The Educational Activities Building

PSU Harrisburg Campus

Figure 1 Images courtesy of BCJ

Technical Assignment 3

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Option: Construction Management

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Executive Summary

Technical Report 3 investigates the project schedule and value engineering topics of the Educational Activities Building project. Additionally, it explores critical industry issues discussed in the 22nd annual Partnership for Achieving Construction Excellence (PACE) Roundtable. Technical report 3 is the base to help identify problems or opportunities to analyze in the spring semester.

The first two sections of this report include a detailed description of the project manager interview with Mr. Adam Dent. The first part focuses on schedule acceleration scenarios. The critical path of the project schedule is grouped in 5 main categories; Excavation, Foundation, Structural Steel, MEP Rough-in and Building Finishes. When Mr. Dent was asked to describe the biggest risks to the project completion date, he said the harsh cold winter of the region where the project is located is the main threat in addition to owner change orders. The last segment of this part discusses potential areas to accelerate the schedule such as working extended hours or accelerate the building enclosure.

The second section of the project manager interview covered value engineering topics. Usually, small project do not implement many value engineering options. However, several ideas were considered in different phases of the project. The different project participants like the CM-at-Risk and architect were on bored early on which helped to eliminate the use of many value engineering options. The ideas that were implemented on this project compliment the goals of the owner by staying under budget and improving the quality.

The last part of Technical Report 3 summarizes the outcome of the 22n annual PACE Roundtable. Two breakout sessions were attended, “Information Management for the Workforce and Criteria” and “Drivers for Effective Multi-trade Prefabrication and Modularization”. These two sessions were very useful and helped two generate few ideas to us on the senior thesis project. The PACE Roundtable concluded with a meeting between each industry member and few students to give feedback on potential analysis for their senior thesis proposal.

Also the problem identification and technical analysis options document that will be presented prior to the senior thesis proposal is attached as an appendix to this technical report. The four technical analysis options are Building Envelope, MEP Systems Modularization, Structural Steel Sequencing and Green Roof System.

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Project Manager Interview:

Schedule Acceleration Scenarios

The Educational Activities Building construction started on February 4th, 2013 and is set for completion on May 31st, 2014. As a part of this technical report, the project manager Mr. Adam Dent was interviewed to gain further information regarding the project construction schedule. The following section will discuss the critical path, the biggest related risks and potential areas to accelerate the schedule.

Critical Path

The critical path of the project schedule consists of many activities that were grouped in five main categories, as illustrated in Figure 2. These five groups are very important due to the significance of their completion on time where any delays in these activities will delay the project completion. Additionally, many other tasks depend on the completion of the critical path activities. First, the excavation is executed and then followed by the foundation. As soon as these activities were completed, the structural steel erection began. While steel erection is moving up the MEP rough-in will start in the ground floor. Finally, after the building enclosure is finished, the interior finishes will begin.

Figure 2 the Educational Activities Building Critical Path

Schedule Risks

Any construction project can encounter many challenges that might delay the completion date. One of the baggiest risks to the Educational Activities Building completion date is weather conditions. As mentioned on the pervious technical reports 1 and 2, the project is located in Harrisburg which is known for long winters. If the cold is severe enough, the construction site will be shut down

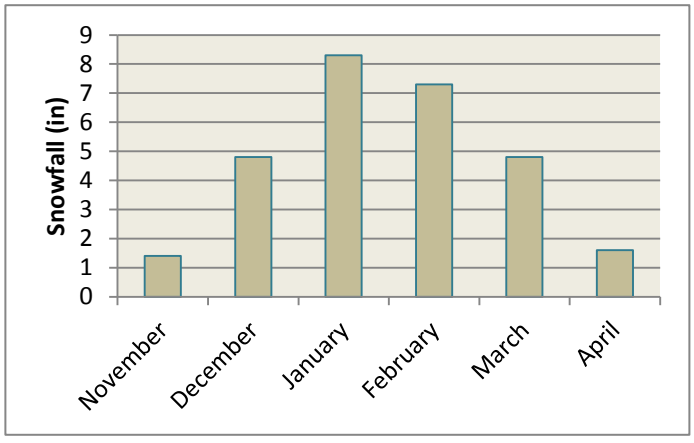

Figure 3 Monthly average snowfall in Harrisburg [1]

and no work will be performed. Harrisburg experiences large amount of snow fall as shown in Figure 3. Snow accumulation could delay the construction for days and might not permit any deliveries to the site. Also, the region receives large amount of rain which means if the building enclosure is not completed and water tight before the rainy season, the interior finishes will be delayed. Another huge problem was caused by the delay of the curtain wall panels' shipment. That led to the interruption of several other activities on the project.

Another risk to the project completion date is the owner requesting change orders. This could delay the project by days or even weeks depending on what the change order alters in the scope of the project.

Potential Schedule Acceleration

Through the interview with the project manager Mr. Dent, few potential areas were discussed to accelerate the project schedule. First, install the curtain wall faster to complete the building enclosure and ensure watertightness and protection from severe weather conditions of winter. This will allow the work to start and continue on any interiors activities such as the building finishes and MEP rough-in.

Another solution is to work extended hours during weekdays or even work on weekends. This will allow the crews to complete their tasks faster to make up for the delays of the project schedule. Additionally, Mr. Dent mentioned that accelerating the steel package fabrication and delivery will help to reduce the overall project schedule.

Value Engineering Topics

When Mr. Dent was asked about the value engineering options of the Educational Activities Building project he stated that "Usually, small projects do not implement many value engineering ideas". However, the project explored several value engineering options at various stages of the project. The CM-at-Risk was brought on board from the beginning, along with the architect and a third party estimator. The three teams were able to evaluate the cost at various project milestones such as schematic design, design development and 50% construction documents phases. Due to the early involvement and the cost evaluation by the three teams, the project stayed on budget and major value engineering were not required during the construction document phase.

The value engineering options that were considered and implemented during the schematic design and design development phases are shown in Table 1 broken up for each phase.

Table 1 Value Engineering options for the Schematic Design and Design Development phases

Schematic Design Phase	Design Development Phase
Delete terrazzo and use polished concrete in the main corridor.	Reduce the quantity of landscape and planting.
Reduce the amount of curtain wall and use brick or metal panel.	Modify structural detail for southeast entry canopy.
Redesign the connector structure.	Reduce the scope of the storm water reclamation system.
Remove VCT in selected laboratories and used sealed concrete.	Substituted and modified light fixture selections.

The value engineering options that have been implemented did not compromise the overall design intent and high level of expectations that the owner had when selecting the design project team. The owner (Penn State), CM-at-Risk (Reynolds) and designers worked closely together to evaluate all the different value engineering options presented and carefully selected those that would not compromise the integrity of the project. Looking at the program of the project as an engineering facility, the polished concrete and sealed concrete floors seemed appropriate for the nature of the facility.

There were several ideas for the value engineering that were considered but not implemented on this project. Those ideas were rejected due to several reasons but mostly for their negative impact on the project schedule, cost and quality. This would contradict the

owner goals and requirements for this facility. The ideas that weren't implemented on this project are the following:

- Deleting the penthouse and using screen only.
- Eliminate concrete slab at roof deck.
- Slope roof deck to reduce amount of insulation.
- Eliminate sunshades.

Critical Industry Issues:

The Annual Partnership for Achieving Construction Excellence (PACE) Roundtable is a great opportunity for the Architectural Engineering students to benefit from the industry members and generate ideas to be applied on their senior thesis project. The event was sponsored by THE Architectural Engineering Department at the Pennsylvania State University. This year's event marks the 22nd Annual PACE Roundtable meeting with the main objective of the "Whole Project Delivery". The conference started with a presentation by Mr. Robert Leicht and Mr. John Messner in which they talked about the history of the organization and a brief introduction of the conference events schedule. Then the students and industry members moved from the main event hall to the first small breakout sessions to discuss several critical industry issues. These breakout sessions help the student to learn more about constructions issues to implement them on their senior thesis project. Additionally, the breakout sessions are a great way to expand the student's professional network by meeting several industry members.

After the first breakout sessions were over the participants went back to the main event hall to attend the guest lecture presentation by Mr. Patrick Harrison, Vice President of Systra Consulting. The presentation discussed systems integration used on rail projects and the opportunities to implement it on building design and construction. Mr. Harrison used a New York City metro project as an example to explain the importance of project planning before the start of construction. At the end of the presentation the attendees went to the second breakout sessions. The last segment of the conference grouped few students with an industry member to discuss the outcome of the Roundtable and potential ideas to be implemented on their senior thesis project.

The PACE Advisory Board identified the main topics of the breakout sessions as illustrated in Table 2, the sessions attended are identified with the underline text.

Table 2 PACE Roundtable breakout sessions

	A. Sustainability	B. Information Technology	C. Integrated Processes
Breakout Session 1	Safety - Prevention through Design	Information Management for the Workforce	Assembling Effective Cross Functional Teams
Breakout Session 2	Owner Phasing Decisions for Cost Effective Retrofits	Efficient Delivery of Facility Management Information	Criteria and Drivers for Effective Multi-trade Prefabrication and Modularization

Breakout Session 1: Information Management for the Workforce

This session was led by Mr. Messner and primarily focused on managing information, use of technology and delivering information to the workforce. The first topic was the focus on the industry standard for information delivery and finding a better way to represent them. Designers spend more time on annotating and documenting drawings than the actual design work. It's necessary to improve a way of presenting these documents to the work force without compromising the time spent on the actual project designing process.

There are many available programs to design and document but none of these software are able to communicate with each other. This drove many construction companies to start creating their own software which led to spending more time during kick-off meetings on software training. There should be a universal software to eliminate the confusing the time wasted on learning working with the different software.

The group moved focus to discussing problems that rises when each of the project participants have their own model. If an item is being altered, each trade would have to update their model, which consumes time and effort. A good solution could be the use of one project model where all parties have access to change or share updates with each other. However, this requires a better transparency, cooperation and trust between the teams.

The discussion also addressed the use of printed versus electronic delivery of information within construction projects. There is a cultural shift toward the use of electronic documents instead of the old fashioned printed documents. This resulted in revers mentoring, meaning that the younger generation is educating the older generation on how to use technology and other modern construction tools. This has been observed in design firms and it is very successful however this trend is moving slowly when it comes to construction companies. This topic introduced two questions, first how can we improved printed documents? For which one of the industry members suggested the use of color coded documents to make it easier to read the drawings. The second question was how much should we rely on technology? Do we eliminate the use of drawings and depend completely on models or just create certain drawings such as trade specific drawings. Also there was an agreement that user interface should be looked at to make it suitable for everyone especially for those who are not used to work with technology. Furthermore, using technology tools like tablets should be evaluated for each case because it depends on the size and cost of the project.

This breakout session helped to generate ideas that could be applied on the Educational Activities Building. First, the use of technology to create a system where each person on site can review what work is required to be completed on each day and what information they need

to know. Another idea is to create a model with access granted to all of the project team to share information and update any changes.

Some of the key contacts that can be reached for advise in this area are the following:

- Ed Gannon from the Office of Physical Plant at Penn State
- John Messner and Craig Dubler from the Architectural Engineering Department
- David Maser from Gilbane
- Chuck Tomasco from Truland Systems Corporation

Breakout Session 2: Effective Multi-trade Prefabrication and Modularization

The second breakout session focused on the use of multi-trade prefabrication and modularization in the construction industry. The discussion started with defining the multi-trade prefabrication which is the manufacture of different building components in shops off site and then delivered to the construction site to be installed. Multi-trade prefabrication requires early cooperation between the different trades to combine their scope of work as a modular unit. Also the labor unions are involved in the prefabrication and installation process. The industry members in the discussion gave several examples on where multi-trade prefabrication and modularization is being used in the construction industry as shown in Table 3.

Table 3 Prefabrication and Modularization based on project types

Project Type	Uses
Healthcare	Bathroom pads and headwalls
Pedestrian bridges	Arch finishes and conduit
Precast parking garages	Concrete members
Volumetric modules	In apartment buildings, where each apartment is fully prefabricated and then stacked on top of each other
Data Centers	Tilt-up and duct bank racks

The following segment of the discussion focused on the advantages and disadvantages of multi-trade prefabrication and modularization. One of its biggest advantages is it can reduce the schedule and cost while improving the safety and quality. Prefabrication and modularization allows building and assembling the components together in a controlled environment where weather can not impact the work which ensures higher quality and productivity. As a result, less skilled labor are required on the field and that leads to saving money on workers cost. On the other hand, prefabrication and modularization requires early

involvement from the different trades. In addition, the more prefabrication is used on a project, the more logistics planning is needed. Therefore, Design-Build delivery method is the best for prefabrication and modularization because it allows the different trades to work together from the start. There are some concerns to consider when planning for prefabrication and modularization:

- Crane/hoisting requirement and planning (Schedule/size)
- Transportation protection and tracking
- Staging area onsite: must have enough space to store the modular units without affecting the work on the construction site.
- Permits
- Labor
- Quality issues: related to hand crafts, for instance prefabricated brick walls could look less appealing than those installed onsite.
- Transit route: road laws could limit the size of the shipment.

Lastly, the industry member agreed on that BIM is a great enabler for multi-trade prefabrication and modularization. Prefabrication could attract people into the workforce because they can work in a controlled environment.

At the end of this session few ideas were considered for the Educational Activities Building. First, study the feasibility of the use of modularization for the MEP system in specific areas of the project. Also the consideration of prefabrication the curtain wall panels. Chuck Tomasco from Truland Systems Corporation and Andy Rhodes from Southland Industries will be contacted for further information.

See Appendix A

Feedback from Industry Roundtable

After the end of the second breakout sessions, each industry member met with few students. This section was detected to discuss the students senior thesis project and what they can take away from the PACE Roundtable that might be beneficial for their projects.

I had the chance to meet Karl Kauffman, project manager from Quandel Group, Inc. I briefly introduced the Educational Activities building project to Mr. Kauffman and talked about what I have learned from the breakout sessions and what ideas I came up with to apply on my senior thesis project.

Breakout Session 1 ideas feedback:

As mentioned in the breakout sessions, I had to main ideas to consider for my senior thesis project. Mr. Kauffman suggested that I should do a study to see the feasibility of implementing technology tools on my project and who would be required to invest in it. Additionally, he mentioned that the competition between trades might affect the ability of having one design model shared between the project teams, “Everyone wants to maximize their profits” he said.

Breakout Session 2 ideas feedback:

As for my ideas from the second breakout session, Mr. Kauffman encouraged me to use modularization for the MEP system due to its advantages. However, he suggested that I should focus on a specific section of the project to implement modularization. For the prefabrication of the curtain wall panels, he suggested to me to find the lead time of prefabrication shops. Additionally, he stressed on the importance of early planning when prefabrication is used on a project.

See Appendix B

Appendix A

PACE Roundtable Research Ideas Form

Student Name Meshal Alenezi

Session 1: Topic: Information Management for the Workforce

Research Ideas:

1) Use of technology to create a system where each person on site can review what work is required to be completed on each day and what information they need to know

2) Creating a model with access granted to all of the project team to share information and update any changes

Session 2: Topic: Effective Multi-trade Prefabrication & Modularization

Research Ideas:

1) Study the feasibility of the use of modularization for the MEP system in specific areas of the project

2) The consideration of prefabrication for the curtain wall panels

Session 3: Topic: _____

Research Ideas:

1)

There were 2 Breakout sessions only.

2)

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Appendix B

Industry Feedback Form

The 22nd Annual PACE Roundtable

Industry Member: Karl Kaufman [Quandel Group, Inc.]

Key Feedback: *Which research topic is most relevant to industry? What is the scope of the*

Session 1B:

* Implementing technology requires training and money, so who will invest in it.
* Also competition between the different trades could effect the trust between the project team which makes it even harder to use one design model.

Session 2C:

* Modularization and prefabrication can reduce the wages due to the use of workers off-site.
* I have to find the lead time of prefabrication shops which heavily depends on upfront planning

Suggested Resources: *What industry contacts are needed? Is the information available?*

* prefabrication shops
* AE department.
* Chuck Tomasco from Trufond Systems Corporation
* The Office of Physical Plant at Penn State

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Appendix C

References

[1] http://www.currentresults.com/Weather/Pennsylvania/snowfall-january.php

Appendix D

Problem Identification and Technical Analysis options

Building Envelope:

The Educational Activities Building will be occupied by Penn State Harrisburg students and faculty. With that being said, it is very important to consider the building functions and its occupants comfortably and productivity. There are many studies that have shown a direct relation between openings in building and occupants' productivity by letting the right amount of daylight seep in.

For this problem, am extensive research will be performed on the benefits of daylight and modifying the building envelope to meet the needs. Different resources will be utilized to understand daylight effect on the occupants in more depth. An analysis will be performed to ensure that any changes will be made will not affect the project schedule and cost negativity.

As a final step, multiple configuration of the building envelope will be designed and examined. The design with the optimum improvements will be chosen based on different criteria and then will be recommended as the best alternative.

Breadth opportunity: Analyzing and redesigning the structural system to ensure its ability to perform under the possible changes in the openings.

Multi-trade Modularization:

The MEP work is separately by each trade which takes a long time for each stage and could cause unexpected delays. Additionally, if any of these activities would overlap each other the site work could become congested with works from different trades. In many cases, there might be clashes between the MEP systems and other components of the building. For instance, an HVAC duct work might collide with an electric conduit or a structural steel member.

As a result, Modularization/Prefabrication is a great solution for this problem. The MEP system could be constructed in modular manners. Where the different components will be prefabricated at the shop and delivered to the site as a puzzle pieces that need to be placed together. This will eliminate any overlapping of activities, lower the cost, accelerate the schedule and increase the safety of the construction site. Additionally, BIM could be utilized early on as a clash detector to avoid any conflicts.

A thorough analysis will be performed to see the feasibility of the use of this alternative for the Educational Activities Building project. Similar completed projects that employed this method of construction will be studied to check its benefits in reality. Other components of the building will also be considered for modularization do to its popularity with new projects.

Structural Steel Re-sequencing:

The project team did a good job with planning the structural steel erection sequencing. However, there is room for a better and more efficient sequencing. The steel frame is erected starting from the south wing and ending with the north wing (Figure1). The south wing is divided into two sections, where one section is being built up and once its completed the work starts on the section and finally to the north wing. This could delay other activities that could have been done as soon as the work on the first level is complete.

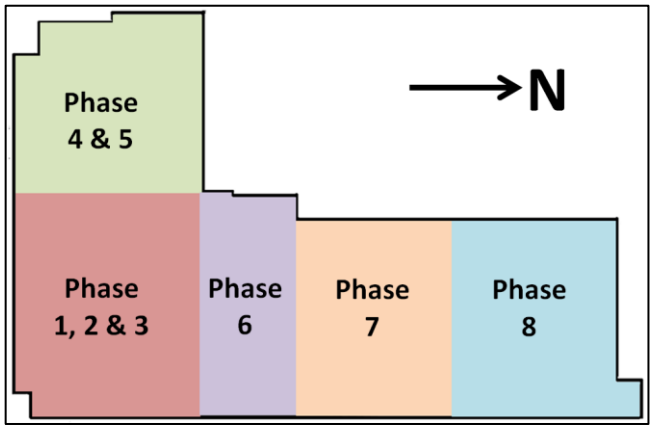


Figure 1 Structural Steel Erection Sequence.

Changing the structural steel sequence to a more efficient plan might have a great positive impact on the project schedule. Different plans will be developed and a grading system will be created to choose the best alternative. The grading system will be based on 4 categories, for each criteria if the new plan is better than the team project plan then it will be given a point but if it is worse, no pints will be given. The 4 categories are as follow:

- Number and cost of cranes
- Impact on the schedule
- Impact on the cost
- Complexity and efficiency

Green Roof System:

The Educational Activities Building will be LEED Certified upon completion. However, there might be a chance to improve the project score and move up a level. One way to do that is utilizing a green roof system for its many advantages.

Different green roof systems will be analyzed to produce a table for their pros and cons and suitability for this particular project and its location. Several, manufacturers will be interviewed to gain more information on this topic. Finally as for every other analysis, a study will be performed to see the impact of this change on the project schedule and cost.

Breadth opportunity: if the green roof system is used on this project, the roof structure should be analyzed and redesigned to adapt to the extra weight imposed by the green roof system.

Appendix E

Proposal Presentation

Educational Activities Building PSU Harrisburg

Image courtesy of BCJ

Project Information

Image courtesy of BCJ

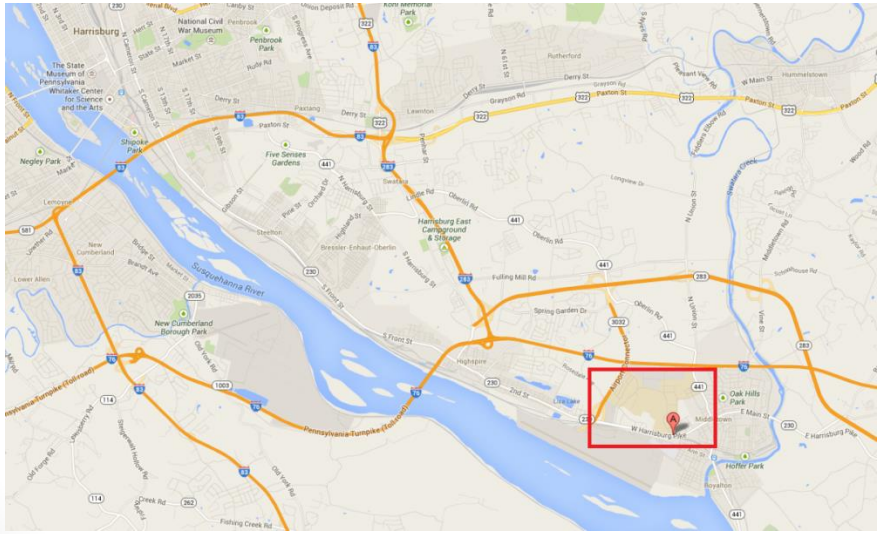


Image courtesy of Google Maps

- Owner: Penn State
- CM: Reynolds Construction
- Size: 51,405 SF
- Building Cost: $19.4 Million
- Construction Date: Feb 2013-May2014
- Design-Bid-Build with CM at Risk

Building Envelope

Image courtesy of prweb.com

Good use of daylight can increase students productivity

VS.

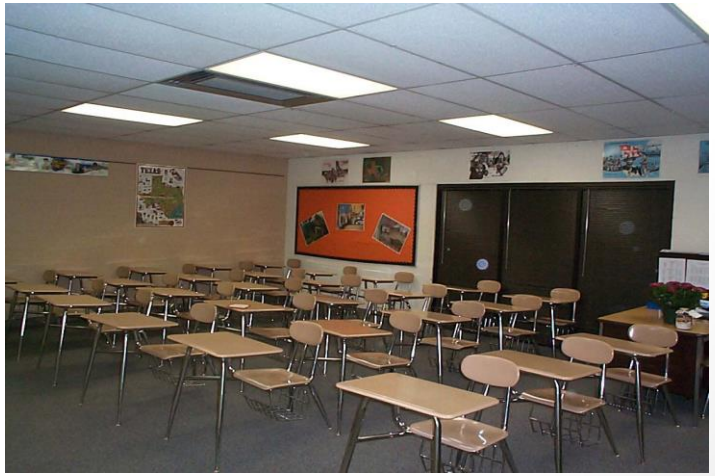


Image courtesy of prweb.com

Structural Breadth opportunity:
I will analyze the structural system
And redesigne it to ensure stability

MEP Modularization

Image courtesy of mepsolutions.com

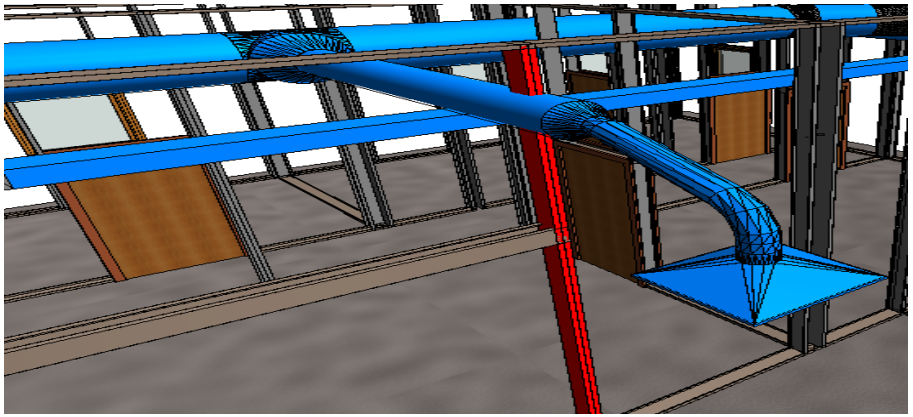
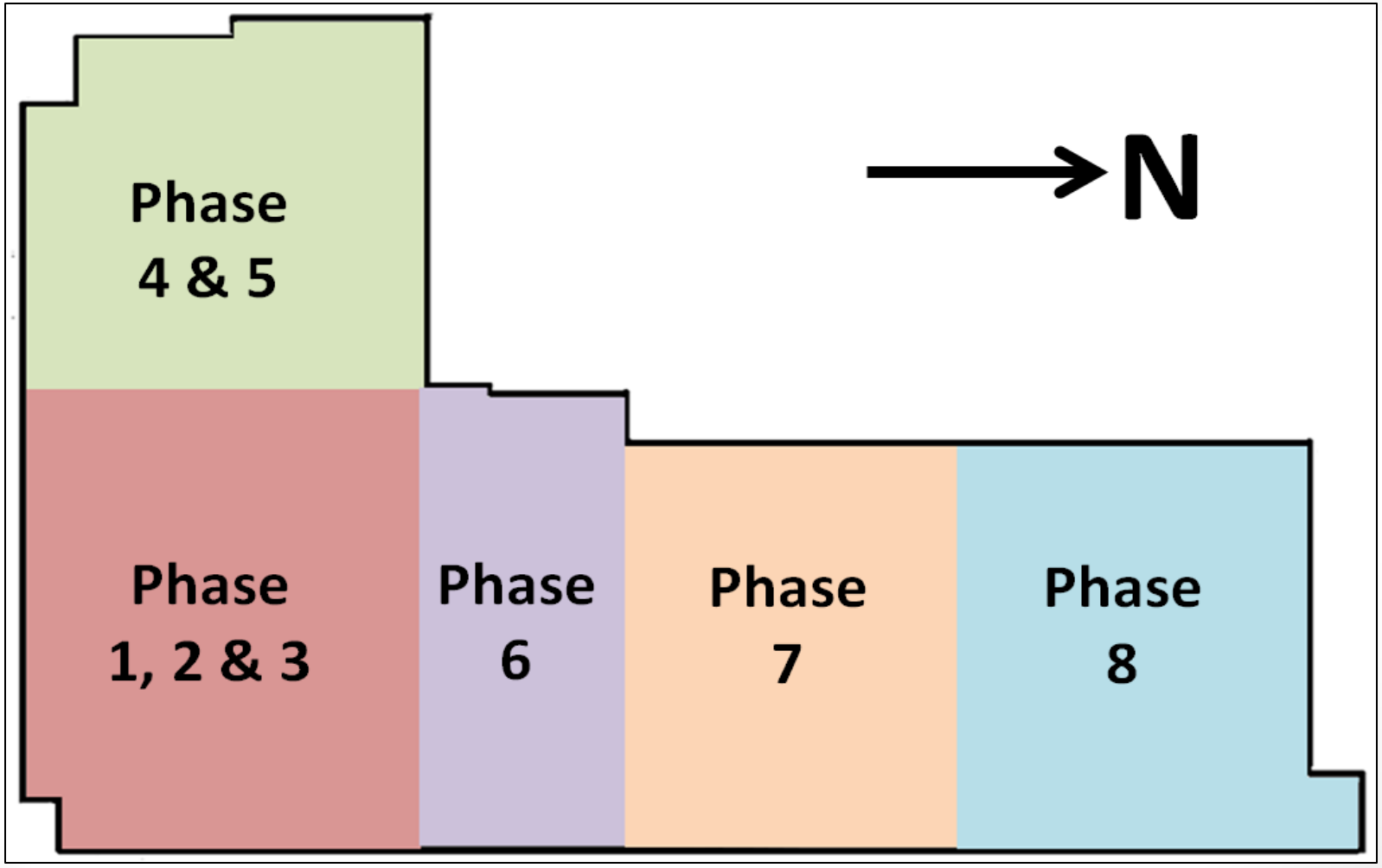


Image courtesy of strucsoftsolutions.com

Structural Steel Sequencing



Green Roof System

Image courtesy of opp.psu.edu

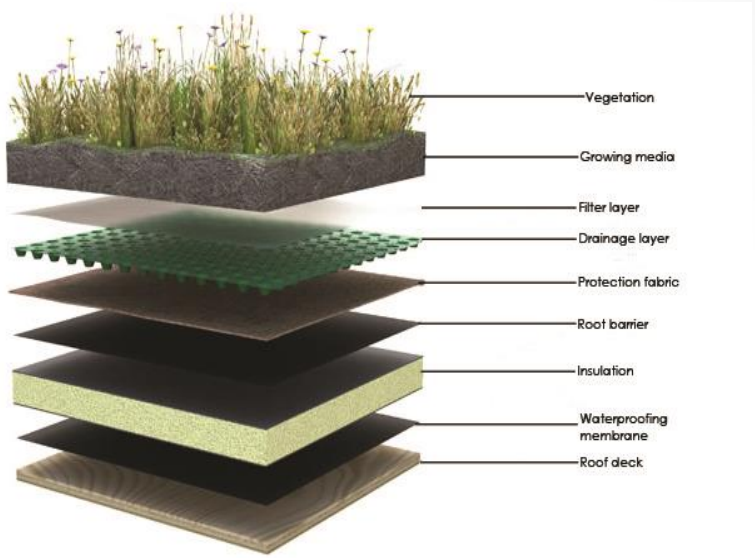


Image courtesy of dcgreenworks.org

Image courtesy of usgbc.org