PRODUCTION MANAGEMENT IN THE TEXTILE INDUSTRY USING THE "YFADI" DECISION SUPPORT SYSTEM

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ABSTRACT

The decision support system (DSS) presented here is dealing with the production planning and scheduling in the textile industry. The DSS aims at the efficient management of a mixed production system (job-shop and flow-shop), such as that of the textile industry. Its main feature is the effective combination of a database and a model based management system in order to merge existing expert knowledge. A powerful user interface makes the DSS user-friendly and a multi-module formulation is used for better interpretation and analysis of the production procedures.¹

KEYWORDS


INTRODUCTION

The textile industry is an appropriate field for the study of production and scheduling problems because of its multi-production operations like warp making, weaving, dyeing and cloth cutting and because of the combination of make-to-stock and make-to-order production. These specific characteristics make the production planning, scheduling and control a difficult task. Consequently, the development of appropriate computerized systems in order to help the management in decision making is necessary.

The "YFADI" DSS in this first release covers the operations of warp making and weaving and can easily adapt to industrial applications with similar production environment. A future release of this DSS will cover all the phases of the textile industry, from spinning to the manufacture of clothes.

SYSTEM ANALYSIS AND DEVELOPMENT

The system provides efficient production management tools applicable to the textile industry. The production plans meet the demand for each product considering due dates, machines'...
capacity and raw materials' limitations. Particular attention has been paid to the following features:
- adaptability to similar mixed production systems,
- user friendliness,
- rapid and efficient information interchange in order to cope with frequent changes in production schedules,
- flexibility.

The development of the DSS has been made through the following stages:
- Fact finding (gathering information concerning production procedures),
- Description and modelling of the system,
- Design (construction of a logical model, employing data flow diagrams),
- Coding,
- Implementation, including experimentation and prototyping of the system.

"YFADI" can work in a standalone system or in a network, supporting more than one users that may be situated in distant locations of a firm.

![Diagram of YFADI Decision Support System]

Fig. 1: The modules of YFADI Decision Support System

The implementation of the system was effected in collaboration with a Database Management System (Oracle DBMS), commercially available, and a Model Based Management System (MBMS), developed by the research team of the project. The DBMS and the MBMS work efficiently under a user-friendly interface. The Knowledge Base of the system was included in simulation and optimization models as well as in algorithms used in order to evaluate alternative schedules, make predictions, define systems' variables and perform analysis of various production situations. For the better presentation, analysis and implementation of the system, the MBMS is partitioned into eight modules:
- Forecasting,
- Orders Processing,
- Aggregate Production Planning,
- Master Production Scheduling,
- Materials Requirements Planning,
- Inventory Management,
- Purchasing,
These modules communicate via the database. The basic interchange of data among these modules are seen in Fig 1. The above modules are written in mixed C and SQL programming languages.

FORECASTING

The Forecasting module makes the short, medium and long term forecasts, which are stored in the database, and measures their accuracy. The inputs of the module are the historical sales data, the whole sales volume of the branch, the outcomes of bid participation, experts' forecasts and the time horizon of the forecasts. The algorithms employed are:
- Multiple regression analysis,
- a new adaptive method for extrapolative forecasting (Pantazopoulos and Pappis, 1993a),
- adaptive Holt-Winters forecasting based on Williams extension (Pantazopoulos and Pappis, 1993b), and
- combination of forecasts based on smoothed weights (Pantazopoulos and Pappis, 1993c).

The module produces reports containing forecasts, comparative results and graphics for the short, medium and long term forecasts.

MASTER PRODUCTION SCHEDULING (MPS)

The core of the MBMS is the Master Production Scheduling (MPS). The MPS determines the quantities of the products that will be produced during each period of the short-term programming horizon and assigns priorities concerning the sequence in which the orders will be processed. The MPS procedure can also be described as an iterative allocation of the existing resources so that finally the capacity of the factory be adjusted to the total requests for production. Two main features of the MPS module in YFADI are the ability of the programming horizon to adjust, so that the user is able to define it according to his needs, and the provision of a "what-if" analysis for the fine tuning of an initial schedule. Fig. 2 is a data flow diagram designed for the MPS module.

Machine Loading consists of two main procedures:
- The Find_Similar_Job procedure, that searches all the similar in-progress and/or scheduled jobs in order to schedule a job just after one of them in order to minimize the set-up time and cost.
- The Smoothing procedure, that attempts to balance the finish dates of the processing of a specific job at various machines, aiming to the almost simultaneous completion of it.

Different priorities may be assigned to different jobs according to instructions which are included in the DBMS or by taking information from the MBMS. Job sequencing is made principally according to the priorities of the customers and, secondarily, according to the due dates of the jobs or the FIFO rule. Additionally, there is an option for the manager to schedule the jobs as he wishes.

The inputs of the module are:
- The capacity requirements from the orders received and the short-term demand that must be scheduled. These requirements are expressed in terms of the kind and amount of resources to be used appearing in operation sheets and bills of materials.
- The constraints, such as the available capacity and buffer inventories, the limits on work-force size and on overtime and the maintenance constraints.
- The decision variables, such as the priority rules and the rules for job dispatching that define,
Orders

Short-term Forecasts

Capacity

User

Rules of sequencing set-up and other requests

Definition of due dates

Machine loading

Rules of Priority

Priorities assessment

Job sequencing

Master Production Scheduling

User

Alternatives

Update

MRP

Database

Fig. 2: A data flow diagram for MPS Module
for example, that a special treatment in the processing of a product must be done in a specific machine.

The outputs of the module are the **Machine Loading**, the **Sequencing** of the jobs, the **Alternative Schedules** and the **Performance Measure**. Several reports are generated from the MPS module, the main being:
- the **Job Status**, with information about start date, finish date, due date and percentage of completeness,
- the **Master Production Schedule**, with information about machine loading, sequencing and priorities of jobs,
- **Gantt-type charts**,
- the **Job Center Status**, with information about deviations from standard capacity, and
- the **Delayed Jobs**, with information about priorities of jobs and the number of delay days.

**AGGREGATE PRODUCTION PLANNING (APP)**

The aggregate planning problem is the production planning problem of an organization seeking to meet a varying pattern of demand over an intermediate span of time (usually between 6 and 18 months). Specifically, the managerial decisions in the aggregate planning problem are to set aggregate production rates and work force levels for each period within the planning horizon. The decisions concerning aggregate production, work force and inventory levels influence several relevant costs like those of overtime, second shifts and subcontracting or of excess inventory and of production rate changes. These costs need to be computed so that alternative aggregate plans can be evaluated on a total cost criterion.

The APP module takes inputs from:
- **Forecasting**, about the estimated demand for each period of the planning horizon,
- **Orders Processing**, about the already known demand,
- **Inventory Management**, about the existing levels of inventories, and
- **Database**, about the requirements for the manufacture of each product and the status of the factory.

Outputs of the module are the Aggregate Production Plans for each period of the planning horizon, the Personnel Employment Program, the Machine Utilization Program and several other reports concerning inventories and subcontractions.

The APP procedure includes the following steps:
- a. Gathering of forecasting data.
- b. Cumulation of demand for various products in a total demand, using a common unit of measurement. In our case, machine-hour is the most appropriate one.
- c. Transformation of total demand into requirements concerning machine hours, work force size and raw materials.
- d. Consideration of alternative schedules and computation of all relevant and total cost.
- e. Selection of the schedule that best fits into the aims of the company.

**ORDERS PROCESSING**

The aim of this module is the introduction of the customers' orders in a well-structured form in order to facilitate the follow-up by the management. The module supplies a lot of reports by grouping the above orders upon request of the manager. So, reports concerning the orders of a specific customer or a specific kind of product during a certain period can be easily obtained. Finally, the module can help the manager determine the policy of the company concerning a specific customer or a specific product based on previous data.
MATERIALS REQUIREMENTS PLANNING (MRP)

This module is aimed at the efficient scheduling of the requirements of raw materials and intermediate products such that the necessary quantities be available in the right time with the aid of Operation Sheets and Bills of Materials. This module is closely collaborating with the MPS module, as the latter provides MRP with the production schedules for each period. The MRP, using a backward procedure, defines for the specific requirements in intermediate products and, finally, in raw materials in order to fulfill the production schedules. By aggregating the materials requirements for each production order, MRP derives analytical schedules of what materials will be needed as well as their quantities and their due dates.

The main inputs of the system are:
- the Production Schedules produced by MPS,
- the Bills of Materials that are available in the Database,
- the available stocks that are produced by the "Inventory Management" module.

Reports are produced in order to inform the Inventory Management as well as the Purchasing via the database for the allocated quantities from the available ones in stocks and for the orders set, respectively.

INVENTORY MANAGEMENT

The module of Inventory Management deals with the status of inventory for each product and gives particular attention to products that are made-to-stock. The economic order quantities, the re-order points, the safety stocks and the lot-sizing for batch production are evaluated for these products. The module takes information about the scheduled inventory status from the MPS and derives the real status by obtaining daily (or periodically, upon user's wish) data from the Production Control and the Purchasing modules.

The main outputs of the system are:
- the safety stocks, the re-order points and EOQ for the make-to-stock products,
- the available inventories of raw materials and finished products,
- the in-progress inventories,
- the on-order inventories.

Several reports are produced concerning inventory classified per kind of product, supplier, size, color, special quality requirements, place of storage, usage, availability, date of entry, time of storage, destination e.t.c.

PURCHASING

Purchasing is dealing with the evaluation of alternative schedules for the purchase of the necessary materials by considering various cost elements and quality requirements. More specifically, the module is fed with data from the MRP and Inventory Management modules and places the final orders. Algorithms have been developed for the appraisal of alternative suppliers combined with possible discounts relevant to quality or quantity. After the orders have been set, the module monitors closely their progress. Every time an order arrives, the Inventory Management module (through the stocks status) is updated. The inputs of the system are:
- the requirements for the make-to-stock products provided by the Inventory Management,
- the scheduled materials requirements, provided by MRP,
- the available stocks, produced by the Inventory Management, and
- cost and lead times for various suppliers, provided by the Database.

Several reports are available, such as orders-in-progress, delayed orders, arrived orders and
order cost and quantity.

PRODUCTION CONTROL

The communication between the DSS and the real situation is effected through Production Control. This module takes daily the elements of production status for each work center and of the progress of each order and compares them with the scheduled ones. In the next step the Inventory Management as well as the MPS are informed about the real production situation and any deviations. The user may alter the production schedules through the MPS module by considering the above deviations.

Two basic reports are available by this module. The one describes progress of orders and the other the production at each work center, machine or worker. After comparison with the MPS schedule, the percentage deviation is derived. A report with aggregated data is also produced aiming at helping MPS be more effective in production scheduling and avoid deviations between the scheduled and the real production.

CONCLUSIONS

"YFADI" has been designed as a tool for effective production management and scheduling in the Textile Industry. It aims at a better utilization of the available equipment, improved turnaround times, the avoidance or early detection of overload situations resulting in effective production control, reduction of work-in-progress and assets tied up in inventories, flexibility in meeting the production requirements etc. Generally, its objective is to minimize the uncertainty and improve the utilization of the volatile information about the structure of activities and user requirements, features that often characterize the real world decision-making situations in the case of the Textile Industry. It is notable that this DSS can be easily adapted to either job-shop or flow-shop environments. The next aim is to cover all the operations in a textile workshop, from spinning to the manufacturing of clothes.

REFERENCES


