The Effectiveness of Electronic Scheduling Template: Case Study on Composite Based Product's Company

Wan Hasrulnizzam Wan Mahmood, Norhafiza Mohamed
Faculty of Manufacturing Engineering,
Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 75450 Melaka
Phone: +606-2332398, Fax: +606-2332414, Email: hasrulnizzam@utem.edu.my

ABSTRACT

This paper discusses the effectiveness of electronic scheduling template used by manufacturing planner in a composite based product's company. The company is manufacturing company and one of the suppliers for Airbus. To produce the composite based product for aerospace industry, it involves various types of composite materials, manufacturing processes and procedures. In addition, it requires highly cost. The other reason is that, manufacturing activities should be well-planned to avoid over expenses on material usage, and meeting the customer deadline. For the application of template, a product was selected for validation. The results positively show the improvement of time to predict the data and the accuracy of the data.

Keyword: Scheduling, Manufacturing Company, Electronic Template

INTRODUCTION

Many authors have given the definitions of what is scheduling. According to Sule [1], scheduling is an act of defining or arranging activities to meet certain requirement, constraints, or objectives. While Pinedo [2] explained that scheduling is a form of decision-making that plays a crucial role in manufacturing and service industries. Within an organization, scheduling pertains to establishing the timing of the use of specific resources of that organization, it related to the use of equipment, facilities, and human activities [3].

Scheduling is concerned in determining the quantity and timing of production for the intermediate future, often from 3 to 18 month above [4]. Meanwhile, scheduling plays undoubtedly a critical role and it is the final temporal decision-making phase where industrial managers have to act for fixing any short noticed variations preserving at the same time expected medium-term efficiency performance [5].

Looking at the operational problems such as the lead time of operation and loading strategies, scheduling seems to be useful to address these issues. All the operation in manufacturing and service industries depends on scheduling to operate their production. The simple term that match with scheduling is the "brain and heart" of the manufacturing. The successful scheduling will produce a successfully operation. A schedule shows the planned time when processing of a specific job will start on each machine that the job requires [1].

Several scheduling approaches exist, from the traditional off-line scheduling systems, which elaborate a production plan (e.g. according to static rules and algorithms) for a specific plan period, to on-line production scheduling systems, which are intrinsically able to modify an existing schedule or regenerate a completely new one for managing upcoming events which could alter the original plan [5].

Meanwhile Ganesan and Sivakumar [6] give explanation that large product varieties, awareness to improve product quality and need for shorter production times necessitate an integrated procuring, production and delivery system as a whole. In addition, to maintain and improve the market share, manufacturing/service systems must respond by delivering required products at right points and time. This demands efficient, effective and accurate scheduling which is a complex task even in the simplest of production environments. Hence, in many production systems, apart from the objectives of minimizing completion time and due-date related measures, scheduling jobs ensure closeness of their completions to each other which are important. In addition to achieve closeness of job completions, a schedule with minimum length is preferred for each job from the time of receipt of the orders, irrespective of the requirements of the individual jobs.

SCHEDULING IN MANUFACTURING

In manufacturing, decision made at this higher planning level may impact the scheduling process directly. Figure 1 shows a diagram of the information flow in manufacturing system. The scheduling function has to interact with other decision-making functions within the plant [2].

Scheduling methods are tools that allow production and other systems to run efficiently. Scheduling efficiency can be measured by various indexes. Two of the most popular are minimization of time required to complete all jobs (makespan) and minimization of penalty for completing jobs early or after the due dates [1].
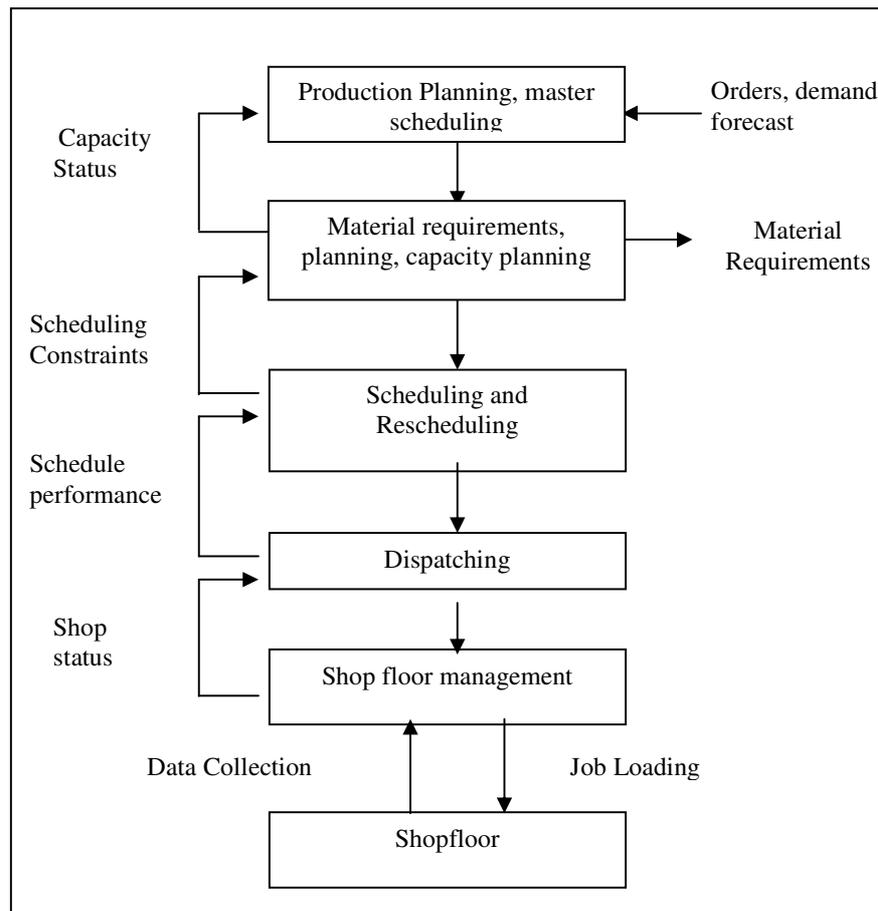

Figure 1: Information Flow Diagram In Manufacturing System
Source: Pinedo [2].

BASIC REQUIREMENTS OF SCHEDULING

Since scheduling is highly context-dependent, some basic requirements of a performance measurement system (PMS) for scheduling evaluation can be highlighted [5].

1) Open and easily customizable - Given the heterogeneity of production systems, a PMS for scheduling evaluation has to be a framework open to different typologies of users and production environments, easily applicable and customizable in order to comprehend different possible manufacturing systems and scenarios.

2) Effective comparison of schedule quality - An industrial practitioner could be interested in taking into account various scheduling techniques and policies; consequently, the PMS has to be capable to compare alternative planning and scheduling practices.

3) Measuring the efficiency of a production system - According to the previous requirements, an industrial practitioner could be interested to know not only relevant measures for scheduling, but also all the operational measures that can be gathered from a shop floor. For example, in a job-shop the setup time cannot be dependent on the job sequences. Therefore, for the sake of scheduling comparison, it can be ignored. However, for a plant manager, the knowledge of total setup-time could be an important measure in order to estimate the required workforce labour to support production.

4) Performance evaluation at diverse levels - Each level of an enterprise needs a specific set of performance measures but, moving up to the corporate hierarchy, measures and indicators tend to be expressed more and more in aggregated terms; whereas at the lowest level a set of single atomic measures can be useful and effective, whereas at upper levels managers need some synthetic indicators.

5) Quantitative data and symbolic judgments - An industrial user could be interested whether a certain production schedule can satisfy one or more specifications (e.g. a certain target value of the production makespan could be needed). In this case, he is searching for a Boolean result, like ''the schedule is capable to satisfy the requirement'' or not. On the contrary, a scheduling researcher could need a support in evaluating his optimisation algorithm or about a specific rescheduling technique. This way, a symbolic judgement like ''very good in costs, good in plant saturation, bad in responsiveness'' could be useful for a user.

6) Focus on organizational goals - In companies, a major problem is that different organizational units involved in a scheduling activity have heterogeneous, often conflicting goals, and, thus, have substantially different expectations from a schedule. For example, the sales department often looks at a schedule from the point of view of orders being delivered to the customer, while the manufacturing department is under pressure to reduce costs. Hence, the sales department would look for a schedule that has good due date performance, while the manufacturing department would prefer a schedule with high machine utilization, few setups, and long production runs.

7) Rescheduling - Scheduling is a nervous and dynamic process; at the shop floor level, disruptions like machine breakdowns or new rush orders are on the daily agenda; when a disruption occurs, a schedule can be revised to limit the degeneration of performances.

CASE STUDY

A manufacturing company was selected for case study. The company is Government Linked Company (GLC) which situated in Melaka, Malaysia and currently active in producing components for aerospace industry. The products are composite base products. For manufacturing scheduling, Schedule and control section is like a brain and heart of the manufacturing department. Schedule and control section is responsible to prepare, provide, plan and organize schedule for manufacturing department. This section includes manufacturing planner, equipment scheduler, material handler and production controller.

After receiving order form customer, manufacturing planner will perform the scheduling for manufacturing. For scheduling, cycle time, material usage and material status are main consideration. Without this information, the scheduling will not run properly. Previously, the scheduling was performed manually and many problems have been occurred during the implementation especially in determining material usage and measuring current status of raw material for re-order.

The first documentation for production starts with Purchase Order (PO). PO is prepared by customer. It involves the quantity of demand product, demand for the year, and date for the product to be completed. Second document is the Vendor Schedule (VS). The VS presents the details about the demand and scheduling of receiving product. Next, the company produces Master Production Scheduling (MPS) and Material Requirement Planning (MRP). There are 2 methods have been applied; Daily Schedule Review (DSAR) and Line of Balancing (LOB). DSAR and LOB present daily production status.

For discussion, a product was selected. To produce the product, it will go through at least 14 processes without rework. The process includes kitting, lay up, bonding, curing, de-mould, trimming, dimensional, glass wrapping, final bagging, NDT, painting, final inspection and packaging. In the normal practice, the product will be produced in a set which consist of 8 units of panel. The company has 4 autoclave machines for curing process. The autoclave is the pacemaker and currently considered the main constraint for scheduling.

SCHEDULING TEMPLATE

The scheduling template has been developed by using Microsoft office (Ecxel) 2003. The software is selected because of knowledge of staff. The development idea of the electronic scheduling template is due to manual scheduling system weaknesses. By considering several of factors in scheduling; time, capability, accessibility, direct information, efficient, manufacturing department was agreed to develop an electronic scheduling template. A pilot project was running. As a result, many improvements have been achieved. Table 2 describes the main elements of scheduling system and the comparison of manual scheduling system against electronic scheduling system.

Table 2: The Elements of Scheduling Template

Element	Manual Calculation	Electronic Scheduling System
Time	Time required to estimate a cycle time and usage of material more than 1 hours.	Time required to estimated cycle time and usage of material below than 1 minute.
Capability / accessibility	Only experienced people able to calculate cycle time and the usage of material.	Whosoever able to use the system to estimate the cycle time and the usage of material.
Direct Information	Usage of the material unable to seen clearly.	Usage of the material visible through graph and chart generate by the system.
Efficiency	Low rate efficiency in term of the accuracy, quality and flexibility.	High rate efficiency in term of the accuracy, quality and flexibility.

The template contains seven data sheets that linked each others. Table 3 presents the data sheet, usage and purposes.

Table 3: The Data Sheet's Name, Usage and Purposes.

Sheet	Usage	Purposes
DATA ENTRY	Estimate duration time	As a main sheet of the system. The sheet linked with TIME DATA and MATERIAL.
MATERIAL	Estimate material usage	Shows the usages of material require for completing the panel. It linked with DATA ENTRY, MONITORING ANCILLARY, MONITORING CHEMICAL and BOM DATA.
MONITORING ANCILLARY	Generate an actual versus plan usage of ancillary material	Its shows the different of material usage between plan and actual usage. The summary of the results shows in graph and pie chart. It was linked with MATERIAL and DATA PAGE.
MONITORING CHEMICAL	Generate an actual usage versus plan usage of chemical material.	Its shows the different of material usage between plan and actual usage. The summary of the results shows in graph and pie chart. It was linked with MATERIAL and DATA PAGE.
TIME DATA	As a database of estimate duration time.	It was linked with DATA ENTRY
BOM DATA	As a database of estimate Material usage.	It was linked with MATERIAL
DATA PAGE	As a database to estimate Monitoring Material Usage.	It was linked with MONITORING ANCILLARY and MONITORING CHEMICAL

The template uses 9 main formulas (equation) based on common calculation in manual scheduling. The following are the formulas:

1) $\sum$ Cycle time per panel = $\sum$ Cycle time in section Kitting + $\sum$ Cycle time in section Clean Room (Lay Up) + $\sum$ Cycle time in section Clean Room (Bonding) + $\sum$ Cycle time in section Auto Clave + $\sum$ Cycle time in section De-mould + $\sum$ Cycle time in section Trimming + $\sum$ Cycle time in section Dimensional + $\sum$ Cycle time in section Glass Wrap + $\sum$ Cycle time in section Final Bagging + $\sum$ Cycle time in section NDT + $\sum$ Cycle time in section Painting
2) Cycle time per quantity = Quantity X $\sum$ Cycle time per panel
3) Days to complete product/ shipment =((Quantity X $\sum$ Cycle time per panel) / 60 min)
4) Hours to complete product/ shipment =((Quantity X $\sum$ Cycle time per panel) / 60 min)/ 12 hours
5) % Difference of material usage= ((Actual Usage – Plan Usage)/ Plan Usage) X 100%
6) Total Actual Usage = Total usage for a week
7) Miss Usage = % Difference of material usage $\leq$ -10 %
8) Hit Usage = -10% < % Difference of material usage < 10%
9) Above Usage = % Difference of material usage $\geq$ 10%

MAINTENANCE

Scheduling template was designed for flexibility. Hence it can be use either the process flow, BOM, material or the standard of material have changes. It was not big changes of the system because it just involve data sheet. For example, if there are changes in BOM, the template just have renovation in BOM data and not bother other sheet. The data was very essential to the template for predict all the information.

All the system that include estimate a cycle time, material usage and the material usage guidance have it own data page that linked by each others. The data page is like a "mother" to the system. There are three types of data page for this system that is time data, BOM data and data page.

DISCUSSION

The template just takes less than one minute to display lead cycle time, BOM and material status through tables and figures. The user only needs to enter the number of product to be produced (demand) to develop scheduling without mistake. Manufacturing planner already simulates the template and discovers that accuracy data which produced by template within 90% accurate. To make sure the accuracy of effectiveness, the value of cycle time and BOM have to update from time to time at least one in three months period not intrude the template.

The template also was tested to determine how far the graph effectiveness to the scheduling. The graph is provided to facilitate user to the real picture material status. Apart from that, user can also classify the material usage through three categories; missing, hit and above. Miss refers to material that is less used, hit mean material within that the moderate and above mean material over used.

Although the template was contributed the accuracy data and value time for manufacturing scheduling, it limited to several constraints. The manufacturing planner has to design and develop many templates to cover all products due to different process, process cycle time and material involved. For the future, it was suggested to develop a multipurpose template which considered all constraints and linked each other for raw material monitoring.

CONCLUSION

Electronic Scheduling Template is one of the alternatives of the implementation scheduling through production. The benefits of the scheduling through the production are improving accountability for all parts and material; ensure all parts are ordered with adequate lead time, reducing the number of emergency purchases and cost of express freight. The other benefits are optimizing maintenance inventory and improve information available for equipment specification. There are various applications of scheduling in production. One of the way by creating template with based upon scheduling. For the purposes of creating a template which was exactly suitable with the concept of scheduling that is flexible was not easy like one thing particle suffixed to the emphatic word in sentence. Sometimes template with plain and foolproof is better. The template is not necessarily very complex which needs long durations of training. Therefore, Microsoft Excel 2003 was selected to facilitate scheduling application. If the scheduling template is using more complex programming and the result only legible by experienced individual, criteria scheduling for flexibility could not be created. With advantage as can produce data less from one minute is one benefit can be described as robustness of the scheduling. Apart from that, with combination monitoring system in this template, effectiveness scheduling was approved.

ACKNOWLEDGEMENT

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