The Development of Energy Efficiency Engineers

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ABSTRACT

This paper discusses my personal experience and the experiences of Michaels Energy with new graduate hires and pursuing quality candidates that can have an immediate impact without a long training period. It outlines the role of education in the development of energy efficiency consulting engineers and process and plant engineers. It will compare the skills of a typical candidate versus the skill set an ideal candidate possesses, and ideas to assist in producing better qualified graduates for this field.

These topics bring to light the possible need to have a path dedicated for energy efficiency through undergraduate and graduate school that is designed to improve the desired skills of new graduate hires.

The results should stimulate discussion on how to increase the number of students interested in energy efficiency and what universities can do to better prepare engineering students for careers in energy efficiency consulting.

Introduction

Shortly after I reviewed the panels for this year's Summer Study, I had the opportunity to start a new branch office for my company with plans on hiring three or four more engineers for that office. I started to look for and consider the types of people that I would want to hire. After reviewing quite a few resumes and conducting some interviews, it became apparent that qualified, or even capable, engineers are a rare find for this field. This sentiment was echoed throughout discussions with my managers, who are more experienced in the hiring process. As a result, I decided to share some of my thoughts about my education and the education of potential candidates to stimulate discussion on how to produce higher quality candidates for the fast growing energy efficiency (EE) industry.

Typical Energy Efficiency Engineer Candidates

The majority of candidates Michaels Energy and I have interviewed, and engineers that we have recently hired, followed the typical path for an HVAC designer. This path usually includes three or four classes that discuss HVAC fundamentals, HVAC design, and perhaps a thermal system design or fluid system design class. These courses are essential in producing a quality candidate for the HVAC design and the energy efficiency engineering fields. These candidates can usually hit the ground running in the HVAC design field, completing design work with minimal guidance on simple systems. More advanced systems require substantial on-the-job training, which is why four years of experience is a prerequisite for taking the PE exam.

Most of the candidates we talked to were unaware that the energy efficiency field even existed. So they concentrated on the design practices and didn't concentrate on retaining the fundamental knowledge required for energy engineers. We always ask candidates what courses they took throughout their education that they found the most beneficial, and the vast majority of

the time it is the two HVAC courses. Outside of these three or four courses focusing on HVAC design, most candidates also relay that the balance did not provide substantial knowledge specific to the design field. Of course this is not true, but it does show that the typical candidate relies heavily on design practices and not the fundamentals behind why the design practices work. We also ask about their lab experiences and what instrumentation they have used. Most have very limited experience with the types of instrumentation equipment commonly used in this industry, such as three phase power loggers or power analyzers.

While HVAC controls is an integral part of the HVAC world, the controls courses offered in most schools focus on dynamic systems and finding the stable points of many different types of control systems, and only briefly discuss thermal system controls. These classes do not go into complex HVAC control strategies. Complex strategies are covered as part of the HVAC design course. However, the design courses often only touch on the many controls schemes out there, as time is not available in these courses for any amount of detailed discussion on controls. The majority of controls training is taught in the workforce.

Like me, many of these candidates are instructed that they will be taught most of the design processes by their mentor at whatever company they end up working for, in part because every company designs a little differently. This may work well for the design field, where most engineers specialize in a building type or system, but it does not work as well in the energy field, where the types of systems that you come across are countless.

Ideal Energy Efficiency Engineer Candidates

The best skill an ideal candidate for the energy efficiency industry can have is a solid fundamental understanding of Thermodynamics, Fluid Mechanics, and Heat Transfer. The reality of these courses is that almost any problem, no matter how complex, can be solved with the combination of an energy and mass balance. Almost all of the equations in the textbook are derived from these laws. If a new hire understands this, he will be light years ahead of his peers.

Each candidate we interview is given a verbal test we affectionately call the "gauntlet," which is designed to test their fundamental knowledge in these fields. It includes questions like, "If the flow remains constant in a pipe and the diameter is halved, how much will the pressure drop increase?" This hinges on the energy balance associated with water flow through a pipe. A good candidate should be able to answer these types of questions right out of school.

The second most important skill they can possess is the solid fundamentals of HVAC design. The vast majority of HVAC knowledge is attained in the thermal, fluids, and heat transfer fundamental coursework, without specific mention to HVAC. The design knowledge comes into play when trying to analyze a system. The ability to understand what the designer was thinking and doing as he designed the system is crucial to being able to fully understand how the system is operating and why it is operating in that manner.

An ideal candidate has observed how these systems are installed and has hands on exposure to real HVAC systems, something that will be hard to integrate into any HVAC program or energy efficiency program. I attained this knowledge through two sources: working as a sheet metal apprentice installing commercial HVAC equipment, and through my graduate work in the Industrial Assessment Center (IAC). Most high quality candidates have seen complex systems through "field trips," sponsored by both professors and professional societies. This enables the candidate to see what can be changed in the field and to understand that changes will occur on almost every design. Sheet metal workers often use their knowledge of similar

systems to make modifications to the design to promote ease of installation and to correct issues unforeseen by the designer. These modifications can, but not always, reduce the efficiency of the system. Field trips can point out such modifications and also allow the students to see the size and complexity that these systems can reach.

Knowledge of how HVAC systems are controlled, both electronically and pneumatically, is also a desired skill. This is something I had a little exposure to and am still improving on. Most of this knowledge is passed on in the field, with only a mention of it in coursework. This is due to the fact that the design courses are full, with teaching design processes of both airside and hydronic systems, which is very important for both the HVAC design field and EE field.

Finally, a quality a good candidate would have experience with instrumentation and programming. This is covered in many of the labs. However, in my experience and from what I've been told by recent graduates, especially graduates focusing on HVAC design, we didn't take much away from these labs. Personally, I took a course in the Agricultural Engineering department that went a step farther and allowed the student to build a system with both an instrumentation side and a programmed control system. This tied in both controls and instrumentation and would be a great experience for any new hire aspiring to get into the field.

Differences

A typical candidate needs to be aware of what the desired credentials are for this field. The more a student believes they will use what they are learning, the more information they will retain. This relates to a lack of awareness of the option to pursue a career in energy efficiency. We believe that if a student is aware and wants to pursue a career in energy efficiency they will retain more of that knowledge because they know that they will use it in their career.

Hands on experience also makes a significant difference in the quality of candidates. The IAC is an extremely valuable program that develops outstanding candidates for the energy efficiency field and for the HVAC field, which is why graduates in these programs are actively pursued for employment. Other programs also exist that sponsor internships that can provide high quality experiences. Iowa, for instance, has a DNR program that provides internships for areas such as optimizing compressed air plants and air balancing. Hands on experiences such as these are often the only way students can see how important controls and instrumentation are especially in this field.

Possible Improvements

According to the Department of Energy's website, there are seven universities that have certificates or programs specifically designed around energy efficiency. On the contrary, almost every major university with an engineering program has an HVAC design program. As a metric, ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) has approximately 51,000 members and the AEE (Association of Energy Engineers) has roughly 14,000 members. This certainly cannot be used directly to correlate the number of energy engineers in the field, but it does show that the number of engineers in this field is not insignificant.

Students need to be aware that this field exists and it is a career option, which would help to produce higher quality candidates. Knowing this would allow the students to actively seek out the courses that will provide the greatest impacts on their career choice. Student advisors should

be informing the students that there is substantial demand for high quality candidates in the energy efficiency field and be able to guide them through the best courses. For our interns, we often recommend the best coursework to pursue following their internships, to try to maximize their education prior to entering the energy efficiency field full time.

The need also exists to expand HVAC courses to include more discussion on HVAC controls. At least one school I know of has already expanded their HVAC coursework by offering three courses, with the third course focused more on controls. Controls could also be covered as a portion of an energy efficiency course, and would need to address complex issues involving building operation, as well as other options for more energy intensive equipment such as compressed air equipment.

With most engineering programs exceeding in length a typical four year degree program, it is difficult to justify adding another course for one specific field. However, there are currently courses offered for other very specific industries, including robotics and internal combustion engines, to name two. With the rapidly growing energy efficiency field, it is time to think about adding an elective that focuses on energy efficiency. This would not only benefit the energy efficiency field, but also the HVAC and process engineering.

Programs that get the students into the field prior to graduation are very advantageous to the energy efficiency industry, and could be expanded or marketed better to the students. As noted earlier, field trips to view more complex systems in operation, or even in the construction stage, can be very beneficial to students. The IAC program that I participated in was an integral part of my education and allowed me to jump right into the industry with minimal training. Experience will come with the job, but any hands on training prior to entering the job market can be invaluable for both the HVAC design and the energy efficiency fields.

A candidate that possesses these ideal traits is difficult to come by and the majority of the well qualified candidates come out of a graduate degree program. This is most likely because additional coursework options were available and they have had exposure to larger, more complex problems. Finding a new hire that has all the ideal traits directly out of bachelor degree program may be difficult. Therefore, pathways through graduate school that focus on efficiency are very important in developing the next generation of energy efficiency engineers.

As with all specific fields of engineering, on the job training is very important and will still be required for any new hire, no matter how qualified they are. But by raising the level of awareness and adding more electives related to energy efficiency, the quality of the candidates coming out of the undergraduate programs could be increased. My opinions are echoed by the majority of our recently hired engineers and the engineers that hired me. I cannot say for certain that these recommendations will increase the percent of well qualified candidates by X amount, but offer my thoughts as a person who truly received a great education for this field.

References

Energy Education & Workforce Development http://www1.eere.energy.gov/education/colleges_universities.html

American Society of Heating, Refrigerating, and Air-Conditioning Engineers Membership Information. http://www.ashrae.org/members/page/589

Association of Energy Engineers Home Page http://www.aeecenter.org/i4a/pages/index.cfm?pageid=1