

Unknown Data Center
Somewhere, USA
4.12.2011



Daniel Suter

Construction Management
AE Senior Thesis Presentation
The Pennsylvania State University

Presentation Outline:

Project Overview

Façade Redesign/Tilt-Up Construction

Alternate Roof Type – Photovoltaic System

- Electrical Breadth

Tablet PC's for Commissioning

Acknowledgements

Questions

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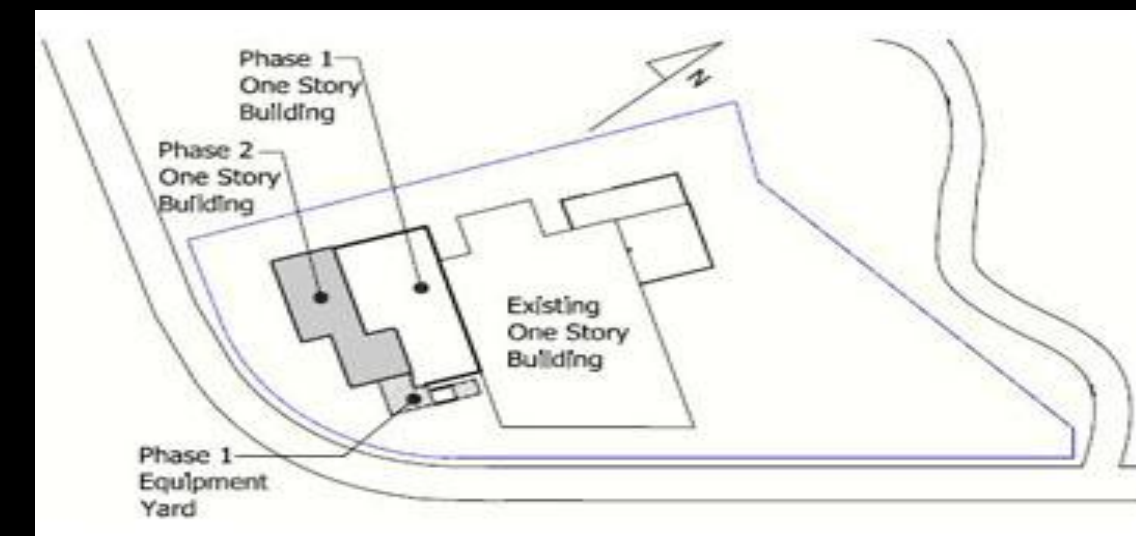
Acknowledgements

Questions

PROJECT OVERVIEW

- Owner – Anonymous
- Occupancy Type - Business
- Size - 17,445 SF South Expansion
- Cost - \$ 50 Million (Design+Construction)
- Construction Duration - December 2008 – August 2010
- Delivery Method - Design-Bid-Build
- Project Team
 - CM – Turner Construction
 - Architect/Engineers – Sigma 7 Design Group
 - Civil – Birdsall Services Group
 - Structural – Goldstein Associates

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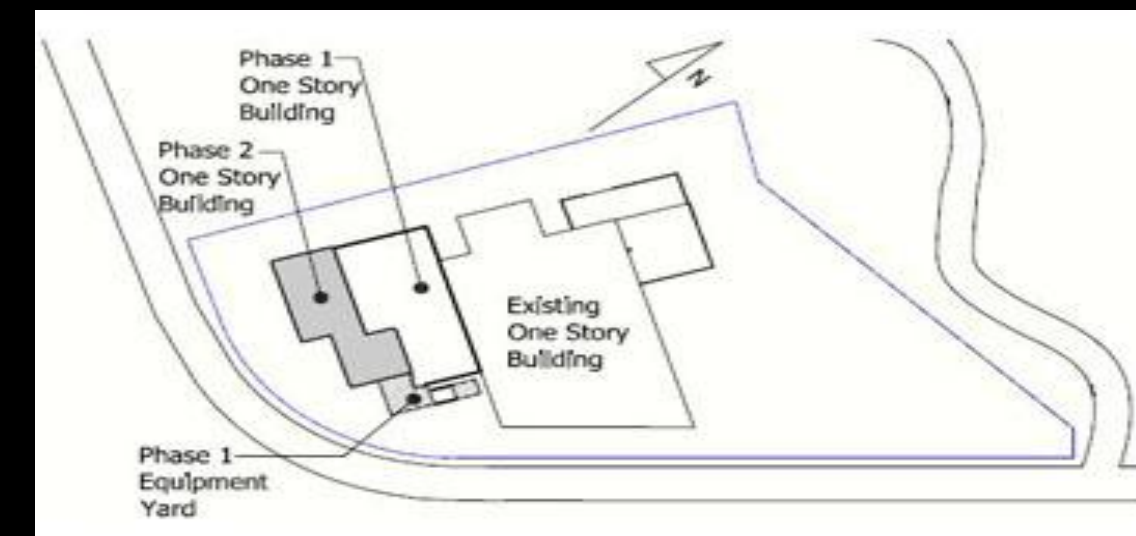
○ Building Enclosure

- Architectural Precast Panels
- Total of 33 Panels to enclose the building
- Penthouse enclosed with EIFS

○ Existing Roof Structure:

- Primary Roof - Composite, EPDM w/ Concrete Pavers
- Penthouse Roof – Composite, Standing Seam Metal Roof

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Façade Redesign/Tilt-Up Construction

- Opportunity
 - Redesigning the 20' Parapet Wall
 - Tilt-up vs. Precast
- Objective
 - Lower Material/Labor Cost
 - Accelerate Schedule

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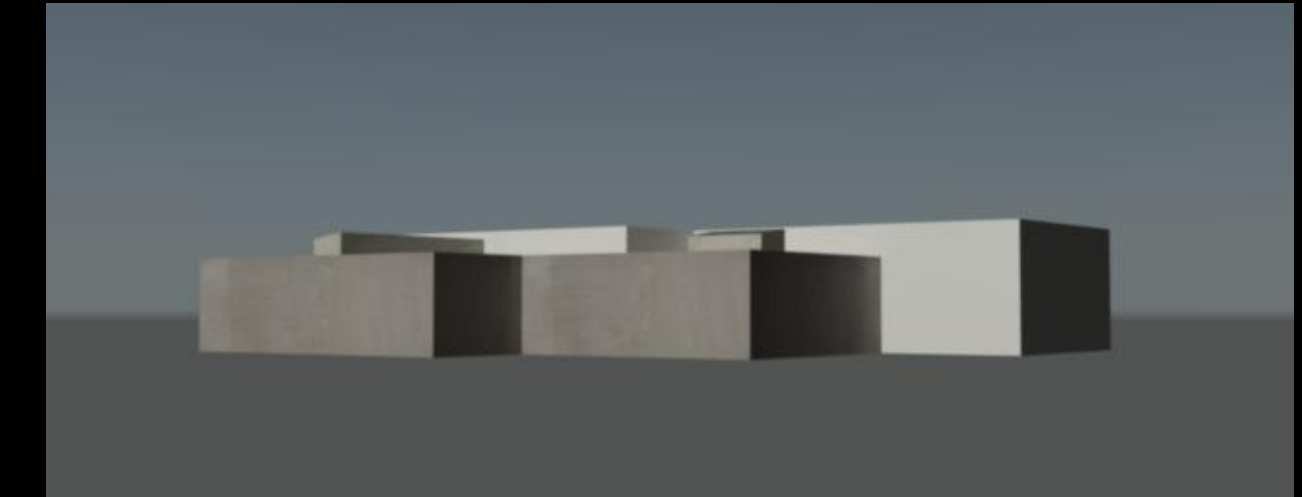
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Questions

Façade Redesign/Tilt-Up Construction

- Conceptual Design:
 - Deduction of 10'
- Design Criteria:
 - Line of Sight
 - Penthouse vs. Building Enclosure

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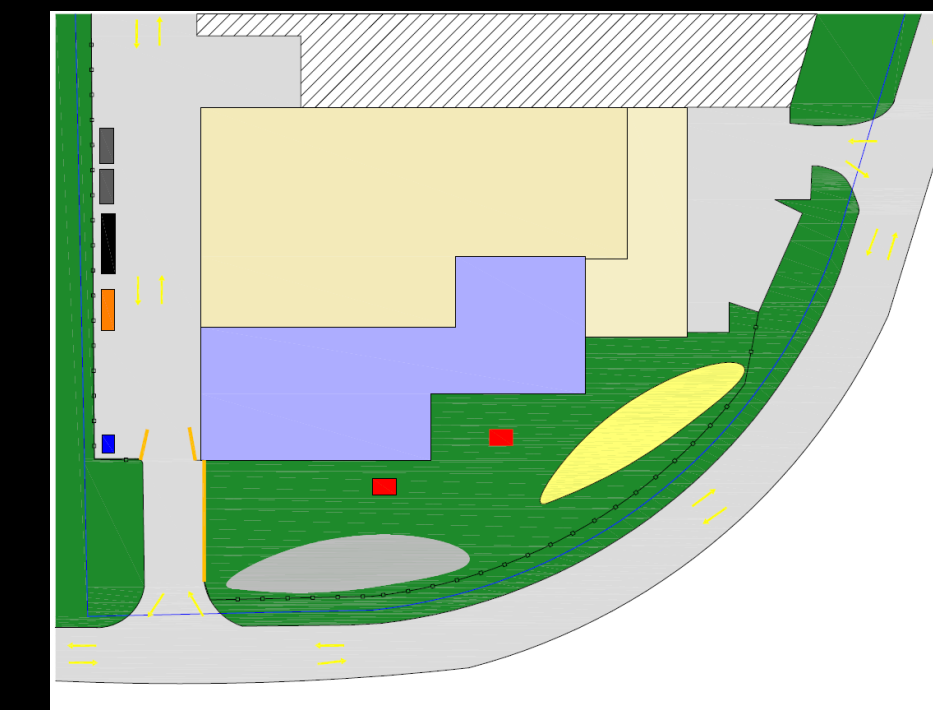
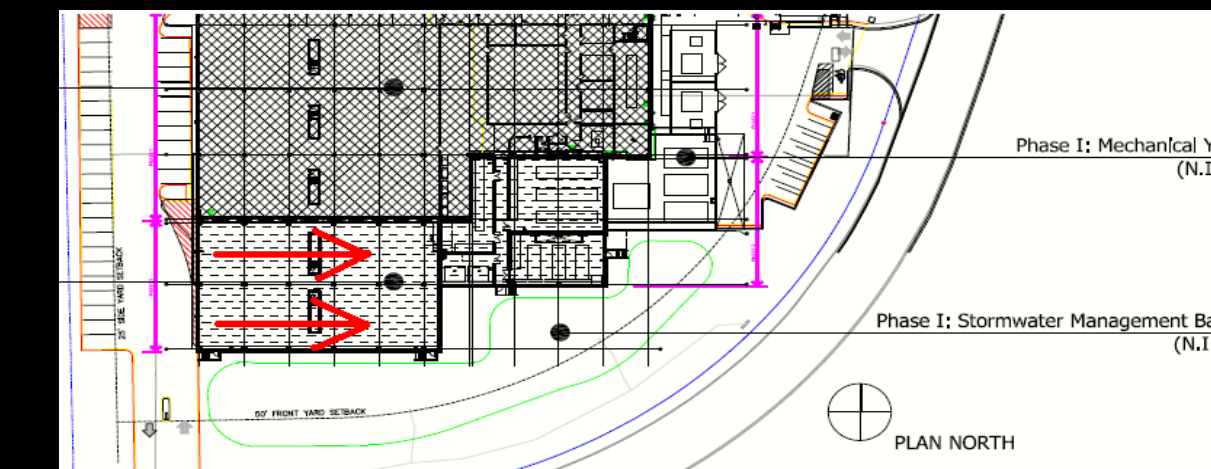
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Questions

Façade Redesign/Tilt-Up Construction

- Sequence
 - Follow the same sequence as Precast (33)
 - Panels are formed and stacked onsite
- Site Layout
 - Need to Revise Site Layout Plan
 - Tilt-up Increases Site Congestion

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Façade Redesign/Tilt-Up Construction

○ RS Means:

- \$41.5/ SF – Precast
- \$15/ SF – Tilt-up

○ Total Savings

- \$160,000 – Includes design
- \$327,000 – Includes design and method

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Cost Comparisons					
<u>Method Type</u>	<u>Cost Per SF</u>	<u>Area before Design</u>	<u>Cost</u>	<u>Area after Redesign</u>	<u>Cost</u>
Precast	41.5	16,197	671,055	12,320	511,280
Tilt-Up	15	16,170	242,550	12,320	184,800

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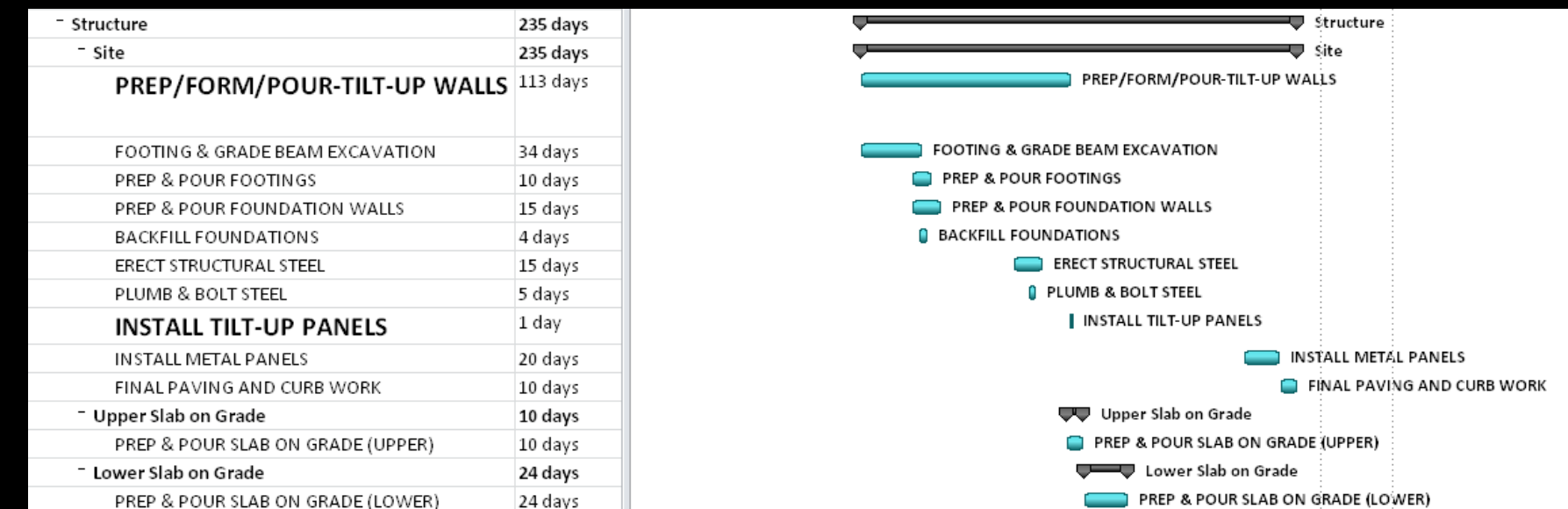
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○ Schedule Impact:

- Precast – 3.3 panels / day
- Tilt-up – 4 panels / hour
 - 33 panels in a nine hour work day
- 9 days cut off cut from the critical path

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Façade Redesign/Tilt-Up Construction

- **Conclusion:**
 - Total Savings of 327,000
 - 9 Days off the Critical Path
- **Recommendations:**
 - The owner should pursue Tilt-up Method, but take note on the safety issues and quality concerns.
 - Highly recommended for the Redesign – Savings of \$160,000
 - Money could pay for PV system

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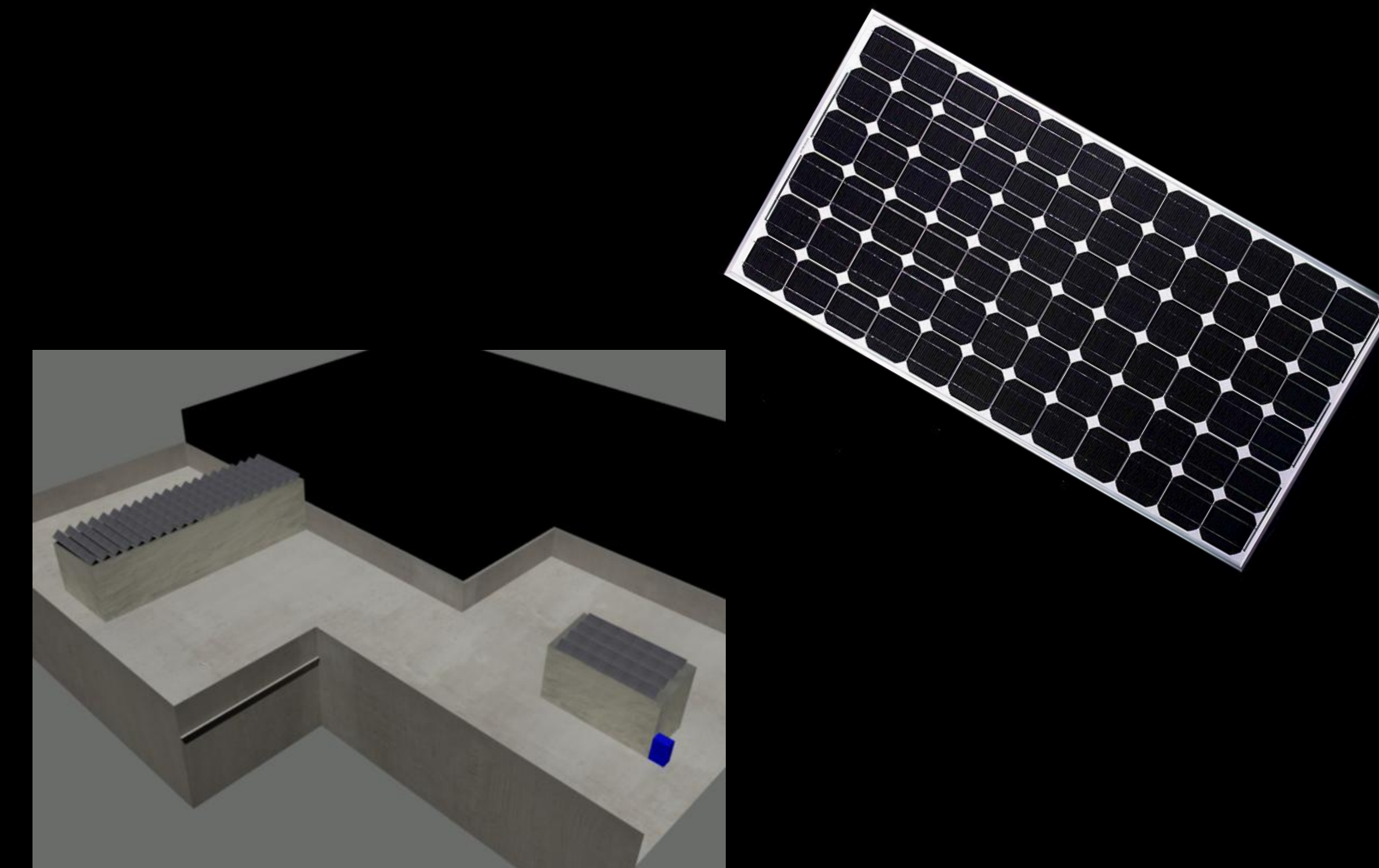
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Questions

Alternate Roof Type – Photovoltaic System

- Opportunity
 - Building is Oriented South
 - Opportunity to utilize the Penthouse roof for design
- Objective
 - Design a Preliminary Photovoltaic System
 - Perform a Financial Feasibility Study
 - Reduce Energy Cost of the Building

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Alternate Roof Type – Photovoltaic System

- What will the power from the panels essentially replace?
- Conclusion:
 - The design will be able to power all of the lighting fixtures in the building.
 - 125 panels required – Design consist of 129 panels
 - 105 panels located on west penthouse
 - 24 panels located on east penthouse

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Energy Loads – Computer Room Lighting Fixtures				
Component	Quantity	Watts	Hrs/Day	kWH
8' 277V Fluorescent	76	60	12	54.72
4' 277 Fluorescent	16	32	12	6.144
Total	92			65

Sizing Calculations	
Sun Hours Per Day	4.21
Watt-Hours Per Day	65000
Watts Per Hour of Sunlight	15439
Actual Power Produced Per Panel	123.5
Number of Panels Required	125

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Alternate Roof Type – Photovoltaic System

○ Calculate Optimal Tilt in Panels

- West Penthouse – 40°
- East Penthouse - 32°

○ Determine Most Efficient Panel:

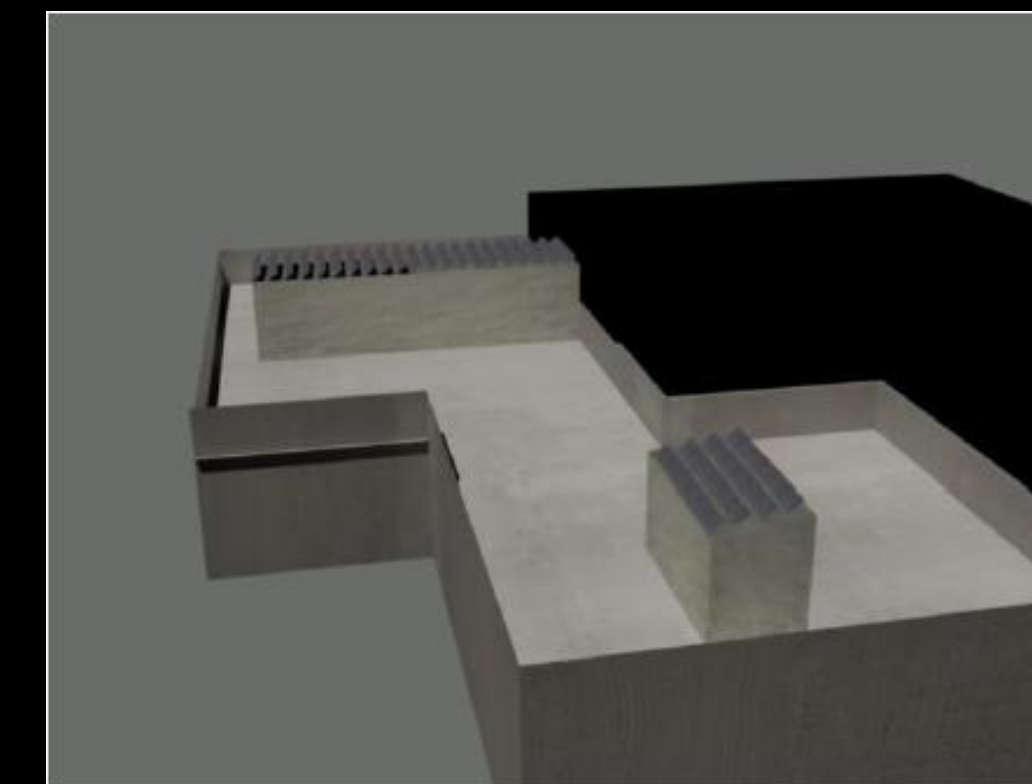
- Sanyo Electric, HIP-200BA19/20



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Tilt Calculations

		Latitude	40 +/- 15
	<u>Penthouse 1 (No Slope)</u>	<u>Penthouse 2 (9° Slope)</u>	
Summer	25°	19°	
Fall/Spring	40°	31°	
Winter	55°	46°	
Mean	40°	32°	



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- PV Watts Calculations:
 - System Produces 31,000 kWh / Year
 - Yearly Savings of \$3900

PV Array Parameters	
DC Rating:	25.8 kW
DC to AC Derate Factor	0.77
AC Rating:	19.9 kW
Array Type:	Fixed Tilt
Array Tilt:	40.5°
Array Azimuth:	180°
Energy Parameters	
Cost of Electricity	12.6 c/kWh

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Month/Year Results			
Month	Solar Radiation (kWh/m ² /day)	AC Energy (kWh)	Energy Value (\$)
1	3.08	1958	246.43
2	3.88	2212	278.40
3	4.93	2981	375.19
4	5.04	2847	358.32
5	5.35	3062	385.38
6	5.54	2981	375.19
7	5.21	2840	357.44
8	5.14	2822	355.18
9	4.98	2718	342.09
10	4.48	2624	330.26
11	3.25	1884	237.12
12	2.90	1805	227.18
Year	4.48	30734	3868.18

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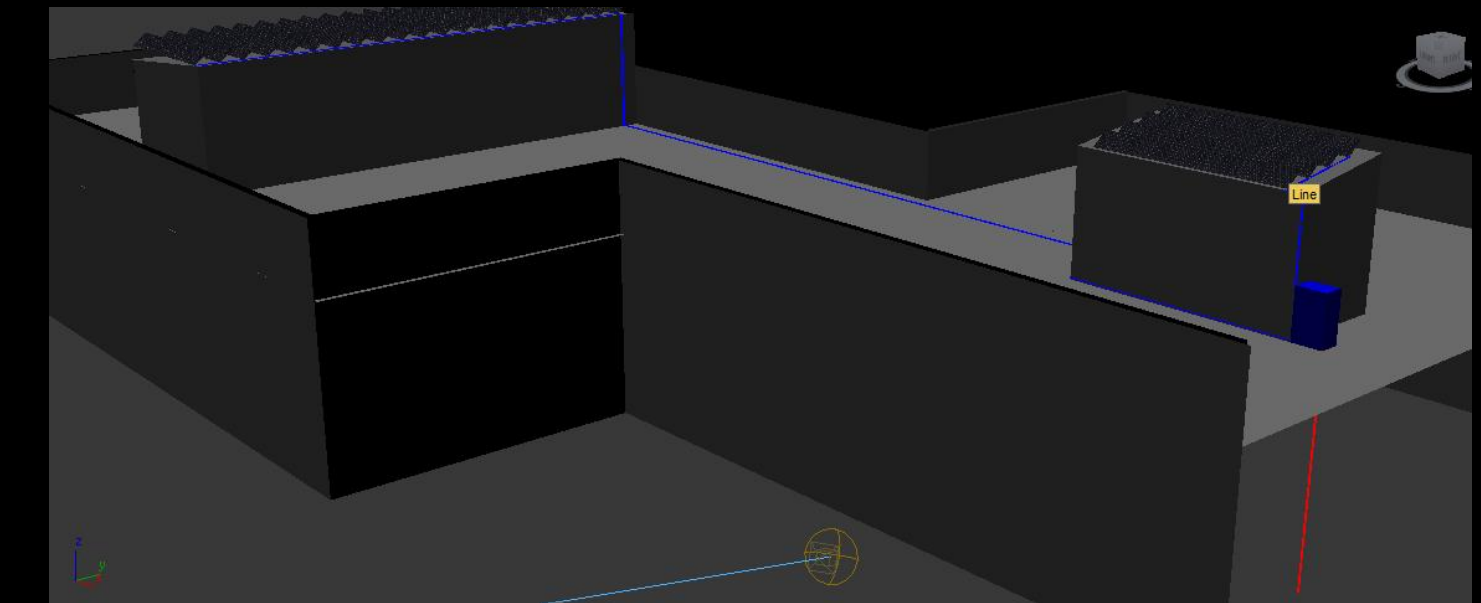
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Alternate Roof Type – Photovoltaic System

- Energy Distribution:
 - DC – Inverter – AC – Grid system
 - Inverter:
 - Sunny Tower ST 36
 - Easy mount
 - Includes all DC/AC connections
- Voltage Drop:
 - DC - Use #8 AWG Wire

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Detailed Cost Breakdown of Proposed System						
Item	Quantity	Unit	Material	Installation	O&P	Total
HIP – 200 BA19	129	EA	957	70	1,387	178,923
Mounting	129	EA	200	19	296	38,184
Inverter	1	EA	21,569	840	30,252	30,252
AC Wire	.26	C.L.F.	168	203	372	97
DC Wire	1.71	C.L.F.	188	203	391	669
Ground Wire	1.97	C.L.F.	75	86	209	412
Conduit/Supports	151	LF	2.02	4.88	9.315	1,407
Total:						249,944

- **Total System Cost:**
 - \$250,000
 - W/ Rebates and Incentives: = **\$160,000**
 - Potential Buy back – 17-18 years

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- **Schedule Impact:**
 - Once the penthouses are constructed, the PV contractor can start
 - Main Concern is Crane Usage
 - Should not affect the critical path

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- **Conclusion :**
 - Up front cost - \$160,000
 - Potential Buyback of 17-18 years
 - Does not affect schedule's critical path
- **Recommendation:**
 - Highly recommended for the owner to consider this preliminary design.
 - Owner has potential to pay for the whole up front cost of this system

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Tablet PC's for Commissioning

- *Introduction*
- Potential Benefits/Challenges
- Case Study
- Conclusion

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Tablet PCs for Commissioning

- **Tablet PC Use:**
 - Quality Control
 - Punch List Management
 - Production Tracking
 - Materials Management
 - Safety
 - **Commissioning**
 - **BIM in the Field**
 - Visual Reporting

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Tablet PCs for Commissioning

○ Potential Benefits:

- Store PDF and paper forms of the budget, schedule, and specs.
- Easier to organize and manage while onsite
- Record performance of mechanical equipment
- Record issues during the commissioning process
- Reference the data on future projects

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○ Challenges:

- Tablet are exposed to hazards on the construction jobsites
- Weather may affect the life of the tablet
- Lack of knowledge in this industry
- Using the tablets to it's full advantage

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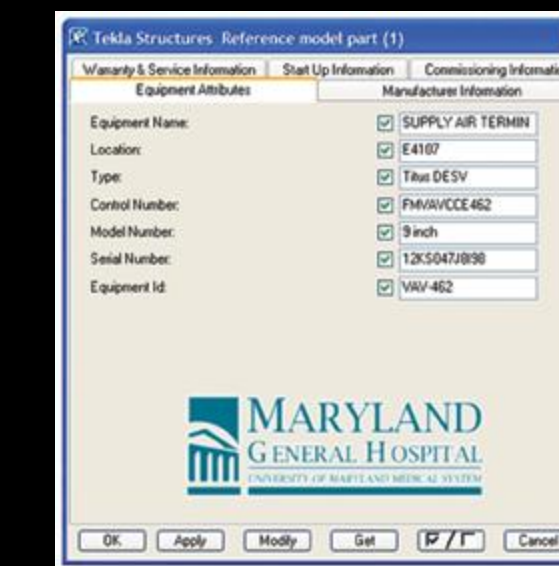
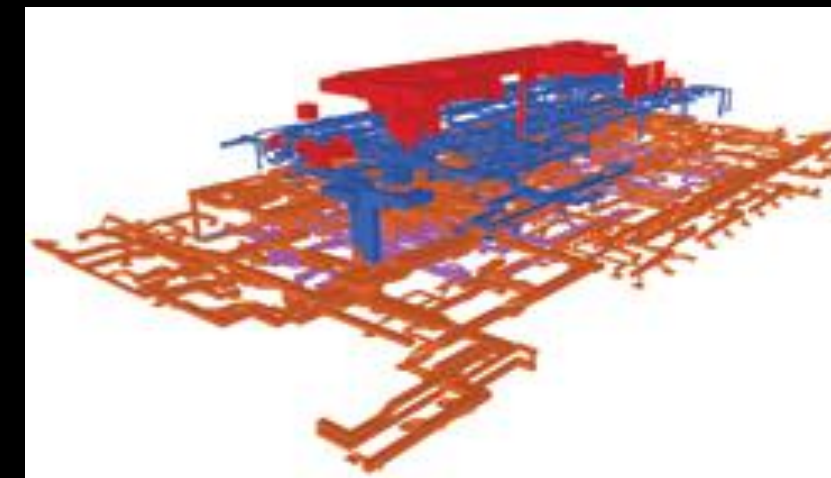
Questions

Tablet PCs for Commissioning

- **Case Study (Maryland General Hospital)**
 - Barton Malow – CM
 - \$57 Million renovation
 - Includes an array of indoor AHU
 - 650 –ton electric chillers/cooling towers
- **Tablets for commissioning**
 - Collected data and documents as one integrated unit with their 3D model.
 - Eliminated all data re-entry
 - Commissioning and their BIM Model totally in synched

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“The same tasks that used to take us days to manage and track, now take just hours”



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Tablet PCs for Commissioning

- **Recommendations:**
 - All CM firms to use tablet PCs for the whole construction process
 - For commissioning – highly recommended for complex MEP projects (hospitals, data centers)
- **Conclusion:**
 - Hard to determine actual value in cost and schedule acceleration.

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SIGMA7 design group



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