

# MILLENNIUM SCIENCE COMPLEX

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Lighting/Electrical Option

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# REVIT MODELING

- ❖ What Revit Information L/E's were given to start with...



# REVIT MODELING

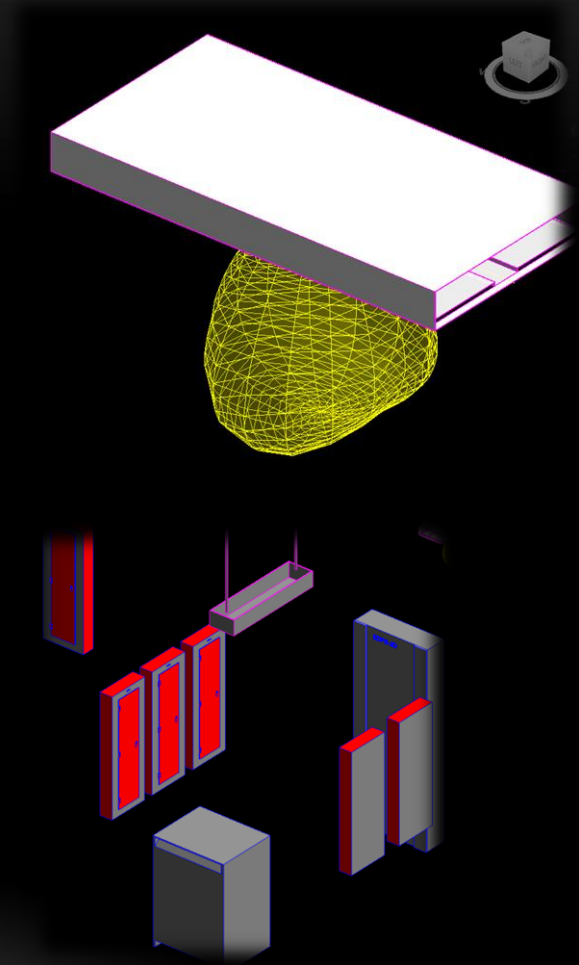
## ❖ What has been added?

### ➤ Luminaires

- ✓ Voltages
- ✓ .ies Files
- ✓ Designations
- ✓ Sizes & Ballast
- ✓ Luminaire Light Loss Factors
- ✓ Hyperlinks to Manufacturer Cutsheets

### ➤ 3<sup>rd</sup> Floor Equipment

- ✓ Panelboards
- ✓ Switchboard
- ✓ Transformers
- ✓ Name Tags



# REVIT MODELING

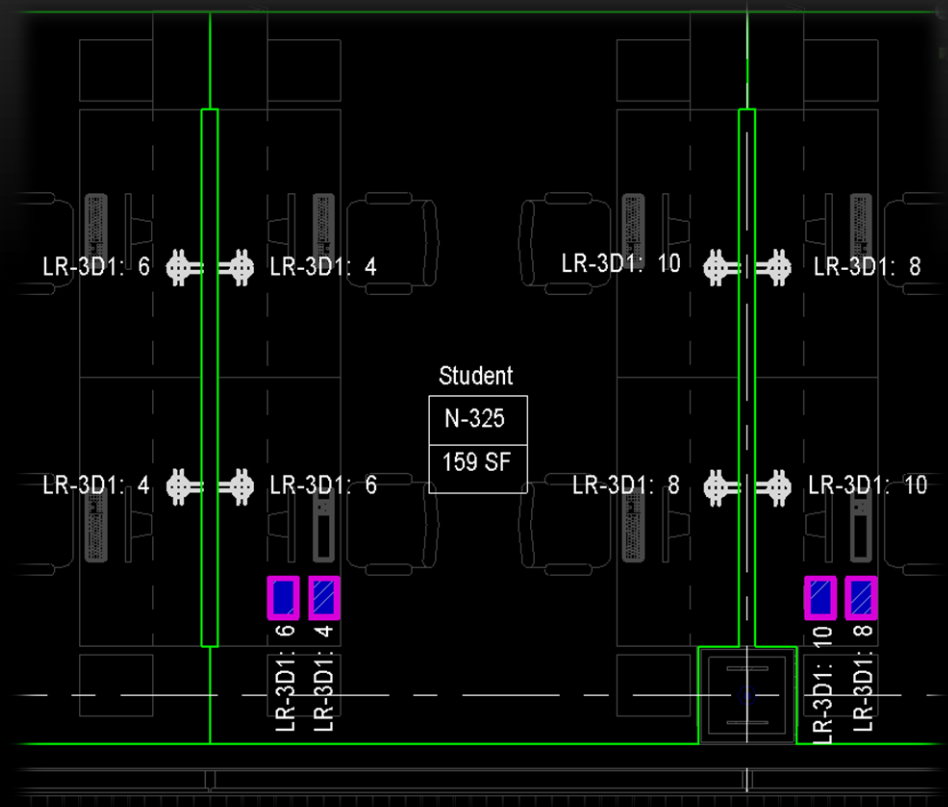
## ❖ What has been added?

### ➤ Receptacles

- ✓ Placed & Located
- ✓ Circuited to panels
- ✓ Estimated Loads (VA)

### ➤ Spaces (Green Outline)

- ✓ Ceiling Hieghts
- ✓ Surface Reflectances
- ✓ Name Tags & Numbers



# REVIT MODELING

❖ What has been added?

- Panel Schedules

Construction Documents



## BRANCH CIRCUIT PANELBOARD SCHEDULE

PANEL: LR-3D1	MOUNTING: SURFACE	FLUSH	MAIN LUGS ONLY	AMP MAIN CB	225
120/208V, 3 PHASE, 4 WIRE			SHORT TRIP MAIN	AMP BUS	225
10,000 MIN A.I.C. 5YM		IN MCC	FED. TRIP LUG	GROUND BUS:	X
NEUTRAL: 200%	NUMBER OF POLES:	42	TVSS	ISOLATED GROUND BUS:	X

CKT No.	LOAD	TRIP (AMP)	KVA/PHASE			POLES			KVA/PHASE			TRIP (AMP)	LOAD	CKT No.
			A	B	C	A	B	C	A	B	C			
1	P.C. RECEPTACLE	20	0.72			1	2	0.90			20	P.C. RECEPTACLE	2	
3	RECEPTACLE	20		1.08		3	4		0.90		20	P.C. RECEPTACLE	4	
5	SPARE	20				5	6		0.90		20	P.C. RECEPTACLE	6	
7	RECEPTACLE	20	1.08			7	8	0.90			20	P.C. RECEPTACLE	8	
9	P.C. RECEPTACLE	20		0.72		9	10		0.90		20	P.C. RECEPTACLE	10	
11	RECEPTACLE	20			0.72	11	12			0.90	20	P.C. RECEPTACLE	12	
13	P.C. RECEPTACLE	20	0.90			13	14	0.90			20	P.C. RECEPTACLE	14	
15	SPARE	20				15	16		0.90		20	P.C. RECEPTACLE	16	
17	P.C. RECEPTACLE	20			1.08	17	18			0.90	20	P.C. RECEPTACLE	18	
19	RECEPTACLE	20	0.90			19	20	0.90			20	P.C. RECEPTACLE	20	
21	P.C. RECEPTACLE	20		0.72		21	22		0.72		20	CLEANING RECEPTACLE	22	
23	P.C. RECEPTACLE	20			0.72	23	24			0.36	20	CLEANING RECEPTACLE	24	
25	P.C. RECEPTACLE	20	0.90			25	26	0.36			20	CLEANING RECEPTACLE	26	
27	RECEPTACLE	20		0.72		27	28		0.36		20	CLEANING RECEPTACLE	28	
29	P.C. RECEPTACLE	20			0.36	29	30			0.72	20	RESTROOM RECEPTACLES	30	
31	RECEPTACLE	20	0.18			31	32	0.54			20	RESTROOM RECEPTACLES	32	
33	RECEPTACLE - E.C.	20		0.72		33	34				20	SPARE	34	
35	SPARE	20				35	36				20	SPARE	36	
37	SPARE	20				37	38				20	SPARE	38	
39	SPARE	20				39	40				20	SPARE	40	
41	SPARE	20				41	42				20	SPARE	42	

SUBTOTALS		4.68	3.96	2.88		4.50	3.78	3.78		SUBTOTALS			
TOTAL LOADS		9.18 KVA	PHASE A			DEMAND FACTOR				60%			
		7.74 KVA	PHASE B			DEMAND LOAD				14.15 KVA			
		6.66 KVA	PHASE C			LOAD X 1.25%				17.69 KVA			
TOTAL CONN. LOAD		23.58 KVA				AMP				49.13			

PANEL NAM LR-3D1	MOUNTING: SURFACE	MAIN AMP CB:
208Y/120V , 3Ph, 4Wire	LOCATION: 208Y/120V	BUS AMP:
ENCLOSURE	FED FROM:	GROUND BUS: Yes
NUETRAL:	NOTES:	

CKT	LOAD	CB		LOAD (KVA)						CB		SERVES	CKT	
		P	TA	A	B	C	A	B	C	TA	P			
1	P.C. Recept	1	20	0.80				0.80			20	1	P.C. Receptacle	2
3	Receptacle	1	20		1.08				1.16		20	1	P.C. Receptacle	4
5	Spare	1	0			0.00			1.16		20	1	P.C. Receptacle	6
7	Receptacle	1	20	0.90				1.16			20	1	Floor Box & P.C. Receptacles	8
9	Receptacle	1	20		0.80				1.34		20	1	Floor Box & P.C. Receptacles	10
11	Receptacle	1	20			0.72			1.16		20	1	Floor Box & P.C. Receptacles	12
13	Receptacle	1	20	0.72				1.16			20	1	Floor Box & P.C. Receptacles	14
15	Spare	1	0		0.00				1.16		20	1	Floor Box & P.C. Receptacles	16
17	Floor Box & Receptacle	1	20				1.08			1.16	20	1	Floor Box & P.C. Receptacles	18
19	Receptacle	1	20	1.08				1.16			20	1	Floor Box & P.C. Receptacles	20
21	Receptacle	1	20		0.72				0.72		20	1	P.C. Receptacle	22
23	Receptacle	1	20			0.72				0.36	20	1	Cleaning Receptacle	24
25	Floor Box & Receptacles	1	20	1.08				0.36			20	1	Cleaning Receptacle	26
27	Receptacle	1	20		0.72				0.36		20	1	Cleaning Receptacle	28
29	Receptacle	1	20				0.36			1.08	20	1	Restroom Receptacle	30
31	Receptacle	1	20	0.54				0.54			20	1	Restroom Receptacle	32
33	Receptacle	1	20		0.36				0.00		0	1	Spare	34
35	Spare	1	0					0.00		0.00	0	1	Spare	36
37	Spare	1	0	0.00					0.00		0	1	Spare	38
39	Spare	1	0		0.00					0.00	0	1	Spare	40
41	Spare	1	0			0.00				0.00	0	1	Spare	42

TOTAL LOADS:	PHASE A	10300 V	60.00%	DEMAND FACTOR
	PHASE B	8420 VA	15912 VA	DEMAND LOAD
	PHASE C	7800 VA	19890 VA	LOAD x 125%
TOTAL CONNECTED LOAD:		26520 V	44 A	DEMAND AMPS

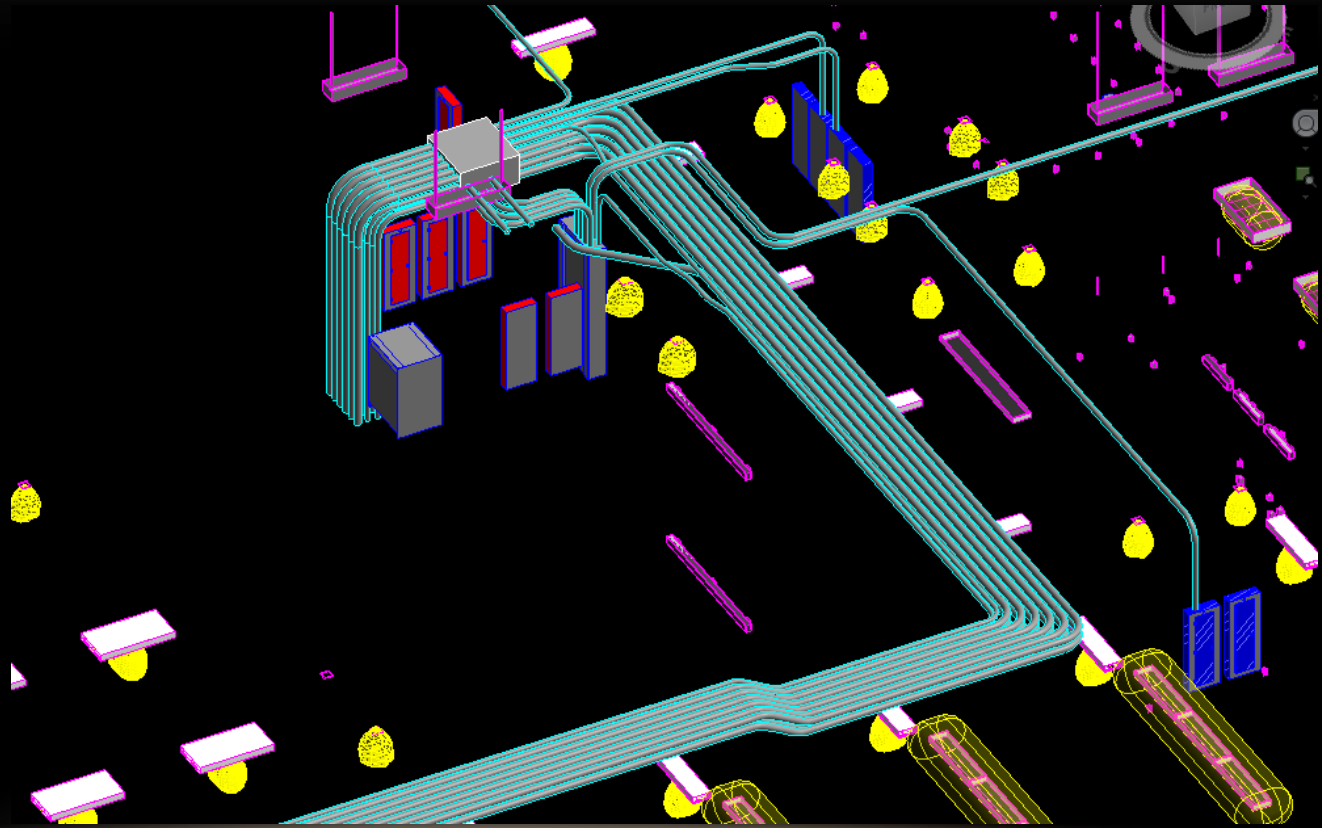
↑  
Revit MEP

# REVIT MODELING

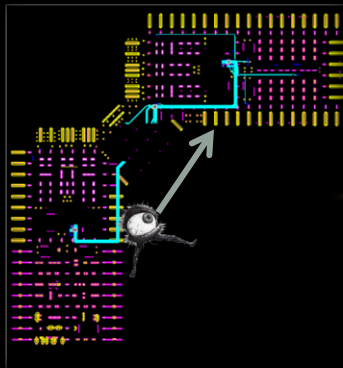
❖ What has been added?

➤ 3<sup>rd</sup> Floor Conduits

✓ 3<sup>rd</sup> Floor Feeders Sized and Modeled (cyan)



3<sup>rd</sup> Floor Plan

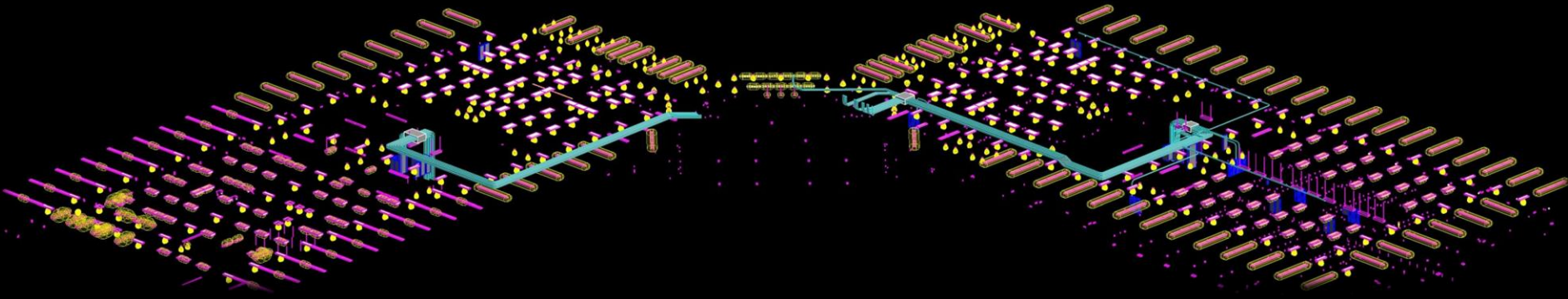


# REVIT MODELING

❖ What has been added?

➤ Conduits

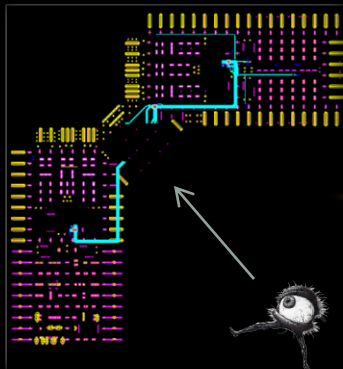
✓ 3<sup>rd</sup> Floor Feeders Sized and Modeled (cyan)



❖ Items Shown

➤ Luminaires, Receptacles, Electrical Equipment, and Conduits

3<sup>rd</sup> Floor Plan



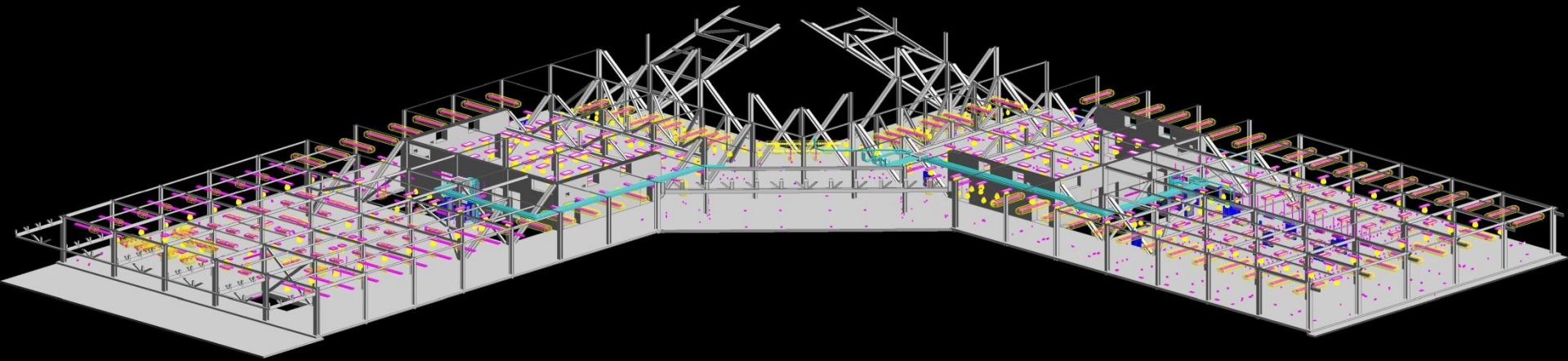


# REVIT MODELING

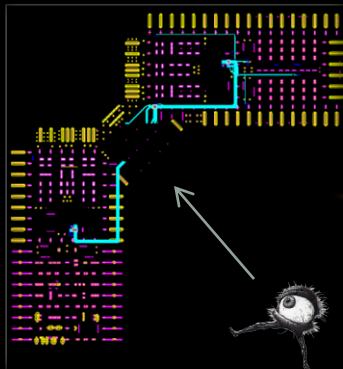
❖ What has been added?

➤ Linked Models

✓ Structural Model (Showing only 3<sup>rd</sup> Floor)



3<sup>rd</sup> Floor Plan



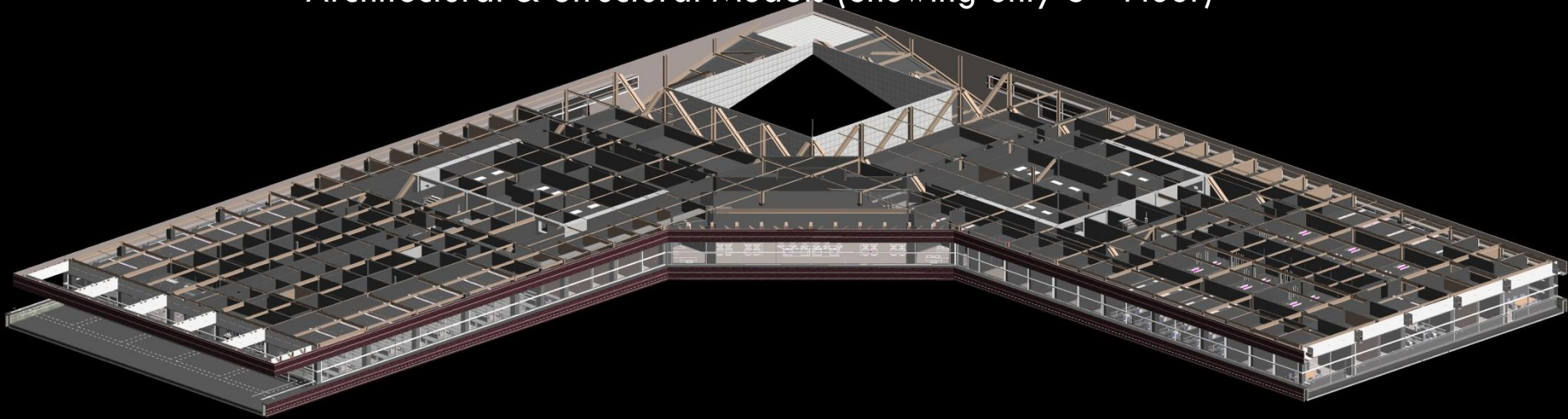


# REVIT MODELING

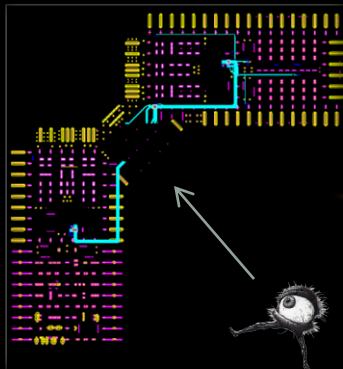
❖ What has been added?

➤ Linked Models

✓ Architectural & Structural Models (Showing only 3<sup>rd</sup> Floor)

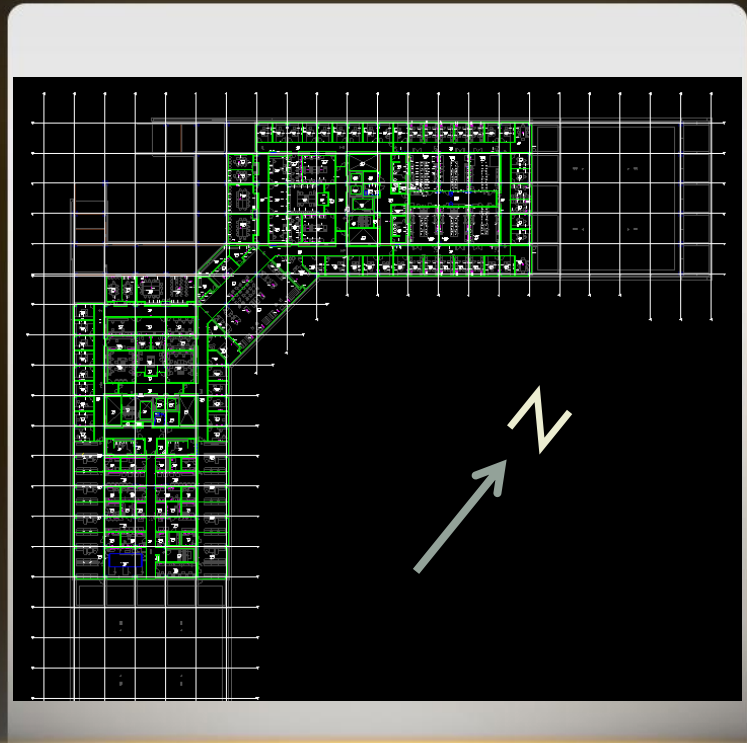


3<sup>rd</sup> Floor Plan



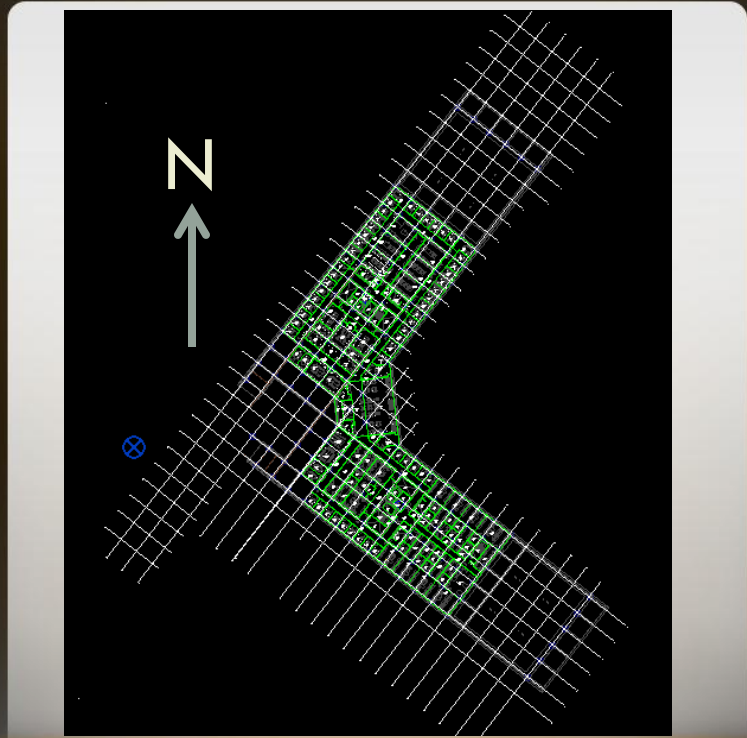
# REVIT MODELING

- ❖ Location, Location, Location...
  - Energy Modeling & Daylighting Model Exports ask “Where is North?”
    - ✓ **Project North** - Determines building orientation on sheet views.



# REVIT MODELING

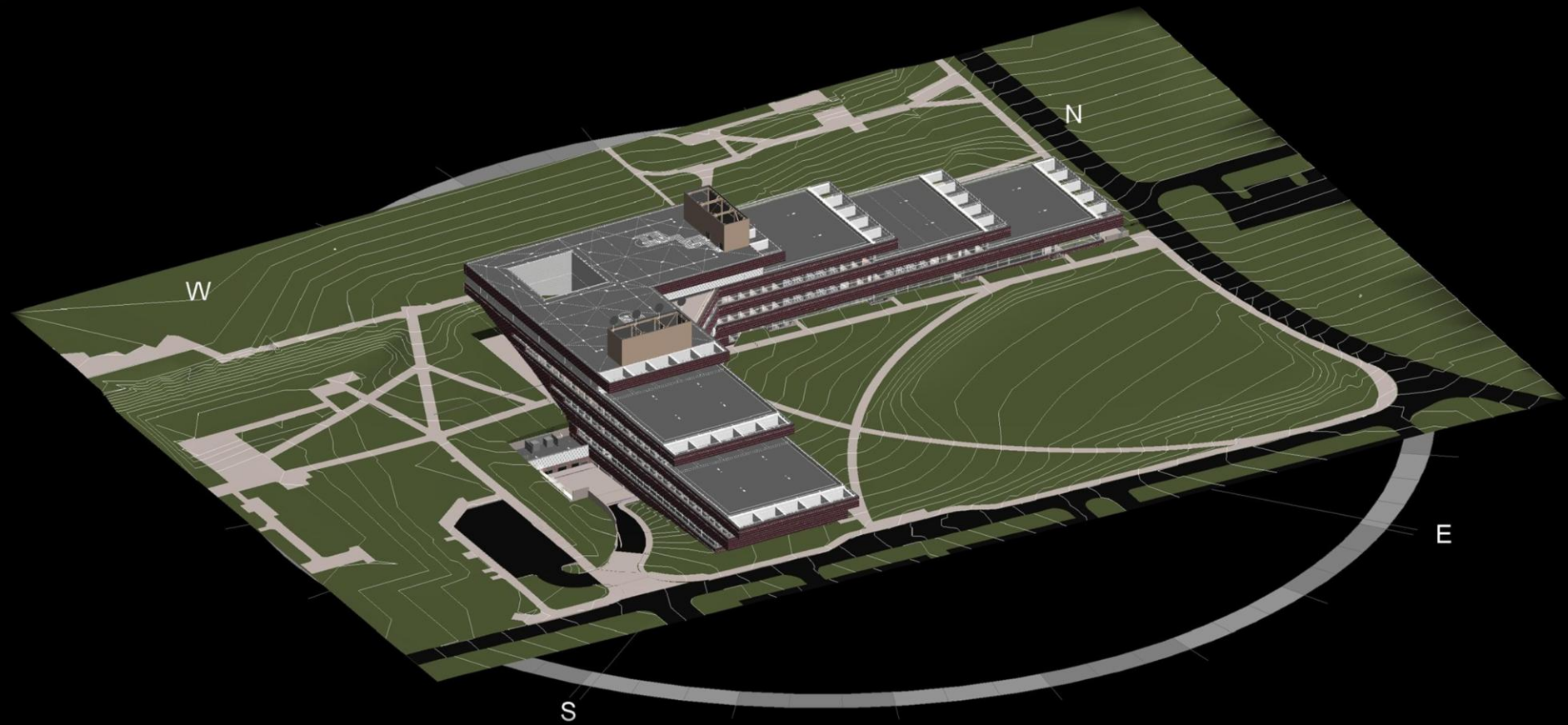
- ❖ Location, Location, Location...
  - Energy Modeling & Daylighting Model Exports ask “Where is North?”
    - ✓ **True North** - Shows Correct Project orientation.
    - ✓ Rotated RVA's building models 52° CCW for accurate building exports for Daylight & Ecotech type models.



# REVIT MODELING

❖ Location, Location, Location...

➤ Energy Modeling & Daylighting Model Exports ask “Where is North?”



# LIGHTING DESIGN WITH REVIT MEP

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A good guess and base estimate

# LIGHTING DESIGN WITH REVIT MEP

## Customizable Options

- Wall Types
- Material Properties
- Paint Finishes
- New Space Properties

## Non-Customizable Options

- Reflectance
- Transmittance
- Default Space Type Parameters

# LIGHTING DESIGN IN REVIT MEP

## ❖ Material Properties

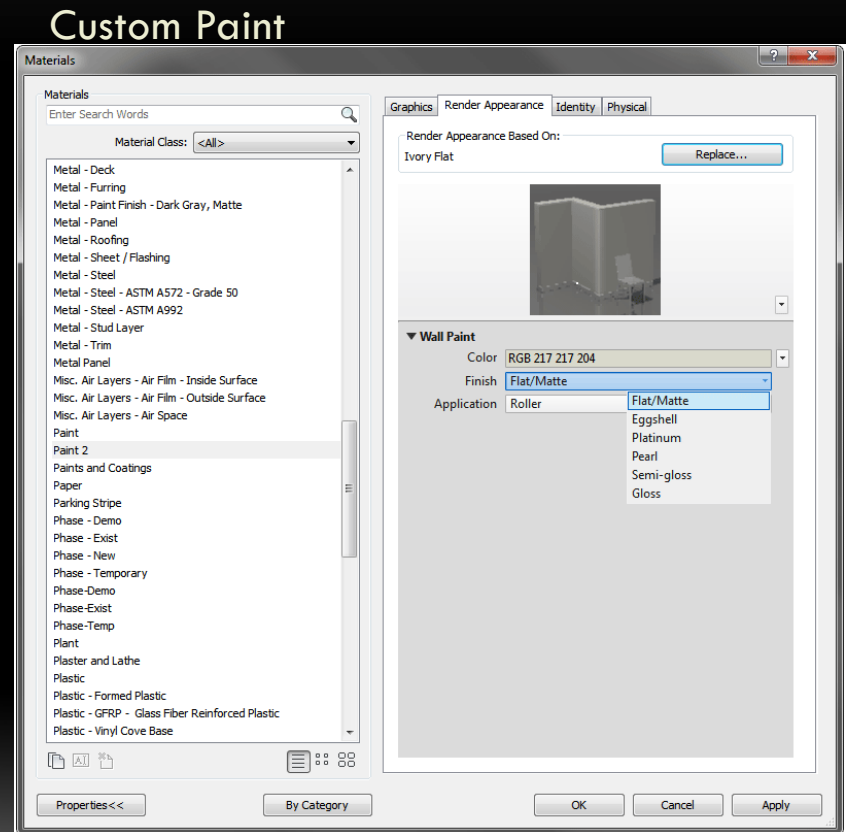
➤ Custom Colors

➤ Custom Finish

✓ Flat/Matte, Eggshell, etc.

➤ Custom Paint Application

✓ Brush, roller, spray





# LIGHTING DESIGN IN REVIT MEP

## ❖ Material Properties

➤ Custom Colors

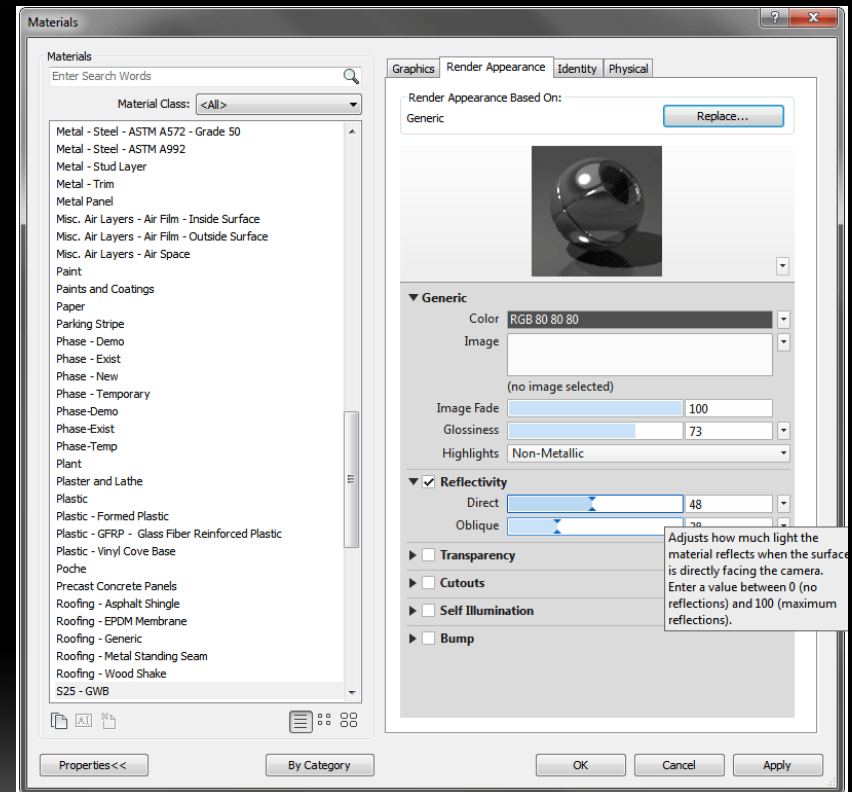
➤ Custom Finish

✓ Flat/Matte, Eggshell, etc.

➤ Custom Paint Application

✓ Brush, roller, spray

## Custom Finishes



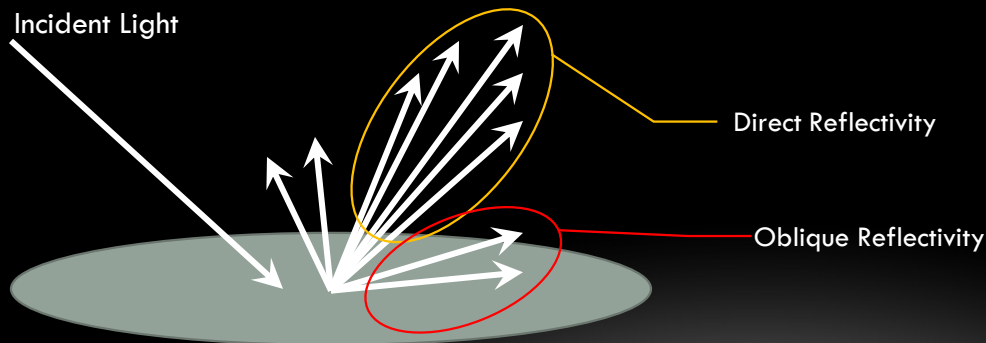
# LIGHTING DESIGN IN REVIT MEP

## ❖ Revit Terminology

- Direct Reflectivity
- Oblique Reflectivity
- Transmissivity

## ❖ Lighting Analysis Terminology

- Reflectance
- Transmittance
- Specularity
- Roughness



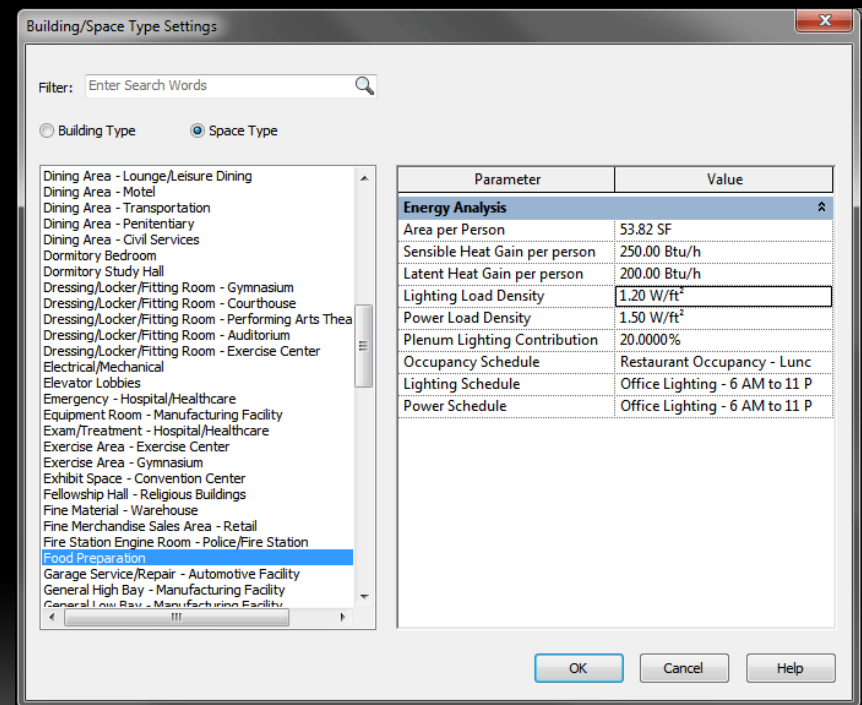
# LIGHTING DESIGN IN REVIT MEP

## ❖ Space Criteria

### ➤ Preloaded:

- ✓ Space Type
- ✓ Power Load Density
- ✓ Lighting Load Density
- ✓ Occupancy Schedules

## ❖ Default Space Type Settings



Building/Space Type Settings

Filter: Enter Search Words

Building Type  Space Type

Dining Area - Lounge/Leisure Dining  
Dining Area - Motel  
Dining Area - Transportation  
Dining Area - Penitentiary  
Dining Area - Civil Services  
Dormitory Bedroom  
Dormitory Study Hall  
Dressing/Locker/Fitting Room - Gymnasium  
Dressing/Locker/Fitting Room - Courthouse  
Dressing/Locker/Fitting Room - Performing Arts Theater  
Dressing/Locker/Fitting Room - Auditorium  
Dressing/Locker/Fitting Room - Exercise Center  
Electrical/Mechanical  
Elevator Lobbies  
Emergency - Hospital/Healthcare  
Equipment Room - Manufacturing Facility  
Exam/Treatment - Hospital/Healthcare  
Exercise Area - Exercise Center  
Exercise Area - Gymnasium  
Exhibit Space - Convention Center  
Fellowship Hall - Religious Buildings  
Fine Material - Warehouse  
Fine Merchandise Sales Area - Retail  
Fire Station Engine Room - Police/Fire Station  
Food Preparation  
Garage Service/Repair - Automotive Facility  
General High Bay - Manufacturing Facility  
General Low Bay - Manufacturing Facility

Parameter	Value
<b>Energy Analysis</b>	
Area per Person	53.82 SF
Sensible Heat Gain per person	250.00 Btu/h
Latent Heat Gain per person	200.00 Btu/h
Lighting Load Density	1.20 W/ft <sup>2</sup>
Power Load Density	1.50 W/ft <sup>2</sup>
Plenum Lighting Contribution	20.0000%
Occupancy Schedule	Restaurant Occupancy - Lunch
Lighting Schedule	Office Lighting - 6 AM to 11 P
Power Schedule	Office Lighting - 6 AM to 11 P

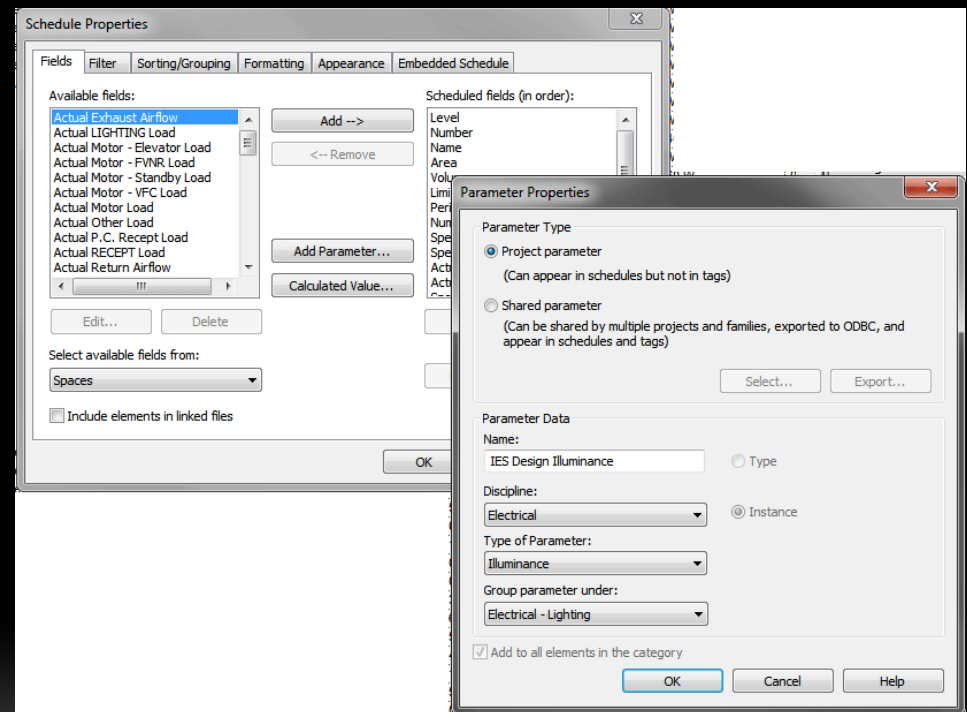
OK Cancel Help

# LIGHTING DESIGN IN REVIT MEP

## ❖ Parameters

- Customizable parameters, but not attached to a default space type
- Can only be added after a schedule is created

## ❖ Schedule Properties



# LIGHTING DESIGN IN REVIT MEP

## ❖ Calculation Variable Inputs

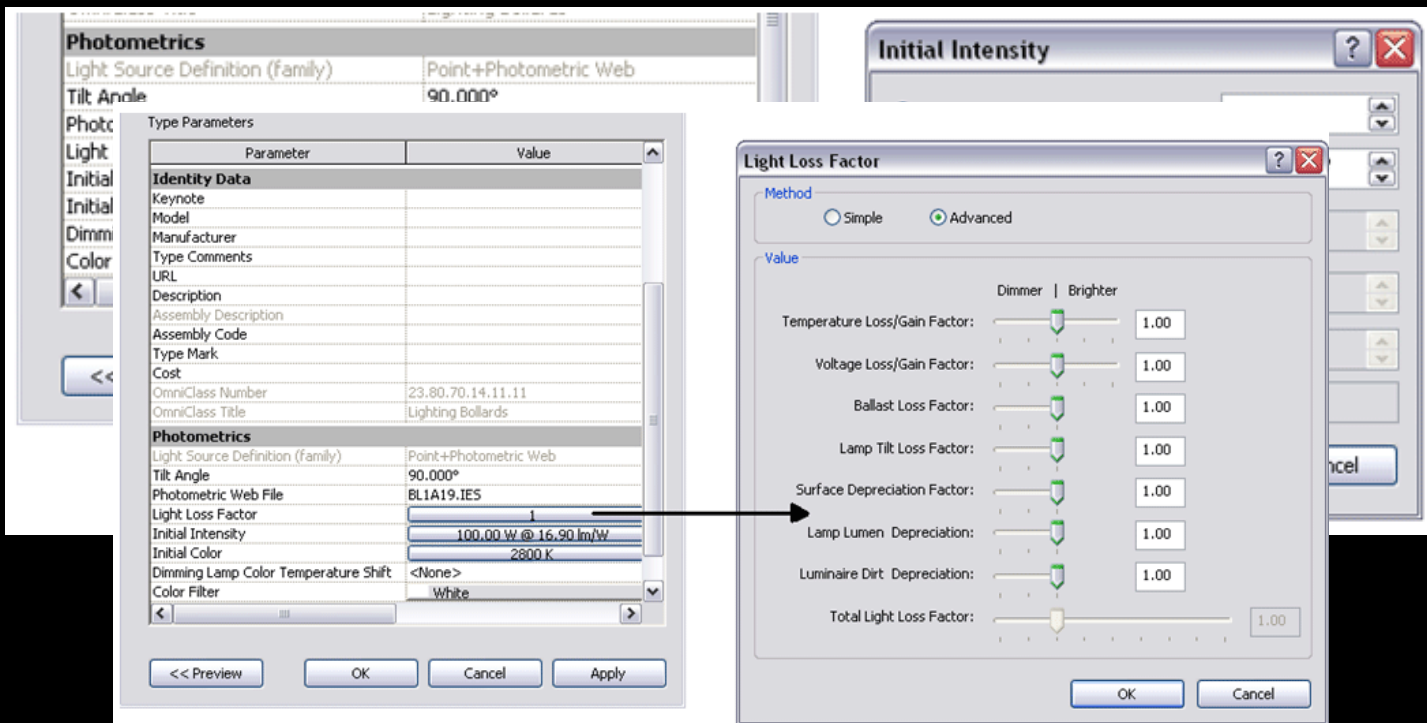
- Calculation Work Plane Height
- Ceiling Reflectance
- Wall Reflectance
- Floor Reflectance
- Light Loss Factors per Luminaire type

## ❖ Calculation Outputs

- Average Estimated Illumination (AEI)
- Room Cavity Ratio (RCR)

# LIGHTING DESIGN IN REVIT MEP

## Light Loss and Initial Conditions



# LIGHTING DESIGN IN REVIT MEP

## Revit Calculation

$$AEI = \sum_{i=1}^n \frac{\text{Lumens at Workplane}_i}{\text{Area}}$$

$$AEI = \sum_{i=1}^n \frac{(II * LLF * CU)_i}{\text{Space Area}}$$

Where:  
 II = Initial Intensity in lumens  
 LLF = Total Light Loss Factors  
 CU = Coefficient of Utilization

## Flux Balance / Lumen Method

$$\begin{bmatrix} -1 & \rho_1 F_{1-2} & \rho_1 F_{1-3} \\ \rho_2 F_{2-1} & -1 & \rho_2 F_{2-3} \\ \rho_3 F_{3-1} & \rho_3 F_{3-2} & (\rho_3 F_{3-3}) - 1 \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ M_3 \end{bmatrix} = \begin{bmatrix} -M_{01} \\ -M_{02} \\ -M_{03} \end{bmatrix}$$

$$CU = \frac{M_{FC} * A_{FC}}{\phi_{LAMP} * \rho_{FC}}$$

$$\text{Illuminance} = \frac{(\# \text{ of Luminaires }) (\phi \text{ per Luminaire}) (CU) (LLF)}{\text{Workplane Area}}$$



# LIGHTING DESIGN IN REVITMEP

## Revit Calculation

The image shows a Revit MEP floor plan of a room with several lighting fixtures (LR-303) and a calculation window. The calculation window displays the following data:

Electrical - Ligh...	
Average Estim...	1.68 fc
Room Cavity ...	2.674891
Lighting Calc...	2' 6"
Ceiling Reflec...	0.860000
Wall Reflectan...	0.760000
Floor Reflecta...	0.130000
Control Type	

## Flux Balance / Lumen Method

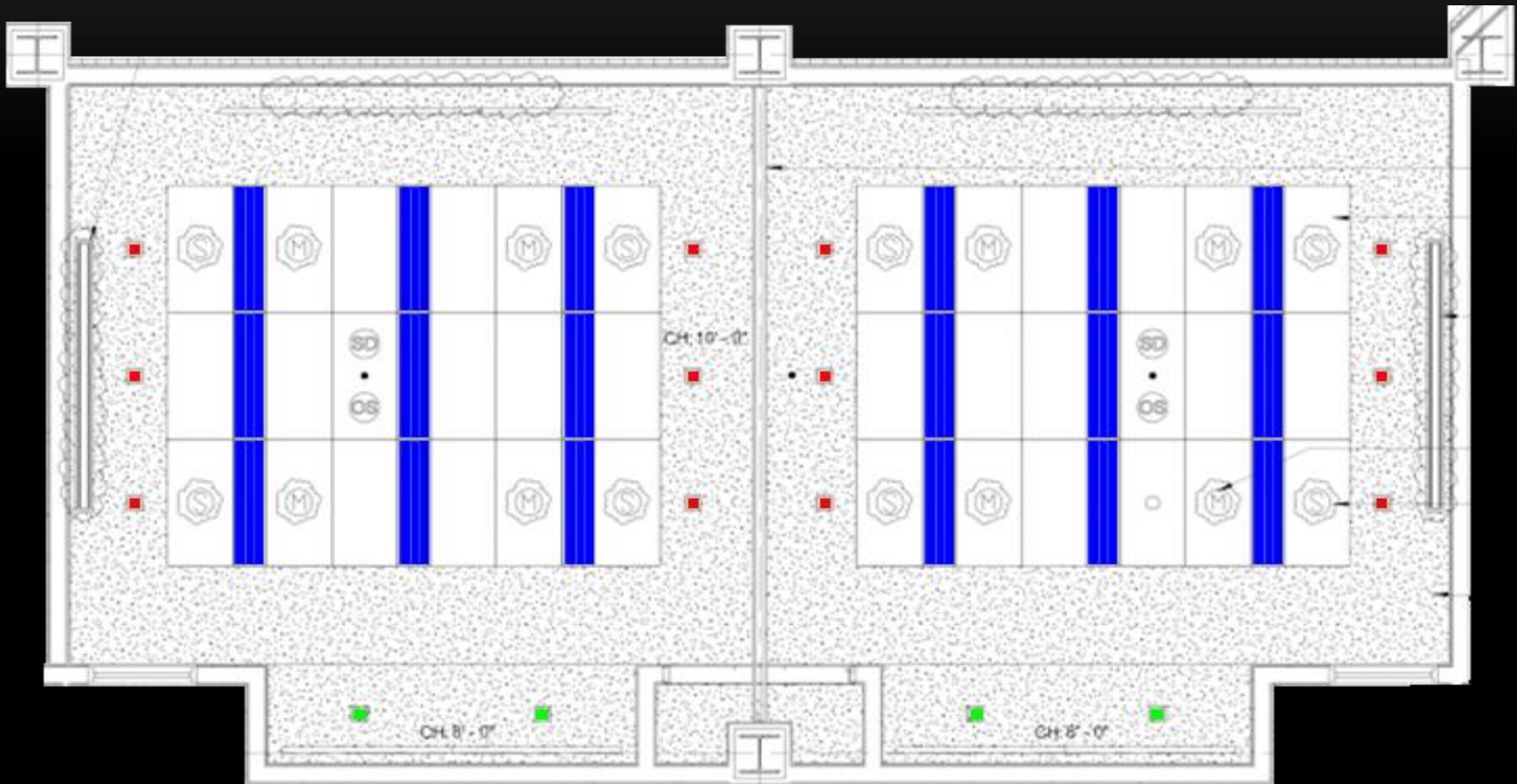
$$RCR = (5H \times (W + L)) / (L \times W)$$

$$RCR = 5(10) \times (18.5 + 42.5) / (42.5 \times 18.5)$$

$$RCR = 3.88$$

ROOM	
LENGTH	21'
WIDTH	20.5'
HEIGHT	11'
SUSPEND HEIGHT ( $h_s$ )	0'
WORK PLANE HEIGHT ( $h_{WP}$ )	2.5'
CEILING REFLECTANCE ( $\rho_C$ )	0.86
WALL REFLECTANCE ( $\rho_{WALL}$ )	0.76
FLOOR REFLECTANCE ( $\rho_F$ )	0.13
OUTPUT	
ILLUMINANCE =	27.66 fc

# SEMINAR ROOM



■ 6" Round Recessed  
Down light 42W  
CFI

■ 1'x4' Recessed (2)  
32W T8 Linear  
Fluorescent

■ 6" Square Recessed  
Down Light 32W  
CFI

# SEMINAR ROOM - CRITERIA

## Meeting Tasks

- Appearance of space and luminaires
- Avoid direct glare
- Modeling of Faces

## Video Conferencing

- Avoid direct glare
- Modeling of faces

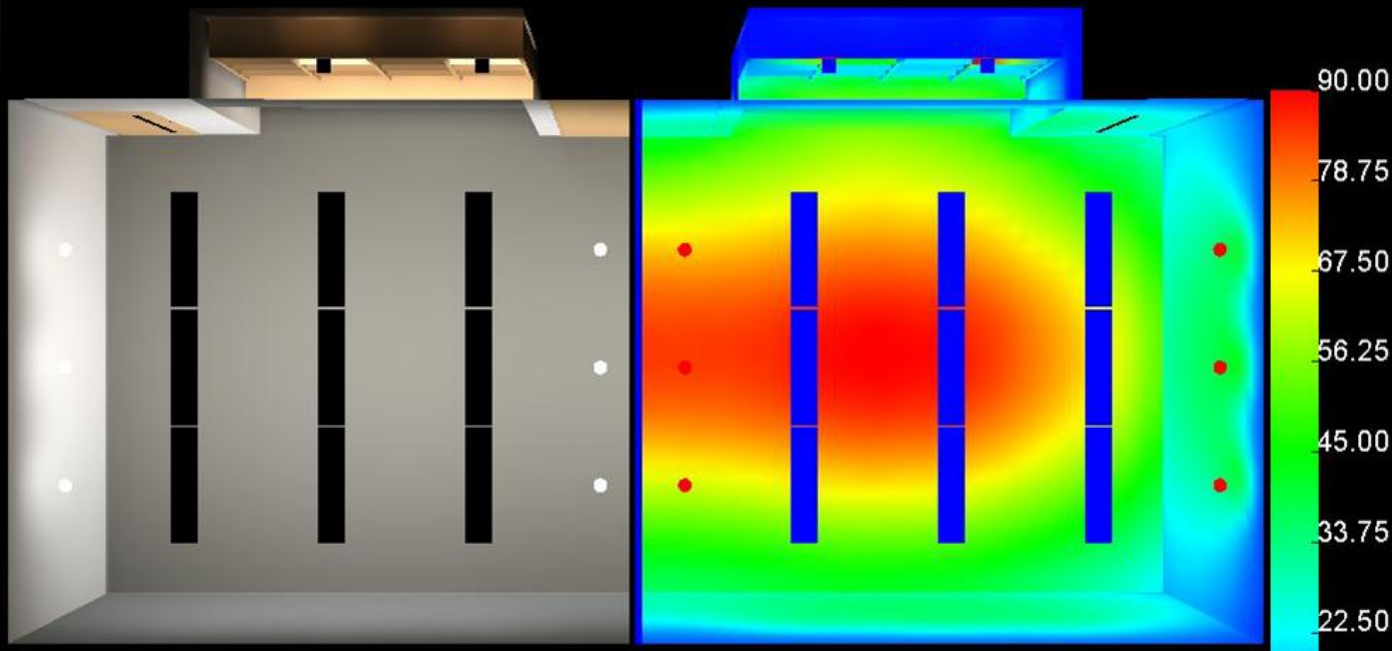
## Illuminance Levels

- Meeting Task
  - 30 fc Horizontal
  - 5 fc Vertical
- Video Conferencing
  - 50 fc Horizontal
  - 30 fc Vertical

## ASHRAE 90.1-2007 LPD

- Conference/Meeting/Multi-Purpose  
1.3W/ft<sup>2</sup>

# SEMINAR ROOM - PERFORMANCE



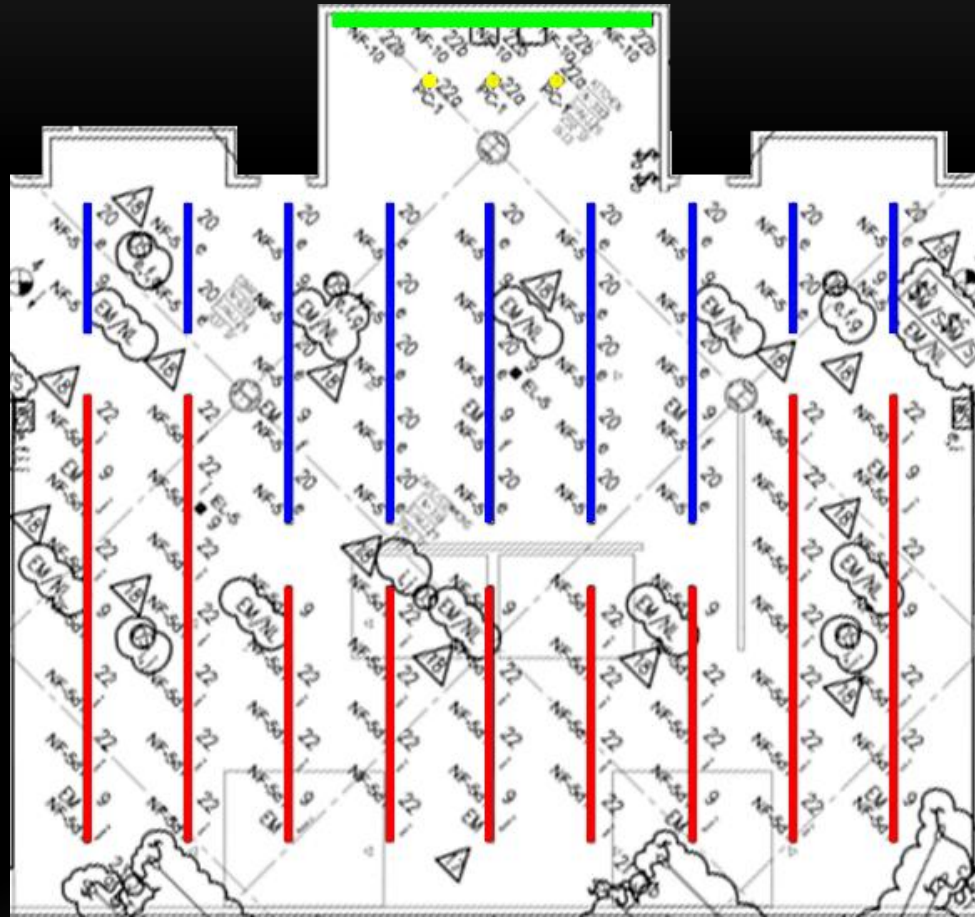
## Illuminance Levels

- AGi32 Actual
  - 74 fc Horizontal
  - 26 fc Vertical

ASHRAE 90.1-2007 LPD

- Actual  $2.15 \text{ W/ft}^2$

# CAFÉ/COMMON AREA



Recessed Linear Slots  
(2) 32W T8 Dimmed



Recessed Linear  
Slots (2) 32W T8



Pendant Mounted  
32W CFL



Surface Mounted  
Ceiling Washer (2) T8

# CORRIDOR/STUDY AREA - CRITERIA

## Food Courts

- Appearance of space and luminaires
- Color Appearance and Contrast
- Daylighting and Control

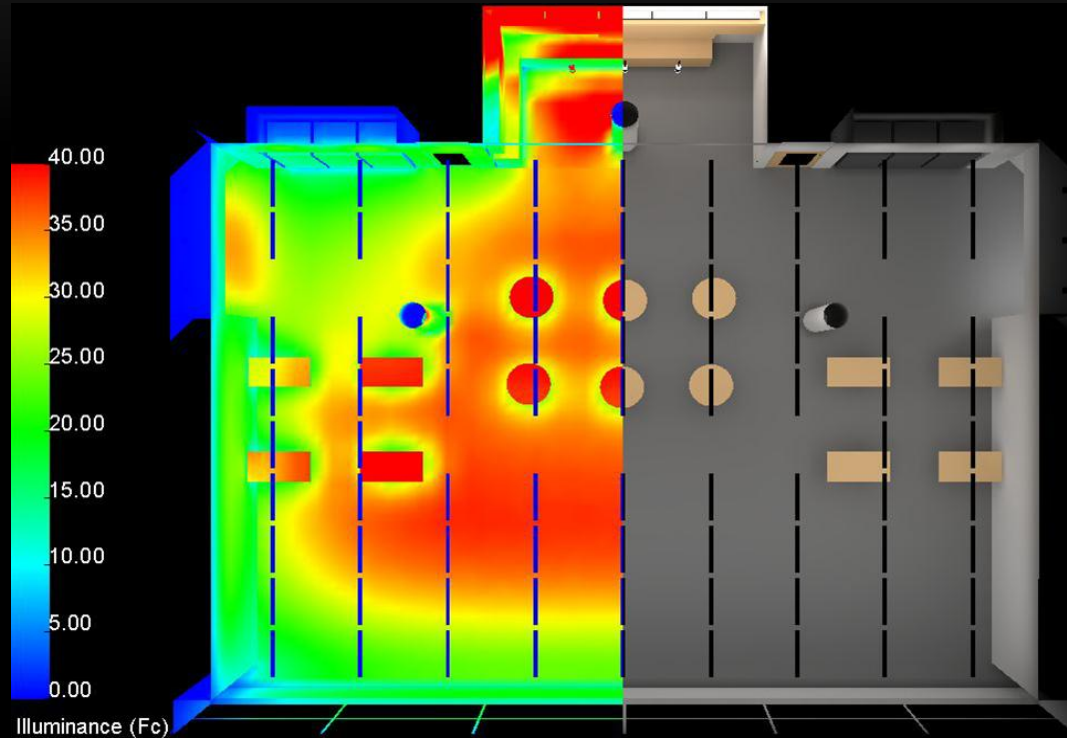
## ASHRAE 90.1-2007 LPD

- Dining Area  $0.9W/ft^2$
- Food Preparation  $1.2W/ft^2$

## Illuminance Levels

- Food Court
  - 30 fc Horizontal
  - 3 fc Vertical
- Dining
  - 10 fc Horizontal
  - 3 fc Vertical
- Food Displays
  - 50 fc Horizontal

# CAFÉ/COMMON AREA- PERFORMANCE



## Illuminance Levels

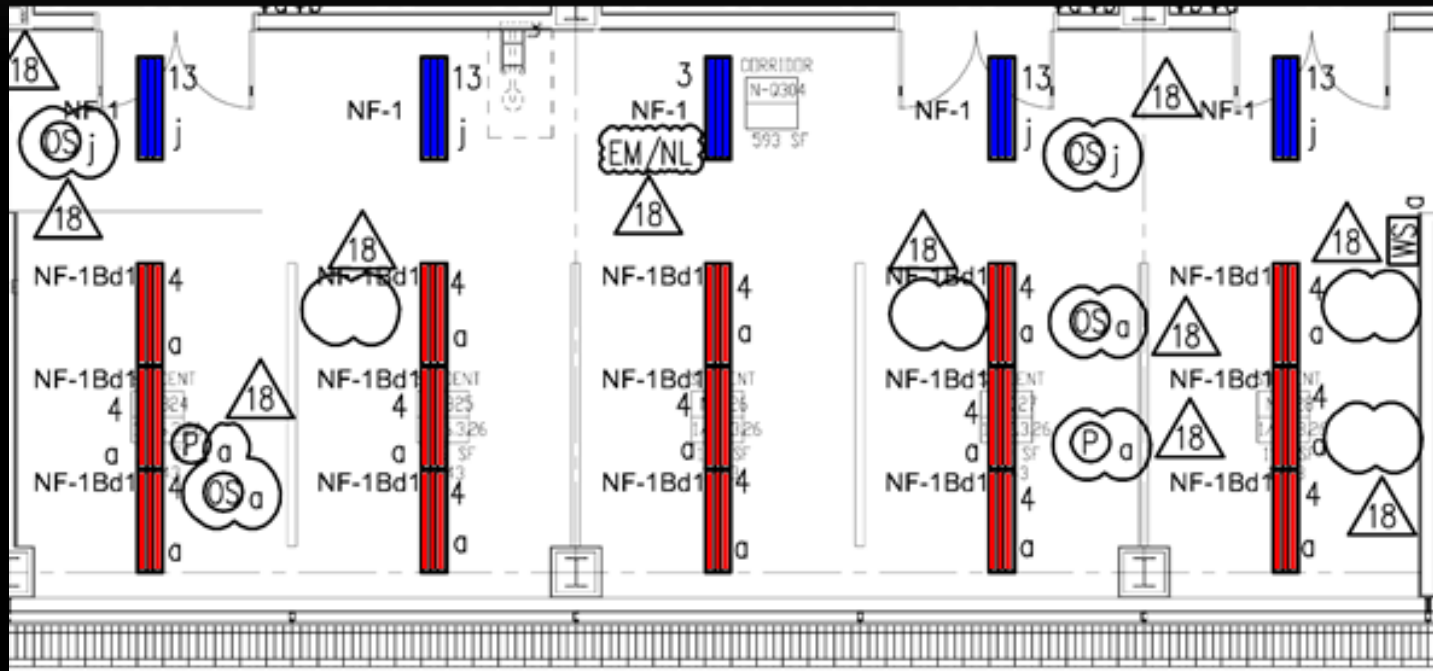
- Actual
  - 35 fc Horizontal
  - 17.8 fc Vertical

ASHRAE 90.1-2007 LPD

- Actual 1.84W/ft<sup>2</sup>



# CORRIDOR/STUDY AREA



■ 1'x4' Recessed (2) 32W T8  
Linear Fluorescent Dimmable

■ 1'x4' Recessed (2)  
32W T8 Linear  
Fluorescent

# CAFÉ/COMMON AREA- CRITERIA

## Corridors

- Shadow Avoidance

## Study Area

- Reading
- Avoid Reflected Glare

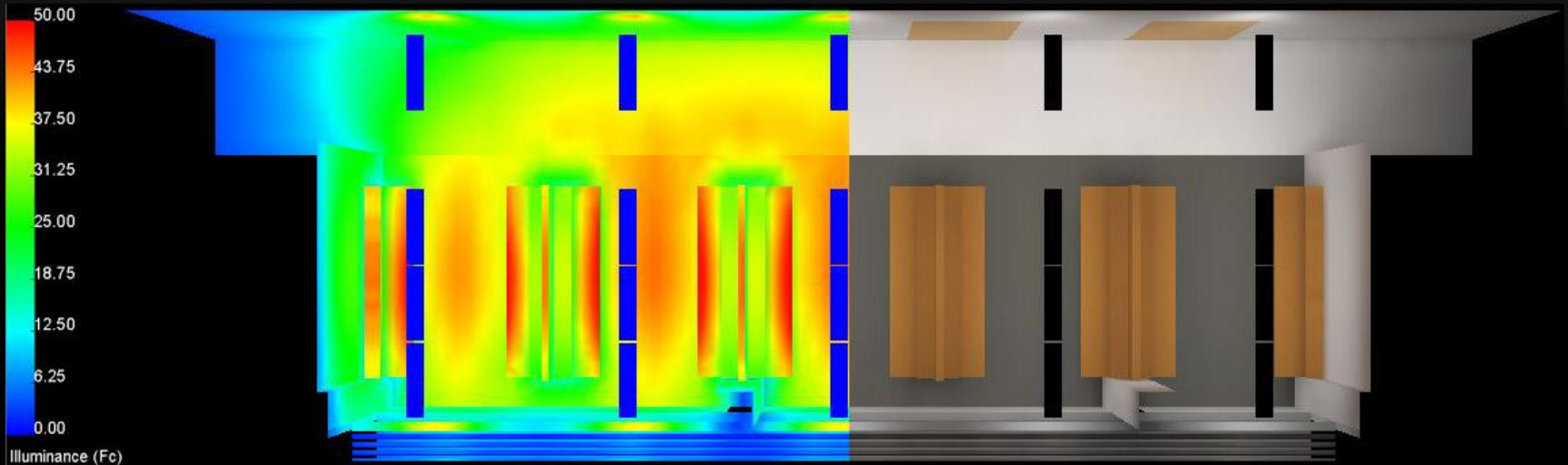
## Illuminance Levels

- Corridors
  - 5 fc Horizontal
- Study Area
  - 30-50 fc Horizontal

## ASHRAE 90.1-2007 LPD

- Corridor  $0.5W/ft^2$
- Study Area  $1.2W/ft^2$

# CORRIDOR/STUDY AREA - PERFORMANCE



## Illuminance Levels

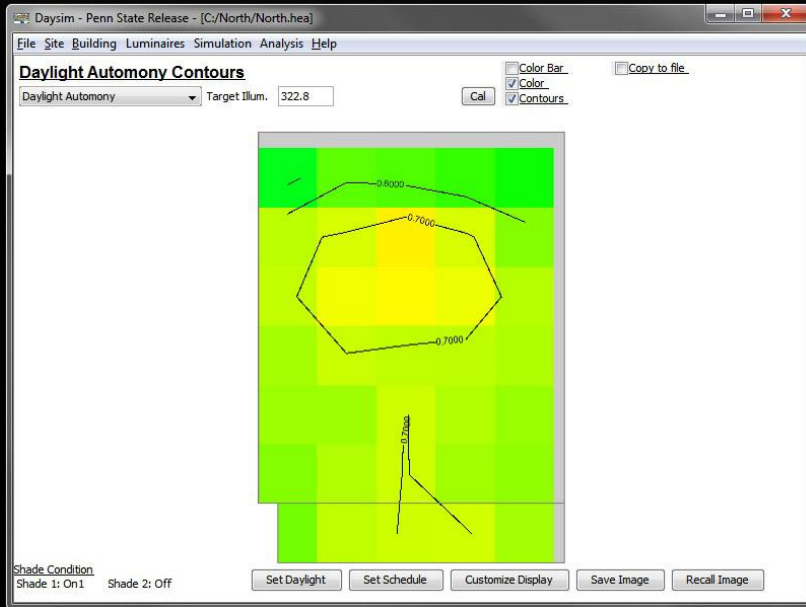
- Actual Corridor
  - 35 fc Horizontal
- Actual Study Area
  - 43 fc Horizontal
  - 18.6 fc Vertical

## ASHRAE 90.1-2007 LPD

- Actual Corridor
  - 0.78W/ft<sup>2</sup>
- Study Area 1.24W/ft<sup>2</sup>

# OFFICE DAYLIGHTING

## Daysim Results – North Facade



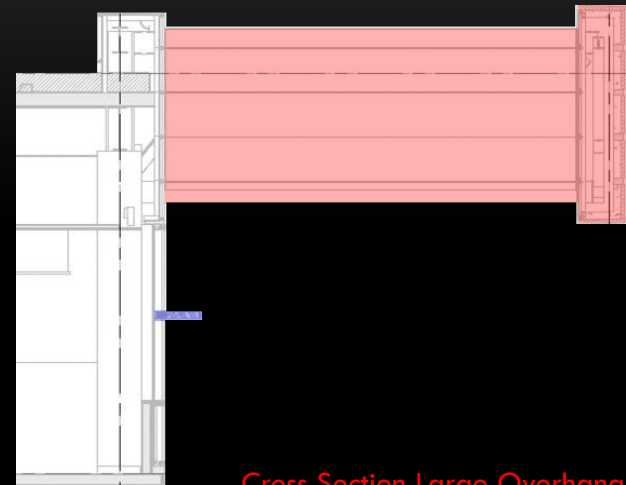
Daylight Autonomy



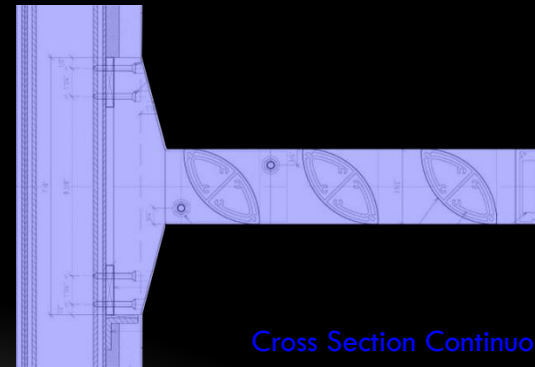
Continuous Daylight Autonomy

# OVERALL DAYLIGHTING

- Architectural Shading Devices
  - **Large Overhangs** – Wings
  - **Continuous Louvered Overhang** – Perimeter
- Lighting Control
  - Dimmable Fixtures in Common Areas
- Shades
  - Motorized Shades in Common Areas
  - Manual Shades in Private Offices



Cross Section Large Overhang



Cross Section Continuous Overhang