Measuring Complexity in Mixed-Model Assembly Workstations

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Over the last years, the number of introductions of new and different car models in automotive industry has increased drastically. The increase of product variety is necessary to answer the market and sustainability demands, however this high variety makes the mixed-model assembly lines become rather complex. As a consequence, new approaches to deal with production processes are required. The introduction of new models increases the complexity of (re)designing factory processes and workstations, and consequently increases significantly the overall complexity of the production system.

Nowadays it is known that the elements presented above increase the manufacturing complexity, but the exact causes and impacts on manufacturing processes are still unknown. Because of the impact of complexity on productivity, it is important to understand what complexity is and what are its main drivers, for that a definition of complexity is proposed and 2 models are suggested to characterize workstations complexity. The research on which this abstract is based was carried out within the vehicle industry of Belgium and Sweden and it is based in real production data, the focus is therefore on workstations along a driven mixed-model assembly line.

A good definition of complexity has to be generic enough to be applicable to different manufacturing systems and at the same time specific enough to guide the decision whether a system is complex or not. After extensive communication with the project partners the following definition is proposed : *"Complexity is the sum of all aspects and elements that makes a task or a set of tasks mentally difficult, error-prone, requiring thinking and vigilance and inducing stress"*.

Subsequently the complexity definition, a set of 11 complexity direct drivers is extracted from real production data and interactions with manufacturers. These drivers are : the picking technology, bulk/sequence kit, the number packaging types, the number tools per workstation, the number machines per workstation, the number work methods, the distance to parts, the variants of same model, variants in this workstation, the different parts in workstation and the number assembly directions. Based on this set of complexity direct drivers two different complexity models are developed with the goal to measure and determine if workstations have a low and high complexity.

An initial model is proposed based on a complexity measure score. This complexity measurement is developed taking into consideration a weighted sum of the 11 variables, i.e., the drivers. Then a statistical model is proposed based on logistic regression, the goal is to adjust the weights and/or reduce the number of variables.This model was defined using only with 4 variables : the number packaging types, the number work methods, the different parts in workstation and the number assembly directions.

To validate the proposed models, a set of experiments were carried out based in a set of 76 workstations which were classified as low or high complex. Initially this set contained 41 workstations classified as low complex and 35 workstations classified as high complex. The initial model was able to classify 82% of the workstations correctly and the statistical model 84% of the workstations correctly.

The complexity definition proposed is able to characterize different manufacturing systems and the models are able to define a complexity measure for assembly workstations.