The Setty Family Foundation 2018 ASHRAE Applied Engineering Competition

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The Setty Family Applied Engineering Challenge tasked my project group with designing a temporary shelter specifically for refugees in Eastern Europe to be used by governments, municipalities, and humanitarian agencies that is cost effective, portable, sustainable, and provides all necessary domestic needs. After months of research and design, we have developed the Poly Shelter; an eight-person structure erected to provide comfortability and safety to those in need. Poly Shelter is designed to withstand the harshest of climates, provide exceptional insulation, and incorporate a rainwater collection system sufficient enough to support each unit. Poly Shelter proves itself to be an economically viable solution to the perpetual worldwide refugee crisis. Its innovative walls, comfortable interior climate, and water management systems will improve countless refugee's quality of life throughout the world. The added privacy that Poly Shelter provides is invaluable in the large camps that refugees find themselves in and allows a sense of normalcy in the worst conditions. Designed to weather the worst climates in Eastern Europe, it could prove as the next breakthrough in solving the current massive refugee crisis.

Key Words: Refugee Shelter, Mechanical, Sustainability, Design, Application

The Project

Prior to January of this year, I had no knowledge of any ASHRAE student competition, but a colleague of mine happened to be a member of the project team representing Cal Poly. After discussing senior project ideas, he announced to me that he was working on the Setty Family Foundation 2018 ASHRAE Student Competition, and their goal was to design a refugee shelter. I was instantly intrigued by the project and, fortunately, his project team was looking for someone with construction experience to spearhead the construction aspects of the project and assist with designing the structure. After meeting the rest of the project team comprised of mechanical engineers, I was extended an invite to begin working as a member of the Poly Shelter design team.

The challenge seemed particularly interesting to me because it has the possibility of actually being implemented in the world, ultimately benefiting thousands of people in need. I was attracted to the challenge of designing something I had never studied before, emphasizing sustainability and creativity of the systems involved, while simplifying installation for whatever organization would launch these shelters. I was also excited for the opportunity to work with students from the Mechanical Engineering department, also presenting me the opportunity to attain knowledge from their experiences in the mechanical industry. Working with an interdisciplinary group provides an educational diversity needed for a problem similar to this student competition.

My role on the project team was to focus on the construction aspects of the structure, the materials used to build the shelter, and focus on cost estimation as well. As the project progressed, I found myself involved in much more than my initially assigned role, and enjoying working with each team member on their sections of the project. I was very comfortable working with a project team, most likely because Construction Management curriculum emphasizes team-based projects in a majority of labs and classes. I also was very comfortable working on a competition team because I had participated in the ASC competition for three years, as well as competing on the Mechanical Contractors Association of America National Problem for three years.

The Process

Prior to designing a refugee shelter, there are multiple variables to elucidate. Some of the preliminary questions we analyzed include:

Where are these shelters going to be implemented in the future?
How harsh is the climate of the chosen location?
Are we designing for just one shelter, or hundreds?
What is expected lifespan of these shelters?
What is the optimum budget to manufacture and ship these shelters?
How many individuals are these structures going to service?

Fortunately for our project team, most of these questions were answered by the competition prompt, which explained the requirements and expectations to each participating team. We began by researching the harshest climates in Eastern Europe, which is the location the shelter is designed for. After identifying the climate and location, we began to design a shelter that would maximize our 260 square foot restriction. Other restrictions that we were challenged to design around were a height constraint of 8.5 feet, no access to municipal water and sewer, and the only power connections are 220V/1ph with a maximum of 15 amps.

After comprehending all of our requirements and conforming our design, we created the model for the Poly Shelter. Designing for the harshest of climates, we over engineered the insulation capacity to support eight individuals, utilizing the air gap provided by double-layer corrugated polypropylene and added hay wattles. After calculating the insulation, we used the heat calculations to size PTAC Unit suitable for the shelter, accounting for the most severe conditions in Eastern Europe. Simultaneously, several colleagues and I were challenged with designing the bathroom unit and rainwater collection methods. We brainstormed and developed a design that included a 500-gallon water tank for rainwater collection, a subsurface water bladder used for recycled water, and a portable toilet that would significantly increase the standard of living for its residents.

When the design stage was complete, we ran a cost report, totaling our estimated price per unit, its lifespan based on the materials used, and shipping costs per unit. All of these numbers are located in the attached report. A major concern of ours was that this design and sizing would not conform to AHRAE Standard 90.2, but our structure complies with the standards flawlessly.

After the design and testing phase, our project team was challenged with summarizing all of our information into a 25-page report, not including an appendix. Selecting which sections were included was definitely difficult, but after simplifying the report we made it work. The final report can be found in the following sections of this project.

Deliverables

The specific deliverable required by the organization included:
The submission must be limited to a 25-page maximum technical report. The document must be formatted to 8-1/2 x 11-inch paper with margins of 1 in, a font size of 11 points using either Arial or Times New Roman, and a line spacing not less than the MS Word standard of 1.15. All documents must be delivered in PDF format and should be clearly readable in black and white print.
Projects shall be evaluated, at a minimum, according to the following criteria listed below. For items not covered specifically below, judging will be based on the merits of the proposal and documentation presented as justification. Teams are urged to use their creativity, but like most real life situations must be based in fact and the ability for the project to be communicated and completed during the current ASHRAE year and within a specific budget.
What is the long term sustainable impact of the project? Include the return on investment, financial investment, and other benefits which may be conferred due to your project.

Does the project address ASHRAE or sustainably related topics?
What is the level of creativity in project selection?
All quantitative analysis items are fully justified and explained in the project write-up.
Clarity of reporting the intent and results of the project, including money budgeted and raised for the project.
Use of ASHRAE Standards and other related materials.

Lesson Learned

After completing my senior project, the major lesson that I learned was that it is important to push oneself; whether by working with a new group of people, focusing on a project that one has never studied before, or simply taking interest in something foreign. If it weren't for my colleague that invited me to join his project team, I would never have had the opportunity to indulge in the refugee shelters of the world, engage in exterior and interior designs, and expand my knowledge of political issues occurring around the world. My project team was extremely diligent in addressing deadlines that were scheduled when we initially began this project, therefore I never felt that we procrastinated during our process. The major lesson that I learned after completing this project was that there is no limit on creativity when designing a structure. We encountered several shelter designs that influenced the Poly Shelter, and I am sure there are hundreds available that could improve our product ever so slightly.