PENN STATE University Park BALLPARK Pennsylvania

Jason McFadden

Construction Management

Senior Capstone Project | Architectural Engineering | *"If you build it, they will come."* Field of Dreams | Architectural Engineering | Senior Capstone Project

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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"

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

Project Overview

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Architectural Accolades

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

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FIELD LIGHTING COLUMNS

PENN STATE University Park — BALLPARK Pennsylvania

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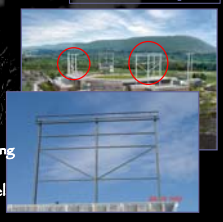
"Leading Off First"

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

Structural Analysis



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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

Presentation Outline

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FIELD LIGHTING COLUMNS
Alternative Design
Structural Analysis
Alternative Structural Member
Easier Erection Method
Maintain Aesthetic Smooth Appeal
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FIELD LIGHTING COLUMNS
Alternative Design
Structural Analysis
Two Options
Tapered Steel Tube Constructed with 1" Plate
Splice Connection
Welding Bead
80 Tons of Steel
5/16" Weld
1" Steel Plate Column
Architectural Engineering
Senior Capstone Project


FIELD LIGHTING COLUMNS
Design & Cost
Structural Analysis
Architectural Tapered Plates
Minimal Structural Integrity
Very Labor Intensive with Welding
28 Days For Shipment
15% of Steel Tonnage (86 Tons)
Maintenance Concern
Water Penetration
Ease of 510 Cable Installation
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Designed Column vs. Proposed Designed Column
"If you build it, they will come." Field of Dreams
FIELD LIGHTING COLUMNS
Alternative Design
Structural Analysis
Two Options
Tapered Steel Tube Constructed with 1" Plate
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80 Tons of Steel
Senior Capstone Project
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FIELD LIGHTING COLUMNS

Designed Column | Structural Analysis

- Architectural Tapered Plates
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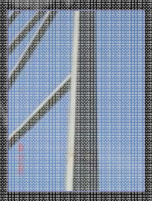
- Maintenance Concern
  - Water Penetration
  - Ease of SJO Cable Installation



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Designed Column vs. Proposed Designed Column

Cost Summary

Designed Column Cost Estimate Summary

Description	Total
Labor	$59,525.12
Material	$65,159.20
Equipment	$98,569.44
Total	$223,253.76

($45,184.20)

Alternate Column Cost Estimate Summary

Description	Total
Labor	$46,266.88
Material	$60,089.72
Equipment	$71,712.96
Total	$178,069.56

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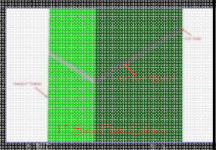
FIELD LIGHTING COLUMNS

Alternate Design | Structural Analysis

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



FIELD LIGHTING COLUMNS

Designed Column | Structural Analysis

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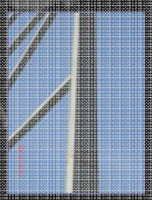
  - Water Penetration
  - Ease of SJO Cable Installation



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Designed Column vs. Proposed Designed Column

Project Impacts

Proposed Alternative Column Design	
Advantages	Disadvantages
Erection duration savings of 7 days.	Possibly could limit the amount of steel fabricator's bidding on project.
Overall cost savings of $45,184.20.	
Heavy equipment (crane) moved off-site quicker.	
Continuous weld on plates adds extra waterproofing of structural member.	
Easier ability to run SJO cable to power light fixtures.	

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FIELD LIGHTING COLUMNS

Alternate Design | Structural Analysis

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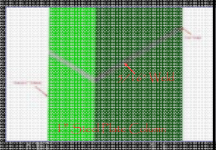
- 80 Tons of Steel



Moment
Axial
Shear
Torque

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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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ELECTRICAL DISTRIBUTION

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"Sliding Into Second"

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

Electrical Analysis

Presentation Outline

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ELECTRICAL DISTRIBUTION
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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
Approx. 275'-0"
Retail Building
Presentation Outline
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Architectural Engineering
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ELECTRICAL DISTRIBUTION
Electrical Analysis
Design Electrical Panel within Retail Building
Provide Cost Data for New Distribution
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"If you build it, they will come."
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ELECTRICAL DISTRIBUTION
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 Raceway to 480 Panel
Storage, 150B
RB-1
RB-2
Architectural Engineering
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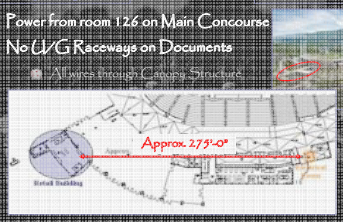
ELECTRICAL DISTRIBUTION

Proposed System | Existing Analysis

- Power from room 126 on Main Concourse
- No U/G Raceways on Documents
  - Allows through Canopy Structure



Steel Canopy Fabrication | Alternate Design

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Designed System vs. Proposed Designed System

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ELECTRICAL DISTRIBUTION

Alternate 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 Raceway to 480 Panel

Steel Canopy Fabrication | Alternate Design

ELECTRICAL DISTRIBUTION

Proposed System | Existing Analysis

- Power from room 126 on Main Concourse
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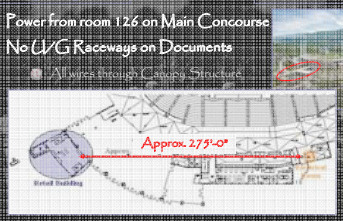
  - Allows through Canopy Structure



Steel Canopy Fabrication | Alternate Design

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Designed System vs. Proposed Designed System

Cost Summary

Designed System Cost Estimate Summary

Description	Total
Labor	$13,784.28
Material	$8,857.50
Total	$22,641.78

($8,771.38)

Alternative System Cost Estimate Summary

Description	Total
Labor	$2,348.65
Material	$11,521.75
Total	$13,870.40

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ELECTRICAL DISTRIBUTION

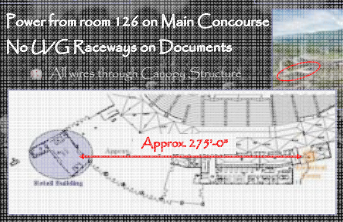
Alternate Design | Electrical Analysis

- 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 Raceway to 480 Panel

ELECTRICAL DISTRIBUTION

Designed System | Proposed Designed

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



Designed System vs. Proposed Designed System

Project Impacts

Proposed Alternative System	
Advantages	Disadvantages
Cost savings of $8,771.38.	
Ease of electrical system maintenance during owner operation.	
Decrease in amount of conduit and wire needed (labor savings).	
Decrease in coordination with other trades for electrical branch conduits installed through main concourse per original design.	
Ease of expansion.	
Less voltage drop experienced on branch circuits.	

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ELECTRICAL DISTRIBUTION

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 Raceway to 480 Panel

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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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Presentation Outline

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CONSTRUCTION RESEARCH

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"Rounding Third"

Steel Design & Construction

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

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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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CONSTRUCTION RESEARCH
Steel Design & Construction
Building Information Modeling (BIM)
Streamline Structural Steel Design and Construction through Computer Modeling
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CONSTRUCTION RESEARCH
Research Questions
Steel Design & Construction
Reduce Waste
Challenges
Implementation
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Methodology
Literature Review of Successful Projects
Selective Interview Participants
Case Study
Steel Design & Construction
Soldier Field Renovation
Penn State Ballpark
"If you build it, they will come." Field of Dreams
Architectural Engineering
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Have the development of steel design/shop drawings changed over the past five (5) years?
Has 3D modeling/BIM changed the steel shop drawing development and review process?
Describe some common problems during the development of shop drawings.
Describe the communication techniques between the designer and detailer during the shop drawing development process.
What are the barriers to implementing building information modeling (BIM) on a project? (cost, time, legal, etc.)
Describe the ideal steel shop drawing review process.
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CONSTRUCTION RESEARCH

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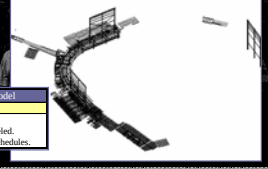
Case Study

Steel Design & Construction

- Penn State Ballpark

Model Created in Revit Structure 2



Case Study BIM Model
Revit Structure 2
65 Hours to create BIM. Some areas could not be modeled. Known steel quantities with schedules.

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CONSTRUCTION RESEARCH

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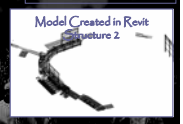
Case Study

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	47' - 8 1/2"
W14X132	1	120' - 6"	Field Level Foundation Plan	1' - 6"	Roof Level Framing Plan	75' - 0"
W14X43	1	35' - 8"	Field Level Foundation Plan	1' - 6"	Concourse Level Framing Plan	47' - 10"
W14X90	1	120' - 6"	Field Level Foundation Plan	1' - 6"	Roof Level Framing Plan	75' - 0"

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Effects of Steel Phase Computer Modeling

BIM for Steel Phase on a Project	
Challenges	Control Method
Contract Language	AISC Code of Standard Practice (Chapter 16) assists with correct verbage.
Design Management	Design decisions made sooner. Steel design coordination through a design model. ✓
Technology	Choose up-to-date software with most effective data exchanging capabilities. CIS/2 continues to help with exchanging data between software will become less of a problem. Create an FTP site to post all documents to be exchange electronically. ✓
Communication	Promotes constant communication and project understanding by project team. ✓
Paper Drawings	3D Model reviewed and approved. Erection Drawings Only.

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Effects of Steel Phase Computer Modeling

Conclusion

- Reduced Waste
- On-Going Technology Challenges
- Implementation

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SUMMARY AND CONCLUSIONS

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"Coming Home"

Summary and Conclusions

- Alternative Structural Column
- Alternative Electrical Distribution ($8,771.98)
- Streamlined Approach for Structural Steel

Presentation Outline

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ACKNOWLEDGEMENTS

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All-Star Support

Acknowledgements

- My friends and family throughout my five-year career at The Pennsylvania State University.
- Industry & Academic Support:

- Bettwy Electric, Ritner Steel, RNR Erection

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"SIMPLIFYING DESIGN TO CONSTRUCTION"

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