Improve Workflow Efficiency by Using Revit MEP for Mechanical Calculations

Ben Roberts – Hoare Lea

MP2462   This class focuses on improving efficiency and consistency in your models by making the best use of the calculations available in Autodesk Revit MEP software. Live demonstrations using real project models show how the calculations that are built into Revit MEP can be made to work for you and where the limitations lie. We cover calculations for duct and pipe pressure drops, equipment duties and flow rates, and rule-of-thumb space loads. We look at what is available in the box and explain how you can add your own calculations to equipment and to spaces. The class takes advantage of the more open API in Revit MEP 2014 and makes use of new add-ins that change the calculation methodology used within Revit to suit your standards. All of these methods can help to link mechanical calculations to your drawings and schedules, cutting out much time compared to traditional processes and enabling far better consistency throughout your project.

Learning Objectives

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

- Set up Revit MEP to use calculations that are relevant to you
- Edit families to automatically calculate engineering parameters
- Include space calculations based on architectural models
- Describe the limitations and explain workarounds of the various mechanical calculation abilities in Revit MEP

About the Speaker

Ben Roberts is an executive mechanical engineer at Hoare Lea Consulting Engineers. He has worked as an engineer on BIM projects since 2009 and is the BIM champion for Hoare Lea. In this role he has established internal standards for BIM project delivery, trained over 220 engineers to use Autodesk Revit and provides on-going support for a large number of BIM projects. His particular focus is on improving workflow and efficiency for engineers, re-using models for analyses and improving the calculation capabilities within BIM models.
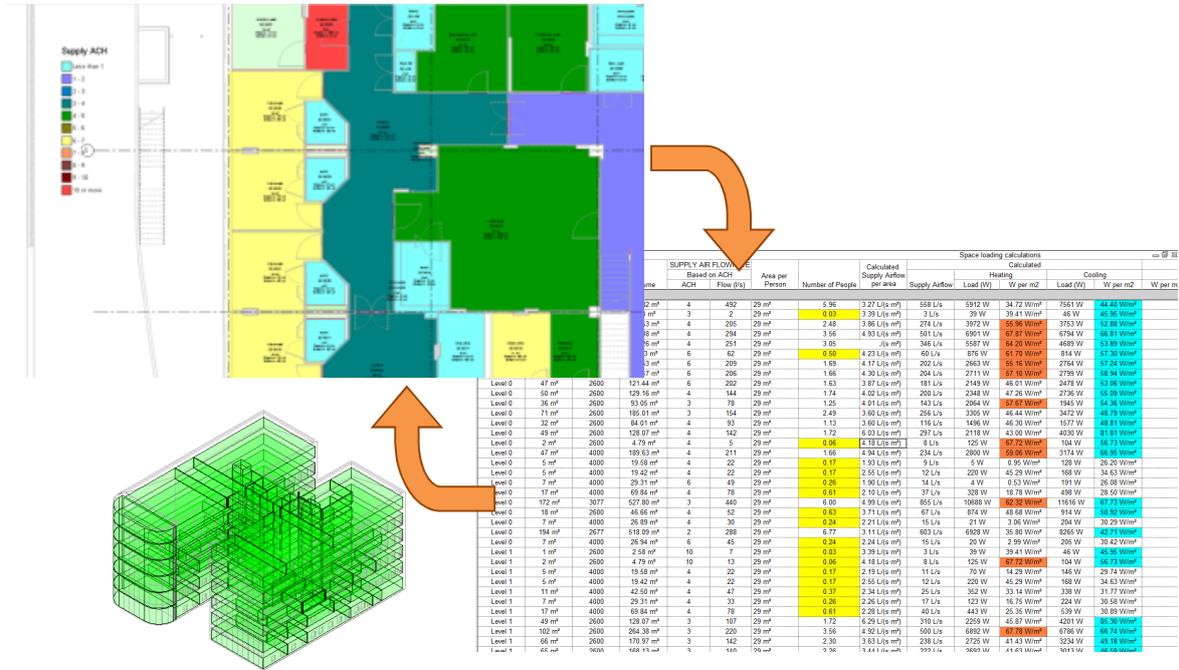
Ben is an active member of the CIBSE BIM steering group and the BSRIA BIM Network, and is involved in developing many industry standards for MEP BIM delivery. He has recently written articles for the RICS Construction Journal and the CIBSE Journal on the subject of BIM, and regularly presents at BIM events, debates, training days and seminars.

His education includes a BEng (Hons) degree in mechanical engineering and an MSc in Sustainable Building Design.

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# Space Calculations Based On Architectural Models

Background

Architects add rooms to a model to show information such as name, number, occupancy, etc. In an MEP model we add spaces, which hold environmental data about that room.

Typically at the early stages of a project, the engineer will take an area schedule and assign room types, required fresh air flowrates, estimated heating and cooling loads, required lux levels and the like. In a Revit environment, this can be linked straight to the architectural layouts, and these initial requirements can automatically update as the partition layouts change.

Step 1 – Add spaces to the model

To add spaces to the model, go to **Analyze>Space**. The first thing to do is set the upper limit using the green options bar beneath the ribbon. Set the upper limit to "**level above**" and the offset to "**0.0**":
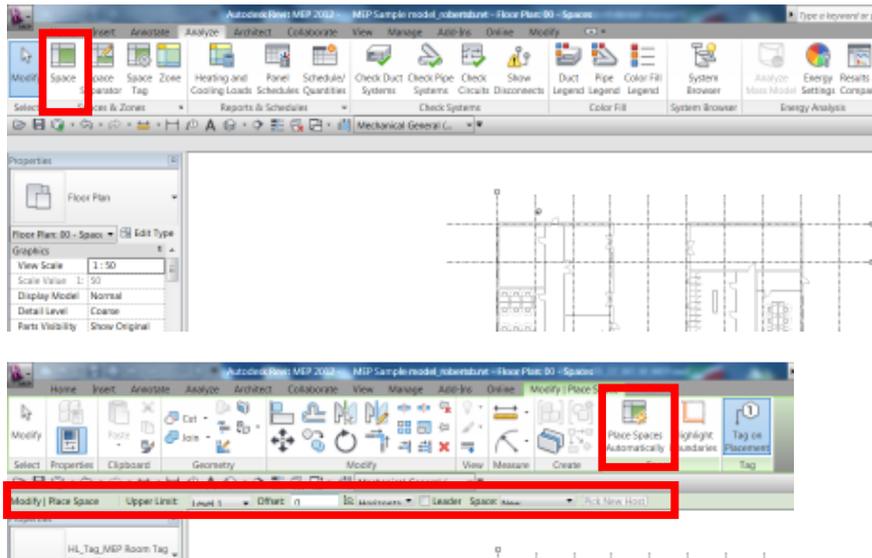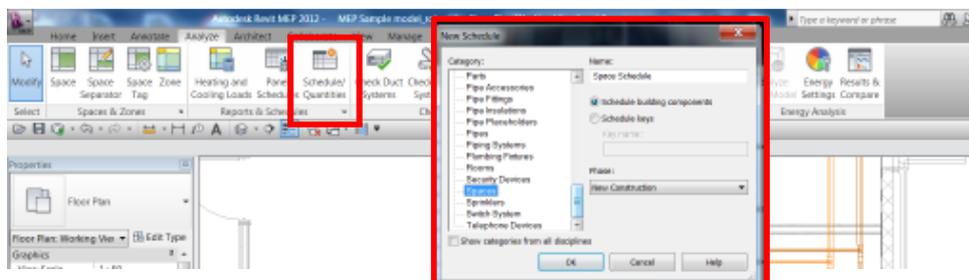

To place the space, hover over a room and it should expand to the surrounding walls, floors & ceilings. There is a "Pace Spaces Automatically" feature to speed things up.

If it doesn't work, check the **room bounding** setting in the linked model, and ensure your levels are correctly aligned.

Step 2 – Create a space schedule

Go to **Analyze>Schedule/Quantities** and pick "spaces"…

Add in some parameters, including: space name, space number, area & volume

Step 3 – Add new parameters and calculations to the schedule

Revit's calculation tool is a bit like Excel, in that you can use some of the same functions (+, -, *, /, IF(), SQRT(), pi(), not(), for example)

In this case, I have shown a simple calculation of air flowrate based on volume and air changes.

Add a parameter called "ACH Supply" (Air Changes per Hour), as a "Number" type. Then add a calculated value called "ACH Supply Airflow" as an "Air Flow" type, and enter the following formula:

ACH Supply * Volume / 3600

Note: The 3600 is to convert from hours to seconds.

TAKE CARE! The units of the calculated value must be correct. i.e. if you mutliply an volume by a number the answer is a volume. In this case, the ACH value is a "number", the volume is m³, and the flowrate is L/s.

So we'll need to divide the result by 1m³ and multiply it by 1L/s to even it out (as shown below)…
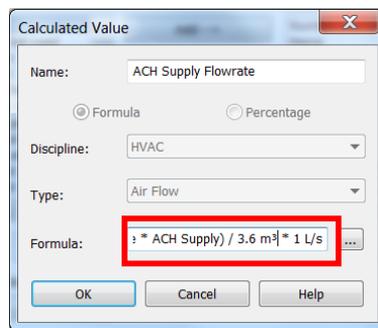
Another way to cancel out the units is to put in the formula as follows…

ACH Supply * (Volume / 1) / 3600 * 1

Revit will automatically change the "1" to the required units, thus cancelling it out.

> Note: You can't use "/" or "-", etc. in any paramter name as Revit will see this as an operator when you put it into an equation. Revit won't tell you that when you name a parameter, so you have to watch out!

In this next example we are going to compare the "Actual Supply Airflow" (this is the value added to air terminals in the space) with the value we just worked out from our ACH rate.

Add the parameter "Actual Supply Airflow" to the schedule. Create a new parameter and give it a name, e.g. "Supply vent check". Then add this equation:

<div align="center">Actual Supply Airflow / ACH Supply Airflow</div>

The resulting value should be close to one – if it is greater than one, you have more airflow in the air terminal than you need in the space; if it is less than one, you need to increase the airflow in your air terminal.

Step 4 – Format to show totals and conditional formatting

You can total the columns under the "formatting" tab. Filters applied to the schedule will affect the totals, so if you need to see total calculated flowrate for just one level, you can filter to just that level and the resulting value will be updated.

You need to apply two things for this to work:

1. Under "Sorting/Grouping", switch on the "Grand totals" tick box. You can also switch on total footers or headers for each group, i.e. level, zone, service type, AHU, etc…
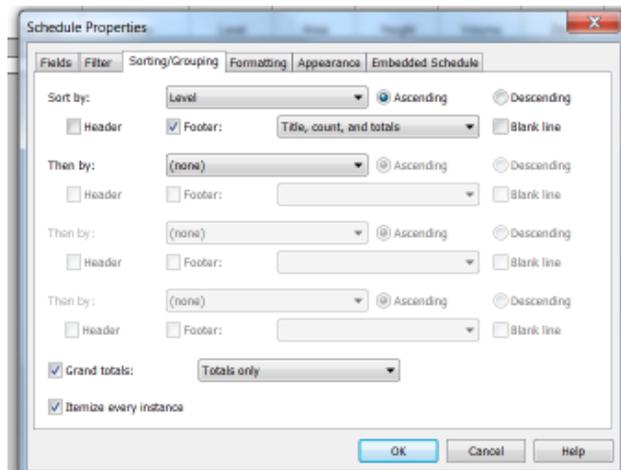
2. Under "Formatting", select the parameters that you want to total and switch on the "Calculate totals" tick box…
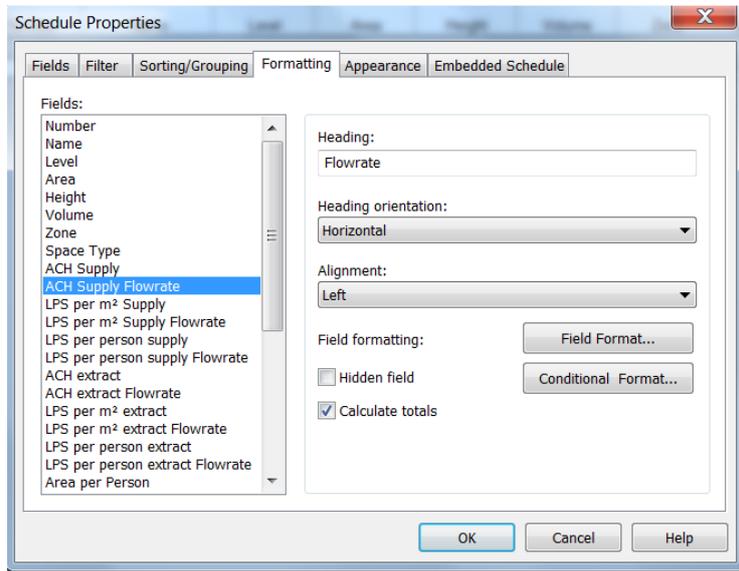
While you're in the formatting tab, select the "ACH Supply Flowrate" parameter and click on "Conditional Format". Under this option, select the "Supply Vent Check" parameter created above and set the rule as "not between 1 and 1.1", then apply a colour.

This will mean that if you have not enough air in the air terminal, or more than 110% require air, the parameter will be highlighted.

Step 5 – Colour up your layouts

Now that you have a parameter for "ACH Supply", you can apply a legend to a layout view and use this parameter for colour coding the view. This is a useful visual check for engineers.

Limitation – you can't apply a colour scheme to calculated values, so you can't use the "Supply vent check" value to colour the layout, unfortunately.

Calculations in Families

Background

The application of this method is very simple – the benefits come from how creative you can be with the functionality. I suggest some commonly used methods below and in the presentation, but you will have lots of other uses too, no doubt…

Drive geometry from design duties

The below example is used in a radiator family to alter the length based on the heating duty. I have taken data from manufacturers to derive the relationship between heat output per unit length, and the height of the radiator…

Calculate flowrates from design duties

Here I've taken a standard equation and applied it using the parameters in the family…

Mass flowrate = heat output / (specific heat capacity * change in temperature)

Now you don't have to calculate flowrate separately and add it manually to every instance of the family.

Pressure Drops in Pipes and Ducts

Background

Revit will calculate pressure drop in accordance with ASHRAE standards. If, like me, you need to use alternative standards, Revit 2014 allows more open access to the API, so these calculations can be changed. In the below case, an add-in has been developed to choose other calculation methods, and I am using the Haaland method, in accordance with CIBSE (Chartered Institution of Building Services Engineers, UK).

Step 1 – Choose your calculation method

You can set this in mechanical settings…
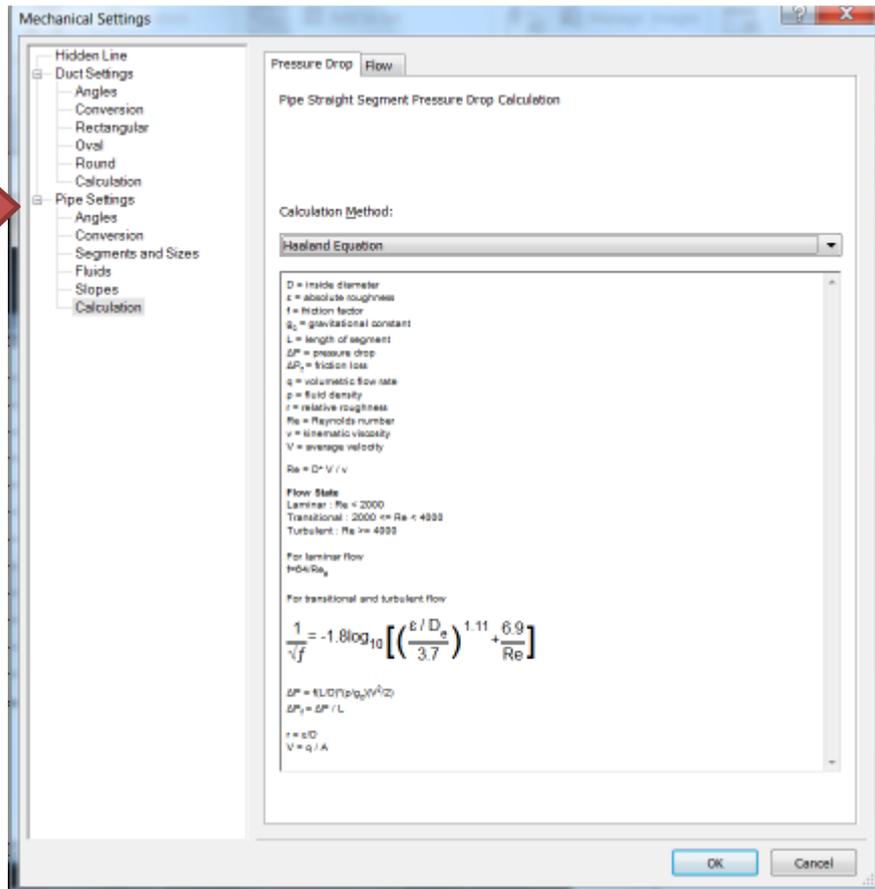
Step 2 – Apply the right settings

This calculation relies on a number of variables set in your model. As such, you have to make sure you have the following things set in accordance with your standards:

a. Roughness. For pipes, this is set under Mechanical Settings>Pipe Settings > Segments and Sizes. For ducts, it is a type property of the duct.
b. Internal diameter (Mechanical Settings)
c. Fluid density and viscosity for each temperature (Mechanical Settings)
d. Apply the relevant temperature to each system type
e. Apply the relevant materials to each pipe type (Edit Type>Routing Preferences)

Once these things are established, the pressure drops and velocities in Revit will be calculated in accordance with your own requirements.

Step 3 – Colour up Your Layouts

You can now use these results to colour-code your pipework or ductwork (add a pipe or duct legend to the view)…

Summary

So now you can...

1. Use calculations in spaces to be quicker in responding to layout changes,
2. Check air terminal flowrates against calculated values,
3. Save time in re-sizing equipment and updating calculations by embedding your calculations within families,
4. Make sure Revit is giving you the right values for pressure drops and velocities, and make more reliable use of the auto-sizing tool.

All of the above can help to save much time doing repetitive and boring tasks, leaving you more time for real engineering!