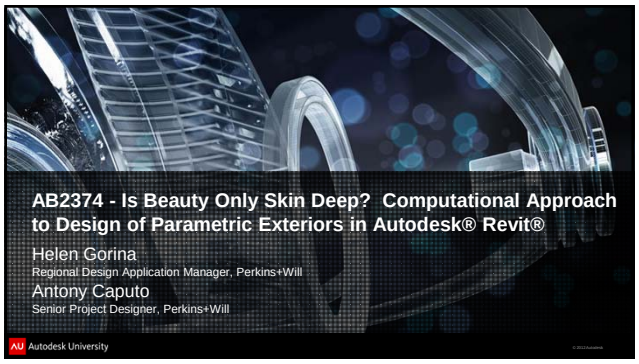

AB2374 - Is Beauty Only Skin Deep? Computational Approach to Design of Parametric Exteriors in Autodesk® Revit®

Helen Gorina
Regional Design Application Manager, Perkins+Will
Antony Caputo
Senior Project Designer, Perkins+Will

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Learning Objectives – Case Studies

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

- Apply your knowledge of shared parameters to streamline design and documentation process.
- Create patterns and panels based on true hexagon with infinite variations of design
- Use material parameters for visual studies
- Understand advantages and shortcomings of different approaches to modeling of complex structures: from traditional modeling techniques to various scripting and latest Revit tools
- Use adaptive components to help you build and refine your design
- Understand how to build families for rapid design iteration and solar radiation analysis in Vasari

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Case studies

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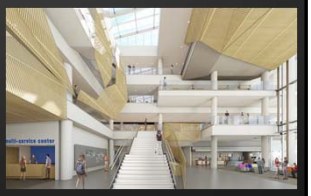
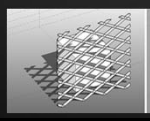
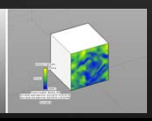
Case studies



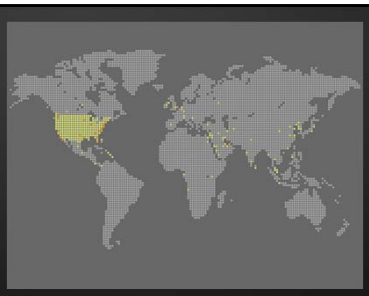


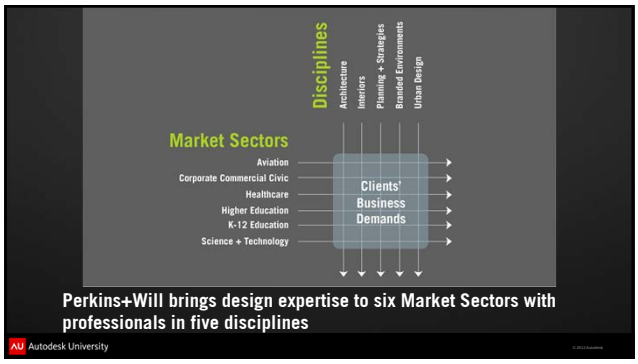


Team

Office Locations

23 offices worldwide:
Atlanta, Boston, Charlotte, Chicago, Dallas, Dubai, Hartford, Houston, London, Los Angeles, Miami, Minneapolis, New York, Orlando, Philadelphia, Research Triangle Park, San Diego, San Francisco, Seattle, Shanghai, Toronto, Vancouver, Washington DC, Sao Paulo.





Perkins+Will brings design expertise to six Market Sectors with professionals in five disciplines

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Market Sectors

AVIATION + TRANSIT | COMMERCIAL + CORPORATE + CIVIC | HEALTHCARE | HIGHER EDUCATION | K – 12 EDUCATION | SCIENCE + TECHNOLOGY

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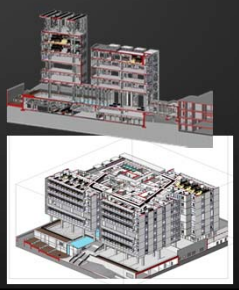
P+W BIM Implementation

- Began in 2004
- Revit Architecture is our Core BIM Application.
- Team of Design Applications Professionals supporting projects internally.
- 850+ Staff trained in-house
- Over 250 projects are completed or underway



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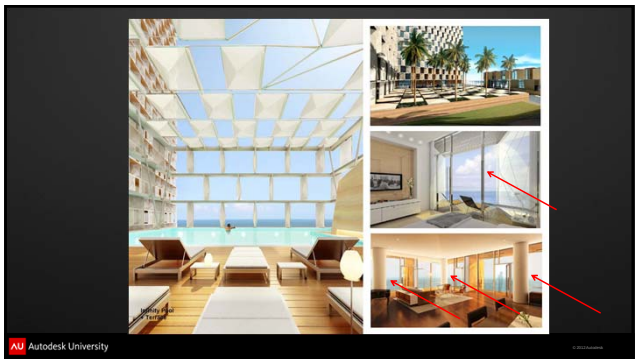
Smooth Sailing

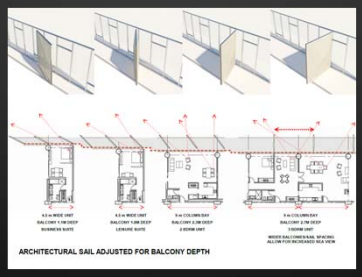
KEMPINSKI HOTEL AND RESIDENCES JEDDAH, KSA

Kempinski Sails

KEMPINSKI

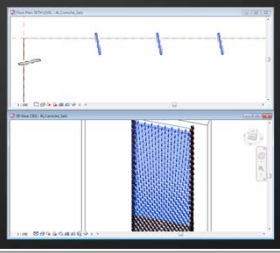


Kempinski Sails



Kempinski Sails

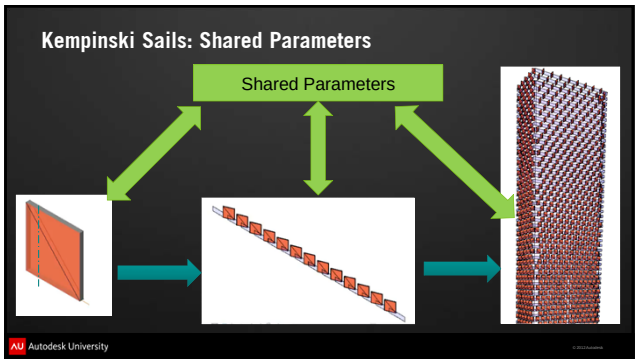
- Each sail is attached at a pivot point. Pivot points are co-linear.
- Zone 1- 6 each have fixed angle and spacing
- Zone 7- angle and spacing increments on each floor.
- Checkerboard effect
- Sail dimensions may change overall and between floors
- Overall floor count may change



Parameters for ZONES

Sails Array angles-ALL												
A1	TA1	A2	TA2	A3	TA3	A4	TA4	A5	TA5	A6	TA6	TAV.ar
0.00°	4	10.00°	8	22.50°	17	32.50°	23	35.00°	26	38.00°	29	66

Kempinski Sails: Shared Parameters



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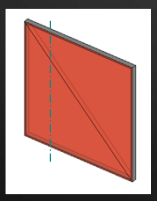
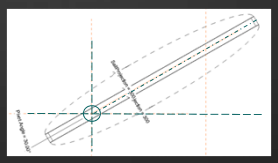
Kempinski Sails

All parameters are shared





Parameter	Value	Formula	Lock
Constraints			
Level (default)	0	=	☑
Dimensions			
Width2	800.0	=	☑
Width1 (default)	3000.0	=	☑
Thickness	150.0	=	☑
SailProjection	300.0	=	☐
SailHeight	4000.0	=	☐
Pivot Angle (default)	30.000°	=	☑

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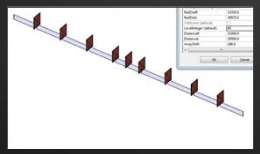
Sail Array Families

One parameter rules them all

66



Sail Panels Schedule

Levels	LevelInteger
1ST LEVEL	1
2ND LEVEL	2
3RD LEVEL	3
4TH LEVEL	4
5TH LEVEL	5
6TH LEVEL	6
7TH LEVEL	7
8TH LEVEL	8
9TH LEVEL	9

- Two families (long façade and short façade)
- Place on the first level, then paste aligned to other levels
- Level integer is an instance parameter. Easy to assign using schedule
- Everything else is calculated

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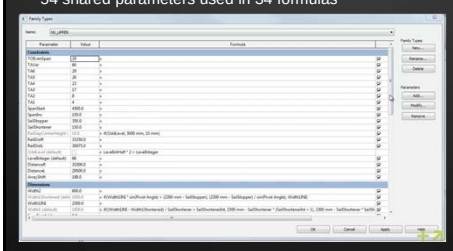
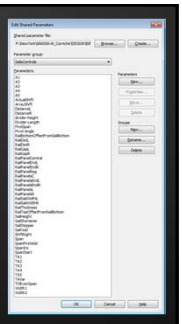
Sail Array Families

54 shared parameters used in 34 formulas



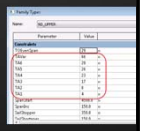


Sail Array Families

Controlling pivot angle: shared parameter calculated in SailArray passed to Sail

Sails Array angles-ALL												
A1	TA1	A2	TA2	A3	TA3	A4	TA4	A5	TA5	A6	TA6	TAVar
0.00°	4	10.00°	8	22.50°	17	32.50°	23	35.00°	28	38.00°	29	66

AngleInc=(90° -A6)/(TAVar-TA6)



IF(condition, true, false)

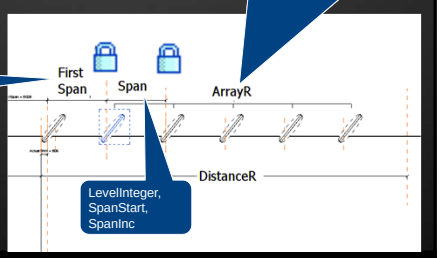
PivotAngle=IF(LevelInteger > TA6, (LevelInteger - TA6 - 1) * AngleInc + A6,
IF(LevelInteger > TA5, A6,
IF(LevelInteger > TA4, A5,
IF(LevelInteger > TA3, A4,
IF(LevelInteger > TA2, A3,
IF(LevelInteger > TA1, A2, A1))))))

Sail Array Family

Controlling Sail arrays number and locations

ROUNDDOWN
(DistanceR - FirstSpan - ActualShift – Width1 * cos(Pivot Angle)) / Span

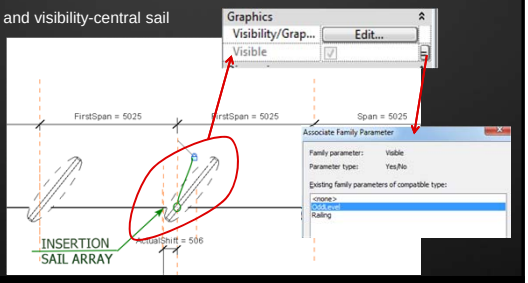
IF(OddLevel, Span, Span/2)



LevelInteger, SpanStart, SpanInc

Sail Array Family

Location and visibility-central sail



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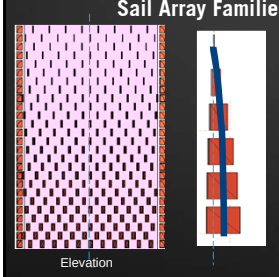
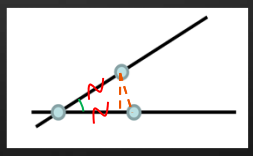
Sail Array Families



Elevation

Do not slouch!



ActualShift = (Width1 - (Width1 + Width2) / 2) –(Width1 - (Width1 + Width2) / 2)*cos(Pivot Angle)

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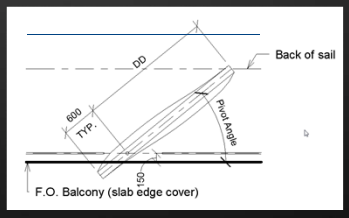
Sail Array Family

Interact with facade

Need minimum access between back of sail and back of balcony.

SailStopper

SailShortener



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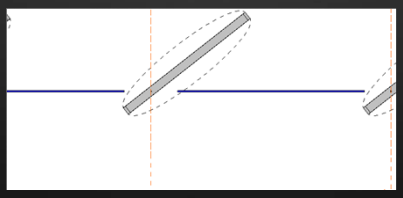
Sail Array Family

Railing is cooperating with Sail

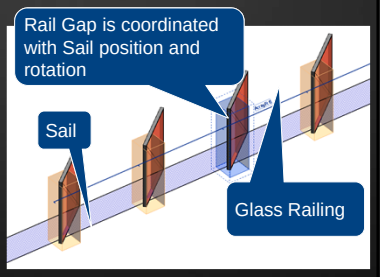
Examples: Levels 3,5,9,27



Sail Array Family

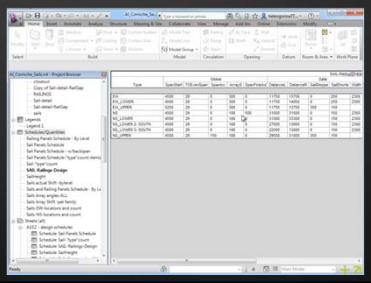
Railing is cooperating with Sail

- Overall length is calculated based on DistanceL and DistanceR
- Gaps are controlled using parametric arrayed voids.
- Gap width is calculated based on sail rotation and width.
- Sail and gap position and sail rotation is calculated based on LevelInteger

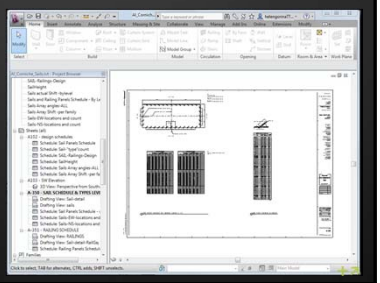


Kempinski Sails

- Parameter management and rapid design iterations



Kempinski Sails
Documentation
Huge time saver



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Meditation Space

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Concept

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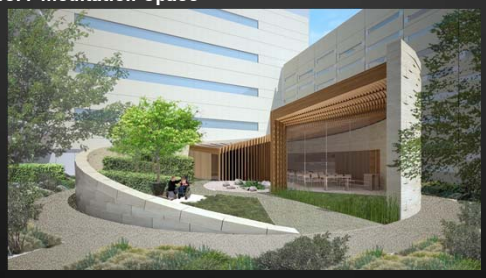
Chapel / Meditation Space



EXTERIOR VIEW – **LOOKING SOUTH-EAST**

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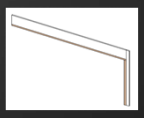
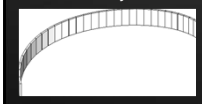
Round 1: Revit 2010, early development

Curtain System



Generic Model



Curtain System

Curtain Systems

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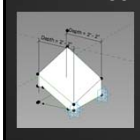
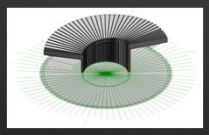
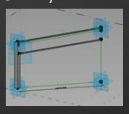
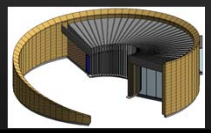
Round 2: Revit 2011 and 2012 , DD









Assembly of Roof – metal, concrete, air space, wood ceiling

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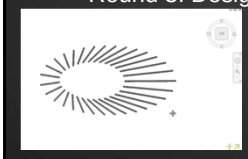
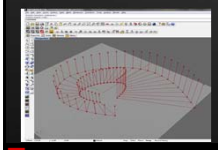
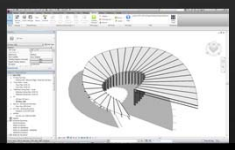
Round 3: Design Changes



Challenge: circle, ellipse , shifted ellipses…
Solution: Script in Grasshopper, bring to Revit as adaptive component using Hummingbird and ModelBuilder of WhiteFeet tools.
http://ghhummingbird.wordpress.com/
http://www.grasshopper3d.com/group/hummingbird
Authors: Mario Guttman and Tim Meador, Perkins+Will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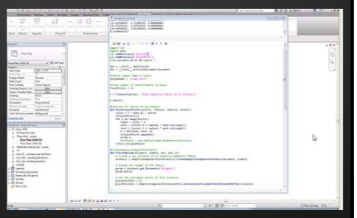
Round 3: Another Approach

Script with Revit Python Shell
Rapid iterations, one software environment
More info: **CP3837-L** - Scripting with RevitPythonShell in Autodesk® Vasari. Class Speaker: Iffat Mai, Perkins+Will



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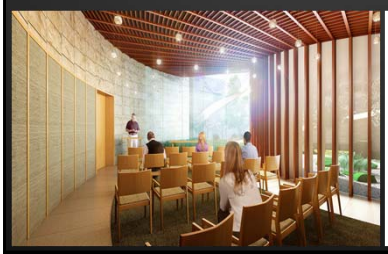
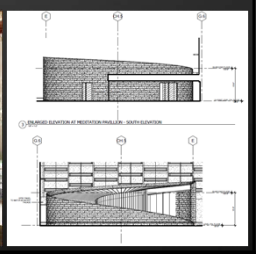
Results

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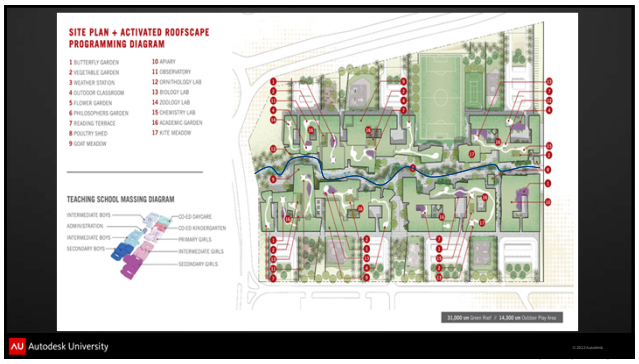
Shade in the Desert

Kuwait University

- 2012 WAN AWARDS Education Sector
- Strong identity for the school, extend learning beyond the classroom


SITE PLAN + ACTIVATED ROOFSCAPE PROGRAMMING DIAGRAM
1 BUTTERFLY GARDEN
2 VEGETABLE GARDEN
3 WEATHER STATION
4 OUTDOOR CLASSROOM
5 FLOWER GARDEN
6 PHILOSOPHERS GARDEN
7 READING TERRACE
8 POULTRY SHED
9 GOAT MEADOW
10 APIARY
11 OBSERVATORY
12 ORNITHOLOGY LAB
13 BIOLOGY LAB
14 ZOOLOGY LAB
15 CHEMISTRY LAB
16 ACADEMIC GARDEN
17 KITE MEADOW
TEACHING SCHOOL MASSING DIAGRAM
INTERMEDIATE BOYS
ADMINISTRATION
INTERMEDIATE BOYS
SECONDARY BOYS
CO-ED DAYCARE
CO-ED KINDERGARTEN
PRIMARY GIRLS
INTERMEDIATE GIRLS
SECONDARY GIRLS
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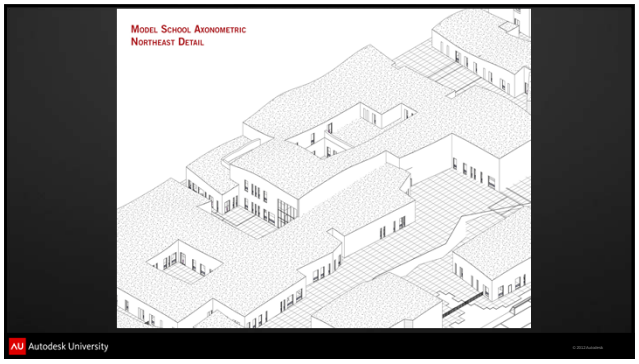
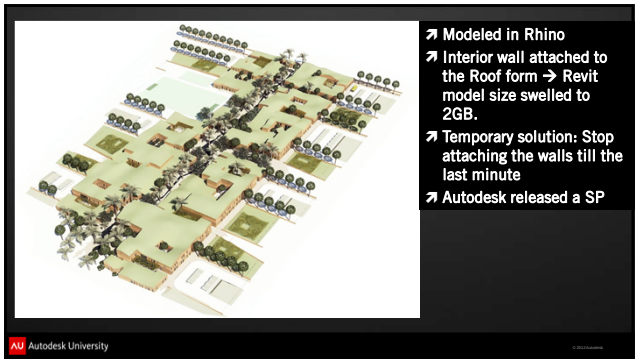

MODEL SCHOOL AXONOMETRIC
NORTHEAST DETAIL
Autodesk University


Modeled in Rhino
Interior wall attached to the Roof form → Revit model size swelled to 2GB.
Temporary solution: Stop attaching the walls till the last minute
Autodesk released a SP
Autodesk University

KU – Faculty Club Hexagonal Pattern

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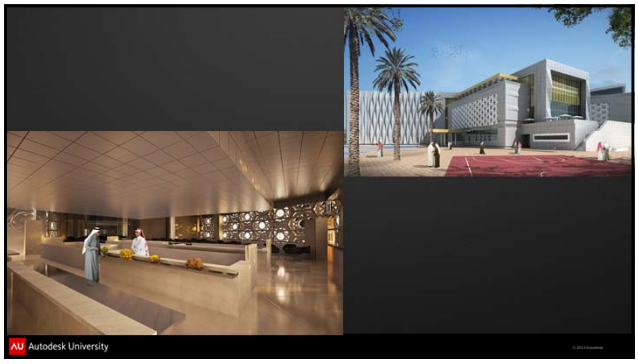

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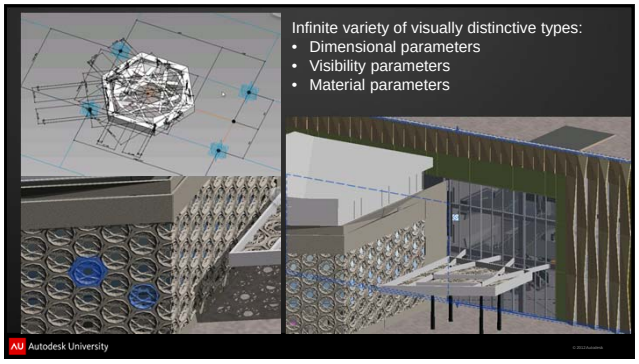
Infinite variety of visually distinctive types:
• Dimensional parameters
• Visibility parameters
• Material parameters
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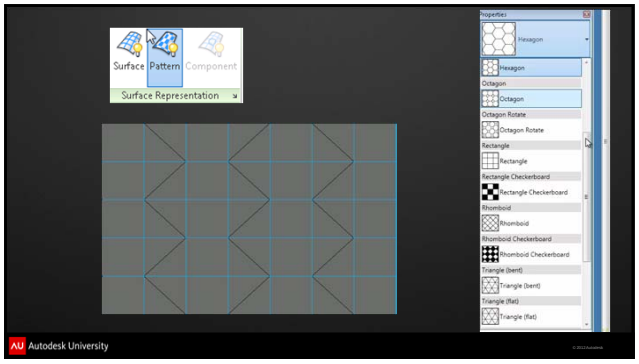
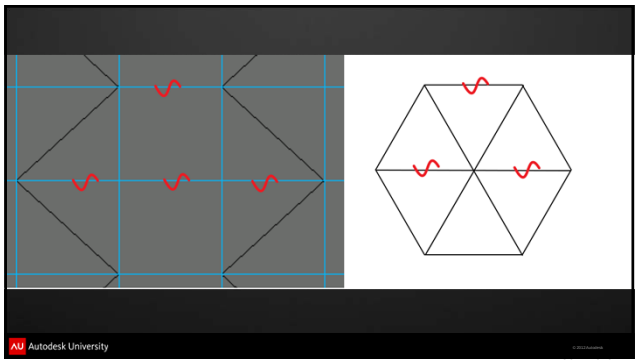
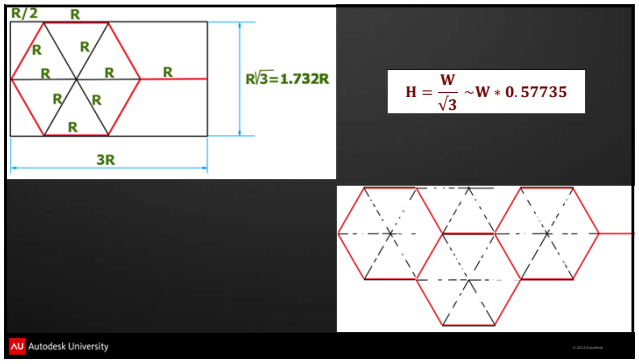
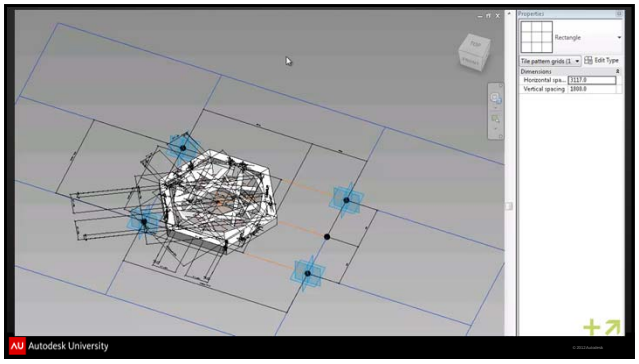
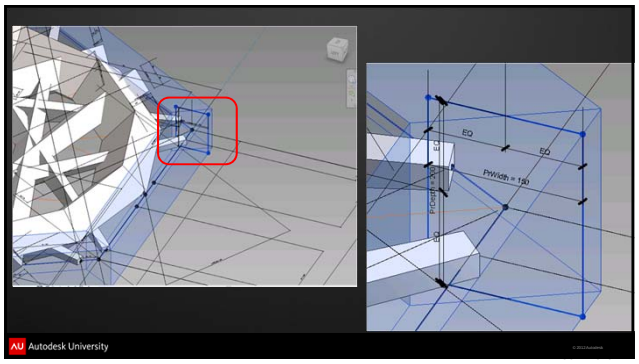

Surface
Pattern
Component
Surface Representation
Autodesk University


Autodesk University


R/2
R
R
R
R
R
R
R
R
R
R√3=1.732R
3R
$H = \frac{W}{\sqrt{3}} \sim W * 0.57735$
Autodesk University


Autodesk University


EQ
EQ
PrWidth = 150
EQ
PrDepth = 200
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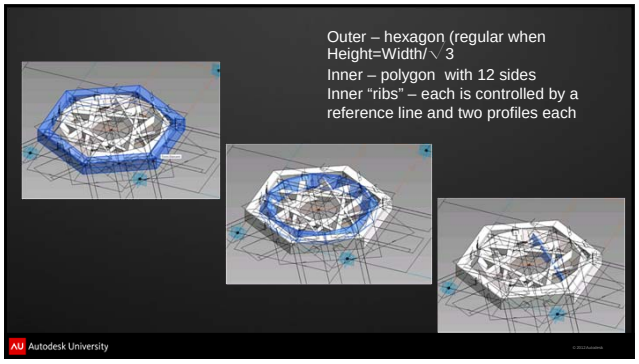
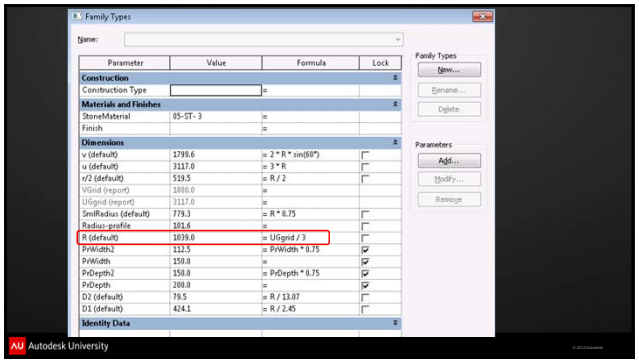
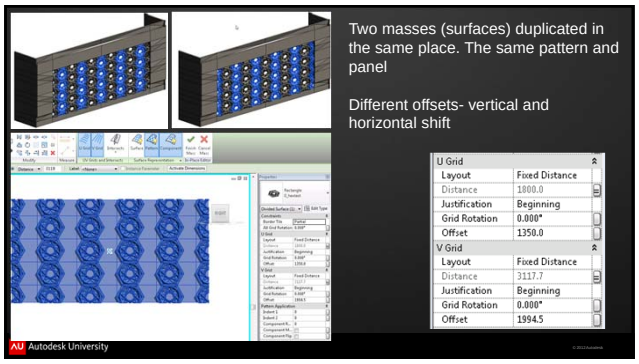
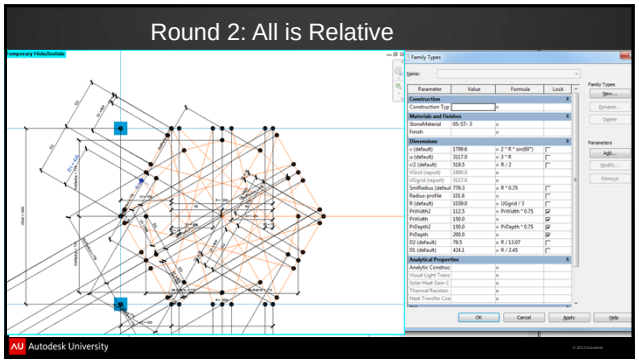
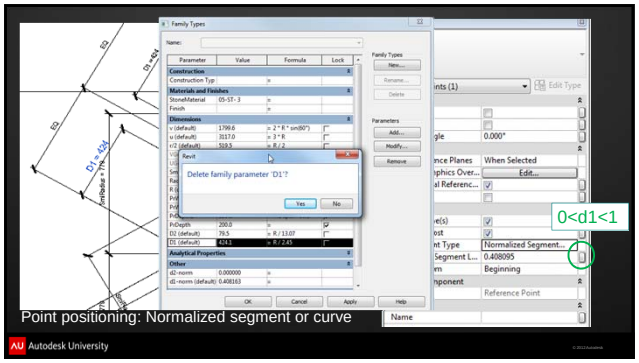

Outer – hexagon (regular when Height=Width/√3
Inner – polygon with 12 sides
Inner "ribs" – each is controlled by a reference line and two profiles each
Autodesk University

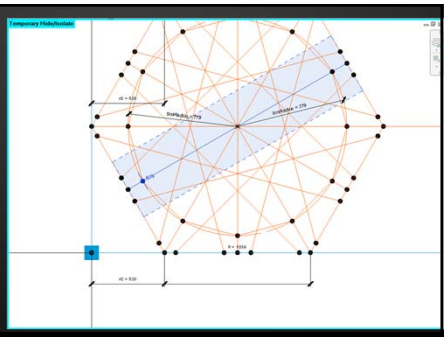

Family Types
Name:
Parameter | Value | Formula | Lock
Construction
Construction Type
Materials and Finishes
StoneMaterial 05-ST- 3
Finish
Dimensions
v (default) 1799.6 = 2 * R * sin(60°)
u (default) 3117.0 = 3 * R
r/2 (default) 519.5 = R / 2
VGrid (report) 1800.0
UGgrid (report) 3117.0
SmlRadius (default) 779.3 = R * 0.75
Radius-profile 101.6
R (default) 1039.0 = UGgrid / 3
PrWidth2 112.5 = PrWidth * 0.75
PrWidth 150.0
PrDepth2 150.0 = PrDepth * 0.75
PrDepth 200.0
D2 (default) 79.5 = R / 13.07
D1 (default) 424.1 = R / 2.45
Identity Data
Family Types
New...
Rename...
Delete
Parameters
Add...
Modify...
Remove
Autodesk University


Two masses (surfaces) duplicated in the same place. The same pattern and panel
Different offsets- vertical and horizontal shift
U Grid
Layout Fixed Distance
Distance 1800.0
Justification Beginning
Grid Rotation 0.000°
Offset 1350.0
V Grid
Layout Fixed Distance
Distance 3117.7
Justification Beginning
Grid Rotation 0.000°
Offset 1994.5
Autodesk University


Round 2: All is Relative
Autodesk University


Delete family parameter 'D1'?
Yes
No
0<d1<1
Point positioning: Normalized segment or curve
Autodesk University

- Point positioning: Normalized
- Points on small radius are hosted by intersection



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Material Matters

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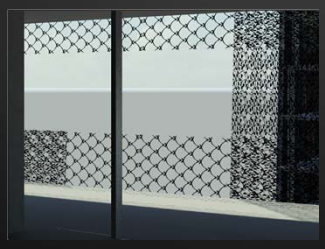
Materials with cutouts



Shaded View
Realistic View
Rendered View

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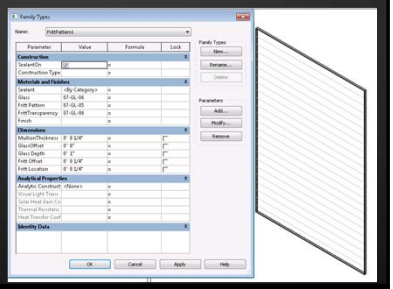
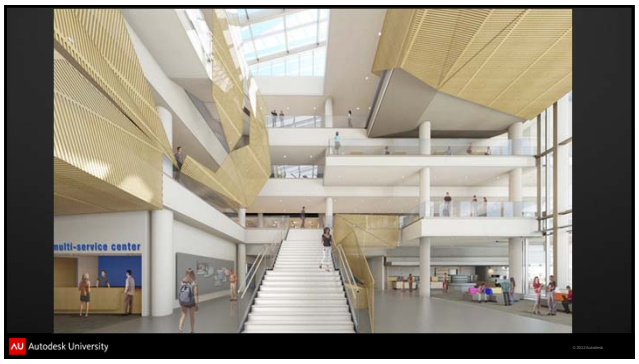
Materials with cutouts

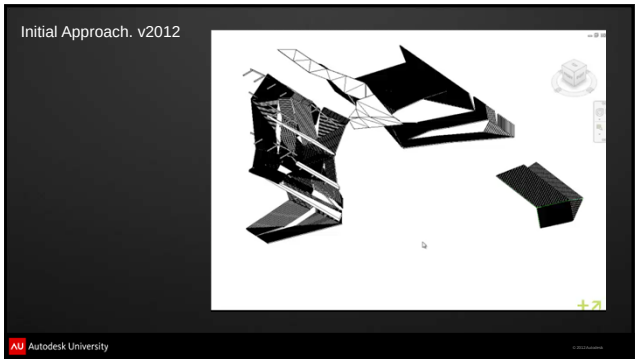
Shaded View
Realistic View
Raytrace
within Revit

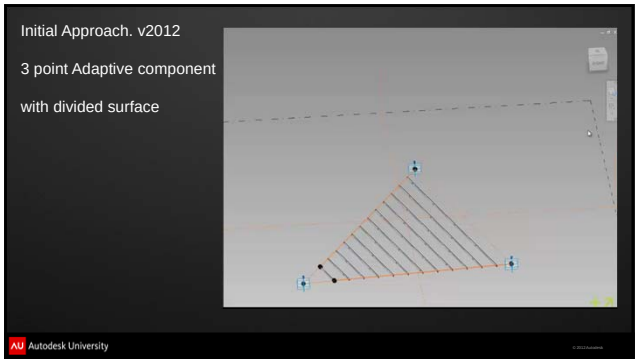
Live Demo Frit Glass Panel



Magic Lantern


multi-service center
Autodesk University


Initial Approach. v2012
Autodesk University

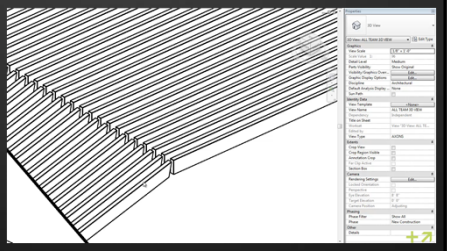

Initial Approach. v2012
3 point Adaptive component
with divided surface
Autodesk University

Refinement. v2013

Swap family

3 point Adaptive component

Divided paths hosting nested adaptive component



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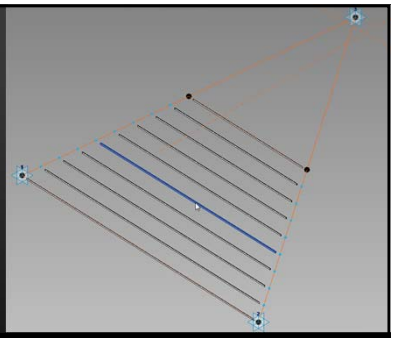
3 point Adaptive component

Divided paths hosting repeated adaptive component



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Solar radiation – Rapid design iterations

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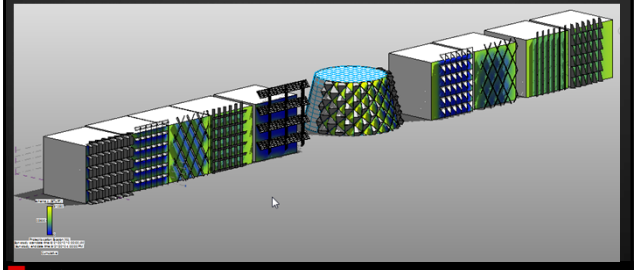
Pre-built parametric families. Rapid design iterations



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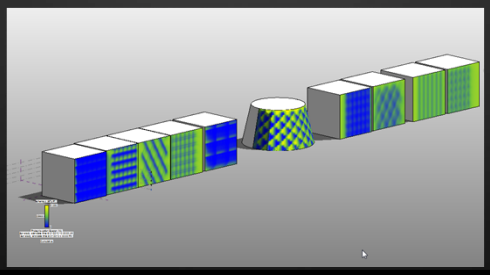
Solar radiation patterns



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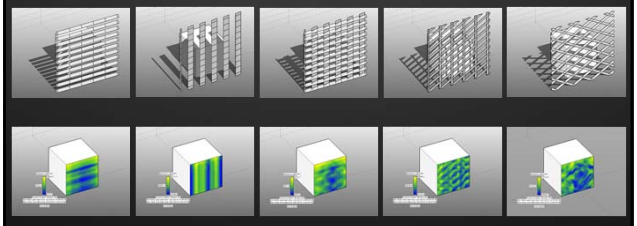
Louvers: some variations



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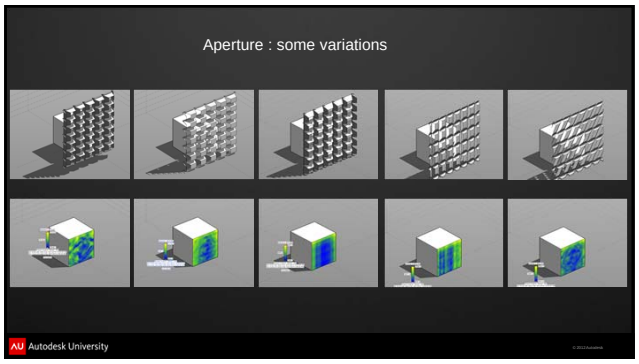
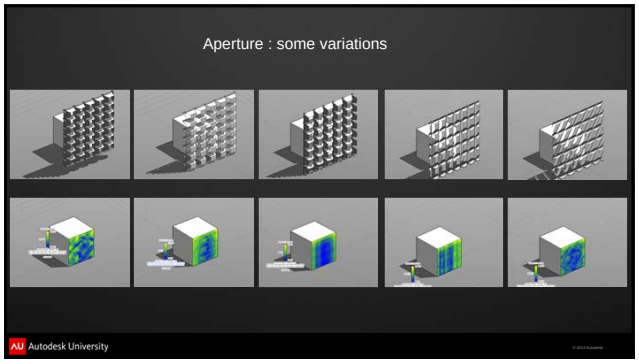

Aperture : some variations
Autodesk University


Aperture : some variations
Autodesk University