Introduction

Abby Tamara, a woman in her mid-80's, loves the outdoors and has always been an avid camper. However, she has several medical conditions that impair her strength and mobility. In addition to her petite 4'1", 117 lb stature, she has kyphosis, arthritis in her thumbs and wrists, and fused L1 through S1 vertebrae from a previous back surgery. Though she can walk short distances unassisted, she typically moves around using a Whill wheelchair. As a result of both her medical conditions and decreased strength due to her age, she has difficulty stooping for long periods of time, bending down and standing up repeatedly, and has limited strength. These conditions prevent her from being able to assemble her camping cot, and have thus prevented her from camping for many years. From January to March 2021, I worked closely with Abby to define her issue, establish the absence of a commercially available solution, and develop a product that meets both her needs, and the needs of campers like her.

Abby currently owns a Thermarest UltraLite LuxuryLite Cot [1], an older but dimensionally identical version of the Thermarest UltraLite Cot. The Thermarest UltraLite Cot's light weight (at just three pounds), compact folded form, and low height are why Abby originally decided to purchase this cot. However, the assembly process requires bending the cot's legs into their bowed positions, which proved too strenuous a task for her. Abby expressed a clear desire for a cot that matched the Thermarest UltraLite Cot's sturdiness, weight, and compact disassembly, but would be easy for her to assemble independently.

Figure 1: Thermarest UltraLite Cot

Additionally, since this project was completed during the Covid-19 pandemic, all meetings were conducted over Zoom video conferencing, and all prototyping and fabrication was conducted with very limited tools.

Design Criteria

My first step was to meet with Abby to determine what she requires from her camping cot. From our meetings we established the following requirements for her camping cot.

- Low-strength assembly/disassembly
- Compact when disassembled

- Single-person assembly/disassembly
- 6” off the ground
- Assembly avoids repetitive motion
- Robust/Stable
- Lightweight, ~3lbs

Notably, Abby had no requirements for aesthetics or for cost. She was adamant that her only priority was to find a way to camp again.

Current Options

A search for existing products on the market found no cots or tools that met her requirements. Simple folding cots, like Byer of Maine’s EasyCot [2], which collapse akin to camping chairs, are too tall, heavy, or bulky. The EasyCot itself weighs 21 lbs and does not meet Abby’s requirements for height or weight. “Ultra light” cots intended for backpackers, like the Helinox Lite Cot [3] or Abby’s Thermarest Cot, require “adult strength” to assemble, and many reviewers report difficulty assembling them. However, since these cots are intended for able bodied backpackers, no assistive assembly tools are available. My research concluded that there is no commercially available cot that is highly portable, easy to assemble, and low to the ground.

Figure 2: Byer of Maine EasyCot

Approach

Abby clearly indicated that she only desires a cot that meets her requirements and has no particular attachment to her Thermarest UltraLite Cot. So long as I could provide her with a solution to let her camp again, I was free to choose any of the following paths.

1. Design and manufacture a completely new cot
2. Modify her cot or another commercial cot
3. Develop a tool for assembling her current cot

Considering the remote nature of my project, I would not be able to meet with Abby or

access her cot in person, nor would I have access to on-campus fabrication tools. As such, I decided to focus on building an assembly tool for Abby's current cot, as it already meets her size requirements and we already know she enjoys its fit, if not its assembly.

Design & Development Process

Brainstorming

Since bending and inserting the cot legs is the only step of assembly Abby has trouble with, my brainstorming targeted ways of making this step easier. I purchased a Thermarest UltraLite Cot Leg Replacement kit to help generate and test potential designs. Abby mentioned that the campgrounds she visits all have picnic tables on which she can assemble the cot instead of stooping down to the ground. My initial designs were purely mechanical devices that Abby could use to assemble the cot on a picnic table. Designs considered at this early stage included pulleys, levers, and over-centering mechanisms that would allow Abby to leverage her body weight to assemble the cot instead of her limited strength. When I presented these concepts to Abby, she expressed hesitancy about pursuing a device that requires any level of force, like a lever, without being able to test it in person. Additionally devices like winches involve cranking, an undesirable repetitive motion. I then shifted into looking at electromechanical devices that would supplant the need for physical effort.

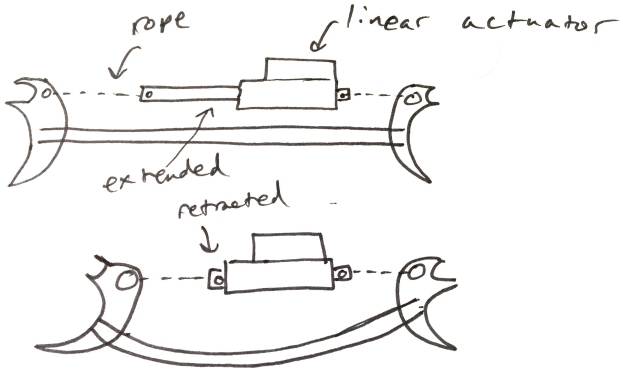

Figure 3: Sketch of linear actuator device

After a proof of concept prototype using a rope hooked onto the Thermarest UltraLite Cot's feet to bend the cot leg I had purchased, I decided that using a switch-controlled linear actuator was the most mechanically simple and user friendly tool to bend a cot leg and keep it bent so Abby could insert it into the body of the cot.

Iteration and Improvement

I iterated my design based on my testing of the device as well as from my regular Zoom meetings and demonstrations with Abby. The original design was controlled by an on/off switch and an extend/retract switch, powered by a non-rechargeable battery,

and had the electronics mounted to a board attached to the actuator. Through testing and iterating both on my own and with Abby, I made the following improvements. The two-switch control system was unintuitive and I replaced it with a double-pole double-throw momentary switch that defaults to the “off” position. Replacing the batteries required too much dexterity and so the single-use batteries were replaced by a Lithium ion rechargeable battery that charged from a typical US 120V AC wall outlet. The exposed electronics were encapsulated by a sealed plastic case to protect against moisture, dirt, and drops. Finally, a carry strap was added for easy carry.

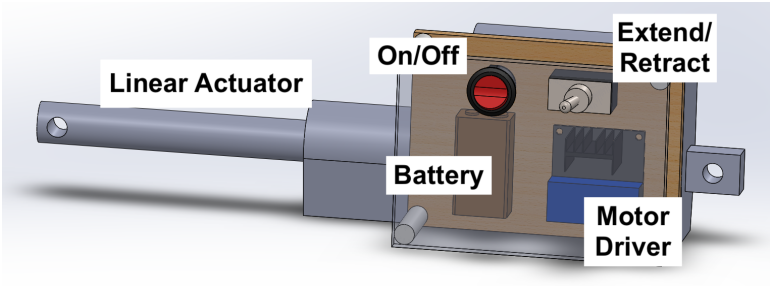

Figure 4: SolidWorks model of early prototype

Outcome

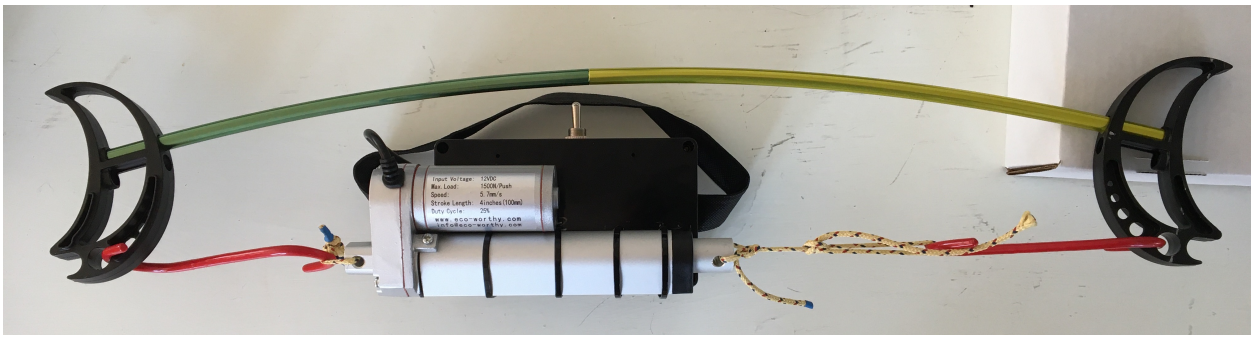

Figure 5: Final device in action

The final prototype met all of Abby’s requirements. It easily hooks onto a cot leg and reliably bends it so Abby can insert it into the cot’s body. Its single switch makes it easy and intuitive to use, and it can be easily charged with an included wall adapter with a full charge indicator. A full battery has the capacity to power the actuator for 3.5 hours of continuous use, far longer than is necessary to assemble the cot. The plastic enclosure makes the device water and dirt resistant, and the tool’s compact size and carry handle makes the device easily transportable. The device weighs 2 lbs, 14 oz, which is manageable for transportation from the car to a picnic table, on which it will rest when in use.

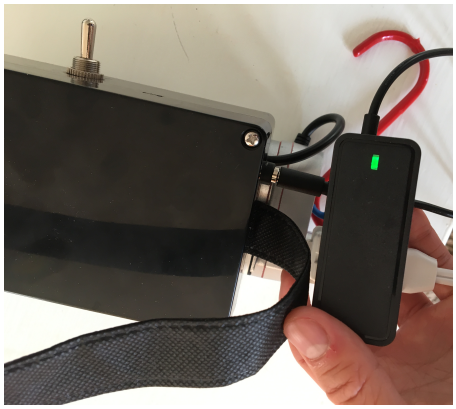

Figure 6: Green light indicates full charge

Aesthetically, the device is streamlined with few protrusions.

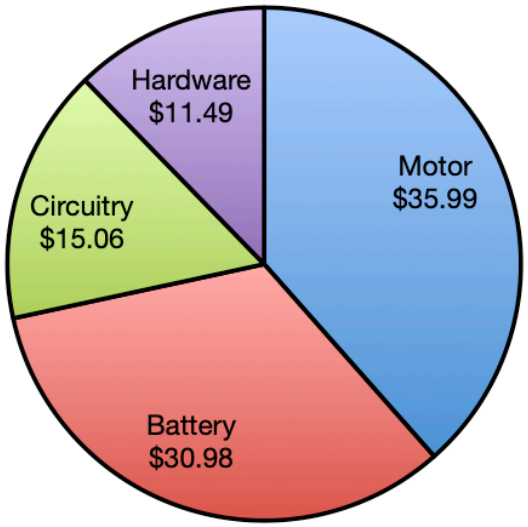

Figure 7: Cot Tool cost breakdown

The total material cost of this device is $93.52 based on prices at the time of purchase. Considering that the Thermarest UltraLite cot and similar "ultra light" cots like the Helinox Lite Cot are priced in the $200-$250 range, the cost of this device is reasonable.

Abby received the device on March 29th, 2021, and has successfully used it to assemble her Thermarest UltraLite Cot. She is pleased with its simple operation, both to use and to charge. The carry handle is ergonomic, and the device's weight is comfortable. Though she had not set requirements for the appearance or cost of the device, she is pleased with its clean appearance and happy to learn that the device would have been very affordable for her, had it been a commercial product.

Discussion

This device was intentionally developed for Abby and her Thermarest UltraLite Cot, and as such may not function as well for campers with different cots or different mobility constraints. However, this tool can be easily adjusted to fit the Helinox Lite Cot, which is assembled similarly. Since these two cots are widely regarded as some of the best ultra-light cots, Abby's Camping Cot Tool is applicable to a wide consumer base.

Figure 8: Helinox Lite Cot

Additionally, this project highlights the unfortunate dearth of ultra-light, compact, and *accessible* camping cots on the market. Though ultra-light cots are designed for backpackers without mobility limitations, Abby's preference for a lightweight cot is indicative of a need to design ultra-light cots for people with impaired mobility.

With this tool serving as an open-source stopgap solution for accessible camping cots, future work will explore accessible, lightweight cots that can be assembled by anyone without requiring a supplementary tool.

References

1. “UltraLite Cot.” *Thermarest*, 22 Mar. 2021, www.thermarest.com/products/cots/ultralite-cot/ultralite-cot.html.
2. “EasyCot.” *Byer of Maine*, 22 Mar. 2021, byerofmaine.com/products/easycot.
3. “Helinox Lite Cot.” *REI Co-Op*, 22 Mar. 2021, www.rei.com/product/158009/helinox-lite-cot.