Devon Hughes, Jackson Young, Stephanie Chen, Caroline Moore

Research

In some parts of the world, water is not transported by miles of pipes and pumps straight into a person's home. In third world countries, it's not uncommon for water to be carried in buckets by women and children back to their homes. Jay Graham, an environmental health specialist working in Benin, Africa saw an elderly woman carrying at least 40 pounds of water on her head alone (Hallett). What if there was a new kind of bucket for people who need to walk 30 minutes or more for water every single day? A fabric bucket that is fashioned as a vest would evenly distribute the weight of water from the shoulders to the waist. This would avoid head and neck pain from carrying large amounts of water on one's head. Our group researched the types of seams, fabric, and waterproofing methods needed to make a successful fabric bucket. We are also drawing inspiration from CamelBak reservoir caps and lifejackets.

Seams are the trickiest aspect of waterproof fabrics. Small holes where thread is punched through fabric allows water to easily enter the inside of a garment. Our fabric bucket is dependent on waterproofed seams to ensure that the bucket can hold at least a gallon of water for one minute. Seams can also be the point at which the fabric bucket breaks due to the weight of water it's holding. According to Won Young Jeong from Pusan National University, seam strength is directly related to the "material for seaming and [the] sewing technology." In addition, "the waterproofness of seams is the weakest in locations where seams intersect and where several pieces join other thickness of material" (Jeong). The strongest type of seam is a flat felled seam that is commonly used in jean fabrics. According to Dhanaswamy Vijay, an expert in seam technology, the lock stitch also performs extremely well with plain fabric. This type of stitch could be used in conjunction with the flat felled seam to have an inner waterproof layer and a strong outer plain fabric layer. If we choose this design, Vijay states that a ripstop weave would be the best choice for an outer layer, as it's proven to be the strongest weave-seam combination tested. In addition to this, Vijay shows that when sewing the fabrics, high seam density should be a priority where additional rows of seams are not desirable.

The biggest challenge in creating a beneficial fabric bucket is making it capable of holding water. Without a waterproofed fabric, water will seep out and will render the bucket useless. However, a laminate can be used to create a barrier to contain water. One of these laminates are known as hot melt adhesives. Hot melt is similar to hot glue sticks. Both are durable, resistant, and create almost instantaneous bonds (Halbmaier). Hot melts could be very appropriate, but unfortunately they could add a lot of weight to the bucket. Especially since it

would be difficult to spread evenly on a large surface area. Large lumps of glue could create additional weight to the bucket, and therefore wouldn't be ideal as the main sealant. A lighter and easily applicable layer would be a better option. Polyurethane adhesive, a type of plastic, can be applied to various fabrics by spray or brush. Once formed, it will remain rigid and water-repellent, perfect for the needs of the fabric bucket. Although plastics usually do have a higher molecular weight, less product will be needed due to its strength and the amount applied can be controlled easily ("Plastics"). In comparison of the two types of sealents, polyurethane seems to be easier to handle and better suited for the fabric bucket than hot melt adhesives. Furthermore, when thinking of a fabric, Moussa proved that the use of cotton and treated polyester was an effective breathable waterproof fabric. The use of cotton would be a breathable fabric that has comfortable contact with the skin, and the use of polyester would be an easily waterproofed fabric. Moussa also outlined that heavier fabrics are often easier to waterproof, as they have fewer and smaller gaps in the fabric. This would be an area to strike balance between, as a lighter bucket would be desirable but a heavier bucket will be more effective.

Some of the inspiration for our fabric bucket came from CamelBak reservoirs. CamelBak Products, Llc has created a way to transport and consume water in a portable pack (Forsman). The pack includes a plastic, twistable cap on the top to allow the pack to be refilled and a flexible tube that acts as a straw, connected to the pack. The pack is made of a flexible, plastic-like, waterproof material so that it can hold and support liquids, without spilling, leaking, or absorbing them. This product is made to fit inside a backpack, which has a flap on the top with clips to buckle to the front of the bag to close it. This has inspired the fabric bucket design because it has emphasized the usefulness and significance of having the bucket be worn as a backpack. Creating a backpack out of the fabric bucket allows individuals to more easily transport large quantities of water over longer distances or periods of time. It also allows people to have their hands free so that they can multitask efficiently. Since the pack can be inserted into a bag or backpack, the fabric bucket should have layers as well, with the inner layer being the waterproof layer, to contain the water, and the outside layer being the backpack, representing exterior style and utility. In addition, the patented design for CamelBak has inspired the fabric bucket design by displaying a thin, flexible plastic pack to hold the water, which is waterproof, keeping the water contained, and light and compact enough to fit into the required dimensions. This is an important factor to consider when creating the fabric bucket because the bucket must have a fabric that imitates the flexibility and the waterproof qualities of the pack.

REI is a recreational equipment company that must accommodate for severe weather, such as rain or mud, when creating apparel or equipment (Rei). Rain is a common focus, as seen through their many products, including rain jackets and other waterproof gear. The main fabric used for these waterproof products is Gore-Tex, which is a popular brand of waterproof laminates. Gore-Tex is created by bonding a membrane to fabric, and then coating the interior with a liquid solution to waterproof it. Some common "membranes" are polyester films. Also, the exteriors of the products have durable water repellent finishes, preventing water from being absorbed into the fabrics, which would cause the gear to become heavier and uncomfortable. REI's use of Gore-Tex and waterproof laminates to create sturdy, waterproof gear helps inspire the design for the fabric bucket because it expresses strong examples of fabrics that will help the fabric bucket meet all its requirements. For the fabric bucket, pre-constructed plastics cannot be used, so a laminate would be a great alternative to contain water while also being flexible, since it is still a fabric, enough to be compressed to smaller dimensions.

Although simple in theory, a convenient fabric bucket is a feat of engineering. A balance needs to be found between form and function. Although aspects of the project, such as dense seams, heavy fabrics, and waterproof materials all serve to make such a bucket effective, there are certain constraints in weight, material prices, treatment prices, and convenience. Drawing on inspiration from established companies such as REI and CamelBak lends credence to the idea that such a feat can be readily accomplished. Using this research allows us to more easily determine a balance between cost and benefit.