

The TCNJ Energy Effort: Applications to Thermodynamics Courses

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Abstract

The College of New Jersey (TCNJ) is a small primarily undergraduate institution currently offering degrees in mechanical engineering, electrical engineering, and computer engineering, as well as engineering management. Due to its small size TCNJ does not have a specialization or program track in the power or energy areas. Lack of student and faculty interest as well as the perception that power was not a “hot” or growing field had created an atmosphere of indifference regarding energy issues common to institutions across the nation. However, through the combined efforts of the college facilities staff and the Department of Engineering a program of energy education and student activities has been initiated which has quickly grown into a robust component of the engineering program and campus. The purpose of this paper will be to describe the TCNJ Energy Effort and its application in existing thermodynamic courses. It is hoped that the success of this effort will serve as a guide and inspiration for other academic institutions and programs to revitalize interest and education in energy issues.

Introduction

The prosperity of the United States is due in no small part to the abundance of energy. Yet at the same time a reliance on oil generates complicated political problems. Methods of generation bring up environmental and health dilemmas. Managing such a critical infrastructure also challenges both business and government with great responsibility. For such an important topic relatively few have a superficial, let alone in-depth, understanding of it.

This can be said to be true for those trained in science and engineering as well; fields intimately associated with energy. In the author's opinion, many students and faculty do not see energy as a "hot" field. Some opinions that have been expressed are that it is not a high paying field, it is not a growth field, nothing new is being done, and other technology areas are more exciting. This situation creates a potential for misfortune. An example can be found with the nuclear engineering field. In recent years enrollment has been down as many nuclear programs have closed their doors. At the same time the combination of a retiring nuclear workforce with the extension of nuclear plant operating licenses and the possibility of future plant construction leaves the nuclear industry with a potential shortage of qualified applicants for vacant positions.

In a climate of energy indifference and tight budgets it is difficult to initiate major renovations of energy education or get new initiatives off the ground. Some schools still maintain energy titled specializations and energy related programs or groups, however, many institutions, especially smaller ones, do not currently have an organized energy program. This paper will present how one institution is overcoming the obstacles and what they have learned along the way.

TCNJ Energy Effort

The College of New Jersey (TCNJ) is a small, primarily undergraduate, public institution in Ewing, NJ. Having started as a teachers college in 1855 there continues to be a strong emphasis on teaching and student involvement. One of the seven schools on campus is the School of Engineering which currently offers ABET accredited degrees in mechanical engineering, electrical engineering, and computer engineering, as well as engineering management. When the author joined this institution in 1999 there was little to no emphasis on energy topics. At the same time a new Director of Facilities was hired for campus who had an extensive history in the power field. With a common interest to get engineering students involved with the campus power house events were set in motion. Through effort and seized opportunities a collaboration now exists which is referred to as the TCNJ Energy Effort. The effort has grown into a robust component of the engineering program and has begun to expand its activities to the rest of campus.

The TCNJ Energy Effort is named appropriately in that it is not a structured program or research group. It does not have an assigned staff or budget. No additional courses are devoted to energy or power. Since nothing is asked of the college administration nothing is expected. The effort has a high degree of flexibility while maintaining limited exposure to budgetary or administrative decisions on campus. It is an endeavor sustained through the desire and personal effort of faculty, staff, students, and industry representatives. As such the scope of its activities is constrained. The effect, however, can still be quite large, particularly with an institution the size of TCNJ.

Activities can be grouped into two categories; 1) those that are specifically desired and 2) those that are opportunistic. Generally speaking the effort has four governing goals which these activities seek to address:

- encouragement and preparation of engineers entering the energy field
- introduction of engineering students to energy issues and relationships
- support the local energy/power industry
- educate the public to increase energy awareness

The activities are also selected with certain guiding principles. Namely that the scope of any item should be such that it violates the stealth approach and activities are cost free or self-funding. In addition, there is a strong desire to emphasize items that promote real world interaction and learning through personal experience.

Current Activities

The TCNJ campus is powered by a gas turbine co-generation system. Steam and chilled water from absorption coolers provide climate control for the buildings on campus. Several buildings are also equipped with geothermal wells. This provides students with the possibility for exposure to a wide variety of equipment and energy functions. Based on this the initial activities of the effort were intentionally sought after; the creation of facilities tours and a student intern program at the power house.

Engineering thermodynamics is a course that can become dry and boring to students unless real life applications are discussed. To supplement the course tours of the campus power house were begun. During the tour facilities engineers explain the purpose of the plant and the advantages to co-generation on campus. Students get to see the control room, gas turbine, steam generators, and absorption coolers. As a concluding activity to the semester the tour has received great interest from the students and has become a favorite part of the course. To continue this real world effect in the Thermodynamics II course a tour was taken at the Salem nuclear plant in southern New Jersey. The tour was arranged through the TCNJ student section of ASME and was attended by approximately a dozen students (this was limited due to restrictions at the plant). Future tours to Salem and other locations are anticipated. The region is rich with unique HVAC and power generation facilities to draw upon.

The second phase of activity was establishing the intern position at the power house. Initially, the college approved funding for a single student intern over the summer. However, due to the success of the first student the college allocated additional funding for a second student and expanded the program throughout the school year. Students have since been assigned actual engineering duties and exposed to real world problems. Contact with contractors is heavily promoted and some students are able to take advantage of training courses. With the help of these students the TCNJ campus has since received the Energy Star award from the Department of Energy for being an exemplar of energy efficiency through co-generation. The intern program is heavily promoted and discussed during both the Thermodynamics I and II courses. To date the students who have been hired were all initially exposed to the program and the power house through the Thermodynamics I course.

As a next step, the natural extension of the intern program was inclusion of senior projects. Engineering students at TCNJ are required to perform a two semester comprehensive design project their senior year. For the first time engineering faculty and facilities engineers have teamed to advise several students. Two of the interns have joined to work on the analysis and redesign of the HVAC system for one of the student townhouse complexes. This is an actual project the Facilities Department was intending to undertake. It is anticipated that the final result will be given directly to contractors for implementation. A third student, who also interned at the plant for one semester, is currently working on a senior project to help develop part of an energy management plan for campus. Whereas the first two students are mechanical engineering majors this student is in management engineering.

The American Power Conference (APC) is held annually in Chicago, IL. In conjunction with the conference the Sponsored Student Faculty (SSF) program allows students and faculty to

attend conference sessions and activities designed to expose students to the energy industry. These activities include several roundtable sessions, a question and answer session with industry, guest speakers, and access to the industry exhibition. Sponsors provide the funding which covers registration and travel to the conference for these students. With the assistance of the facilities staff several local sponsors were located from campus contractors (Air Engineering) and local utilities (PSE&G). Two students and one faculty member attended in 2001. The conference had a great influence on these students. Both students interned in the power field the following summer and are now involved with energy related senior projects. The students who attended in 2001 and those registered for 2002 were all attracted through the Thermodynamics II course.

Following the above successes an evening event was planned so that engineers, sponsors, and students could gather socially. This provided a chance for sponsors to hear about the experiences of the APC attendees and to find out about other student projects on campus. Students not already involved in the effort were encouraged to attend, especially freshman and sophomores who would be likely interns and conference attendees in the future. Donations from industry, staff, and faculty members present allowed the student meals to be subsidized. The dinner received great attendance and support making it a new annual event. Along the same lines Fall 2001 marked the first issue of the Energy Tidings newsletter. This publication is intended to showcase student work in and outside of class related to the power industry. The first issue contained articles written by the Facilities staff, students, and faculty.

While some activities are actively promoted others are very opportunistic. For instance, each summer TCNJ hosts a Collegebound program funded by the state. This program is for high school students from “economically disadvantaged” school districts. The students are exposed to a range of disciplines and experiences over the five week session. Last year the engineering course for upcoming 11th graders was without an instructor. The author volunteered for this activity and updated the course based on a preexisting energy systems topic. Students were exposed to various aspects of energy production and use, had guest lectures from engineers and interns, toured the campus power house, and used computer simulations of power plants to get a hands-on feel for the topic.

Another opportunistic activity is independent study. Independent study presents the easiest way for students to make up one or two missing credits. Many students have now been exposed to basic energy topics in the thermodynamics courses. By structuring a course format that covered the basics of energy systems and allowed independent research on a topic of the student’s choosing a highly sought after independent study option was then created. Standard lecture notes and links to information have been placed on the web so that students can work at their own pace and research what interests them. This also saves time on the instructor’s part.

Occasionally other items arise which are tailor made for the effort. Each year TCNJ chooses a topic of conversation for the Community Learning Day. For this event campus activities, guest speakers, and panel discussions are organized along a common theme. The 2001-2002 theme is “Sustainable Communities”. A panel session was put together on the topic of “Tradeoffs in Energy Production and Use” as part of day’s events in October. Speakers from the nuclear field, renewable energy, and a local utility described the benefits and social costs of different forms of power production. The tradeoffs associated with the public’s power decisions were then

discussed. The session was very well attended with the majority of attendees coming from outside engineering.

Lessons Learned in General

There are several lessons that have been learned from these experiences. The most important is that having a power program/degree or being a large university is not necessary to foster student and public energy education. The critical factor appears to be a flexibility and willingness to seize opportunities. There are many resources available for energy education. Even at a smaller institution such as TCNJ there is a wide selection of library literature, numerous alumni in the field, and industrial collaborations. It is important to learn to recognize these options and opportunities.

By proper selection of activities to pursue additional opportunities will present themselves. At the same time it is important to choose the activities that are promoted carefully. It is important not to embrace every opportunity. Since the TCNJ effort could be described as “volunteer” work it would be easy to become overextended.

If the flexible and often times random nature of the activities can be accepted the next biggest obstacles are sustaining and balancing the effort. This is an issue that is currently being addressed at TCNJ. Having plenty of activities to choose from does not appear to be a problem. However, the activities are not well balanced by discipline. The majority of student involvement to date has been with mechanical engineering students. It has proven much harder to interest electrical students in the effort. More work must be done in this area to better balance the activities and participation.

It has been found that some activities are achievable by students alone. For instance, the Energy Tidings newsletter is written largely by students and will in the future be printed and mailed by students. However, many activities require a faculty coordinator. While there are many individuals in industry who are willing to support students they still have to be asked to do so. Therefore, a pressing concern is the overall “management” of the effort in the future. Since the effort is not organized as a program with a Director or Program Head a creative solution remains to be found.

Lessons Learned in Thermodynamics Courses

The Energy Effort activities that have been described interact nicely with existing thermodynamics courses. In most cases minimal amounts of time are taken from the normal class coverage. The two greatest benefits that all students receive are exposure to the real life power environment and increased discussion in class. Even minimal efforts at providing outside of class opportunities, such as the American Power Conference and Community Learning Day, spark in-class questions and discussion. This not only causes students to be more involved in class but allows them to explore the social relevance of thermodynamics.

Support is a two-way road. The TCNJ Energy Effort would not exist without the student interactions within the thermodynamic courses. While the activities described are open to all

students those currently enrolled in a thermodynamics course make up the majority of the “audience.” Interns and conference attendees are drawn heavily from these courses. Panel and guest speaker sessions gain attendance from promotion in class. In addition, the Energy Tidings newsletter is now locating authors and future articles through the Thermodynamics I course. In one case a course assignment is being modified slightly and used as a future article.

What the Future Holds

With an institution the size of TCNJ only so many activities can be supported in the effort. However, there is one area in which more involvement is desired; public education. TCNJ has a long history as a teaching college and routinely receives funding for K-12 teacher training initiatives. A nice addition to the program would be teacher training for the region’s K-12 teachers. This offers a wide ranging result for the least effort. Several workshop topics are currently being examined including one on radiation organized by the American Nuclear Society (ANS). The possibility of using undergraduate assistants in these programs is being explored. For the types of material covered it is likely that these students will be drawn from existing and previous thermodynamics courses.

For the already established activities constant “maintenance” is also necessary. This largely involves personal contact. As students graduate new ones must be exposed to the effort. The new students must be encouraged to explore the topics and take advantage of the possibilities. Current industry contacts must be refreshed and new ones constantly found in order to keep the effort up-to-date and dynamic.

In conclusion, the TCNJ Energy Effort has proven to be a very worthwhile endeavor. It is not something that can be done alone and the author is fortunate to have the assistance of many dedicated and very qualified individuals. While the format of the effort requires a small sacrifice of personal time the payback in terms of increased energy awareness and student success has been vast.

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