Decreasing Musculoskeletal Injuries in Soldiers Through the Use of Anthromorphic Exoskeletons

Ryan Dolan, *Biomedical Engineering, University of Rhode Island*
BME 181 Second Presentation, March 31st, 2013 <Ryan_Dolan@my.uri.edu>

***Abstract*— This paper will attempt to briefly cover and offer a solution to a problem that almost every sailor, soldier, marine, and airmen encounters while conducting their duties. It will mainly focus on the cause of musculoskeletal injuries in serviceman, in this case, due to heavy lifting of objects and gear that are of vital importance to completion of their mission. And attempt to offer an example of a solution that is in the works as we speak. As well as offer a brief breakdown of the mechanics and electronics that allow the aforementioned solution to function in a manner that decreases musculoskeletal injuries in soldiers.**

I. Introduction

Most soldiers today can agree that they are required to go above and beyond the call of the average man as it relates to the amount of hard and, almost literally, back breaking work that they are ordered to do to complete their tasks at hand. It would not be a rare occasion if a soldier was asked to pick up his 80lb rucksack along with his 27lb M249 SAW and 600 rounds of 5.56mm ammunition and march on foot to a location that is 35-40km away through rough, wet, mountainous terrain. Due to the strenuous nature of a soldiers work musculoskeletal injury is almost all too common an event in the armed forces. Injuries ranging from sprained ankles all the way to herniated disks in a soldiers back can not only put the soldier out of commission, but it will severely deter the unit as a whole from accomplishing it's mission if it keeps losing it's workhorses to something that can and hopefully will not be a problem. In a study of soldier's with back pain due to their everyday activities, only 2% that received treatment in Washington or Germany actually returned back to their units. This is an extremely low rate of return for a problem that can be so easily fixed or improved through the use of biomechanical devices.

Lockheed Martin is hoping to do just that with its implementation of the HULC (Human Universal Load Carrier Device). It is both Lockheed's and the military's hope that the HULC device can significantly decrease the amount of soldiers put out of commission from doing activities ranging from picking up heavy objects to carrying heavy loads of equipment for a mission that requires an extra amount of firepower.

II. HULC (Human Universal Load Carrier)

The HULC is the latest innovation in anthromorphic exoskeletons offered by a combination of Berkeley Robotics and Human Engineering Laboratory and Lockheed Martin. The original design was first constructed in the Berkeley Robotics and Human Engineering Lab, then both the BRHEL and Lockheed reached an exclusive licensing agreement that allowed Lockheed to produce and modify the original platform. The HULC is an anthromorphic, having or relating to human qualities, completely untethered, hydraulic powered exoskeleton that provides the operator with the ability to carry up to 200lbs for an extended period of time. The heavy loads are transferred to the ground through the designs use of titanium framework/legs. One might think that such a device would severely deter the operator's mobility. But the simplistic design combined with advanced electronics allows the operator to have very similar if not the same range of mobility as someone not using the HULC. Soldiers merely have to stretch out a leg and step into the foot beds of the device, strap the straps around the waist, thighs, and shoulders and the device is ready to go. Onboard sensors in the footpad interpret the foot movement of the operator and relay that information to a microcomputer housed within the device that provides the exoskeleton with electrically signals to mimic the movement of the operator. Not only does it mimic the movement but it also amplifies and enhances the movement of the operator through its hydraulic system. It provides power assistance at both the knees and the hip. Other exoskeletons are the market today are limited by their need to be tethered to a power source do to inefficient design. The HULC eliminates the need for a tether through a very efficient hydraulic architecture that allows a smaller source of electricity such as a battery for power. When the battery power is low the HULC system continues to support the weight. And when the batteries die the HULC can still support it's maximum weight, which eliminates the risk of the load collapsing on a soldier due to an electrical issue.

A soldier equipped with the HULC will be able to carry loads up to 200lbs across very rough and dangerous terrain, and if he/she comes under fire will not be limited by the HULC to find cover and return fire.

TAKEN FROM THE LOCKHEED MARTIN WEBSITE

TOTAL WEIGHT WITHOUT BATTERIES: 53LBS

POWER: LITHIUM POLYMER BATTERIES

ELECTRONICS: FLEXIBLE, EXPANDABLEELECTRONICS ARCHITECHTURE. CUSTOM SINGLE-BOARD MICROELECTRONICS HOUSED IN A SEALED ENCLOSURE. NO FANS USED OR NEEDED

HYDRAULICS: EFFICIENT LOW-FLOW, HIGH PRESSURE HYDRAULIC SYSTEM USING STANDARD HYDRAULIC FLUD.

References

[1] http://www.lockheedmartin.com/us/products/hulc.html
[2] http://en.wikipedia.org/wiki/Human_Universal_Load_Carrier
[3] http://www.medpagetoday.com/PublicHealthPolicy/MilitaryMedicine/16889

[4] http://www.youtube.com/watch?v=hWumbs9MQdM