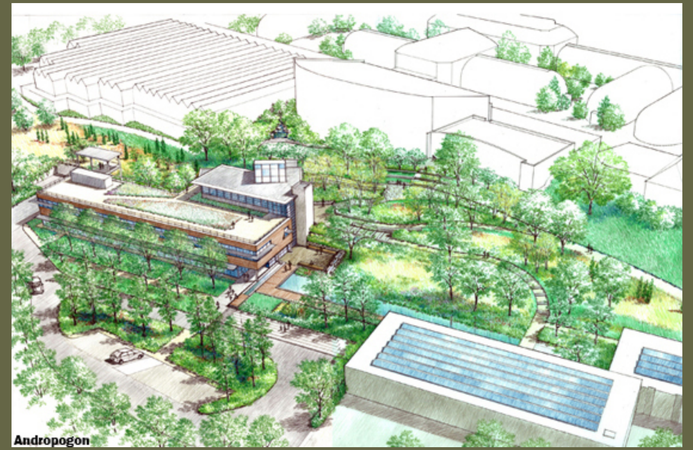
Center for Sustainable Landscapes

Pittsburgh, PA

Daniel Zartman | Construction
Advisor : Dr. Robert Leicht



Images courtesy of the Design Alliance Architects

Project Background

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Presentation Outline:

I. Project Background
- **I. General Information**
- II. Building Information

II. Analysis 1: Critical Industry Issue
III. Analysis 2: Constructability
IV. Analysis 3: Value Engineering
V. Analysis 4: Schedule Acceleration
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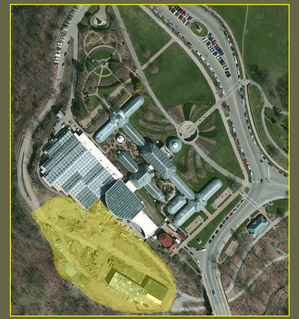

Images Courtesy of Microsoft Corporation

General Project Information:

- Owner: Phipps Conservatory
- Contractor: Turner Construction
- Location: Schenley Park, Pittsburgh, PA
- Function: Mixed Use (Office/Education)

Building Size :

- Area: 24,350 GSF
- Height: 40’- 4” (3 Stories)

Project Size:

- Contract Value: $10 Million ($410 per SF)
- Project Type: New Construction
- Project Duration: 11 Months

Images Courtesy of Turner Construction

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Project Background

Structural System:
- Substructure: Concrete Strip/Spread Footing
- Superstructure: Braced Steel Frame

Building Envelope:
- Exterior Walls: 8” Metal Stud w/ Reclaimed Barn Wood Facade
- 7,600 SF Green Roof

Sustainable Achievements:
- LEED Platinum
- Living Building Challenge
- SITES Certification for Landscapes
- Net-Zero Annual Energy Consumption
- Net-Zero Annual Water Consumption

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Images Courtesy of Turner Construction

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Analysis 1: Critical Industry Issue - Avoiding Traditional Delivery Methods on Publicly Funded Projects

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Presentation Outline:

I. Project Background
II. Analysis 1: Critical Industry Issue
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Images courtesy of the Design Alliance Architects

Critical Industry Issue: Legislation in Pennsylvania prevents public projects from utilizing progressive delivery systems.

State requirements for publicly funded projects:

- Traditional Design – Bid – Build
- Hard-bid
- Multiple Prime Contracts

Problems:

- Does not adequately address the needs of complex projects
- Does not incentivize the contractor to minimize schedule and cost growth

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Images courtesy of the Design Alliance Architects

Critical Industry Issue: Legislation in Pennsylvania prevents public projects from utilizing progressive delivery systems.

Research Goal: To create a decision tree that illustrates the progressive alternatives available to Penn State's OPP.

Funding Types:

- Private
- Public
- Combination

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Critical Industry Issue: Legislation in Pennsylvania prevents public projects from utilizing progressive delivery systems.

Research Goal: To create a decision tree that illustrates the progressive alternatives available to Penn State's OPP.

Research Method: Analyze projects completed in PA by public and private owners using public funding.

Project Features Analyzed:

- Funding Type
- Delivery System
- Contract Type
- Procurement Method

Industry Members Interviewed:

- John Bechtel – Asst. Director of Design and Construction at Penn State's OPP
- James Hostetler – Director of Construction and Design at Bucknell University
- Kristine Retetagos – VP Preconstruction Turner Construction Pittsburgh
- Tim Gilotti – Radner Property Group
- Jeff Sandeen - Hensel Phelps Construction Co
- Mike Arnold – Foreman Group
- Elizabeth O'Reilly - Deputy Secretary of Pennsylvania's Public Works

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Penn State's Office of Physical Plant:

- Operates as an extension of DGS
- Public funding types most commonly received:
  - Delegated (most common) – OPP is given money with specific use
  - Non-Delegated (uncommon) – DGS stays heavily involved

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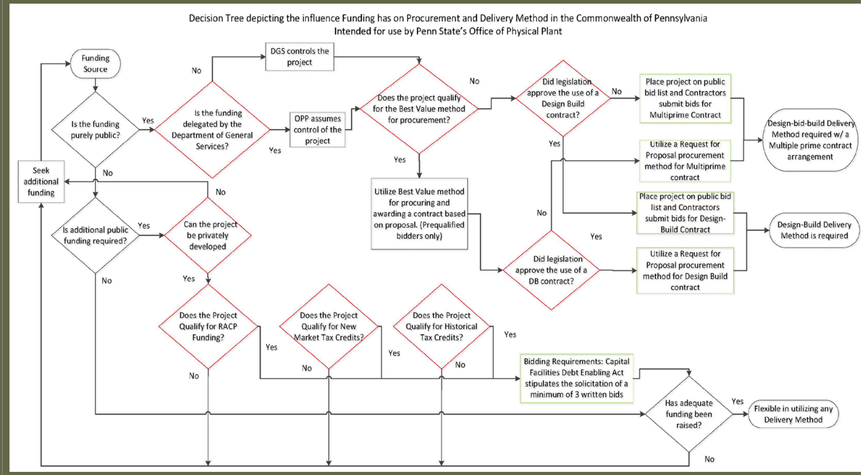
Projects Researched:

- SCI Benner: Design-Build, GMP
- Bucknell University Bookstore: Design-Bid-Build, CM At-Risk, GMP
- Center for Sustainable Landscapes: Design-Bid-Build, CM At-Risk, GMP

The Decision Tree: Illustrates the influence funding has on procurement, delivery and contract methods

- Black Diamonds: Represent questions that can be answered by OPP project staff
- Red Diamonds: Represent decisions that are made by the Government
- Green Boxes: Display the conditional procurement methods



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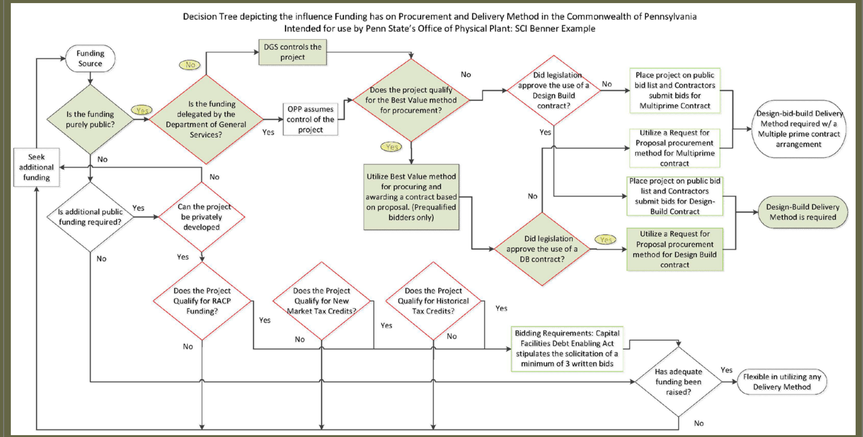
Project: SCI Benner

- Project Synopsis: $174 million new construction of a 2,000 bed medium security prison
- Location: Bellefonte, PA
- Owner: Department of General Services
- Delivery Method: Design-Build
- Contract Type: GMP
- Procurement Method: Best Value



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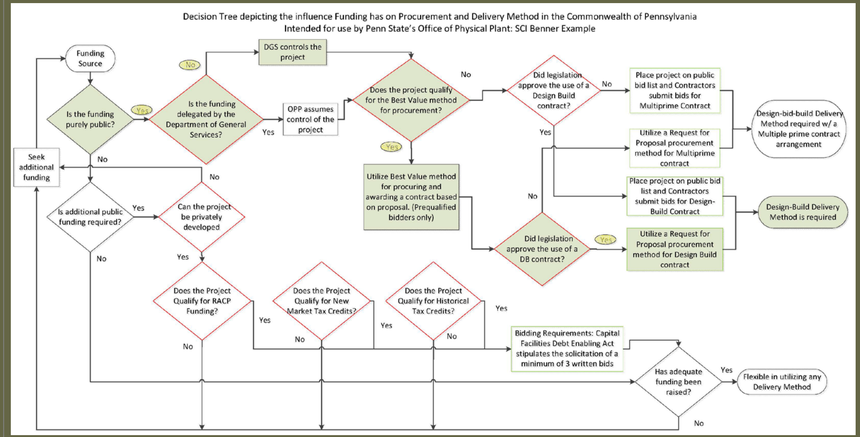
Decision Tree depicting the influence Funding has on Procurement and Delivery Method in the Commonwealth of Pennsylvania
Intended for use by Penn State's Office of Physical Plant: SCI Benner Example



Conclusions: Project Exemption is Plausible

- Provided exemption is approved by DGS
- Provided exemption is authorized by Legislation

Recommendations

- 2 out of 3 owners analyzed utilized a traditional delivery system despite exemption
- Pursue the use of contemporary delivery methods when necessary

Analysis 2: Constructability – Alternative Design of Atrium

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Problem Identification: 2-Story radiused cast-in-place concrete atrium stair

- Labor intensive
- Produces a large amount of onsite waste

Images courtesy of the Design Alliance Architects

Analysis 2: Constructability – Alternative Design of Atrium

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Problem Identification: 2-Story radiused cast-in-place concrete atrium stair

- Labor intensive
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Research Goal: Develop an alternative atrium design that:

- Improves Constructability at a minimal cost
- Maintains the spaces passive performance
- Aesthetically pleasing

Images courtesy of the Design Alliance Architects

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Problem Identification: 2-Story radiused cast-in-place concrete atrium stair

- Labor intensive
- Produces a large amount of onsite waste

Research Goal: Develop an alternative atrium design that:

- Improves Constructability at a minimal cost
- Maintains the spaces passive performance
- Aesthetically pleasing

Proposed Solution:

- Structural steel stair
- Transfer thermal mass to atrium walls

Images courtesy of the Design Alliance Architects

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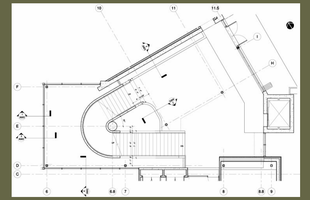
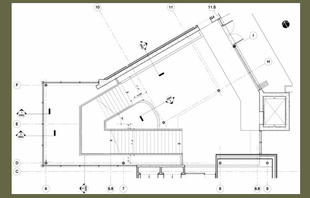
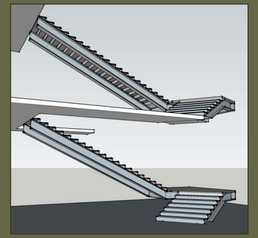


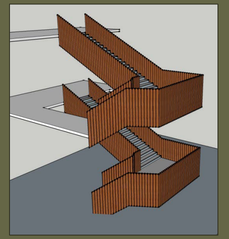
Alternative Design (Below)

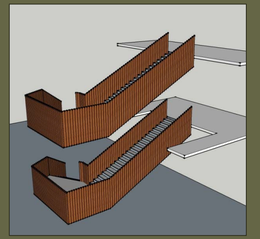


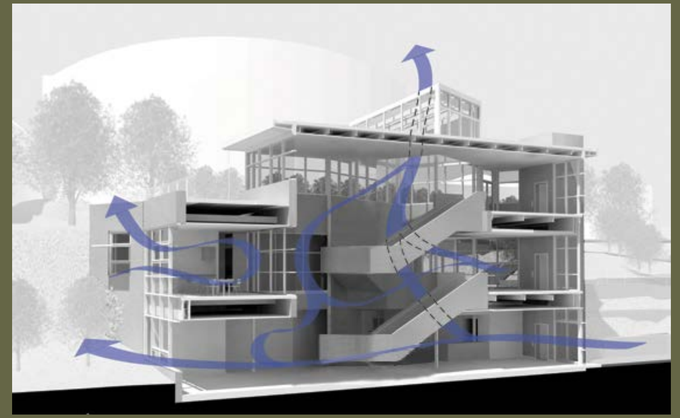
Changes to Original Design in Alternative Design

- Alternative Stair
  - Structural Steel
  - Rectilinear
  - Self-supporting









Imagery based off of one provided by The Design Alliance Architects

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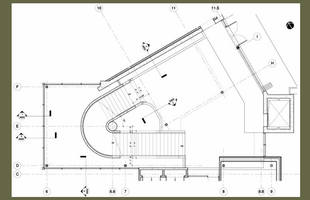

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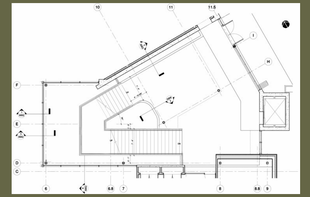
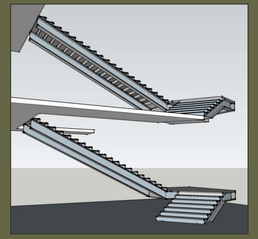
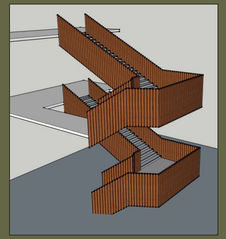
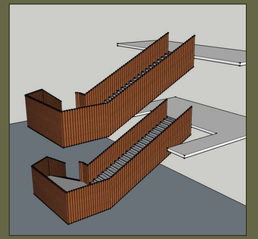


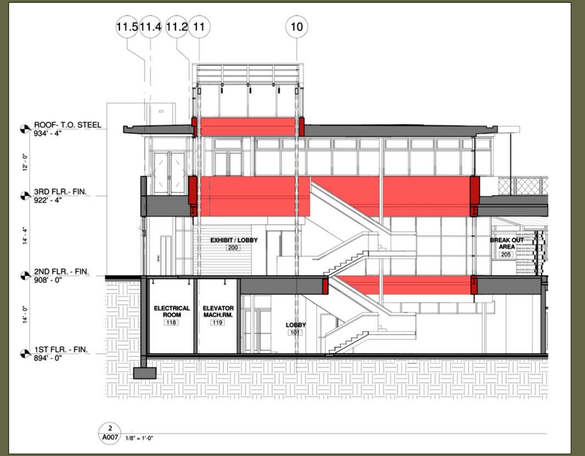
Changes to Original Design in Alternative Design:

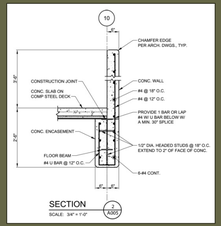
- Alternative Stair
  - Structural Steel
  - Rectilinear
  - Self-supporting
- Alternative Wall Design
  - Inc. thickness of concrete by 3 inches
  - Net decrease in concrete: 3 cubic yards

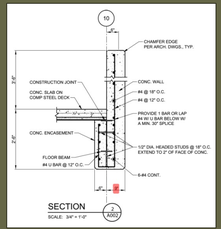












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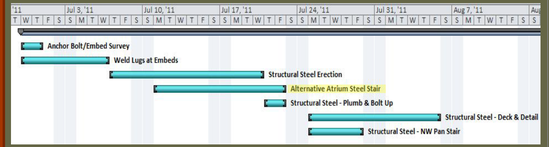
Schedule Impacts:

- Original Design: 20 days
- Alternative Design: 10 days (phased with steel erection)
- Not located on critical path



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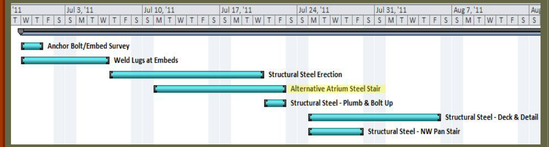

Cost Summary:

- Net Increase: $70,000
- Resulting from:
  - No central support added approximately $25,000
    - Increased connections costs
    - Increased structural steel costs
  - Terrazzo finishes added approximately $15,000

Cost Comparison		
Original Design - Cost of Concrete Stair	**$**	**49,950.00**
Alternative Design - Total Cost	**$**	**119,707.63**
Alternative Design - Cost of Steel Stair	$	105,603.65
Alternative Design - Increase in Wall Thicknesses	$	14,103.98
Net Increase in Alternative Design over Original Design	**$**	**69,757.63**

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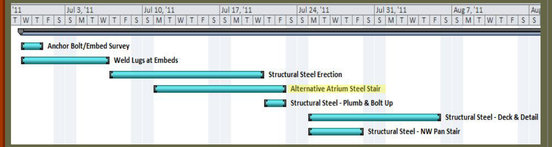

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Alternative Design Conclusions: Not Recommended

- Pros
  - Comparably Sustainable
  - Minimizes Construction Waste
  - Improves Aesthetics
  - Reduces Schedule by 10 days
- Cons
  - Significantly increased material cost

Recommendations

- Make adjustments to reduce cost:
  - Replace terrazzo
  - Add column

Analysis 3: Value Engineering – Redesign of Raised Floor Distribution System

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Images courtesy of *accessfloorsystems.com*

Problem Identification: Raised Floor Distribution Plenum

- Higher system costs
- Increased building height from redundant plenum spaces

Images courtesy of *kingspan.com/raised_flooring/full.jpg*

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Analysis 3: Value Engineering – Redesign of Raised Floor Distribution System

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Problem Identification: Raised Floor Distribution Plenum

- Higher system costs
- Increased building height from redundant plenum spaces

Research Goal:

- Reduce system cost without compromising performance
- Improve constructability

Images courtesy of *kingspan.com/raised_flooring/full.jpg*

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Analysis 3: Value Engineering – Redesign of Raised Floor Distribution System

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Images courtesy of *accessfloorsystems.com*

Problem Identification: Raised Floor Distribution Plenum

- Higher system costs
- Increased building height from redundant plenum spaces

Research Goal:

- Reduce system cost without compromising performance
- Improve constructability

Proposed Solution: Relocated HVAC distribution to above the ceiling

Images courtesy of *kingspan.com/raised_flooring/full.jpg*

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Analysis 3: Value Engineering – Redesign of Raised Floor Distribution System

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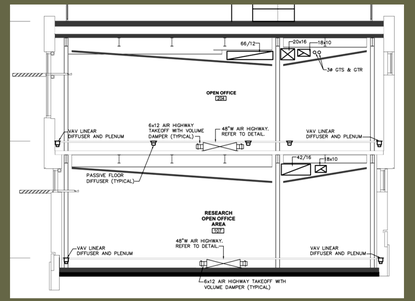
Original Design

- 14” Raised Access Floor System
- In-floor electrical distribution

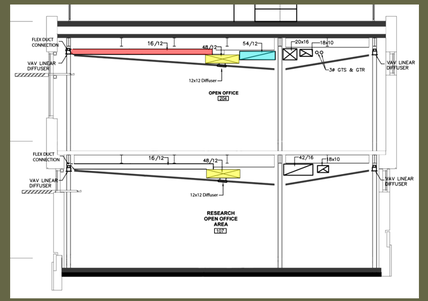
Alternative Design

- Lowered the ceiling 6”
- Reduced building height by 8”
- Maintained High Volume/Low Velocity flow rate

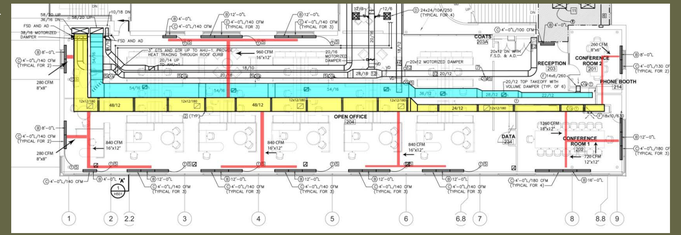
Original Design: Raised Floor Distribution



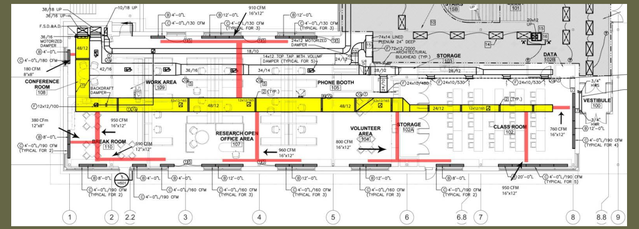
Alternative Design: Above Ceiling Distribution



Alternative Design: Second Floor



Alternative Design: First Floor



Analysis 3: Value Engineering – Redesign of Raised Floor Distribution System

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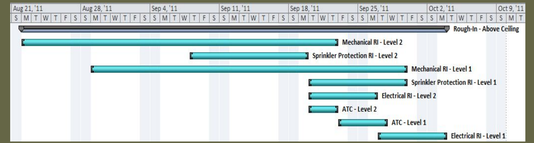
Schedule Impacts:

- Original Design: 16 days
- Alternative Design: 24 days
- Neither designs were located on the Critical Path

Schedule Durations for Raised Floor Analysis

System	Schedule Duration (Days)	Total Man Hours	Crew Size
Raised Floor Dist.	**16**	480	6
Ceiling Dist.	**24**	581	3



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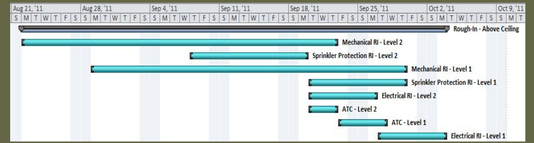

Cost Impacts

- 46% Decrease in cost
- Indirect Costs
  - Reduction in building height (credit)
  - Flooring Cost
  - Electrical Distribution Contingency
  - Sales Tax Credit

Total System Comparisons

Raised Floor Distribution System - Total Cost	**$**	**110,000.00**
Raised Floor - Material Cost	$	76,000.00
Raised Floor - Labor Cost	$	34,000.00
Ceiling Distribution System	**$**	**50,838.00**
Ceiling - Material Cost	$	7,696.00
Ceiling - Labor Cost	$	19,620.00
Indirect Costs	$	23,521.00
Net Decrease in System Cost:	**$**	**59,162.00**
Total Man Hours:		581 hrs

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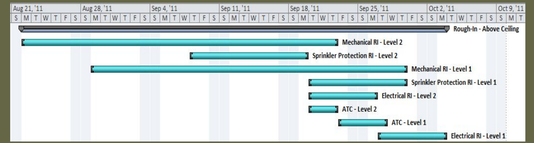

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Net Decrease in System Cost:	**$**	**59,162.00**
Total Man Hours:		581 hrs

Alternative Design Conclusions:

- Added 100 hours of work
- Reduced cost by approximately $59,000

Recommendations:

- Met analysis goal to increase project's value
- Pursue alternative design based on significant decrease in system cost
- Marginal compromises in value

Analysis 4: Schedule Acceleration –Alternative Wall System

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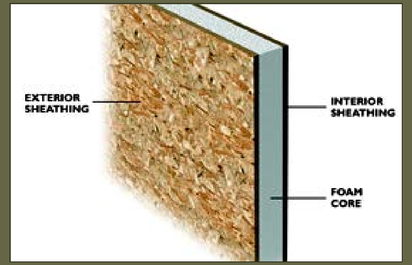

Images courtesy of *sips.org*

Problem Identification: 8" Metal Stud Exterior wall

- Time and Labor intensive
- Located on the Critical Path
- Produces a large amount of waste onsite

Images courtesy of *sips.org*

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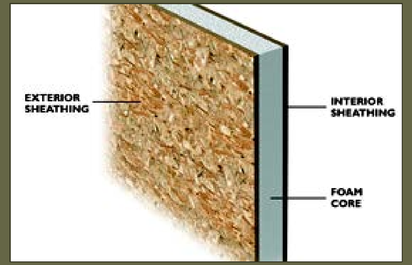

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Research Goal: Develop alternative design

- Decreases the project schedule

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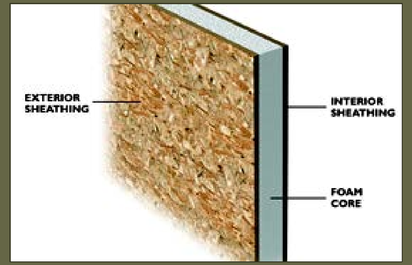

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Research Goal: Develop alternative design

- Decreases the project schedule

Proposed Solution: Structural Insulated Panel System (SIPS)

- High performance wall type composed of:
  - OSB Sheathing
  - EPS (Expanded Polystyrene) Foam Core
- Increase superstructure to accommodate additional load

Images courtesy of *sips.org*

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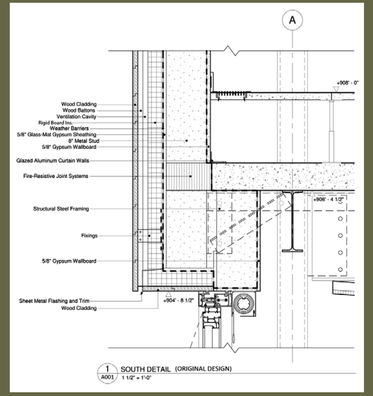
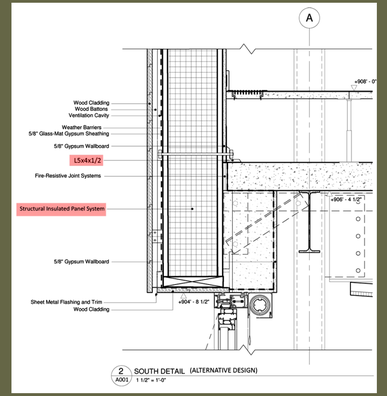
Original Design

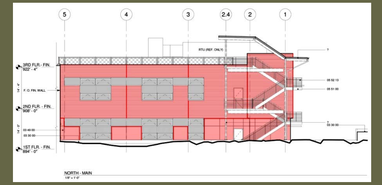
- 8” Metal Stud Framing
- 2” Rigid Board Insulation
- 5/8” Fiberglass-matt gypsum board

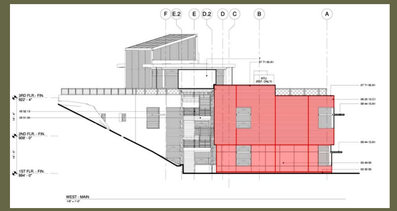
Alternative Design

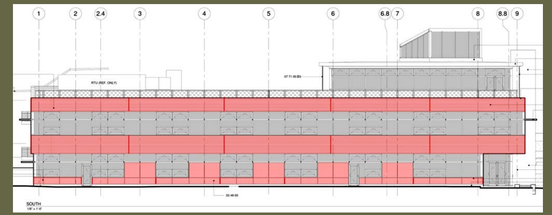
- 10 ¼” SIP Panel

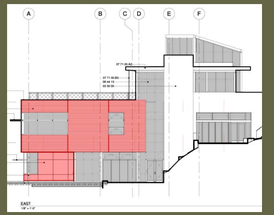












Analysis 4: Schedule Acceleration –Alternative Wall System

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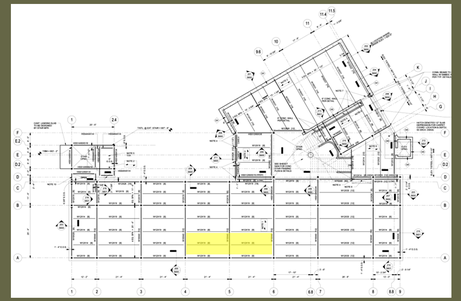
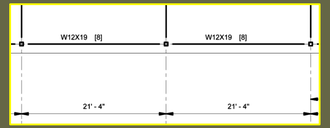
Structural Impacts: Structural Breadth

- Original Stud Wall: 45 PLF
- Alternative SIP Wall: 75 PLF

Results:

- W12x19 Spandrel Beams were found to be inadequate
  - Max. Allowable Def. = 1.07”
    - Deflection = 1.3”
  - Max. Allowable Bending Moment = 55.9 ft-kips
    - Bending Moment = 82.2 ft-kips
- W12x26 Spandrel Beams were found to be adequate
- HSS 6x6x5/8 Columns were found to be adequate





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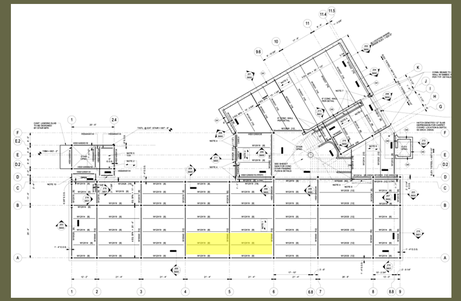

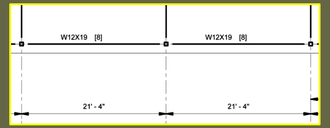

Sustainability

- Provides superior conductive and convective performance
- No additional LEED points gained

Relative R-Value Comparison	
R-Value Original Design	**25.3**
2" Rigid Board Insulation	8
5/8” Fiberglass-mat	8
8" Wall Cavity	9.3
R-Value Alternative Design	**35**
(2) 7/16" OSB Sheathing	1
10 1/4" SIP w/ EPS Core	34

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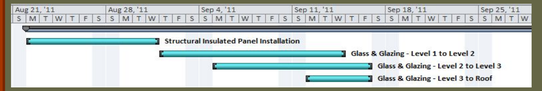
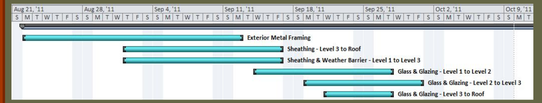
Schedule Impacts:

- Reduced the project schedule by a total of 8 days
- Allowed Glazing to begin 8 days earlier than the original schedule

Schedule Durations for Façade Analysis

System	Schedule Duration (Days)	Total Man Hours	Crew Size
8" Metal Stud Framing	**16**	770	6
SIP Wall Panel	**8**	320	5





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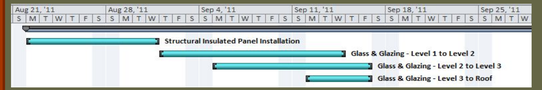

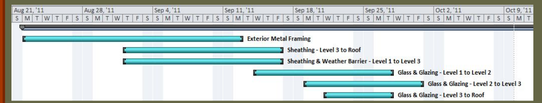

Cost Impacts:

- SIP System Cost w/ General Conditions Savings: $74,920
  - Includes increased cost of superstructure of $2,578

Façade Estimate Summary		
Total Original Metal Stud Wall System	**$**	**71,216**
Original Design Labor Cost	$	42,508
Original Design Material Cost	$	25,708
Adjusted Total Alternative Wall System Cost	**$**	**74,920**
Total Alternative SIP Wall System	$	88,382
Alt. Design Labor Costs	$	37,594
Alt. Design Material Costs	$	50,789
Estimated General Conditions Savings	$	(13,462.00)
Net Increase in Cost	**$**	**3,704**

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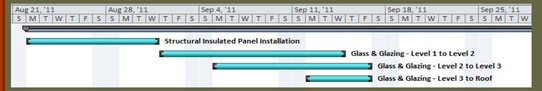

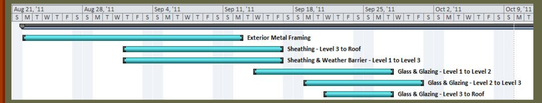

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Alternative Wall Construction Design Conclusions:

- Reduces project schedule by 8 days
- Increases Superstructure
- Improves the performance of the building envelope
- Marginal increase in cost

Recommendations:

- Met analysis goal to reduce project schedule
- Pursue alternative design as specified due to significant schedule savings

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Recommendation/Conclusion

Analysis 1: Critical Industry Issue - Avoiding Traditional Delivery Methods on Publicly Funded Projects

- Project exemption can be gained by OPP

Analysis 2: Constructability – Alternative Design of Atrium

- Rejected alternative design due to substantial increases in cost

Analysis 3: Value Engineering – Redesign of Raised Floor Distribution System

- Accepted above ceiling distribution system as a result of the significant cost savings

Analysis 4: Schedule Acceleration –Alternative Wall System

- Accepted Structural Insulated Panel System as a result of reduced schedule and marginal increase in cost

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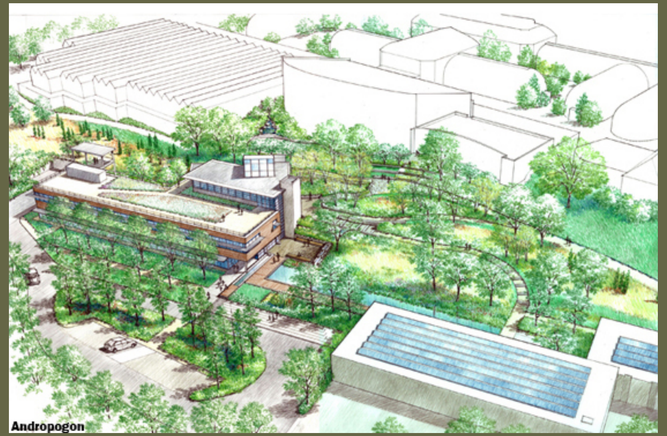
Questions



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Megan Corrie, Kristine Retetagos of *Turner Construction* contacts and project sponsors
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David Zartman and staff of *Zartman Construction*
James Hostetler Director of Construction and Design *Bucknell University*
John Bechtel Assistant Director of Design and Construction of *Penn State OPP*
Tim Gilotti of *Radner Property Group*
Jeff Sandeen of *Hensel Phelps Construction Co.*