

4. An approach to multicriteria scheduling problems

4.1 Justification of the study

4.1.1 Motivations

In the context of production, the planning phase is broken down hierarchically into different levels: strategic, tactical and operational. The production plan at the tactical level determines the quantities of products to make by time period. Its objectives are:

- to satisfy the customers' requirements, that is to say to supply the customer with the product he wants, in the desired quantity and at the desired date,
- to balance continuously the existing resources and the resources necessary for production, by avoiding underloading as well as overloading,
- to ensure production at lowest cost or at least with maximum profitability.

Next, at the operational level, the established plan must be followed as best as it can. This is not without bringing up some coherence problems, allied to the fact that the first module handles aggregated information, and the second detailed information. Scheduling has as principal objectives:

- to minimise work-in-process in the shop,
- to have high respect for the planned and promised delivery dates given to the customers,
- and to optimise the shop resources.

By its very nature therefore, a scheduling problem in the context of production is very often multicriteria. RCPSP may also involve several criteria of time and cost type ([Herroelen et al., 1998a] and [Hapke et al., 1998]) as for example:

- the respect of delivery dates,
- the cost related to the duration of an activity when this duration belongs to an interval and has to be fixed.

Examples of such problems are time/cost trade-off problems. As a general rule, and as [Roy, 1985] points out, taking several criteria into account enables

us to provide the decision maker with a more realistic solution. Some concrete examples are presented in section 4.1.2.

Different states-of-the-art of multicriteria scheduling can be found in the literature (see [Dileepan and Sen, 1988], [Fry et al., 1989], [Hoogeveen, 1992a], [Nagar et al., 1995a] and [Hoogeveen, 2005]). Analysis of these works underlines:

- the necessity of knowing the results of the domain of multicriteria optimisation to understand well the difficulties related to taking into account conflicting criteria,
- the need for a typology enables us to formalise the different types of problems and to unify the notation of these problems,
- the need for a knowledge of the results on single criterion scheduling problems.

Application of multicriteria optimisation constitutes a field of activity which has been little explored until today.

4.1.2 Some examples

Many scheduling problems in the production domain involve several criteria. We find in the literature numerous works dealing with a category of problems which correspond well to a situation: the need to produce “Just-in-Time”. This need translates into two wishes, one is not to deliver to the client late, the other is not to store the finished products. To produce “Just-in-Time” is therefore a trade-off between producing slightly late and not too early. Numerous definitions of “Just-in-Time” scheduling exist in the literature. These works are presented in chapter 5.

We now present some scheduling problems corresponding to practical situations, whatever their application field.

Manufacture of bottles

A factory manufactures glass bottles the colours of which are selected in advance at the planning phase ([T'kindt et al., 2001]). A furnace containing the molten glass of a given colour, serves several different forming machines. These machines are fitted with several moulds, allowing several types of bottles to be made, which correspond to several orders. Changing a mould on a machine takes a negligible time compared to the production time, thus allowing the changeover from one product to another in hidden time. The manufacture of a product by a machine creates a profit which can be measured. One of the objectives is therefore, given the production horizon, to assign the jobs to the machines, in order to maximise the total profit. On the other hand, change of colour in the furnace affects the set of machines which it serves, and this change can only occur when all the machines have