Development of a Special Purpose Exoskeleton for Use by Firefighters

Team Exo: Donald Spriggs, Tom Bigot, Brett Ingram, Liam Smith, Connor Bosco, Nick Salanitri, Jess Mense, Dr. Peter Sunderland

University of Maryland Honors College Gemstone Program

Background

- The National Fire Protection Association found over 40% of firefighting injuries were overexertion and strain
- Sprains and muscular injuries also accounted for 40% of firefighting injuries
- These injuries could be prevented with the use of a load-bearing exoskeleton

Research Objective

How can we reduce overexertion injuries in firefighters?

- Exoskeletons have seen introduction into the manufacturing industry to reduce physical strain.
- Our team's research is focused on developing an exoskeleton tailored to firefighters that is heat resistant, inexpensive, comfortable, and practical.

Methodology

- Design, build, and test successive prototypes that improved upon each other.
- Draft the first design for our exoskeleton on paper and in the CAD software SolidWorks
- Construct the first prototype with easily obtainable materials such as 3-D printed ABS plastic and nylon straps. This was tested for comfortability and qualitative effect
- Design the second prototype with information gathered from the first, and built with sturdier materials like powdered Nylon and leather straps

Current Prototype

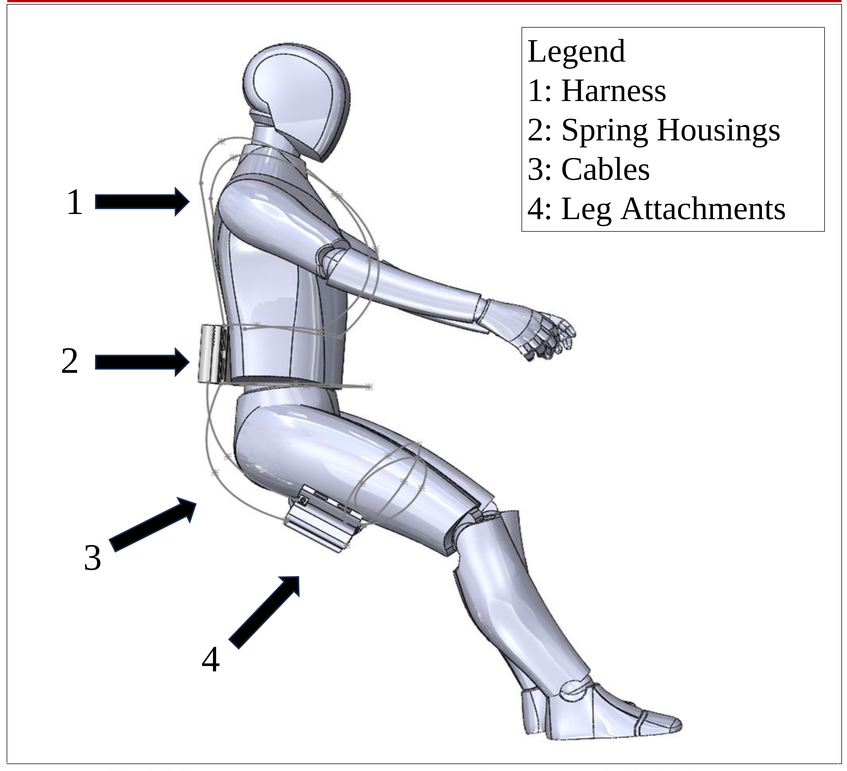

Fig 1. Model of our current prototype design produced in SolidWorks

Fig 2. Back view of first prototype

Fig 3. Back view of current prototype

Acknowledgements & References

We would like to thank our mentor Dr. Peter B. Sunderland, Dr. David Lovell, Dr. Allison Lansverk, Dr. Craig Carignan, Mr. Mark Coulbourne, the Gemstone Staff, our firefighter participants, and the Globe Manufacturing Company, LLC

Testing

- Conducted qualitative tests of the first prototype focusing on the ergonomics of the design
- Tests for the second and future prototypes will include:
  - Stress testing of the spring at realistic loads
  - Use EMG (Electromyography) and an oximeter to quantify exertion during tasks both with and without exoskeleton support
  - Thermal testing to determine heat and flame rating of exoskeleton

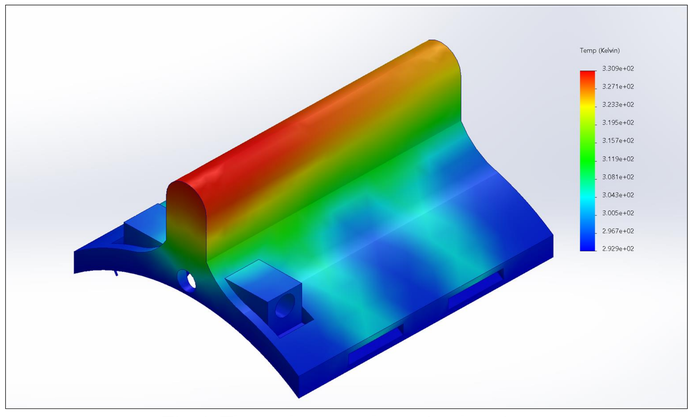

Fig 4. Thermal test on the spring housing

Future Research Goals

- Test the exoskeleton to real-world thermal and force loads
- Discuss with firefighters for future iterations of the prototype
- Determine material selection for production models
- Verify integrability of exoskeleton with standard firefighting equipment (oxygen tank, turnout gear)
  - Specific parts of our prototype need to be able to safely withstand thermal loads