

# Calvin College HVAC and Physical Plant Design Project

Fall 2005

Engr 333

Prof. Heun

Calvin College is in the process of designing a new campus wellness center to replace the existing Fieldhouse complex. The wellness center is to be completed in three phases by late 2008. The college is working with GMB (Holland, MI) on specifications and designs for building systems. Two significant challenges faced by designers are directly related to mechanical engineering concepts that we have either studied in previous courses or will be studying this semester: (a) design of the Heating, Ventilation, and Cooling (HVAC) systems for the wellness center itself and (b) design of upgraded campus power and steam system infrastructure (physical plant) to provide electricity and heat to the new wellness center and future campus buildings. Additional challenges are provided by recent increases in costs for natural gas and electricity. (For example, the price the college pays for natural gas has doubled in the past year.)

The requirements for the HVAC system include providing heating in the winter, cooling in the summer, and dehumidification for the entire complex, including the aquatic center. Requirements for the physical plant include developing enough heating and electrical power capacity for the wellness center *and* additional building projects in the future, providing an appropriate level of redundancy in the physical plant, and developing easy-to-maintain infrastructure that integrates well with existing campus facilities. All systems must meet current building codes. The designers must simultaneously meet these requirements and achieve both energy efficiency and cost effectiveness.

Your challenge for this semester-long project is to develop realistic designs for the wellness center HVAC system and upgraded physical plant infrastructure.

Your deliverables are

- (a) a single final report (for the entire class) that proposes a feasible plan for achieving your objectives,
- (b) two posters to be presented at the Calvin Environmental Assessment Program (CEAP) conference on **Thursday, 1 December 2005**, and
- (c) a departmental seminar given by the class on **Friday, 2 December 2005**.

Elements of your proposed plan should include:

- Evidence of thorough research into technology options for achieving the stated objectives, including print and online resources and personal interviews and contacts
- A schedule showing a timeline for construction of facilities
- Proposals for locations of any new facilities required to meet the goal
- Detailed documents describing the design of the HVAC and steam/power systems
- Detailed documentation showing that the proposed systems will meet college requirements
- A realistic plan to finance capital projects
- A financial evaluation of the economic advisability of your design plan. The timeline for this financial analysis should be 30 years.

The customer for this design analysis project is Calvin's Vice-President for Finance, Henry DeVries.

The ENGR 333 section will be divided into 5 groups of 5 students each. (One group will have 6 students.) One group will be an "integration" group, responsible for overall planning and structure of the

project. Two groups will focus on the HVAC system, and two groups will focus on physical plant infrastructure.

The responsibilities of the integration group could include

- Quantifying and communicating Calvin's current and potential future energy usage (steam and electricity) to the other groups. This will allow the physical plant groups to "size" their electricity and steam production facilities.
- Working with the HVAC and physical plant groups to obtain cost, efficiency, and site information for various technology options.
- Investigating options to reduce energy usage on campus and therefore reduce capital costs for physical plant improvements. (Options might include installation of double-glazed windows everywhere on campus, green roofs, etc.)
- Developing energy conservation programs for the campus as both an annual energy cost-saving measures and a means of reducing the up-front cost of new Physical Plant systems. Programs should include a significant communications option.

The responsibilities for the HVAC groups could include

- Parameterizing the costs and efficiencies of various HVAC system options as a function of heating/cooling capacities and communicating this information to the integration group.
- Specifying heating and air-conditioning equipment to be purchased and installed in the wellness center.
- Gathering cost information for the HVAC systems.
- Projecting the performance and energy usage of the specified HVAC systems.
- Identifying the in-building space requirements for the HVAC systems.

The responsibilities for the Physical Plant groups could include

- Identifying the site needs for physical plant technologies and assessing the impact on Calvin's physical resources.
- Specifying steam and power equipment to be purchased and installed as part of the upgraded physical plant.
- Gathering cost information for physical plant systems.
- Developing financing proposals for electrical power and steam technologies, including loans, incentives, and grants.
- Defining cost tradeoffs including effect of replacing existing, inefficient boilers; balancing up-front energy-efficient investments in the new buildings against long-term energy cost expenditures; building heating cost tradeoffs for reducing temperatures for closed-campus periods (like Christmas vacation).

The first tasks for each group will be to focus your area of inquiry for the project and develop a schedule for your work this semester.

All groups must perform thermo-economic analyses in their area of responsibility; that is, there must be both thermodynamic (broadly construed as conversion of energy from one form to another) and economic components to your work.

All groups must arrange a tour of Calvin's existing physical plant facilities (including the co-gen plant) with Paul Pennock (see *Resources* below).

There will be three short, in-class progress reports in the form of oral presentations. There will be one in-class final presentation that summarizes the results of the Calvin design project. Each student must give one of the presentations. The presentations must be professional quality, must concisely report your progress, and provide sufficient technical detail for peer and professor review of your progress.

The in-class progress reports must include the following elements:

- Status relative to your schedule (and any re-planning that has occurred since your last report)
- Work accomplished since your last report (including technical details)
- Issues or concerns (and plan for addressing them)
- Work planned for upcoming reporting period

The final in-class oral report should provide the final technical details of your analysis, how your technical analysis was used in the final plan for your group, and the final conclusions for your group.

Bring printed copies of your presentation for guests and the professor.

The written final report should follow the technical memo format, including a two-page summary with conclusions. The integration group is responsible for the introductory two pages. Each group (integration, HVAC, and Physical Plant) should provide a detailed appendix (in technical memo format, of course) to the overall technical memo that describes the analysis performed and the proposals developed by the group. Students will be graded on the quality of their group's contribution to the overall effort of the class.

As stated above, the audience for the final written report is the Calvin College Vice President for Finance, although the final grade will be assigned by the professor. Your final report will consist of

- (a) a paper copy of a technical memo with extensive appendices and
- (b) electronic copies of any programs or analysis tools that you developed during the project.

You must distribute copies of your final report to the VP for Finance, your resources (see below), and the professor. You must also send a note of appreciation to your resources for their assistance during the semester.

- Resources:
- Paul Pennock, Calvin Physical Plant: contact for physical plant tours and general physical plant information  
(616) 262-9230 (mobile)  
pennockp@aol.com (email)
  - Henry DeVries, VP for Finance, [hdevries@calvin.edu](mailto:hdevries@calvin.edu), 6-6148
  - Jim VanderVeen, GMB Associates, (616) 796-0200, [jimv@gmb.com](mailto:jimv@gmb.com)
  - Dan Slager, Calvin Physical Plant: contact for finance and purchasing information  
(616) 526-6267  
[slagda@calvin.edu](mailto:slagda@calvin.edu)
  - Classroom learning on exergy, economics, and thermal analysis
  - Prior laboratory and lecture classes

Group selection will be conducted by the professor. To apply for one of the available positions, prepare a cover letter and resume and turn it in to the professor by **Monday 12 Sept 2005**. Your cover letter should indicate your interest in either an integration position, and HVAC position, or a Physical Plant position. Below are the job postings:

### *HVAC and Power Systems Integration Engineer*

The Advanced Thermal Design group at Calvin College requires part-time work on system design for an HVAC system for a proposed new Wellness Center at Calvin's Knollcrest Campus. Initial tasks will include (a) communicating current and potential future energy usage on campus, (b) working with HVAC and physical plant engineers to obtain cost, efficiency, and site information, (c) developing ways to reduce energy costs on campus.

Successful candidates will have excellent group communication skills, three years of undergraduate experience focused on Mechanical Engineering, and a strong desire to provide system-level engineering expertise to a challenging and dynamic engineering group. Candidates must already be enrolled in ENGR 333 for the Fall 2005 semester. Apply if you desire professional growth through an innovative R&D project. Equal opportunity employer. Participate in creating your own future.

### *HVAC Systems Engineer*

The Advanced Thermal Design group at Calvin College requires part-time work on HVAC system design for a proposed new Wellness Center at Calvin's Knollcrest Campus. Initial tasks will include (a) finding costs and efficiencies for various HVAC system options, (b) equipment specification for new campus buildings, (c) predicting energy usage of the campus over time, and (d) identifying in-building space requirements of HVAC systems.

Successful candidates will have excellent group communication skills, three years of undergraduate experience focused on Mechanical Engineering, and a strong desire to provide system-level engineering expertise to a challenging and dynamic engineering group.

Candidate must already be enrolled in ENGR 333 for the Fall 2005 semester. Apply if you desire professional growth through an innovative R&D project. Equal opportunity employer. Participate in creating your own future.

### *Physical Plant Systems Engineer*

The Advanced Thermal Design group at Calvin College requires part-time work on Physical Plant system design at Calvin's Knollcrest Campus. Initial tasks will include (a) identifying site needs for physical plant infrastructure upgrades, (b) selecting equipment to be purchased for upgraded physical plant systems, (c) gathering cost information for physical plant systems, (d) developing financing proposals for power plant systems, (e) evaluating cost/energy efficiency tradeoffs for investments in new buildings.

Successful candidates will have excellent group communication skills, three years of undergraduate experience focused on Mechanical Engineering, and a strong desire to provide system-level engineering expertise to a challenging and dynamic engineering group.

Candidate must already be enrolled in ENGR 333 for the Fall 2005 semester. Apply if you desire professional growth through an innovative R&D project. Equal opportunity employer. Participate in creating your own future.

To apply for these positions, send your resume by Monday 12 September 2005 to:

Prof. Matthew Kuperus Heun  
Engineering Department  
Calvin College  
Grand Rapids, MI 49546

# Calvin ENGR 333 Design Project Schedule (2005)

Class meets MTWF 12:30–1:20 in NH053

Day	Date	Activity
Fri	9 Sep	Calvin Design project introduction, objectives, deliverables
Mon	12 Sep	Cover letter and resume due
Tue	13 Sep	Group assignments announced
Tue	13 Sep	Calvin Design project work
<b>Tue</b>	<b>20 Sep</b>	<b>In-class group presentations (7 minutes + 2 for questions) Report on objectives, work schedule, and proposed analysis approach</b>
Tue	27 Sep	Calvin Design project work
<b>Tue</b>	<b>4 Oct</b>	<b>In-class group presentations (7 minutes + 2 for questions) Report on analysis performed to date</b>
Tue	11 Oct	Calvin Design project work
Tue	18 Oct	Calvin Design project work
<b>Tue</b>	<b>1 Nov</b>	<b>In-class group presentations (7 minutes + 2 for questions) Report on preliminary results</b>
Tue	8 Nov	Calvin Design project work
Wed	16 Nov	Calvin Design project work
Fri	18 Nov	Calvin Design project work
Mon	21 Nov	Calvin Design project work
Tue	22 Nov	<b>Calvin Design project final presentations (13 minutes + 2 for Qs)</b>
Wed	23 Nov	<b>Calvin Design project final presentations (13 minutes + 2 for Qs) Report on final results</b>
<b>Thur</b>	<b>1 Dec</b>	<b>CEAP Poster Session</b>
<b>Fri</b>	<b>2 Dec</b>	<b>ENGR Department Seminar</b>
Thur	15 Dec	Design project final written report due at 4:30 PM