Leveraging Campus Resources for HVAC Laboratory Development

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Abstract

The purpose of this paper is to explore innovative opportunities for stretching limited university resources for laboratory development. The context of this discussion is an ongoing renovation project in the Applied Energy Laboratory, which is part of the Mechanical Engineering Technology Department at Purdue University. A relatively small initial capital investment by the University has been leveraged to provide more than $150,000 worth of heating, ventilating, and air conditioning equipment. In the near future, continuing education short courses are expected to help this facility become nearly self-sufficient.

Laboratory development is never complete

Facilities engineering has become an important career option for many Technology students. The continuing boom in industrial and commercial construction has helped create a strong demand for technicians who operate and maintain mechanical systems in modern commercial buildings. In fact, a recent report published by the American Society of Mechanical Engineers shows that facilities engineering will be one of the fastest growing technical careers over the next ten years.[1]

Maintaining a modern heating, ventilating, and air conditioning (HVAC) laboratory for teaching tomorrow's facility engineers is an ongoing challenge. Technology constantly changes, necessitating regular upgrades to laboratory equipment. Although there have been modest improvements to pumps, fans, and other HVAC components over the past 20 years, there has been a tremendous revolution in how these components are operated and controlled.

Like all areas of technology, microprocessors have dramatically improved HVAC system performance. Building automation systems, which feature a user-friendly personal computer interface, monitor and control all mechanical equipment. Sophisticated computer algorithms optimize energy efficiency by modulating heating and cooling depending upon the time of day or level of human occupancy. Fire suppression, alarms, and lights are frequently an integral part of a comprehensive building automation package.

The Applied Energy Laboratory, which is part of the Mechanical Engineering Technology Department at Purdue University, has struggled to remain up-to-date. This twenty-year-old instructional facility includes a forced air system, a hydronic system, and solar collectors. All components are linked to an environmental chamber so their performance can be precisely evaluated. By 1995 this facility was showing its age. The basic mechanical equipment was fully operational, but the 1970's vintage control systems were unable to achieve precise control of temperature or humidity.

Preliminary plans for modernizing the Applied Energy Laboratory began in 1996. This large project was completed in three phases. Phase 1 upgraded the lab's forced air system and was completed in the summer of 1997.[2] Phase 2 renovated the lab's hydronic system and was completed in the summer of 1998.[3] Figure 1 illustrates the recent Phase 3 project, which added digital controls to the Applied Energy Laboratory's solar collector system.[4] Old pumps, heat exchangers, and solar collector panels were replaced, while sensors, electronic valves, and a variable speed drive were wired to a digital control panel.

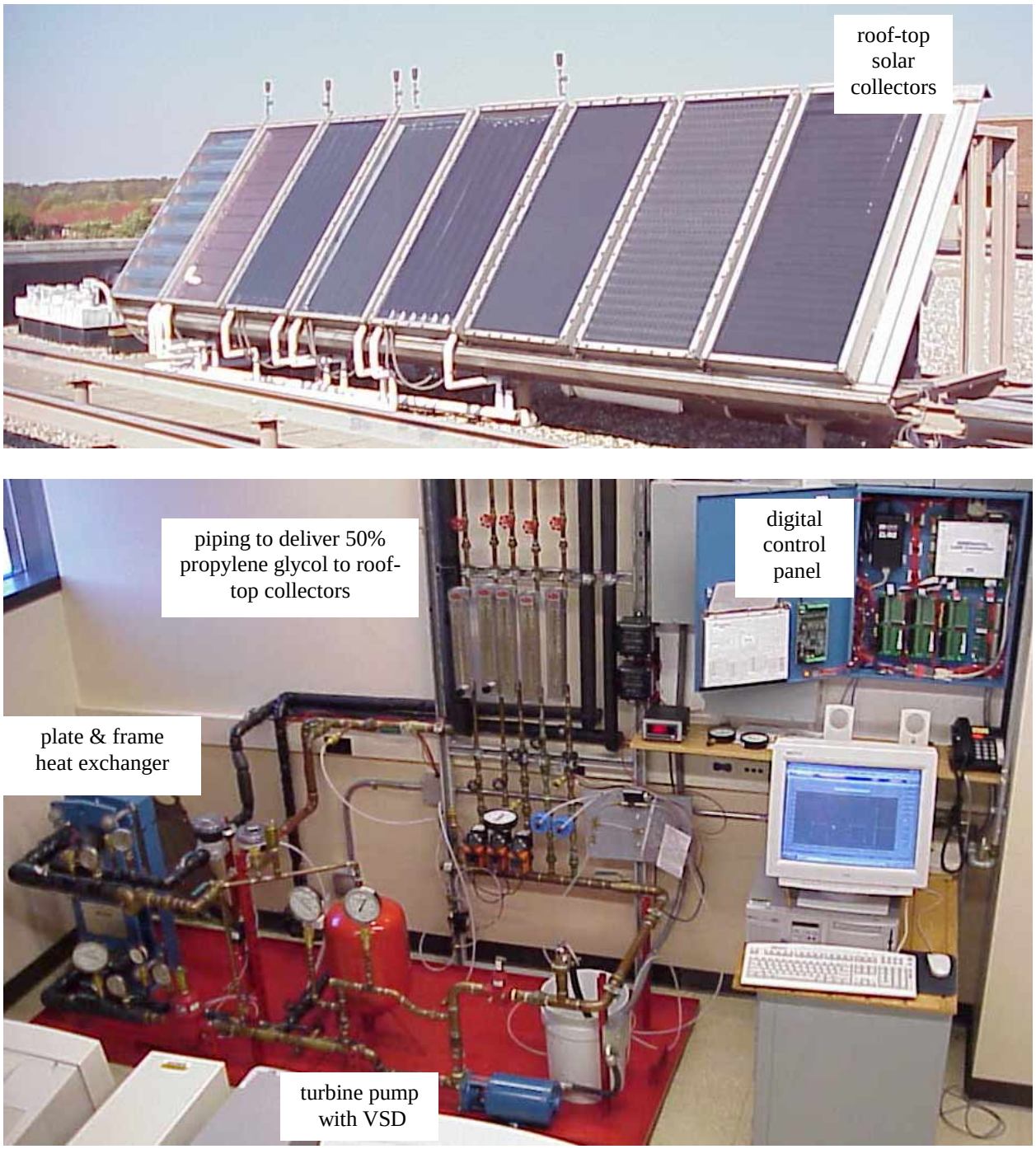

Figure 1. Renovations to the lab's solar collectors cost nearly $30,000.

Improving the laboratory equipment posed many technical challenges, but by far the biggest hurdle was financing this large project. Table 1 summarizes the capital expenditures for each phase of the renovation. The price tag for the entire project exceeded $163,000, which is well beyond what Purdue University was willing to support. The costs do not include labor, since the MET Department's technicians completed most of the work. Unfortunately, institutional resources almost always constrain the quality and quantity of technology in student laboratories.

Table 1. The cost of equipment for renovating the Applied Energy Lab was about $163,000.

Project	Cost of Capital Equipment	University Support (% of equipment cost)	Corporate Donation (% of equipment cost)
forced air system	$53,000	15	85
hydronic system	$53,000	14	86
solar collectors	$30,000	45	65
personal computers	$27,000	100	0
totals:	$163,000	34	66

The initial funding to modernize the Applied Energy Laboratory was crucial, but additional recurring funding is still needed to keep the facility at state-of-the-art. Consider the personal computer, which has become a basic tool for HVAC work. A five-year-old personal computer is inadequate for most new building automation applications. To be successful, the lab's development plan must identify and develop long term funding sources.

Show me the money!

The key point of this paper is to point out the unique relationship between most universities and HVAC manufacturers that strongly encourages corporate donations to student laboratories. Universities are huge consumers of HVAC equipment! Purdue University operates more than 150 buildings on its West Lafayette campus and many more across the state of Indiana. All of these buildings have HVAC equipment and most are computer controlled. The money spent for facilities operation and maintenance is a significant portion of Purdue University's billion-dollar annual operating budget.

The simple truth is that most HVAC manufacturers, including building automation vendors, are anxious to have their products seen and used on college campuses. Universities are a lucrative long-term revenue source. Donating hardware and software to a student laboratory is one good way for a technical salesperson to get a foot in the door. It is a good business decision to donate equipment for use by faculty and students, particularly when most contributions are tax deductible.

As reflected in Table 1, renovations to the Applied Energy Lab took full advantage of the generosity of HVAC manufacturers. Corporate donations totaled approximately 2/3 of the estimated $163,000 total renovation cost. Table 1 also shows that donations of personal computers, which have become an everyday commodity, were hard to come by. The university financed the entire cost of new personal computers for the Applied Energy Laboratory.

To fully exploit the relationship between HVAC vendors and universities, academic departments must maintain a close working relationship with personnel from the operations side of the university. Surprisingly, many HVAC faculty members have very little contact with their counterparts in facilities engineering. However, the personnel who operate and maintain the campus will know which manufacturers are likely to donate equipment. The facilities services staff at Purdue University has been instrumental in obtaining building automation equipment for our Applied Energy Laboratory.

It is also important to briefly mention some of the more traditional reasons for corporate support of laboratory development projects:

- Many companies are simply generous supporters of higher education. Donating equipment is one way of giving back to the community.
- Many companies recognize that today's students will become tomorrow's customers. Students begin to develop "brand name" recognition while they are still in school.
- Many companies are interested in enhancing the technical training of their future employees. It makes good sense to help maintain modern laboratories at universities where they recruit.

Maintaining HVAC Laboratories

In addition to teaching undergraduate students, modern laboratories facilities can be used for hosting continuing education short courses. These short courses can help provide the revenue stream to maintain the HVAC equipment. There is a huge external demand for building automation training. All new buildings have sophisticated computer controls, but there are very few opportunities for continuing education on this topic. The renovation of Purdue's Applied Energy Laboratory has specifically targeted this opportunity.

Interestingly enough, our first "external" customer will probably be Purdue University's Facility Services Group. Their need for computer-based facilities training increases with each new building or renovation project. A new Food Science building on the West Lafayette campus is a perfect example of a building with mechanical and electrical systems that are almost entirely computer controlled.

Figure 2 summarizes the idealized collaboration between corporate sponsors and the university for renovating the Applied Energy Laboratory. An initial corporate donation got the ball rolling and prompted supplemental support from the university. In our case, a donation of building automation hardware and software provided the cost sharing required to justify a university-sponsored summer faculty grant. Once laboratory development was underway it became relatively easy to leverage corporate donations into additional financial support from the university. This process has been repeated several times over the past five years. By fall of 1999 every major mechanical system in the student laboratory was near state-of-the-art, which makes this facility an attractive option for offering continuing education short courses. In the near future, we expect the Applied Energy Laboratory to become self-sufficient. In other words, corporate donors and continuing education seminars could provide 100% of the funding for maintaining and upgrading the laboratory equipment.

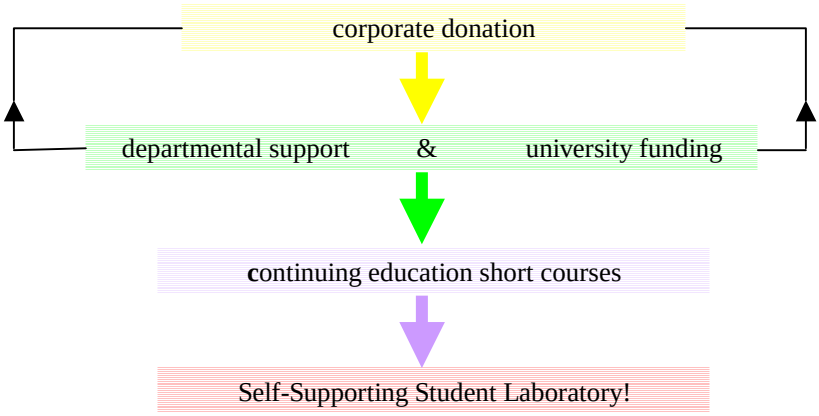

Figure 2. The ultimate goal is a self-supporting student laboratory.

Acknowledgments

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