Wilkes-Barre/Scranton International Airport
Avoca, Pennsylvania
Thesis Technical Assignment 3
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Executive Summary

The third thesis technical assignment is for the most part a “jump start” for this spring semester thesis. This assignment details and draws out all the topics that will be researched. The PACE seminar that was held in State College, Pennsylvania was a critical time for many students to get ideas to research for their thesis topic. Getting an idea is key here so students can spend time over winter break formulating how they will gather their information as well as start setting up surveys or interviews.

Accompanying the thesis topic three or four building issues had to be generated for next semester for students to apply their knowledge and fix what went wrong with the building. Issues have to be major problems and apply to many different aspects of construction within in schedule reduction, value engineering and constructability. These issues will be evaluated and a solution will be reached.

Critical Industry Issues

The basic ideas founded throughout the Frontiers of Innovation seminars surrounded 4D modeling and construction. 4D is the hottest topic in the industry today — as well as its biggest taboo. There were a multitude of reasons to use it, as well as ways to apply it in real scenarios. The obstacle that holds back the advancing development of 4D modeling is the people in the industry. Employees often encounter difficulty while trying to understand how the technology is applicable, as well as determining the value of its true potential. Many find it too risky to invest in, and they fail to see how directly it will affect the construction process.

The sessions that I attended at the PACE Seminar were both Frontiers for Innovation sessions. I have an interest the advancement in technology, and I believe the ways these

innovations apply to the world around me are fascinating. The construction industry is way behind on many advances in technology — this observation drove the discussion in these sessions.

One of the topics discussed in the first session involved Building Integrated Models (BIM). Essentially, these are 4D models, but they also include cost and time variables. This means each object within the model is assigned a value of cost and an estimate of time needed to build it. From these models, it is possible to derive a reasonably good estimate for the project. With a little more work, one could extract a schedule from it as well. This is a great advancement in the pre-construction phase, but architects — not construction companies — would most likely be using this software and developing the models. This could pose a threat to construction companies, because this process would remove the importance of having an estimating and scheduling department. If the industry adopts BIMs as the standard, all contractors would have set figures and costs of the building. This would make competing for bids very difficult: there would be no competition aside from the cost at which the contractors would physically do the work. Of the industry members attending the session, most stated they are indeed anxious about using the 4D modeling because of the risk that is involved. They feel they could spend the money on something else that works adequately. Currently, there are not enough cases of 4D models working on projects to change their minds. Conversely, Charlie Yetter from Trammell Crow Company was in the session and could vouch for the effectiveness of 4D modeling: it saved four weeks in their effort to get one project back on track.

A topic I brought up during the sessions was using a third entity in the pre-construction process. Currently, a general hierarchy is set up, with the owner at the top and the architect and construction manager below the owner. If a 4D modeling company were added to the process,

one more party would share the row with the architect and construction manager. Since the industry is so stubborn in changing, the technology would have to adapt to it. Using a firm or company would make this possible. The 4D company would have to work directly with the construction manager and the architect to achieve the desired effect. This concerned many industry people at the seminar, because a lot of the work would be redundant due to the fact that the CM would make its schedule and estimate. In addition, there might be extra drawings involved. Applying this idea to a Design-Build company would provide its best use. This would make designing and creating the schedules a much smoother process, because it would be self-contained. Design build is already ahead of its time, so it is more likely for this company setup to adopt 4D modeling as one of its services. It would also be more expected if Design-Build companies, instead of other companies, took on this new view of construction. It cannot be denied, however, that changing any company's format is definitely risky business.

Another strong point in the debate over using 4D models is the elimination of mock-ups for buildings. Why make a mock-up when you can see already what the building will look like? This key question drove a heated debate and highlighted a good consideration. With the development of 4D, building renderings can be created that are almost lifelike. Some of the computer animated movies have lifelike modeling; comparable quality could be possible if 4D modeling were further developed. The reason much of this technology has not yet been better developed is the lack of interest to use it or even learn about it, which leaves this question: If change is so good, why is this industry so afraid of it?

What was most surprising about this meeting was how avoidant industry members seem about using this technology in their companies, while simultaneously so poorly motivated to do anything about it. It almost seems like they are waiting for the industry to change around them

and not taking any initiative in making it better. The people themselves are astounding, stuck in their ways yet wanting all-new technology at their fingertips. I was also surprised at how open they were to suggestions. They took all of the students' suggestions and ran with them: they fear using this technology and learning about it, but they definitely don't hesitate to voice their ideas or opinions about technology.

The topic I'm most interested in is value engineering. Many people like to value-engineer systems, creating alternate plans such as changing a pre-tensioned elevated slab to a composite slab construction. I am always interested in saving money — so why not save money on all fronts? One of these fronts that are left wide open is the pre-construction phase of a project. All the planning and effort put into making a building what it is before ground is phenomenal. If costs could be cut right from the start by using something like 4D modeling, perhaps more costs could be cut or better planned down the line. I feel using BIMs and 4D modeling, and even immersive 3D, are all valuable assets to this trade. I would like to be well prepared with the knowledge of technology so I can show a company how this could save money, time and effort overall when I enter the field. Also I feel that the use of 4D modeling could be used to identify systems in buildings that could be reengineered to be more cost effective. The contacts I know of that could directly advise me on my idea include the AE:CM staff, as well as a few graduate students who are researching similar topics.

Critical Issues Research Method

There are many issues that plague today's modern construction industry. Many say that the construction industry is 20 years behind in its practices. During the PACE seminar, many of these problematic issues in construction were discussed. One of the big topics that was heavily talked about was the use of 4D CAD. This is an interesting topic and needs to be further researched in how it is applied and where it can be best applied in the industry. Many companies and firms want to use the software but are to afraid of the risk involved.

4D CAD and modeling are important tools that can be used in construction but, due to the reluctance of the construction industry to try new things, has gone unrefined. Proving the effectiveness of 4D CAD would be most helpful to further bring the development and application of this technology in the construction industry.

The proposed thesis research topic is an in-depth look at how 4D CAD can be used in the pre-construction process — and even during construction — to solve conflicts between trades. Research will include what kind of jobs would best be outfitted for this kind of program and look into whether there is a most effective company or firm to use it, such as an architectural firm or design-build firm. By looking at how each kind of pre-construction company or firm and how they operate, a "best fit" will be determined as to where 4D CAD will best operate.

Research will include many views from different industry members. Design firms, construction managers, as well as architectural firms will need to be interviewed with their opinions and applications of 4D CAD. The best way to gather information is to talk to the people who are actively using 4D CAD and taking the risks involved with using it. Trammel Crow will be the first company with which to start research. They have actively used 4D CAD in one of their Washington, D.C. projects. Research will also include looking into any related journal

articles that have been published by legitimate authors. A survey will also help gather information. The survey will be set up by targeting different levels of people and their involvement in 4D; there also may be a pre-survey to determine which survey should be sent to which particular party. The survey will provide clues of what is holding back or pushing 4D CAD in the industry, and from that, a conclusion will be drawn.

General Survey Questions

-Have you been involved with 4D CAD or modeling?

If yes:

-What programs did you use?

-In what stages did you use it?

-Were there any risks or added expenditures involved?

If you used 4D CAD or Modeling mid way through construction, did you save time and/or money?

-Is there anywhere you would like to see an improvement in the soft/hardware?

-Were your employers or subcontractors open to using it as an aid in construction?

If no:

-What is the main fear behind 4D CAD/Modeling?

-Do you feel that it would be beneficial to your company/job?

-Would your employees be open to trying it on certain jobs?

To what kind of jobs would you most likely apply it?

-Would you like to see opportunities for training in 4D CAD/Modeling?

-Would you like to see the development of a professional 4D Modeling Firm as a buffer between the Architect and CM/GC?

-Would you use such a firm on your projects or jobs?

Problem Identification

Problem 1

The steel erection on this job was a critical issue with the overall timing and phasing of this project. Due to the steel erectors' preference, they raised the steel out of the sequence that was originally planned for financial issues. This set back the overall project by approximately three months and caused further complications of pushing typical seasonal construction phases into different times of the year.

Problem 2

A further investigation of the HVAC system will be necessary to review the conflict with ceiling height. Areas that were in conflict were the placement of a lintel for the sandstone wall, an area where the duct was bent around a superstructure beam, and the coiling overhead gate at the security checkpoint. An investigation as to why and how this happened will be conducted, and the problem will be solved.

Problem 3

Early Installation of the freight elevator: If the freight elevator were installed earlier, there would have been a better flow of site traffic for deliveries of materials. The installation of the elevator

also would have helped with the early completion of building enclosure. Combined with that and the overhead doors, the installation of the wood ceilings could have come at an earlier date.

Problem 4

The addition of extra security features to the security network caused many reorders of much of the hardware for the building. Also, the complications of selecting an outbound baggage conveyor belt caused many complications with the large x-ray machine that would be used for scanning the check baggage.

Technical Analysis Method

Problem 1

The main focus of this analysis will be within the constructability and the scheduling of the topic. Research methods will include the review of how the originally planned schedule differed from what was performed, what kind of deliveries were made for the steel, the trim-up of the steel when erected, the phasing of the erection areas and the impact of the season change on certain construction items.

Problem 2

Reviewing the constructability of this problem is the most important aspect, due to the key fact that the HVAC may have been installed improperly or oversized for the envelope allowed. Because of this, extra work had to be preformed to lower lintels and add on to additional costs. Reviewing the above ceiling plan and the conflicts that evolved will be the essence of this evaluation.

Problem 3

With the late addition of the security system details, many last-minute changes have been made. If a further detailed look had been taken at what security parts would be needed in what locations, the airport could have managed a way to cut a better deal on the equipment that would have to be installed. Reviewing the methods of security system selection would have saved on overall costs of that part of the contract.

Problem 4

The installation of the airport's freight elevator would have managed on-site traffic better. Looking at the additional bonuses of early freight elevator installation would have sped up the schedule by a few weeks. Complete building enclosure would have been achieved, and building conditioning would have been underway, thus speeding up the air balancing allowing humidity-sensitive materials for the ceiling to be installed. Reviewing the schedule and reallocating different activities would have saved the job a few weeks in work time.

Weight Matrix of Thesis Analyses

Description	Research	Value Eng.	Constructability	Schedule Red	Total
Analysis 1	15	10	20	55	
Analysis 2	10	20	50	20	
Analysis 3	10	45	20	25	
Issues Research	65	15	10	10	
Total					100 %