DEVELOPMENT OF MES FUNCTIONALITIES FOR SUPPORTING MANAGEMENT DECISIONS

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ABSTRACT

The modern production information engineering systems highly utilize computer aided application systems. As a result of research and development activities three large application systems have been developed which offer "turnkey" solutions for the management to support decision making. They are Enterprise Resources Systems (ERP), Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) and Manufacturing Execution Systems (MES).

The scope of this paper is to overview the functional components of the aforementioned systems and to investigate the possibilities of integrating them.

Among the MES functionalities the production tracking and monitoring have significant importance. They can be applied as feedback for the decision making system thus extending the traditional roles such as production reports generation, logistical and distributional tasks.

The supervisor function of the MES proceeds from the cumulative behaviour of production. The qualitative and quantitative descriptors of the output of the production and the utilization of the resources must be compared to the production plans. This can be one of the aspects of the decision making system of the production management.

The paper also presents a new intensity based model entities for projects and production activities in order to manage the tasks of production planning and scheduling. A brief summary will be given on the experience obtained so far by using a software application "ProTerv".

KEYWORDS: Manufacturing Execution System, Enterprise Resources System, Systems integration

INTRODUCTION

The modern production information engineering systems highly utilize computer aided application systems. As a result of research and development activities three large application systems have been developed which offer "turnkey" solutions for the management to support decision making. They are as follows:

- Enterprise Resources Systems (ERP),
- Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) and

- Manufacturing Execution Systems (MES).

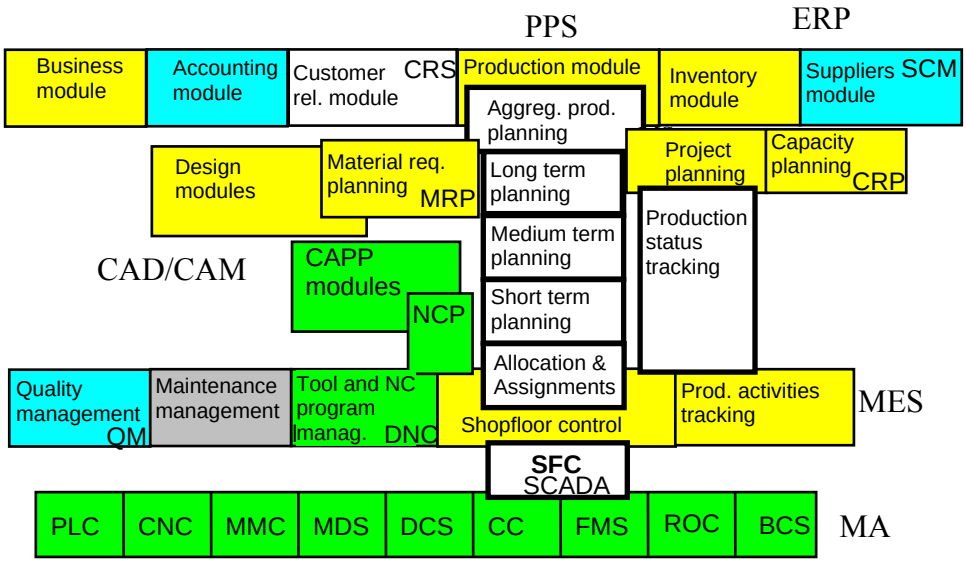

Figure 1
Hierarchy of production information system components

Figure 1 shows a typical hierarchical layout of production information systems. The upper three levels involve the aforementioned computer aided application systems, while at the lowest level belongs to the Manufacturing Automation (MA).

In the field of make-to-order (MTO) type production, integrated planning and execution systems are more and more important because of the increasing requirements of cost, quality and time performances. MTO production is characterized by individual product usually designed from a set of firm level components, and small batch production on universal CNC machines at job-shop environment. When the products to make is quite complex then we can denote them as separate projects. In this environment there are a lot of uncertainties in incoming orders and availability of machines, equipment or human resources. For this reason, up-to-date engineering data and fast real time information management are most important tools to achieve production goals.

The project-oriented production of enterprises producing individual machines requires high level project planning and scheduling application, which plans and schedules the time flow of project activities with special regards to the finite production resource capacities and hard time (due date) constraints.

OVERVIEW ON MES FUNCTIONAL COMPONENTS

A Manufacturing Execution System (MES) is a collection of hardware/software components that enables the management to control production activities from order launch to finished goods. While maintaining current and accurate data an MES guides, initiates responds to and reports on plant activities as they occur. MES provides mission-critical information about production activities to decision support processes across the shop floor level of manufacturing management [1].

MESs are intended to provide plant-wide insight into the production process, informing about the state of production, production performance, and emergence and allocation of production costs to products. MES may improve better resources planning and allocation, allows supervising the process execution, thus it is possible to promptly identify and react to abnormal events. Product tracking, as the core functionality of a MES system has the main objective to accompany and supervise the manufacturing process. Based on requests from the production manager or upper Enterprise Resources Planning (ERP) system, the feedback information from low level Supervisory Control and Data Acquisition (SCADA) systems, and inputs from the user/operator it has to be in the position not only to know the current state of production and state of all products, but also to recognize abnormal, deviant or critical states in the production process [2].

It brings together data from a wide range of sources into one integrated whole, it can [9]:

- download the job schedule from your ERP,
- allow inventory to be allocated as used,
- generate labels for inventory created,
- follow the quality control plan and prompt operators to record checks,
- provide real-time SPC alarms for those responsible for the process,
- connect direct to plant equipment and sensors (PLCs) to monitor when machines are running, count production and spoilage,
- upload actual performance back to the ERP,
- providing real-time alarms and exception reports,
- analyse historic data and perform trend reporting.

MES FOR SUPPORTING PROJECT ORIENTED APPROACH

The supervisor function of the MES proceeds from the cumulative behaviour of production. The qualitative and quantitative descriptors of the output of the production and the utilization of the resources must be compared to the production plans. This is the base of the decision making system of the production management. Figure 2 shows the work spent on certain task which varies during the execution. In this example task starts at a low intensity then gradually increases.

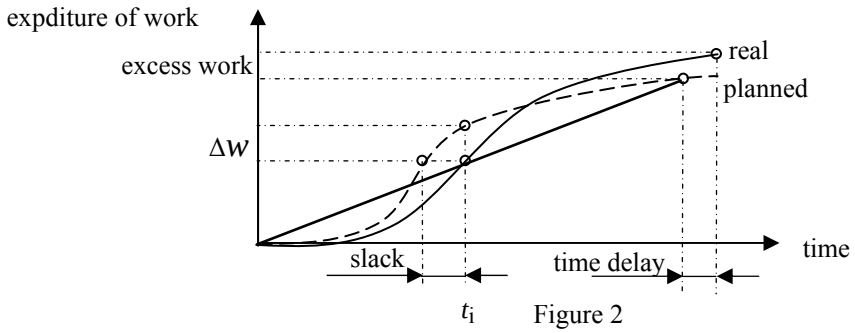

Figure 2
Real and planned expenditures of work on a task

In make-to-order manufacturing three different kinds of projects can be classified. They are as follows:

1. Project work for tender
   This is the basic version of project work, which consists of the analysis of demand (or: interest) of the potential purchaser (or: customer), a feasibility study of the project and determination of the main data of the project. The deadline of the project previously accepted has to be determined on the basis of such a model, in which the activities and their work demand are only known at an estimated level.
2. Detailed project planning work
   This is the principal version of project work including all the known phases of product design, technology process planning and production planning on the basis of the customer's order. The project must be included in the actual projects running in the same period. Scheduling of the project is to be carried out by taking into consideration the actual business goals and by fixing the constraints and the objective function.
3. Ad hoc redesign, replanning and rescheduling of projects
   This is a correcting and modifying version of project work. It is used when certain modification is required due to unexpected factors, failures etc.

For a concrete project some tasks can run parallel, while other tasks may have precedence constraints. There can be several projects in progress at the same time which behave as they would competing for the limited resources. In a real manufacturing environment there are tight deadlines. In this model it was assumed that the enterprise may have cooperative suppliers, and some of the activities can be outsourced.

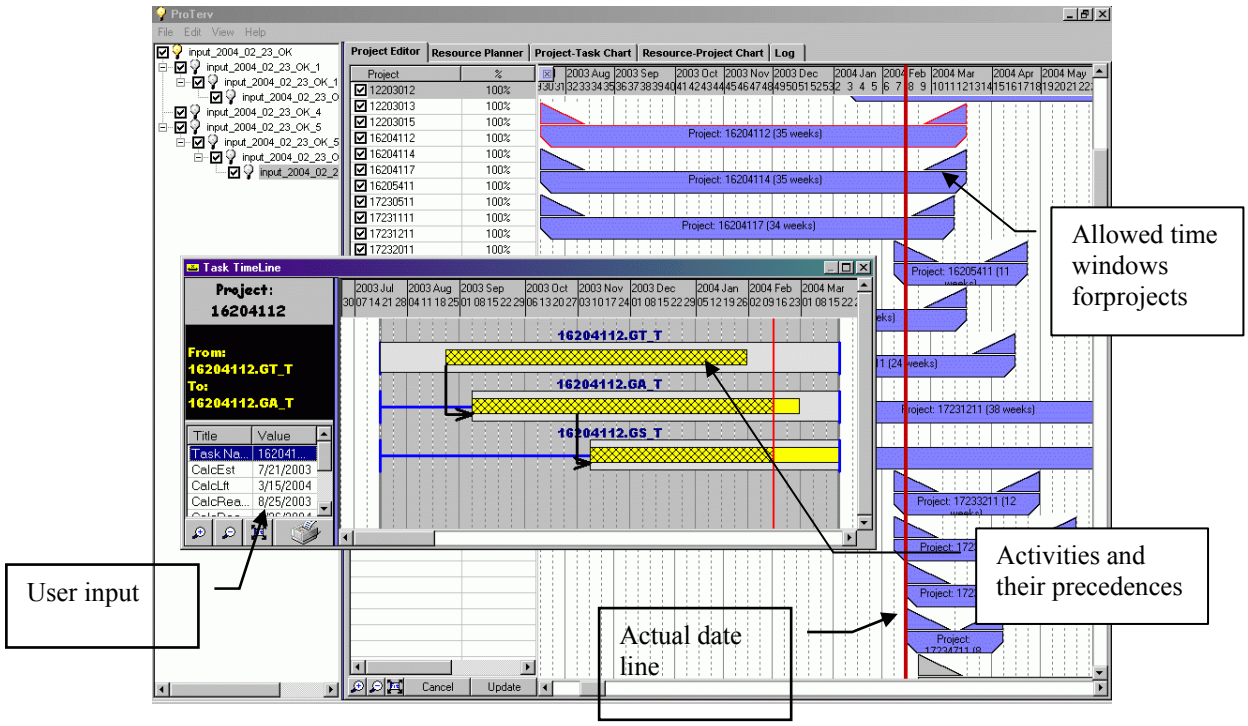

Figure 3
Screen window for defining project activities in the ProTerv production planner

In the recent years new decision support software has been developed called "ProTerv" [7]. The work was carried out by the Computer and Automation Research Institute of the Hungarian Academy of Sciences (G. Erdős [6]) in collaboration with Machinery Plant of General Electric, Consumer and Industrial and Department of Information Engineering of University of Miskolc. It supports variable intensity tasks. It requires input form various sources such as:

- database of the connected ERP system,
- MES data on actual production progress,
- CAD/CAM data such as BOM data,
- various user entries.

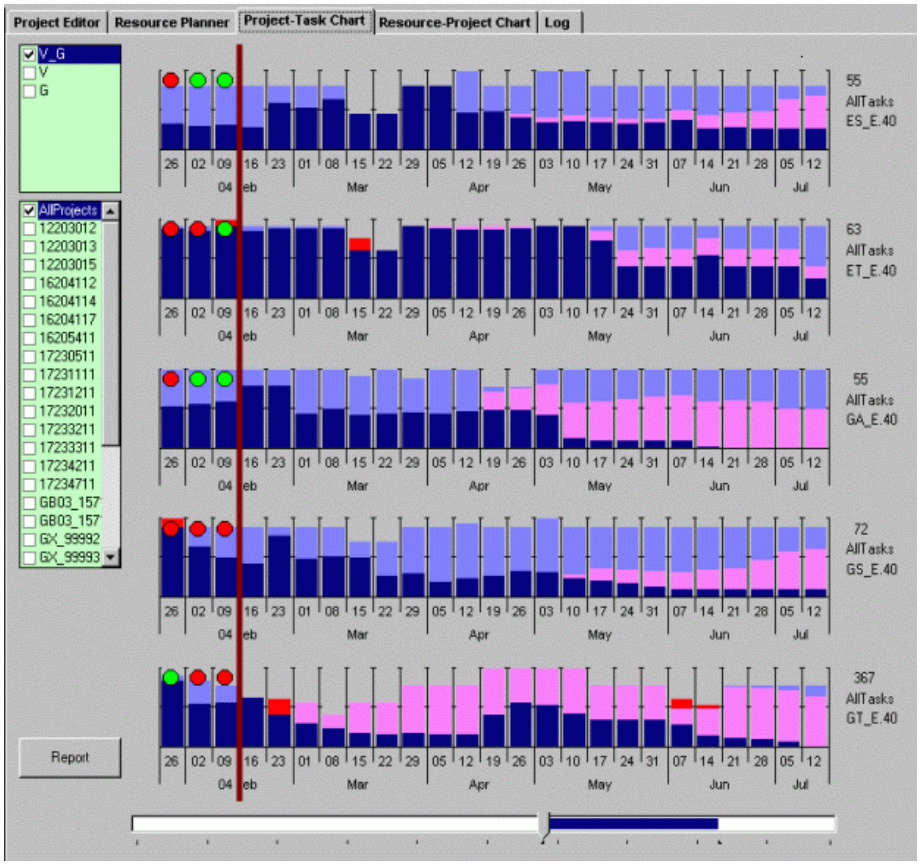

Figure 4
Production plan as the output of „activity rate" based scheduler

Figure 4 shows a product plan generated with "ProTerv". It contains the real activity rates as well as the planned ones. You can also notice when there are reserves in the system and also you can detect the activities which would require resources beyond the limit.

The pilot version of "ProTerv" has been introduced by Machinery Plant of General Electric, Consumer and Industrial. The experiences show the fact that all the three aforementioned classes of project types require data collected by MES. The reliability of the data is also a key factor.

CONCLUSION

The number of computer applications in production information engineering has been continuously growing. These applications cover all aspects of production activities. The applications tend to form application groups. The integration of application groups and functional components demands various requirements and techniques. The development of MES, ERP and CAD/CAM functions stems from the demand on integration.

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