UNIVERSITY WEST

Design and Evaluation of Augmented Reality for Industrial Operators: Informing Design Guidelines

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ACADEMIC DISSERTATION

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Abstract

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Automation has improved efficiency and quality in manufacturing, yet some tasks such as assembly, inspection, and maintenance still depend on manual work because of their complexity and need for flexibility. Augmented Reality (AR) can support these tasks by placing digital information directly in the workspace and registering it to the objects involved. While AR hardware has developed considerably, design knowledge for industrial AR remains fragmented, and many evaluations are conducted in laboratories with participants who do not routinely perform the work. How AR should be designed to support industrial operators therefore remains insufficiently grounded in production practice.

This thesis addresses this gap through Design Science Research. Four AR guidance prototypes were developed and evaluated in four industrial settings across three manufacturing companies, covering House assembly, Inspection, Tool change, and Changeover operation. Each prototype was evaluated in the setting where the work is normally carried out, by the people who normally carry it out: 25 assemblers, inspectors, operators, and maintenance engineers. Contextual inquiry and observation were combined with measures of usability, workload, and task completion time. The empirical findings from these cases were combined with a systematic review of existing AR design guidelines to identify and consolidate design knowledge for industrial AR.

The results show how recurring operator requirements can be translated into concrete forms of AR guidance. They also identify conditions that determine whether AR supports or interferes with work, including registration accuracy, visual clarity, operator control, physical and cognitive comfort, and alignment with the pace and coverage of the workflow. The main contribution is a set of thirteen design guidelines for operator-centric AR guidance, derived by synthesizing empirical findings from the four industrial cases with a systematic review of existing AR design guidelines.