Final Report
Alumni Memorial Hall Renovation
I-PRO 335
Spring Semester 2008
Illinois Institute of Technology

IMAGE SOURCE:
http://www.ruhr-uni-bochum.de/kgi/projekte/rub_expo/k5/k5_t4.htm

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1 Introduction

Alumni Memorial Hall (1945-46) is Mies van der Rohe's first classroom building on the Illinois Institute of Technology main campus. The building is a steel frame structure with brick infill. While the building as a whole is not under historical preservation status, the exterior elements are, and the University has decided to extend the historic status of the campus as a whole to the treatment of all the existing buildings of the original Mies master plan.

The building is home to the Departments of Civil, Architectural and Environmental Engineering. The building's space uses include a material's testing lab, computer labs, classrooms, graduate office space, Professor's Offices, and administration offices.

I-Pro 335 Alumni Memorial Hall Renovation is in its third semester. This semester will also be the last semester for I-Pro 335.

2 Objectives

The scope of I-Pro 335 is both a conclusion to unfinished work from the previous two semesters along with new projects that will start and end this semester. Work to be concluded and closed-out from last semester are as follows:

- The LEED (Leadership in Energy and Environmental Design) work to be completed from last semester will be finalized with the completion of templates that breakdown the points needed to acquire LEED ratings. Along with the work to finalize the LEED analysis a recommendation will be made that identifies by title and/or position the members that we see as necessary to form the LEED steering committee that would over-see the process and work with U.S. Green Building Council.

- Further A.D.A. (Americans with Disabilities Act) design development must be completed to re-work the elevator's location. As it stands right now, the elevator is seen through the windows and may produce an aesthetically unpleasing result. New technologies in lift design may help in this solution or possibly moving the elevator to another part of the building may be required.

- The Code of Ethics produced last semester was a good first attempt and stands as a good foundation. However, several elements just fall short of making it complete and coherent. Rather than writing a new one, it was our opinion that to take the existing one and rewrite it was a better use of our resources and would make a more valuable Code in the end.

New projects to be completed this semester are:

- The green roof design was a lead-in to our conversations about ultimately what to do about water management on the site. Plumbing as a whole will have to be addressed by the I-Pro if we are to have a complete understanding of what systems should be researched and can be utilized most efficiently. Several systems that have already been discussed are the use of grey and rainwater recycling in toilets, a cistern to hold rainwater run-off to help curb erosion, and what are the

systems that can be implemented to update the normal building plumbing to be more efficient.

- HVAC issues were some of the most criticized aspects of A.M.H. on the survey last semester. The perception is that the heating and cooling of certain areas of the building are inadequate during the summer and winter, if not all year. This leaves a great deal of research that can be accumulated on ways to improve this environmental sense and be redesigned to account for these deficiencies. In addition there needs to be an analysis of what kinds of hood fan exhaust needs to be provided for in the lab areas, and does this system need to be dealt with separately from the normal system to prevent contaminated air from being re-circulated throughout the building.

- Electrical systems are high on the priority list, and are required by law, to be upgraded and brought up to code. This means a complete inventory and re-design of what the building's new demands will be. The first step will be establishing lighting needs; next making calculations based on those needs and finally design. This will also include updating the alarm system for security, safety and code reasons. Additionally, there is a significant amount of 'off-heating' that is produced in the computer labs, it will be investigated to see if this heat can be captured and re-used.

- Construction schedule and cost estimation are vital to the success of a project. Change management orders are costly and can gravely affect the outcome of a project for the owner, architect and contractor. Scope, schedule, and cost are the three elements that make up a change order. Being able to understand how altering one of these elements creates pressure on the other two is critical to project management. By utilizing RS Means and either Microsoft Project or Primavera the students taking on this task will gain insight into how critical these jobs are.

3 Research Methodology

I-Pro 335 is a historical building renovation project that requires a group of individuals working together from across multiple disciplines. To work most effectively, the group was divided into four individually managed teams: Architects, Civil Engineers, Architectural Engineers, and Electrical Engineers. Tasks were assigned to each team based upon area of expertise. The teams were further divided into sub-teams to distribute the workload into manageable sections. A hierarchy of teams with individual management was essential to create a multidisciplinary group that could communicate and coordinate efficiently. The objectives of the individual teams and sub-teams are as follows.

Architects

Project Architect

- Serve as head management position to coordinate all aspects of the project from start to finish.
- Responsibility for final LEED documentation.
- Present final project plan to client.

Design Architect

- Research variables for ADA compliance and coordinate findings with other teams.
- Present necessary changes to client.
- Produce a final set of plans in AutoCAD.

Civil Engineers

Structural Design

- Check current design for structural integrity.
- Modify current design to accept additional loads from green roof and new mechanical equipment.

Green Roof Design

- Research and design a green roof system that maximizes potential LEED points.
- Determine storm water runoff reduction and design underground cisterns to capture excess water for reuse.

Elevator Design

- Research modern elevator designs to minimize energy usage.
- Design a two story elevator that satisfies ADA requirements.
- Design a two story glass curtain wall enclosure that is integrated with the current structural design.

Construction Management

- Develop a parametric and line item cost estimate of the renovation to present to the client.

Architectural Engineers

Energy Analysis

- Use building geometry, building materials, and occupancy to calculate heating and cooling loads for the building.

HVAC Design

- Use results from energy analysis to size HVAC ductwork.
- Recommend efficient mechanical equipment to be used.

Electrical Engineers

Lighting Design

- Determine electrical load for current design.
- Re-design lighting to fit new building layout and improve energy usage for LEED points and cost savings.

Electrical System Design

- Research lab equipment loads and update the building's electrical system to accept loads and conform to current building code.

Life Safety

- Design updated emergency lighting, signage, and fire alarm systems that are ADA compliant.

4 Assignments

Architects

Thomas Denney – 5th Year Architecture – Project Architect

- Organized weekly meetings and established deadlines
- Final LEED recommendations
- Final report with full documentation for advisors
- I-Pro project plan

Bradley Weston – 5th Year Architecture – Design Architect

- *ADA design development and access path design*
- *Selected aesthetic elevator location*
- *Bathroom design*
- *Developed final set of AutoCAD drawings*
- *I-Pro poster and brochure*

Civil Engineers

Michael Ericksen – 4th Year Civil Engineer – Construction Management

- Parametric (square foot) estimate for building renovation
- Preliminary line item construction cost estimate
- Construction schedule
- I-Pro final report

Garret Forkan – 4th Year Civil Engineer – Green Roof Design

- Calculated annual rainfall load on building
- Designed underground rain water cistern storage
- Determined runoff reduction based on green roof design
- I-Pro poster and brochure

Ei Sheng Hong – 4th Year Civil Engineer – Elevator Design

- Researched ADA and Elevator safety code requirements
- Consulted with elevator manufacturers
- Designed foundation and structure for elevator and equipment
- Created 3D model of proposed elevator design
- I-Pro final presentation

Yong-Wan Kim – 4th Year Civil Engineer – Elevator Design

- Looked at glass enclosed elevator case studies around Chicago
- Designed glass curtain wall surrounding elevator
- Integrated curtain wall structure with existing structure
- I-Pro midterm report

Justin M. Kirk – 4th Year Civil Engineer – Green Roof Design

- Researched ways to reduce runoff, including pervious concrete, rain gardens, rain barrels, and green roofs
- Measurements of pervious and impervious areas of building's site
- LEED documentation for Civil Engineering team
- I-Pro midterm presentation

Eric Rogers

- Green roof feasibility – strength and serviceability checks
- Modified beams and columns for elevator shaft
- Organized structural hand calculations into digital copies
- Final report to advisors

Nathaniel Roth – 4th Year Civil Engineer – Structural Design

- Green roof feasibility – strength and serviceability checks
- Green roof layout
- I-Pro Powerpoint presentation

Architectural Engineers

Kieran Healy – 4th Year Architectural Engineer – HVAC Design

- Case study of recent Wishnick Hall renovation
- Researched duct design
- Input proposed layout and energy analysis results into Duct software to size each system component
- LEED documentation for Architectural Engineering team
- I-Pro final report

Amy Sissala – 4th Year Architectural Engineer – Energy Analysis

- Input materials and occupancy of each room into HVAC Explorer software and calculated heating and cooling loads
- Researched mechanical equipment
- Proposed duct layout in AutoCAD
- I-Pro ethics report

Electrical Engineers

Adrian Jesus Ontiveros – 5th Year Electrical Engineer – Lighting Design

- Redesigned lighting systems and layout
- Incorporated occupancy and daylight sensors
- I-Pro meeting minutes
- I-Pro project plan

Dipti Sharadendu – 4th Year Electrical Engineer – Life Safety

- Designed updated fire alarm systems
- Designed ADA compliant layout for alarm systems and signs
- Developed emergency exit plans
- I-Pro ethics report

Alexander Warner – 4th Year Electrical Engineer – Electrical System Design

- Calculated electrical load for static equipment and lighting
- Designed new outlet layout and updated circuit panels
- Leed documentation for electrical engineering team
- I-Pro midterm presentation

5 Obstacles

Over the course of the semester, the teams encountered various problems that had to be overcome in order to meet their objectives. In order to work past the obstacles, we would discuss our problems team by team during the weekly meetings, and collectively come together and address the problem. The solutions included knowledge from team members in another discipline, consultation with outside sources, and individual problem solving.

Architects

- Existing CAD files and plans of Alumni Memorial Hall were poor in quality
- The programming requirements for the building were unclear from previous semesters

Civil Engineers

- Due to the historical nature of the building, the steel portion of the building was done using rolled wide-flange shapes that are no longer produced and not listed in current steel manuals.
- The self supporting elevator may not be structurally stable.
- The cost of the Gen2 elevator is considerably more expensive than a typical hydraulic elevator, and it is unknown whether this additional cost will outweigh the benefits.
- The overhead required for the elevator shaft is higher than the second story.
- Determining what type of connection to use to integrate the elevator shaft structure with the existing structure.
- Design changes regarding structural, mechanical, and electrical systems were not finalized until near the end of the semester. This put a time constraint on the quality of the cost estimate that could be produced. The construction schedule could not be completed.
- The historical exterior eliminated the use of rain barrels for storm water storage, so a more complex underground system needed to be designed.
- Site runoff was difficult to calculate because no team members had taken classes that cover it in detail.

Architectural Engineers

- New analysis and design software had to be learned
- The unclear programming requirements and the electrical redesign put a time delay on the energy analysis model
- Models and duct designs had to be updated to accommodate changes resulting from design work in other teams

Electrical Engineers

- No educational background pertaining to electrical systems in buildings
- Learning new standards, building codes, and equipment
- Learning photometric software for lighting design
- Determining how many light fixtures needed to be updated or changed due to lighting requirements

6 Results

Architectural Design

- New office layouts
- Bathroom expansion and addition
- Elevator addition
    - 2 story ADA compliant glass enclosed elevator
    - 72”x72”x20” polycarbonate skylight on roof
    - Gen2 machine room-less elevator systems
        - Lubrication free
        - Space saving
        - Energy efficient
        - Reduced vibration and noise
- Handicap accessible hallway
- Handicap entrance ramp addition
- Student work area expansion

Green Roof Design

- Benefits:
    - Storm water management
    - Improved energy efficiency of building
    - Absorbs external noise pollution
    - Processes airborne toxins
- Loads:
    - Dead Load: Decking and green roof
    - Live Load: Precipitation

- Member Capacity:
    - Ultimate load vs. design strength
    - Bending strength of beams
    - Axial strength of columns
- Storm water management
    - Impervious area on site reduced from 64% to 43%
    - Total volume of water leaving site reduced from 3252 cubic feet to 2686 cubic feet
    - Storm water runoff reduced 17%; LEED point available

HVAC Design

- Room loads calculated and zones created
- Duct layout and sizing to ventilate each room adequately
- Air handler with 100-ton capacity
    - Recommend Trane M-Series 100-ton
- LEED Credits
    - Additional ozone protection
    - Building systems monitoring
    - Improved indoor air quality

Electrical Design

- Outlets
    - Improved layout
    - 649 total outlets for building
- Size wires, breakers, and circuit panels according to building demand

- Riser and one-line diagrams graphically show building's electrical system
- Life Safety and ADA
    - Heat and smoke detector layout
        - FP-11 FirePrint Detector
    - Fire hose and extinguisher layout
    - Horns and visual strobe alarm layout
        - Siemens HS-HMC R & HS-HMC W (horn strobe – high intensity multi candela fire alarm)
    - Remote enunciator
    - Manual alarm pull layout
    - Fire alarm enunciator
        - Siemens Addressable Fire Alarm Control Panel: FireSeeker FS-250
    - ADA and emergency signage layout
        - Color scheme
        - Height placement
        - Raised letter and pictogram
        - Brail lettering
- Lighting
    - Fewer fixtures
        - Reuse current lights in hallways
        - Edapt Luminaires in offices, classrooms, and labs
    - Use of direct and indirect lighting
    - Occupancy and daylighting sensors
    - Personal dimming controls for desktops

- LEED Credits
    - Light pollution reduction
    - Minimum energy performance
    - Optimize energy performance
    - Measurement and verification
    - Controllability of systems – perimeter
    - Innovation and design process

Cost Estimate

- Parametric Estimate
    - $8,990,800.00 to build a new Alumni Memorial Hall
- Line Item Renovation Estimate
    - $4,037,542.79 to renovate the existing building

7 Recommendations

After working through obstacles and concluding the work of this semester's I-Pro, several recommendations were made that could improve the project in the future.

- Incorporate the HVAC design with a hydronic (water) heating and cooling system to further increase thermal comfort
- The new lighting design is more efficient than the present one. Because the building has had the lighting system updated recently, the payback period from energy savings would be longer if it was further renovated because the school hasn't made up what was spent on the current design.
- Run a P-delta analysis on the lateral load resisting frames to see if the green roof will have any effect on the lateral resistance of the current structure.
- Fully document the final design to improve the cost estimate and construction schedule.
- Asbestos removal and remediation should be considered in the actual renovation.
- AutoCAD standards should be set up for all of the work done by the group.
- The foundation for the elevator curtain wall should be researched.
- A more appropriate skylight should be selected for the top of the elevator shaft.
- The thickness of the elevator's glass can be reduced with more extensive material analysis.
- The elevator shaft columns were designed using assumed load values for the green roof, roof slab, and HVAC equipment. More accurate load descriptions will yield a better axial load of the column. The effect of dynamic and vibration load was neglected, and should be considered.

8 References

Architects

1. Ramsey and Sleeper. Architectural Graphics Standards. Wiley, 2003.

Civil Engineers

1. Steel Construction Manual, 13th ed. American Institute of Steel Construction, Inc., 2005.
2. Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-05. American Society of Civil Engineers, 2006.
3. Building Construction Cost Data. RS Means, 2007.

Architectural Engineers

1. McQuiston, Faye C., Parker, Jerald D., Spitler, Jeffery D. Heating, Ventilation, and Air Conditioning: Analysis and Design. Wiley, 2005.

Electrical Engineers

1. Bosela, Theodore R. Electrical Systems Design. Prentice Hall, 2003.
2. Egan, David M., Olgyay, Victor. Architectural Lighting. McGraw-Hill, 2002.

Software

1. *Microsoft Project* – project planning
2. *Microsoft Powerpoint* – presentations
3. *Microsoft Excel* – meeting minutes and agenda setting
4. *AutoCAD* – final drawings
5. *SAP2000* – structure analysis
6. *MathCAD* – organize hand calculations into digital file
7. *Photometric Viewer v3.1* – lighting analysis
8. *SketchUp* – elevator 3-D model
9. *HVAC Load Explorer* – heating and cooling load analysis
10. *DUCT* – HVAC duct sizing

Websites

1. City of Chicago Stormwater Management Manual
   http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/ChicagoStormwaterManualFeb2508.pdf

2. "Pervious Concrete: When it rains...It drains"
   http://www.perviouspavement.org/engineering%20properties.htm

3. A Guide to Stormwater Best Management
   Practiceshttp://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/GuideToStormwaterBMPs.pdf

4. "Building Sustainably"
   http://www.hydrotechusa.com/brochures/Sustainability.pdf

5. Hydrotech Green Roof
   http://www.hydrotechusa.com/brochures/GardenRoof.pdf

6. Trane: M-Series Climate Changer Air Handlers
   http://www.trane.com/Commercial/Uploads/Pdf/1020/clchprc003_en_mseriescatalog_1205.pdf

7. Chicago Municipal Code
   http://www.amlegal.com/library/il/chicago.shtml

8. U.S. Access Board
   http://www.access-board.gov/

9. Gen2 Elevator
   http://www.otis.com/products/listing/0,1357,CLI1_PRT73_RES1,00.html

9 Acknowledgements

The members of I-Pro 335 would like to thank the following individuals for their help over the course of the semester.

IIT Faculty

Ralph Muehleisen – CAEE Dept. - muehleisen@iit.edu – (312) 567-3545

- Cost estimating
- Electrical systems in buildings
- HVAC design
- Acting client: approved renovation plan design and program requirements
- Elevator selection approval and overall design

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- Historical AISC steel sections
- Structural design

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- Structural design

Paul Anderson – CHBE Dept. – andersonp@iit.edu – (312) 567-3531

- Runoff reduction methods

IIT Staff

Nancy Hamill-Governale – Facilities – hamill@iit.edu – (312) 567-7555

- Audit sheets from 2006/2007 lighting renovation

Leonard Gill – Facilities – lgill2@iit.edu – (312) 567-8926

- Wishnick Hall recent mechanical renovation plans for case study

Representatives

Sid Osakada – City of Chicago Department of Water Management – sid.osakada@cityofchicago.org – (312) 744-0344

- Chicago storm water management manual and spreadsheet tool

Mr. Ralph – Otis Elevator Company – www.otisworldwide.com

- Loads from elevator
- Elevator cost estimate