The New Upper Dublin High School

Senior Thesis Final Presentation
Stephen Kelchaw
Construction Management
Presentation Overview

- Building Overview
- Thesis Theme/Goals
- MAE Requirements
- Analysis I – LEED on Projects
  - Analysis II – Geothermal Well System
- Mechanical Breadth
- Analysis III – Rainwater Collection
- Analysis IV – Lighting System Analysis
  - Lighting/Electrical Breadth
- Summary/Conclusions
- Questions
Building Overview

- Size: 368,000sf
- Location: Fort Washington, PA
- Project Budget: $119.2 Million
- Pursuing minimum LEED Silver rating
- Located on the same site as the existing high school

Upper Dublin High School Construction Project

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4-year construction timeline (Aug. ’08 – Aug.’12)

2 Phases with multiple sub-phases

Major Milestones:

- December 2009 – Gym/Pool Completion
- December 2010 – Classroom Wing/Phase I Completion
- January 2011 – Final demolition of existing high school
- August 2012 – Phase II/Final Building Completion
Thesis Theme/Goals

**Overall Theme:**

- Impact of implementing sustainable practices and technologies on construction projects

**Main Goals:**

- Look at sustainability from a CM’s point of view
  - Study the impact of implementing new/additional technologies with a cost and schedule focus
  - Keep in mind the public, school district, and students
  - Take advantage of this opportunity to look at the impact of sustainability on an actual project
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• Graduate Class Incorporation:
  • AE 597D – “Sustainable Building Methods”
  • AE 572 – “Project Development and Delivery Planning”
Analysis I – LEED on Projects

**Goals:**
- Study the benefits of pursuing LEED on projects
- Determine the impact of LEED on schedule and overall costs
- Take a look at how LEED changes the project structure

**Why did the UDSD Pursue LEED?**
- Project approved by public referendum
- Held several town meetings
- Public pushed for energy efficiency, a healthier facility, and a building that serves as an educational tool
Analysis I – LEED on Projects

• Main Points of Contact:
  - Owner
  - Construction Manager
  - LEED Consultant

• LEED Checklist and Responsibilities:
  - LEED for Schools, released in 2007
  - Integrative Design Process
  - Increased amount of paperwork
  - Responsibilities Matrix
Analysis I – LEED on Projects

• **Project Structure Changes:**
  - Third-party commissioning agent
  - LEED Consultant
  - Energy Modeler
  - No difference in labor crews

• **Additional Costs and Benefits:**
  - There aren't necessarily additional costs
  - LEED provides proof that a building meets initial expectations
Analysis I – LEED on Projects

**Conclusion/Recommendations:**
- Can be implemented without additional costs
  - Integrative Design Approach
- The only major timeline difference is increased paperwork
  - Divided in Responsibility Matrix
- Some additional entities may be necessary
- LEED provides proof that the building was constructed as expected.
- Beneficial to all construction projects
Analysis III – Rainwater Collection

**Goals:**
- Look into the addition of a rainwater collection system for this school
- Implement a system that is cost friendly, and will not impact the schedule

**Initial Observations:**
- This area receives approximately 48” of rain annually
- Large amount of roof area
- Large potential for rainwater collection

• Upper Dublin High School Construction Project
Analysis III – Rainwater Collection

- Discussion with Owner and CM:
  - Rainwater collection was not considered during design
  - This was mainly due to cost and space
  - There was also a lot done with storm water management and water efficiency
  - This would have been valuable as a learning tool for students
Analysis III – Rainwater Collection

- **Rainwater Collection System Attributes:**
  - Low space requirements
  - Minimal Cost
  - Visible
  - Educational

- **Solution:**
  - RainXchange Rain Barrel by Aquascape, Inc.
  - 75 gallon capacity
  - Can be combined in series
  - $250 per barrel
Analysis III – Rainwater Collection

• **Implementation:**
  - 4 barrels can be combined for a 300 gallon capacity
  - Based on an average 4in. rain per month, this requires 120ft² of roof space
  - Roof can be sectioned off to funnel water into rain barrel through guttering
  - Can be installed after building completion
  - Located in a visible area

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Analysis III – Rainwater Collection

**Conclusions/Recommendations:**
- Large-scale rainwater collection is not a feasible idea
- RainXchange rain barrels are very inexpensive
- They can be installed post-construction
- They are relatable for the students and is something they can implement in their own homes
Analysis IV – Lighting System Analysis

• **Goals:**
  - Research the components of the main classroom lighting system
  - Compare these technologies to other industry lighting systems
  - Compare efficiency between this lighting system and typical lighting systems
Analysis IV – Lighting System Analysis

**Lighting System Components:**
- Occupancy and Daylight Sensors
- High-output T5 Fluorescent lighting

  Combination will decrease lighting loads by up to 80% compared to standard switching controls

**T8 versus T5 Fluorescent:**
- HOT5 cost 3-4 times the price of a T8 fluorescent bulb
- HOT5 is only slightly more efficient than a T8
- Both have a 20,000 hour lifecycle

### Lamp Performance Table

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Color Rendering Index (CRI)</th>
<th>Efficacy (lumens/watt)</th>
<th>Coefficient of Utilization (CU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T12</td>
<td>69</td>
<td>72</td>
<td>0.44</td>
</tr>
<tr>
<td>T8</td>
<td>85</td>
<td>92</td>
<td>0.74</td>
</tr>
<tr>
<td>T5</td>
<td>85</td>
<td>103</td>
<td>0.90</td>
</tr>
</tbody>
</table>
Analysis IV – Lighting System Analysis

• **Added Benefit to HOT5 Fluorescent:**
  - Produces much more light than a T8
  - This will reduce the quantity of lights needed per room
  - The value will increase with the size of the project

• **Conclusions/Recommendations:**
  - HOT5 costs much more than T8, but makes it up in performance and quantity of light
  - The combination of elements create a very efficient lighting system
Lighting/Electrical Breadth

**Goal:**
- To find a comparable replacement for the HOT5 fluorescent in terms of cost, energy efficiency, and performance

**LED Fluorescent Tube:**
- 50,000 hour lifecycle
  - Can be used in the same fixture as the fluorescent lamp
  - Does not require a ballast
- Consumes much less energy at 12W (compared to 54W)
• Easy Installation:
  • Requires bypass of the ballast
  • Simple wiring can be performed by building maintenance

• Disadvantages:
  • 8-10 times more expensive than HOT5 ($75 each)
  • Much less light output (900 lumens compared to 5,000 for HOT5)
Upper Dublin High School Construction Project

**Lighting/Electrical Breadth**

- **Load Reduction, Cost, Payback**
  - Approx. 117 classrooms
  - 6 fixtures per classroom with 4 lamps per fixture
  - $260 per 4-pack of LED Tubes
  - $182,500 total initial cost
  - 3.5 year payback
  - Estimated 17 years total service life

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**Load Reduction, Cost, Payback**

<table>
<thead>
<tr>
<th></th>
<th>Classroom Fixtures per Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Reduction</td>
<td>LED Fixtures</td>
</tr>
<tr>
<td>Cost</td>
<td>LED Fixtures</td>
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<tr>
<td>Payback</td>
<td>LED Fixtures</td>
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<tr>
<td>Total initial cost</td>
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• Conclusions/Recommendations:
  • Pros far exceed cons of LED Fluorescent Tubes to HOT5
  • Initial cost is reasonable, and payback is very quick
  • Large reduction in energy consumption
  • Significantly lower light output than a HOT5
  • This is not suitable as a direct replacement for the existing fixtures
Summary/Conclusions

• Main thesis goals were met
• Sustainability was looked at from the standpoint of a construction manager
• LEED can be a valuable addition to any project
• Many sustainable technologies exist, but some still need development

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Questions

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Owner
The Upper Dublin School District
Michael Pladus – Superintendent of Schools
Brenda Jones Bray – Business Administrator

A.E. Faculty
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Industry
D’Huy Engineering, Inc.
Warren M. Gercke – Senior Project Manager
Gilbert Architects, Inc.
Brian Good

7 Group
Marcus Sheffer – LEED Consultant

Aramark Technical Services
Chris Skalski – Commissioning Agent

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