2013

INTRAMURAL BUILDING ADDITION AND RENOVATION – PHASE I

Gonzalo Lay
The Pennsylvania State University
Department of Architectural Engineering
Construction Option

AE 481 W – FALL 2013
Faculty Advisor: Ray Sowers
TECHNICAL REPORT I

EXECUTIVE SUMMARY

The intended purpose of this technical assignment is to evaluate the conditions in which the Intramural Building Addition and Renovation project is constructed. Thorough evaluation of the building's characteristics such as cost, schedule, deliver method, building systems, client information and site conditions have been performed to obtain better understanding of the project.

The Pennsylvania State University is a widely recognized public university in Pennsylvania. The University's main campus is University Park, which is centered in the heart of Pennsylvania, State College. Founded in 1855 as an agricultural and farmers school, the University gained expanded to a massive school, with 24 campuses and the offering of 160 majors throughout them. Currently enrolled with more than 96,000 students across its campuses, the University houses high end educational facilities and is ranked nationwide among the top schools in both academics and athletics.

Due to the University's large student body, facilities must be updated to their finest and provide high quality services to maintain its status as a highly ranked university. The Pennsylvania State University has three primary athletic facilities with full access to students. Among these, Rec Hall and White Building are the two athletic facilities that get the most visitors for weight training and classroom use. The Intramural Building, out of the three is the least updated facility, and is relatively close to East Halls, the highest populated area in the university. Students primarily use the Intramural Building for recreational sport use. Through student polls, the University's Student Council proposed the improvement of this facility to allow for an improved active student lifestyle. In addition to this improvement, the new construction of the Intramural Building will distribute the student demand of fitness and recreation throughout the University's campus. This will result is less crowded gyms, reduction of time waiting in lines, and improvement of the university's recreational program.

The University chose Moody Nolan as the lead architect to design the new addition of the Intramural Building, with hopes to change the face of the dull existing building. The new construction was broken down into three phases, which expand outward with dynamic façades from the existing building's southern, western, and northern sides. Teamed with one of the top ranked sport complex contractor in the nation, Mortenson Construction was selected under a GMP contract of all three phases, to manage the construction.

Unlike several project at the university's campus, the funding of this project comes from fees the students pay in their tuition to improve existing facilities for their use rather than state funding. After the renovation of Rec Hall in '06, which achieved LEED status, this newly and improved Intramural Building is seeking LEED Silver Accreditation, from not only the new construction, but also the proposed ongoing interior renovation of the existing facility.

Phase I of the Intramural Building encompasses the renovation of the existing mechanical, electrical and fire suppression systems, as well as the new construction of a 46,000 SF addition to the existing building. The

construction cost of Phase I is of $19 million and is scheduled to be open doors to students by the beginning of 2014 Spring Semester. Mortenson hopes to meet this tight schedule and move towards the following two phases with great success. To meet this schedule and the student demand for recreational activities, the Intramural Building will keep its doors open to students during the renovation and construction. This is crucial for the construction team, because of the built up in awareness of safety onsite. The University demands the safety of all students, as well as the opportunity of students to perform extracurricular and recreational activities.

In order to meet the new mechanical, equipment and lighting demands of the existing building and new addition, larger electrical distribution panels will be installed. Two new electrical 2000 A and 1600 A switchboards will be able to handle the loads of the new AHUs and be able to distribute power to the future phases to be constructed after the completion of phase I.

The new addition features an exterior façade which resembles the western face of Rec Hall. However, this curtain wall system will provide aesthetics as well as functionality when it comes to its operation. Utilizing motorized system, the recycled, low-e glazing of the curtain wall will be operational, allowing the opening and closing of glass panels, letting through natural ventilation, as well as natural lighting.

TABLE OF CONTENTS

INTRAMURAL BUILDING ADDITION AND RENOVATION

GONZALO LAY
Technical Assignment I

Construction Option
Advisor: Ray Sowers
9/16/2013

Mortenson construction

The Pennsylvania State University is ranked among the top schools in both academics and athletics. In addition to this, the school has been growing significantly throughout its existence, including the offering of new majors, and the expansion to other locations throughout Pennsylvania. As of today, the University has a total enrollment of 96,562 students, including World Campus programs and campuses. At the University's Main Campus, the enrollment is of 45,351 undergraduate students. Having such a large student body, Penn State's facilities must be updated to their finest and provide top notch services to maintain its status as a highly ranked university.

The Pennsylvania State University has three primary athletic facilities with full access to students. Among these, Rec Hall and White Building are the two athletic facilities that get the most visitors for the use of weight training, and class use. The Intramural Building, out of the three is the least updated facility, and is relatively close to East Halls, the highest populated area in the university. Students primarily use the Intramural Building for recreational sport use. The University's Recreational Sport department creates several tournaments throughout the academic year services for students to compete and creating a diversion from the academic life.

Through student polls, the University's Student Council proposed the improvement of this facility to allow for an improved active student lifestyle. In addition to this improvement, the new construction of the intramural building will distribute the demand of fitness and recreation throughout the University's campus. This will result is less crowded gyms, reduction of time waiting in lines, and improvement of the university's recreational program.

The funding of the project comes partially from the students and the university. Students pay with their tuition, fees that go towards the improvement of athletic and technological facilities. With this funding, Penn State will now offer students the opportunity to experience an improved extracurricular activity life and allow them to increase student day productivity.

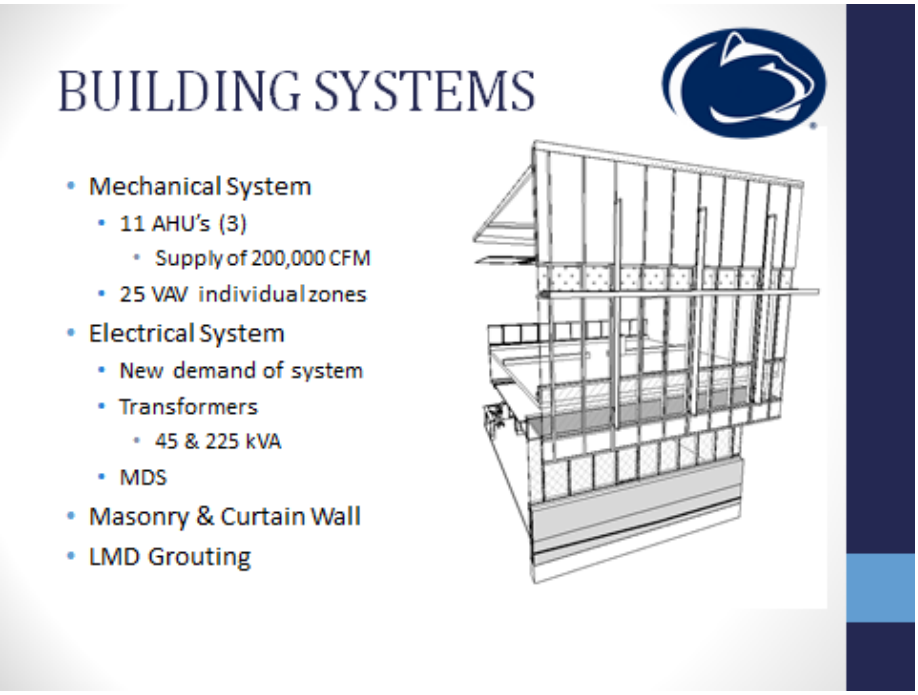
Stressing the demands of student recreational activity, the Intramural Building will be active throughout the construction of the new addition and renovation. Penn State demands the highest of quality, the best management of the budget, and the most punctual delivery of the project in both the design and the construction aspect of every building. With this in mind, safety is also a concern for Penn State and it is crucial to keep a healthy environment for both the university and the students.

Demolition - The Intramural Building Addition is designed to connect to the existing building in all three levels, the basement, main, and mezzanine; therefore partial demolition of the southern face of the existing building is required. Moreover, the existing Intramural Building will be undergoing renovation of the interior systems, including the mechanical, plumbing, and electrical, as well as an upgrade of the facility. As expected by project team, there was no hazardous material (Asbestos) encountered throughout the demolition. However lead-based paint is present on the masonry and concrete structures to be demolished. This will be mostly found in the exterior southern façade of the building that will be connecting to the new construction. The proper disposal of these materials is vital for the project's goal of achieving LEED Silver accreditation. In addition to the disposal, demolition in each specific location must follow the proper removal of all salvageable materials and systems, such as the masonry face-brick. The basement level will undergo the demolition of selective interior partitions, exterior storefront, water service entry piping, and fin tube radiators, removal of electrical switchboards, lighting, fire alarm and electrical devices, as well as exterior concrete walls. The Main and Mezzanine level will experience a major southern demolition which includes the brick façade, bathrooms and associated piping, removal of diffusers and ducts, as well as the complete removal of two racquetball courts (wood flooring/wall paneling), lighting and electrical devices.

Structural Steel Frame - The Intramural Building Addition is primarily a structural steel framed facility, with reinforced concrete masonry construction. Korda/Nemeth Engineering, designed the steel frame as a non-self-supporting frame, however with the installation of slabs, decks, masonry walls and cast in place concrete walls, it would support the building perfectly.

The basement walls have been designed for an equivalent lateral fluid pressure of 60 pounds per cubic foot. The columns for the building consist of various W12, HSS10 and HSS12. These columns are designed to resist gravity load moments of 675 foot-pounds. Floors are designed to a 2 ½" of Normal Weight Concrete with 3" Deep galvanized composite metal floor deck, with an overall thickness of 5 ½". The bracing for the frame utilized HSS Shapes, where all the other structural steel is mostly W shaped beams and joists members. Throughout the erection of the steel, two mobile cranes will be used. These will be located in the eastern and western end of new construction.

Cast in Place Concrete - Used throughout several aspects of the structure system of the Intramural Building Addition, cast-in-place concrete is specifically found in the foundation system, but it is also found on retaining walls, slabs on grade and metal decks. The foundation system comprises primarily on spread footings strip footings, which are both earth formed and poured into the compacted soil. The slabs on grade and metal deck are both wood formed. Then concrete is then poured in sections from the concrete truck into the slab's welded wire fabric (WWF).



Mechanical System -The Intramural Building Addition has a Mechanical Room in the Basement, and a Mechanical Penthouse located in-between the mezzanine level and the roof. The project's mechanical system is comprised of air handling units, exhaust fans, fan and heating coil units, and a combination of finned tube radiators and split AC units. The whole facility, including renovation and addition will house 11 Air Handling Units (Avg. 3 Tons) that supply up to 200,000 CFM of total air. These connect to 25 VAV boxes to supply air flow to individual zones. These units are manufactured both by Engineered Air and Trane (Model: Performance Climate Changer). The building system will run with the university's steam line. Four pumps are responsible for the circulation of water throughout the building; two correspond to chilled water, and the other to hot water.

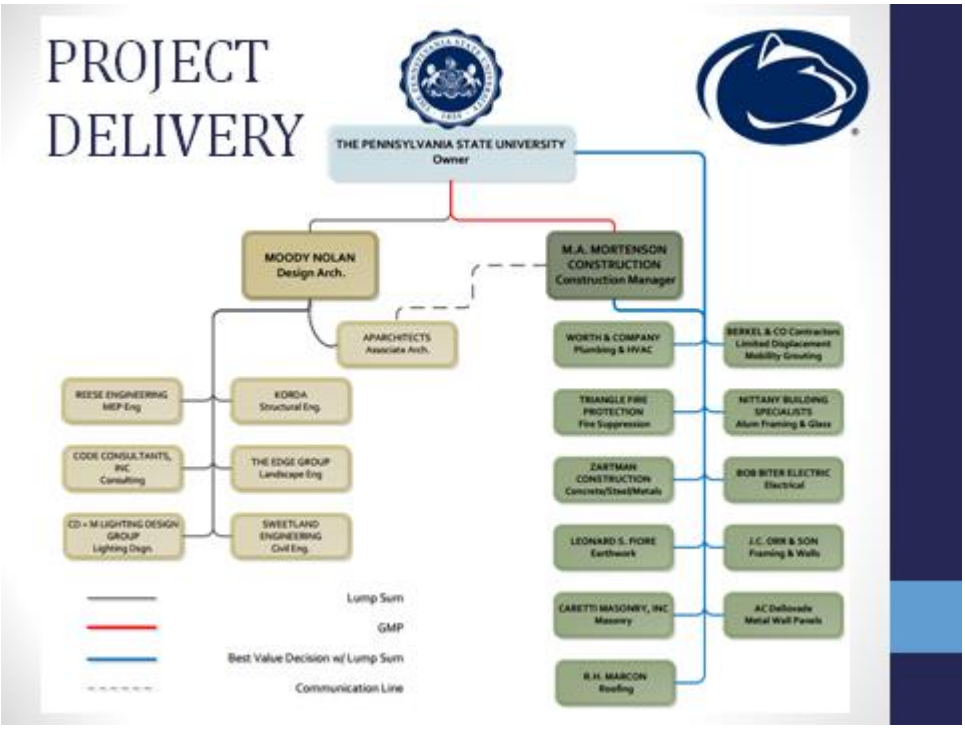
Electrical System - The interior renovation of the existing Intramural Building consists of an upgrade of the current systems, including electrical and lighting. The new demand of the system to be installed is unable to be met by the current existing electrical system. This upgrade of the electrical system will be able to meet the current demands of the Intramural Building and also the demands of the upcoming building phases. There are five transformers which are directly related to the building. Two of them are located outside of the building, pad-mounted, servicing 480/277V Secondary. One is responsible for handling the campus emergency circuit, while the other to service the building continuously. For the existing building, a new 2000A, 480/277V "MDS" substitutes the existing switchgear. It then feeds into four different switchboards to meet the demands of the new mechanical, electrical and lighting systems. One of those switchgears (1600 A, 480/277V) is located in the new addition, which later feeds into 7 panel boards. Two of the panel boards feed into two 45kVA and 225 kVA transformers to supply power for the high demand of electrical equipment in the fitness loft area.

Masonry & Curtain Wall -The existing intramural building consists of a brick veneer façade, with some breaks of curtain wall and storefront. In order to maintain that façade style, the new addition has components of the existing building as well as the inclusion of metal panels and a more visible curtain wall. The masonry scope of the building encompasses face-brick and CMU blocks. The typical exterior finish is brick veneer with metal stud back up and brick veneer with concrete masonry. The face brick size is Norman type, 2 ¼"x11 5/8" 3 5/8". This brick is also required to be manufactured regionally and harvested of recovered regionally within 500 miles from the project site, for LEED Accreditation points. The building's curtain wall is also one of the main architectural and design features. It is designed to not only allow natural lighting, but also be operational, allowing ventilation as well. In additional efforts to obtain LEED accreditation, the glazing will be made out of ¼" recycled glass, with insulation properties and low E glazing. The curtain wall has typical 4 ½" thick aluminum-frames along the façade and a 7 1/2" thick frame along the corners. The curtain wall is the last portion of the exterior façade to be installed to prevent damages.

Support of Excavation - Before any construction starts, it is required for every project to perform a geotechnical report, to verify the status of where the building will be constructed. This report resulted in the finding of soft soils and voids in the bedrock. Limited Mobility Displacement Grouting (LMDG) was utilized to improve the existing subsurface voids and displace the existing natural soils. The intent of this is to displace soft soils and fill possible voids in the bedrock. To properly fill the voids under the construction site, Portland cement and fine aggregate as the mixture (grout) was used. The completion of this LMDG results in the stabilization of the subsurface, which reduces the vulnerability to settlement, as well as sinkhole development.

The Intramural Building New addition is located on the northeastern corner of the Pennsylvania State University's Campus in University Park, Pennsylvania. It nears the main sport complexes of the Nittany Lions, including the newly Constructed Pegula Ice Arena, the Beaver Stadium, and Bryce Jordan Center. The new addition is to be constructed in front of the existing IM building. The site is clearly a very open field, but the actual construction is restrained by the actual location of the existing building and the Curtin Road. Throughout Phase I, the site will be very accessible for material delivery and construction. However, due to its proximity to the major sporting and event complexes, there are high levels of student traffic, both pedestrian and vehicular. Moreover, the Intramural Building will be open for students throughout the construction and the renovation. With that, the site must be checked frequently to ensure student safety, and prevent hazards on site.

The site has two vehicular entrances, along University Drive and through the IM Building parking lot. A temporary gravel access road was created to facilitate the access to the trailers. The main entrance, along university drive, is primarily used for material and equipment delivery, but also is used for trailer access. Parking for construction workers is located across University Drive, at Lot 44 Stadium West.



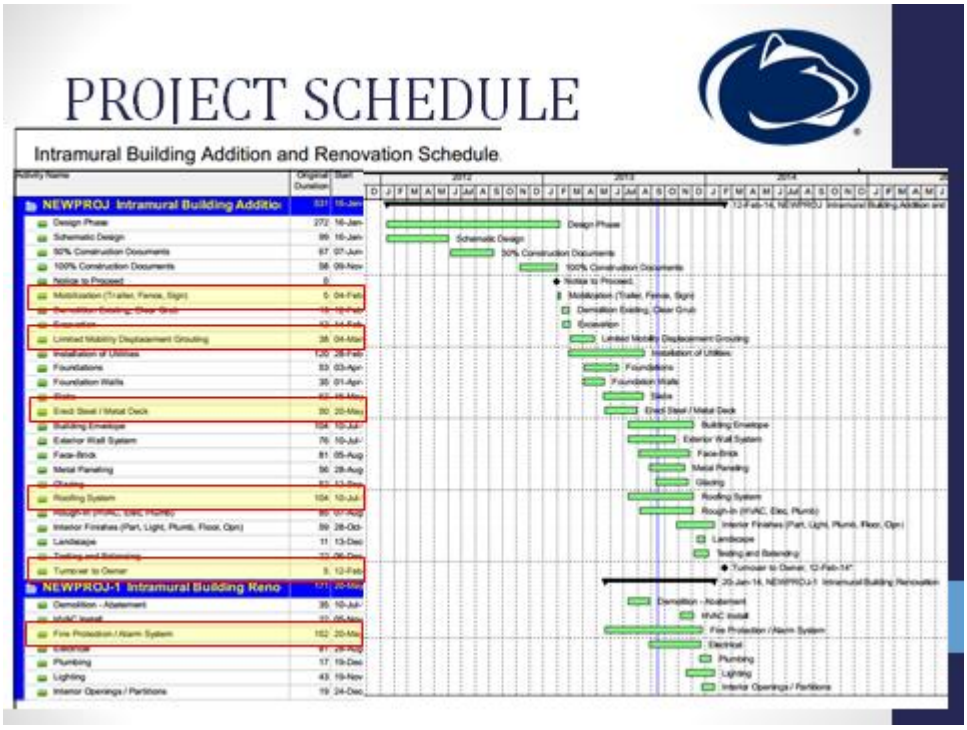
The Pennsylvania State University and Mortenson Construction have a guaranteed Maximum Price contract to perform the construction of the Intramural Building – Addition and Renovation Phase I. The project itself is delivered as a multiple prime method. Mortenson acts as the Construction Manager, while the holding lump sum contracts with the different contractors. The University is fond of having control of its construction projects, therefore participates in the awarding of contracts. Mortenson is scheduled to also manage the construction of the two future phases of the Intramural Building, which will follow upon substantial completion of Phase I.

Penn State has a separate contract with Moody Nolan, who serves as the main design architect of the project. Moody Nolan is a design firm based out of Ohio. Due to their location restrains, APArchitects plays the role of associate architect, representing Moody Nolan. APArchitects is a key member of the project, serving as the main communicator between Moody Nolan and Mortenson Construction to coordinate the construction of the project. Moreover, important roles in the design are covered by engineering firms, which coordinate the design of the structural, MEP, lighting systems, exterior landscaping and utilities.

Subcontractors and other main trades were chosen by Mortenson through the Penn State conditions. Mortenson broke down the project into 2 main bid packages (34 bids), which were sent to bid to subcontractors. In order to bid for University projects, contractors are required to go through a prequalification process. This process includes the analysis of contractor's financials, EMR and bonding capacities, as well as performance in previously completed projects. Once approved, the contractors submit their bids to Penn State to analyze the different cost. Using a best value decision process, Mortenson awarded the bids to the contractor with the best qualifications and prices.

Mortenson Construction is a family owned construction company, headquartered in Minneapolis, Minnesota. Mortenson's focuses its field of work in a wide range of industries, including education, corporate, healthcare, sports and event centers.

The project is currently under the management of Kendall Nielsen, who is Mortenson's project executive. Under Kendall, Melanie Morehart is the new inclusion to the project team; she plays the role of project manager. She is in charge of the Dustin Loy the Superintendent, Jason the Assistant Project Manager, and the Stormy the Project Admin. Jason is in charge of the construction's structure system. Dustin as a superintendent controls the majority of the construction processes on site. Under his command, Kyle is the safety coordinator, Roshan is the MEP coordinator, and Danny is the enclosure and finishes specialist.



Construction commenced on February 1st, 2013, starting with the new addition of the Intramural Building. In June, demolition and abatement activities took place to begin the renovation of the existing building. The duration of the project is 13 Months, with the projected finish date in February of 2014.

Addition

Earthwork -Earthwork section includes the demolition of the existing structures in the addition of the building, the mass excavation, the soil modification and installation of underground utilities.

Structural -The structural section includes the foundation work, the erection of steel, and the pouring of slabs on grade and elevated slabs. The foundation work consists of the excavation, forming, reinforcing and pouring of strip and spread footings as well as the installation of the basement's retaining wall. The building consists of a structural steel frame and is erected upon the completion of the foundation work. Once the erection of steel is finished, the pouring of slabs can begin.

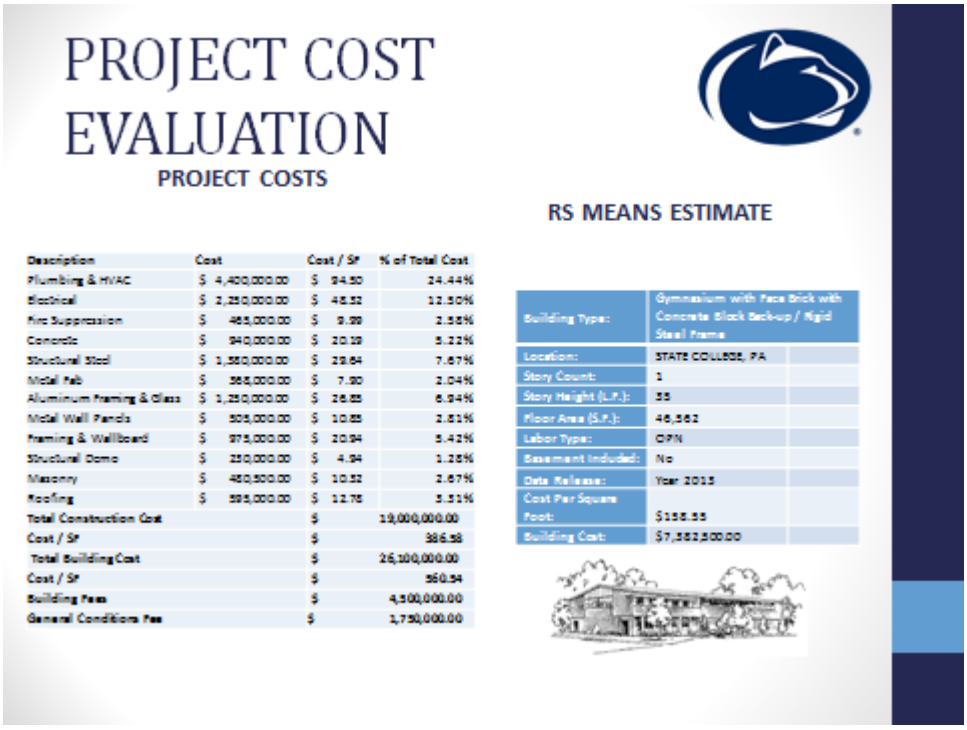
Building Envelope - This section entails the enclosure of the building. The first activity for the building's envelope is the installation of the roof. Then comes the exterior wall framing (metal studs) followed by the face brick and the metal paneling. Upon completion of the face brick, the curtain wall can be installed. This activity begins after most of the enclosure is finished to prevent damages.

MEP Rough-In & Finishes

Upon finishing the installation of the roof, the MEP Rough-In for the building can begin. Finishes can begin once the building is enclosed.

Renovation

The renovation portion of the building involves the replacement of the existing MEP systems, including the fire suppression system. This entails the demolition and abatement of the existing systems, and the installation of the new ones.



PROJECT COST EVALUATION

PROJECT COSTS

Description	Cost	Cost / SF	% of Total Cost
Plumbing & HVAC	$ 4,400,000.00	$ 94.50	24.44%
Electrical	$ 2,250,000.00	$ 48.32	12.50%
Fire Suppression	$ 465,000.00	$ 9.99	2.58%
Concrete	$ 940,000.00	$ 20.19	5.22%
Structural Steel	$ 1,380,000.00	$ 29.64	7.67%
Metal Fab	$ 365,000.00	$ 7.80	2.04%
Aluminum Framing & Glass	$ 1,250,000.00	$ 26.85	6.94%
Metal Wall Panels	$ 505,000.00	$ 10.85	2.81%
Framing & Wallboard	$ 975,000.00	$ 20.94	5.42%
Structural Demo	$ 230,000.00	$ 4.94	1.28%
Masonry	$ 480,500.00	$ 10.32	2.67%
Roofing	$ 595,000.00	$ 12.78	3.31%
Total Construction Cost		$	19,000,000.00
Cost / SF		$	386.58
Total Building Cost		$	26,100,000.00
Cost / SF		$	560.54
Building Fees		$	4,500,000.00
General Conditions Fee		$	1,750,000.00

RS MEANS ESTIMATE

Building Type:	Gymnasium with Face Brick with Concrete Block Back-up / Rigid Steel Frame	
Location:	STATE COLLEGE, PA	
Story Count:	1	
Story Height (L.F.):	35	
Floor Area (S.F.):	46,562	
Labor Type:	OPN	
Basement Included:	No	
Data Release:	Year 2013	
Cost Per Square Foot:	$158.55	
Building Cost:	$7,382,500.00	

The construction cost for the Intramural Building Addition and Renovation is around $19 Million, at $386.58/SF. With the inclusion of indirect costs such as General Conditions, Bonding & Insurance, and Construction Management fees, the project costs is of $26.1 Million, at $560.54/SF. The plumbing and mechanical costs for the project account 24.44% of the total construction costs. The electrical costs account 12.5% of the total construction costs. The systems stated above are the largest components of building costs. This can be explained by the fact that the project consists of not only an addition but a renovation of the MEP systems in the existing building.

RS Means CostWorks, version 2013 was utilized for the Square Foot Estimate of the Intramural Building Addition only. The building is 46,000 SF and has a building perimeter of 110 lf. Floor height, time, and location factors were accounted for to arrive at the final square footage estimate. The estimated building cost for the addition of the project was $7,382,500 at $160.49/SF. This was assuming that the building had a face brick façade, meaning neither metal wall panels nor curtain wall glazing.

Comparing the costs of the building to the estimated costs was a challenge because of the inability to separate the costs of the addition and renovation. Costs related to the MEP systems cannot be compared in this estimate due to the reason state above. Therefore the only analysis is on the building shell. The new addition consists of a 3 story (basement, main, and mezzanine) gymnasium. RS Means allows only gymnasiums to be 1 story high, thus ignoring the metal decking and beams included in each of the floors, as wells as the elevated slabs and partitions. In addition to this, the estimated cost for the exterior façade disregarded the use of any glazing curtain walls and decorative metal panels.