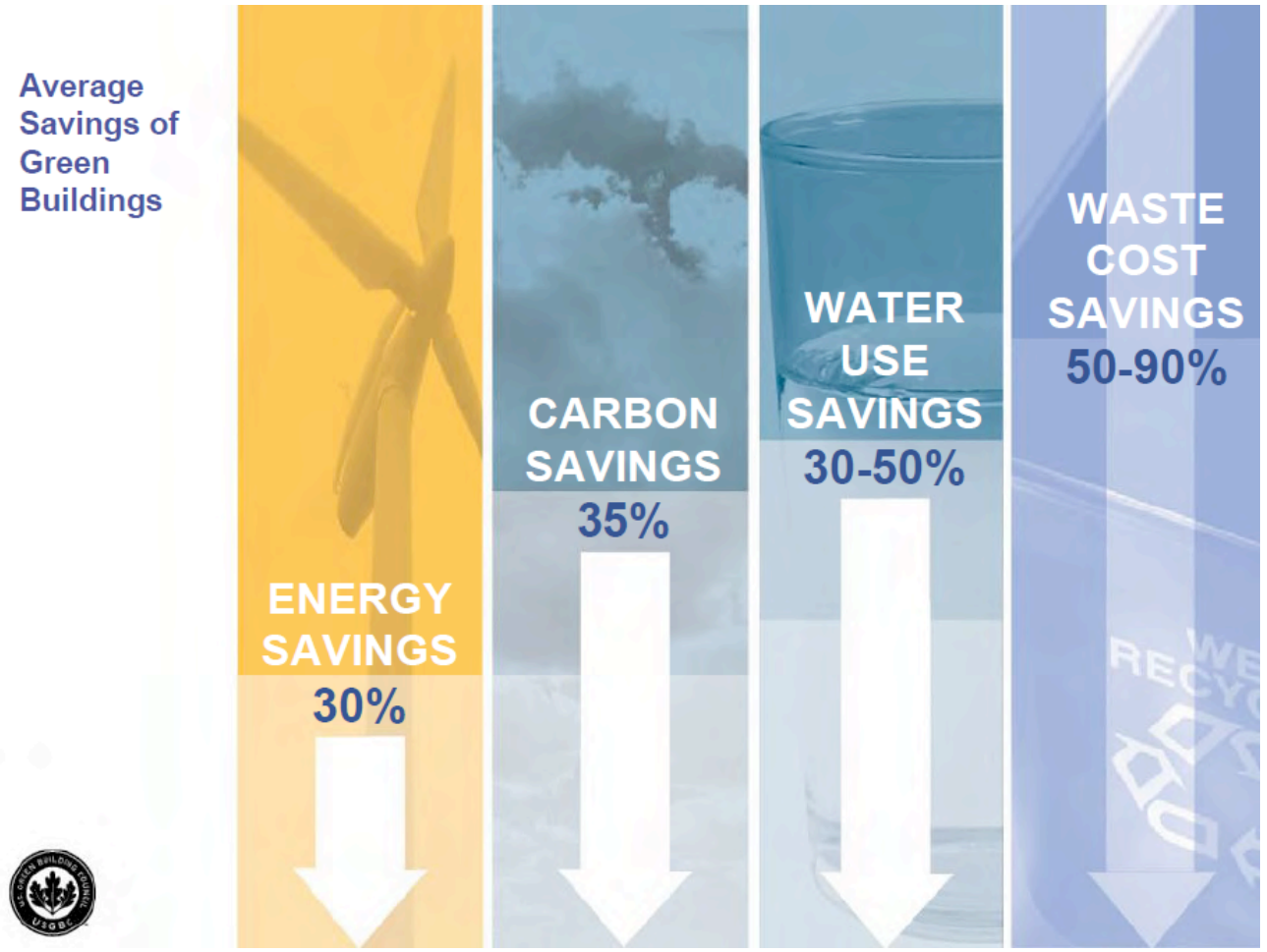
48-749 Parametric Modeling
Lecture 4

Carnegie Mellon University
School of Architecture

Lecture 4

- Bim used in Sustainable Design
  - Water Calculations
    - Rainwater
    - Water used by fixtures- Ex01
- Design Options
  - Ex02
- Families General classification
- Solar Studies
- Curtain Wall System

Green Building Savings



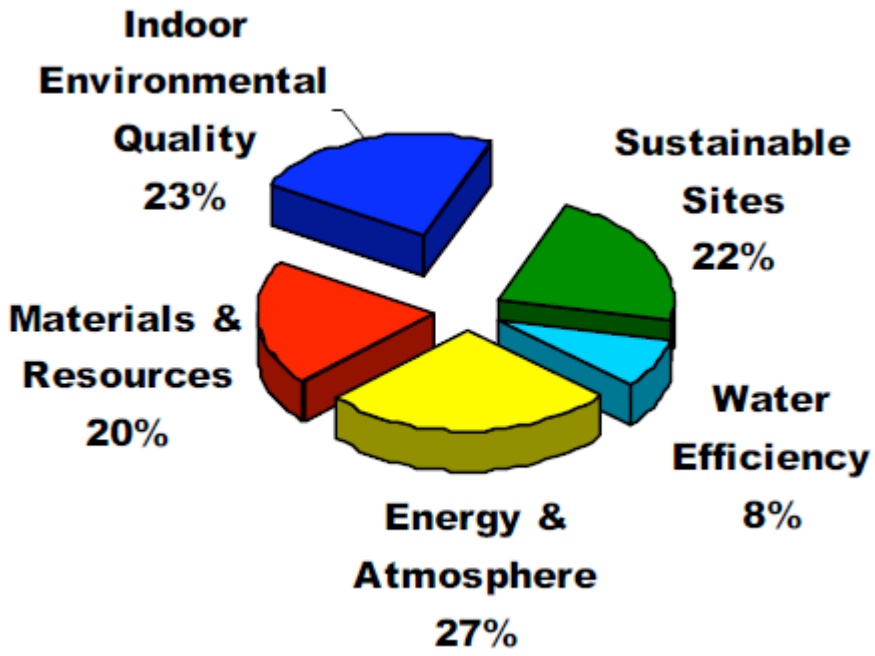
LEED points

- Sustainable Design Categories (LEED NC 2.2)

Project Checklist — **69 points**

1.	**Sustainable Sites**	**14 points**
2.	Water Efficiency	5 points
3.	Energy & Atmosphere	17 points
4.	Materials and Resources	13 points
5.	Indoor Environmental Quality	15 points
6.	Innovation & Design Process	5 points

LEED point distribution



LEED point distribution

LEED-NC

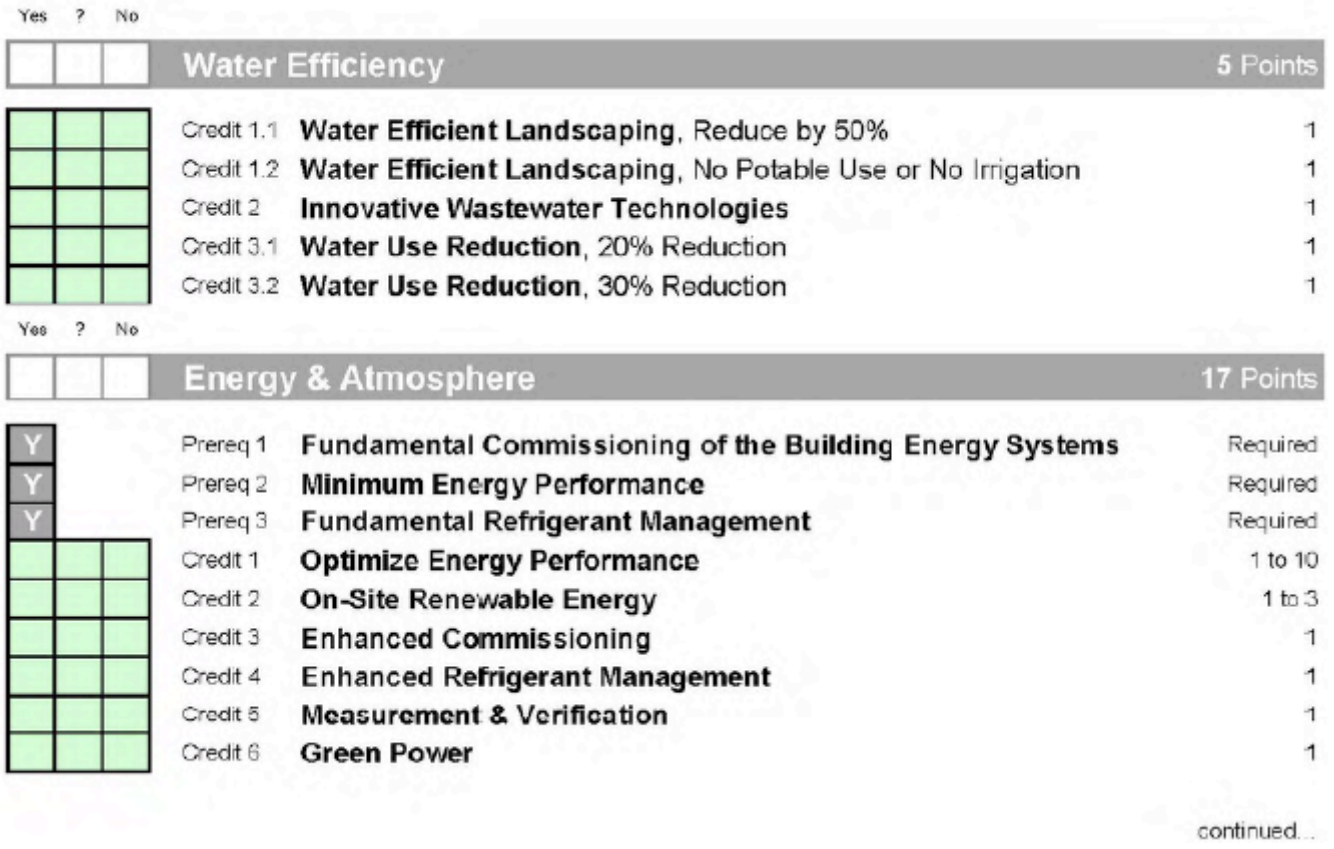
LEED-NC Version 2.2 Registered Project Checklist

<< enter project name >>

<< enter city, state, other details >>

Yes	?	No	Sustainable Sites	14 Points
Y			Prereq 1 **Construction Activity Pollution Prevention**	Required
			Credit 1 **Site Selection**	1
			Credit 2 **Development Density & Community Connectivity**	1
			Credit 3 **Brownfield Redevelopment**	1
			Credit 4.1 **Alternative Transportation**, Public Transportation Access	1
			Credit 4.2 **Alternative Transportation**, Bicycle Storage & Changing Rooms	1
			Credit 4.3 **Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1
			Credit 4.4 **Alternative Transportation**, Parking Capacity	1
			Credit 5.1 **Site Development,** Protect of Restore Habitat	1
			Credit 5.2 **Site Development,** Maximize Open Space	1
			Credit 6.1 **Stormwater Design,** Quantity Control	1
			Credit 6.2 **Stormwater Design,** Quality Control	1
			Credit 7.1 **Heat Island Effect,** Non-Roof	1
			Credit 7.2 **Heat Island Effect,** Roof	1
			Credit 8 **Light Pollution Reduction**	1

LEED point distribution



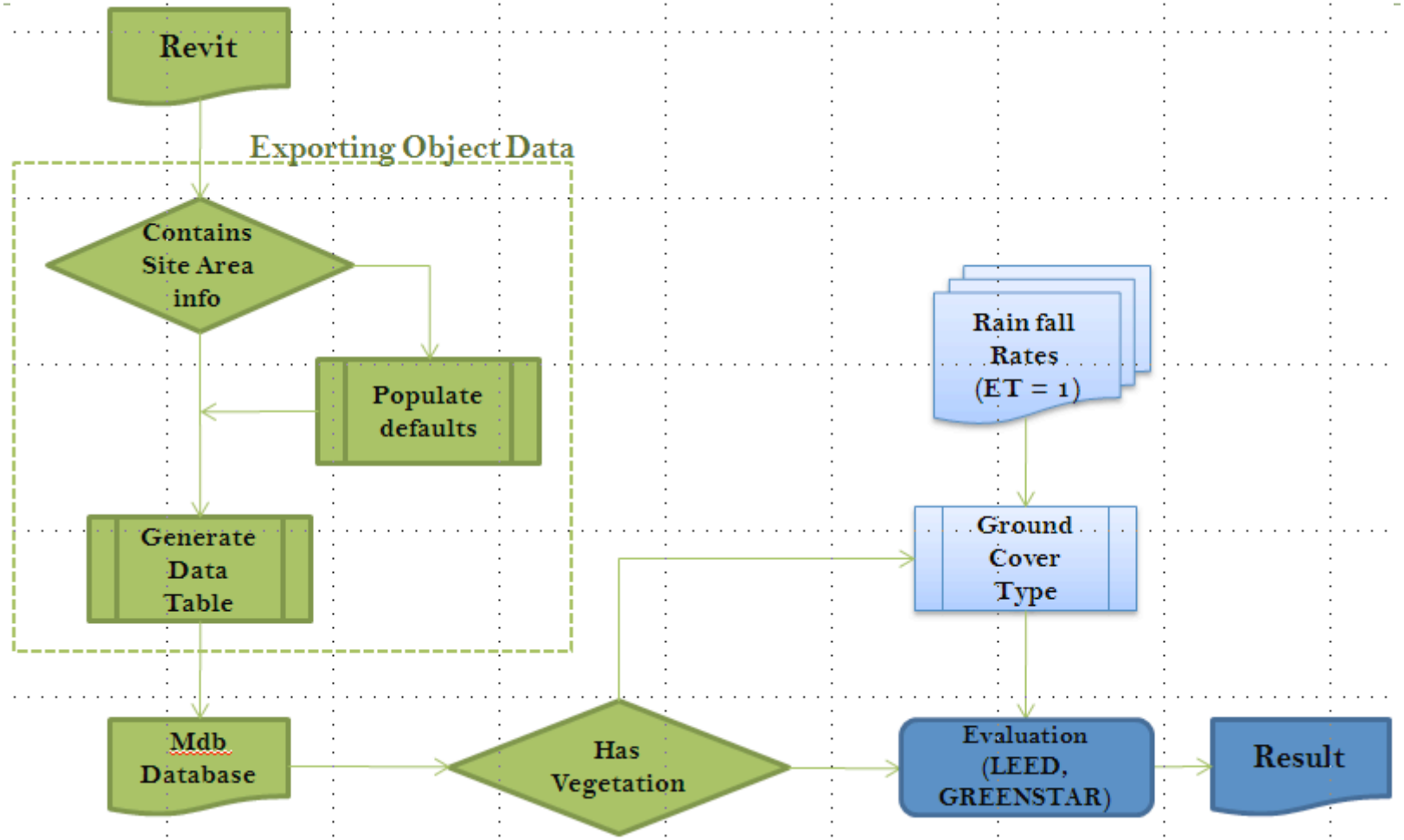
Yes	?	No			
			Water Efficiency		**5** Points
			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
			Credit 2	**Innovative Wastewater Technologies**	1
			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
			Credit 3.2	**Water Use Reduction**, 30% Reduction	1
Yes	?	No			
			Energy & Atmosphere		**17** Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
			Credit 1	**Optimize Energy Performance**	1 to 10
			Credit 2	**On-Site Renewable Energy**	1 to 3
			Credit 3	**Enhanced Commissioning**	1
			Credit 4	**Enhanced Refrigerant Management**	1
			Credit 5	**Measurement & Verification**	1
			Credit 6	**Green Power**	1

continued...

Gaps in Objects in Revit

Framework Elements	Reference / Process	Availability in Revit	Customization in Revit	gbXML element
HAVC equipment	Process/ref	Equipment		Yes (multiple)
AreaVegetatedRoof		roof	yes	Area
LightingSystem	Process	light	yes	LightingSystem
Illumination Level		light	yes	Illuminance
EffectiveVentialtion	Process	Equipment		IntEquip
ReduceEnergyFromBase	Process			Yes (multiple)
UseCapturedRainwater		none		none
UseRecycledWasterWater		none		none
CapturedRainwaterQuantity		none		none
GlobalWarmingPotential		none		Refrigerant Type

Processes and Artifacts for WE 1.1 (Water Efficient Landscaping) & Wat-3



Water Calculation

- There is currently no bim tool that combines the quick analysis of climatic data and building systems for optimizing water use

- For rainwater we can find data from
  - http://www.weatherbase.com
  - or http://wwwworldclimate.com

Average Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mm	66.0	59.6	84.7	80.1	91.7	91.0	97.9	83.2	73.6	60.8	68.5	70.8	928.7
inches	2.6	2.3	3.3	3.2	3.6	3.6	3.9	3.3	2.9	2.4	2.7	2.8	36.6

Source: PITTSBURGH GR P'BURG, ALLEGHENY COUNTY data derived from NCDC Cooperative Stations. 42 complete years between 1952 and 1995

Water Calculation

- Rainwater harvesting potential
- Identify roof area from bim model
- The area that can be used to collect rainwater
  - Canopies
  - Green roofs –rainwater will go towards irrigating plants
  - Terraces or desks
- Roof Area* monthly rainfall* .8 = Monthly Rainwater collection

Water Calculation (common terms)

- Potable water – Water that is suitable for drinking and is supplied from wells or municipal water systems
- Non- potable water- is water that is not suitable for human consumption without treatment that meets EPA drinking water standards
- Gray water- is defined as wastewater from sinks, lavatories, laundry facilities and water fountains
- Black water – is waste water from toilets or sinks where food is prepared

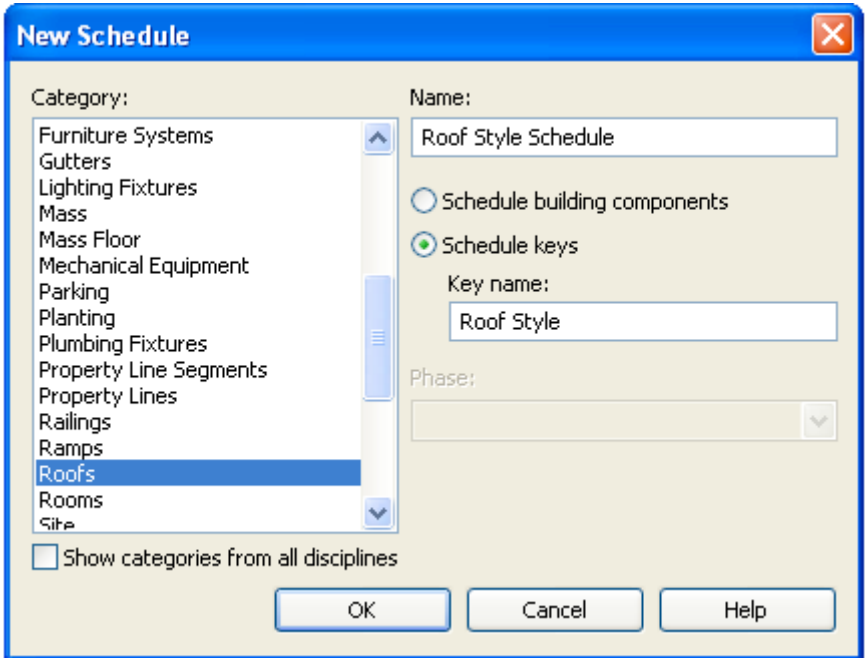
Rain Water Calculation

- Schedule Building Components:
  - Each object instance will appear in the schedule by default.
- Schedule keys:
  - Best used to setup a number of standard "styles" for an object type. Each row of data in the Key Schedule will create a new style to apply to an object. Once applied, the style will pre-fill all fields as needed.
    - Key Schedules cannot utilize Shared Parameters for a field; "Project Parameters" are only available in this schedule type.
    - To combine "Keys", "Project Parameters" and "Shared Parameters" in a schedule, use a "Building Components" schedule type.

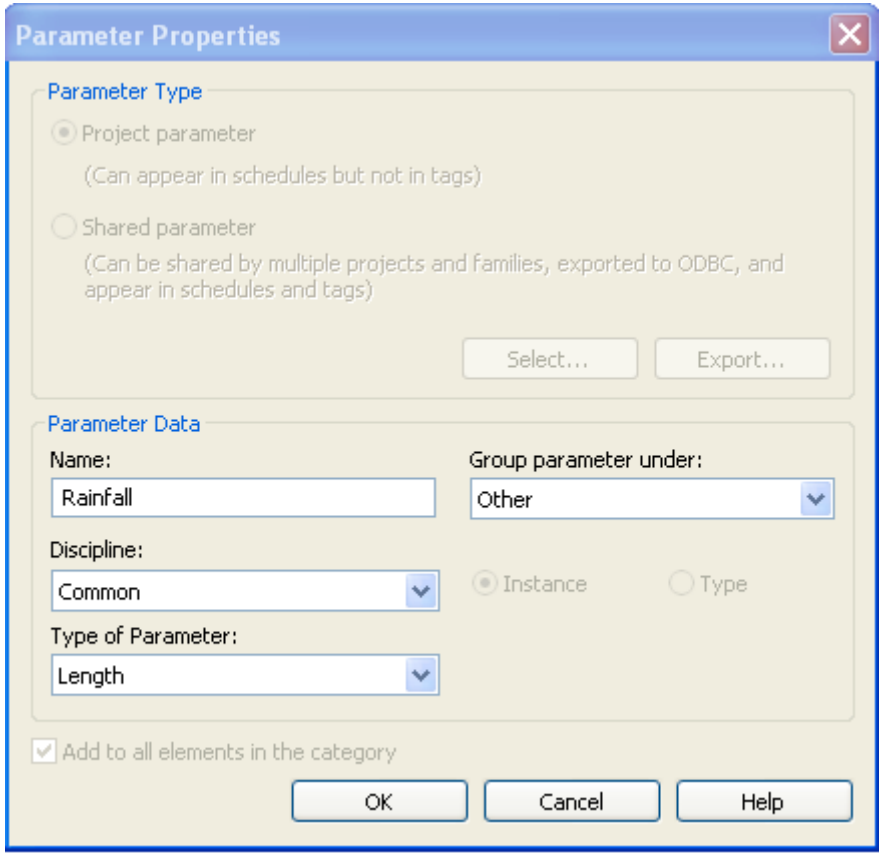
RainWater Calculation- formula use

- Formula used = (Area* RainFall * .08)
- Parameters used in formulas are case sensitive for example AREA, area and Area are three different things
- Revit keeps track of its units that is why multiplying Area * RainFall we have to choose volume in the Calculated Value Tab

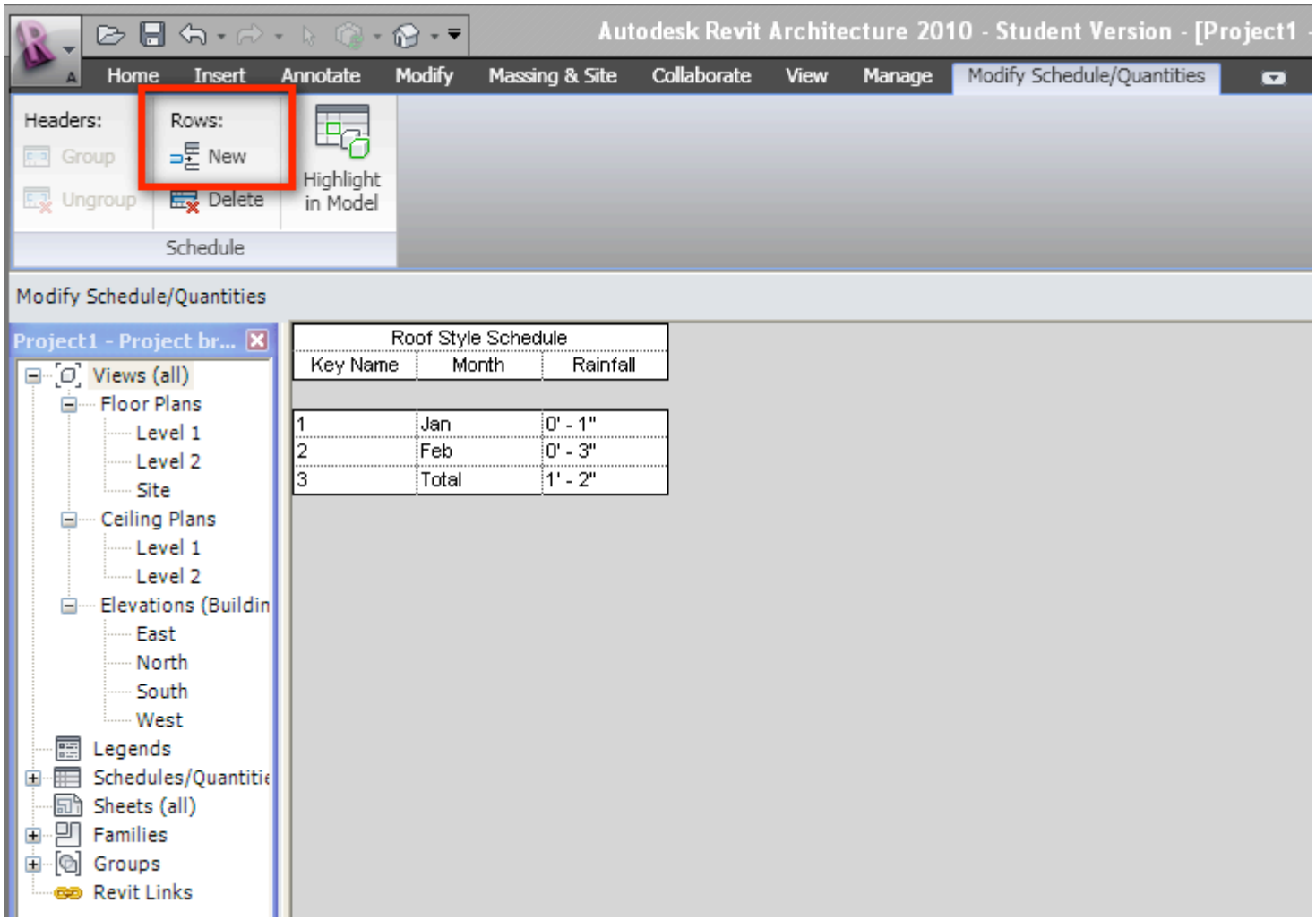
RainWater Calculation- create key schedule



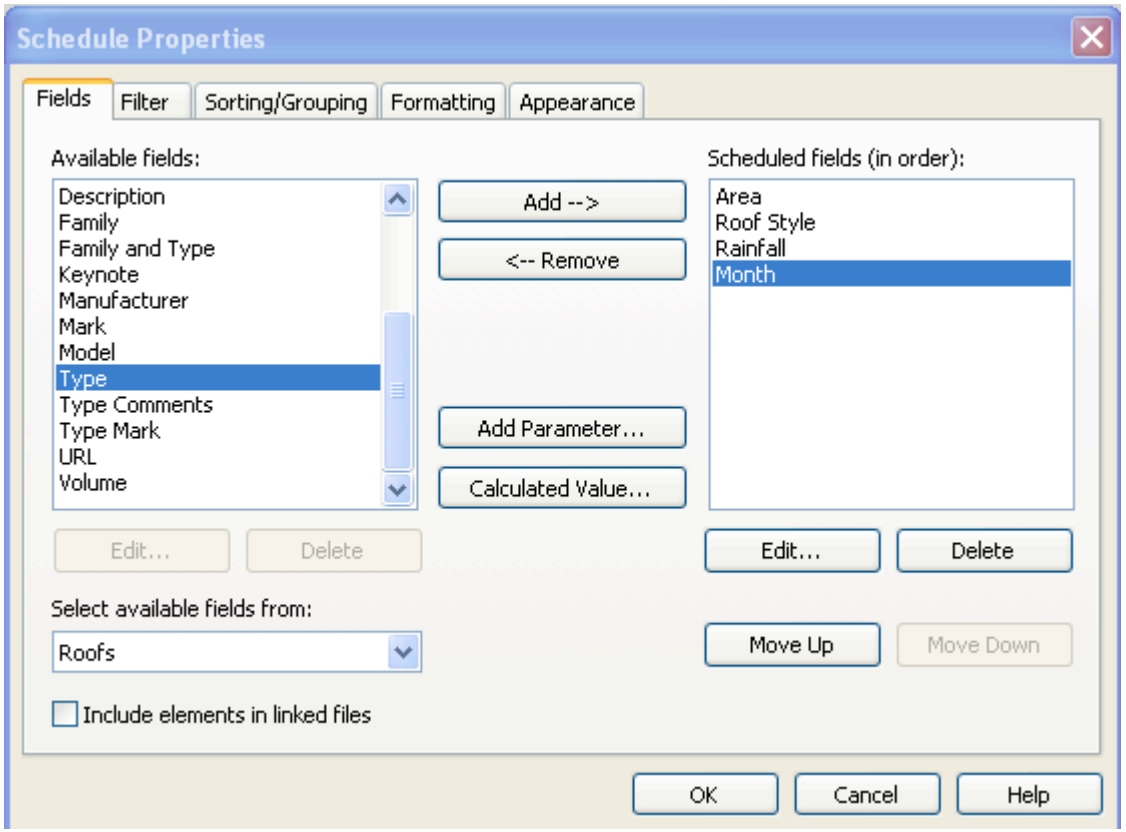
RainWater Calculation- Add parameters to key schedule



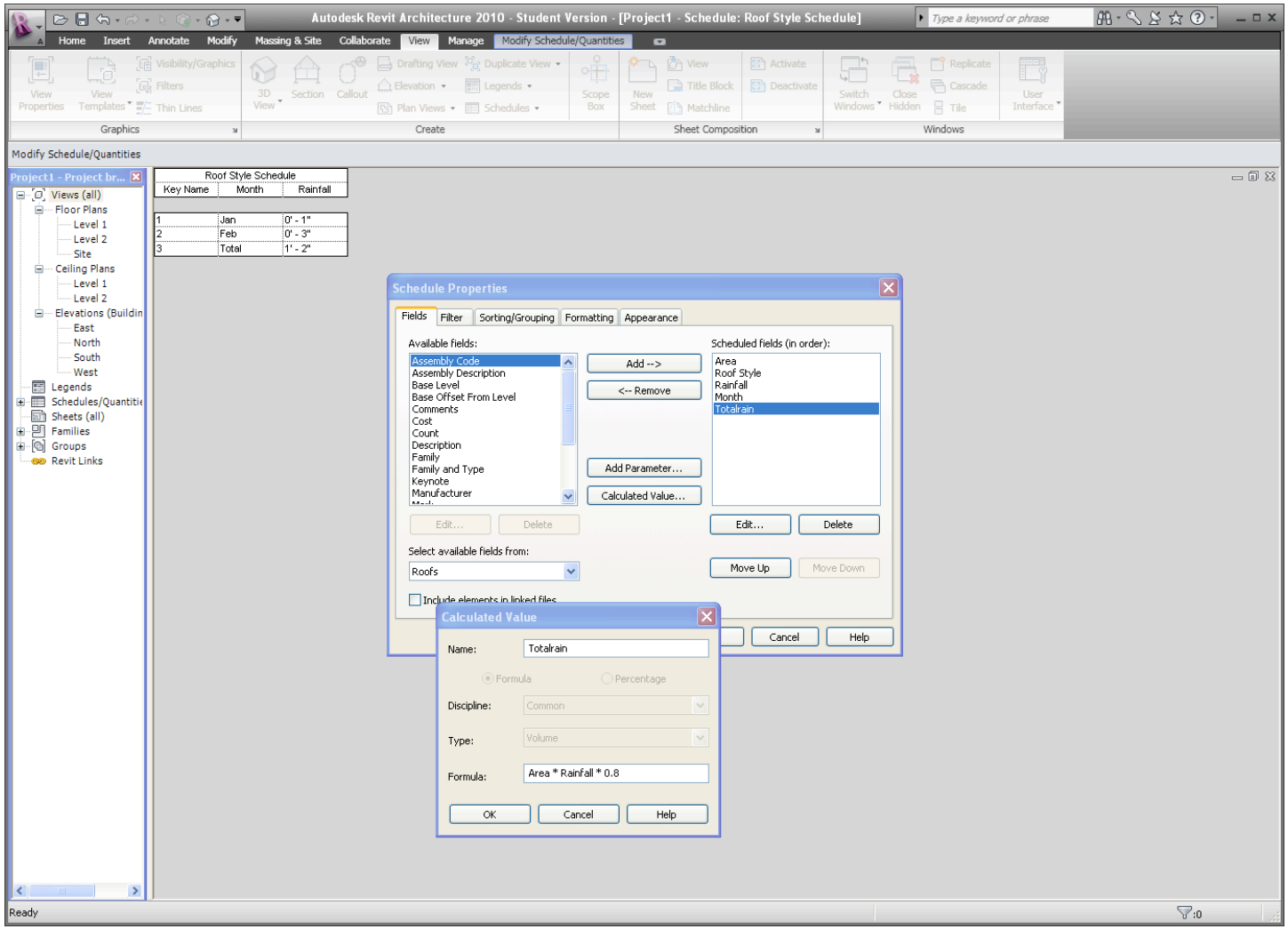
RainWater Calculation- Add rows and enter values



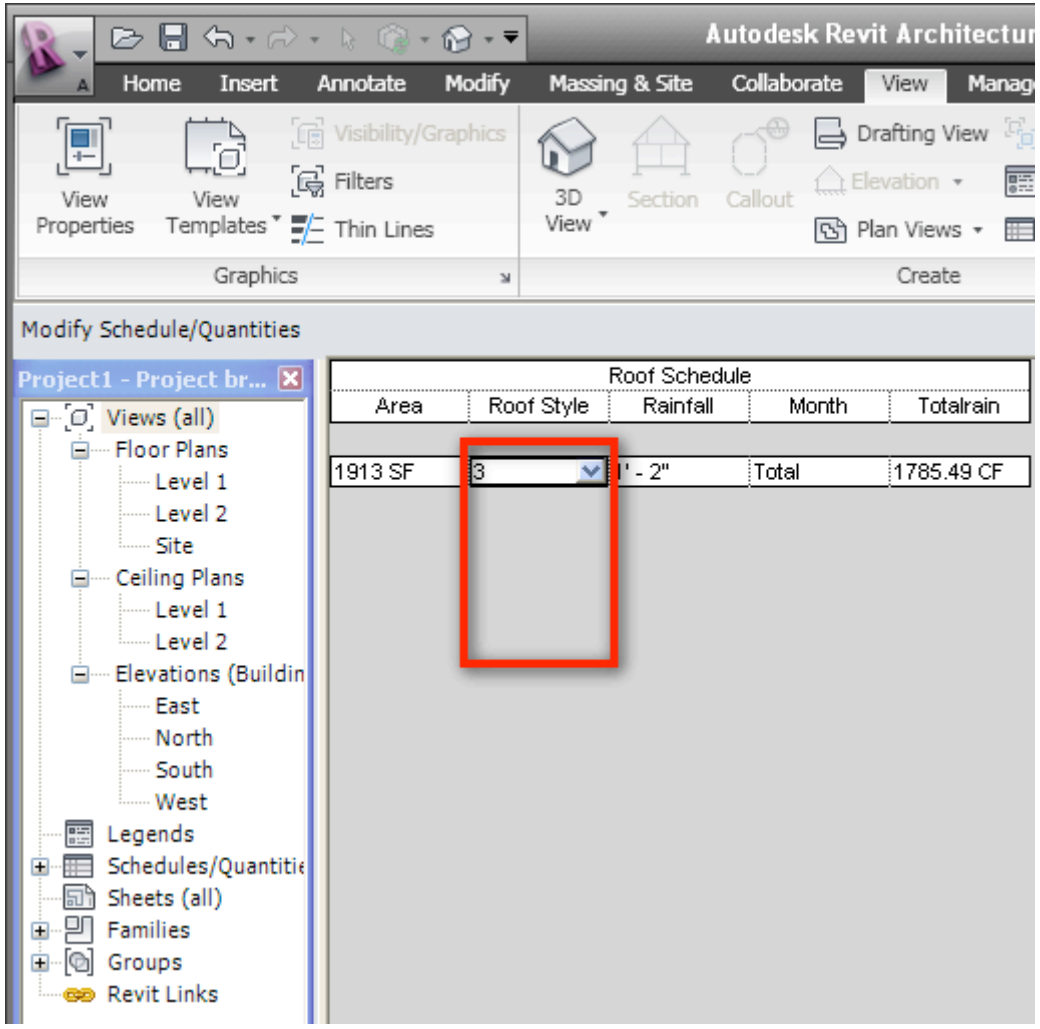
RainWater Calculation- Create component schedule



RainWater Calculation- Add Calculated Value by putting in formula



RainWater Calculation- Select by key to view results of each month or total



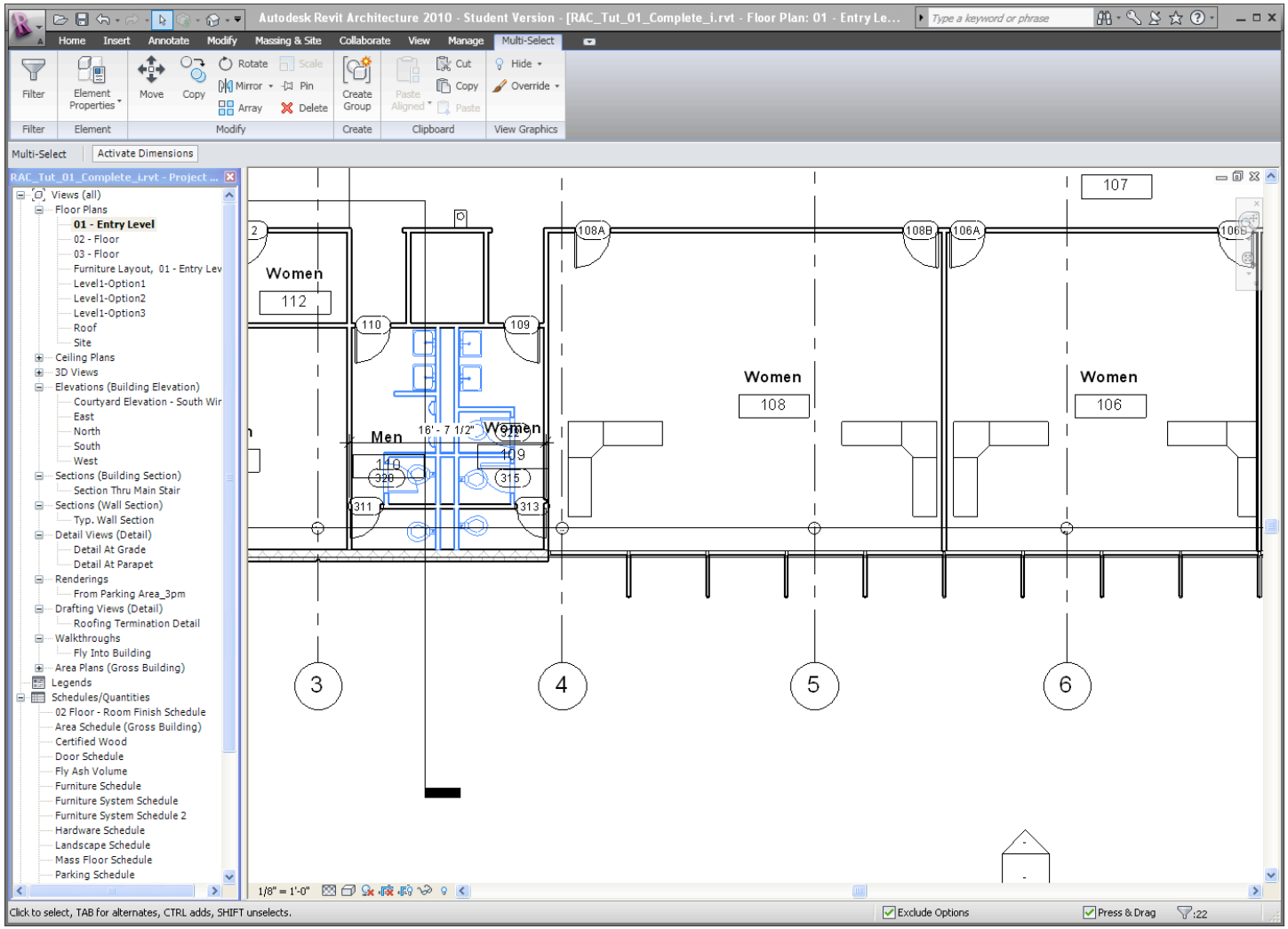
Room Style and Schedule - Exercise 01

- Draw a few rooms (3-6)
- Tag the rooms with room tags
- Create a key schedule which includes
  - Key
  - Name
  - Sfperperson
- Create a schedule of building components from rooms category-select
  - Area
  - Key
  - Room Style
  - Name
  - Sfperperson
  - Add Calculated- Persons (Formula= Area/sfperperson)

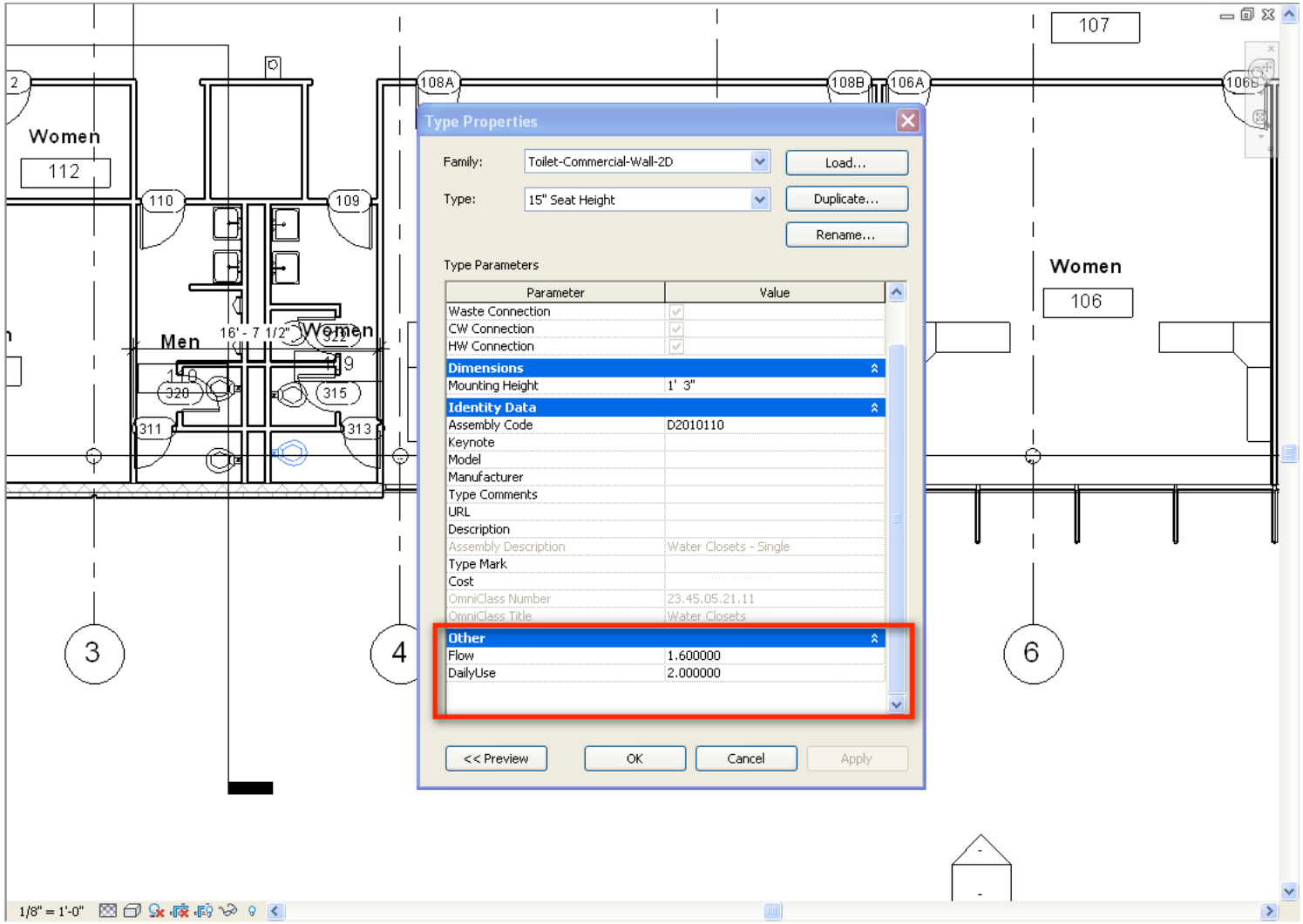
Building Non-Potable water need - Exercise 02

- Total Number of Fixtures by type
- Flow Rate of the fixtures
- Fixture number of use
- Approach
- Fixture Load= Number of fixtures*fixture use*Flowrate
- You can use your model from assignment 1 or example file from the blackboard

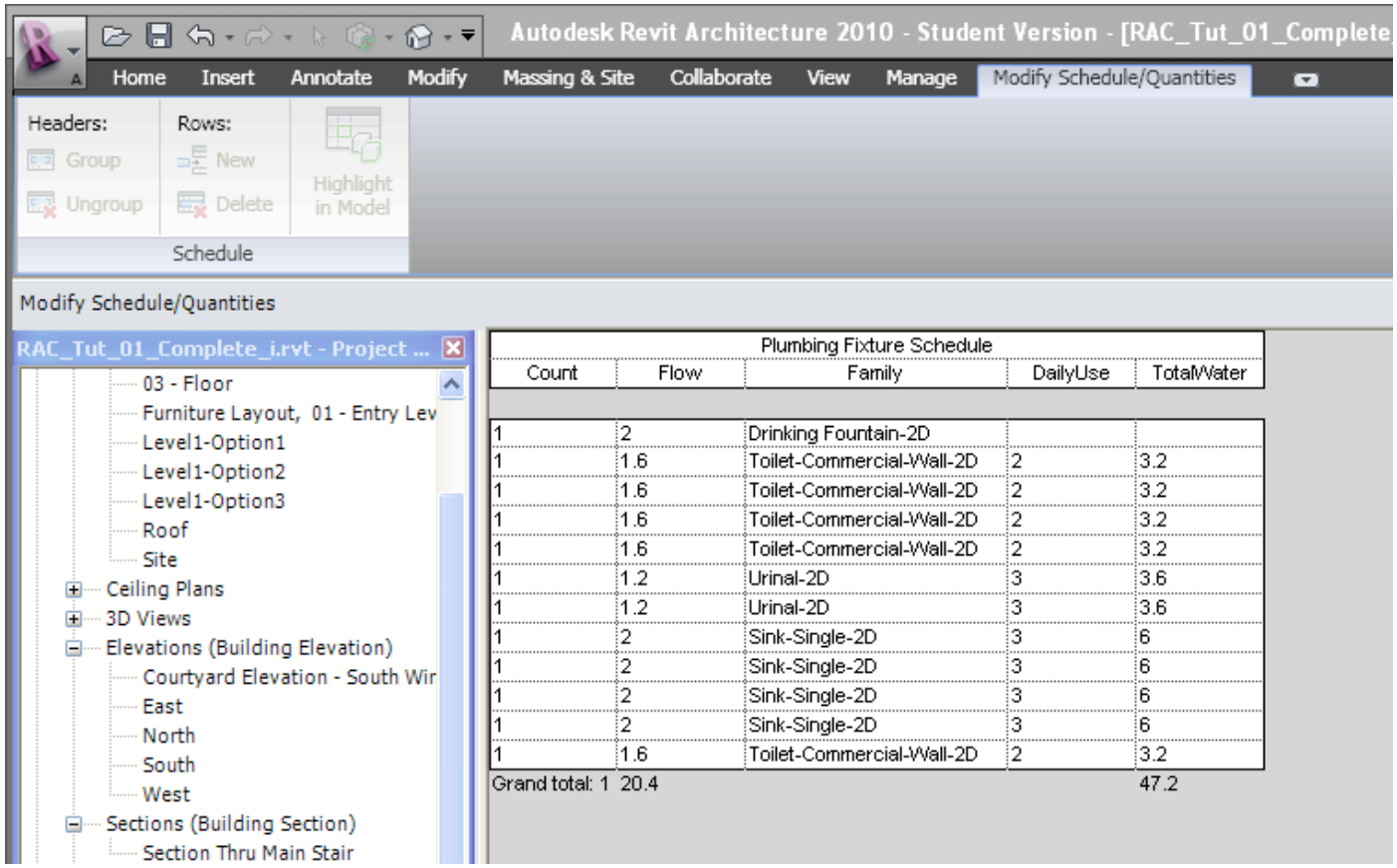
Fixture Load Calculation- Add fixtures



Fixture Load Calculation
Add Shared Parameter



Fixture Load Calculation- Show Total water use in the schedule



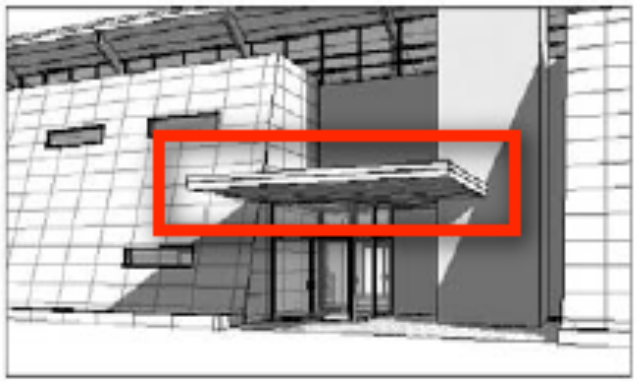
Plumbing Fixture Schedule

Count	Flow	Family	DailyUse	TotalWater
1	2	Drinking Fountain-2D		
1	1.6	Toilet-Commercial-Wall-2D	2	3.2
1	1.6	Toilet-Commercial-Wall-2D	2	3.2
1	1.6	Toilet-Commercial-Wall-2D	2	3.2
1	1.6	Toilet-Commercial-Wall-2D	2	3.2
1	1.2	Urinal-2D	3	3.6
1	1.2	Urinal-2D	3	3.6
1	2	Sink-Single-2D	3	6
1	2	Sink-Single-2D	3	6
1	2	Sink-Single-2D	3	6
1	2	Sink-Single-2D	3	6
1	1.6	Toilet-Commercial-Wall-2D	2	3.2
Grand total: 1	20.4			47.2

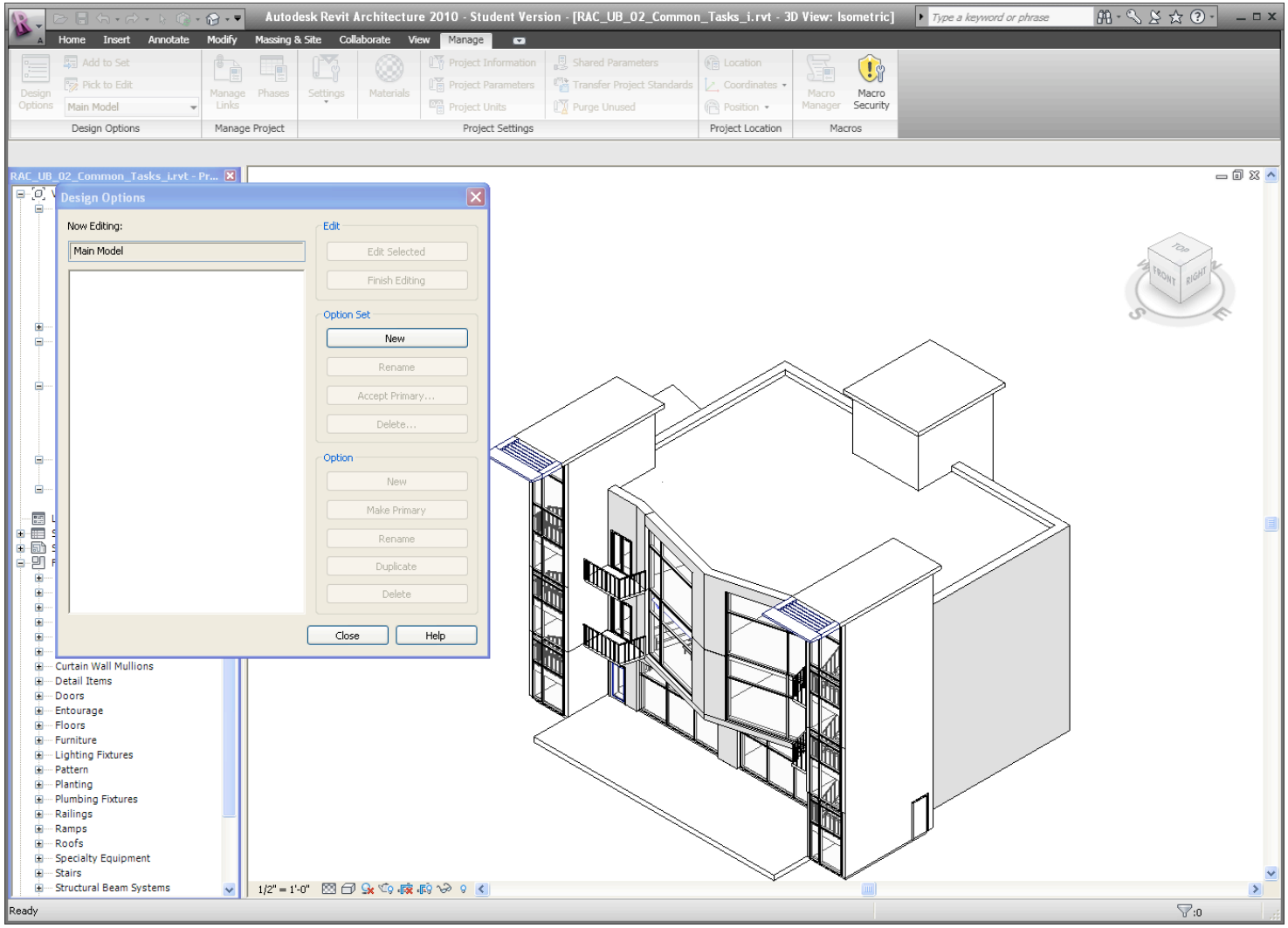
Design Options

- Design options allow the creation, mock up and evaluation of different options in the same file

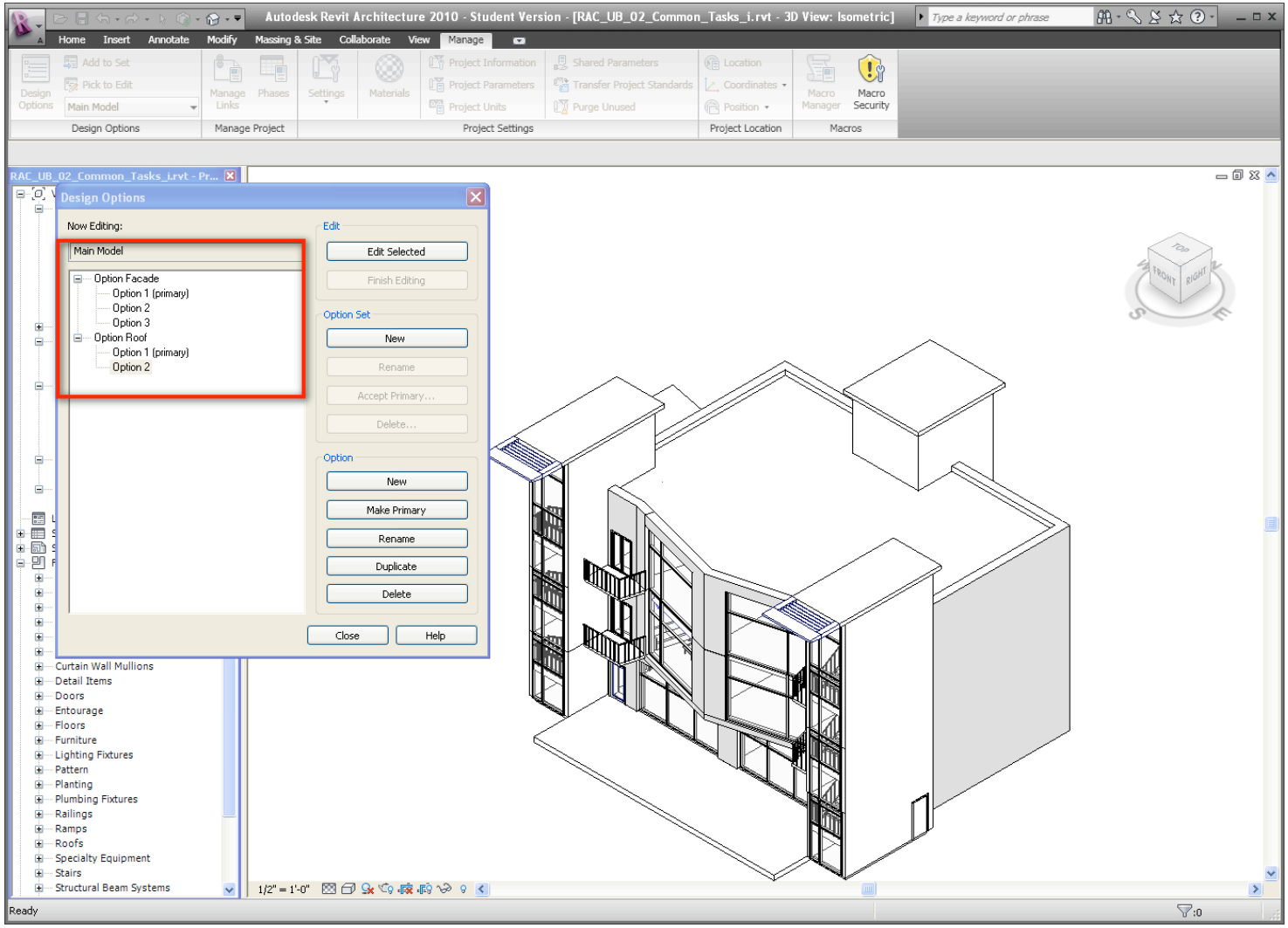
- The main model with the elements remain the same and not effected by the changes done in different options



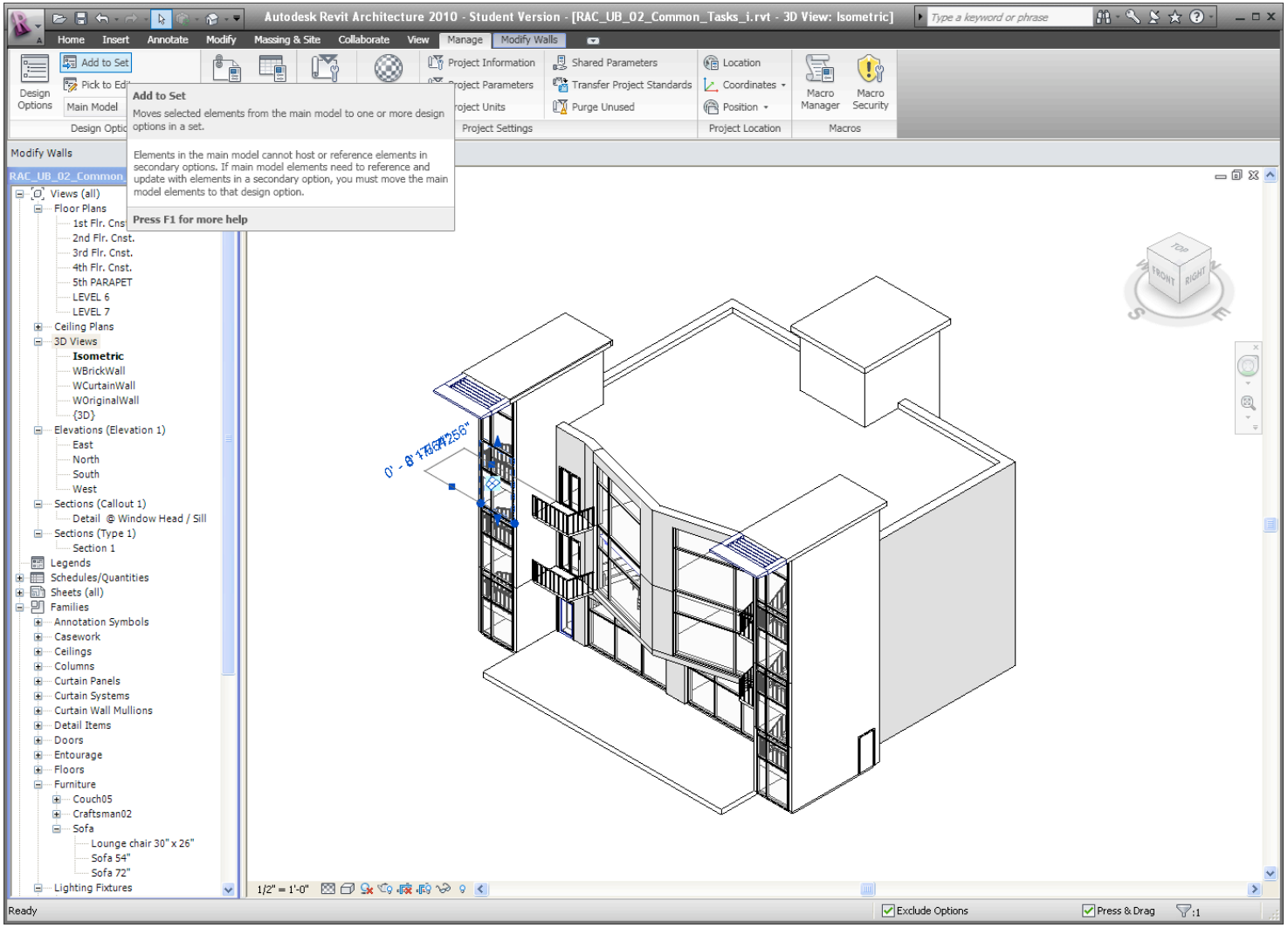
Design Options



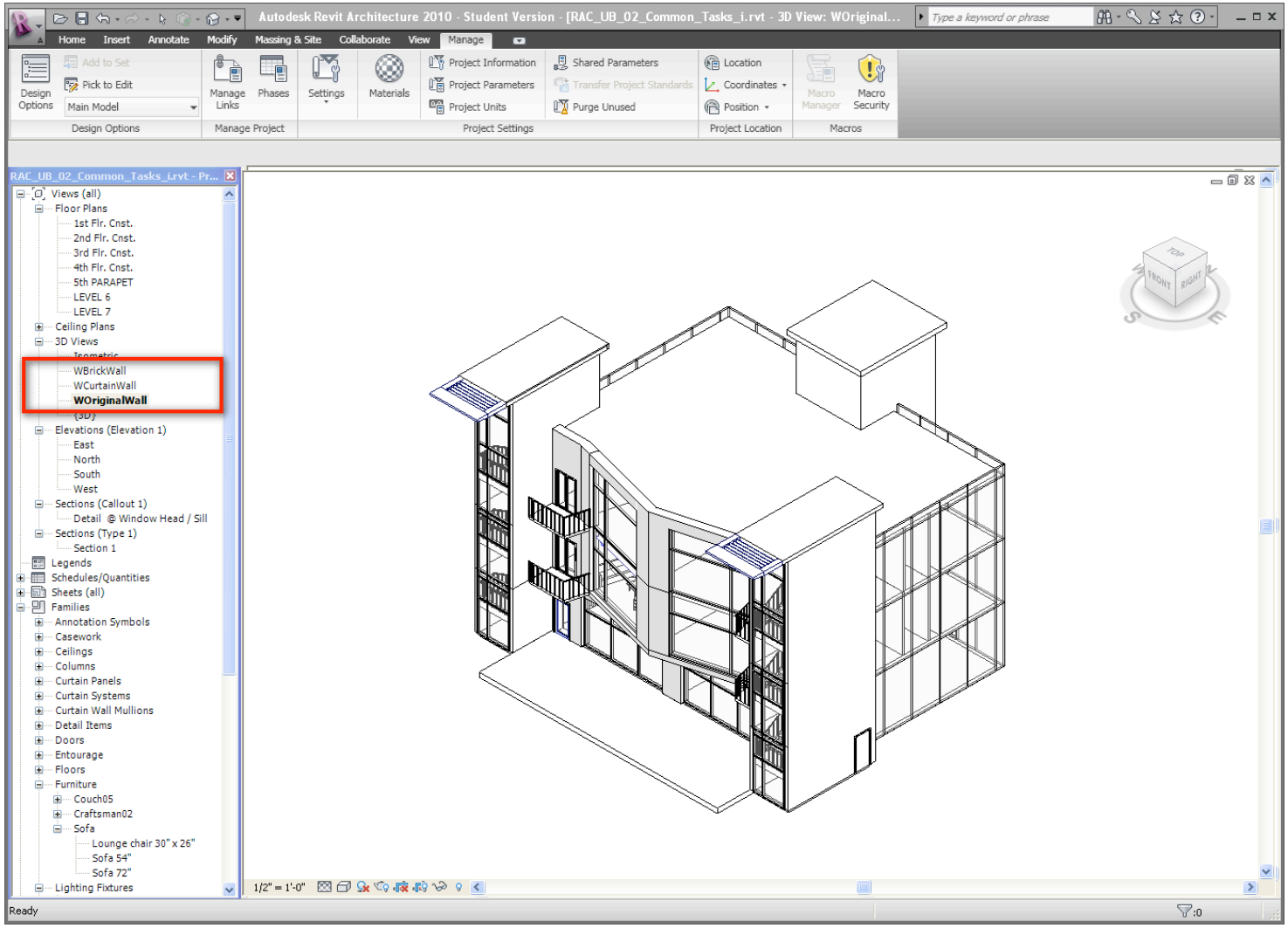
Design Options - creating option sets



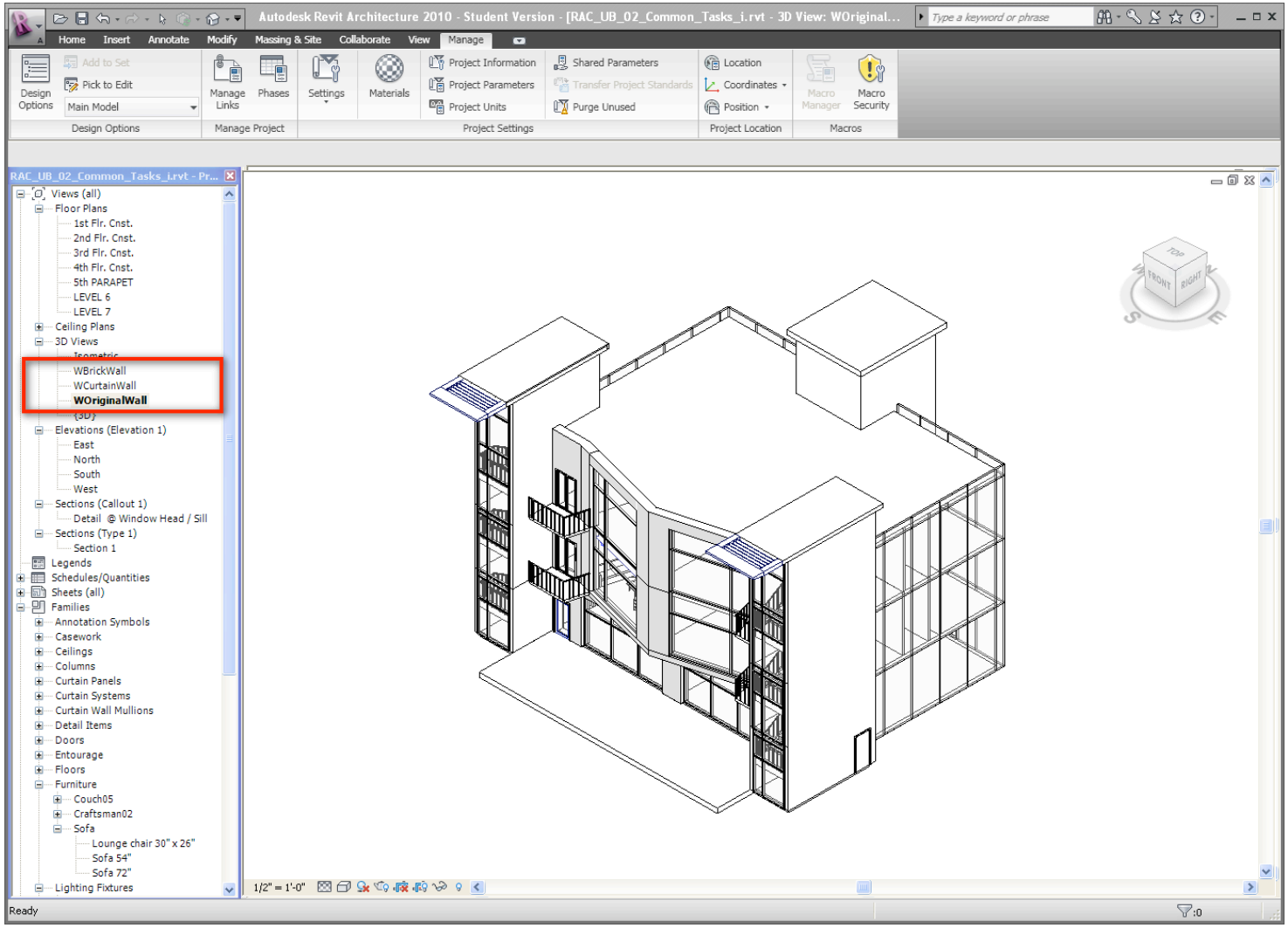
Design Options – adding elements to an option



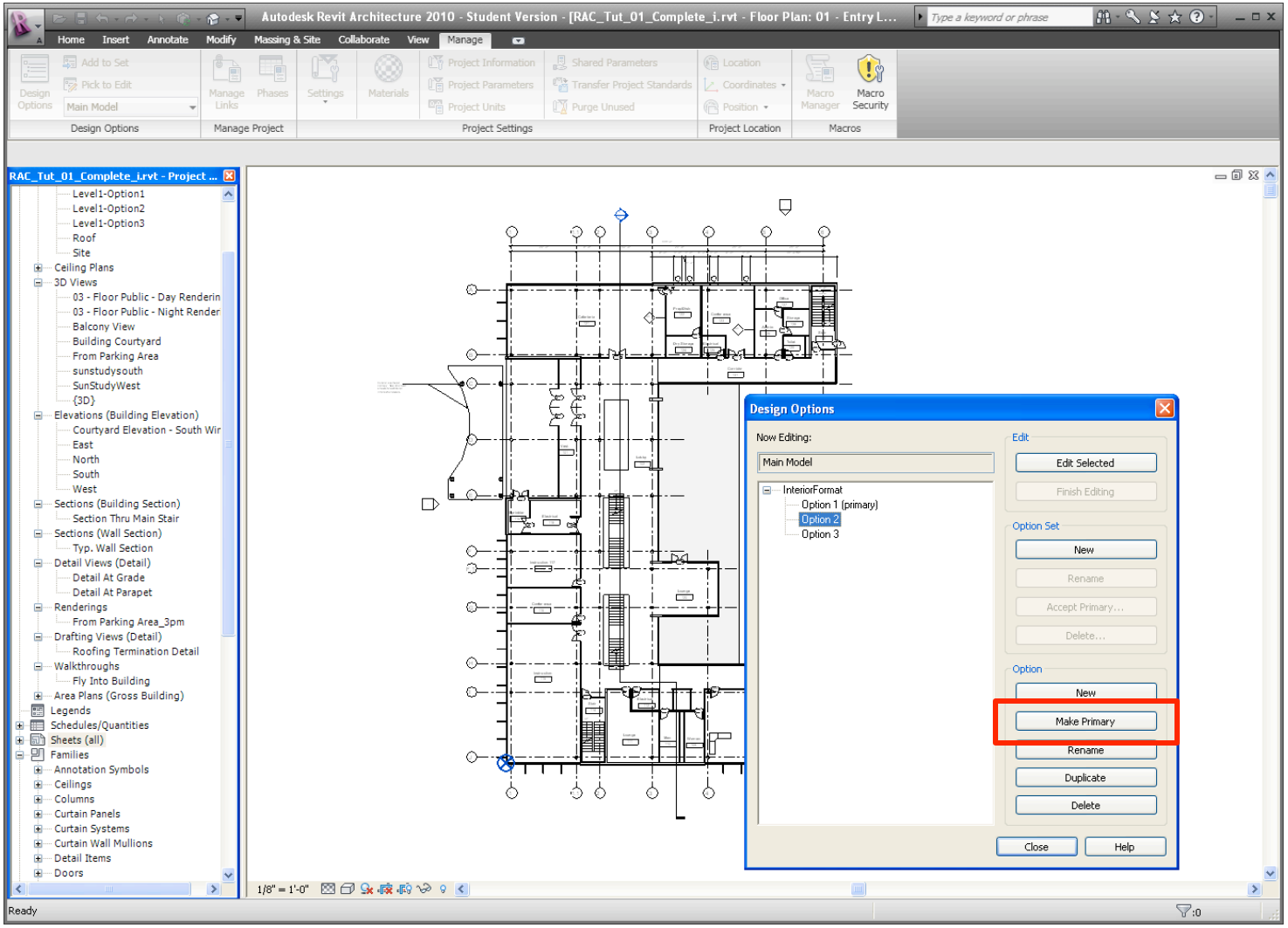
Design Options – Creating views to display options



Design Options – Creating views to display options



Design Options – accepting design options



Families

- www.revitcity.com
- www.arcat.com
- http://seek.autodesk.com

Families

- Choose from correct family Template

- These templates are time-savers, because they already have the right category assigned, they provide
  - important reference planes that drive the behavior and geometry

Families

- Families that show up on only one view
  - Drafting
  - Annotation

- Families that show up in all views once placed in model
  - Model based
    - 2D – used to make 2D details of the model
    - 3D – used to make 3D geometric representation

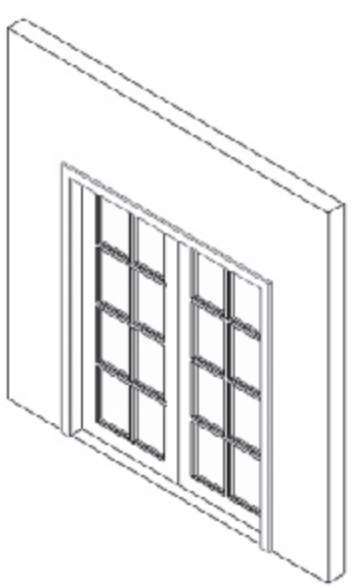
      - These include host based families such as wall, floor, ceiling, roof, line based and generic model.
      - Note that there may be 2D families nested to embed more information

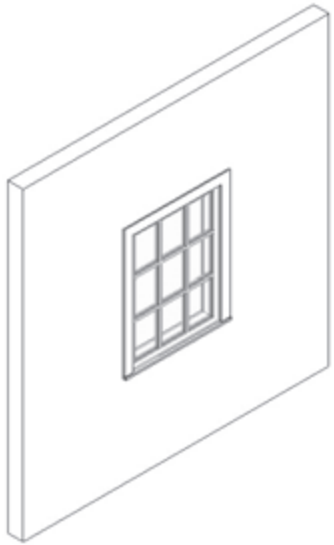
Families

- Host Based Families
- Profile Based Families
- 2D Line Based Families
- 3D Line Based Families
- Face Based and Work plane based Families
- Rich Photorealistic Content (RPC) Families
- Detailed Component Families
- 3D Families

Families

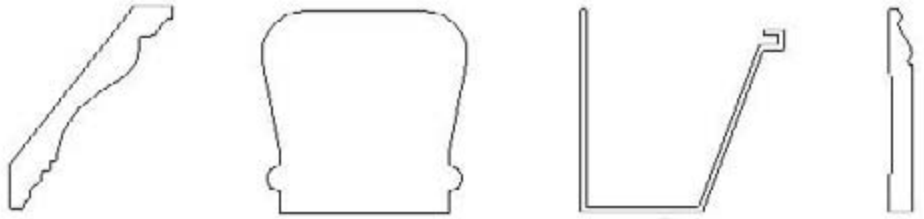
- Host Based Families
  - These include widows,, doors, skylights, solar panels, lighting – they are installed into something else
  - These elements require a host to be mounted to
  - If the host is deleted the element will be deleted too





Families Profile Based

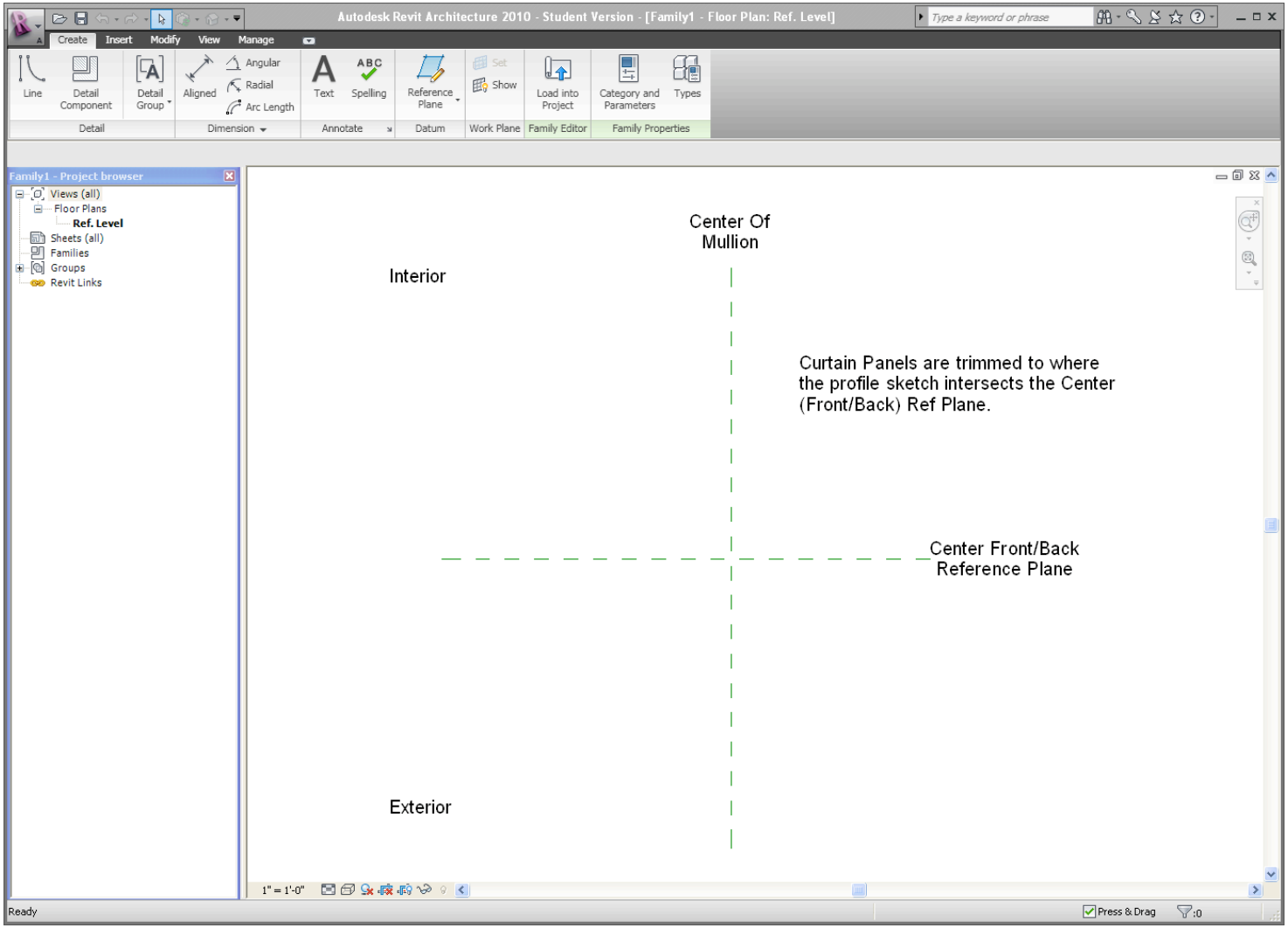
- Profile Based Families
  - Many architectural details have cross sections that run in linear manner
  - Baseboards, cornices, handrails are some examples
  - These can be constructed by extruding the profile to a path
  - Profiles must be of a closed loop line



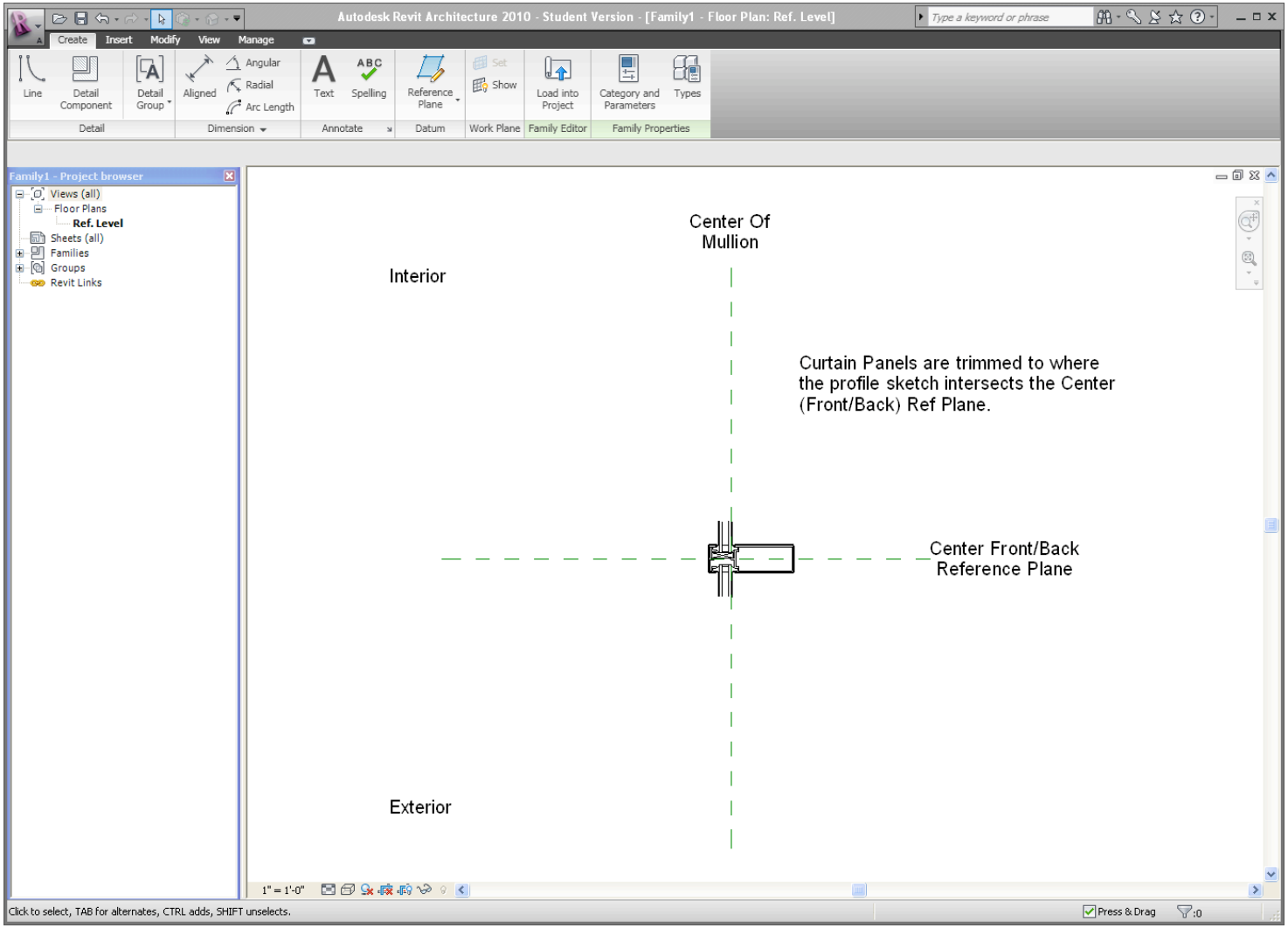
Families Profile Based

- Profile Based Families
  - Multiple lines may cause errors
  - Cannot have multiple loops in a profile family but can import a component that can mimic the representation

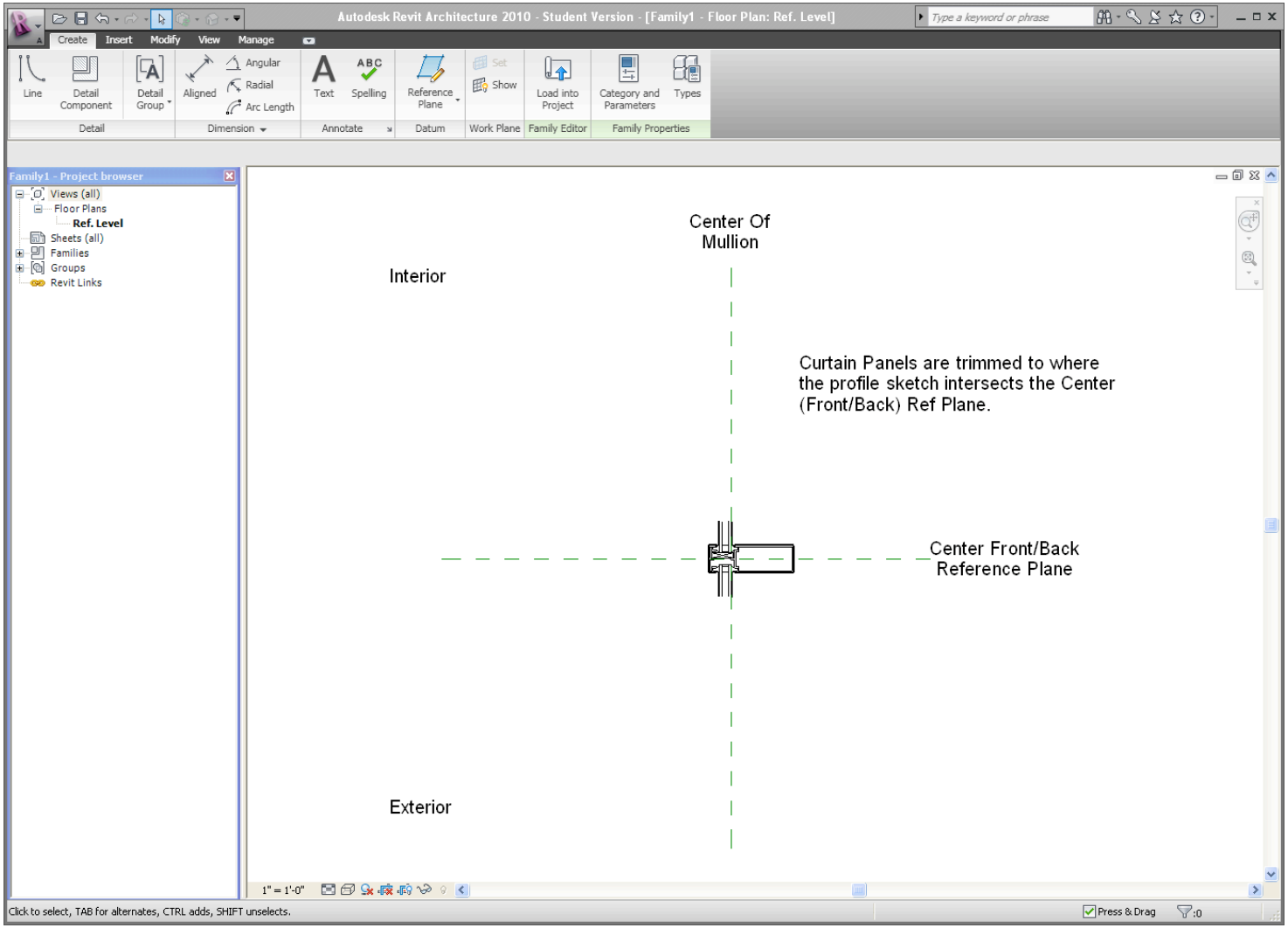
Families Profile Based



Families Profile Based

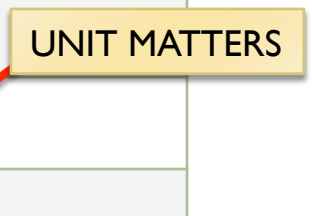


Families Profile Based



Formula driven Family
2D/3D Generic Line-base Model

Function	Abbreviation
Addition, Subtraction, Multiplication, Division	**+**, **-**, *****, **/**
Exponentiation	**^** (ex. X^Y, X raised to the power of Y)
Logarithm	**log**(x)
Square root	**sqrt**(x)
Sine, Cosine, Tangent	**sin**(x), **cos**(x), **tan**(x)
Arcsine, Arccosine, Arctangent	**asin**(x), **acos**(x), **atan**(x)
e raised to an x power	**exp**(x)
Absolute Value	**abs**(x)



Formula driven Family

- A conditional statement in the formula:

  IF (**conditional statement**, **option 1**, **option 2**)
- When the conditional statement equals to Yes(True), the option 1 is selected; otherwise, option 2.

- ex,
- Simple IF: =IF (Length < 0', 1', 300mm)

  IF with logical AND: =IF (AND (x = 1 , y = 2), 8 , 3)

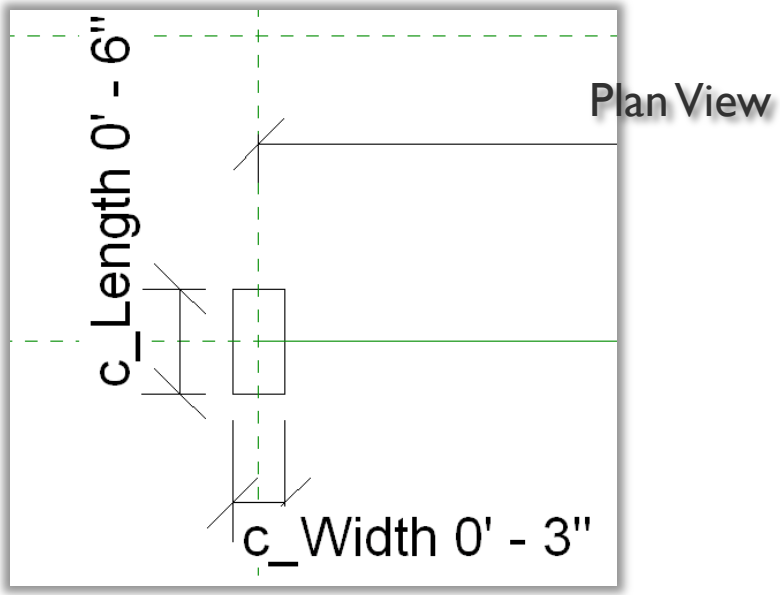
  IF with logical OR: =IF (OR (A = 1 , B = 3) , 8 , 3)

  IF with Yes/No condition: =IF (**Long**, 50, 60),
- where **Long** is a **Yes/No** parameter defined as **Long = Length > 40**

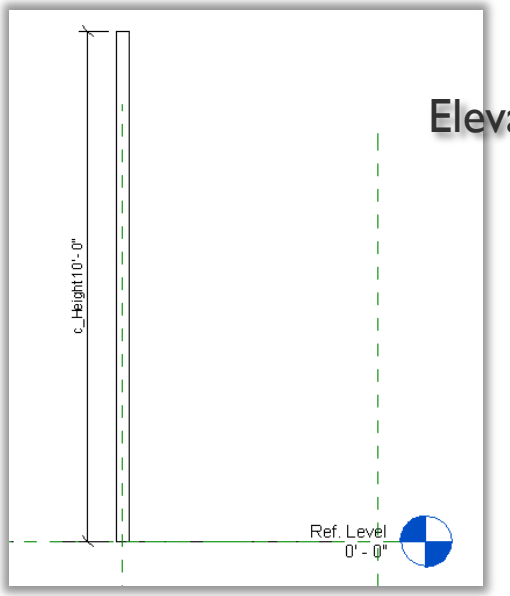
  Embedded IF statements:
- IF (Length < 35' , 2' 6" , **IF (Length < 45' , 3' , IF (Length < 55' , 5' , 8')**))

Formula driven Family(01-1)

- Using Formula to evenly distribute the geometry elements (linear translation).
- Start from a **generic line-based model** and make a solid extrusion with three parameters, width, length, and height. Make sure each parameter works properly with the model.



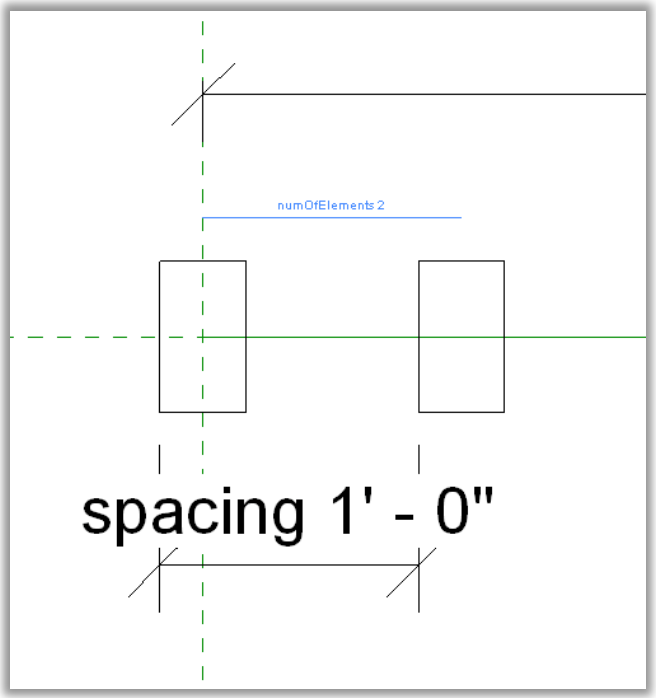
Plan View



Elevation View

Formula driven Family(01-2)

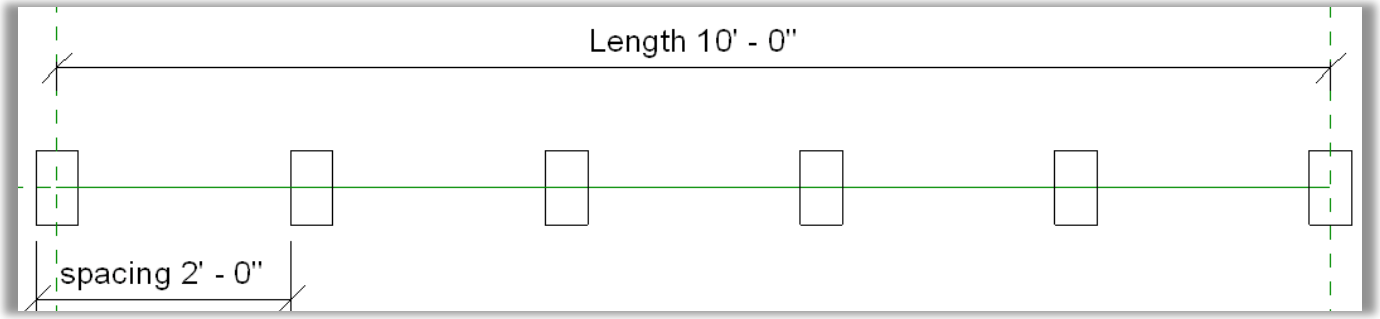
- First, add an Array modifier.
  You can find it in **Modify → Array** (use linear translation).
- Add Linear Dimension for the distance between first two array elements.
- Promote these two elements as the instance parameters.



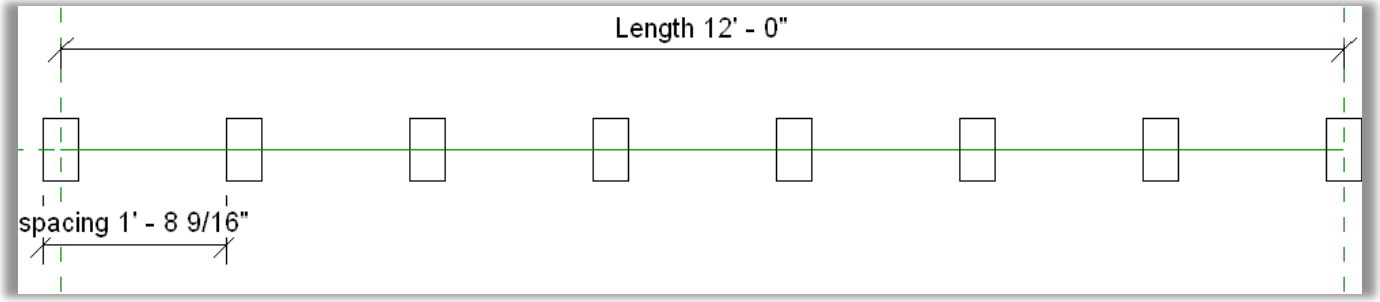
Formula driven Family(01-3)

- Set up the formula to control the spacing based on the number of cloned objects.

  spacing* = *Length* / *numOfClone



Variation 01



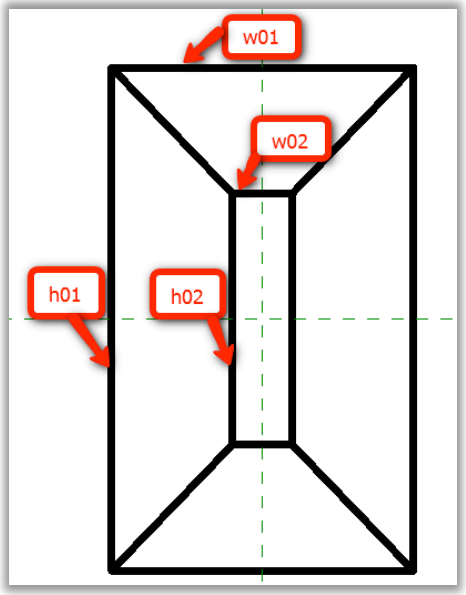
Variation 02

Formula driven Family(02-1)

- In-class exercise:
- Now you know how to use a formula to control the spacing of an array modifier. This exercise is for your to use formulas on multiple parameter settings.

1. Object: **Solid Blend**
Similar to Solid Extrusion, instead of drawing single profile for extrusion, you will need to specify button and top profiles for extrusion.

2. **Parameter settings**: set up 2 scaling factors to control the ratios between the top and button profiles.

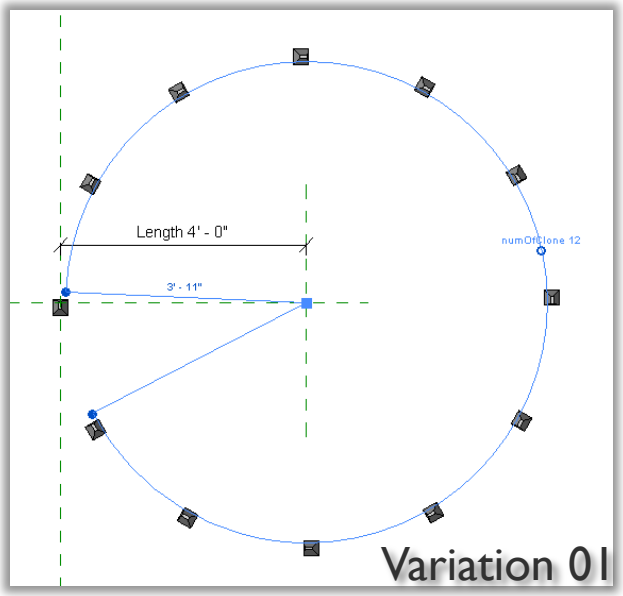


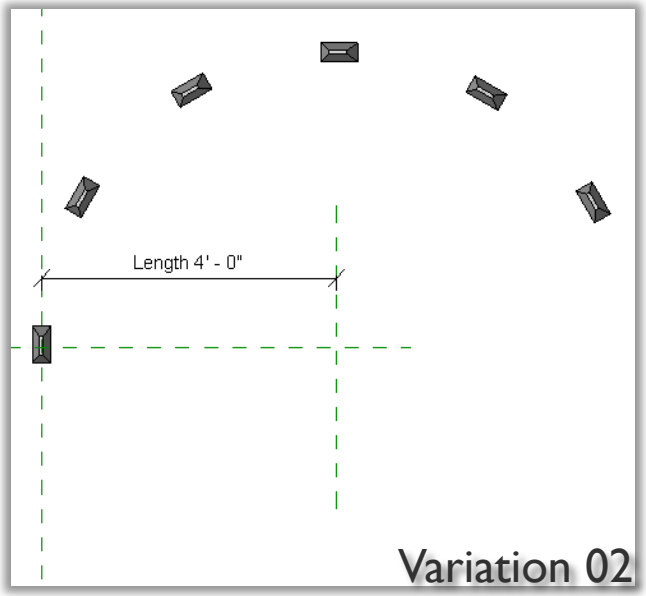
h02 = h01 * scaleHeight
w02 = w01 * scaleWidth

Constraints:
0.1 <= scaleHeight <= 0.5
0.2 <= scaleWidth <= 0.7

Formula driven Family(02-2)

- Objective:
- The objective of this exercise is to use the Radial Array modifier and increase number of the cloned objects as the dimension of the original object decrease.

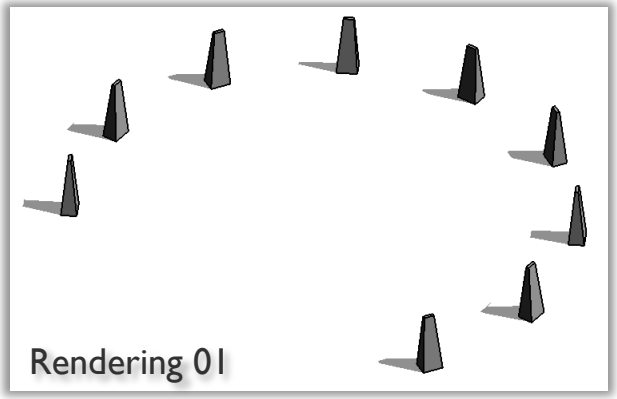


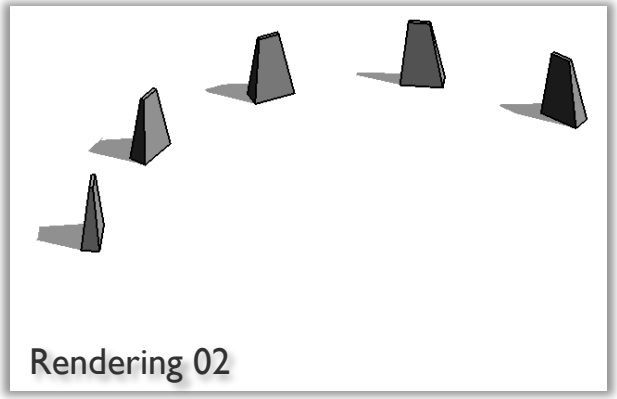


Formula driven Family(02-3)

- Family Types
  IF(, ,)

Result images:





Solar Radiation Technology Preview

- Before you start, go to Autodesk Lab and download the plug-in developed by Ecotect.

  Link: http://labs.autodesk.com/utilities/ecotect/

What this does?

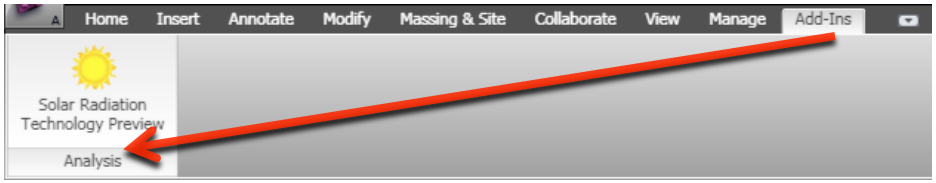
Analyze the effects of solar radiation on various surfaces of your conceptual building model.

System Requirement:

Revit Architecture 2010 Update 1.

Solar Radiation Technology Preview
User Interface

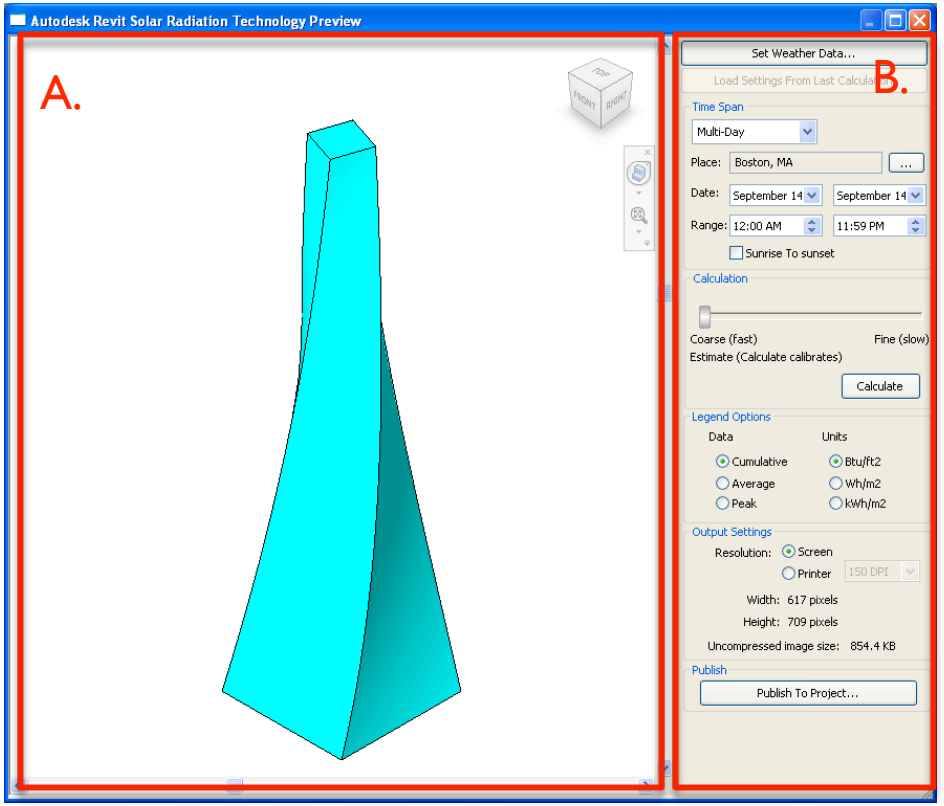
Plugins can be found in the Add-Ins Tab



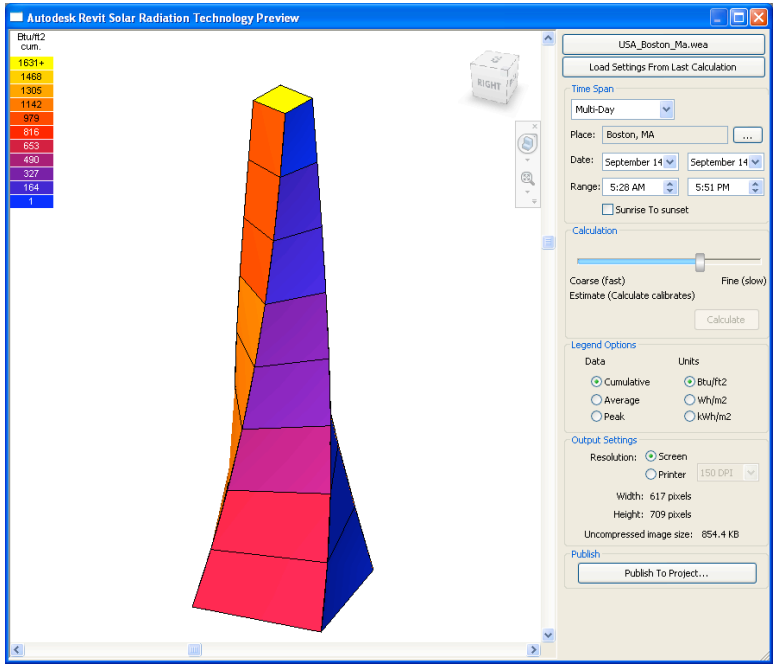
A. 3D Model viewer

B. Control panel

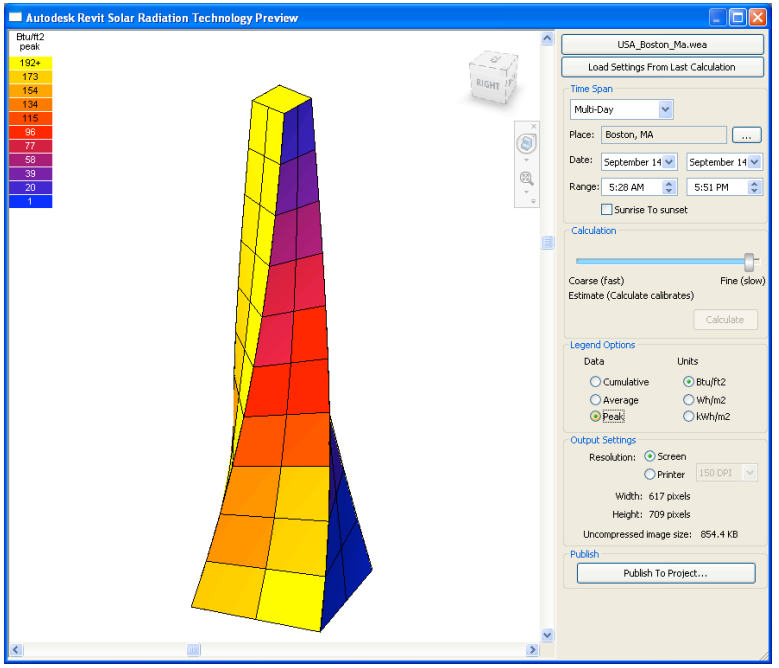
Time Span
Calculation
Legend Option
Output Settings
Publish



Solar Radiation Technology **Studies**

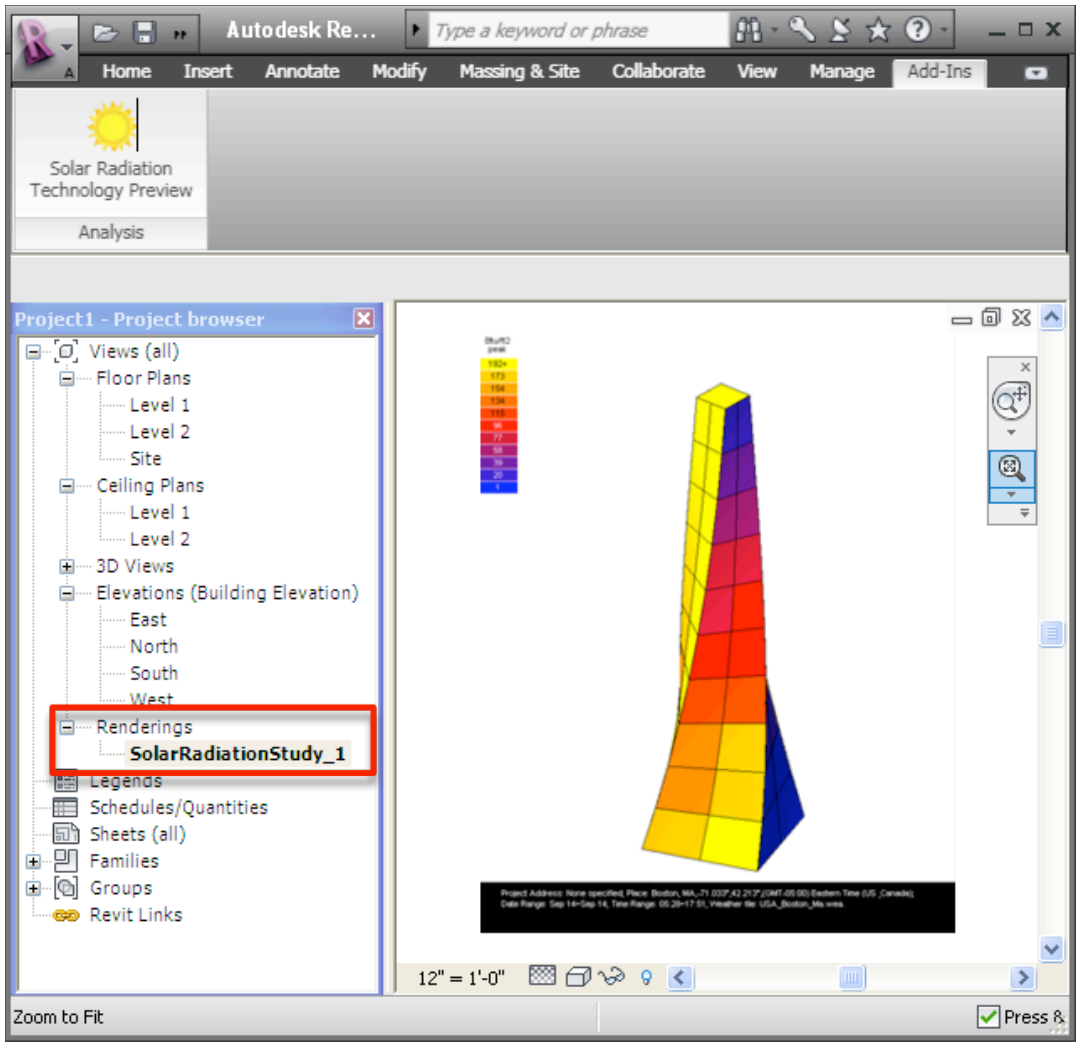


Weather file: USA_Boston_MA
Place: Boston, MA
Calculation: Medium
Legend Option: Cumulative



Weather file: USA_Boston_MA
Place: Boston, MA
Calculation: Fine
Legend Option: Peak

Solar Radiation Technology **Publish**



After modify the settings for solar radiation, rendering images can be published to the project as the reference for the continuing development. The output renderings can be found under the Renderings Views.