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Exoskeleton-Enhanced Manufacturing: A Study Exploring Psychological and Physical Effects on Assembly Operators' Wellbeing

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Abstract : Industry 4.0 offers possibilities for increased production volumes and greater efficiency whilst at the same time presenting new opportunities and challenges for the human workforce. Exoskeletons have been used in healthcare and are now starting to be adopted in manufacturing. The potential benefits of reducing fatigue and physical strain are attractive prospects of the technology for industry; however, the novelty of exoskeletons and surrounding ethical issues raise concerns amongst the stakeholders. The current case study investigated the introduction of an upper body exoskeleton designed to support posture but not increase physical strength in a factory over three time points: before the exoskeleton was introduced, and one and two months post-introduction once operators had experienced working with it. The main focus was to evaluate changes in operators' workload, situation awareness, technology self-efficacy, and physical discomfort following the introduction of the exoskeleton. After using the exoskeleton over two months, operators reported a decrease in temporal demand and an increase in performance of the NASA TLX instrument. Furthermore, over the second month, operators' self-reported technology self-efficacy scores increased, but at the same time, their situation awareness decreased. Interestingly, operators' physical discomfort after using the exoskeleton for two months increased from not uncomfortable to quite uncomfortable in the shoulder, arm, and middle back regions. The results suggest that self-perceived task efficiency improved; however, increased discomfort and decreased situation awareness scores indicate that two months might not be long enough for the exoskeleton to be integrated into operators' mental body schema. The paper will discuss further implications and suggestions for exoskeleton introduction to manufacturing environments.

Keywords : exoskeleton, manufacturing, mental workload, physical discomfort, situation awareness, technology self-efficacy
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