48-749 Parametric Modeling Lecture 5

Carnegie Mellon University School of Architecture

Lecture 5

Bim used in Energy Simulation

- Green Building Studio
- Families Continued
- 3D Families
 - Nested Family
 - Family category and Parameters
- Curtain Wall System
 - Mullion
 - Grid
 - Panel

Green Building Savings

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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 energy credits

Achieved	P/Auto			
7 of 9	15			17 Points
100%	100%	Prereq 1	Fundamental Building Systems Commissioning	Required
100%	100%	Prereq 2	Minimum Energy Performance	Required
100%	100%	Prereq 3	CFC Reduction in HVAC&R Equipment	Required
0%	0%	Credit 1	Optimize Energy Performance	1 to 10
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0%	0%		20% New Buildings or 10% Existing Building Renovations	2
0%	0%		25% New Buildings or 15% Existing Building Renovations	3
0%	0%		30% New Buildings or 20% Existing Building Renovations	4
	0%		35% New Buildings or 25% Existing Building Renovations	5
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	0%		45% New Buildings or 35% Existing Building Renovations	7
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0%	0%	Credit 2.2	Renewable Energy, 10%	1
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n/a	100%	Credit 3	Additional Commissioning	1
100%	0%	Credit 4	Ozone Depletion	1
	100%	Credit 5	Measurement & Verification	1
100%	0%	Credit 6	Green Power	1

Achieved Requires extension of objects Missing object Requires simulation results/ref

LEED energy credits-procedure

- Achieve increasing levels of energy performance above the baseline to reduce environmental impacts
- Baseline building performance rating per ASHRAE/IESNA Standard 90.1-2004 by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard.

Overview of Autodesk Green Building Studio

- Web Based platform that can be accessed directly from Revit Architecture and MEP
- Capture early sustainable design analysis to support the process of reducing negative environmental impacts
- Communicate among the extended building design team using Autodesk design applications, and other compatible energy and green analysis software
- Creates file formats for other energy simulation software like
 - DOE 2 for eQuest
 - Energy Plus

Energy Calculation

- Green Building Studio
- http://usa.autodesk.com/adsk/servlet/index?id=11179508&siteID=123112



Energy Calculation-register for GBS

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Autodesk⁻

Energy Calculation –Go to downloads

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Energy Calculation-Download Revit 2010 Add-in and GBS Desktop



Energy Calculation-Create New Project in GBS



Energy Calculation in GBS- Process

Create New Project in GBS

- Select Type of project
- Input and select the location of the project
- Select the appropriate weather file
- Prepare Project in Revit Architecture 2010 for export to gbXML format
 - The rooms have to be tagged and Room Area, Volume Computation has to be enabled for gbXML export
- Once project is ready, go to Add-ins and choose GBS
 - This will export the current file to the project selected in GBS and will create a base run









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City*	Pittsburgh		
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Fuel Cost*	1.412 \$0.00/Therm		
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Energy Calculation in GBS- Process

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Energy Calculation in GBS- Report

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- Dry Bulb Temperature Dry-bulb temperature T_{db}, can be measured using a normal thermometer freely exposed to the air but shielded from radiation
- Wet Bulb Temperature This is the temperature indicated by a moistened thermometer bulb exposed to the air flow. The rate of evaporation from the wet bandage on the bulb, and the temperature difference between the dry bulb and wet bulb, depends on the humidity of the air. The evaporation is reduced when the air contains more water vapor.



 Relative Humidity- is a term used to describe the amount of <u>water vapor</u> that exists in a gaseous mixture of air and water.

$$RH = \frac{p_{(H_2O)}}{p^*_{(H_2O)}} \times 100\%$$

- *RH* is the relative humidity of the mixture being considered;
- $p_{(H_2O)}$ is the partial pressure of water vapor in the mixture;
- $p^{*}_{(H_2O)}$ is the saturated vapor pressure of water at the temperature of the mixture.



- Cooling Degree Days Hot days, which may require the use of energy for cooling, are measured in cooling degree-days.
 - On a day with a mean temperature of 80 degrees F, for example, 15 cooling degree-days would be recorded (80 – 65 base = 15 CDD).
- Heating Degree Days Cold days are measured in heating degree-days.
 - For a day with a mean temperature of 40 degrees F, 25 heating degree-days would be recorded (65 base – 40 = 25 HDD). Two such cold days would result in a total of 50 heating degree-days for the 2-day period.

- U Factor: U-Factor measures the heat transfer through a building element (window, door) and describes how well the product insulates or conducts heat.
 - The lower the U-Factor, the greater resistance to heat flow and the better its insulation value.
 - \blacktriangleright SI units W/(m²K) and US units of BTU/(h $^\circ\,$ F ft²)
 - R value is the reciprocal of U factor R= 1/U
- Solar Heat Gain Factor Solar Heat Gain Coefficient (SHGC) is the fraction of solar radiation admitted through a window, door, or skylight.
 - Expressed as a number between 0 0.87
 - The lower a window's SHGC, the less solar heat it transmits, and the greater its shading ability.

Families

- Host Based Families
- Profile Based Families
- D 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 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

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Families Profile Based: load in detailed profile from

library - (Detailed components>Div 08 Openings>Storefronts>Typical Section)



Families Profile Based – sketch profile in single loop



Families Profile Based – select line drawing and set visibility settings to fine

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Families Profile Based – Select mullions to change profile and open element type properties

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Families Profile Based – Duplicate the Type and rename, choose created profile

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Families Profile Based – view profile loaded into project



Families Nested - Creating sunshade

- Nest Families
- Create Extrusions for Support and Blade
- Create Array of blades
- Use formula to lock in design intent

Families Nested – Creating sunshade- first create the bracket using a generic line based family

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Families Nested – Creating sunshade- Augment the support family with parameters

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Families Nested – Creating sunshade- Add blade family to the Support family



Families Nested – Creating sunshade- Array of blades controlled by formula



Curtain Wall Components

- A curtain wall system is composed of the following three components:
 - Curtain Grid
 - Mullions
 - Curtain Panel <u>at least a curtain panel to start from</u>

Functions related to Curtain Wall System:



Home \rightarrow Build \rightarrow Curtain System Home \rightarrow Build \rightarrow Curtain Grid Home \rightarrow Build \rightarrow Curtain Mullion

Curtain Wall Components

Functions related to Curtain Wall System:



Curtain System

Creates a curtain system on the face of a mass or generic model.

You cannot edit the profile of a curtain system. If you want to edit the profile on a vertical face, place a curtain wall.



Curtain Grid

Creates a grid line in a curtain wall or curtain system.

As you place curtain grids, they snap to evenly spaced intervals or to visible levels, grids, and reference planes. Each section of the curtain grid is filled with a separate curtain wall panel.



Mullion

Creates a horizontal or vertical mullion on a curtain grid.

Specify the shape of mullions by loading a mullion profile into the project, or creating a custom profile. When you add mullions to a grid, the mullions resize to fit the grid.



Create a Curtain Wall



Curtain Wall Properties

A. Curtain PanelB. Curtain Grid PatternC. Curtain Mullions

To specify/modify the values for each one of them, click on the value fields (none) and select the desired value from the pull-down menu.

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Curtain Wall Components_Curtain Grid





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Curtain Wall Components_Mullion(1)

You can initiate a mullion elements by selecting the curtain grid elements in your project.



Step 01: Select the Mullion type

Step 02: Manually Placing a mullion element by Grid lines

Curtain Wall Components_Mullion(2-1)

 You can also assign the Mullion types by changing the Elements Properties of a Curtain System.

Step 01: Select the Curtain System you have created in your project. Step 02: Click on Edit Type.. Button

🔲 Instance	e Properties		
Eamily:	System Family: Curtain S	ystem	✓ <u>L</u> oad
<u>Т</u> уре:	5'×10'		Stat Type
Instance Pa	rameters - Control selecte	d or to-be-cre	
	Parameter		Value
Constrain	ts		\$
Room Boun	ding		
Related to I	Mass		
Grid 1 Pac	tern	- 14	\$
Justification		4 Begipping	
Offset	•	0'0"	
Grid 2 Pat	tern		\$
Number		4	
Justification	۱	Beginning	
Offset		0'0"	
Identity D)ata		\$
Mark			
Phasing			\$
Phase Crea	ted	New Constru	ruction
Phase Dem	olished	None	
			OK Cancel

Curtain Wall Components_Mullion(2-2)

pe Propertie	es	
Family:	System Family: Curt	ain System
<u>T</u> ype:	3' × 2'	V Duplicate
		<u>R</u> ename
Type Paramete	ers	
	Parameter	Value
Construction	n	*
Curtain Panel		None
Join Condition		Not Defined
Grid 1 Patte	rn	\$
Layout		Fixed Distance
Spacing		3' 0"
Adjust for Mul	lion Size	
Grid 2 Patte	rn	\$
Layout		Fixed Distance
Spacing		2' 0"
Definier For Mul	llon 5176	
Grid 1 Mullio	ms	
Interior Type		Rectangular Mullion : 2.5" x 5" rect
Border 1 Type		Rectangular Mullion : 2.5 x 5 rect
Border 2 Type		Rectaligular Mullion : 2,5 x 5 rect
Grid 2 Mullio	Ins	Sastangular Mullion - Ein
Rorder 1 Tupe		Rectangular Mullion ; Fin
Border 2 Type		Rectangular Mullion : Fin
	~	roccarigatar Hallor H H
Keypote	u	^
Model		
J		
<< Preview	Ok	Cancel Apply
ton 0	2. Chan	an the Mullion
ieh Or	J. Unan	

Type Properties ¥ Rectangular Mullion Family: Load.... Fin ~ Duplicate... Type: ne... Update Profile for Mullion Type Parameters Value Parameter ~ Constraints Angle 0.000 Offset 0'0" Construction Profile fin : fin Default Position Corner Mullion in : fin System Mullion Profile: Circular Thickness System Mullion Profile: Rectangular Materials and Finishes Material Metal - Aluminum Dimensions Width on side 2 0' 1 1/2" Width on side 1 0' 1 1/2' **Identity Data** Keynote Model Manufacturer Type Comments URL Description Assembly Description Assembly Code ¥ << Preview OK Cancel Apply. Step 03: Update Mullion Profile

Curtain Wall Components_Mullion Profile





Associated Parameters

Curtain Wall by Customized Mullion Profiles



