

Chapter 1

Statement of Production Scheduling

The current environment in companies is characterized by markets facing fierce competition and from which customer requirements and expectations are becoming increasingly high in terms of quality, cost and delivery times. This evolution is made even stronger by rapid development of new information and communication technologies which provide a direct connection between companies (business to business) and between companies and their clients (business to customer). In this type of context, company performance is built on two dimensions:

- a technological dimension, whose goal is to develop intrinsic performance of marketed products in order to satisfy requirements of quality and lower cost of ownership for these products. Technological innovation plays an important role and can be a differentiating element for market development and penetration. In this regard, we must note that rapid product technological growth and the personalization requirements for these products expected by markets often lead companies to forsake mass production and instead focus on small or medium-sized production runs, even on-demand manufacturing. This requires them to have flexible and progressive production systems, able to adapt to market demands and needs quickly and efficiently;

- an organizational dimension intended for performance development in terms of production cycle times, respect of expected delivery dates, inventory and work in process management, adaptation and reactivity to variations in commercial orders, etc. This dimension plays an increasingly important role as markets are increasingly volatile and progressive, and require shorter response times from companies.

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Therefore, companies must have powerful methods and tools at their disposal for production organization and control [BAI 99].

This production organization must be considered not only at company level, but also from its position in the supply chain where it is one of the links, resulting in a global “virtual” company which must be focused on satisfying customer needs under the best possible conditions [BAI 99, WU 98].

To achieve these goals, a company organization normally relies on the implementation of a number of functions including scheduling which plays a vital role. Indeed, the scheduling function is intended for the organization of human and technological resource use in company workshops to directly satisfy client requirements or demands issued from a production plan prepared by the company planning function. Considering market trends and requirements, this function must organize the simultaneous execution of several jobs using flexible resources available in limited amounts, which becomes a complex problem to solve. In addition, it is this function which ultimately is responsible for product manufacturing. Its efficiency and failures will therefore highly condition the company’s relationship with its customers. Within companies, this function has obviously always been present, but today it must face increasingly complex problems because of the large number of jobs that must be executed simultaneously with shorter manufacturing times. This situation is obviously the result of the current environment as it was described earlier.

Offering efficient and powerful solutions to scheduling problems thus defined constitutes an important economic challenge. Despite the simplicity of formulating this type of problem, it must be noted that to date there is no “one” method able to solve all possible scenarios. In fact there are a number of generic problems differentiated by the characteristics of jobs to be performed or resources available to perform them. Specific methods can then be associated with the resolution of each of these generic problems, these specific methods being either a specific interpretation of the problem in a general way, or a specific method dedicated to the problem involved. Resolution of a concrete problem starts by identifying the generic problem to which we can associate it, followed by the selection of the method(s) adapted to the resolution of this problem. We must also note that the decision problem associated with the scheduling problem belongs to the category of combinatorial NP-complete problems. Consequently, resolution by exact methods is not realistic for large problems, justifying the use of powerful heuristic methods. This explains why research on scheduling problems is always popular and demands numerous studies [WIE 97].

The goal of this book is to present a number of methods for the resolution of scheduling problems. There are a number of studies, past or present, on scheduling

issues [HER 06, LEU 04, PIN 05, SUL 07]. In this book, we have chosen to emphasize approaches to strictly solve or to improve the solution for problems actually encountered in the real world. This leads us to the organization of this book as follows.

A global presentation of concepts in relation to the scheduling domain and basic methods for solving classical scheduling problems is proposed in Chapter 2. The following two chapters present heuristic type resolution methods to solve large problems: metaheuristics (Chapter 3) and genetic algorithms (Chapter 4). Chapter 5 discusses an approach based on constraint propagation aiming at characterizing all solutions to a problem, which can be useful to help in searching for optimal solutions or in decision support. Chapter 6 recalls resolution principles based on the use of priority rules to generate a schedule by simulation or to identify priority rules to be used to organize scheduling in real time. The two following chapters discuss three scheduling problems for specific production lines: cyclic scheduling to satisfy mass production of a limited number of products (Chapter 7) and hoist scheduling (Chapter 8). Chapter 9 addresses an important practical extension of the scheduling problem: choosing which resource to use for each job operation, coupled with the operation scheduling for resources used. Chapter 10 considers a specific problem for which operations to be performed are not linked to sequencing constraints. Finally, the last two chapters focus on scheduling problems in uncertain environments or in environments which are not completely specified, a situation often encountered in practice. The fuzzy approach makes it possible to consider these two characteristics (Chapter 11), whereas the decision support approach makes it possible to organize job processing in real time according to the real state of the workshop and thus to consider unforeseen situations, using deterministic models (Chapter 12).

It is important to note that although this book often uses vocabulary and examples inherent to the manufacturing field, methods presented can be used to organize processing of any type of activity requiring available resources in a limited amount, in particular service activities, provided of course that the processing constraints are similar to those of one of the models considered in this book.

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