BIM + Building Performance Analysis
Using Revit 2014 and IES Virtual Environment

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Contents

1.1 Introduction

Integrated Building Performance Analysis (IBPA) can be a powerful tool to evaluate and inform decisions throughout the design process, starting at the earliest stages. In order to design a high-performance building and implement an integrated process, the traditional design process needs to change. No longer can the design team leave the analysis too late in design development, it needs to start early. By working holistically from concept stage, the project team can analyse a number of options and make informed decisions on the associated pros and cons.

The Virtual Environment (VE-Pro) is an integrated analysis platform developed by Integrated Environmental Solutions (IES). It is a collection of building performance modelling and analysis modules leveraging a single integrated data model. The intent is to provide the high quality information required to design, build and operate better performing, more sustainable buildings without having to build a different model for each type of analysis (e.g. energy, daylighting, etc.). The VE is linked to Revit Architecture and Revit MEP through plug-ins that allow users to build models in Revit and then analyse them using a range of products with the Virtual Environment family. Integration with other BIM tools is achieved by importing data in a gbXML format into the Virtual Environment. The analysis tools include annual energy/carbon consumption, building loads, daylighting and electric lighting, climate, water, air flow and LEED/BREEAM/Greenstar credits. The Virtual Environment can be applied from the earliest stages of the design process, when greatest opportunity often exists for making improvements, right through to detailed design and even into operation of the building.

A key issue to understand is that there are fundamental differences between an energy model and an architectural model used to generate construction documents and the ability to cycle through design options in a timely manner requires understanding of both. From the Engineers perspective they require only information pertinent to the question at hand, reducing variables will reduce analysis time. From the Architects perspective, the visual character of the overall model is important to convey the design intent as well as the detail to express the layering of ideas. gbXML (refer to section 1.4 - Basic gbXML information) is used to streamline the data flow from Revit to IES Virtual Environment. It is important to note that no exchange format is perfect and there are still limitations on what can be transferred between BIM and energy simulation software. An important point to note is that, many BIM elements do not support information exchange identifying the thermal performance characteristics that are needed to run energy analysis. Therefore, the users are required to specify these values at the point of translation, so the analysis can be performed with the appropriate characteristics. Architects tend to want to analyse their 'specific' wall design with specific layers', when, at an early stage, identifying the wall as an R-24 (thermal value) may be sufficient to develop comparative analysis between cases. When carrying out design exploration at different stages of the process, it is advisable to utilise the appropriate level of detail for the analysis, making it easier to focus on outputs that can inform the design. Too much detail at the early stages can cloud the fundamental design decisions.

In order to take advantage of the ability to integrate BIM + Building Performance Analysis, the BIM model needs to be developed with this work flow considered. The usefulness and accuracy of the analysis results depend greatly on the quality of the input data. The intent of this white paper is to provide guidance on best practice when creating BIM models in order to successfully export to the VE for Building Performance Analysis and to leverage the ability to do analysis cycles informing the design and testing ideas as the design evolves. This paper focusses on the Revit integration, however the principles are the same regardless of which BIM tool is being implemented.

1.2 Basic gbXML Information

Green Building XML schema, referred to as “gbXML”, was developed to facilitate the transfer of information from building information models to performance (predominantly energy) analysis tools.

When the user clicks on ‘Set Model Properties’ within Revit using the IES toolbar, in the background a gbXML file is being read and exported. The 3D model the user sees is a gbXML model. This shows what will be exported for analysis, so it’s important to look at this model to see what elements will translate correctly and what won’t.

XML is a web-based, standards-compliant specification that can be used to store and transport virtually any kind of data. It is based on a relatively simple text-based syntax similar to HTML. Green Buildings XML (gbXML) was developed to facilitate interoperability between myriad building design and development modelling tools. IES is involved in development of the gbXML schema to enhance the translation and have included a number of features in the import function to smooth the gbXML import process.

(Refer to www.gbxml.org for more detail information regarding gbXML documentation.)

In order to facilitate a smooth translation from 3D modelling software (e.g. Revit) to the Virtual Environment there are a number of considerations users should be aware of when creating their BIM (Revit) model.

Like any type of analysis, the usefulness and accuracy of the results depend greatly on the quality of the inputs. In order to take advantage of this advanced workflow between the platforms, the Revit model must be properly prepared for analysis. Under normal circumstances there will be a Revit model for documentation and a separate, stripped down version of the Revit model for export to the VE.

All bounding elements from the model, i.e. the walls that make up a room, its floor and ceiling, (See section 1.12 Surfaces) will translate as 2D surfaces which represents ‘enclosed’ geometry i.e. the 3D zone. (Rooms or spaces depending on what version of Revit is being used).

1.3 Data Exchange gbXML

A gbXML document organizes information according to the following hierarchy: Location, Building, Space, Surface and Opening.

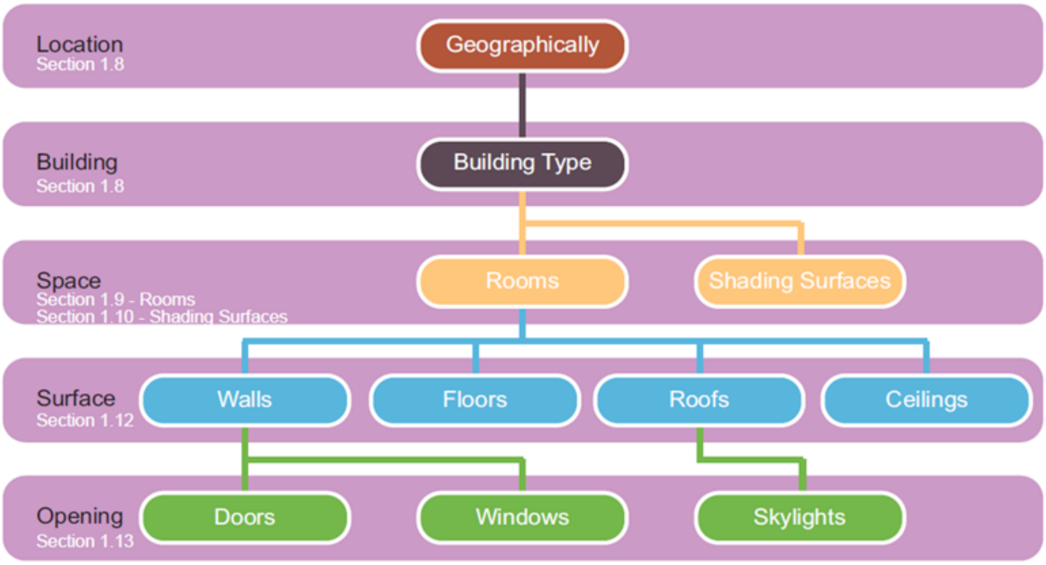


Figure 1: gbXML structure

1.4 Adjacencies

In order for the building performance model to understand whether a surface is exterior or interior, placing Rooms (refer to Section 1.9 - Rooms) accurately is critical. If there is no Room adjacent to another space, then the vertical wall is considered as an Exterior wall and the associated construction profile will be assigned. If Rooms are placed on both sides of walls, then it is considered as Interior. Even if the space is a shaft or an unoccupied space, where a room might not typically be placed, it is important in this case that a Room is inserted otherwise the rooms surrounding the shaft or unoccupied space will be read as exterior spaces. Refer to the diagrams below which illustrate how gbXML determines surfaces. (Figures 2 – Adjacency Diagrams)

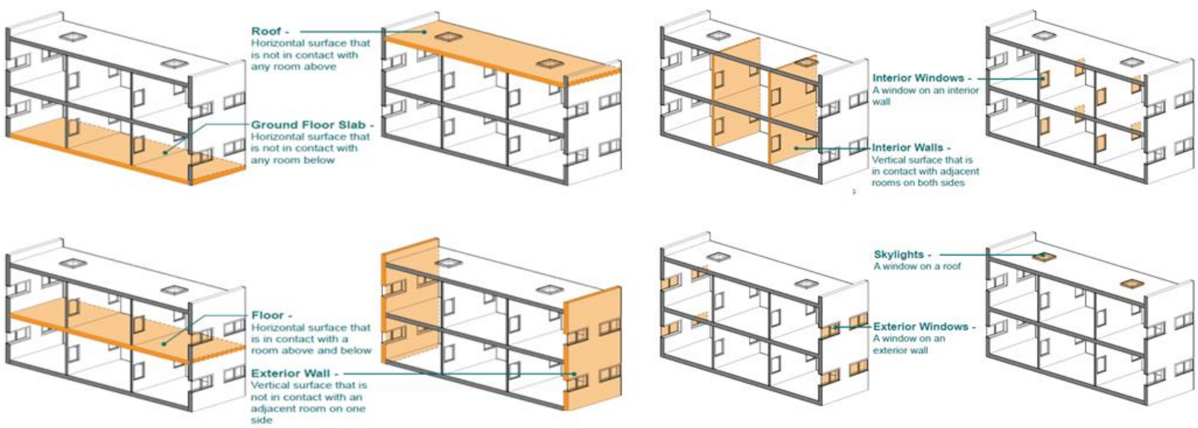


Figure 2: Adjacency Diagrams

1.5 Checklist for Translating Revit to IESVE

The following checklists/tips summarise the process users should go through in the Revit model before attempting to export the VE. . Each item is described in more detail in subsequent pages of this document.

1. **Rooms** (refer to Section 1.9 - Rooms)
   Make sure all rooms/spaces are place in every area of the building to create a fully enclosed building envelope, and adjacencies of Rooms are correct.

2. **Room Bounding Elements** (refer to Section 1.12)
   Check or uncheck room bounding elements that are necessary for design / building Performance model. If an interior space has many ½ walls or jogs (that protrude into but do not divide spaces), these walls can often be made non-room bounding leaving a simple room perimeter to bound the space.

3. **Define all Upper and Lower Boundary** (refer to Section 1.14 - Defining the Upper & Lower Boundary)
   Make sure all the Upper and Lower Limits and Offsets are correct

4. **Project Information** (refer to Section 1.8 - Project Information)
   Make sure the Energy Data parameter in the Project Information is filled out correctly

5. **Room Volume Computations** (refer to Section 1.15 - Room Volume Computations)
   Make sure Room Volume Computations is checked

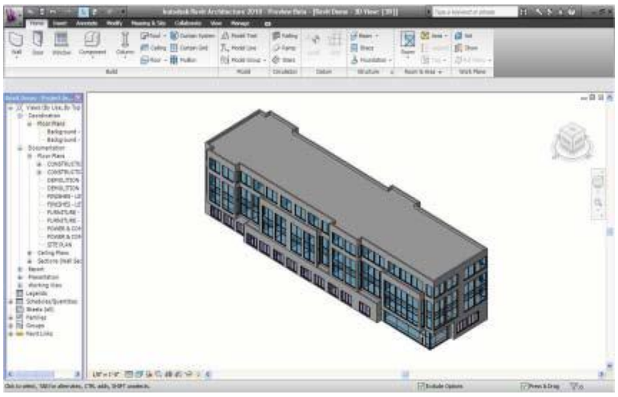
6. **If it's a central model, detach from central.**
   Clean up views, elements that are not related to energy analysis (casework, railings, etc.), and purge unused. This will help reduce the size of the file.

7. **Try to keep the model as lean as possible in Revit**,
   This will be worth it when trying to run analysis and will impact runtime greatly. Only keep elements essential to the gbXML. It is common to maintain separate Revit construction document models and Revit analysis models, though in the future hopefully that will change. For analysis, simplicity of the model is paramount. For example, use a single wall from ground floor level to the roof instead of stacked or layered complex wall. Use actual window families instead of a curtain wall embedded in opaque walls. Use simple, generic families if possible. Always use the appropriate family type for any custom components.

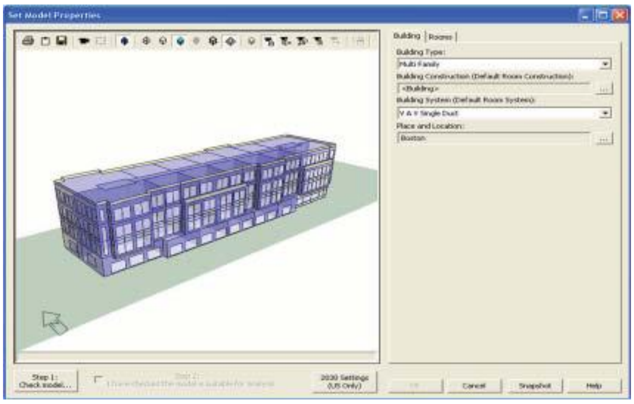
1.6 Work Flow Example Revit to IESVirtual Environment

This diagram illustrates a typical work flow using Revit.

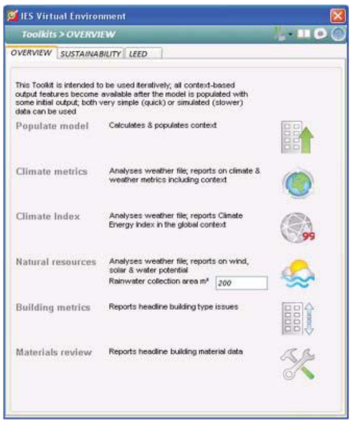
1. Design



2. Translate



3. Analyse



4. Carry further

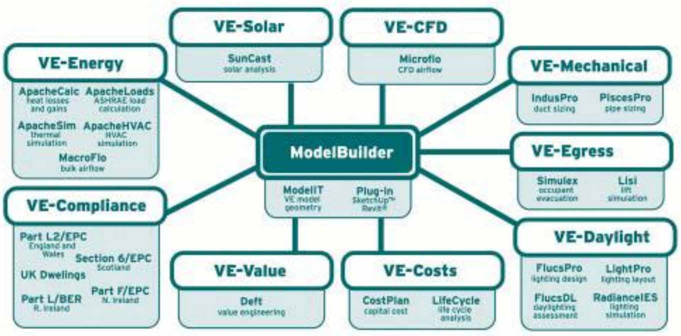


Figure 3: Typical Workflow Diagram

1.7 Area & Volume Computation

This has to be set to ‘Areas and Volumes’ for the successful creation of a gbXML file. (See section 1.15 - how to set this)

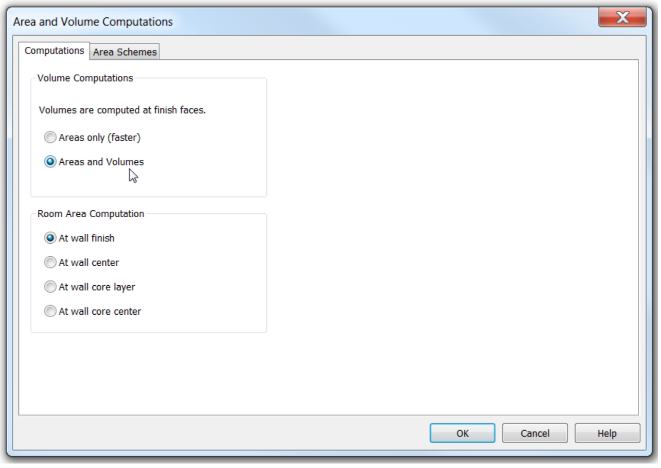


Figure 4: Area and Volume Computations

1.7.1 Levels

In addition a room or a space has to be placed everywhere in the model to create a fully enclosed building envelope. These rooms/spaces (see section 1.9 Rooms and Spaces) should be tied to the levels within the model. This is best practice in the event that there are later updates to the floor levels which will in turn adjust the room/space heights automatically if they are tied.

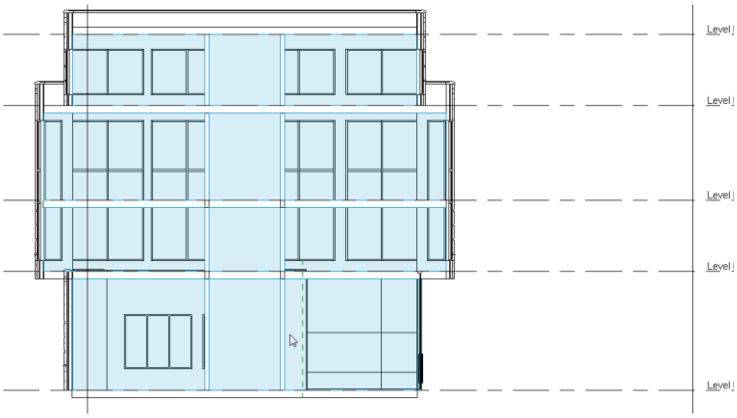


Figure 5: Section through Revit Model

At this stage the ‘Visibility Graphics’ can be turned on to check if the room or space placed is filling the model as required.

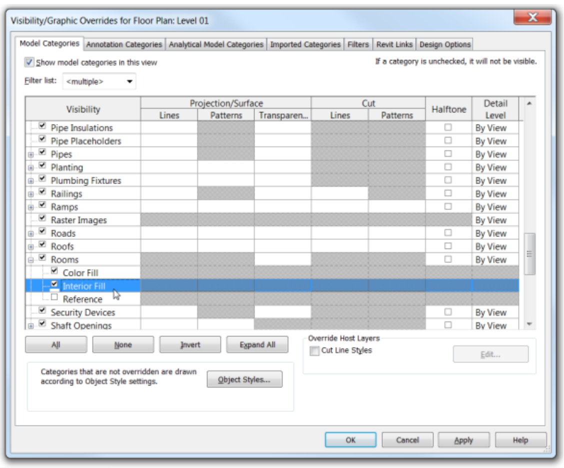


Figure 6: Visibility Graphics Dialogue within Revit

1.8 Project Information

Defining the location of the project is very important for design / energy performance analysis because this determines what weather data is used for the analysis. Location and associated climate play an important role in the performance of the building and should be used to inform the design. This information can be set in Revit or in the Virtual Environment plug-in.

In Revit go to Manage > Location

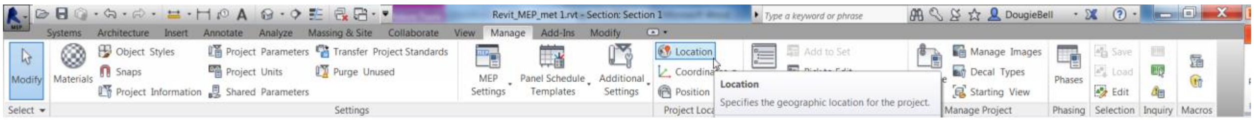


Figure 6: Setting Project Location in Revit

This can also be set within the 'Energy Analysis' Instance within the 'Project Information'. (Figure 7- Project Information > Energy Analysis >Energy Settings) In addition to the buildings location there is additional information that can be exported with the gbXML from Revit for building performance analysis. This information can also be set in the VE plugin. Details of this information are given below.

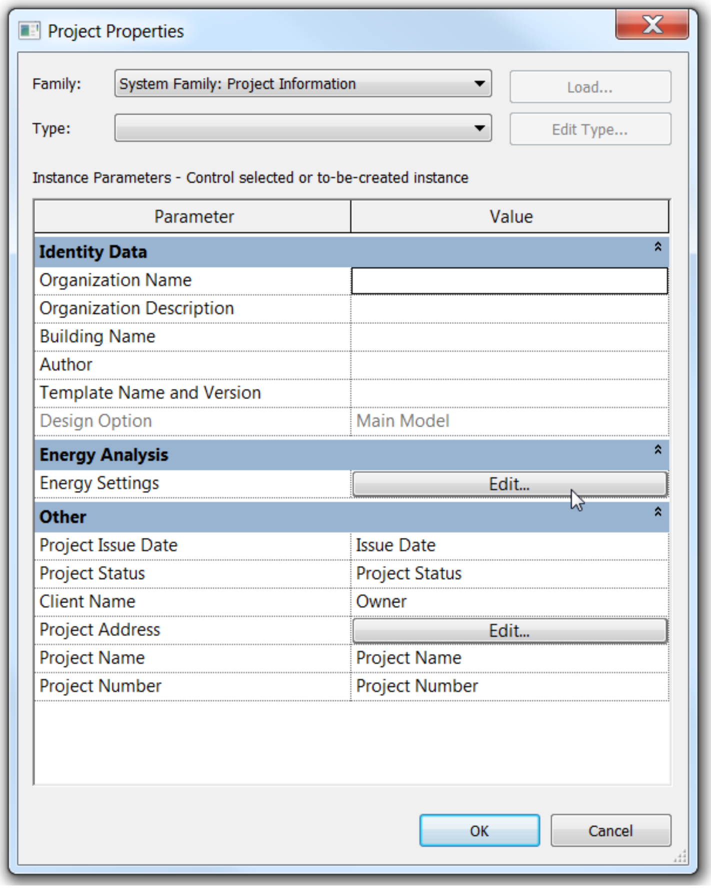


Figure 7: Project Information - Project Properties

NB: There are a few differences between the Architecture & MEP settings (Figures 9/10 on the following page), but the basic information is the same. In addition, there are other methods to set project information. Location can be set on its own in the Manage>Location. The same information as shown above can also be set in the Analyze>Energy Settings or on export when it is a manual gbXML export using the Revit gbXML function. When using the <Virtual Environment Plugin, this information will be extracted automatically.

Building Type: Specifies the type of building according to the gbXML schema 0.37 ("http://www.gbxml.org/schema" version="0.37") and Building Type spaces similar to ASHRAE Standard 90.1 building categories.

Postal Code: Location and climate should be set correctly as this will affect analysis results. Postal Code can be used to determine the location of the building.

Ground Plane: Specifies the level that serves as the ground level reference for the building. Spaces below this level are considered below ground. The default ground level in the Virtual Environment is zero.

Project Phase: Specifies the stage of construction (Existing, New Construction). Make sure the Rooms that are being placed in the Revit model are in the same phase as the Project Information. If the phase selected in this dialog is different than the room property specified the user will see the warning dialogue shown in Figure 8 below.

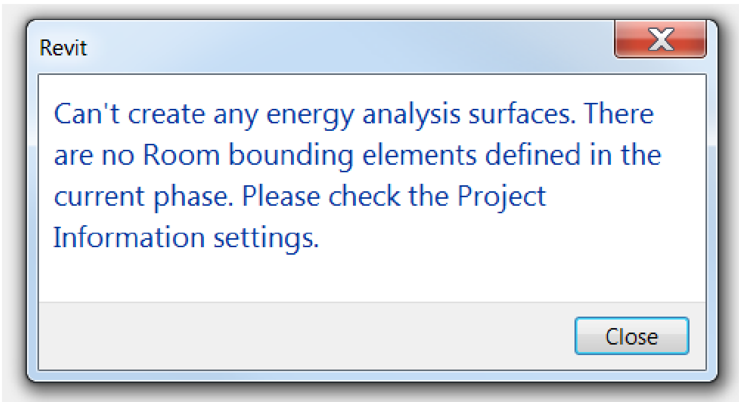


Figure 8: Project Information - Project Phase - Error Dialog

Sliver Space Tolerance: Specifies the tolerance between surfaces within the model. Within the Virtual Environment this is referred to as the adjacency separation distance. Best practice is to leave the default that is defined within the Revit dialog box. If the default is increased this could result in larger 'sliver spaces' which may allow light, solar radiation, air flow and thermal transfer between zones that in reality do not exist.

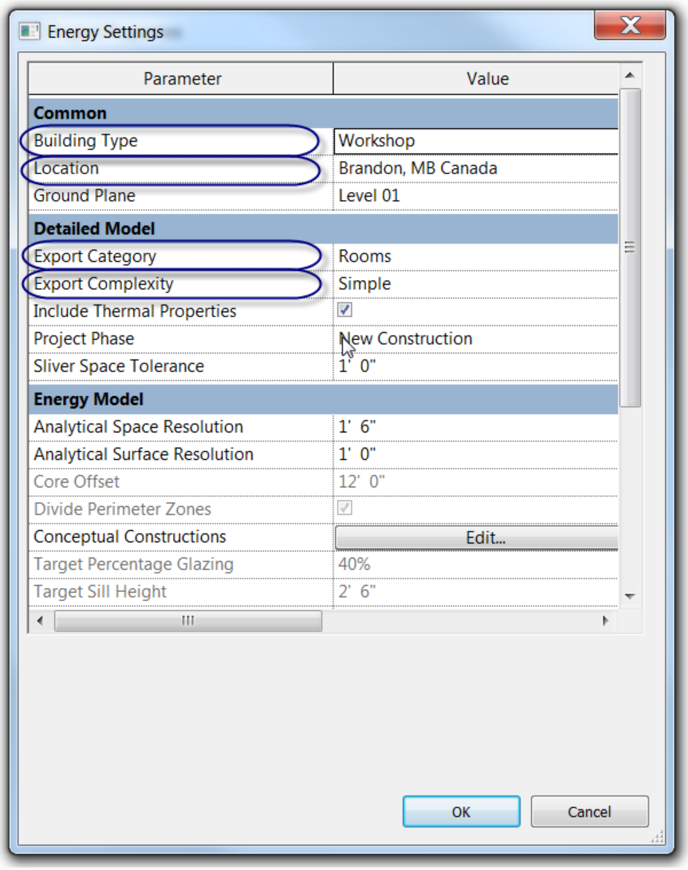


Figure 9: Energy Settings - Revit Architecture 2014

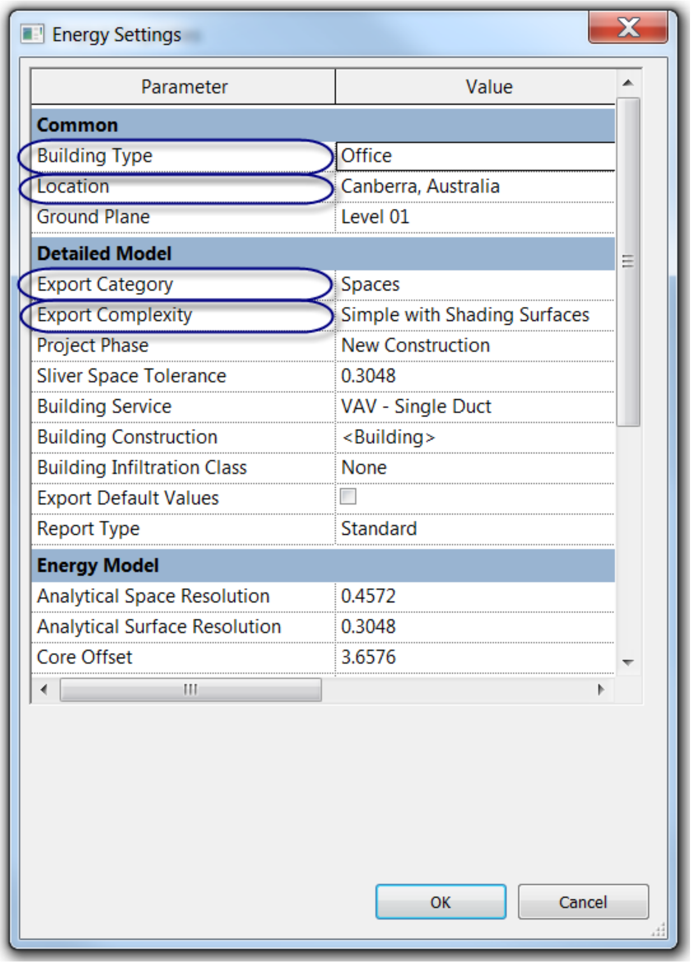
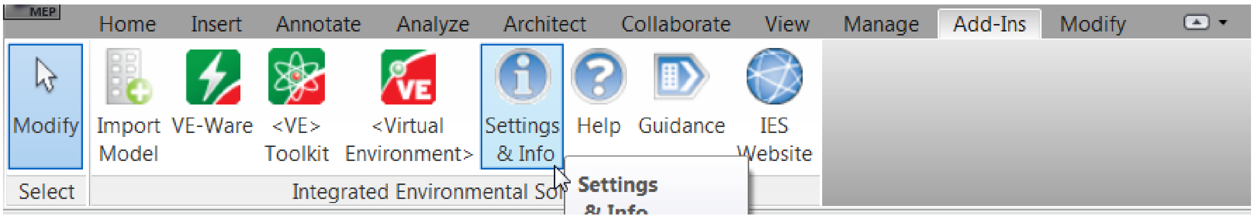


Figure 10: Energy Settings - Revit MEP 2014

1.8.1 Export Settings – Architecture v MEP

Export Complexity: To set this go to the Settings & Info>Setting and select the gbXML Export tab. The user can select from five different options ranging between Simple to Complex with Mullions and Shading Surfaces. An explanation of the 5 options is given below. The main advantage of this setting is that export time is reduced when using the simple options.



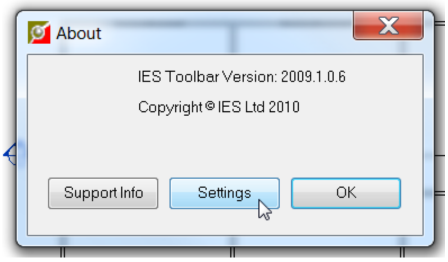


Figure 11: VE plugin > Settings & Info

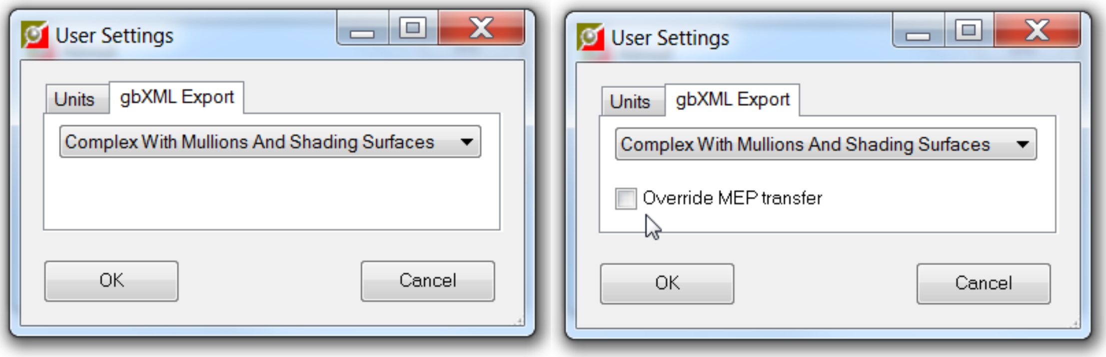
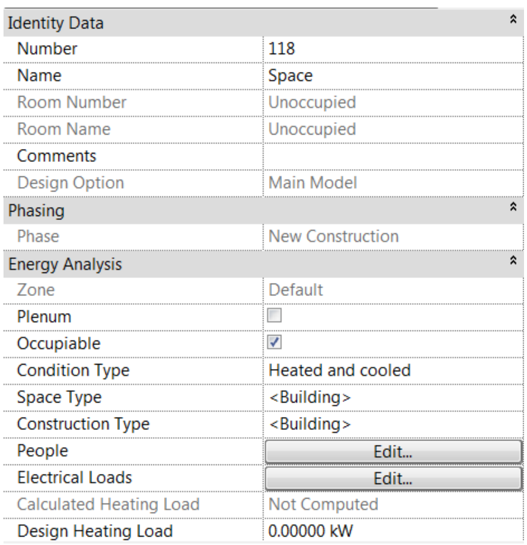


Figure 12: VE plugin > gbXML Export Tab

NB: There is one key difference between Revit MEP and Architecture in the 'User Settings' Dialogue. MEP has an override transfer option which allows the user to export settings for rooms such as lighting loads and occupancy information which have been set up within Revit.



Identity Data	
Number	118
Name	Space
Room Number	Unoccupied
Room Name	Unoccupied
Comments	
Design Option	Main Model
Phasing	
Phase	New Construction
Energy Analysis	
Zone	Default
Plenum	☐
Occupiable	☑
Condition Type	Heated and cooled
Space Type	<Building>
Construction Type	<Building>
People	Edit...
Electrical Loads	Edit...
Calculated Heating Load	Not Computed
Design Heating Load	0.00000 kW

Figure 13: MEP Space Data – Space Properties

There are five levels of complexity for export, seeFigure 14 – gbXML Complexity:

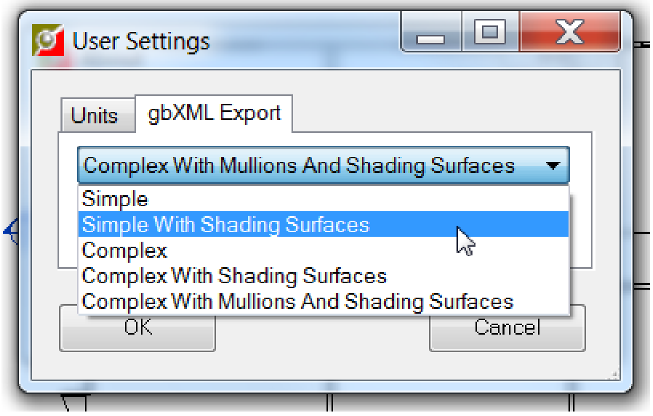
1. Simple: Simple means that curtain walls and curtain systems are exported with one "large" opening with the total opening area equal to all openings; a curtain wall with 50 panels gets exported as 1 opening. This is appropriate for thermal simulation, particularly early stage analysis.

2. Simple with Shading Surfaces: Export with simple glazing type and shading surfaces

3. Complex: Complex means that curtain walls and curtain systems are exported with several openings, panel by panel; a curtain wall with 50 panels will be exported as 50 openings

4. Complex with Shading Surfaces: This will export with a complex glazing type and include shading surfaces

5. Complex with Mullions and Shading Surfaces: This export option is the most complex type, including shading surfaces and mullions. 'With mullions' means that mullions in curtain walls and systems are exported as shading surfaces. A "simplified" analytical shading surface is produce from a mullion based on its centreline, thickness and offset. Remember that this is the most complex type of export, and will create hundreds, even thousands of shading surfaces. Use the level necessary for the analysis required. This is appropriate for Radiance calculations where the user will want to see the effect of the mullions.



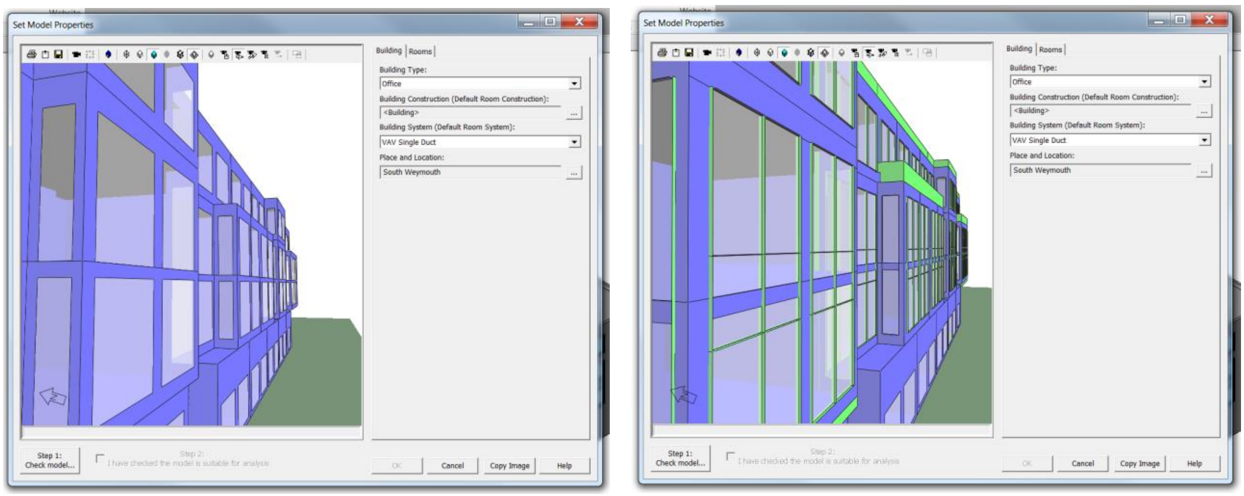


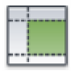
Figure 14: gbXML Complexity

1.9 Rooms & Spaces

Rooms are the most fundamental element for design/building performance analysis. They are elements that determine the accuracy of analysis from a Revit model. There are two different ways to model these within Revit which is determined by what Autodesk product the user is running.

Room

Revit Architecture 2014



Space

Revit MEP 2014

In Revit Architecture the user defines ROOMS in the model which the gbXML will recognise on export. In Revit MEP the user defines SPACES and can do so using an automatic SPACE placement tool. If these are not set the correct way round there is a warning that will pop up. (P10: Figure 8 - Project Information - Project Phase - Error Dialog)

If this does occur then the user can define within Revit weather to export Rooms or Spaces. To alter this go to the energy settings in the project information (P9 Section 1.8 Project Information) or go to File>Export>gbXML and open up the 'Export gbXML' settings dialogue. In the 'Export Category either can be defined for export.

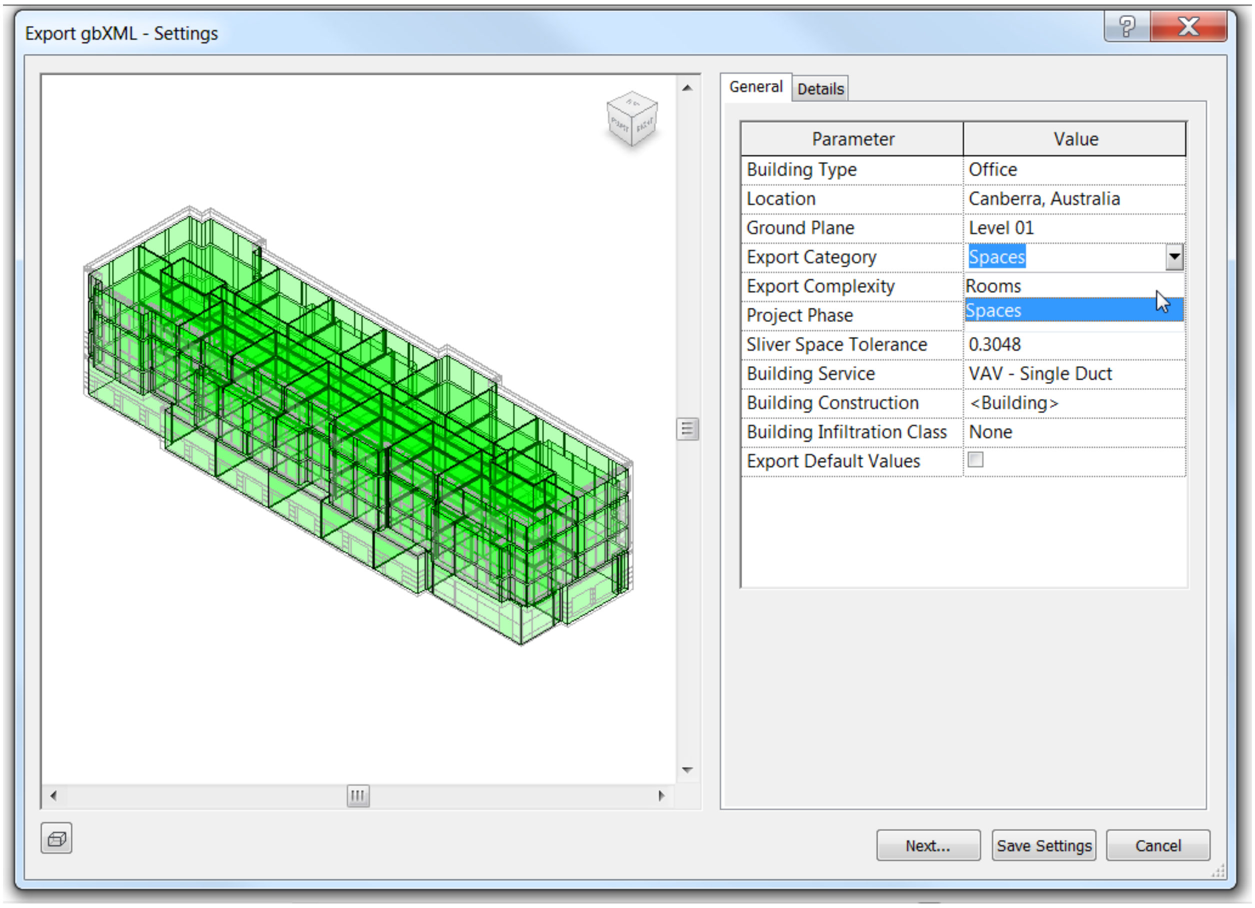


Figure 15: Export gbXML Settings – Revit

NOTE: Within the gbXML schema the Space is the analogy for a Room. For the purposes of clarity in this paper we will refer to these elements as Rooms in all cases.

"Room inside a Room"

The VE does translate the "room inside a room" or "donut" condition shown below, (Figure 16: Room inside a Room condition) but a cleaner geometry can be achieved by modelling the outer room as two parts utilising room separation lines.

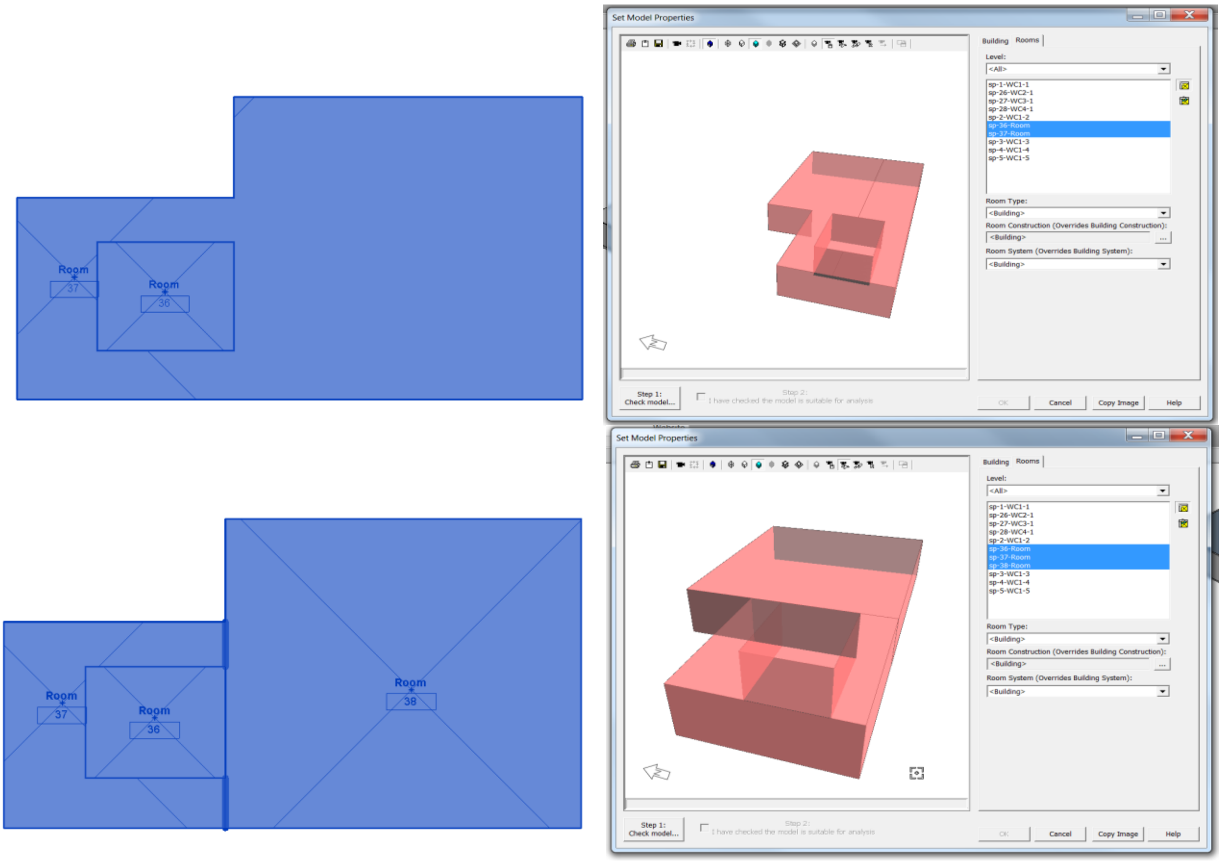


Figure 16: Room inside a Room condition

Where do we see this condition?

- Elevator Shafts
- Chases
- Closets
- Core and Shell style buildings
- AVOID floor openings. Add these in VE if necessary

Another issue to consider when creating the Revit model are the two different ways to model and define rooms within the Revit model; one is Zone-Based Modelling and the other is Room-Based Modelling.

1.9.1 Zone-Based Modelling

Zone-Based modeling is the concept of modeling and defining the Room by the thermal zone. A thermal zone is an individual space or group of interior spaces with the same thermal conditioning requirements.

Zone-Based modeling is especially useful when the project is in early design stage, since the internal layout might not be certain, it is best to simplify elements as much as possible.

The best way to defined Zone-Based modeling is to group all Rooms with similar thermal and space characteristics such as solar orientation, occupancy, lighting, and equipment loads into one Room. For example, in an office building, perimeter offices that are facing a similar orientation could be combined into one 'Room' (Figure 18: Zone-Based Modeling - Floor Plan).

When choosing any of these options the key is to carefully consider what outputs are required from the analysis.

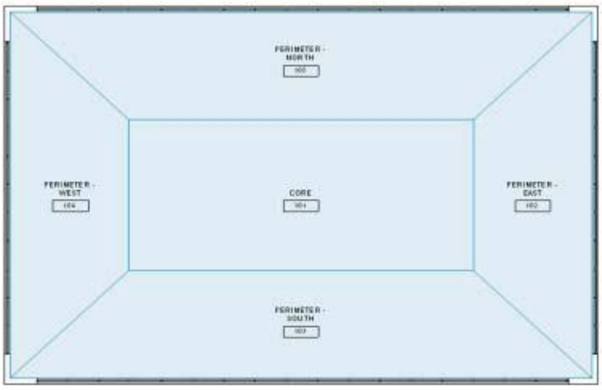


Figure 17: Zone-Based Modeling - Floor Plan - Perimeter vs Core

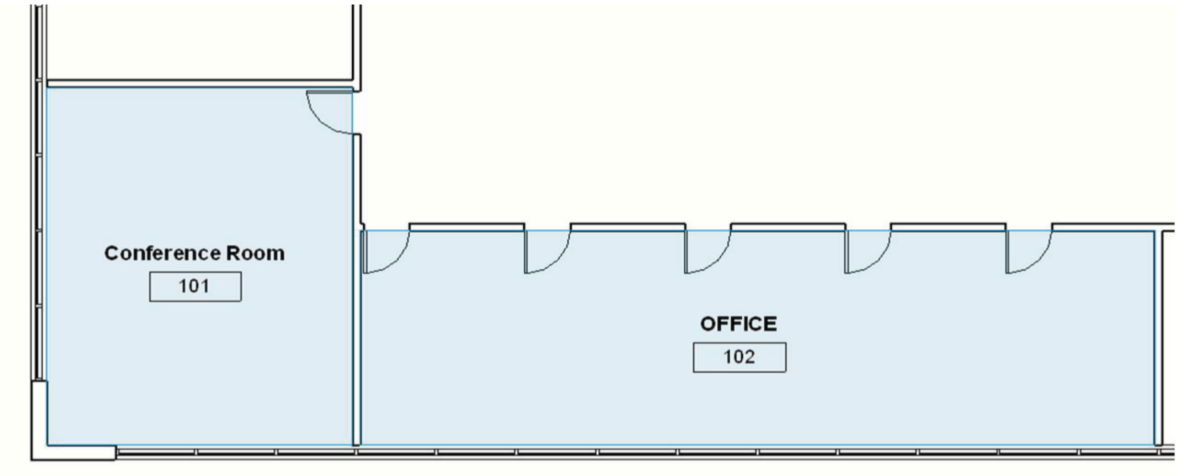


Figure 18: Zone-Based Modeling - Floor Plan

1.9.2 Room-Based Modelling

Room-Based Modeling is the concept of modeling and defining each Room as its own thermal zone. There are cases where this might occur, for example, a hotel, even though the hotel suites might be all facing similar orientation, but since each room can be thermal controlled separately, it might be useful to use Room-Based Modeling method rather than Zone-Based modeling.

For Room-Based Modeling, or any thermal modelling, it is important to place a “Room” in every space of the model, even if the space volume is a shaft.For example in Figure 20, the two rooms highlighted in red could be overlooked because the user does not want to analyse the results of these rooms. However in order for the model to be translated correctly these must be defined as rooms otherwise the model will come through with holes and internal surfaces represented as external in the geometry which will affect the results. The end goal is to achieve a fully enclosed building enevelope.

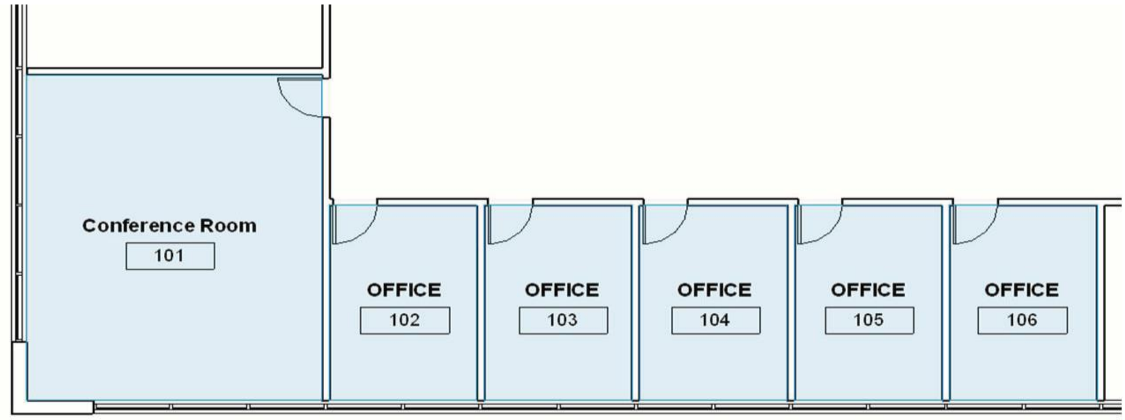


Figure 19: Room-Based Modeling - Floor Plan

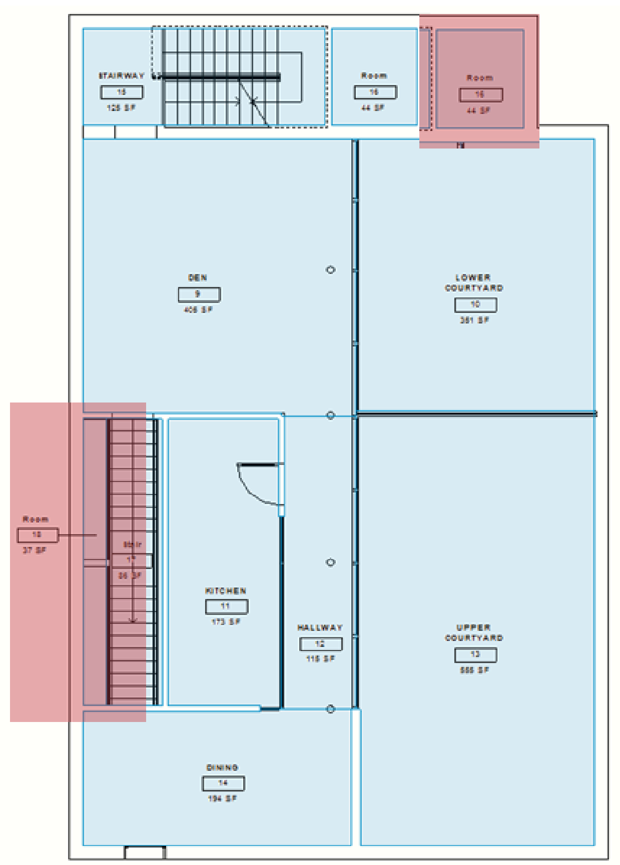


Figure 20: Placing Rooms

1.10 Shading Surfaces

When surface are created that are not room bounding these are interpreted as shading elements in the Virtual Environment when Room bounding elements are not bound by a Room. Roof Overhangs, balconies, or even surrounding buildings can be defined in this way and should all be considered when running building analysis because they will shade the building; however they should not be considered as rooms for analysis.

Shading devices need to be created as an obstruction with wall, roof or mullion families (Figure 22 - Curtain Wall Mullions Translation). The massing tool can also be used to build shading and then apply walls, floors and roofs by face.

Floor families and in-place systems will not translate as shading.

NOTE: Within the Virtual Environment, Shading surfaces, shading devices, surround buildings are known as obstructions. For the purpose of clarity here, these items are referred to as shading surfaces throughout.

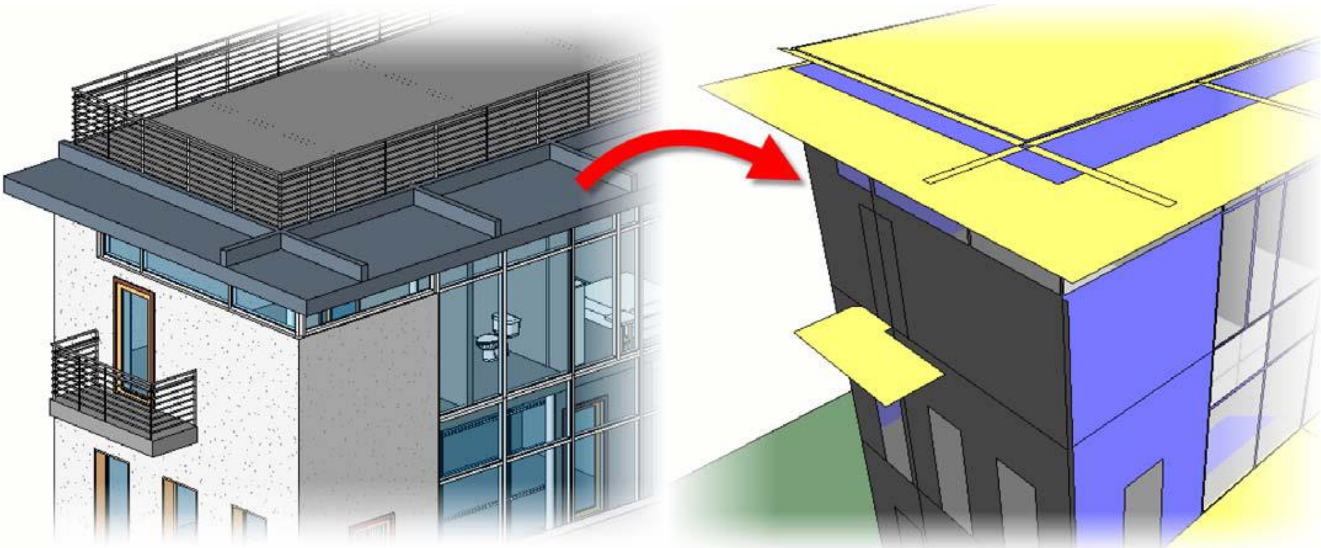


Figure 21: Shading Surfaces Translation

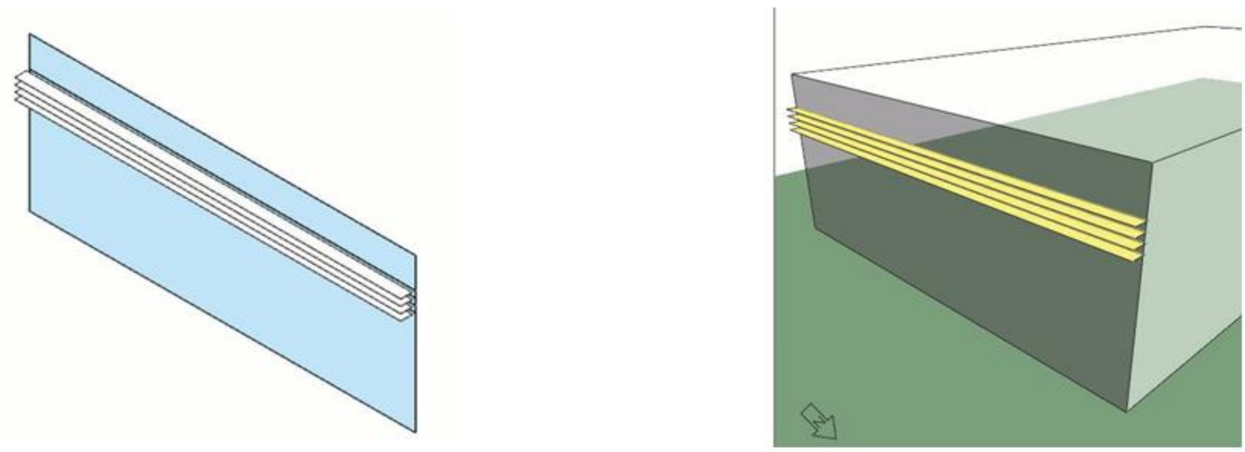


Figure 22: Curtain Wall Mullions Translation

1.11 Rooms vs Shading Surfaces

The best way to check if the elements are translating as Rooms or Shading Surfaces is to go to IES Set Model Properties dialog (Figure 23 - IES Set Model Properties). Elements that are in blue will be treated as Rooms (Figure 24 - Set Model Properties - Model Translation - Room), and elements that are in yellow will be treated as Shading Surfaces (Figure 25 - IES Set Model Properties - Model Translation - Room with Shading Surfaces)

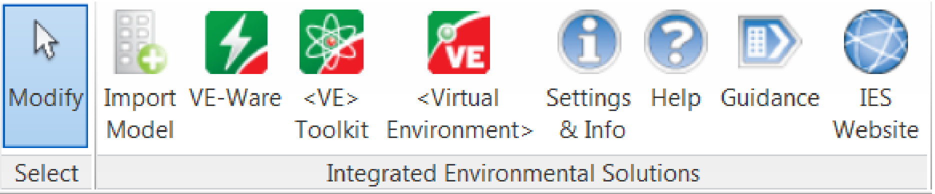


Figure 23: IES Set Model Properties

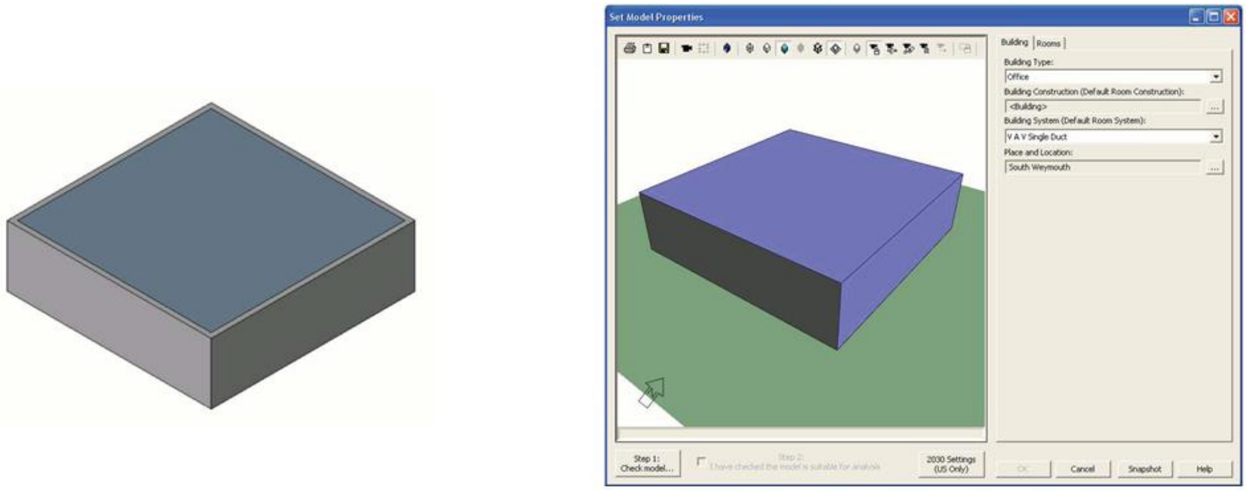


Figure 24: Set Model Properties - Model Translation – Room

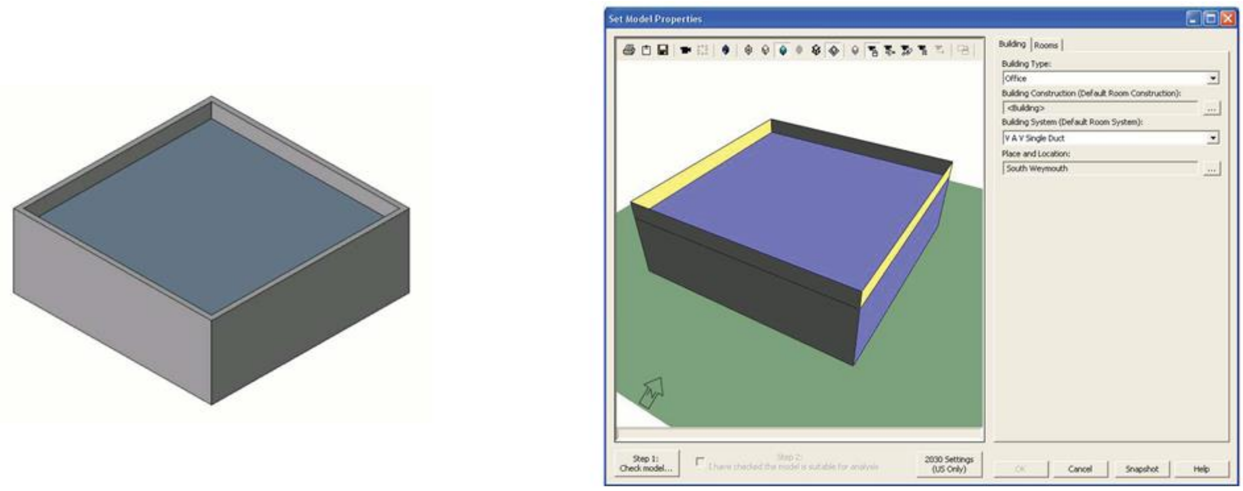


Figure 25: Set Model Properties - Model Translation - Room with Shading Surfaces

1.12 Surfaces

Rooms are defined by bound volumes for gbXML translation from a Revit model to a building performance model.

During the translation of the Revit model, these bounding elements are translated into 2D surfaces that enclose the 3D spaces (rooms). (See Figure 26 - Revit Model Translation to Virtual Environment)

The following elements are room bounding elements for Room Area and Volume Computations:

- Walls (Curtain, standard, in-place, face-based)
- Roofs (Standard, in-place, face-based)
- Floors (Standard, in-place, face-based)
- Ceilings (Standard, in-place, face-based)
- Columns (Architectural)
- Curtain systems
- Room Separation Lines

The user can check or uncheck 'Room bounding' instance parameter (Figure 28 - Room Bounding - Instance Parameters). If a room bounding element is unchecked, it will be excluded from the building performance analysis.

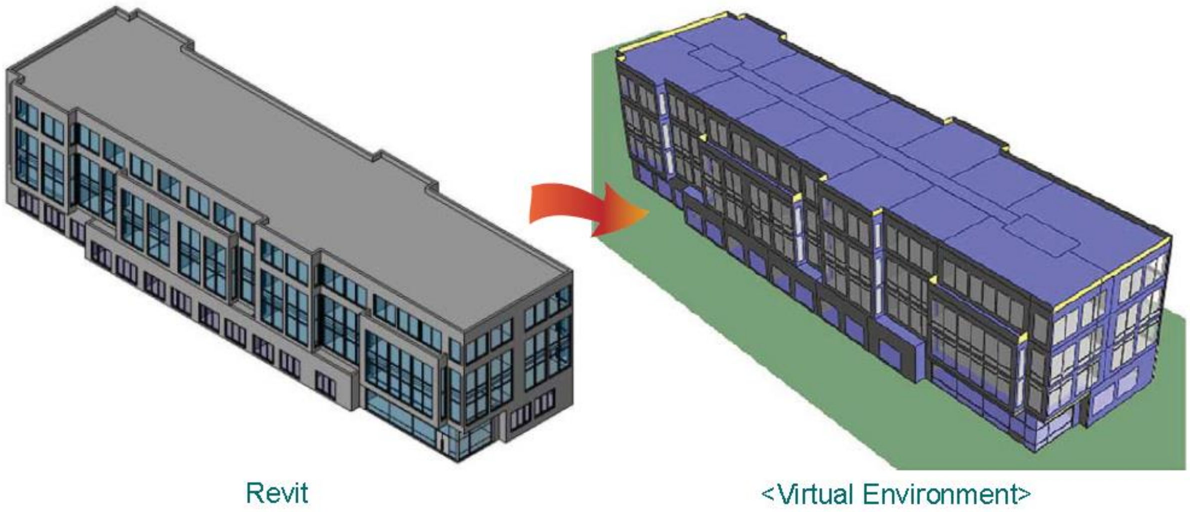


Figure 26: Revit Model Translation to Virtual Environment

Another situation where a Room bounding element is broken up into multiple surfaces is when rooms are adjacent to one another. In order to allow for situations where one room is conditioned while the other is unconditioned, the separating wall is treated as two surfaces in the Revit model.

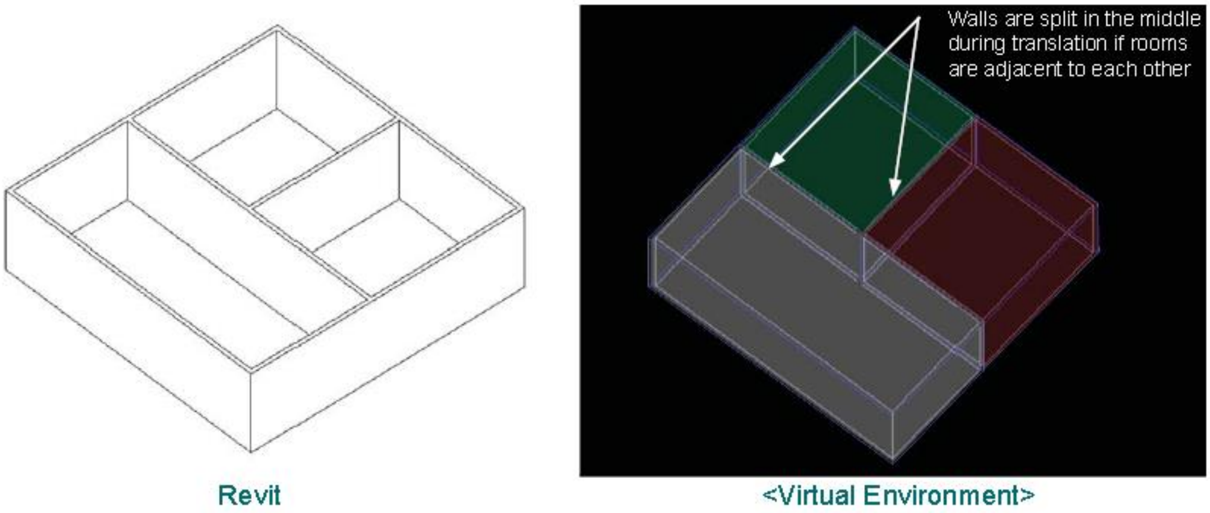


Figure 27: Breaking Wall into Two Surfaces in Building Performance Model

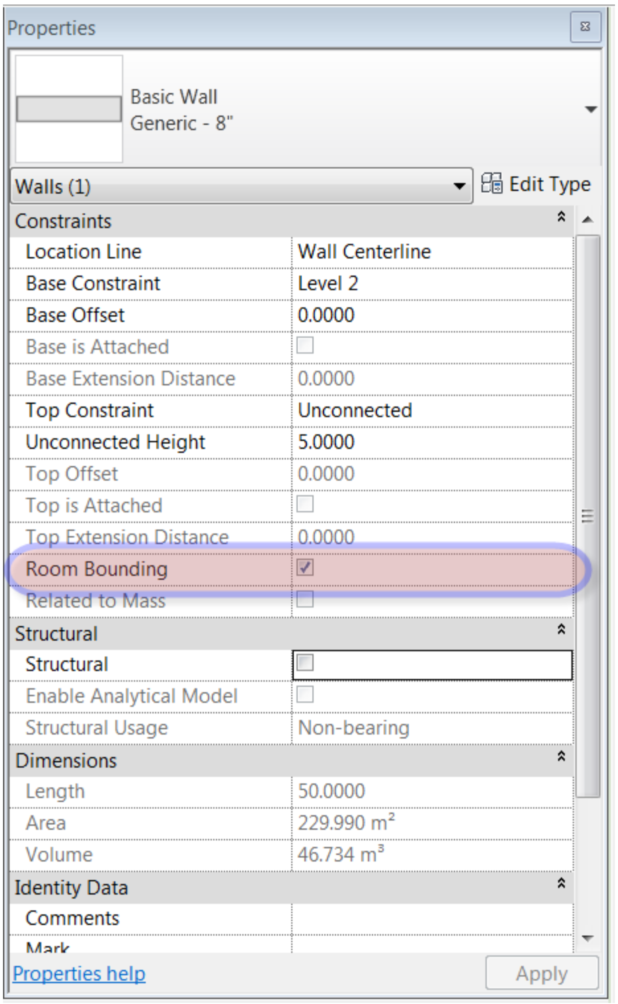
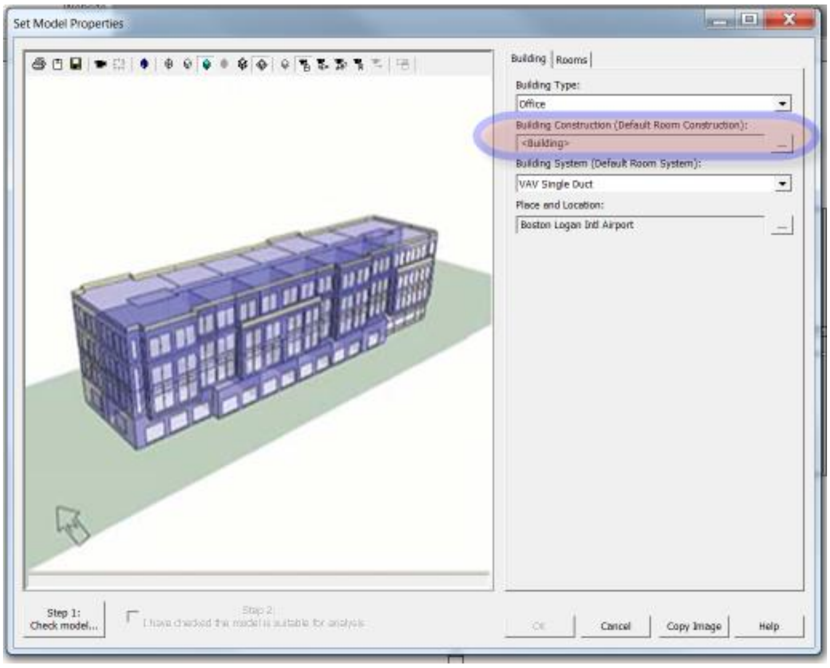


Figure 28: Room Bounding - Instance Parameter

The following sections will describe some of the issues to be aware of when modelling. Understanding these issues will help to produce a more accurate analysis model. This is where the differentiation between a Revit model for documentation purposes and a Revit model for an energy analysis purposes occurs.

1.12.1 Walls

Revit constructions and materials are not utilised by the Virtual Environment, because they do not necessarily contain the thermal properties needed to conduct dynamic thermal simulations. Therefore at the 'Set Model Properties' dialog, the user will be prompted to identify these at the building and/or room level.



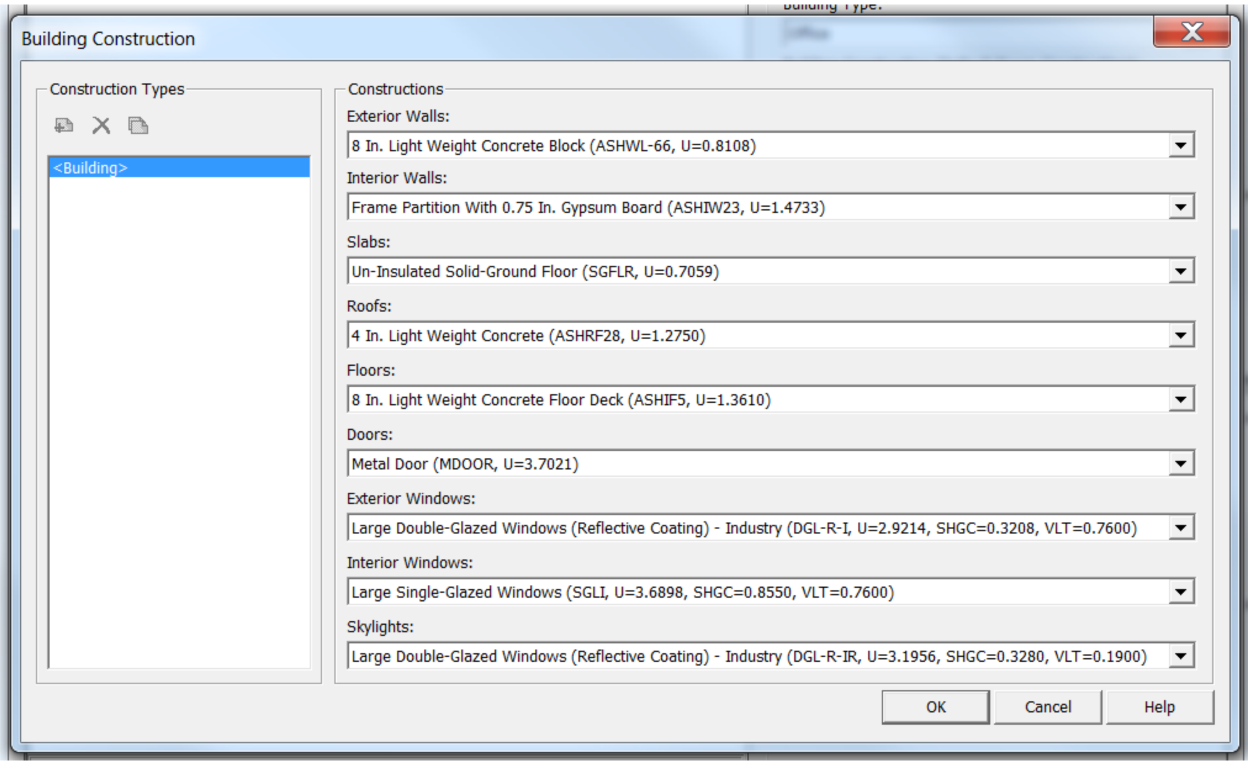


Figure 29: IES VE Building Construction Dialog

1.12.2 Walls – Basic modelling

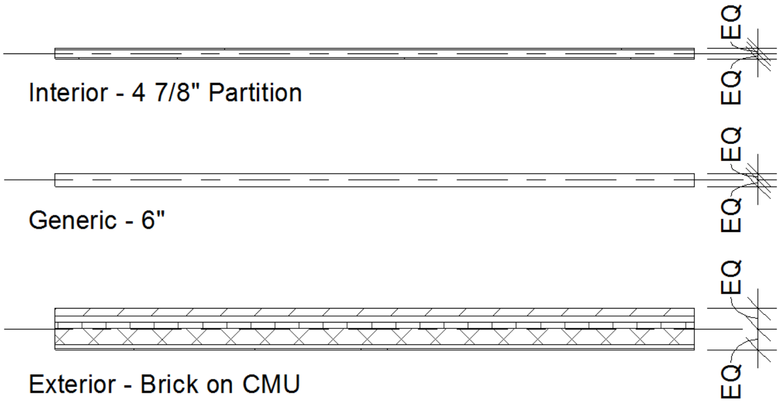


Figure 30a: Constructions

Walls translate from the ***Centreline*** of the wall regardless if it's a generic wall, interior wall or exterior wall. The thickness of the wall matters as this defines where the centreline will be located. Align walls based on centreline when designing, not wall face, if wall thickness varies.

Problem wall conditions:

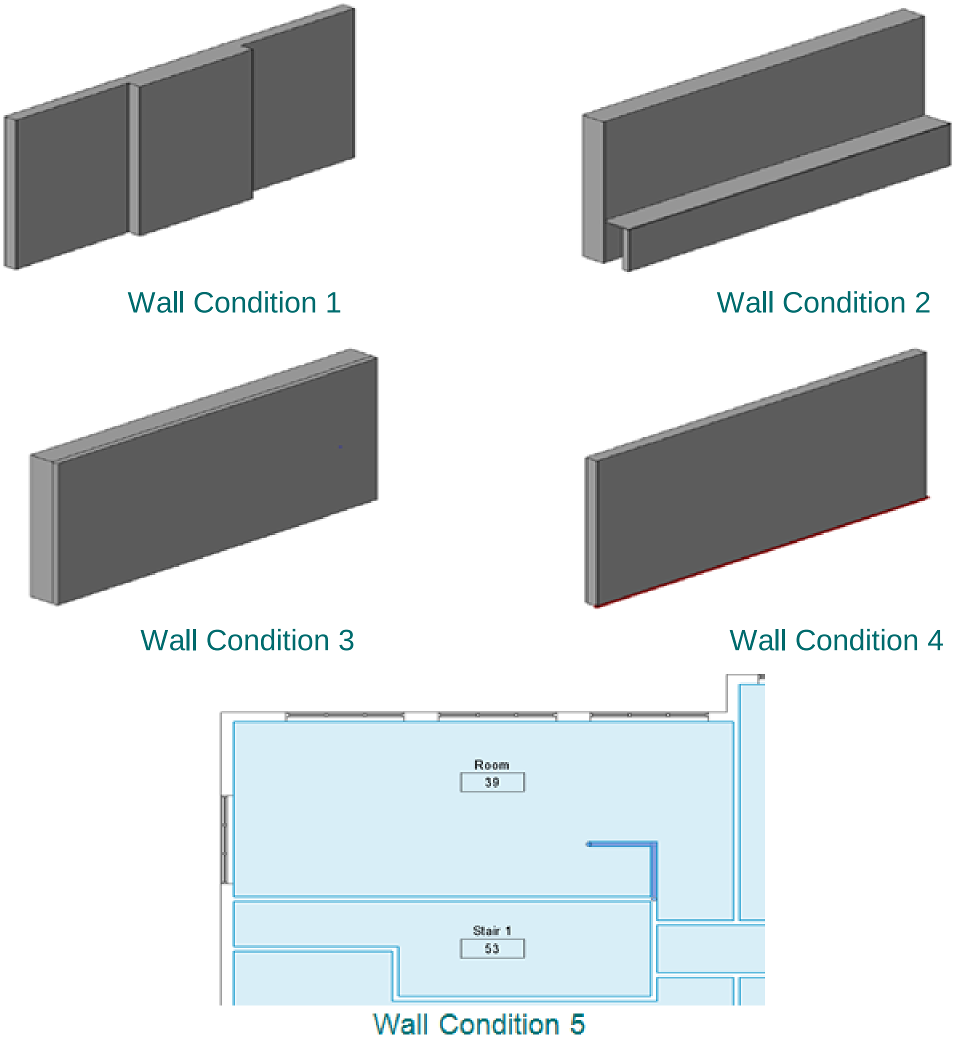


Figure 30b: Problem wall conditions

Wall Condition 1: Wall thickness changes on one side but align on another side. When this is imported it can result in holes on the exterior of the building. There is a fix for this when using the IES/Revit plug-in, however a standard gbXML will likely present these problems.

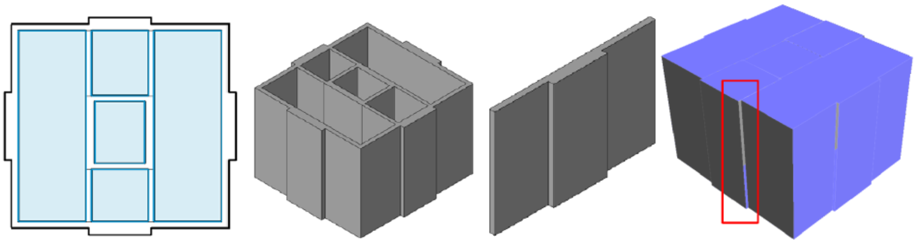


Figure 31a: Wall Condition 1

Wall Condition 2: Sill condition where the sill is made from a wall element. The results are that the room perimeter is "bound" in Revit by the sill wall, not the actual exterior wall. The solution is to make both the sill vertical wall, but also the horizontal shelf element, non-room bounding.

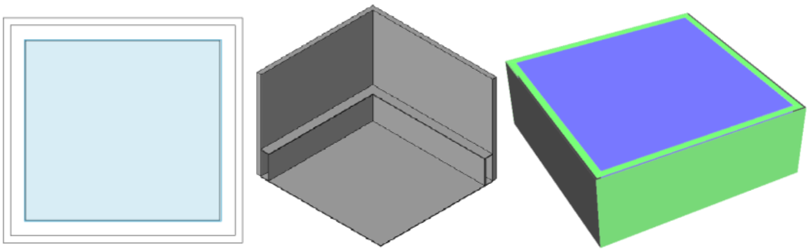


Figure 31b: Wall Condition 2

Wall Condition 3: Two layers of wall next to each other. The result is much the same as condition 2, as the interior wall becomes the bounding wall, and the exterior wall becomes a shading element. Either make the interior wall non-room-bounding, or build the core/layers of a wall using the constructions rather than layering two elements.

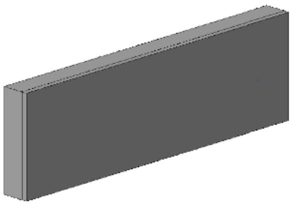


Figure 31c: Wall Condition 3

Wall Condition 4: A room separation line (red) is next to the wall. This does almost the same thing, except it makes a HOLE on the perimeter, with a shading element over it. ONLY use room separation lines to separate two spaces with a hole between them (meaning divided space without a wall or barrier). Never use around the perimeter of a room to get it too bound quickly. If it is not bounding correctly, there is an issue with the Revit model that must be addressed.

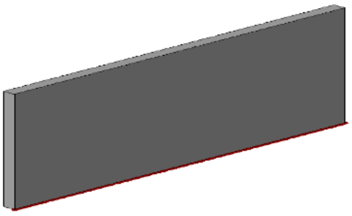


Figure 31d: Wall Condition 4

Wall Condition 5: When a partition protrudes into a room but does not close off to create a separate space (Figure 30b - Problem wall conditions) you have two choices. One, make the partitions in question non-room bounding or two; use room separation lines to partition off the required space

1.12.3 Floors

Revit floor types do not translate directly to the Virtual Environment, because they do not contain the thermal properties needed to conduct dynamic thermal simulations. Therefore at the 'Set Model Properties' dialogue, the user will be prompted to identify these at the building and/or room tab (Figure 29 - IESVE Building Construction Dialog). If openings between floors are included these should be removed before exporting to gbXML, as these will cause polygon lines to appear in the building performance model. Even though in reality spaces such as stairs, risers and elevator shafts do continue through multiple floors (Figure 32 - Openings through multiple floors), it is best to identify each room separately and then create the openings within theVirtual Environment (Figure 32 - Floors - Model from one level to next).

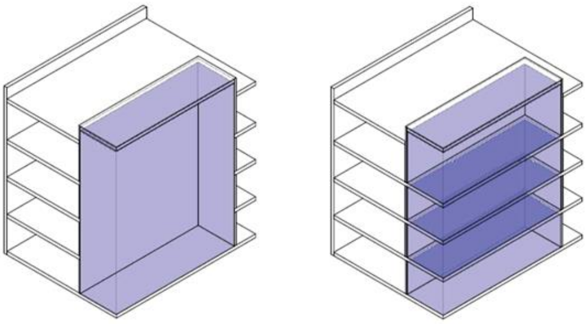


Figure 32: Openings through multiple floors/Floor Model at each Level

Problem Floor Conditions:

Floor Condition 1: A layer of floor construction on top of another and both are set to room bounding. Make the finished floor surface non-room bounding, ideally there will be a single floor slab for each floor. The other issue this causes is rooms disappearing in Revit. Avoid layered walls, floors and generally any layered elements that bounds rooms in the gbXML hierarchy.

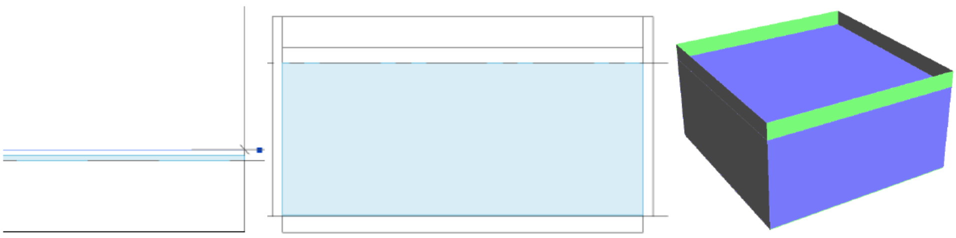


Figure 33a: Floor Condition 1

Floor Condition 2: A sloped floor ramp can cause similar issues to above. Make the ramp or sloped floor non-room bounding. If there are things like light shelves in rooms, those are also room bounding as they will affect the way the room volume fills the space.

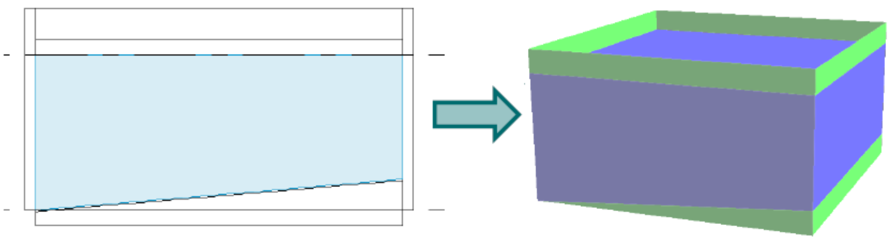


Figure 33b: Floor Condition 2

1.12.4 Roofs

Revit roof types do not translate directly to the Virtual Environment, because they do not contain the thermal properties needed to conduct dynamic thermal simulations. Therefore at the ‘Set Model Properties’ dialogue, the user will be prompted to identify these at the building and/or room tab. (Figure 31 - IESVE Building Construction Dialog P22) Always specify the Upper Limit above the top of the roof. It is especially important if the roof is sloped or pitched. This will ensure that there are no unnecessary shading surfaces in the building performance model. For a sloped roof, when Areas and Volumes are checked under Area and Volume Computations, the room will automatically wrap around the sloped roof. (Figure 34 - Room Volume at Slope Roof)

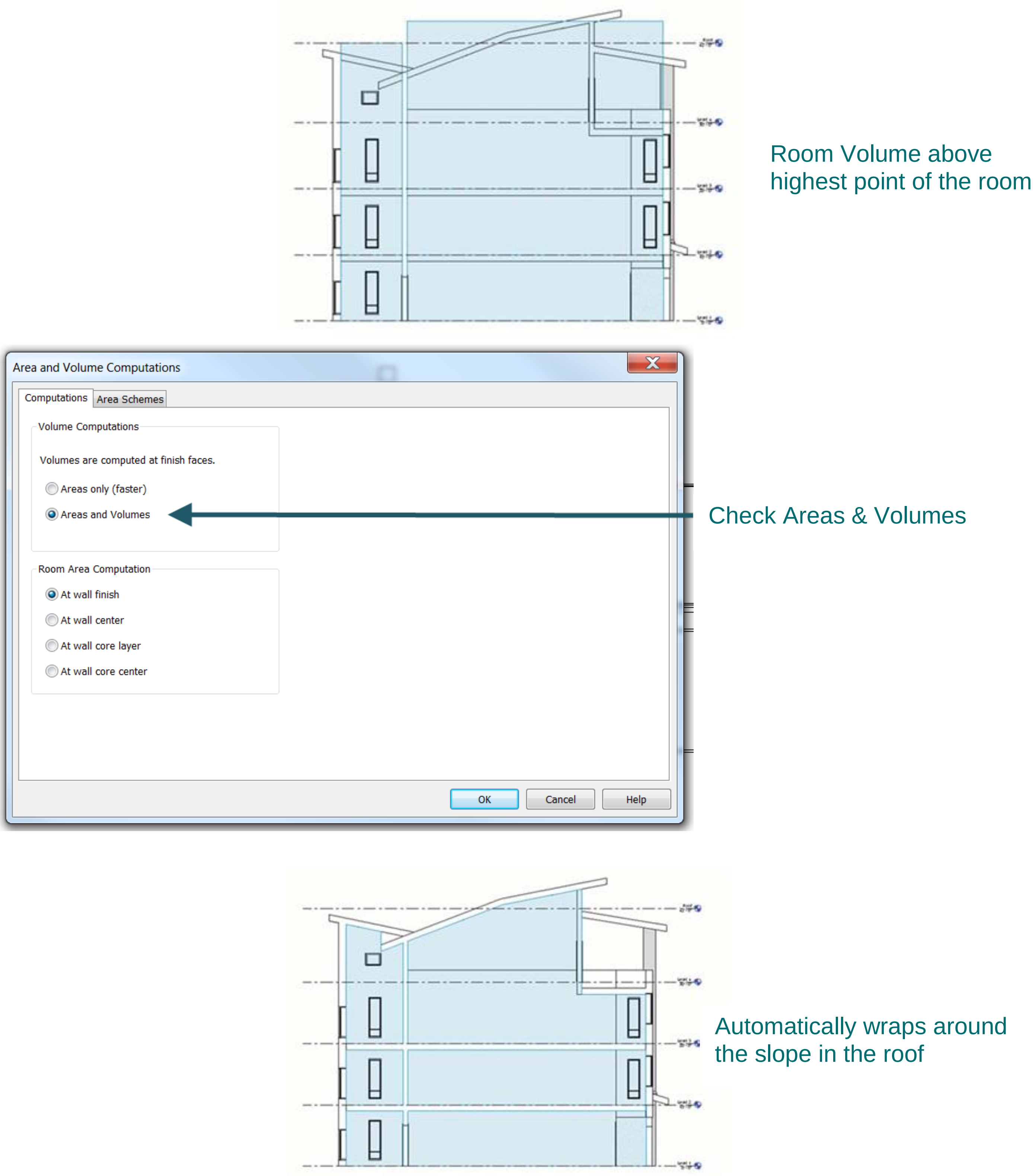


Figure 34 - Room Volume at Slope Roof

1.12.5 Ceilings & Columns

When it comes to modelling ceiling voids the first question that has to be answered is what is being simulated. This will determine if there is a requirement to include the ceiling voids in the model or not. If there is then there must be a room added to represent the void making sure that there is a fully enclosed building envelope with no air gaps. Within Revit MEP these spaces can be marked as plenums within the space properties dialogue. If this option is too complex another solution is to export the model excluding the plenum areas and model them within the VE. If they are not required for the analysis purposes, then the ceiling levels can be set to non-room bounding and the room levels set to the floor above.

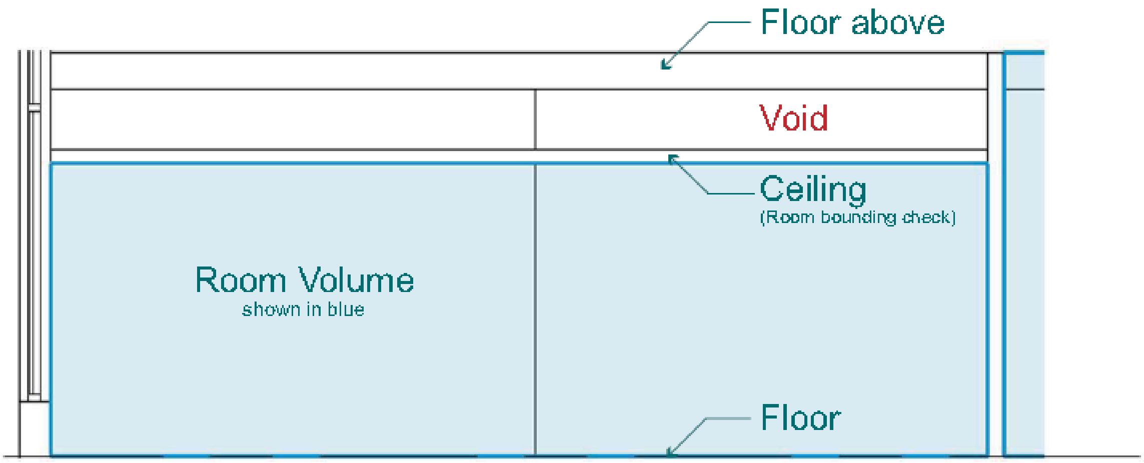


Figure 35 - Ceiling Void

Columns as room bounding elements will impact the volume of the building performance model. The volume of the column itself is subtracted from the total Room Volume, thus reducing the room volume. It is recommended that these are set to be non-room bounding (Refer to Figure 36 – Columns Translation from Revit to IESVE) for all columns before exporting the Revit Model to the Virtual Environment. Since there is no Room defined inside of the columns, and the columns are translated as surfaces for geometry, the room will mistakenly identify the adjacent space as exterior. If the columns are critical elements for the analysis, they can be recreated within the Virtual Environmenti.e. Required for lighting studies. Figure 36 - Diagram on the left.
Diagram Below Right - The Columns has room bounding "Unchecked", and it translated successfully into Virtual Environment

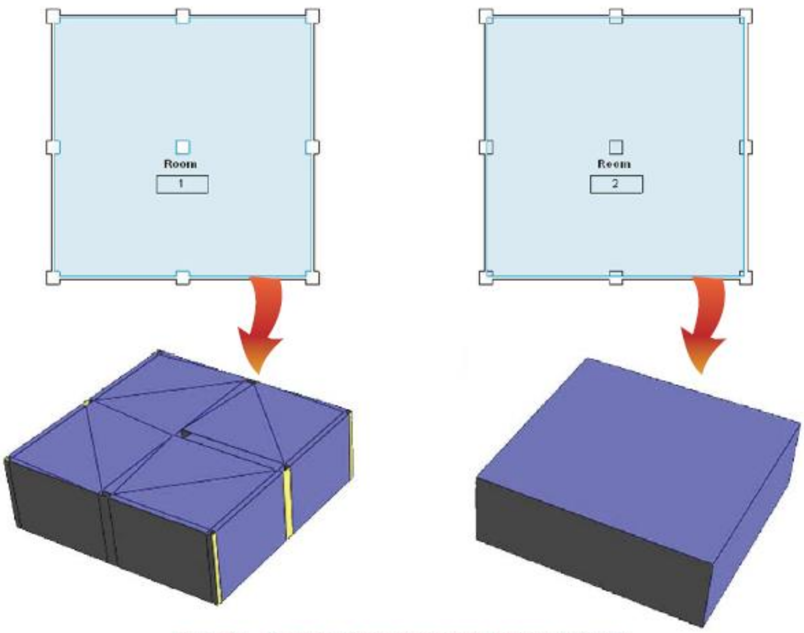


Figure 36 - Columns Translation from Revit to IES<VE>

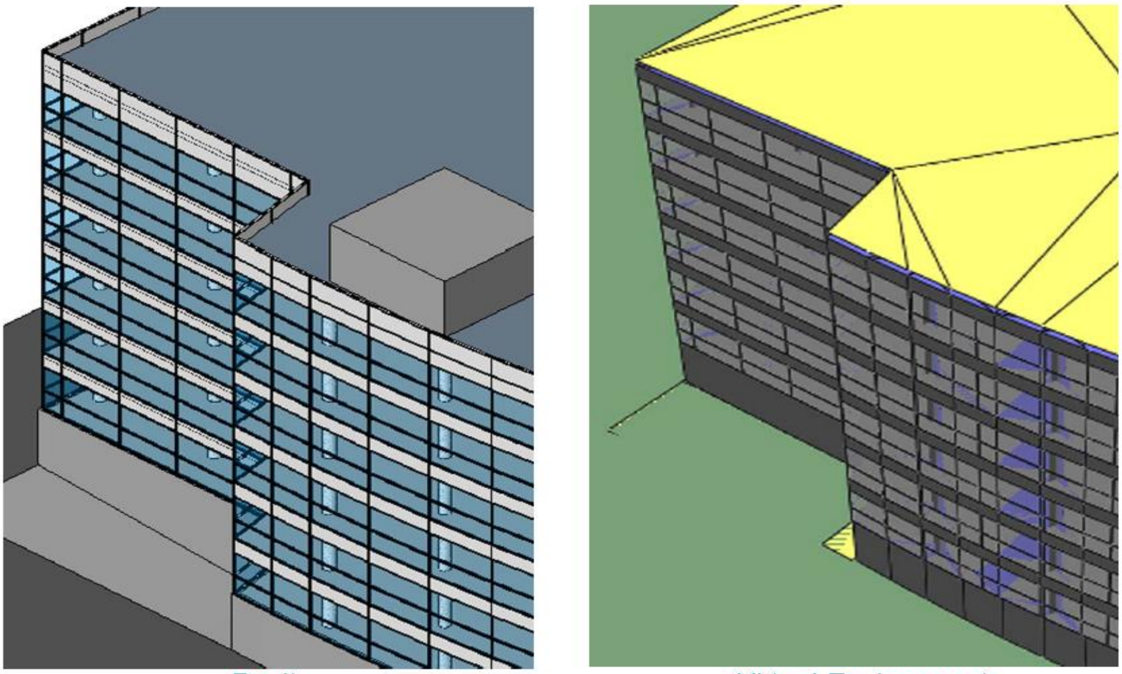
1.12.6 Curtain Walls

Curtain walls are “translated” into surfaces and openings for the purposes of export to a building performance model. A curtain wall will be translated as a Wall surface. For every glazing panel in the Curtain wall, there will be a window opening. If the Curtain wall is curved, it will be faceted to several planar wall surfaces.

NOTE: If the glazing panel material is less than 3% transparency, it will be translated as a solid panel.

Tips for better translation using curtain walls:

1. Try to do a full height curtain wall if possible, or as few sections as possible. This means ideally the curtain wall goes from ground to roof across all the floors. To insert opaque sections into the wall, replace the glazed panel with a panel with 3% transparency or less and it will translate as a solid wall. DO NOT stack walls, as is common practice in many firms, as this confuses the room perimeter. Grid the curtain wall and adjust the panels to get the correct window/wall coverage, rather than many different walls, for best translation.
2. Doors in curtain walls will not be translated. Leave as glazed panel if glazed doors, as doors will come through as solid panels. For it to translate as a door, it must be in the door family. Glazed doors are not an option in the toolkits, and must be made in the VE.
3. Do not embed curtain walls into opaque or any other walls, as it will cause issues with the translation of the glazing. Keep it simple, using the correct family for the correct envelope element. Use a custom created window if necessary.



Revit <Virtual Environment>

Figure 37 - Curtain Wall Translation

1.12.7 Room Separation Lines

Room separation lines are Room bounding elements. They are useful in building performance analysis if a large room needs to be calculated for different HVAC loads. For example, for separating a perimeter zone 15’-0”/6 meters from the building envelope from an interior zone or if a large open plan area in the model is to be zoned.

1.13 Openings

Openings are elements such as windows, doors and skylights. They are usually hosted components in the system families. Like ‘Room bounding’ elements and surfaces, openings are represented as 2D surfaces during the translation from building information model to building performance model. The model will only translate what is needed to conduct for the analysis. Note that the railings did not translate into Virtual Environment from the Revit model, because they have very little, if any, influences on the analysis.

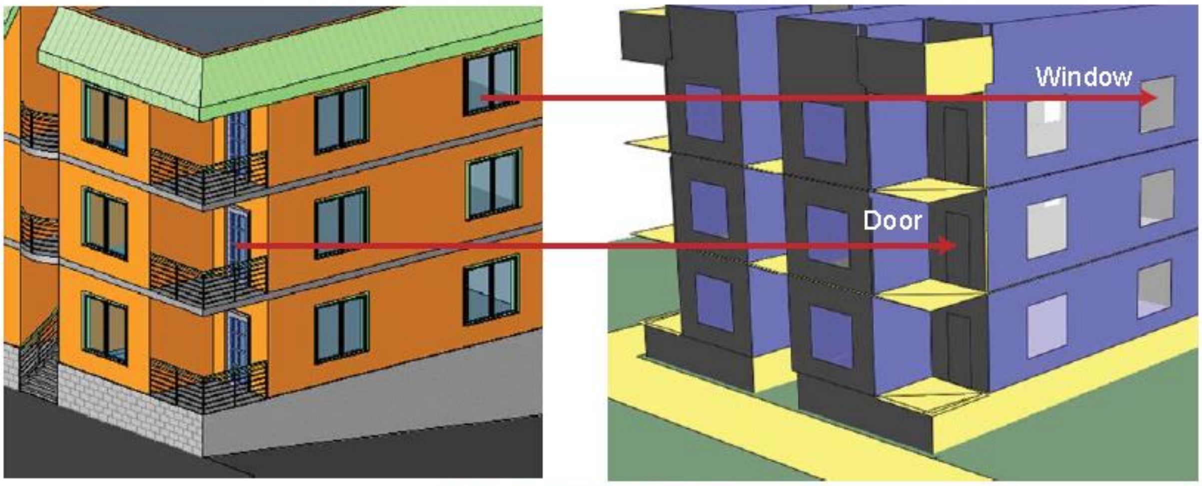


Figure 38 - Openings Translation

1.13.1 Doors

It is very important to use a door template when creating custom doors. If a door template was not used, it can result in the Room to extending beyond the area expected.

1.13.1.1 Elevator Doors

It is recommended to use a door template when creating elevator doors. If an elevator is required, then another template should be used to create that separately. An elevator door should also be placed at each floor level the elevator crosses.

1.13.1.2 Glass Doors

Doors with glazed panels will not export as a glazed door during the gbXML translation. Once exported to the Virtual Environment, the glazed panels can be added. The other option is to define the door as a piece of glazing.

1.13.2 Windows

When creating custom windows, it is also very important to use a window template. If a window template was not used. It can affect the analysis calculations by allowing air flow where none is present.

1.14 Defining the Upper and Lower Boundary

Together, the Upper Limit and Limit offset parameters define the upper boundary of the room. It is important to make sure the Upper Limit and Limit Offset is set correctly for design/energy performance analysis. If the Upper Limit and Limit Offset leave a void between the define area and the level above, this void area will recognised as exterior in the design/building performance model. As a general rule, it is a good practice to set the Limit Offset to 0’-0”, and set the Upper Limit to the next level, or the height that covers the highest point in the space. The reason for that is for any reasons the floor to floor heights change later in the design phase, the room volume will always be constrained. Use the Base Offset parameter to indicate the distance between the base level and the lower boundary of the room. Enter a positive number to move the lower boundary above the base level. Enter a negative number to move the lower boundary below the base level.

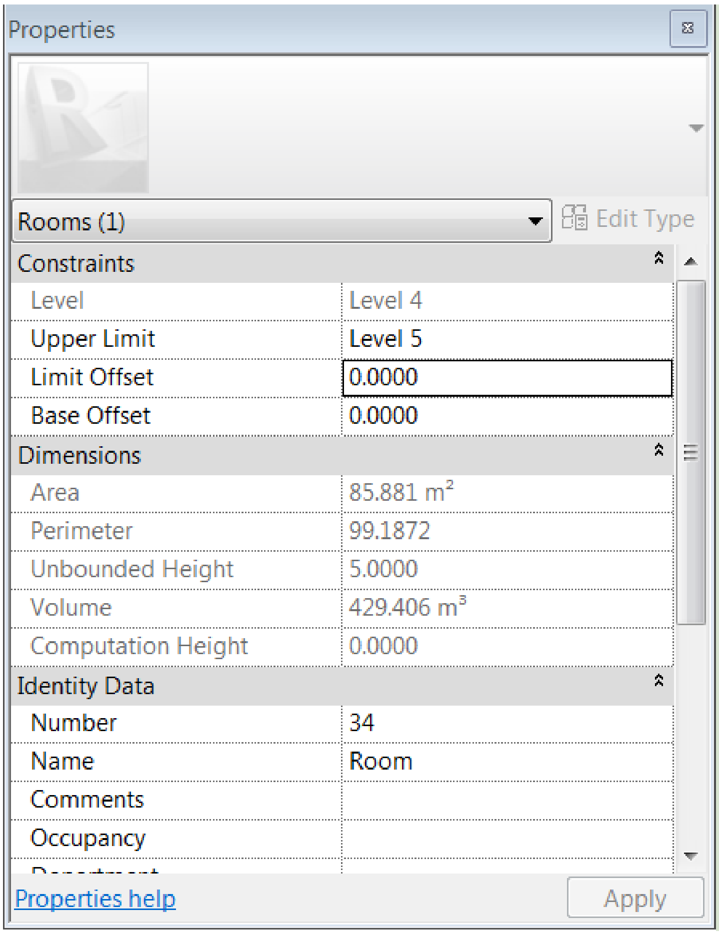
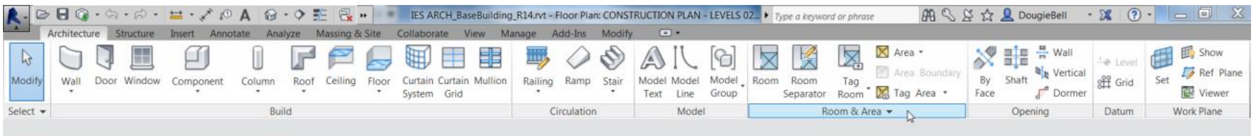


Figure 39 – Properties Dialogue

1.15 Room Volume Computations

Compute Room Volumes determines the room volume and room height. Room volume computations affect Revit performance; it is turned off by default. Before performing analysis it is critical to set this. The Location where this is set is dependent on the version of Revit.

Revit Architecture – It can be set on the Home tab in the Room & Area section.



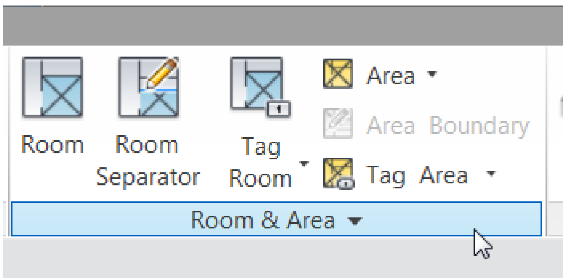
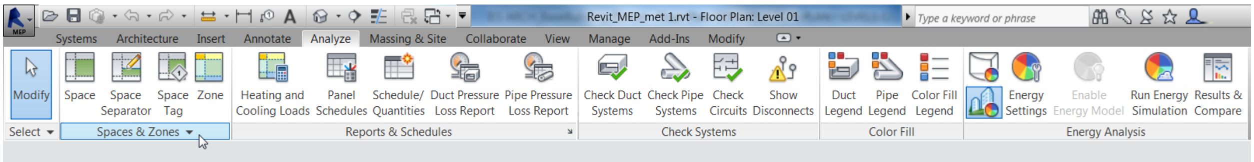


Figure 40: Room Volume Computations setting in Revit Architecture

Revit MEP – It can be set in the Analyze tab in the Spaces and Zones section.



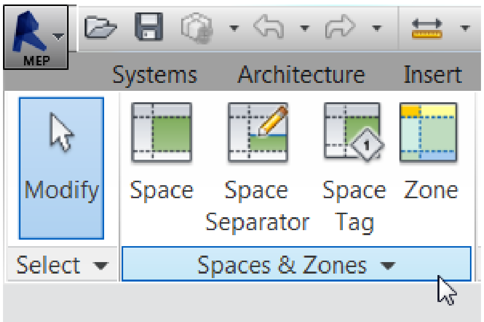


Figure 41: Room Volume Computations setting in Revit MEP

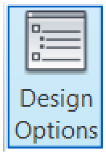
NOTE: Room volumes are computed to the wall finish, regardless of the Room Area Computation setting.

1.16 Linked RVT Files

In Revit, Rooms/Spaces are recognised as room bounding elements that are placed in linked RVT models. After linking the Revit model into the project, select the linked model, go to Edit Type/Type Properties in the element properties and make sure Room Bounding is checked.

1.17 Design Options

If design options are used in Revit, the primary option is typically the preferred design. It is usually displayed in the project views by default. All others are secondary. During the export to gbXML, the primary option is the option that will be export. If another option needs to be export for design/energy performance analysis, click tools menu > Design Options > Design Options or click on the Design Options toolbar.



In the Design Options dialog, select the secondary design option to promote. Under Option, click Make Primary

.

1.18 Families

Currently, lighting fixtures will not be able to export from Revit to IESVirtual Environment. The ability for lighting fixtures to translate into IESVirtual Environment is under development. Most of the families do not export during the gbXML translation. Components can be placed separately in Virtual Environment and used in daylight, natural ventilation, or CFD analyses.

1.18.1 Building Constructions

These must be set using the IES toolbar. Constructions set in Revit don't contain the detailed parameters such as material density, conductivity, vapour resistance, etc, necessary to use for a dynamic thermal analysis.

1.18.2 Lighting Data

Currently, lighting data can be export from Revit to IESVirtual Environment.

These do not export directly from Revit to Virtual Environment. If lighting files have (.ies) format photometric data, these can be imported and used in FlucsPro, LightPro, and RadianceIES to explore dimming strategies, energy usage, different layout options, etc. Many manufactures will provide the (.ies) files on their website for all of their luminaire products.

1.18.3 Furniture

Furniture will not export out as part of the building performance model. Components can be placed separately in IESVirtual Environment.

1.19 Cleaning Out Existing Revit Models

By reducing the amount of information in the Revit model, it can greatly reduce the file size and the runtime on building performance analysis.

1.20 Import Enhancements – Virtual Environment

The new import settings have been improved and the control has been given to the user.

Tidy Algorithm – This is a function developed by IES that runs on import gbXMLs to the Virtual Environment. The user can choose to turn this function on or off with this tick box. The tidy function will try to:

- Close rooms
- Add/remove vertices & edges
- Invert surfaces when orientated incorrectly

Include space boundaries resulting from columns – This function was developed to help in particular where BIM models are being reverse engineered for gbXML export to the Virtual Environment. With this option deselected the VE will ignore columns that are in the gbXML as long as the BIM package they are coming from have them correctly tagged as ‘columns’.

Minimum space boundary area(m^2) to be considered for inclusion – this allows the user to set a tolerance level which allows for small surfaces to be ignored further cleaning up the imported geometry.

Maximum number of surfaces to allow in space boundary (when tidying) – This option allows the user to set a tolerance for the tidy algorithm. In the image of the user preferences dialogue it is set at 500, therefore all spaces that have less than 500 surfaces will have the 'tidy algorithm' applied to them. If the space has more than 500 surfaces the raw geometry will be imported into the VE.

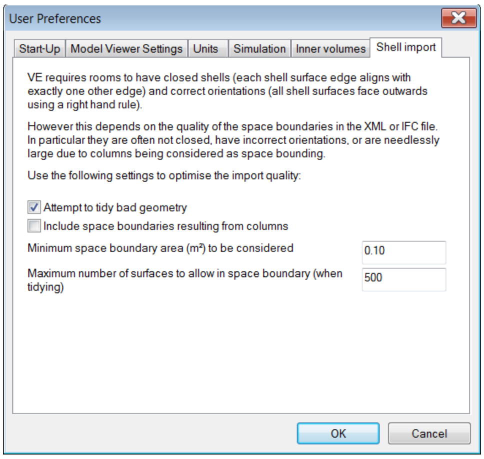


Figure 42: VE > User Preferences > Shell Import

Another useful option in the 'User Preferences' dialogue under the 'Inner Volume' tab is the "Remove the override protection from imported inner volumes". Unchecking this allows for a cleaner geometry import as well as any geometry changes once in the Virtual Environment.

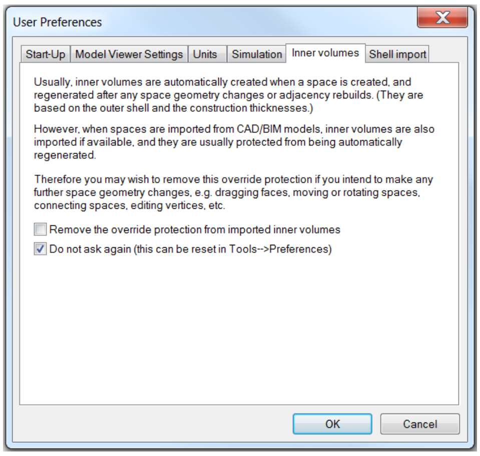
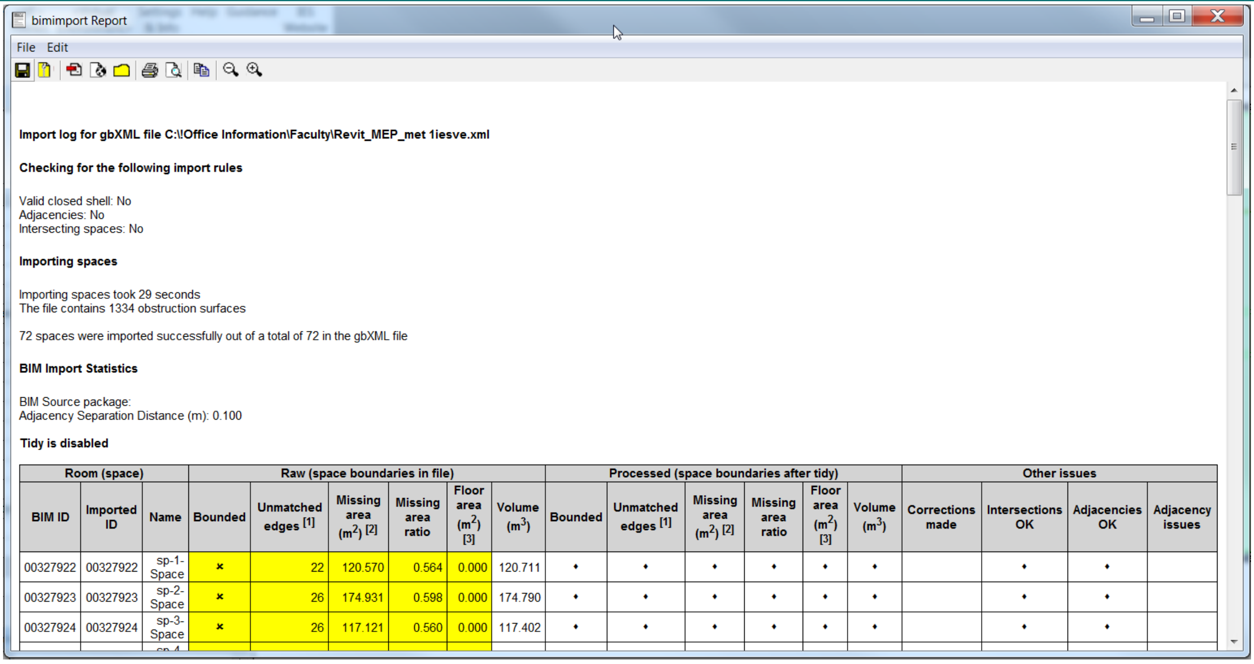


Figure 43: VE > User Preferences > Inner Volumes

1.21 BIM Import Report

As part of the import process of a gbXML file into the Virtual Environment IES have introduced a new report that gives the end user a much clearer picture of the work being carried out by the software in the background in trying to import geometry. The report highlights the quality of the raw gbXML before any VE algorithms are applied.



bimimport Report

File Edit

Import log for gbXML file C:\!Office Information\Faculty\Revit_MEP_met 1iesve.xml

Checking for the following import rules

Valid closed shell: No
Adjacencies: No
Intersecting spaces: No

Importing spaces

Importing spaces took 29 seconds
The file contains 1334 obstruction surfaces

72 spaces were imported successfully out of a total of 72 in the gbXML file

BIM Import Statistics

BIM Source package:
Adjacency Separation Distance (m): 0.100

Tidy is disabled

Room (space)			Raw (space boundaries in file)						Processed (space boundaries after tidy)						Other issues			
BIM ID	Imported ID	Name	Bounded	Unmatched edges [1]	Missing area (m^2) [2]	Missing area ratio	Floor area (m^2) [3]	Volume (m^3)	Bounded	Unmatched edges [1]	Missing area (m^2) [2]	Missing area ratio	Floor area (m^2) [3]	Volume (m^3)	Corrections made	Intersections OK	Adjacencies OK	Adjacency issues
00327922	00327922	sp-1-Space	×	22	120.570	0.564	0.000	120.711	•	•	•	•	•	•		•	•	
00327923	00327923	sp-2-Space	×	26	174.931	0.598	0.000	174.790	•	•	•	•	•	•		•	•	
00327924	00327924	sp-3-Space	×	26	117.121	0.560	0.000	117.402	•	•	•	•	•	•		•	•	

Figure 44: VE > gbXML BIM Report