The Research and Economic Development Center

Erie, Pa

Kristen Eash	Option: Construction Management
Advisor : D. Riley	Date: 4-3-06
Summary Book	

The Research and Economic Development Center (REDC)

Kristen Eash
http://www.arche.psu.edu/thesis/eportfolio/current/portfolios/kre124/
Construction Management
Advisor: David Riley

September 26, 2005

Building Stats

- Location: Penn State Erie Campus
  Behrend Campus
  Erie PA
- Occupancy Type: Classrooms, Labs, and Offices
- Size (Total Sq. Ft.): 161,500 Sq.Ft.
- Stories: 2.5 Floors
- Primary Project Team:
  - Owner: The Pennsylvania State University
    and Department of General Services
  - Architect: Weber Murphy Fox, Inc.
- Construction: April 28, 2004 to February 2006
- Total Cost: $30 million

Architecture

- The building has 2 wings
- Will have engineering labs, offices, classrooms, and computer labs.
- Mechanical rooms are on Basement and Second floor
- The Walls are curtain wall system that supports structural glass, brick with glass windows and metal wall panels
- The Roof is Thermoplastic Sheet Roofing over the high roof with the low roof being Architectural Metal Roofing

Structural System

- The building sits on three different types of foundations.
- The building is a steel building, with a typical column size of W14x61 and W18x35 beams
- There is no typical bay size but they run about 30'x30'.
- All floor slabs are 4" concrete slabs with 6x6 W1.4xW1.4 wire mesh.









Electrical System

- Primary service will come into the building through an underground duct bank near the loading docks.
- The first secondary feed, after coming in the building will go through a 480Y/277 volt, 1500KVA transformer and serves the majority of the building.
- The other secondary feed will enter into a 240 volt, 500 KVA transformer and will be sent out to the lab and manufacturing areas.
- The emergency power will be an indoor diesel generator rated for 150 KW at 480Y/277V.

Mechanical System

- The central cooling plant will consist of two 250 ton screw chillers and cooling towers
- The central heating plant will be two 3852 MBH cast iron hot water boilers with natural gas burners.
- There are 12 AHUs.
- Air is distributed through ceiling diffusers.
- The entire building will run off of a Direct Digital Control system.

Construction

- This project began in preliminary design stage.
- After the design had been completed a CM Agency General Contractor and Primes were hired through a bidding process.
- Construction began with the ground breaking on April 28, 2004 and is scheduled to finish on February of 2006.
- The building cost came to $21.5 million. With soft costs added in the total for the building was $30 million.

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Executive Summary

The Thesis expands on the topics for the semester long thesis research class and discusses in more depth the topics and decisions that will be presented during the Thesis Presentation. This book will go into detail of my three selected analysis topics as well as my research topic. I will discuss why each topic was chosen and describe the critical issue with each as well as provide background, research and conclusions. A general synopsis of my building will also be presented.

From the issues that were identified as a result of the PACE Roundtable, I chose to look into an issue that directly affected my project for my industry research topic; WBE/MBE solicitation. This is the process whereby all contractors who wish to bid on any DGS project need to solicit bids for subcontracted work from minority and women owned businesses. I intended to find out whether requiring this is deemed fair by prime contractors, if they increase their bids due to being forced to provide this extra work, and if there are any other issues with respect to the solicitation process. In fact, most contractors do not find this fair and just under half of them increase their bids by .5-10% with the average increase being roughly 4 %.

After a visit to my building and talking to the workers and key player for the project, several issues were brought up. Those issues were narrowed down to be used for my three technical analyses. These consisted with adjusting the cladding system for the building from a metal panel siding to either the brick or glass panels which clad the remainder of the building, structurally redesign of the skylights to remove the steel joist that runs through the center of it, and adding windmills to the roof of my building to generate electricity.

I proposed to redesign the cladding of the building to increase the construction ease and cost of the building. This will take into account the cost of fixing the system while the building is in its first fifty years of building use. A comparison with brick and glass panel walls was conducted. Research into the initial cost of construction and schedule, research into maintenance costs, a comparative analysis between the systems using cost, and schedule, and a summary are the measurable steps of this analysis. The result of this analysis was to switch the building to brick construction due to the drastic decrease in cost and the minimal increase in construction time. The structure was the same for both.

For my first breath assignment I will do a structural analysis of a skylight in an attempt to remove the steel joist from the center of it. This will make the skylight look nicer and allow more light into the area. I will perform a load analysis of the skylight and then do a structural analysis to redesign the roof system for the joist to be removed. In my summary I will show the new design of the skylight. This analysis resulted in the recordation to remove the joist and support to the system with two smaller joist in it’s place. The cost increase was less than $80 and a schedule extension of merely 3 hours.

For the windmill analysis, I researched the wind patterns of Erie, PA to discover the power generating capabilities of the building. I also performed a cost analysis of the electricity savings versus the initial cost. I also performed a structural analysis of the roof to make sure that the windmill will be able to be placed on the roof. Finally, the schedule impact was looked at. It was concluded that 12 windmills should be placed on the building and these would pay themselves off within the first year. The electrical system was also redesigned to accommodate the new power supply.

Introduction

This thesis is the culmination of a year's worth of work. It began in the fall by learning the building's systems and construction techniques. It followed, by finding problems and construction issues with the building. Next, three building problems and one industry issue was selected for in-depth research and problem solving. For my project, these were a cladding system replacement, a skylight redesign, the addition of windmills to the roof of the building, and WBE/MBE Solicitation impacts. With the topics selected the remainder of the semester involved performing various analyses such as structural and cost. Finally, recommendations for each topic were made.

Throughout this book you will become acquainted with various parts of my research starting with basic building systems and moving through each research topic. You will learn what criterion was important to the owners and building users. Looking through their eyes you will be able to see why each recommendation was made.

Building Background

General:

- **Building Name:** Research and Economic Development Center (REDC) Building
- **Location:** Penn State Erie Campus
  Behrend Campus
  Erie PA
- **Building Occupants:** School of Business
  School of Engineering and Engineering Technology
  Pennsylvania State University
- **Occupancy Type:** Classrooms, Labs, and Offices
- **Size (Total Sq. Ft.):** 161,500 Sq.Ft.
- **Stories:** 2.5 Floors
- **Primary Project Team:**
  - Owner: Department of General Services
  - Using Agents: The Pennsylvania State University
  - Architect: Weber Murphy Fox, Inc.
  - Consulting Architect: NBBJ
  - Structural Engineer: Steele Structural Engineers
  - MEP Engineer: H.F. LENZ Company
  - Civil Engineer: Urban Engineers
  - Technology Consultant Group: The Sextant Group
  - Construction Manager: Turner Construction Co.
  - General Contractor: EE Austin & Son, Inc.
  - Mechanical Prime: Renick Brothers
  - Plumbing Prime: Raibe Environmental
  - Electrical Prime: Keystone/Deon – Pyramid
  - Fire Protection Prime: Simplex Grinnell

- **Dates of Construction:**
  - Start: April 28, 2004
  - Finish: February 2006

- **Cost Information:**

The overall cost of the building is $30 million or $165.76/SF. Minus soft costs the actual building cost is $21.5 million or $133.13/SF. The General costs of the building are $13,379,000 or $82.84/SF. HVAC costs were bid at $3,430,000 or $21.24/SF. The Plumbing System is $925,000 or $5.73/SF. The electrical system and telecom together cost $3,394,816 or $21.02/SF. Finally, the Fire Protection system came to $328,800 or $2.04/SF.

- **Project Delivery Method:** Design-Bid-Build

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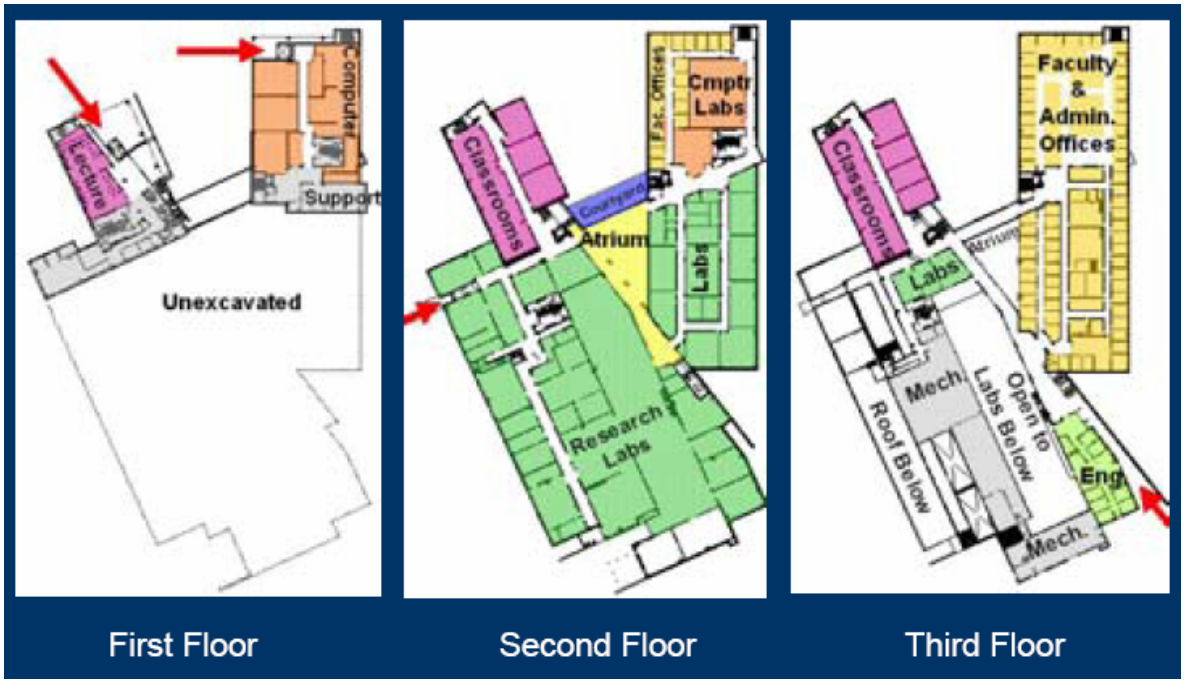
Architecture:

The building consists of a half basement and two floors with the top floor boasting an atrium bridge. The building is to link two sections of campus to promote a more unified college. It features two wings; the first faces Jordan Road and the Knowledge Park; the second faces towards the east side of campus. Wooded areas surrounding the site will be maintained along with new and existing pathways. The facility will be mainly brick as is the norm for all Penn State Buildings. The building will be home to the College of Engineering and Engineering Technology as well as the School of Business. About half of the building will be engineering labs. One fourth is proposed to be classrooms and computer classrooms. Offices will make up the remaining fourth. Mechanical rooms will be located on the Basement and Second floors.



Building Envelope:

The building has a curtain wall system that supports structural glass in the stairways, brick with glass windows in the main part of the building and metal wall panels in the dock areas. The roof is Thermoplastic Sheet Roofing over most of the roof with the low roof being Architectural Metal Roofing. Under the roofing is a six inch layer of roofing insulation over steel deck.

Construction:

This project began in preliminary design stage. An estimate was drawn up using the campus estimators and the building was found to be overpriced. By removing an auditorium the building design and estimate were completed. After the design had been completed a CM Agency was hired through a bidding process. The CM Agency then held the bidding for the General Contractor and Primes. Construction began with the ground breaking on April 28, 2004. The scheduled finish for construction is set for February of 2006. The building cost came to $21.5 million. With soft costs added in the total for the building was $30 million.

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Electrical:

Electricity will come in from the medium voltage campus distribution system. Primary service will come into the building through an underground duct bank near the loading docks. This will be for future campus expansion. Two secondary feeds will also be provided. The secondary feed, after coming in the building will go through a 480Y/277 volt, 1500KVA transformer and serves the majority of the building. The other secondary feed will enter into a 240 volt, 500 KVA transformer and will be sent out to the lab and manufacturing areas. Electricity will flow from the transformer to the main breakers to the main distribution center. There will be approximately 35 - 240/120 V, 3 phase, 3-4 W panel boards; 20 – 480Y/277 V, 3 phase, 4 W panel boards; 4 – Motor Control Centers at 480 V, 3 phase, 3 W; and one natural gas generator run from the power supplied. The emergency power will be an indoor diesel generator rated for 150 KW at 480Y/277V. This will be located in a room next to the loading dock and will be able to provide 24 hours of backup.

Lighting:

The lighting in the building is fairly simplistic and very systematic. For all of the labs, shops, and large bay areas there will be Metal Halide suspended bell lights. In the offices classrooms and smaller labs there will be fluorescent recessed lights with dimming capabilities.

Mechanical:

The central cooling plant will consist of two 250 ton screw chillers, cooling towers and primary/secondary pumps. The central heating plant will be two 3852 MBH cast iron hot water boilers with natural gas burners and primary/secondary zoned pumping.

The Air system will include five roof top, three basement, and four second floor air handling units. Of these ten are variable air volume and two are constant. One system has a redundant cooling for winter requirements. The building is zoned based on occupancy. Air is distributed to rooms through ceiling diffusers.

Though out the building there are 26 exhaust fans to remove air (8 rooftop, 7 basement, 2 first floor, and 9 second floor). In some areas there are cabinet unit heaters that use water to provide extra heating. The computer server rooms will have DX air conditioning units for 24 hr/ 365 day cooling capabilities. The entire building will run off of a Direct Digital Control system.

Structural:

The building sits on three different types of foundations – strip, pad, and retailing wall. Form these the steel superstructure arises. The typical column size is W14x61. Where there are CMU columns it is 8” CMU with 8” bond beam and 2 #4 bars. There is no typical bay size but they run about 30’x30’. All floor slabs are 4” concrete slabs with 6x6 W1.4xW1.4 wire mesh. The average beam size is around a W18x35 with 22KCS3 Joists. Exterior walls are all curtain walls with brick, glass, or metal. The roof is framed with 22K7 beams with joists at 3’6” on center and horizontal bridging.

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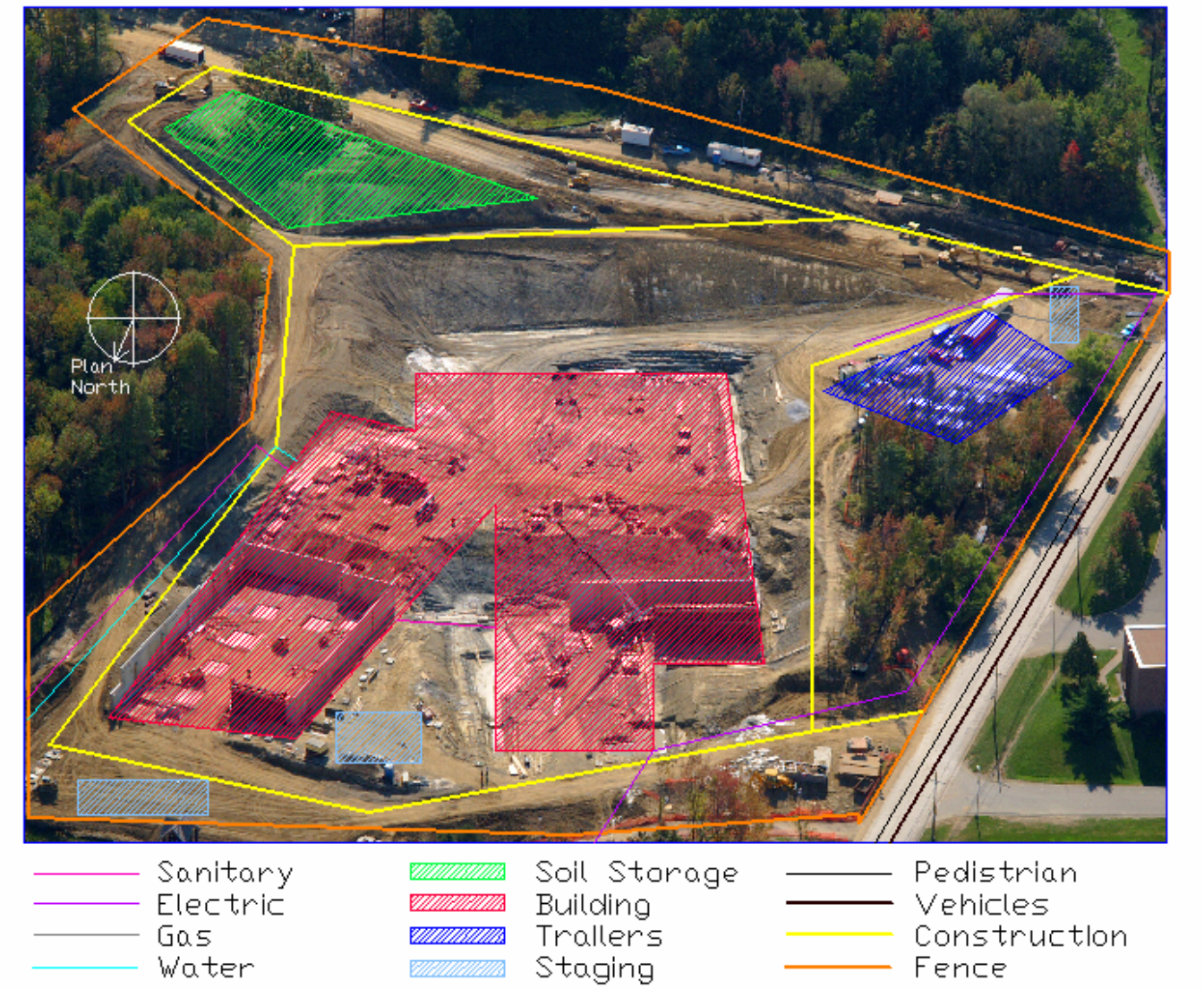
Site Plan:



The picture above shows the REDC building during the excavation stage. The site is very steep with a rise of 50' over the length of the building. It has a shale sub-grade with silt under layer. Retaining walls will be very important. The building footprint shows the location of the building and the lines around it show the traffic, site boundaries, staging and storing areas, trailers, and utilities. Near the building is the main road into campus and the campus chapel. This is the closest building to the construction and has an elevation of 1043 ft. Contractors are given parking in the University's commuter parking lot which is located ¼ mile from the site.

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Local Conditions:

The preferred method of construction is this part of Erie is steel frame construction. The contractors in this area also prefer the traditional method of project delivery, Design-Bid-Build. Construction parking is provided by the university in a nearby parking lot.

There is no practice of recycling of specific materials such as glass, paper, plastic, drywall, etc., on this project. Different accommodations, however, are made for "regular" construction waste and "heavy" construction waste. The regular materials are those already mentioned, but the heavier items consist mainly of concrete, aggregate, brick, etc. We collect the regular materials in dumpsters which usually amount too $300 to $400 per pull. The heavy construction materials are loaded into pickup, flat bed, and dump trucks and taken to local companies that turn the materials into crushed stone for use in future projects. The cost for this is usually $5 to $10 per load, and sometimes free! All in all, the project experiences about a 3 to 1 savings when recycling this way.

Client Info:

The Owner for this building is the Department of General Services. They hold the contracts for the CM Agency as well as all of the Primes. They employ a construction inspection group too. The REDC building is being built so that the user group, The Pennsylvania State University, will have a new educational facility for The School of Business and The School of Engineering and Engineering Technology. The placement of the new building was to bridge the two different sections of campus and make the entire campus more accessible by way of new walkways.

The building was estimated and expected to stay with in a budget of $30 million dollars so change orders are attempted to be kept at a minimum. Safety is to be overseen by the General Contractor and follow the department's standards. The Schedule should be adhered to as much as possible with the CM Agency, Turner, overlooking it. The only interesting thing on the schedule for the both the owner and the using group is the MUST FINISH BY DATE. This is expected to be January 31, 2006.

The key to completing this project to the owner's satisfaction is to get it done on time and on budget. The Department of General Services also needs the end users, the two colleges, to be please with the work for them to be satisfied with the construction.

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Problems Identified with Building Design:

• All cable trays in the server rooms are regular cable trays but the ones through the remainder of the building are ladder trays. According to the crew running wires it is much more difficult to run wires in this type of tray.

• The mechanical room distributions are weird. Finishes in the A section can't be completed due to the fact that the mechanical rooms haven't been finished and tested. This means that this area of the building can't be completed.

• There are issues with access to Mechanical rooms. If there is a problem with an AHU there is no way to get most of them off or out of the building. There is one on the roof that is covered by an overhang that is now inaccessible. And there is a knee wall blocking the ones on the 2nd floor from being brought out how they were brought in.

• There is no site access (driving) to any of the north side of the building.

• There have been issues with the metal paneling on other buildings in this area. The panels have been having issues with buckling and not sealing at window areas. Also where the panels are joined this sealing strip has been known to deteriorate within the first five years of building operation.

• An auditorium is being added to the building now that it is +80% completed. This is going to to out to bid soon. Will it be cheaper this way or as a negotiated C.O.

• The sky lights for the building all have joists running through them.

• I would like to see if wind power could be utilized to cut down on the building power load.

• The School is worried about the loading dock location. It is located next to two main building transformers and is on a steep slope with a hard curve. This could be problematic due to the icy winters that Erie normally receives.