Project X

Mid-Atlantic Region, USA

Technical Report 3

Taylor M. Sweeney | 11 Novmeber 2015

Construction Management | Dr. John Messner

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Executive Summary

Project X officially broke ground June 2013 and was completed in December 2014. This project encompassed the base building and the first and second floors. The third and forth floors were completed under a different contract at the Owner's request. This document will highlight an interview with the Project Manager discussing project management services provided to the client and value engineering topics that were utilized and ones that were suggested but not implemented.

This project, like many projects today utilized Building Information Modeling (BIM). With the goals of the project and its Owner and mind a BIM use list was created and compared to how BIM was actually implemented on Project X. Project X integrated 3D models to build virtual mock-ups as well as a coordination tool between the MEP trades. This proved to be highly successful because the clashes between the trades were caught well ahead of time allowing for changes to be made before construction even began.

Sustainability implementation was also considered for this report. Many projects look to achieve a LEED certification. With Project X in mind and the use of the building thought of a list of potential points was generated, indicating that the project could achieve a Gold LEED certification. The Owners of this project requested that the building be designed to achieve a LEED Silver certification in Shell and Core Development. Once construction was complete Project X was LEED Gold certified.

On November 3rd Penn State Architectural Engineering hosted the Fall PACE Roundtable, that brought together students and industry professional to discuss the industry and issues that it is currently facing. Two sessions were attended: Distributed Leadership vs. Centralized Decisions and Driving Collaboration into the Field. As well as a discussion panel that focused on Enabling the Workforce: Hiring and Retaining Young Leaders.

In conclusion I spoke with industry professionals Leaha Martyruska, of James G. Davis Construction, and David Maser, of Gilbane Construction Company to discuss potential research topics from the breakout sessions from the PACE Roundtable.

Field Interview

The field interview was conducted with David Brooks of Forrester Construction Company. Forrester was the general contractor for Project X and David Brooks is serving as the Project Manager for Project X. A full transcript of the conversation can be found in Appendix A.

Project Management Services

While Forrester Construction Company is a general contractor, they also provide preconstruction services to their clients when needed. In the case of Project X Forrester worked with Owner to develop a GMP and performed value engineering services on the project before everything was finalized. The largest constraint that the client faced was the phasing of the project. The project was delayed a full six months due to issues with the building permit and obtaining it. Another issue that contributed the permit issue was the fact that the architect and engineers were not local, meaning they weren't familiar with local jurisdictions making the process for approval that much more difficult

Value Engineering

During preconstruction Forrester worked with the Owner on the design of the building. They worked to achieve the goal of Owner's of having an energy efficient building while remaining in the desired budget and time frame. Many of the ideas were looked at for value engineering. During this process the site work was scaled down. The original design consisted of large planters outside the building to help with storm water as well as to help beautify the building. During the value engineering process these were replaced with smaller scale and less grand planters. Another item that was considered for value engineering but not implemented was the metal paneling on the exterior of the building as well as the rating of the glass in the curtain wall. While these changes were considered to be possible changes, changing the manufacturer of the metal panels and the rating of the glass for the windows ultimately they were not implemented upon the Owner's request. Changing these would have effected the energy efficiency of the building, which the Owner was adamant on staying as efficient as reasonably possibly.

Critical Industry Issues-PACE

Each year the Architectural Engineering Department at Penn State hosts a Partnership for Achieving Construction Excellence Roundtable. This event, that occurs each fall, brings together Penn State students and construction industry leaders to discuss the industry and some of the issues that the industry is facing. This year's event was 24th Annual Roundtable and was held in the Nittany Lion

Inn on Tuesday November 3, 2015, and focused on *Enabling the Workforce*. The day began with Keynote Presentation on *Life after the BIM Revoluation* by Professor Amor, followed by two breakout sessions, and a Panel Discussion focused on *Hiring and Retaining Young Leaders*. The day ended with discussion between industry professionals and fifth year students regarding the students' thesis work.

Breakout Session 1

The first breakout session attended was facilitated by Dr. Robert Leicht. This session focused around the leadership on the jobsite: Distributed Leadership vs. Centralized Decisions. Distributed leadership was defined as a gathering of different voices to lead a project, but also the sharing of risks and responsibilities, 'Injection of Innovation'. To incorporate distributed leadership it starts with the contract, if it is written into the contract there is more buy in from the project team because they have to do it. This idea centers around collaboration between all parties that are involved in the project, promoting the idea that each person plays a vital role to their project. But it does raise the questions: What do you need to do? What do you want to do to expand your knowledge? While each individual's job description is written out, it is up to them to go above and beyond to expand on their knowledge to make the leadership team that much better.

With distributed leadership finding its way onto jobsites, companies and owners are finding that projects are better, being completed on time, under budget, and with a larger profit. This raises the bar for the project team to create a better project, because each discipline is interwoven in the project. It is also promotes the development of trust between the team members, which again produces a better quality project.

Breakout Session 2

The second breakout session attended was again facilitated by Dr. Robert Leicht. This session revolved around collaboration in the field, not only between the project team but, the laborers on the project as well. Currently the collaboration on projects center around the use of shared trailers, weekly subcontractor meetings and the use of look-ahead schedules. If projects implement these it is found that collaboration is higher on the job. Other ways to promote collaboration between the trades and teams are to use BIM and pull planning. For collaboration to work on a jobsite, there needs to be a common goal, and the right group needs to be in the room. Those involved with the project all need to be on board for the collaboration to take place and be effective.

For the collaboration effort to be a success a key is to get the foremen to be involved; if their workers see them working collaboratively the workers are more likely to do the same. Also the use of technology really allows for collaboration to

occur on the jobsite. The use of Bluebeam, for example, allows for different trades to use the same drawings and document what work they have completed and share this information with other trades. While the idea of collaboration between the trades can be found on many jobs, there is some hurdles that teams need to overcome in the future. One issue, and the main issue, is the generational gap. This idea is relatively new, so people who have been in the industry for years are not always open to this idea. Also this refers to the use of technology. Not everyone in the industry is accustomed to the technology of today and will not take the time to learn and understand the technology. These peoples can interfere with the collaboration on a jobsite.

Feedback from PACE Industry Roundtable

At the end of the roundtable, students had the opportunity to sit down with industry members and discuss their work on their thesis projects. During this time I had the opportunity to talk with Leaha Martyruska from James G. Davis Construction and David Maser from Gilbane Building Company. During the discussion the research topics focused around the collaboration of the project teams and how this can affect the project quality. One-way to look at this is the type of project delivery method that is used and the length of time it takes the Owner / Architect / Owner's Representative to answer RFIs and submittals. With a prolonged amount of time these documents can really affect the schedule and the budget of the project. The next topic that was explored was safety on the jobsite. Safety is always a main concern on the jobsite, and it is everyone's goal to have everyone on the site go home at the end of the day. During this discussion the idea of safety sign psychology was brought around. Do jobs that implement signs that are boring in nature have more safety incidents on site compared to jobs that use signs created by children or having a saying such as 'Put your safety glasses on so you can see your wife and kids tonight'. Are there more or less incidents on sites that make the signs personal to the workers compared to the generic signs.

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Leading Industry Practice Evaluation

Building Information Modeling Use Evaluation

In recent history Building Information Modeling, BIM, has become an instrumental tool to the construction industry. At Penn State there is the Computer Integrated Construction Research Program that is working with BIM and its uses in the construction industry and how it can improve the construction process. BIM can be encompassed in all phases of the construction process. This program can be used to create models of the project that can be used for cost estimation, scheduling, and clash detection.

Though there are many uses for BIM in a construction project, for Project X it would be best utilized to develop a virtual model, perform 3D coordination, and performing an engineering analysis. The owner of Project X wanted an energy efficient building, so the use of BIM will help with energy analysis. 3D modeling is also a great benefit of using BIM. With Project X having a high amount of both mechanical and electrical equipment, 3D coordination and clash detection implementation before construction would be very useful. This would allow for any issues with drawings to be figured out before construction even began, keeping the schedule and budget in tact. Introducing BIM at the very beginning of the project will minimize any issues that could arise during construction.

See Appendix B for the proposed list of BIM uses and Level 1 Process Map.

Project X has already been completed without the use of Google Sketch Up and BIM. During the preconstruction phase Forrester Construction assisted in the creation of a 3D model that was used for coordination and clash detection. It was also used in the creation of a virtual mockup. Figure 1 shows a picture of the virtual mockup for the gusset and base plate for the exterior metal panels. The 3D model was created using Google Sketch Up. BIM was used for MEP coordination. With the use of Navisworks Forrester Construction was able to facilitate the coordination of the MEP models to ensure that there weren't going to be any construction issue. The Figure 2 shows the 3D Model that was used to coordinate the MEP work.

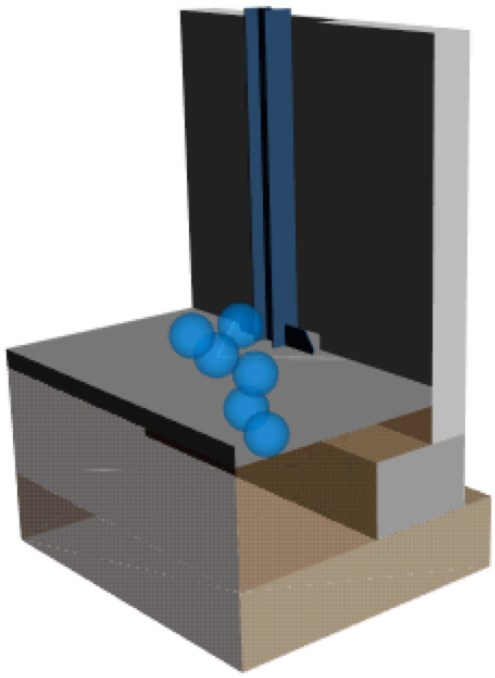

Figure 1: Virtual mock up of gusset and base plate

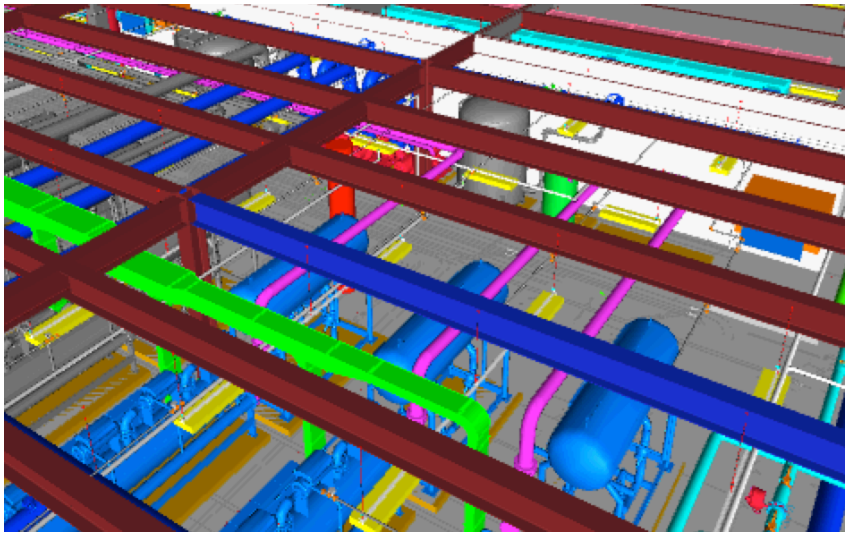

Figure 2: 3D Model used to MEP Coordination

Sustainable Implementation

The owner of Project X was very concerned with the energy efficiency of the building, and was adamant that building at least LEED Silver Certified, but at the completion of the project, Project X was certified as a LEED Gold rating in the Core and Shell Development division. After reviewing the LEED point system for

Building Core and Shell Development, this project could easily obtain a Silver certification if not a Gold certification. To obtain this certification, the designers of Project X should focus on the energy consumption of the building. Since this is new construction the reuse of materials really cannot be factored in. Energy and Atmosphere is the best way for the building to not only meet the goals of the owner (having an energy efficient building) but to achieve a Silver certification. This is the way that the project team approached Project X's LEED certification during construction. The most appropriate approach was to focus on the Energy and Atmosphere. The project was able to obtain more points in the Optimize Energy Performance than predicted pushing the points in the LEED Gold certification range. Appendix C has the breakdown of points that the Project should have gone after originally.

Appendix A

Field Supervisor Interview

Appendix B

BIM Use List and Map

X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING		DESIGN AUTHORING		SITE UTILIZATION PLANNING	x	BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS	x	DESIGN REVIEWS		CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
		x	3D COORDINATION	x	3D COORDINATION		ASSET MANAGEMENT
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS		3D CONTROL AND PLANNING		DISASTER PLANNING
		x	ENERGY ANALYSIS	x	RECORD MODELING	x	RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
		x	SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
x	PHASE PLANNING (4D MODELING)	x	PHASE PLANNING (4D MODELING)	x	PHASE PLANNING (4D MODELING)	x	PHASE PLANNING (4D MODELING)
x	COST ESTIMATION	x	COST ESTIMATION	x	COST ESTIMATION	x	COST ESTIMATION
x	EXISTING CONDITIONS MODELING	x	EXISTING CONDITIONS MODELING	x	EXISTING CONDITIONS MODELING	x	EXISTING CONDITIONS MODELING

BIM USES

Planning
Validate Program
Owner | Programming

Schematic Design
Author Schematic Design
Env. | Design Authoring

Schematic Design
Perform 3D Coordination
FCC | 3D Macro Coordination

Schematic Design
Develop Virtual Prototype
Env. | Virtual Prototyping

Schematic Design
Perform Engineering Analysis
exp. | Engineering Analysis

Design Development
Author Design Development
Env. | Design Authoring

Design Development
Perform 3D Coordination
Env. | 3D Macro Coordination

Design Development
Develop Virtual Prototype
Env. | Virtual Prototyping

Design Development
Perform Engineering Analysis
exp., BE | Engineering Analysis

Construction Documents
Author Construction Documents
Env. | Detailed Map

Construction Documents
Perform 3D Coordination
Env., FCC, exp., BE | 3D Macro Coordination

Construction Documents
Develop Virtual Prototype
Env. | Virtual Prototyping

Construction Documents
Perform Engineering Analysis
exp., BE | Engineering Analysis

END PROCESS

Operations
Compile Record Model
FCC | Record Model

Operations
Compile O&M Records
FCC | Record Model

INFO EXCHANGE

Program Model

Schematic Design
- Architectural Model
- MEP Model
- Structural Model
- Civil Model

Schematic Design 3D Macro Coordination Model

Schematic Design 3D Virtual Prototypes

Schematic Design Engineering Analysis Model

Design Development
- Architectural Model
- MEP Model
- Structural Model
- Civil Model

Design Development 3D Macro Coordination Model

Design Development 3D Virtual Prototypes

Design Development Engineering Analysis Model

Construction Documents (WP)
- Architectural Model
- MEP Model
- Structural Model
- Civil Model

CD (MP) 3D Macro Coordination Model

CD (MP) Engineering Analysis Model

CD (MP) 3D Virtual Prototypes

CD (MP) 3D Micro Coordination Model

Record Model

Appendix C

LEED Point Breakdown

LEED 2009 for Core and Shell Development

Project Checklist

Project Name

Date

Sustainable Sites — Possible Points: 28

Y	?	N			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation—Public Transportation Access	6
2			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	2
3			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
			Credit 7.1	Heat Island Effect—Non-roof	1
			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1
			Credit 9	Tenant Design and Construction Guidelines	1

Water Efficiency — Possible Points: 10

Y			Prereq 1	Water Use Reduction—20% Reduction	
1			Credit 1	Water Efficient Landscaping	2 to 4
			Credit 2	Innovative Wastewater Technologies	2
1			Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 37

Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
15			Credit 1	Optimize Energy Performance	3 to 21
2			Credit 2	On-Site Renewable Energy	4
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5.1	Measurement and Verification—Base Building	3
3			Credit 5.2	Measurement and Verification—Tenant Submetering	3
2			Credit 6	Green Power	2

Materials and Resources — Possible Points: 13

Y	?	N			
Y			Prereq 1	Storage and Collection of Recyclables	
			Credit 1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 5
2			Credit 2	Construction Waste Management	1 to 2
			Credit 3	Materials Reuse	1
2			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
			Credit 6	Certified Wood	1

Indoor Environmental Quality — Possible Points: 12

Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3	Construction IAQ Management Plan—During Construction	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6	Controllability of Systems—Thermal Comfort	1
1			Credit 7	Thermal Comfort—Design	1
1			Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

			Credit 1.1	Innovation in Design: Specific Title	1
			Credit 1.2	Innovation in Design: Specific Title	1
			Credit 1.3	Innovation in Design: Specific Title	1
			Credit 1.4	Innovation in Design: Specific Title	1
			Credit 1.5	Innovation in Design: Specific Title	1
			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

			Credit 1.1	Regional Priority: Specific Credit	1
			Credit 1.2	Regional Priority: Specific Credit	1
			Credit 1.3	Regional Priority: Specific Credit	1
			Credit 1.4	Regional Priority: Specific Credit	1

Total — Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Appendix D

PACE Roundtable Feedback

Project Team Integration - Session 1-C:

Distributed Leadership vs. Centralized Decisions

Facilitator: **Dr. Robert Leicht** **Ballroom DE**

Questions

1. What comes to mind when you hear the term "Distributed Leadership" ?
2. To what extent are we seeing leadership roles distributed within teams?
3. How are these interactions, particularly in integrated teams, changing from traditional leadership models in construction?
4. What opportunities do the use of distributed leadership models in design and construction teams offer?
5. What challenges are emerging in the sharing of information, clarity of roles and responsibilities, and process for meeting commitments?
6. How does the shift to building integrated teams influencing the process for making decisions in the design and construction phases of projects?
7. What tensions need to be balanced to enable distributed teams and leadership to function effectively, while still maintaining the appropriate involvement and input from key stakeholders and overall project leaders?

Notes

1. Gathering different voices to ~~local~~ project
Sharing of risks Breakdown of responsibilities
Decision Making / Shaping / Guiding
"injection of innovation"
Enable the leadership amongst ~~team~~, build trust

- Where is distributed leadership popping up?
Set up in contract
Enables collaboration
Every team member has a role to play, should be held accountable
Unify team, create team environment in contract not necessarily IPD
"One Team" "Know your Role, Do your Job"
What do you need to do / What do you want to expand knowledge on

Why is it appealing?

- Better project, done on time, under budget, larger profit

Contractual decision making? risks needs to change to gain full benefit

How to get good team to be a great team

Raise the bar

Building trust before project so you can rely

Balance between risk and valid

Are you taking smart risks and learning from them

Possible Questions

- Decision making process, why they were made
- Who/When/What/Why
- Decision Making Process Frameworks
- Is this conscious/unconscious
- Goals & Keys of Success at beginning and end

Project Team Integration - Session 2-C:

Driving Collaboration into the Field

Facilitator: **Dr. Robert Leicht**

Ballroom DE

Questions

- What is the current model, or level, of collaboration we see amongst field personnel?
- To what extent, and in what ways, do we expect to see field personnel sharing information and working collaboratively?
- Do we know of any examples of teams or projects that were able to create a high performing collaborative field team?
- What benefits do we expect from having our foremen and field personnel working more collaboratively?
- What challenges or limitations are limiting the current levels of collaboration in the field?
- How could greater levels of collaboration for field staff be enabled?
- What barriers, contractual or behavioral, are creating these limitations?
- How does technology influence the sharing of information and collaboration amongst field personnel (e.g. mobile devices, modeling, etc.)

Notes

Where is collaboration now?

- Field input
- BIM Boxes
- Shared trailers
- Weekly subcontractor meeting
- Driven by CM superintendents
- Utilization of look-ahead schedules
- pull planning
- also more that can be done

To be collaborative there needs to have a common goal

- Need right group in room

Transparency?

How to be collaborative?

Project Delivery method can influence

Procuring your partners

Hand selecting people

Difference between coordination and collaboration

How to be effective?

Get foreman buy-in

trickle down

Remove individuals that aren't willing to collaborate

"Get the right people on the bus"

Technology

Bluebeam

Bottom-up / Top-down

Generational Gap

Clearly Explain

Get everyone involved

Questions

Technology in foreman's hand

Sign of project for technology

Practices that enhance collaboration (techniques)

↳ Co-location

Flow Chart

STUDENT FORM

Student Name TAYLOR SWEENEY

Session 1: Topic: DISTRIBUTED LEADERSHIP VS CENTRALIZED DECISIONS

Research Ideas:

1) DISTRIBUTED LEADERSHIP STYLE, VERSUS THE RESPONSE TIME ON RFI's AND SUBMITTALS

2) DESESSION MAKING FRAMEWORK - WHO MAKES DECISIONS WHO QUICKLY AND THE IMPACT GIVEN DELIVERY METHOD

Session 2: Topic: DRIVING COLLABORATION INTO THE FIELD

Research Ideas:

1) EFFECTIVENESS ON CO-LOCATION AND WHEN DOES IT MAKE SENSE

2) ~~DISTR~~ COLLABORATION IN OFFICE AND FIELD AND THE RESPONSE TIME FOR RFI's AND SUBMITTALS

Session 3: Topic: SAFETY

Research Ideas:

1) PROGRAM DEVELOPMENT TO GET SUBCONTRACTORS TO BUY-IN, APPLICATION FOR PITONE

2) PSYCHOLOGY OF SAFETY SIGNS BEING UTILIZED, IF THERE ARE LESS ACCIDENTS ON SITE

"YOUR WIFE AND KIDS WANT YOU HOME TONIGHT"

STUDENT FORM

Industry Member: LEAHA MARTYRUSKA & DAVID MASER

Key Feedback:

Which research topic is most relevant to industry? What is the scope of the topic?

- The correlation between lead time on RFIs and submittals and project delivery method
- Safety on the site and psychology of signs used

Suggested Resources:

What industry contacts are needed? Is the information available?

* Signs regarding safety and safety orientation details from projects

Leana Martyruska

David Maser

Mike Barnhart

Dan Free

John Becktel

Rob Leicht

* utilize these people and their projects for delivery methods and lead times on documents

Appendix E

Presentation Slides