Mueller Laboratory Renovation

Technical Report #3
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Table of Contents

Executive Summary

The Mueller Laboratory renovation is a project that presents many challenges. The critical path of the project is tied to the placement of the AHUs, which is dependent on the roof deck being reinforced. This is only possible if the demolition is completed on time. Careful demolition on the first floor is also crucial to following the project schedule since that floor interfaces with the second floor services, which are to remain.

Careful planning of exact routes of the MEP systems is the obvious way to value engineer the Mueller renovation. An accurate 3D model allows for offsite and pre fabrication. These techniques save both money and crucial schedule time.

Situated in the center of the Penn State campus means that the renovation job site is very small and in a busy area. Furthermore, the building is remaining partially occupied. Having the large number of people near the project site, as well as in the building creates many concerns for safety. Also the building's services to the occupied floors must not be interrupted.

Utilizing BIM will help the Mueller renovation in many ways. From planning, budgeting, and scheduling, to construction and conflict resolution, to building operation, an accurate BIM model is a great tool for this project.

Breakout sessions at the PACE Roundtable were enlightening. Discussions of when and how innovation could occur spurred our imaginations. And an investigation of global sustainability tactics inspired us to build truly efficient buildings, not just ones with LEED certifications.

Conversing with an industry professional was also useful. His comments in the breakout sessions showed his knowledge of a variety of topics. He also had good suggestions of further industry contacts to help in the author's thesis project.

Staying on Schedule

The critical path of the Mueller renovation is closely connected with the rough demolition work being done. To support the new rooftop air handling units, the roof deck must receive additional structural support. This is accomplished by adding several large support beams underneath the room deck, as seen in Figure 1.

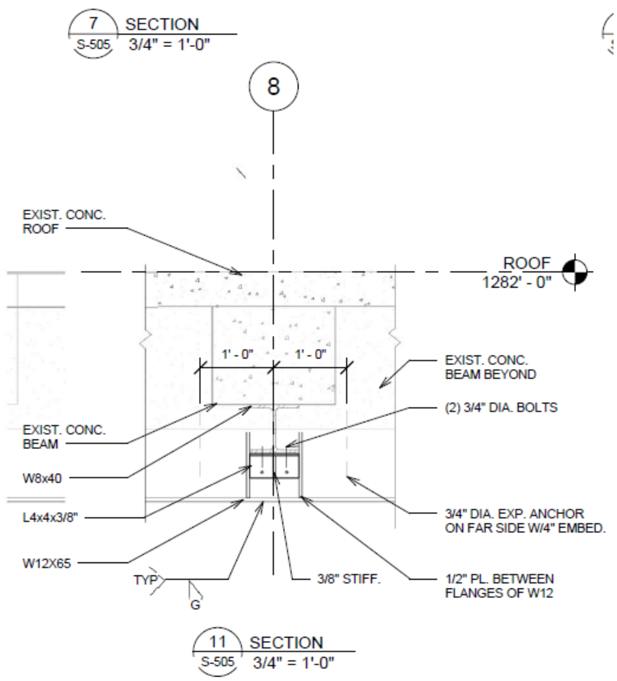

Figure 1. Reinforcement of roof deck.

In order to install these beams, the underside of the roof deck must be accessible. This means that the existing MEP systems in the sixth floor ceiling plenum must be removed to allow access to the bottom of the roof deck. Only once this demo is completed can the reinforcing steel be installed. Since the AHU have a set delivery date, it is critical that the roof be ready to receive them at that date. And reinforcing the roof deck depends on the sixth floor demolition being completed. Large delays in the project schedule could result if the installation of the reinforcing is delayed. If necessary extra manpower should be brought in to ensure the demolition is completed on time.

Next on the critical path is the demo occurring on the first floor. At this juncture the new MEP systems run upward to the rest of the building's floors. However, the second floor services all run up through the first floor ceiling. Hookups to the roof top AHUs and the electrical distribution panels must be run, but the services to the second floor cannot be interrupted. Accidental shutdown of services to the second floor could be devastating to the building's occupants, and must be carefully avoided. Taking the time for extensive planning and careful marking of what system components to will help avoid mistakes and keep the demo on track.

Only once the demo on the sixth and fourth floors is completed can the demolition on the fourth and fifth floors proceed. And, obviously, this demolition by nature must happen before the installation of new systems, fixtures, and finishes. So for the Mueller renovation the demolition, driven by needs of the MEP system, is the critical path of the schedule. Additional labor can be used to accelerate the schedule somewhat, but care must be taken to not disturb services for the building's occupants.

Value Engineering

An extensive 3D model of the Mueller renovation's MEP system is the project's prime example of value engineering. The 3D model allows all paths of ducts, pipes, and conduits to be planned beforehand. This allows for offsite fabrication of ductwork, and prefabrication of pipe and conduits runs. Both of these techniques save time and money while delivering a high quality finished product. Saving money is always attractive to an owner, but saving time may be more important to the Mueller building's owner, Penn State. The project needs to be completed prior to the start of the Fall 2015 semester, so accelerating the schedule by creating a detailed 3D model is prudent. Though there is an added cost to developing such a 3D model, the schedule savings are worth it.

Though the 3D model is quite detailed, it does not show locations of existing services in existing shafts and walls. A further inspection could have located the exact locations of these services to further streamline the project. However, the time savings would be minimal, and probably not worth the added cost of finding all the services running through the building.

Constructability Challenges

There are several constructability challenges of the Mueller Lab renovation, all stemming from the fact that the building is on an active university campus. The Mueller building is located in the middle of campus, very close to busy classroom buildings as well as the university library. This means that there are many thousands of students walking all around the jobsite each day. Keeping these students safe and out of the jobsite is crucial. This requires fencing and closely monitored gates, as well as signage and new walkways to move pedestrian traffic around the jobsite without hindrance (see Figure 2).

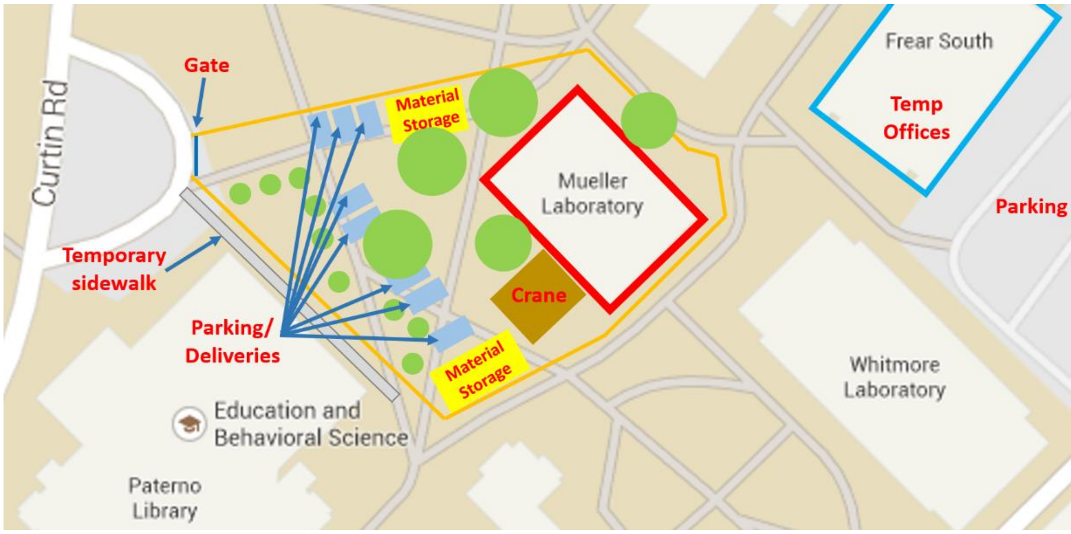

Figure 2. Project site.

In addition to students walking near the job site, the building is also remaining partially occupied during construction. This brings up a host of challenges: occupant safety, comfort, minimal interruption of MEP services, sensitivity of laboratory equipment and experiments, etc. Proper barriers in the building to keep occupants out of the active work zones are needed, as well as clear notice to the occupants of upcoming changes they need to be aware of. Good communication with the building's occupants to determine what services must remain connected at what times will help avoid loss of research data or laboratory experiment accuracy and safety.

One other difficulty of the project is the tight job site. Sandwiched between other campus buildings and with a steep drop off on the south side, all deliveries, contractor parking, and crane location must happen within a very small space. Coordination between the trades is necessary so as to minimize problems and keep the site safe. On time deliveries are a must so as to stay on schedule and prevent needless clearing of the delivery area. Also, the access road to the site is right next to the university library's loading dock. Communication with the library so as to not interfere with their deliveries, as well as to alert them of upcoming deliveries to the job site, will ensure that the project is a "good neighbor."

BIM Utilization

Using BIM is by far the smartest way to coordinate work between the MEP trades on a project like the Mueller Lab renovation. Modeling the existing conditions of the building as well as coordinating placement of the ductwork, piping, and electrical distribution systems is the only way to accurately estimate the project cost, as well as streamline the construction process.

As part of the site analysis a BIM model of the existing conditions should be constructed. As the renovation's program is discussed the BIM model can help confirm that the program is feasible (i.e. space in ceiling plenum for ducts, feasibility of core drilling, etc.)

When the program is complete the construction process can now be designed with BIM. This includes everything from exact placement of the MEP systems, to locations for contractor vehicles and tools, to locating the crane.

When the project is complete, since the MEP systems will have been upgraded for the first time in 50 years it makes sense to provide the owner with a copy of the BIM model and associated information. This way new electrical and lighting systems, thermostat options, and laboratory exhaust capabilities can be fully understood and utilized by the building's occupants and maintainers.

The Mueller renovation's CM, Barton Malow, has also utilized BIM in a way not laid out here. MEP installation conflicts can be solved by bringing an iPad right to the area of concern. There the trades and supervisors can review the plans and together quickly find solutions to problems. A senior project engineer for Baron Malow said of the usefulness of the having the BIM model on iPads "a picture is worth 1000 words but discussing the issue at its physical location is priceless." This portability of the BIM model not only delivers a higher quality product, but also saves time.

Barton Malow also reports that the BIM model allowed the various trades to develop their means and methods models. These models allowed for coordination of the trades. As such, Barton Malow says the BIM model was "very effective."

Breakout Session Topics

The author attended the "Implementing Innovative Design" breakout session at the PACE Roundtable. The most striking piece of the session was the discussion of when should innovation occur. It was claimed that innovation in a project occurs in the 0-10% range. At this point implementing innovative design and techniques is effortless, since everything is in the planning stages. However, it was brought up that although this is the easiest, and perhaps most economically feasible, time that that innovation can occur, that we should be careful to not limit ourselves to that timeline. Rather, we should be constantly seeking to innovate, in both materials and methods. Granted, large innovation becomes more difficult as the project progresses. However, there is always the possibility for innovation. It was even brought up that though a large innovation late in a project may cause construction to cost much more, building operating and lifetime costs could be reduced by such and innovation. Thus it seems that an understanding of what is "cost" is crucial. If cost is defined solely as construction cost, then innovation may well be better off occurring between 0-10% in a project. But if a building's cost is viewed as that over its lifetime, then perhaps innovation should be happening constantly throughout construction.

The author also attended the "Sustainability in the Global Community" breakout session. Discussion of the shortcomings of LEED brought about talk of what should "sustainability" look like? At one point it was said we should strive for "efficiency, not LEED." This idea may have much truth to it. Recent studies have shown some LEED buildings to be using as much or more energy than their non-LEED counterparts. It was discussed that perhaps some standard other than LEED should be adopted. California's new building regulations were discussed, as well as German implementation of solar energy and some Middle Eastern countries realizing the need to move beyond oil dependency. The discussion finished by proposing that perhaps we need to examine the way we build, and change it if necessary. Buildings that are too tightly sealed prove to be unhealthy to work in, so perhaps innovative methods of ventilation need to be developed. New methods of insulation, such as "phase change" materials were discussed, and showed promise of helping buildings be more sustainable.

Both these topics could be used in regard to the Mueller Lab renovation. As discussed, innovation can happen anytime during a project. From Penn State's perspective, saving money on the lifecycle cost of a building is very important, so innovation should not be limited to the design phase. Also, it is important for Penn State to seek to be sustainably. New AHUs and more efficient electrical distribution will help in this aspect. When construction is complete the building's occupants should be trained in the efficient operation of their building.

Feedback from Industry Roundtable

At the PACE Roundtable Chuck Tomasco was kind enough to discuss the Mueller renovation with the author. Mr. Tomasco also attended the breakout session on sustainability, and his contributions there insightful. He commented that the way that electricity is distributed has not changed greatly in the past 50 years. He also predicted that in the next 10-15 years that this would change, and that electrical distribution would be revolutionized.
Mr. Tomasco also suggested that I contact several CM firms to learn how their renovation techniques compare to Barton Malow's. Several companies he suggested I contact include Grunley, Clark, and Gilbane.