

**Cinema-Dining
Terrace
Expansion
Suburbia, USA**

Technical Report III

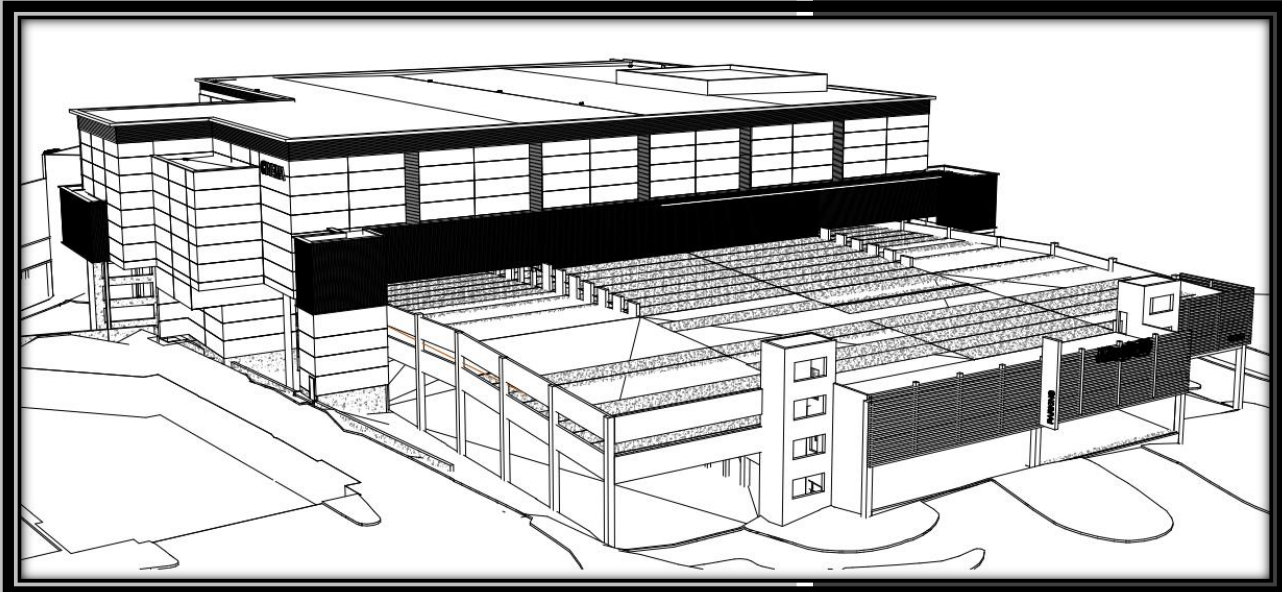


Image Courtesy of The Whiting-Turner Contracting Company

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Cinema-Dining Terrace Expansion
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Executive Summary

The schedule for the Cinema-Dining Terrace Expansion has two major critical path activities that also happen to be two key areas that can be used to accelerate the schedule if needed. The first is the foundations which can incorporate after hours work and temporary heat to withstand low temperatures, all to help accelerate the schedule. The second is the steel logistics and erection. The steel mill orders must be placed early in order to keep the project on schedule but with the direct purchase of the tower crane and the possibility of moving to 6 days 70 hours/week from 5 days 40 hours/week, the steel erection has the potential to accelerate the schedule if necessary.

Value engineering that was implemented on the Cinema-Dining Terrace Expansion didn't use any substantial changes, but in the end saved the owner a considerable amount of money. Through the use of different installation methods and different details, the use of the same materials could be incorporated at a much cheaper price. Changing out certain expensive materials for cheaper but adequate ones was also used in a few areas where aesthetic appeal didn't matter as much. Overall, nearly all of the suggested value engineering areas were implemented to a certain extent on the project.

The Partnership of Achieving Construction Excellence (PACE) held its annual Roundtable Discussion that gives students and faculty in person access to industry professionals and prominent topics in the industry. Two of the issues discussed were Safety Prevention through Design and Efficient Delivery of Facility Management. From the Safety Prevention through Design breakout session, research ideas surrounding Integrated Project Deliveries and BIM came up. The Efficient Delivery of Facility Management breakout sessions brought up research topics such as early assessments and BIM integration. In the end, the key feedback received was to research ways BIM could be used to impact both safety and the facility management aspects.

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Project Manager Interview

Schedule Acceleration Scenarios

For the Cinema-Dining Terrace Expansion, the project schedule is very strict so finding areas to accelerate the schedule and defining the critical path are essential. The two main activities that define the critical path would be the foundations and the steel erection. These activities are key to keeping the project on schedule so accelerating these activities when possible is a great way to decrease the schedule.

The foundations are important because the entire structure is tied to it so a delay there could cause catastrophic delays for the entire project. The site has an active road running right through the middle so certain areas couldn't be worked on during regular hours. One technique used to accelerate this would be to do work in these areas after hours. Though this would help on the schedule, it would most definitely add to the costs. Working at night comes at a premium cost not only for the crew but also to keep a concrete plant open. Night work could involve more equipment such as lights, increased worker pay, and when working with concrete, the concrete needs to meet code so a plant would need to reopen after hours which all increase the costs. Another technique used to accelerate the foundations is to provide temporary heat for the concrete when necessary so work could continue as usual even if the temperatures are low. This again will help accelerate the schedule but will come at a cost. When you deal with heating concrete, paying for the heaters and a crew to ensure fire safety will almost always add to the overall price. Once the foundation work has been completed, the steel erection can begin which is the next main activity on the critical path

The steel logistics and erection are along the critical path for a similar reason as the foundation, nearly the entire rest of the building waits for its completion to proceed with the other work. Steel is known to be a long lead item so one technique used to accelerate the schedule is to get the steel mill orders out as early as possible. One way to do this is to have the mill order as a separate contract. This allows the mill orders to be put in early ensuring their arrival early on the project. Another technique that could be used to accelerate the steel erection would be to move from the original 5 day 40 hour/week schedule to a new fast-tracked 6 day 70 hour/week schedule. This could definitely help accelerate the schedule if needed but would yet again come at a cost. Overtime and Saturday pay for workers is more costly than regular hours so that adds nearly 30 hours of increased pay. Another way to ensure the steel stays on schedule is to directly purchase the tower crane for the allotted time period as opposed to letting the steel erector purchase it. This gave the GC control of its erection and then it could also be used for more than just steel, such as placing air handling units.

Overall, the foundations and steel are two areas that are critical to keeping on schedule but also show opportunities to help accelerate the schedule in certain scenarios but it always come at a cost.

Value Engineering Topics

The Cinema-Dining Terrace Expansion didn't have any drastic Value Engineering that would change the building completely but it did still contain some areas where proper implementation could keep the quality while decreasing the cost. One of the main areas that value engineering was implemented was on the exterior skin.

The skin was of key interest of the owner since that is the first impression people will get of the project. To avoid detracting from the owners aesthetic goals for the skin, the materials primarily remained the same, but the installation techniques and details were altered. These alterations ensured increased productivity and decreased costs but still kept the appearance that the owner desired. The metal panels are a good example of an altered detail that helped save time and money but still kept the necessary quality. Instead of a smaller panel size, the panel size was increased that the number of panels decreased which saves time on manpower. The material was thick enough to be made in bigger sizes so doing that kept the aesthetic appeal but saved money on production and installation.

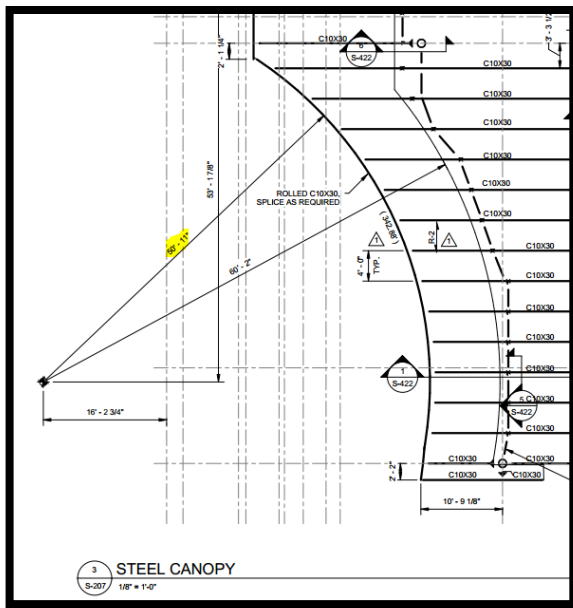


Figure 1: Steel Canopy Design Change- Courtesy of The Whiting-Turner Contracting Company

Another example of value engineering involves slightly changing the designed dimensions to substantially simplify the constructability. The canopy originally was curved with three different radii dimensionally when going around the curve. The differing piece size and installation for each piece was unnecessary for a curved canopy that could be made a uniform radii and keep the desired aesthetic appearance. The resulting canopy design can be seen in **Figure 1** to the left. This change still kept the appearance that the owner desired, but made it far more constructible. Though the owner desired certain appearance and quality, there

were still some areas where material changes were the logical value engineering technique.

The sloped glass roof that would be over the new food court was surrounded by a rather expensive metal trim. This metal trim, though aesthetically pleasing, was unnecessary. Nobody besides the maintenance crew was going to be

able to see this metal trim, so the metal trim was changed to a far cheaper material that could still perform up to the standards.

Another area where a material change was in order was the new aluminum fin tube façade being wrapped around the south and west side of the parking garage. The fin tubes were primarily there to support a graphic that was being installed. With that being the primary goal, a far cheaper material that could still perform the job was suggested to be used instead. The aluminum fin tubes were far too expensive to be primarily used to just support the graphic.

In the end, nearly all of the value engineering suggestions made were implemented on the project in one way or another. This saved the owner a considerable amount of money, and in certain areas saved the laborers a fair amount of work. Some alternative value engineering suggestions that weren't pursued could be the use of two tower cranes to accelerate the schedule and/or prefabrication and unitization of the curtain wall systems.

Critical Industry Issues

PACE Roundtable Introduction

The Partnership for Achieving Construction Excellence (PACE) holds an annual Roundtable Discussion that provides the opportunity for the Penn State Architectural Engineering students and faculty to interact with industry professionals to discuss critical industry issues. Some of the main topics discussed at this year’s discussion were Sustainability, Information Technology, and Integrated Processes. Under each of these main topics came two breakout sessions to further analyze specific subtopics. During the breakout sessions, students, faculty, and industry professionals would migrate to the rooms where specific subtopic were being discussed. The breakout sessions mostly consisted of the industry professionals and faculty discussing the details of the subtopics amongst themselves which allowed students the opportunity to listen and learn, but many students also spoke up with either a comment or question when they found the opportunity. The following sections analyze two of the subtopics discussed during the breakout sessions.

Session 1: Safety Prevention through Design

During breakout session 1, the “Safety – Prevention through Design” discussion analyzed how safety is being, and can be, assessed during the design phase on projects. This discussion was full of riveting conversation that ended up splitting the discussion into a few even smaller topics.

To properly analyze safety prevention through design, the design process needed to be explored. The design process changes drastically when comparing two of the main contract types, Design-Build and Design-Bid-Build. From the discussion, it was pretty clear that the industry puts most safety expertise with the general contractor no matter what contract type though.

Under a design-build contract, the general contractor is involved from the very beginning of design which allows for detailed input early. This collaboration creates a much easier environment for safety to be incorporated at the beginning of a project. The general contractor then has the ability to design for a safer construction phase but also for a safer operations phase. Safety during the operations phase, once the project has been turned over, was a topic that surprised many of the students, which added to the already fascinating discussion.

Under a design-bid-build contract, the general contractor is not involved early in a project, and since most consider them to be the experts on safety, that made it difficult to incorporate safety early in a project. It was brought up multiple times, that for design-bid-build project to design for safety, it required a designer that was an expert on construction, construction safety, and on operations safety. It isn’t outlandish for a designer to design for safety when it comes to the operations side, but for a designer to be able to design for construction safety is really asking for too much. If the designer does design for construction safety, they will then have to dictate the

construction process precisely to the general contractor or construction manager to ensure that the safety precautions are followed properly. This creates a micro-managing process that in the end can create a lot of tension throughout a project while also changing liabilities depending on how the contracts are written.

From these discussions, multiple research possibilities surfaced for the Cinema-Dining Terrace Expansion. Since the project contract type can be a large factor in team collaboration, it seemed obvious that looking into the use of an Integrated Project Design (IPD) for this project would be an excellent research topic. Analyzing how similar projects used an IPD and how safety could be incorporated from that is one of the main areas of research that could be explored. Comparing these projects to the Cinema-Dining Terrace Expansion could then help display the positive or negative affect and IPD could have on cost, schedule, and the ability to design for safety.

Another research opportunity for the Cinema-Dining Terrace Expansion ties into the use of BIM on the project.

Figure 2 shows a project that used its BIM model to show the equipment traffic plan to create a safer site. BIM was barely used on the Cinema-Dining Terrace Expansion project so not only looking into implementing BIM, but also how this implementation could assist in designing for safety creates a unique research topic. Contacting industry professionals from the roundtable about BIM and its possible uses towards safety could be one of the research paths used to complete this analysis.

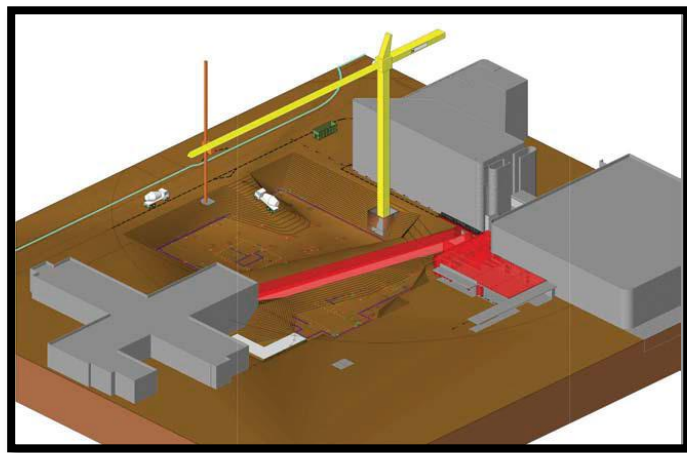


Figure 2: Site Equipment Traffic Planning -
Courtesy of www.asse.org

(See Appendix B – Feedback from Industry Roundtable for contact list)

Session 2: Efficient Delivery of Facility Management Information

One of the subtopics during the second breakout session discussed “Efficient Delivery of Facility Management Information”. This explored how Facility Management (FM) Information is being delivered, the challenges in this delivery, and where this information and delivery is going in the future.

Throughout the discussion, it became pretty obvious that a main concern was that the Facility Management Information needs to be provided in a format that the operators are going to be able to understand. If this is going to be done efficiently, then the owner and operators need to be established early. Some general contractors when turning over a BIM model to operations will train the operations team to use this model, but that takes time and money.

Another aspect discussed that surprised some of the students is the use of early Asset Lifecycle assessments and Energy Audits. The reason these can be helpful for efficient delivery of FM information is to design early for easy maintenance and pick systems and materials that can potentially require less maintenance/replacement.

One of the large challenges is that owners don't know what they want and most of the time don't know what to do with a BIM model. Another challenge, as said before, is getting the owner to see the value in putting time and money into efficiently delivering the FM information.

This discussion created research possibilities that mostly revolve around using BIM for facility management. Researching into the operations team for the Cinema-Dining Terrace Expansion and examining their ability to use a BIM model for operations will be one tactic. Another technique will be to look at similar projects to examine what they did and how they presented the FM information to the operation staff. Since BIM wasn't used much on the project, researching into starting a BIM model from the beginning then using that to turn over to the operations staff could be a creative opportunity to incorporate BIM.

Feedback from Industry Roundtable

During the last discussion session, small groups with a few students and one industry professional had the opportunity to meet and discuss each student's building, the sessions they attended, and the opportunities. A group of us met with Project Director Dan Buchta from Barton Malow. When discussing the Cinema-Dining Terrace Expansion, the main research topic that is most relevant to the industry is the use of BIM to improve construction & operations safety and improve the Facility Management Information.

For construction safety, BIM can be used to show phasing, details for connections with the existing building, and animations displaying the existing conditions. This information can be used to determine the best subs for the project, improve the schedule, and possibly improve the cost.

BIM can be helpful for operations, especially if you know the operating staff beforehand. A BIM model can then be used to show where maintenance areas and equipment are located, giving the operators the opportunity to express where they would prefer them to be located. This in turn can improve safety and the maintenance.

(See Appendix B – Feedback from Industry Roundtable)

Problem Identification and Technical Analysis Options

Means and Methods Schedule Delays

One of the major concerns for the owner and the project is the schedule, particularly opening the parking garage for the holiday season. That being said, the opportunity to improve the schedule by changing some of the site logistics is an opportunity worth looking into. In the early phases, the existing site logistics utilizes one tower crane in the center of the existing parking garage and two hydro cranes on either side of the building at various time periods. In order to install the tower crane, the existing precast concrete double T's must be removed in the area of which the tower crane will be located. Though it is only considered to be means and methods, the aspect of removing approximately a hundred thousand pounds of concrete on each of the 4 floors to make room for the tower crane adds complications and time to the schedule.

One solution to this problem could be moving the planned tower crane and adding another tower crane, the schedule could be improved and the complications of removing the existing precast concrete could be avoided. Two tower cranes running at once could substantially decrease the demolition duration and the steel erection durations while also being able to assist wherever else they are needed. Also, not putting a tower crane in the middle of the existing parking garage eliminates the temporary removal of 4 floors worth of large pieces of precast concrete in the original tower crane location. To complete this investigation an analysis of the schedule and costs would need to be done while also investigating into the daily revenue of this portion of the mall once it will be opened. This will allow the comparison of the initial costs compared to the savings of possibly finishing the project earlier.

Looking a little deeper into the new tower crane locations, an analysis could be done to see whether the new stair tower foundations required could be used as the foundations for the tower cranes. A structural analysis could show the upgrades needed to accommodate the loads that would come with supporting a tower crane. These new locations would then be outside the major footprint of the building and use foundations that were required anyway. Performing an analysis into the sequence changes required could help display how the schedule might be affected.

Curtain Wall Prefabrication and Unitization

A general problematic area is accelerating the schedule whenever possible. The exterior façade is a combination of exterior glazing, metal panels, and EIFS. This façade is located on the north, south, and east sides of the cinema and accounts for the majority of the curtain wall on the project. The façade adds the aesthetic appearance that the owner desires. The curtain wall takes approximately 120 days to install for all the sides.

One solution to decrease the curtain wall durations could be prefabricating the curtain wall in units ready to be installed on arrival. This would include the framing, air barrier, insulation,

windows, and finish whether it be glazing, metal panels, or EIFS. These units could then easily be installed directly off of the delivery trucks. A cost analysis would be necessary to see how the initial costs of prefabrication compare to the possible savings from accelerating the schedule. The owner desires the specified appearance and quality so the use of prefabrication could help the schedule without affecting either appearance or quality. The sooner the mall opens, the sooner the owner can start making money off of the investment so the schedule is of utmost importance.

Acoustics in the Cinema

A problematic feature of the interior is that the theaters have minimal acoustical design. The Cinema portion of the Cinema-Dining Terrace Expansion is a 16 screen movie theater. In each of these rooms, there is a certain amount of design needed for acoustics that seems to be minimal. In order to create the desired movie experience for the customers, acoustics must be done well and done right.

The use of a more detailed acoustical design could assist in improving the value of the theater. An analysis could be done to see how a more detailed acoustical design could affect the costs and sound quality. An analysis could also be done to see if these more detailed designs could affect the schedule.

Water Drainage Recycling System

Another problematic feature of the Cinema-Dining Terrace Expansion is the lack of sustainable designs on the project. Though LEED isn't being strived for, the incorporation of water recycling can still be done to assist in the overall building utilities.

The use of a water drainage recycling system has the potential to decrease water needed for the Cinema by using the recycled water for toilet water. A cost analysis could be performed to see if such a system is work using. A water usage analysis could be performed to exam whether enough water is being saved to even consider the system.

BIM Utilization

One aspect of design and construction that are problematic is the MEP coordination. Coordinating the HVAC with all trades was limited so an excess of RFI's and change orders occurred.

The use of BIM for 3D coordination is a solution that would not only simplify this process. A program such as Navisworks can be used for clash detection. Coordination is a problem that can be solved with the proper use of BIM but BIM also has many other uses that could apply to this project.

Looking into how BIM can assist in the Tower Crane Relocation, the Curtain Wall Prefabrication, the Cinema Acoustics, and the Water Drainage Recycling System can be a research area that ties all the other research areas together. BIM can be used for the Tower Crane Relocation to display to the owner the changes, benefits, and negatives while also being used by the project team to display the new site logistics and the new sequencing needed. 4D modeling could be used to display to the owner how the costs of prefabricating the curtain wall can be made up for by the time saved and the efficiency of the process. BIM can also be used to improve safety by including it in the designs and also create a more visual construction process that can help prevent potential dangers. Sequencing and phasing can be more easily displayed with the use of BIM which can assist in improving safety and construction efficiency.

Another aspect of BIM that can be extremely useful is its utilization for the Facility Management. If planned properly, the BIM used during design, coordination, and construction can then be used as the facility management information. Analysis can be done to look into the facility management team and the costs of using BIM for facility management.

Appendix A – Critical Industry Issues

Session 1:

Safety Prevention through Design

Research Ideas:

- 1) How could the use of an Integrated Project Delivery (IPD) assist in creating a safer construction site during construction and also create a safer building during operations?
 - a. Could the involvement of all parties, together, have significantly improved the safety during the key, most dangerous, aspects of construction?
 - b. Could the operations team have been brought in during design and made a significant difference in the safety of the building during operations?
- 2) How could the use of BIM improve the safety during construction and during operations?
 - a. Could BIM show specific hazards involved in certain activities of construction and help create safety plans for said activities?
 - b. Could BIM be used to display locations of safety equipment?

Session 2:

Efficient Delivery of Facility Management Information

Research Ideas:

- 1) Could the use early assessments have been beneficial in the project and the delivery of facility management information?
 - a. Could an assessment of Asset's Lifecycles or an Energy Audit have improved the overall facility for the owner?
- 2) Could integration have assisted in establishing the detail in which the Facility Management (FM) team desired the information?
 - a. How can the project team determine the detail in which they present the operations information to the FM staff?
 - b. Because BIM was barely used on this project, could the FM staff handle receiving a BIM model containing the FM information or does the information need to be presented in another way?

Appendix B – Feedback from Industry Roundtable

Industry Member Discussion

Key Feedback: Dan Buchta – Barton Malow Project Director

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

- 1) BIM – specifically finding ways to use BIM for Safety and Facility Management
 - a. Safety
 - i. Display specific hazards that could arise during construction
 - ii. Model means and methods of performing the key, most dangerous, construction activities
 - iii. Coordination to make installation and maintenance easier
 - b. Facility Management
 - i. Could a BIM Model be beneficial to a FM staff?
 - ii. Would the time and money be worth it?
 - iii. How detail of a BIM model would be useful and would training be necessary for the FM staff?

Suggested Resources:

What industry contacts are needed? Is the information available?

- 1) Penn State Office of Physical Plant (OPP) – They have experience using BIM for many projects and working for a university, safety and facility management are two huge aspects of every project.
 - a. Craig Dubler – Virtual Facilities Engineer
 - b. Ed Gannon – Manager of Design Services
- 2) James G. Davis Construction – They have extensive experience with BIM and the use of it on projects in the DC area so they could assist in the practicality and suggest specific subcontractors.
 - a. Bill Moyer – Executive Vice President
- 3) Contacting the project team and the owner to discuss the FM staff is definitely a necessity.

Appendix C – References

References

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