

Survival Kit Integrated Life Ring

Author:

Ed Rozploch - err1014@sru.edu

Logan Wolak - lbw1009@sru.edu

Syed Sardar - sms1078@sru.edu

Advisor:

Dr. Jheng-Wun Su - jheng-wun.su@sru.edu

SlipperyRock
University™

Executive Summary

Life preservers, or life rings, are found along shorelines and on sailing vessels around the world. While their use often leads to survival and rescue, there are dire instances in which the flotation aspect of the life ring is simply not enough. The following proposes a life ring integrated with watertight compartments that can house life-saving equipment. This design will become an essential tool along remote shorelines and aboard sailing vessels, increasing the likelihood of rescue for a person who has fallen into or overboard in the most treacherous waters. The new design will be produced in two stages, consisting of additive manufacturing (AM) and the existing life ring production process. Once implemented, the survival kit-integrated life ring will save lives threatened by water in the most extreme situations.

Contents

Executive Summary2

Contents.....3

Problem Statement4

Industry Overview.....5

Design and Functionality6

Utilization of DDM Materials and Processes8

Value Chain Leverage, Agility, and Lean9

Cost Analysis10

Conclusions11

References12

Problem Statement

Every year in the United States there are over 4,000 fatal unintentional drownings ^[1,2]. There is a great risk factor associated with large bodies of water, especially in cold and treacherous locations. In many water survival scenarios, rescue is not always imminent. When a person falls in from shore or overboard a floating vessel, they can quickly be swept away from rescuers. In the few seconds before a person is swept away, life rings are often thrown by bystanders or other personal. These are crucial to keep the swimmer afloat while awaiting rescue but offer no other rescue capabilities. We aim to increase the survival and self-rescue ability of a person floating at sea.

Industry Overview

Traditional life rings serve as emergency flotation devices that can be thrown to anyone in need of assistance. They are designed to keep the person afloat and are commonly used along shorelines and on floating vessels. However, they offer no additional rescue capabilities and do not provide any survival tools for the person in need. Our proposal for the SME Digital Manufacturing Challenge is the development of a flotation device that contains items typically found in a survival kit. This device will resemble the iconic life-saver ring and function as an emergency flotation device that can be thrown to anyone in need of assistance. Additionally, the device will be integrated with commonly recognized survival and rescue items. This adapted life ring addresses the community safety aspect of the SME design challenge. These devices can replace any life ring currently in place along shorelines and on floating vessels, particularly benefiting remote settings where immediate rescue may not be available. While the act of throwing a life ring to a person in need suggests awareness of the situation, rescue may not always be imminent. Even when a life ring is thrown, individuals can quickly be swept away from rescuers, facing extended periods in the water. This device is designed to increase the likelihood of survival and rescue during prolonged rescue operations and in the most dire situations.

Design and Functionality

The design was created to fill a void in cheap and popular life buoys shown in figure 1. Most boaters are incapable of affording expensive inflatable life rafts which contain lifesaving equipment. This design creates a watertight container that is easily integrated into modern life buoys. The container can be molded into the buoy easily and cheaply.

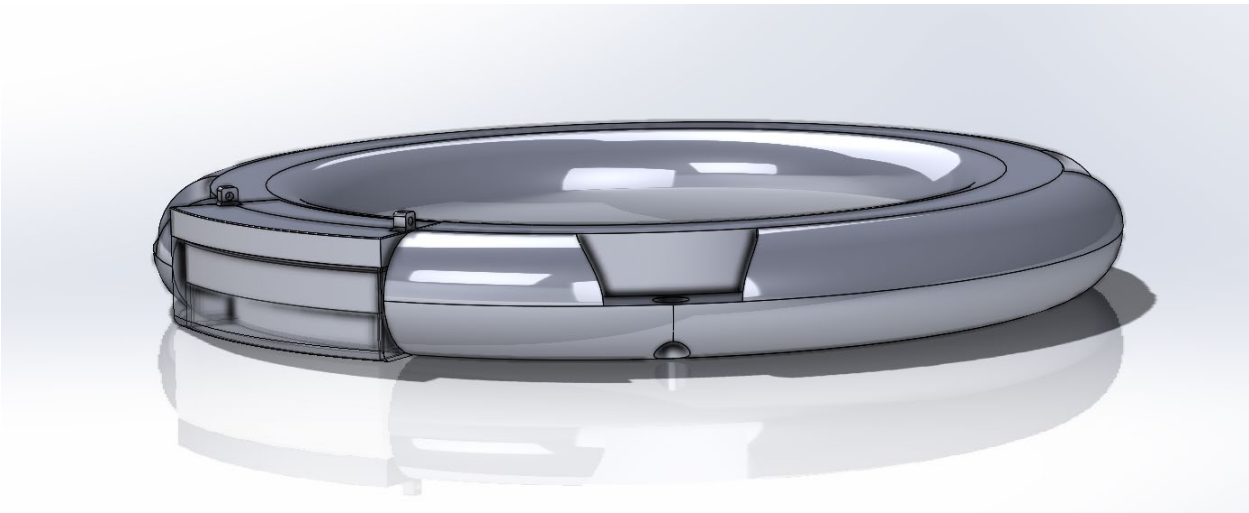


Figure 1: Container integrated into life buoy

The container can be filled with life-saving equipment of the users choice. From water and survival rations, to signaling lights, the added functionality increases the likely hood of survival for the user who might be lost at sea. To ensure all life saving equipment is protected from the elements the container and lid have interacting O-ring seals shown in Figure 2. The lid of the container has loops to secure the lid to the life buoy to ensure it does not get lost during use and to aid in the removal of the lid if the user is potentially exhausted from being stranded at sea.

The assembled container is shown in Figure 3. The design allows for a cheap but critical improvement to standard life buoys which can greatly improve the survivability of individuals who have fallen overboard out at sea.

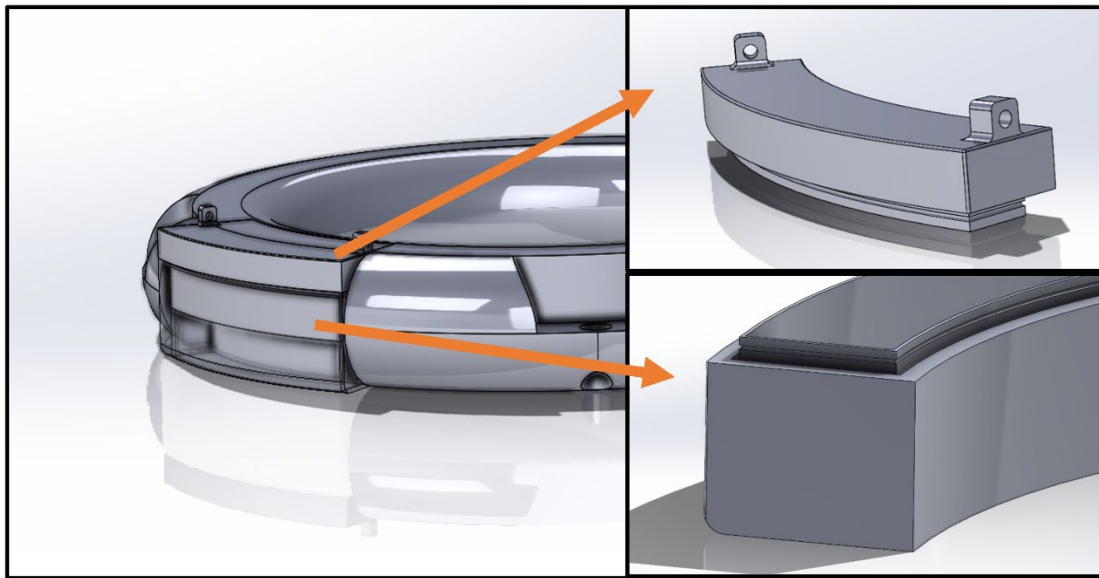


Figure 2. O-Ring seals

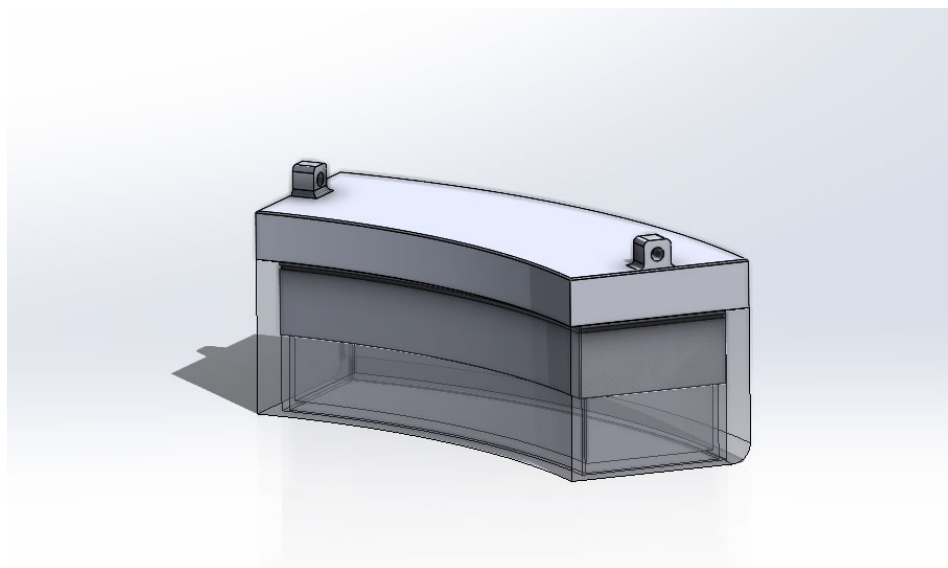


Figure 3. Container and lid when closed

Utilization of DDM Materials and Processes

Our justification for the use of 3D printing is large production capability and the cost. 3D printing is widely available in the modern day, and it is relatively quick with large parts. For our proposed design, the skeleton frame and watertight compartments would be 3D printed. These frames would then be used in the existing life-ring production process to be molded with life ring. For the 3D printing aspect of the production, FDM and PETG (polyethylene terephthalate glycol) will be used. FDM is a common printing process and offers a wide range of capabilities. As for the material, PETG can be processed at lower temperatures lending itself to faster production times. It was also chemical resistant. To accommodate the water aspect of a life ring's purpose, PETG is great for waterproof applications^[3,4]. PETG is also great for the snap-fit applications of the easy open yet waterproof compartments. At the end of its lifespan, this product can be recycled.

After the frame is 3D printed. It will be integrated with the molding process used to produce the standard life ring. This process molds a polyethylene shell around a polyurethane foam core.

Value Chain Leverage, Agility, and Lean

This design will be most useful if introduced to established manufacturers. The design of the skeleton structure can be introduced to the existing life ring production process. Adaptations can be made to the existing production process to integrate the frame structure and watertight compartments. The existing life rings can then be molded around the new structure. This will create a rigid and seamless final product. Once the final product is produced, the survival components can be added.

In terms of selling the new product, new marketing may be needed. Most existing applications of life rings require their use. Therefore, they are not sought after by consumers. One angle may involve convincing lawmakers to require the new life ring in the most suitable locations. This would include treacherous shorelines and commercial sailing vessels. The private customer needs to be convinced that this product makes them safer in the event of a disaster. They are applicable on all watercraft as they offer an additional factor of disaster prevention.

In terms of agility, the entire production process is relatively fast. 3D printing is fast and cheap and will cause little or no delay in the existing production process. Once an initial production of the frame and compartments creates enough stock, it will be integrated with the buoy production process. This will make the total production process very efficient in terms of time and material usage. There is very little waste associated with both the 3D printing process and the buoy molding process. Any waste or excess material from either process can be reused or recycled.

Cost Analysis

The cost of our design will stem from the initial cost of the FDM 3D printers, electricity, and the PETG. In addition, the cost of the existing life ring production process and included survival items will be added to the AM cost. The initial cost will be in the range of \$150 - \$300 with an expected run time of 7,500 printing hours to 15,000 printing hours (printing for 8 hours every day for 5 years)^[5]. The lifespan of the printer will decide how many complete units can be made per printer. If the final design takes 6 hours to print, then the estimated units made per printer will be around 1900 units and \$0.11/unit based on average printer cost. The next factor to be considered is electricity. Electricity is highly variable with location and time of day. A conservative estimate is \$0.025/hour and \$0.15/unit based on average 100 W power demand per printer and doubling local electricity cost. Material cost also varies and this is the most costly aspect of the process. PETG, on average, costs \$48/kg. With an estimated mass of 250g/ piece, material will contribute \$12 to the unit price^[6].

Finally, the cost of the existing buoy production process will make the most significant contribution to the total cost of the final product. While this varies with product quality, the estimated cost of \$40/unit is reasonable for a high quality product. When this is added to the unit cost of the frame construction, the total estimated cost is **\$52.26/unit**.

Conclusions

In conclusion, the goal of our survival kit integrated life ring is to provide an extra level of self-rescue for those in water rescue situations. With the ability to produce the device quickly and cheaply through 3D printing, it offers a cost-effective addition to the existing life ring production process. The device consists of a skeleton frame with watertight compartments. This frame can then be molded with the polyurethane buoy for a total cost of \$52.26/ unit. This device has several applications that include treacherous shorelines and sailing vessel decks around the world. 3D printing is the main justification for the use of our design due to its fast production capabilities and low cost. The estimated cost for producing the device will come from the initial cost of the FDM 3D printers, electricity, material choice and the life buoy production. With its versatility and increased survivability factor, this new life ring will increase the likelihood of rescue for anyone in a water survival scenario.

References

- [1] Centers for Disease Control and Prevention, "Drowning Data,"
<https://www.cdc.gov/drowning/data/index.html>
- [2] ABC7 Chicago, "How to Avoid Drowning Statistics: Lake, Pool Safety Tips,"
<https://abc7chicago.com/how-to-avoid-drowning-statistics-lake-pool/12015695/>
- [3] 3D With Us, "PETG Filament Review: Waterproof Pros & Cons,"
<https://3dwithus.com/petg-filament-review-waterproof-pros-cons>
- [4] The 3D Printer Bee, "Is PETG Filament Good for Outdoor Use?"
<https://the3dprinterbee.com/petg-outdoor-use/>
- [5] Dwamena, M., "How Long Does a 3D Printer Last? Creality Ender 3 & Others," 3D Printerly, <https://3dprinterly.com/how-long-does-a-3d-printer-last-creality-ender-3-others/> (accessed Nov. 30, 2023).
- [6] Verbatim, "Verbatim PET-G Filament 1.75 mm - Black," Verbatim Online Shop, <https://www.verbatim-europe.co.uk/en/prod/verbatim-pet-g-filament-175-mm--white-55052/> (accessed Nov. 30, 2023).

Engineering drawing for container

