THE NEXT GENERATION OF HVAC ENGINEERS AND TRAINING IN MECHANICAL ENGINEERING

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Abstract

Professionals in the Heating, Ventilating, and Air Conditioning (HVAC) industry have noted concerns regarding the appropriateness of the coursework offered at universities across the nation to students seeking an education in HVAC systems. At the core of this concern lies the issue of whether or not an adequate curriculum is being offered on a regular basis to these students at academic institutions since 1986. Very few large Mechanical Engineering Departments currently offer some energy related courses in their Mechanical Engineering curriculum for those students interested in entering the HVAC profession.

However, today's modern building technology encompasses a wide range of disciplines, and integrates the latest engineering technology in design, energy conservation, and energy management. Current computer technology (such as advanced building simulation software, and direct digital control systems) offer the ability to operate facility systems more effectively. Because there is a large demand for college trained professionals in the energy efficiency profession, energy educators must develop an academic program capable of meeting the challenge of equipping students with a repertoire which would allow them to function successfully in the modern building energy industry.

Introduction

Traditionally, the HVAC undergraduate education curriculum is provided by the Department of Mechanical Engineering. The department typically offers basic coursework, including all mathematics courses, computer courses, thermodynamics courses, fluid mechanics courses, and heat transfer courses. The HVAC courses include Thermal Environment Engineering or the Principle of Heating and Air Conditioning; which affords the necessary training in HVAC related designs and calculations. HVAC engineers are taught practical designs through on-the-job training. Studies [1, 2, 3] dated as far back as 1986, from the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE), the American Society for Engineering Education (ASEE), and the National Science Foundation (NSF) confirm that only a small number of schools provide an education in HVAC Systems that is considered comprehensive in its scope,

and depth. Thus, the plight of the HVAC education remained unaltered.

During the Tri-State Engineering Society meeting in the summer of 2002, author [4] presented a survey about the HVAC education in three Southern states. The findings from this survey indicated that two of the seventeen Mechanical Engineering Departments surveyed, offered only one technical elective course related to the HVAC courses required for engineers. The Mechanical Engineering Departments assessed in the survey were located in the state of Alabama, Arkansas, and Louisiana. Due to small number of graduate seniors that normally enrolled in this type of coursework, most Mechanical Engineering Departments are unable to offer the HVAC related courses. The survey was expanded to investigate universities with larger numbers of students enrolled in Mechanical Engineering Departments. This was accomplished through an internet search, which proved quite revealing. Of the top fifteen universities, with the most Bachelor degrees awarded in Mechanical Engineering, those students had the following HVAC training:

[1] Undergraduate Training

All fifteen schools focused on in the survey, have HVAC related courses in their Mechanical Engineering course description. The departments utilized the technical elective to furnish one to two HVAC courses during the student's senior year. A typical example was found in the curriculum at Texas A&M University, which had two HVAC related courses offered regularly

[2] Continuing Education

Many large universities make HVAC related courses available through various continuing education programs. For instance, at North Carolina State University, the Energy Management Certificate Program was offered. Numerous societies such as ASHRAE, and the AEE afford similar programs.

[3] Graduate Training

Each of the fifteen schools offer HVAC related courses in their graduate course description. Such as the Texas A&M University's Master of Engineering Program, in which graduate students are allowed to undergo HVAC coursework. HVAC courses are accessible via the Thermal Fluid Sciences option there.

Moreover, HVAC training is currently only extended at universities experiencing a large number of students enrolled in the Mechanical Engineering Program.

The Next Generation HVAC Engineers and Training

There are three major reasons to review the growing interest in the next generation of HVAC engineers and training. Specifically, the three reasons are technological considerations, energy

efficiency policies, and energy professional personnel. All three of these components are vital to reversing the grim HVAC education plight.

The first rationale for reviewing the growing interest in the next generation of HVAC engineers and training is that technological considerations [5, 6, 7] offer a greater degree of freedom to design and operate a facility system. Computer technology, such as Advanced Building Simulations Software, Life Cycle Costs, and Digital Control Systems impart this kind of innovation and efficiency. Additional training is needed for traditional HVAC engineers.

The second rationale for reviewing the growing interest in the next generation of HVAC engineers and training, is the energy efficiency policy resulting from the *Energy Policy Act of 1992 and Executive Order 12902*. This act stipulates that federal agencies be required to meet stringent energy efficiency targets mandated by the Executive Order [8]. In fact, most states have established state legislation to implement an Energy Conservation Measure (ECM) in all their state agencies.

The third rationale for reviewing this issue is that the demand for qualified energy professionals [9, 10, 11] capable of implementing the latest technology for ECM requires highly skilled HVAC Engineers able to design, operate, and maintain the facility. To achieve the energy savings, many Energy Service Company(s) (ESC) are formed. Therefore, the demand for recent college graduates in energy engineering is high.

The International Performance Measurement and Verification Protocol (IPMVP) overview [12] states *"if all cost-effective efficiency investments were public and commercial buildings in the United States of America, for example, efficiency project spending would roughly triple, and within a decade would result in a savings of twenty billion dollars per year in energy and water costs, create over one hundred thousand permanent new jobs, and significantly cut pollution"*. As an Energy Project Director and Energy Auditor for the past ten years, I have performed more than four hundred energy audits in governmental facilities, universities, health care organizations, public schools, and private industry buildings. Two commonalities are usually found in all these structures. One commonality usually found is that most facilities have not yet implemented the use of energy efficient technologies, due to budget constraints. The second commonality is that the performance contract provided by the Energy Service Company (ESCO) normally launches many Energy Conservation Measure(s) (ECM).

Nonetheless, many older HVAC engineers and building managers do not have the latest training to properly operate and verify the amount of energy savings. Conventional HVAC engineers require further knowledge of the most recent energy industry developments to fulfill their job function. With respect to the building energy conservation, one may consider the HVAC Engineer's title to be equivalent to the new title of *Energy Engineers*, or *Building Energy Manager*.

Today's Energy Engineers or Building Energy Mangers must take a broader range of responsibilities, and accountability for the facilities they oversee. The job requirements for the middle and upper level of Energy Managers to manage a large facility, have multiplied greatly in

recent years. In addition to the demand for implementation of energy conservation, Energy Managers are obligated to develop a future plan that alleviates risk through alternate energy sources, financial derivative, and an overall plan of management. Further, these managers must develop requested proposals, supervise the construction, as well as provide measurement and verification of the energy savings.

Building Energy Systems Option in Mechanical Engineering

Based on the author's experiences regarding HVAC education, I have submitted a proposal to establish the ***Building Energy System Option*** in the Mechanical Engineering Undergraduate and Graduate Programs. A minimum of three technical electives in HVAC related courses should be taken by the student in their senior year. This proposal would encompass three typical courses, which are delineated below:

[1] The Fundamentals of HVAC

This course should address the basic design process of HVAC Systems. Additional topics include the indoor air quality and computer simulation.

[2] Building Energy Systems and Management

This course should focus on the energy conservation, alternate energy systems, energy management, and control systems.

[3] Senior Project

This course should emphasize hands-on project assignments in energy auditing, and Building Commissioning in university campus buildings.

Other available courses include Energy Control Systems, Alternative Energy Systems, Co-generation, Preventive Maintenance and Security, Building Constructing Project Management, and more. Coursework should be available at the graduate level. The author proposes a Master of Engineering in Building Energy Systems Option should be established to fill the void in advanced training for upper level energy managers. The Undergraduate Program, and the Master of Engineering Program in Building Energy System Option should strengthen the current HVAC educational system. These programs should be established in every state for selected universities, regardless of the enrollment size at the university. Additional highly skilled new Energy Engineers could be trained by the state university to reduce the shortage in existence at each state level.

Conclusion

The HVAC educational system is now in a transitional phase; wherein, universities must redefine their direction and strengthen their curriculum to ensure that training is adequate for the next generation of HVAC Engineers graduating from college. Societies such as the ASHRAE, ASME, AEE, NSPE, ASEE, NSF, and DOE should provide the necessary promotion and financial

support to ensure that Mechanical Engineering Departments can offer the HVAC related courses and conduct the Energy related research in their department.

References

1. Claridge, D.E., Feng, C.C., Kreider, J.F., "Research Needs in HVAC System Executive Summary", Proceeding Workshop on Research Needs in HVAC Systems, University of Colorado 1986.
2. Sherif, S.A., Sengupta, S., Kakac, S., Olsen, T., "Improving HVAC Education-A Case Study", ASHRAE, 1988, pp. 1390-1399.
3. Meredith, D.B., "Current Demand for HVAC and R Graduates.", ASHRAE TRAUS, Vol. 95, pp. 1178-1181.
4. Chen, Chu-Chen, "Modern HVAC Engineers and Training." *Tri-state Engineering Societies Annual Meeting*, June30-July 3, 2002.
5. Bushby, S.T., and Newman, M., "BAC Net Today", ASHRAE Journal, pp. 10-18, October 2002.
6. Chen, Chu-Chen, Rideau, H.M., El-Khatib A.M., and Joshi,G.A., "Vibration Diagnostic Analysis and HVAC Application", *The Third International Symposium on HVAC*, Shenzhen, China, Volume 2, pp. 850-856, November 1999.
7. Kohl, R., "Commissioning HVAC Control-Systems", ASHRAE Journal, 43 (12), pp. 27-50, December 2001.
8. Ginsberg, M., "New Directions in Federal Energy Management", 17th World Energy Engineering Congress, pp. 555-562.
9. Lobash, M., "Finding a Space in a Facility Career." Building Operating Management, February 2003.
10. Moriarta, Courtney, "The Next Generation of Energy Efficiency Professionals." State Energy Program, Rebuild America Conference, July 29-August 1, 2002.
11. Mumma, Stanley A., "HVAC: The Next Generation", Consulting-Specifying Engineer, January 2003.
12. The International Performance Measurement and Verification Protocol, http://pmvp.org.

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