TECHNICAL ASSIGNMENT 1

September 16, 2013

SOUTH HALLS RENOVATION: EWING-CROSS

UNIVERSITY PARK, PA

Quaid Spearing

Construction Option

Advisor: Dr. Anumba

SOUTH HALLS RENOVATION: EWING-CROSS

EXECUTIVE SUMMARY

The South Halls Renovation and New Construction project is located in University Park of the Pennsylvania State University. It consists of the renovation of four dormitories, the construction of a new dormitory, and renovations to Redifer Hall. The focus of this technical assignment is an inclusive report focusing on the existing conditions of the Ewing-Cross Renovation. The findings of this technical assignment will serve as the foundation for future thesis assignments.

CLIENT INFORMATION

In 2009, Penn State had a feasibility study performed to look into the potential construction activities that could be performed in the South Halls complex. They felt that there was a need to renovate the South Halls because the MEP systems were past their useful life, and the buildings did not meet current energy and building codes, including not being ADA compliant. Penn State also had a desire to relocate all sororities to South Halls. By placing all sororities in South Halls, Penn State is able to allocate each sorority their own floor. In addition, Penn State follows long term planning by making 50 year decisions. They wanted to make sure the renovation had durable spaces and quality equipment; Penn State's mentality is to renovate, not replace. A full description of the client information can be found on page 6 of the appendix.

EXISTING CONDITIONS

The existing conditions of the site were analyzed as a precursor for future construction site plans and logistics. Located along College Ave. and McKean Rd, the South Halls complex has extensive underground utilities in place due to Penn State's expansive infrastructure. Campus chilled water was extended to South Halls because of the renovations. As part of the project, Penn State requires Barton Malow to recycle a minimum of 75% of the construction waste, which exceeds the minimum requirements for LEED. A unique challenge to the project is the fact that there are numerous trees that need protection, because Penn State is an arboretum. An existing conditions plan can be seen on page 7 of the appendix.

BUILDING SYSTEMS SUMMARY

A great amount of research was performed to understand the complexity of the building systems implemented in Ewing-Cross. The building is a 71,002 gsf renovation dormitory building. The existing structure consists of HSS steel columns and lift concrete structural slab; the new bathroom floor slabs will be composite slab-on-deck. The building enclosure consists of masonry brick veneer with CMU backup encloses the building, along limestone veneer stone panel projections supported by metal stud framing. The mechanical rooms on ground floor house the Energy Recovery ventilation (ERV) units that supply fresh air to the building's spaces. Campus chilled water, along with heating hot water (from Redifer) is supplied to fan coil units to condition the spaces. The main electrical distribution panel (MDP) on the ground floor of Ewing provides 480Y/277V, 3P, 4W power to the major mechanical equipment and the existing distribution panel (LDP); the LDP supplies 208Y/120V to the various lighting/receptacle panel boards throughout Ewing-Cross. Emergency power is fed from Redifer Hall via a 3P medium voltage switch into a 75 kVa transformer to an emergency distribution panel (EDP) directly to the LDP. Photos and building system summaries can be found on pages 8-9 of the appendix.

SUSTAINABILITY

Ewing-Cross is aiming to achieve a LEED certification but is tracking to achieve LEED Silver Certification. The project follows the LEED 2009 for New Construction and Major Renovations and is currently able to achieve 47 points, in the various categories, which can be seen in the table below.

Table 1: Ewing-Cross LEED Checklist

South Halls Renovation LEED Checklist	
Category	**Points**
Sustainable Sites	11
Water Efficiency	6
Energy and Atmosphere	3
Materials and Resources	9
Indoor Environmental Air Quality	10
Innovation and Design Process	6
Regional Priority Credits	2
Total	**47**

PROJECT DELIVERY SYSTEM

Investigation into the project delivery system was performed to gain a better understanding of how the project parties work together. Based upon the findings of the feasibility study, Penn State requested proposals from several project teams, including Barton Malow/Clark Nexsen, who were eventually selected on a Best Value basis. The South Halls project utilizes a Design-Build delivery method with Barton Malow contracted with Penn State on a $94.1M Guaranteed Maximum Price (GMP) contract, and Clark Nexsen contracted with Barton Malow on a Lump Sum Basis. A GMP gives Penn State the

flexibility to adjust the project, while still having a cap on the price; this works well with a design-build project, as there can be numerous change orders with fast tracked projects.

Clark Nexsen serves several functions on the project team: Design Architect, Mechanical Engineer, Electrical Engineer, Structural Engineer, and Fire Protection Engineer. Unlike most projects where work is bid on a Lump Sum low bid basis, the primary Design Assist Specialty Contractors were selected through a two stage proposal where each contractor was scored based on their proposals. Open communication is a key factor in the project delivery system, with the DA subs often deferring directly to Clark Nexsen, decreasing turnaround time for critical issues. Overall, the project delivery method is unique because it is design-build, with integrated project delivery (IPD) concepts, such as: collaboration, co-location, open communication, early involvement of key participants, and BIM. The project organizational chart can be found on page 10 of the appendix.

PROJECT STAFFING

An analysis of Barton Malow's staffing plan was executed to gain a greater understanding of how the design-build team works. Barton Malow's staffing plan for the Ewing-Cross renovation follows a typical structure for a project of this size; the senior project manager oversees the project from the co-location field office, with his support staff, comprised of project engineers and a project technician. The senior superintendent works in unison with project management team, and has two superintendents who report directly to him. Design-Assist specialty contractors are also co-located with Barton Malow in the Redifer Hall field office, promoting communication among trades. The project staffing plan can be seen on page 11 of the appendix.

PROJECT COST

Along with the new building Chace (P1A-2), and the Haller-Lyons renovation (P1A-1), the Ewing-Cross renovation (P1B) is phase one of a two phase $94.1M project. The actual building cost of the Ewing-Cross renovation is approximately $11,838,550, with the actual total project cost at about $15,204,750. These costs were compared to a square foot estimate which came out to $13,868,500. It was found that the square foot estimate was slightly lower than the actual cost of construction, due to factors such as, but not limited to, demolition costs, the limitation of choices in RS Means, and the fact that much of the existing structure will remain. A full cost comparison, including a percentage of total cost breakdown, can be found on page 12 of the appendix.

PROJECT SCHEDULE SUMMARY

Once Barton Malow and Clark Nexsen were hired as the design build team, the design phase for South Halls began at the end of May in 2011. The notice to proceed was given on May 1st, 2012, with construction beginning on Chace and Haller-Lyons. Construction on Ewing-Cross began with the demolition and abatement of the interiors in May of 2013, and is expected to reach substantial completion in December of 2013, in anticipation of student move-in for the 2014 spring semester. In total, the construction of Ewing-Cross is an aggressive seven month duration, with a unique phasing of the interior work. A full project schedule, along with descriptions of the foundations, structure, and interior phases can be found on page 13 of the appendix.

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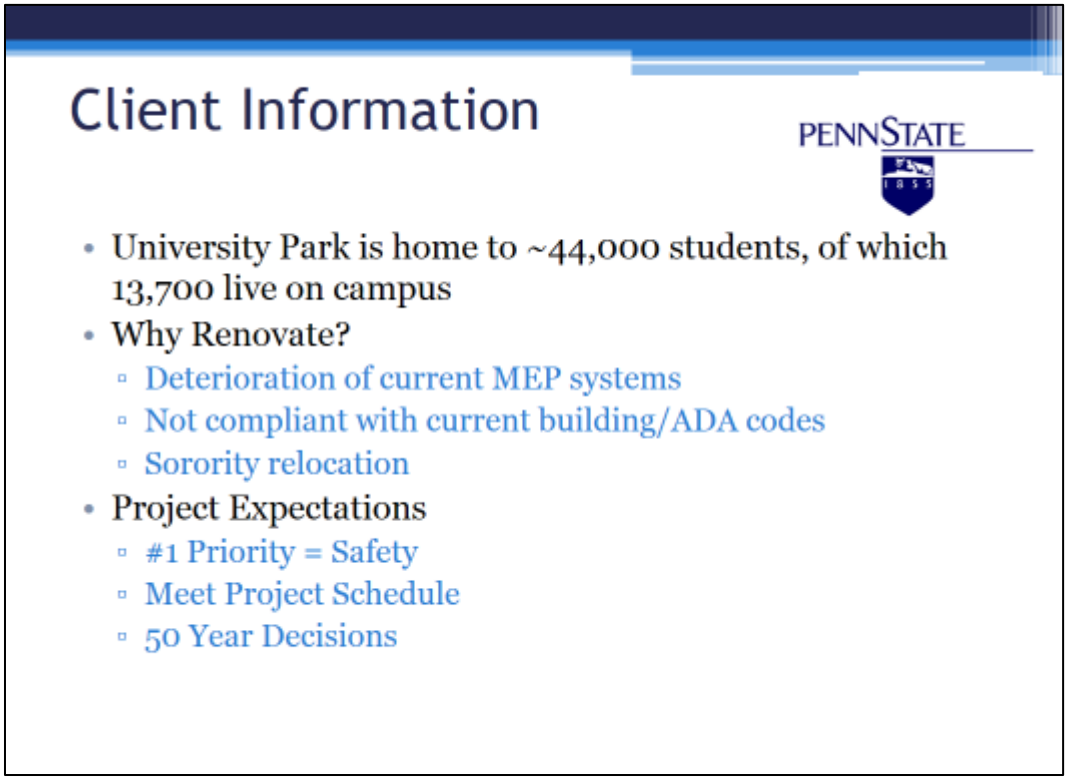


Why Renovate?

The original facilities were constructed in the 1950's, and over the last 60+ years, were well maintained. However, there were several issues with MEP systems: the mechanical equipment was past its useful life, and the sprinkler systems in place were temporarily installed, in anticipation of a future renovation. Most of the building systems did not meet current energy and building codes, including not being ADA compliant. In addition to the overall deterioration of the South Halls complex, Penn State had a desire to relocate all sororities to South Halls. A large portion of the sororities on campus are located in Pollock and South Halls. By placing all sororities in South Halls, Penn State is able to allocate each sorority their own floor.

Project Expectations

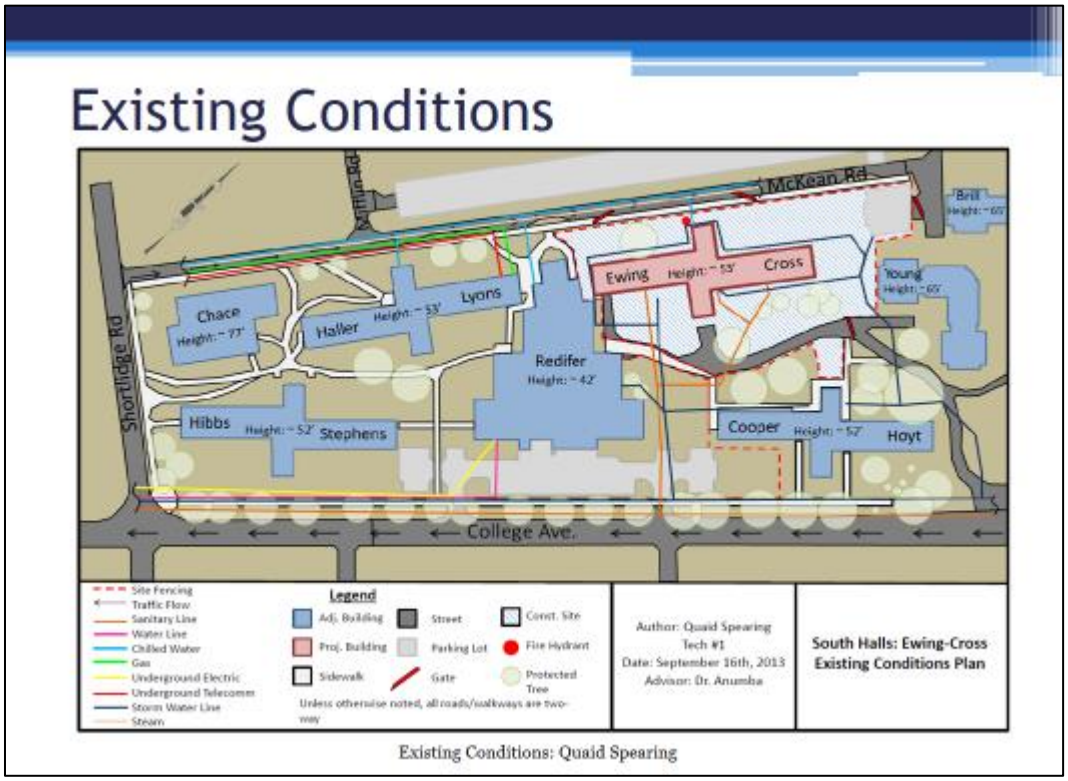
Penn State considers safety the highest priority for the South Halls projects; not only during construction, but safe facilities for the students to reside in. Following safety, the project schedule is the most critical aspect. The first renovation, Haller-Lyons, took one year to complete. However the next three buildings have anticipated schedule durations of 7 months each, leaving little room for error in respect to delivery of the project. In terms of cost and quality, Penn State has high expectations. Unlike most other owners who only make 15-20 year decisions, Penn State follows a long term planning approach by making 50 year decisions. They wanted to make sure the renovation had durable spaces and quality equipment; Penn State's mentality is to renovate, not replace. Examples of what Penn State expects from projects can be seen all across the campus. There are several buildings that are greater than 100 years old. Another example is their choice to use slate roofing, as opposed to asphalt shingles.

Sequencing Issues of Interest

The most notable sequencing issue is the overall phasing of the project. Much planning went into determining the order in which the four buildings would be renovated. A big factor that played into the phasing of the buildings was which two Penn State would want to renovate if they could only complete half of the overall project.

Keys to Owner Satisfaction

Overall the keys to owner satisfaction are: safety, delivering the project on time and under budget. There is no flexibility in schedule for each phase of the project, and they expect the project to meet the budget, all without a loss in quality.



Existing Conditions: Quaid Spearing

Location

The South Halls complex is located in University Park, between College Ave and McKean Rd, with Ewing-Cross adjacent to Redifer commons. By State College standards, space is a constraining factor with a very tight site. In addition, all the surrounding buildings are occupied during construction. There are extensive underground utilities that run along College Ave and McKean Rd in utility tunnels, due to the existing facilities. Campus chilled water was brought to South Halls because of the renovations occurring.

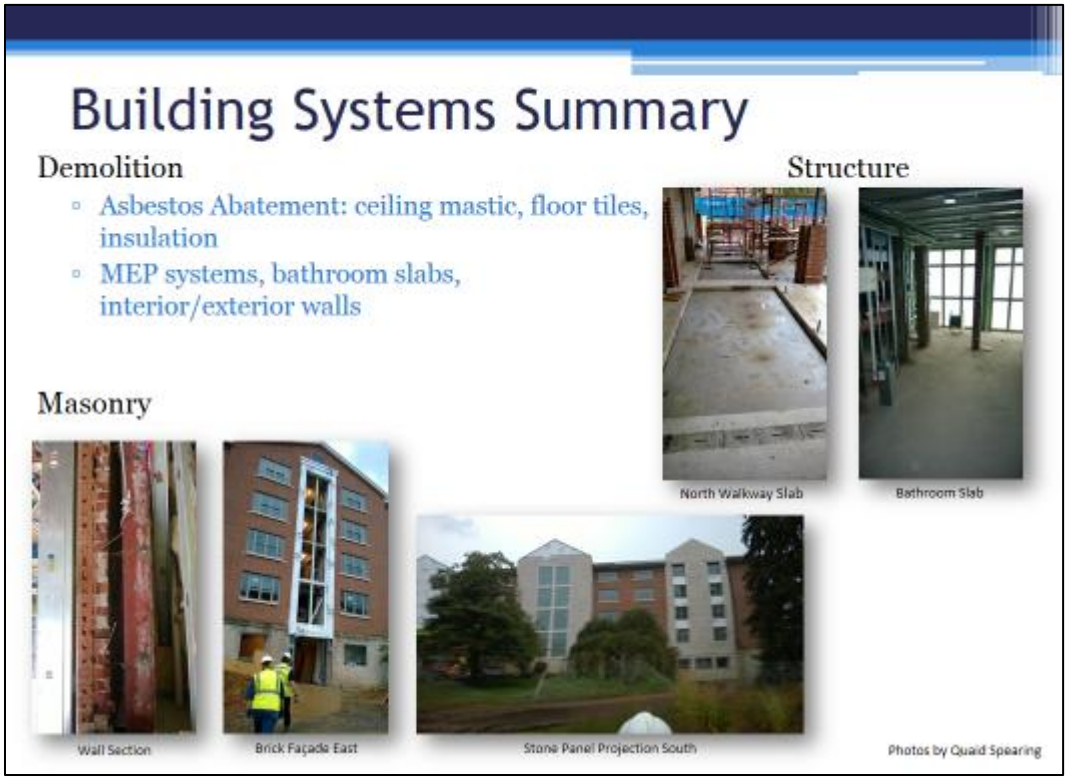
Local Conditions

A unique challenge of working on the Penn State campus is the fact that they are an arboretum, and many trees will need protection during construction.

Parking: Typical for most construction projects on campus, workers are required to park offsite at the commuter lots located near the Bryce Jordan Center and Beaver Stadium; from there, workers then ride the bus over to the jobsite at South Halls.

Soil: The geotechnical report from CMT Labs showed that the four boring locations around Ewing-Cross contain a layer of topsoil approximately 4 to 18 inches thick. Underlying the topsoil, the soils around Ewing-Cross consist of a layer of natural residual soils consisting primarily of clay and silt sized particles with varying amounts of sand sized particles and weathered dolomite fragments. These soils sit directly on dolomite bedrock, which resides between 1 and 13 feet below the existing surface grades. Based upon the boring samples from CMT, it was determined the soils around the building would have suitable bearing capacity. Compacted PennDot 2A course was recommended for structural fill under footings and slabs. Groundwater testing was performed at each bore hole; there were several areas where ground water encountered during drilling activities. However, at the four locations surrounding Ewing-Cross, groundwater was not encountered.

Recycling: Per PSU requirements, the contractor is required to recycle a minimum of 75% of construction waste; greater than minimum the requirements for LEED.



Demolition

Since this is a renovation project, demolition makes up a considerable portion of the project. There was a large amount of abatement work that included the removal of asbestos tiles and insulation. Other demolition includes the removal of all sorority and bedroom furniture; portions of the exterior storefront, exterior walls, and interior walls; the removal of the bathroom floor slabs; and the demolition of the existing mechanical, electrical, and plumbing systems.

Structural Steel Frame

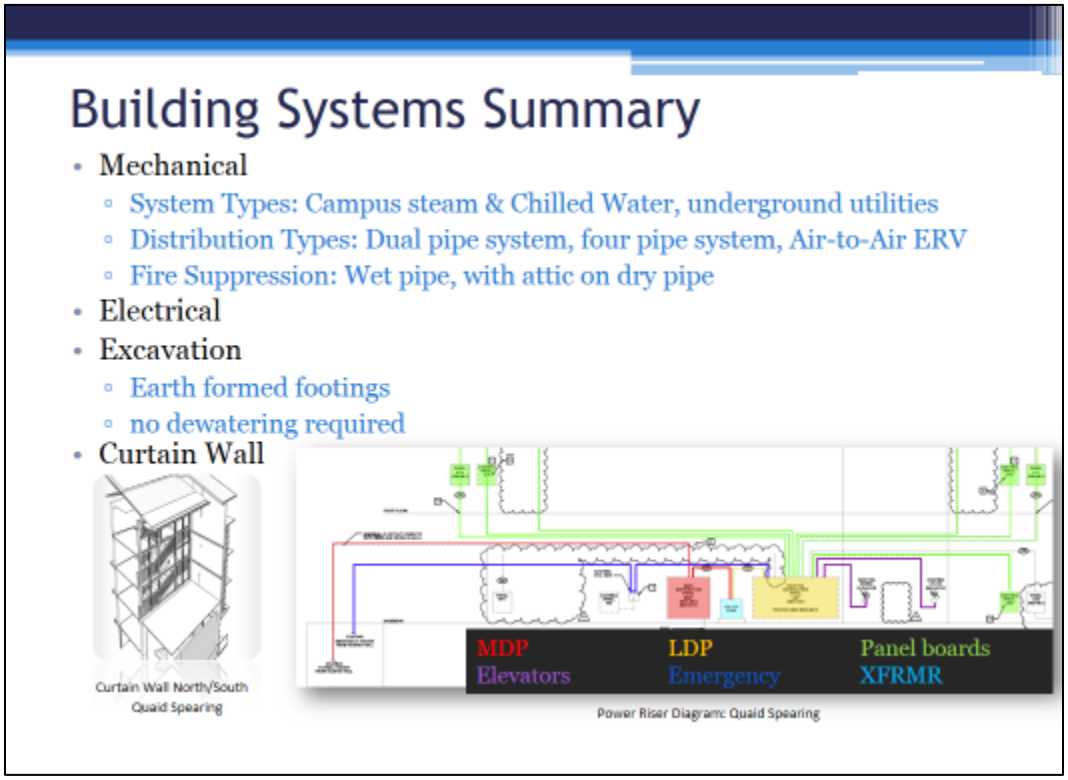
Ewing-Cross was constructed in 1955 using mainly HSS steel columns and wide flange members. Additional lateral resistance is not required because the building's weight was increased by less than 5%. The existing structural steel frame will remain in place. The bathroom floor construction (2-4) consists of a 3 ¼" LW Concrete on 3" VLI composite metal deck, reinforced with 6x6 wwf. A mobile truck crane was utilized for the placement of the steel members. The crane was located on the south side of Ewing-Cross. On the north side, two (2) smaller crawler cranes were used for the placement of the metal stud framing for the stone panel projections.

Cast in Place Concrete

The original floor slabs in Ewing-Cross were designed as Lift Concrete Structural Slab. A majority of the existing structure will remain; will the exception of the bathroom floor slabs. The new foundations consist of earth formed spread and continuous footings and wood formed concrete foundation walls to support the stone panel projections and columns for the wraparound porch. The most unique cast-in-place concrete for the South Halls Renovation is the bathroom composite slab-on-deck; the old slab had to be cut out and replaced so that the proper floor slope could be achieved for drainage. It was designed as shored composite construction and was placed with a concrete pump directly from the concrete truck. While the rest of the construction follows a top-down sequence, the bathroom slabs were constructed from the ground up so that shoring could be placed to support the above floor slab.

Masonry

The two façade types implemented are the existing brick veneer with CMU backup, 1-1/2" rigid insulation, 6" batt insulation, and accented by limestone wall sweeps; and the stone panel system consisting of ¼" veneer backed by metal furring strips, 5/8" sheathing and 8" metal studs. Hydraulic scaffolding was utilized for the placement of brick and limestone panel veneer.



Mechanical

Campus steam is supplied to Redifer to heat supply water to the auxiliary buildings. Hot water is transferred from Redifer to Ewing-Cross through heat exchangers, and campus chilled water is pumped directly into Ewing-Cross from the utility tunnels to the ground floor mechanical room. There are three main mechanical systems that serve Ewing Cross. The first system is a dual temperature system which provides heating/cooling through Fan Coil Units (FCU) that service student bedrooms, sorority suites and lobbies. The second system consists of Two Air-to-Air Energy Recovery Ventilation (ERV) units which are used to supplement and supply outside air to each room. The third system is a Four Pipe heating/cooling System which services the Ground and First Floors Common Areas. In addition to the three main mechanical systems, special accommodations were made to provide heating and cooling to the two meetings rooms on the first floor; both are fed by separate 1700 CFM Air Handling Units (AHU). The building makes use of a wet pipe sprinkler system for all areas except for the attic, which will remain on the existing dry pipe sprinkler system.

Electrical

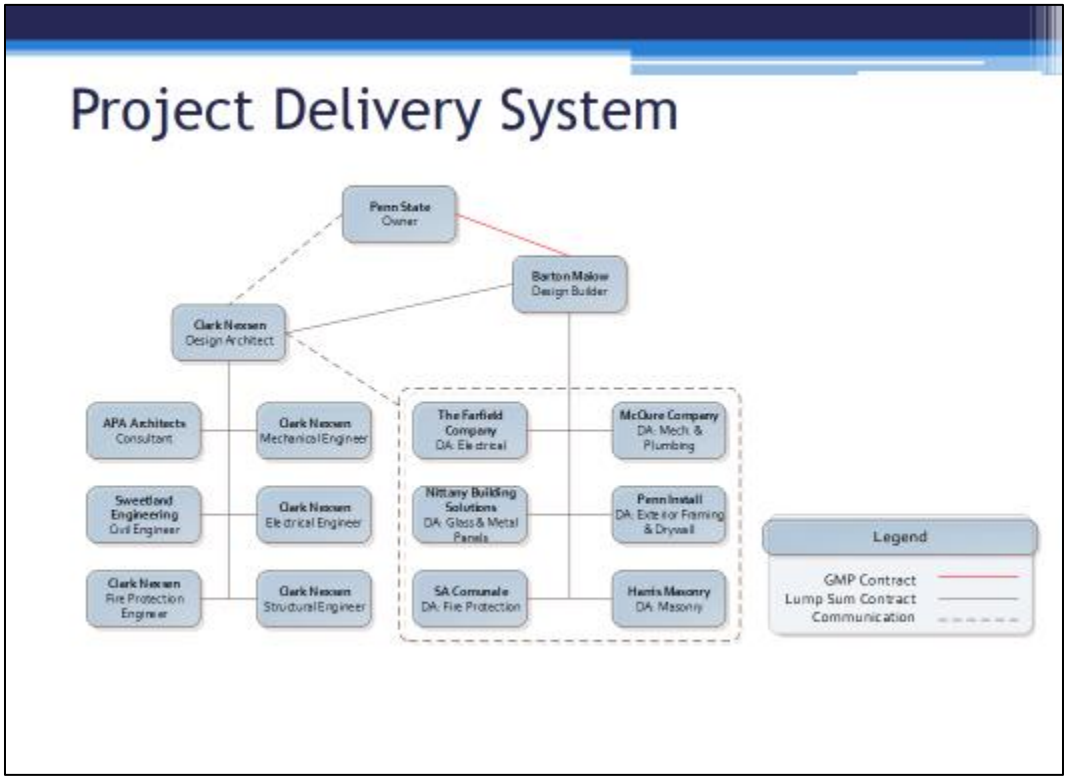
Similar to the other buildings at South Halls, Ewing/Cross has a normal feeder and an emergency feeder from Redifer Hall. The system requires a demand service of 354.6 kVA. It is supplied via 480V utility feed that travels through a 600A main distribution panel (MDP), which feeds major mechanical equipment that requires 480Y/277V and also feeds the 600A existing distribution panel (LDP), via a 150 kVA step-down transformer. The elevators and all of the smaller panel boards are directly supplied via the LDP panel and are rated at 208Y/120V and primarily service the power and lighting loads. Emergency Power is supplied to an Emergency 3-phase medium voltage switch that feeds into a 75kVA emergency transformer. The transformer services an emergency distribution panel (EDP) which ties directly into the LDP via 208V utility feed, and can used to energize the essential loads during a power outage.

Curtain Wall

The curtain wall works to allow natural light to penetrate the stairwells for both Ewing and Cross. Aluminum frame storefront and insulated low-e glass are the two components of the curtain wall system. The low-e glass will help to reduce the building heat loads as well as earn LEED credits.

Support of Excavation

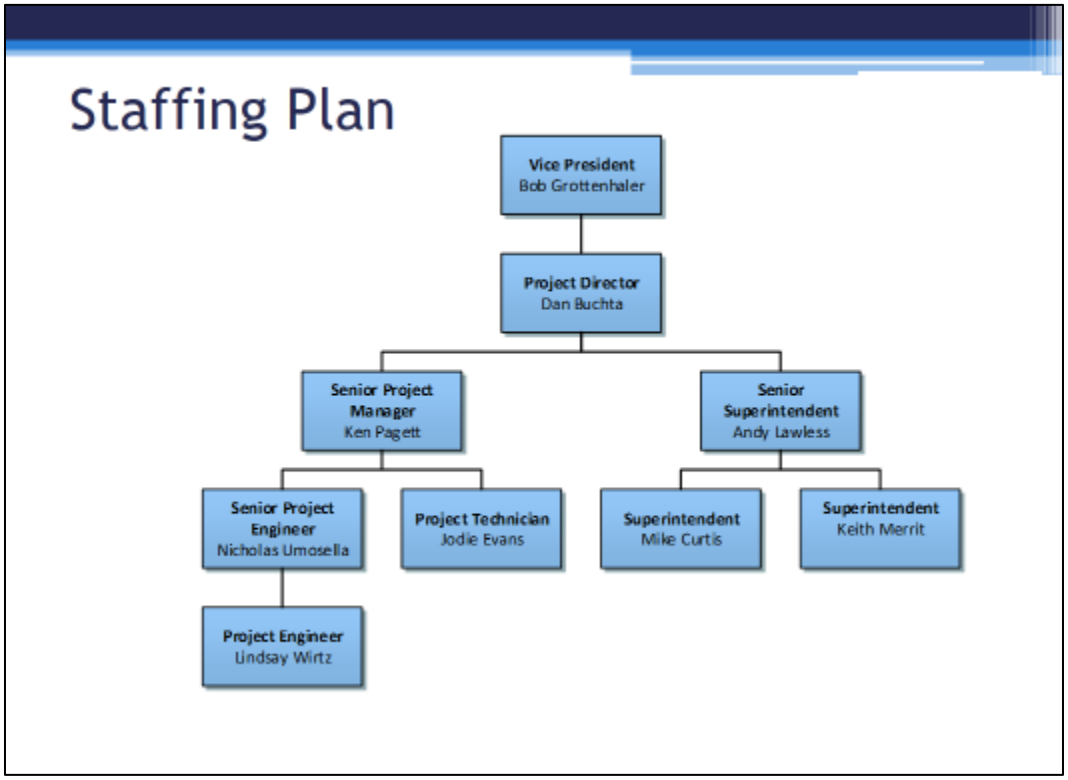
Because a majority of the structure is to remain, very little excavation is needed for the renovation of Ewing-Cross. The excavation needed for strip and continuous footings is earth formed, and there were no critical issues with the water table around Ewing-Cross; therefore, no dewatering system will be required.



The South Halls Renovation and Construction utilizes a Design-Build delivery method, with Barton Malow Company acting as the Contractor and Clark Nexsen as the designer. In 2009, Penn State had a feasibility study performed to look into the potential construction activities that could be performed in the South halls complex. Based upon the findings of the study, Penn State requested proposals from several project teams, including Barton Malow/Clark Nexsen, who were eventually selected on a Best Value basis. Barton Malow is contracted with Penn State on a Guaranteed Maximum Price (GMP) contract, and Clark Nexsen and all Design Assist Specialty Contractors are contracted with Barton Malow on a Lump Sum Basis. A GMP gives Penn State the flexibility to adjust the project, while still having a cap on the price; this works well with a design-build project, as there can be numerous change orders with fast tracked projects.

Clark Nexsen serves several functions on the project team: Design Architect, Mechanical Engineer, Electrical Engineer, Structural Engineer, and Fire Protection Engineer. Unlike most projects where work is bid on a Lump Sum low bid basis, the primary Design Assist Specialty Contractors were selected through a two stage proposal where each contractor was scored based on their proposals. The judges were comprised of the project management team as well as a Penn State Office of Physical Plant (OPP) project manager. The specialty contractor with the highest average score was awarded the work for their respective trade. Selecting DA specialty contractors through scoring allowed Penn State to select the contractors that would provide the best value and quality, not just the lowest bid.

Open communication is a key factor in the project delivery system, with the DA subs often deferring directly to Clark Nexsen, decreasing turnaround time for critical issues. DA specialty contractors are also co-located with Barton Malow in the Redifer Hall field office, promoting communication among trades.



The project staff is located in the co-location office in Redifer Commons. The staffing chart shown above, details Barton Malow's project team for the South Halls renovation. Everybody in the staffing plan works out of the field office, except for the Project Director and Vice President.

In looking at the staffing plan in detail, Bob Grottenhaler serves as the Vice President of Barton Malow's Baltimore office, with Dan Buchta reporting directly to him. Heading the project management on site is handled by Ken Pagett. Reporting directly to him is the Senior Project Engineer, Nicholas Umosella, and the Project Technician, Jodie Evans. Lindsay Wirtz serves as the Project Engineer and reports to Nicholas. On the field side, Andy Lawless serves as the Senior Superintendent and has two superintendents who report to him; Keith Merrit and Mike Curtis.

The staffing plan represents the management staff for the Ewing-Cross Renovation, Phase 1B, and is adjusted accordingly for future phases as required. Similar to the project organization, open communication among the staff is crucial; even though there is a vertical management structure, most decisions are made by the project team as a whole.

Project Cost Evaluation

Table 1: RS Means Square Foot Estimate

RS Means Square Foot Estimate	South Halls Renovation: Ewing-Cross Penn State University Park , Pennsylvania , 16802
Building Type:	College, Dormitory, 4-8 Story with Face Brick with Concrete Block Back-up / R/Conc. Frame
Location:	STATE COLLEGE, PA
Story Count:	4
Story Height (L.F.):	8
Perimeter (L.F.):	895
Floor Area (S.F.):	71,002
Labor Type:	STD
Basement Included:	Yes
Data Release:	Year 2013 Quarter 3
Cost Per Square Foot:	$195.34
Building Cost:	$13,869,500.00

Significant System Costs

- Mechanical & Plumbing
- Electrical
- Drywall & Ceilings

Key Differences

- Existing Structure
- Roofing
- Low floor heights

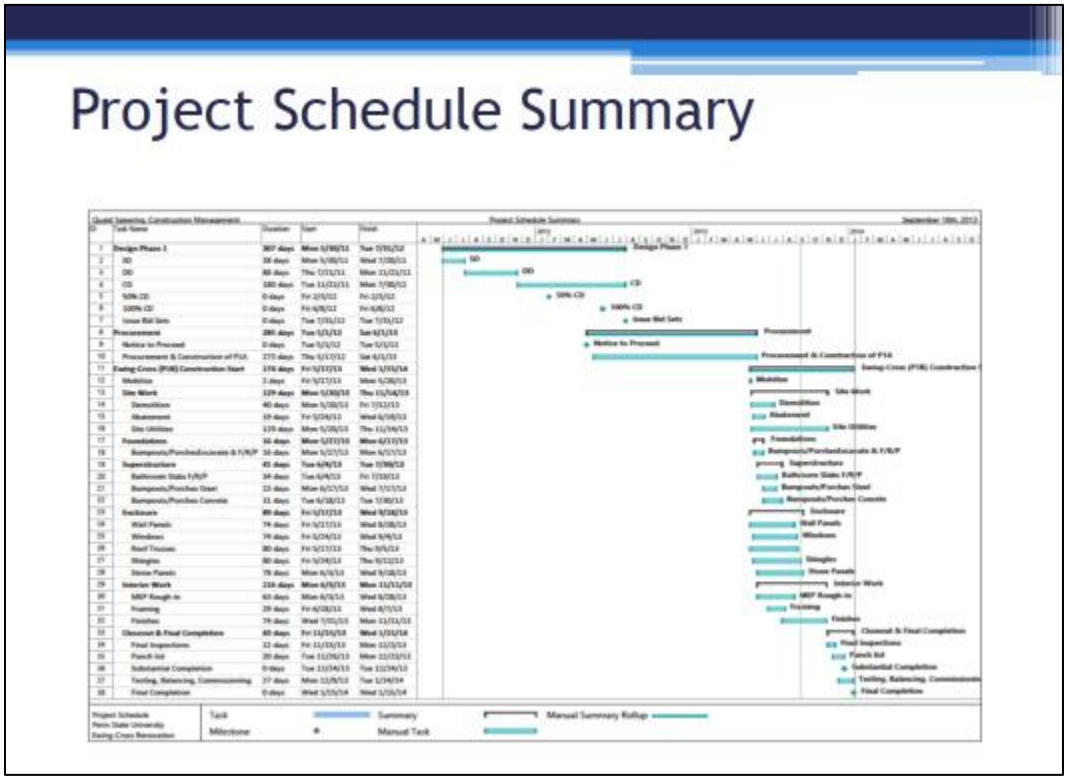
Table 2: Building Cost Summary Comparison

	South Halls: Ewing-Cross Actual Cost				Square Foot Estimate		
Description	Total Cost	SF	Cost/SF	% of Total	Total Cost	Cost/SF	% of Total
Demolition	$ 386,250.00	71002	$ 5.44	3.26%	-	-	-
Concrete	$ 414,900.00	71002	$ 5.84	3.51%	$ 1,787,500.00	$ 25.18	17.24%
Masonry	$ 998,450.00	71002	$ 14.06	8.44%	$ 377,500.00	$ 5.32	3.64%
Metals	$ 413,950.00	71002	$ 5.83	3.50%	-	-	
Roofing	$ 692,400.00	71002	$ 9.75	5.85%	$ 323,000.00	$ 4.55	3.11%
Doors & Hardware	$ 417,000.00	71002	$ 5.87	3.52%	$ 481,500.00	$ 6.78	4.64%
Glazing & Metal Panels	$ 817,800.00	71002	$ 11.52	6.91%	$ 110,000.00	$ 1.55	1.06%
Drywall & Ceilings	$ 1,017,600.00	71002	$ 14.33	8.60%	$ 793,500.00	$ 11.18	7.65%
Flooring	$ 372,550.00	71002	$ 5.25	3.15%	$ 687,500.00	$ 9.68	6.63%
Fire Protection	$ 130,350.00	71002	$ 1.84	1.10%	$ 230,500.00	$ 3.25	2.22%
Mechanical & Plumbing	$ 2,782,950.00	71002	$ 39.20	23.51%	$ 2,579,000.00	$ 36.32	24.87%
Electrical	$ 1,304,000.00	71002	$ 18.37	11.02%	$ 1,305,000.00	$ 18.38	12.58%
Total Building Construction Cost	**$ 11,836,550.00**	71002	**$ 166.71**	100.00%	**$ 10,369,500.00**	**$ 146.05**	100.00%
Total Project Costs	**$ 15,204,750.00**	71002	**$ 214.15**		**$ 13,869,500.00**	**$ 195.34**	

The construction cost for Ewing-Cross is approximately **$11,836,550**, at **$166.71/SF**; including the indirect costs such as General Conditions, Bonding & Insurance, and CM Fees, the Project Costs comes out to **$15,204,750**, at **$214.15/SF.** The mechanical & plumbing cost is $2,782,952 and accounts for 23.51% of the total construction cost. The electrical cost is $1,304,000.00 and accounts for 11.02% of the total construction cost. Upon further analysis of the building systems costs, it is apparent that the two largest components are the mechanical and electrical systems. This is due to the fact that a majority of the structure is existing to remain, and the MEP systems were entirely replaced.

The RS Means Online, version 2013, was utilized for the Square Foot Estimate of Ewing-Cross. The building is 71,002 sf and has a building perimeter of 895 lf. Location, floor height, and time factors were used to arrive at the final square foot estimate. A total building cost of **$13,869,500.00** was found at **$195.34/SF**. It was assumed that the entire building was brick façade, i.e. no limestone veneer or metal panels.

There are several factors that influence the differences among the actual building cost and the square foot estimate. The main factor being that the square foot estimate assumes a new structure. Demolition costs are not taken into account with the square foot estimate. Another factor that makes the actual building cost higher than the square estimate is the low floor to floor heights. At 8'-0", coordination of the MEP systems becomes more difficult, as there is less 'real estate' for each system above ceiling, creating a higher level of BIM coordination needed, as well additional labor to install numerous bulkheads. Floor construction (concrete) costs are also significantly different; the square foot estimate is nearly $1,000,000 greater than the actual cost. This can be accounted to the fact that the existing slabs are remaining, except for the bathroom slabs. Roofing cost are significantly different, with the actual cost approximately $600,000 higher; the SF estimate assumes a built-up roof with perlite, while the actual roof is a shingles system utilizing recycled rubber and plastic slate shingles.



Construction began on May 1st, 2012, starting with the new building, Chace Hall, and the first renovation, Haller-Lyons. Upon the closure of the 2013 spring semester, construction began at Ewing-Cross on May 17th, 2013. When compared to the 12 month schedule for Haller-Lyons, Ewing-Cross is under an aggressive 7 month window for Substantial Completion at the end of December 2013.

Foundations Phase

The foundation work includes the spread column footings that will support columns and the continuous footers that will support the stone panel system bumpouts. The foundation phase begins with the excavation and pouring of the column footers on the North Side of Ewing-Cross. The South Side excavation and pouring of column footers begins slightly after the North Side.

Structural Phase

The structural work follows the sequencing set by the foundation work, with steel columns going into place after the column footings. The wrap around porch slabs on the south follows the columns, with the beam and roof decking for the exterior porch/walkways going into place after that. The bathroom slab construction follows a ground up sequence. Work will begin in Cross, with the level 2 slab. Immediately after slab L2 is poured, shoring is erected for slab L3, which is poured once slab L2 has reached minimum sufficient strength, followed by the shoring for slab L4 and the subsequent pour. The three slabs in Ewing follow this same pattern, lagging about three (3) weeks behind Cross.

Finishes Phase

As this is a renovation project, a majority of the project is interior work on the critical path. Similar to the bathroom slab sequencing, interior work in Ewing lags slightly behind Cross. The interior work follows a top-down sequencing, with the work on the fourth and third floor rooms and corridors occurring simultaneously, by utilizing two crews for each portion of the interior work. As each trade finishes on the fourth and third floor, they move to the second and first floor respectively. The ground floor houses primarily the mechanical rooms and equipment, and interior work on this floor follows its own sequence throughout the entirety of the project. The restroom core interior work occurs simultaneously on all four levels, with each trade following on after the interior work for the rooms and corridors is complete.

Ewing follows the same interior trade sequencing as Cross, finishing about one (1) month after for the rooms and corridors, and about two (2) weeks later than the Cross Restrooms.