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European Journal of Operational Research 161 (2005) 111–125

EUROPEAN JOURNAL OF OPERATIONAL RESEARCH

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Reducing simulation models for scheduling manufacturing facilities

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Available online 3 December 2003

Abstract

Within the framework of the application of their industrial management system, companies compile a Master Production Schedule (MPS). However, once the MPS is released, daily events may require it to be brought into question. The use of reduced models within the framework of flow dynamic simulation enables quick decision-making while maximizing the use of resources and minimizing risk. The article shows the advantage of model reduction and how we arrive at it. Afterwards we develop an analysis of the influence of the model factors by highlighting the differences between the simulation results and MPS. Finally we show the circumstances in which the flow dynamic simulation with reduced models is relevant.

Keywords: Simulation; Modeling systems; Re-scheduling; MPS

1. Introduction

Increasing both productivity and reactivity has become a prime objective for managers of manufacturing systems. Productivity implies paying very close attention to external variables such as clients, sales etc as well as to resources (machines, labour etc.). Reactivity can lead to extreme flexibility in planning, an excellent awareness of the expectations expressed by external factors (customers, socio-economic context...) and a perfect awareness of expectations and activities within the organisation. This may give rise to increasingly immediate problems such as being aware of the situation of the production system at any moment, measuring gaps and changes and being aware of their causes, knowing and measuring the changes in the factors involving employees.

New elements must therefore be added to the production management system in order to increase productivity and reactivity and this based upon improved knowledge of what happens on the shop floor.

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doi:10.1016/j.ejor.2003.08.042

The system of planning and re-planning should thus take into account all the events related to production resources whilst at the same time maintaining their meaning.

Within the framework of the application of their industrial management system, companies compile a daily, weekly or monthly Master Production Schedule (MPS)—weekly being the general rule. The choice of a particular MPS gives rise to a "predictive scheduling" with respect to a group of Manufacturing Orders (MO), viewed statically at this level as a "complete entity". "Predictive scheduling" is the function that concerns the MPS initially established with the Manufacturing Planning and Control System (MPCS), in opposite of "Reactive scheduling" that gives the new MPS established after disruptions during the concerned week. Each MO deals with the manufacturing of an article, has a manufacturing routing and hence relates to a list of Work Centers (WC). At this level of planning, load/capacity equilibrium is obtained via the "management of critical capacity" function or Rough-Cut Capacity Planning (RCCP) which essentially concerns bottlenecks [21]. Goldratt and Cox, in «The Goal» [6] put forward the Theory of Constraint (TOC). This approach seeks to identify capacity constraints, attempts to use them as best as possible and to subordinate all other things to the exploitation of these constraints. The aim of the TOC is to maximise the bottleneck production. When reached, equilibrium means that the MPS is validated and goes into operation for the period (P) in question. This validation is made after the establishment of different scenarios that must be evaluated by the master scheduler.

However, once the MPS is released, daily events may require it to be brought into question: it's the problem of rescheduling.

The real time systems performing manufacturing checks (production reporting) will input information very rapidly into the management systems [13]. The decision-making process (Fig. 1) include the establishment of scenarios, the evaluation of these scenarios and finally the decision. The ever present problem today is the speed at which decisions can be made when faced with all this information which may appear to have lost all meaning [15,16]. Indeed, when the decision is made within the space of a few hours only, the situation on the shop floor has already changed. Following predictive scheduling, the MPCS will propose a placing of the MO that we have said to be "static". Effectively their load has been calculated using the cumulated mean processing time per MO taken as a fixed time entity (mean unit run time multiplied by the number of items per MO plus the mean setup time). At this level, the manager will seek to saturate the bottlenecks (this is the essential role of Rough Cut Capacity Planning). Following the release of this "MO portfolio", the time variables relative to the arrival intervals, λ, and service durations, μ, on the work centers (queuing systems theory) will create temporary overloads and under-loads. In this context, the apparent balance emanating from the predictive scheduling will, in fact, be an imbalance that the manager has to handle. Here it is useful to use dynamic simulation (discrete event simulation) of flows not only to highlight possible overloads but also to locate and deal with possible residual capacity (temporary underload). A rescheduling following a problem will inevitably lead to an even more critical situation on the bottlenecks. It becomes important to "retrieve" all the "time spaces" that have been freed by the unpredictable phenomena influencing production flows. It is the main problem of this decision-making process. The master scheduler look for the first schedule that attains to these objectives.

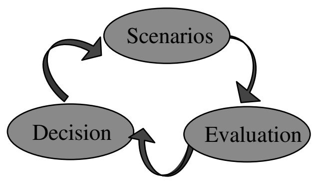

Fig. 1. The decision-making process.