Custom Design Tools for Façade Performance Optimization

Façade Tectonics

May 6, 2021

Elliot Glassman, AIA, NCARB, LEED AP BD+C, CPHC

Elliot Glassman

AIA NCARB LEED BD+C CPHD

Senior Associate + Senior Technical Principal

WSP Built Ecology

National Leader of Computational Design for Building Systems

Bachelors of Architecture

New Jersey Institute of Technology

Masters of Design Studies in Sustainable Design

Harvard Graduate School of Design

2020 NYC Energy Code

Key Updates

Overall Efficiency Increase

- *Commercial: 5% more than the state code (approximately 13% more than ASHRAE 90.1-2013)*
- *Residential: Increases by about 19% more than the 2016 NYCECC*

Envelope

- *Hotel/motel/dorm/multifamily – no more than 15% worse than prescriptive;*
- *All other – no more than 7% worse*

"When should you use an off-the-shelf tool and when should you create your own?"

Interoperability

Validated
Simulation Engine

Integration

Customizability

Software
Capability

Application Flexibility

Cost

Workflow Flexibility

Applicability

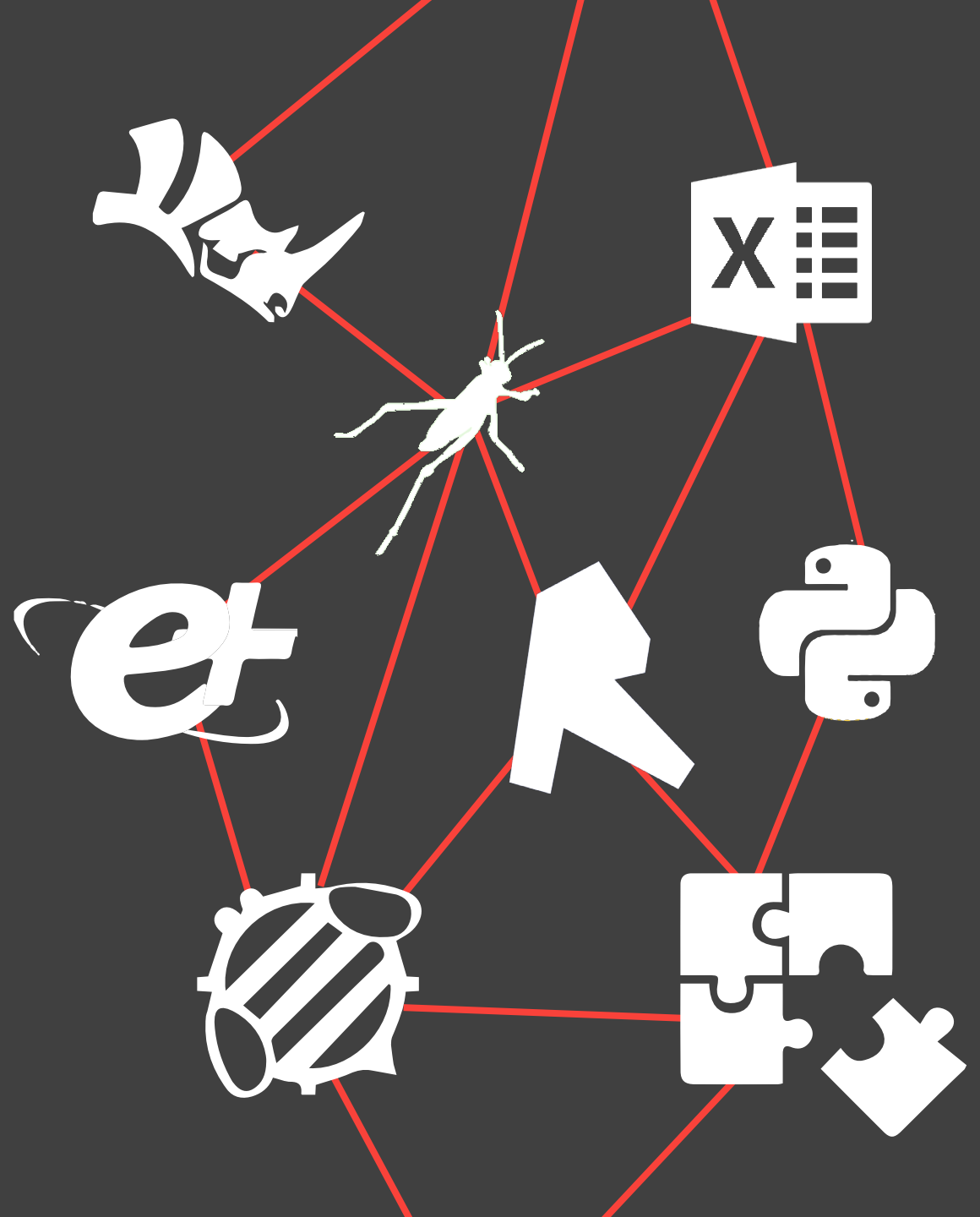
Development Effort

Risk

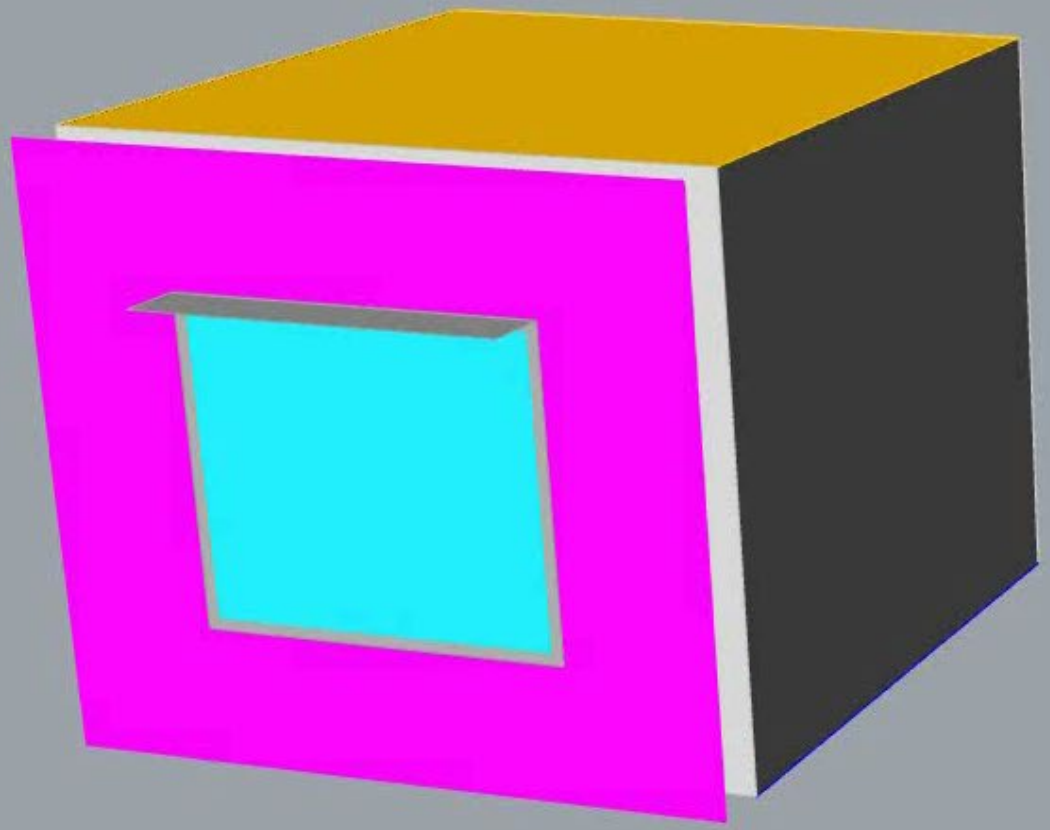
Standalone

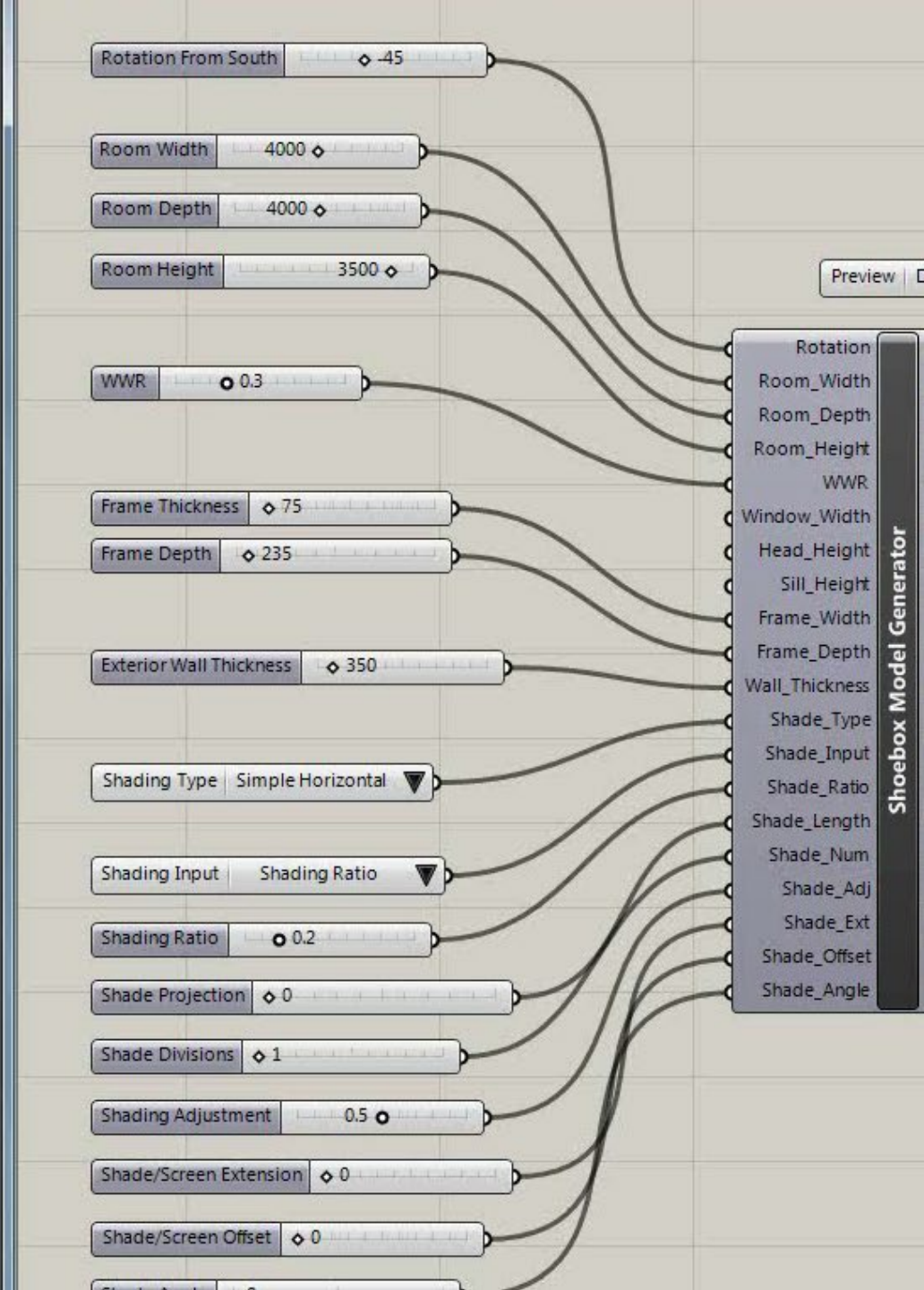
tool

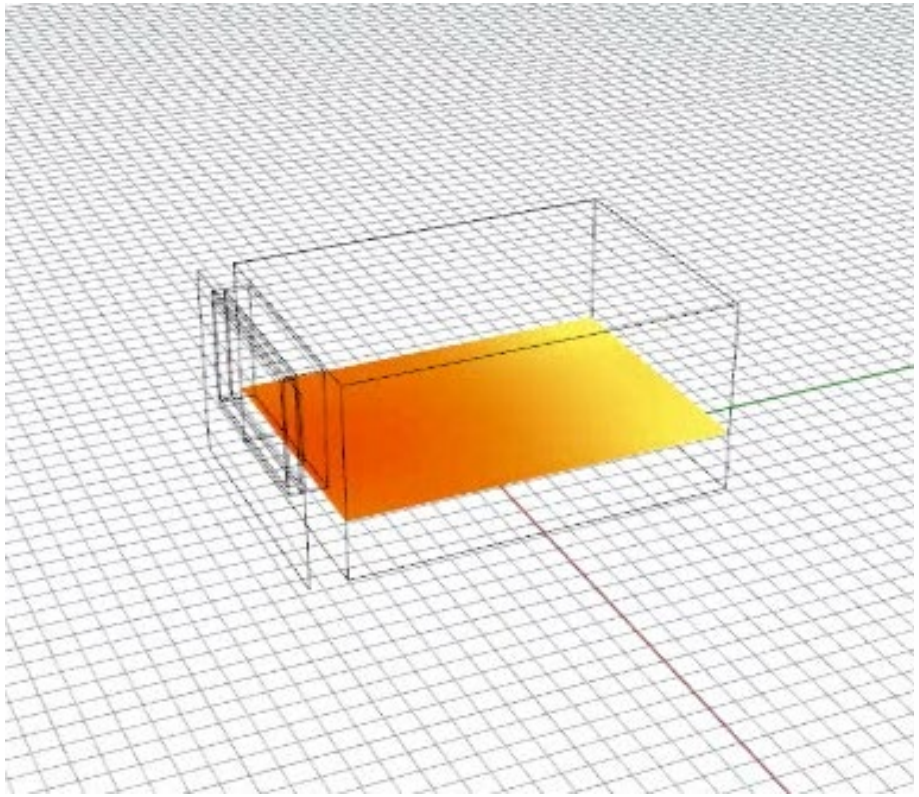
vs



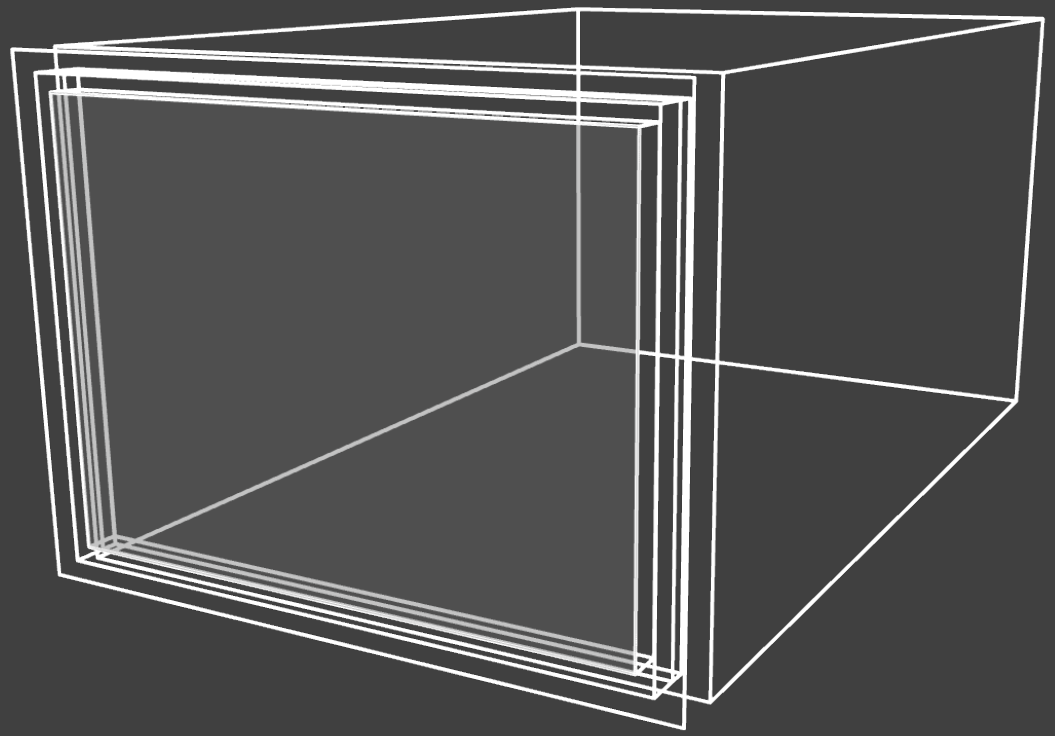
Parametric
Modeling



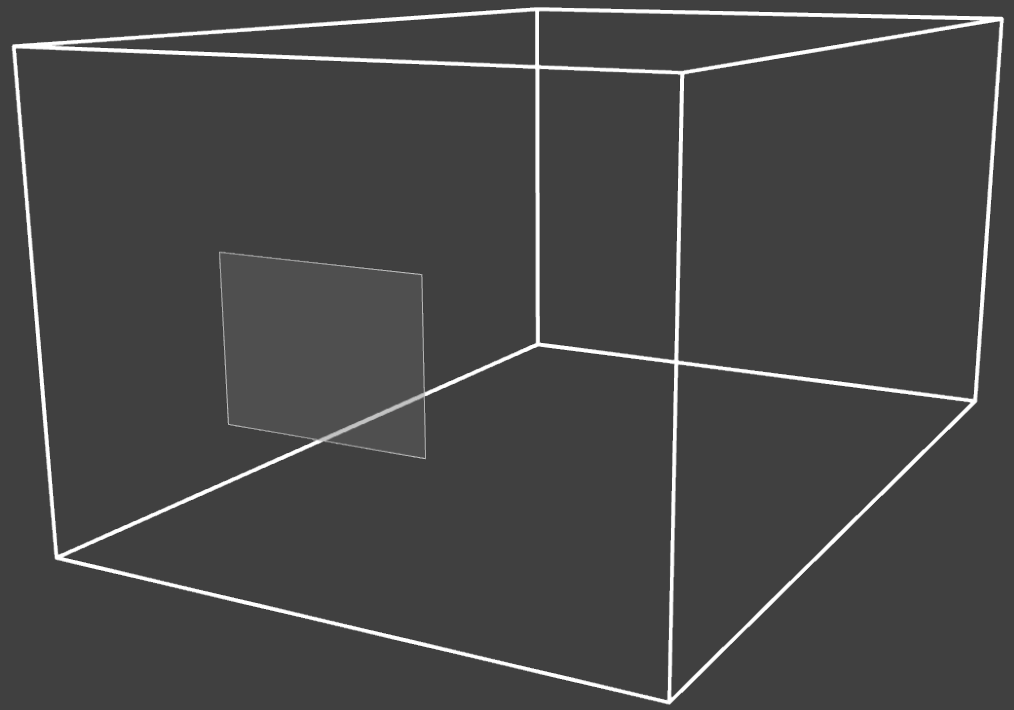




Inputs					Results		
Room	Room Depth (ft)	Orientation	Window Width (ft)	VLT	WWR (%)	sDA (%)	ASE (%)
Living Room	24	Northeast	9.8	0.7	70	100	100
		North				90	90
					60	80	80
				0.6		70	70
			8		50	60	60
						50	50
			7.5		40	40	40
				0.5		30	30
		Southwest			30	20	20
						10	10
Bedroom	16	South	6	0.4	20	0	0



Optimized Daylight Shoebox Model



Optimized Energy Shoebox Model

Central Parametrically Defined Physical Design Parameters

- Floor Plates,
- Floor to Floor Height
- Glazing Size and Locations
- Shading Size and Locations

Daylight Model Interpretive Rules

- Walls with Thickness
- Flat Window Surfaces Inside Wall Openings
- Mullions
- Distinct Architectural Elements by Surface Reflectance or Transparency

Daylight Model

Energy Model Interpretive Rules

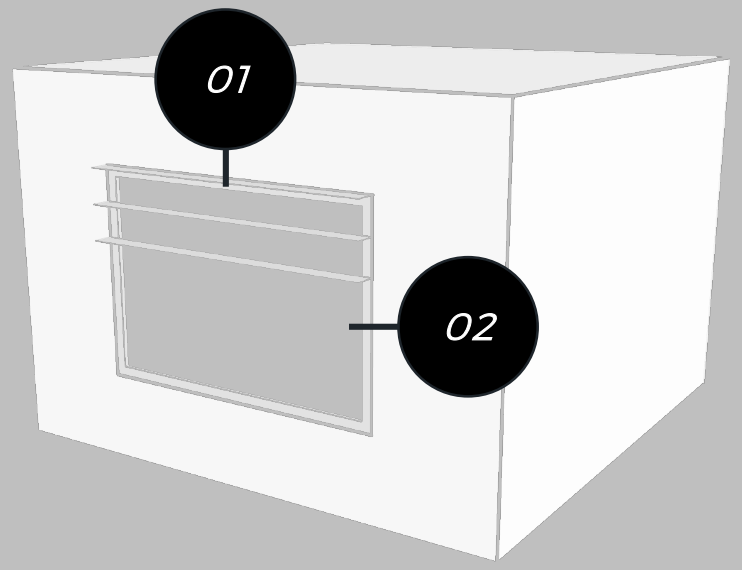
- Enclosed Zones
- Infinitely Thin Surfaces
- Window Surfaces Overlapping with Exterior Walls but Not Touching Edge

Energy Model

CFD Model Interpretive Rules

- Air Inlet and Outlet Elements
- Sufficient Element Thickness for Good Meshing

CFD Model



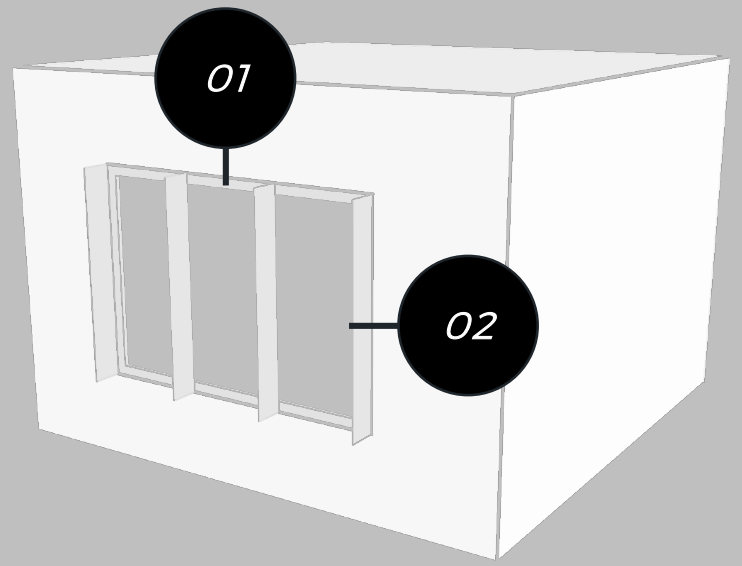
01 Window to Wall Ratio
02 Shading Ratio

Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	11.43 W/ft²	11.75 W/ft²	12.07 W/ft²	12.38 W/ft²	12.69 W/ft²	13 W/ft²
0.9	11.57 W/ft²	11.93 W/ft²	12.29 W/ft²	12.64 W/ft²	13 W/ft²	13.35 W/ft²
0.8	11.71 W/ft²	12.12 W/ft²	12.54 W/ft²	12.95 W/ft²	13.33 W/ft²	13.73 W/ft²
0.7	11.86 W/ft²	12.33 W/ft²	12.78 W/ft²	13.24 W/ft²	13.7 W/ft²	14.14 W/ft²
0.6	12.02 W/ft²	12.54 W/ft²	13.05 W/ft²	13.55 W/ft²	14.06 W/ft²	14.56 W/ft²
0.5	12.19 W/ft²	12.75 W/ft²	13.32 W/ft²	13.89 W/ft²	14.44 W/ft²	14.99 W/ft²
0.4	12.35 W/ft²	12.98 W/ft²	13.6 W/ft²	14.22 W/ft²	14.83 W/ft²	15.43 W/ft²
0.3	12.52 W/ft²	13.2 W/ft²	13.88 W/ft²	14.55 W/ft²	15.22 W/ft²	15.88 W/ft²
0.2	12.69 W/ft²	13.44 W/ft²	14.17 W/ft²	14.9 W/ft²	15.62 W/ft²	16.33 W/ft²
0.1	12.87 W/ft²	13.67 W/ft²	14.46 W/ft²	15.24 W/ft²	16.02 W/ft²	16.79 W/ft²

WWR

Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	51.9% sDA 20.8% ASE	70.2% sDA 29.1% ASE	96.5% sDA 37% ASE	100% sDA 39.8% ASE	100% sDA 43.6% ASE	100% sDA 46.4% ASE
0.9	51.6% sDA 20.1% ASE	69.9% sDA 30.4% ASE	95.8% sDA 36.7% ASE	100% sDA 40.8% ASE	100% sDA 45.7% ASE	100% sDA 49.1% ASE
0.8	48.8% sDA 22.5% ASE	67.5% sDA 28.4% ASE	95.2% sDA 34.3% ASE	100% sDA 41.9% ASE	100% sDA 39.8% ASE	100% sDA 48.8% ASE
0.7	49.8% sDA 22.8% ASE	68.2% sDA 31.1% ASE	91.7% sDA 32.5% ASE	100% sDA 39.1% ASE	100% sDA 49.1% ASE	100% sDA 45% ASE
0.6	47.4% sDA 23.2% ASE	66.8% sDA 31.5% ASE	93.8% sDA 32.9% ASE	100% sDA 39.1% ASE	100% sDA 48.8% ASE	100% sDA 50.9% ASE
0.5	50.5% sDA 26% ASE	65.4% sDA 32.9% ASE	93.4% sDA 36.3% ASE	100% sDA 41.5% ASE	100% sDA 48.4% ASE	100% sDA 53.3% ASE
0.4	50.9% sDA 26.6% ASE	68.5% sDA 33.2% ASE	93.4% sDA 39.1% ASE	100% sDA 45.7% ASE	100% sDA 50.2% ASE	100% sDA 51.9% ASE
0.3	51.2% sDA 29.4% ASE	67.5% sDA 36% ASE	93.4% sDA 41.2% ASE	100% sDA 47.8% ASE	100% sDA 55.4% ASE	100% sDA 59.9% ASE
0.2	51.9% sDA 28.7% ASE	68.9% sDA 36.7% ASE	95.5% sDA 44.6% ASE	100% sDA 49.1% ASE	100% sDA 54% ASE	100% sDA 63.7% ASE
0.1	53.3% sDA 33.2% ASE	70.2% sDA 39.8% ASE	96.9% sDA 45.7% ASE	100% sDA 52.6% ASE	100% sDA 56.7% ASE	100% sDA 60.9% ASE

WWR

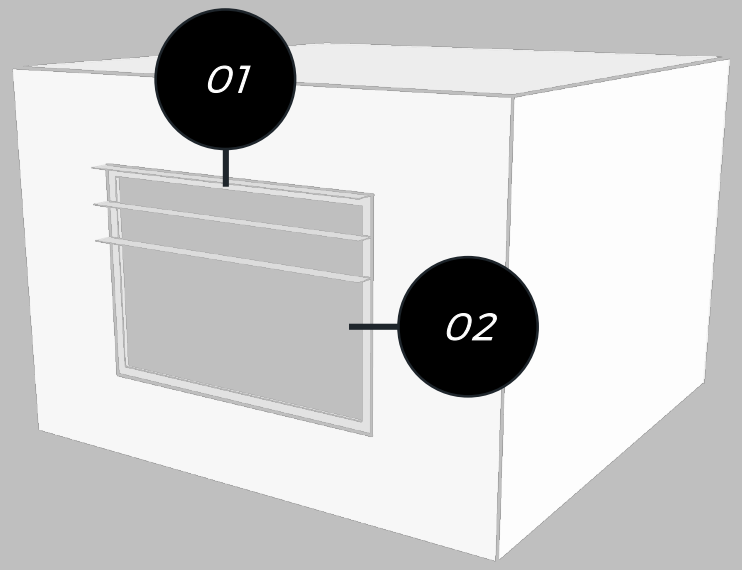


Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	12.79 W/ft²	13.56 W/ft²	14.31 W/ft²	15.07 W/ft²	15.81 W/ft²	16.59 W/ft²
0.9	12.79 W/ft²	13.56 W/ft²	14.33 W/ft²	15.09 W/ft²	15.85 W/ft²	16.6 W/ft²
0.8	12.8 W/ft²	13.57 W/ft²	14.34 W/ft²	15.1 W/ft²	15.86 W/ft²	16.62 W/ft²
0.7	12.8 W/ft²	13.58 W/ft²	14.35 W/ft²	15.11 W/ft²	15.87 W/ft²	16.63 W/ft²
0.6	12.81 W/ft²	13.59 W/ft²	14.36 W/ft²	15.13 W/ft²	15.9 W/ft²	16.66 W/ft²
0.5	12.83 W/ft²	13.6 W/ft²	14.37 W/ft²	15.15 W/ft²	15.91 W/ft²	16.68 W/ft²
0.4	12.84 W/ft²	13.62 W/ft²	14.4 W/ft²	15.18 W/ft²	15.95 W/ft²	16.71 W/ft²
0.3	12.87 W/ft²	13.67 W/ft²	14.46 W/ft²	15.25 W/ft²	16.03 W/ft²	16.8 W/ft²
0.2	12.92 W/ft²	13.74 W/ft²	14.54 W/ft²	15.35 W/ft²	16.14 W/ft²	16.93 W/ft²
0.1	12.98 W/ft²	13.81 W/ft²	14.64 W/ft²	15.46 W/ft²	16.27 W/ft²	17.08 W/ft²

WWR

Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	55.7% sDA 29.4% ASE	71.3% sDA 36.3% ASE	96.5% sDA 44.3% ASE	100% sDA 49.5% ASE	100% sDA 57.8% ASE	100% sDA 58.5% ASE
0.9	55.7% sDA 29.8% ASE	71.3% sDA 36.7% ASE	96.9% sDA 44.6% ASE	100% sDA 49.8% ASE	100% sDA 57.8% ASE	100% sDA 59.5% ASE
0.8	55.7% sDA 29.8% ASE	71.3% sDA 37% ASE	96.2% sDA 44.6% ASE	100% sDA 50.2% ASE	100% sDA 58.5% ASE	100% sDA 60.6% ASE
0.7	56.7% sDA 29.8% ASE	72% sDA 38.1% ASE	97.6% sDA 45% ASE	100% sDA 50.9% ASE	100% sDA 58.8% ASE	100% sDA 60.9% ASE
0.6	57.1% sDA 30.1% ASE	72% sDA 38.8% ASE	97.9% sDA 46.4% ASE	100% sDA 51.6% ASE	100% sDA 58.8% ASE	100% sDA 61.9% ASE
0.5	57.1% sDA 30.4% ASE	72% sDA 39.4% ASE	98.3% sDA 46.4% ASE	100% sDA 51.9% ASE	100% sDA 60.2% ASE	100% sDA 62.6% ASE
0.4	57.1% sDA 31.5% ASE	72% sDA 40.5% ASE	97.9% sDA 46.7% ASE	100% sDA 52.2% ASE	100% sDA 60.2% ASE	100% sDA 62.6% ASE
0.3	56.7% sDA 33.2% ASE	74% sDA 41.2% ASE	98.3% sDA 48.8% ASE	100% sDA 52.6% ASE	100% sDA 60.2% ASE	100% sDA 63.7% ASE
0.2	57.8% sDA 33.6% ASE	74.7% sDA 41.9% ASE	98.6% sDA 49.5% ASE	100% sDA 53.3% ASE	100% sDA 62.3% ASE	100% sDA 65.1% ASE
0.1	57.8% sDA 34.9% ASE	75.4% sDA 42.9% ASE	98.6% sDA 50.2% ASE	100% sDA 54.7% ASE	100% sDA 62.3% ASE	100% sDA 65.4% ASE

WWR



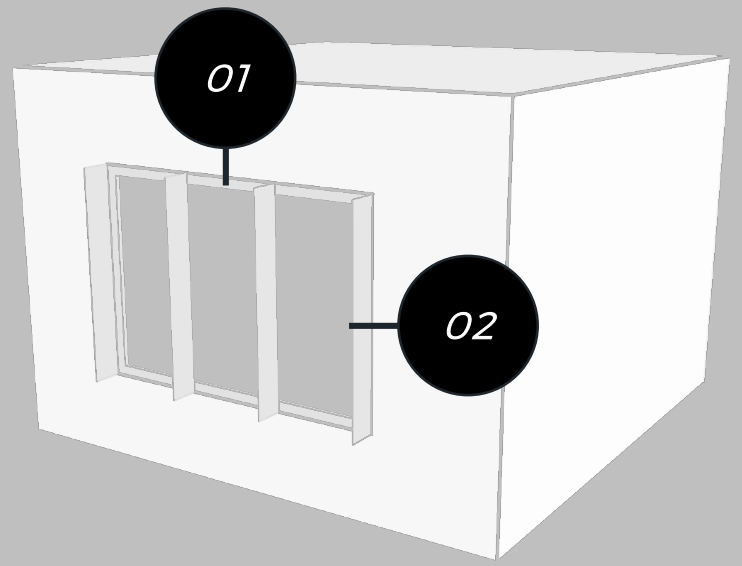
01 Window to Wall Ratio
02 Shading Ratio

Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	11.11 W/ft²	11.33 W/ft²	11.54 W/ft²	11.75 W/ft²	11.96 W/ft²	12.17 W/ft²
0.9	11.21 W/ft²	11.45 W/ft²	11.7 W/ft²	11.94 W/ft²	12.17 W/ft²	12.41 W/ft²
0.8	11.31 W/ft²	11.59 W/ft²	11.87 W/ft²	12.15 W/ft²	12.41 W/ft²	12.68 W/ft²
0.7	11.41 W/ft²	11.73 W/ft²	12.04 W/ft²	12.35 W/ft²	12.66 W/ft²	12.96 W/ft²
0.6	11.52 W/ft²	11.88 W/ft²	12.23 W/ft²	12.57 W/ft²	12.91 W/ft²	13.26 W/ft²
0.5	11.64 W/ft²	12.03 W/ft²	12.42 W/ft²	12.8 W/ft²	13.18 W/ft²	13.56 W/ft²
0.4	11.76 W/ft²	12.18 W/ft²	12.61 W/ft²	13.03 W/ft²	13.45 W/ft²	13.87 W/ft²
0.3	11.88 W/ft²	12.34 W/ft²	12.81 W/ft²	13.27 W/ft²	13.73 W/ft²	14.18 W/ft²
0.2	12 W/ft²	12.5 W/ft²	13.01 W/ft²	13.51 W/ft²	14 W/ft²	14.5 W/ft²
0.1	12.12 W/ft²	12.66 W/ft²	13.21 W/ft²	13.75 W/ft²	14.28 W/ft²	14.82 W/ft²

WWR

Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	38.1% sDA 19% ASE	57.8% sDA 25.6% ASE	71.3% sDA 31.8% ASE	93.8% sDA 33.6% ASE	100% sDA 38.8% ASE	100% sDA 38.1% ASE
0.9	37% sDA 18.3% ASE	55.7% sDA 25.3% ASE	68.5% sDA 31.8% ASE	90.7% sDA 32.5% ASE	99.7% sDA 35.3% ASE	100% sDA 38.4% ASE
0.8	37.4% sDA 20.1% ASE	55% sDA 27% ASE	68.5% sDA 31.1% ASE	88.2% sDA 33.2% ASE	98.3% sDA 32.5% ASE	100% sDA 45.3% ASE
0.7	36.7% sDA 20.8% ASE	53.3% sDA 29.1% ASE	66.8% sDA 29.4% ASE	85.8% sDA 35.3% ASE	98.6% sDA 44.3% ASE	100% sDA 41.5% ASE
0.6	37% sDA 22.8% ASE	55.7% sDA 29.8% ASE	65.7% sDA 30.1% ASE	87.2% sDA 36.3% ASE	99.3% sDA 44.6% ASE	100% sDA 45.3% ASE
0.5	42.2% sDA 26.6% ASE	53.6% sDA 30.4% ASE	66.8% sDA 33.9% ASE	84.8% sDA 38.1% ASE	99.3% sDA 40.5% ASE	100% sDA 48.8% ASE
0.4	39.8% sDA 23.2% ASE	55.4% sDA 32.9% ASE	67.1% sDA 35.6% ASE	86.5% sDA 40.5% ASE	99% sDA 43.9% ASE	100% sDA 45.7% ASE
0.3	40.8% sDA 27.3% ASE	55.4% sDA 33.6% ASE	68.5% sDA 38.1% ASE	86.5% sDA 43.3% ASE	99.3% sDA 49.8% ASE	100% sDA 52.2% ASE
0.2	42.2% sDA 26.6% ASE	57.1% sDA 32.9% ASE	68.2% sDA 41.9% ASE	92% sDA 45% ASE	99% sDA 51.2% ASE	100% sDA 56.1% ASE
0.1	42.6% sDA 30.8% ASE	58.1% sDA 37% ASE	70.9% sDA 45% ASE	92.4% sDA 48.4% ASE	100% sDA 53.3% ASE	100% sDA 56.1% ASE

WWR



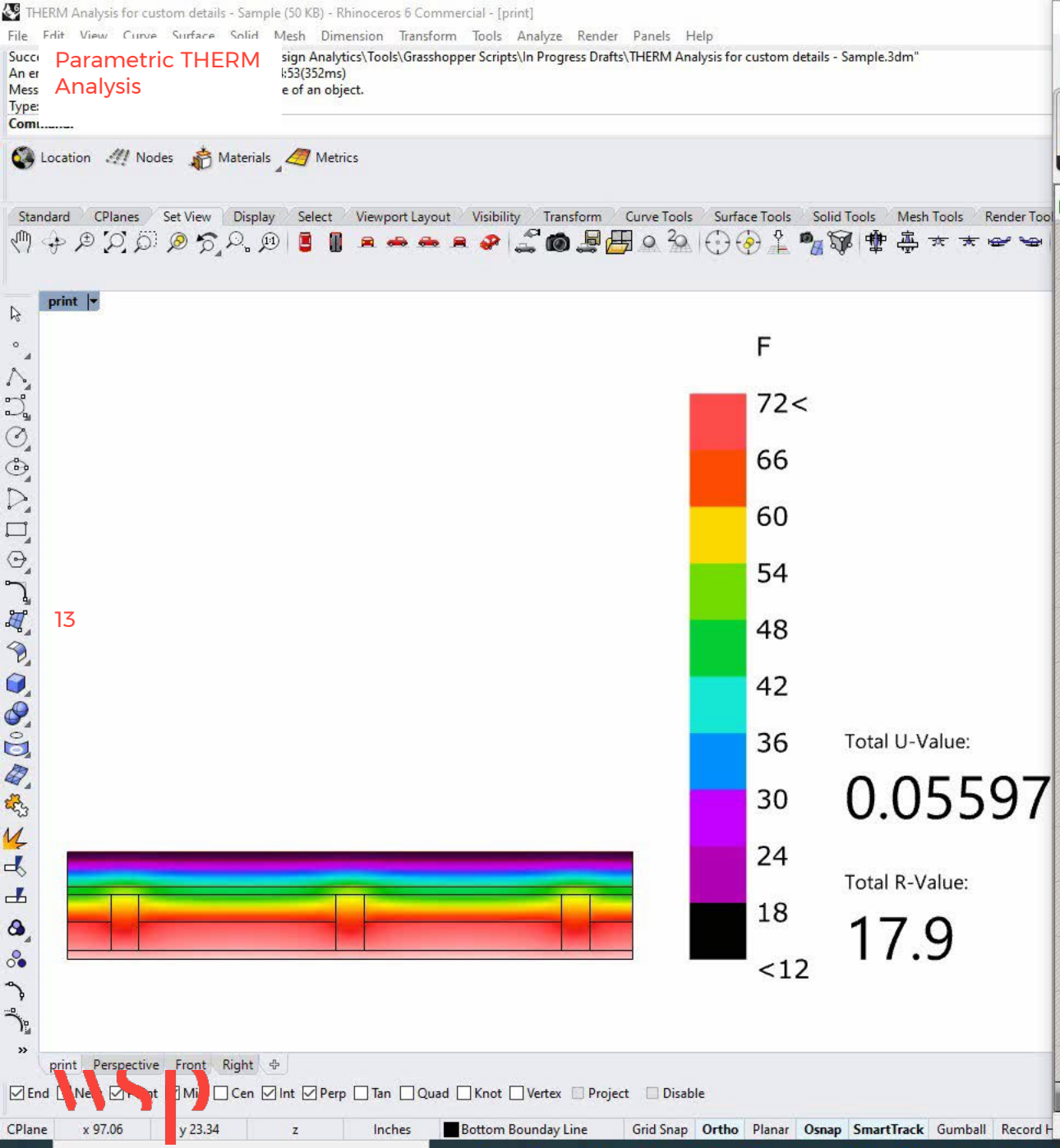
Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	12.07 W/ft²	12.6 W/ft²	13.12 W/ft²	13.63 W/ft²	14.14 W/ft²	14.68 W/ft²
0.9	12.07 W/ft²	12.6 W/ft²	13.12 W/ft²	13.65 W/ft²	14.17 W/ft²	14.68 W/ft²
0.8	12.08 W/ft²	12.61 W/ft²	13.13 W/ft²	13.66 W/ft²	14.18 W/ft²	14.7 W/ft²
0.7	12.08 W/ft²	12.61 W/ft²	13.14 W/ft²	13.66 W/ft²	14.19 W/ft²	14.71 W/ft²
0.6	12.09 W/ft²	12.62 W/ft²	13.15 W/ft²	13.68 W/ft²	14.2 W/ft²	14.73 W/ft²
0.5	12.1 W/ft²	12.63 W/ft²	13.16 W/ft²	13.69 W/ft²	14.22 W/ft²	14.74 W/ft²
0.4	12.11 W/ft²	12.64 W/ft²	13.18 W/ft²	13.71 W/ft²	14.23 W/ft²	14.76 W/ft²
0.3	12.12 W/ft²	12.67 W/ft²	13.21 W/ft²	13.75 W/ft²	14.29 W/ft²	14.82 W/ft²
0.2	12.15 W/ft²	12.71 W/ft²	13.27 W/ft²	13.82 W/ft²	14.37 W/ft²	14.91 W/ft²
0.1	12.19 W/ft²	12.77 W/ft²	13.34 W/ft²	13.9 W/ft²	14.46 W/ft²	15.02 W/ft²

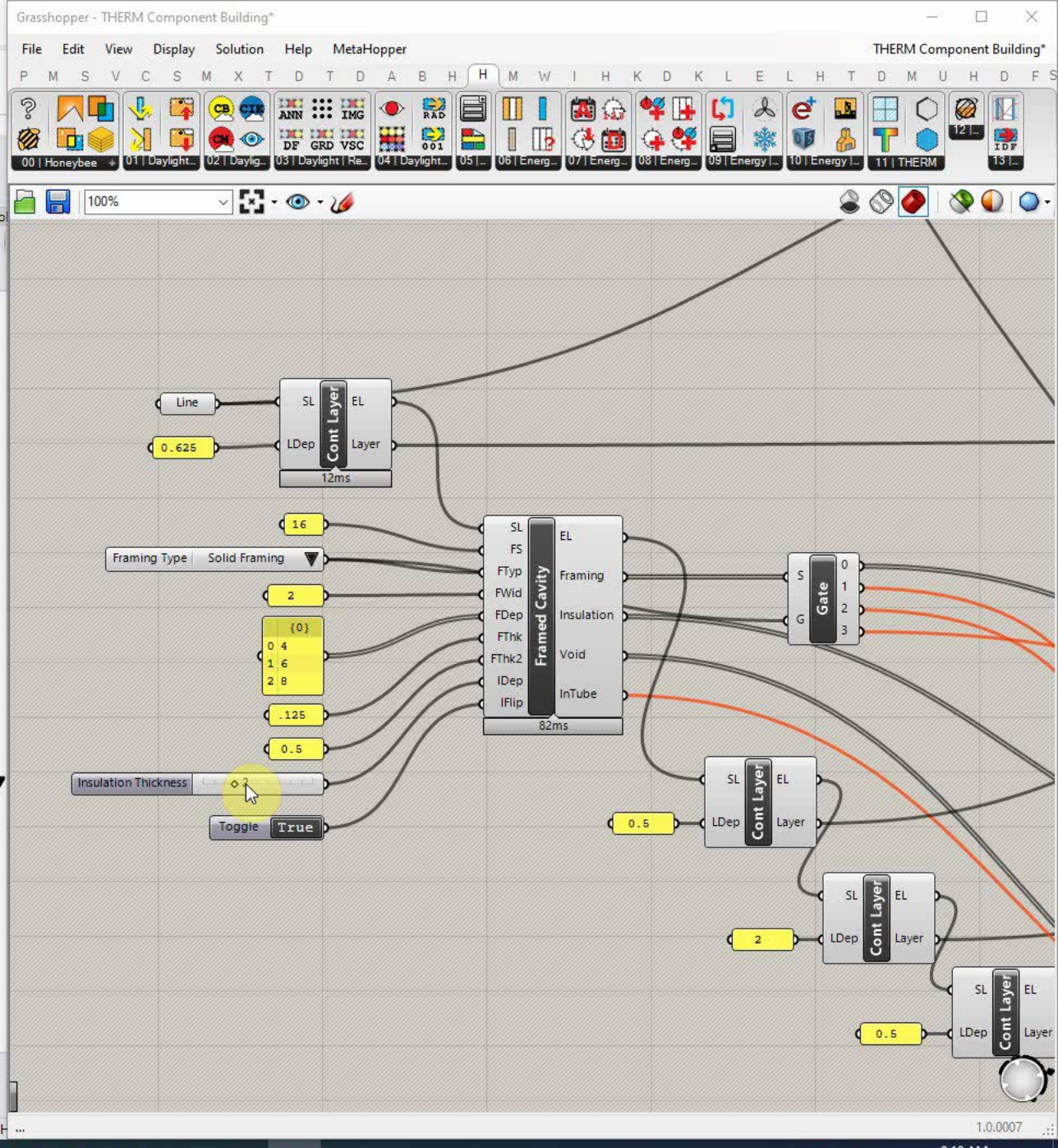
WWR

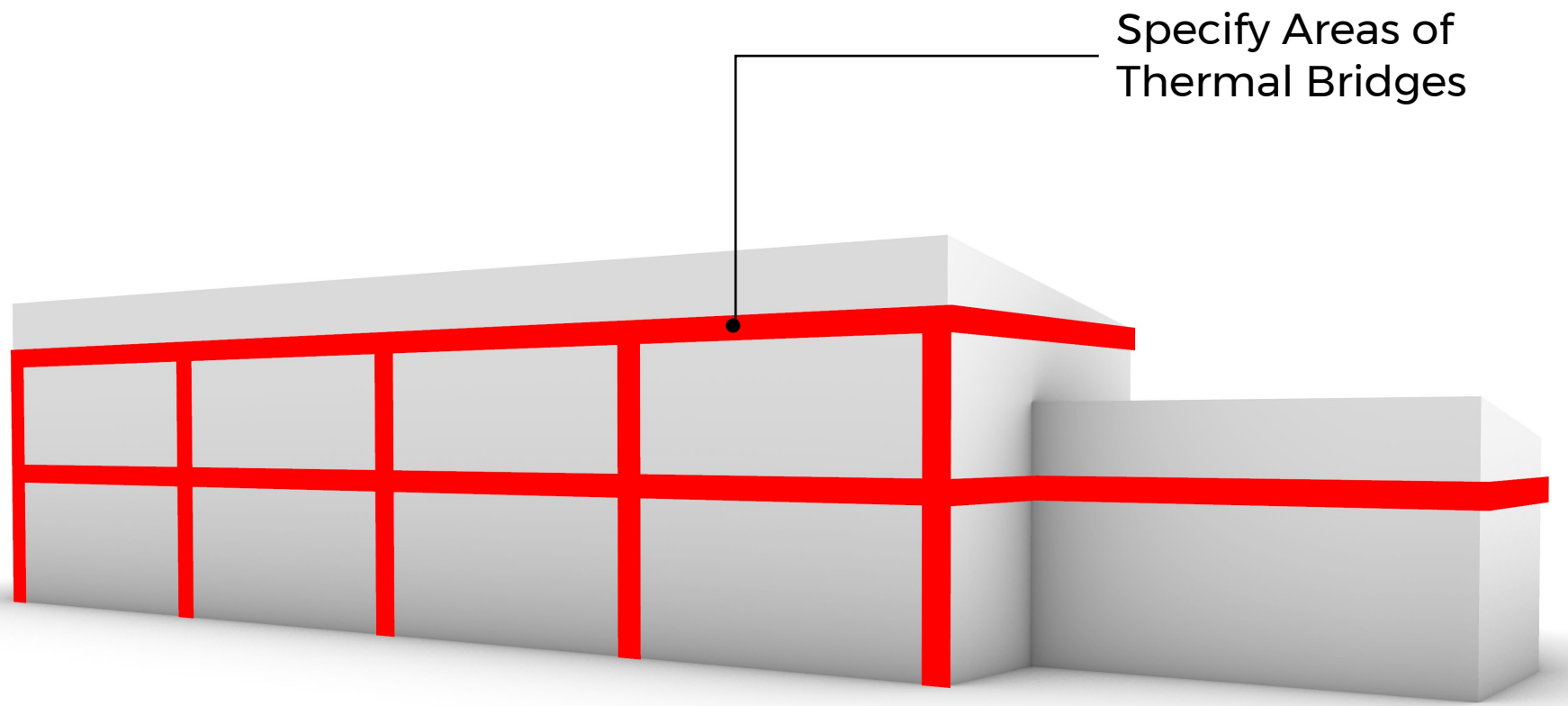
Shading Ratio	0.3	0.4	0.5	0.6	0.7	0.8
1	45% sDA 28.4% ASE	59.5% sDA 34.3% ASE	71.6% sDA 41.9% ASE	93.4% sDA 47.4% ASE	100% sDA 52.9% ASE	100% sDA 56.4% ASE
0.9	44.6% sDA 28.4% ASE	59.2% sDA 34.6% ASE	73% sDA 42.2% ASE	93.8% sDA 47.8% ASE	100% sDA 52.9% ASE	100% sDA 57.1% ASE
0.8	44.6% sDA 29.1% ASE	59.9% sDA 34.9% ASE	72.3% sDA 42.2% ASE	94.1% sDA 48.1% ASE	100% sDA 54% ASE	100% sDA 57.4% ASE
0.7	46.4% sDA 29.1% ASE	60.2% sDA 35.3% ASE	73.4% sDA 42.6% ASE	93.4% sDA 48.4% ASE	100% sDA 54% ASE	100% sDA 57.8% ASE
0.6	45.7% sDA 29.4% ASE	59.9% sDA 35.6% ASE	74% sDA 43.6% ASE	93.4% sDA 48.8% ASE	100% sDA 54.3% ASE	100% sDA 58.1% ASE
0.5	46.4% sDA 29.8% ASE	60.6% sDA 36.3% ASE	74.7% sDA 43.6% ASE	94.5% sDA 49.5% ASE	100% sDA 55.4% ASE	100% sDA 58.8% ASE
0.4	46% sDA 30.4% ASE	60.9% sDA 37.4% ASE	74% sDA 43.9% ASE	95.5% sDA 50.2% ASE	100% sDA 55.4% ASE	100% sDA 58.8% ASE
0.3	47.1% sDA 31.8% ASE	61.6% sDA 38.4% ASE	74% sDA 46% ASE	96.5% sDA 50.5% ASE	100% sDA 56.1% ASE	100% sDA 59.2% ASE
0.2	47.4% sDA 32.5% ASE	60.9% sDA 39.4% ASE	75.4% sDA 46.7% ASE	96.9% sDA 50.9% ASE	100% sDA 57.8% ASE	100% sDA 60.2% ASE
0.1	47.4% sDA 33.6% ASE	63% sDA 40.1% ASE	76.1% sDA 47.4% ASE	97.2% sDA 52.2% ASE	100% sDA 58.1% ASE	100% sDA 60.9% ASE

WWR

Parametric THERM Analysis






Specify Areas of
Thermal Bridges

Thank you!

Elliot J. Glassman
AIA, NCARB, LEED AP BD+C, CPHD
WSP Built Ecology
elliot.glassman@wsp.com

wsp.com