



Autodesk University 2014

Utilizing BIM for Data Center Design

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Description:

Many of the major design and construction firms already rely on BIM for their data center designs to take advantage of 3D clash detection and the production of coordinated construction documents. However most do not realize that those functionalities are only the tip of the iceberg when it comes to the usefulness of BIM models. This class will give an overview of how to utilize BIM to expedite and enhance the following workflows:

- Generating automated Bills of Materials (BoM's) using Excel spreadsheets
- Energy analysis, LEED compliance modeling, and load calculations using eQuest or Trace700
- Computation Fluid Dynamic (CFD) modeling with both Autodesk's Simulation CFD and Future Facilities 6Sigma Room for troubleshooting and optimizing airflows
- Discuss current and future optimization opportunities

The handout associated with this class will provide all of the detailed information necessary for implementing the above workflows.

Learning Objectives

1. Link your BIM models to spreadsheets to semi-automate the transfer of data from your BIM model to the various analysis tools.
2. Generate building geometry appropriate for CFD and energy models.
3. Export building geometry through gbxml, acis, and .stl formats.
4. Identify shared parameters required for each of the workflows.

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About the Speakers

Nicole Shumaker is an erstwhile atmospheric scientist whose research experience in experimental and modeling groups introduced her to numerical analysis of complex systems and the importance of high-quality, real-world data to calibrate the models. She entered the design software industry at a time when parametric modeling was virtually non-existent in the building industry and integrated design was often antithetical to the conventions of practice. With a zeal for the latent potential of simulation-led sustainable design, in 2003 she committed to help champion the transition to Building Information Modeling (BIM). As Director of BIM Market Development at Applied Software, she helped educate, support and connect AEC firms and asset managers who pioneered BIM and Integrated Project Delivery (IPD). She then served as North American Channel Manager for Integrated Environmental Solutions (IES), in 2008 and 2009. She detoured to launch a successful start-up specializing in digital ground temperature monitoring systems for the Arctic and Antarctic from 2006-2012. In 2013, Nicole joined the Sustainability Solutions team at Autodesk as Marketing Program Manager and continues to collaborate, educate and, occasionally, instigate to advance the democratization of sustainable design.

Nicole graduated from the Georgia Institute of Technology with a BS in Earth and Atmospheric Sciences. In her spare time she loves to race a lovely, old wooden sailboat named Youngster and is, slowly, learning to play guitar.

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Aryn Bergman is a mechanical engineer providing BIM and energy analysis consulting services as an independent contractor. He focuses on designing high-performance buildings, specifically data centers utilizing Building Information Modeling (BIM), computational fluid dynamics (CFD), and energy modeling. He graduated from North Carolina State University with a BS in mechanical engineering and has been in the building industry for nearly 10 years. Prior to going independent, he worked at a variety of companies, including URS/AECOM, Facebook, Inc.; Autodesk, Inc.; and Glumac.

While not working, Aryn likes to volunteer in rebuilding efforts in developing areas such as Haiti and South Sudan. He's also passionate about mountain biking, snowboarding, and Krav Maga, and he is in the process of learning how to sail.

His areas of expertise include data centers, BIM, energy modeling, CFD, HVAC (heating, ventilating, and air conditioning) design, and retro commissioning.

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Abbreviations:

BIM = Building Information Modeling
CFD = Computational Fluid Dynamics
DCIM = Data Center Infrastructure Management
BEMS = Building Energy Management System
BoM = Bills of Material
PLM = Product Lifecycle Management
autoBoM = Automated Bill of Material
IL1 = Imagination Land 1
ITI = Information Technology Infrastructure

Required Software, Services, and Plugins

Revit 2014 or 2015
Sim CFD 2015 or 2016
Green Building Studio Service
6Sigma Room
Rushforth Projects Parameter Transformer Revit Plugin
Sumex Design Shared Parameters Manager (SPM) Revit Plugin
STL Exporter for Revit
Microsoft Excel
Trane Trace700
eQuest 3.64

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File Checklist

BIM Standard Shared Parameters V2.6.txt

File used for creating the shared parameters within the model and families.

IL1 ITI Project Library.rvt

Project library of the Revit families and system families of the cable tray and cabling infrastructure.

IL1 Arch Analytical.rvt

Simplified architectural geometry used for energy and CFD analysis.

IL11-A Server Rack Layout.rvt

Example cluster server rack layout.

IL1-A ITI Cable Tray.rvt

Example model of the cable tray, rack posts, and other IT infrastructure equipment.

IL1-A ITI Cable Calcs.rvt

Example BIM model using conduits to calculate cable path lengths in 3D.

IL1-A ITI BIM BoM v1.0.xlsx

Example BoM spreadsheet for the cable tray and associated IT equipment from the Revit model.

IL1-A ITI BIM Cable BoM v1.0.xlsx

Example spreadsheet that calculates the cable lengths and the BoM of the cable trunks from the associated Revit model.

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Introduction

The Building Industry Data Flow Diagram below represents the relationship of the flow of data between key disciplines and services (the smaller circles) associated with the life cycle of a data center; each with massive opportunities for optimization. The three interlocked circles represent the major design phases that rely on models and data generated by tools in each of the numbered surrounding smaller circles.

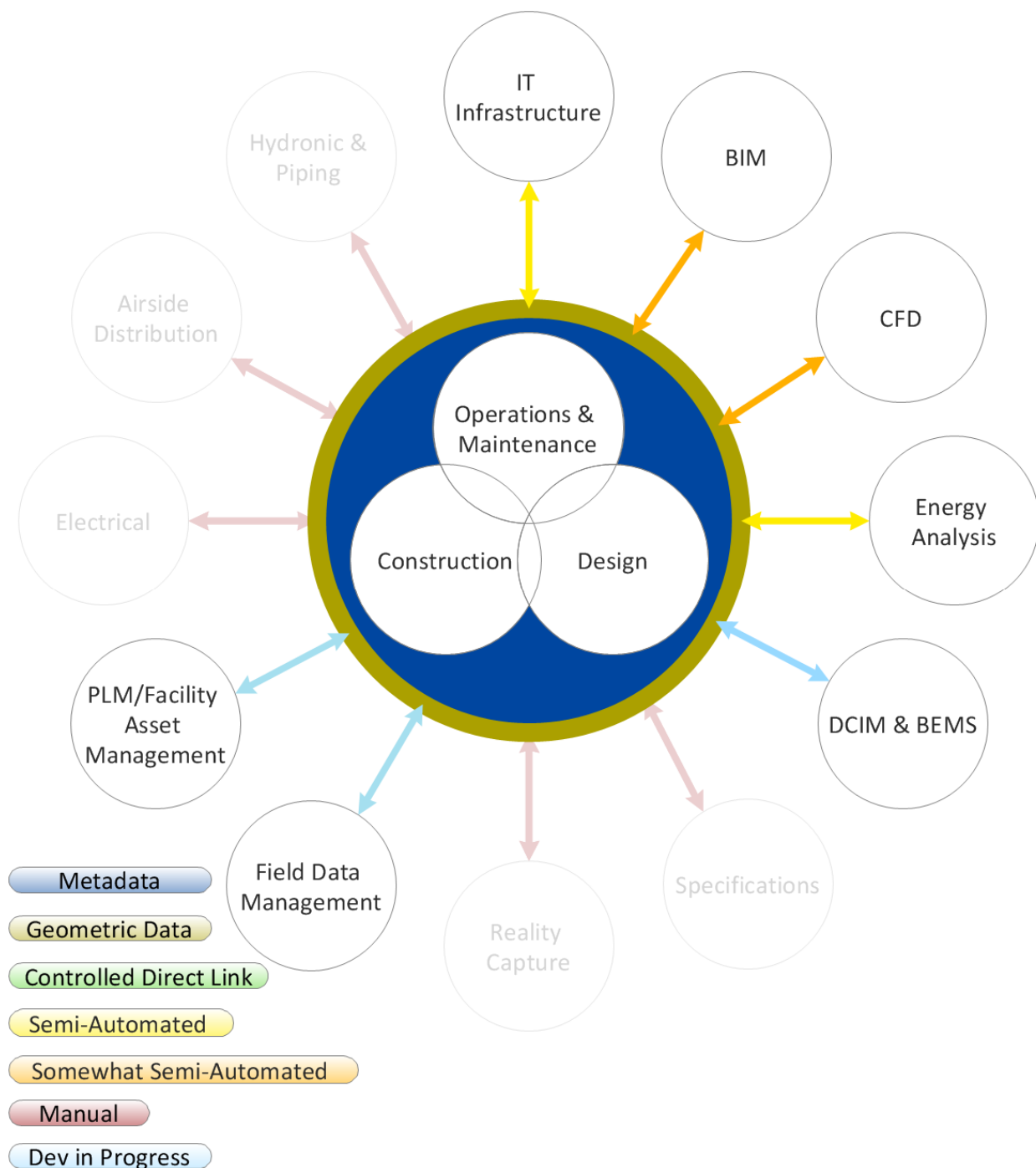


Figure 1: Building Industry Data Flow Diagram

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The data can be broken down into 2 main categories:

Metadata - The blue circle represents metadata managed in databases and spreadsheets such as part numbers, logical positioning, and PLM data.

Geometric Data - The gold represents the 3D geometric data associated with the physical geometry of the data center, equipment, and distribution systems. This data is managed and transferred in a variety of file formats such as gbxml, CAD, ACIS, etc.

The color of the arrows represents the following states for the flow of data:

Controlled Direct Link – Data flows automatically in real time or on demand with minimal user interaction and effort. Trended data is instantly accessible. Additionally, the visualizations, dashboards, and other interactions with the data are fully customizable to the point of satisfying even the most ninja of building industry professionals. None t

Semi-Automated – Data flows between tools through import/export features and plugins. Interaction is initiated by the user each time the transfer of data is required.

Somewhat Semi-Automated - Data flows between tools through import/export features and plugins, but require multiple, complicated steps of interaction per data transfer. And/or the data that is transferred is incomplete and requires some manual entry.

Manual – Data needs to be transferred, created, and modified manually the user.

The areas in bold will be discussed in the class and in this handout. The first section covers a workflow for transferring facility asset management data associated with the IT infrastructure from a Revit model to spreadsheets for generating autoBoM's.

The second section will detail how to build your geometry in Revit so that it can be imported into eQuest or Trace700 for energy analysis, load calculations, and LEED compliance models along with the importing and exporting process.

The third section will detail how to build your analytical geometry in Revit for CFD modeling in 6Sigma Room and into Sim CFD. The importing and exporting process will be discussed.

Lastly, projects that are currently in progress or starting soon along with potential future projects will be discussed.

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BIM for PLM/Facility Asset Management Data and AutoBoM's

This section will outline the key steps in creating Revit models for generating facility asset management data, how to extract that data, and how to generate automated BoM's.

Server Rack Layout

While Server Rack layout models are sometimes used for generating AutoBoM's they are generally used to expedite generating the database and DCIM (Data Center Infrastructure Management) tools required for the optimal operations of a data center. It is important to pay attention to the following parameters and attributes.

1. Layout out the server racks and **do not use the mirror families** as it inverses the orientations value exported to Excel.
2. Apply the following logical positioning data:
 - a. RackPosition: the position of the rack within the row
 - b. RowLocation: The row that the rack resides in
 - c. DataCenterSide: Which side of the data center where the rack is located.
 - d. SuiteLocation: The data hall the where rack is located.
 - e. DataCenterLocation: The data center the where the server rack is located.This is only important for clients and projects with multiple data center locations.

There are view filters to assist in identifying the correct RackPositions and RowLocations.

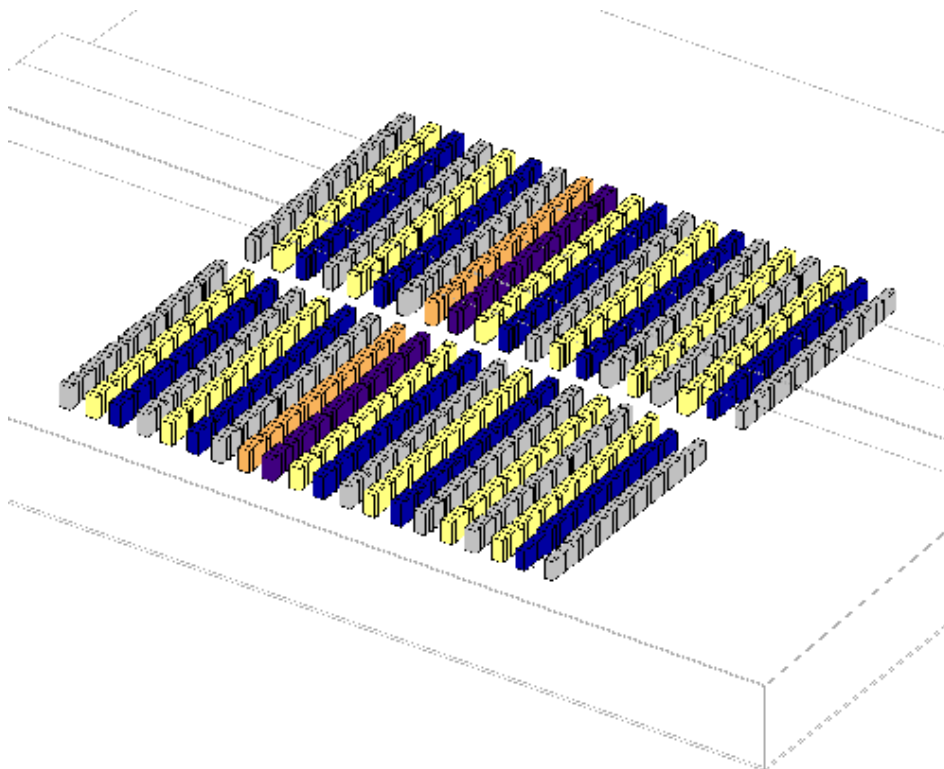


Figure 2: 3D Revit view with the row location view filter

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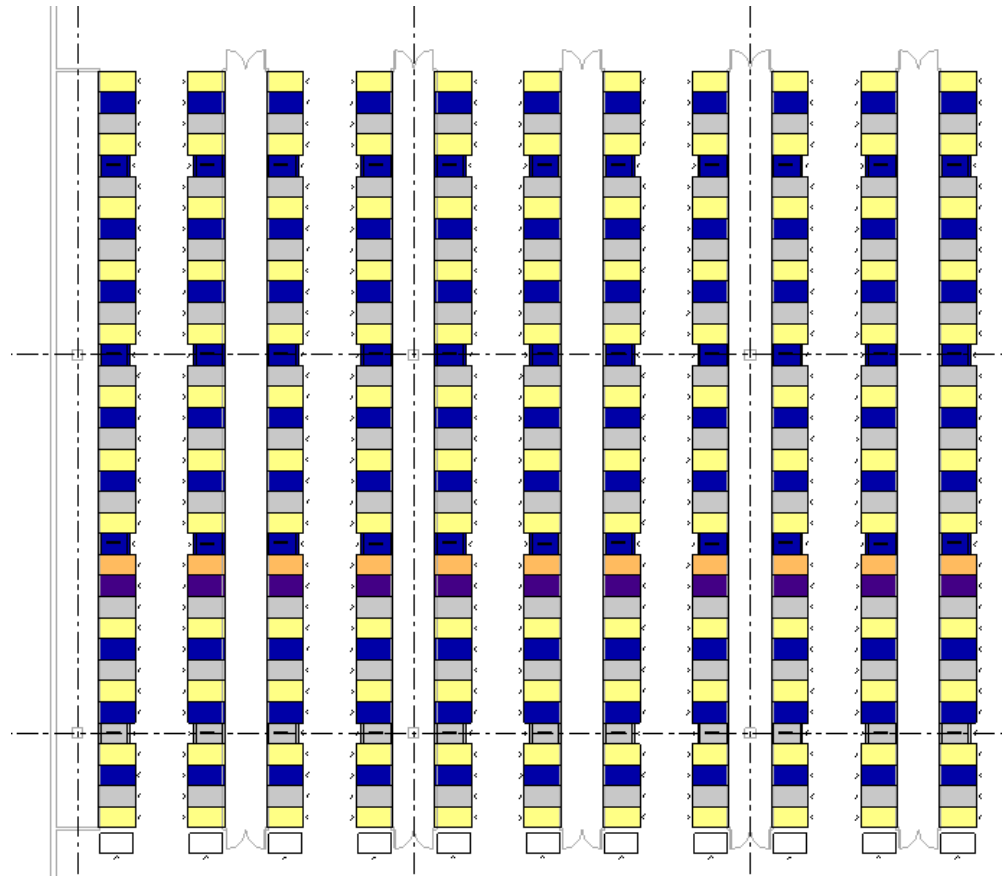


Figure 3: Floorplan Revit view with the rack position view filter.

3. Select the Revit families then click on the Parameter Transformer Tool. Select Existing File and navigate to the *IL1-A Server Rack Layout v1.0.xlsx*
4. Although not necessary in this workflow, you can make changes in the Excel spreadsheet and then import them back in the Revit model using the Parameter Transformer Tool. In doing so you can swap out family types in the model but not entire families.
5. Do not make changes or add calculations to the spreadsheet tab used by the Parameter Transformer Tool as break the importing and exporting process. Instead, link to the data from other tabs and/or copy and paste the data elsewhere.
6. Often, clients may require you to generate a .csv or as a text file before importing it into their DCIM system.

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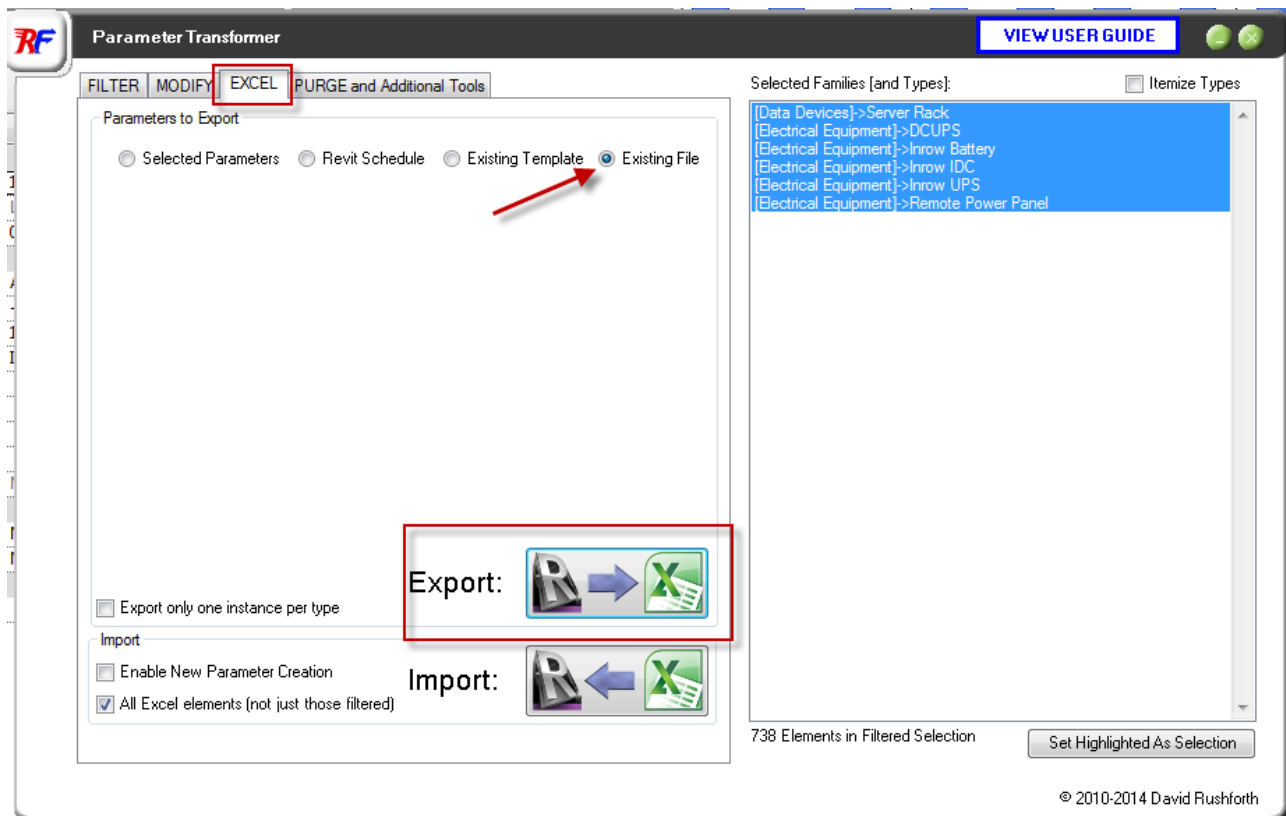


Figure 4: Screenshot of the Excel tab of the Parameter Transformer plugin.

ITI Cable Tray and Equipment

This section will outline how to create Revit models of the cable tray and associated support equipment and export the data to Excel for generating BoM's. This model will include the following equipment

- Patch Panel Racks
 - Vertical Wire Managers
 - Pathways and Fittings
 - Basket Tray
 - Ladder Tray
1. Review/add/modify the IL1 ITI Project Library.rvt along with the Lookup table on the 4th tab in the IL1-A ITI BIM BoM v1.0.xlsx spreadsheet.
 - a. The important shared parameters are:
 - i. Rack posts and vertical wire managers:
 1. PartNumber (type)
 2. Model
 - ii. Manufacturer
 - iii. UnitHeight, UnitWidth, and UnitDepth (type)

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- iv. Color (type)
- b. Cable tray runs and fittings
 - i. EquipmentType (type parameter in fittings, instance for runs)
 - ii. Manufacturer
 - iii. Model
 - iv. Height and Width (instance)
 - v. Color (type parameter in fittings, instance for runs)
 - vi. CableLength (fittings only)

Note: Cable Tray with Fittings must be used. For cable tray systems that do not require fittings for elbows, crosses, tee's, etc., label associated Revit cable tray fitting family with the EquipmentType = Node The fittings will not be accounted for in the BoM (since they don't exist), but the cable lengths will.

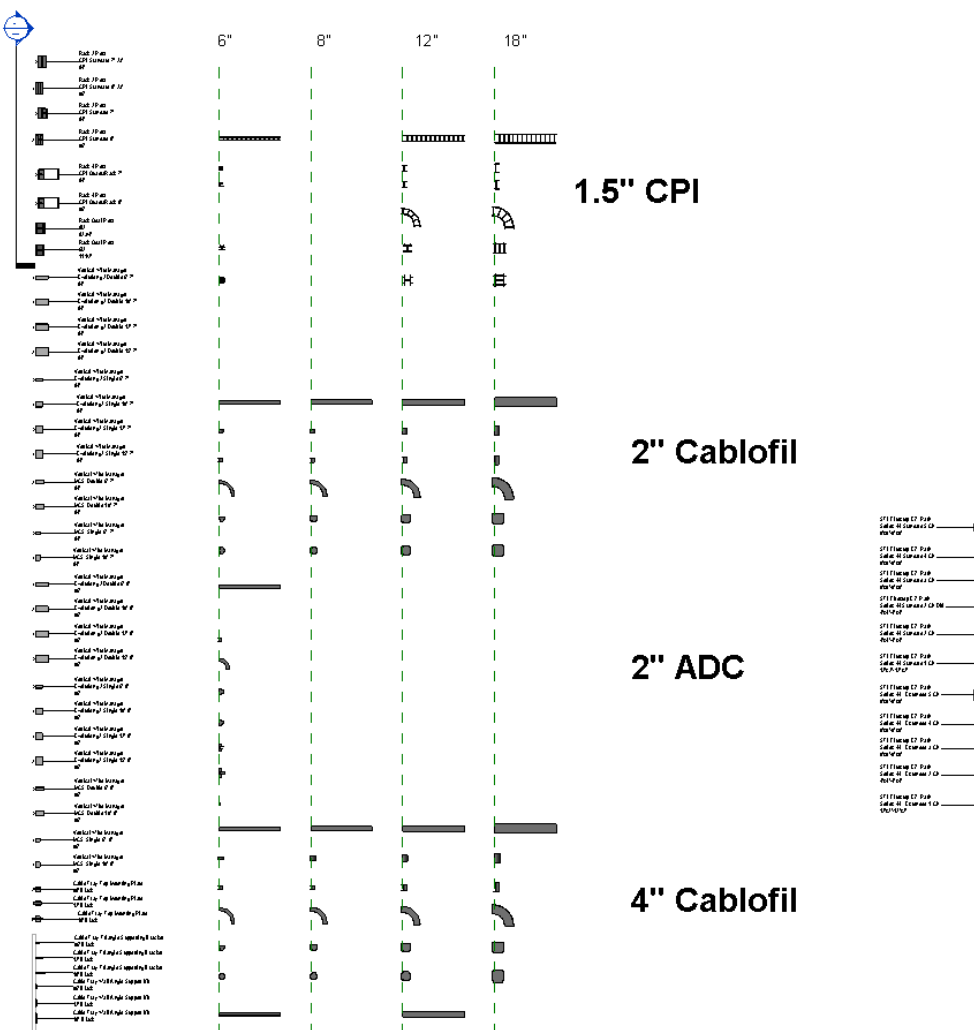


Figure 5: Screen of the IL1 project library.

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2. Layout the patch panel rack posts, vertical wire managers, etc.
3. Input the following project specific shared parameters (instances)
 - a. DatacenterLocation
 - b. SuiteLocation
 - c. DatacenterSide
4. Model the cable tray. Use only the cable tray from the project library. **View filters are recommended for isolating and identifying separate cable tray systems.** Pay attention to the following parameters:
 - a. DatacenterLocation
 - b. SuiteLocation
 - c. DatacenterSide
 - d. EquipmentType: Cable tray runs must be labeled “Run” prior to exporting to Excel.
 - e. Height and Width
 - f. Color

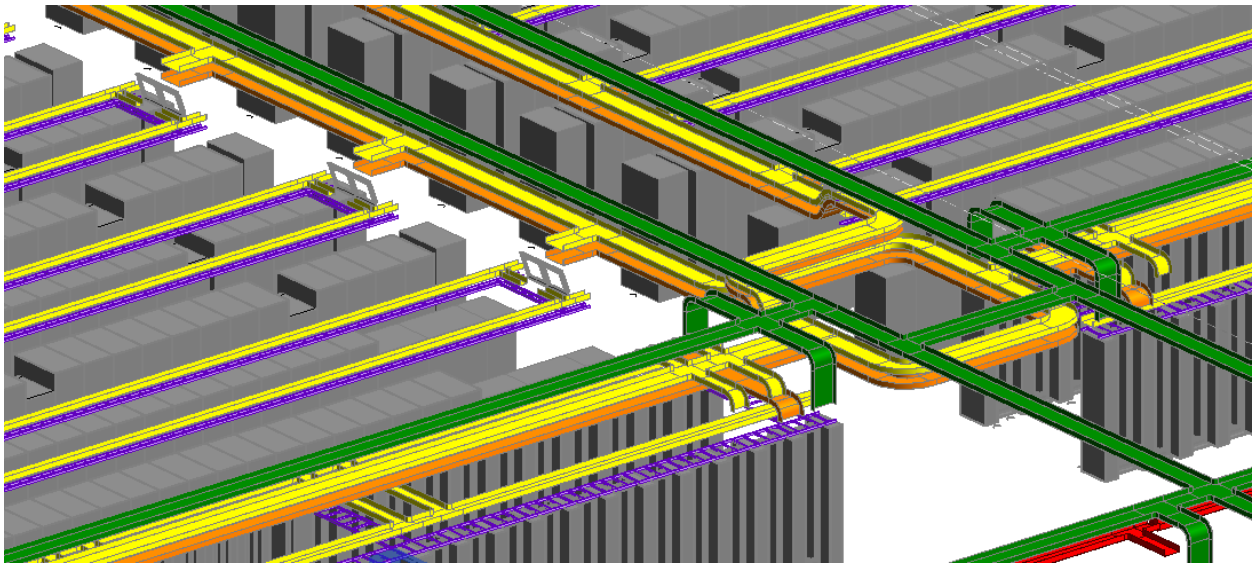


Figure 6: Screenshot of a portion of the Revit model of the cable tray and supporting equipment.

5. Export through the Parameter Transformer tool to the IL1-A ITI BIM BoM v1.0.xlsx spreadsheet.
 - a. Verify the equipment has the correct part numbers in the “To BIM” tab.
 - b. Verify the equipment is summing correctly in the BoM tabs.
6. Copy and paste (values only) the To BIM tab to the CIBT to BIM spreadsheet. Import the data back into the Revit model.

The quantities and BoM's are automatically calculated:

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	Manufac	Equipment Type	Height (in.)	Width (in.)	Unit Length	Color	PartNumber	Supplier	Total Length (ft.)	Total Quantity
22	CPI	Top Mounting Plate	1.5	18		Black	12730-718			0
23	Cablofil	Run	4	4	10	Black	CF105/100EZBLK		0	0
24	Cablofil	Run	4	4	10	Blue	CF105/100EZBLUE		0	0
25	Cablofil	Run	4	6	10	Black	CF105/150EZBLK		3,000	300
26	Cablofil	Run	4	6	10	Blue	CF105/150EZBLUE		456	46
27	Cablofil	Run	4	8	10	Black	CF105/200EZBLK		0	0
28	Cablofil	Run	4	8	10	Blue	CF105/200EZBLUE		0	0
29	Cablofil	Run	4	12	10	Black	CF105/300EZBLK		1,446	145
30	Cablofil	Run	4	12	10	Blue	CF105/300EZBLUE		607	61
31	Cablofil	Run	4	18	10	Black	CF105/450EZBLK		3,726	373

Figure 7: Sample of the quantities of Cablofil tray in the ITI-A example

Cable Length Calculation model and BoM

1. Determine the number of potential different cable path routes. In the IL1-A example there are 12 main paths and 2 different sub paths. Modify the *Cable Path Length Calcs* tab in the *IL1-A ITI BIM Cable BoM v1.0.xlsx* file to calculate the lengths of each of the different cable paths.
2. Trace the various main trunk paths running from the bottom of a rack post to the first row cable tray intersection using the cable path (non-fitting) conduit. Label the conduit and fittings with the PathwayM1, M2, M3, S1, etc.
3. Creating color filters for identifying the different cable paths is recommended.

Main Path	Length	Sub Path	Length
M1	41.2095097	S1	11.91731807
M2	38.0156076	S2	11.36010306
M3	40.1197743		0
M4	62.7863154		
M5	61.7840972		
M6	61.5613476		
M7	64.3722405		
M8	63.2825583		
M9	63.076316		
M10	38.4110777		
M11	38.9718691		
M12	40.8111488		
	0		

Figure 8 Cable Path Length Calcs tab.

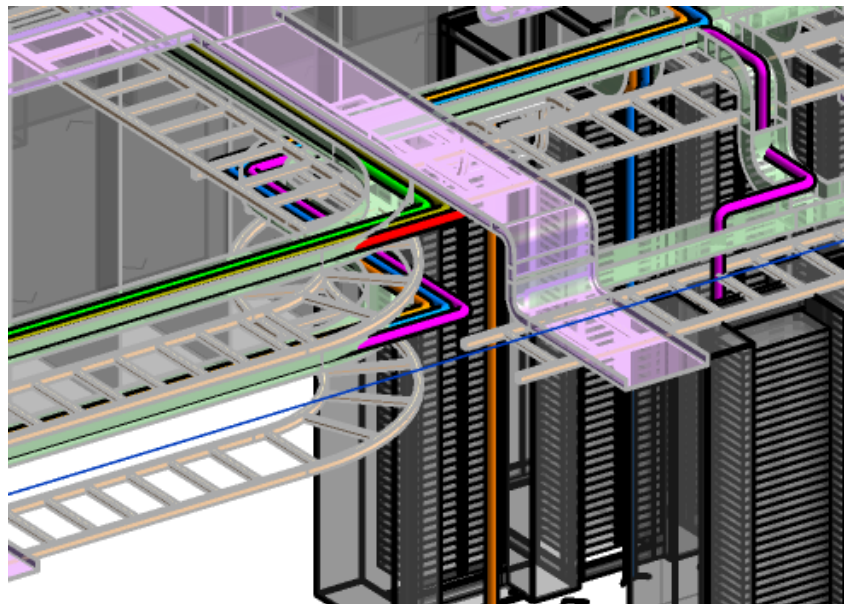


Figure 9: Example starting point for using conduit to draw the cable trunk paths.

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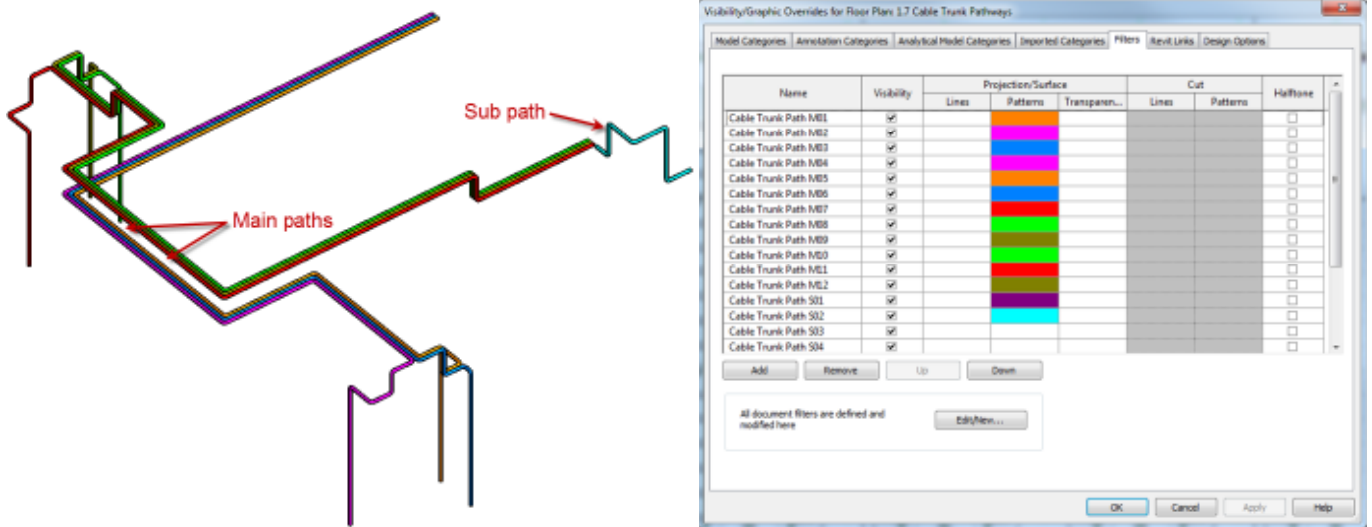


Figure 10 Cable paths represent with color coded conduit cable with no background.

4. Select the conduit and export the data to the *IL1-A ITI BIM Cable BoM v1.0.xlsx* spreadsheet.
5. On the autoBoM tab
 - a. Apply the starting row, the distance b/t rows values.
 - b. Associate the post connections with the main and sub path ways.

The fibre bundles per length, M-boxes, and, and M-Plates are calculated.

B	C	D	E	F	G	H	I	J	K	L	M	N
Starting Row						3	Distance b/t Rows (ft)				16.00	416.0
Trunk Label						Main Path Label	Sub Path Label	Path Length (ft)	Sub Path Length (ft)	Total distance (ft)	Length (ft)	M-Boxes
b	3	&	4	outside (POST 1)	b3&4 - outside (POST 1)	M1	S1	41.2	11.9	53.1	60.0	4.0
b	3	&	4	outside (POST 2)	b3&4 - outside (POST 2)	M1	S1	41.2	11.9	53.1	60.0	4.0
b	5	&	6	outside (POST 1)	b5&6 - outside (POST 1)	M1	S1	57.2	11.9	69.1	70.0	4.0
b	5	&	6	outside (POST 2)	b5&6 - outside (POST 2)	M1	S1	57.2	11.9	69.1	70.0	4.0
b	7	&	8	outside (POST 1)	b7&8 - outside (POST 1)	M1	S1	73.2	11.9	85.1	90.0	4.0
b	7	&	8	outside (POST 2)	b7&8 - outside (POST 2)	M1	S1	73.2	11.9	85.1	90.0	4.0
b	9	&	10	outside (POST 1)	b9&10 - outside (POST 1)	M1	S1	89.2	11.9	101.1	110.0	4.0
b	9	&	10	outside (POST 2)	b9&10 - outside (POST 2)	M1	S1	89.2	11.9	101.1	110.0	4.0
b	11	&	12	outside (POST 1)	b11&12 - outside (POST 1)	M1	S1	105.2	11.9	117.1	120.0	4.0
b	11	&	12	outside (POST 2)	b11&12 - outside (POST 2)	M1	S1	105.2	11.9	117.1	120.0	4.0
b	13	&	14	outside (POST 1)	b13&14 - outside (POST 1)	M1	S1	121.2	11.9	133.1	140.0	4.0
b	13	&	14	outside (POST 2)	b13&14 - outside (POST 2)	M1	S1	121.2	11.9	133.1	140.0	4.0
b	15	&	16	outside (POST 1)	b15&16 - outside (POST 1)	M1	S1	137.2	11.9	149.1	150.0	4.0
b	15	&	16	outside (POST 2)	b15&16 - outside (POST 2)	M1	S1	137.2	11.9	149.1	150.0	4.0
b	17	&	18	outside (POST 1)	b17&18 - outside (POST 1)	M1	S1	153.2	11.9	165.1	170.0	4.0
b	17	&	18	outside (POST 2)	b17&18 - outside (POST 2)	M1	S1	153.2	11.9	165.1	170.0	4.0
R									S	T	U	
Bill of Materials												
Item								Length	UoM	QTY		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								10 ft		0.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								20 ft		0.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								30 ft		0.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								40 ft		0.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								50 ft		2.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								60 ft		4.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								70 ft		6.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								80 ft		2.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								90 ft		6.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								100 ft		6.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								110 ft		4.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								120 ft		6.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								130 ft		4.0		
OM3 - 16 x 24core MTP bundled fibre (black cable sock)								140 ft		6.0		
M-Boxes								Each	420.0			
M-Plates								Each	420.0			

Figure 11: Sample BoM on the Cable autoBoM tab.

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BIM for Energy Analysis

This section will detail how to create Revit families and analytical architectural models for the use in energy models, HVAC load calculations, and LEED compliance models. Exporting the geometric and some meta data from Revit will be covered.

Revit Project Template File

To expedite the process of creating BIM geometry for energy analysis it helps to create a template file with the appropriate families and views.

A cleaned out version of the *IL1 Arch Analytical.rvt* would make an excellent start.

Revit Families

Start with creating exterior, interior, and underground walls. Use only one thickness as walls with varying thicknesses will introduce errors in your model. Create different materials for your interior and exterior walls so that you can assign different colors for identification purposes in your model. If an interior wall is mistakenly used as an exterior wall, then that surface will appear in the energy model. Do the same for interior and exterior floors and roofs. Use a standard thickness (i.e. 6") because in some models you will need to align roofs to floors.

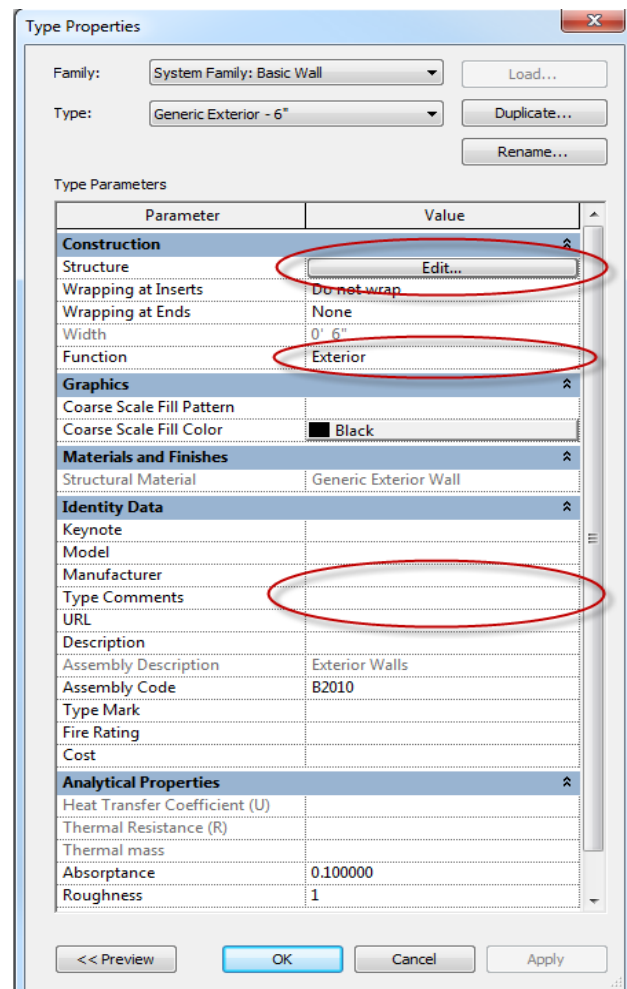
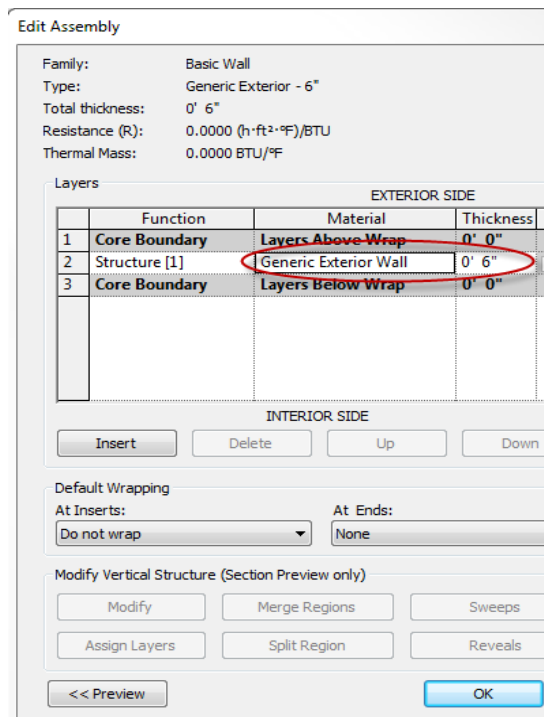


Figure 12: Key parameters and properties of an analytical wall.

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Optionally, use the Types Comments for descriptive text and filtering purposes.

Ceilings can be a different thickness, but only use ceilings if you need to model HVAC systems that utilize stratified air such as Under Floor Air Distribution (UFAD) and displacement ventilation.

Doors are rarely used in energy models as ASHRAE 90.1 states that you do not need to model an exterior surface if it is less than 10% of the overall surface area of the building. If doors are needed, then follow the same guidelines for creating windows and skylights. Use simple geometry and a different material surface for identification purposes.

For building shading devices create a family type for the walls for vertical shading devices and a family type of roof for horizontal and angled shading devices. Thickness does not matter.

Note: Shading devices must be rectangular and will only appear in the DOE2 energy model and not in the Trace700 model. Shading devices in Trace700 must be manually inputted.

Views

Create floor plans and 3D views with the Discipline set to “Architectural” so that the architectural elements are more visible and easier to select. Create a sub-Discipline “Energy Modeling” for larger projects where you’d like to group views with the energy analysis geometry together in the project tree.

Create a view on the ground floor with the Orientation set to “True North.” This will allow you to create the geometry in plan view and be able to rotate the project True North anytime without affecting the orientation of other views.

Create additional views for the space and HVAC zones. For the spaces, click the Color Scheme button under the view properties and set the Category to be spaces, create a new scheme and the color to be controlled by the name.

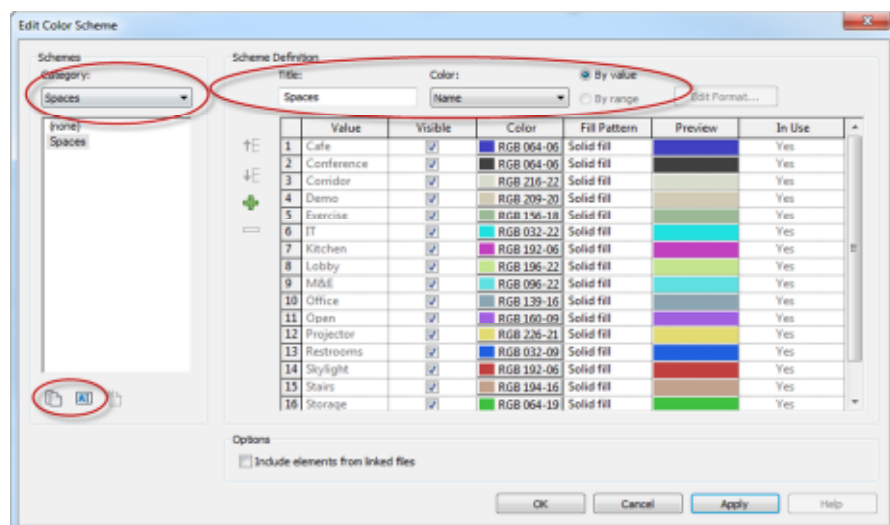


Figure 13: Sample space view filter.

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Create two schedules view for spaces; one where the spaces are itemized and another where the spaces are grouped by their names. This will allow you to use the space name to identify the space type and edit the internal loads for the same space types in one place. Add the Fields as you see in the image on the following page.

If the Revit lighting and electrical equipment families have electrical connectors mapped, “Actual” lighting and equipment power loads instead of “Specified” can be used. Revit will automatically calculate the Lighting Power Densities (LPD) and Equipment Power Densities (EPD) for you.

If creating the geometry for a DOE2 model, Create only one schedule for the HVAC zones and add the fields seen in the image below for control.

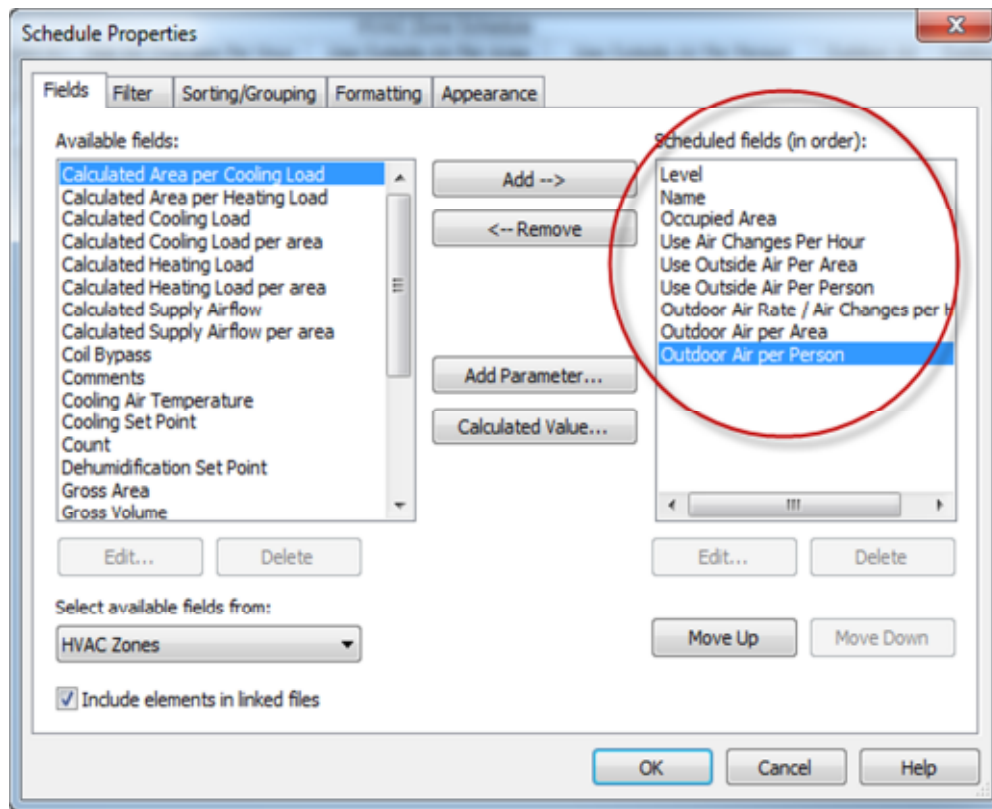


Figure 14: Zones values transferred to a DOE2 model.

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Generating Analytical Building Geometry with Revit

General Rules

- Do not use Rectangular Straight Wall Openings. These openings are not space bounding.
- Do not allow for any gaps between architectural elements. The space object may “leak” and not allow for energy analysis to be performed.
- Do not use in-place families. Use the native tools for windows, walls, floors, roof, etc. In place families do not translate to the energy analysis program.
- Do not include shaft or stairwell openings. These unconditioned spaces will be accounted for in the block load spaces.
- Do not use design options. If you need to show different design options, save them as separate models.
- Do not include columns, utility shafts, and other building components that do not bound occupiable spaces.
- Do not include doors unless the surface areas covered by the doors are more than 10% of the exterior surface of the building.
- Do not use space or room separation lines. They can be difficult to align in floor by floor situations in a way that does not give you geometry errors.

Energy Model Settings

Edit the Energy settings (Analyze>>Energy Analysis>>Energy Settings)

- Set the Postal Code.
- Set the Ground Plane.
- Set the Project Phase. Spaces must be placed in the same phase as the Project Information phase.
- Energy Export Complexity set to Simple with Shading Surfaces.
- Set Sliver Space Tolerance. Leave the default value of 1’ 0”. Too much sliver space may allow light, solar radiation, and air flow thermal transfer between zones that in reality do not occur.

Under the Area and Volume computations (Analyze>>Space & Zones>>Area and Volume Computation) check to see if the Volume computations is set to Areas and Volumes.

Linking Models

Linking in architectural models can be useful to “trace” over the geometry to create an energy model architecture. Make sure the **Room bounding building constraints for the linked models is not checked**.

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Orientation

In the floor plan oriented to true North, click on Project Location under the Manage tab and either rotate True North or Project North to the correct orientation.

Walls

Start with the exterior walls and have them extend from the ground level of the building to roof or its other upper bounding element. This will give you the general shape of the building when creating other building elements in different views.

Use the same thickness walls for all building walls. Different thickness will introduce geometry errors in your model.

Model spandrel glazing as an exterior wall.

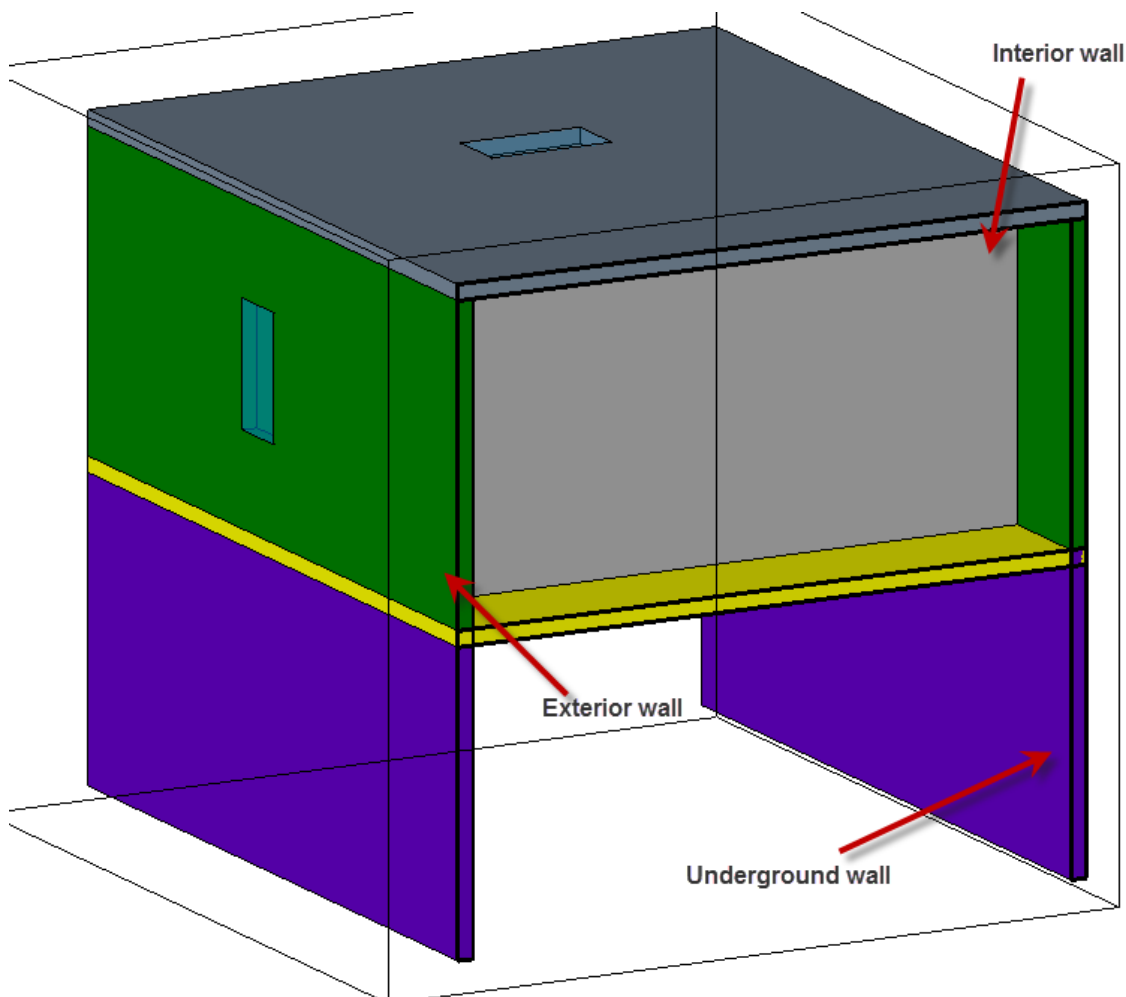


Figure 15: Sample analytical Revit geometry color coded with materials.

Model interior walls on a floor by floor basis and use interior walls to define the boundaries for your HVAC spaces and thermal zones. Interior walls that cross floor levels will lead to alignment headaches further down the modeling process. It is important to avoid using

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any interior walls as exterior walls. You will not receive any errors; however those surfaces will not appear in the DOE2 or Trace700 model geometry. This is where color coding the different wall types with view filters or their material is useful.

Model underground walls separately from exterior walls. Be sure that neither the underground nor the exterior walls cross the ground plane as this will give you a modeling error.

When modeling curved walls, use straight walls and windows broken up into panels.

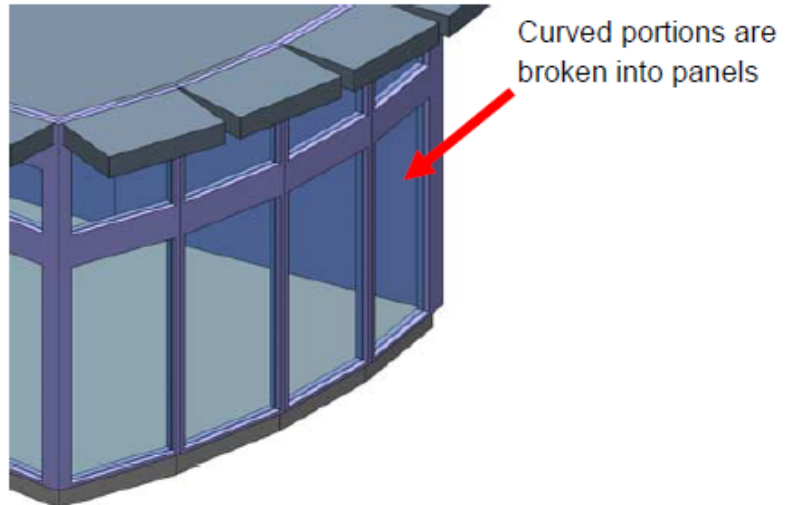


Figure 16: Curved wall example.

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Roofs

Roofs should be the one thickness and the same thickness as floors and offset appropriately so that a single space could encompass the entire roof and floor slab properly. When a roof is created, the bottom of the Roof is based on the level whereas the top of the Floor is based on the level, which does not bound the Roof properly. The roof should be offset by the thickness of the roof.

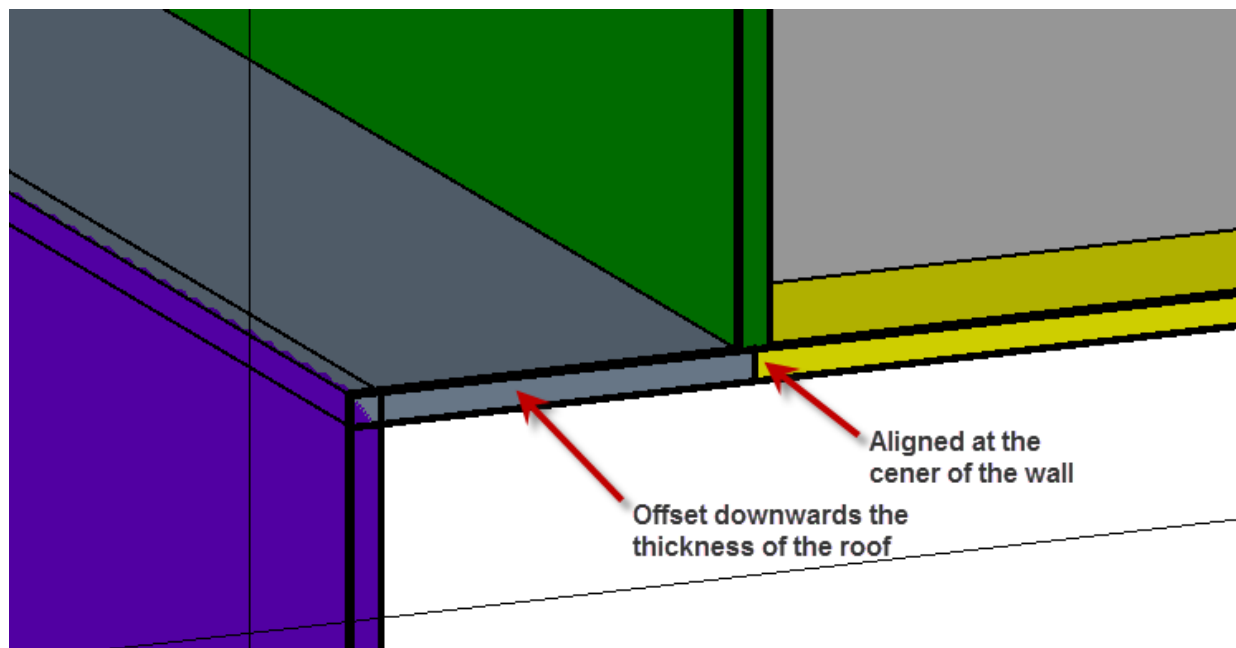
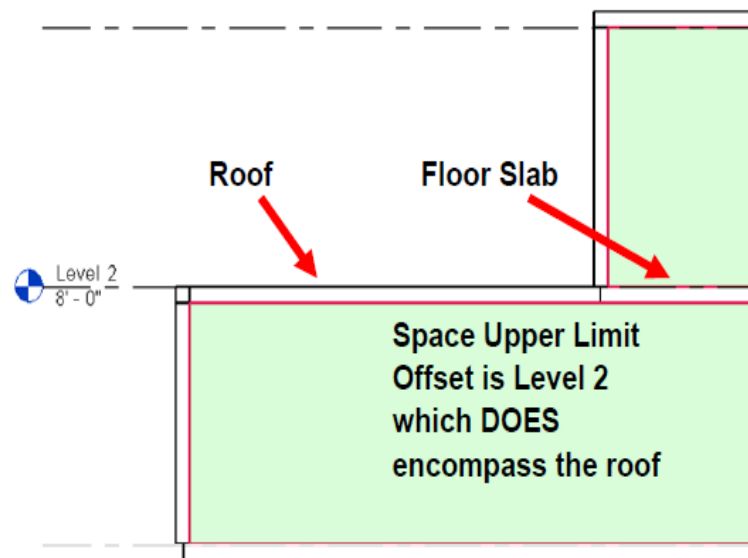


Figure 17: Roof and floor intersection.

Floors

Floors should be one thickness; the same as roofs. Floor boundaries should either the center line or interior surface of the exterior walls. For consistency, have floors at same elevation as the space. Any floor that extends beyond an exterior wall should be modeled in two separate pieces; the part with an interior space above as a floor and the part that exterior above should be modeled as a roof; otherwise you will receive an error in your model.

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Model slab on grades as exterior floors.

Do not model stairwell or shaft openings in floors.

Windows and Skylights

Windows and skylights should be modeled with a simple geometry.

Model curtain walls using the same simple geometry. Offset the edge of the window from the edge of a bounding wall, floor, or roof by at least 0.5”.

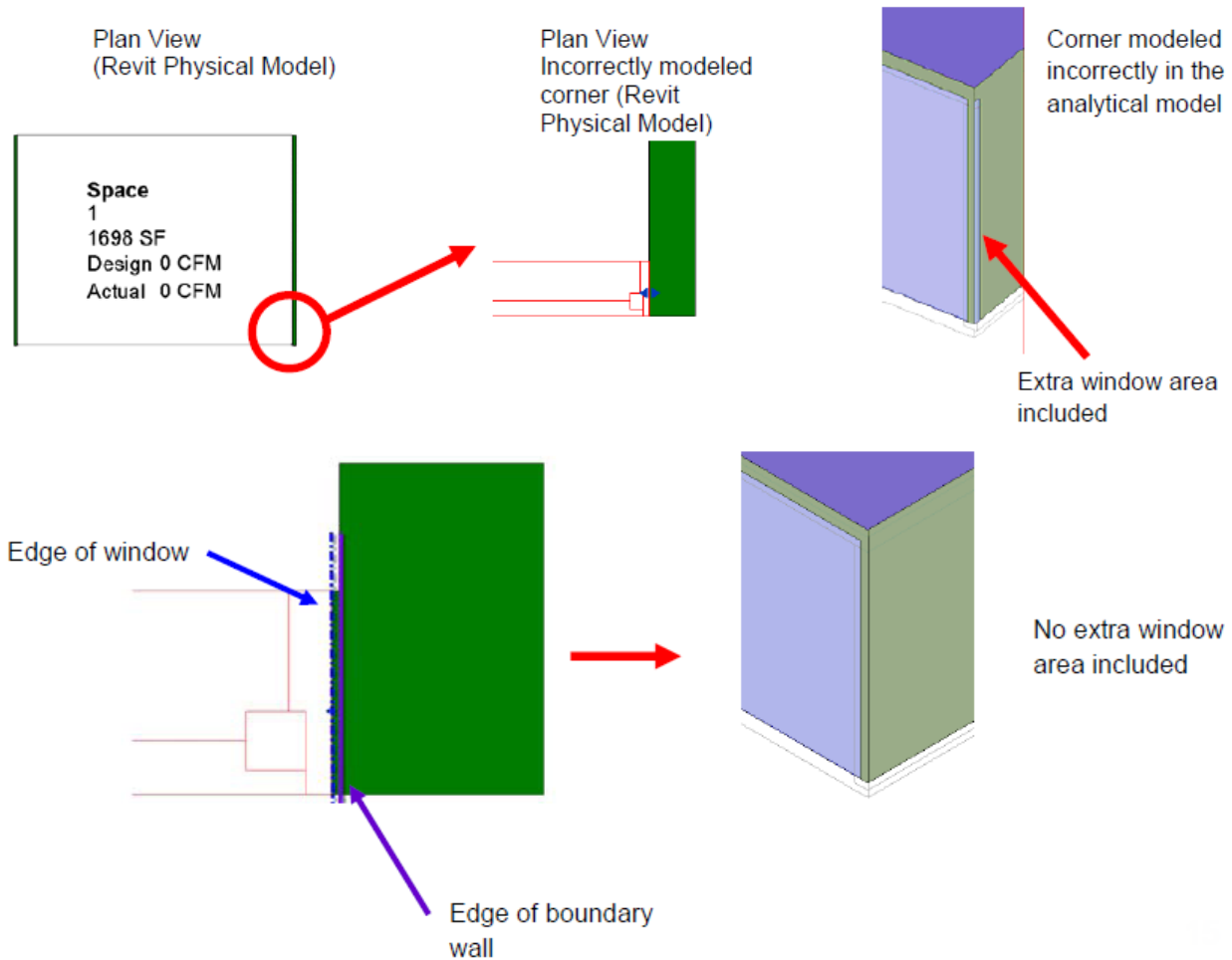


Figure 18: Windows near wall edges model with and without the offset.

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Ceilings

Ceilings should only be used when the HVAC system type utilizes the stratification effect of warmer air rising to improve performance such as UFAD or displacement ventilation systems. Add the ceiling at the elevation above the occupied volume (usually 6' to 7'). Add a space set as an occupied space below the ceiling and a space above the ceiling set to be a plenum space. You can use a common space plenum for the entire floor area. Shading

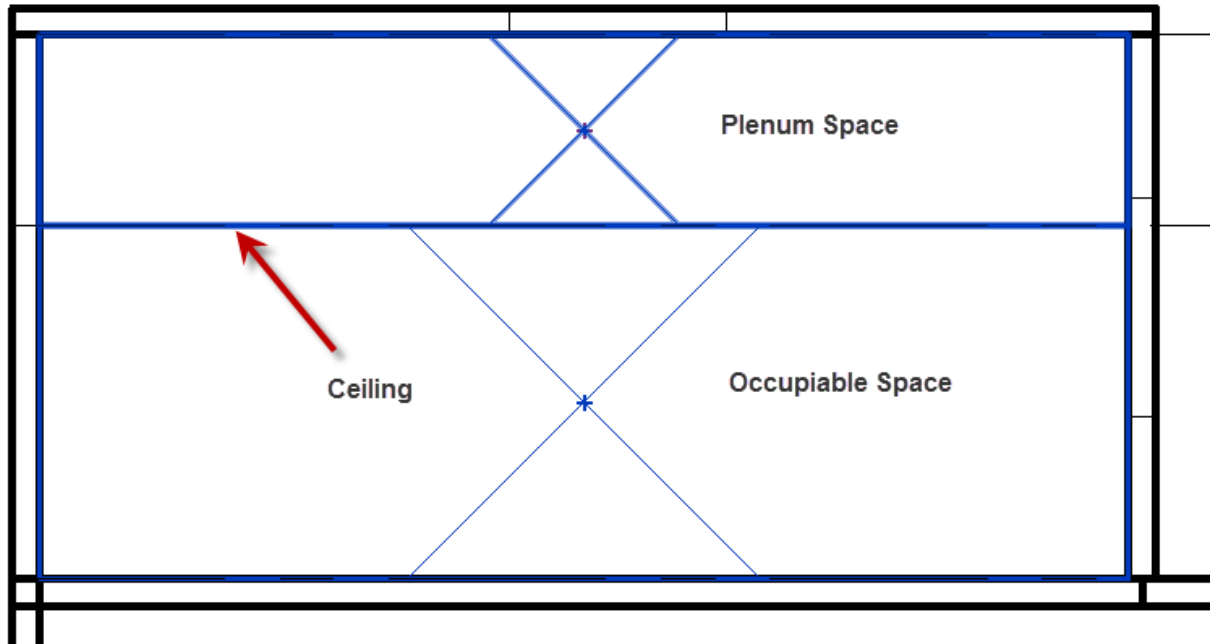


Figure 19: Section View of a space with a ceiling.

Devices

Shading devices must be modeled as rectangles. Use walls for vertical shading devices and roofs for horizontal and angled shading devices.

Spaces

Set the height of the space to be at the level above if there are interior spaces on the floor above. If the upper bounding element is a roof, the top surface must be offset the thickness of the roof to match its top surface. Otherwise Revit will add a shading device above the roof.

For spaces with UFAD or displacement ventilation, the top surface of the space must align to the ceiling.

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Edit the space whether the space is Occupiable or a plenum under the space properties and the Conditioning Type. You can also edit the Occupancy [People] and Electrical Loads within the space.

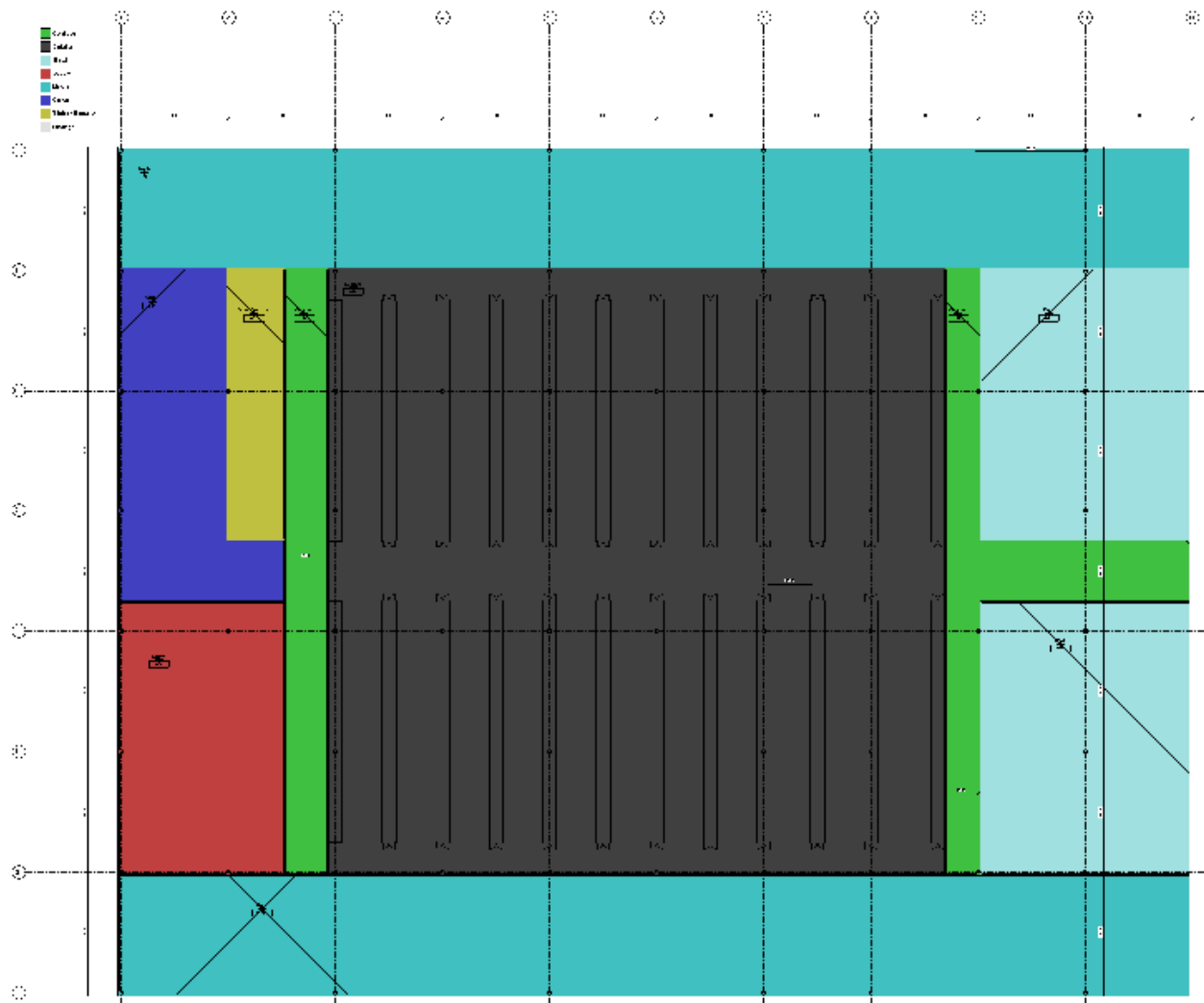


Figure 20: Sample space layout

Electrical and lighting loads from the connectors of properly configured lighting and electrical equipment will sum for the spaces if the Actual Values option is selected under the space.

Note that electrical loads do not show for linked model equipment.

Alternatively you can use the grouped space schedule to control the parameters for a particular space type [name].

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Zones

Zones are only required if plan on generating a DOE2 model. Trace700 only require spaces.

In the zone properties or in the zone schedule, edit the Outdoor Air Information. You can also edit the heating and cooling setpoint temperatures, but it is generally easier to edit this information in the energy modeling tool.

The Space and Zone Tool feature in the Rushforth Projects Revit plugin will expedite this process.

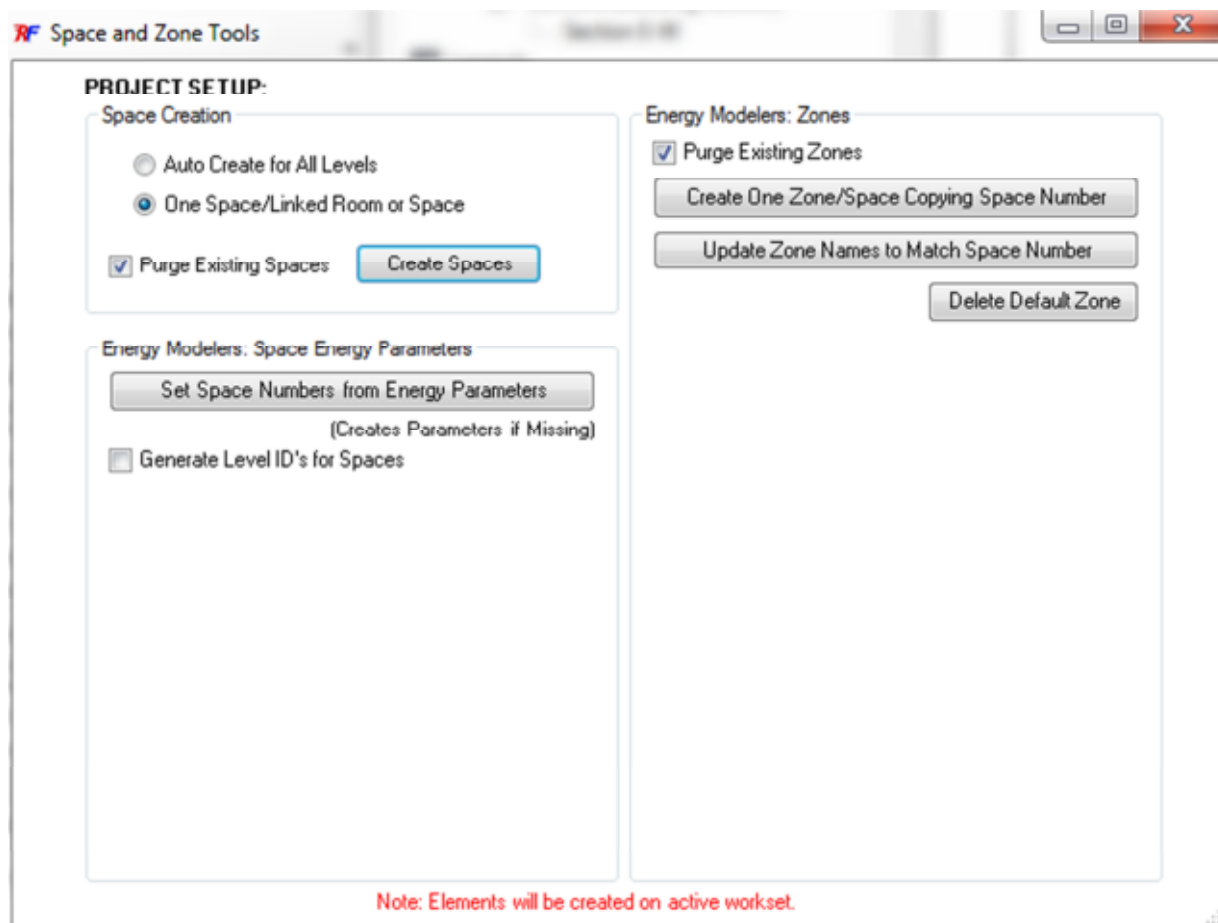


Figure 21: The Parameter Transformer tool by David Rushforth

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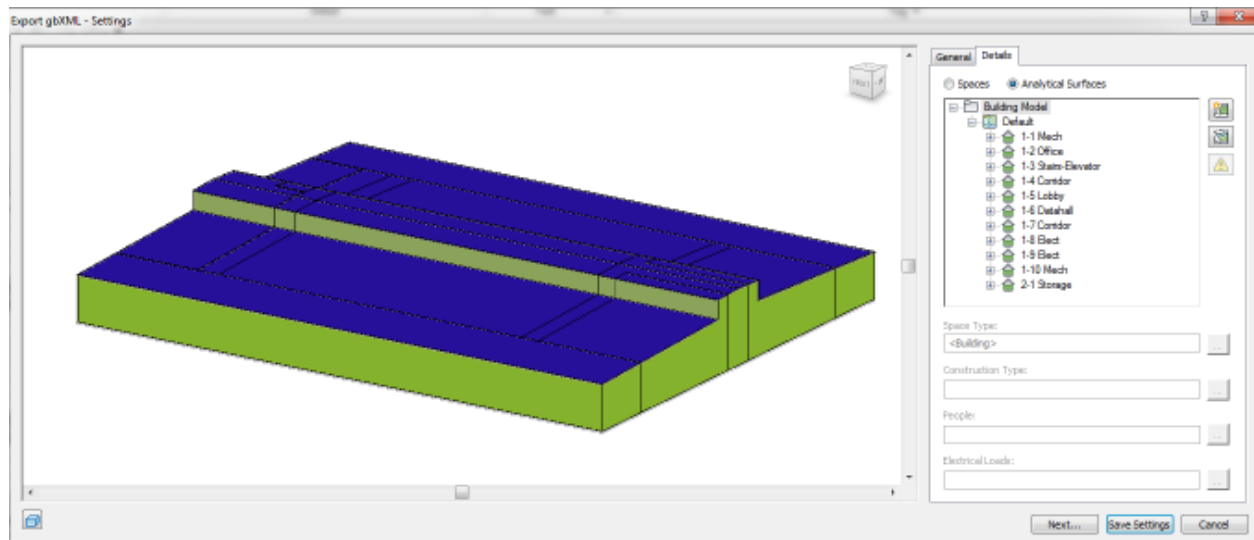


Figure 22: Image of the gbxml export window in Revit.

Inspecting the Model Geometry

Inspect the model geometry within Revit. Click the R>>Export>>gbxml. Click on the details tab, choose analytical surfaces, and set the view to shaded. Any geometry that is represented by a translucent brown shading surface is a sign that you have a problem.

Importing gbXML into eQuest

Export the gbXML file and upload it to Green Building Studio then download the .inp file found in the Export and Download Data Files tab. Open the .inp geometry in eQuest and inspect it for errors and inconsistencies with your BIM model.

Importing into Trace700

Trace700 models are more forgiving. Too forgiving. Instead of errors and crashing, the model will usually run, but with the geometry incorrect. It is recommended that you inspect all gbxml geometry in eQuest prior to importing into Trace700.

To import the gbxml file, select import from the File drop down menu. Select the data that you want to import, then delete the default room.

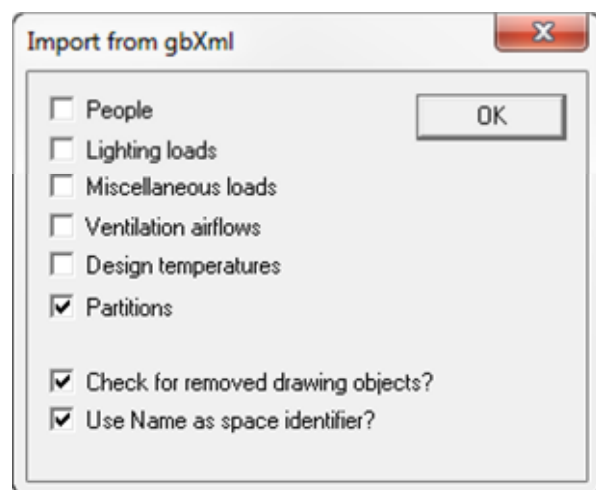


Figure 23: Trace700 Import tool

Troubleshooting

Whenever a model crashes GBS, often the error message will not help you identify the origin of the error. When this occurs, employ a method called “Divide and Conquer.” Start with splitting the building in half either vertically or horizontally, do a run for each side.

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Whichever has the error, split that model and repeat. Sometimes the both halves of the model will have an error. For example with two spaces or zones have the same number/name. When this occurs try multiple places to split the model until you have one that runs and one that doesn't. Repeat until you find the error or until you contain the error in one space. In the latter situation, section off portions of the space until you have isolated the error.

BIM for CFD Models

General

The majority of the analytical geometry created for energy modeling can be used for CFD models, but also:

- Create 3D view with only the elements to be modeled in CFD. Anything hidden in active 3D view will not be included in the CFD model. Use visibility graphics to hide categories of elements or the hide tool. You can also use section boxes to exclude unnecessary geometry.
- Avoid small offsets between geometry. Use the join and align commands to eliminate small gaps. Use thin lines to see details more closely.
- Fine features on furniture should be removed; i.e. small diameter tubing, railings, rounds, fillets, holes, etc.

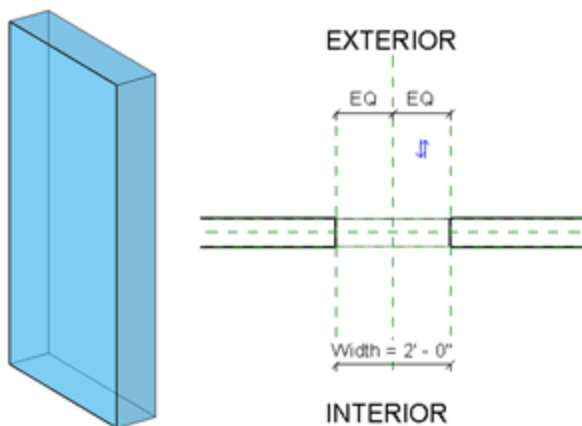


Figure 24: Simplified window for CFD.

For windows and skylights create families that are only openings with an extrusion representing the glazing area. Curtain walls windows with sills and other detailed geometry may cause errors in the energy model and will slow down CFD model run times.

For doors, vents, and other openings, use similar simplified families.

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Revit to Simulation CFD

Simulation CFD is ideal for modeling conceptual data hall layout where only the rack kW is known. It is also excellent for modeling support areas and external models of the building.

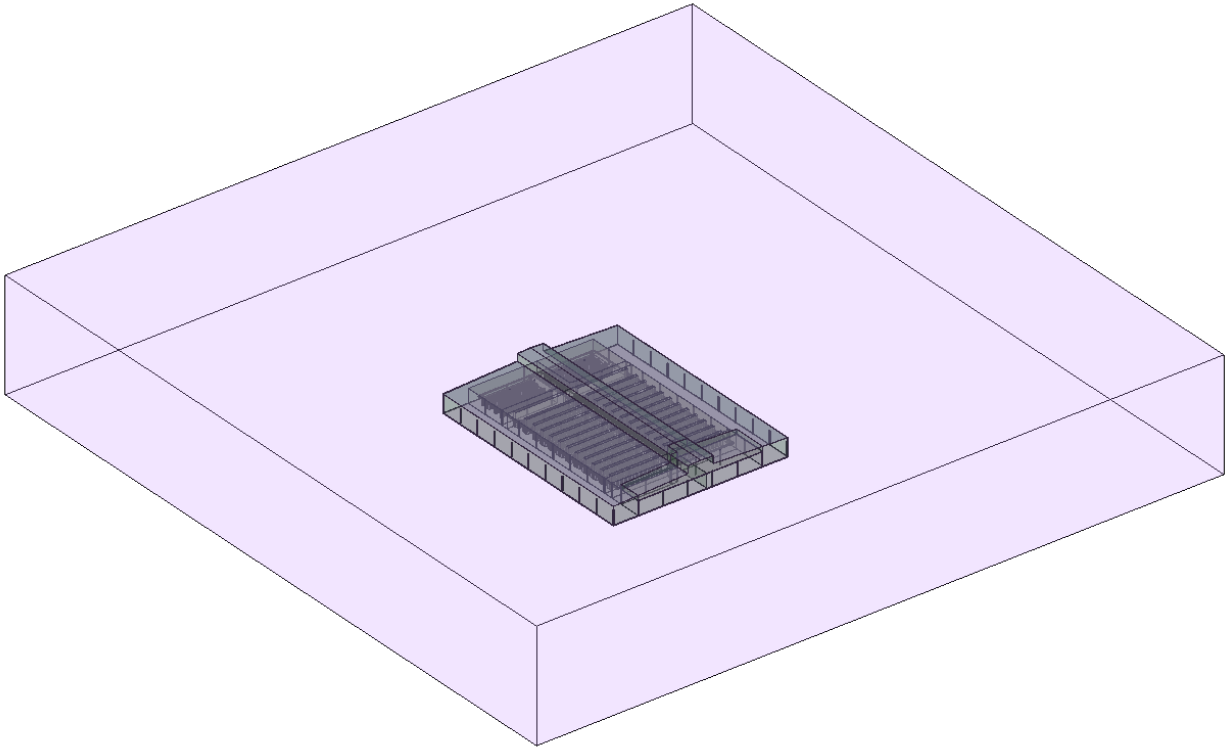


Figure 25: Image of a model surrounded by an mass representing the air volume for Sim CFD. Use a rectangular shaped mass 3 to 5 times bigger than the dimensions of the area with the building and landscape geometries to represent the air volume. This will make it possible to setup a velocity boundary condition to represent the wind.

Use the detail view settings, section boxes, visibility graphics overrides, family properties and/or view filters to show only the analytical geometry required for the CFD model.

See the “3D - Analytical Sim CFD” view tab. In this example, view model categories were used to isolate the geometry to be modeled. Additionally, the view is set to medium detail. The families were built with simplified geometry when the view detail is set to medium.

There are two ways to import the geometry into Sim CFD; the Sim CFD Revit plugin (recommended) or by exporting to the ACIS (.sat) file format from Revit. If the direct link is used, clever family and system family names can be used to apply equipment and material property data in Sim CFD.

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Revit to 6Sigma Room

Much of the same geometry used for Sim CFD can also be imported into 6Sigma Room CFD model, but not all. Dumb geometry that only interacts with the airflow by block it can be imported using the .stl format.

Geometry that can be imported through the .stl format:

- Cable tray
- Duct not involved with the data hall's air distribution
- Piping
- Banks of conduit
- Furniture
- Walls no involved with isolating airflows
- Columns

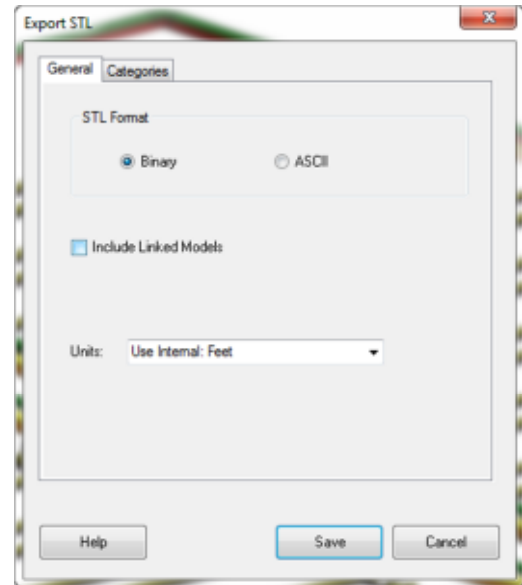


Figure 26: Image the .stl exporter plugin

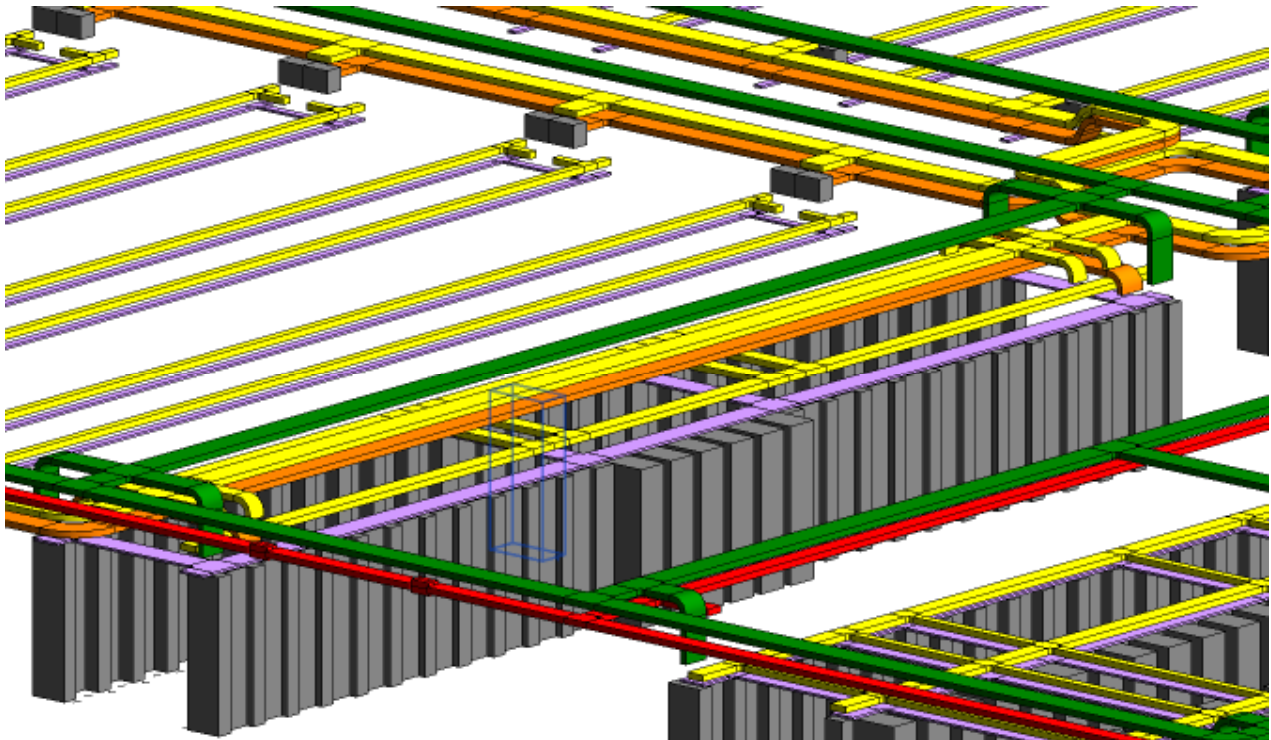


Figure 27: Image of the cable tray, rack posts, vertical wire managers, etc. simplified for CFD.

An example .stl model of the *IL1-A Cable Tray.rvt* has been included in the class materials. Import the geometry as solid CAD Definition.

Utilizing BIM for Data Center Design

The following are examples of active geometry that **should not be imported**:

- Server Racks and other heat producing IT equipment
- Aisle Containment
- Raised floors
- Walls, floors and roofs defining the boundaries of the CFD model

Instead active equipment and architectural elements should be manually model 6 Sigma Room.

3D CAD files can be brought into 6 Sigma Room to locate active equipment. Any facility asset management and equipment performance data can be imported to expedite the modeling process. Samples have been provided.

Upcoming and Potential Future Optimization Projects

The optimization projects ongoing or scheduled to start soon:

Revit to Agile PLM: Link Revit models to Agile PLM for AutoBoM's instead of Excel.

Revit to Siemens Clarity LC DCIM: Using 3D CAD and Excel spreadsheets to import geometry and data from a Revit data center model into Clarity LC for DCIM.

Revit to Sanvoo's vConstructor: Use the vConstructor field data management tools to provide access and the ability to modify BIM metadata in the field.