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APPROACHES FOR SOLVING PRODUCTION PLANNING AND SCHEDULING PROBLEMS USING INTEGRATED HEURISTIC METHODS

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Abstract: *In this paper, the general solutions for problem-solving in production planning and scheduling are presented. While responsibility of planning assumes answering questions of what needs to be produced in relatively long period, responsibility of scheduling is, on the other hand, dedicated to modes in which manufacturing can be realized in a shorter period. Today, manufacturers are facing ever-growing competition on the market. Taking into account considerable pressure induced by competition, making an efficient production planning and scheduling is a must. Rational production and detailed plan to satisfy customers' demands, and to acquire economic benefits, should thus be made. This plan can be realized as long-term, medium-term, or short-term strategy.*
Key words: *Production planning, production scheduling*

1. INTRODUCTION

Production planning and scheduling (PPS) are based on production load and capacities over various horizons and on different levels by determining flow of materials and use of resources. PPS are strongly interdependent, although they have their own timescale, resources, activities and optimization criteria. Planning provides adherence of high-level temporal and resource capacity constraints and in that way appoints goals and also the resource and temporal constraints for scheduling. Moreover, scheduling is accountable for conversion of production plans into executable schedules respectively according to detailed resource tasks and operation sequences. Inadequate scheduling strategy can obstruct the realization of a good planning; and vice versa, a good scheduling strategy can perform much better than an inadequate planning strategy (Egri et al., 2004).

By consistent production planning and scheduling, period of production cycle is being reduced, with reduction in revolving capital and inventory, as well as shipping period, and an increase in equipment usage.

Orders issued in manufacturing process have to be translated into jobs with related due dates. Frequently these jobs have to be processed on machines in a given order or sequence in a workcenter. If certain machines are occupied, there may be a delay in job-processing. Machine break-down or longer-than-acceptable processing times are just some of unexpected events on shopfloor. Since they have great impact on schedules, they need to be taken into account (Pinedo, 2005).

All these issues make PPS really complex and problematic for solving. Although it is hard to resolve such complex problems, it is necessary to find efficient support methods and intuitive, flexible models with fast dependable solution techniques. PPS problems have to be treated in an integrated way regardless of whether they are solved in the superior-inferior hierarchy.

Recently APS (Advanced Planning and Scheduling) systems are more often used combined with enterprise management processes in order to improve customer service and on-time delivery, reduce expediting, overtime and inventory, and increase throughput and profit (Musselman et al., 2002).

2. PRODUCTION PLANNING

Production planning is most often understood as a process of systematic search and goal-setting, as well as preparation of tasks whose realization affirms reaching previously set production targets.

Production planning (PP) is to meet customer demands making the aggregate plan of using production resources (workforce, equipment) and material. The plan should be made for period of several months. PP determines the production capacity and material requirements over time and gives date of completing each customer's order. For example, issues such as if one should increase or decrease the work force, when required materials should arrive, and so on. Due to strong mutual relationship between the decisions, these matters must be addressed simultaneously. Material Requirements Planning (MRP), Manufacturing Resource Planning (MRP II) and Capacity Requirements Planning (CRP) are necessary to be processed in an integrated way in order to achieve better results(Egri et al., 2004).

In principle terms, a company has to possess certain stock which ensures company's normal functioning. In case of considerable stock, expenses get higher, revolving capital is blocked, large warehouses are needed, etc. On the other hand, case of small stock leads to possible disruptions in production, and in that sense, generates growth in expenses.

Tasks in long-term planning are planning of investments, methods and actions, and, lastly, resources. Speaking in terms of short-term/long-term planning encompass preparations of planning, expense planning and quality assurance. Finally, short-term tasks are set on acquiring production program and plans, NC programming and planning of auxiliary production processes.

3. PRODUCTION SCHEDULING

Production scheduling, in stricter meaning of the word, is comprised of launching, surveillance and correctional measures (ensuring task performance in terms of quantities, dates, quality, expenses and work conditions). Goals of production scheduling originate from production targets. Most commonly used aims consider: meeting respective dates of shipments, increasing usage of given capacities, lowering interphase stocks, shortening cycles of production, etc.

The positioning of scheduling is traditionally between planning and execution (Fig. 1.). A planner defines sequence of tasks (the plan) that will deliver the product. A scheduler determines on specific resources, operations, and their timing to achieve respective tasks (the schedule) (Fromherz, 2006).

Activities of planning are being fulfilled in modeling of production systems on higher levels, while lower levels are dedicated to processing of orders, launching and fulfilment of tasks, as well as surveillance and assurance.

Lowest levels are committed to performing activities on work stations.

Unlike the phase of planning when material quantities are decided upon, in this phase of production scheduling precise quantity of materials needed for every order is being set. This phase is usually termed as disposition of materials because it is in this phase that dates, quantities (type/amount) and places where to supply material is adopted.

Calculated needs in material are being adjusted with state of materials in stock, also according to type and amount in relation to defined dates of production. During constant process of production, state of stock $S$is constantly changing, because intensity of output$f_2(t)$directly follows respective intensity of input $f_1(t)$which, by definition, means that$S_0 \neq S_1 \neq S_2$ ... in period t_0, t_1, t_2...

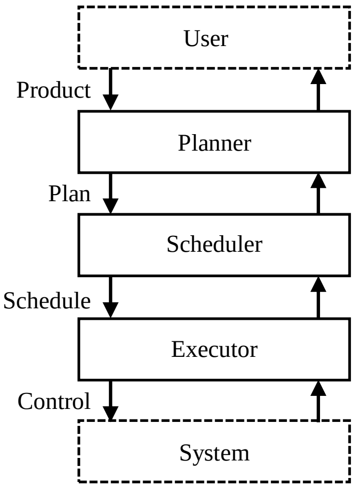

Fig. 1.Scheduling in context (Fromherz, 2006)

4. PROBLEMS AND SOLUTIONS

There are many existing models and each of them includes a number of parameters. However, these parameters may vary, which makes the model more complex.

The actual values of capacities and prices are influenced by several factors such as maintenance, urgency, market position, etc. Each project consists of several activities and each activity may require a number of different resources.

All in all, this makes the model complex and complicated, and, in that respect, creates numerous problems in finding adequate and appropriate solutions.

Traditionally in manufacturing resource planning (MRP II) systems, the production planning processes are following a top-down hierarchical approach (Yan, 2000). But it cannot be sure that for the generated production plan a feasible production schedule will exist. The detailed job-shop scheduling constraints must be taken into account to allow a feasible production schedule (Lasserre, 1992). Some authors for solving production planning and scheduling problems adopt integrated methods. Lasserre (Lasserre, 1992) uses an integrated job-shop planning and scheduling model with exact capacity constraints.

In their research, some authors base their solutions on approximate algorithms and heuristic algorithms. Methods like tabu search, beam search, ant colony algorithm, simulated annealing algorithm and genetic algorithm are restricted for solving some particular problems. For example, to find solution in the fast way, tabu search and beam search use a search strategy. The simulated annealing algorithm shows better performance in the local search and in global search the genetic algorithm proves much better (Zhang & Yan, 2003). Individual using of this method cannot guarantee reaching a good solution.

In that respect, some authors used a mixed strategy. Jwo used a genetic algorithm for global search and simulated annealing algorithm for local search (Jwo et al. 1999). By using these hybrid algorithms, problems could be solved more successfully than using a single one (Zhang & Yan, 2003). Zhang and Yan have reached a solution in an integrated mode for multi-period production planning and scheduling problem with setup time and batches for a kind of job-shop and build-up of a nonlinear mixed integer program model.

These solutions should successfully minimize the holding costs of the work-in-process inventory, the production costs, the penalty costs of the parts which are over-/underproduced, as well as the tardiness time costs and the setup costs, in order to maximize the earliness time.

5. CONCLUSION

Rational production and detailed plan to satisfy customers' demands, and to acquire economic benefits, has to be made.

In recent years, new methods used are able to support planning even if detailed information on production technology is not available.

The model can handle design, engineering, as well as traditional production processes.

Future research should be directed towards developing integrated methods which combine different heuristic methods competent in providing the best solution for production planning and scheduling.

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