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A note on "The general lot sizing and scheduling problem"

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Abstract. Fleischmann and Meyr (1997) develop a model for the lot sizing problem with sequence dependent setup costs. In this note we show that this model is limited to the case where production state between two consecutive periods is conserved only if the available capacity of the preceding period exceeds the minimum batch quantity. We generalize the model by modification.

Keywords: Lotsizing – Scheduling – Sequence dependent setup costs

Fleischmann and Meyr (1997) develop an integrated lot sizing and scheduling model (GLSP) that determines lot sizes and sequences of items in a capacitated environment with dynamic demand and sequence dependent setup costs. The GLSP-CS formulation (in which the setup state is conserved) presented in the paper ensures that the production quantity of any item in the first position of a production lot is greater than the minimum batch quantity. However, this limitation may be unrealistic in the following situation on which no explicit assumptions have been posted in the paper: Considering the case where an item's production extends over to a new period, if the first period is restricted in terms of capacity such that production of the minimum batch quantity is not possible, this model inevitably leaves the available capacity in the first period idle and forces production to start in the second period, as the following example demonstrates.

Consider a problem with 2 items, 2 periods and 2 positions per period where the capacity per period is 2 units. Let the other data be as shown below:

	m_j	a_j	h_j	d_{j1}	d_{j2}
Item 1 ($j = 1$)	1	1	1	1	0
Item 2 ($j = 2$)	2	1	1	0	3

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where m_j, a_j, and h_j denote the minimum batch size, unit processing time, and unit inventory carrying cost for item j, respectively, and d_{jt} is the demand of item j in period t. All other model parameters are equal to zero.

If we denote the production quantity of item j in position s by X_{js} and the inventory of item j at the end of period t by I_{jt}, then the optimal solution of the example problem is $X_{11} = 1, X_{22} = 1, X_{23} = 2, I_{21} = 1$ with a total cost of 1. Here, the production of item 2 starts at the second position of period 1 using the remaining capacity of 1 unit. Nevertheless, with the original form of the minimum batch size constraints, the Fleischmann-Meyr model is unable to find a feasible solution in this example. The reason for this is the fact that the remaining capacity in period 1 (1 unit) cannot be used since it is smaller than the minimum batch size of item 2 (2 units) and the capacity in period 2 is insufficient for the production of the total demanded quantity of item 2 (3 units).

This example explains the reason why modifying the minimum batch size constraint may be essential, especially if the capacity is critical and minimum batch sizes are considerably large. We therefore propose the following modification on the minimum batch size constraints in the last position of a period:

$$X_{js} \geq m_j(y_{js} - y_{j(s-1)}) \quad \forall j, t, s \neq L_t \tag{1}$$

$$X_{js} + X_{j(s+1)} \geq m_j(y_{js} - y_{j(s-1)}) \quad \forall j, t, s = L_t \tag{1'}$$

where L_t denotes the last position in period t.

Note that with this modification, some of the valid inequalities presented in the paper also need to be modified.

References

Fleischmann B, Meyr H (1997) The general lot sizing and scheduling problem. OR Spektrum 19(1): 11–21