

BLD225071

Automating Occupancy: A Smarter Way

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Learning Objectives

- Learn how to develop area schemes to calculate area
- Learn how to construct key values, conditional formatting, and calculated values in Revit Schedules
- Learn how to perform Revit and Excel data collection through Dynamo
- Learn how to integrate user selection of different state and local code requirements

Description

Does your Revit Occupancy Calculation workflow have problems? Does it rely on users' input to drive most (if not all) of the values for calculation? Are you struggling with the management of variations in fire codes? To provide solutions to these obstacles, attend this course to get an in-depth view of SmithGroup's automation of Occupancy Calculations in Revit. The workflow utilizes Dynamo, Area plans, Schedules, Excel Data, and the integration of various Code Requirements.

Speaker

A BIM Technologist at SmithGroup, a national multi-disciplinary firm, in the Washington, DC office. With almost a decade of experience in Base Building Architecture, primarily focused on developing advanced workflows utilizing Revit and Dynamo. An active participant in Washington DC based user groups, serving as an advisor and regular speaker to Revit DC and Dynamo DC.

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Table of Contents

Introduction	3
Why Automate Occupancy Calculations?	3
Required Dynamo Packages	3
Number of Occupants.....	4
Area.....	5
Why Areas (and not Rooms)?	5
Area Schemes.....	7
Area Plans	7
Area Type Rules.....	8
Gross vs. Net Area Calculation Rules	9
Area Boundaries.....	10
Area Boundary Lines & Dynamo	11
Areas.....	13
Areas & Area Schedules.....	15
Occupant Load Factor	16
Area Schedule of Keys - Function of Space	17
Code Sources	20
Key Values & Dynamo / Excel	20
Number of Occupants.....	24
Revit Calculation	24
Calculated Values	24
Occupant Load Factor & Dynamo	25
. Fixed Seating.....	27
Calculation	27
Calculated Value Modification.....	27
Fixed Occupants & Dynamo	28
Conditional Formatting.....	29
Area Tag.....	30
Calculated Value	31
Dealing with Changes.....	32
The Workflow in Action.....	35
Workflow Requirements.....	35
The Workflow Process.....	35

Introduction

Why Automate Occupancy Calculations?

While working on an advanced workflow the question of whether “the juice is worth the squeeze” is always asked. Why automate this workflow? What makes occupancy calculations a good candidate for automation?

The first reason this workflow was automated was to keep the information within Revit. Architects and Engineers have had their methods of calculating occupancy in the past, it’s not something new, but to have the information within Revit is a huge time saver, especially throughout the course of the project as a whole. An integrated workflow within Revit negates the need to export to Excel and have another database do the calculations.

While working through creating a system within Revit a few limitations of the program were encountered such as the inability to include Key Values in formulas and the inability to tag calculated values. This led to incorporating Dynamo into the workflow.

The other automation tools within the workflow were driven by the flexibility of the calculations themselves; different jurisdictions require different code variations.

In all, these are the reasons Occupancy was chosen as an automation workflow:

- Integrated workflow in Revit. No exporting.
- Inability to have key values part of formulas.
- Inability to tag calculated values.
- Calculated values in tags in Revit 2017 – yay!
- Multiple code sources, code modifications, etc.
- Automation of boundary lines from room elements.

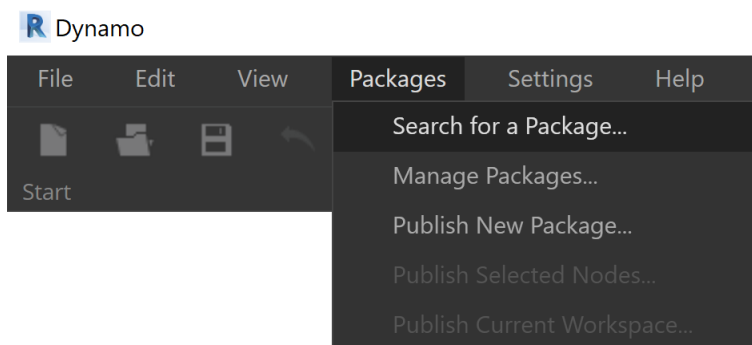
Required Dynamo Packages

In total there are 3 Dynamo graphs to complete the workflow, all of which require custom package(s). Special thanks to Konrad and Andreas for sharing their hard work.

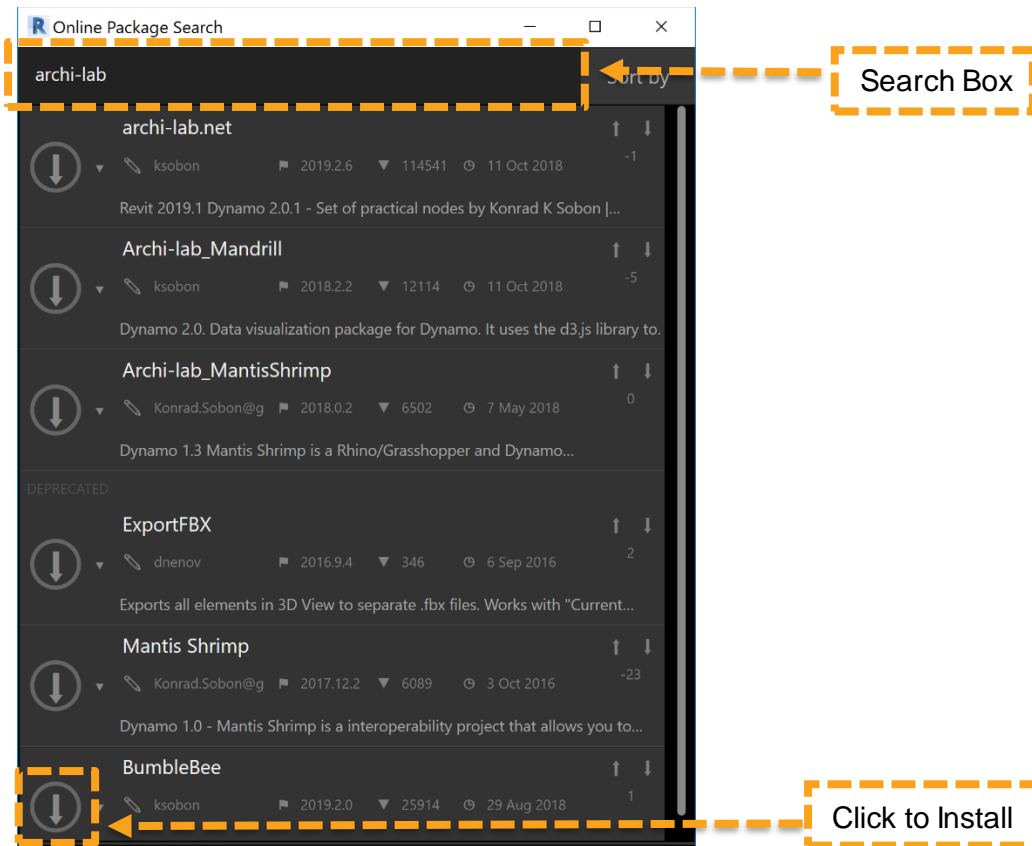
In short, a Package is a collection of Custom Nodes.

To install a package within Dynamo do the following:

1. In Dynamo go to Packages / Search for a Package...



2. Search for the required Package and install



3. Install the following Packages:

- Archi-lab.net
- Archi-lab BumbleBee
- Clockwork for Dynamo 2.X

Number of Occupants

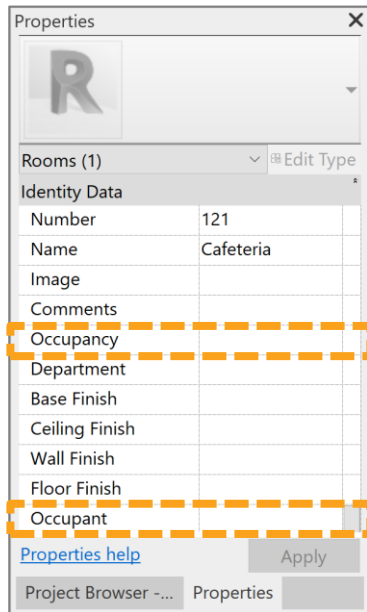
Life Safety is encompassed by numerous calculations. The Calculation we will be focusing on is the Number of Occupants.

The International Building Code, Section 1004 states that “For areas without fixed seating, the occupant load shall be not less than that number determined by **dividing the floor area** under consideration **by the occupant load factor assigned to the function of space** as set forth in Table 1004.1.2.”

$$\frac{\text{AREA}}{\text{OCCUPANT LOAD FACTOR}} = \text{NUMBER OF OCCUPANTS}$$

Area

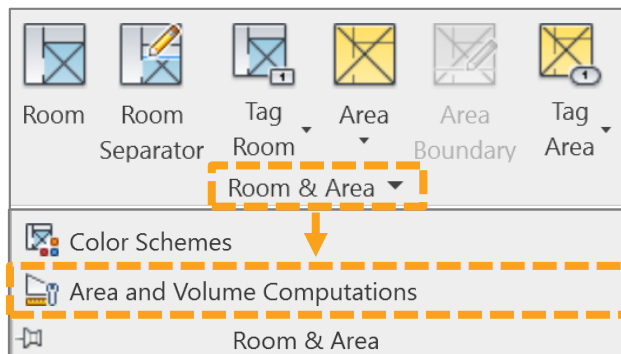
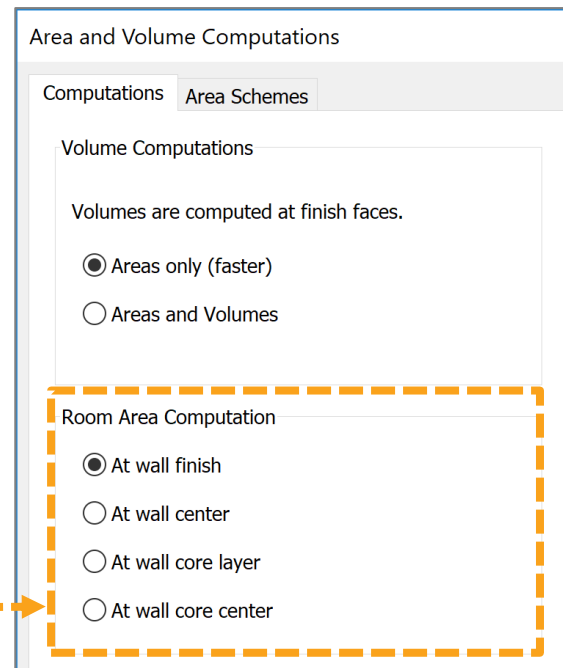
Why Areas (and not Rooms)?



Rooms (1) Edit Type	
Identity Data	
Number	121
Name	Cafeteria
Image	
Comments	
Occupancy	
Department	
Base Finish	
Ceiling Finish	
Wall Finish	
Floor Finish	
Occupant	

There is a bit of debate as to whether rooms or areas should be used for Life Safety. Revit Rooms contain parameters related to Occupancy. Rooms, however, are very limited and serve as the primary graphic to annotate the spaces architecturally.

Rooms calculate area based off a plane of walls, every wall is calculated the same. This is not necessarily the way that area is calculated for purposes of Life Safety / Occupancy.

Area and Volume Computations

Computations Area Schemes

Volume Computations

Volumes are computed at finish faces.

☒ Areas only (faster)

☐ Areas and Volumes

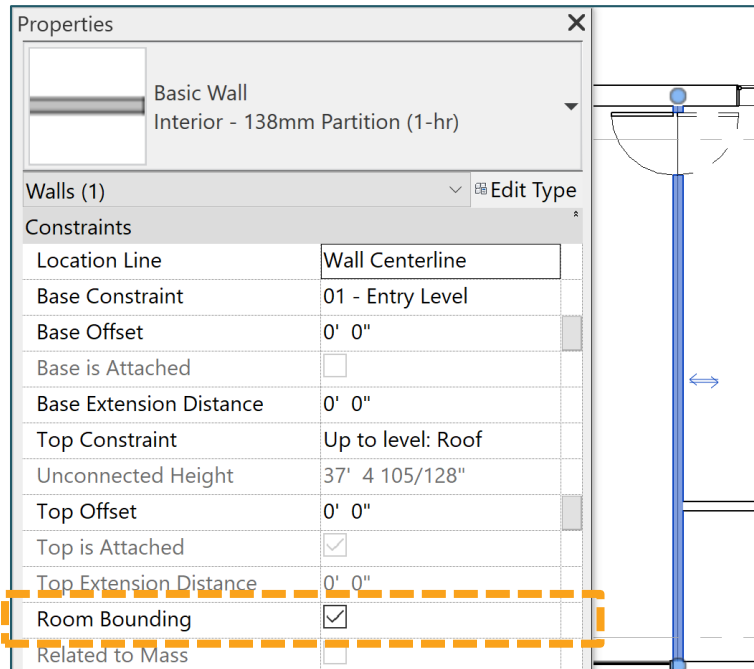
Room Area Computation

☒ At wall finish

☐ At wall center

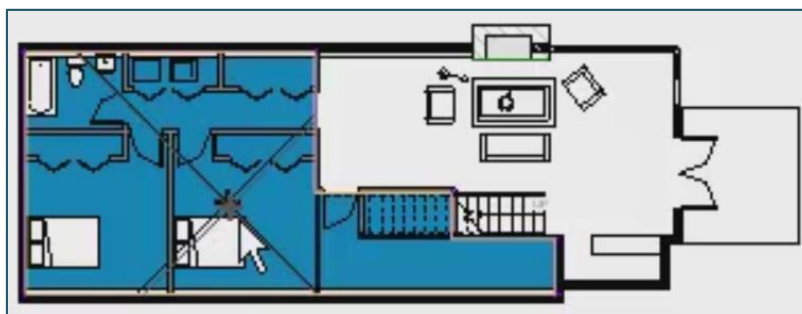
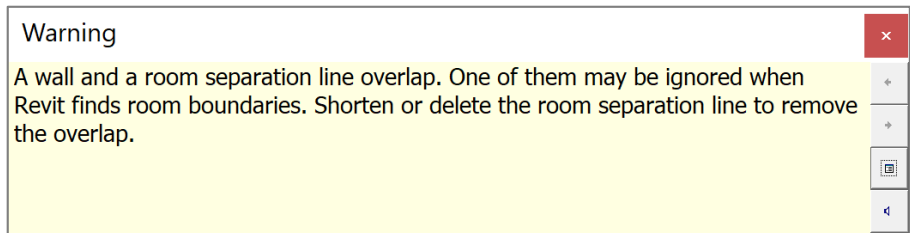
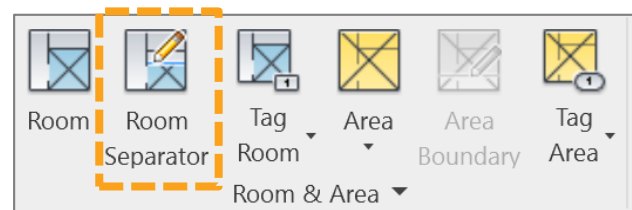
☐ At wall core layer

☐ At wall core center



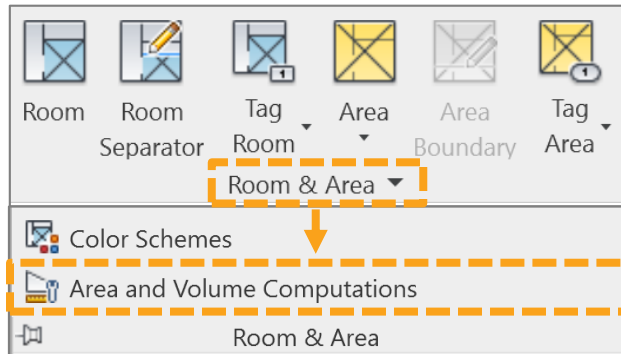
Room Area is computed by other model elements as well as walls – columns, room separation lines, etc. – making it potentially difficult to decipher where the area is being computed from.

If a room separator is drawn on top of a wall Revit will produce a warning. Not a serious warning, but these types of warnings get created rapidly when trying to accurately depict area through Rooms in Revit.



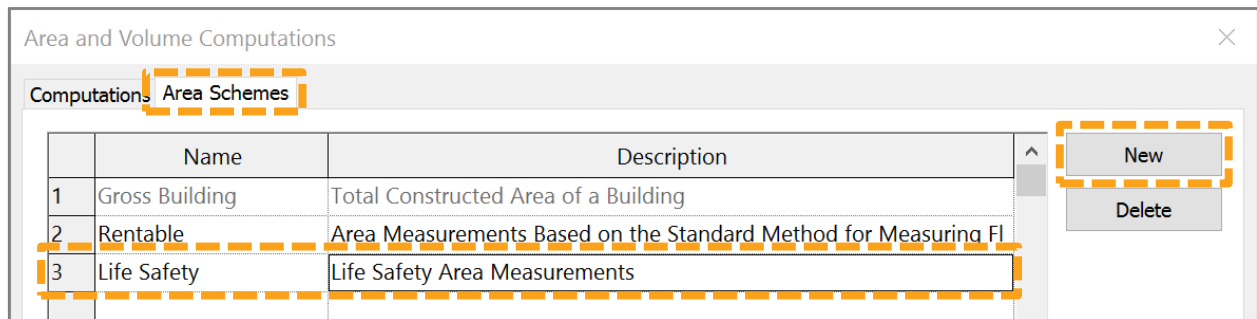
Graphically we may need Life Safety Areas to be different than Room Areas. For example, a Life Safety Area may need to encompass many rooms, as in a residential unit. (The image shown to the left comes up in the Revit Tool Tip while hovering over "Area".)

Area Schemes



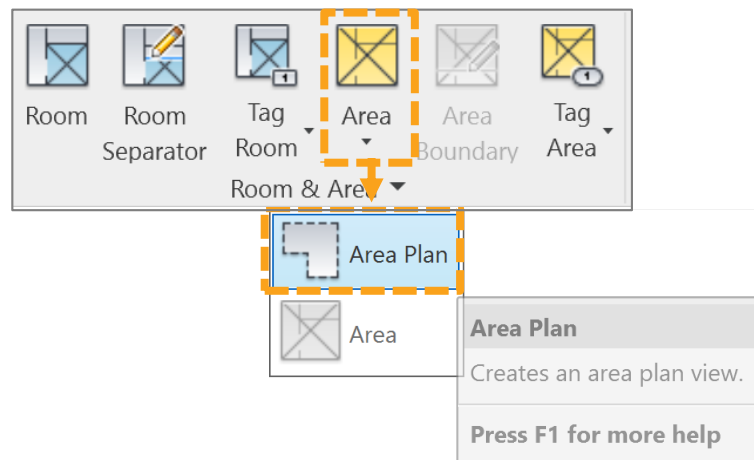
Area Schemes in Revit are specifically used for Area Calculations. Two Area Schemes come with Revit out of the box – Gross Building and Rentable. For this workflow we will create a scheme named “Life Safety”.

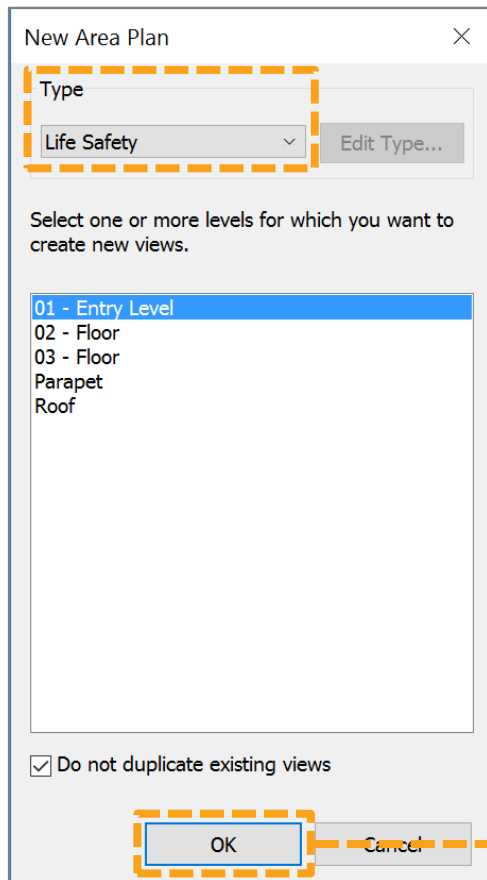
Note: The scheme name is important when transferring schedules from project to project. If the scheme name matches identically, the schedules will be tied to the scheme.



Area Plans

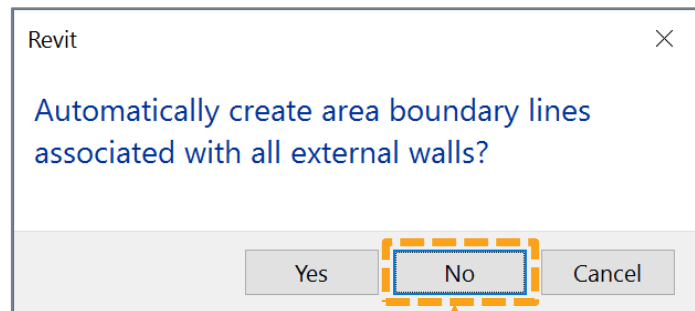
Now that the Area Scheme has been created Area Plan(s) can be created. Within the Architecture tab in Revit / go to Area / Area Plan.





Ensure that the Life Safety Scheme is the selected type when the views are created. More than one view can be created at once, if desired, by selecting views while holding the Ctrl key. Click OK.

A secondary box will come up asking whether to “Automatically create area boundary lines associated with all external walls?”. For this purpose click “No”.



Area Type Rules

Rules are determined by one type of space bordering another space.

The following table shows area measurement rules. To find the appropriate measurement rule, find the selected Area Type and the corresponding Bordering Area Type.

<http://help.autodesk.com/view/RVT/2017/ENU/?guid=GUID-B4AC3088-DBA8-4EB0-BA8F-CAF8EC1EBF9D>

Gross Building Area Scheme Types

Gross Building Area Scheme Types		
Area Type Selected	Bordering Area Type	Measurement Rule
Gross Building Area		
Gross Building Area	None	Area Boundary measured to the outside surface of building.
Gross Building Area	Exterior Area	Area Boundary measured from outside surface of building.
Exterior Area		
Exterior Area	Exterior Area	Area Boundary measured from wall centerline.
Exterior Area	Gross Building Area	Area Boundary measured from outside surface of building.

If you select the Apply Area Rules option, Revit automatically changes the wall boundary position when you change the area type. (See About Area Types.) For example, office area is measured at the wall centerline, while exterior area is measured to the exterior wall face. By applying area rules, the area boundary position updates in accordance with area type changes.

<http://help.autodesk.com/view/RVT/2017/ENU/?guid=GUID-0AB09044-22FC-4116-8845-0D558BA129C1>

Gross vs. Net Area Calculation Rules

Unfortunately, the typical way of calculating area for Life Safety does not comply with Revit's internal Area Type Rules, therefore, we will not take advantage of it.

The 2015 International Building Code Commentary, Means of Egress states:

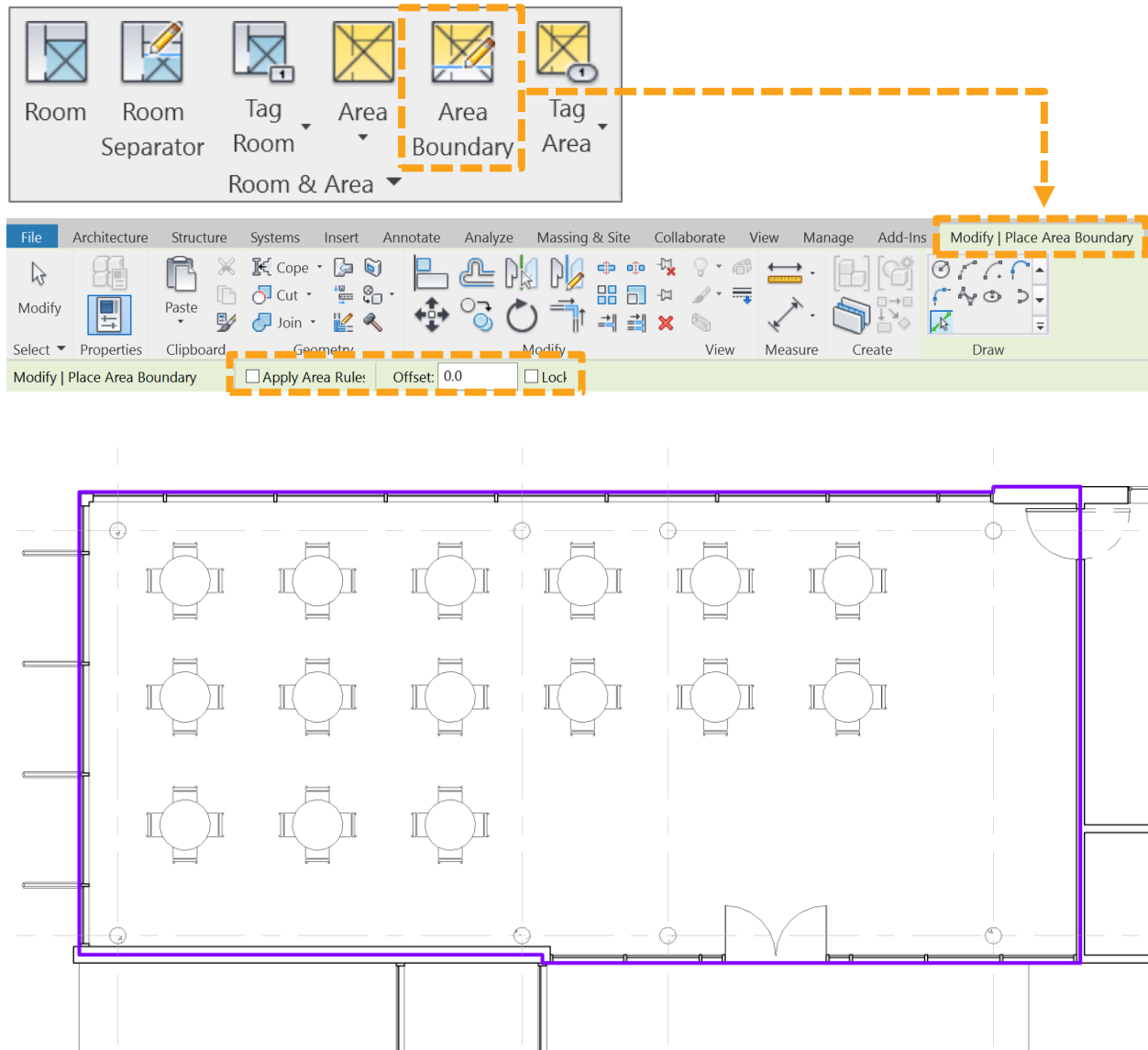
“The **gross floor area** technique applied to a building only **allows the deduction of the plan area of the exterior walls, vent shafts and interior courts** from the plan area of the building.

The net floor area permits the exclusion of certain spaces that would be included in the gross floor area. The net floor area is intended to apply to the actual occupied floor areas. The area used for **permanent building components, such as shafts, fixed equipment, thicknesses of walls, corridors, stairways, toilet rooms, mechanical rooms and closets, is not included in net floor area.**”

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR ^a
Assembly	11 gross 30 net
Gaming floors (keno, slots, etc.)	
Exhibit gallery and museum	
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	7 net
Concentrated (not fixed)	

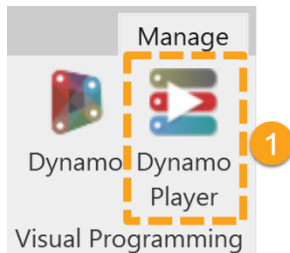
Area Boundaries

Areas are only bound by Area Boundaries. Now that we have reviewed net vs. gross area and created Area Plan(s) we can draw the boundaries.

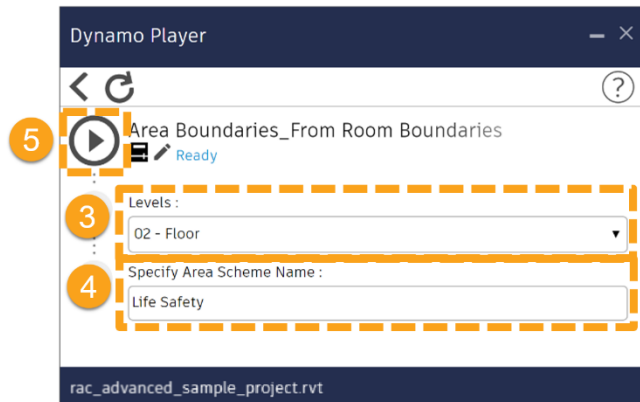
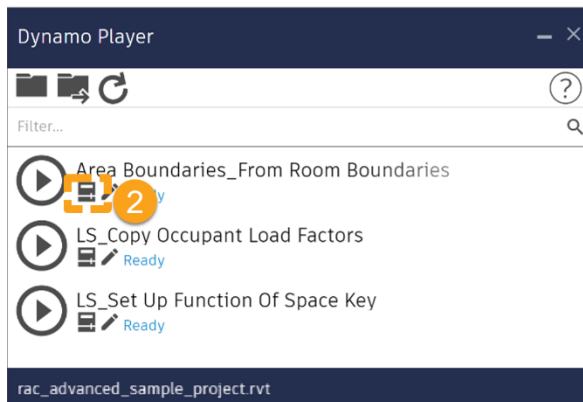


Area Boundary Lines & Dynamo

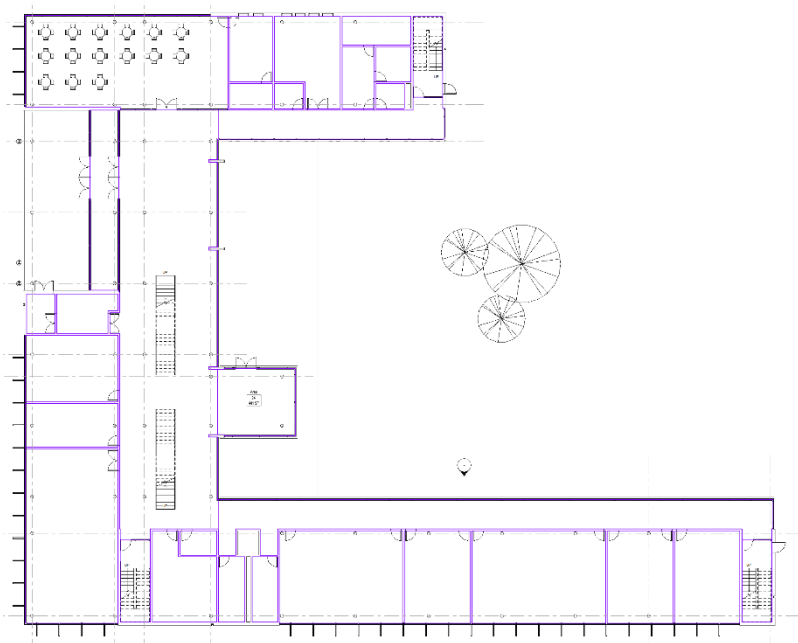
Ultimately drawing area boundary lines can take a long time. Typically, at this point in the project, rooms have already been placed within the Revit model, this will give us a good starting point for boundaries. Utilizing Dynamo we can create area boundary lines from room boundaries as a starting point and adjust the boundaries around to comply with the net vs. gross area calculation rules based off the function of each space.

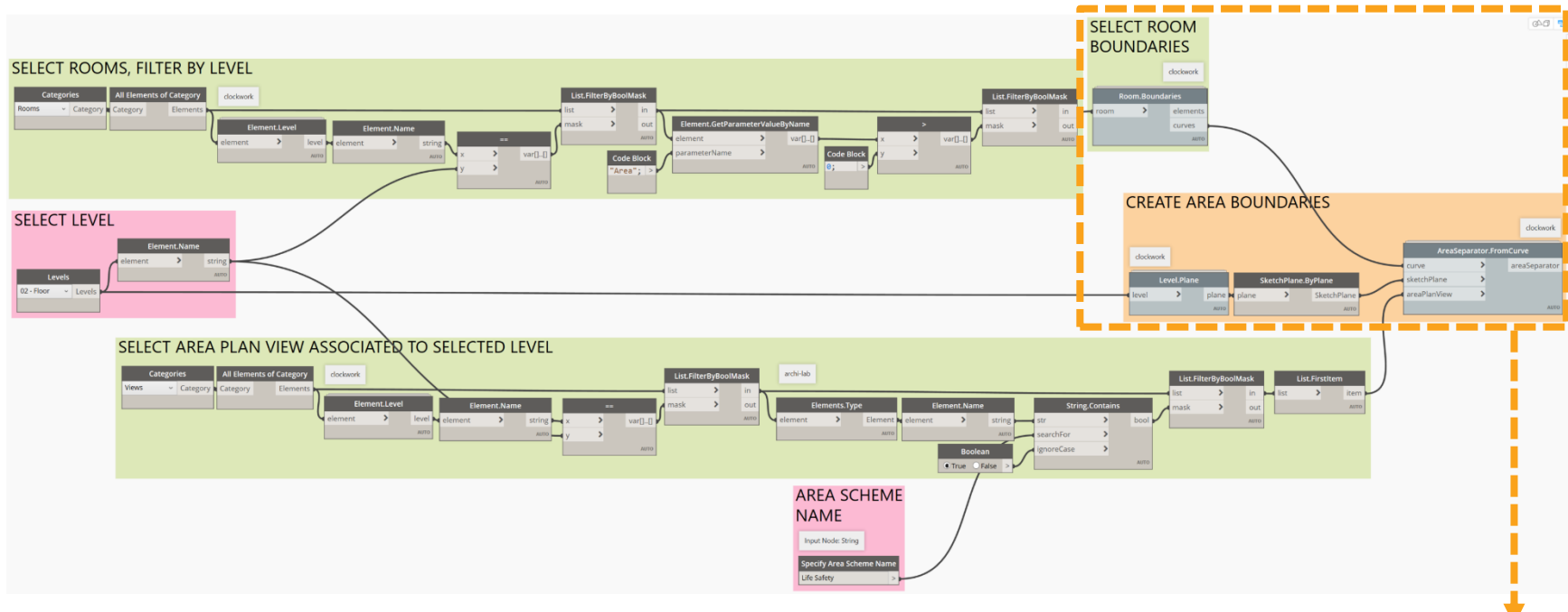


1. In Revit, go to the manage tab, click on Dynamo Player.
2. Click on the “Edit Inputs” icon under “Area Boundaries_From Room Boundaries” graph.
3. Specify the Level to populate the Area Boundary Lines to.
4. Scheme Name should be set to “Life Safety”.
5. Press Play

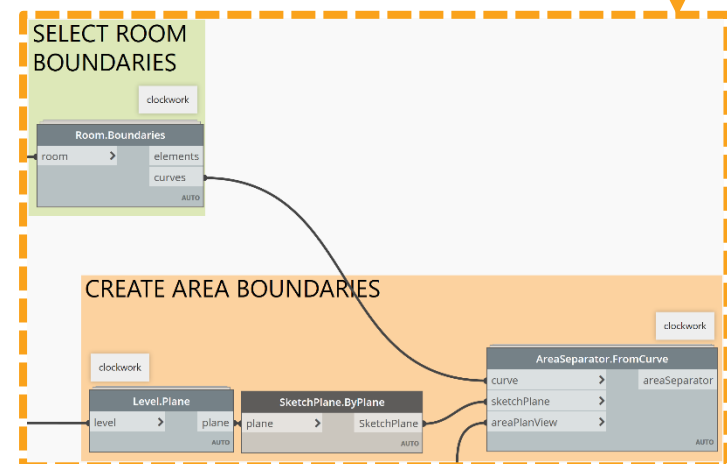


The graph takes a moment to run but once it is complete we have area boundaries where ever there where rooms model within the level specified.



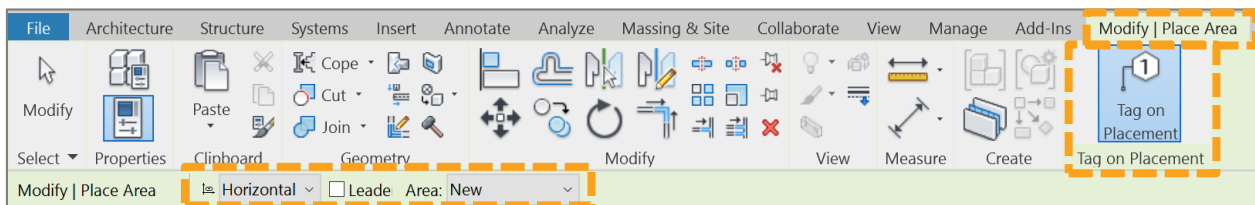
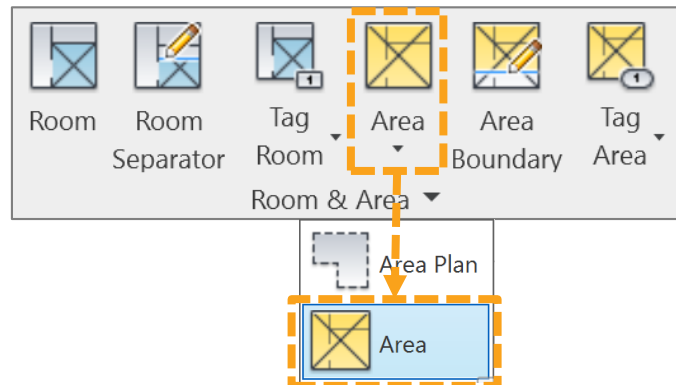


The packages required for this script (Area Boundaries_From Room Boundaries.dyn) are archi-lab and Clockwork. The package Clockwork provides a node to select the room boundaries (walls, room separators, columns, etc.) as well as a node to create the area boundaries.

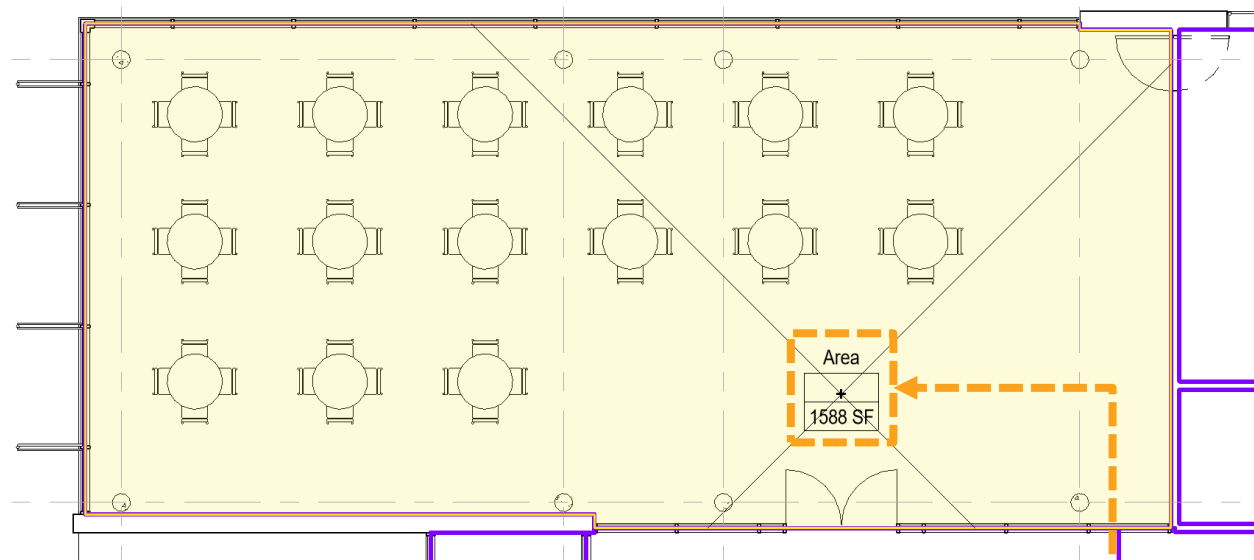


Areas

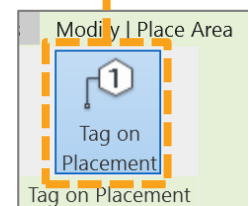
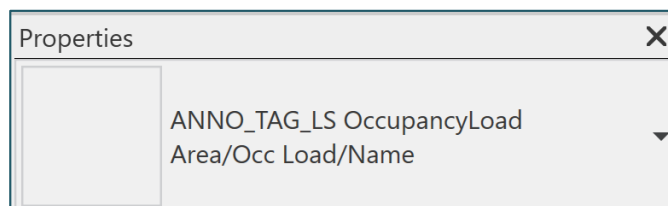
Created within the project so far: area scheme, area plan, area boundaries.
Now to place the areas.



The modify green tab has been activated on the Revit toolbar. Notice directly below that “Tag on Placement” is selected, meaning that the area will be annotated when placed. In addition, there are modify tools at the bottom of the toolbar; tag orientation, leader options, and whether a new area or a placeholder area will be placed.



Tag family / type
created for life
safety areas:



Area and Volume Computations ✕

Computations Area Schemes

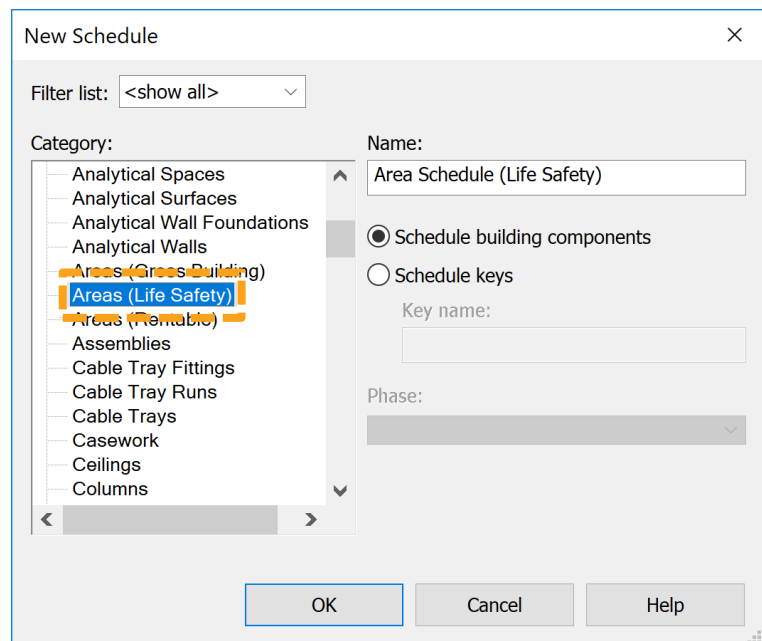
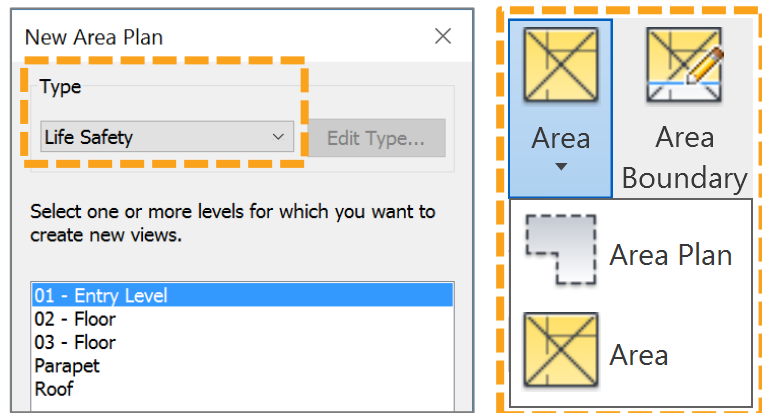
	Name	Description	
1	Gross Building	Total Constructed Area of a Building	
2	Rentable	Area Measurements Based on the Standard Method for Measuring FI	
3	Life Safety	Life Safety Area Measurements	

New

Delete

Each area scheme has its own distinct set of plans, boundaries, and areas. Area boundaries and areas will only be visible in the plans which reference the area scheme. Ex: life safety area boundaries and areas will only be visible in life safety area plans (not floor plans, gross building area plans, etc.)





If the Area Scheme is deleted all of the associated elements will be deleted also.



Areas & Area Schedules

Just like other modeled elements in Revit, once placed they can be scheduled. The schedule below demonstrates the data that we will need to gather to calculate occupancy. So far, by simply placing the area, we have two parameters populated – Name and Area. Half of the user inputs are done!

The colors depict how the information will be gathered within Revit:

-  Orange values will be user driven inputs
-  Light blue columns will be driven by Dynamo
-  Grey values will be populated through key schedule values
-  Dark blue represents the value that will be calculated

<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	(none)					1,588 SF		<input checked="" type="checkbox"/>	

Occupant Load Factor

$$\frac{\text{AREA}}{\text{OCCUPANT LOAD FACTOR}} = \text{NUMBER OF OCCUPANTS}$$

Now that the area has been obtained we can move onto the occupant load factor. The occupant load factor is assigned based off the function of the space (area) itself. These factors vary slightly depending on the code being referenced. Below is the occupant load factor table from the 2015 International Building Code.

**TABLE 1004.1.2
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT**

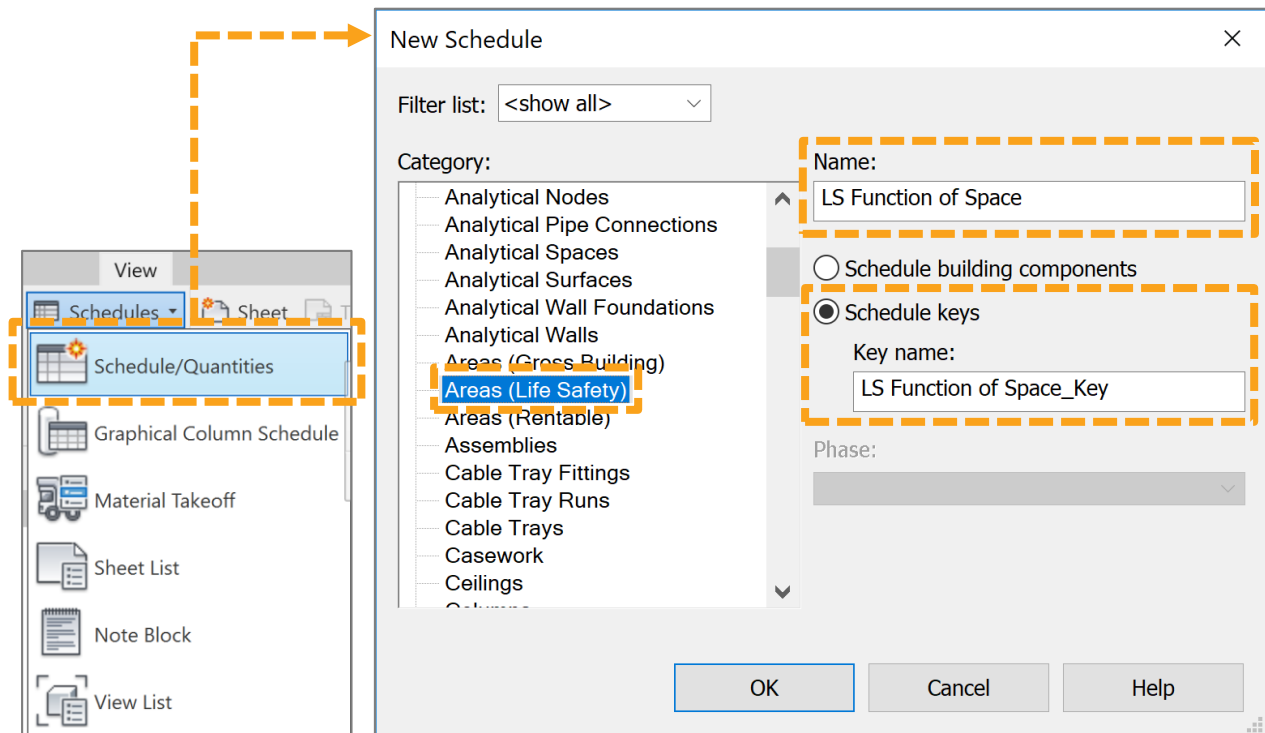
FUNCTION OF SPACE	OCCUPANT LOAD FACTOR ^a
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit gallery and museum	30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	
Concentrated (not fixed)	7 net

Area Schedule of Keys - Function of Space

To assign the function of space to the area within Revit we are going to use a key schedule. The beauty of a key schedule is that the values become associated; by assigning the function of space to the area the occupancy load value can tag along.

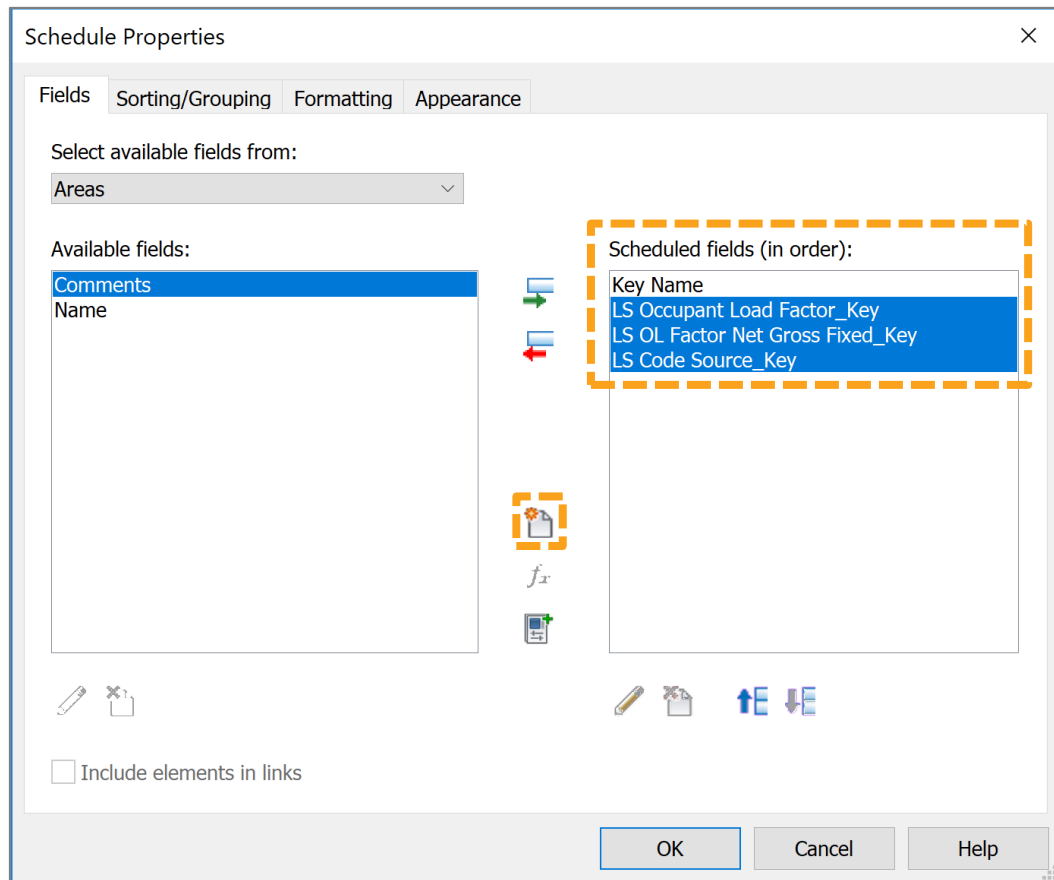
Creating a key schedule is much like creating a typical building component schedule. In the view tab within Revit select “Schedule/Quantities”.

Rather than creating a new schedule of building components, select “Schedule keys”.



Within the schedule properties 3 parameter have been created:

- LS Occupant Load Factor_Key
- LS OL Factor Net Gross Fixed_Key
- LS Code Source_Key



Note: Parameters have been named with “_Key” to indicate to the Revit user that the value derives from a key value.

Once the key schedule has been created a data row can be added to populate the data (image on next page).

File	Architecture	Structure	Systems	Insert	Annotate	Analyze	Massing & Site	Collaborate	View	Manage	Add-Ins	Modify	Modify Schedule/Quantities
Properties	Areas Key Name	Format Unit Calculated Combine Parameters	Insert Delete Resize Hide Unhide All	Insert Data Row	Delete Resize	Merge Unmerge	Insert Image Clear Cell	Group Ungroup	Shading				
Properties	Parameters	Columns	Rows	Titles & Headers									

<LS Function of Space Keys>			
A	B	C	D
LS Function of Space_Key	LS Occupant Load Factor_Key	LS OL Factor Net Gross Fixed_Key	LS Code Source_Key
ACCESSORY STORAGE AREAS, MECHANICAL EQUIPMENT ROOM	300	GROSS	IBC 2012

Now that the data has been populated into the key schedule the “LS Function of Space_Key” parameter can be associated within the area schedule. By associating the “LS Function of Space_Key” the three new parameters created within the key schedule properties will also be associated.

- Orange values will be user driven inputs
- Light blue columns will be driven by Dynamo
- Grey values will be populated through key schedule values
- Dark blue represents the value that will be calculated

<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level Area	ACCESSORY MECHANICAL AN	IBC 2012	300.0		GROSS	1,588 SF		<input checked="" type="checkbox"/>	

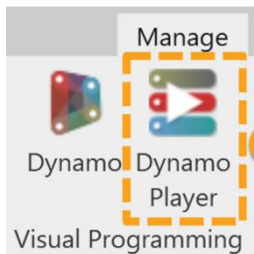
Code Sources

I've been mentioning the International Building Code but when it comes down to it there are more – National Fire Protection Association, GSA's P100.

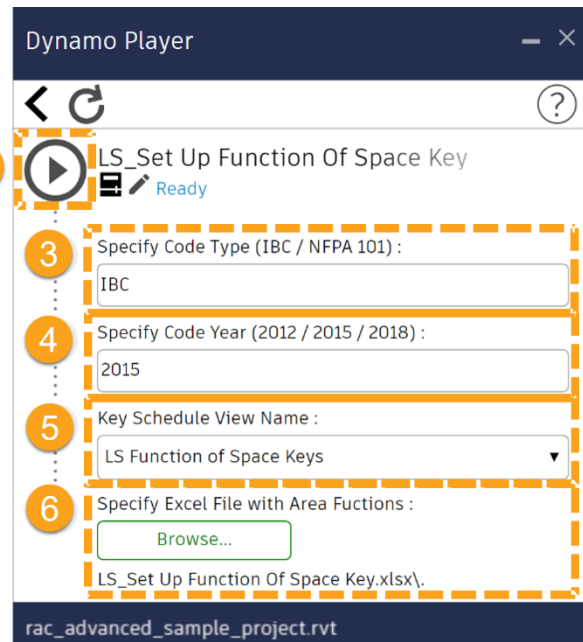
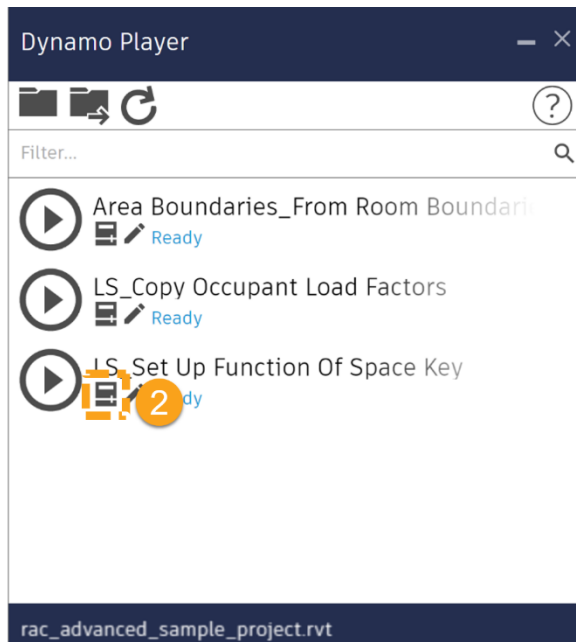
The second Dynamo graph in the workflow is the setup of the function of space keys.



Key Values & Dynamo / Excel



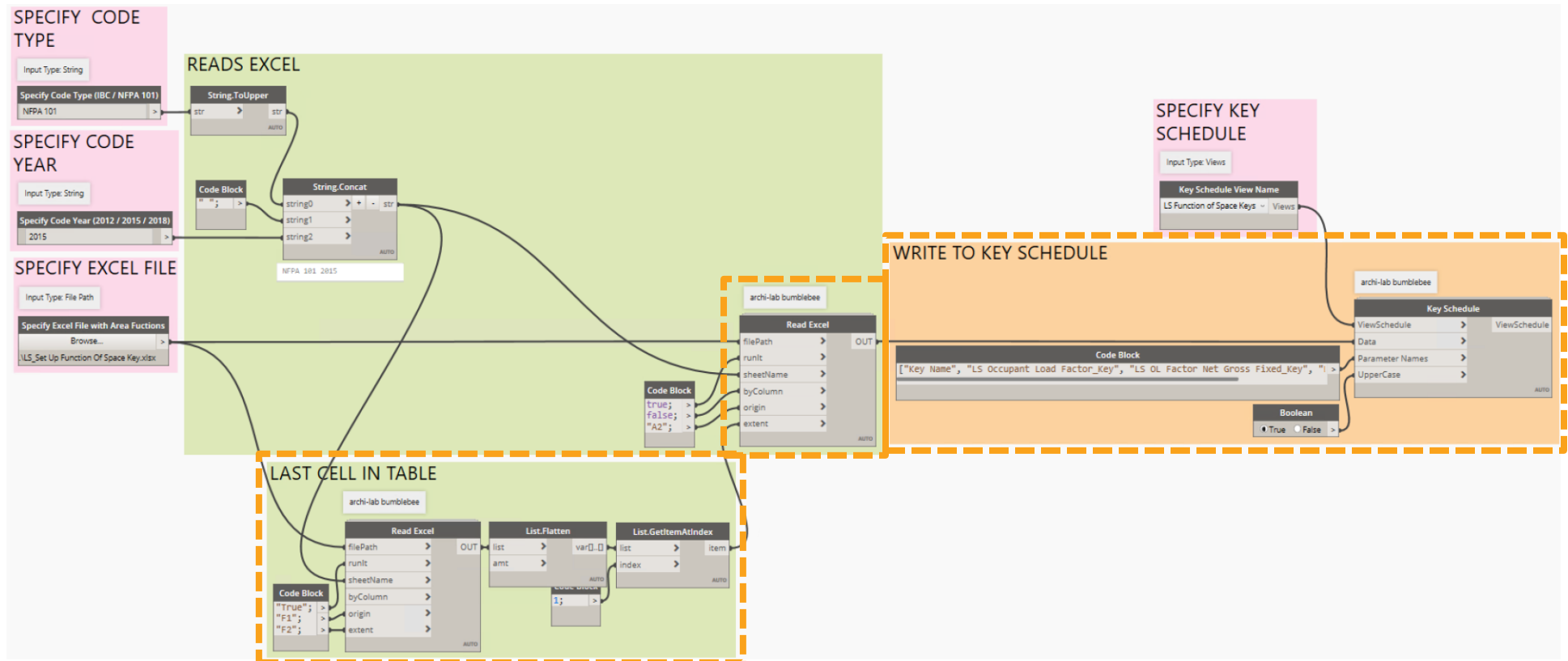
1. Open Dynamo Player
2. Click "Edit Inputs" below "LS_Set Up Function Of Space Key"
3. Specify Code Type
4. Specify Code Year
5. Specify Key Schedule View Name
6. Specify Excel File with Area Functions
7. Press Play



	A	B	C	D	E	F
1	LS Function of Space	LS Occupant Load Factor	LS OLF Gross-Net-Fixed	Code Source		Last Cell in Table D28
2	Accessory Mechanical and Storage Areas	300	gsf	IBC 2018, Table 1004		
3	Assembly Use - Commercial Kitchens	100	gsf	NFPA 101, Table 7.3.1.2		
4	Assembly Use - Concentrated	7	nsf	NFPA 101, Table 7.3.1.2		
5	Assembly Use - Exercise Rooms with Equipment	50	gsf	NFPA 101, Table 7.3.1.2		
6	Assembly Use - Exercise Rooms without Equipment	15	gsf	NFPA 101, Table 7.3.1.2		
7	Assembly Use - Exhibits Galleries and Museums	30	nsf	IBC 2018, Table 1004		
8	Assembly Use - Fixed Seating	0	Fixed	NFPA 101, Table 7.3.1.2		
9	Assembly Use - Library Reading Rooms	50	nsf	NFPA 101, Table 7.3.1.2		
10	Assembly Use - Library Stack Areas	100	gsf	NFPA 101, Table 7.3.1.2		
11	Assembly Use - Locker Rooms	50	gsf	IBC 2018, Table 1004		
12	Assembly Use - Stages and Platforms	15	nsf	NFPA 101, Table 7.3.1.2		
13	Assembly Use - Standing Space	3	nsf	NFPA 101, Table 7.3.1.2		
14	Assembly Use - Unconcentrated	15	nsf	NFPA 101, Table 7.3.1.2		
15	Business Use - Concentrated	50	gsf	NFPA 101, Table 7.3.1.2		
16	Business Use - General	100	gsf	NFPA 101, Table 7.3.1.2		
17	Educational Use - Classrooms	20	nsf	NFPA 101, Table 7.3.1.2		
18	Educational Use - Shops and Laboratories	50	nsf	NFPA 101, Table 7.3.1.2		
19	Health Care Use - Inpatient Sleeping	120	gsf	NFPA 101, Table 7.3.1.2		
20	Health Care Use - Inpatient Treatment	240	gsf	NFPA 101, Table 7.3.1.2		
21	Health Care Use - Outpatient/Ambulatory Care	100	gsf	NFPA 101, Table 7.3.1.2		
22	Industrial Use	100	gsf	NFPA 101, Table 7.3.1.2		
23	Mercantile Use - Sales Area on Floors Above Street Floor	60	gsf	NFPA 101, Table 7.3.1.2		
24	Mercantile Use - Sales Area on or Below Street Floor	30	gsf	NFPA 101, Table 7.3.1.2		
25	Mercantile Use - Sales Area on Two or More Street Floors	40	gsf	NFPA 101, Table 7.3.1.2		
26	Mercantile Use - Storage, Stock, and Shipping Areas	300	gsf	NFPA 101, Table 7.3.1.2		
27	Parking Garage	200	gsf	IBC 2018, Table 1004		
28	Unoccupied	0	N/A	N/A		
	IBC 2012	IBC 2015	IBC 2018	NFPA 101 2012	NFPA 101 2015	NFPA 101 2018

Essentially the data is derived from an Excel spreadsheet. The different code sources and versions are sheets within the spreadsheet itself.

This approach allows for not only different code versions but also the ability to fine tune the code versions for our every day use. As you can see shown in the image the “NFPA 101 2015” code source also contains IBC 2018 functions of space as they are frequently used by our Fire Protection Engineers.



<http://archi-lab.net/bumblebee-dynamo-and-excel-interop/>

Archi-lab BumbleBee allows for the interoperability between Dynamo and Excel. The “Read Excel” node is pulling the data from the sheet specified by the user via Dynamo Player. This workflow also contains a cell within the workbook that informs the “Read Excel” node how many rows of data to bring in. The information is then populated into a key schedule also specified by the user, once again using a BumbleBee node, into the parameters created earlier into the area key schedule.

<LS Function of Space Keys>

A	B	C	D
LS Function of Space_Key	LS Occupant Load Factor_Key	LS OL Factor Net Gross Fixed_Key	LS Code Source_Key
ACCESSORY MECHANICAL AND STORAGE AREAS	300.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - COMMERCIAL KITCHENS	200.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - CONCENTRATED	7.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - EXERCISE ROOMS	50.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - EXHIBITS GALLERIES AND MUSEUMS	30.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - FIXED SEATING		FIXED	IBC 2015, TABLE 1004
ASSEMBLY USE - LIBRARY READING ROOMS	50.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - LIBRARY STACK AREAS	100.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - STAGES AND PLATFORMS	15.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - STANDING SPACE	5.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - UNCONCENTRATED	15.0	NSF	IBC 2015, TABLE 1004
BUSINESS USE - CONCENTRATED	50.0	GSF	IBC 2015, TABLE 1004
BUSINESS USE - GENERAL	100.0	GSF	IBC 2015, TABLE 1004

The key schedule has now been populated with the specified code type and version. Now the functions of space are ready to be assigned to the areas placed within the model.

Once the function of space has been assigned it will automatically assign the associated key parameters (highlighted in grey in the LS Area Schedule). If the function of space is changed the associated parameters will also change to reflect the specified function of space.

<LS Area Schedule>

A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	(none)					1,588 SF		<input checked="" type="checkbox"/>	
	(none)					1,588 SF 0			
	ACCESSORY MECHANICAL AND STORAGE AREAS								
	ASSEMBLY USE - COMMERCIAL KITCHENS								
	ASSEMBLY USE - CONCENTRATED								
	ASSEMBLY USE - EXERCISE ROOMS								
	ASSEMBLY USE - EXHIBITS GALLERIES AND MUSEUMS								
	ASSEMBLY USE - FIXED SEATING								
	ASSEMBLY USE - LIBRARY READING ROOMS								

Number of Occupants

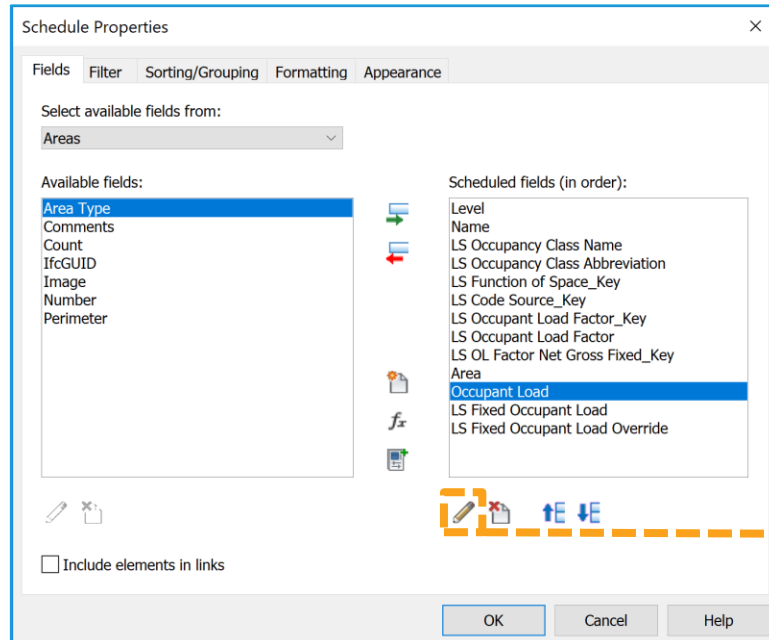
Revit Calculation

$$\text{roundup} \left(\frac{\text{AREA} / 1\text{sf}}{\text{OCCUPANT LOAD FACTOR}} \right) = \text{NUMBER OF OCCUPANTS}$$

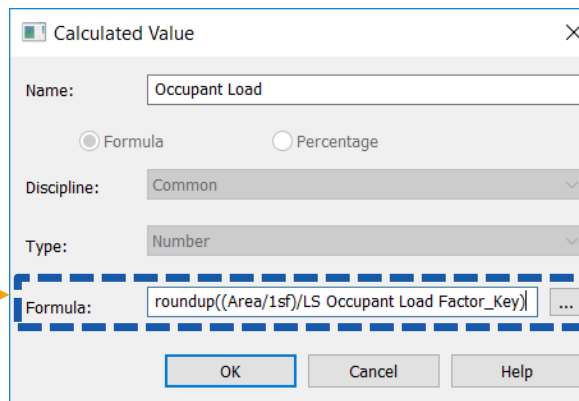
The first thing to understand is that the number of occupants must be an integer (or a whole number; we cannot have part of a person), therefore, we round up the value. Second is understand units of calculation – area (or square feet) needs to be converted to a number – hence “Area/1sf”.

Calculated Values

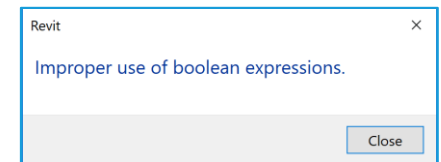
<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ACCESSORY MECHANICAL AND	IBC 2018, TABLE 1004	300.0		GSF	1,588 SF			



Now that we have obtained the area and the occupant load factor calculating the number of occupants should be easy, right? Divide the area by the occupant load factor and you have your number of occupants? Unfortunately, it's not quite that easy. Within the schedule we will go to the fields and look at the “Occupant Load” formula parameter. When a key value is included in the formula, we get the error “Improper use of boolean expressions”.



roundup((Area/1sf) / LS Occupant Load Factor_Key)



Occupant Load Factor & Dynamo

<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - CONCENTRAT	NFPA 101, TABLE 7.3.1, 7.0		7	NSF	1,588 SF	227		0

The formula can be modified to include the “LS Occupant Load Factor Parameter” rather than the key value.

The formula now works with no error messages. As you can see in the schedule above the Occupant Load is now calculated.

Schedule Properties

Fields Filter Sorting/Grouping Formatting Appearance

Select available fields from:

Areas

Available fields:

- Area Type
- Comments
- Count
- IfcGUID
- Image
- Number
- Perimeter

Scheduled fields (in order):

- Level
- Name
- LS Occupancy Class Name
- LS Occupancy Class Abbreviation
- LS Function of Space_Key
- LS Code Source_Key
- LS Occupant Load Factor_Key
- LS Occupant Load Factor
- LS OL Factor Net Gross Fixed_Key
- Area
- Occupant Load
- LS Fixed Occupant Load
- LS Fixed Occupant Load Override

☐ Include elements in links

OK Cancel Help

**roundup((Area/1sf) /
LS Occupant Load Factor)**

Calculated Value

Name: Occupant Load

☒ Formula ☐ Percentage

Discipline: Common

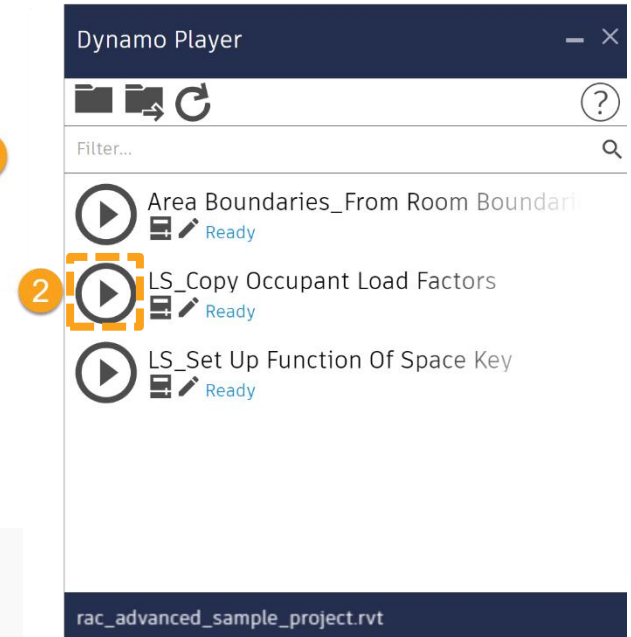
Type: Number

Formula: roundup((Area/1sf)/LS Occupant Load Factor)

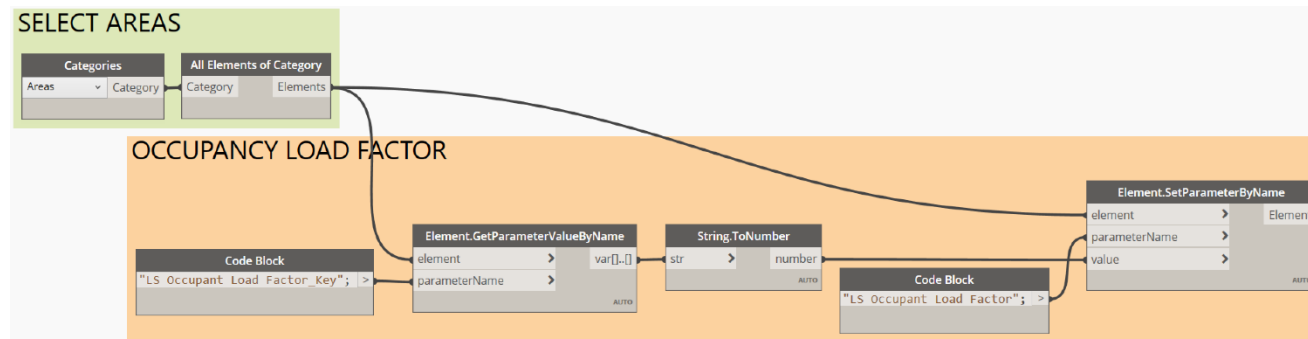
OK Cancel Help

Rather than manually transcribing the values (which could lead to user error over the span of many areas) we will use a very simple “read and write” dynamo script.

1. Open Dynamo Player
2. Play “LS_Copy Occupant Load Factors”



Within Dynamo data is copied from “LS Occupant Load Factor_Key” to “LS Occupant Load Factor”.



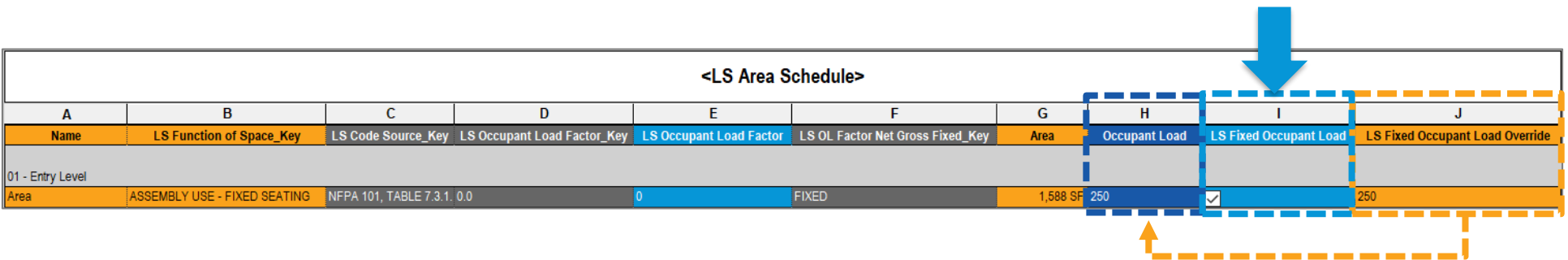
<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - CONCENTRAT	NFPA 101, TABLE 7.3.1	7.0		NSF	1,588 SF	227		0

. Fixed Seating

Calculation


“For areas having fixed seats and aisles, the **occupant load shall be determined by the number of fixed seats** installed therein.” (1004.4)

$$\text{FIXED SEAT COUNT} = \text{NUMBER OF OCCUPANTS}$$



<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - FIXED SEATING	NFPA 101, TABLE 7.3.1. 0.0	0	FIXED		1,588 SF	250	<input checked="" type="checkbox"/>	250

Calculated Value Modification


Calculated Value

Name:

Occupant Load

Formula

Percentage

Discipline:

Common

Type:

Number

Formula:

`roundup(if(LS Fixed Occupant Load, LS Fixed Occupant Load Override, (Area / 1 SF) / LS Occupant Load Factor))`

OK

Cancel

Help

A conditional format has been built into the formula so that if “LS Fixed Occupant Load is checked then it will use the “LS Fixed Occupant Load Override, otherwise it will use the original formula of “Area” divided by “LS Occupant Load Factor”

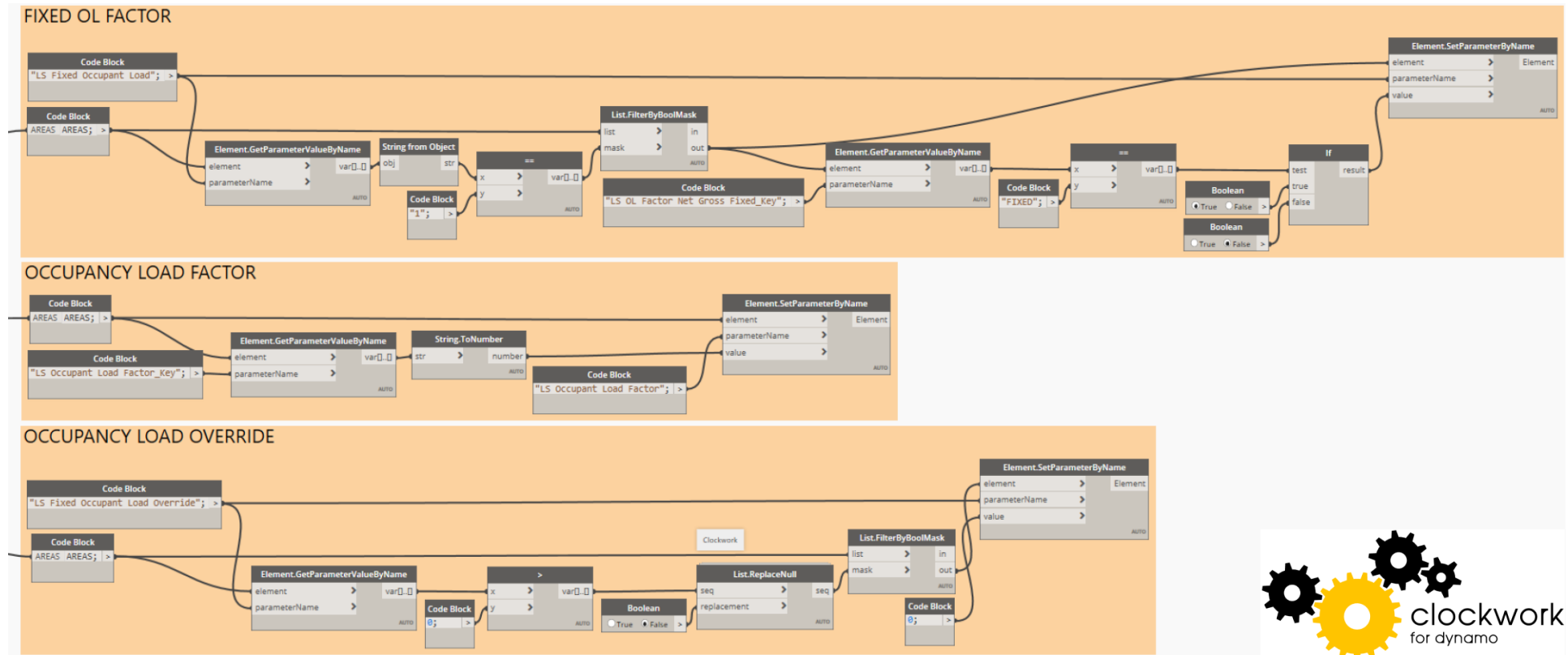
`roundup(if(LS Fixed Occupant Load,
LS Fixed Occupant Load Override,
(Area / 1 SF) / LS Occupant Load Factor))`

Fixed Occupants & Dynamo

To account for the fixed seating the occupant load factor graph is modified. The user still follows step 1 – 2; open dynamo player, play “LS Copy Occupant Load Factor”. Two additional workflows have been added to the graph.

1. If the parameter “LS OL Factor Net Gross Fixed_Key” is Fixed the “LS Fixed Occupant Load” parameter will be checked. This is the conditional statement built into the formula so that, if checked, the “Occupant Load” = “LS Fixed Occupant Load Override”. (top orange group of nodes)
2. “LS Occupant Load Factor_Key” to “LS Occupant Load Factor” (middle orange group, shown in previous graph)
3. If the “LS Occupant Load Override” has not been given a value (it is not greater than 0) it will be given the value of 0. (bottom orange group)

F
LS OL Factor Net Gross Fixed_Key
FIXED

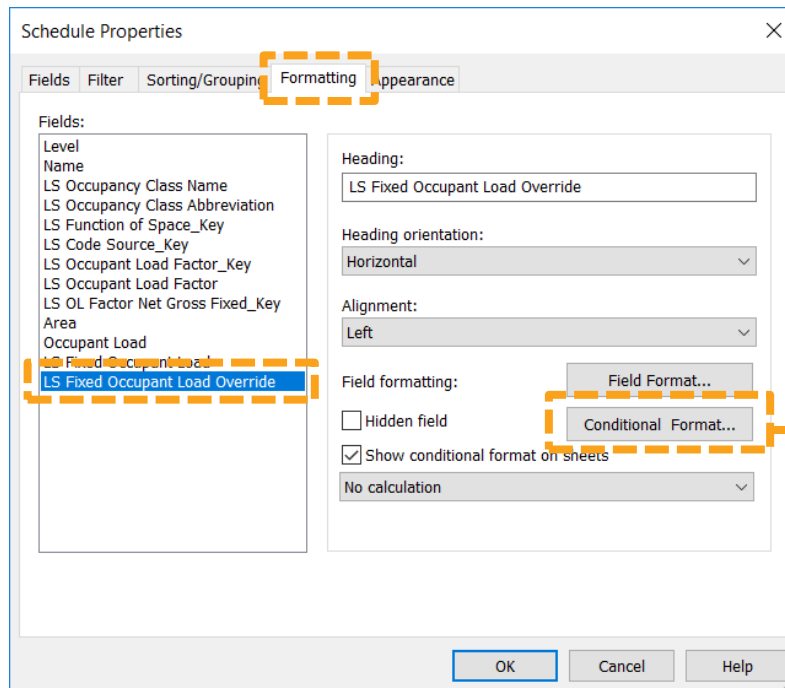


<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - FIXED SEATING	IBC 2015, TABLE 1004		FIXED		1,588 SF	0	<input checked="" type="checkbox"/>	0

Conditional Formatting

Upon running the graph fixed spaces will show with a conditional format. If the value is 0, and the “LS Fixed Occupant Load” parameter is checked, the field will be shaded red to signal the user that the data needs to be input. Once updated the Occupant Load will equal the value per the formula and the conditional format will be removed.

The conditional format can be setup through the formatting tab of the properties.



Schedule Properties

Fields: Filter Sorting/Grouping **Formatting** Appearance

Fields:

- Level
- Name
- LS Occupancy Class Name
- LS Occupancy Class Abbreviation
- LS Function of Space_Key
- LS Code Source_Key
- LS Occupant Load Factor_Key
- LS Occupant Load Factor
- LS OL Factor Net Gross Fixed_Key
- Area
- Occupant Load
- LS Fixed Occupant Load
- LS Fixed Occupant Load Override**

Heading: LS Fixed Occupant Load Override

Heading orientation: Horizontal

Alignment: Left

Field formatting:

☐ Hidden field

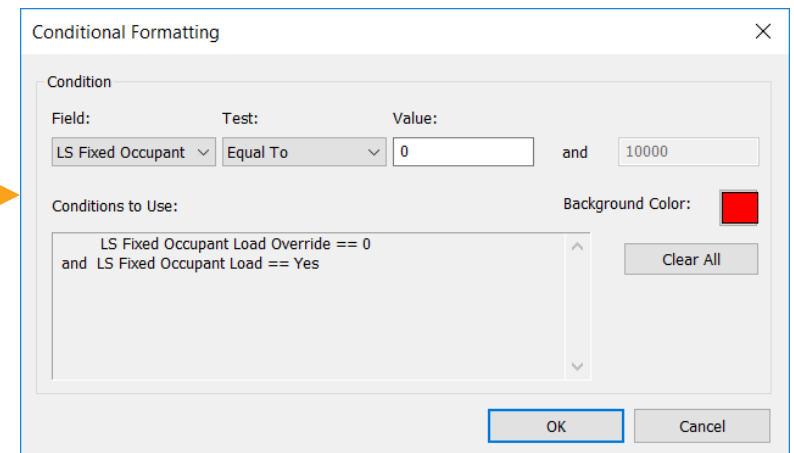
☒ Show conditional format on sheets

No calculation

Field Format... Conditional Format...

OK Cancel Help

- Orange values will be user driven inputs
- Light blue columns will be driven by Dynamo
- Grey values will be populated through key schedule values
- Dark blue represents the value that will be calculated



Conditional Formatting

Condition

Field: LS Fixed Occupant Load Test: Equal To Value: 0 and 10000

Conditions to Use:

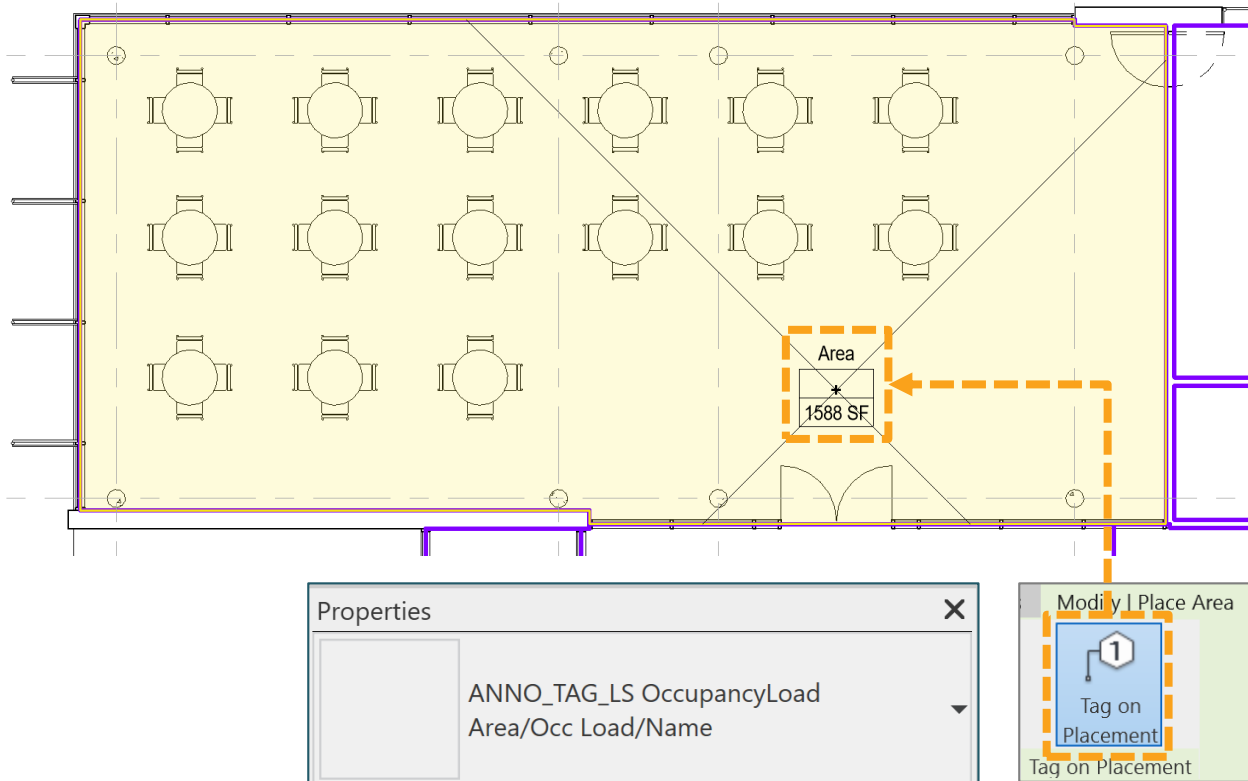
LS Fixed Occupant Load Override == 0 and LS Fixed Occupant Load == Yes

Background Color: X

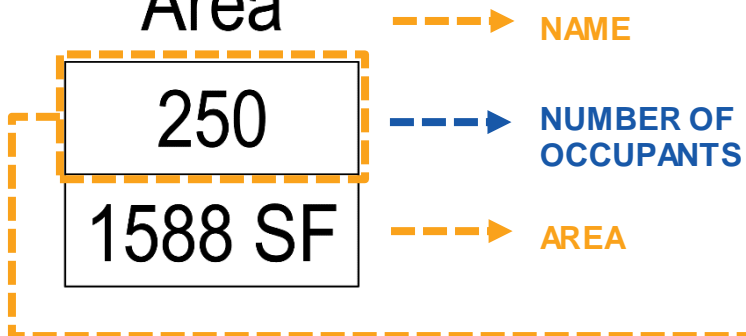
Clear All

OK Cancel

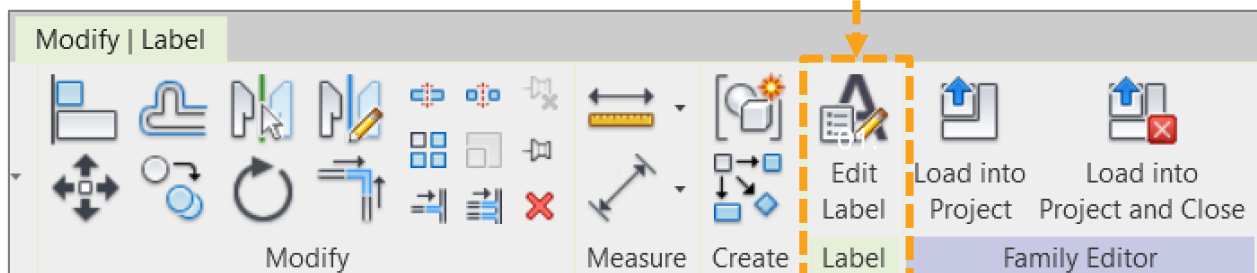
Area Tag



Area



In the area tag family select the label that represents the number of occupants, click "Edit Label".



Calculated Value

Edit Label

Select parameters to add to the label. Parameters will be combined into a single label.

Enter sample values to represent this label in the family environment. ☐ Wrap between parameters only

Category Parameters

Select available fields from:

Areas

- Area
- Area Type
- Comments
- IfcGUID
- Level
- LS Fixed Occupant Load
- LS Fixed Occupant Load Override
- LS Occupant Load Factor
- Name
- Number
- Perimeter

Label Parameters

	Parameter Name	Spaces	Prefix	Sample Value	Suffix	Break
1	Occupant Load	1		100		<input type="checkbox"/>

OK Cancel Apply

Calculated Value

Name: Occupant Load

Discipline: Common

Type: Number

Formula: `roundup(if(LS Fixed Occupant Load, LS Fixed Occupant Load Override, (Area / 1 SF) / LS Occupant Load Factor))` ...

OK Cancel Help

roundup(if(LS Fixed Occupant Load, LS Fixed Occupant Load Override, (Area / 1 SF) / LS Occupant Load Factor))

This formula is the same as the formula in the area schedule for Occupant Load. Now both the schedule and the area tag will reflect the schedule with the built-in conditional statement for the fixed seat occupant calculation.

Note: Parameters must be Shared to Label within Tag

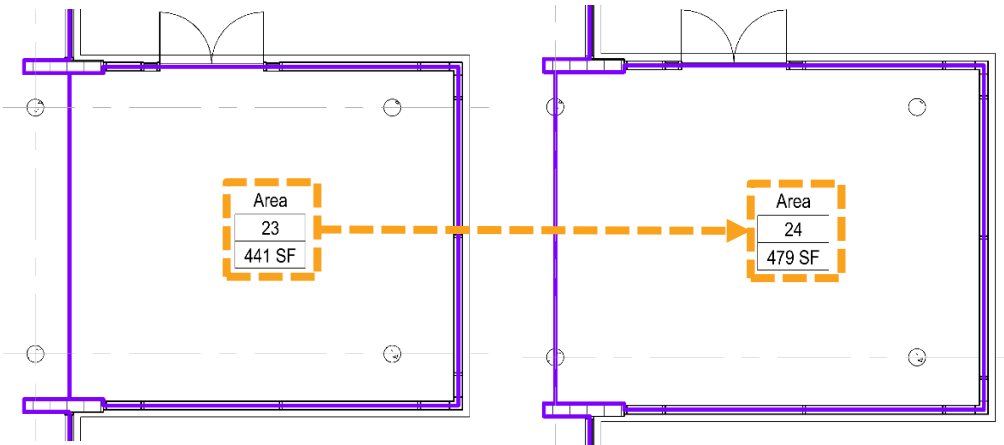
Dealing with Changes

Scenario 1: Area boundaries move / SF changes – Automatic

<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space Key	LS Code Source Key	LS Occupant Load Factor Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - CONCENTRATED	IBC 2015, TABLE 1004	7.0	20	NSF	441 SF	23		0
Area	ASSEMBLY USE - CONCENTRATED	IBC 2015, TABLE 1004	7.0	20	NSF	479 SF	24		0

In both scenarios 1 & 2 the values automatically update because the “Occupant Load” in both the schedule and the area tag is a formula, the value automatically updates when the area and/or the fixed seat count is modified.

**roundup(if(LS Fixed Occupant Load,
LS Fixed Occupant Load Override,
(Area / 1 SF) / LS Occupant Load Factor))**



Scenario 2: Number of Fixed Seats Changed (“LS Fixed Occupant Load Override”) – Automatic

<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space Key	LS Code Source Key	LS Occupant Load Factor Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - FIXED SEATING	IBC 2015, TABLE 1004			FIXED	441 SF	50	<input checked="" type="checkbox"/>	50
Area	ASSEMBLY USE - FIXED SEATING	IBC 2015, TABLE 1004			FIXED	441 SF	60	<input checked="" type="checkbox"/>	60

Scenario 3: "LS Occupant Load Factor" Changes

Changing the "LS Function of Space_Key" value for an area, as mentioned previously, automatically changes the key values that are associated with it. Unfortunately, the formula for "Occupant Load" cannot include the key value, it includes "LS Occupant Load Factor" which is not automatically updated when changing "LS Function of Space_Key".

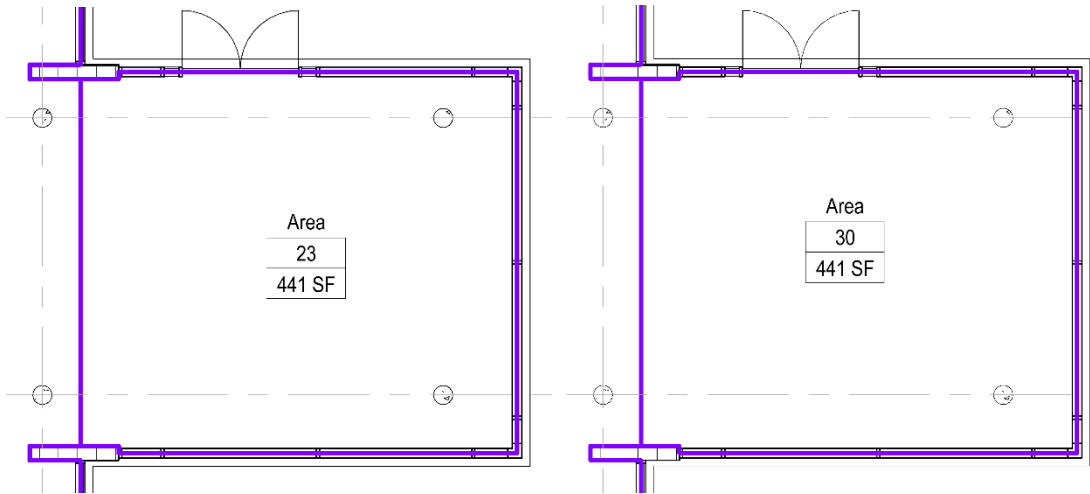
<LS Function of Space Keys>

A	B	C	D
LS Function of Space_Key	LS Occupant Load Factor_Key	LS OL Factor Net Gross Fixed_Key	LS Code Source_Key
ACCESSORY MECHANICAL AND STORAGE AREAS	300.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - COMMERCIAL KITCHENS	200.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - CONCENTRATED	7.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - EXERCISE ROOMS	50.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - EXHIBITS GALLERIES AND MUSEUMS	30.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - FIXED SEATING		FIXED	IBC 2015, TABLE 1004
ASSEMBLY USE - LIBRARY READING ROOMS	50.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - LIBRARY STACK AREAS	100.0	GSF	IBC 2015, TABLE 1004
ASSEMBLY USE - STAGES AND PLATFORMS	15.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - STANDING SPACE	5.0	NSF	IBC 2015, TABLE 1004
ASSEMBLY USE - UNCONCENTRATED	15.0	NSF	IBC 2015, TABLE 1004

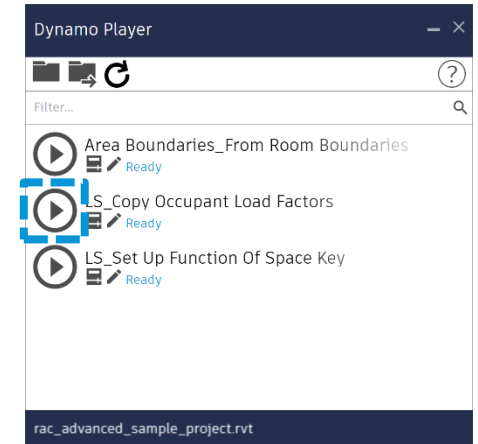
By opening Dynamo Player and playing "LS_Copy Occupant Load Factors" the value is copied over and the "Occupant Load" has been updated in both the schedule and the area tag.

<LS Area Schedule>

A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - CONCENTRATED	IBC 2015, TABLE 1004	7.0	7	NSF	441 SF	64		0
Area	ASSEMBLY USE - CONCENTRATED	IBC 2015, TABLE 1004	15	7	NSF	441 SF	64		0
Area	ASSEMBLY USE - CONCENTRA	IBC 2015, TABLE 1004	15	15	NSF	441 SF	30		0



In both scenarios 3 & 4 the area tag, as well as the schedule, will be updated when the Dynamo graph “LS_Copy Occupant Load Factors” is played using the Dynamo Player.



Scenario 4: “LS Occupant Load Factor_Key” Changes

If the “LS Function of Space” does not change but the associated “LS Occupant Load Factor_Key” changes, all of the areas associated to the function of space key will automatically be updated with the new occupant load factor value. As noted in scenario 3, however, the key value is not being used in the formula, “LS Occupant Load Factor” is the value that needs to be updated. By playing the “LS_Copy Occupant Load Factors” graph through Dynamo Player the values will be updated and the “Occupant Load” formula will follow suit.

A	B
LS Function of Space_Key	LS Occupant Load Factor_Key
ACCESSORY MECHANICAL AND STORAGE AREAS	300.0
ASSEMBLY USE - COMMERCIAL KITCHENS	200.0
ASSEMBLY USE - CONCENTRATED	7.0
ASSEMBLY USE - CONCENTRATED	15.0

<LS Area Schedule>									
A	B	C	D	E	F	G	H	I	J
Name	LS Function of Space_Key	LS Code Source_Key	LS Occupant Load Factor_Key	LS Occupant Load Factor	LS OL Factor Net Gross Fixed_Key	Area	Occupant Load	LS Fixed Occupant Load	LS Fixed Occupant Load Override
01 - Entry Level									
Area	ASSEMBLY USE - CONCENTRATED	IBC 2015, TABLE 1004	7.0	7	NSF	441 SF	64	0	0
Area	ASSEMBLY USE - CONCENTRATED	IBC 2015, TABLE 1004	15	7	NSF	441 SF	64	0	0
Area	ASSEMBLY USE - CONCENTRA	IBC 2015, TABLE 1004	15	15	NSF	441 SF	30	0	0

The Workflow in Action

Workflow Requirements

- Area Scheme – “Life Safety”
- Area Schedules (Insert Views from File – Area Scheme Names must match exactly)
 - LS Area Schedule
 - LS Function of Space Keys
- Dynamo Packages
 - archi-lab.net (Konrad K Sobon)
 - archi-lab BumbleBee (Konrad K Sobon)
 - Clockwork for Dynamo 2.x (Andreas Dieckmann)
- Dynamo Scripts
 - Area Boundaries_From Room Boundaries
 - LS_Set Up Function of Space (and accompanying Excel File with Code Data)
 - LS_Copy Occupant Load Factors
- Area Tag containing Calculated Value

https://drive.google.com/open?id=1QQo1xs9HHhIYyvSy1dNRI_yz_BXXqghP

The Workflow Process

The automation workflow for the calculation of number of occupants can be completed with the following steps:

1. Create area scheme / plans, insert schedules from project
2. Create area boundaries (Dynamo)
3. Place areas
4. Load function of space key values (Dynamo)
5. Assign functions of space to placed areas
6. Copy occupant load factors and account for fixed seats (Dynamo)