Technical Assignment 3

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Executive Summary

The contents of this final technical assignment begin to look into possible research topics for the spring semester. It recognizes current issues facing the construction industry today and with possible methods to research these topics and find solutions. Additionally, it begins an in-depth study into our senior thesis building looking at ways to reduce schedule, value engineer parts of our building, and constructability reviews.

Inside you will find a critical industry issues paper which summarizes the subjects discussed at the 2005 PACE Roundtable Meeting sessions I attended. First, discussing frontiers for innovation which talked about the building information model (BIM) and how it relates to the construction industry. At this session we discovered that no one in the industry really has a full understanding of the use of BIM and how or when it is beneficial. Secondly, it discusses healthcare facility and design and the need for "greener" facilities due to O&M requirements.

Following this is a report that explains what my critical issues research method and how I plan to achieve my desired goals. My critical issues research method is the use of technology in the construction industry related to building information modeling and the cost vs. benefit outcome ratio based upon project size, sophistication, etc. I plan to gather a pool of information on various buildings with the information above kept in mind and to then conduct phone as well as in person interviews with the people on those projects. I intend to find out if the person feels that if a BIM model were used would it have proven beneficial. As well, how much would that have been worth in dollar amounts for the project to incur an additional cost.

Lastly, there is a problem identification section listing several problematic features on my senior thesis building followed by a technical analysis methods section on how I wish to pursue researching each matter. The outcomes of these alternative methods will weigh their results based upon a weight matrix developed between research, value engineering, constructability review, and schedule reduction.

Between all of the above analysis I feel that I should be able to thoroughly analyze the Food Science Building and provide much added benefit to the project.

Critical Industry Issues

Executive Summary

The 14th Annual PACE Roundtable meeting held on October 13, 2005 was a valuable learning experience. It was interesting to hear about all of the innovative approaches being researched and beginning use in our industry such as building modeling and "greener" healthcare facilities. Additionally, the feedback from all of the industry professionals provided some "real-world" insight to how each new and innovative approach would be most useful. Although many of the sessions seemed very intriguing to me I had to choose between the two that I felt would be most helpful to me and my research for thesis. During the morning session I choose to first attend the Frontiers for Innovation I session and then the Healthcare Facility Design and Delivery II.

Frontier for Innovation I – Promoting Innovation brought many exciting new ideas to my attention while also bringing some "real-world" experience and insight into those ideas. The complete use of a BIM model is not widely know-of through the industry to its' full extent; this was a somewhat shocking discovery for myself. Additionally, what projects, companies, owners, facilities, or trades an innovation such as this would be most useful for is unknown. Therefore, I hope to study this topic as part of my research through thesis.

Healthcare Facility Design and Delivery – Enabling Processes in Healthcare Design and Construction also discussed many innovative and industry specific topics that I found may be useful to my thesis project. While I am not doing my thesis research on a healthcare facility, my thesis building contains laboratories and a food production area. I feel that these two areas, specifically the food production area could benefit from using some of practices of healthcare facilities due to their similar high cleanliness and mechanical requirements. This session provided some great steps that are necessary for a successful healthcare project which I feel can translate over to my project.

The 2005 PACE Roundtable Meeting was an extremely useful learning experience; for my career and for research topics to study for thesis. I found both of the sessions I attended particularly interesting and exceptionally insightful. The large participation and turn out of all the leading industry professionals I found to be extremely rewarding. The PACE conference was a one of a kind experience I've never been part of before and am glad to now say that I have.

The 14th Annual PACE Roundtable meeting held on October 13, 2005 was a valuable learning experience. It was interesting to hear about all of the innovative approaches being researched and beginning use in our industry. Additionally, the feedback from all of the industry professionals provided some "real-world" insight to how each new and innovative approach would be most useful. Although many of the sessions seemed very intriguing to me I had to choose between the two that I felt would most helpful to me and my research for thesis. During the morning session I choose to first attend the Frontiers for Innovation I session and then the Healthcare Facility Design and Delivery II. Below are some of the key topics I remember from the sessions.

Frontiers for Innovation I – Promoting Innovation discussed three main topics: 1) What innovations are effective or could be effective in the construction industry? 2) How can companies take advantage of the new innovations and what are the best ways to do this? 3) What are the best ways to promote the development and use of new innovative solutions? The general concentious of the room, filled with intelligent industry professionals with many years of experience, was that none of them really knew what specific innovations are being developed and researched in the industry. When the question was asked "Who knows what a BIM model is?" the only people that raised their hand were my fellow colleagues and I. Even the few professionals in the room that have only been out of school for 5-8 years did not really know what a Building Information Model (BIM) was. Even more shocking is that most of them admitted that if it wasn't for coming to the PACE conference and dealing with the professors in the AE Department they would have even less knowledge of what innovations are being developed! The biggest lesson learned from here was that once out of college the industry in general does not do a good job in getting all the latest technical innovations out to the people who could really use or benefit from it. Additionally, the bigger issue is when they know of the innovations but do not know how to use or implement them to their fullest capacity.

The innovation that was mostly discussed during the first session was implementing the use of a BIM model in today's construction process. We discussed who would use such a model and how they would benefit from it. Some stated that they felt it would be useful to their construction organization to build such a model before actual construction begins to help with coordination and planning. While others thought that it could also be useful to certain owners

when the owner plans to keep and maintain the building for many years. An example of an owner such as this would be an OPP or a governmental agency that runs and maintains government buildings such as the case with the Pentagon.

Construction management companies can take advantage of an innovation such as a BIM model or a 4-D model in many ways depending on how in depth they use it. An advantage that most might consider is for their presentation to an owner mostly for show and to possibly explain some details they feel will be problematic; this would show their interest and care in the project. Although at this point using an innovative program such as this would have to be a cost that the CM pays for. Therefore, on smaller projects this would not be a logical innovation to use based upon cost. However, some professionals felt that depending on the type of facility being constructed the benefit of developing a model such as this would outweigh the cost for a CM to develop such a model. For example, these individuals felt that a detailed up-front model for a highly MEP facility would enable them to make better choices for coordination, etc. while also foreseeing design conflicts before the issue would arise in the field; ultimately producing a savings to the project.

One way to help promote and develop the wide spread use of innovations such as this is to provide some dollar numbers along with the programs. For instance, an effective way to get an owner or CM to add this cost into their budget up front is to provide them with data on previous projects that shows the dollar amount of the long term cost savings by implementing this technology at the beginning. Additionally, developing some type of chart, etc. that could be used as a guide to whether or not it would be useful to implement this technology. Such as a chart that classifies project size in square foot and dollar amount along with a technology or MEP sophistication scale that would suggest whether or not it might be worth looking into.

I feel that this session was the most beneficial and interesting to me. There were many topics discussed that I found interesting and that could be useful to the industry. The benefit outcome and cost analysis of these new innovations could be a possible research topic for my thesis that I feel may benefit the industry.

Healthcare Facility Design and Delivery II – Enabling Processes in Healthcare Design and Construction reviewed three main topics: 1) What are the critical design and construction steps needed to deliver successful healthcare facilities? 2) What O&M issues help to push the

case for performance (green) healthcare facilities? 3) Would funding and facility operations be a worthwhile adventure for a contractor's to pursue?

The critical design and construction steps necessary to deliver successful healthcare facilities ranged from the designer to the tradesman. A good designer that heavily interacted with the owner and more importantly the user group of the facility proves to be extremely important to reducing the delays and changes made during the job and during construction, ultimately affecting schedule and cost. Additionally, building enclosure is huge milestone for a healthcare facility even more than it would be for a regular commercial building. This is due to the fact that once enclosed the cleanliness water tightness of the building must be maintained due to its future healthcare use. Also, at this time you're many detailed and "sterile" rooms can begin work with their expensive materials and equipment that must be installed in each of them. Along with a good designer you must also have many well qualified contractors installing the work. For example, a commercial building electrical contractor would have a difficult time to be able to perform the electrical work necessary in a healthcare facility to meet schedule, quality, and budget.

The O&M issues that help to push the case for "greener" more performance facilities comes back to new innovations and the economy. The demand and standardization for more sanitary healthcare facilities is prevailing. This can largely be seen in the higher more stringent requirements for indoor air quality. Additionally, the rising costs of utilities such as fuel and electricity push for buildings and building's system to run and be built more efficiently.

The new interest of the contractor providing funding and facility operations of a healthcare facility was not a widely accepted idea by most that attended. Most attendees felt that the contractor taking some funding responsibilities upon themselves would not prove to be a wise and profitable adventure. Additionally, the facility operations are a task that should be performed by people that do that everyday. Likewise, we as contractors should build buildings not operate them.

The healthcare facility design and delivery session provided some unknown insight into this field. I hope to use and relate some of this information to my thesis building project as well. I feel that the sanitary requirements and detailed planning procedures and concerns can be related to the needs and requirements for that of a food processing facility, "The PSU Creamery".

The 2005 PACE Roundtable Meeting was an extremely useful learning experience; for my career and for research topics to study for thesis. I found both of the sessions I attended particularly interesting and exceptionally insightful. Pertaining to my thesis research I will try to incorporate some of the ideas that were discussed in the sessions. The first area of interest being the cost analysis benefit of using BIM models along with whom should use them and on what projects or areas of a project. I will look into researching a wide variety of projects along with interviewing many of the personnel involved with each project to accomplish this task. Secondly, I am going to study some of the practices of building healthcare facilities and how those practices and trade secrets could pertain and benefit other highly mechanical facilities such as food processing. This topic might prove a bit tougher to research and more thought will have to given on how to carry this out. The large participation and turn out of all the leading industry professionals I found to be extremely rewarding. The PACE conference was a one of a kind experience I've never been part of before and I can only hope that years from now I may be able to come back and represent my company and help out future alumni as everyone who attended this year did for me.

Critical Issues Research Method

A critical issue facing the construction industry today is the use of technology within our industry. How much technology is too much? When is the best time to use technology? Who does it benefit the most? These are just a few questions facing the construction industry and the professionals within. Additionally, this information must be given to the people who can use it the most, the professionals out there working in the industry everyday. As an industry we do not do a good job of getting all of the latest technical innovations out to the people they would benefit the most. These are all problems facing us right now that I wish to address in my area of critical issue research analysis with the use of technology in construction relating to the use of 3D and 4D modeling. Furthermore, this analysis could also be taken into account for more sophisticated programs such as BIM's, building information modeling.

The use of 3D, 4D, and BIM modeling related to the cost vs. benefit outcome for different owners, projects, and construction managers is something that no one in the industry seems to have a good grasp on. This is what I wish to determine through my research. Thus my research will hopefully become useful to all professionals in the construction industry such as owners and construction managers as well as the sub-contractors. Through my research I hope to develop an easily readable chart that can be used to help in determining this information from project to project.

In the course of my research I hope to develop a chart that rates projects based upon size, sophistication, dollar amount, floors, square foot, building use, etc. Using this chart I will rate the projects selected based upon a scale undetermined at this point. At this point I will assign which projects model usage was used or not. Additionally, it will be noted if a model was used for the presentation by the CM. If there are any projects that did use some sort of modeling I will then rate those projects based upon a percentage if the professionals on the project thought it was useful or not. Then, for the remainder of the projects that did not use any sort of modeling I will rate those projects on a percentage based upon whether or not the professionals on the job felt that a type of modeling would have proven useful. *See a draft of the chart attached.

In the course of gathering all of this information a great deal of professional and industry input will be needed and communication and contacts will be crucial. Thus, for this part of the research I will rely heavily on the contacts I've made through my many internship opportunities

over the last three years. I will primarily use information hopefully to be gathered from Turner Construction Company and Gilbane Building Company. Additionally, I will utilize the input from many other industry contacts I've made with sub-contractors and the trades people. All of the above input will be gathered mostly through face-to-face conversation with the professionals or over the phone if necessary. Although, for some of the input needed a survey will be conducted; the survey will be used mainly when trying to gather information from professionals that were on the projects and on their thoughts on whether or not a model would have been helpful and in what case. *See draft of survey attached.

Lastly, I wish to view all of the types of modeling available to the industry. I will then try to list the advantages and disadvantages of each. I will further try to rate the different programs based upon which would be best for the depending application: MEP coordination, overall building view (presentation), detailed analysis and record keeping, etc. Finally, a general cost that can be applied to each program for each use; whether it be an upfront presentation cost or a dollar per hour for a CADD expert.

Though the above research will be difficult and is dependent upon a lot of industry input I feel that I can achieve the overall goals of my research. By utilizing all my professional contacts made through work experiences and the department of AE's construction management staff I feel that I can achieve significant results on the cost vs. benefit outcome on the multiple uses of technology and building modeling in the construction industry.

Building Modeling in the Construction Industry
Cost vs. Benefit Matrix
**Draft*

Project	Location	Size			Building Use		Highly Sophsticated Building Systems	Building Modeling				Added Value / Effectiveness	
		Dollar Amount $	# of Floors	Square Feet	Primary	Secondary		Yes	No	Type	Use	Professional's Input	% Added Value
ABC	PA	30 mil	3	75,000	Food Processing	Retail	Production Area	x		4D	Presentation	Senior PM	60%
XYZ	CA	40.5 mil	4	100,000	Laboratories	Higher Education	MEP	x		3D	MEP Coordination	Superintendent	40%

Building Model Use in the Construction Industry
Survey Questionnaire

For Senior Thesis Research
Educational Purposes Only
By Tony Lucostic

Company:_____
Name:_____
Title:_____

1) Has there ever been an electronic building information model used on any of your projects and if so what kind?
    a. 3D CAD Model
    b. 4D CAD Model
    c. Other_____

2) If so what was it used for?
    a. Presentation
    b. Overall Job Coordination
    c. MEP Coordination
    d. Job Specific Coordination: What was it?_____
    e. Other_____

3) Have you ever been involved with a project that you feel a building model would have proved useful? If so what was the project and how would you have used the model to benefit your project?

4) If you decided a building model would prove beneficial for your need on your project above how much would you pay for the model to still be beneficial to the outcome? And/or how would you pay for the model?

Problem Identification

There are several features of the Food Science Building that I feel are problematic and could provide added benefit to the project if addressed. These issues are related to the building's technical systems along with construction methods used. Below I will list and briefly discuss these issues. Further investigation will narrow down these topics so that I may concentrate on the few that I decide to research.

List of problematic features on the Food Science Building

- Structural slab and beam encasements of the second floor east (ceiling of the production area).
- Exterior sheathing system of the building.
- Coordination of the production area.
- Stainless steel bollard detail.
- Requirements necessary for the production area to pass FDA inspection.
- Site and building logistics.

The structural slab and beam encasements work at the second floor east was a major schedule delay to the entire progress of the job with particular concern to the production area. The entire production area ceiling had to be covered and meet certain sanitary requirements due to the fact that it will be a food processing area. Additionally, there is a chemical used to clean the entire production area once a week, which is powerful enough to eat through typical carbon steel. Thus, was the need for the steel beams of this area to be encased with concrete. The process of shoring, forming, and reinforcing in this area took an incredible amount of time and pushed back every sequence of work following. The elevated structural slab and beam encasements had to be completed before any further work could go on in the area. A possible topic to research would be the use of precast double tee's in this area.

The exterior sheathing system of the building is not a typical sheathing detail and required a lot more effort than usual (for further explanation of this system see attached building systems summary). The many irregular details and overlapping of the carpenters and masons work slowed construction considerably which ended up pushing the building enclosure into the winter. The main reason for the sheathing was to increase the building's thermal performance by raising it to an R-13 value. A possible topic to research would be to look into other sheathing systems that can give you the high performance rating and compare constructability.

Coordination in the production area is crucial to project success. The project's main task is to open up the production area on time with inspections passed. Some of these inspections take months in advance to schedule. There is not a substantial completion for the production area as there is for the remainder of the building; it either will be running and operational by the turnover date or not. Thus, long and short term coordination and scheduling need to be done to ensure that every trades work in this area follows in a sequential manor. This takes much time and preperation and is crucial for project success. I feel that due to the heavy coordination of the mep trades needed in this

area that in some ways it can be related to a hospital project and that some of the tricks of the trade on those projects could be helpful to the production area. Also, possible use of 3D and 4D modeling could prove beneficial in this area.

Throughout the buildings production area there are stainless steel bollards placed in specific areas to protect corners, doors, equipment, etc. The detail on the bollards places them in 2' of concrete with rebar below the finish floor slab. The excessive structural detail here proved extremely troublesome when coordinating with mep trades and the concrete contractor. Additionally, due to the fact that you are laying out these bollards prior to a finish slab being poured it was extremely difficult to locate and place them correctly in relation to the doors and equipment to be installed in the future. A research idea would be to calculate the structural load necessary for the bollards and a possible redesign of the installation process. Also, possible other solutions would be to install concrete curbs around the areas which need protected after the equipment, walls, and doors are set.

The production area is the most critical part of the building when looking at schedule and coordination. A significant part of this is all of the requirements necessary for a food processing area to pass inspection from the FDA and other agencies. Researching all the necessary requirements for such an area could prove to be extremely beneficial if a various solution is found. An extensive value engineering investigation and research could prove to be a huge schedule savings if a different more effiective solution is found.

Site and building logistics were challenging when the project was coming out of the ground. Site lay-down areas and access around the project were constantly changing and becoming more cramped as the other east subcampus projects where pushing there way to Food Science. Also, when working on campus student consideration must always be kept in mind. As well setting up the building with loading zones, access points, and lay-down could have possibly been addressed in a more efficient manor.

As I continue to investigate each option in further depth I will narrow down the few topics above that I choose to research heavily. This analysis will be based upon the feedback that I receive from PSU AE Faculty and other industry members on their opinions of what would prove the most beneficial to the project and the industry.

Technical Analysis Methods

There are three main parts of the Food Science Building that I will analyze technically that hopefully will impact the value engineering analysis, constructability review, and schedule reduction. The first part of the building I will analyze will be the structural slab and steel beam encasements of the second floor east side above the production area. Secondly, I will look into the exterior sheathing system of the building. Lastly, I will investigate the coordination and the necessary requirements for the Production Area of the building.

For my first technical analysis I will investigate using precast double tee's in lieu of the structural slab and steel beam encasements on the second floor east side above the production area. This will require much structural analysis and calculations on my part along with researching the necessary cleanliness and sanitary requirements for the ceiling in the production area. I feel that this will provide added value to the building and can definitely be seen as a value engineering item. Also, I feel that this would be a key added feature to constructability in this area while expediting the schedule significantly. In order to perform this analysis I will use my previous skills learned in the AE program and professors of the AE department when needed. All of the issues discussed above I hope to be able to use to provide an added savings to the project and be able to assign a number value to each by the end of my research.

The second technical analysis I'll perform will review the exterior sheathing system of the building. The current system being used provides an R-13 value which is just a few added values above a normal commercial buildings' R-9 to R-11 value. The system is very tedious and difficult to install and coordinate when compared to some other traditional systems. Through my research hear I hope to be able to learn in depth about various types of exterior wall systems and the rated R-values etc. Additionally, I will research the constructability of each type of system along with material and installation cost. I also wish to gain an understanding of which components of an exterior wall system can be used in different applications to achieve a desired goal or rating. I will perform this analysis by using my previous skills learned in the AE curriculum program and by researching outside sources. The outside sources I would utilize would be manufactures and industry specialists that focus on exterior wall systems. I feel that this analysis could provide added benefit in value engineering, constructability, and schedule reduction.

Lastly, I will research the Production Area of my building looking heavily into the coordination and requirements of the area. Due to the necessary cleanliness and sanitary requirements of the area a lot of restrictions are placed on the materials and types of construction used in the area. This area has significantly impacted the schedule of the project being the driver from day one when they broke ground. The Production Area is intricate and complex in its design to be able to fit inside of a building that also serves as classroom, laboratory, and retail area. It would only take researching and finding a few key aspects of the area to value engineer and it would provide the entire project with a huge cost and schedule savings as well as possible constructability improvements. In order to achieve this I plan to research requirements through literature and manufactures. In addition I will work with the owner to make sure that my ideas are within their desired interests.

Through researching and analyzing the Food Science's structural slab, sheathing, and production area I feel that I can determine the project's major areas for savings in each of the departments of value engineering, constructability review, and schedule reduction. Hopefully, the added value of all of these analyses will bring the overall project in under budget and ahead of schedule.

Weight Matrix

Matrix shows how I will distribute my research efforts throughout the spring.

Description	*Research*	*Value Engineering*	*Constructability Review*	*Schedule Reduction*	*Total*
Structural Slab Analysis	15%	30%	20%	35%	100%
Exterior Sheathing Analysis	0%	20%	60%	20%	100%
Production Area Analysis	25%	35%	10%	30%	100%
Building Modeling Research Cost vs. Benefit	60%	15%	10%	15%	100%
Total	100%	100%	100%	100%	100%