MILLENNIUM SCIENCE COMPLEX

AE SENIOR THESIS: IPD/BIM (2010-2011)





Paul Kuehnel: Structural

Jon Brangan: **Construction Management**







Jon Brangan | Construction Management

Paul Kuehnel | Structural

Building STIMULUS



The Pennsylvania State University Millennium Science Complex







Mike Lucas: Electrical & Lighting



Sara Pace: Mechanical

Mike Lucas | Electrical/Lighting

Sara Pace | Mechancial



• Location: University Park, PA

- Construction Dates: June 2008 June 2011 \bullet
- Estimated Cost: \$230 Million budgeted \bullet
- Project Delivery Method: Design-Bid-Build
- Size: 275,600 Square Feet
- Type of Use: Science Complex



Building Overview



Cantilever Design

Façade Design

Energy Modeling

Reflection

³uilding **STIMULUS**

Integrated Project Delivery

- Weekly Meetings • Project Work Spaces
- Essential Communication Tools









Building Overview

IPD/BIM Thesis

Design Goals







Doodle		JANUARY 2 Wed 19	2011	m	JANUARY 2 Thu 20	011		
	4 participants	1:00 PM - 2:00 PM	2:00 PM - 3:00 PM	4:30 PM - 5:30 PM	7:00 PM - 8:00 PM		7:00 PM - 8:00 PM	8:00 PM - 9:00 PM
	Miguel	1	~	~	1		1	~
Facade Design Meeting	Sara			~	~		1	~
Poll closed 👤 4 🗭 0 🔕 74 days ago	Paul	1	~	~	~		1	~
	Jon				~		1	~
Discuss potential issues with facade types.		2	2	3	4		4	4

Energy Modeling

Reflection

Cantilever Design

Façade Design

"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis

Cantilever Design

Façade Design

Energy Modeling

Reflection

"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- 4D Modeling
- Sequencing
- Site Utilization

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis

Planning with BIM





Cantilever Design

Façade Design

Energy Modeling

Reflection



"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis

Construction & Coordination

• 3D Trade Coordination



Cantilever Design

Façade Design

Energy Modeling

Reflection

Construction & Coordination

- 3D Trade Coordination
- Clash Detection

"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis



Cantilever Design

Façade Design

Energy Modeling

Reflection

- 3D Trade Coordination
- Clash Detection
- Verifying Model Accuracy

"Building Information Modeling is the process of generating and managing building data during it's *life cycle."*

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis

Construction & Coordination



Cantilever Design

Façade Design

Energy Modeling

Reflection

Primary use of BIM Post-Construction

"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis

Facilities Management

Cantilever Design

Façade Design

Energy Modeling

Reflection

"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- Lee, Sacks and Eastman (2006)

- Primary use of BIM Post-Construction
- F.M. Model Contains:
 - Manufacturer Information
 - Model Numbers
 - Website Link

Building Overview

IPD/BIM Thesis

Design Goals

Facilities Management

Family Product Information



Cantilever Design

Façade Design

Energy Modeling

Reflection

www.ledalite.com/products/voice
 VP Parabolic
 VP-1-G-12-P-R-1-32-277SO
 Lightolier
 STD-D
 1x4 Ceiling Recessed Fluorescent Downlights
 Advanced - Mark 7
 IZT-132-SC

- "Building Information Modeling is the process of generating and managing building data during it's *life cycle."*
- Primary use of BIM Post-Construction
- F.M. Model Contains:
 - Design Information

- Lee, Sacks and Eastman (2006)

IPD/BIM Thesis

Facilities Management

Family Product Information

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Cantilever Design

Façade Design

Energy Modeling

Reflection



"Building Information Modeling is the process of generating and managing building data during it's life cycle."

- Lee, Sacks and Eastman (2006)

- Primary use of BIM Post-Construction
- F.M. Model Contains:
 - Design Information
 - Quantities
 - Engineering Information

Building Overview

IPD/BIM Thesis

Design Goals

Facilities Management

Family Product Information



Cantilever Design

Façade Design

Energy Modeling

Reflection

ctrical	
ttage Comments	32
mber of Lamps	1
np	F32T8 ADV835 Alto II
ctrical - Lighting	
culate Coefficient of Utilization (defa	V
efficient of Utilization (default)	
ctrical - Loads	
id Type	Lighting
parent Load	34.16 VA

BIM Project Execution Planning Procedure



- Areas of Focus
- BIM Project Execution Plan
 - BIM/Project Goals
 - BIM Uses
- Identify Metrics of Success

Building Overview

IPD/BIM Thesis

Design Goals

Building Stimulus Design Goals

PRIORITY (HIGH/ MED/ LOW)	GOAL DESCRIPTION
н	Assess Cost Associated with Design Changes
Н	Increase Effectiveness of Design
н	Interdisciplinary Design Coordination

Cantilever Design

Façade Design

Energy Modeling

Reflection

POTENTIAL BIM USES

Cost Estimation, Existing Conditions Modeling

Design Authoring, Design Reviews, 3D Coordination, Engineering Analysis, Existing Conditions Modeling

Design Reviews, 3D Coordination

Building Stimulus Cantilever Overview

- Main architectural feature of the building
- Intersection of Materials Sciences and Life Sciences
- Occupiable and Non-Occupiable space on 3rd and 4th floors (Mech. Penthouse)
- Features a 3 bay x 3 bay opening
- 3 isolated quiet labs below plaza





Cantilever Design

Façade Design

Energy Modeling

150

feet

Reflection

MULUS

Building Stimulus Cantilever Design Goals

- Structure: Reduce steel and increase load path efficiency
- Lighting: Create an Inviting Entrance
- Construction: Increase Productivity
- Alternative Energy





Cantilever Design

Façade Design

Energy Modeling

Reflection

- SAP 2000 used to model the structural system of the cantilever
- Existing Conditions modeled and checked for:
 - Member strength
 - Overall Deflection
 - Stiffness





Cantilever Design

Façade Design

Energy Modeling

Reflection

- SAP 2000 used to model the structural system of the cantilever
- Existing Conditions modeled and checked for:
 - Member strength
 - Overall Deflection
 - Stiffness



Switch Braces to Tension

Increase in Deflection and Inefficiency of Load Path

Do not continue with Tension

Cantilever Design

Façade Design

Energy Modeling

Reflection

iteration, continue with Compression

FIMULUS

- SAP 2000 used to model the structural system of the cantilever
- Existing Conditions modeled and checked for:
 - Member strength
 - Overall Deflection
 - Stiffness





Cantilever Design

Façade Design

Energy Modeling

Reflection

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Kip-ft					
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STIMULUS

- SAP 2000 used to model the structural system of the cantilever
- Existing Conditions modeled and checked for:
 - Member strength
 - Overall Deflection
 - Stiffness





	Exis	ting	Rede	esign
Frame	2	5	2	5
Р	1000	1000	1000	1000
U	11.5141	12.8985	12.9544	11.7441
К	0.011514	0.012899	0.012954	0.011744
% diff		11.34		9.80

- stiffness for load sharing
- Result: percent difference in stiffness less than 10%

Cantilever Design

Façade Design

Energy Modeling

Reflection

Redesigned trusses to have similar

IMULUS







Building Overview

IPD/BIM Thesis

Design Goals



Exterior Plaza Lighting Design Section View

Cantilever Design

Façade Design

Energy Modeling

Reflection







Building Overview

IPD/BIM Thesis

Design Goals

Exterior Plaza Lighting Design Section View



Cantilever Design

Façade Design

Energy Modeling

Reflection







Building Overview

IPD/BIM Thesis

Design Goals

Exterior Plaza Lighting Design Section View



Cantilever Design

Façade Design

Energy Modeling

Reflection







Building Overview

IPD/BIM Thesis

Design Goals

Exterior Plaza Lighting Design Section View



Cantilever Design

Façade Design

Energy Modeling

Reflection







Building Overview

IPD/BIM Thesis

Design Goals

Exterior Plaza Lighting Design Section View



Cantilever Design

Façade Design

Energy Modeling

Reflection







Building Overview

IPD/BIM Thesis

Design Goals

Exterior Plaza Lighting Design Section View



Color Rendering



Energy Modeling

Reflection

Cantilever Design

Façade Design







Building Overview

IPD/BIM Thesis

Design Goals

Exterior Plaza Lighting Design Section View

Pseudo Color Rendering



Cantilever Design

Façade Design

Energy Modeling

Reflection





Z-Plane: 0.5 m

Building Overview

IPD/BIM Thesis

Design Goals

Wind Turbine Analysis



Z-Plane: 24 m

Model

- Domain Size: 900 x 900 x 100 m
- Standard K-ε Chen Model
- Hybrid Scheme

Simulation Results

- Grid Size: 107 x 108 x 20
- Iterations: 5000
- Duration: 4 hrs. 22 min
- % Mass Residual: 0.0906%

Cantilever Design

Façade Design

Energy Modeling

Reflection

Cascade Swift Wind Turbine

- Start-up Speed: 3.58 m/s
- 1200 kWh/year at 5 m/s
- Spacing Requirements: 22 ft

- Grid Size: 123 x 134 x 22
- Iterations: 3000
- Duration: 4 hrs. 48 min
- Mass Residual: 0.166%



Z-Plane: 30 m

Building Overview

IPD/BIM Thesis

Design Goals

Wind Turbine Analysis



- 18 turbines
- Cost: \$8,500/unit
- Total savings: \$1,624

Reflection

Energy Modeling

Façade Design

Cantilever Design

Final Results

• Total Array: 21,600 kWh/year

Building Stimulus Façade Design Goals

- Increase Thermal Efficiency
- Reduce Precast Panel Weight
- Create Efficient Construction Process
- Daylighting Integration User Comfort





Cantilever Design

Façade Design

Energy Modeling

Reflection

- Two Glazing Configurations
- Large Cavity Space
 - Thermal Barrier
 - Daylighting Integration



Double Skin Facade



Cantilever Design

Façade Design

Energy Modeling

Reflection







t	1
3	3
<u>.</u>	1
3	3
1	
3	3

Building Overview

IPD/BIM Thesis

Design Goals

Daylighting Integration Double Skin Shading System



Façade Design



Energy Modeling

Reflection

Cantilever Design

Shading Control Girasol System **Requires No Electricity**





t	1
3	3
<u>.</u>	1
3	3
1	
3	3

Building Overview

IPD/BIM Thesis

Design Goals

Daylighting Integration Double Skin Shading System





Façade Design

Energy Modeling

Reflection

Cantilever Design



Double Skin Facade Single Skin Facade N Ν

Building Overview

IPD/BIM Thesis

Design Goals

- - -

Daylighting Integration Student Study Area & Corridor Layout

Pseudo Color Rendering – 6.21 10AM





Cantilever Design

Façade Design

Energy Modeling

Reflection

Double Skin Facade Single Skin Facade N Ν

Building Overview

IPD/BIM Thesis

Design Goals

- - -

Daylighting Integration Student Study Area & Corridor Layout

Color Rendering – 6.21 10AM





Cantilever Design

Façade Design

Energy Modeling

Reflection





New Façade

Building Overview

IPD/BIM Thesis

Design Goals





Reflection





New Façade

660,000

Building Overview

IPD/BIM Thesis

Design Goals





Reflection



Original

New Façade

0

Building Overview

IPD/BIM Thesis

Design Goals





Energy Modeling

Reflection





New Façade

2,350,000

Building Overview

IPD/BIM Thesis

Design Goals





Reflection



Original

New Façade

Building Overview

IPD/BIM Thesis

Design Goals

Cantilever Design

\$0



Electricity
Chilled Water
Steam

\$10,000 \$20,000 \$30,000 \$40,000 \$50,000 \$60,000

Cost

Façade Design

Energy Modeling

Reflection



- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads



IPD/BIM Thesis

Precast Panel Design **Existing Precast Panel**



C-GRID®

pilaste

Steel reinforced

Shear truss

Insulating Foam

Secondary reinforcing

Thin brick finish (optional)

Cantilever Design

Façade Design

Energy Modeling

Reflection

Panel Material Research



³uilding **STIMULUS**

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads

Precast Panel Design Precast Panel Iterations





Cantilever Design

Façade Design

Energy Modeling

Reflection

STIMULUS

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads



Precast Panel Design Precast Panel Final Design



- $f'_c = 5000 \text{ psi}$
- f_r = 353.55 psi with FOS = 1.5 (PCI p363)
- Slab Thickness = 6 in
- End Rib Dimensions = 6 in x 12 in
- Mid Rib Dimensions = 8 in x 12 in

Cantilever Design

Façade Design

Energy Modeling

Reflection

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads

Precast Panel Design Precast Panel Final Design





Energy Modeling

Reflection

Cantilever Design

Façade Design

IMULUS

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads

Precast Panel Design Precast Panel Final Design – Constructability



- Steel stud perimeter wall
- Interior Wall
- Insulation
- Vapor Barrier
- Interior Glazing
- Precast Panel
- Exterior Glazing

Cantilever Design

Façade Design

Energy Modeling

Reflection

IMULUS

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads





Precast Panel Design **Original Panel Installation Sequence**



Cantilever Design

Façade Design

Energy Modeling

Reflection

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads





Precast Panel Design **Original Panel Installation Sequence**



Double Skin Panel Installation Sequence



Cantilever Design

Façade Design

Energy Modeling

Reflection



ingle Skin Facade Panel Installation Sequence



MULUS

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads

Precast Panel Design

ursday 8:00:00 AM 11/12/2009 Day=1 Week=

4D Model



Cantilever Design

Façade Design

Energy Modeling

Reflection

- Reduce weight of panel
- 24 in. air gap between inner face of precast panel and outer face of interior wall.
- Maintain continuous vertical air gap
- No cracking under transportation, construction, or service loads



Precast Panel Design Panel Design Cost

	Redesign	Original	Difference
Design	\$ 5,034,645	\$ 5,492,340	\$ (457,695)
ctions	\$ 181,250	\$ 150,000	\$ 31,250
	\$ 5,629,240	\$ 6,007,802	\$ (378,562)

Enclosure System Cost

System	Total Proposed	Original	Difference
Panels	\$ 5,629,240	\$ 6,007,802	\$ (378,562)
Insulation	\$ 842,792	\$ 741,948	\$ 100,844
Caulking	\$ 204,081	\$ 168,917	\$ 35,164
Louvers	\$ 123,200	\$ 366,600	\$ (243,400)
Windows	\$ 3,277,210	\$ 2,719,570	\$ 557,640
Total	\$ 15,429,539	\$ 15,357,852	\$ 71,687

Façade Design

Cantilever Design

Energy Modeling

Reflection

Building Stimulus Energy Modeling Design Goals

- Reduce Energy Consumption
- Lighting and Mechanical Integration
- Simulate a More Realistic Energy Profile





Cantilever Design

Façade Design

Energy Modeling

Reflection

- Preliminary Façade
- Preliminary Daylighting

- ASHRAE LPD's
- ASHRAE MPD's
- Existing Systems

Base Model

Building Overview

IPD/BIM Thesis

Design Goals

MEP Information Exchange





IPD/BIM Thesis

Design Goals



Chilled Beams





Energy Modeling

Reflection

Cantilever Design

Façade Design



IPD/BIM Thesis

Design Goals

Chilled Beams





Energy Modeling

Reflection

Cantilever Design

Façade Design



IPD/BIM Thesis

Design Goals

Chilled Beams

Energy Consumption for Third Floor





Energy Modeling

Reflection

Cantilever Design

Façade Design





IPD/BIM Thesis

Design Goals

Cantilever Design

Chilled Beams

Electricity Consumption for Third Floor

Façade Design



Energy Modeling

Reflection



IPD/BIM Thesis

Design Goals



Chilled Beams

Yearly Utility Cost for Third Floor

\$15,000 \$30,000 \$45,000 \$60,000 **Utility Cost**

Purchased Steam

Purchased Chilled Water

Electricity



Energy Modeling

Cantilever Design

Façade Design

Reflection

Chilled Beam Luminaire Integration Color Render

Private Office Floorplan





Building Overview

IPD/BIM Thesis

Design Goals

Chilled Beam Luminaire



Energy Modeling

Reflection

Cantilever Design

Façade Design

Chilled Beam Luminaire Integration Color Render

Private Office Floorplan





Building Overview

IPD/BIM Thesis

Design Goals

40.00 _35.00 30.00 25.00 20.00 15.00 10.00 5.00 0.00 Illuminance (Fc)

Energy Modeling

Cantilever Design

Façade Design

Reflection

Illuminance Pseudo Color



Chilled Beam Luminaire Integration Color Render

Private Office Floorplan





Building Overview

IPD/BIM Thesis

Design Goals

Illuminance Pseudo Color



Cantilever Design

Façade Design

Energy Modeling

Reflection

IPD/BIM Thesis

Design Goals

Determining Existing Plug Loads

Cantilever Design

Façade Design

Energy Modeling

Reflection

Existing Panel Schedule

PANE	ïL			BR.	ANC	H C	IRC	UIT	P	ANE	LBC	AR(DS	SCHEDULE		
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5	Rec		POPAPA DOR	20	0.40	0.00	-		-	6.04	5.40	-	80	RECEPTACIE	1.1	6
7	Dec	6	RECEPTARIA	20		0.00	0.40				0.40	0.44	80	VACUUM PUMP	1.	8
à	Vac	7	BECEPTACLE	20	0.40			7		0.84	_	10.0T	20	VACUUM OPEN		10
11	Dec		VACUUM OVEN	20	0.40	0.20	-		10	0.04	0.40		20	RECEPTACLE	10	10
11	Dec	11	BECEPTACLE	20		1000	0.40	11	12		-11.1 W.	0.40	20	GPC - TWP	12	14
13	Rec	13	RECEPTACLE	20	0.40		0.40	18	14		-	0.70	10	SPARE	14	14
15	Rec	18	RECEPTACLE	20		0.40	_	15	18		0.40		20	RECEPTACLE	16	16
17	Spa	17	SPARE	20			_	17	10			1.00	20	EQUIPMENT (7) (8) (9) # (16)	10	18
19	Spa	10	SPARE	20			_	15	20	1.00	-		20	CAVUUM OVEN (20)	20	20
21	Spa	21	SPARE	20				21	22		1.80		00	ULTRASONICATOR (17)	11	22
23	DM.	25	DM4 (8)	10			1.20	29	24			0.40	20	RECEPTACLE	24	24
25	Spa	25	SPARE	20			al and the	25	26	1.80	_		20	UV CROSHLINKER (16)	10	26
27	Spa	27	RECEPTACLE	20		0.40		27	20				20	SPARE	10	28
29	Rec	29	RECEPTACLE	20			0.40	29	30		_	-	20	SPARE	30	30
31	Spa	31	SPARE	10			- Transferre	31	37				20	SPARE	34	32
33	Spa	33	SPARE	20				3.9	34			-	20	SPARE	34	34
35	Spa	35	SPARE	20				35	38				20	SPARE	38	36
37	Spa	37	SPARE	20				37	38		_	-	20	SPARE	30	38
39	Spa	29	SPARE	10			_	39	40			-	20	SPARE	40	40
41	Spa	41	SPARE	20				41	42				20	SPARE	42	42
			SUBTOTALS		1.00	2.10	2.40	<u> </u>		4.44	3.00	2.92	—	SUBTOTALS	٦	
			TOTAL LOADS	5.64	RVA	PHA	SE A			DEMA	ND F	CTOR		60%	1	
			A DOCTOR (P. PATER)	5.18	KVA.	PRA	SE B			DEMA	ND LO	A.D		9.68 XVA	1	
				5.32	KVA	PHA	88 C			LOAD	X 1.3	15%		12.11 KVA		
			TOTAL CONN. LOAD	10.14	KVA					AMP				33.63		



Building Overview

IPD/BIM Thesis

Design Goals



Determining Existing Plug Loads Modeling Electrical Information In Revit

Exporting to Trace

Cantilever Design

Façade Design

Energy Modeling

Reflection

Existing Panel Schedule

PANEL LB-3D6 208Y/120V , 3Ph, 4Wire 10,000MIN A.I.C. SYM NUETRAL:		MOU LOC FED NOT	INTIN ATION FRON ES:	MAIN AMP CB: M.L.O. BUS AMP: 225 A GROUND BUS: Yes									
скт	LOAD	C	СВ			LOAD	(kVA)			СВ		SERVES	СКТ
		Р	TA	Α	В	С	Α	В	С	TA	Ρ		
1	Receptacle N-324A	1	20	0.18			0.54			20	1	Receptacle N-324A	2
3	Receptacle N-324A	1	20		0.18			0.36		20	1	Receptacle N-324A	4
5	Receptacle N-324A	1	20			0.36			0.84	20	1	Vacuum Pump N-324A	6
7	Receptacle N-324A	1	20	0.18			0.84			20	1	Vacuum Oven N-324A	8
9	Vacuum Oven N-324A	1	20		0.18			0.36		20	1	Receptacle N-324A	10
11	Receptacle N-324A	1	20			0.36			0.48	20	1	GPC - THP N-324A	12
13	Receptacle N-324A	1	20	0.18			0.00			20	1	Spare	14
15	Receptacle N-324A	1	20		0.18			0.36		20	1	Receptacle N-324A	16
17	Spare	1	20			0.00			0.00	20	1	Spare	18
19	Spare	1	20	0.00			0.00			0	1	Spare	20
21	Spare	1	20		0.00			0.18		20	1	Ultrasonicator N-328A	22
23	DMA N-341A	1	20			0.18			0.36	20	1	Receptacle N-328A	24
25	Spare	1	20	0.00			0.18			20	1	UV Crosslinker N-328A	26
27	Spare	1	20		0.00			0.18		20	1	Receptacle N-328A	28
29	Receptacle N-328A	1	20			0.36			0.00	20	1	Spare	30
31	Spare	1	20	0.00			0.00			20	1	Spare	32
33	Spare	1	20		0.00			0.00		20	1	Spare	34
35	Spare	1	20			0.00			0.00	20	1	Spare	36
37	Spare	1	20	0.00			0.00			20	1	Spare	38
39	Spare	1	20		0.00			0.00		20	1	Spare	40
41	Spare	1	20			0.00			0.00	20	1	Spare	42
				PHASE 2100 VA PHASE 1980 VA PHASE 2940 VA				60.00% DEN 4212 VA DEN 5265 VA LOA 15 4 DEN				MAND FACTOR MAND LOAD AD x 125% MAND AMPS	



Building Overview

IPD/BIM Thesis



Determining Existing Plug Loads Modeling Electrical Information In Revit

(3rd Floor) ducational Version - (PSI MSC ELL - * Nor a legionary an phone A+ C+ D+ - c × Electrical Loads Lighting <u>V</u>alues: Actual Alexander and Alexander 681.42 W Load: Original 1.22 W/fe) Load <u>D</u>ensity Contribution to plenum (if exists): -20.00% -to 1 316 1 C LB-306 11 ±€! LB-305 18 306 2 🖨 🗰 🚓 18 306 10 Power New Plug Loads LB-306 13 E LB 305 Values: Actual 22600.00 W) Load: ±2 14 106 10 Diganic Eles & Phy Chemical Luk 40.48 W/fe) Load D<u>e</u>nsity 8-3244 551.57 4,000,000 6,000,000 8,000,000 10,000,000 2,000,000 15:100 2.45 kBTU/yr OK Cancel <u>H</u>elp + Flachade Options II Editable Only Frees & Drag

Cantilever Design

Façade Design

Energy Modeling

Reflection

Receptacle Energy Consumption







IPD/BIM Thesis

Design Goals

Determining Existing Plug Loads Modeling Electrical Information In Revit

(3rd Floor) Lautonal Venion - PSI MSC III. . Sor a terrent in phone A. C. S. A. D. - 6 × Electrical Loads Lighting <u>V</u>alues: Actual Witness of Summer 681.42 W Load: Original 1.22 W/fe) Load <u>D</u>ensity Contribution to plenum (if exists): 10 18-316 -0 20.00% 出版106 LB-306 11 ±€! LB-305 18 306 2 🖨 💥 🚓 18 306 10 Power New Plug Loads LB-306 13 E 16 305 Values: Actual 22600.00 W) Load: ±€ 1.8-306 TD Dyanic Elec & Pho Ehemical Lak 40.48 W/fe Load Density 4,000,000 6,000,000 8,000,000 10,000,000 2,000,000 15-100 2.45kBTU/yr OK Cancel <u>H</u>elp ed Models : EVT Links : Linked Next Model ; MSC AUCH (NAW) et : 7 : Josefien Jets 🐣 (Next Editate) 3 - Power 🕞 😨 Main Model + Flachade Options I Editable Only Frees fit Drag

Cantilever Design

Façade Design

Energy Modeling

Reflection

Receptacle Energy Consumption





4,000,000 6,000,000 8,000,000 10,000,000







\$2,300,000

Metrics of Success and Reflection

Façade Redesign Peak Envelope Loads Reduction - Cooling Load Heating Load Reduce Panel Weight Daylight Integration – Improve Visual Comfort – Improve Overall Appearance – Reduce Solar Heat Gain Minimize Constructability Issues

Lighting Design

Cantilever Redesign

- Alternative Energy Implemented
- **Steel Tonnage Reduced**
- Truss Design Efficiency Increased

- Emphasize Architectural Features and Entrance

Energy Usage Primary Energy Use Reduction (MBtu/yr) Reduced Life Cycle Cost Meet ASHRAE Lighting Power Densities

Cantilever Design

Façade Design

Energy Modeling

Reflection

MULUS

- Thorton Tomasetti Engineers
- Rafael Viñoly Architects
- Flak & Kurtz
- Bob Biter Electric
- Whiting Turner
- Eric Mitchel (Mechanical P.M. Flak & Kurtz)
- Josh Miller (B.I.M. Coordinator at Gilbane)
- Chris Dolan (Whiting Turner)
- Adam Fry (Electrical P.M. at Mueller Associates)
- Stephanie Hill (M.E.at Mueller Associates)
- Matthew Danowski (M.E.at Mueller Associates)







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- Members of K.G.B. Maser
- Last but not least, all friends and family

QUESTIONS & COMMENTS AE SENIOR THESIS: IPD/BIM (2010-2011)

