Wearable Device Acceptance in Manufacturing: An Industrial Case Study

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Abstract

Research has shown the benefits of incorporating wearable devices in manufacturing operations, including improved productivity and worker safety. However, many barriers prevent the actual use of wearable devices in industry. In this paper, we present a case study of wearable device implementation at a medium-sized manufacturing facility. Ten Strive Sense3^{TM} smart compression shorts were provided to the manufacturing facility. They were used by operators across the facility to measure overall worker load. Challenges with the devices were immediately apparent, primarily related to the invasive nature of the device. The employer also had significant challenges interacting with the device's app, preventing the acquisition and use of collected worker data. Partnering with Strive, adjustments to the wearable devices were made, primarily in the form factor, to improve worker acceptance. We will present an overview of the pilot implementation process, as well as important lessons-learned along the way. Finally, challenges identified in this case study will be compared to the implementation barriers reported in literature.

Keywords

Safety, Manufacturing, Wearable Technology, Case Study

1. Introduction

Manufacturing jobs are often physically demanding, and often lead to muscle fatigue and operator overwork injuries. Certain types of jobs are more physically demanding than others, though the difference in work and physicality can be hard to quantify. To measure the physical work, athletic teams often use wearable sensors to track energy expenditure, postures, and distance moved [1]. The same measurement principles can be applied to manufacturing work, using the same type of technology [2].

In this case study, we implemented Strive Sense3^{TM} smart compression shorts wearable devices at a manufacturing facility. The goal of using the device was to quantify how much lower body movement was made in terms of hours standing, distance moved, and some elements of posture that could be inferred. Also, we were interested in muscle load of the main leg muscle groups such as glutes, hamstrings, and quadriceps. There was interest in understanding the difference in the amount of movement between the operator jobs to better balance workload and better define physical operator requirements. There was also an overall interest in understanding the feasibility of using wearable sensor devices in a manufacturing setting, particularly in terms of assessing comfort and usability for the workers.

Our research team has previously used Strive [3] wearable devices to measure muscle activity, physical load, and performance of NCAA Division-1 athletes [4], [5]. The device used in this case study was the Strive Sense3^{TM}, a pair of compression shorts equipped with an inertial measurement unit (IMU) in the "pod" which is mounted on the waistband of the shorts and surface electromyography (sEMG) sensors which are positioned over the large muscle groups in the wearer's legs. These sensors are used to measure external load (sum of accelerations across all axes during movement, divided by a scaling factor) and muscle load (sum of muscle activation from all sEMG sensors, divided by a scaling factor), respectively [4]. A companion smartphone application and web dashboard are used to interface with the data collected from Strive Sense3^{TM}. The use of wearable technology has become commonplace in athletics [6]. The technology is now being extended to measure and improve performance of operators in manufacturing settings. However, many barriers exist during implementation of these devices in an industry setting [7]–[12]. These barriers often include: (1) comfort/discomfort and range of motion of device placement [6], [13], (2) the ability of the device to make the work task more effective versus the intent of the task [6], [14], (3) expectations