Hedging and standard - MRP

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Zusammenfassung: In MRP-Paketen ist es möglich, Normen für Sicherheitsbestände zu verwenden. Jedoch keines der MRP-Pakete bietet Hedging als eine alternative Möglichkeit für Sicherheitsnormen an, obwohl diese Technik aus theoretischer Sicht mehrere Vorteile bietet. An der Universität in Eindhoven hat man versucht, Hedging in ein existierendes MRP-Paket einzubauen. Der funktionale Entwurf zeigte: Was auf den ersten Blick aussah wie eine einfache Ergänzung eines MRP-Pakets, hatte schließlich einen großen Einfluß auf viele MRP-Module.

Summary: In standard-MRP packages it is possible to use safety stocknorms. In none of the standard-MRP packages however, it is possible to use hedging as an alternative technique for safety stocknorms, although this technique has several advantages from a theoretical point of view. At Eindhoven University of Technology an attempt is made to incorporate hedging in an existing MRP-package.
From the functional design it appeared, that what originally seemed to be a simple addition to the options available in an MRP-package, turned out to have a rather large impact on many of the MRP-modules.

1. Introduction.

The goal of this paper is to investigate the flexibility of standard-MRP with respect to building in an extra option called hedging. The logic of MRP is assumed to be known here. Details on MRP can be found in Orlicky's book [1]. Hedging is an alternative for the use of safety stock norms and is described in an article by Miller [2].

A general introduction on hedging is given below together with an argumentation on the merits and demerits of hedging. In section 3 two possible ways to implement hedging in an MRP-package are mentioned. The impacts of hedging on MRP are discussed in Section 4.

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2. Hedging.

* Introduction on hedging.

Hedging is an alternative for the use of norms for safety stock or safety time. Ultimately it will result in extra physical stock, which can be used to absorb all kind of fluctuations, especially fluctuations in demand. Hedging consists of raising the requirements for a product by adding time-phased extra requirements called hedges. Hedging is usually performed at the Master Production Schedule (MPS)-level.

Example: Assume the following requirements and hedges for a product called C:

period	1	2	3	4	5	6	7
Requirements	10	10	10	10	10	10	10
Hedges	5	-	-	3	-	-	-
Total requirements	15	10	10	13	10	10	10

Figure 1. Requirements planning for product C in period 1.

The actual production for product C is based on total requirements. Instead of 10 units in period 1 (based on the requirements only), 15 products are made. A safety stock of 5 products will be the result.

With a leadtime of 2 periods for product C the hedge in period 4 does not influence the order release for C in the current period. It does however enlarge the planned order release of C in period 2. Consequently the requirements for a component of C, say product D, are enlarged. If D has a leadtime of 6 periods, the order release of D is affected by the hedge in period 4 and in the end there will be created a safety stock of three units of D.

At the beginning of the next period (period 2) the hedge in period 4 will enlarge the order release for C and thus result in safety stock for product C unless action is taken. If for example every period the hedge is put off one period (see figure 2), the hedge in period 4 still leads to safety stock for D, the component of C, but not to safety stock for product C itself. In effect hedging distributes the safety stock over the production chain.

period	2	3	4	5	6	7
Requirements	10	10	10	10	10	10
Hedges	5	-	-	3	-	-
Total requirements	15	10	10	13	10	10

Figure 2. Requirements planning for product C in period 2.

The benefit of having a hedge in period 4 is, that the requirements for C three periods from now on may be raised with 3 products without endangering the material availability of the components. With no safety stock and a leadtime of 6 periods for D this would not have been possible. Note that the safety stock for D is controlled by the hedges of C.

* Advantages and disadvantages of hedging.

Advantages of hedging are:

1. The safety stocknorm is implemented on the MPS-level. Due to the per definition limited number of items at this level the control of the stocknorms is relatively simple.
2. The hedge is implemented as a time-phased extra requirement. This results in a reduction of the number of reschedule-in messages compared to a safety stock norm in standard MRP-systems. In standard MRP systems the safety stock norm is implemented as an immediate requirement, equivalent to one hedge in period 0. In case the safety norm is implemented as a time-phased extra requirement which is put off every period, the total extra requirements until a fixed point in the future will decrease as time goes by.

   Assume in the previous example that the leadtime of C equals 4 periods. According to figure 1 the hedges up to period 4 were 5+3=8 in the current period: period 1. One period later the hedges up to period 4 were 5 (fig. 2). This matches reality: As time goes by it becomes more evident what the real demand will be and so less safety is required.

   In case the safety norm is implemented as an immediate requirement, a constant amount of safety is required all the time. As a consequence hedging will yield more reschedule-out and thus less reschedule-in messages compared to the systems currently available. The increase in reschedule-out messages can be dampened.
3. The stocknorm for a component is called integral if the norm may be covered by inventory of the component as well as by inventory of any of its parent-parts. The hedges work as integral stocknorms. This prevents that components are ordered unnecessary in situations where enough inventory is available of the parent-parts of these components.

   In case of hedging the stocknorm for the MPS-product as well as for the components is implemented as an extra requirement on the MPS-level. This implies that if the MPS-product has sufficient inventory available, the stocknorm for the component is netted by the inventory of the MPS-product. Thus no components are ordered if there are no gross requirements for the component. So in hedging the safety stocknorm is used as an integral norm.

Safety stocknorms for the absorption of demand forecast errors should indeed be integral norms. This is a consequence of the fact, that if demand forecast errors can be absorbed by inventory at the component level, these can also be absorbed by inventory at the parent-part level.

Recall that standard-MRP does generate an order for the safety norm of the components regardless of how many inventory of the MPS-product is available. So standard MRP interpretes the safety stocknorm as a local norm. That means, that the safety stock norm for the components always leads to physical stock at the component level.

4. In assembly environments the safety stocks of components from one parent-part are controlled in a coördinated way: At the MPS-level it is decided how many safety stock should be available and by MRP-explosion this is translated to all components. In this way it is impossible, that one component strives for a safety stock of 100, while another component with the same parent-part strives for no safety stock.
5. The use of safety stocks is better supported with hedging. In standard MRP the master scheduler does not know whether a change in the MPS is realistic. With hedging he may raise the level of the MPS up to the level of the original MPS plus the hedges and still be sure, that the material to allow such a raise is available. The MPS no longer needs to be constant. The only constraint is that the MPS plus the hedges remain constant.

Disadvantages of hedging are:

1. The MRP-scheme for periods beyond the leadtime is garbled because its input is no longer the expected requirements, but rather the maximal requirements (the expected requirements plus hedges). Particularly the Available Balance, Planned Orders and Planned Order Release do not resemble the expected values anymore. As a result the Capacity Requirements Planning, which is based on the Planned Orders, overestimates the future capacity requirements and thus sees problems where there are none.
2. By hedging an amount of safety is implemented at the MPS-level. This safety is then exploded to all components and consequently all components receive an equivalent amount of safety. If some components are common while others are not, the required safety is not the same for each component.

   Likewise, if the supply and/or production processes for each of the components have very different characteristics, the uncertainties and the corresponding safety norms per component may differ. To deal with these differences safety stocknorms still have to be implemented for each component. It appears that in most situations hedging cannot fully replace the safety stocknorms.

3. The implementation of hedging in MRP-software.

There are two possible ways to implement hedging in standard-MRP-software. The first one stems from the observation, that hedges increase the requirements or forecasts of the MPS-items. From this observation the hedges are interpreted as "additional forecasts" and treated exactly the same way as the real forecasts. So the records, screens and programs, which were meant to deal with the forecasts only, are then used for the hedges too. The second way is to make separate records, screens and programs for the hedges.

The first way requires less adaptation of the software, but has three severe disadvantages:

1) The forecast is connected with one specific need date. It is characteristic for the hedges that their need-date changes every review-period. If the need-date of the "extra forecast" does not change, it will ultimately result in physical stock at the MPS-level: An expensive solution.
2) The planner cannot distinguish the real forecasts from the additional forecasts or hedges.
3) The Rough Cut Capacity Planning (RCCP) is no longer valid because the total forecast does no longer represent the average requirement.

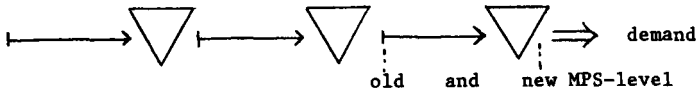
Designing separate records, screens and programs for the hedges seems to be necessary.

4. Major impacts of hedging on the MRP-philosophy.

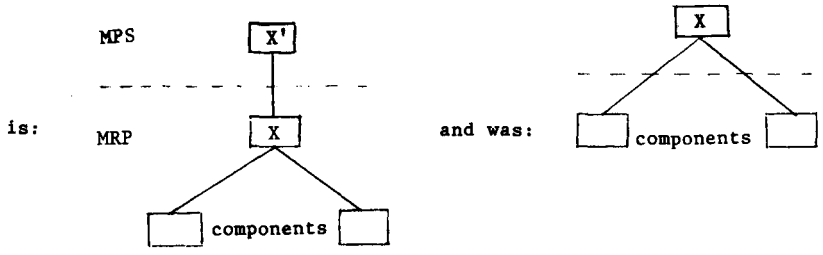
Although at first glance hedging seemed to be a fairly simple addition to an MRP-package, detailed elaboration of the concept revealed, that hedging does not neatly fit within standard-MRP-logic. The main cause for this is that in case of hedging all requirements are maximal requirements, whereas MRP is based on expected requirements. As a consequence many of the concepts and functions in MRP get a different interpretation or become garbled. (see disadvantage 1 of hedging in section 2).

The RCCP is a good example to illustrate the effort, which is needed to restore the effects caused by the implementation of hedging. Performing the RCCP according to standard MRP when the requirements are raised with hedges leads to overestimating the future requirements. To avoid this, the RCCP should be performed on an MPS without hedges, i.e. before the hedges are added. The hedges are added to the requirements of the MPS-item before these requirements are netted and lot-sized. (otherwise the hedges in the first periods will not be netted even though there is plenty of inventory available). These two facts lead to the conclusion, that the MPS should be the requirements of the MPS-item before netting and lot-sizing.

So it appears, that due to hedging the MPS should be seen as an agreement between Sales and Production expressed in terms of requirements rather than in terms of production orders as it is in standard-MRP. That implies, that the MPS-level has to be moved towards the point after the stockpoint for the MPS-product.



In order to avoid radical changes in the MRP-software-architecture the following solution is suggested to allow hedging in MRP-software: The user must enter a twin-MPS-item for every MPS-item. This twin-item is an MPS-controlled item; it is being used to determine the MPS without lot-sizing and netting. If this MPS is determined by the master scheduler it makes up together with the hedges the dependent demand for the original MPS-item. The original item is now interpreted as an MRP-controlled item and for this item the planned orders are calculated from the dependent demand, inventory on hand and the open orders, taking lot-sizing into account. The new productstructure



It should be noted here, that in this option the Available to promise is based on the MPS without lot-sizing and netting plus the hedges. That implies that e.g. stock due to lot-sizing is not incorporated. Compared to the current situation more safety stock is incorporated, since all the hedges for the components are now available to promise.

The fact that the MPS takes no lot-sizing into account implies, that the input for the RCCP is changed and the RCCP-calculations should be adapted to this. The variable resource requirements should be raised with an additional set-up-charge and the fixed resource requirements should be set equal to zero. The additional set-up-charge is equal to the set-up-time divided by the average production.

Possible capacity-inventories are not distinguished by most MRP-software-

packages and the RCCP can therefore not take account of them if the inventory on hand is left out of the RCCP-calculations.

The above illustrates, that the implementation of hedging in standard-MRP-packages requires artificial methods of adaptions.

Acknowledgements.

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Literature.

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