.00 CFM
Outdoor Air per Area | 0.08 CFM/ft²
Air Changes per Hour | 0.090000
Outdoor Air Method | by People and by Area
Heating Set Point | 70.00 °F
Cooling Set Point | 74.00 °F
Humidification Set Point | 0.0000%
Dehumidification Set Point | 70.0000%
Revit Frameworks
Energy Model – Analytical Systems
• Analyze tab ➤ Energy Optimization panel ➤ 🌍
Revit Frameworks
Energy Model – Analytical Geometry
### Analytical Spaces Schedule

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Space Type</th>
<th>Heating Set Point</th>
<th>Area</th>
<th>Volume</th>
<th>Air Changes per Hour</th>
<th>Latent Heat Gain per person</th>
<th>Outdoor Airflow</th>
<th>Peak Latent Cooling Load</th>
<th>Peak Cooling Load</th>
<th>Peak Heating Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space 5</td>
<td>&lt;Building&gt;</td>
<td>70 °F</td>
<td>298 SF</td>
<td>2180.7</td>
<td>0</td>
<td>200</td>
<td>21</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 6</td>
<td>&lt;Building&gt;</td>
<td>70 °F</td>
<td>444 SF</td>
<td>5267.2</td>
<td>0</td>
<td>200</td>
<td>35</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 8</td>
<td>&lt;Building&gt;</td>
<td>70 °F</td>
<td>88 SF</td>
<td>906.7</td>
<td>0</td>
<td>200</td>
<td>7</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
</tbody>
</table>

### Analytical Glass

<table>
<thead>
<tr>
<th>Opening Type</th>
<th>Area</th>
<th>Solar Heat Gain Coefficient</th>
<th>Visual Light Transmittance</th>
<th>Heat Transfer Coefficient (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operable Window</td>
<td>6</td>
<td>0.76</td>
<td>0.81</td>
<td>0.503</td>
</tr>
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<td>0.76</td>
<td>0.81</td>
<td>0.503</td>
</tr>
<tr>
<td>Operable Window</td>
<td>18</td>
<td>0.76</td>
<td>0.81</td>
<td>0.503</td>
</tr>
<tr>
<td>Operable Window</td>
<td>18</td>
<td>0.76</td>
<td>0.81</td>
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<td>0.503</td>
</tr>
<tr>
<td>Operable Window</td>
<td>18</td>
<td>0.76</td>
<td>0.81</td>
<td>0.503</td>
</tr>
<tr>
<td>Operable Window</td>
<td>14</td>
<td>0.76</td>
<td>0.81</td>
<td>0.503</td>
</tr>
</tbody>
</table>

### Analytical Surfaces

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Area</th>
<th>Thermal Resistance (R)</th>
<th>Thermal Mass</th>
<th>Heat Transfer Coefficient (U)</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling</td>
<td>2.59</td>
<td>1.82</td>
<td>0.39</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Exterior Wall</td>
<td>1.54</td>
<td>9.45</td>
<td>0.65</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Interior Wall</td>
<td>11.66</td>
<td>1.74</td>
<td>0.09</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Raised Floor</td>
<td>1.75</td>
<td>1.04</td>
<td>0.57</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Slab on Grade</td>
<td>22.16</td>
<td>2.70</td>
<td>0.05</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.03</td>
<td>34.08</td>
<td>0.05</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
## Revit Frameworks

### Analytical Spaces

<table>
<thead>
<tr>
<th>Room Name</th>
<th>Space Type</th>
<th>Heating Set Point</th>
<th>Area</th>
<th>Volume</th>
<th>Air Changes per Hour</th>
<th>Latent Heat Gain per person</th>
<th>Outdoor Airflow</th>
<th>Peak Latent Cooling Load</th>
<th>Peak Cooling Load</th>
<th>Peak Heating Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space 5</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>298 SF</td>
<td>2180.7</td>
<td>0</td>
<td>200</td>
<td>21</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 6</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>444 SF</td>
<td>5267.2</td>
<td>0</td>
<td>200</td>
<td>35</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 8</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>85 SF</td>
<td>906.7</td>
<td>0</td>
<td>200</td>
<td>7</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 7</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>200 SF</td>
<td>2556.9</td>
<td>0</td>
<td>200</td>
<td>18</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 1</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>115 SF</td>
<td>799.2</td>
<td>0</td>
<td>200</td>
<td>8</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 2</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>145 SF</td>
<td>1020.5</td>
<td>0</td>
<td>200</td>
<td>10</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 4</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>264 SF</td>
<td>1963.2</td>
<td>0</td>
<td>200</td>
<td>18</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Space 3</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>357 SF</td>
<td>2648.9</td>
<td>0</td>
<td>200</td>
<td>25</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Analytical Space 1</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>264 SF</td>
<td>856.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Analytical Space 3</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>357 SF</td>
<td>1156.6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Analytical Space 2</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>268 SF</td>
<td>960.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
<tr>
<td>Analytical Space 4</td>
<td>&lt;Building&gt;</td>
<td>70°F</td>
<td>260 SF</td>
<td>825.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Not Computed</td>
<td>Not Computed</td>
<td>Not Computed</td>
</tr>
</tbody>
</table>
Revit Frameworks
Dynamo – 101
Revit Frameworks
Dynamo – Data Mining
Revit Frameworks
Dynamo – Geometry

Points → Lines → Surfaces → Solids
Revit Frameworks
Dynamo – Place Objects In Revit
Learning Objectives

- 101 Revit’s Systems Analysis
- Connect 2D schematics, 3D model & Analytical model
- Streamline Revit Workflows with API
Customization & Data Connection
Mise en place (Everything In Its Place)
Revit Systems Analysis 101
Revit Frameworks

Revit
Revit Frameworks
Shared Parameters
Revit Frameworks
MEP Families
Revit Frameworks
MEP Systems
Revit Frameworks
Rooms

Architecture Rooms

MEP Rooms
Integrated Workflow
Project Template
Integrated Workflow

Project Setup

RUN DYNAMO PROJECT SET UP SCRIPTS
Integrated Workflow
Copy Linked Rooms
Integrated Workflow

Create Space At Room Location

Get Architecture Room Data
- ArchRms // 1-2.1 Get architecture Room Location and Parameters
  - ArchRms.Location;
  - ArchRms.GetParameterValueByName("Number");
  - ArchRms.GetParameterValueByName("Name");
  - ArchRms.GetParameterValueByName("Room Code");
  - ArchRms.GetParameterValueByName("Occupancy");
  - ArchRms.GetParameterValueByName("Room Type");

Set Parameters for new created Spaces and Rooms
- NewSpace // 1-3.2 Set Space parameters
  - number NewSpace.SetParameterByName("Number", number);
  - name NewSpace.SetParameterByName("Name", name);
  - CodeID NewSpace.SetParameterByName("Code ID", CodeID);
  - PPL NewSpace.SetParameterByName("Occupancy", PPL);
  - RmType NewSpace.SetParameterByName("Room Type", RmType);
Integrated Workflow

Add Spaces To Remaining Openings
Integrated Workflow

Subdivide Large Rooms
Integrated Workflow
Add Space Type
Integrated Workflow
Add Space Type

Room Names

Key Word Table

Fitness Function

Best Match
Integrated Workflow

Energy Model Setup - Weather
Integrated Workflow
Energy Model Setup – Thermal Properties
Integrated Workflow
Energy Model Review – Dynamo
Integrated Workflow

Systems Analysis – Analytical Space Loads
Integrated Workflow
Systems Configurator -
Integrated Workflow

Analytical System Set Up

MEPAnalysisNodes.SpacesToSystemZone
Spaces ➤ System-Zone
Name ➤

MEPAnalysisNodes.AirSystem
Name ➤ Air System

MEPAnalysisNodes.WaterLoop
Name ➤ Water Loop
Main Title – 1 column with bullets


• First-level bullet: closed circle. Text style: gray, 1.4 spaced, Arial 30pt font.
    ▪ Third-level bullet: closed square. Text style: gray, 1.4 spaced, Arial 30pt font.
Main Title – 2 column bullets

LOREM IPSUM
Lorem ipsum dolor sit amet, consectetur adipiscing elit.
Cras lacinia interdum odio, at cursus elit sagittis lobortis. Proin eu nisl molestie, dignissim ante ut, dictum ex.

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• First-level bullet: closed circle. Text style: gray, 1.4 spaced
  • Second-level bullet: open circle. Text style: gray, 1.4 spaced
    ▪ Third-level bullet: closed square. Text style: gray, 1.4 spaced
Title Goes Here

Title 1


Title 2

What is BIM?
Opportunities
“If it was easy it would just be the way!”
Revit Systems Analysis
True BIM