PENN STATE University Park BALLPARK Pennsylvania

Jason McFadden

Construction Management

"SIMPLIFYING DESIGN TO CONSTRUCTION"

"If you build it, they will come." *Field of Dreams*

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Presentation Outline

- Project Overview
- Technical Analyses
  - Steel Tapered Column Analysis
  - Electrical Distribution Analysis
- Streamlining Structural Steel Design and Construction
- Summary and Conclusions
- Acknowledgements
- Clarifications & Questions

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"In The Batter's Box"

Project Overview

- Sports Facility
  - Penn State Baseball (Big Ten)
  - State College Spikes (Minor League "A")
- 35 Acre Open Field Site
- Traditional Project Delivery w/ CM Agent
- $25.3M Construction Cost
- June 2005 – May 2006 Construction Schedule

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Architectural Accolades

Project Overview

- 5,406 Fixed Seating Capacity
- 18 Luxury Suites
- School Of Journalism Media Observation Area
- 18.55' RF Outfield Fence
- 60' Tall Entrance Masonry Pylon
- Sand Grid Drainage System
- 44' Scoreboard Height

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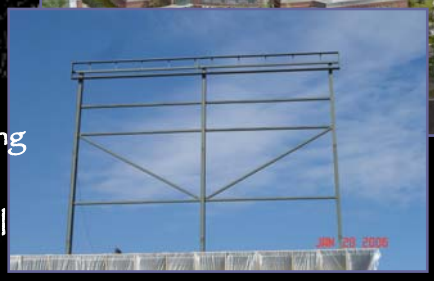
"Leading Off First"

- (1) W14X132
- (2) W14X90
- Encased with 1" Plates
- HSS Lateral Cross-Bracing
- 120'-6" Above Field Level

Structural Analysis



FIELD LIGHTING COLUMNS

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Designed Column

- Architectural Tapered Plates
  - Minimal Structural Integrity
- Very Labor Intensive with Welding
  - 28 Days For Structure
- 15% of Steel Tonnage (86 Tons)
- Maintenance Concern
  - Water Penetration
  - Ease of SJO Cable Installation

Structural Analysis

FIELD LIGHTING COLUMNS

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Goals

Structural Analysis

- Alternative Structural Member
- Easier Erection Method
- Maintain Aesthetic Smooth Appeal

FIELD LIGHTING COLUMNS

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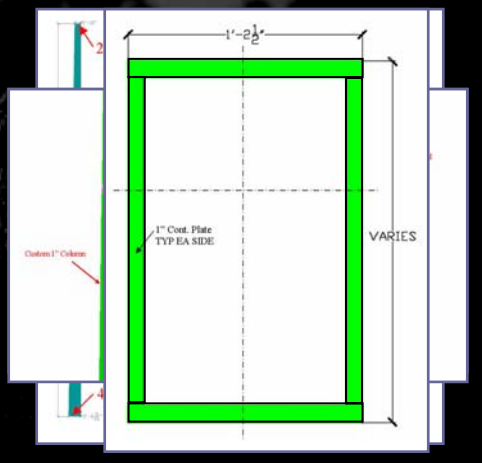
Alternative Design

Structural Analysis

- Two Options
- Tapered Steel Tube Constructed with 1" Plate
- Splice Connection
- Welding Bead
- 80 Tons of Steel



FIELD LIGHTING COLUMNS

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Designed Column vs. Proposed Designed Column

FIELD LIGHTING COLUMNS

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Designed Column vs. Proposed Designed Column

Cost Summary

Designed Column Cost Summary	
Description	Total
Total	$223,300

Alternative Column Cost Summary	
Description	Total
Total	$178,100

($45,200)

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Designed Column vs. Proposed Designed Column

Project Impacts

Proposed Alternative Column Design	
Advantages	Disadvantages

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Designed Column vs. Proposed Designed Column

Conclusion

- Proposed Column...
  - Decreased Steel Tonnage
  - Significant Labor Savings
  - Easier Erection Method
  - Same Aesthetic Architectural Appeal

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"Sliding Into Second"

Electrical Analysis

- Retail Store & Ticket Building
- Year Round Use
- 2000 S.F.

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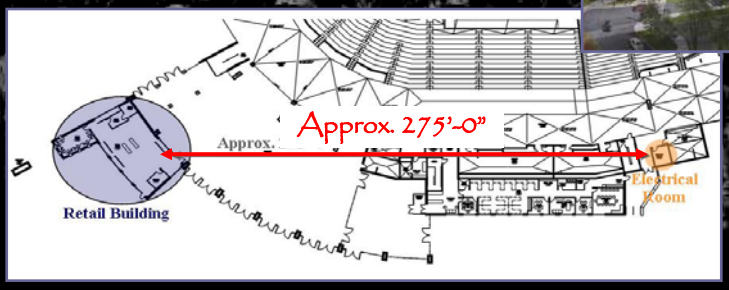
Designed System

Electrical Analysis

- Power from room 126 on Main Concourse
- No UG Raceways on Documents
  - All wires through Canopy Structure



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Goals

Electrical Analysis

- Design Electrical Panel within Retail Building
- Provide Cost Data for New Distribution

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Alternative Design

Electrical Analysis

- Panels Located in Storage Room, 150B
- RB-1 → 480Y/277V, 3Φ/4W
  - 100A
- RB-2 → 208Y/120V, 3Φ/4W
  - 50A
- Transformer → 15kVA
- 1-1/4" Underground PVC Conduit to 480 Panel

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Designed System vs. Proposed Designed System

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Designed System vs. Proposed Designed System

Cost Summary

Designed System Cost Summary	
Description	Total
Total	$22,700

Alternative System Cost Summary	
Description	Total
Total	$13,900

($8,800)

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Designed System vs. Proposed Designed System

Project Impacts

Proposed Alternative System Design	
Advantages	Disadvantages

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Designed System vs. Proposed Designed System

Conclusion

- Proposed Distribution...
  - O&M Value to Owner
  - Substantial Cost Savings
  - No Additional Load on Overall System

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"Rounding Third"

Steel Design & Construction

- Technology Savvy Industry
  - Computer Generated Fabrication Models
  - CNC Equipment

CONSTRUCTION RESEARCH

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"Rounding Third"

Steel Design & Construction

- Current Process is Inefficient
  - Arch. Design
  - Struct. Design
  - Fabrication Model
  - Update Fabrication Model
  - Erection Dwgs.

Big Paper Trail

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Research

Steel Design & Construction

- Building Information Modeling (BIM)
  - "Intelligent" 3D Model
  - Electronic Database of Project
  - Mandated by GSA for all future projects (2006)

Streamline Structural Steel Design and Construction through Computer Modeling

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Research Questions

Steel Design & Construction

- Reduce Waste
- Challenges
- Implementation

CONSTRUCTION RESEARCH

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Jason McFadden — Construction Management

Methodology

- Literature Review of Successful Projects
- Selective Interview Participants
- Case Study

Steel Design & Construction

Soldier Field Renovation

AISC ASSOCIATE

Thornton-Tomasetti Group

STEELFAB

Barton Malow

Penn State Ballpark

CONSTRUCTION RESEARCH

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Have the development of steel design/shop drawings changed over the past five (5) years?

Hand drawing to Automation.

3D shop drawing models linked to CNC equipment.

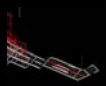
3D model given to contractors for bidding.

Has 3D modeling/BIM changed the steel shop drawing development and review process?

Defined scope with BIM during design.

Model reviews instead of drawing reviews becoming more common.

Models exported directly to CNC equipment.



Describe some common problems during the development of shop drawings.

Model maintenance and discipline.

Architectural changes during approval process.

????

Incomplete design documents.

Coordination with architectural documents.

Describe the communication techniques between the designer and detailer during the shop drawing development process.

Rarely direct contact between designer and detailer.

Attach screen shot of model to request for information (RFI).

What are the barriers to implementing building information modeling (BIM) on a project? (cost, time, legal, etc.)

Different way of thinking.

Fee issues with more design services.

Accuracy of model.

Understanding how BIM benefits project team.

Interoperability.

Describe the ideal steel shop drawing review process.

Coordinated Team

Decisions made instead of delayed.

Software easily exchange information.

Model review instead of paper drawings.

Information exchanged electronically.

CONSTRUCTION RESEARCH

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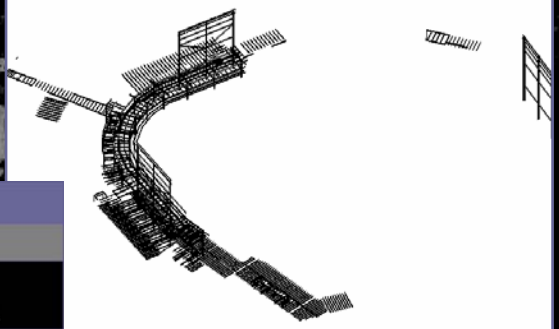
Case Study

Steel Design & Construction

- Penn State Ballpark

Model Created in Revit Structure 2



Case Study BIM

Revit Structure 2

65 hours to create BIM.
Some areas could not be modeled.
Known steel quantities with schedules.

CONSTRUCTION RESEARCH

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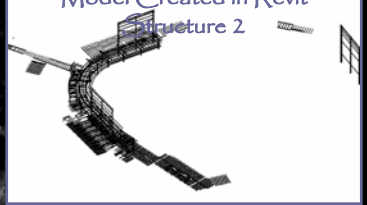
Case Study

Steel Design & Construction

- RFI's
  - 20% Related to Elevation Discrepancy
- No Column Schedule
  - Automatically Created with BIM Software

Model Created in Revit Structure 2



Penn State Ballpark

Structural Column Schedule

Column Description	Quantity	Length	Base Level	Base Offset	Top Level	Top Offset
W14X90	1	118'-6"	Concourse Level Framing Plan	-14'-6"	Roof Level Framing Plan	75'-0"
W14X43	1	15'-9 1/2"	Field Level Foundation Plan	-1'-6"	Concourse Level Framing Plan	-0'-8 1/2"
W14X132	1	120'-6"	Field Level Foundation Plan	-1'-6"	Roof Level Framing Plan	75'-0"
W14X43	1	15'-8"	Field Level Foundation Plan	-1'-6"	Concourse Level Framing Plan	-0'-10"
W14X90	1	120'-6"	Field Level Foundation Plan	-1'-6"	Roof Level Framing Plan	75'-0"

CONSTRUCTION RESEARCH

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Designed System vs. Proposed Designed System

Project Impacts

Proposed Streamlined Design to Construction	
Advantages	Disadvantages
Better design coordination with structural documents.	Fee issues with additional design services.
Ability to link with structural analysis programs.	
Easily export model to CIS/2 file format.	
Coordination review and interference check feature with Revit Structure 2.	
Known quantities with BIM.	
3D Model Review in lieu of drawing review.	

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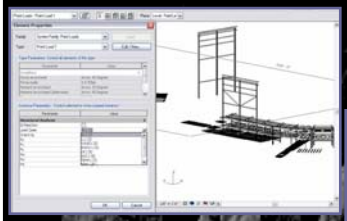
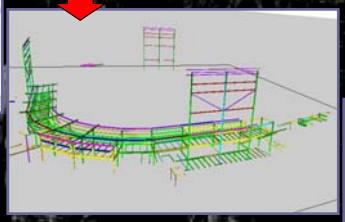
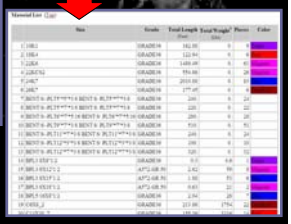
Effects of Steel Phase Computer Modeling

Conclusion







CONSTRUCTION RESEARCH

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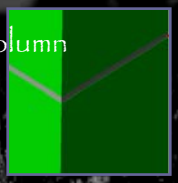
"Coming Home"

Summary and Conclusions

- Alternative Structural Column



- Alternative Electrical Distribution ($8,800)
- Streamlined Approach for Structural Steel

SUMMARY AND CONCLUSIONS

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All-Star Support

Acknowledgements

- My friends and family throughout my five-year career at The Pennsylvania State University.
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- Bettwy Electric, Ritner Steel, RNR Erection

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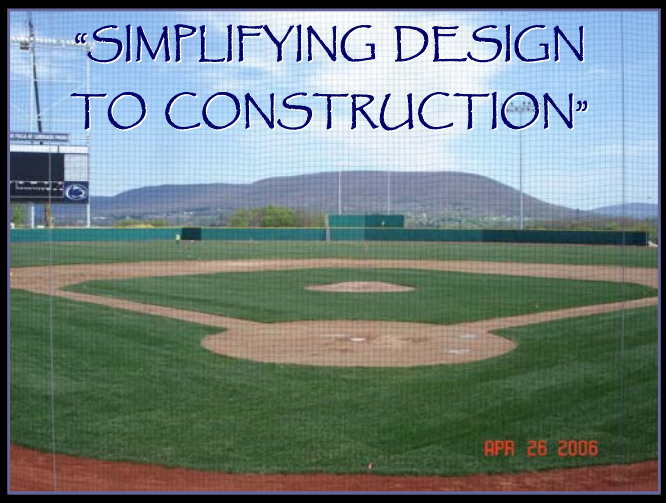
"SIMPLIFYING DESIGN TO CONSTRUCTION"



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