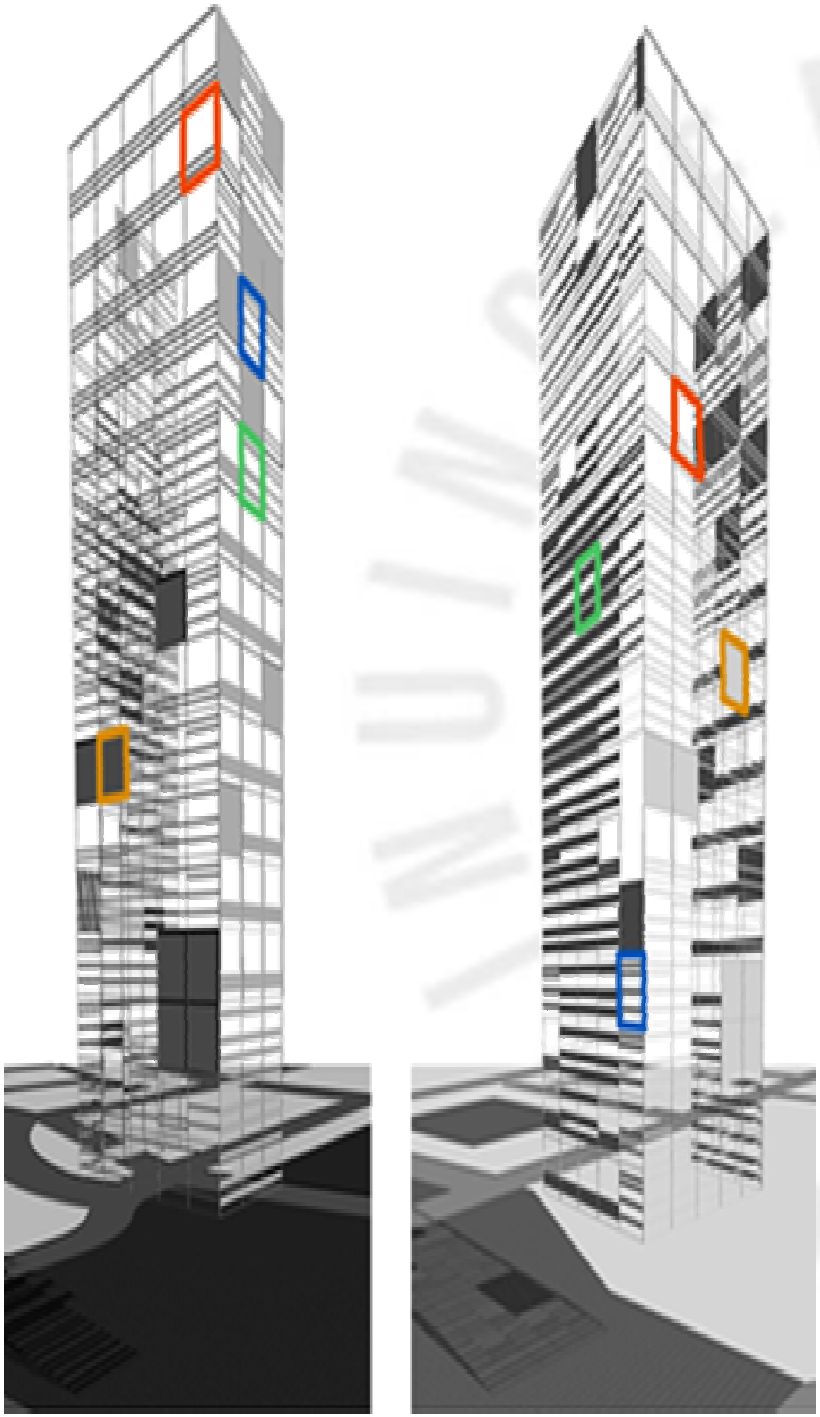

Performance-Driven Façade Configuration: *Parametric Thinking for Integrated Building Practice*

By: Zaki Mallasi (PhD, LEED ® BD+C)

Architecture & Design Days, 10 -11 October, 2012

AIA Middle East - Jeddah

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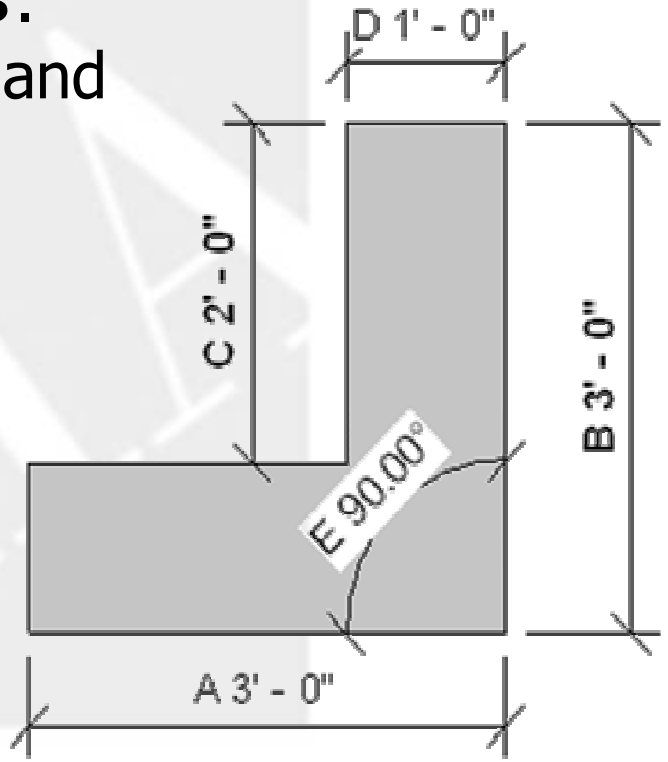
PRESENTATION GOALS

❑ This lecture demonstrates how to use **Analytical Design Data** to drive design of the building envelope using **Design Computation** processes and combined with custom-built **3D Parametric Objects**.

❑ Parameters are referred to as '**constraints**'. Examples Parameters: length, rotation angle, and number.

❑ Typical design data for a façade vary from one designer to another, examples are: spatial arrangements, **penalization pattern**, solar exposure, **visibility control (privacy)**, and aesthetic preference.



LEARNING OBJECTIVES

- Discover **possibilities** and **opportunities** from utilizing **BIM** within an integrated design framework.

- Developed unique and **innovative design thinking process** using digital design tools.

- Bringing awareness to advanced computational and **design optimization capabilities in Revit**.

- Share the process on how to transfer the **BIM model data** to **digital fabrication** and track cost.

PARAMETRICS PERFORMATIVE DESIGN
AUTOMATION ANALYSIS FAÇADE
ENVELOPE PROCESS METHODOLOGY
TECHNIQUE SHADING SIMULATION
OPTIMIZATION ENERGY PERFORMANCE
HEAT GAIN ORIENTATION VIEWS
ORIENTATION PROCESS EFFICENT
AUTOMATED SYSTEM FOR DESIGNING
MEASURABLE EARLY STAGE
ASSISTANCE/INFORMING STRATEGIES
RESULTS SCORECARD RECORDS PROGRESS
VALIDATES DESIGN

… SOME PRACTICAL NOTES

- ❑ This lecture is designed **to inspire**.
- ❑ Project case study and examples in this lecture are very **specific to designing the exterior building envelope**.
- ❑ If you didn't learn anything from me, then I must **learn something from you**.
- ❑ Please make this lecture an interactive session by **asking questions** and **share your thoughts**.

PARAMETRICS PERFORMATIVE DESIGN AUTOMATION ANALYSIS FAÇADE ENVELOPE PROCESS METHODOLOGY TECHNIQUE SHADING SIMULATION OPTIMIZATION ENERGY PERFORMANCE HEAT GAIN ORIENTATION VIEWS ORIENTATION PROCESS EFFICENT AUTOMATED SYSTEM FOR DESIGNING MEASURABLE EARLY STAGE ASSISTANCE/INFORMING STRATEGIES RESULTS SCORECARD RECORDS PROGRESS VALIDATES DESIGN SOLUTIONS/DECISIONS BENEFITS EFFICIENCY CORRELATION BETWEEN ENERGY ANALYSIS AND DESIGN ITERATION AND EXPLORATION

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OVERVIEW

❑ **DESIGN COMPUTATION** establishes a foundation for utilizing a number of digital design methods to **PROVIDE SOLUTIONS** and **AUTOMATION** for a design problem.

❑ The two project case studies presented here resulted in the **DEVELOPMENT** of a **REVIT ADD-ON** with base functionality towards an automated means of **designing the configuration of a façade**.

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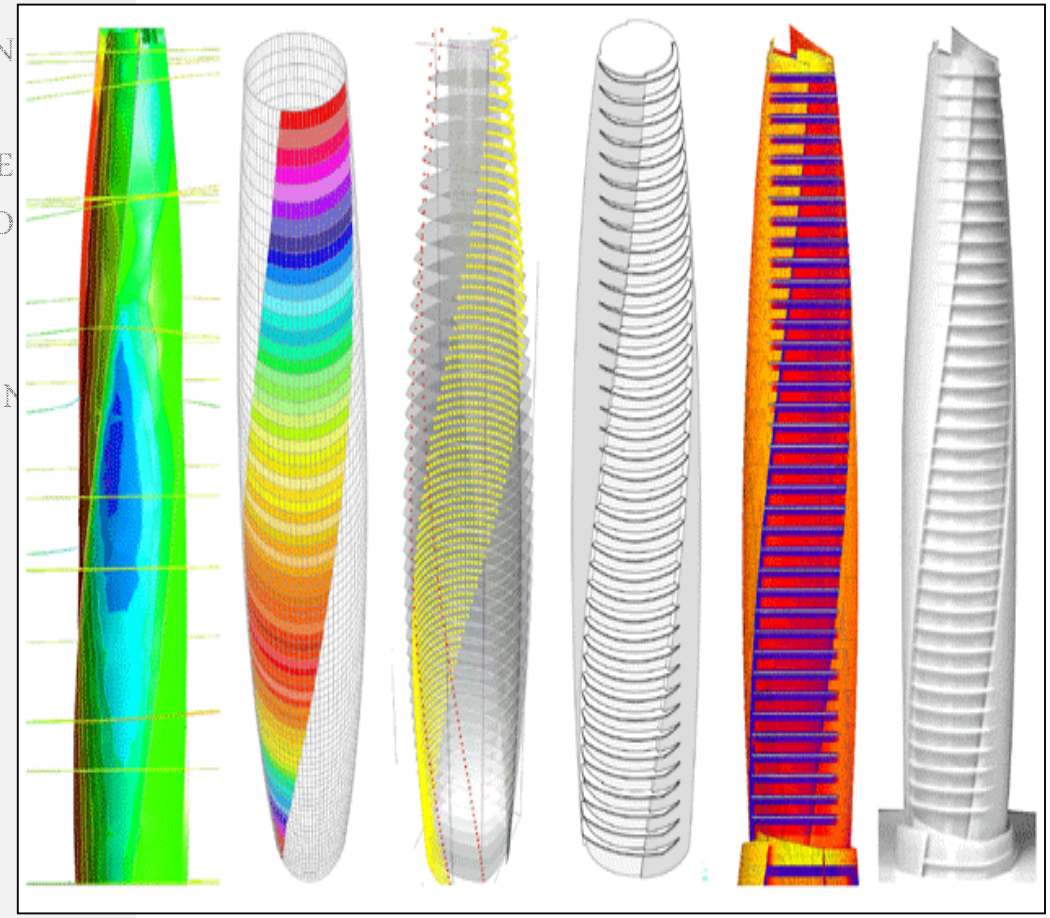
OVERVIEW



AEDAS RESEARCH GROUP

PARAMETRICS PERFORMATIVE DESIGN
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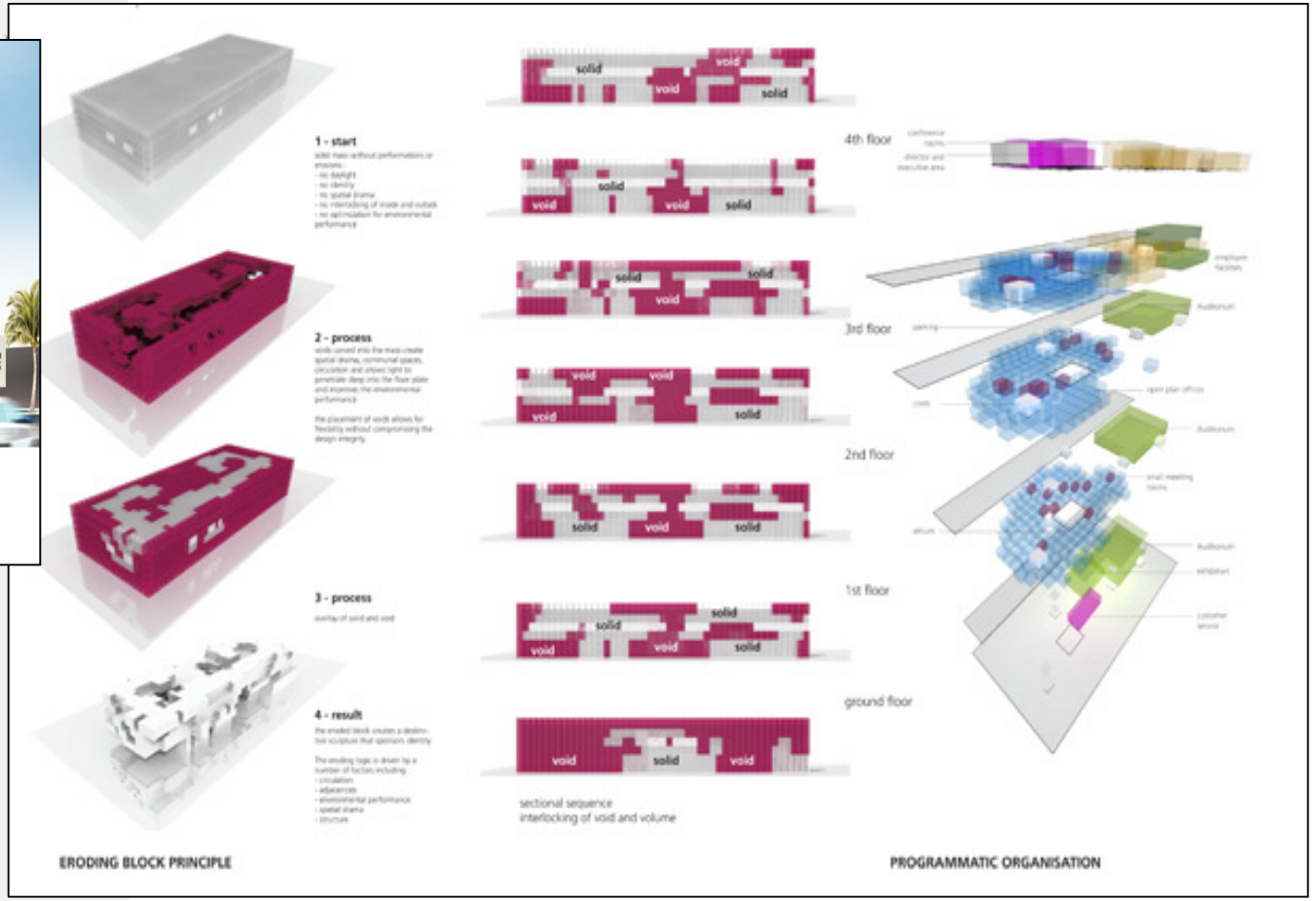
OVERVIEW



AEDAS RESEARCH GROUP

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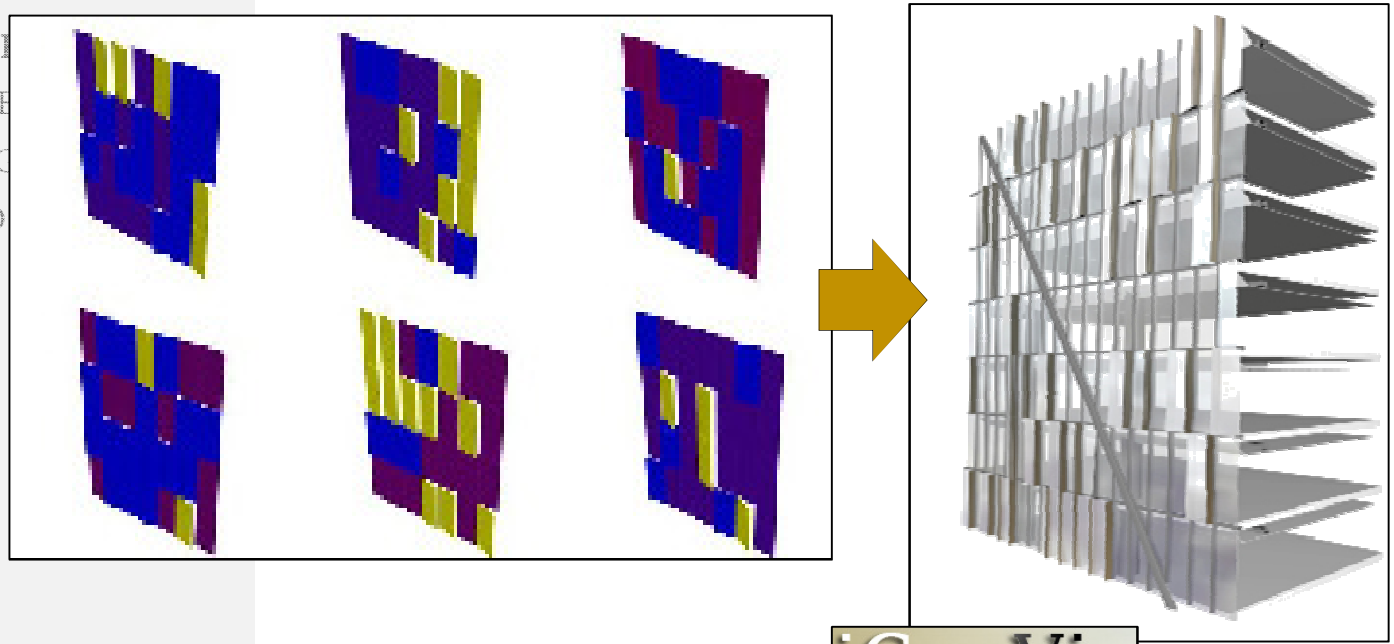
OVERVIEW

❑ The façade design analysis here is inspired by changing façade panel configuration based on **ANALYTICAL DESIGN IMAGE** (designer sketch for wall panel types, solar radiation image, specific pattern, etc.).



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KEY IDEAS

*'...An approach to applying **evidence to design process** that neither turns designers into scientists nor requires time'*

Chong et. al. (2011), *Design Informed: Driving Innovation with Evidence-Based Design*

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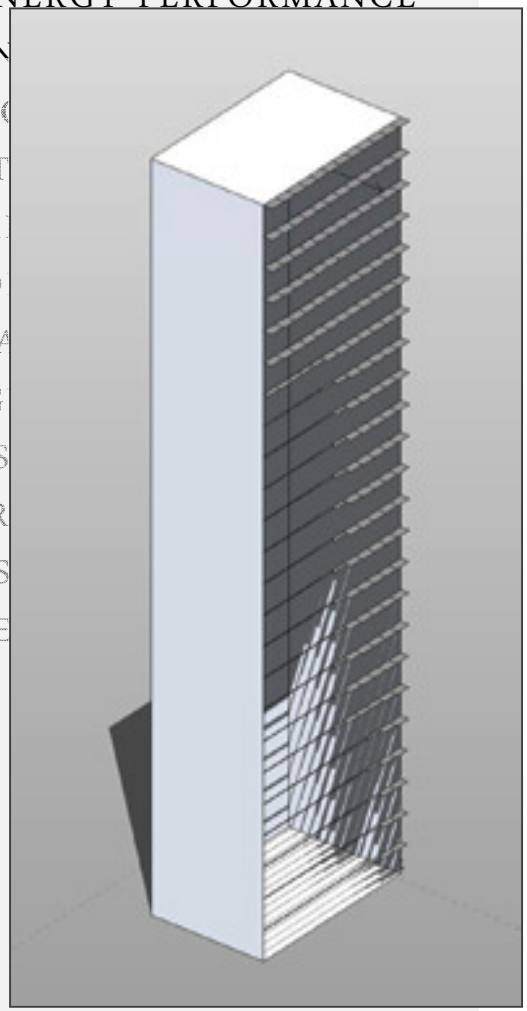
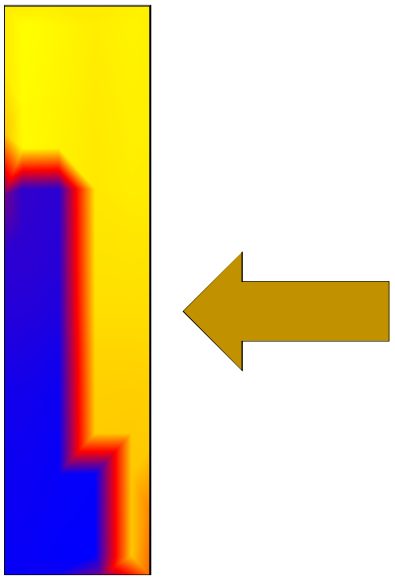


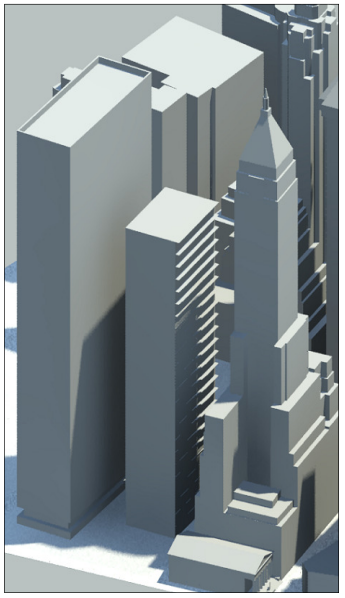
Façade Sunshade Analysis

KEY IDEAS

The images below represent a performance optimization technique where **SOLAR RADIATION DATA** is visualized as an image, and then utilized to size the shading devices in a building façade.



Façade Solar Exposure



Revit BIM Massing Model

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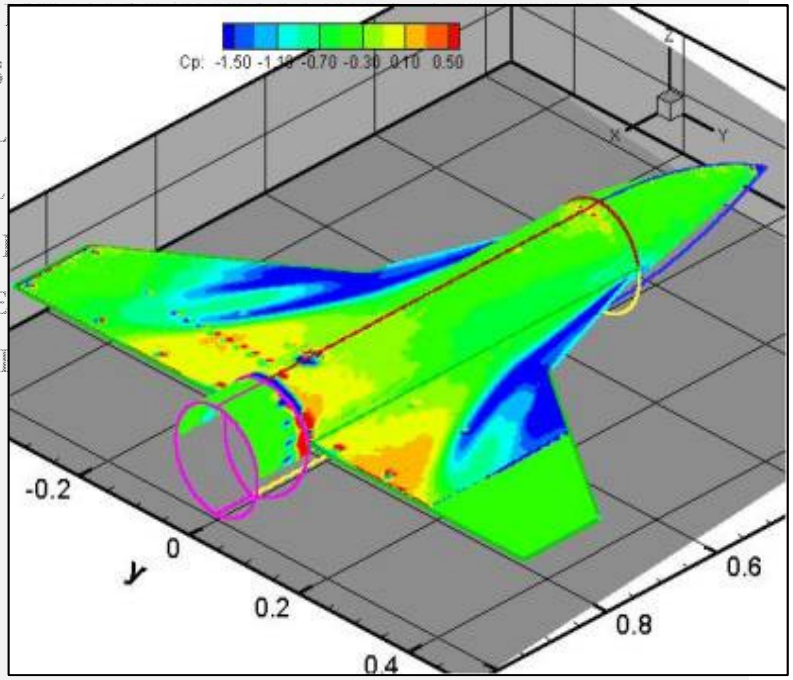
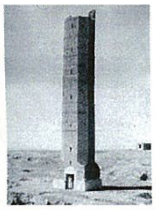


Vibration Testing

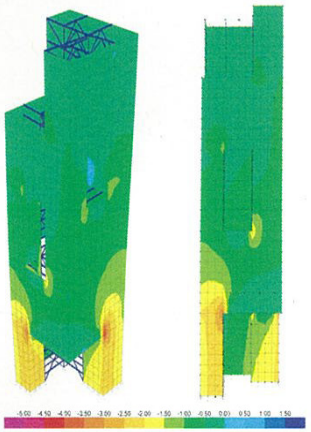
KEY IDEAS

❑ In fact, other industries have their **DESIGN PROCESSES REVOLUTIONIZED** by seeking **GOAL-ORIENTED SCHEMES** such as: industrial product design, art, furniture design, ship building, urban planning, car design, aerospace engineering, etc.

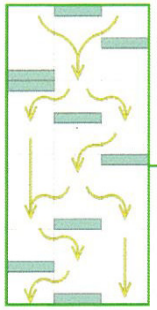
❑ The power of **PARAMETRIC DESIGN** computation can be harnessed to **EXPLORE POSSIBLE DESIGN SOLUTIONS** that yield interesting ideas which might not have been found through the traditional manual methodologies. This is simply looking to answer different '**What if Scenarios**'.



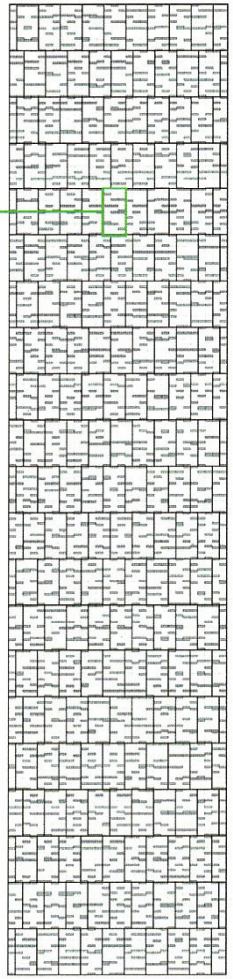
MONOLITHIC TOWER (LOAD BEARING WALLS)



STRESS DIAGRAM UNDER GRAVITY LOADS

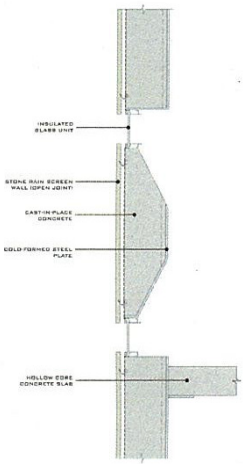


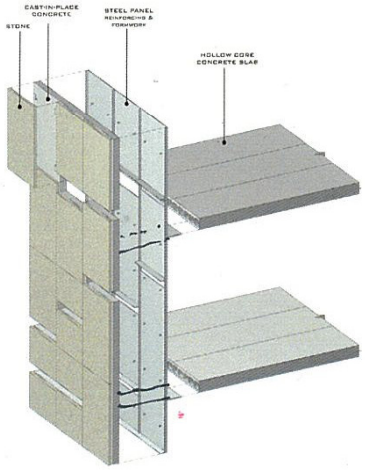
GRAVITY LOAD FLOW AT
LOAD BEARING EXTERIOR WALL

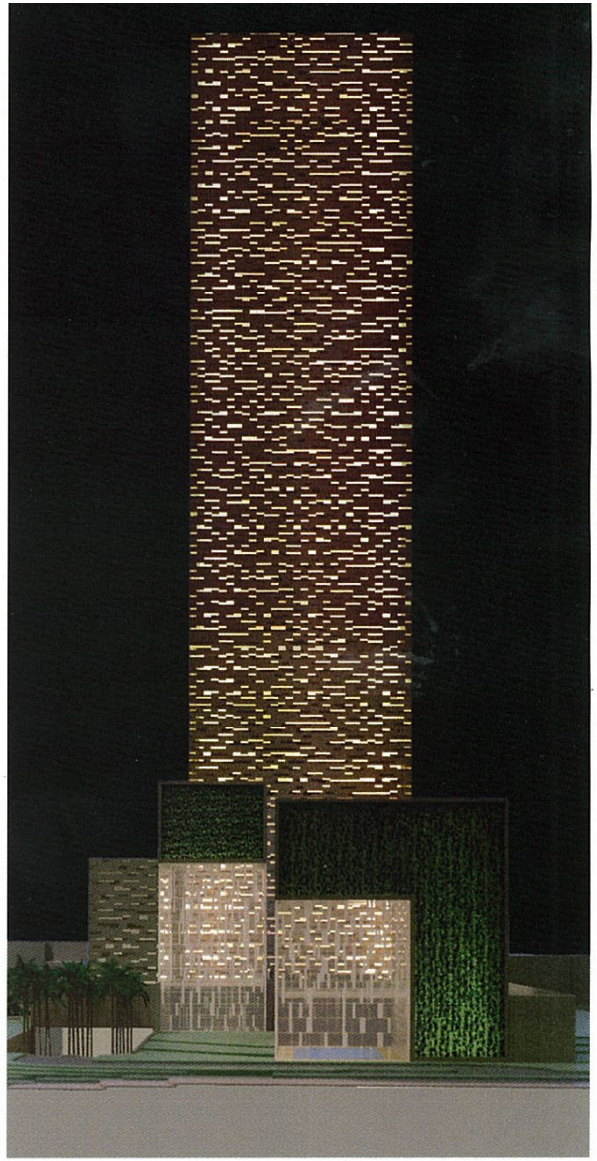


DECREASED
THICKNESS
(3" CONCRETE)

INCREASED THICKNESS
(18" CONCRETE)







Source: Vincent Poon, Perkins + Will, New York.

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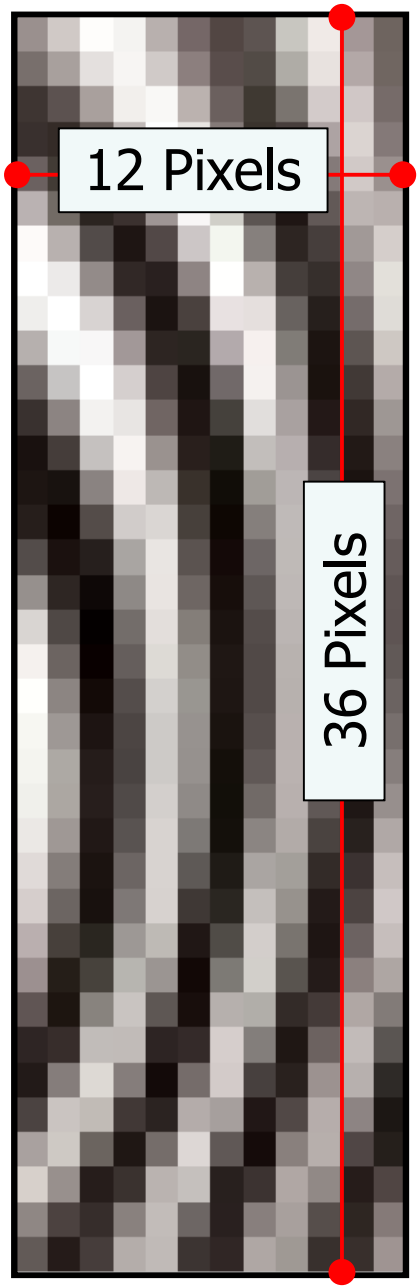
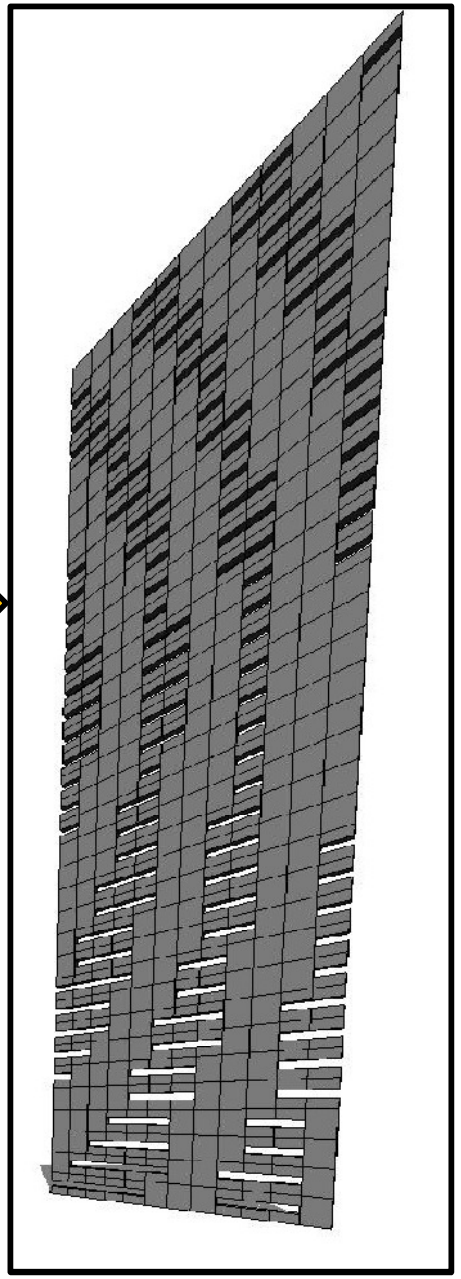


Panel Types Definition [12 X 36 Pixels]



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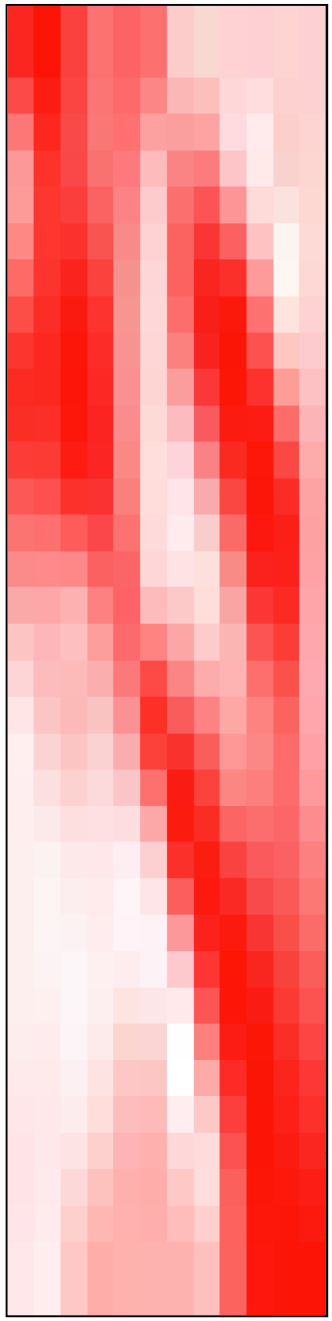
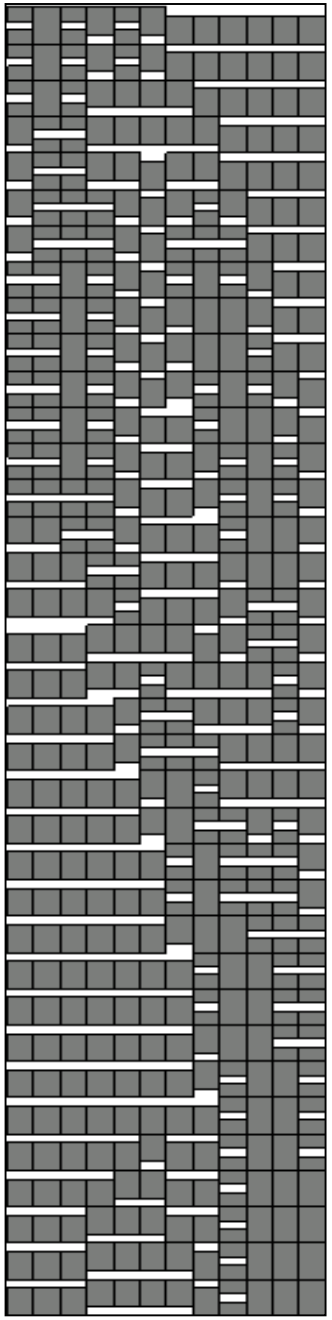
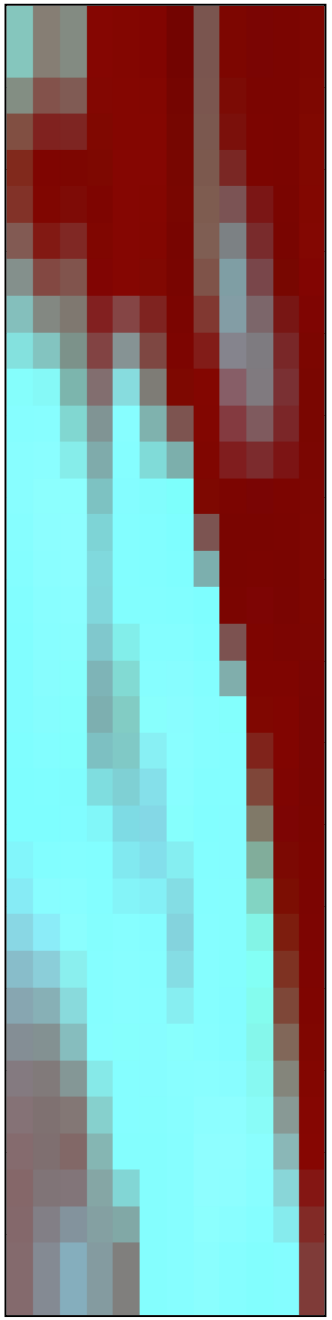
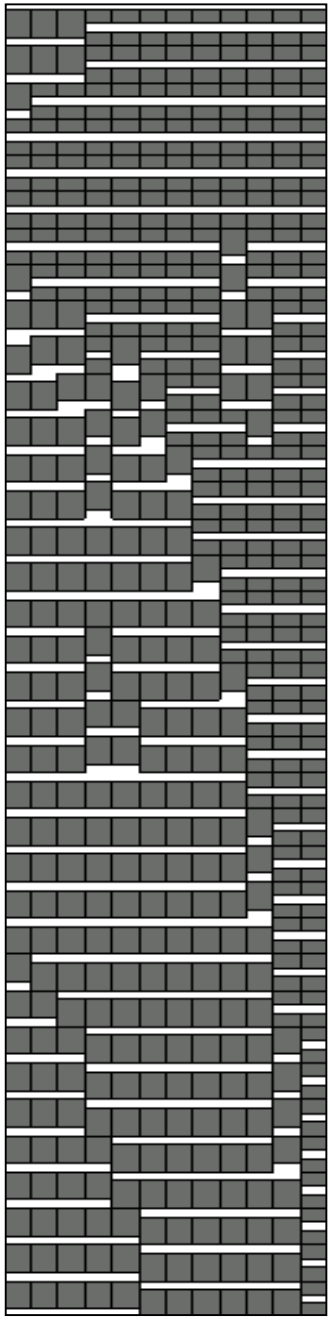




SCHEME A





SCHEME B

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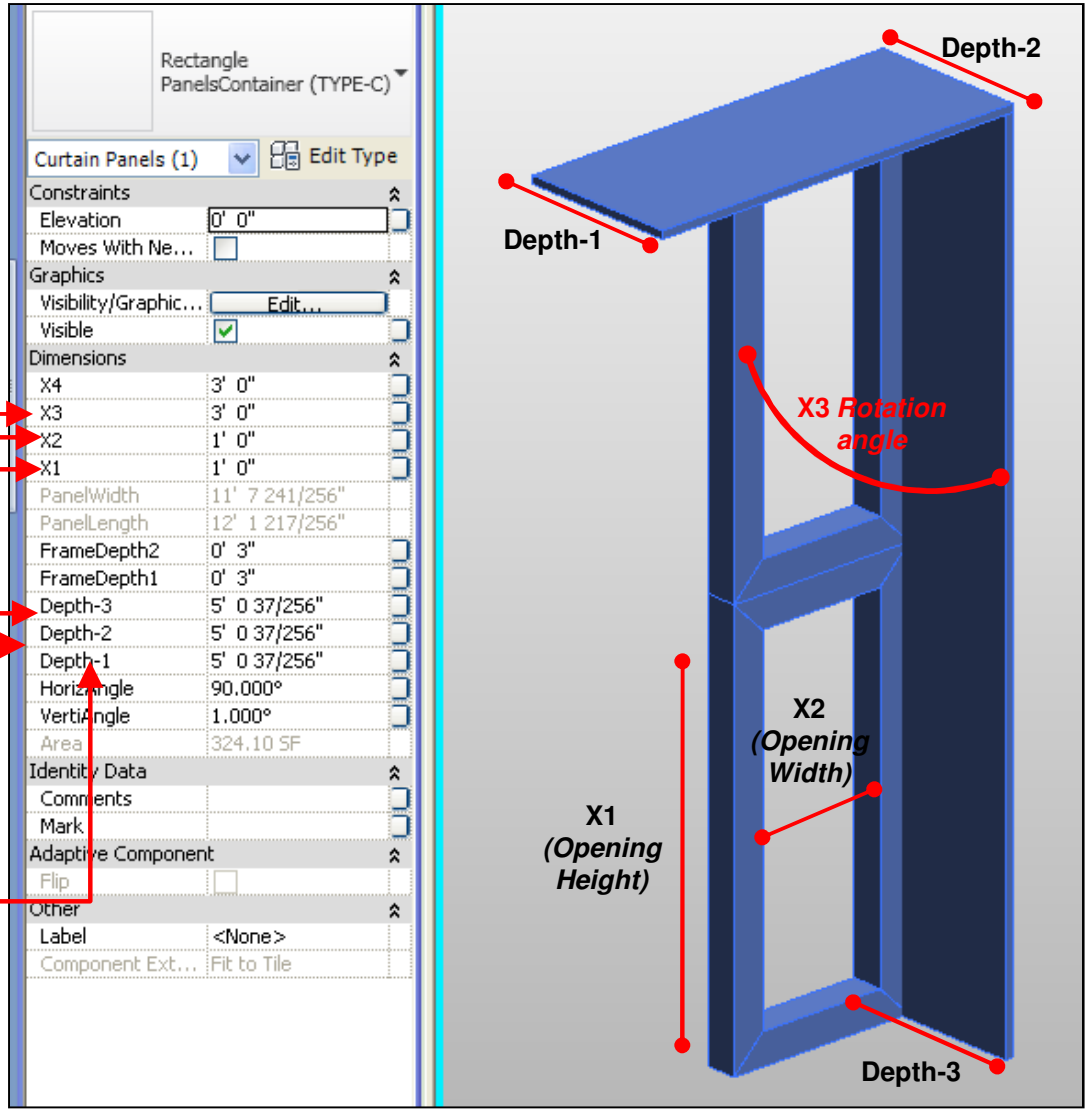
Parametric Revit Panel Family Set Up

❑ Design the pattern-base curtain panel family using the exact parameters type and name as shown here.

1. **Angle parameter X3**
2. **Length parameter X2**
3. **Length parameter X1**
4. **Length parameter Depth-3**
5. **Length parameter Depth-2**
6. **Length parameter Depth-1**



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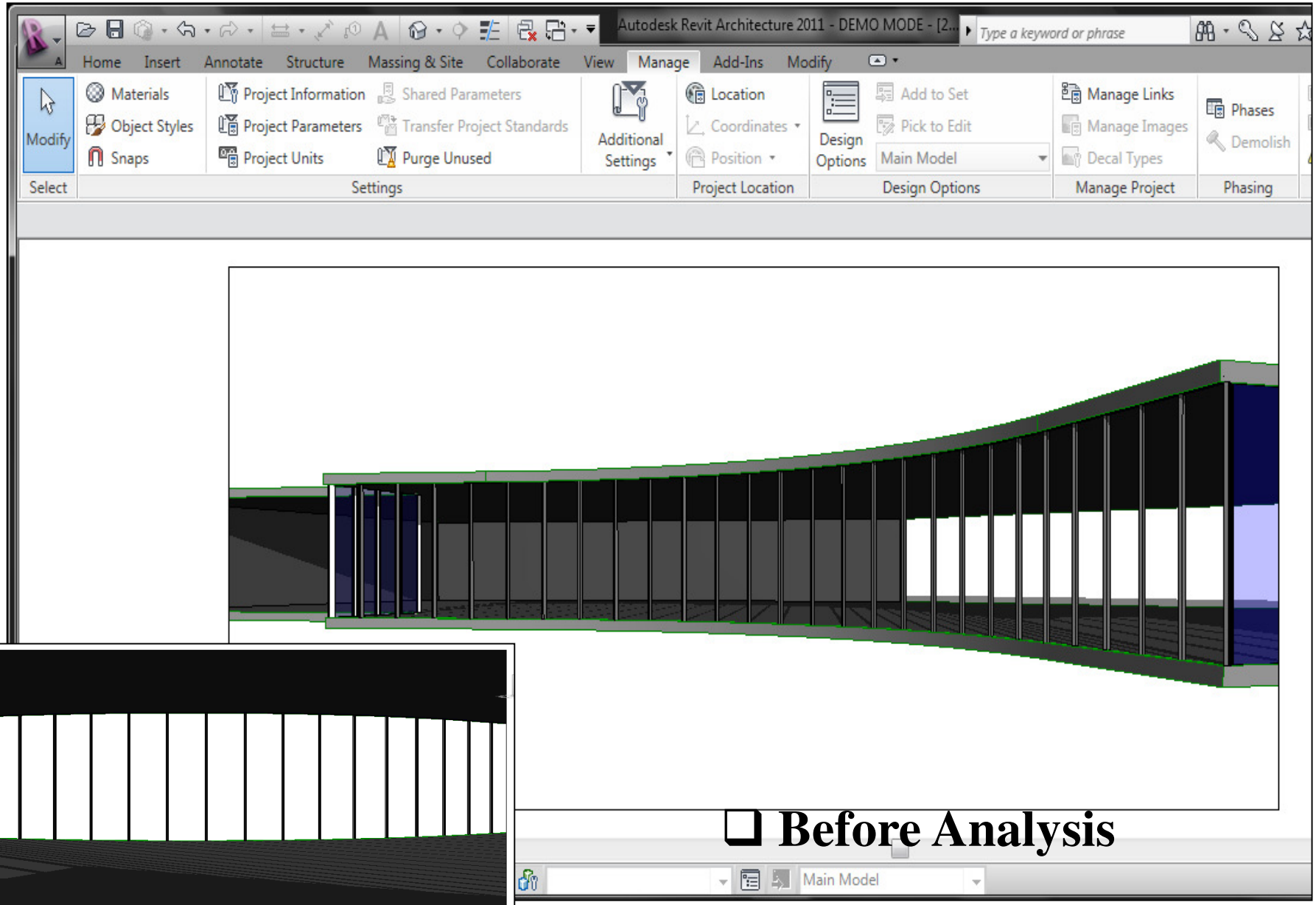
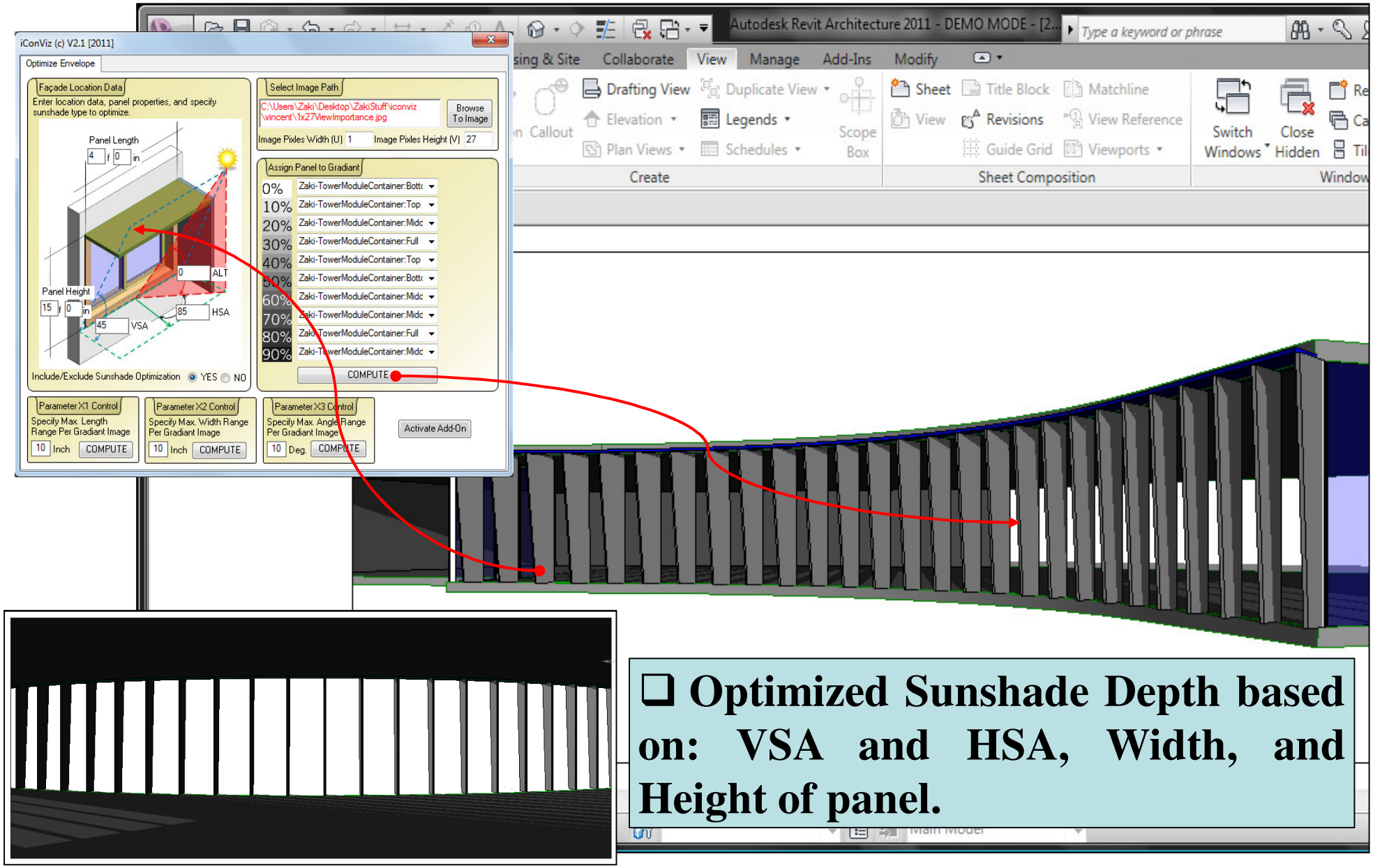
LIVE DEMO :: Direct Connection Between Image Data and Revit Curtain Wall Panels



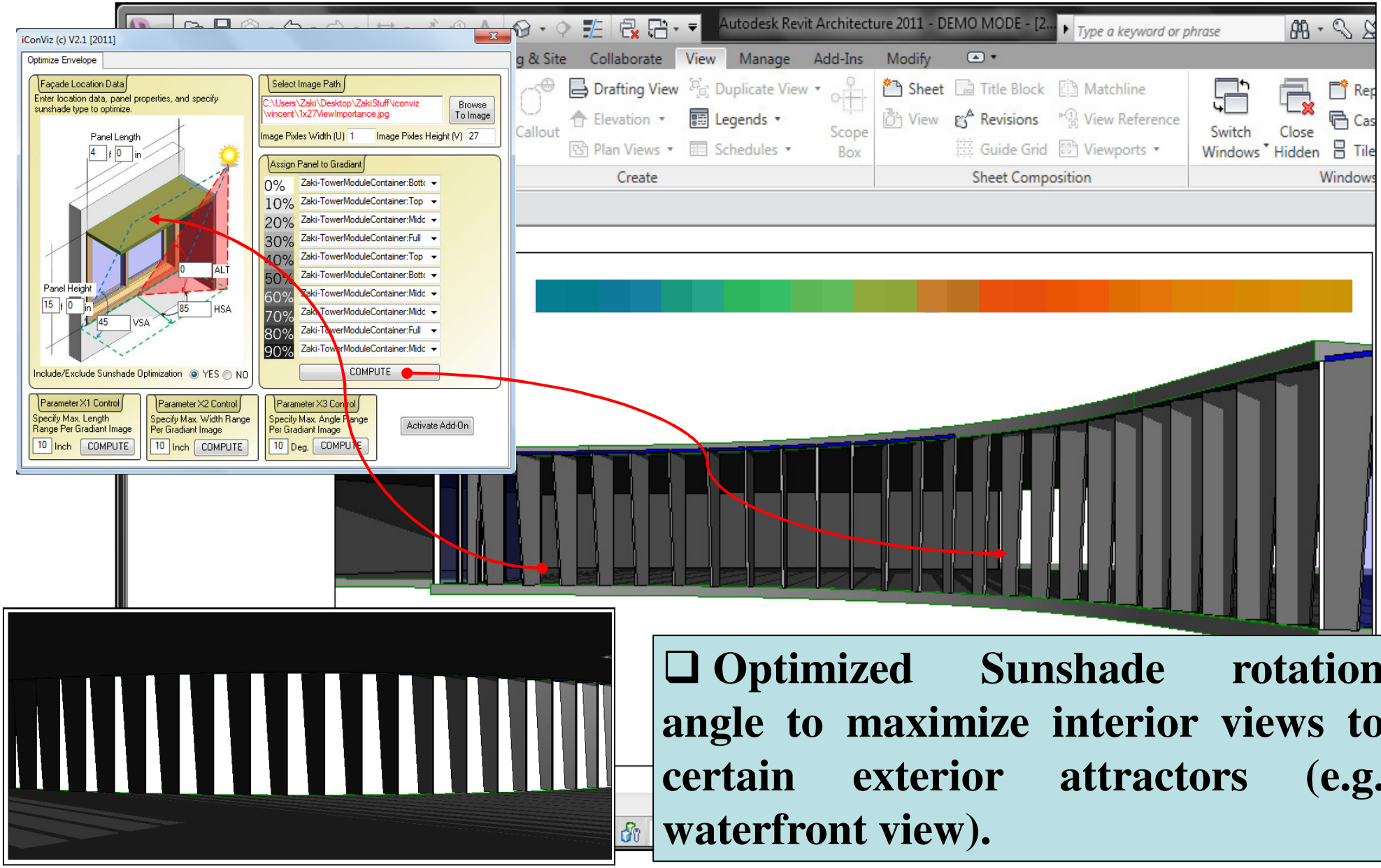
❑ Before Analysis

LIVE DEMO :: Direct Connection Between Image Data and Revit Curtain Wall Panels



❑ **Optimized Sunshade Depth based on: VSA and HSA, Width, and Height of panel.**

LIVE DEMO :: Direct Connection Between Image Data and Revit Curtain Wall Panels



❑ Optimized Sunshade rotation angle to maximize interior views to certain exterior attractors (e.g. waterfront view).

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Project 1 - Socio-Design Competition (1st Prize)

How Can a School Inspire Socially-Aware Design

Project Name: NEST

Project Location:
London, UK

Project Type: Higher Education – Social Design

Perkins + Will Team:

-John Poelker.

- Shannon Goodman.

- Zaki Mallasi.

- Mike Hodge.

- Sumegha Shah.

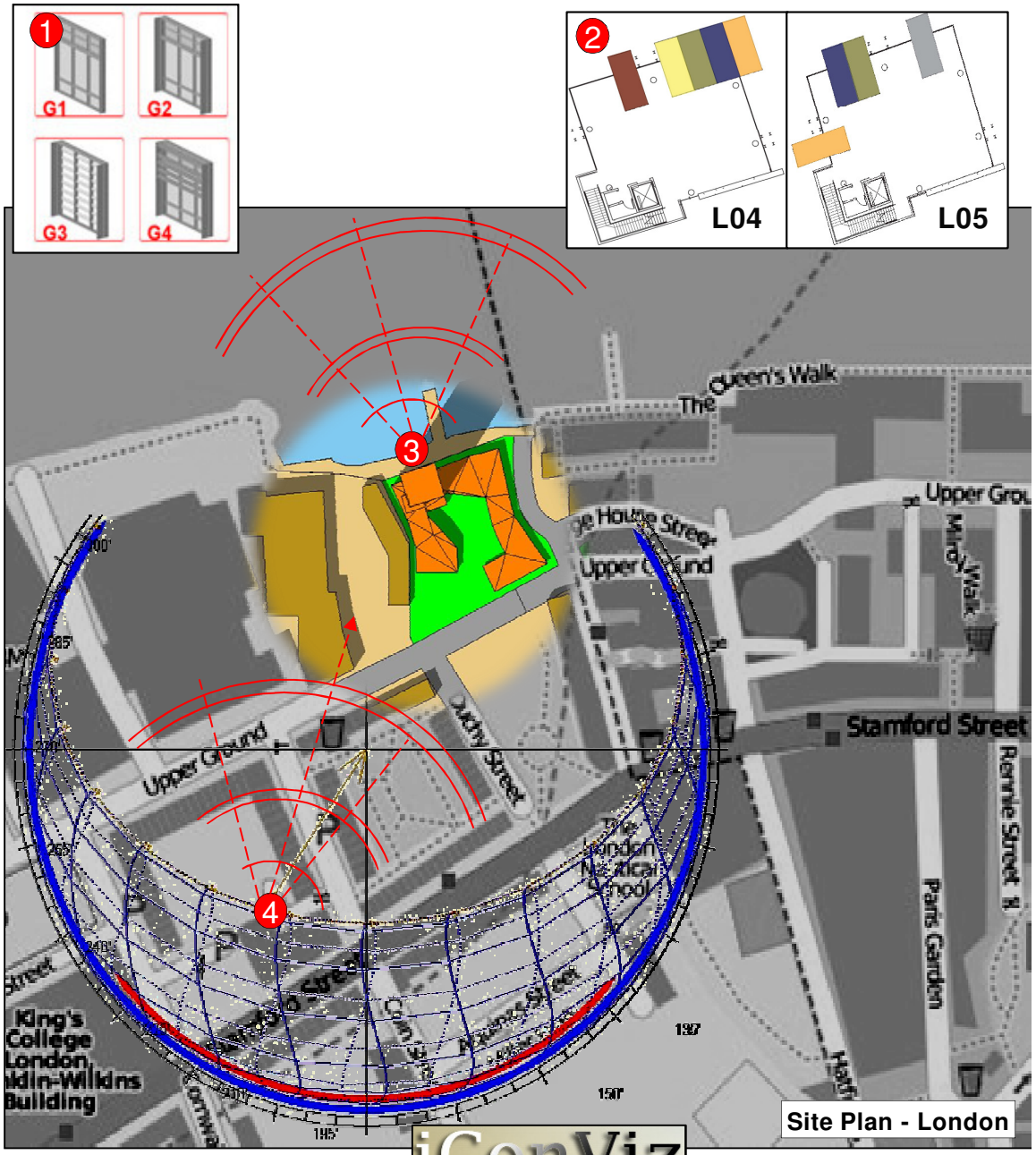
THE DESIGN COMPUTATION ANALYSIS WORKFLOW

STUDY ENVELOPE AND DESIGN ATTRACTORS

The diagram to the right shows the School competition site plan in London. The table below lists the main attractors which define the development of the **TOWER SKIN** The **FOUR DESIGN ATTRACTORS** chosen have crucial influence on the Tower enclosure design. They are:

Design Attractors		
Attractor Name	Level of Importance *(0-100% range)*	
1 **Panel type selection**		10%
2 **Floor plan layout**		20%
3 **View priority to Outside**		30%
4 **Solar exposure level**		40%

These attractors act as the starting point for a computational design procedure and for designing Revit object parameters that drive the tower components. Each attractor has a '**LEVEL OF IMPORTANCE**' value which influence the values of parameters and hence the Tower envelope.



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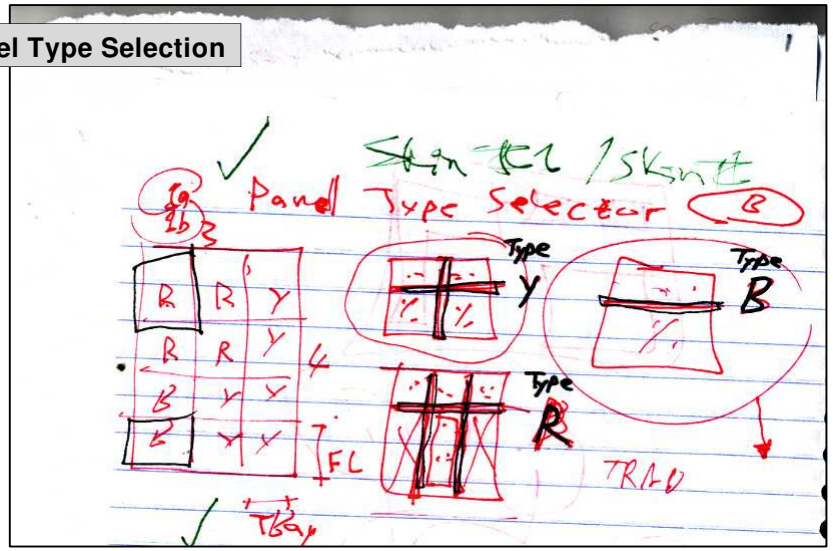
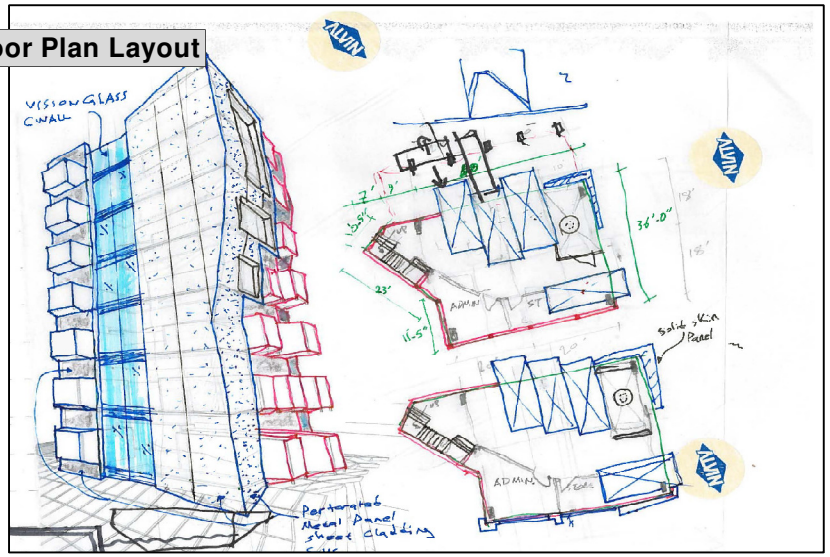
THE DESIGN COMPUTATION ANALYSIS WORKFLOW

STUDY ENVELOPE AND DESIGN ATTRACTORS *(PROCESS THINKING)*

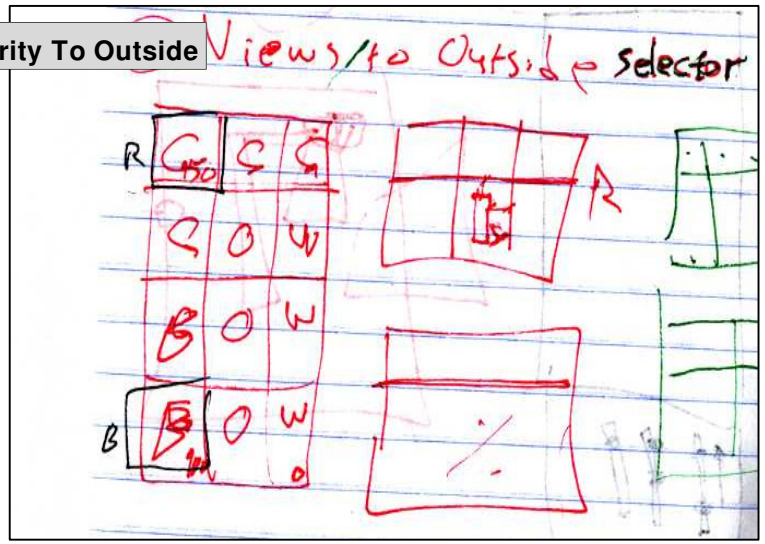
1 Panel Type Selection



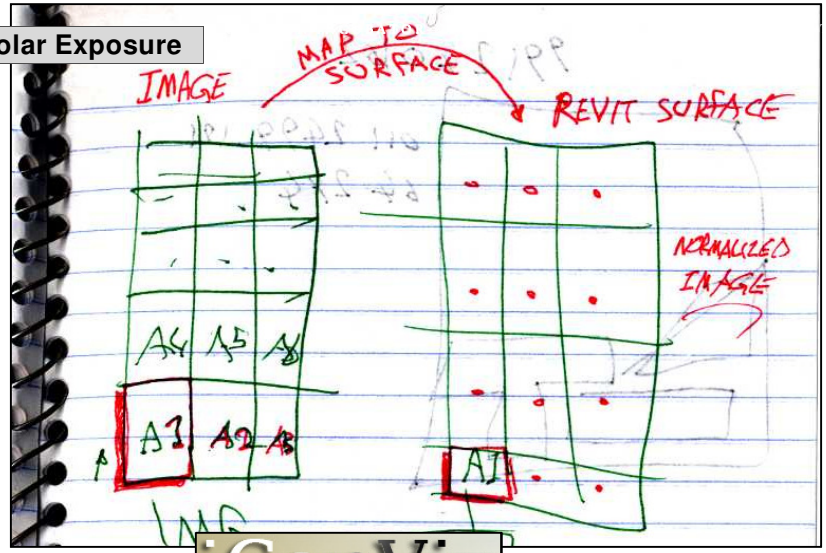
2 Floor Plan Layout



3 View Priority To Outside



4 Solar Exposure



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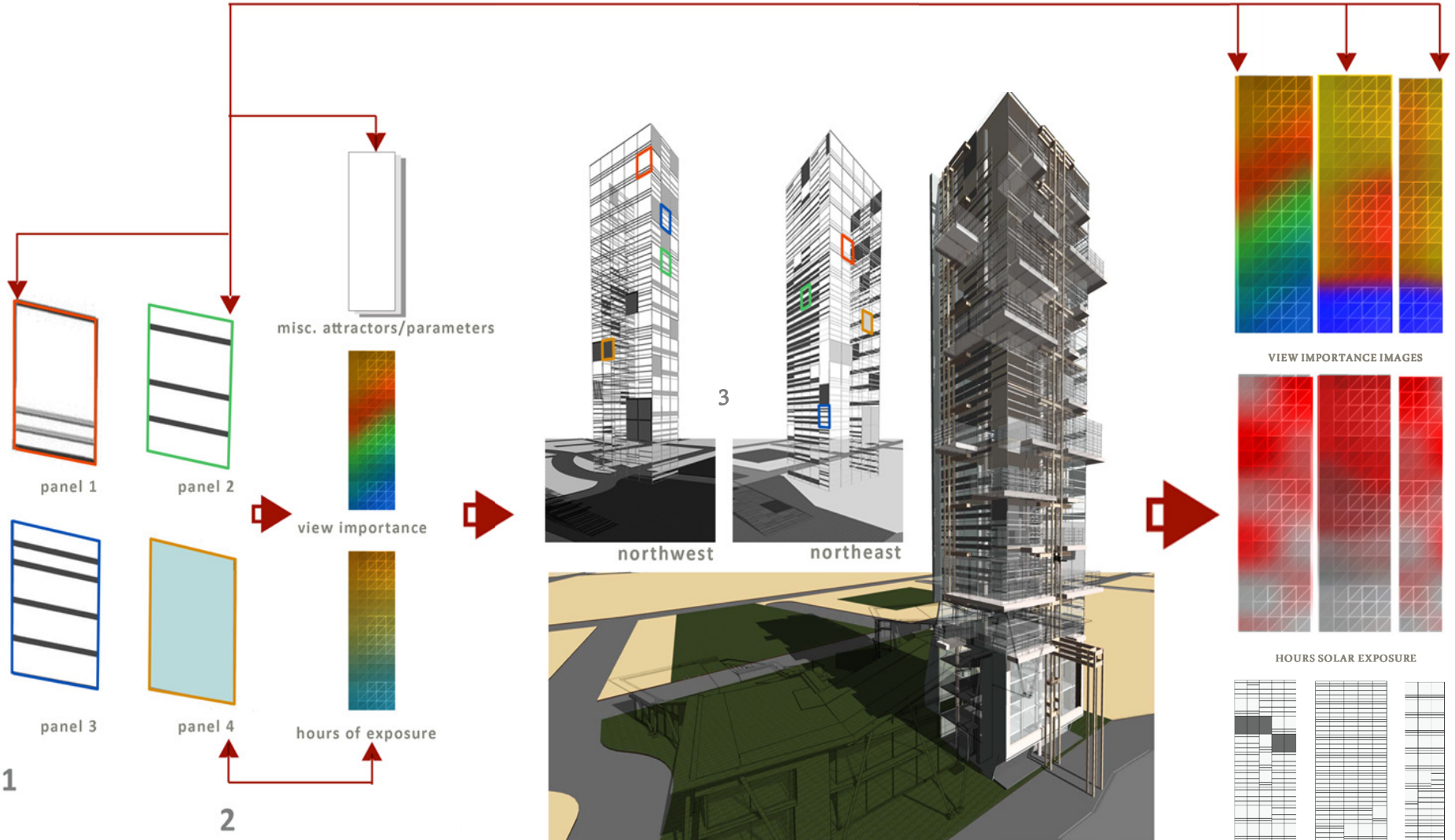
THE DESIGN COMPUTATION ANALYSIS WORKFLOW

CURTAIN WALL PANEL OPTIMIZATION



CUSTOMIZED REVIT PANEL FAMILY SET UP

WORK CREDITS:
MIKE HODGE AND ZAKI MALLASI

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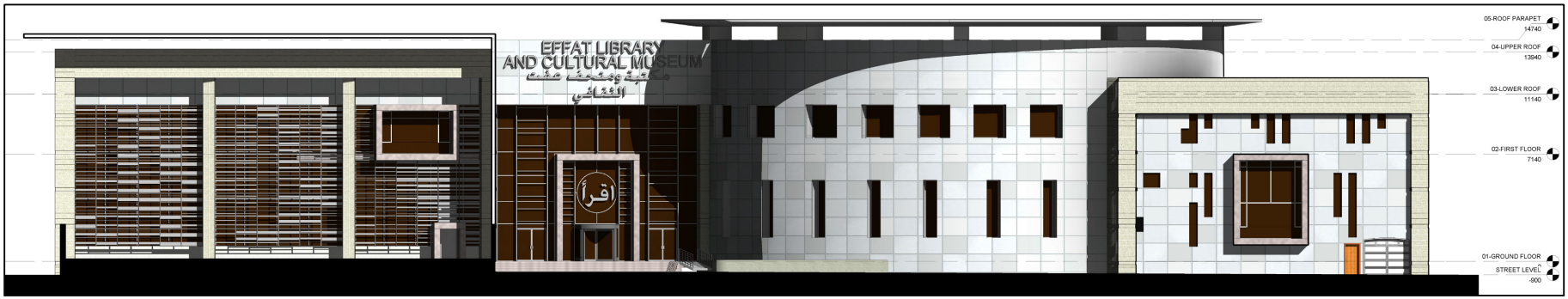
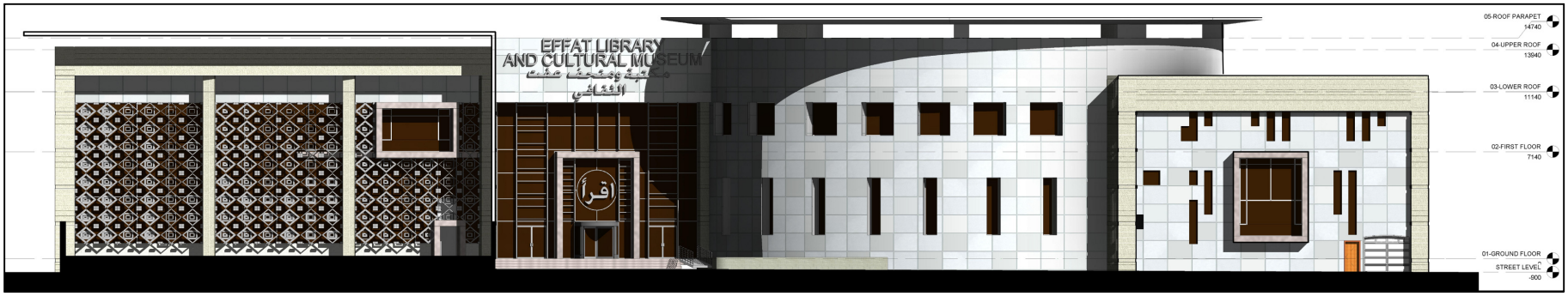
Project 2 – Effat University New Library, Jeddah, Saudi Arabia

North Elevation – Skin Option A



North Elevation – Skin Option B



North Elevation – Skin Option C

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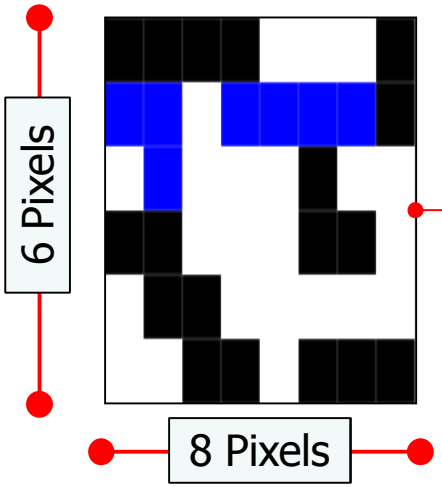
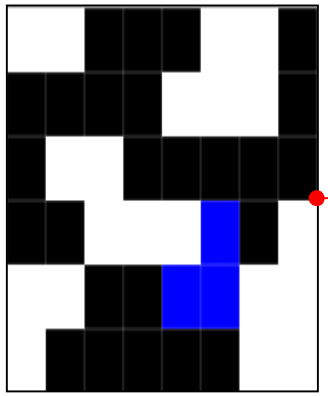
Project 2 – Effat University New Library, Jeddah, Saudi Arabia

North Elevation – Left



North Elevation – Middle



North Elevation – Right

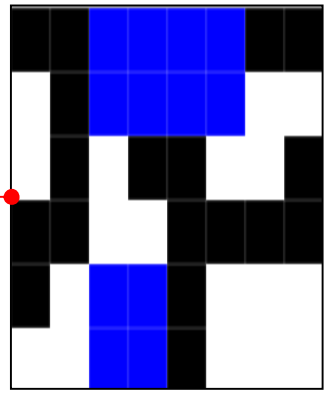


Image Data used for:

1) Screens panel type selection.

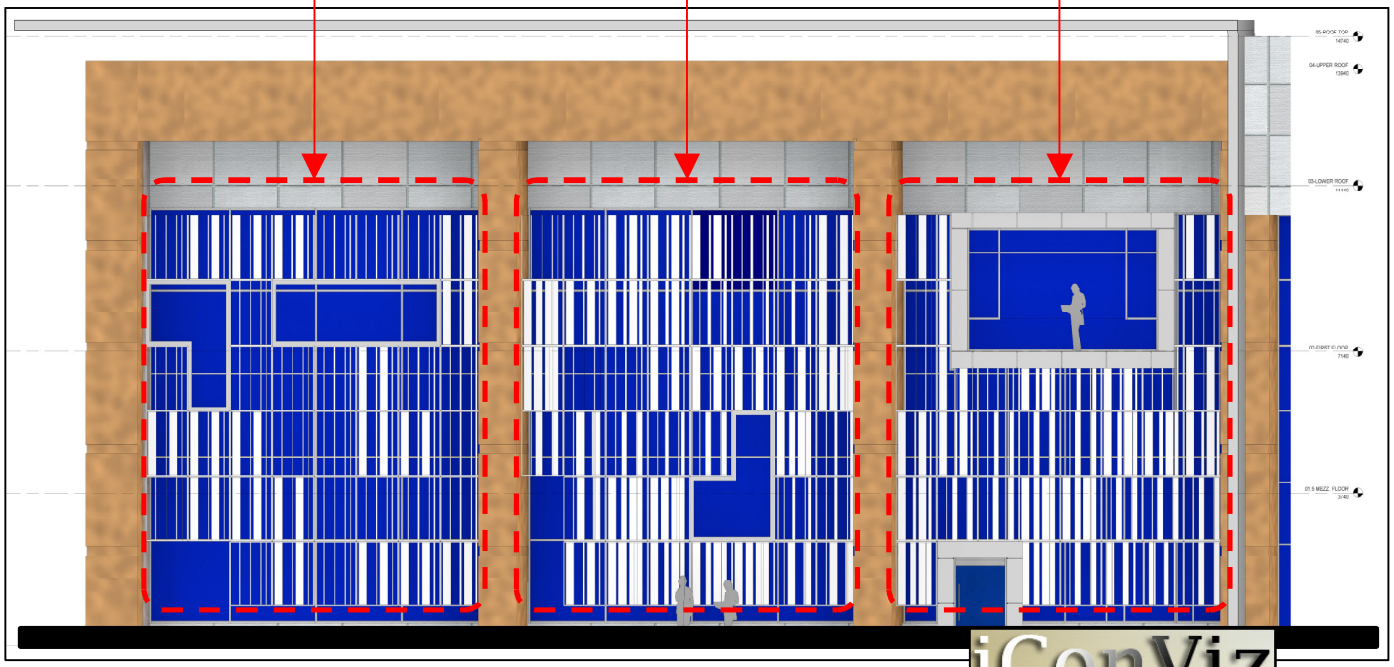
2) Privacy view control.

3) Façade Layout.

Panel Type A

Panel Type B

No Panel



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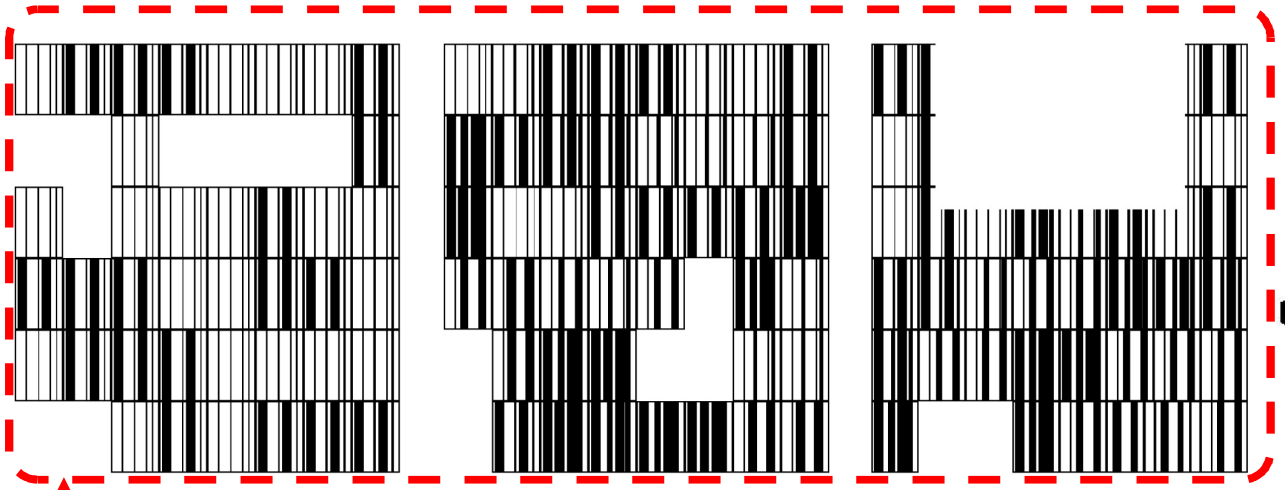
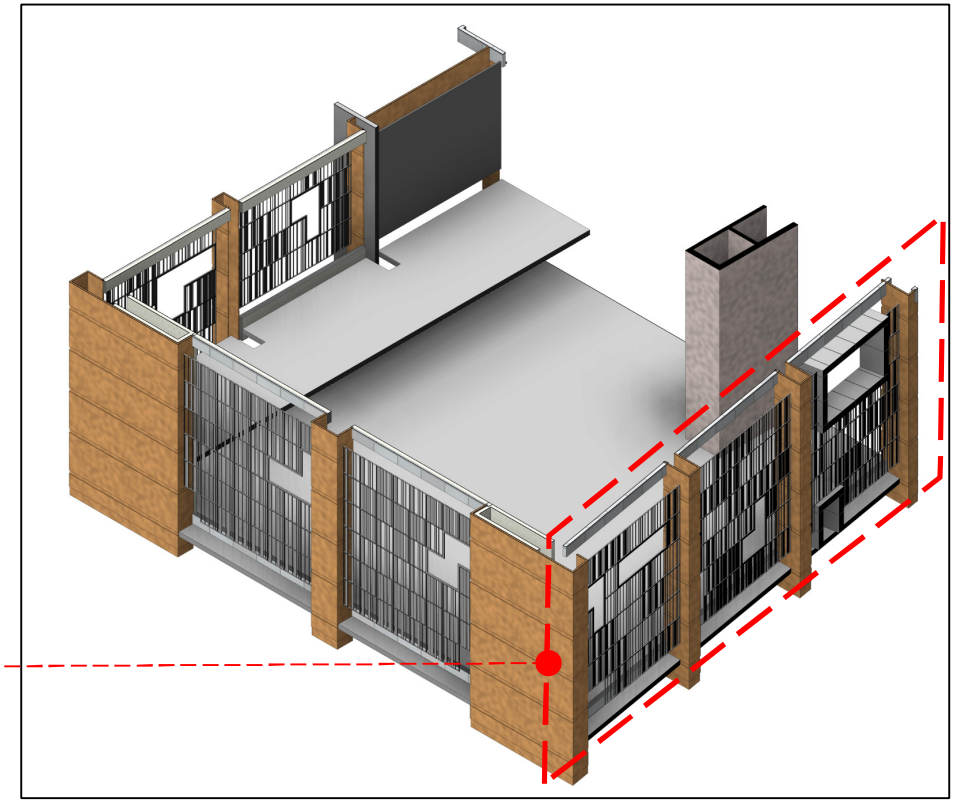
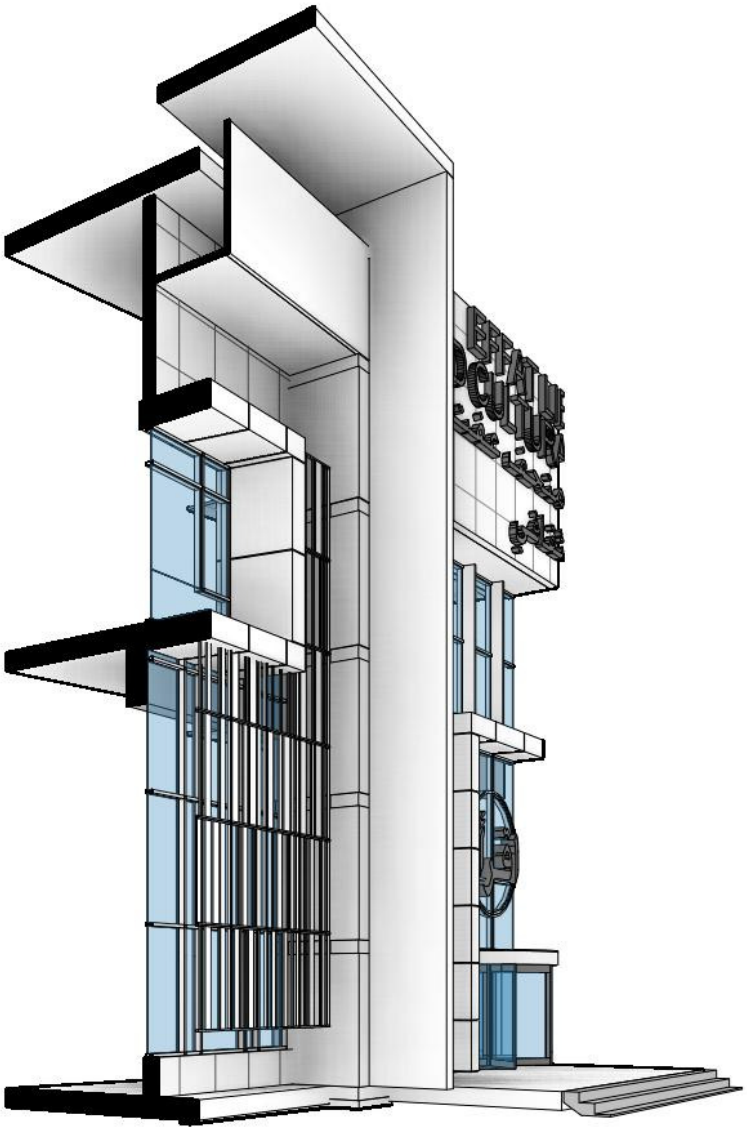




North Elevation Panels



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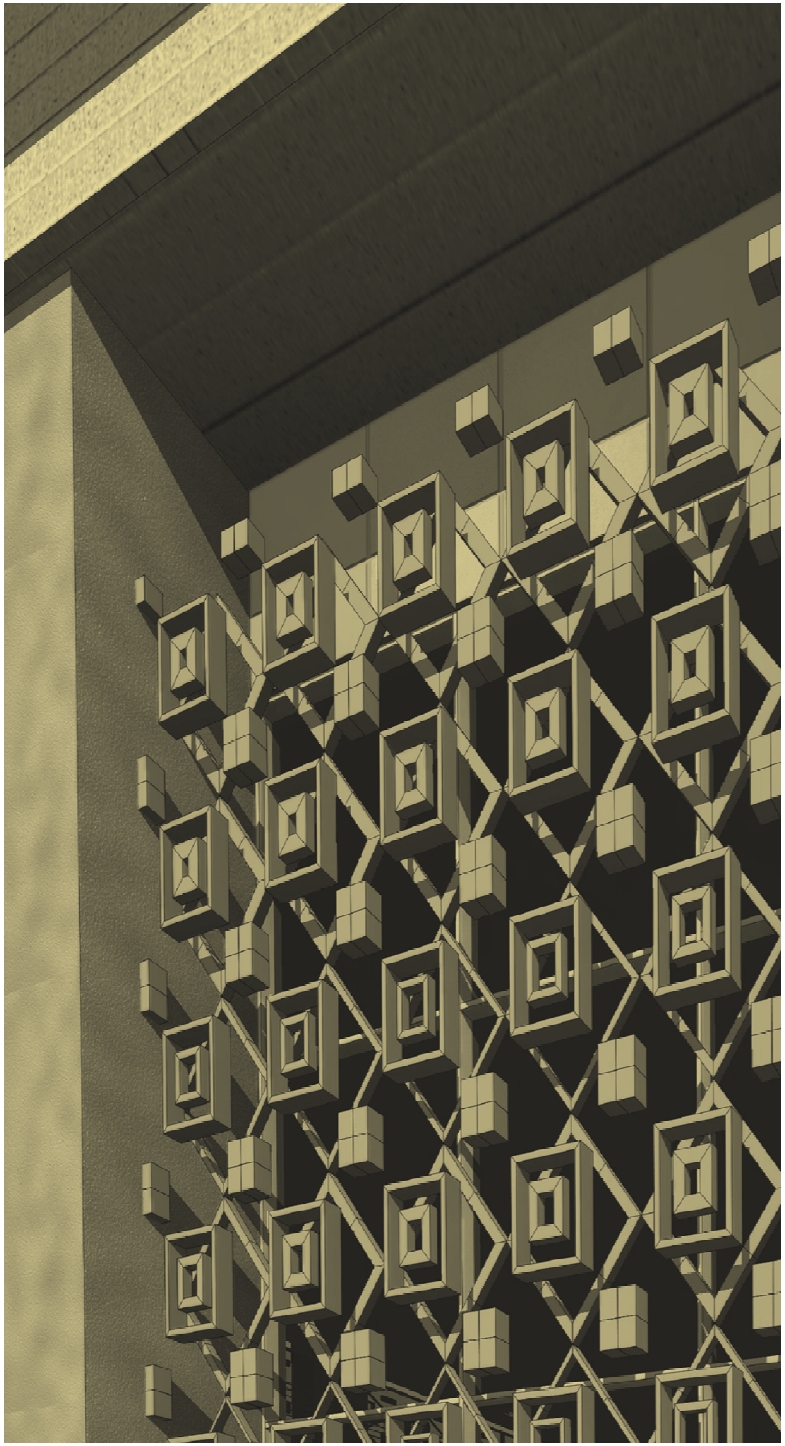
North East Corner View of Final Design Option

PARAMETRICS PERFORMATIVE DESIGN AUTOMATION ANALYSIS **FACADE/ENVELOPE** PROCESS METHODOLOGY TECHNIQUE SHADING SIMULATION PANEL SELECTION **OPTIMIZATION** ENERGY PERFORMANCE HEAT GAIN ORIENTATION VIEWS ORIENTATION **PROCESS** EFFICENT AUTOMATED SYSTEM FOR DESIGNING MEASURABLE EARLY STAGE ASSISTANCE/INFORMING STRATEGIES **RESULTS** SCORECARD RECORDS PROGRESS VALIDATES DESIGN SOLUTIONS/DECISIONS **BENEFITS** EFFICIENCY CORRELATION BETWEEN DATA ANALYSIS AND DESIGN ITERATION AND EXPLORATION

CONTENTS



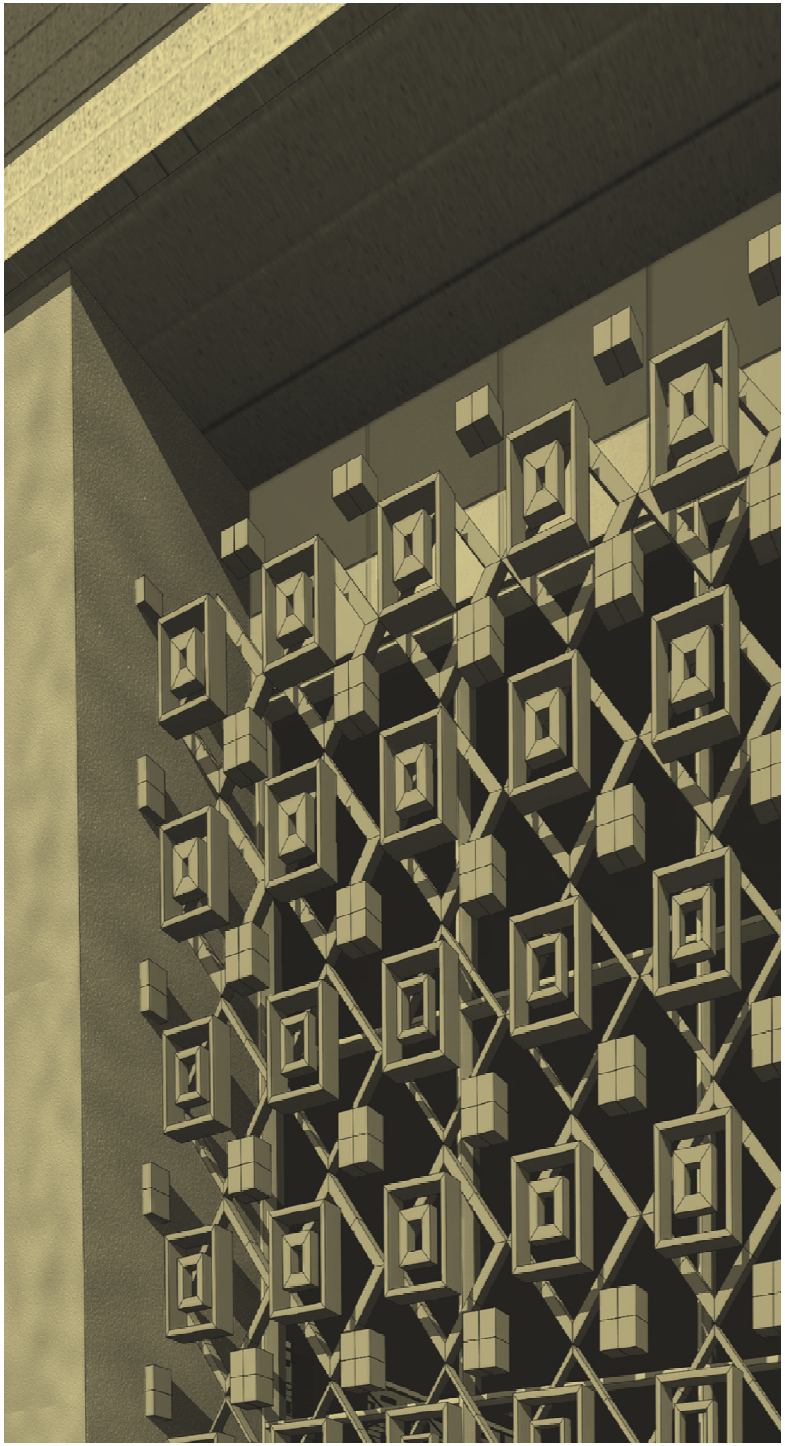
CONCLUSION

- ❑ Develop methodology from here and direction for additional exploration in design studio curriculum.

- ❑ Further research and development of more generic parametric design tools for: design analysis, process automation solutions, and higher level parametric functionality/utility.

- ❑ Different advantages can be observed from applying performance-based façade design.

- ❑ Consider the 'global view' benefits of BIM models to efficiently update and speed design changes documentations.



CONCLUSION

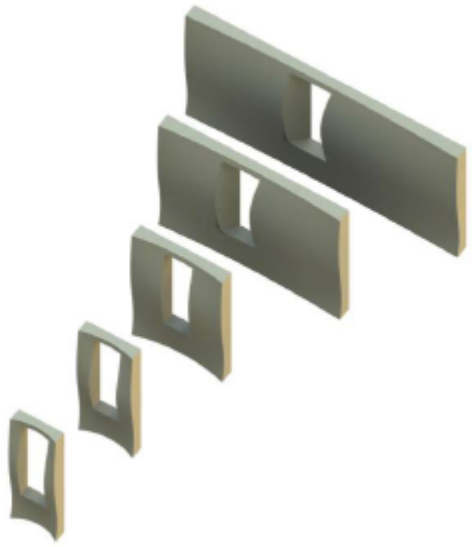
- ❑ Computational Design mechanism offers an interesting path towards forming concepts into contemporary architectural discourse.

- ❑ Parametric design offers some advantages over traditional modeling methods, since it allows adaptation of an object through the use of rules and object's properties.

*If we can **support our design thinking process** with analytical data, some design ideas would evolve and will more likely produce **designs we've never though about**.*

CONCLUSION

Family	Types	Count	Opening Angle	Opening Height	Height	Width	Area	Unit Cost	Total Cost
Panel5	A	120	-90.00°	8' - 0"	10' - 0"	5' - 0"	50 SF	2000	240000
Panel5	B	20	-70.00°	8' - 0"	10' - 0"	6' - 0"	60 SF	3000	60000
Panel5	C	17	-70.00°	8' - 0"	10' - 0"	7' - 0 23/32"	71 SF	3000	51000
Panel5	D	15	-70.00°	8' - 0"	10' - 0"	8' - 0"	80 SF	3000	45000
Panel5	E	13	-70.00°	8' - 0"	10' - 0"	9' - 2 25/32"	92 SF	3000	39000
Panel5	F	12	-70.00°	8' - 0"	10' - 0"	10' - 0"	100 SF	3000	36000
Panel5	G	11	-70.00°	8' - 0"	10' - 0"	10' - 10 29/32"	109 SF	3000	33000
Panel5	H	10	-70.00°	8' - 0"	10' - 0"	12' - 0"	120 SF	3000	30000
Panel5	I	18	-70.00°	8' - 0"	10' - 0"	13' - 4"	133 SF	3000	54000
Panel5	J	8	-70.00°	8' - 0"	10' - 0"	15' - 0"	150 SF	3000	24000
Panel5	K	8	-50.00°	8' - 0"	10' - 0"	15' - 0"	150 SF	6000	48000
Panel5	L	14	-50.00°	8' - 0"	10' - 0"	17' - 1 23/32"	171 SF	6000	84000
Panel5	M	18	-50.00°	8' - 0"	10' - 0"	20' - 0"	200 SF	6000	108000
Panel5	N	25	-50.00°	8' - 0"	10' - 0"	24' - 0"	240 SF	6000	150000
Panel5	O	8	-50.00°	8' - 0"	10' - 0"	30' - 0"	300 SF	6000	48000
Panel5	P	4	-45.00°	8' - 0"	10' - 0"	30' - 0"	300 SF	7000	28000
Grand total: 321									1078000



Work Credits: Vincent Poon

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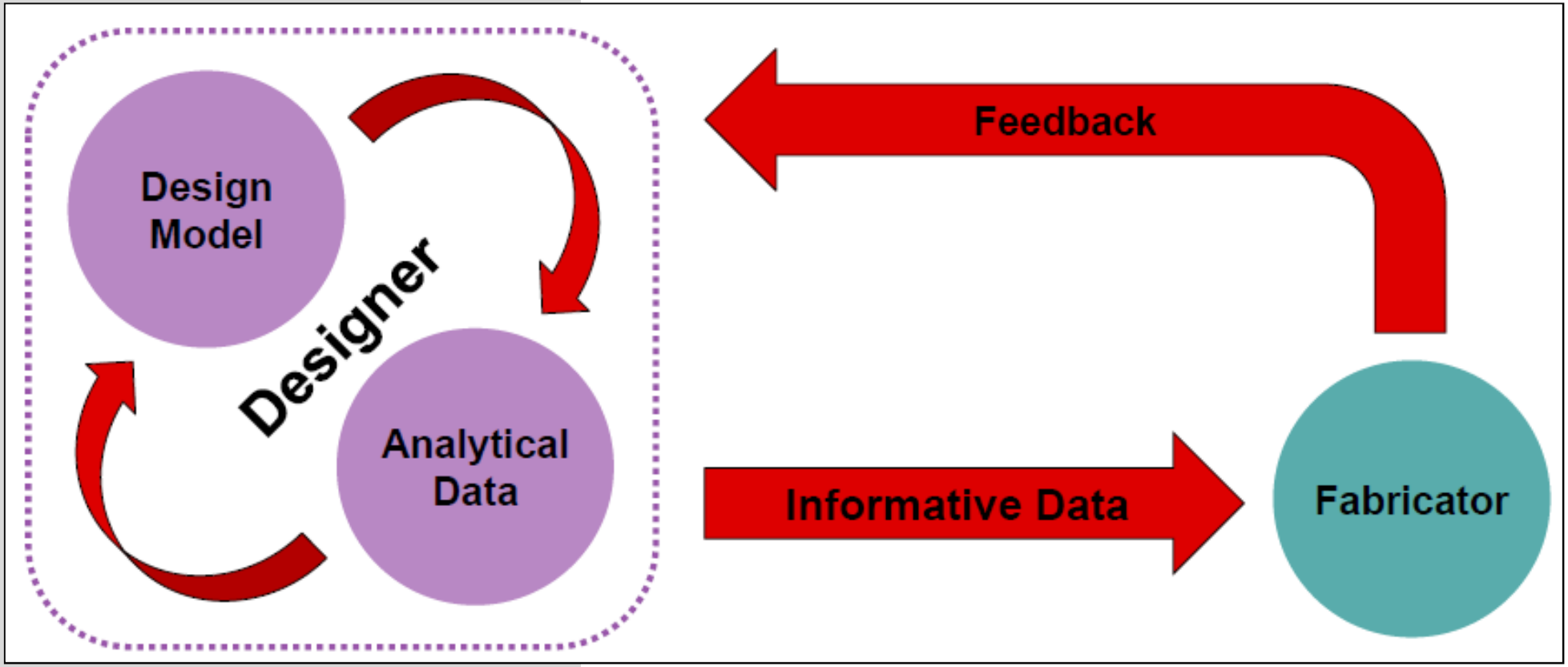
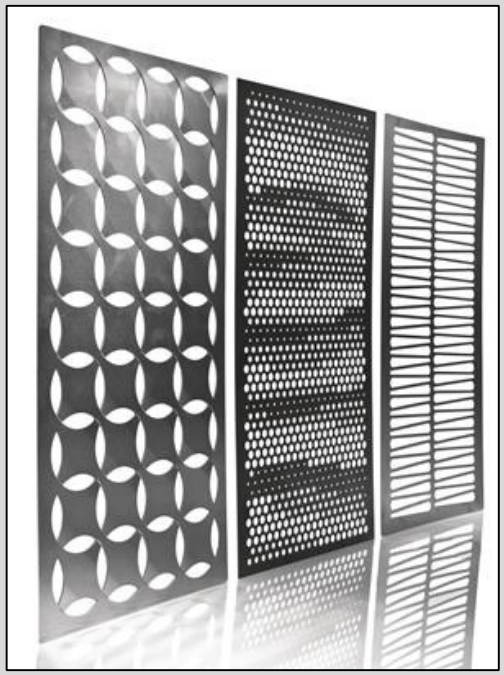
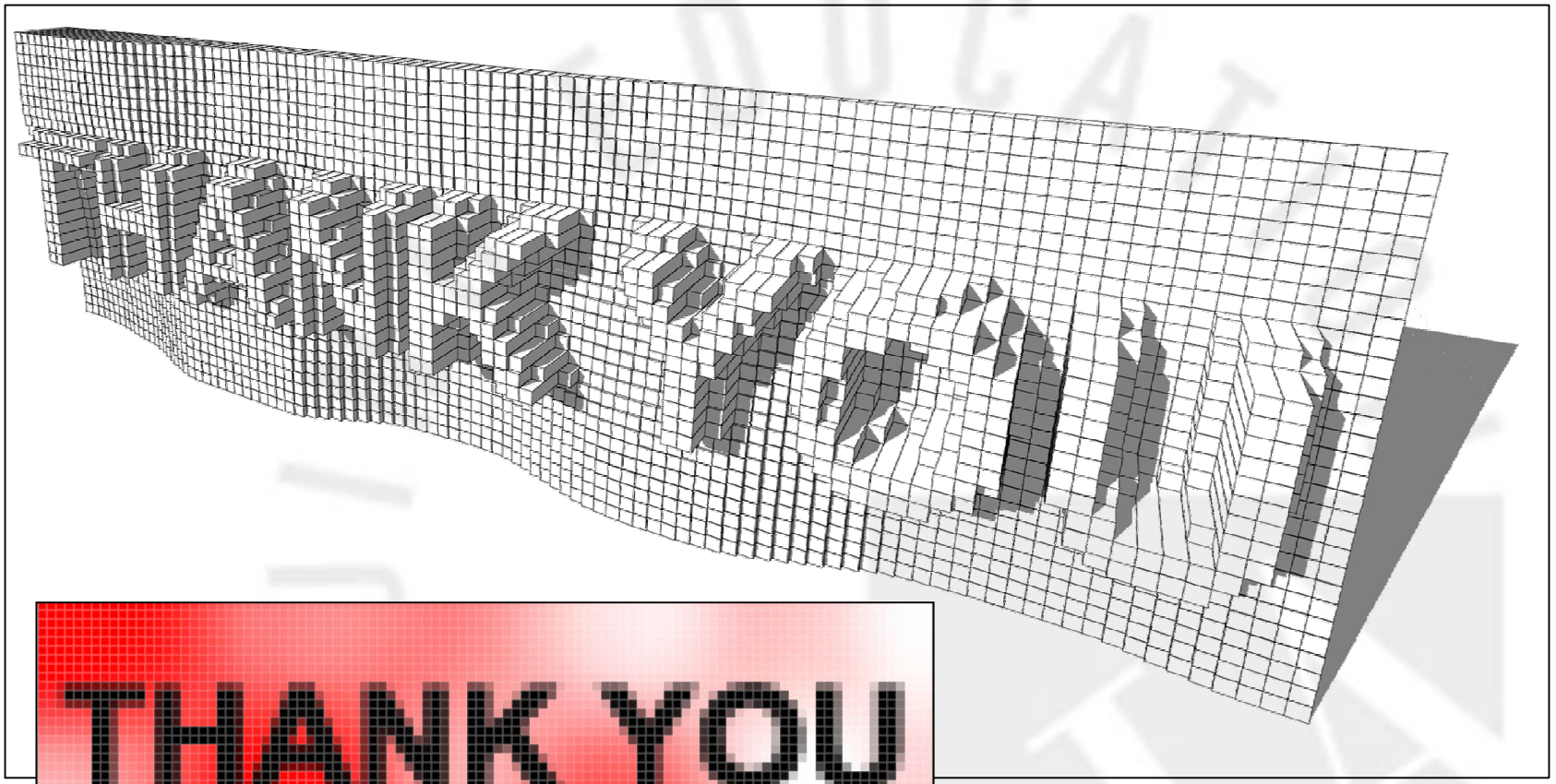
CONCLUSION



Work Credits: Vincent Poon



Work Credits: LMN Tech Studio (http://lmnts.lmnarchitects.com)



THANK YOU

جامعة عفت
EFFAT UNIVERSITY

This concludes The American Institute of Architects Continuing Education Systems Course

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