

Mechanical Engineering for the International Humanitarian Sector: Development of a Passive Insulation Packaging Solution

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Extended Abstract

To battle childhood starvation and malnutrition, the United Nations Humanitarian Response Depot (UNHRD) aims to provide at risk children with specially formulated foods that are filled with essential nutrients. These temperature-sensitive nutrient-dense foods, referred to as Specialized Nutritious Foods (SNFs), help save the lives of children around the world. Unfortunately, when SNFs reach temperatures $>30^{\circ}\text{C}$, nutrients found in the food begin to degrade. Through their partnership with Mercer University, UNHRD requested that a Mercer engineering student senior design group provide an all-encompassing solution to ship SNFs within allowable temperatures.

The student team performed research and designed multiple solutions. After completing an in-depth theoretical thermal analysis of various solutions, a 'Thermal Shield' design was selected., which the team modeled and prototyped on a scaled level. The Thermal Shield is made up of six connected panels that zip together, enclosing the packages of SNF entirely. It consists of two materials sewn together at their edges - a mylar reflective vinyl and a nylon rip-stop fabric, and is filled with low-dust cellulose insulation. After its construction, tests were performed on the prototype to prove its effectiveness and address any potential for redesign. The constructed and tested design of the Thermal Shield proves to be an effective solution to ship SNFs and is ready for full-size prototyping and field testing, which is being led by members of the same team while they serve with UNHRD as United Nations interns.

This project can be used in an upper-level mechanical engineering class such as heat transfer, as a specific, real-world example that demonstrates passive cooling, and incorporates principles of: radiation and irradiation, convection, thermal mass, temperature gradient, and other relevant topics within heat transfer. The humanitarian use for this product makes it an excellent way of piquing students' interest while they learn fundamental mechanical engineering concepts.