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A model for manufacturing systems simulation with a control dimension

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Abstract

The objective of this article is related to the potential improvement of computer simulation as applied to manufacturing systems. Through our contacts with the operational environment, we have observed that simulation is not used to its full potential. One remark is that existing tools are not adapted to modelling the decision process: they fall short of offering effective integration into the control process of production. Control is usually limited to scheduling and does not lend itself to practical application. In order to enhance the capabilities of computer simulation and make it more responsive to today's industrial needs, we present a way of introducing such control into simulation by pursuing generic and applicable concepts. The core concepts that constitute the framework of our research are a global structure supporting the co-ordination and co-operation relations; a local structure presenting a typology of industrial control adapted to our needs; a control centre, the main concept used to introduce control into simulation. The modelling language used is UML and the model is implemented using the object-oriented language JAVA. An industrial application was carried out in the company *Alcatel* with the help of the *Apollo* platform.

Keywords: Manufacturing systems; Industrial control; Decision-making; Modelling and simulation

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1. Introduction

Simulation is widely used in the world and therefore it is very familiar [12]. The most important reasons and advantages of simulation methodology for modelling manufacturing systems are that:

- realistic models are possible, they are a practical approach to representing the important characteristics of a manufacturing system and may incorporate any complex interactions that exist between different variables;
- options may be considered without direct system experimentation and alternative designs can be easily evaluated, independently of the real system;
- a computer simulation models ability to directly address the performance measures typically used in a real system;
- non-existent systems may be modelled;
- visual output helps and assists the end-user in model development and validation;
- no advanced mathematics is required;
- analytical methods are perceived to be unhelpful by management or may require over-simplification.

Law and Kelton [27] summarise some reasons for the spectacular increase in the use of simulation in the field of manufacturing systems as follows:

- automated systems are so complex they can typically be analysed only by simulation;
- computing costs have been reduced by microcomputers and engineering workstations;
- improvements in simulation software have reduced model development time, thereby allowing for more timely manufacturing analyses;
- the availability of animation has resulted in a greater understanding and use of simulation by engineering managers.

The use of simulation for manufacturing systems design and analysis is rightfully recognised by scientists and industrial managers and the literature is abundant in this field. We can refer to several subjects: productivity analysis [36], Just-In-Time system design [44], comparison of two kinds of line management [9], flexible hybrid assembly system analysis [40], automated overhead warehouse system description [31], business process modelling [21]...

Traditionally, simulation has been used for offline decision-making. One of the limitations of its use for online decision-making is the considerable amount of time spent in gathering and analysing data. Consequently, this has resulted in decision-makers relying on simulation primarily for offline decision support and not for the critical online decision-making that may arise. In real-time control, the three key issues are data acquisition, quick response and instantaneous feedback. The major components of online simulation systems generally consist in a data acquisition module, a simulation model and a cell controller. Over recent years, some articles have been published in this field. However, most of them only concern scheduling