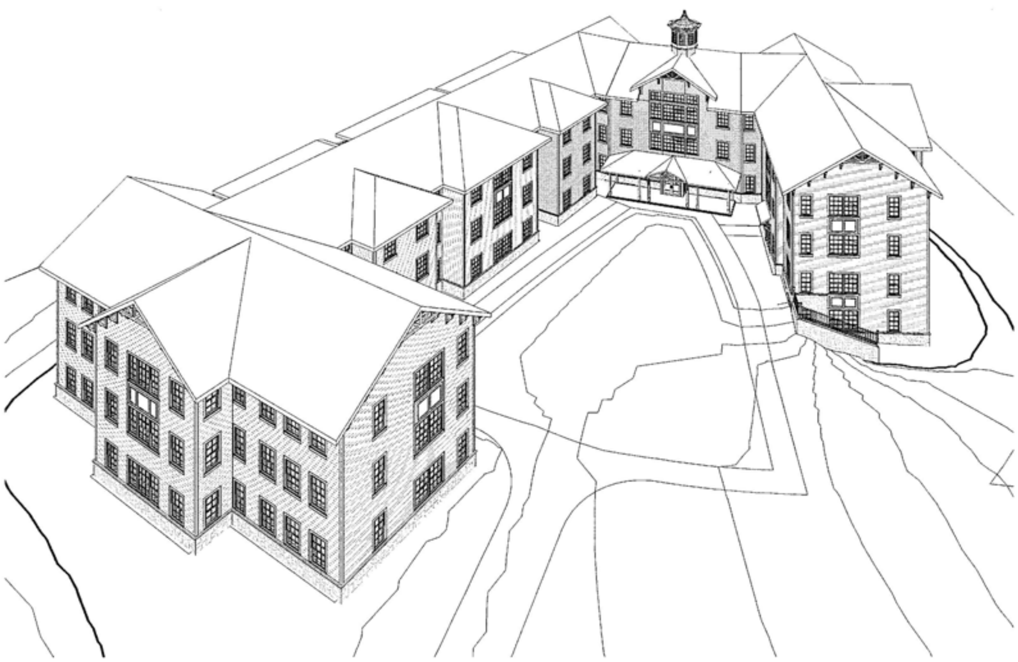
THESIS PROPOSAL



NEW STUDENT HOUSING BUILDING
AT
THE MOUNT ST. MARY'S UNIVERSITY
EMMITSBURG, MD

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2. EXECUTIVE SUMMARY

The Mount St. Mary's University began the design of this new student housing project with a fixed budget and certain goals. One of those goals was for the building to utilize sustainable systems in order to promote environmental consciousness while at the same time assuring a comfortable and functional building for the students who would reside there.

The following pages outline my proposal for an investigation into optimizing possible "green" design approaches that could have been implemented at this new dormitory. At the same time, I will attempt to maximize life cycle costs while simultaneously minimizing first costs and operational costs, and based on the results of each system, I will attempt to determine the best possible sustainable building approach in terms of cost efficiency.

My depth work will entail a detailed analysis of the current geothermal system as well as a comparison to other conventional means of design for thermal comfort. Breadth work will encompass two forms of solar design, solar collectors for heating of the domestic hot water and photovoltaic panels for energy storage, as well as an analysis of how each system will affect constructional decisions and costs. After completing all analyses, I will attempt to create a model in EES or another similar program that will be capable of optimizing the building with respect to first costs and life cycle savings.

As I have stated in my previous technical assignments, I feel that the designed system for this new student housing project is probably one of the best possible based on the realistic budget of the project and the desires of the university. This investigation is to be preformed as an exercise in optimization, the goal of which being an attempt to determine a best possible sustainable system based on initial, operational, and life cycle costs.

3. EXISTING CONDITIONS

As designed, the new student housing project at the Mount St. Mary's University consists of enough 3- and 4-bedroom suites to house approximately 200 students comfortably. Each of these living units has complete control over thermal comfort and lighting. The building's architecture suggests a rural village, complementing the rest of the campus without being overly obtrusive.

The building's mechanical system has two major components: a dedicated outdoor air system utilizing energy recovery and a geothermal heating and cooling system. The ventilation system is composed of three 1050 CFM energy recovery units which provide tempered ventilation air to numerous water-source heat pumps located throughout the building. The heat pumps, which range in capacity from 12 MBH to 30 MBH, are located in each suite and lounge area. They are capable of providing all of the building's required heating and cooling through the utilization of water being pumped through 125 geothermal wells located throughout the site. There is also a single 600 MBH, 750 gallon domestic hot water heater that runs off of natural gas, which serves the building's heated potable water requirements.

The building's electrical system is 208Y/120V, 3 phase, 4 wire and runs through a single 1600V switchboard, which feeds the other 14 panelboards located throughout the building. The building's lighting system consists of various 120V fluorescent wall washers, ceiling-mounted pendants, and other conventional downlighting, and the emergency lighting is all on battery backup.

4. PROPOSAL OBJECTIVE

As stated in previous technical assignments, the Mount St. Mary's University began this new student housing project with a budget of approximately $10 million, and their goal was to create a sustainable, environmentally friendly dormitory to house their growing population of students. The university was very interested in sustainable or "green" technologies. They wanted to project an image of environmental consciousness without taxing their budget too sorely or compromising the function of the building. It was with this mindset that energy recovery, geothermal heating and cooling, and natural ventilation were all implemented into the project.

Due to budget constraints, greatly in part to the costs of the geothermal system, certain aspects of the original design had to be modified or cut from the project entirely. The energy recovery units were scaled down by half, the original steel studs were replaced with wood 2x6's, and many of the desired finish materials became unaffordable. Also, the cost of achieving basic LEED Certification proved to be too high to be considered; however, could a Silver rating have been possible, the university may have followed through with more than just a preliminary study.

Therefore, the proposed goal of this thesis is to look at many of the components of green design that could have feasibly been implemented into the project and to analyze the potential benefits of each against first cost and life cycle savings. It is hoped that after looking at all considered options acting together as a complete system, an optimal green design can be achieved, the most environmentally conscious design which minimizes first and operational costs while maximizing life cycle savings.

5. CONSIDERED ALTERNATIVES

5.1. Green Roof

Green roofing design is an exciting and growing form of green design which I was initially very interested in analyzing. A green roof system can provide better drainage, reduce heat island effect, and reduce building cooling loads, and LEED recognizes these benefits as well. At first glance, it would seem that this type of system would compliment this project very well.

Green roofs, however, are still a highly experimental form of design, as I have been learning in my independent study this fall with Dr. Srebric. We have been attempting to determine accurate characteristics of green roofs, such as R-values and rates of drainage, which would allow these systems to be better understood, more universally accepted, and designed with greater accuracy. With a slope of 30° and a desired aesthetic quality of a rural village, I have to question if this building would be a good choice for such a system. Drainage issues become more influential and slippage becomes a real factor. The cost of installing this system on the entire roof would seem to be intuitively prohibitive for such a small budget, and were such a system to be implemented, the building's structural system would have to be examined due to the greater weight of a green roof than conventional shingles. Also, it does not appear that the current research that I have been helping with will be finished until after this thesis must be complete, greatly limiting the actual analysis that I would be able to perform.

At this point, I have not entirely ruled out adding green roofs to the scope of this investigation. Perhaps after greater discussion of this alternative with my faculty advisor, an accurate method of analyzing the implementation of this system into the new student dormitory could be formulated.

5.2. Regenerative Dual Duct Ventilation System

The concept of a regenerative dual duct ventilation system was introduced to me by Dr. Mumma during class recently, and I considered the idea of comparing such a system to the current dedicated outdoor air system with energy recovery. This system is also very experimental, having been implemented in only a handful of schools according to a paper written on the subject by Dr. Mumma himself. It is a very complex all outdoor air system utilizing energy recovery, indirect and direct evaporative cooling, dual ductwork for cool and neutral air, and a great many controls. While the paper goes on to claim that the system is, in fact, very innovative and saves on a great deal of energy usage, it appears that there has been no substantial examination of the system as it affects economics, constructability, or maintenance. This fact coupled with the fact that the system would be extremely difficult to model accurately has forced me to conclude that such a system would not be beneficial to this investigation.

6. DEPTH WORK

I have decided to take the geothermal heat pump system under consideration as the main depth topic of this investigation. While I have defended this system in my previous technical assignments as being the best form of heating and cooling under the circumstances, the fact remains that such a system is very expensive, and as the focus of this thesis is to be the sustainability of the building as a whole based on overall first cost and life cycle savings, a system with such a great first cost must be analyzed to see if its benefits and life cycle savings warrant its adoption.

There are three other potential types of systems which I would like to compare against the geothermal system in terms of both system costs and total building costs: conventional air-source heat pumps rejecting heat to condensing units, water-source heat pumps rejecting heat to a cooling tower, and a relatively new form of heating and cooling, variable refrigerant volume (VRV) fancoil units, which also reject heat to condensing units.

VRV was introduced to me during my internship this summer, and it was the opinion of several of the engineers there that such a system could have definite benefits once it is better understood. It implements variable flow of refrigerant to provide simultaneous heating and cooling and can also achieve far greater lift than conventional systems. During my investigation, I will be looking at Daikin VRV units, as they appear to be the forerunners of this particular form of technology. More information about VRV can be located at the company's website as listed in my references.

Careful determination of the locations of the heat rejection apparatus would be necessary due to the aforementioned aesthetic requirements of the building, but I feel that a detailed comparison of these systems will prove to be a large deciding factor when the building is finally analyzed with regard to all proposed systems. The poor efficiencies of several of these systems might be offset by their overall savings in the long run, and I feel that in the interest of implementing other sustainable forms of design, the prohibitive first cost of the geothermal system might cause another choice to prove more favorable in this new light. Carrier's HAP will be used to perform the necessary calculations and energy and cost analyses.

7. BREADTH WORK

7.1. Mechanical

The current domestic hot water system utilizes natural gas as a fuel for heating the water in the hot water heater. As the university is focused on sustainable design, I propose to analyze the impacts of installing solar heat collectors at specific locations on the south-sloping roofs and using the collected energy to heat the domestic hot water.

This solar system would probably need to utilize refrigerant in the piping to keep the system operational in the winter, necessitating the addition of a heat exchanger, and analysis could prove the need for a larger tank or that a secondary form of heating might be needed for cloudy days. Using the methods and the knowledge gained from Professor Jae-Weon Jeong this semester, such a system could be accurately sized and its impact on the overall building cost determined. While the first cost of this system may make it less attractive, the energy and monetary savings could greatly outweigh the initial costs.

7.2. Lighting/Electrical

Along the same vein as the solar system mentioned above, a photovoltaic system for energy generation could also prove beneficial on this project. These PV cells would also be located at certain locations along the south-sloping roofs, and could be used to create storable electric energy, which could have various uses in such a building. Such a system could be used to charge or replace the battery backup on the emergency lighting in the building, guaranteeing greater reliability and less maintenance; however, this approach would require the wiring system of the building be analyzed in order to attach the electrical storage to the additional lighting. The electrical storage could also be used to supplement an electrical hot water heater connected to a solar heating loop on cloudy days or to defer some of the buildings electrical costs.

Once again, methods and knowledge gained from Professor Jae-Weon Jeong will be used to size this system effectively. It is my opinion that, while very innovative and sustainable, this system my also prove too costly in the short term to justify its inclusion at the end of this investigation.

7.3. Constructional

Because of all of the different systems that I am proposing and analyzing, it is going to be necessary to determine the first costs of each from a construction management point of view. The cost of installing the geothermal wells must be weighed against the costs of buying and installing condensing units or a cooling tower. Pricing must be done on both solar systems, as well as on factors such as additional wiring or the fact that the natural gas line might no longer be needed. Lead times might also be affected and must be looked at in order to determine how changes in the schedule might influence labor costs. In an analysis in which the main goal is to determine greatest overall benefit versus cost, the costs associated with construction management cannot be ignored and need to be taken into the larger scope in order to establish the most efficient, cost effective system for the new dormitory.

8. PRELIMINARY RESEARCH

- "Geothermal heat pumps." Consumer Energy Center. 12 Dec. 2006 <http://www.consumerenergycenter.org/home/heating_cooling/geothermal.html>.
- Liu, K. "Sustainable building envelope - garden roof system performance." RCI Building Envelope Symposium. New Orleans, LA. 5 Nov. 2004.
- Mumma, Dr. Stanley. Architectural Engineering. Dept. home page. 2001. Pennsylvania State University. 12 Dec. 2006 <http://doas-radiant.psu.edu/>.
- Mumma, Dr. Stanley. "Innovation examination - a closer look at a new idea." *Engineered Systems*. pp. 48-56. April 2004.
- "VRV System." Daiken Tanzania Limited. 12 Dec. 2006 <http://www.daikintanzania.com/vrv.asp>.

APPENDIX A - TENTATIVE SCHEDULE

The following is a tentative schedule of my proposed workload next semester. The schedule is subject to change.

Table A.1 - Tentative Spring Schedule

Week		Task
1	Jan. 15 - Jan. 21	Begin Research on Geothermal and Conventional Systems
2	Jan. 22 - Jan. 28	Comparative Analysis of Heating / Cooling Systems
3	Jan. 29 - Feb. 4	Comparative Analysis of Heating / Cooling Systems
4	Feb. 5 - Feb. 11	Preform Research of Solar / Photovoltaic Systems
5	Feb. 12 - Feb. 18	Develop Solar Heating System
6	Feb. 19 - Feb. 25	Develop Photovoltaic System
7	Feb. 26 - Mar. 4	Begin Creating EES Model to Combine Systems
8	Mar. 5 - Mar. 11	Deal With Other Unresolved Issues
9	Mar. 12 - Mar. 18	Spring Break
10	Mar. 19 - Mar. 25	Catch Up / Preform Construction Management Cost Analysis
11	Mar. 26 - Apr. 1	Finish Optimization Model on EES or Other Program
12	Apr. 2 - Apr. 8	Finish Research and Analyses
13	Apr. 9 - Apr. 15	Write Final Report
14	Apr. 16 - Apr. 22	Finalize Thesis report
15	Apr. 23 - Apr. 29	Thesis Presentations
16	Apr. 30 - May 6	Finals