Marymount University

26^{TH} STREET PROJECT

BENJAMIN J. MAHONEY | CONSTRUCTION MANAGEMENT
FINAL PRESENTATION | APRIL 13, 2010

Presentation Outline

Presentation Outline

Project Overview

- Location
  - 4763 Old Dominion Drive
  - Arlington, VA
- Owner
  - Marymount University
  - Catholic University
  - 3,600 Students.
- Project Goals
  - Expand Academic Spaces
  - Expand Student Housing
  - Expand Parking Capacity

Presentation Outline

I. Project Overview
II. Introduction to Analyses
III. Analysis I: Short Interval Production Scheduling
IV. Analysis II: MEP Coordination
V. Analysis III: Green Roof Design
- Structural Breadth
- Mechanical Breadth

VI. Lessons Learned
VII. Acknowledgements
VIII. Questions

Project Overview

- Occupancy Type
  - Residential, Business, Storage/Garage & Assembly
- Size
  - 267,000 Square Feet
- Number of Stories
  - (4) Below Grade Parking, (3) Above Grade + Penthouse
- Construction Dates
  - April 2009 – September 2010
- Building Cost
  - $42 Million
- Delivery Method
  - Design-Bid-Build w/ CM Agent

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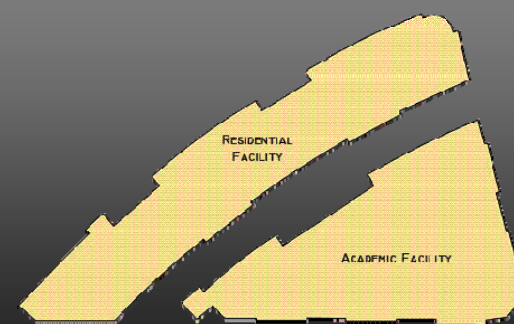
Project Overview

- Residential Facility
  - 62 Units Housing 239 Students
  - 77,000 Square Feet
- Academic Facility
  - 52,000 Square Feet
  - Laboratories, Classrooms, Offices
- Below Grade Parking Garage
  - 138,000 Square Feet



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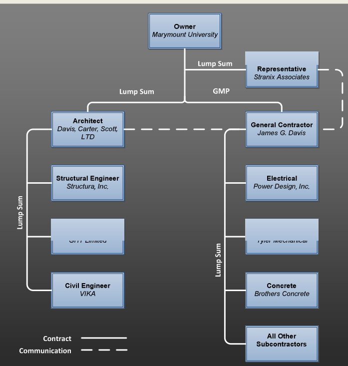
Project Team

PROJECT TEAM	
Owner:	Marymount University
Owner's Representative/CM:	Stranix Associates
General Contractor:	James G. Davis Construction Corp.
Architect:	Davis, Carter, Scott LTD.
Structural Engineer:	Structura, Inc.
MEP Engineer:	GHT Limited
Civil Engineer:	VIKA
Landscape Architect:	Lewis Scully Gionet
LEED Consultant:	Sustainable Design Consulting
Cast-In Place Concrete Subcontractor:	Brothers Concrete Construction, Inc.
Pre-Cast Concrete Subcontractor:	Arban & Carosi
Mechanical/Plumbing Subcontractor:	Tyler Mechanical Contracting, Inc.
Electrical Subcontractor:	Power Design, Inc.



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Introduction to Analyses

- Analysis I: Short Interval Production Scheduling
- Analysis II: MEP Coordination Techniques
- Analysis III: Green Roof Design

Presentation Outline

Analysis I: Short Interval Production Scheduling

- Problem Statement:
  - The repetitive nature of the activities involved with this phase of the project provides an opportunity to attempt to bring the efficiencies of the "manufacturing process" to the construction industry.
- Goal:
  - This type of work will allow the workforce to maximize their productivity, without sacrificing quality. In turn, this will create a schedule that is more predictable, easier to track, and easier to communicate.

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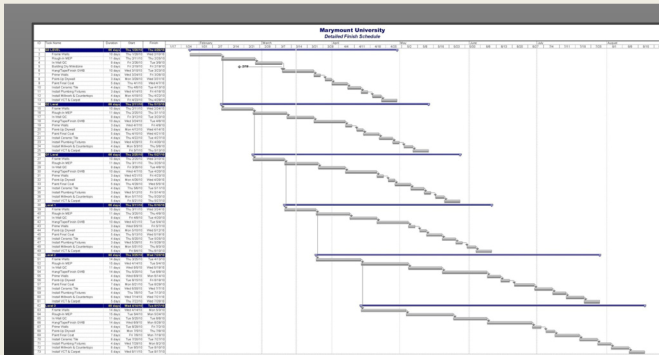
Current Project Schedule

- February 2010 – September 2010
  - 26 Week Duration
- Dependent upon the Building Dry Milestone
  - February 19, 2010
- Involves all Interior Finish Activities for the Residential Facility



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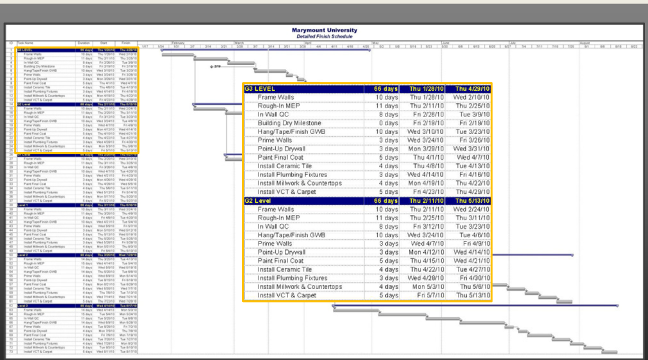

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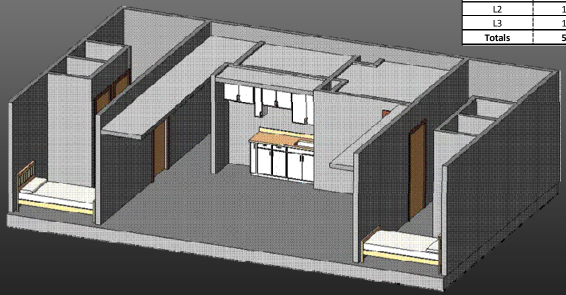
Development of a SIP Schedule

- Break the Building down into Zones/Sections
  - 52 Zones, In Total
  - 1 Zone ~ 900 Square Feet

Building Zones		
Level	Zones	Occupancy
G3	5	26
G2	7	36
G1	7	36
L1	9	42
L2	12	53
L3	12	53
Totals	**52**	**246**



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Development of a SIP Schedule

- Break the Building down into Zones/Sections
  - 52 Zones, In Total
  - 1 Zone ~ 900 Square Feet
- Determine the Sequence of the Critical Path

Number	Color	Critical Activity
1	Red	Frame Metal Studs
2	Green	Rough-In MEP
3	Blue	Preform In Wall QC
4	Orange	Hang/Tape/Finish GWB
5	Gray	Prime Walls
6	Gray	Point-Up Drywall
7	Gray	Paint Final Coat
8	Purple	Install Ceramic Tile
9	Teal	Install Plumbing Fixtures
10	Navy	Install Millwork & Countertops
11	Yellow	Install VCT & Carpet

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Development of a SIP Schedule

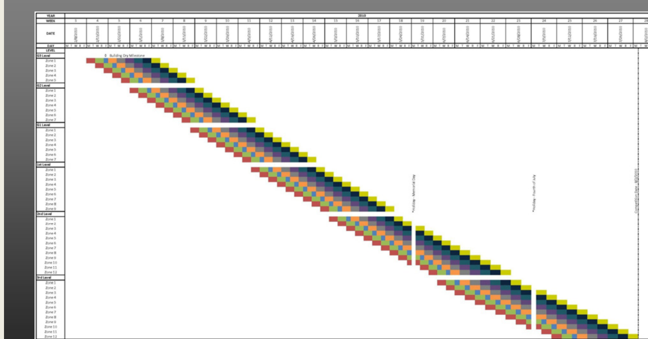
- Break the Building down into Zones/Sections
  - 52 Zones, In Total
  - 1 Zone ~ 900 Square Feet
- Determine the Sequence of the Critical Path
- Level Resources to Ensure Consistent Durations

Number	Color	Critical Activity
1		Frame Metal Studs
2		Rough-In MEP
3		Preform In Wall QC
4		Hang/Tape/Finish GWB
5		Prime Walls
6		Point-Up Drywall
7		Paint Final Coat
8		Install Ceramic Tile
9		Install Plumbing Fixtures
10		Install Millwork & Countertops
11		Install VCT & Carpet

Presentation Outline

Development of a SIP Schedule

- Break the Building down into Zones/Sections
  - 52 Zones, In Total
  - 1 Zone ~ 900 Square Feet
- Determine the Critical Path of the Schedule
- Level Resources to Ensure Consistent Durations
- Create the SIPS Schedule



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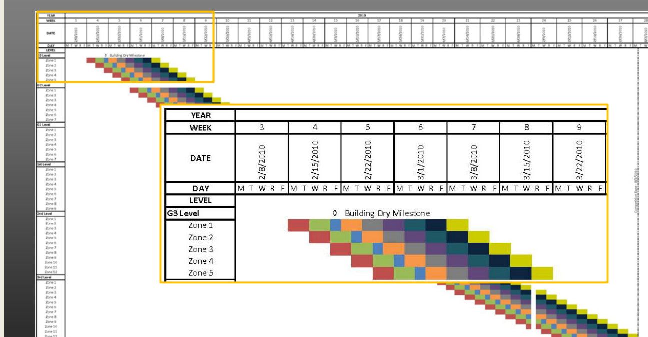
SIP Schedule

- Typical Zone Duration
  - 17 Working Days
- February 2010 – August 2010
  - 24 Week Duration



Presentation Outline

Conclusions & Recommendations

- Activity Shortened by 10 Working Days (8% Reduction)
  - Reduces General Conditions Costs
  - Delays or Stoppages will be Accounted For
- Potential for Early Project Completion
  - Avoid Liquidated Damages
- Schedule can be Utilized as Visual Tool
  - Extremely Predictable
  - Easy to Communicate
  - Easy to Track

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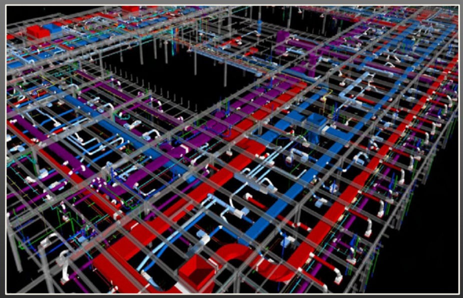
Analysis II: MEP Coordination Techniques

- Problem Statement:
  - The coordination of the MEP Systems have the potential to be extremely problematic. The practice of 3D Coordination has proven itself to be an extremely effective and efficient alternative to 2D Coordination. However, it has yet to become an Industry Standard Practice.

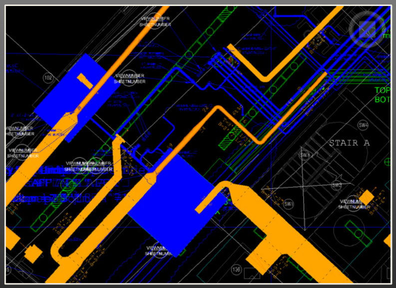
- Goal:
  - Generate a survey that will help establish motives as to why this practice is not being utilized more frequently within the Organization, and more specifically the Construction Industry



Presentation Outline

Current MEP Coordination Method

- Project Team Utilized "Traditional" Coordination
  - 2D Composite Drawings
- Very Time Consuming
  - Generating Composite Drawings
  - Approval Process
  - Coordination Meetings
- Multiple Parties Involved
- Clashes are Inevitable
  - Generate Unnecessary Change Orders
  - Cause Schedule Delays



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3D MEP Coordination

- Computer Software the Combines 3D Modeling & Clash Detection
- Numerous Initial and Long-Term Benefits
  - Initial Benefits
    - Efficient Coordination of an Intricate System
    - Provides a 3D Model that is Easily Visualized
    - Increased Interaction Between trades

Presentation Outline

3D MEP Coordination

- Numerous Initial and Long-Term Benefits
  - Long-Tem Benefits
    - 3D Model can be Utilized for Digital Fabrication
    - Evaluating Model Promotes an Increased Productivity
    - Decreases the number of RFI's and Change Orders
    - Owner Provided with a Higher Quality Product
    - Physical Model serves as a 3D "As-Built"

Presentation Outline

MEP Coordination Survey

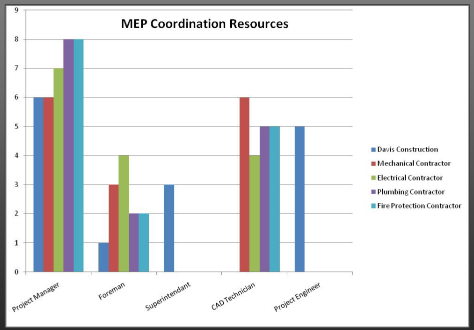
- Distributed to Representative from James G. Davis Construction
  - Generated Ten Responses
  - Included Project Engineers to Senior Vice Presidents
- Completely Anonymous
- 10 Total Questions
  - 4 Questions Regarding 2D Coordination
  - 6 Questions Regarding 3D Coordination

Survey Participants		
Num.	Current Position	Years of Experience
1	Senior Project Manager	12
2	Project Engineer	3
3	Project Manager	13
4	Virtual Construction Manager	2
5	Project Engineer	4
6	Project Executive	11
7	Senior Vice President	32
8	Project Engineer	11
9	Project Executive	12
10	Senior Vice President	19

Presentation Outline

MEP Coordination Survey Results

- Questions Regarding 2D MEP Coordination
  - What resources are typically involved with the MEP Coordination process?
  - What is the typical turn-around time for receiving "approved" composite drawings?
  - Is there money allocated in your budget for MEP Coordination?



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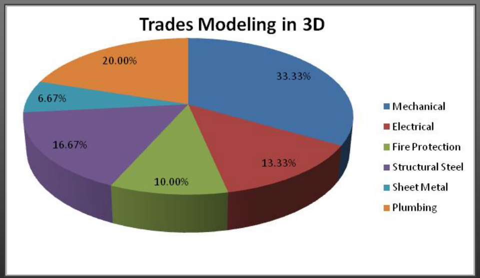
MEP Coordination Survey Results

- Questions Regarding 3D MEP Coordination
  - Are you aware if any trades are beginning to model equipment / components in 3D?
  - What trade would be most likely to accept / reject the change to 3D MEP Coordination?
  - What have been reasons for not pursing 3D MEP Coordination on projects that you have been involved with in the past?



Presentation Outline

Organizational Impacts

- 80% of Employees feel that that they can successfully manage the 3D MEP Coordination process
- James G. Davis is currently utilizing 3D Coordination on 3 projects
  - Committed to utilizing it on major projects in the future
- To ensure that the Projects are Successful, a new role within the Organization has been developed.

Presentation Outline

Integrated Construction Engineer (ICE)

- Educational program that provides employees with the adequate knowledge base to successfully manage 3D Coordination efforts
- Currently, 11 ICEs within the Organization
  - Former Project Engineers
  - Former Asst. Superintendants
  - Former Layout Engineers
- Main Role: Guide project teams through this process
- Remain intact within Project Teams

Presentation Outline

Conclusions & Recommendations

- Project Team Guidelines
  - Seek assistance from an ICE
  - Start the Coordination Process as soon as possible
  - If possible, involve the Engineer / Designer
  - Establish a clear order of Coordination
  - Foreman should be involved during clash resolution

Presentation Outline

Analysis III: Green Roof Design

- Problem Statement:
  - Design a Green Roof that will increase the thermal efficiency of the building's envelope, improve stormwater management, and increase the durability of the roofing membrane.
- Goal:
  - Increasing the thermal efficiency of the building's envelope will help to reduce the overall loads on the HVAC System. The higher initial costs of a Green Roof are expected to be offset by the extended lifecycle and energy savings.

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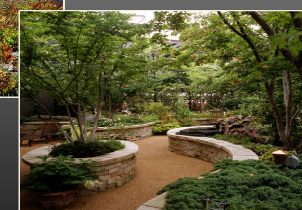
Current Roofing System

- White, Fully Adhered, Thermoplastic Polyefin (TPO) Membrane
  - Covers Entire Roofing Area
    - Residential Facility Roof Area ~ 11,500 Square Feet
    - Academic Facility Roof Area ~ 16,900 Square Feet
  - Membrane adhered to Extruded Polystyrene Insulation

Presentation Outline

Green Roof Selection

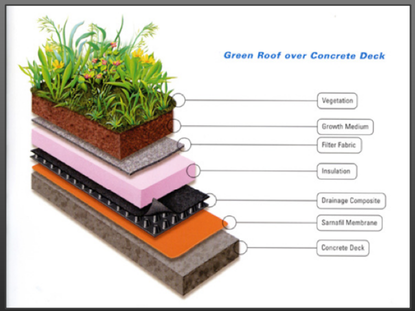
- Extensive V. Intensive Green Roofs
  - Extensive
    - Lightweight
    - Low Maintenance Costs
    - No Irrigation Required
  - Intensive
    - Better Insulating Value
    - Better Stormwater Management
    - Generally Accessible



Presentation Outline

Marymount University Green Roof

- Sika Sarnafil Extensive Green Roof System
  - Lightweight System will have Minimal Impact on the PT Roof Deck
  - Indigenous Vegetation Requires no Irrigation
  - Maintenance Costs Comparable to Existing Roofing System
  - Soil Cover Protects the Membrane from Ultra-Violet Light
  - Potential Reduction in Energy Costs
  - Reduction in Stormwater Run-Off



Presentation Outline

Green Roof: Structural Breadth

- Original Design Criterion
  - Academic Facility
    - Slab Thickness = 9" Post-Tensioned Concrete
    - Live Loads = 30 PSF
    - f´c = 5,000 psi
  - Residential Facility
    - Slab Thickness = 7" Post-Tensioned Concrete
    - Live Loads = 30 PSF
    - f´c = 5,000 psi

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New Design Criterion

- Loads:
  - Framing Dead Load = Self-Weight
  - Superimposed Dead Load = 40 psf (Green Roof)
  - Live Load = 30 psf (Section 1607.0, IBC)
  - Snow Load = 20 psf
- Concrete:
  - f'c = 5,000 psi
- Rebar:
  - f_y =60,000 psi
- PT:
  - Un-Bonded Tendons = ½", 7-Wire Strands

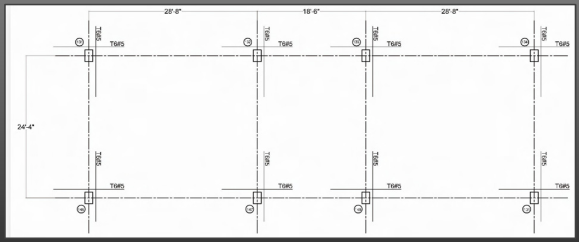
TOTAL DEAD LOAD - Residential Facility Green Roof					
Mark	Area (sf.)	Area Comparison	Density	Total (lbs.)	Total (psf)
Growth Media	11563.00	0.33	85.00	327618.33	28.333
Separation Layer	11563.00	1.00	0.03	38.54	0.003
Drainage Pannel	11563.00	0.17	60.00	115630.00	10.000
XPS Insulation	11563.00	0.33	1.80	6937.80	0.600
Waterproofing Membrane	11563.00	1.00	0.14	1618.82	0.140
				TOTAL	40

TOTAL DEAD LOAD - Academic Facility Green Roof					
Mark	Area (sf.)	Area Comparison	Density	Total (lbs.)	Total (psf)
Growth Media	16896.00	0.33	85.00	478720.00	28.333
Separation Layer	16896.00	1.00	0.03	56.32	0.003
Drainage Pannel	16896.00	0.17	60.00	168960.00	10.000
XPS Insulation	16896.00	0.33	1.80	10036.22	0.594
Waterproofing Membrane	16896.00	1.00	0.14	2365.44	0.140
				TOTAL	40

Presentation Outline

Two-Way Post-Tension Design

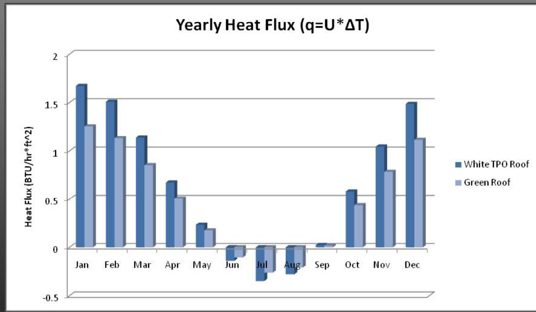
- Slab Design:
  - Slab Thickness = 8"
  - Bottom Bars = #5 @ 10 in. O.C.
  - Top Bars = 6 - #5 @ Int. Supports
    = 6 - #5 @ Ext. Supports
  - PT Tendons = 22, Un-bonded Tendons
- Supporting Columns: OK
- Residential Columns Extended



Presentation Outline

Green Roof: Mechanical Breadth

- Annual Energy Savings
  - Q = Area (ft^2) * (Cumulative Ann Savings) * (Hr/Day) * (Day/Yr)
  - Q = (28,450 ft^2) * (1.9 BTU/HR*ft^2) * (24 Hr/D) * (365 D/Yr)
  - Q = 473,521,800 BTU/Year
- Annual Energy Savings = **$2,705**



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LEED NCv2.2 Analysis

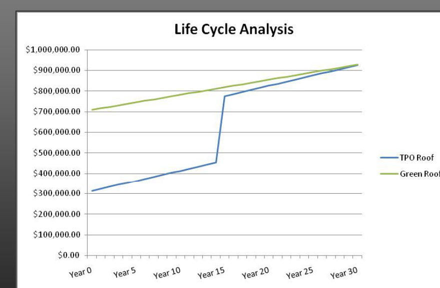
- Green Roof Direct Impacts
  - Sustainable Sites
    - Credit 5.1: Site Development
    - Credit 6.1: Stormwater Design
  - Water Efficiency
    - Credit 2.0: Innovation Wastewater Technologies
  - Innovation & Design Process
    - Credit 1.4: Green Roof Design
- Project Score = 33
  - LEED Silver

Presentation Outline

Cost Impacts

- Green Roof Cost Impacts

Roofing System Cost Comparison		
	TPO Membrane	Extensive Green Roof
Cost	$11.00/SF	$20.00/SF
Lifecycle	15 Years	40 Years
Initial Cost	$312,950.00	$709,000
Energy Savings	-	$2,705



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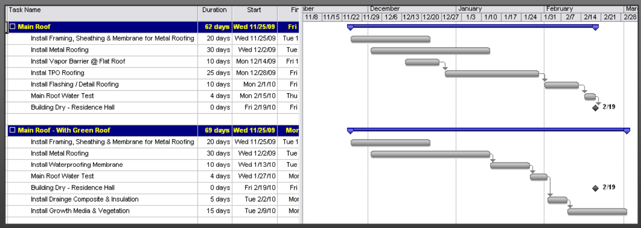
Schedule Impacts

- Existing Fully Adhered, White, TPO Roofing Membrane
  - 62 Days
- Sika Sarnafil Extensive Green Roof
  - 69 Days



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M.A.E. Requirement

- Incorporation of a Green Roof System
  - AE 597D: Sustainable Building Construction
    - LEED Analysis
  - AE 542: Building Enclosure Science and Design
    - Evaluation of the Building Envelope

Presentation Outline

Conclusions & Recommendations

- Financial Impacts
  - Increased Thermal Efficiency Generates $2,705 Annually
  - Higher Initial Costs offset by Lifecycle Costs
  - 30 Year Return on Initial Investment
- Sustainable Impacts
  - Reduces Overall Load on the Mechanical Equipment
  - Extended Lifespan
  - LEED Silver Status

Presentation Outline

Lessons Learned

- Analysis I: Short Interval Production Scheduling
  - A repetitive schedule is an efficient schedule
  - Reduces the total duration and generates savings
- Analysis II: MEP Coordination Techniques
  - Employees need to be educated on new technologies
  - Very time & resource extensive process
- Analysis III: Green Roof Design
  - Higher initial cost can be offset by durability
  - Different systems have varying levels of sustainability

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Special Thanks

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- Mr. James Faust
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- Dr. David Riley
- Mr. Craig Dubler

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- Erik Kaniecki
- Rami Natour
- Aaron Galvin

Marymount University
- Dr. Ralph Kidder
- Mr. Upen Malani
- Dr. James Bundschuh

Stranix Associates
- Ms. Bhavna Mistry Lee

Others
- Maddie
- My Family & Friends

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QUESTIONS?