



# TECH 3

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*Alternative Method  
Analysis*

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## Executive Summary

The purpose of this technical report is to identify areas of the project that are good candidates for research, through the exploration of alternative methods, value engineering, schedule compression, and critical industry issues. The information derived will form the basis of the final thesis proposal regarding 2B + G + M + 7 Development at Mansoura.

After interviewing with the Project Manager, the critical path of the project schedule was analyzed in order to identify the biggest risks and potential acceleration scenarios for the project schedule. The excavation and completion of the foundations, MEP rough-ins and exterior finishes posed the largest potential for delays in the project schedule, as these activities were very intensive, and needed to be completed in time, in order for the project to be delivered to the owner at the proposed date of completion. Prefabrication of the MEP system, working overtime and increasing the number of machinery on site were all considered as opportunities to accelerate the schedule if needed.

The value engineering process of the Mansoura Development was not a huge focus on the project, because cost was not considered an issue, whereas higher quality and schedule reduction was seen as the main overall goals for the owner. Collaboration between the owner, architect and contractor was implemented to try finding areas that would be able to cut down on time, without diminishing from the quality of the end product. As of yet, the only two areas accepted for value engineering is the conduits and roofing type, with the suggested use of MC Cables rather than EMT conduit and EPDM roofing instead of TPO. Many other options were suggested but were declined by the owner or architect. Options such as using aluminum feeders instead of copper and reducing light fixtures and outlets were suggested but not implemented into the project.

Critical industry issues were discussed with industry professionals at the 22<sup>nd</sup> Annual PACE Roundtable event on the topic of “Whole Project Delivery”, helped serve as future research ideas to be implemented in the final senior thesis proposal. Break-out sessions regarding “Assembling Effective Cross Functional Teams” and “Criteria and Drivers for Effective Multi-trade prefabrication and Modularization” helped generate discussion between students and industry leaders, in order to understand and improve critical industry issues faced within the construction industry.

Feedback from designated Industry members regarding the proposed thesis was taken into account. David Maser of Gilbane, provided feedback regarding the Mansoura Development to incorporate what was learnt from the break-out sessions into the senior thesis project.

Research of different contract scenarios, use of prefabrication, and reworking the floor plan layout were some feedback topics given in regards to the Mansoura Development.

## Project Manager Interview

The purpose of the Project Manager Interview was to identify research areas where it was possible to improve the project, whether it was to reduce the schedule time for the project, implement better safety techniques, or even help reduce cost of construction. I proceeded with interviewing Mohammad Abdul Khaleel, Project Manager for 2B + G + M + 7 Development at Mansoura. He is employed by Commitment Construction Company, who is the sole contractors for this Mansoura Project. Questions were based on two topics, Schedule Acceleration Scenarios and Value Engineering.

### Schedule Acceleration Scenarios

The Substantial completion date of the project was extremely important to the project team, as the quicker the building is completed, the quicker the owner can receive revenue from tenants. In addition to the completion date, the critical path of the project is just as important as this is what the project must follow in order to achieve the proposed completion date. The critical path of the project schedule revolves around the foundation, exterior finishes of the building and MEP rough-ins. The reason these are important is because these activities have an immense amount of work to be done, with a small window of time for completion. Finishes would follow installation of the MEP work. Any delay in these areas would effect in turning in the project at the proposed completion date.



**Figure 1: Critical Path**

The schedule of the project was phased floor-by-floor for each system, as noted in Tech 1 & 2. As seen in the above figure, MEP system is important for the timely completion of the building. Therefore the key risks to the project completion date would be the improper or delayed installation of this system. If submittals for this equipment are not completed on time or ahead of time, it will have a negative effect on the schedule, as there will be a delay in receiving the equipment. In the case that this happens, labor cost and time will increase, as laborers cannot perform their specific duties without the equipment on hand. This too will affect the completion date, which will disallow the owner to rent out the space to tenants. Another risk for the timely completion of the project would be the unforeseen conditions while excavating for the foundations. Conditions such as a high water table, settlement, and sink holes can all affect in the delay of the project schedule, as the foundations cannot be constructed before

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these issues are taken care of. Thus research must be done prior to excavation in order to understand and manage the water table and soil conditions that will be worked with while excavation is taking place.

Due to the development being a residential tower, all floors excluding the basements, ground floor and mezzanine floors have an identical design. This creates a potential to accelerate the schedule if needed. The use of prefabrication for the MEP system components could help assist the laborers and have a potential for savings, but would have to be designed for at the start during the design phase. Working overtime, increasing skilled man power and working on weekends would also benefit the project by completing tasks before the proposed time of completion, which would in turn make it possible for Commitment Construction to acquire future projects. However there also comes a downside to overworking the workforce; they can eventually contribute to a decreased deficiency, allowing for mistakes to occur which in turn has negative effects to the completion of the project and could result in financial losses for the contractor and owner due to the delay. Lastly, machinery such as increasing the number of concrete pumps on site could also help accelerate the project schedule, as material would be readily available without any delay of transportation. However with this addition comes an added cost to the project.

## **Value Engineering Topics**

Prior to the beginning of construction, the architect, contractor and owner worked together in order to create some value engineering ideas to improve the project. Many steps were taken to ensure that this facility would be of high quality as what the owner requested. While value engineering includes ways of cost cutting on a project, the main goal was to improve the quality of the building and reducing the total project schedule; therefore value engineering was not the main focus of the project. Many ideas were considered during this process, but only a select few were implemented. The following are some areas of value engineering that were suggested on the project.

### **Conduits**

One area that was accepted to date for value engineering was the conduit. It was suggested to use MC Cable instead of using EMT conduit, due to the reduced material cost and less labor intensive, in comparison to the installation of conduit. However this was just an idea proposed, and is not yet implemented into the project. Further research is taking place to find out what areas (commercial or Residential) would be more economical to implement the MC Cable.

### **Roofing Type**

Another idea that was considered and applied is to use EPDM instead of TPO roofing. EPDM is an extremely durable synthetic rubber roofing membrane. Similar to TPO it is typically used on low slope roofs and is very durable. The reason for the use of EPDM was because it is less expensive, easier and faster to install. Its performance is similar to TPO and no special equipment is needed for installation.

### **Feeders**

Additionally, it was also proposed to use Aluminum feeders as opposed to copper feeders. This would help reduce the cost, but decrease the quality and efficiency of the feeders. The constant expansion and contraction of aluminum wire, could cause terminations in the wire connectors, and cause them to become loose, which in turn would need to be serviced more often. This proposition was not implemented, as the owner wanted to make sure tenants were living in a building of the highest quality possible.

### **Fixtures & Outlets**

Another idea which was suggested by the contractor, but not agreed upon by the architect, was the reduction of light fixtures and electrical outlets, which would result in a reduction of branch wiring. Even though this would have helped reduce costs, it was believed that this would reduce the aesthetic appeal of the building, which in turn would decrease the over quality that

the owner is striving for. Since the building is mainly for residential use, it was deemed most appropriate to keep the design as is.

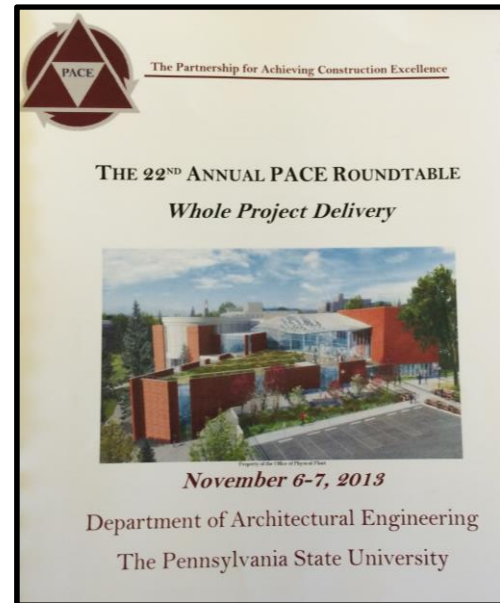


**Critical Industry Issues**

The 22<sup>nd</sup> Annual PACE (The Partnership for Achieving Construction Excellence) Roundtable Meeting on the topic of “Whole Project Delivery” was held on November 7<sup>th</sup>, 2013 at the Penn Stater Conference Center in State College, PA. All 5<sup>th</sup> year Construction Management students, Penn State faculty and top industry professionals were in attendance of this event. The event began with some general information about PACE and the continuing effort of the AE department to research and improve the construction industry.

Following the introduction, there were 2 break-out sessions in which attendees broke into groups to examine specific topics in either, Sustainability, Information Technology or Integrated Processes. Each session was dedicated to a specific topic in one of the categories. Penn State faculty facilitated the different sessions to help create some interaction between the students and industry leaders, in order to discuss the select topics. Critical industry issues were discussed during the sessions, to allow the students to further explore the different topics raised during the discussion and serve as advice for their senior thesis projects. After both break-out sessions were completed, each industry leader was assigned to a small group of students to further investigate the ways they can explore the topics discussed in the morning and incorporate the most appropriate aspects in their senior thesis projects. The following section included both breakout session that were attended, *Assembling Effective Cross Functional Teams* and *Criteria and Drivers for Effective Multi-trade prefabrication and Modularization*.

Figure 2: 22<sup>nd</sup> Annual PACE Roundtable  
Courtesy of Penn State



	A. Sustainability	B. Information Technology	C. Integrated Processes
Personnel	<b>Session 1A:</b> Safety - Prevention through Design	<b>Session 1B:</b> Information Management for the Workforce	* <b>Session 1C:</b> Assembling Effective Cross Functional Teams
Integration	<b>Session 2A:</b> Owner Phasing Decisions for Cost Effective Retrofits	<b>Session 2B:</b> Efficient Delivery of Facility Management Information	* <b>Session 2C:</b> Criteria and Drivers for Effective Multi-trade prefabrication and Modularization

Figure 3: Break-out Sessions – Courtesy of Penn State

### **Break-out Session #1: Assembling Effective Cross Functional Teams**

This break-out session titled “Assembling Effective Cross Functional Teams” focused on the idea of integration between different organizations in order to deliver a better project. The session was facilitated by Professor Gretchen Macht & Bryan Franz. To begin the discussion, all attendees were asked to brainstorm key words and topics that associated with having an effective cross functional team. Ideas ranged from communication, collaboration, common goals, leadership, efficiency, accountability and much more.

After the brainstorm session, the group was asked to come up with and discuss ways to produce effective cross functional teams, through good or bad past experiences. Contract type and procurement method were one of the issues the group agreed would affect a project when creating an effective team, as time and funding would come into play. Owner perspective of the team would also create an effect on the team, because experienced owners differ from inexperienced. Experienced owners understand that forming the right team will help save money and time in the future for project completion, however an inexperienced owner would mainly be focusing on the initial price, and in turn form a team that deems cheapest, even though the members of the team don’t work well together, which can create problems in the future of the project.

The owner was seen as one of the main components in creating an effective team, and the group agreed that it’s best to have internal support within a company for the owner in order to provide advice and help, regarding issues the owner might not know or understand throughout the completion of a project. There are several ways to create trust within members when building a team; some include forming a team that have had previous experience with each other; forming a team with good references from trusted sources, or use specific members that you trust within a company. It was noted that there have been many cases when there have been 2 teams within the same company, completing the same task; however both come out with different outcomes due to the difference in team collaboration.

The best value method when creating a team would be to prequalify the contractors, subcontractors, etc. in order to find the best match that would suit the specific completion of the project. A great way to create better collaboration within a team is for the owner to generate some sort of incentive (money is a good incentive). This will help force the team to put their difference aside and work together in order for both to gain the added bonus.

The group also discussed possible ways to deal with that one toxic member that may appear in a team; and how to rebuild the team after dealing with that specific person. A few options that were given by the industry leaders are as follows:

- To suffer through the process, as doing otherwise can just delay the schedule.
- Provide incentive to the individual to bring them back into the team.
- Set a standard for all group members to follow from the start.
- Share responsibility in order to complete task in time.
- Threaten that member and/or fire them (Last option if all else fails).
- Personality tests, interviews, etc. can be taken when forming teams in order to identify that toxic member before the project begins.

A topic I found really interesting and quite surprising was shared by one of the industry leaders, Steve Lee, from Benchmark Construction, regarding finding ways in creating an effective team. He mentioned that some companies put teams through a faux example/test scenario which brings the team into a room and provides them with a fake project which they had to complete within a certain time. This served as a kind of interview process to see how and if the group could work well together under tough situations.

Lastly, communication was voted as one of the main challenges in the construction site, and in order to create an effective team, ease of communication was essential. There were many suggestions given, however one that seemed most important was bringing everyone together on site (All key players in one trailer). This allows everyone to see and understand each other's challenges. It also allowed discussion between the different members. The main idea that was concluded for this was that personal interaction goes further than email, text, etc.

With regard to this break-out session, better team coordination and selection process of team members could be applied in the Mansoura Development. Even though Commitment Construction is the sole contractors on site, effective teams can be built to tackle specific areas of the project. Different teams can be assigned to different tasks in order to complete the specified activity. Personality tests and faux examples as explained before can be used to help group specific members that would work well together, which in turn would create multiple effective teams. Steve Lee of Benchmark would be a great contact who would be able to provide me with advice regarding personality tests and faux example scenarios.

After the first break-out session concluded, students were given a presentation by Patrick Harrison, the Vice President and Sector Manager of SYSTRA. The presentation talked about systems integration for metro-rail work and the opportunities in building systems.

## Break-out Session #2: Multi-trade Prefabrication

This break-out session titled “Multi-trade Prefabrication” focused on the idea of increasing productivity in the construction industry, including project schedule, costs, safety and quality. The session was facilitated by Professor Ray Sowers and John Messner. To begin the discussion, attendees were asked to provide examples where they have seen multi-trade prefab or modularization. The examples that were given included the following:

- Healthcare (headwalls/bathroom pads)
- Pedestrian bridges (Arch finishes/conduit)
- Precast Parking garages
- Volumetric Modules (Apartment buildings)
- Data Centers (PC Panels/Duct bank racks)

The group then proceeded to provide advantages of having prefab/modularization. An advantage is that it helps to cut down on labor costs and there is quality control. Shop prefab as opposed to on site prefab can be put together with a higher quality, higher productivity (faster) and is safer to assemble due to the environment being controlled. This in turn saves money due to less labor required on field.

Industry leaders agreed that modularization is proposed by the General Contractor and greatly depends on the preexisting relationship with the trades that will be working with. Since prefab takes time to implement, it was suggested that companies should start designing for prefabrication in the design phase and include early involvement with subcontractors. This helps prevent future problems from occurring and helps plan in the case that custom construction equipment is needed. Therefore the delivery method best suited for the prefab process would be design-build as it would provide increased collaboration between the trades early in the planning stages.

With advantages, come many challenges and concerns, which must be planned before in order to create a successful project. These include:

- Staging areas (site logistics) must have enough space to incorporate these modular sections in the construction site without affecting other areas.
- Transportation and protection must also be considered, as these modules are of different sizes, therefore weight limits and road restrictions must be looked up prior to delivery.
- Crane/hoisting is another area that is of concern, since special equipment may be needed to install specific modules. Equipment must be delivered on time in order not to affect the project schedule.

- Quality issues related to hand crafts (e.g prefabricating brick walls) could be of a concern with regards to aesthetic appeal as opposed to those installed on field.

Lastly the industry leaders gave concerns about fabricating offsite. Two main issues came up; one was that inspections could be difficult in coordinating, as inspectors could deny travelling to the specific prefab locations (which could be located in a different state than project location) since it is not in their jurisdiction. This can add unwanted costs of sending the specific system just to be inspected. The other issue is that trying to change specific parts on a modular piece can be challenging after it has been constructed. This could really affect and delay the project delivery if changes are needed.

A few closing words by the industry leaders about prefab was that BIM was a big enabler for prefabrication, and offsite prefab could attract more people into the workforce as they would not have to suffer through climate changes, or moving away from family for the duration of the project. However onsite prefab maybe be quite beneficial in the case of ease of changeability.

With regard to this break-out session, prefabrication of the MEP system could be applied in the Mansoura Development. Since the residential part of the building (7 floors) are identical, it would be a good idea to explore the use of prefabrication. Chuck Tomasco of Truland Systems Corporation would be a great contact who would be able to provide me with advice regarding prefabrication for the Mansoura Development,

### **Summary**

The break-out sessions and PACE roundtable event in general were very informative and beneficial to all students. It helped connect the bridge between academic and construction industry issues. The discussions were really engaging and helped students understand how industry leaders are thinking towards select topics that are of research to many students. There was a consensus in all break-out sessions that the industry is trying to find better solutions to the problems faced in the past, in order to deliver a higher quality product to owners, while still making a profit.

## Feedback from Industry Roundtable

To end the PACE Roundtable meeting, students formed a group of three or four and were assigned to an industry leader to explore their building and the sessions attended (both break-out sessions) to help incorporate what was learnt into their senior thesis project. Industry leaders provided feedback to each student individually based on their past experience in the construction industry. Both break-out sessions helped provide me with some ideas regarding my senior thesis project. One idea included using prefabrication in my building since my building is mainly a residential tower with identical floors; therefore provided the potential for the use of prefab. I met with David Maser, BIM coordinator for Gilbane who provided me with feedback regarding areas I should research and implement in my senior thesis project.

Four key feedback ideas were given:

- 1. Higher a CM that can overlap and stack trades to condense schedule.**

It was suggested to look at different contract scenarios such as GMP or CM@Risk in order to find ways to cut down on the schedule and save money.

- 2. Look into Prefabrication and see where you can save money.**

Since my building is a residential tower with seven typical floors, prefabrication was an idea that could be researched to see if it was worth to go through prefab.

- 3. Pre-cast concrete vs. Cast in Place**

It was suggested to contact a precast concrete company in Pennsylvania (High Concrete Company) and compare the prices of Precast vs. cast in place to see if there is any area to save money.

- 4. Rework floor plan to reduce different room layouts and to have a better outcome with prefabrication.**

Since there are seven typical floors, it was suggested to rework room layouts to reduce the variety of layouts in order for prefab to be beneficial. It was also suggested to contact Eggrock, which is a bathroom modularization company to research prices in order to implement in my project.

**\*See Appendix A for PACE Feedback Forms**

## APPENDIX A - PACE FEEDBACK FORMS

Student Name

Ramy labna

Session 1:

Topic:

Assembling Effective Cross functional teams

Research Ideas:

- 1) Success of project related to procurement method
  - Design-build vs. design-bid-build, etc.
- 2) Put team together before (IPD process)
  - faux example given by Steve Lee from Benchmark.

Session 2:

Topic:

Multi trade Prefabrication

Research Ideas:

- 1) Volumetric Modules (apartment buildings)
  - repetitive layout
  - offsite pre-fab.
- 2) designing for pre-fab
  - Potential Pre-fab?
    - pipe chase/shafts
    - wet walls, etc.
  - MEP systems

Session 3:

Topic:

Research Ideas:

1)

NOT APPLICABLE TO THIS

2)

PACE ROUNDTABLE!



Industry Member:

David Maser - Gilbane

**Key Feedback:**

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

- higher CM than can overlap & stack trades to condense schedule  $\Rightarrow$  GMP, CM @ Risk
- look into Prefab, see if you save money.
- pre cast conc vs cast in place.
- rework floor plan if its 4 diff room layouts

**Suggested Resources:**

What industry contacts are needed? Is the information available?

- contract scenarios
- high concrete company (Precast conc. company)
- eggrock (bathroom modularization company in wisconsin)

Industry leaders

- $\rightarrow$  Steve Lee [Benchmark Construction]
- $\rightarrow$  Chuck Townsco [Triland Systems Co.]