AB2260 - No Pain All Gain: Autodesk Revit 2014 Automatic Energy Analytical Model Creation and Analysis

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Class summary…

Energy analysis has typically been a complex and time-consuming endeavor. At its foundation lies an energy analytical model (EAM) and while advances in BIM have made significant gains in collaboration and productivity, EAM creation is still largely a skilled manual effort and subject to wide variability in BIM and energy analysis practices. **A new feature in Autodesk Revit 2014** Energy Analysis software that **uses architectural building elements now greatly simplifies and standardizes EAM creation and subsequent analysis**. This class provides background on what an EAM actually is, current industry practices and standards, and a comprehensive walkthrough of numerous worked examples directly in Revit 2014 to highlight how this new feature actually translates different architectural building elements and configurations into a high quality EAM, all without having to add, rebuild, or do any other bespoke model preparation, thereby helping you to deliver higher performing buildings more cost effectively and with greater confidence.

Refer to Autodesk University 2012 Class AB2678 for more general background on Revit Energy Analysis

Key learning objectives

At the end of this class, you will be able to:

- Explain what exactly an energy analytical model (EAM) is and the different ways and means they can be created
- Describe how the new Energy Analysis feature, which uses Building elements, works in Revit 2014
- Show how accurate the resulting EAMs can be and how they compare to typical industry tools and practices
- Describe how the EAM can be analyzed by Autodesk Green Building Studio in the cloud in a fraction of the usual time and effort

What ‘pain’ in energy analysis?

- Lack of time in the design process
- Rapidly changing design information

} Especially at early stages

- Widely varying tools and practices (documentation & analysis)
- Requires significant time and expertise
- Difficulty in assuring quality & consistency
- **Need for an Energy Analytical Model (EAM)**

Revit Energy Analysis Features & Workflows…

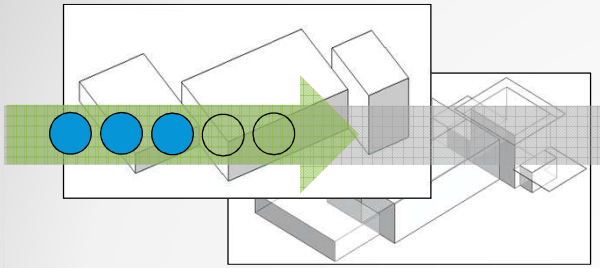
CONCEPT

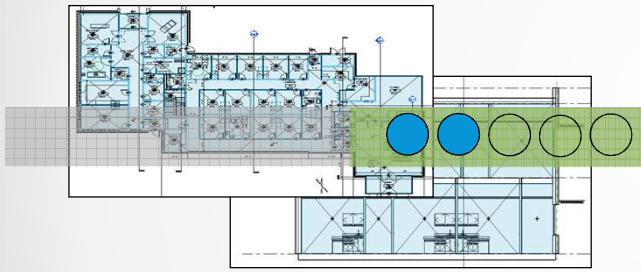
DETAIL

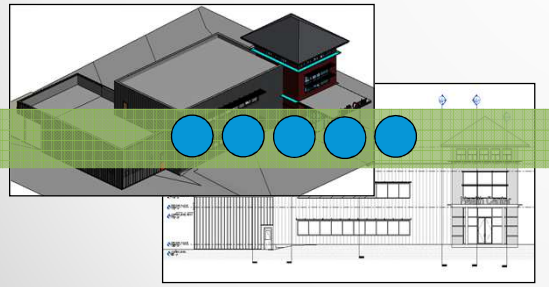
'Use Conceptual Massing elements'

'Use Room or Space elements'

Revit 2014 – 'Use Building Elements'



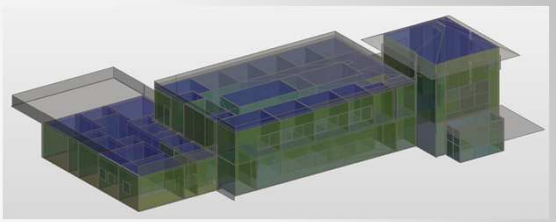




Revit Integrated

gbXML export

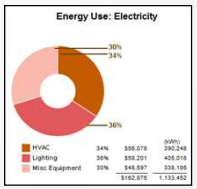
Revit Integrated

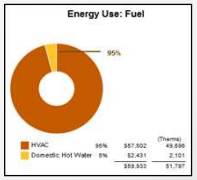


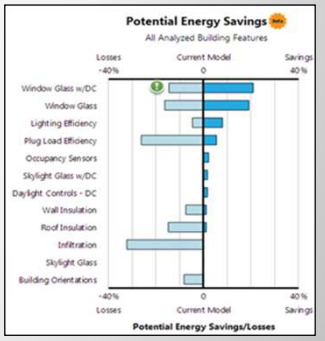
Energy Analytical Model

AUTODESK GREEN BUILDING STUDIO

DOE-2







Whole Building Energy Simulation

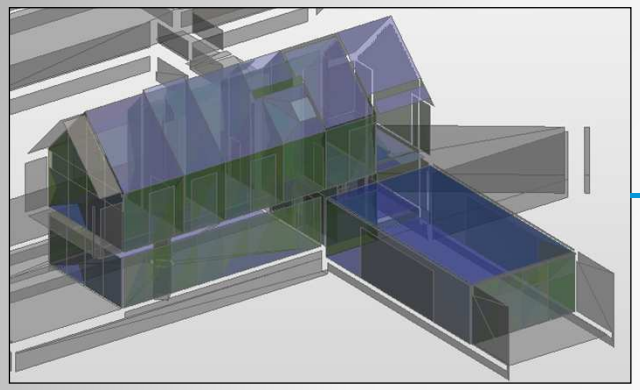
Typical application

Relative ease & speed

Exercise 1.0 – The Basics

- Energy Analysis ‘using building elements’
  - Set minimum energy settings:
    - Location
    - Building type
  - Run an energy simulation
  - View simulation results
  - **View the Energy Analytical Model**

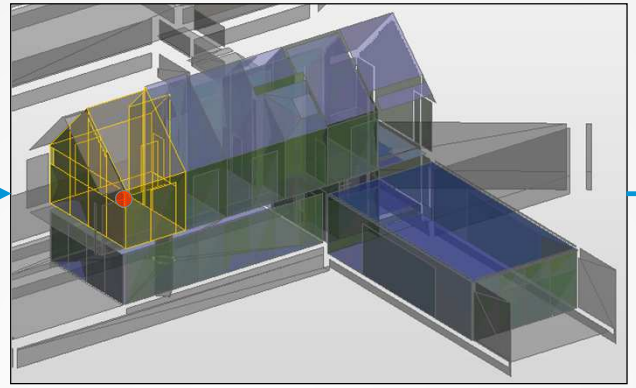
What does an Energy Analytical Model contain?

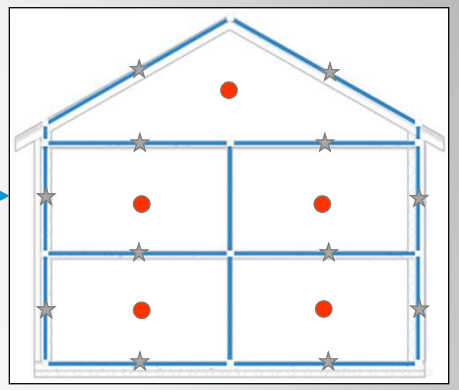


An EAM comprises of ***Spaces***, ***Surfaces*** & ***Zones***

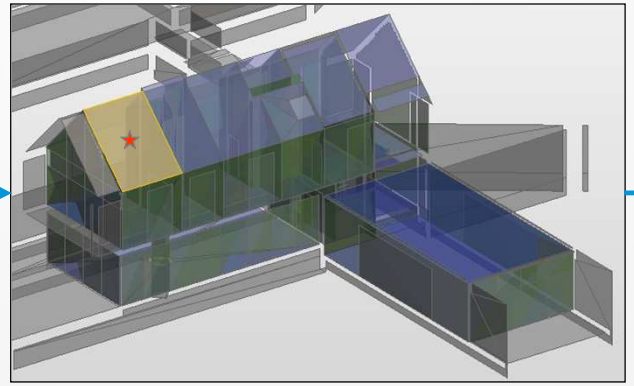
Zones are simply groups of one or more ***Spaces*** *for HVAC* system assignment

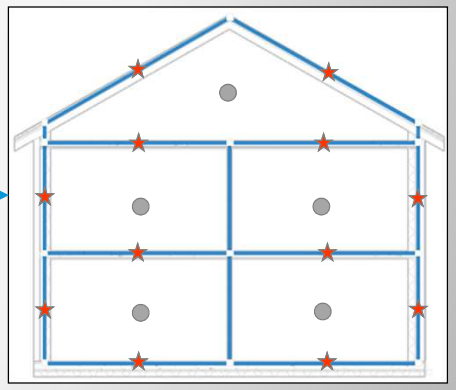
For more information see this BPA blog post and this BPA help topic on EAMs





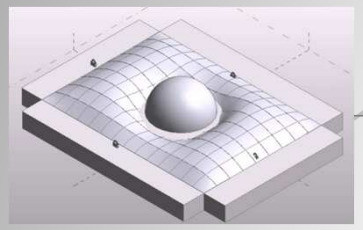
Spaces are discrete volumes of air that experience heat loss and gain individually each with an ***Area*** and ***Volume***





Surfaces are discrete paths of heat transfer b/w ***Spaces*** and the outside based on ***Adjacency***, ***Type*** & ***Planar Geometry*** i.e. Area, Orientation & Tilt

Typical EAM accuracy & precision…



Abstraction

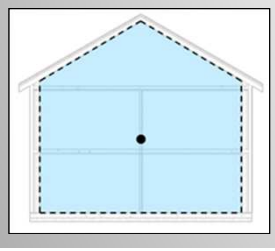
Design process

Reality

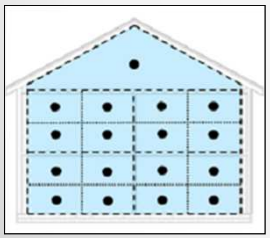
Spaces			Surfaces		
Discretization	Area	Volume	Adjacency & Type	Area	Orientation & Tilt

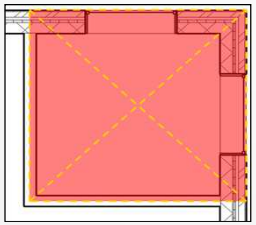
Accuracy (+ / -)

Typical tools & practices ~ +/- 10% overall

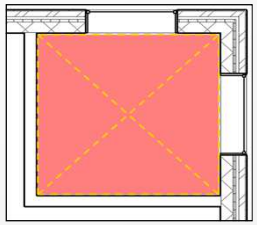


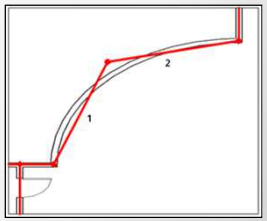
Vs.



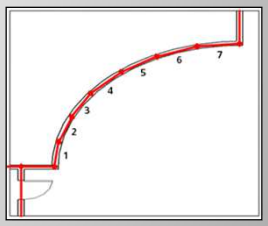


Vs.





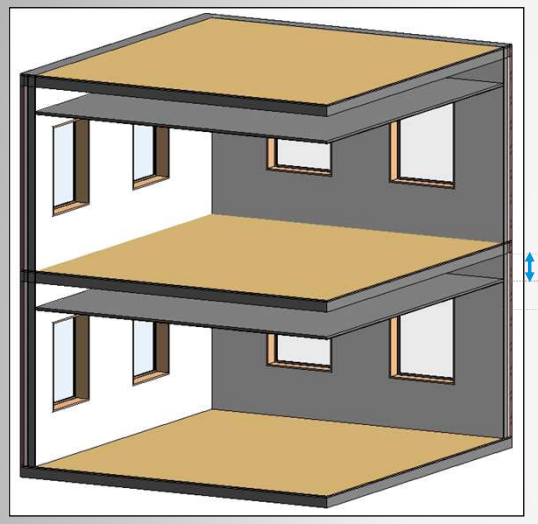
Vs.



Exercise 2.0 – Best Practices

1. **Clearly identify the elements used in EAM creation**
   - Use a 3D view, Set Visibility / Graphics Overrides, Check Phases etc.
2. **Disable any elements 'unnecessary' for analysis**
   - Look for exterior walls, floors, slabs etc.
3. **Look for and address any obvious missing elements or gaps**
   - Orbit around the building, view from above and below
4. **Run preliminary simulation and check the EAM**
   - Default resolution settings
   - Confirm all necessary spaces present
   - Confirm shade surfaces where appropriate (sign of missing elements or gaps)
   - Assess surface precision
   - Identify and address any missing elements or gaps and repeat
5. **Reduce resolution incrementally**
   - No more than necessary

Special cases – Void spaces



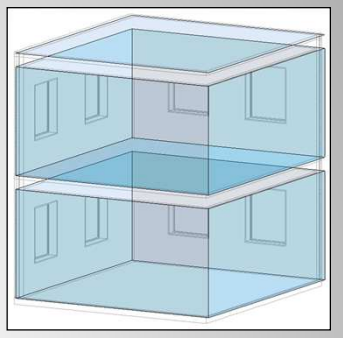
Ceiling voids of varying depth

Need for separate analytical spaces?

Note: Behavior vertical voids is similar except for free floating simulation

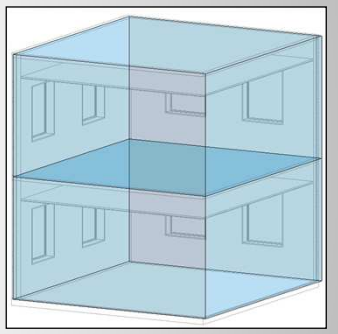
Less depth / Less resolution

→ No analytical spaces for ceiling voids & w/ small gaps



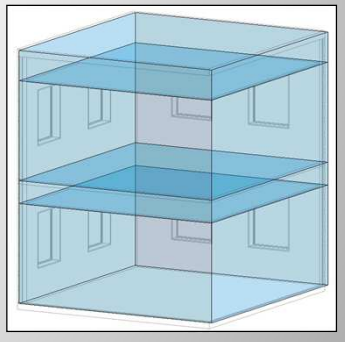
Disable room bounding

→ No analytical spaces for ceiling voids

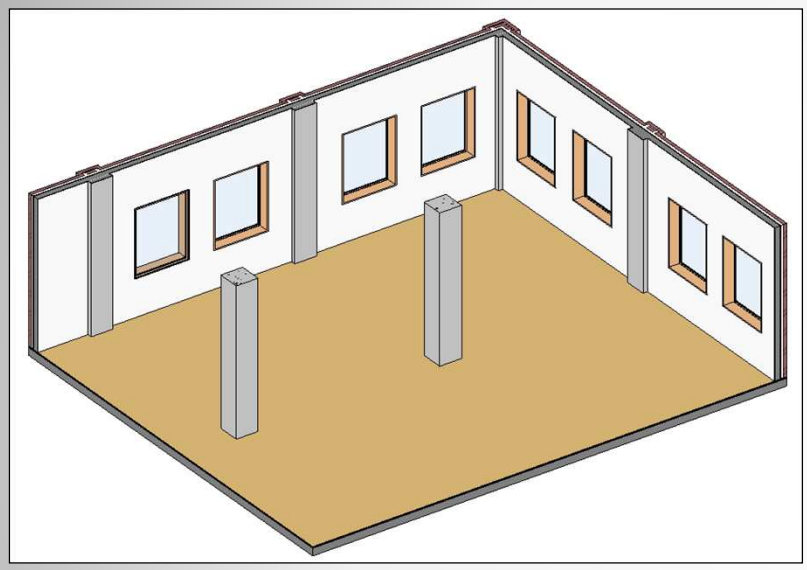


More depth / More resolution

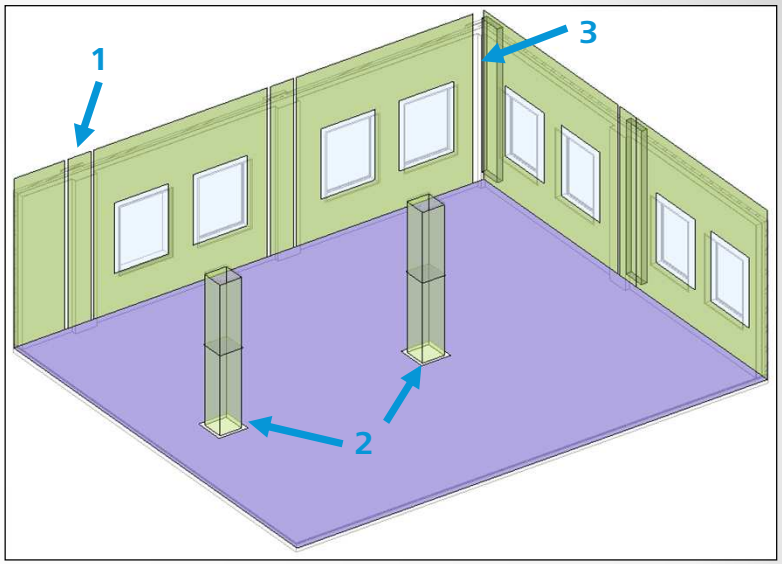
→ Separate analytical space separation for ceiling void & simulated as 'free floating'



Special cases – Columns



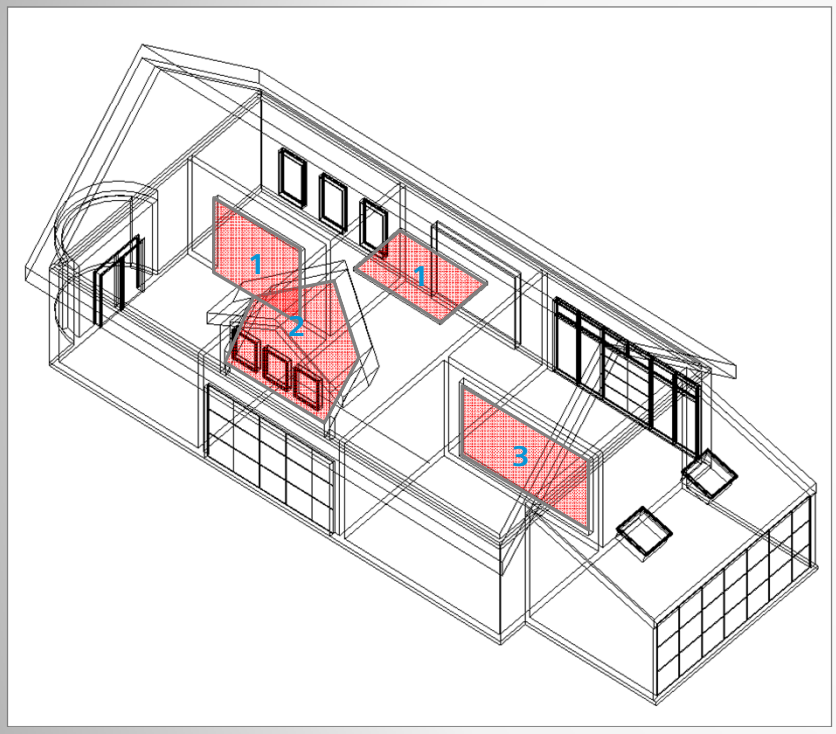
Interior and Exterior Columns



Note: Ceiling & interior walls hidden from view

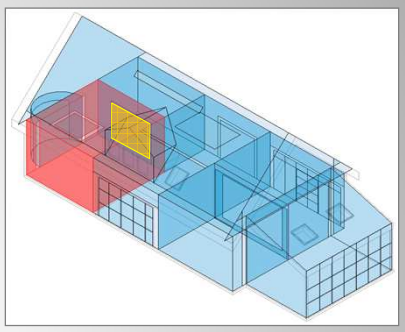
1. Separate analytical surfaces created
2. Floor area excludes columns
3. Some gaps / shades surfaces will exist

Special cases – Openings



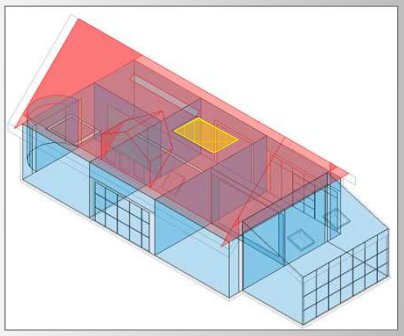
1. Revit openings by face, shaft, wall or vertical

→ Separates analytical spaces with air opening surface



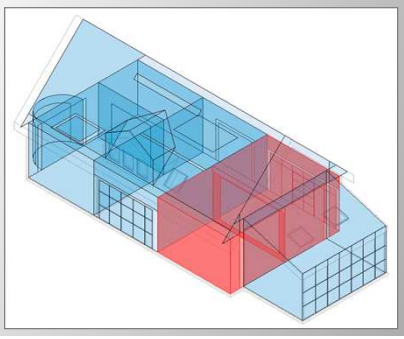
2. Dormer openings

→ No analytical space separation or air opening surface



3. Edited profile 'cutouts'

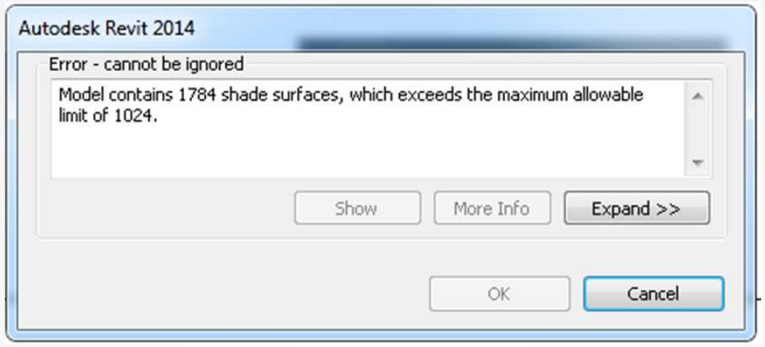
→ No analytical space separation or air opening surface



Exercises 1.1 & 1.2 – Advanced data options

- Specifying building element material thermal properties
  - E.g. Specify properties of glazing, roofs and walls
- Specifying space element properties
  - E.g. Specify ‘space type’ of the living room

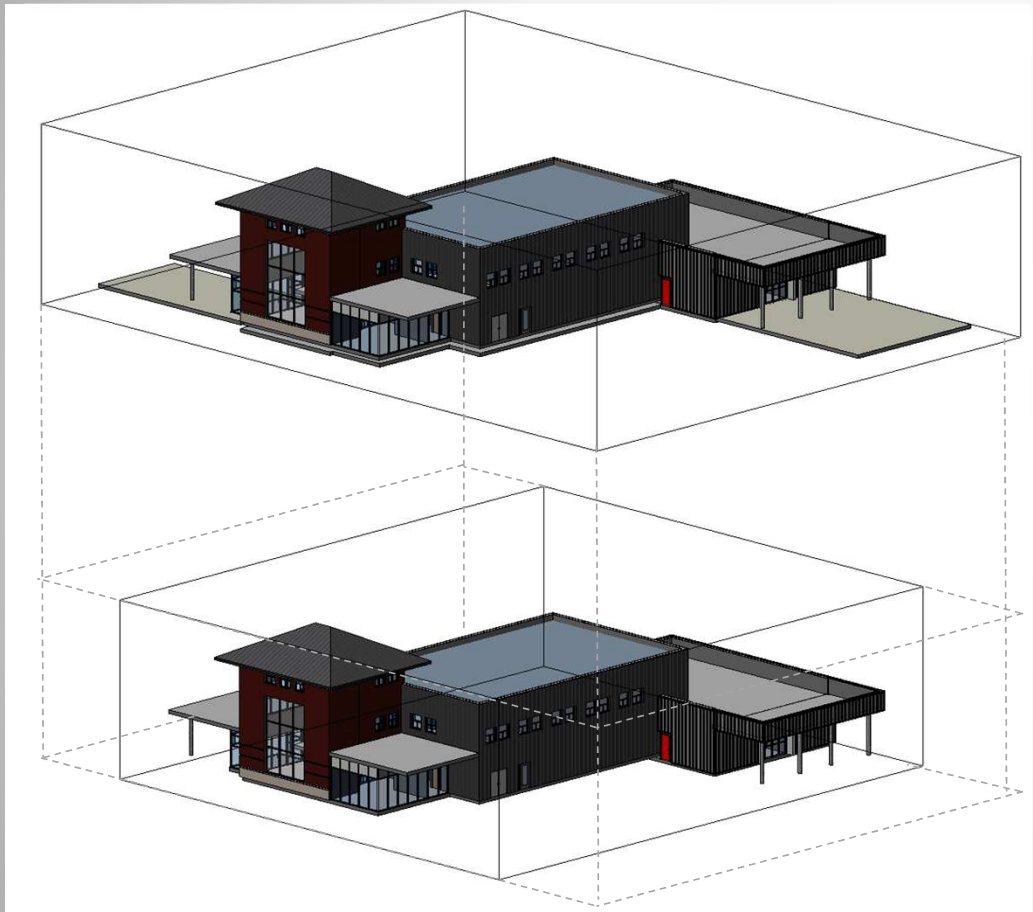
Current limitations – Analytical surface count



- Common error message (especially if many missing elements or gaps in Revit model that result in shade surfaces)
- Due to limits in DOE2.2 simulation engine

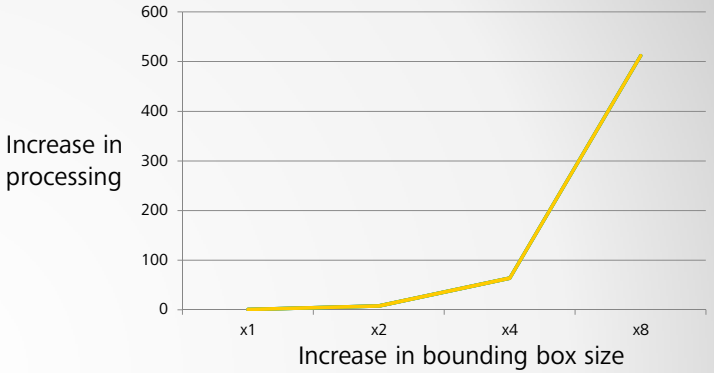
These limits are greatly increased with latest version of DOE2.2

Current limitations – Computational

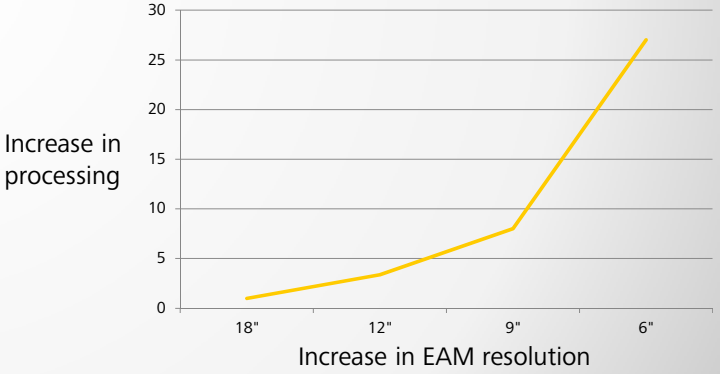


Revit's section box used to provide a representation of EAM bounding box size

Building size (bounding box size)



EAM Resolution



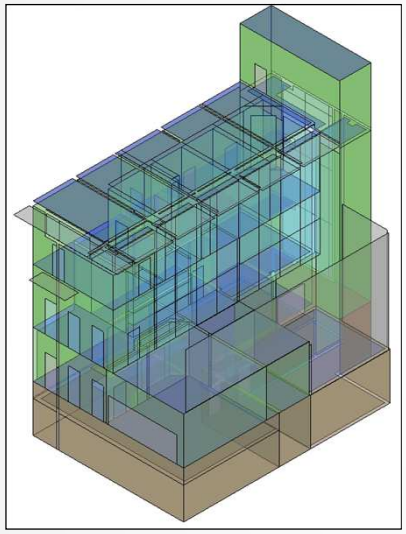
Processing increases roughly on a cubic basis to building size and EAM resolution

Current limitations – Other

- In place components
- Non parallel ‘sandwiched’ elements
- No air surfaces for Room / Space separators
- No EAM visibility & scheduling

Resulting EAM accuracy & precision

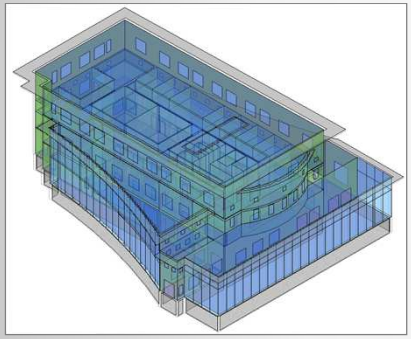
Sample Revit model with known measures



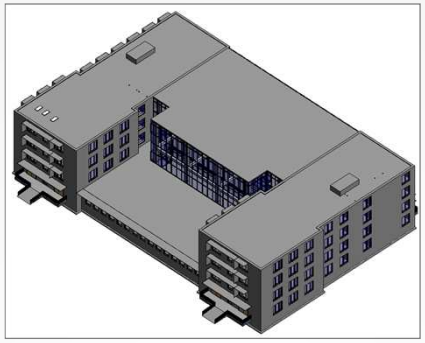
Resulting EAM

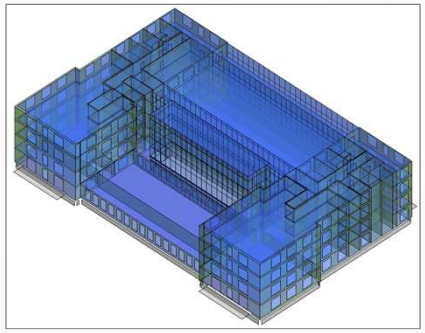
EAM Components	Actual	EAM	Difference
Spaces - Floor area (ft^2)	5,719	5,725	0.1%
Spaces - Volume (ft^3)	73,564	71,920	-2.2%
Surfaces - Roofs (ft^2)	1,291	1,212	-6.1%
Surfaces - Exterior walls (ft^2)	8,144	7,858	-3.5%
Surfaces - Interior walls (ft^2)	5,582	5,376	-3.7%
Surfaces - Interior floors (ft^2)	4,521	4,818	6.6%
Surfaces - Underground walls (ft^2)	2,375	2,324	-2.1%
Surfaces - Underground slabs (ft^2)	2,244	2,182	-2.8%
Surfaces - Doors (ft^2)	368	358	-2.7%
Surfaces - Fixed windows (ft^2)	1,867	1,889	1.2%
Surfaces - Operable windows (ft^2)	309	301	-2.6%
Average Difference			-1.6%

More EAM accuracy & precision assessments

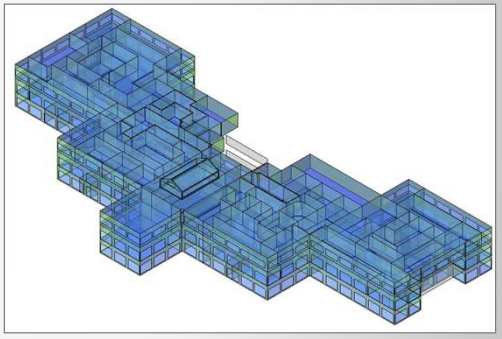


EAM Component	Actual	EAM	Difference
Spaces - Floor Area (ft^2)	26,510	24,858	**-6.2%**
Spaces - Volume (ft^3)	362,959	361,081	**-0.5%**
Surfaces - Walls (ft^2)	45,966	45,701	**-0.6%**
Surfaces - Floors (ft^2)	26,405	24,932	**-5.6%**
Surfaces - Roofs (ft^2)	11,034	10,943	**-0.8%**
Surfaces - Doors (ft^2)	1,570	1,544	**-1.7%**
Surfaces - Windows (ft^2)	9,898	10,105	**2.1%**
Total Average			**-1.9%**





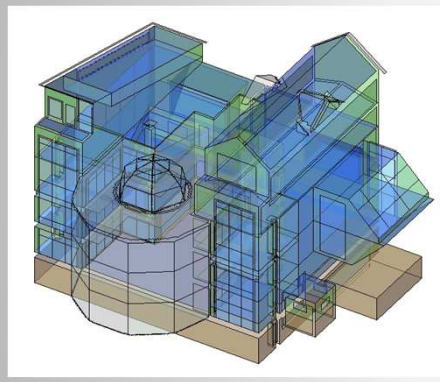
EAM Component	Actual	EAM	Difference
Spaces - Floor Area (ft^2)	102,574	95,912	**-6.5%**
Spaces - Volume (ft^3)	1,135,735	1,142,128	**0.6%**
Surfaces - Walls (ft^2)	110,150	109,274	**-0.8%**
Surfaces - Floors (ft^2)	105,158	95,913	**-8.8%**
Surfaces - Roofs (ft^2)	31,750	30,603	**-3.6%**
Surfaces - Doors (ft^2)	3,604	3,525	**-2.2%**
Surfaces - Windows (ft^2)	40,087	40,657	**1.4%**
Total Average			**-2.8%**



EAM Component	Actual	EAM	Difference
Spaces - Floor Area (ft^2)	116,447	116,865	**0.4%**
Spaces - Volume (ft^3)	1,433,339	1,416,906	**-1.1%**
Surfaces - Walls (ft^2)	162,876	161,784	**-0.7%**
Surfaces - Floors (ft^2)	121,834	116,865	**-4.1%**
Surfaces - Roofs (ft^2)	43,841	43,510	**-0.8%**
Surfaces - Doors (ft^2)	0	0	**0.0%**
Surfaces - Windows (ft^2)	24,891	24,687	**-0.8%**
Total Average			**-1.0%**

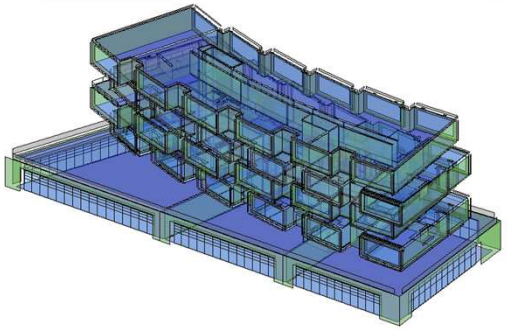
Other sample model complexity & quality

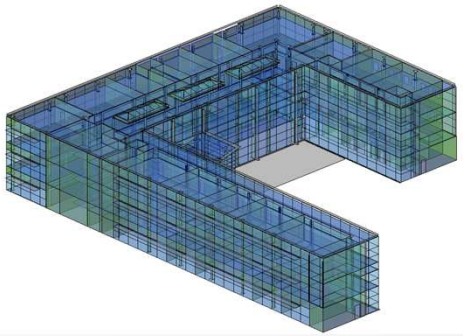
~2-5 days → **Traditional EA tools & practices** → ~2-3 Weeks

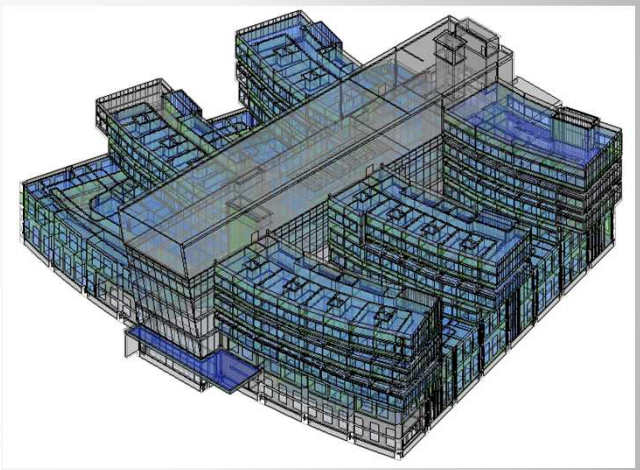


Multiple Complex Conditions

Typical size & complexity



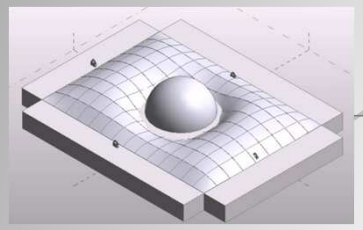




Large & Complex

~30 min. → **Revit Energy Analysis using Building elements** → ~3-5 hours

Relative EAM accuracy & precision…



Abstraction

Design process

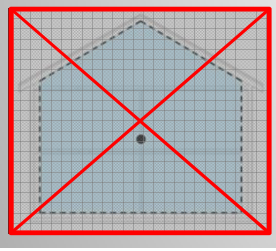
Reality

Spaces			Surfaces		
Discretization	Area	Volume	Adjacency & Type	Area	Orientation & Tilt

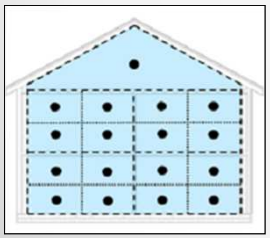
Typical tools & practices ~ +/- 10% overall

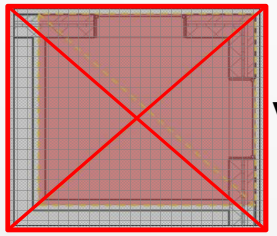
Accuracy: + / -

Building element EAM < ~ -5% overall

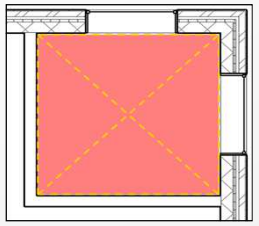


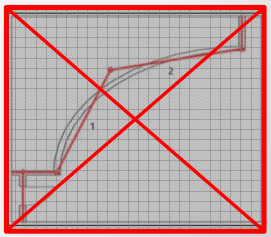
Vs.



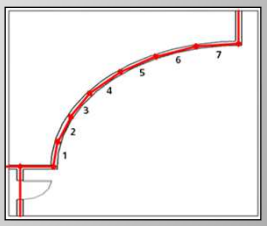


Vs.





Vs.



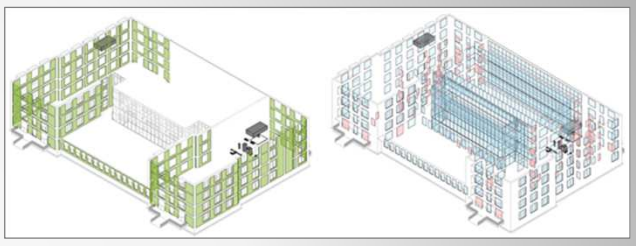
Disclaimer…

We may make statements regarding planned or future development efforts for our existing or new products and services. These statements are not intended to be a promise or guarantee of future availability of products, services or features but merely reflect our current plans and based on factors currently known to us. These planned and future development efforts may change without notice. Purchasing decisions should not be made based upon reliance on these statements.

These statements are being made as of Tuesday December 3rd 2013 and we assume no obligation to update these forward-looking statements to reflect events that occur or circumstances that exist or change after the date on which they were made. If this presentation is reviewed after Tuesday December 3rd 2013, these statements may no longer contain current or accurate information.

Potential areas for future development…

- EAM algorithm speed (+accuracy)
- Thermal zoning
- EAM visibility & scheduling
- Transparency of inputs
- More parallelized simulation
- Cloud configuration & collaboration
- EnergyPlus simulation engine
- Lighting simulation (A360 Rendering)
- Conceptual & Mobile



Project Solon

EnergyPlus

FormIt

LEED Daylighting Plugin (Labs)

In summary – Why ‘all’ gain?

- Significantly less time & skill required
- Typically higher quality EAM than standard practice
- Greater consistency & transparency
- Can actually help improve Revit model quality (completeness)
- **Easier access to Energy Analysis for architects**
- **Easier for engineers to leverage the Revit model**
- **Better value for building owners**

Conduct higher quality Energy Analysis earlier in and more regularly throughout the building lifecycle.

Thank you. Questions?

For more information see the Autodesk BPA blog:

http://autodesk.typepad.com/bpa/