National Safety Council

Case Study

MSD Solutions Lab an nsc program

Exoskeleton Implementation in an Aircraft Engine Supplier

What's the Risk?

Musculoskeletal disorders (MSDs), specifically back injuries, are a major focus at the General Electric Aerospace Erlanger warehouse facility. Over 80% of all General Electric Aerospace's parts and components pass through the warehouse weekly. The 400,000-square-foot Erlanger distribution center has about 155 employees who perform material handling tasks that often demand bending and twisting to complete their tasks. Manual material handling is described at the site as dynamic, incongruent, and repetitive. As a result, back injuries are the most common injury at the warehouse (about 26% of strain-related injuries), followed by shoulder injuries (about 19% of strain-related injuries). From 2019 to 2023, 53% of injuries at the distribution center were caused by lifting or lowering material. Due to the risks, General Electric Aerospace at the Erlanger location considered that exosuits could be a potential solution to address the risks associated with manually unloading trailers and to help accommodate an aging workforce.

Project Aims

Through participation in the MSD Solutions Lab Pilot Grant Program, the goal of the project was to investigate the effectiveness of HeroWear's Apex 2 exosuit on reducing fatigue, muscle strain, and other ergonomic risks in users. The initial focus of the study was on the job task of unloading tractor trailers, as this job involves several employees per truck that manually lift and carry boxes off the truck. General Electric Aerospace was also interested in determining the employee acceptance and operational benefits and efficiency of using the HeroWear exosuit.

Implementation of Exoskeletons

Ten randomly selected employees were trained and fitted on how to wear the HeroWear suits by the HeroWear training team. Employees wore the suits over the course of six weeks to get familiar with and learn how best to use the exosuits for their specific tasks. Participants completed initial questionnaires and surveys at the start of the pilot program, three weeks in, and at the end to provide feedback on how the exosuit helped reduce fatigue, lowered physical demands, and enhanced efficiency.

To evaluate the ergonomic risks, wearable surface electromyography sensors were used to measure muscle activity. Nine employees, seven men and two women, participated in the muscle testing. Eight wireless, surface electromyography sensors were attached bilaterally to biceps, quadriceps, hamstrings, and lumbar extensor muscles. Calibrations for maximum voluntary contraction, a measure of muscle strength that indicates the

greatest amount of force a muscle or group of muscles can generate, were conducted for each individual and each muscle. Employees were coached over a two- to three-week period on how to perform maximum voluntary contractions prior to the muscle testing data collection to reduce error when performing the maximum effort.

Pilot implementation began with a team kickoff meeting to provide an overview of the project. Following this, HeroWear personnel conducted training sessions on how to use the exosuit and ensure proper fit. Coaching was also offered by HeroWear staff on the correct usage of the exosuit, along with gathering feedback from participants. Baseline measurements were taken to assess ergonomic risks and productivity levels for the job, both with and without the exosuit. Over four to six weeks, employees continued to practice using the exosuit, during which time productivity and employee questionnaires were administered. After one to two months of usage, ergonomic risks and productivity were evaluated using wearable sensors and time study techniques. An interim report was then developed to highlight the benefits observed and lessons learned during this phase. Based on these findings, course corrections were made to adjust the pilot parameters, followed by an additional four to six weeks of usage of the exosuit, where productivity and employee questionnaires were again collected. Finally, after this extended period, a second round of data collection on ergonomic risks and productivity took place using wearable sensors and time studies, culminating in the development of a final report and case study.

Impacts and Lessons Learned

Results of the muscle activity data from the wearable sensors were inconclusive, and the exosuit appeared effective for only some employees. Muscle activity was compared for each testing condition while wearing and not wearing an exosuit. An analysis of muscle activity for each task condition and individual shows that, for some muscles, activity decreases in certain cases, while for others, it increases. These results seem to be specific to the tasks performed and the body mechanics involved. A reason for this inconsistency in muscle activity may have been asymmetric twisting while material handling. Since boxes without handles were used, employees staggered their hands to make it easier to lift boxes. This creates asymmetric postures of the arms, back and legs, and could explain the differences in bilateral muscle activity. Moving forward, boxes with handles may circumvent some of these issues with asymmetrical postures and subsequent differences in muscle activity and strain.

A review of employee feedback collected through surveys revealed more conclusive evidence. Eighty percent of employees who utilized the exosuits in the pilot found that the exosuit transformed their posture. Users reported that the exosuit helped them maintain proper shoulder posture, supported spinal alignment, and offered lower back support when they reached forward during material handling. Those using the exosuit also appreciated the adjustable tension and support offered by the device. Employee feedback also suggested that the exosuit rewards proper body mechanics, with 90% of employees saying it helped their body mechanics. Wearing the exosuit provides noticeable support when squatting down, assists with lifting when rising from a squat, and makes bending at the waist, an action that is generally not recommended, more challenging.

A few site-specific challenges arose during the pilot. The main drawback for employees was that they routinely wear fall protection for their daily work. This makes it difficult to comfortably wear the exosuit underneath the fall protection. In addition to comfort, it became cumbersome for employees to regularly don and doff fall protection and an exosuit multiple times throughout their shift.

Employees at the site have also already created safe habits, such as raising the forks of their forklift to a waist-level working height to ensure proper ergonomics while lifting and moving packages, and not engaging in lifts over 40 lbs. for a single worker. Breaks at the site are also frequent, allowing employees to rest in between strenuous work tasks. These habits contribute to the prevention of MSDs, which may complicate the

assessment of the effects of the exosuits, as most employees are already practicing safe material handling movements. Yet, despite these positive habits, trialing of the exosuits was still seen as a necessary step to determine if risks and injuries could be further lessened.

Overall, although the asymmetric twisting involved in the work made it more challenging to interpret the results related to muscle activity from wearable sensors, employees believed that the exosuits helped improve their body mechanics and posture. Yet, determining how to best utilize both the exosuit and fall protection in tandem is still to be determined. Future research and pilots should continue to explore the interaction between exosuits and fall protection as well as the impact of exosuits on worksites with strong ergonomic safety processes already in place to determine their incremental impact.

GE Aerospace

GE Aerospace is a world-leading provider of jet and turboprop engines, components, and integrated systems for commercial, military, business, and general aviation aircraft. With a strong focus on sustainability and next-generation propulsion systems, GE Aerospace supports a global fleet and partners with major airframe manufacturers worldwide. Its commitment to safety, performance, and environmental responsibility drives its contributions to the future of flight.

HEROWEAR

At HeroWear, we design and manufacture exosuits to take the strain off the backs of hardworking men and women around the world. Our exosuits work like an extra set of back muscles, offloading up to 40% of back muscle strain, reducing injury risk, fatigue, and work-related discomfort for users. We have thousands of users at hundreds of customers in more than 30 countries around the world.