Theory into Practice: A Collaboration between Lipscomb and Trane

Miss McKenzie Caroline Lawry, Lipscomb University

McKenzie Lawry is a senior mechanical engineering student at the Raymond B. Jones College of Engineering at Lipscomb University.

Theory into Practice: A Collaboration between Lipscomb and Trane

This executive summary details a poster to be presented at the ASEE 2018 Annual Conference in the College Industry Partnership division.

Abstract

The Raymond B. Jones College of Engineering at Lipscomb University is currently building a relationship with Trane in Nashville, TN. This relationship between theory at the college and practice at Trane began to develop more heavily during the construction of the Fields Engineering Center on Lipscomb University's campus. The Raymond B. Jones College of Engineering had a vision to make their new engineering building not only a place to host learning, but also an environment that could be used as a learning tool itself. Trane, as an engineering company with a local Nashville office that has employed Lipscomb engineering students and graduates, found value in preparing students for their future careers through expanded learning opportunities in the classroom. The company saw a need for real-world experiments to be conducted in a learning environment and wanted to keep the college's goal of having the building itself be the learning tool. In response to the request from the college, Trane employees worked alongside the college faculty to assist the college in achieving this goal through a few different projects. The first project completed through this partnership was the installation of a one-ton water source heat pump created by Trane. Trane employed a current Lipscomb engineering student for a summer internship with the specific purpose of being involved in this project. Trane had a vision to install the water source heat pump to be a stand-alone unit to be utilized as a testing device for engineering students in thermal-fluids courses. The unit has seventeen different types of sensors for a total of thirty-three covering pressure, temperature, flow rate, and humidity measurements in air, water, and refrigerant. The sensors installed allow students to carry out experiments that incorporate junior and senior-level mechanical engineering courses such as Thermodynamics, Fluid Mechanics, and Design of Thermal-Fluids Systems. The one-ton water source heat pump will be used in these classes to conduct experiments that expose the engineering students to more real-life situations while incorporating the stand-alone unit into the building structure. In addition to this project, Trane has made many of the mechanical engineering systems in the Fields Engineering Center available for viewing, recording, and testing including graphical user interfaces. For example, the building's mechanical room was utilized as a learning tool during a junior-level lab course to better describe the concepts of pumps and piping systems. Though the partnership between Trane and the college is still in its initial phase, both parties have already benefited from the projects completed and hope to continue to collaborate toward improved learning experiences for students in the college. As projects are completed, Trane and the college expect to utilize the various learning tools for educational research by examining student experiences and learning outcomes with respect to ABET criteria.

College Industry Partnership

The partnership with the Raymond B. Jones College of Engineering at Lipscomb University and Trane began in 2014 when the local Trane office in Nashville, Tennessee began meeting with the Dean of the College of Engineering, Dr. Justin Myrick, about summer internship opportunities for engineering students. Prior to this relationship Trane had worked with Lipscomb University on multiple campus projects, so the opportunity to grow our professional relationship through a partnership whereby the University can offer

unique engineering experiences for their students and Trane can recruit talented young engineers into their organization was a natural next step. Since this partnership began, Trane has employed the services of both interns and full time graduate engineers. In 2015, as the university developed plans to build a facility dedicated to the engineering college, we continued our collaboration to realize the dream of the Dean to utilize the building and building systems as a practical teaching tool for faculty and students. Representatives from Trane and the engineering faculty met to brainstorm on ways we could utilize the building as a teaching tool – we primarily expanded on existing lab experiments already in the curriculum to develop new laboratory experiments using instrumentation added to the new building's hydronic system as well as a dedicated heat pump system in the Thermal-Fluids lab with high-level instrumentation. This allowed for lab exercises calculating heat transfer, air flow, thermodynamics, hydronics, efficiencies, etc. The resulting lab curriculum benefits students insomuch as it provides them with practical experiences that directly relate their theoretical knowledge introduced in their engineering coursework, and it also benefits Trane insomuch as they are able to work with young engineers who have practical experiences with commercially available mechanical systems. The direct link in students' theoretical knowledge and practical experience is the key to the success of our partnership.

Industry-Provided Equipment

Part of the benefits of the college and industry partnership between Lipscomb and Trane is the opportunity to collaborate on equipment or building usage as educational tools. When the engineering building was in the design phase, the engineering faculty began communicating ideas with Trane, the equipment manufacturer for the project. This was the perfect opportunity to bring the engineering practice into the classroom where theory is taught. Trane jumped at the idea of being able to use the building as a practical educational tool and quickly began facilitating opportunities for sensing and measuring parameters throughout the building. Over the coming months, Trane installed sensors that communicate to their custom HVAC software Tracer SC which can be viewed live with up to date information on the building's system functions. Lipscomb engineering students can study the building using the Tracer SC software to learn more about efficiency of various engineering systems and how they function. In the summer of 2017, Trane installed a water source heat pump system in the Thermal-Fluids lab in the engineering college. The water source heat pump as installed is shown in Figure 1.

Figure 1 The water source heat pump was installed in the Thermal-Fluids Lab with the supply air shown at the far right and various sensors along the length

In Figure 2, a virtual diagram of the water source heat pump system is shown as it would be seen in the Tracer SC software. Note that live measurements are shown on the diagram in the Tracer SC software, but have been removed here for simplicity. The air flow through the ducting system starts with the return at the top of the image and the supply shown at the right. Starting at the supply, a damper restricts the amount of air flow through the system. The filter removes any debris or dust in the air before passing the refrigeration coils where heat is supplied or removed from the air. A fan after the coils supplies flow rate for the ducting system. Following the fan is an air flowmeter and a reheating coil. The reheating coil is included in the system to supply neutral air to the room. Throughout the ducting, various sensors including pressure, temperature, and humidity are shown as white, black, and blue probes, respectively.

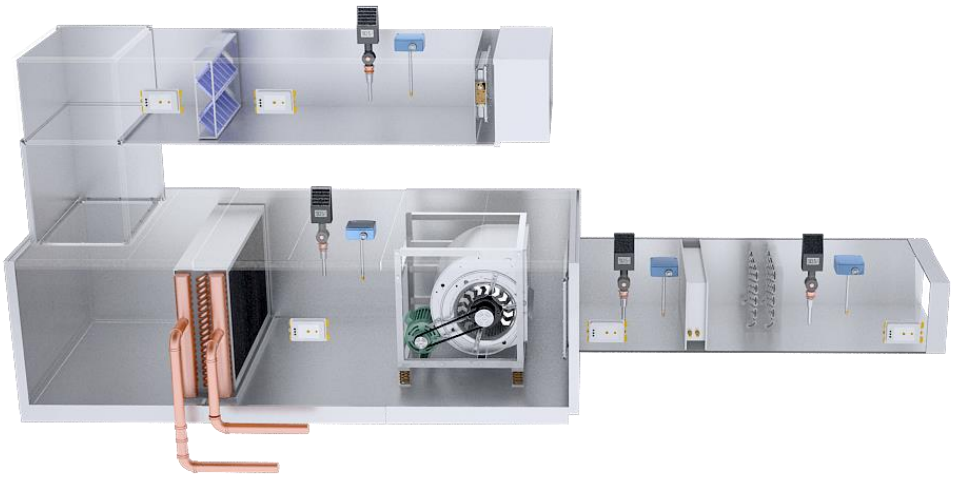

Figure 2 Virtual diagram of the ducting system for the water source heat pump provided by Trane

In Figure 3, a virtual diagram of the refrigeration cycle is shown as it would be seen in the Tracer SC software. Again, measurements typically shown in the Tracer SC software have been removed from the figure.

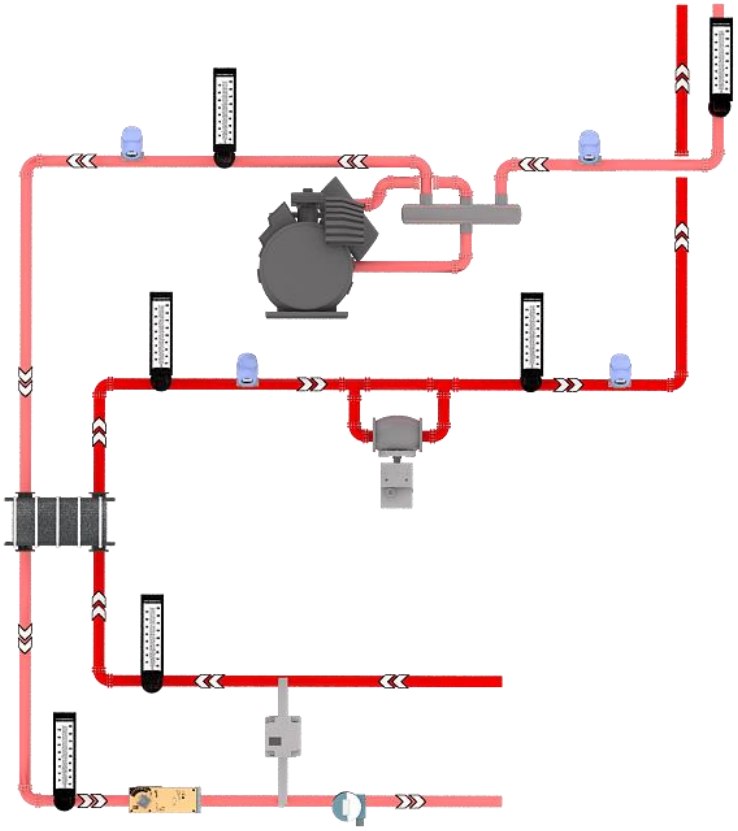

Figure 3 The refrigeration cycle diagram includes a compressor, switching valve, water-refrigerant heat exchanger, and various sensors along the refrigeration lines

Figure 4 displays a schematic diagram of the sensors included in the water source heat pump. The return air is represented in the top of the diagram. Following through the duct is the damper and filter with various sensors labeled. At the bottom of the diagram, the refrigerant cycle is represented and labeled out of the evaporator coil. Both the refrigerant to air and water to refrigerant cycles are represented in the evaporator coil and the coil depicted above the water return and supply, respectively. After the evaporator coil in the duct, various sensors are clearly labeled as well as the fan, flowmeter, and reheat coil.

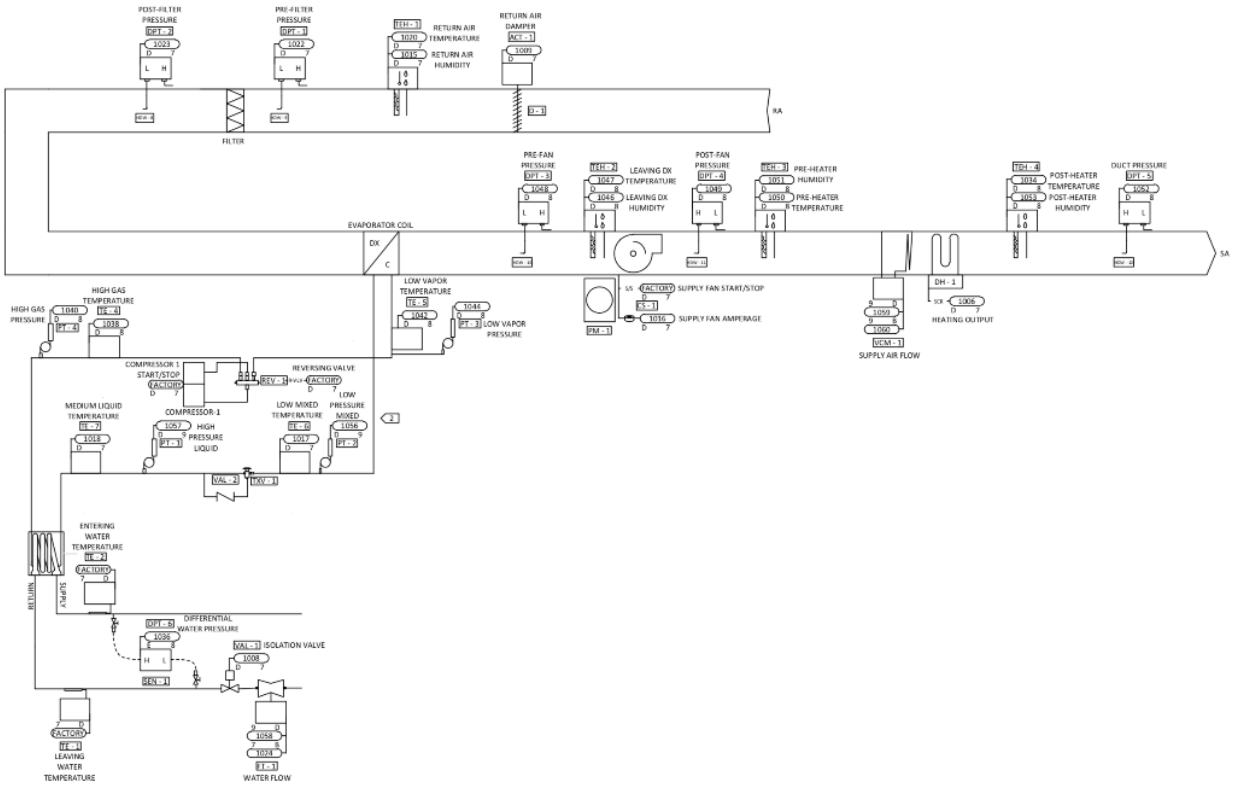

Figure 4 Sensors are located throughout the ducting of the water source heat pump as well as in the refrigeration cycle

Experiments using Equipment

The engineering college expects to utilize the systems that Trane has provided in the Thermal-Fluids lab specifically for mechanical engineering juniors and seniors. In the spring semesters, a one-hour lab is conducted in the lab that guides junior-level students through various exercises based on fluid mechanics, thermodynamics, or heat transfer topics. In the past, many of these experimental setups were provided by a vendor at high cost to the college. These apparatuses, though designed well, allow for experimentation or validation of a fundamental concept rather than a real-world application of the concept. The systems provided by Trane give our students a glimpse into what a thermal-fluids systems actually looks like and how it is used in industry. The water source heat pump itself can be used to investigate topics from all three fundamental mechanical engineering courses. For a fluid mechanics example, students can investigate the pressure change through the ducting system to better understand the effects of a dirty filter. Recently, a group of students in a senior course called Design of Thermal-Fluid Systems designed and tested this experiment. The results of their tests are shown in Figure 5. The refrigeration cycle within the water source heat pump can be used as a teaching tool for thermodynamics concepts. Additionally, there are a variety of heat transfer mechanisms throughout the system which can be defined, evaluated, and compared to industry standards. The college also expects to utilize the building systems made available by Trane for teaching tools as well. During the spring semester of 2017, the students in the Thermal-Fluids Lab were given the opportunity to view the mechanical room next to the lab. With the instructor's guidance, the students identified water systems including configuration of the pumps in the mechanical room and on drawings provided by Trane. Through this partnership with Trane, the college of

engineering hopes to continue improving real-world application experiences for students to better prepare them for their future careers.

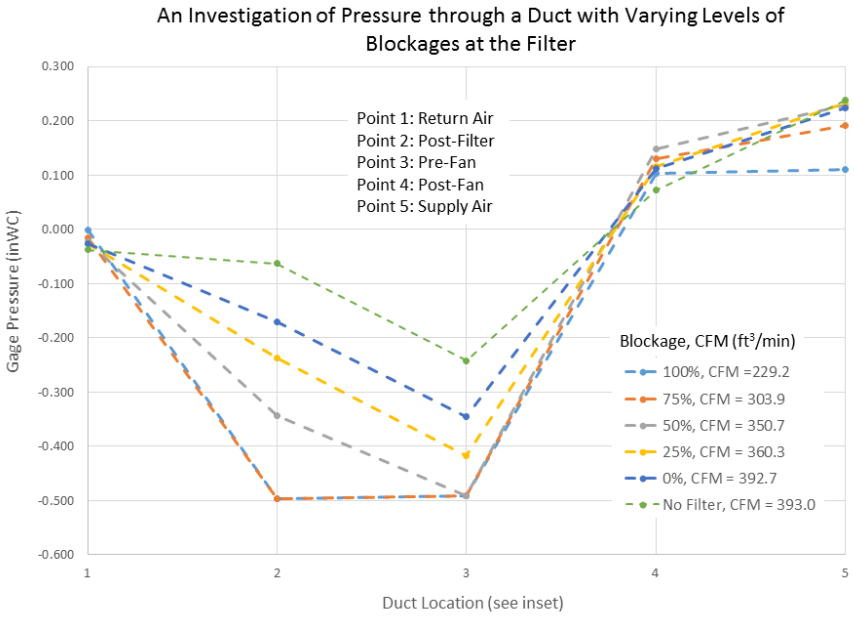

Figure 5 Results of an experiment designed by mechanical engineering seniors to demonstrate the use of the water source heat pump for teaching fluid mechanics concepts

ABET Accreditation

By implementing this HVAC unit into the Fields Engineering Center at Lipscomb University, the following ABET requirements are met:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

These ABET requirements ensure that the students obtaining engineering degrees are well versed about engineering and can apply it to a broad audience. With the 1-ton WSHP installation the students in the engineering program at Lipscomb can broaden their skillset and get a deeper learning on HVAC while applying the topics of Thermodynamics, Heat Transfer, and Fluid Mechanics that they learn in the classroom.

Conclusion

While the partnership between Lipscomb and Trane is still in the budding stages, mutual benefits have already been discovered. Lipscomb has received educational tools that provide opportunities to teach real-world concepts using various equipment as well as a partnering company that is highly interested in hiring Lipscomb engineering students as interns or employees. On the other side of the partnership, Trane

has received skilled interns and employees as well as a facility to provide training for technicians as needed. With the current success of the partnership, both parties are committed to continuous improvement and seeking future opportunities for collaboration on bringing theory into practice.