# Team Information

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# College Entry Supplemental Report

The team is using 3D printing using PLA plastic as its DDM process. We are using this method because our design involves many small, interconnected components which are oddly shaped. Machining these parts would be labor-intensive and costly. Many of these components do not undergo a large amount of stress, so plastic is an ideal material to use as it is cheap and can be printed fairly quickly, requiring no labor hours to oversee prints while they are being manufactured. Pieces can be designed to print with very small tolerances using minimal skill. Many of these fits are in awkward places and would require a master machinist to construct, but can be done with a few keystrokes and knowledge of the limits of a 3D printer. Our team is using Ultimaker 2, and 2+'s for our 3D printing.

The social impacts of our design are plentiful, helping to treat pressure sores, an issue which plagues many disabled, elderly, or otherwise incapacitated individuals who may already be struggling with an array of medical issues. Pressure sores, or ulcers, are a painful type of skin injury. They can also be quite dangerous, due to a high risk of infection. These sores develop when pressure is applied to an area of the body for a prolonged period, limiting blood flow to the tissue. This insufficient blood flow to the tissue causes margination and hypoxia, damaging the tissue. Once these sores form they are very challenging to heal since they are often disturbed due to their location, causing them to be very painful and have a high risk of infection. The CDC's most recent study found that pressure sores affect 11% of nursing home patents. In hospitals pressure sores are the cause of death in 11.6% of patents with pressure sores as a secondary diagnosis. Pressure sores also impact paraplegic individuals daily lives, these sore can keep them bed ridden and away from work and everyday life for weeks and sometimes months.

Currently there are many products on the market, such as various foams and gels to better distribute pressure when a patient sits on them, but for individuals who are unable to readjust themselves pressure sores often still form. Our team had the opportunity to work with a paraplegic individual who has struggled with pressure sores, on creating a device to help reduce the formation of these sores.

One of the biggest challenges in the treatment of pressure sores is the lack of information currently known about them. Our device can measure the pressure distribution, and then based on this distribution, or external input, redistribute the pressure. This allows our device to be used by researchers to learn more about the formation of pressure sores, as well as more information about how to avoid and treat them. Researches could even use our device to find the ideal configuration to distribute pressure and how often pressure should be redistributed.

The pressure sensor is designed as a variable resistor. This resistor is comprised of a PLA casing, metal banana clips, Bare Conductive Electric Paint® (BCEP), copper plates, and conductive silicone sheets. The casing separates the sensor into two sections – a base and a top. Each section is similar in design. A current travels through one banana clip, which then conducts through the BCEP and onto the copper plate which is covered with a piece of conductive silicone. Each half is married together with the conductive silicone making contact. The silicone is compressible, which allows for the resistivity to decrease as more pressure is applied. The primary difference between the two sections (base and top) is the top is much thinner – allowing for the PLA material to experience deflection. This deflection controls the overall compression of the silicone which theoretically allows for a larger range of reading.

Environmentally, our project has a low impact. It primarily uses PLA, which is a biodegradable and derived from renewable resources, such as corn starch. It has no direct emissions, as it runs on 12VDC power from a wheelchair battery. The manufacturing process involves using 3D printers, which also produce no emissions and do not pose a threat to the environment with dangerous runoff or anything of that nature.

The cost of using 3D printing as a DDM can be estimated by examining the amount of PLA used to construct each component for a fully designed wheelchair pad. Each individual actuator contains, in terms of 3D printed parts; a motor base, motor cover, washer filler, shaft coupler, coupler insert, actuator, actuator casing, sensor bottom, and sensor top. In addition, each actuator is interconnected to adjacent actuators using 3D printed beams. The following is a table showing amount of PLA, in meters and grams, is used to print each component for one actuator, and then total, considering the full design uses 16 actuators.

Table 1. PLA used in design

| Part | Material (m) / per | Material (g) / per | # of Pieces in Complete Design | (m) total | (g) total |
|---|---|---|---|---|---|
| Motor Base | 0.6 | 5 | 16 | 9.6 | 80 |
| Motor Cover | 0.63 | 5 | 16 | 10.08 | 80 |
| Washer Filler | 0.13 | 1 | 16 | 2.08 | 16 |
| Shaft Coupler | 1.27 | 10 | 16 | 20.32 | 160 |
| Coupler Insert | 0.11 | 1 | 16 | 1.76 | 16 |
| Actuator | 6.27 | 50 | 16 | 100.32 | 800 |
| Actuator Casing | 7.83 | 62 | 16 | 125.28 | 992 |
| Sensor Bottom | 1.14 | 9 | 16 | 18.24 | 144 |
| Sensor Top | 0.59 | 5 | 16 | 9.44 | 80 |
| Connector (0.84in) | 0.19 | 2 | 8 | 1.52 | 16 |
| Connector (1.39in) | 0.28 | 2 | 4 | 1.12 | 8 |
| Connector (1.84in) | 0.35 | 3 | 10 | 3.5 | 30 |
| Connector (1.88in) | 0.36 | 3 | 4 | 1.44 | 12 |
| Connector (1.9in) | 0.36 | 3 | 4 | 1.44 | 12 |
| Connector (2.4in) | 0.44 | 3 | 4 | 1.76 | 12 |
| Connector (2.8in) | 0.51 | 4 | 2 | 1.02 | 8 |
| Angle Connector (Left) | 0.28 | 2 | 2 | 0.56 | 4 |
| Angle Connector (Right) | 0.28 | 2 | 2 | 0.56 | 4 |
| Total Material | Length: 310 m | | | Weight: 2474g (2.474kg) | |

Using Table 1, it can be found that the total material used per actuator is 18.57m, or 148g of PLA. This can be multiplied by however many actuators are desired in a given seat (based on size of supportive cells) to obtain the amount of PLA used.

The 2.85mm PLA spools, which the Ultimaker 2/2+ use, cost approximately $25.49 for 1kg, purchased from Amazon.com [1]. Therefore, the cost of printing material for each actuator costs $3.77. Printing all of the parts of the design which we intend to use DDM for would cost $63.06. Compared with cost of machining these small, intricate parts, the cost is miniscule. The amount to be manufactured would depend on the number of research teams interested in using the design to study and treat pressure sores, but an initial estimate would be approximately 100 units created, with a grand total of $630.60. This cost does not include pieces, such as thrust bearings, bolts for use as the power screw actuator, and standoffs which would need to be purchased.

## References

[1] "MeltInk3d Black 2.85mm PLA 3D Printer Filament 1Kg: Industrial & Scientific." Amazon.com: MeltInk3d Black 2.85mm PLA 3D Printer Filament 1Kg: Industrial & Scientific. N.p., n.d. Web. 28 Feb. 2017.