Human interaction with variability in manual manufacturing processes. A case study.

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Abstract

This paper summarises the investigation of human interaction with external variability in a complex manual manufacturing process. Humans play a key role in complex manufacturing processes in industry and skilled operators carry out critical tasks in different industries such as aerospace, automotive and heavy-machinery. Most of these processes are difficult to automate due to the external variability presents in the processes. To understand how humans are coping with this variability and successfully delivering a product complying with the standards required is fundamental in order to automate the process.

The processes investigated within this paper are grinding and polishing of metallic components for high-value applications. First, the sources of variability were identified and the key characteristics for variability determined and after that, the operators performing the process were observed and interviewed, paying special attention to those steps where variability was present.

The results suggest that operators are able to adapt to external variability whilst delivering the product within specification, but they were not able to explain how. In addition, it seems that they have conscience of dealing with variability but, probably because they acting under skill and rule based behavior (Rasmussen, 1983), they could not clarify what are the methods used to successfully handle this variability. This means that, although they are successfully reducing external variation, it was very hard to extract their knowledge and to determine how they were coping with the variability because the tasks were performed without conscious attention.

They mainly use vision to check their work and they control critical features as marked in the operational procedure. They know when the tool is degraded but they cannot establish how often this happens. Operators adapt to this deterioration and customise their own tools. In order to automate the process, the automated solution should be able to monitor wear of the tool. In addition, it has to measure tool deterioration and be able to adapt to this deterioration by changing pressure applied and time of operation as operators are doing.

For automation purposes, the biggest challenge found has been how to deal with the wear of the tools. Operators have proved that they are capable of accommodating this variability but, if the process is automated, the solution would also need to overcome this wide range of wear in the tools. This will involve a profound study of tool deterioration and operators' behaviour in order to link wear, pressure applied and time of operation. Furthermore, it was observed that operators prepare and customize their own tools. This customization has no effect in the final product delivered but it must be considered in the solution.

1. Rasmussen, J. (1983). Skill, rules and knowledge: Signals, signs, and symbols, and other distinctions in human performance models. *IEEE Transactions on Systems, Man, and Cybernetics*, *13*(3), 257–266.