Cathedral Place
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Executive Summary

The Thesis Proposal developed here will introduce the specific investigations into Cathedral Place for the depth and breadth elements of the AE Senior Thesis in the second semester. Analyses of particular problems related to lighting design, electrical distribution, mechanical systems and/or integration, and cost-management will be completed and solutions proposed in an attempt to identify alternatives to the current design. The Proposal consists of four parts: a Lighting Depth, an Electrical Depth, Mechanical and Construction Management Breadths, and the Project Schedule for the coming semester. The specifics are listed below.

The Lighting Depth will redesign five areas of the building relative to those specified in Technical Assignment #3 (see the link on the following pages). This redesign will focus on developing an image for the building, and redefining the building as a hallmark in the downtown area as opposed to another building with simple exterior illumination. As well, the lighting design will take into consideration the daylighting availability in an attempt to reduce the power density and meet the requirements set forth in ASHRAE 90.1 while meeting the lighting design goals found in the IESNA Handbook. Of particular note in the redesign is the use of atypical light distribution systems to achieve certain effects such as a wave pattern in the entrance lobby.

The Electrical Depth seeks to analyze the building from a standpoint that precedes construction – development of a system with the assumption that the building has a single owner/operator taking all profits garnered and paying all bills resultant from the construction and operation of the building until its end use. The redesign will use a single distribution system for the whole building and attempt to minimize materials, labor, and price fluctuations from the utility company. Resizing of the whole system and its individual components, as well as analysis of tenant power requirements and current load requirements will be integral to the redesign.

The Mechanical and Construction Management Breadths are, for the most part, an extension of the two depth work proposals and their relationship with the cost of the building and the impact the new systems will have on the mechanical system. Of particular concern is the use of daylighting in the electrical and lighting designs and its use or impact on the thermal loads of the building. Breadth work focused on the mechanical system will analyze its design and the use of this system, while the construction management breadth will analyze the building and systems as a whole and project their costs into the future to attain a payback period and/or analysis of profitability by changing over the system.

All of these analyses will be challenging and quite specific to the building. Utilizing all of the knowledge as an Architectural Engineer and not just the proficiencies in a Lighting or Electrical capacity will provide an accurate and interesting look at the building's system alternatives and the real-world impact of aesthetic value, functional simplification, and development marketability from both the engineering and owner/developer standpoints.

Background to the Building

Cathedral Place is one of the newest construction projects in the Milwaukee, WI downtown area. It is one of the few multi-use facilities having undergone development in the past 5 years. The architecture of the building exemplifies “form follows function”, but does not sacrifice architectural style and creativity in the process. Cathedral Place is carved from three distinct entities which give rise to the “multi-use” moniker – retail at ground level, parking and condominium for the lower 9 stories (at 85% and 15% floorplate usage, respectively), and spec/tenant office for the upper 8 stories.

Construction of the building started in January of 2002 and tenants began occupancy in March of 2004. The building cost approximately $53,000,000 and is currently filling the last of the condominiums for 100% building usage. Staked claims to the building reside with the overall building developer/owner Van Buren Management through a property management agency, The Redevelopment Authority of Milwaukee, and the condominium residents.

The building’s name is derived from the small 1-square-block park located across the street from the northern façade (the cathedral itself being kitty-corner from the building to the northeast). While the building serves little purpose to the park or cathedral themselves, it does serve as a new visual landmark to the area, and has created a hub from which the multi-zoned surrounding area can stem. It is this quality that gives Cathedral Place its prominence.

Within the building many “individuals” are represented – the office tower, individual condominium residents, retail tenants, and the parking authority. It is this disparity in “ownership” that has complicated much of the design and in some instances fragmented the building as a whole – relative to overall aesthetic design, electrical distribution, and mechanical systems as well. These design schisms are where the analyses of the forthcoming problems have their foundation.

Depth Proposal – Lighting Redesign

Problem and Solution

The first depth topic to be analyzed will be the lighting redesign of a variety of spaces throughout the building. The lighting design will not focus specifically on attaining a minimum light level, or altering spaces architecturally (to a great degree) to make better use of a current system, but instead develop a personality or atmosphere that would allow the building to be represented as a whole without sacrificing the individualist natures of the tenants. For this reason, certain spaces were considered with respect to the building's hierarchy and circulation.

The larger components (such as the façade and ground-level lighting) must meld with the major public spaces (such as the lobby and parking structure spaces) with finality in an individual component (tenant office reception and open office) of the building. It is this metaphysical flow from which the lighting design will develop appropriate solutions to better represent the building and identify it internally and externally as a hallmark of the area and among the new construction projects.

The redesign will not focus entirely on the aesthetic improvement of the space from the creative sketching standpoint, but will address many of the technical concerns of such a redesign and the impact the solution will have on the remaining building systems. Within the design, integration with further depth work, or the overall efficiency and cost-effectiveness of the design will be paramount in developing the appropriate solution. Among the technical elements to be considered in the design are:

- Usage of new and upcoming lighting technologies (LED, colored T5 lamps, etc.)
- Integration of daylight into specific spaces
- Controllability considerations for the entire building, and/or sections therein
- Atypical light distribution necessities based on certain design goals
- Lowered maintenance and building autonomy/intelligence

The overall solution design is to emphasize the qualities of the lakefront in an inland/"landlocked" appearance and subtly reinforcing the building as a multi-zonal hub for the downtown area and neighborhood using the "central water fountain in the park" metaphor and maintain reference to that metaphor throughout the building's major and public spaces. The solution will include technical elements as described above to relate the lighting to the electrical design as well, and reestablish lighting as a necessary, but also energy and cost-efficient means of proclaiming the building.

Detailed analysis of the lighting redesign (particularly focused on the five spaces of concern to the thesis) can be found in the Technical Assignment #3, here.

Tasks and Tools

Utilizing the design criteria analysis developed in the Technical Assignment #1 from the IESNA Handbook, and the redesign schematics (revised following presentation and professional critique) from Technical Assignment #3, the design development phase of the project will begin. Lamps, ballasts, luminaires, and luminaire/distribution approximations will be utilized within computer modeling programs such as AGI32 for light levels, and either Radiance or Viz 2005 for better modeling aesthetics. Daylight studies begun for the Technical Assignment #1 will be further analyzed using AGI32 and specific knowledge gained in the AE Solar Energy class (AE 456). For those light distribution approximations with atypical designs, TracePro and/or mock-ups will be used to determine alterations or feasibilities of the design elements. Further research into lighting control systems and building management systems will be performed to either directly enhance the lighting design and aesthetics, or be indirectly utilized for building energy reduction through timing and switching.

Task and Methodology Outline

1. Design Development Processing
   a. Identify problem solutions from Lutron presentation
   b. Reanalyze two or more alternatives for selected spaces
   c. Develop finalized solution in quick sketch
2. Fixture Selection and Development
   a. Find appropriate fixtures for general illumination
   b. Identify specialized fixtures or installations (LEDs)
   c. Approximate custom distribution installations or design using TracePro
   d. Compare all fixtures with reference to controllability and power requirements relative to ASHRAE 90.1
3. Computer Modeling
   a. AutoCAD model all spaces with medium-quality of detail
   b. (Further) develop Viz models from AutoCAD bases with higher detail
   c. Radiance develop specialized or unique spaces (lobby)
   d. Analyze rendered images and numerical results for IESNA compliance
4. Daylighting Analysis
   a. Analyze lobby space for daylighting inconsistencies (as per owner request)
   b. In-depth development of daylighting integration at Open Office and through skylights in Office Receptions
   c. Set up daylight studies relative to the existing conditions studies to understand impact redesign has
   d. Complete vast daylight study for daily timings and yearly timings from weather data and AGI32 analyses, renderings, and numerical data.

Depth Proposal – Electrical Redesign

Problem and Solution

The electrical system of Cathedral Place has few if any design flaws relative to the distribution system and its functionality over three distinct billable owners. At first glance, the system seems to be poorly engineered from a "single-building-distribution" standpoint, but is actually very well developed to account for the three main services it has to provide. This is also evidenced by the three incoming services at differing levels provided by the utility.

The utility provides separate service to the parking structure, the office tower and retail, and the residential sections at varying voltage levels of 480V, 13.2kV, and 208V respectively. This requires three transformers of differing ratings and sizes, as well as 3 different switchgear or primary distribution panels. From these differing distribution points, various bus ducts, or cable pulls provide main service to the building. Based on these conditions, the emergency power for the building is specific only to overall shell-and-core construction to allow safe egress of all occupants.

The problem here is a seeming redundancy that provides no additional value except separation of the building's entities. The problem and subsequent solution will involve analysis of the building as configured compared to the building under the direction of a single owner, and alteration of the "use" of spaces. By treating the building as a single entity, the cost of multiple services, multiple transformers (some costs bourn by the owner himself), and the multiple-riser configuration can be reduced, if not eliminated. Additionally, sizing and specification of the building bussing, branch circuits, circuit protection, etc. will have to be reanalyzed and redesigned to equate with the "reassignment of ownership" task. This redesign, while being functional and specific to the electrical depth, will directly correlate with the Construction/Cost Management breadth to be addressed later in the proposal.

Also, relative to the lighting redesign, alterations in the building's power requirements and the sizing of the branch circuits will also have to be changed. From the lighting redesign implementation and analysis (mainly from the daylight analyses), the possibility of using photovoltaics may be analyzed and utilized if time permits.

Tasks and Tools

The electrical redesign will take many of the assumptions of use and power consumptions specific to the floors and spaces as found in Technical Assignment #1. All of the redesign will be very careful to maximize allowances made by the 2002 National Electric Code and to stringently adhere to all of those code requirements for branch and circuit sizing, load balancing, and feeder tapping (for motor loads). The redesign will also take into careful consideration the changes made based on the lighting redesign and possible photovoltaic use and energy production within the building.

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Task and Methodology Outline

1. Design Development Processing
    a. Analyze all of the space and diagrammatically organize the building loads
    b. Develop an efficient system relative to conductor/bus total length, efficiency, voltage drop (over 18 stories), and constructability issues
    c. Revisit all calculated Mechanical and Lighting loads
2. Diagram, Layouts, and Sizing
    a. Use AutoCAD to develop One-line diagrams of utility entrances with obtained knowledge from utility engineers
    b. Develop detailed riser diagram of building
    c. Work backward from end-use entities to size branches, wiring, protections devices, and panelboards/distribution centers
3. Cost Analysis
    a. Develop load profile for building and compare the total current costs with the new costs of the system and service entrances, voltages, power-factor fees, etc.
    b. Develop cost analysis of materials and labor for alternate system
    c. Project the cost and savings into the future to develop payback periods and profitability (or lack thereof) of current system

Executive Summary

Based on the lighting and electrical redesigns of the building at an in-depth look, the impact these design have on the building stretch to all of the remaining building disciplines. Of particular interest to these redesigns are the cost impacts they will have both initial, and long-term (payback), and the mechanical impact elements such as daylighting will have on the space. The additional analyses of these topics will give a much better real-world look at the building and broaden the scope of the project such that I will have a much better "bigger-picture" look at the building and the necessity to integrate many of its components.

The mechanical analysis will take into consideration the use of daylighting specifically at the open office and reception areas of an office tenant space. The thermal characteristics of the glazing on the curtainwall, and the glazing applied to the skylights (and skylights in development) have a great impact on cooling and heating loads over the course of the year. The possible integration of a daylight harvesting heat-storage option will be analyzed briefly, and the possibility exists for the analysis of further utilizing the steam utility provided to the building currently.

The construction management breadth topic will take all of the redesign issues and the breadth work into account and attempt to quantify as a cost or profit the impact these systems and redesigns will have initially and into the long-term. Analyses of costs incurred from a utility standpoint, a construction standpoint, maintenance and life-expectancy standpoint, as well as development and ownership profitability can be accounted for in the construction management breadth analysis. While all redesigns have inherent cost effects, attempting to redesign systems with the intention of reducing budgets for those systems should be addressed separately.

The following breadth analyses give a more specific idea of their intentions and the impact they have on the overall thesis project. They correlate themselves with the depth topics to prove that a clearer view and understanding of the "grander-scheme" can be obtained through their analysis.

Breadth Proposal – Mechanical Analysis

Mechanical Emphasis

Two particular interests to the mechanical systems are readily apparent upon brief review of the mechanical drawings. First, the extensive glass curtainwall system and the thermal gains and losses associated with such an "open wall" system are to be seriously considered. Second, the utilization of cooling towers, evaporative fluid coolers, and the downtown steam utility service for building heating eliminates all boilers and chillers, but also comes at a distinct utility cost.

The mechanical breadth topics will address both of these concerns, but specifically analyze only one of them in more depth. Since the solar gains with respect to the lighting design will be analyzed, and the possibility of using photovoltaics for electricity production (at a small scale) forthcoming, the thermal gains of these daylighting analyses is only prudent. The possibility of harvesting daylight energy for heating systems is also of interest. Storing the energy in spaces that would otherwise become free due to the electrical redesign will become a distinct possibility and integration of these systems, much more obvious.

For the second consideration, energy usage and efficiency of that usage may be analyzed as well. Using the steam service to its maximum capacity (or capability given relatively few utility restrictions) may allow the building to work more efficiently, or waste less energy (as the actual usage would remain the same in heating the building considering a closed-system model). One particular interest is using the remaining steam energy by enclosing and possibly heating levels of the parking structure to reduce the effects of Wisconsin winters on occupant's happiness and cause a reduction in the use of electric heating elements at certain levels of the structure.

Once these topics have been briefly covered, consultation with professors and/or outside sources will help specify which direction to pursue and the depth in which it should be analyzed. Use of previously mentioned lighting software for daylighting will be used, and a greater abundance of hand calculation and formal review will be used for these mechanical analyses.

Construction/Cost Management Emphasis

Building on the previously mentioned depth and breadth topics, cost analysis becomes one of the greatest concerns to a projects development, and the contentment of the owner/developer with the engineering and construction process. Cost analysis will be performed on the redesigned lighting and electrical systems to a very high degree. The possibility of using daylighting for interior lighting, possible energy production, and the further possibility of heat storage obviously reduces the day-to-day costs of the building and can overall reduce the energy consumption of the building. Higher initial costs to the project will be analyzed in terms of their long-term achievements in cost-savings and payback periods with respect to the life of the building.

The lighting redesign will undoubtedly incur a higher cost that was originally planned. The cost savings will only occur after time relative to maintenance issues, lamping costs, and overall life expectancy extensions developed with better building automation and control. After the redesign, the cost analysis will tell whether the change in the lighting design and the benefits of the buildings "self-advertising" outweigh the current cost and design or not.

The electrical redesign will attempt to gain as many savings as possible through a more simplified design requiring fewer materials, less labor, and better service power pricing and billing. The reduction in costs of owner-purchased equipment may itself skew the cost in favor of redesign, and upon completion, the analysis will be able to say for certain.

Project Schedule

This is the tentative project schedule developed for the Spring Semester of 2006. Adherence to this schedule is obviously necessary as many tasks will overlap and some concurrently start with others. Given the possibility of using such design elements as Photovoltaics, Steam Utility maximization, etc. the schedule is subject to change in minor detail.

Week of	Event	Duration (weeks)
01/09	Start working on 3D models of spaces	2
01/16	Analysis of Basic Lighting Design in AGI32	4
01/23	Analysis of Power Requirements	4
01/30	Daylight Analysis	1
	Electrical Analysis of Photovoltaics	1
02/06	Mechanical Analysis of Daylighting and Steam Utility	2
02/13	Rework Specific Areas of Lighting Design	2
02/20	Finalize Lighting Design	2
02/27	Finalize Electrical Design - Load Profile Development	1
03/06	SPRING BREAK	
	Reevaluate all topics, fine-tune as necessary	1
03/13	Construction Management Work - Cost Analyses	2
03/20	Finalize all topics	1
03/27	Final Thesis Book Development	1
04/03	Thesis Presentation Development	1
04/10	Thesis Presentation	1
05/12	Graduate	0.142857