1099 New York Avenue
Washington, D.C.

William D. Cox
Construction Management

April 14, 2008
Presentation Outline

- Project Overview
- LEED Evaluation
- Green Roof Energy Analysis (*Mechanical Breadth*)
- Green Roof Structural Analysis (*Structural Breadth*)
- Process Mapping MEP Coordination with Building Information Modeling
- Summary & Conclusions
- Questions
Project Overview

- 173,260 Square Feet of Premier Office and Retail Space
- 11 Stories Above Grade, 4 Stories Below Grade Parking
- Construction Costs: $31,600,000
- Project Duration: June 2006 through March 2008
Project Team

Owner

TISHMAN SPEYER

Architect

Thomas Phifer and Partners

Structural Engineer

Tadjer-Cohen-Edelson

MEP Engineer

Syska Hennesy Group

General Contractor

James G. Davis Construction

Agenda

Project Overview

LEED Evaluation

Green Roof Energy Analysis

Green Roof Structural Analysis

Process Mapping MEP Coordination

Summary & Conclusions

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Penn State AE Senior Thesis

Construction Management
Project Features

Structure

- Foundation rests on 3,000 psi Grade Beams and Spread Footings
- Parking Deck Structure comprised of combination 4”, 8” and 12” reinforced concrete decks
- Building frame is 4,000 psi post-tensioned concrete with an Effective Post Tensioning Strength between 100 and 1000 kips
Program Features

Mechanical

- (2) 1440 GPM 500 ton Cooling Towers serve (15) Self-Contained Water Cooled Air Conditioning Units at each level

- VAV Boxes with Reheat Coils to distribute air throughout occupied spaces
Project Features

Electrical

- Building Serviced by a 3φ, 4-Wire, 460/265 Volt, 4000A Main Bus that steps down through (3) 30KVA, 3φ, 460/120V Transformers

- Emergency Power Supplied by (1) 350/438 KW/KVA 480/277V Generator
Project Features

Curtainwall

- South and West facades are constructed of a high performance, low-e coated insulated glass system
- “Fish-scale” assembly, each panel lies in a separate geometric plane
- North and East facades composed of face brick and punch-out windows
Achieving Sustainability
Achieving Sustainability
Achieving Sustainability

Problem

➢ After construction for 1099 New York Avenue had already been underway, Tishman Speyer enacted a new policy that state all new construction projects must be a minimum of LEED Silver

Objective

➢ Investigate project as designed to determine the credits already earned
➢ Develop guidelines for areas of improvement on 1099 New York Avenue and Future Projects
Achieving Sustainability

LEED Silver

- United States Green Building Council states that a core and shell construction project must earn a minimum of 28 Credits to be rated LEED Silver

- Six areas of focus
  1. Sustainable Sites
  2. Water Efficiency
  3. Energy & Atmosphere
  4. Materials & Resources
  5. Indoor Environmental Quality
  6. Innovation & Design process
Achieving Sustainability

Evaluation of Current Credits Obtained

- **Sustainable Sites (3 Credits)**
- **Water Efficiency (2 Credits)**
- **Energy & Atmosphere (3 Prerequisites)**
- **Materials & Resources (2 Credits)**
- **Indoor Environmental Quality (1 Prerequisite, 2 Credits)**
Achieving Sustainability

Evaluation of Credits to be Obtained

Target Areas

- Sustainable Sites (5 Credits)
- Water Efficiency (1 Credit)
- Energy & Atmosphere (3 Credits)
- Materials & Resources (1 Prerequisite, 4 Credits)
- Indoor Environmental Quality (1 Prerequisite, 6 Credits)

9 Previously Earned
+ 19 To be Earned

Total: 28 Credits
Achieving Sustainability

How can these credits be obtained?

- Install bicycle racks within close proximity of the fitness center
- Reserve priority parking spaces for fuel efficient vehicles
- Reduce water usage by 20%
- Install a green roof that covers more than 50% of the building footprint
- Implement a Construction Waste Management Plan
- Use materials containing recycled content
- Control pollution of the indoor environment
Achieving Sustainability

Why a Green Roof?

- **Reduce Stormwater Runoff**
  - Can retain up to 2” of rainfall
- **Reduce Urban Heat Island**
  - Decreases in the release of greenhouse gases
- **Increased Service Life of Materials**
  - Standard life cycle of 50 years
- **Energy Conservation**
  - Up to 50% reduction in consumption on the top floor
- **Improvement of the Aesthetic Environment**
  - Building already has a public access roof, enhance it!
- **Re-Green Washington, D.C.**
  - Initiative by ASLA for 21,700,000 sq ft of green roofs to be installed within the District of Columbia in the next 20 years
Green Roof Energy Conservation Analysis
Green Roof Energy Analysis

Problem

- The performance of a green roof varies upon:
  - Material Composition
  - Orientation
  - Area of Coverage
  - Ratio of Coverage Area to Building Area

Objective

- Develop an energy model of the building using TRACE 700 that includes the thermal properties of a green roof and compare against an energy model of the building as it was originally designed
# Estimated Energy Savings

<table>
<thead>
<tr>
<th>Description</th>
<th>Electric Consumption (kWh)</th>
<th>Water Consumption (1000 gal)</th>
<th>Total Source Energy (kBtu/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Heating</td>
<td>101,605.4</td>
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<td>10,404.4</td>
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<td>Cooling Compressor</td>
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<td><strong>Totals</strong></td>
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<td><strong>1,904.7</strong></td>
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<td>Cooling Accessories</td>
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<td><strong>Totals</strong></td>
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<td><strong>47,315.2</strong></td>
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Green Roof Energy Analysis

Estimated Energy Savings

<table>
<thead>
<tr>
<th>Total Source Energy as Designed (kBtu/yr)</th>
<th>Total Source Energy w/ Green Roof (kBtu/yr)</th>
<th>Estimated Savings</th>
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<tr>
<td>49,049.9</td>
<td>47,315.2</td>
<td>3.54%</td>
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Estimated Cost Savings

<table>
<thead>
<tr>
<th>Initial Cost Increase</th>
<th>Energy Savings (1 yr)</th>
<th>Energy Savings 20 yr (Life of Mechanical Equip.)</th>
<th>Energy Savings 50 yr (Life of Green Roof)</th>
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<tbody>
<tr>
<td>$82,700</td>
<td>$845</td>
<td>$16,900</td>
<td>$42,250</td>
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</table>
Conclusions & Recommendations

- Green Roofs are not the miracle cure for energy savings
- Less effective on taller buildings
- Despite small savings in performance, green roofs still offer other environmental benefits and installation is recommended
Green Roof Structural Analysis
Green Roof Structural Analysis

Problem

➢ The selected green roof system adds a load of 26 lbs/sq ft to the roof structure. The lower roof currently supports 22 lbs/sq ft, the penthouse roof only supports 8 lbs/sq ft.

Objective

➢ Analyze the current penthouse roof structure to determine if it can support the increased load from the extensive green roof system. A slab redesign will be performed if necessary.
Green Roof Structural Analysis

Current Conditions

Loading (from ASCE7):

- Live Load: 30 psf
- Snow: 30 psf
- Gravel Ballast: 5 psf
- Polystyrene Foam Insulation: 1 psf
- Filter Fabric: 1 psf
- Waterproofing Membrane: 1 psf

Total Live Load = 30 psf
Total Dead Load = 38 psf

Factored Loading: 1.2 D + 1.6 (L) + 0.5 (S) = 1.2 (8 psf) + 1.6 (30 psf) + 0.5 (30 psf) = 72.6 psf
Green Roof Structural Analysis

Proposed Conditions

**Extensive Green Roof Loading:**

- Live Load: 30 psf
- Snow Load: 30 psf
- Extensive Green Roof System: 26 psf

Total Live Load = 30 psf
Total Dead Load = 56 psf

Factored Loading: 1.2 D + 1.6 (L) + 0.5 (S) = 1.2 (26 psf) + 1.6 (30 psf) + 0.5 (30 psf) = 94.2 psf
# Direct Design Method for Two-Way Slabs

<table>
<thead>
<tr>
<th>Location</th>
<th>(M_u) (ft-k)</th>
<th>(b) (in)</th>
<th>(d) (in)</th>
<th>(M_u \times 12/b) (ft-k)</th>
<th>(\rho)</th>
<th>(A_s) (in(^2))</th>
<th>Bars</th>
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<td><strong>Long Span</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(2) Half Col. Strip</td>
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<td>84</td>
<td>7</td>
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<td>0.236</td>
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<tr>
<td>Ext. Neg.</td>
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<td>84</td>
<td>7</td>
<td>2.67</td>
<td>0.0021</td>
<td>0.200</td>
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<tr>
<td>Positive</td>
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<td>84</td>
<td>7</td>
<td>4.3</td>
<td>0.0021</td>
<td>0.200</td>
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<tr>
<td>Mid. Strip</td>
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<td></td>
<td></td>
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<tr>
<td>Int. Neg.</td>
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<td>132</td>
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<tr>
<td>Ext. Neg.</td>
<td>6.2</td>
<td>132</td>
<td>7</td>
<td>0.6</td>
<td>0.0021</td>
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<td>#5@12” O.C.</td>
</tr>
<tr>
<td>Positive</td>
<td>20</td>
<td>132</td>
<td>7</td>
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<td><strong>Short Span</strong></td>
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<tr>
<td>Ext. Col. Strip</td>
<td>Negative</td>
<td>15.5</td>
<td>42</td>
<td>6</td>
<td>4.4</td>
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<tr>
<td>Positive</td>
<td>24.7</td>
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<td>0.280</td>
<td>#5@12” O.C.</td>
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<tr>
<td>Middle</td>
<td>Negative</td>
<td>13.9</td>
<td>84</td>
<td>6</td>
<td>2.0</td>
<td>0.0024</td>
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<tr>
<td>Positive</td>
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<td>2.4</td>
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<td>7.1</td>
<td>0.0029</td>
<td>0.280</td>
<td>#5@12” O.C.</td>
</tr>
</tbody>
</table>

**Notes:**
- \(M_u\) = factored moment
- \(b\) = effective width
- \(d\) = depth
- \(A_s\) = area of reinforcement
- \(\rho\) = reinforcement ratio
- Bars: Diameter and spacing of reinforcement in inches.
Slab Redesign

- The slab was checked for punching shear. The nominal shear strength for the slab was calculated to be $\phi V_c = 111.4$ kips, factored shear was determined to be $V_u = 53.9$ kips

- No additional shear reinforcement was required

- Existing Drop Panels can be eliminated for savings
Cost Comparison

➢ The green roof adds an additional $10 per sq ft

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Original Roof Cost</td>
<td>$275,000</td>
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<tr>
<td>Additional Cost for Green Roof Material</td>
<td>$82,700</td>
</tr>
<tr>
<td>Increased Reinforcement</td>
<td>$1,000</td>
</tr>
<tr>
<td>Concrete Material Savings</td>
<td>($2,100)</td>
</tr>
<tr>
<td>Concrete Labor Savings (1 day)</td>
<td>($300)</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$356,300</strong></td>
</tr>
</tbody>
</table>

➢ Total roofing cost is increased by 30%
Green Roof Structural Analysis

Schedule Impact

➢ The installation of a green roof would require an additional 2-3 days beyond the planned 35 days

➢ With the drop heads no longer being required, there is over 500 sq ft of formwork that no longer needs to be installed, a savings of one day
Conclusions & Recommendations

- Structural design is simple
- Cost to redesign is feasible, in fact it’s less
- Change in schedule is minimal
- Recommendation for green roof installation remains
Mapping & Testing the MEP Coordination Process

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Thinking Lean

Principles of Lean Thinking

1. Specify what does and does not create value from the customer’s perspective

2. Identify all the steps necessary to design, order, and produce the products across the whole value stream

3. Make those actions that create value flow

4. Only make what is pulled by the customer

5. Strive for perfection by continually removing successive layers of waste
Moving Towards Lean Thinking

1. Understand Waste
2. Establish Direction
3. Understand the process
4. Map the Process
Process Mapping

Alexander’s Dynamic System Model
Mapping MEP Coordination

The 2D Design Coordination Process

- Control resources based on feedback
- Manipulate process based on designer/subcontractor feedback
- Feedback
- Schedule?
- Efficiency?

Construction Manager (Coordinator)

- Developed Design
  - Component Size & Location
  - Shop Drawings
  - Light Table

2D Design Coordination

- Inadequate Designs
- Clashing Components
- Unapproved Drawings

- Coordinated Design
- Approval from various trades

Summary & Conclusions

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Penn State AE Senior Thesis
Construction Management
Mapping MEP Coordination

Understand Waste/Establish a Direction

- Developed Design
- Component Size & Location
- Shop Drawings
- Light Table

2D Design Coordination

- Inadequate Designs
- Clashing Components
- Unapproved Drawings
Mapping MEP Coordination

Mapping the 3D Design Coordination Process

- Identify Potential uses for model
- Identify Modeling Requirements
- Establish Drawing Protocol

Construction Manager (Coordinator)

- Establish Conflict Resolution Process
- Develop Protocol for Addressing Design Questions

3D Design Coordination with BIM

- Developed Design Models
- Component Size & Location
- Collision Detection Software

- Coordinated Design ready for Fabrication
- Approval from various trades
Mapping MEP Coordination

Mapping the 3D Design Coordination Process

3D Design Coordination with BIM

- Integrate Discipline Specific 3D Models
- Identify Conflicts between Components/Systems
- Develop Solutions for the identified Conflicts
- Document Conflicts and Solutions
Mapping MEP Coordination

Problem

- During core construction, it was discovered that although the MEP Systems had been coordinated on the drawings, there was difficulty with fitting all of the components into the available space. This same problem was also noticed in the main lobby.

Objective

- Compare the 2D Design Coordination Process against the 3D Process to determine the potential time and cost savings.
Mapping MEP Coordination

Testing the 3D Design Coordination Process

- A 3 Dimensional Model of the Main Lobby and its MEP Components was constructed
Mapping MEP Coordination

Testing the 3D Design Coordination Process

- The model was imported into Navisworks for the mechanical and plumbing systems were compared against each other.
Why was there a collision?

- System components with a combined depth of 2’ – 3” must pass through a plenum space that is only 1’ – 9” deep
Mapping MEP Coordination

Finding a Solution

➢ Two possible solutions:
  1. Resize the pipe
  2. Relocate the pipe
Verifying the Process

3D Design Coordination Experience

➢ A series of five case studies were researched to determine the average increase in productivity while implementing BIM

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>Estimated Increase in Productivity</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>General Motors Manufacturing Facility</td>
<td>30%</td>
</tr>
<tr>
<td>B</td>
<td>The Camino Medical Group Project</td>
<td>25%</td>
</tr>
<tr>
<td>C</td>
<td>Harborview Medical Center</td>
<td>50%</td>
</tr>
<tr>
<td>D</td>
<td>Alcoa World Alumina Plant</td>
<td>20%</td>
</tr>
<tr>
<td>E</td>
<td>NLA Federal Building</td>
<td>19%</td>
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Average Productivity Increase 28.8%
Verifying the Process

Potential Savings

Agenda

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LEED Evaluation
Green Roof Energy Analysis
Green Roof Structural Analysis
Process Mapping MEP Coordination
Summary & Conclusions

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28.8% Savings
Mapping MEP Coordination

Conclusions & Recommendations

- The majority of the projects surveyed were either healthcare or manufacturing facilities
- 1099 New York Avenue is a Core & Shell Project, not MEP intensive
- Increased Productivity should be estimated as 60% of observed value
- Increase of 17.3% provides a four month schedule acceleration
- With such potential for efficiency and savings, begin implementing 3D Design Coordination Process as part of the LEED initiative
Summary & Conclusions
Summary & Conclusions

Achieving Sustainability

- Easy to achieve when implemented at the correct stage of design
- Team effort, creating guidelines is the responsibility of the owner

Energy Considerations for Green Roofs

- Green roofs are not the miracle cure for optimizing energy performance
- Still has other environmental benefits
Summary & Conclusions

Structural Considerations for Green Roofs

- Cost of structural redesign is feasible
- A green roof can pay for itself over a period of 20 years

Mapping & Testing the MEP Coordination Process

- Potential for 17.3% increase in productivity, 4 month schedule acceleration
- Implement Lean Process as part of the sustainability policy
Acknowledgements

James G. Davis Construction Corporation
- Bill Moyer
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- Joel Miller

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- Cynthia Bowden

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- Dr. Riley
- Dr. Horman
- M. Kevin Parfitt
- Dr. Messner

Syska Hennesey Group
- Jim Miller

Barton Malow Company
- Mark Falzarano
- Corinne Ambler
Questions?