The potential benefits of an exoskeleton in industry settings

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1. Introduction

Various manual work tasks necessary to industrial manufacturing processes are difficult to automate – even today - due to their complexity. This is particularly the case in assembling and dismantling operations, such as those used in the automotive or food processing industries, where material handling and heavy-goods lifting are typically carried out by shop-floor workers. This type of work entails severe risk of injury, resulting in low job productivity, high long-term dropout rates, and even disability. To overcome these challenges, a new project, called Robo-Mate, has been designed.

The objective of Robo-Mate is to develop an intelligent, easy-to-manoeuvre, and wearable body exoskeleton for manual-handling work. The fundamental idea behind Robo-Mate is to enhance work conditions for load workers and facilitate repetitive lifting tasks, thereby reducing the incidence of work-place related injury and disease. As a consequence, productivity, flexibility and the quality of production will increase.

Exoskeletons can readily be found in certain fields and their development to date has been mainly driven by military and medical applications. However, such models are ill-suited for industrial use due to excessive weight or inadequate functionality, such as not being able to provide the lifting and/or manual handling support indispensable to industrial settings. Therefore, developing an exoskeleton specifically destined for use in industrial environments is crucial.

The first steps in the project is to analyze the needs for an exoskeleton, to formulate a use case (to focus on in development), and then to come to a list of prioritized requirements to fulfill.

2. Methods

The question about the needs have been answered on the basis of a literature review, stakeholder interviews and expert sessions, both on the macro-economic level, the meso-company level and the micro-worker level. On that basis functional requirements have been formulated. Both needs and functional requirements have been generated as input for a Quality Function Deployment (QFD) table. Data was further analysed to establish and prioritize specific elements for the design of the exoskeleton system.

3. Results

Based on the industry needs, the following two cases were defined for further elaboration into design needs and specifications:

- Use-case 1: frequent two handed lifting of loads of medium weight (up to 15 kg)
- Use-case 2: one handed manual operations (assembly or disassembly) in stressful body posture
- The major outcomes from the QFD analysis are
- The data indicates the stakeholder's top priorities for the concept design are safety and usability.
- The data indicates that the exoskeleton should be designed to comfortably be worn by the user (anthropomorphic fit and thermodynamic comfort), and that it should stabilise movements within the users range of movement. Additionally, the movement of the exoskeleton should match the user's movements and support the body throughout a range of static and dynamic postures while stabilising the movements and minimising compressive forces and muscle loading.
- The data indicates that the exoskeleton should have wide adaptability, is not restrictive in use should easily allow workers to rotate between one and two-handed task, have built in adjustability for users, and enable precise movements.
- The data indicates that the exoskeleton should be risk assessed and trial tested throughout the design process and it should meet all applicable standards and codes of practice. Additionally, the exoskeleton should be designed with other exoskeleton users or ambulatory workers in the vicinity in mind.

An overview of various types of exoskeletons which reflects the above outcomes will be presented at the conference.