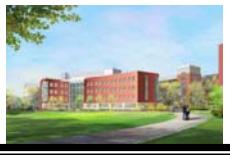
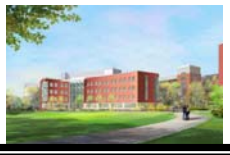


Project Background

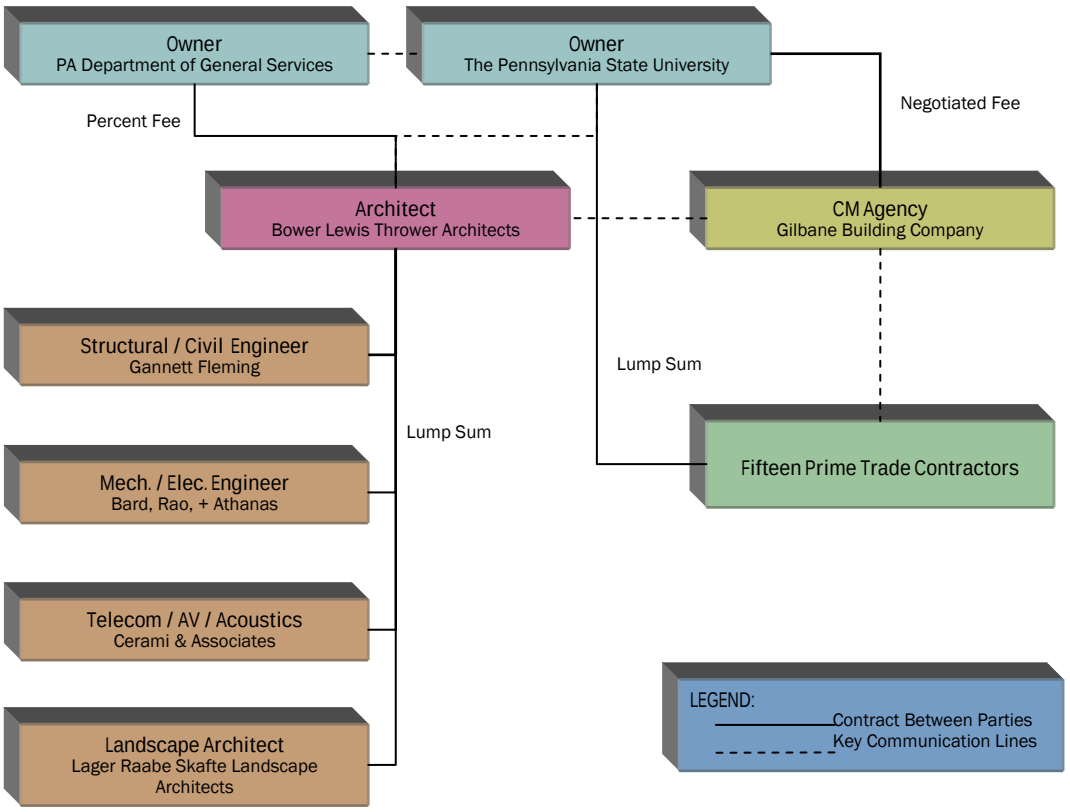
This thesis takes an in depth look at the Penn State University School of Forest Resources Building in University Park, PA. This brand new 92,000 S.F. facility will bring the educational and administrative aspects of the School under one roof. The project is funded by the PA Department of General Services with construction costs estimated at almost $22,000,000. Because the project is state funded, certain contractual arrangements were required. The most interesting of these being a CM Agency with 15 prime contractors. DGS began to look for an architect in April of 2002 and the project is scheduled to be completed in December 2005. The Forest Resources building is part of the East Sub-Campus development which includes the construction of five new buildings. The Forest Resources building will attempt to receive a basic LEED certification.

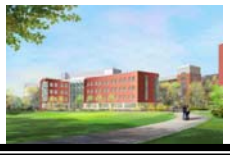
The Penn State School of Forest Resources Building is being delivered as a design-bid-build with some interesting contract relationships because it is funded by the PA Department of General Services (DGS). DGS hired an architect, Bower, Lewis Thrower Architects, to design the building. The architect's contract states that they receive a fixed percentage of the final construction costs of the building. They were paid initially based on a preliminary estimate, but their fee will need to be adjusted once actual construction costs are known. The Pennsylvania State University (PSU), as the owner, holds all contracts with the prime contractors. There are fifteen primes for this project. These are all lump sum contracts, which were issued to the low bidders in a public bid. Penn State has also hired Gilbane Building Company as the Construction Management Agency. Gilbane receives a cost plus fee contract. The cost of their services is a guaranteed price, however, so if Gilbane goes over budget for their services, it will cut into the profit. This arrangement was chosen mainly to meet the regulations of DGS and to satisfy the needs of Penn State. In DGS projects it is standard for the state to hold the design contract and for multiple prime contractors to be used. Penn State chose to hire Gilbane as an agency rather than a CM at risk because had they chosen an at risk arrangement, the bid for the CM would



have been an open bid. Because of DGS regulations, Penn State would have had to accept the low bidder as CM at risk, but PSU wanted to receive proposals from a select few CM firms. This was only possible by making them a CM Agency. The following is an organizational chart for the project and a project directory listing key contacts appears on the following page.

School of Forest Resources Building Project Organizational Chart





School of Forest Resources Project Directory

Owner: The Pennsylvania State University (PSU)
- DGS Liaison – Richard Tennent
- Project Manager – Richard Riccardo
- Contract Administrator – Bernadine Harrity

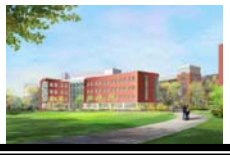
Construction Manager: Gilbane Building Company (GBCo)
- Project Executive – John Denning
- Sr. Project Manager – Motaz Alkaysi
- Project Engineer – Chris Figler

Architect: Bower Lewis Thrower Architects (BLTA)
- Project Architect – Kevin Aires

Mechanical / Electrical Design Engineer: Bard, Rao + Athanas (BR+A)
- Project Engineer – Dave Fallon
- Electrical Engineer – Mike Fahey
- Plumbing / Fire Protection Engineer – Ronald Howie
- HVAC Engineer – Ed Marchand

Structural / Civil Design Engineer: Gannett Fleming
- Structural Engineer – Peter Joyce
- Civil Engineer – Gary Garbacik

Prime Contractors:
- Sitework – Stone Valley Construction
- Piles – Brayman Construction Corporation
- Concrete – Quandel Group
- Masonry – Cost Company
- Structural Steel / Misc. Metals – Amthor Steel
- Roofing – David M. Maines
- Curtainwall / Windows – KNZ Construction
- HVAC – S. P. McCarl Company
- General Trades – Leonard S. Fiore
- Elevator – Port Elevator
- Laboratory Casework – Moran Scientific Systems
- Automatic Temperature Controls – Logical Automation
- Plumbing – W. G. Tomko
- Fire Protection – S. A. Communale Company
- Electrical – State College Electrical and Mechanical



Building Systems Summary

Demolition

No demolition was required for this project. The site was covered in asphalt, however, and this needed to be removed before work could begin.

Structural Steel Frame

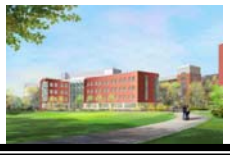
Moment frames as well as standard wide flange beams and columns create the frame for this building. The steel will be erected in fourteen separate lifts. There is typically only one column splice through the height of the building. The lower two floors of two different sections will be erected. Then the upper two floors of those two sections will be placed in the same order. After two sections are topped out, erection will move to the next two designated lifts. The floor deck is a 2" deep composite steel deck system, and the roof is made from 1-1/2" deep steel deck. All trade contractors are responsible for their own hoisting, so there will be no central crane that everyone has access to. The steel erector will bring in crawler or truck mounted cranes as necessary for erection.

Cast in Place Concrete

Concrete that can not be poured directly from the chute will be pumped into place. The pump will be mobile and placed where it is needed for the pouring operations.

Precast Concrete

There are no main precast elements in this building. Coping, sills and other exterior trim are made of precast concrete and finished to look like limestone. The limestone that was specified around the base of the building and in some of the window assemblies was replaced by cast stone in order to save money. This precast will be lightweight panels finished to look like limestone.



Mechanical System

The three large air handling units for the building are located in the mechanical penthouses. There is a penthouse on the roof of each wing of the building. There are some parts of the mechanical system found in the basement mechanical room, but the largest components are in the penthouses. Two Trane air handling units will control the climate for the building, and the third unit is a custom unit designed to handle the laboratory spaces. The entire system will be connected to the campus steam tunnels and the new adjacent chiller plant.

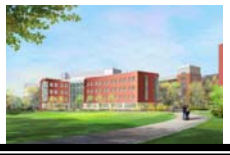
The sprinkler system covers all areas of the building. IT is classified as ordinary hazard (Group I) for all areas except mechanical rooms, which are classified ordinary hazard (Group II). The entire arrangement is a wet pipe system with connections for the fire department.

Electrical System

The building is powered by three 12.47 kV feeders to the transformer in the electrical vault. This is stepped down to 480 V before traveling inside the building to the main switchgear. There is one 4160 V emergency feeder that can power the emergency systems of the building. This feeder comes from the campus generator system and can provide uninterrupted power in the event of an outage. There is one set of main switchgear that distributes the power to six distribution panels. From here the power is divided even further to meet the needs of the building.

Masonry

Most of the building is covered with a brick veneer. These are standard size bricks that have been pre-selected by Penn State so that they match all other buildings on campus. Around the base of the building are courses of cast stone panels finished to look like limestone. Masonry is supported by steel angles attached to the structural steel. In order to lay the brick, the mason will use hydraulic scaffolding to keep the procedure easy and quick. Standard scaffolding will be used



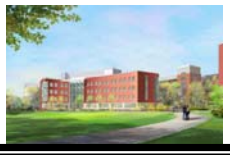
on the curved Meadow wing because the large sections of hydraulic scaffolding will be difficult to secure to the building and they will leave large gaps between the scaffolding and the building.

Curtain Wall

The curtain wall is an outside glazed pressure wall system of tubular aluminum sections with self supporting framing and factory pre-finished, glass and glazing. A professional engineer employed by the curtain wall contractor is responsible for the design of the system and all shop drawings must be signed and sealed by the professional engineer. The system also includes infill metal panels, sun shades, aluminum entrance doors and cast stone panels.

Support of Excavation

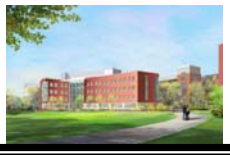
The main excavation was for the basement under the Bigler wing. This excavation was able to be benched back at a 1:1 ratio for safety. There was a catch basin already in place on site to control the run off water, so no dewatering was needed specifically for this site. After heavy rains excess water had to be pumped out of certain areas of the excavation.



Local Conditions

When building on the Penn State campus most buildings will be a structural steel frame with a brick veneer exterior. All steel erection and equipment placement is done with crawler or truck mounted cranes and you will not see a tower crane in State College. The Forest Resources building, like several other buildings on campus, is funded by the Department of General Services. This means that the current Prevailing Wage Act must be enforced per DGS regulations. The local union work force is utilized in most of these projects. Most construction sites on campus are congested, and leave little room for material storage or construction parking. Contractors are required to park in large lots located behind Beaver Stadium, and steel shakeout is sometimes done in fields off campus. Because this project is attaining a LEED certification, recycling of construction materials is mandatory. This can add extra cost to the building as special arrangements must be made to dispose of materials.

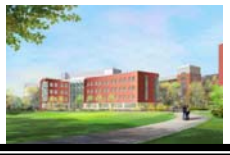
Before construction was started, CMT Laboratories conducted a sub-surface investigation of the site. Several test bores were taken to check the soil quality and bearing capacity of the bedrock. The samples were taken at depths ranging from 42 to 65 feet. The ground water table was not encountered during the investigation, which makes dewatering unnecessary for excavation. Dolomite bedrock was discovered at depths ranging from 2 feet to 45 feet across the site. This variation can be expected due to the pinnacled nature of the Nittany Formation. There was no evidence of sinkholes or caving during the investigation, but with this type of bedrock, sinkholes may develop during or after construction. Recommendations for foundations in this area are for drilled piles and grade beams.



Client Information

The Pennsylvania State University is the owner of this building with the School of Forest Users being the end-user. It was decided that a new building was needed for the School in order to consolidate the educational and administrative aspects of the program under one roof. The initial decision to build a building in this location was made in order to balance the site next to the Smeal College of Business Building. The School of Forest Resources was the most likely candidate needing a new building, so the building became theirs.

As with any project at Penn State, quality is of the utmost importance. Buildings are expected to last a minimum of fifty years before needing replacement. The second most important aspect for a building on campus is that it meets the occupancy and program requirements. Safety is also paramount to the successful completion of a project. Of course, cost and schedule are still important factors for a project, but efforts are usually made to construct a quality building in a safe manner. DGS pays all construction costs for this project so Penn State can maintain their focus on quality and safety. To help the building meet the needs of the future occupants, faculty and staff from the School of Forest Resources are invited to take part in design decisions. Safety efforts can be evidenced by the University's aggressive OCIP program. Safety orientations and drug screenings are mandatory for anyone working on the job site. If the University receives a quality building that satisfies the needs of the occupants, they will be pleased.



Design Coordination

The new Forest Resources Building has a large amount of laboratory space, which can cause many MEP coordination problems. In each lab space there is normal HVAC duct, special exhaust duct for fumehoods, piping for normal water distribution, vacuum piping, gas piping, compressed air piping, special lab waste piping, sprinkler lines, electrical distribution, and often times special electrical circuits for lab equipment. This building has a 14'-0" floor to floor height and a 9'-6" ceiling height in the lab spaces. This leaves only 4'-6" to fit all of the piping, conduit, and ductwork into the plenum space. If you take into account the steel beam depth of at least 12", careful MEP coordination becomes vital for these laboratory spaces.

By contract, the HVAC, Plumbing, Fire Protection, Electrical, and Automatic Temperature Controls Contractors have 90 days from Notice to Proceed to complete coordination drawings. The process of coordination begins with the HVAC contractor who receives blank CAD templates from the architect. He lays out all of his ductwork, submits the drawings for approval from the engineer, and when approved, forwards them to the plumbing contractor. The plumbing contractor then adds his layer of pipes to the drawings and submits them to the engineer. This process continues for all of the above listed contractors until complete coordination drawings are approved. The contractors are not contractually required to develop 3D CAD drawings, but 3D drawings or immersive virtual models could aid the coordination process.