AUTODESK. UNIVERSITY

Dynamo + Revit Systems Analysis

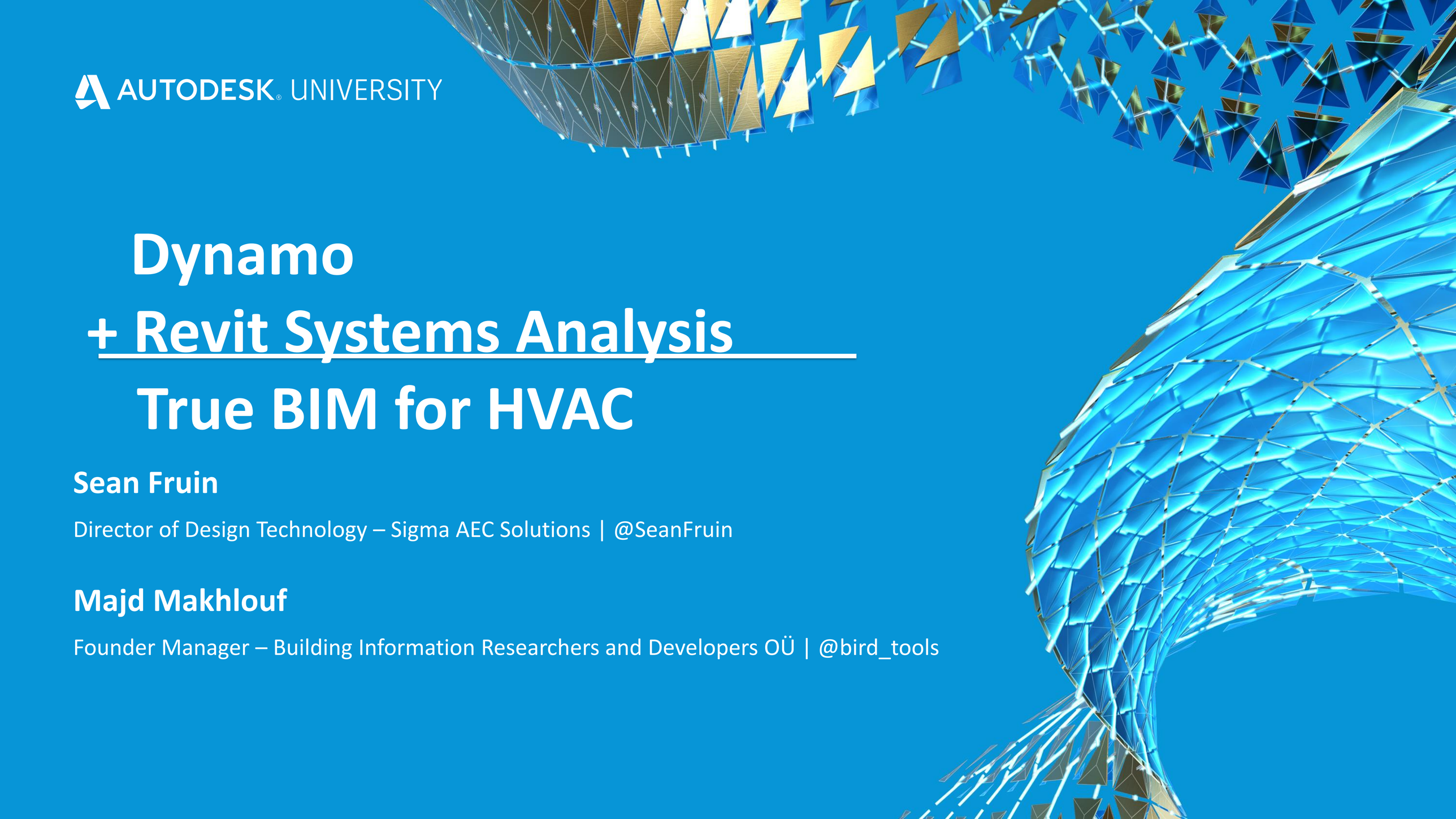
True BIM for HVAC

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.

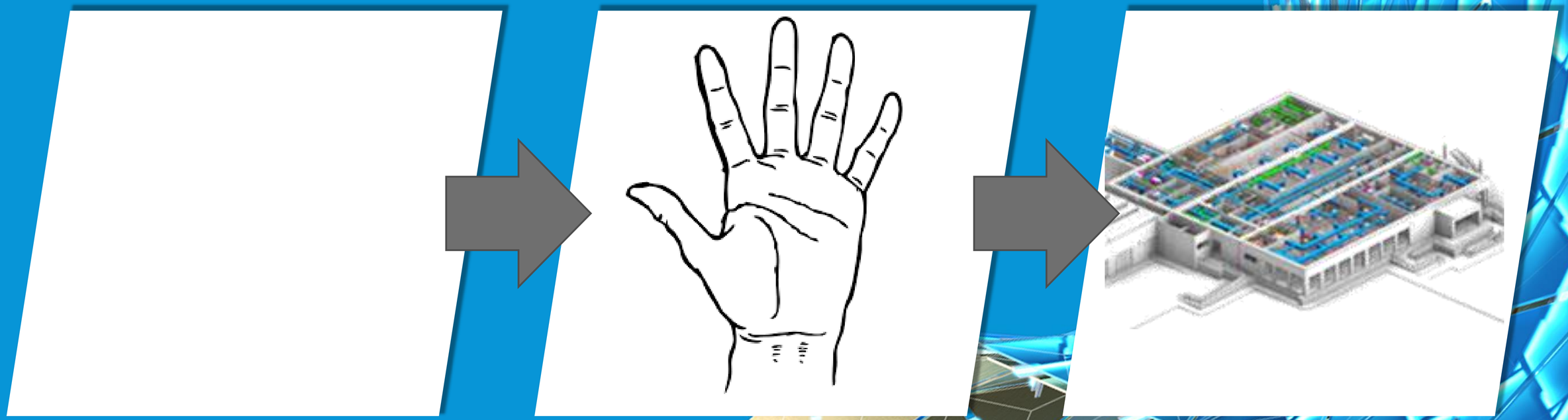
About the speakers
Majd Makhloof

Majd Makhloof
@bird_tools

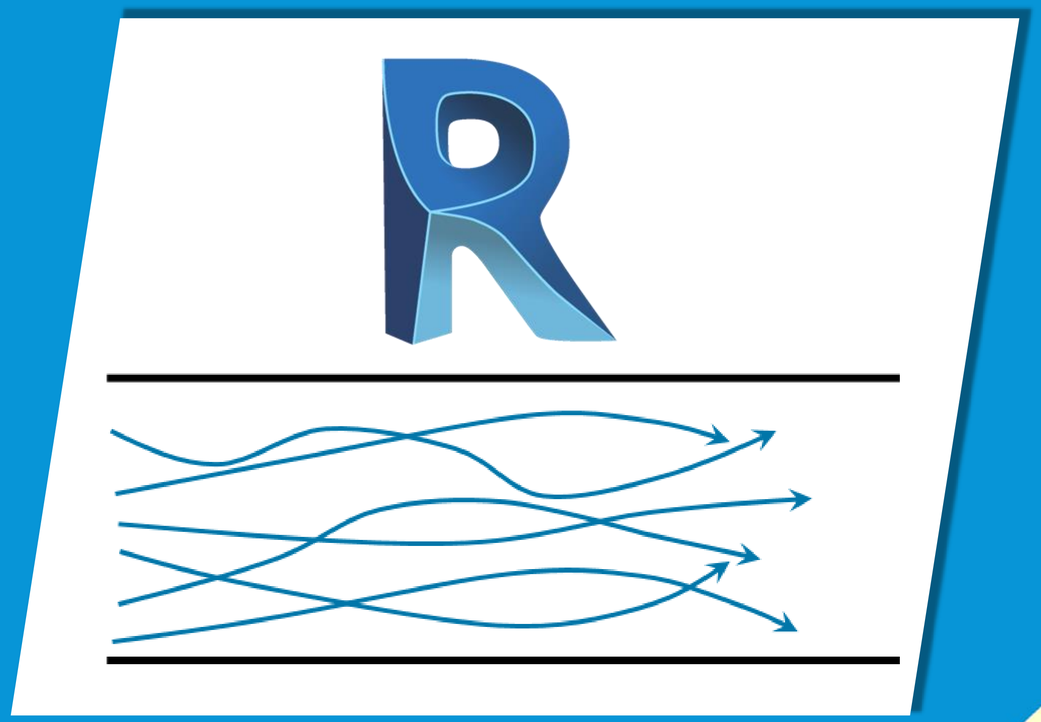
Majd is a Mechanical Engineer and Design Technologist, with a Master of Science in Mechanical Engineering. He's an Autodesk Revit Certified Professional and a member of the Autodesk Developer Network. In January 2020, he founded Building Information Researchers and Developers OÜ, a software development 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.”

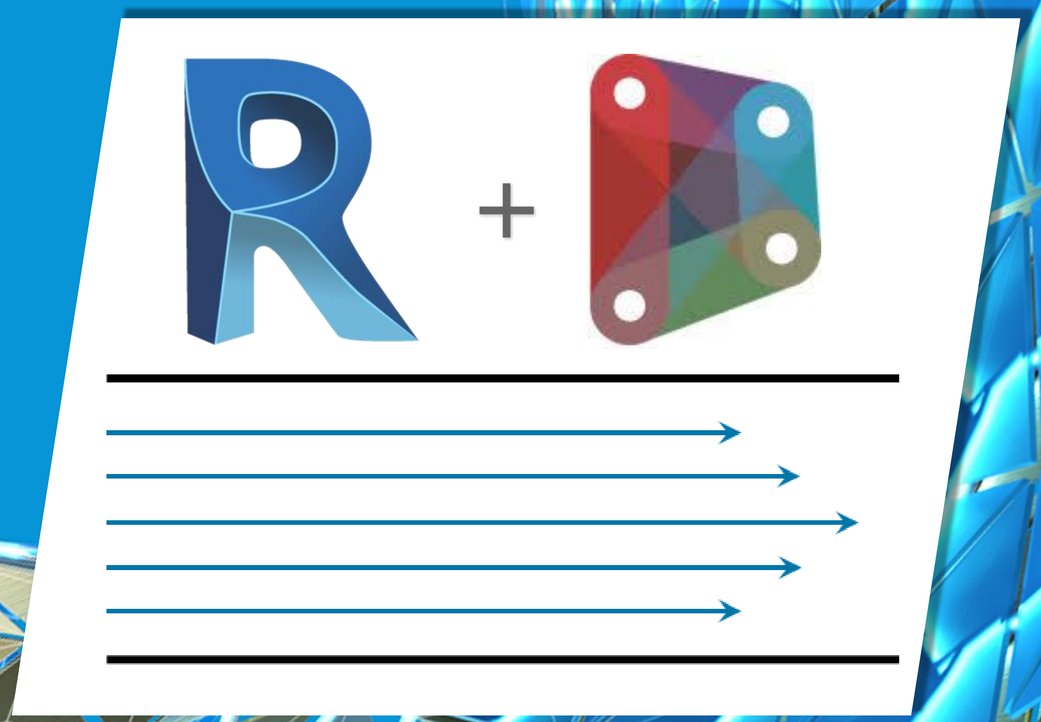
Problem?



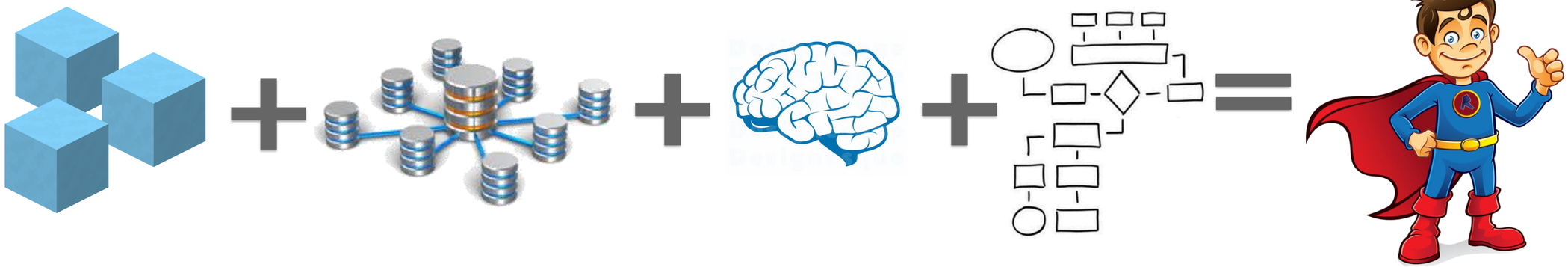
True BIM



VS.

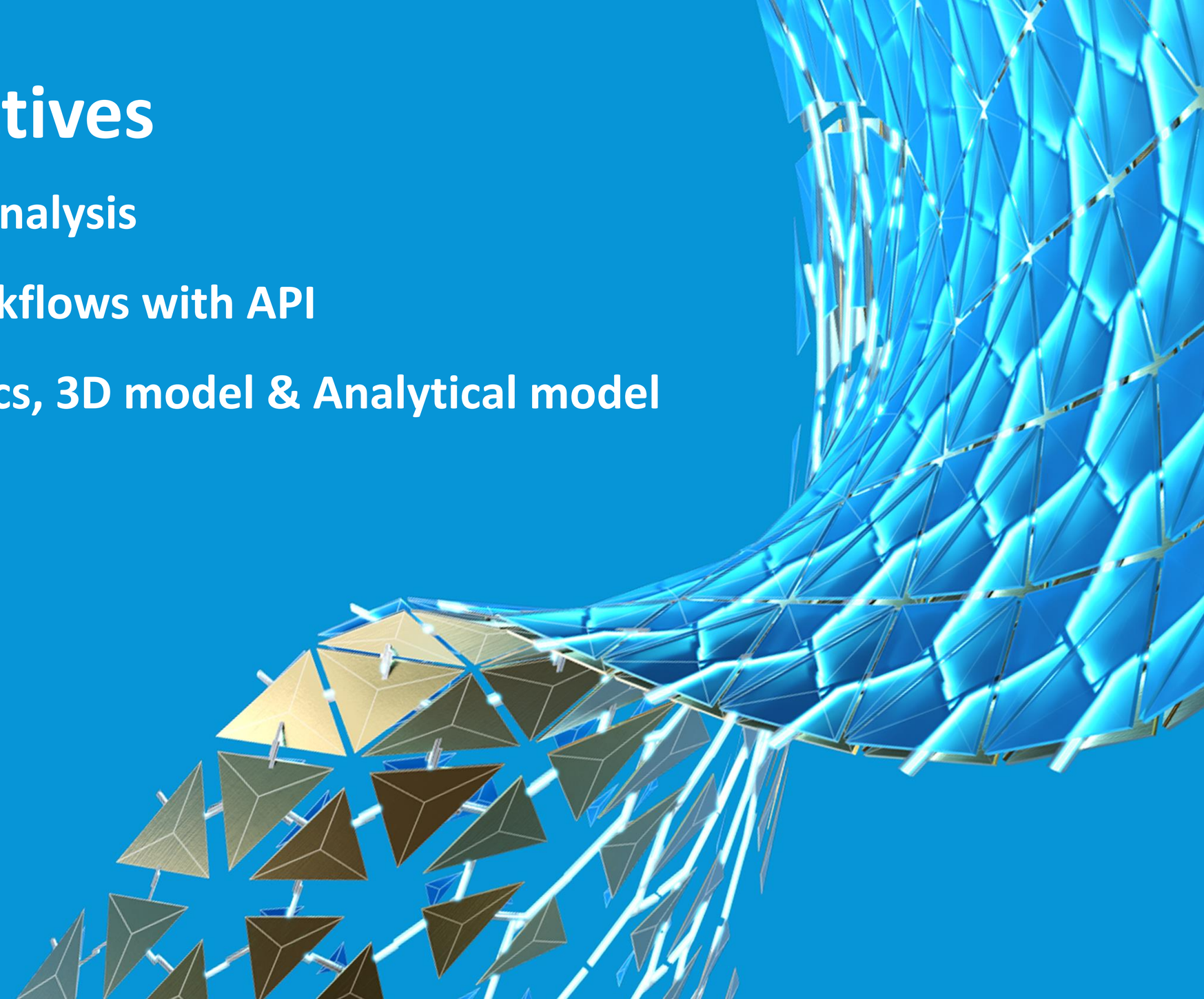


True BIM

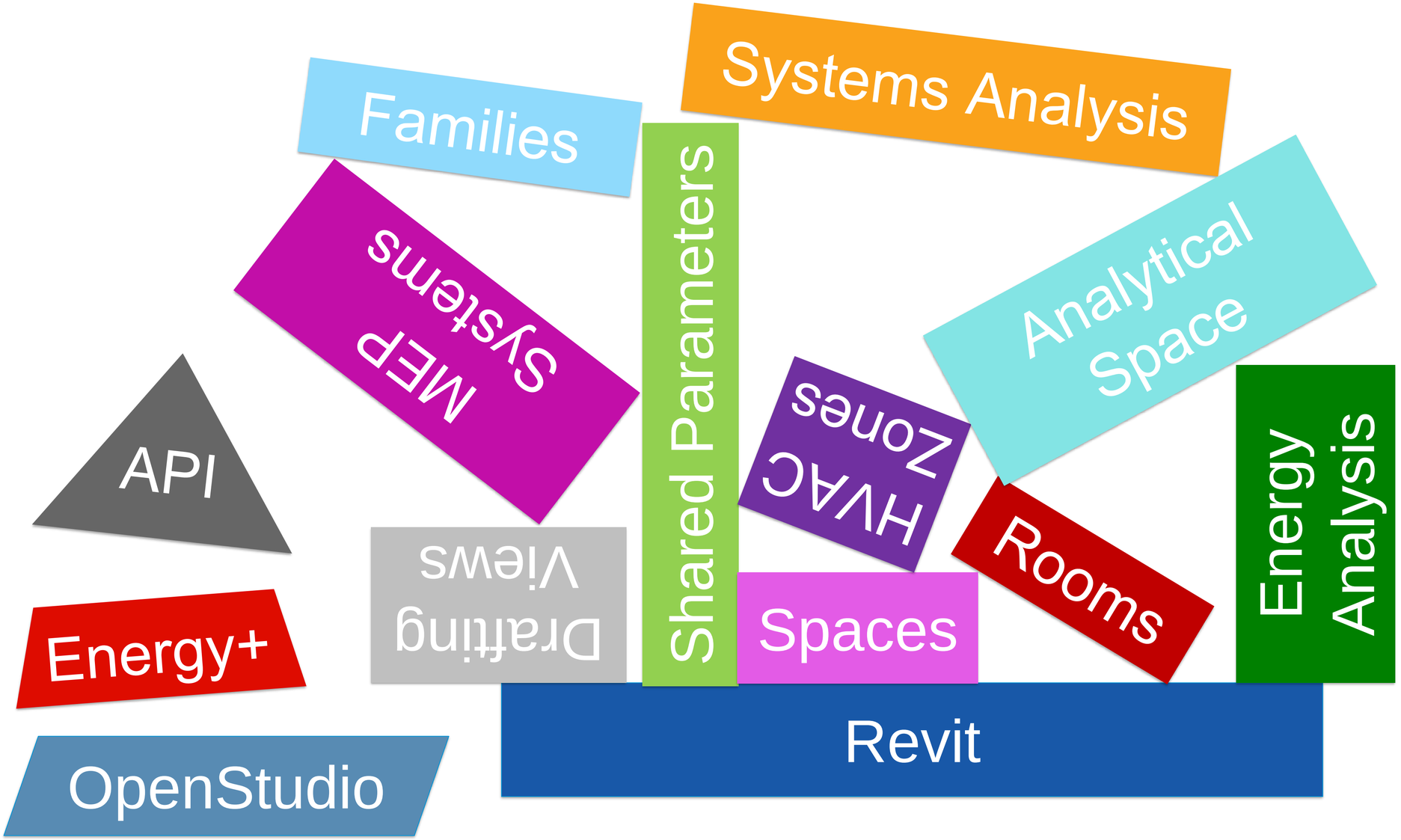


Learning Objectives

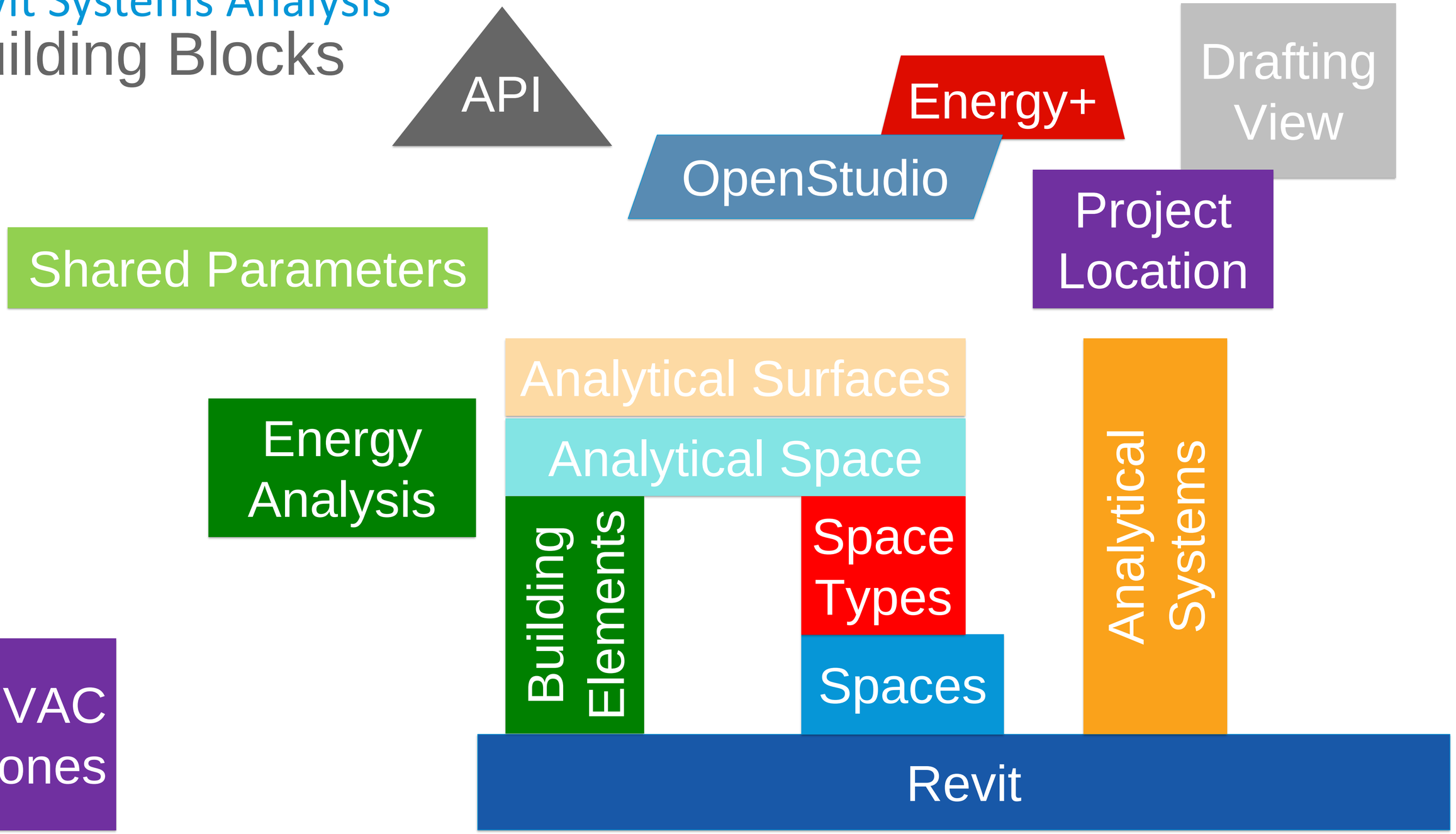
- ☐ 101 Revit’s Systems Analysis
- ☐ Streamline Revit Workflows with API
- ☐ Connect 2D schematics, 3D model & Analytical model



Revit Systems Analysis
Building Blocks ?



Revit Systems Analysis
Building Blocks



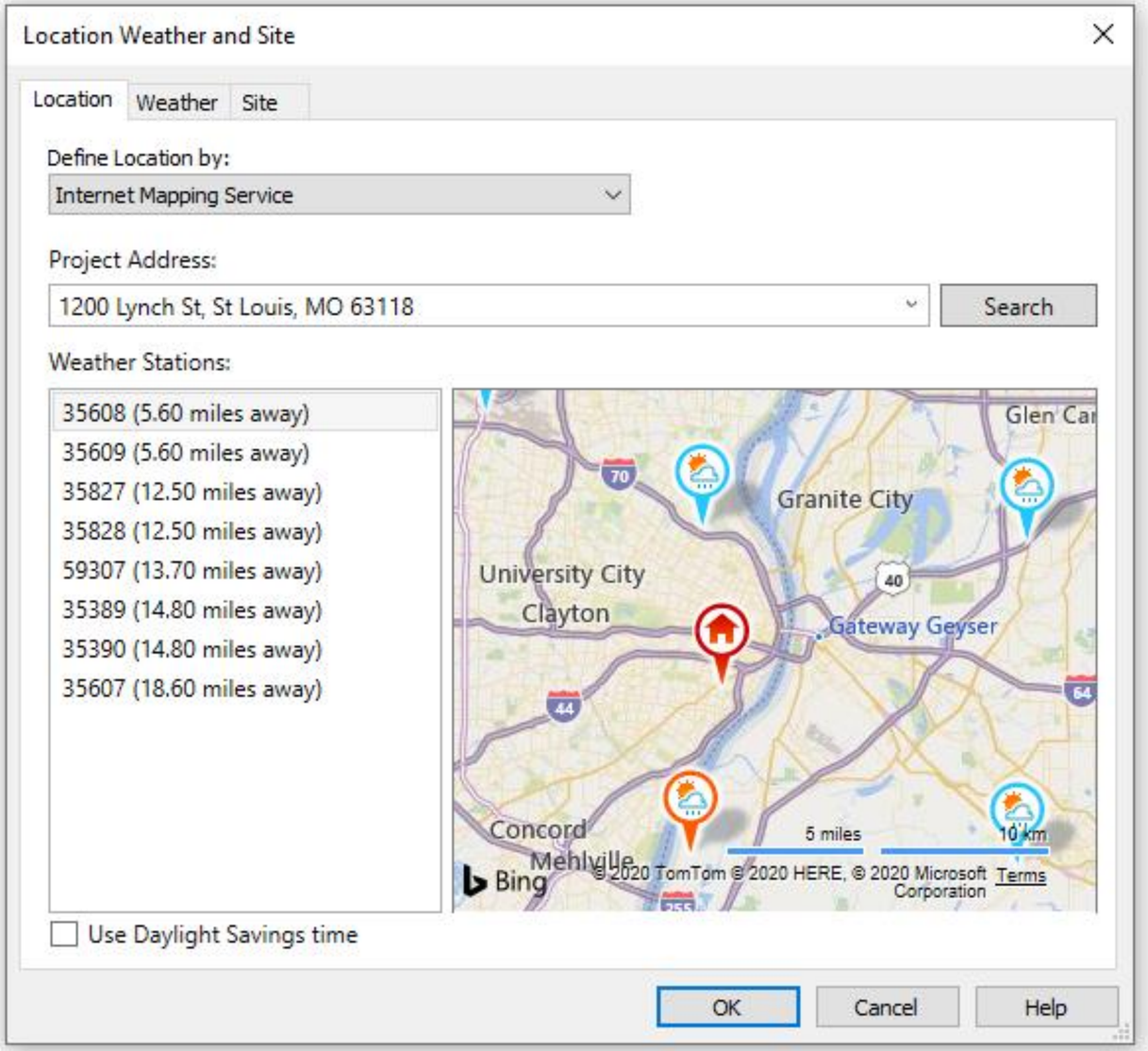
Revit Systems Analysis
101

Revit Systems Analysis

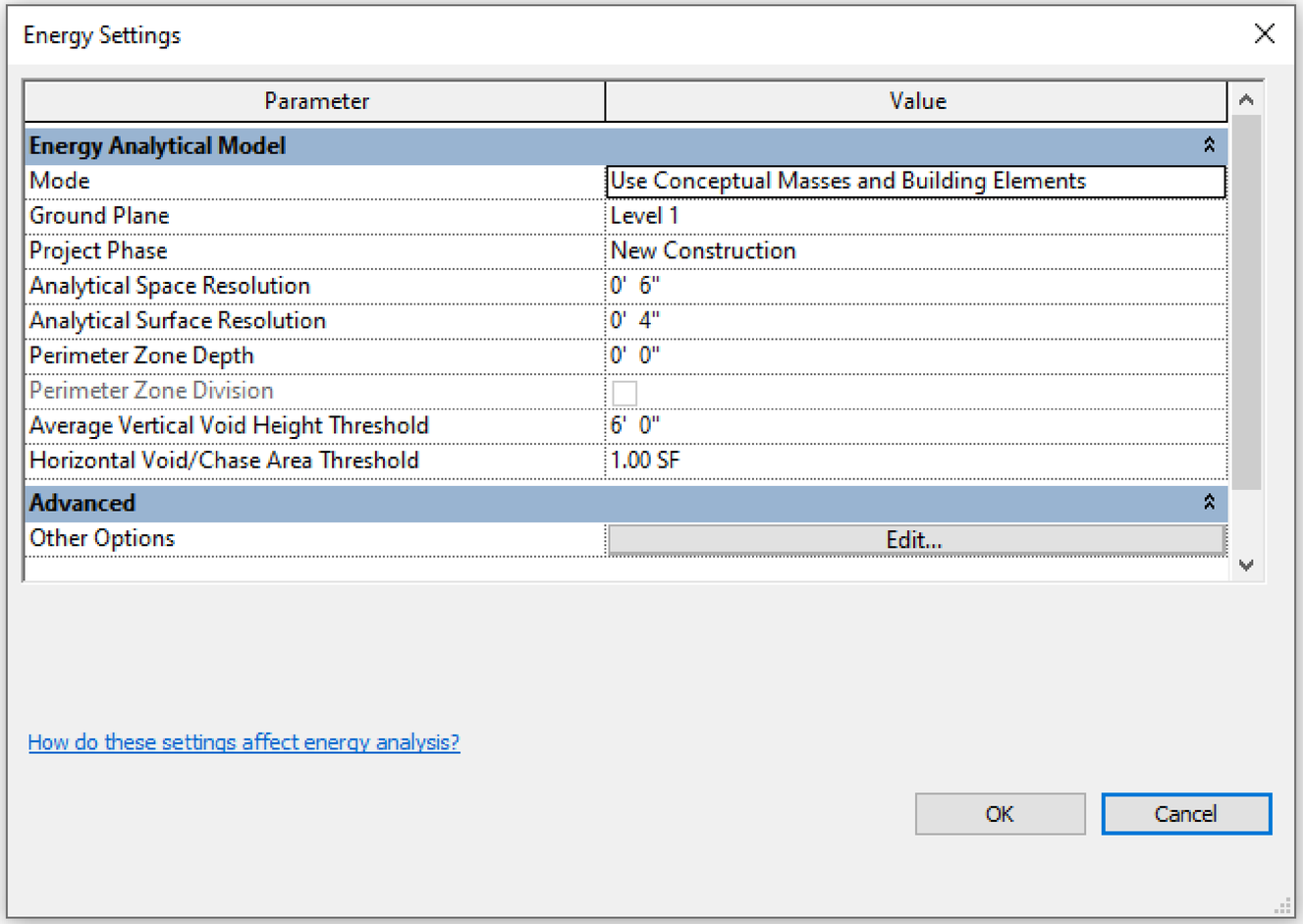
Energy Model – GBXML

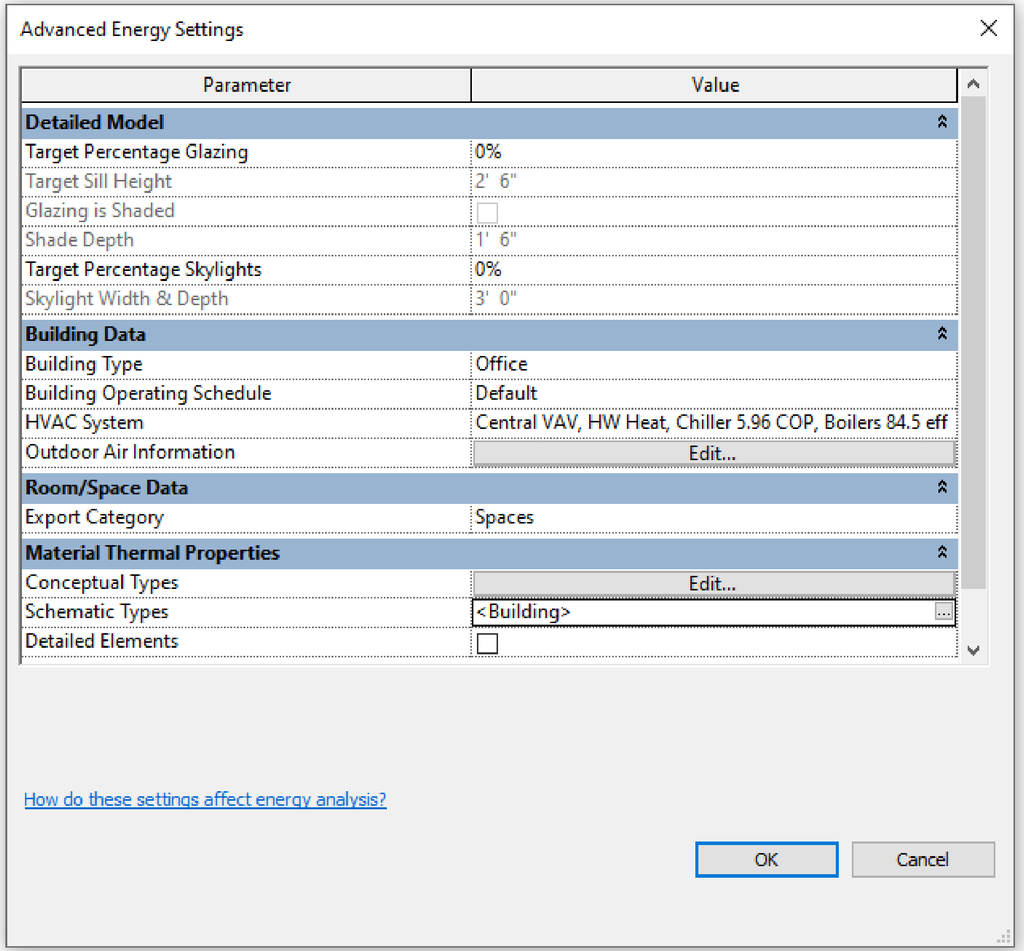
- Location / Weather Data
- Building Geometry
- Thermal Properties
- HVAC Systems

Revit Frameworks
Energy Model – Weather Data

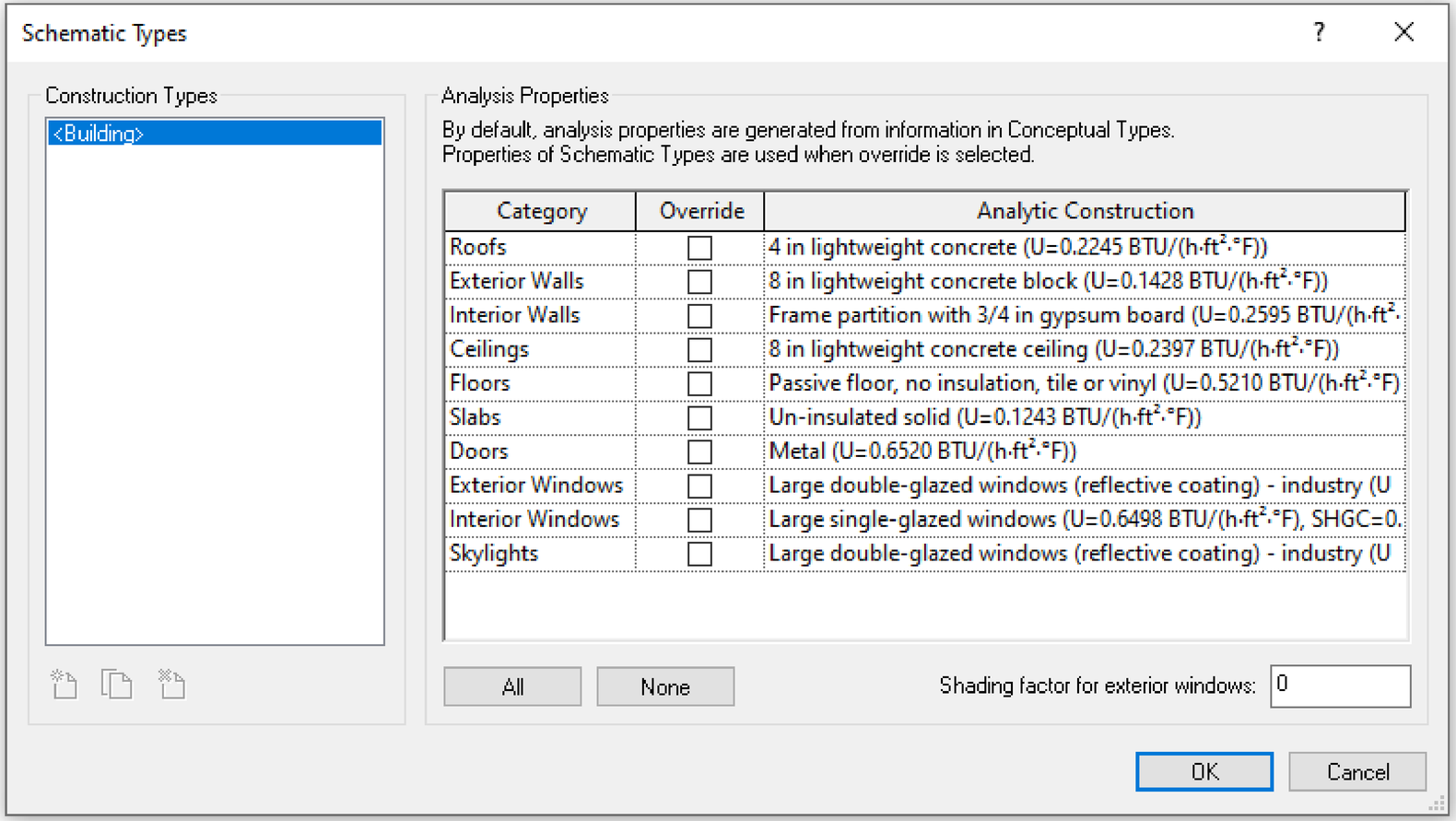


Revit Frameworks
Energy Model - Settings

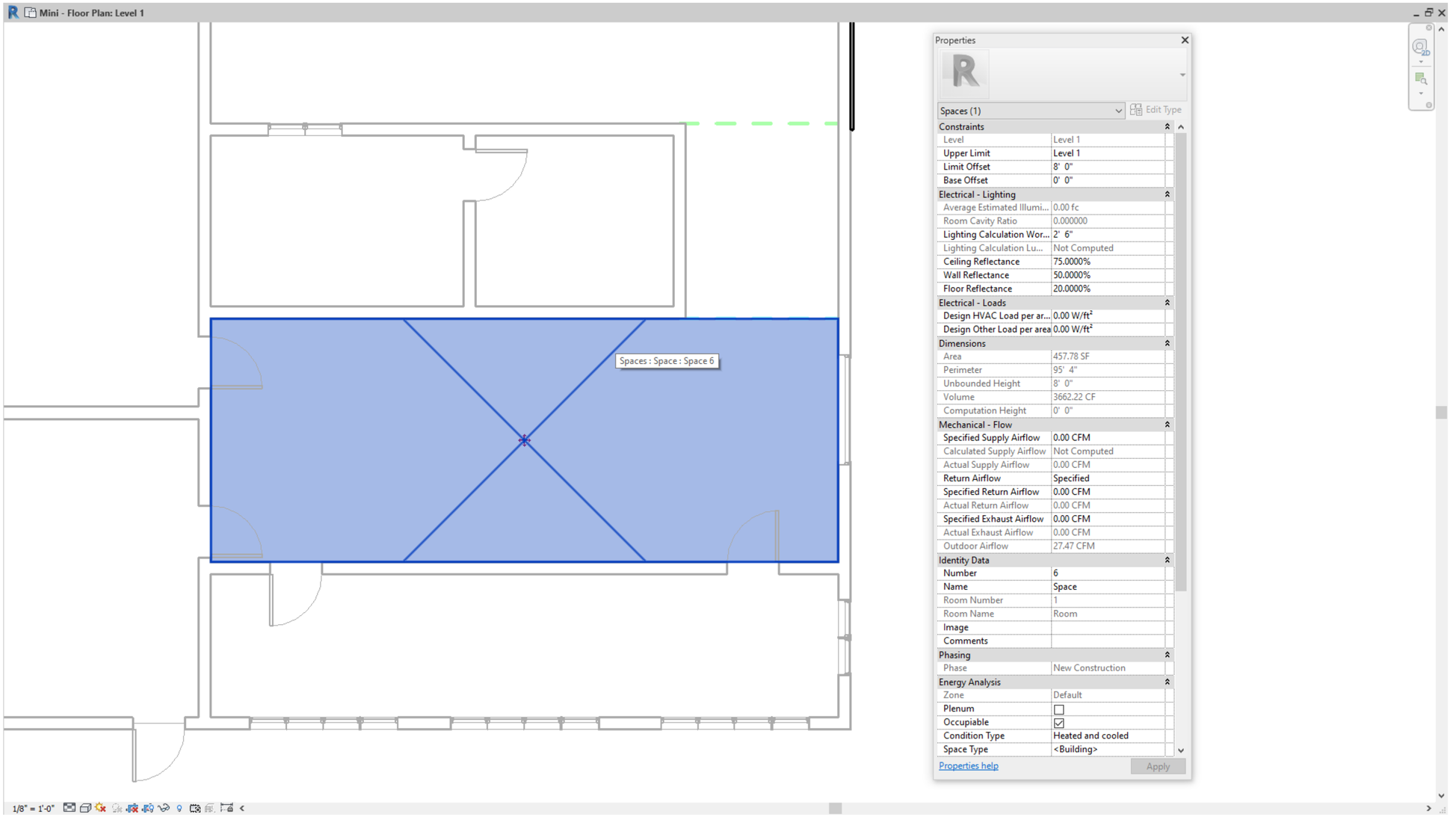




Revit Frameworks
Energy Model – Material U value

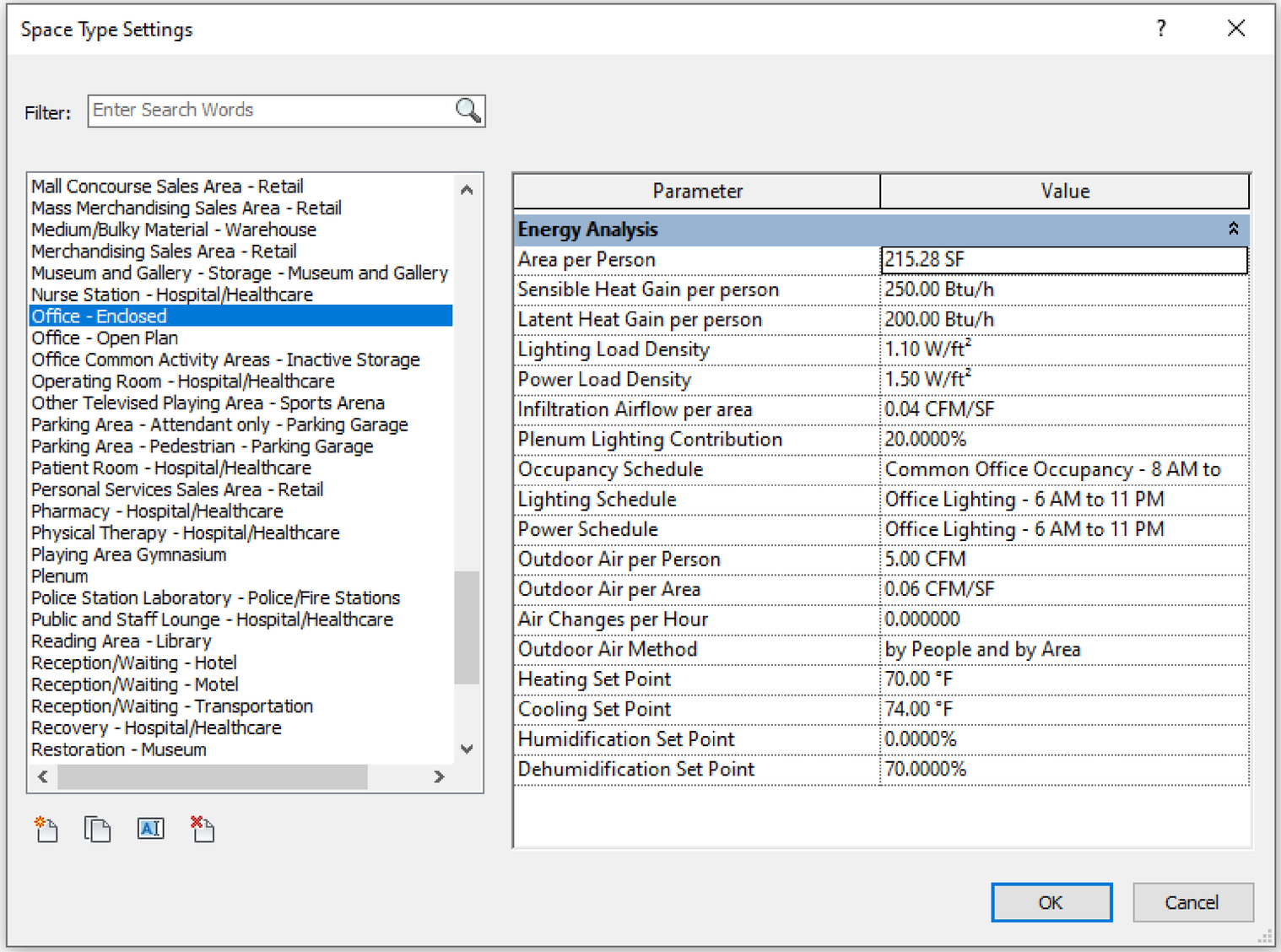


Revit Frameworks
Spaces

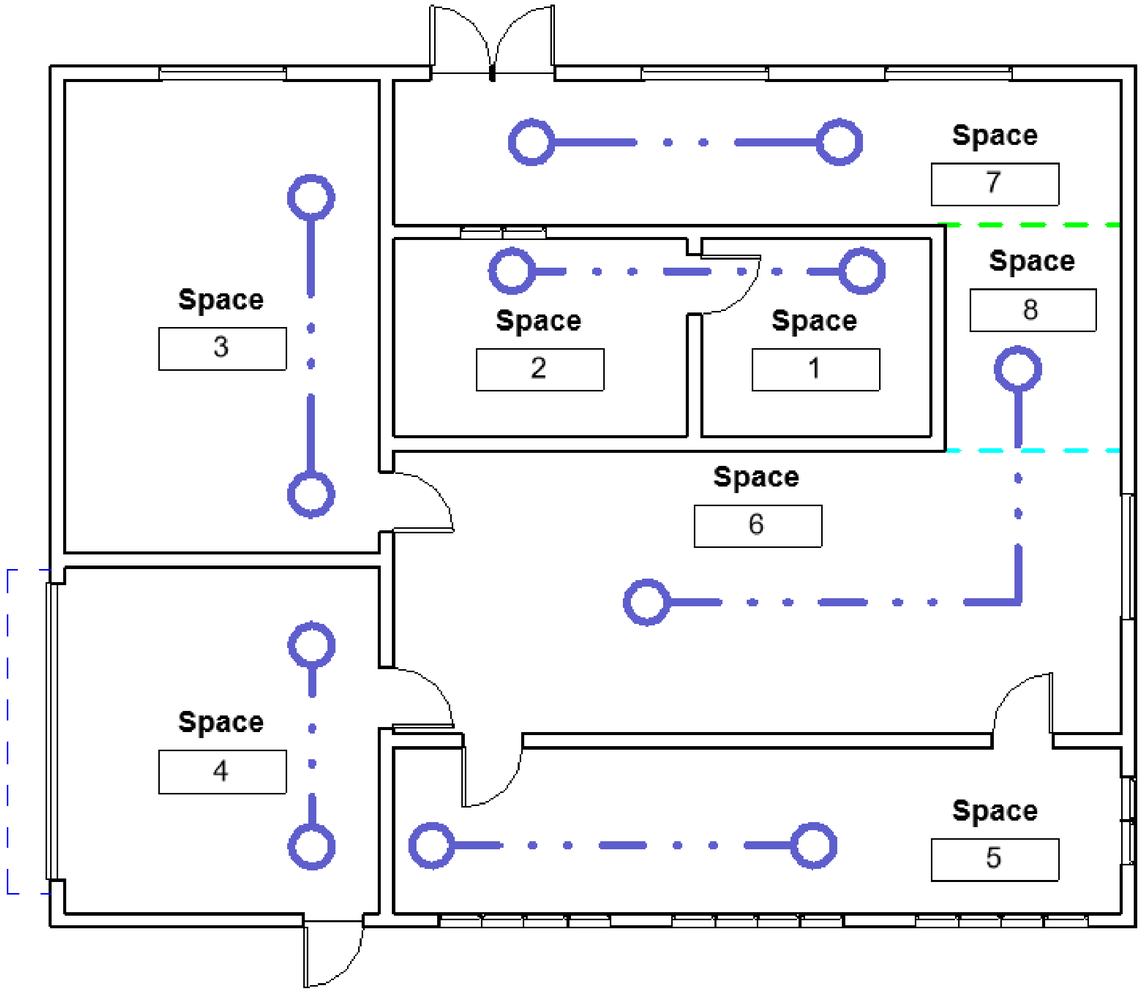


Revit Frameworks

Spaces – Building/Space Type



Revit Frameworks
System Zones



Revit Frameworks

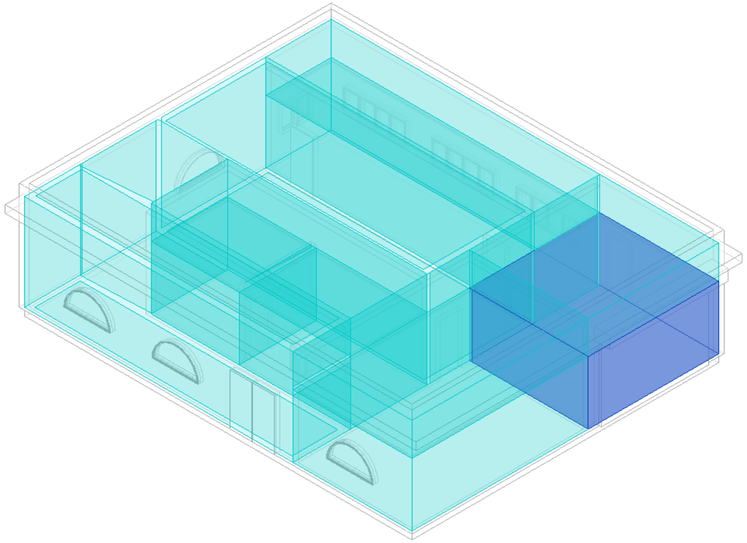
Energy Model – Analytical Systems

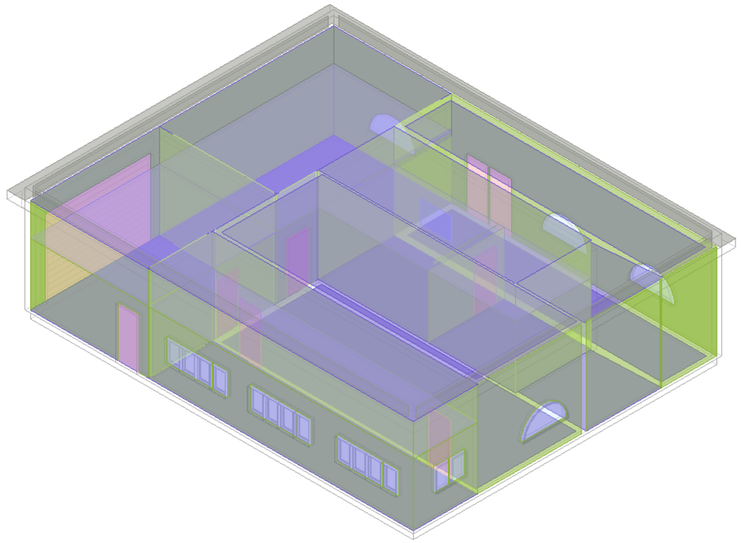
Energy Model – Create Energy Model

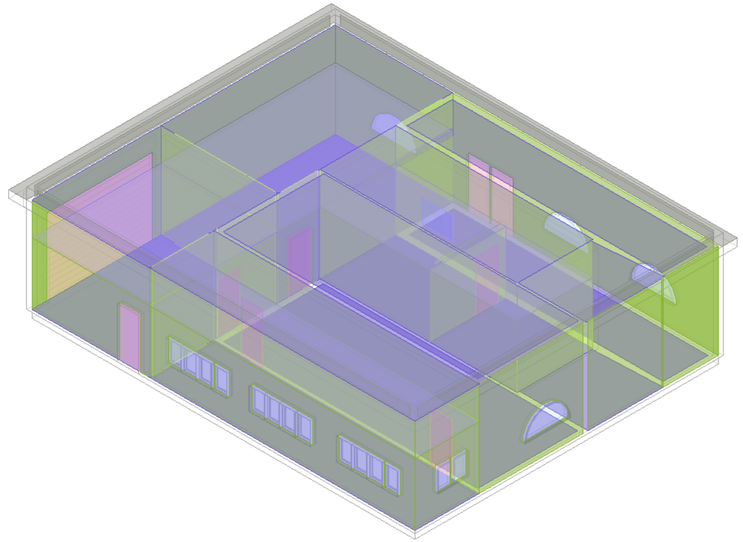
- Analyze tab ➤ Energy Optimization panel ➤ 

Revit Frameworks

Energy Model – Analytical Geometry







Revit Frameworks

Energy Model – Analytical Geometry Data

Mini - Schedule: Analytical Spaces Schedule

<Analytical Spaces Schedule>

A	B	C	D	E	F	G	H	I	J	K
Room Name	Space Type	Heating Set Point	Area	Volume	Air Changes per Hour	Latent Heat Gain per person	Outdoor Airflow	Peak Latent Cooling Load	Peak Cooling Load	Peak Heating Load
Space 5	<Building>	70 °F	298 SF	2180.7	0	200	21	Not Computed	Not Computed	Not Computed
Space 6	<Building>	70 °F	444 SF	5267.2	0	200	35	Not Computed	Not Computed	Not Computed
Space 8	<Building>	70 °F	88 SF	906.7	0	200	7	Not Computed	Not Computed	Not Computed

Mini - Schedule: Analytical Glass

<Analytical Glass>

A	B	C	D	E
Opening Type	Area	Solar Heat Gain Coefficient	Visual Light Transmittance	Heat Transfer Coefficient (U)
Operable Window	6	0.76	0.81	0.503
Operable Window	6	0.76	0.81	0.503
Operable Window	18	0.76	0.81	0.503
Operable Window	18	0.76	0.81	0.503
Operable Window	6	0.76	0.81	0.503
Operable Window	18	0.76	0.81	0.503
Operable Window	14	0.76	0.81	0.503

Mini - Schedule: Analytical Surfaces

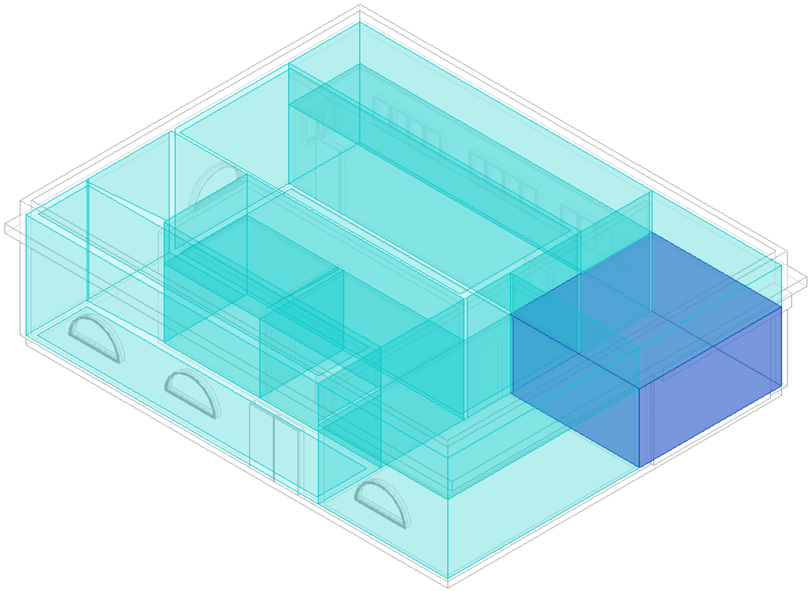
<Analytical Surfaces>

A	B	C	D	E	F
Surface Type	Area	Thermal Resistance (R)	Thermal Mass	Heat Transfer Coefficient (U)	#
		2.59	1.82	0.39	10
Ceiling		1.54	9.45	0.65	5
Exterior Wall		11.66	1.74	0.09	16
Interior Wall		1.75	1.04	0.57	24
Raised Floor		22.16	2.70	0.05	7
Slab on Grade		21.03	34.08	0.05	8

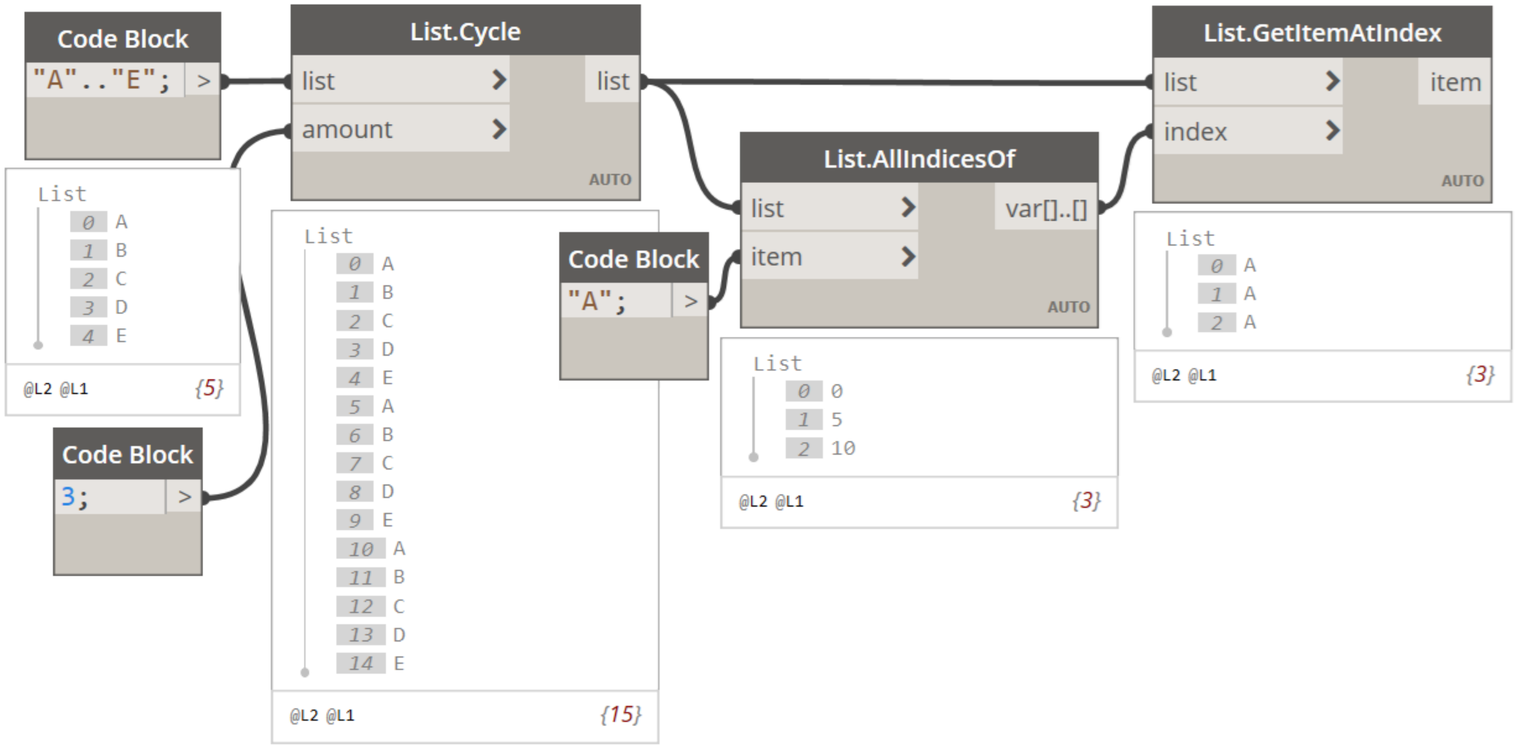
Revit Frameworks
Analytical Spaces

Mini - Schedule: Analytical Spaces Schedule

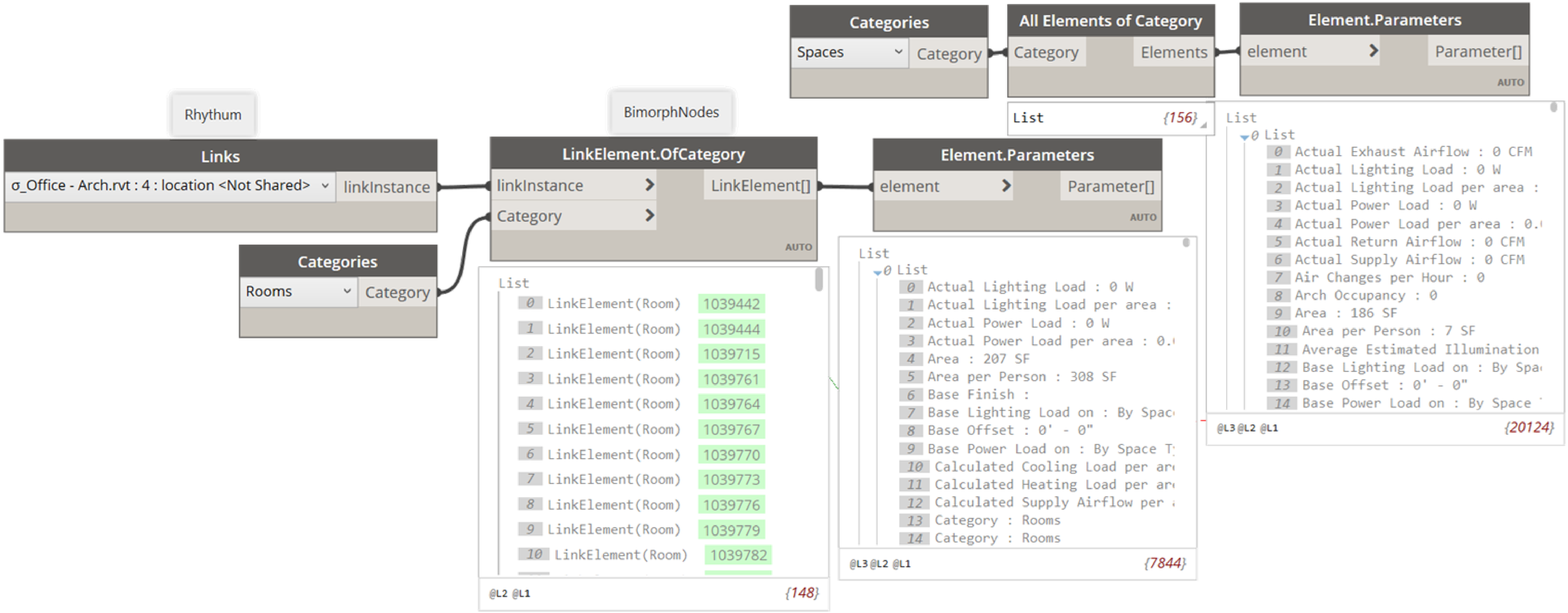
<Analytical Spaces Schedule>										
A	B	C	D	E	F	G	H	I	J	K
Room Name	Space Type	Heating Set Point	Area	Volume	Air Changes per Hour	Latent Heat Gain per person	Outdoor Airflow	Peak Latent Cooling Load	Peak Cooling Load	Peak Heating Load
Space 5	<Building>	70 °F	298 SF	2180.7	0	200	21	Not Computed	Not Computed	Not Computed
Space 6	<Building>	70 °F	444 SF	5267.2	0	200	35	Not Computed	Not Computed	Not Computed
Space 8	<Building>	70 °F	88 SF	906.7	0	200	7	Not Computed	Not Computed	Not Computed
Space 7	<Building>	70 °F	200 SF	2556.9	0	200	18	Not Computed	Not Computed	Not Computed
Space 1	<Building>	70 °F	115 SF	799.2	0	200	8	Not Computed	Not Computed	Not Computed
Space 2	<Building>	70 °F	145 SF	1020.5	0	200	10	Not Computed	Not Computed	Not Computed
Space 4	<Building>	70 °F	264 SF	1963.2	0	200	18	Not Computed	Not Computed	Not Computed
Space 3	<Building>	70 °F	357 SF	2648.9	0	200	25	Not Computed	Not Computed	Not Computed
Analytical Space 1	<Building>	70 °F	264 SF	856.5	0	0	0	Not Computed	Not Computed	Not Computed
Analytical Space 3	<Building>	70 °F	357 SF	1156.6	0	0	0	Not Computed	Not Computed	Not Computed
Analytical Space 2	<Building>	70 °F	298 SF	960.9	0	0	0	Not Computed	Not Computed	Not Computed
Analytical Space 4	<Building>	70 °F	260 SF	825.5	0	0	0	Not Computed	Not Computed	Not Computed



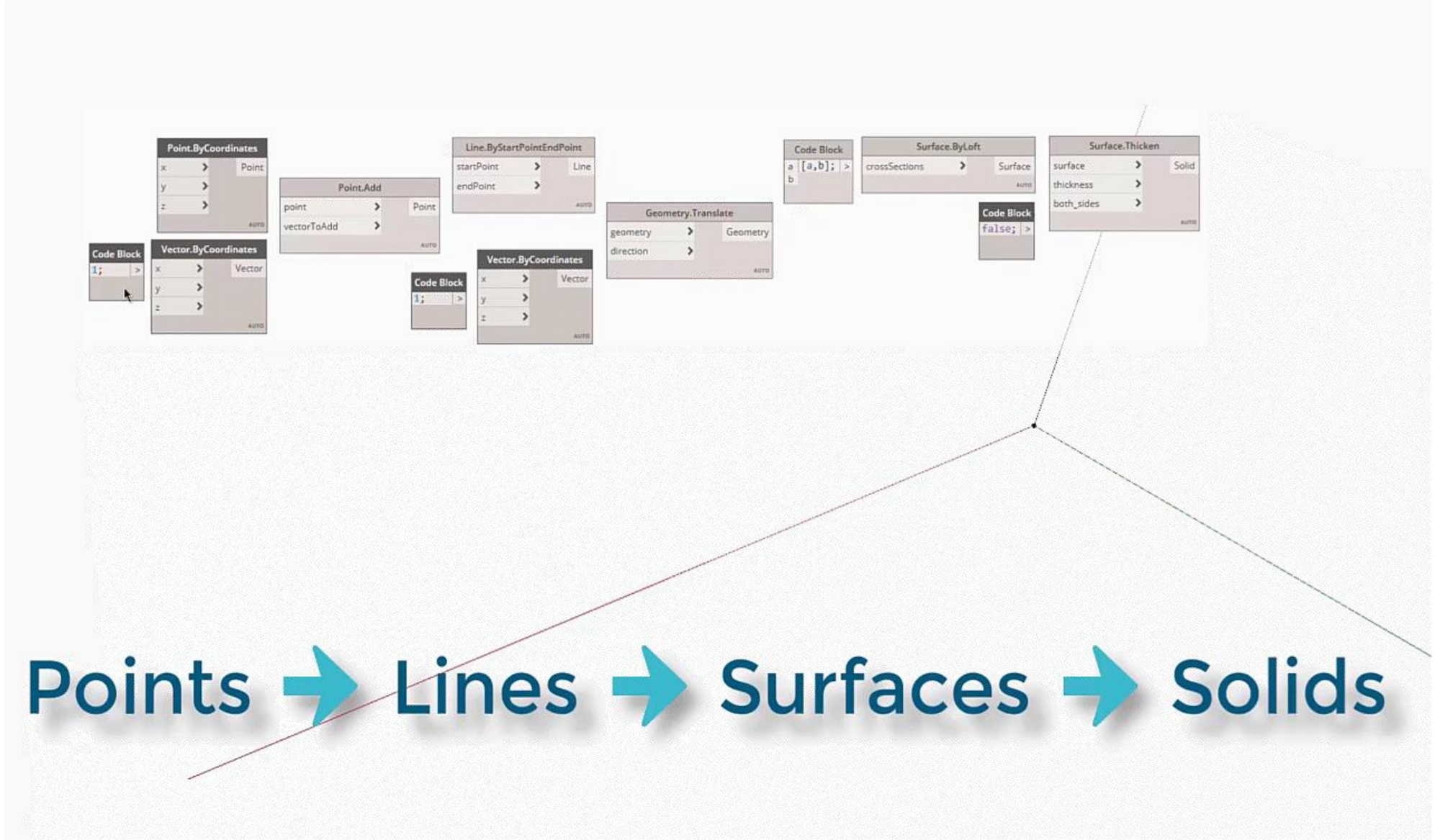
Revit Frameworks
Dynamo – 101



Revit Frameworks
Dynamo – Data Mining

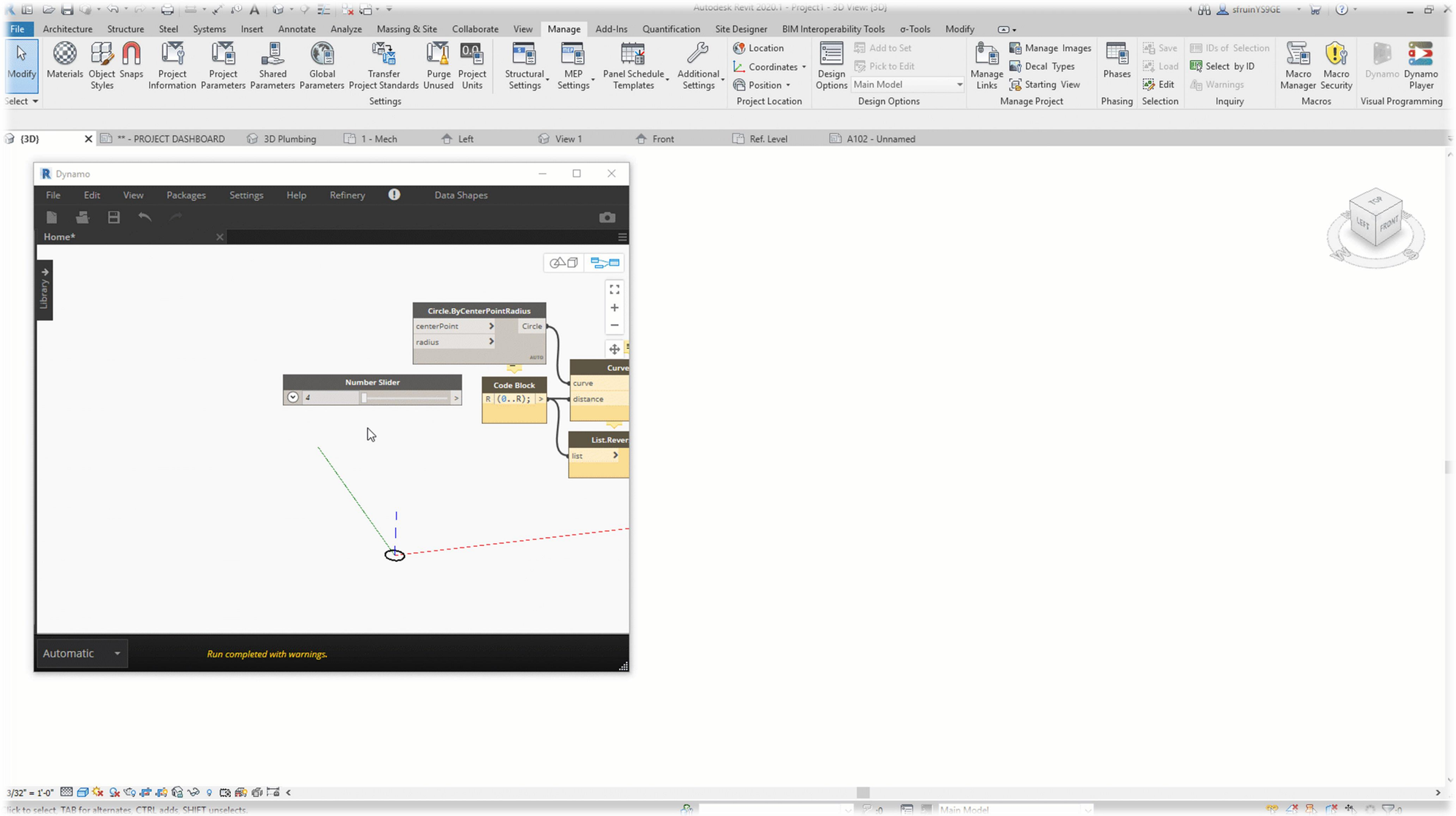


Revit Frameworks
Dynamo – Geometry



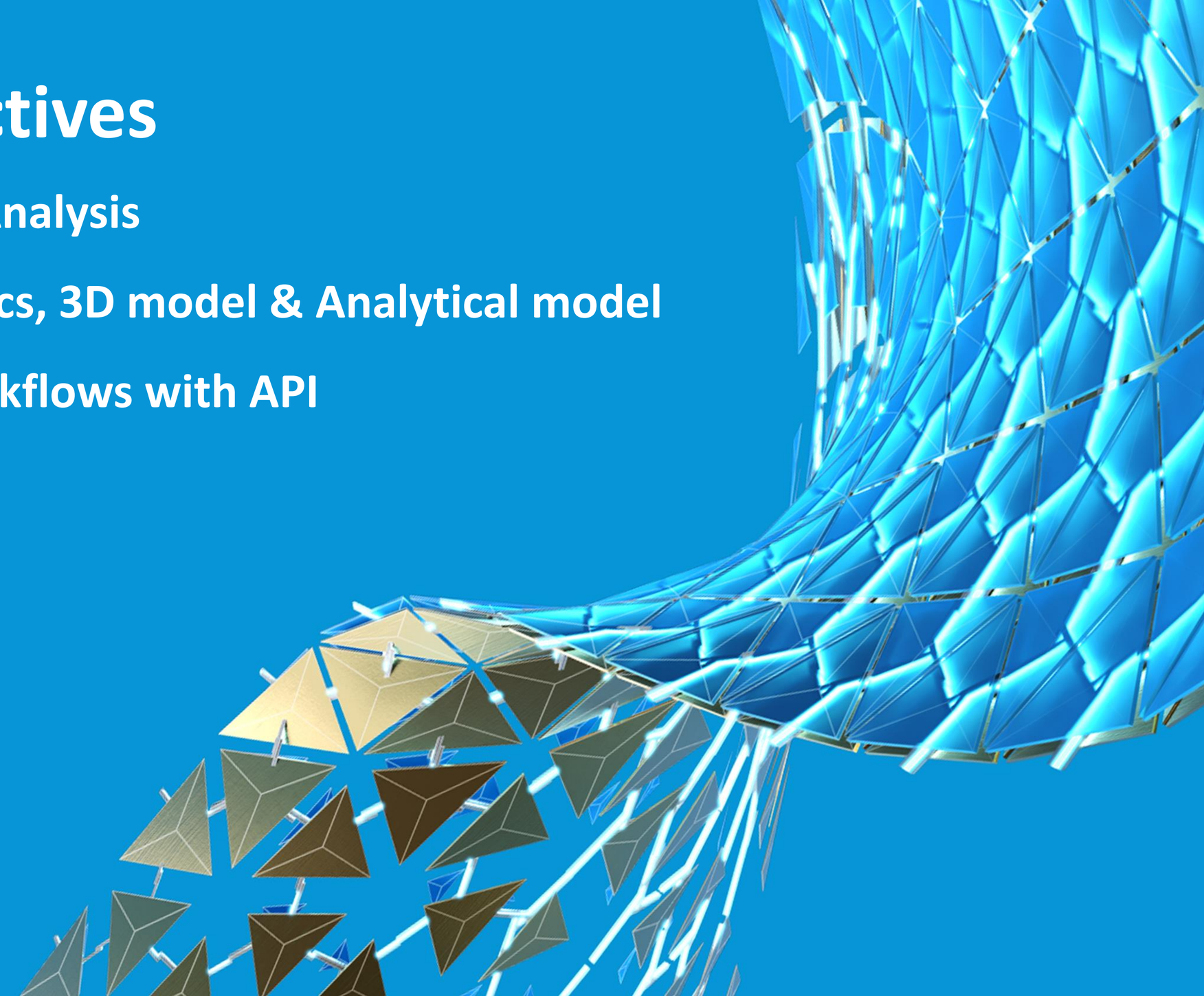
Revit Frameworks

Dynamo – Place Objects In Revit



Learning Objectives

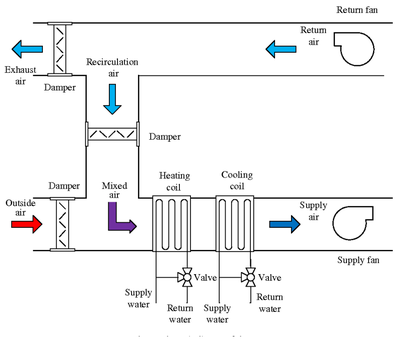
- [x] 101 Revit's Systems Analysis
- [ ] Connect 2D schematics, 3D model & Analytical model
- [ ] Streamline Revit Workflows with API

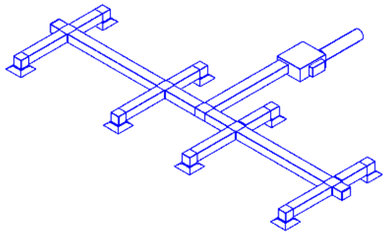


Customization & Data Connection

Mise en place (Everything In Its Place)

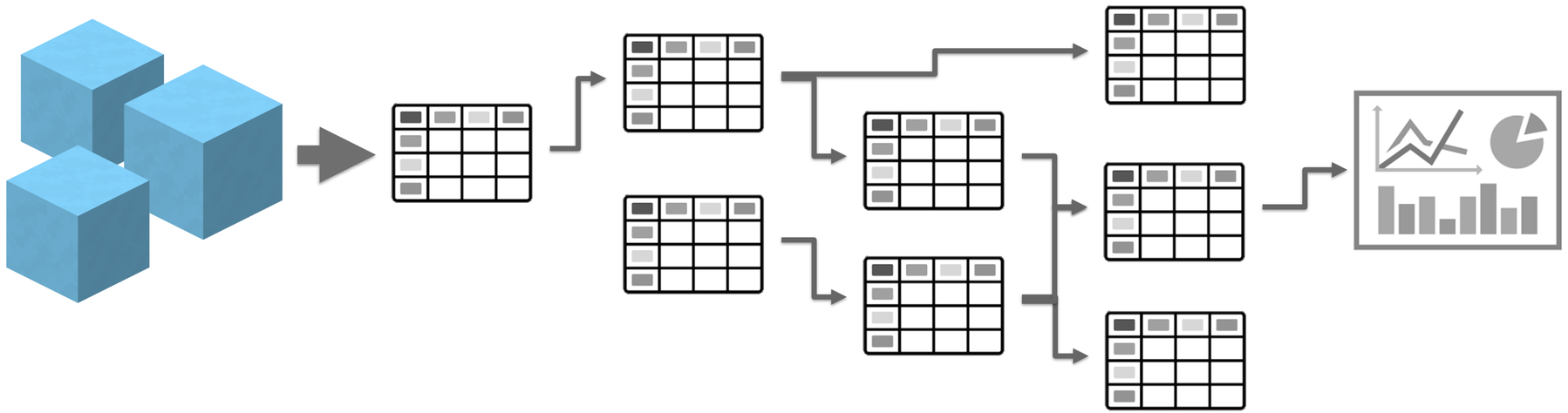
Revit Systems Analysis 101





Revit Frameworks

Revit

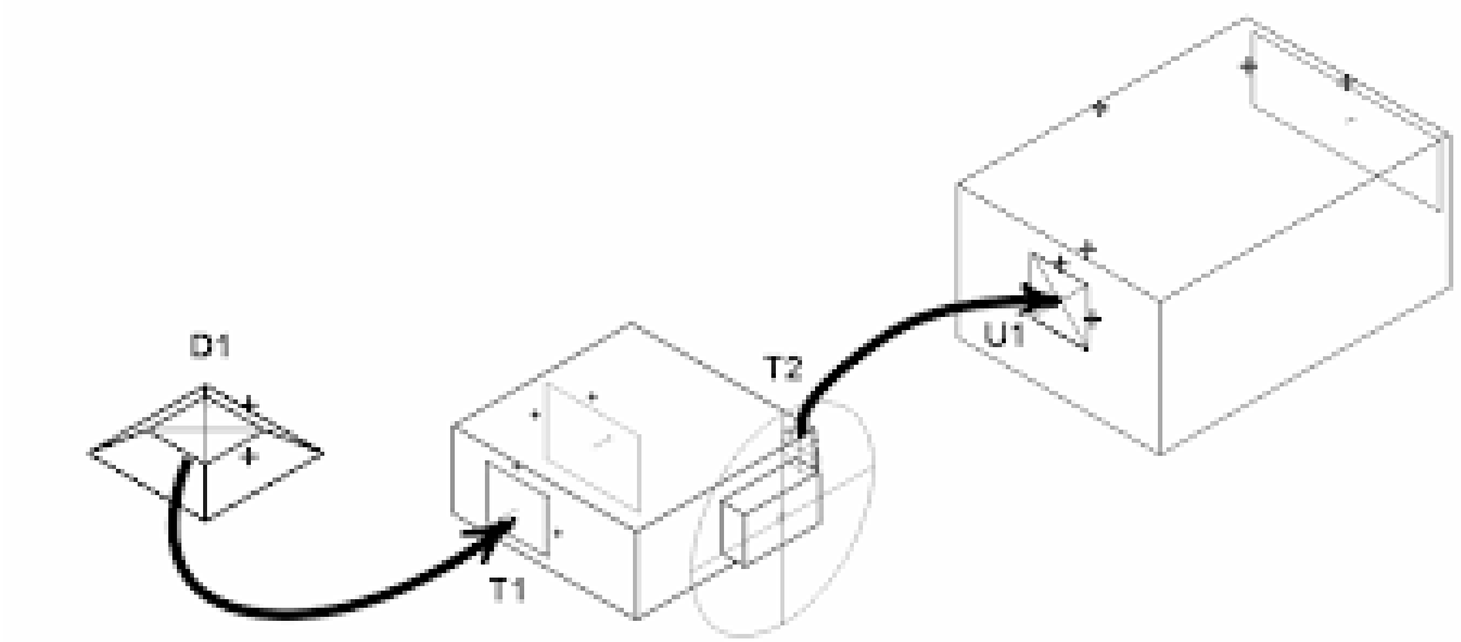


Revit Frameworks

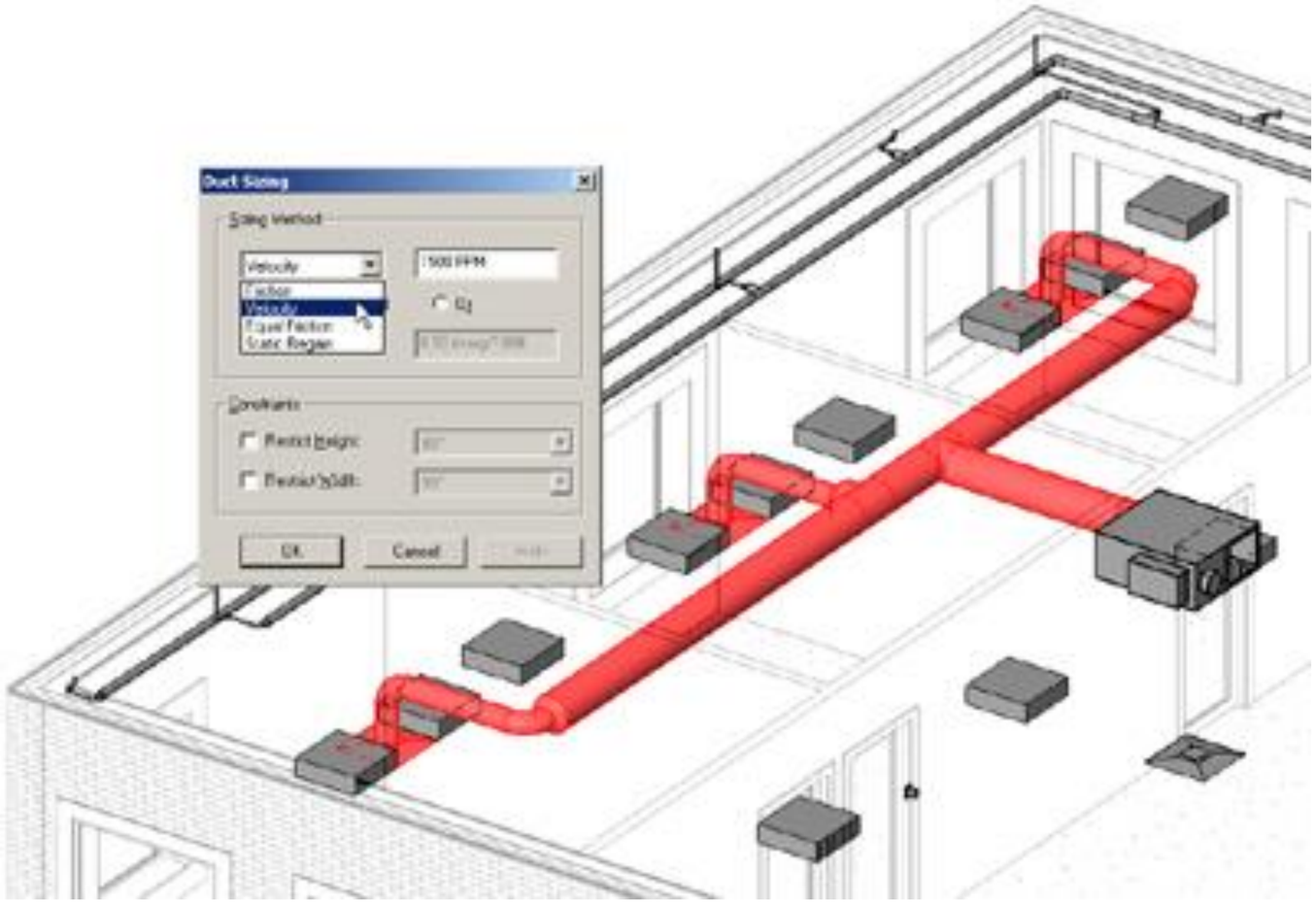
Shared Parameters

Revit Frameworks
Families

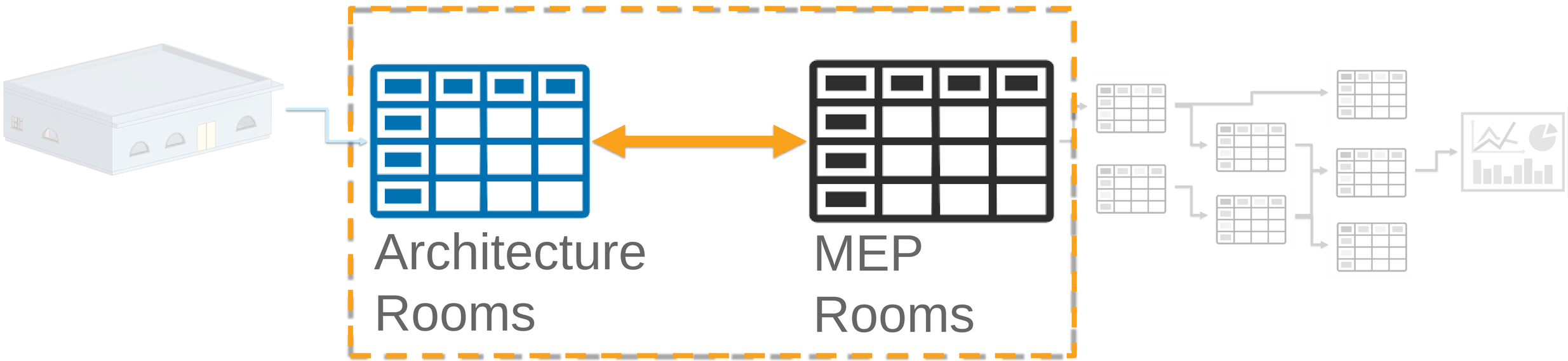
Revit Frameworks
MEP Families



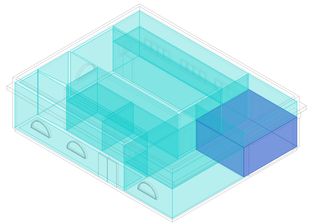
Revit Frameworks
MEP Systems

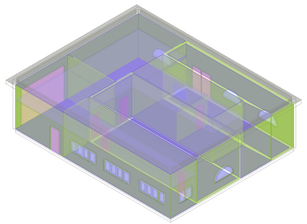


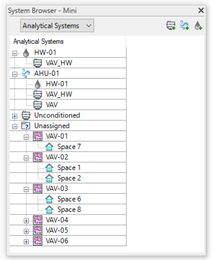
Revit Frameworks
Rooms

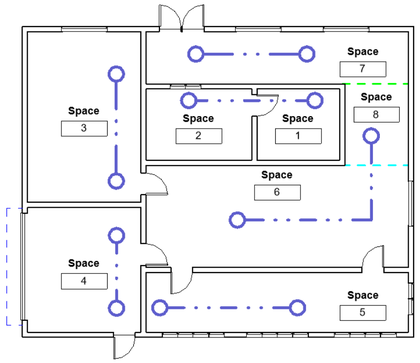


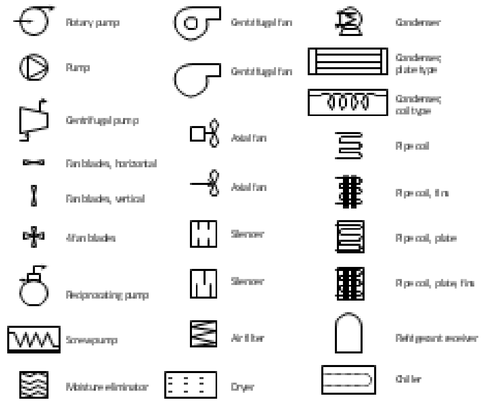
Integrated Workflow
Project Template

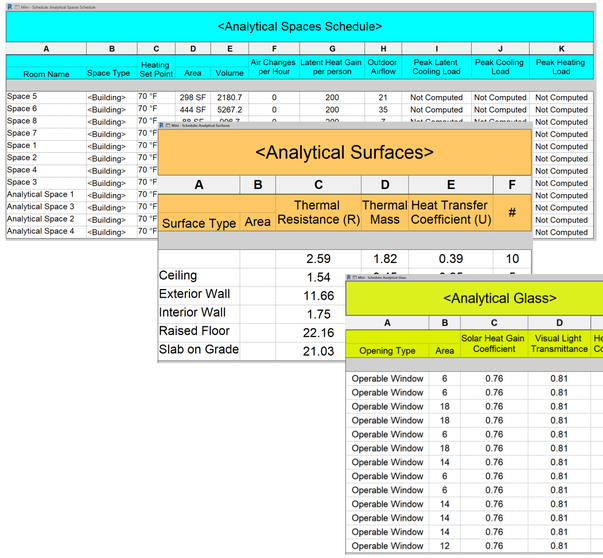












<Analytical Spaces Schedule>

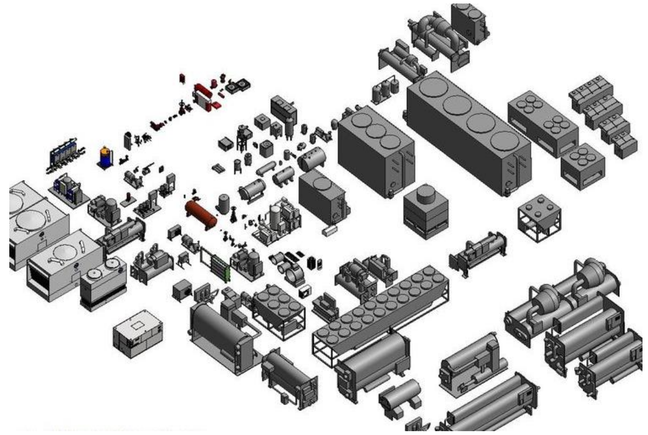
Room Name	Space Type	Heating Set Point	Area	Volume	Air Changes per Hour	Latent Heat Gain per person	Outdoor Airflow	Peak Latent Cooling Load	Peak Cooling Load	Peak Heating Load
Space 5	<Building>	70 °F	298 SF	2180.7	0	200	21	Not Computed	Not Computed	Not Computed
Space 6	<Building>	70 °F	444 SF	5267.2	0	200	35	Not Computed	Not Computed	Not Computed
Space 8	<Building>	70 °F	88 SF	996.7	0	200	7	Not Computed	Not Computed	Not Computed
Space 7	<Building>	70 °F								Not Computed
Space 1	<Building>	70 °F								Not Computed
Space 2	<Building>	70 °F								Not Computed
Space 4	<Building>	70 °F								Not Computed
Space 3	<Building>	70 °F								Not Computed
Analytical Space 1	<Building>	70 °F								Not Computed
Analytical Space 3	<Building>	70 °F								Not Computed
Analytical Space 2	<Building>	70 °F								Not Computed
Analytical Space 4	<Building>	70 °F								Not Computed

<Analytical Surfaces>

Surface Type	Area	Thermal Resistance (R)	Thermal Mass	Heat Transfer Coefficient (U)	#
		2.59	1.82	0.39	10
Ceiling		1.54			
Exterior Wall		11.66			
Interior Wall		1.75			
Raised Floor		22.16			
Slab on Grade		21.03			

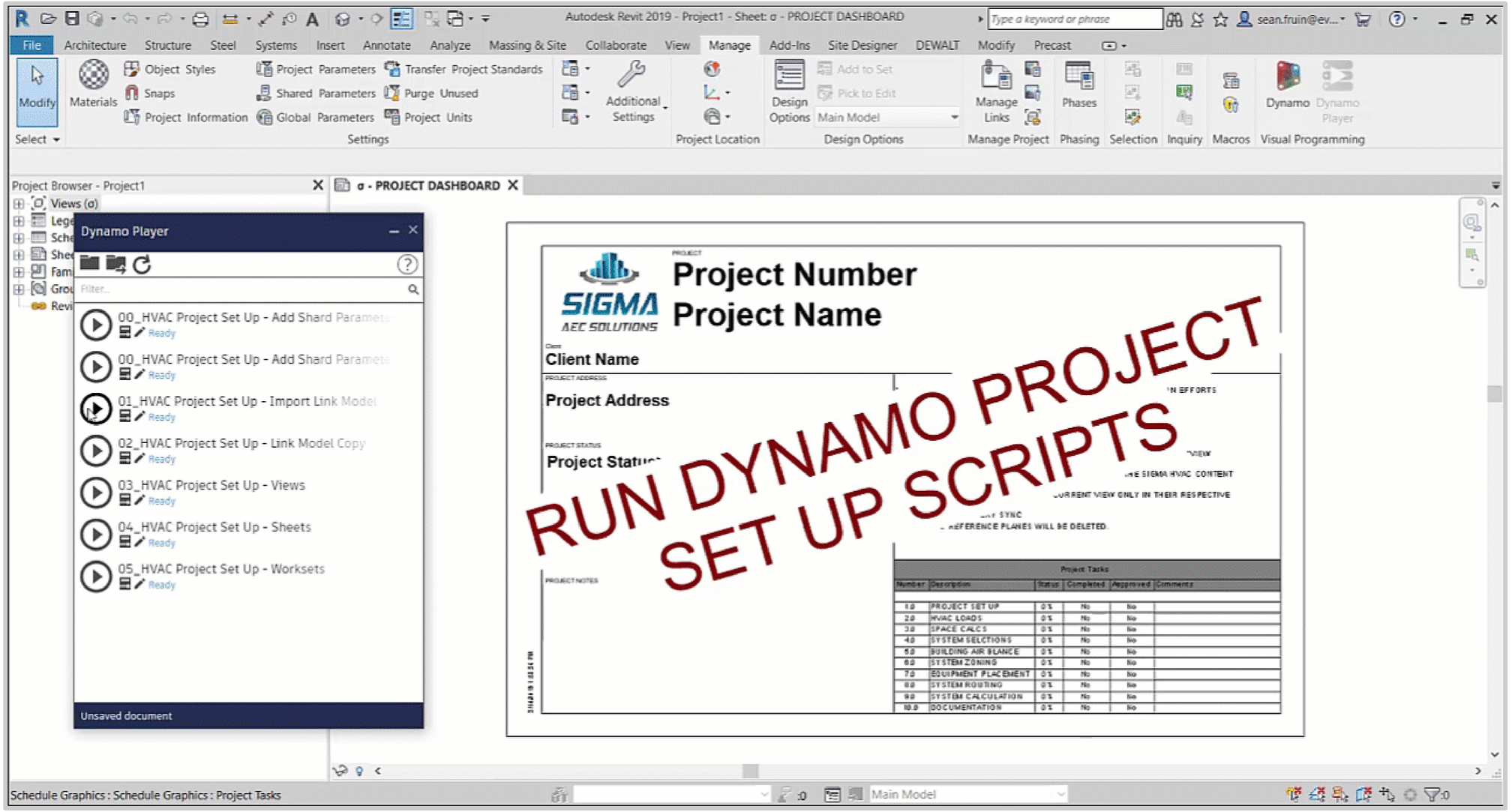
<Analytical Glass>

Opening Type	Area	Solar Heat Gain Coefficient	Visual Light Transmittance	Heat Transfer Coefficient (U)
Operable Window	6	0.76	0.81	0.503
Operable Window	6	0.76	0.81	0.503
Operable Window	18	0.76	0.81	0.503
Operable Window	18	0.76	0.81	0.503
Operable Window	6	0.76	0.81	0.503
Operable Window	18	0.76	0.81	0.503
Operable Window	14	0.76	0.81	0.503
Operable Window	6	0.76	0.81	0.503
Operable Window	6	0.76	0.81	0.503
Operable Window	14	0.76	0.81	0.503
Operable Window	14	0.76	0.81	0.503
Operable Window	14	0.76	0.81	0.503
Operable Window	12	0.76	0.81	0.503



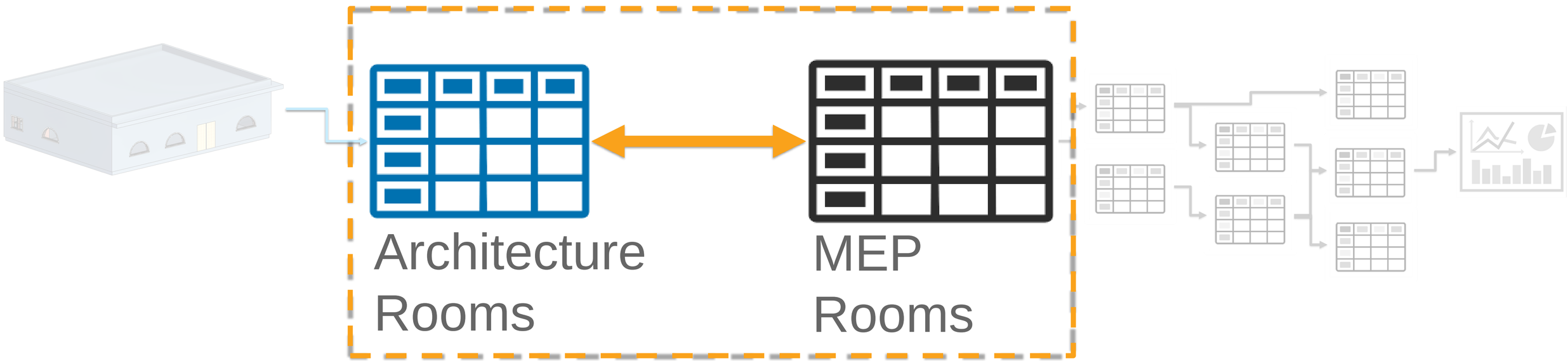
Integrated Workflow
Project Setup

1) **Import Link Model**
2) **Set Room Bounding**
3) **Aline Model**
4) **Set Survey Point**
5) **Set Origin Point**
6) **Set Project Base Point**
7) **Pin Link Model**
8) **Phase**
9) **Scope Boxes**
10) **Copy Levels**
11) **Copy Grids**
12) **Copy Match Line**
13) **Enter Project Info**
14) **Make Ceiling Plans**
15) **Name Ceiling Plans**
16) **Make Floor Plans Views**
17) **Name Floor Plans**
18) **Assign View Templates**
19) **Make Keynote Schedules**
20) **Name Keynote Schedules**
21) **Set Keynote Filter**
22) **Make Sheets**
23) **Name Sheets**
24) **Set Sheet Number**
25) **Set Sheet Id**
26) **Place Floor Plan Views**
27) **Place Sheet Legends**
28) **Place Keynote Schedules**
29) **Aline View on Sheet**
30) **Create Worksets**



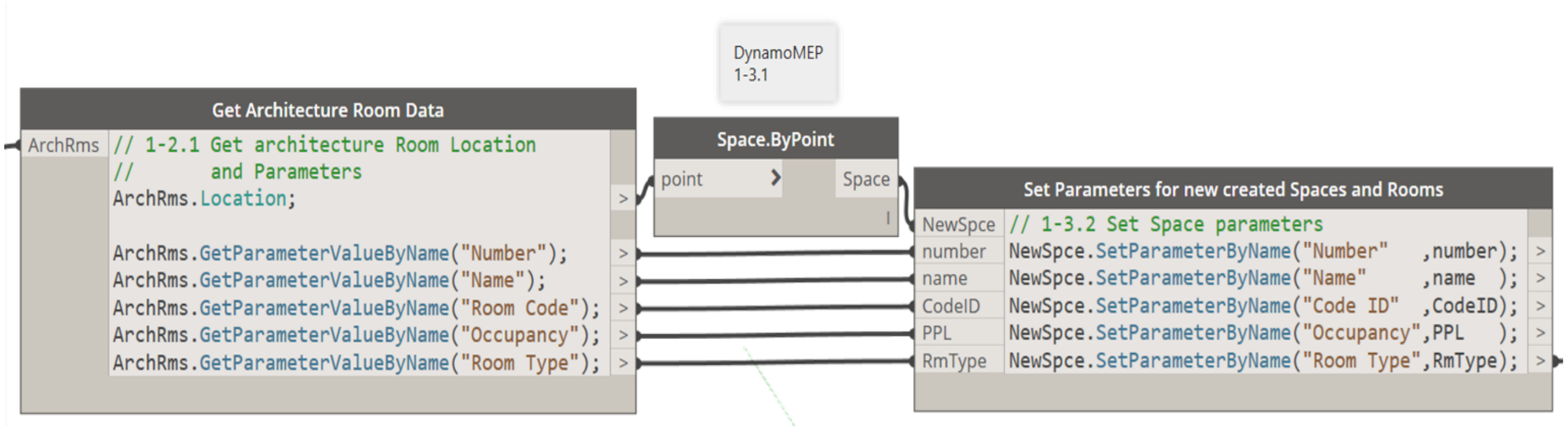
Integrated Workflow

Copy Linked Rooms



Integrated Workflow

Create Space At Room Location



Integrated Workflow

Add Spaces To Remaining Openings

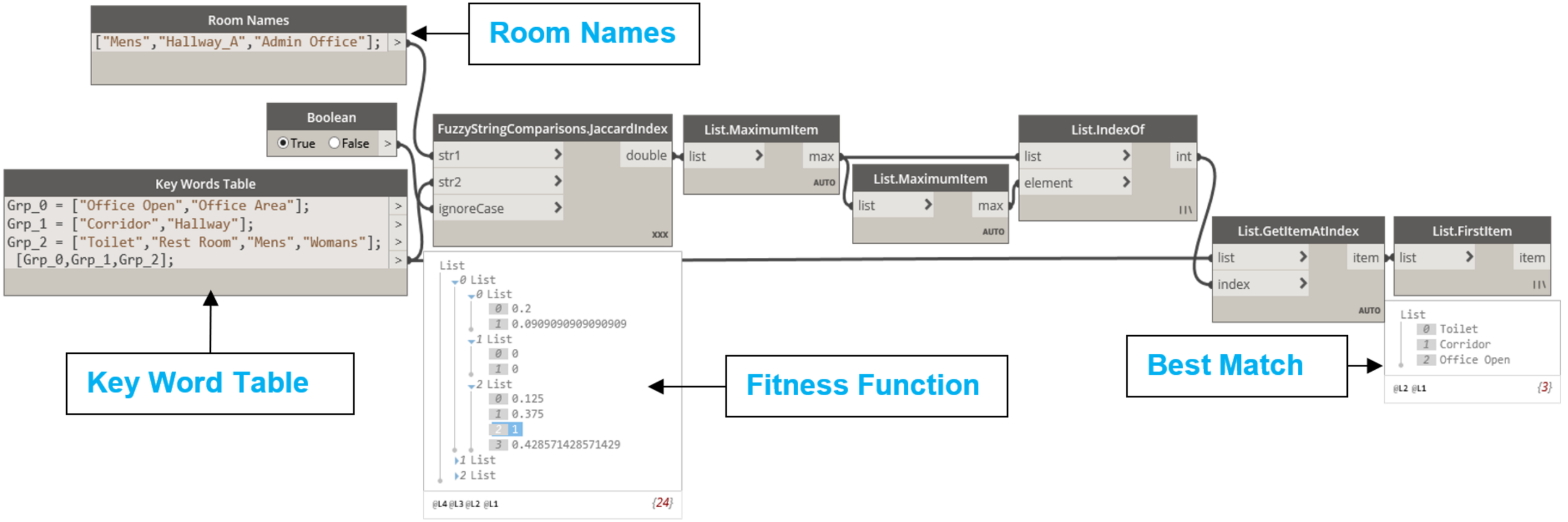
Integrated Workflow

Subdivide Large Rooms

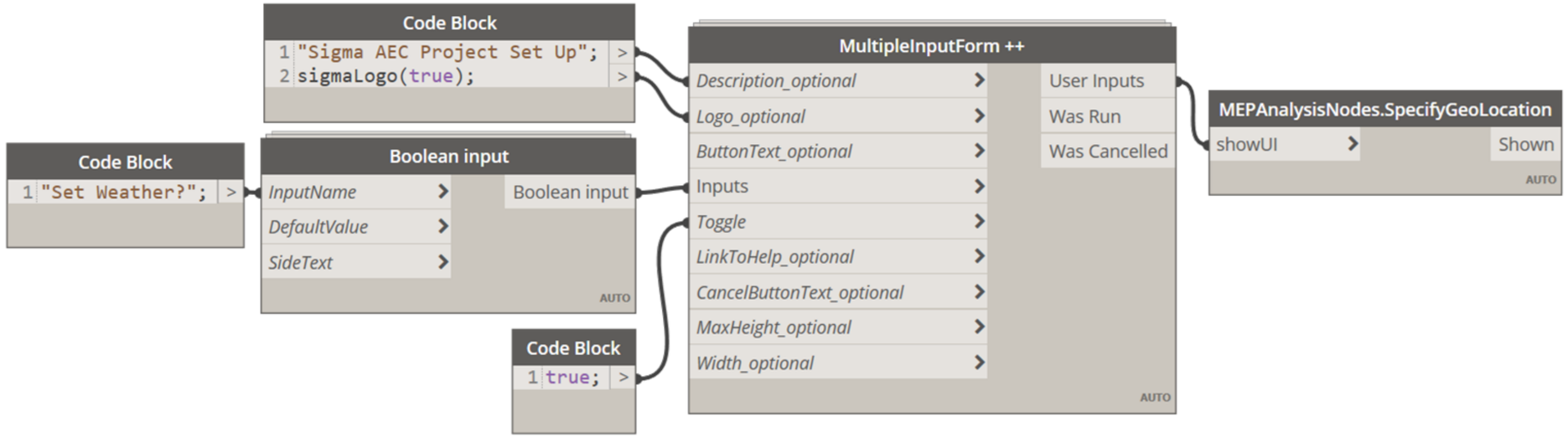
Integrated Workflow

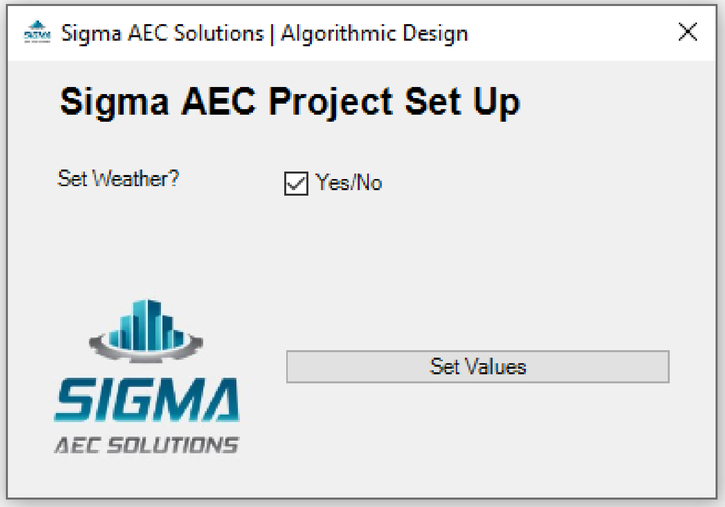
Add Space Type

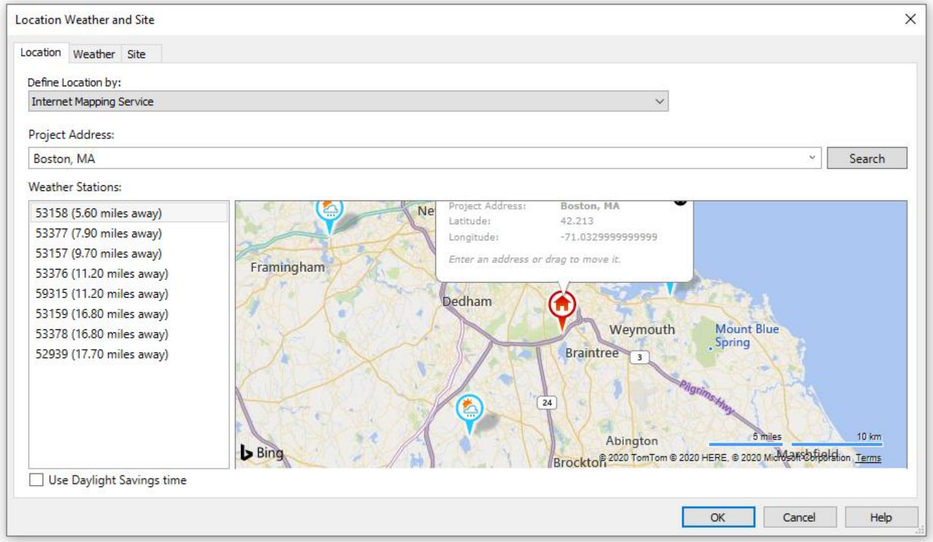
Integrated Workflow
Add Space Type



Integrated Workflow
Energy Model Setup - Weather







Integrated Workflow

Energy Model Setup – Thermal Properties

Integrated Workflow

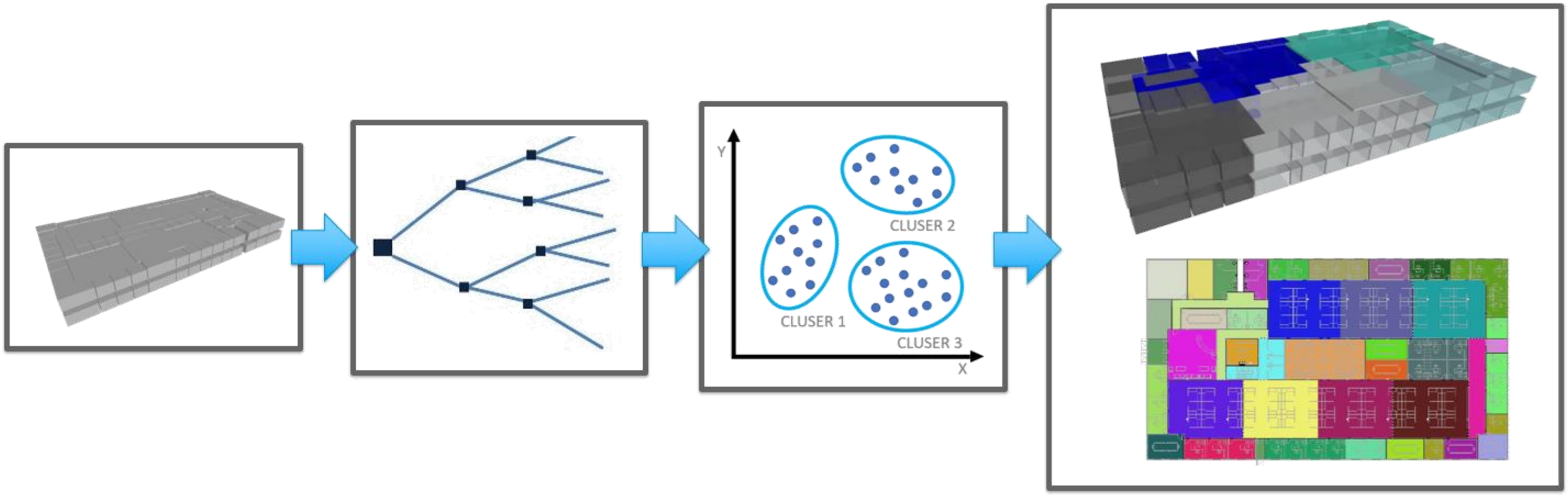
Energy Model Review – Dynamo

Integrated Workflow

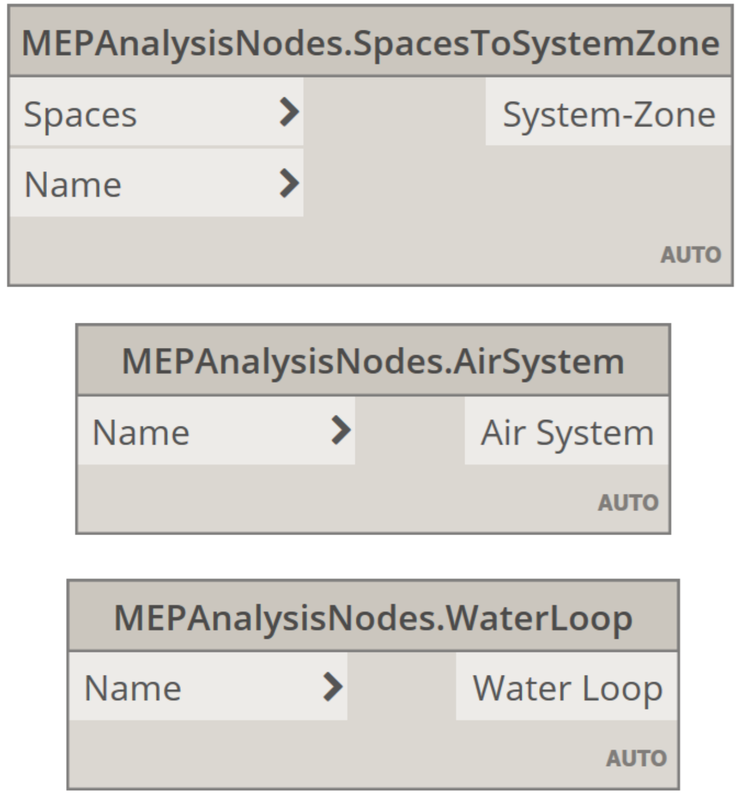
Systems Analysis – Analytical Space Loads

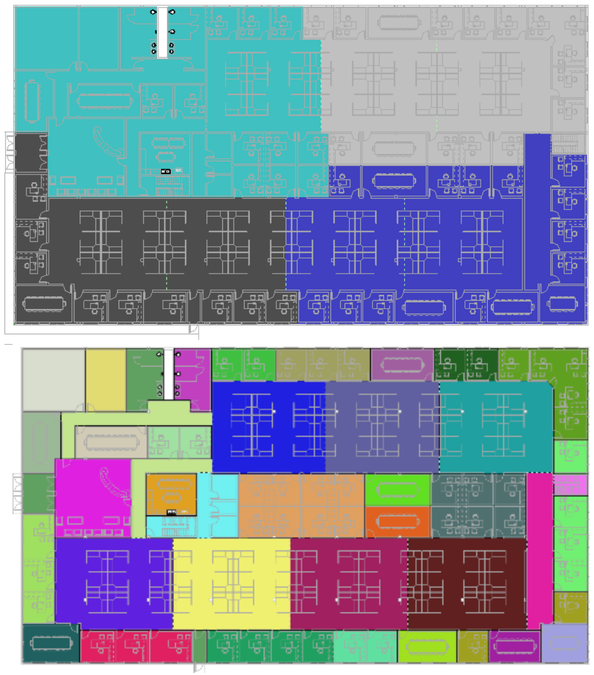
Integrated Workflow
Systems Configurator

Integrated Workflow
Systems Configurator -



Integrated Workflow
Analytical System Set Up





Main Title – 1 column with bullets

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- **First-level bullet: closed circle. Text style: gray, 1.4 spaced, Arial 30pt font.**
  - Second-level bullet: open 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

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1 column with image

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Title 2

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Text with image background

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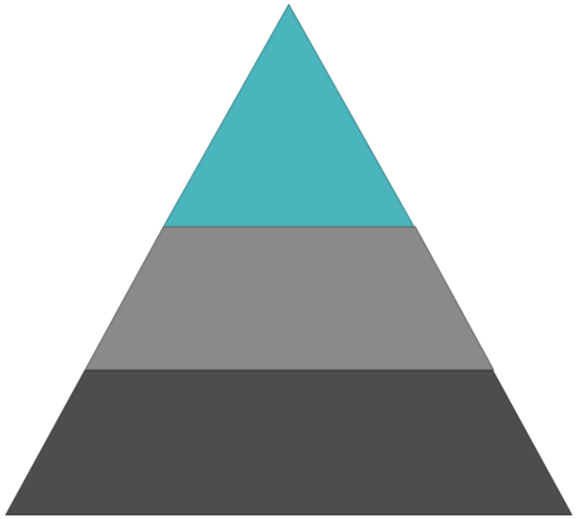
Photo credit goes here

What is BIM?
Opportunities

“If it was easy it would just be the way!”

+

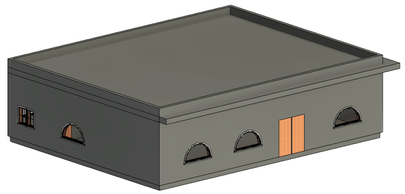


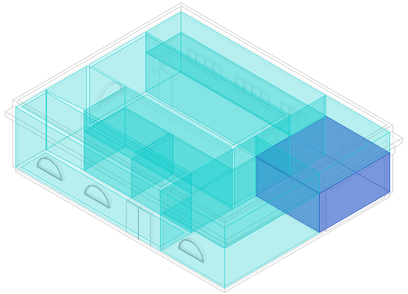
Cool Stuff

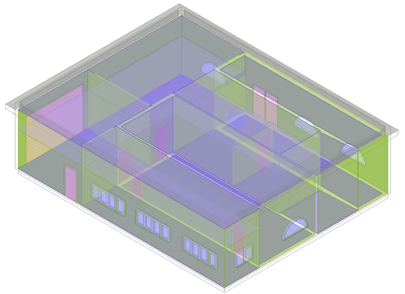
Standard Process

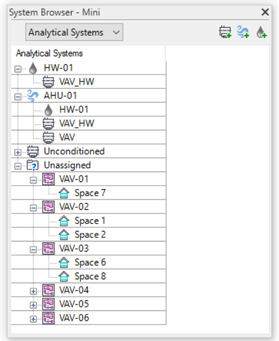
Revit Template

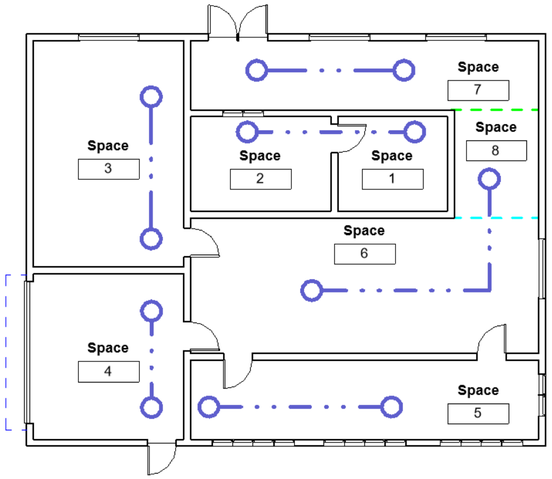
Revit Systems Analysis
True BIM











ENVELOPE

Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [ft2]	2172.47	631.31	494.41	546.70	500.05
Above Ground Wall Area [ft2]	2172.47	631.31	494.41	546.70	500.05
Window Opening Area [ft2]	117.17	26.42	20.18	70.57	0.00
Gross Window-Wall Ratio [%]	5.39	4.18	4.08	12.91	0.00
Above Ground Window-Wall Ratio [%]	5.39	4.18	4.08	12.91	0.00

Conditioned Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [ft2]	1678.64	564.46	457.75	328.90	327.53
Above Ground Wall Area [ft2]	1678.64	564.46	457.75	328.90	327.53
Window Opening Area [ft2]	117.17	26.42	20.18	70.57	0.00
Gross Window-Wall Ratio [%]	6.98	4.68	4.41	21.46	0.00
Above Ground Window-Wall Ratio [%]	6.98	4.68	4.41	21.46	0.00