

## Fall Thesis Proposal



Villanova University: School of Law  
Villanova, PA

Jason Greer  
Lighting/Electrical Option

December 18, 2007

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## **Executive Summary**

The proposal for the AE senior thesis defines the work that will be completed for the different areas of analysis and redesign for the Villanova University: School of Law in the spring of 2008. Both the depth and breadth analyses will look at the building systems in an integrated fashion. The idea behind this is to not only discover ways to improve one system, but to improve them all collectively.

The depth analysis will focus on the lighting and electrical systems for the law school. The lighting depth will redesign four spaces: the courtyard, the atrium, the moot court and the 135 seat classroom. The overall design goals for all spaces are to enhance the architecture present in the building, provide a workable and comfortable environment for the occupants and limit the building's environmental effects. The building will be redesigned using ASHRAE 90.1 and the recommendations from the 9<sup>th</sup> Edition of the IESNA Lighting Handbook.

The electrical depth will provide revisions to the circuiting in the four spaces that will be redesigned. A protective device coordination study with short circuit calculations will be performed. The distribution system for one floor will be redesigned and then analyzed and compared to the existing distribution system. Lastly, analysis will be performed on the motor control center. The analysis will focus mainly on the sizing of the main equipment and feeder. If there is room for a redesign, a cost analysis will be performed to see what savings could be had.

The two breadth topics that will be explored are mechanical and acoustical. The mechanical breadth will study the cooling load reduction in the atrium due to the solar controls that will be included on the atrium's lighting redesign. The acoustical analysis will study the acoustical requirements for a courtroom and classroom. The moot courtroom will then be analyzed to see if one or both of the requirements can be met. After this analysis is done, a cost analysis will be performed to determine if the implementation of the chosen acoustical system is feasible.

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## **Building Overview**

The Villanova University: School of Law is located on Villanova University's campus in Villanova, PA. The law school will provide the current law students a state of the art law library as well as additional classrooms and other learning spaces. Construction has recently begun at a total construction cost of \$56.5 million. When the project is complete, the School of Law will be approximately 170,000 square feet spread across 4 floors and a sub-basement. Gilbane is serving as general contractor for this project. Construction is scheduled to last 21 months which sets owner occupancy for August, 2009.

The building will consist of a law library, classrooms, courtrooms, dining facilities, a chapel, and administration and faculty offices. This building will provide a centralized location for all of the services law students at Villanova University require. The School of Law has a very dominant atrium that looks out onto an open courtyard. These views along with the multitude of high quality spaces inside will make the law school one of the most prominent buildings on campus.

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## **Depth Analysis: Electrical Design**

1. **Redesign branch circuit distribution for the four spaces in which lighting was redesigned.** The four spaces in which the lighting is being redesigned are the courtyard, the atrium, the 135 seat classroom and the moot courtroom. This part of the electrical depth will entail resizing distribution equipment, conductors as well as changing panel board layouts.
2. **Conduct a protective device coordination study that includes a short circuit calculation.** The path that will be analyzed is that path that leads to panel board RP-3NB. The path goes from the main switch gear, then to LP-1N, to LP-3N, to RP-3NA and finally to RP-3NB.
3. **Change from supplying power down stream from standard lighting panels to a more centralized distribution system.** Currently the Villanova University: School of Law does not utilize distribution panels throughout most of the building. Once the power leaves the main switchboard, it runs to standard 42 pole lighting panels. The smaller panels further downstream are fed from there. The smaller panels are also protected by the lighting panel up stream.

I propose that changing from the current design to a design that implements dedicated distribution panels on each floor will reduce the sizes of the majority of the building's feeders. By using the distribution panels, the lighting and receptacle panels will be used for only branch circuits which will free up many spaces in the panels. Currently there are not many spares throughout the whole building which could cause problems later if there is desire for growth. By using the distribution panels, many of the existing panels will have the necessary spares and spaces.

After redesigning the distribution system I will do a cost analysis of the new system. The cost analysis will focus on the possible reduction in feeder sizing, the reduced number of breakers required in the lighting panels and the shortening of the length of feeders required for the down stream panels.

4. **Analyze and design one major mechanical equipment motor control center and its feeder.** I will analyze the current motor control center as well as its feeder. During the analysis I will be checking if the sizing of the equipment is correct per the NEC 2005. Many times equipment is oversized for ease or safety. I will investigate any possible savings if the equipments is in fact oversized. After analyzing the necessary size of the equipment, I will analyze the sizing of the feeder that supplies the MCC.

If the equipment is not sized correctly, I will resize all of the equipment associated with the motor control center. I will do the same with the feeder.

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After this step is completed, if necessary, I will then do a cost analysis in order to determine the savings that would be possible if the new design were implemented.

### **Depth Analysis: Lighting Design**

The existing lighting systems for the Villanova University: School of Law consists of mainly fluorescent sources. The types of luminaires are mainly recessed down lights, pendant fixtures, and recessed wall wash fixtures. The down lights and pendants are used mainly as a means of providing the necessary light levels in the spaces. The wall washers are used as accent lighting and some display lighting. In specialty spaces such as the atrium, incandescent track lighting is utilized as accent lighting that is flexible enough to be re-aimed.

The controls are limited to occupancy sensors in the classrooms and other standard spaces. The more specialized spaces such as the courtrooms and atrium do have localized dimmers and scene control. A more sophisticated control system will provide the possibility of more energy savings. The atrium, however, is lacking daylight controls. The space is a double high space with clear, south-east facing glazing along the entire façade. Because of this, the space will see a fair amount of mid-morning to mid-day sun. In order for this space to be usable and comfortable in the morning hours, daylight controls will have to be introduced.

The most noticeable feature of this building is the atrium that can be seen from the street, parking lot and courtyard. The amount of glazing will turn the space into a glowing beacon as seen from the outside. This is going to be the cornerstone of the lighting design for the law school. All of the other spaces are important but the atrium is what will be seen by everyone, not just the occupants of the building.

The scope of the lighting redesign will be four spaces. The spaces include the courtyard, the atrium, a large classroom and the moot courtroom. The main ideal that will be carried throughout the lighting design is that the legal institution has forever been one of prestige and excellence and the lighting should embrace and enhance that.

### **Comments from designers at Lutron (12/13/07)**

*Andrea Hartranft:*

- Nice presentation, good use of space
- Time restraints w/ quotes
- Put plans together that need to be together
- Start at entry and work way into space
- Font colors sometimes hard to read
- Finishes may be better in rendering not leaders

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- Bigger section
- In the classroom, function is highest priority
  - Lighting the dark wood is secondary to the necessary tasks
- Good layering of light
- Atrium
  - Need to light back wall for 3D feel
  - Make sure wood reads before fully accenting

*Sandra Stashik*

- Good use of Photoshop “pick lines”
- Atrium
  - Use beam/structure to incorporate light
- Good layering of light
- Forget incandescent in wood accenting
  - Maybe only accent in front
- Moot Courtroom
  - Show plan to indicate locations for light
  - Show RCP for better understanding of space
  - Good layering in sections

*Mike Barber*

- Well thought out concept
- Be careful with mixing source when accenting wood
- White/yellow wasn't clear
- Be careful of high angles on witness stand
- Show more plans for better understanding of space
- Clean up floor plans
- Think about uplighting trees
- Turn lights on in other side of wing, make it more 3D

**Solution**

This proposal will provide a limited description of the proposed lighting solutions. For a more detailed analysis as well as graphical representations, please refer to Technical Assignment 3.

*Overall*

The main design goal is to have the building be a point of interest during evening hours. The atrium will be the space that can be seen from the outside and will be the most well known part of the building from the date of completion. Hopefully, this will be a well known and interesting part of the new campus skyline. Another overall design goal for the law school is maximum flexibility. Many of the spaces are multifunctional spaces

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and because of that, the lighting has to be controlled in a manner which allows for each task to be easily accomplished.

*Courtyard*

The courtyard has the purpose of leading you to the main entrance of the law school. The space is to be lit to a safe level while still allowing the atrium to speak for itself. The landscaping will be accented in a subtle manner as to not distract from the elegance of the internal space. All landscape lighting and exterior lighting will be controlled using a photocell to switch on. The lighting will be switched off using a time clock set to a certain time of night.

*Atrium*

The atrium is the space that will be seen from the exterior. There is a great deal of wood that can be accented. The space will be used for a variety of functions so the lighting must be controlled in such a manner that scenes are easily changed. The amount of daylight that will enter the space is something that most definitely has to be addressed. In the morning hours, a great deal of sunlight will enter the atrium. The proposed design will incorporate solar shades for the glazing. For the same reason, blackout shades will be implemented for the times when there is a function that requires zero daylight in the space. The controls will also include photocells that will allow for some load shedding when there is adequate daylight in the space.

*135 Seat Classroom*

The classroom is mostly functionally driven. The main consideration is that the students can get their work done in a comfortable atmosphere. There is a presentation area up from which will be lit to a higher level than the ambient lighting in the space. The side walls have some acoustical paneling which has been designed into the space as a point of interest. This is a material that can be lit in different ways to bring out its texture and will contrast with the smooth walls. The controls in the classroom will have to provide flexibility because of its different possible uses.

*Moot Courtroom*

The courtroom is much like the classroom in the way that it has many of the same functions. The one difference is the fact that it will be used in mock court proceedings. The design goals for this space are similar to that of the classroom with a few exceptions. The design should create a realistic courtroom setting. The wood in the classroom brings the users back to the ideal of excellence and prestige. The lighting in this space has the potential to accent some of the wood work. The controls will again be a scene controller that can change the lighting scene easily whenever necessary.



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**Solution Method**

After working through the lighting design method, the final product will be documented using both paper and electronic media. Hand sketches, Photoshop renderings, and realistic renderings will all be used throughout the design process. The final product will be lighting plans for all four of the redesigned spaces as well as at least two photorealistic renderings.

**Tools**

The reference documents that will be used during the redesign of the spaces are as follows: ASHRAE 90.1, IESNA Lighting Handbook, 9<sup>th</sup> Edition, and the LEED 2.1 Reference Guide. All reference material will be used where necessary.

All lighting calculations will be done using AGI32 lighting software. The renderings will be done using a combination of AGI32, Photoshop and Autodesk VIZ. Lighting plans will be done using AutoCAD.

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**Breadth Analysis: Mechanical**

Hopefully the changes that will be made the atrium space in dealing with solar controls will positively affect the cooling loads of the building in the summer months. With that goal in mind, I will do a mechanical cooling analysis on the atrium space. The analysis will look at the cooling load reduction the solar shading will provide to the atrium. After the new cooling load has been determined, an annual cost saving analysis will be performed in order to discover the money that will be saved yearly on the cost to cool the atrium.

**Breadth Analysis: Acoustics**

The moot court is a room that has a lot of hard surfaces, a lot of wood and an intricate ceiling. Currently there are only a few acoustic panels located on the perimeter of the space. I will perform a reverberation time analysis on the current conditions and compare that to the recommended acoustic criteria for courtrooms and classrooms. I will determine if there is a way to have a system that will work for both settings or if there is a way to change the acoustics of the space depending on it use. After determining the best solution for the desired acoustic situation, I will do a cost analysis on the new system in order to determine the feasibility of implementing that system.

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<b>AE 482 Spring 2008 Schedule</b>		
<b>Week</b>	<b>Focus</b>	<b>Task</b>
Winter Vacation	LTG	Work on Electronic 3D Models Work on Concept Sketches
1.14.08 to 1.20.08	LTG	Finalize Electronic 3D Models Finalize Electronic 3D Models
1.21.08 to 1.27.08	LTG	Calculations and Controls (Atrium)
	Elec	Recircuit Atrium Accordingly
1.28.08 to 2.3.08	LTG	Calculations and Controls (Moot Court and Classroom)
	Elec	Recircuit Moot Court and Classroom Accordingly
2.4.08 to 2.10.08	LTG	Calculations and Controls (Courtyard)
	Elec	Circuit Courtyard
2.11.08 to 2.17.08	Elec	Protective Device Coordination Study / Short Circuit Analysis
2.18.08 to 2.24.08	Elec	Redesign of Distribution System
2.25.08 to 3.2.08	Elec	Cost Analysis of Distribution System Redesign
<b>3.3.08 to 3.9.08</b>	<b>Elec</b>	<b>Spring Break - Start Analysis of MCC</b>
3.10.08 to 3.16.08	Elec	Finalize Redesign of MCC Cost Analysis of MCC Redesign
3.17.08 to 3.23.08	Mech	Load Analysis of Atrium Space Cooling Load Reduction with Solar Controls in Atrium
3.24.08 to 3.30.08	Acoust	Acoustical Analysis of Moot Court Acoustical Redesign of Moot Court
3.31.08 to 4.6.08	Acoust	Finalize Acoustical Cost Analysis
	LTG	Final Renderings
	All	Begin Final Report
4.7.08 to 4.13.08	All	Complete Final Report Complete PowerPoint Presentation
<b>4.14.08 to 4.20.08</b>	<b>ALL</b>	<b><u>Faculty Jury Presentations</u></b>