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On the integration of time-phased material and net operational cash requirements

S.D.P. Flapper
ON THE INTEGRATION OF TIME-PHASED MATERIAL AND NET OPERATIONAL CASH REQUIREMENTS

S.D.P. FLAPPER

ABSTRACT

In this paper the usefulness of a system for (detailed) forecasting of time-phased net operational cash requirements based upon (detailed) time-phased material (resource) requirements is examined. It is outlined how such a system may be realised in practice. The (dis)advantages of this system with respect to presently used systems are discussed as well as the requirements for its useful implementation.

INTRODUCTION

Operational cash flows result from production and sales activities. Therefore reliable forecasts with respect to net operational cash flows should be based upon the production and sales activities that are (planned) to be undertaken for the different (groups of) products/services in the course of time.

Fig.1 shows schematically the relationships between the sales/production activities of a company and the resulting in-coming and out-going cash flows, i.e. cash receipts and cash disbursements. Thereby the exchange of information between Sales Planning and Production Planning with respect to quantities of products/services is indicated by the long arrows, whereas the short fat printed arrows denote the cash flows that (would) result from executing the different sales and production plans. Each year companies generate for each of their different groups of final products/services a yearly sales plan, as indicated in the right-hand side upper corner of Fig.1. Starting from the set of these (aggregate) sales plans, and taking into account the desired and available stock quantities of final products, product group production plans are generated. From the (aggregate) sales/production plans the resulting cash receipts/disbursements can be derived. Based upon the above mentioned sources of information (and taking into account things like the long term strategy of a company) it is decided whether or not (parts of) the sales and production plans for the different product/service groups are accepted. (In Fig.1 this decision is indicated by the little asterisk in the "sales activities" column at the right-hand side.) If not, new sales plans have to be generated for (some of) the product/service groups, and the above mentioned procedure is passed through anew until the sales and production plans can be accepted (financially).

Next a company may disaggregate its set of global sales plans for its different final product groups into time-phased (i.e. quarterly, monthly) final product/service groups sales plans. Starting from the latter and the global product group production planning arrived at before, a procedure, similar to the procedure described above, is passed through in order to estimate time-phased (i.e. quarterly, monthly, weekly) production plans for all final product/service groups of a company. See also note 1) at the end of this article.
FIG 1 CASH DISBURSEMENTS/RECEIPTS AND PRODUCTION/SALES ACTIVITIES

From these plans the corresponding time-phased (i.e. weekly, daily) resources requirements can be derived, giving rise to detailed time-phased liquidity requirements (cash disbursements).

At present many companies base their forecasts of their net operational cash flows upon their longer term (monthly, quarterly, or even yearly) product (group) production and sales plans. These companies often don't use the (often) available time-phased resource requirements plans.

During the period of time between the moment of acceptance of the long term forecasts of the net operational cash flows and the moments that actual cash flows leave or enter these companies, as indicated in the lower half of Fig.1, the long term forecasts are taken for granted however.

By adhering this strategy, it may take quite a long time before it becomes clear whether the actual cash disbursements and/or cash receipts exceed(ed) or are (were) less than the cash disbursements and cash receipts planned for a given period.
(Some companies amend their longer term cash flow forecasts only when it becomes clear that "considerable" differences between these forecasts and actual cash flows (are to) occur. This may apply for instance when, due to a strike in the company, no final products have been (or will be) produced/delivered during some period of time. Or when it becomes clear that a given (semi-)finished product or raw material can not be delivered to the company during some "longer" period of time.)

In case the realised net operational cash flow for a given period would turn out to exceed the net cash flow planned for that period, maybe it wouldn't have been necessary to borrow money, thereby saving loan expenditures. Besides it might have been possible to invest part of the extra receipts, resulting in an in-coming rent cash flow.

In case the realised net operational cash flow would turn out to be less than planned, it might be necessary to borrow (a considerable amount of) money under rather bad conditions.

In the next section of this paper we shall quantify the differences between planned and realised cash flows and deal with the possible origins of these differences in some detail.

**PLANNED AND REALISED CASH FLOWS**

Denoting the difference between realised and planned cash flows by \( \Delta (\text{net cash flow}) \), it holds

\[
\Delta (\text{net cash flow}) = (\text{net cash flow})_{\text{realised}} - (\text{net cash flow})_{\text{forecasted}} \\
= ((\text{cash receipts} - \text{cash disbursements})_{\text{realised}} - (\text{cash receipts} - \text{cash disbursements})_{\text{forecasted}} \\
= ((\text{cash receipts})_{\text{realised}} - (\text{cash receipts})_{\text{forecasted}} - (\text{cash disbursements})_{\text{realised}} - (\text{cash disbursements})_{\text{forecasted}} \\
= \Delta (\text{cash receipts}) - \Delta (\text{cash disbursements}).
\]

More detailed \( \Delta (\text{net cash flow}) \) reads

\[
\Delta (\text{net cash flow}) = (pr(i,c(j))\times qr(i,c(j)) - pf(i,c(j))\times qf(i,c(j)) \\
- (pr(m,s(n))\times qr(m,s(n)) - pf(m,s(n))\times qf(m,s(n))) \\
(\text{E1})
\]

where

- \( pr(i,c(j)) \) denotes the price actually paid per unit of product/service \( i \) by customer (group) \( j \)
- \( qr(i,c(j)) \) denotes the quantity of product/service \( i \) for which per unit actually price \( pr(i,c(j)) \) has been paid by customer (group) \( j \)
- \( pf(i,c(j)) \) denotes the price that was expected (forecasted) to be paid per unit of product/service \( i \) by customer (group) \( j \)
- \( qf(i,c(j)) \) denotes the quantity of product/service \( i \) for which it was expected that per unit price \( pf(i,c(j)) \) would be by customer (group) \( j \)
- \( pr(m,s(n)) \) denotes the price actually paid per unit of product/service \( m \) to supplier (group) \( n \) by the company
- \( qr(m,s(n)) \) denotes the quantity of product/service \( m \) for which per unit price \( pr(m,s(n)) \) was actually paid to supplier (group) \( n \) by the company
- \( pf(m,s(n)) \) denotes the price that was expected (forecasted) to be paid per unit of product/service \( m \) to supplier (group) \( n \) by the company
- \( qf(m,s(n)) \) denotes the quantity of product/service \( m \) for which it was
expected that per unit price $pf(m,s(n))$ would have to be paid to supplier (group) n by the company).

The savings on interest that might have been realised when our planned cash flows would completely have fit the actual cash flows, are given by

$\left(\text{interest rate actually paid} - \text{interest rate that might have been paid}\right) \times \left(\text{net cash flow}\right) \times \left(\text{lending period}\right)$  
\hfill (E2)

Investing $\left(\text{net cash flow}\right)$ might have yield

$\left(\text{investment or interest rate}\right) \times \left(\text{net cash flow}\right) \times \left(\text{investment or lending period}\right)$  
\hfill (E3).

From the following figure

\[
\begin{array}{c|c|c|c|c}
pr & \cdots & \cdots & \cdots & \cdots \\
pf & \cdots & \cdots & \cdots & \cdots \\
\hline
qf & qr & \cdots & \cdots & \cdots \\
\end{array}
\]

it is easily seen that $\left(\text{net cash flow}\right)$ can be rewritten as follows

$pr \times qr - pf \times qf = \left(\text{pr} - \text{pf}\right) \times qf + pf \times (qr - qf) + \left(\text{pr} - \text{pf}\right) \times (qr - qf)$  
\hfill (E4).

Expression E4 provides a good starting point for analysing $\left(\text{net cash flow}\right)$.

The first term after the $=$ sign of expression E4 describes the contribution to $\left(\text{net cash flow}\right)$ that is entirely due to unexpected changes in the prices for given products/services.

Reasons why the term $\left(\text{pr} - \text{pf}\right) \times qf$ may differ from zero are

1) inflation/deflation
2) changes in exchange rates
3) prices of products/services were higher/lower than expected but this was not due to inflation/deflation nor to changes in exchange rates

Ad 1) and ad 2).

These points don't require any further comments.

Ad 3).

Unexpected scarcity/abundance of products sold/bought that may be caused by bad/very good harvests due to bad/good weather conditions, strikes etc.

A possibility to overcome 1) and 2) partly, may be to conclude forecast contracts. Generally 1), 2) and 3) can hardly or not be influenced by an individual company however.
The second term after the = sign in expression E4 describes the contribution to -(net cash flow) that is entirely due to unexpected changes in the quantities of given (groups of) products/services. Reasons why pr*(qr - qf) may not be equal to zero are

4) more or less products delivered than expected
5) payments weren't timely taken care of (from an economical point of view this effectively produces the same effect as actually delivering less/more products).

Ad 4).

The quantities of the different products/services actually delivered by/to the company may be less than forecasted a.o. due to

- production problems within the company or within one or more of its suppliers or customers
- problems concerning the transport to/from the company
- the appearance of new/substitute products and/or sales activities of competitors.

On the other hand the above mentioned quantities may be higher than forecasted because of

- production problems within the company's competitor's production units or within the production units of their suppliers
- problems concerning the transport to and/or from these competitors

How to deal with 4)?

Quite often it will be possible for companies to get, at least some, timely insight into some of the problems mentioned under 4). Many companies use ((partly) computerised) production planning and control (information) systems, providing detailed time-phased (daily, weekly) information about their (planned) production (and purchase) activities (a.o. about the material flows corresponding with these activities).

Besides many companies do have ((partly) computerised) systems for the planning and controlling of their sales and purchases. Based upon this short term insight, short and/or medium term purchase/production/sales plans may be adjusted in the course of time. Starting from these adjusted plans it would be possible to generate better forecasts for the in-coming and/or out-going operational cash flows in the course of time.

Ad 5).

The contracts between the company and its customers/suppliers aren't sticked to by (one of) the participants with respect to the moments of payment. Reasons for this may be a.o.

- heavy competition, by which one can afford to deviate from what has been agreed upon
- the company may be the only or most important customer of a number of its suppliers, and/or the company has only few customers for certain products
- solvency problems.
In this way realised sales/purchases didn't result in timely in-coming and/or out-going cash flows.

From the a company's point of view this problem can only be solved by improving the negotiation position of the company with respect to its customers.

Note that the reasons for having deviations between planned and realised cash flows as mentioned under 1) upto 4) are due to dynamical changes in the environment of the company, whereas the reasons mentioned under 5) are of a more static nature.

The third term after the = sign in expression E4 describes the contribution to \( \text{\textsuperscript{\textsuperscript{\textdagger}}}(\text{net cash flow}) \) due to an unexpected simultaneous changes in both the price for a given product/service and the quantity of that product/service.

Taking into account the above mentioned different origins for the different terms making up \( pr\times qr - pf\times qf \), the latter can be rewritten as follows

\[
pr\times qr - pf\times qf = (pr - pf)\text{inf/def}qf \text{(reason 1))} \\
+ (pr-pf)\text{exr}qf \text{(reason 2))} \\
+ (pr-pf)n\text{inf/def/exr}qf \text{(reason 3))} \\
+ pf(qr - qf)\text{pro/del} + (pr - pf)\text{inf/def/exr}(qr - qf)\text{pro/del} \\
+ (pr - pf)n\text{inf/def/exr}(qr - qf)\text{pro/del (reasons 4) and 5) })
\]

From this expression it becomes clear that as far as \( \text{\textsuperscript{\textsuperscript{\textdagger}}}(\text{net cash flow}) \) is concerned, using detailed (short term) time-phased material requirements plans for generating detailed (short term) time-phased cash flow plans will be useful if

a) the prices don't fluctuate "too much" unexpectedly,
b) the prices for the purchase/sales parts are high, and
c) the uncertainties with respect to production/delivery and demand (for sales items), may be "considerable".

(In this context it should be remarked that companies may deliver such a mix of products/services that the extra in-coming cash flows due to some (groups of) products/services "always" will be compensated by the extra out-going cash flows caused by some other (groups of) products/services in the same period of time. This may apply e.g. to companies delivering alternative products/services like travel agencies offering several different trips for the same market segment for the same period of time.)

Considering all the above it may be stated that a system for forecasting and controlling time-phased net operational cash flows based upon time-phased material (resource) requirements will be useful if

- the discrepancies between realised and planned cash flows are "considerable" and ("almost") completely due to the delivery of more or less products than expected, and
- these discrepancies can be forecasted so much in advance that it still will be possible to amend financial contracts, and
- the latter amendments will give rise to an increase of the in-coming cash flows (and/or decrease of the outgoing cash flows) that (considerably)
outweights the increase of the out-going cash flows resulting from the setup and usage of the above mentioned system.

Examples of companies for which the above mentioned conditions may hold are

-aircraft constructing companies,
-car companies,
-engineering works,

producing products requiring (relatively) expensive parts like engines that are delivered by external companies.

Having outlined what gains may be expected from having improved forecasts of cash flows arising from material flows, a system for forecasting/controlling time-phased net operational cash flows is proposed that is based upon ((partly) computerised) (information) systems for planning and controlling purchasing/production/sales activities that are used by many companies. Thereby we first restrict ourselves to the net operational cash flows resulting from in-coming and out-going material flows (i.e. purchases and sales). (A rough indication of some aspects of such a system is given in [2].)

RELATIONSHIPS BETWEEN CASH FLOWS AND GOODS FLOWS

As can be seen from expressions E2 and E3 it's not only the magnitude of net cash flow that determines the gains from having better forecasts. The latter are also determined by the length of the lending/investment periods and the heights of the prevailing interest/investment rates concerned in. The longer the lending/investment periods are and the higher the interest/investment rates are, the larger E2 and E3 are.

The lending/investment periods are strongly related to the cash conversion periods of the final products/services generated by the company.

In order to clarify how time-phased net operational cash requirements are related to time-phased material flows, let us consider a company that produces and sells 1 type of final product FP only. For simplicity's sake let us assume further that 1 unit of final product FP is made up of 1 unit of semi-finished product SP that in its turn is made up of 1 unit of raw material RM. (Otherwise stated we assume the following BOM structure for FP

```
--------
| FP   |
--------
  1    |
--------

--------
| SP   |
--------
  1    |
--------

--------
| RM   |
--------
```

Besides we assume that the only material that is bought by the company in order to produce FP, is RM.
Then the only out-going material flow concerns FP whereas the only in-coming material flow concerns RM. So as far as materials are concerned all in-coming cash flows originate from selling FP whereas all out-going cash flows are generated by buying RM.

Because we first want to explain only the basic relations between cash flows and goods flows, we shall also assume that the delivery conditions of all suppliers of RM are exactly the same and that the latter also holds with respect to the conditions under which FP is delivered to all customers. (The more realistic situation where these simplifying assumptions normally not hold, will be discussed later on.)

Fig.2 shows the different periods of time that are of importance with respect to the cash disbursements resulting from the time phased material requirements for RM, as well as the different periods of time that are of importance with respect to the cash receipts resulting from selling FP.

<table>
<thead>
<tr>
<th>credit time supplier</th>
<th>credit time customer</th>
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<tbody>
<tr>
<td>UPS</td>
<td>cash conversion period</td>
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<tr>
<th>S----&gt;RM----&gt;SP----&gt;FP----&gt;C</th>
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<td>\ ----&gt; \ ----&gt; \ ----&gt; \</td>
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<tr>
<td>T1 T2 T3 T4 T5 T6 T7 T8</td>
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</table>

Fig 2 GOODS FLOWS, CASH FLOWS AND THE CORRESPONDING PERIODS OF TIME

A central place in Fig.2 is occupied by the material flow in the middle, where

S denotes supplier
C denotes customer (i.e. the organisation/person that buys FP from the company),

\ / denotes a stock location
\ ----
|     | denotes a (group of) production steps (processes)

whereas the fat printed long vertical lines indicate the physical boundaries of the company considered.
The 2 rows of horizontal lines at the bottom of Fig.2, denote the different times that play a part in the production and delivery of FP. Thereby the "manufacturing" times mark the pure processing times only. The different "storage" times concern the periods of time that RMs, SPs and FPs are kept in special stock locations (denoted by the up-side-down triangles), from which they can be detracted by means of an explicit order only, as well as the times for waiting before and after the different production steps (processes), i.e. the periods of time resulting from work-in-process storage. The moments upon which the above mentioned periods of time begin or end, are marked by T1 upto T8.

(It should be remarked that Fig.2 can easily be extended to include operations that have to be performed in going from RM to SP and/or going from SP to FP, but are taken care of by external companies, thereby giving rise to extra cash flows. Likewise it should be remarked that the period of time between T6 and T8 can be subdivided into sub periods of time, representing the periods of time during which FP is in the different parts of the distribution chain that is taken care of by the producing company itself (i.e. the transport of FPs to and from regional warehouses, retails etc., as well as their storage in these locations.)

The 2 rows of horizontal lines at the top of Fig.2, denote the different times that connect the material flow in the middle with its resulting cash flows.

The credit time supplier, denoted at the left-hand top corner of Fig.2, indicates the period of time that may elapse between the arrival of RM at the company and the last moment that the company can pay for this supply in order that the supplier receives its payment in time. UPS denotes the utmost payment date supplier.

The credit time customer, denoted at the right-hand top corner of Fig.2, marks the period of time between the moment of delivery of FP to the customer and the moment that the payment made by the customer for this delivery has to be received by the company. UPC denotes the utmost payment date customer.

The cash conversion period, indicated by the long, fat printed horizontal line at the top of Fig.2, denotes the period of time that elapses in between the moment that the raw materials, required for the production of an FP, have been paid by the company (formally UPS), and the moment that the money that the customer paid for the FP, has become available to the company (formally UPC).

(It should be remarked that Fig.2 essentially applies to only 1 (group of) RM(s) (and SP(s)) that plays a part in producing an FP. Moreover the supply and delivery times in Fig.2, as well as the credit time supplier/customer apply to 1 (group of) supplier(s)/customer(s) only. In principle a separate Fig.2 should be generated for each individual RM and SP that plays a part in the production of a given FP.)

Fig.2 clearly indicates the different quantities (periods of time) that together determine the length of the cash conversion period.
Now, having outlined how goods flows and cash flows are mutually related, attention is paid to time-phased materials requirements that are the origin of part of the cash flows to and from a company.

**TIME-PHASED MATERIALS REQUIREMENTS**

Table 1 shows the time-phased requirements for some (group of) (semi-finished) product(s) or raw material(s) X for several periods of time, as may be obtained from e.g. MRP-I type calculations [1].

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**TABLE 1 TIME-PHASED MATERIALS REQUIREMENTS**

For the sake of completeness the meaning of the different rows of Table 1 is stated hereafter.

The "gross requirements" for period i (i=1,2,...) denote the quantity of X expected to be required during period i (i=1,2,...) according to planned or ordered quantities of product(s containing item(s)) X.

The "scheduled receipts" for period i marks the quantity of X that has been ordered already and is therefore expected to become available in period i.

The "on hand" quantity for period i indicates the quantity of X that has to be ordered in order to fulfill the "gross requirements" for X in period i. (When the MRP-I algorithm is used, the "on hand" quantity of period i is obtained by adding up the quantities "on hand" of period i-1 and "scheduled receipts" of period i, and subtracting from this sum both the "gross requirements" and the safety stock norm for period i. If the latter subtraction results in a positive figure, this figure is indicated at the cross section of the row "on hand" and the column corresponding with period i. If the latter subtraction gives rise to a negative figure, the result is indicated at the cross section of the row "net requirements" and the column presenting period i.)

The "planned due" quantity of period i is obtained by approximating the "net requirements" quantity of period i by an integer multiple of a given lot size (stating the size of the smallest production/purchase order for X).

Finally the row "planned release" of period i equals the "planned due" quantity of X for period i+L, where L denotes the so-called production (or purchasing) lead time i.e. the number of periods required for producing X from its constituent parts (or the number of periods required for delivering X).
Table 1 forms the starting point of this paper.

**TIME-PHASED CASH DISBURSEMENTS AND CASH RECEIPTS**

To each period in Table 1 corresponds a positive or negative cash requirement (cash disbursement or cash receipt). These cash requirements result from resource flows before, during or after that period.

In order to derive the time-phased expenditures, that are generated by the time-phased material requirements for the production of FPs, at least the following quantities have to be registered for each purchase item:

- a) its ordering lot size
- b) its price (that may depend upon many different things like the quantity bought)
- c) the period of time in between the moment that a quantity of a purchased item has been delivered to the company, and the last moment upon which that quantity should have been paid for by the company (the credit time supplier). This period of time, like the price, depends upon the contract between the supplier of the purchase item and the company. It may depend a.o. upon the quantity bought.

C) forms the bridge for going from the in-coming material flows to the out-going cash flows, resulting from these.

Apart from the "negative" cash flows arising from purchasing raw materials and semi-finished products, (hopefully) also "positive" cash flows arrive at the company from the sales of their FPs.

For these FPs at least the following quantities have to be registered from a financial point of view:

- a) its selling lot size
- b) its selling price (that may depend a.o. upon the quantity sold, the buyer)
- c) the period of time in between the moment that a quantity of an end product is sent from (or delivered by) the company considered, and the last moment upon which that quantity should have been paid for by the receiving customer (which depends upon the contract for delivering a given quantity of a given FP between the company and a given customer) i.e. the credit time customer.

The "cash receipt lead time" c) forms the bridge for going from out-going material flows (i.e. sales) to in-coming cash flows.

Whereas a) and b) can be, and are, registered for purchase/sales items in many purchase/sales (goods flow) control information systems (like MRP-II systems), the same doesn't always hold with respect to c).

In the latter case, as a first step on our way of integrating material flows and cash flows, the "cash expenditure/receipt lead time" c) should be added to the set of data elements that is used for describing a purchase/sales item within existing purchase/sales (goods flow) control information systems (see also Note 1) at the end of this article).
Table 2 shows how the time-phased cash requirements of our company as a whole may be presented similarly to the way Table 1 presents the time-phased requirements for a given (raw) material or (semi-finished) product. (Note that Table 1 usually deals with the time-phased material requirements for 1 raw material or (semi-finished) product only. It doesn't seem worthwhile to do something similar with respect to cash flows due to problems arising e.g. from the usage of (common) parts that have to be ordered together but are used for the generation of more than 1 product/service.)

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**TABLE 2 TIME-PHASED CASH REQUIREMENTS**

So Table 2 may be generated for showing the total time-phased cash requirements of a company as a whole as obtained by

a) aggregating the time-phased in-coming and out-going cash flows corresponding to all in-coming and out-going (raw) materials and (semi-finished) products,

b) aggregating the time-phased in-coming and out-going cash flows corresponding to all resources concerned in generating the final products/services by the company.

Hereafter we first restrict ourselves to Tables 2 of type a).

(In the following two sections attention is paid to b)).

In that case the "gross requirements" for a certain period of time in Table 2 indicate the "amount of liquidities" that is expected to flow from the company during that period of time as a result of the in-coming material flows of purchased RMs (and SPs) before, during or after that period.

Starting point for calculating the figures in the row "gross requirements" of Table 2 are the quantities in the rows "scheduled receipts" and "planned due" of the Tables 1 for all purchased RMs and SPs (because the latter state the quantities of the different RMs and SPs that should enter the plant during a given period of time for a timely delivery of given quantities of FP). Next these quantities are offset with the credit times of their suppliers, and multiplied by the prices that have to be paid to the suppliers.
The row "scheduled receipts" in Table 2 marks the liquidities that are expected to arrive at the company during the different periods of time as a result of the sales of FPs before, during or after these periods (where the quantities sold are offset with their buyers credit times and multiplied by their sales prices).

The row "on hand" in Table 2 denotes the liquidities that may be directly available at the end of a certain period of time (i.e. at the beginning of the next period). This may be cash, current banking accounts or liquidities that can be made available in a given period from e.g. deposit accounts, the selling of bonds and the like. Because we restrict ourselves here to the cash flows that are directly related to the material flows to and from a given company, the row "on hand" should not include the directly available liquidities reserved for purposes like investments in machines, buildings, pay rolls etc.

(Under some circumstances part of the money reserved for the latter might be dealt with as liquidity safety stocks, similarly to the way that material safety stocks are dealt with by e.g. MRP-I calculations.)

In Table 2 the row "net requirements" denotes the time phased cash requirement for each period of time, as far as generated by the material flows of FPs (to be) sold, and RMs and SPs (to be) purchased! Thereby the "net requirements" figure for period i is obtained by subtracting the "scheduled receipts" figure for period i and the "on hand" figure for period i-1 from the "gross requirements" figure for period i (i.e. similarly to how material net requirements are generated by means of MRP-I calculations).

In contradistinction to the figures appearing in the row "net requirements" of Table 1, the row "net requirements" of Table 2 may contain negative figures. These negative figures correspond with liquidities that may be invested by the company.

In Table 1, the row "planned due" may differ from the row "net requirements" due to the usage of physical lot sizes. Similarly it may be worthwhile to combine the cash requirements for a number of periods from a finance point of view ("expenditure lot sizes"). It is for registering the results of the latter that Table 2 includes the row "planned due".

It may not always be possible to obtain or to invest the "amounts of liquidities" stated in the row "planned due" immediately when required. In order to realise the latter, some time before the planned due "amounts of liquidities" have to be (/will become) available, activities have to be undertaken. This period of time can be looked upon as a "financing lead time". In order to make the influence of this lead time on the time-phased cash requirements clear, the row "planned release" has been included in Table 2.

The periods of time used within Table 2 don't have to have the same size as the periods of time used in the Tables 1, as long as the due dates of all purchase/work/sales orders are known by the goods flow control - cash flow control information system. In that case always a one to one correspondence between the figures in the time periods of the different tables can be established.
Clearly it should be the responsibility of the finance department of the company to define the "appropriate" sizes of the time period buckets to be used in Table 2 as well as the "appropriate" size of the cash planning period, because the finance department has to take decisions, based upon the information supplied by Table 2. Thereby it has to be taken into account generating a realistic Table 2 requires "correctly" updated Tables 1. This requires tuning of these 2 sets of tables and thereby of their planning periods.

It may be useful to depict the figures in the row "planned release" of Table 2 diagrammatic as shown in Fig.3.

```
<table>
<thead>
<tr>
<th>net cash requirements (in some monetary unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0------------------------------------------</td>
</tr>
<tr>
<td>1 2 3 4 5 6 --- period #</td>
</tr>
</tbody>
</table>
```

FIG 3 TIME-PHASED NET CASH REQUIREMENTS

Starting from Fig.3, the finance department may decide what forms of credit may be most appropriate for covering the positive cash requirements, as well as which forms of investment may be most appropriate for the negative cash requirements.

(The dotted horizontal line in Fig.3 might e.g. suggest the liquidities that might be obtained by means of longer term loans, requiring less rent to be paid. For the remaining positive cash requirements other financial resources, like short term loans, might be more appropriate.)

When we restrict ourselves to the example company producing/delivering 1 FP, that this company produces itself out of 1 SP that in its turn is produced by the company out of 1 RM, Table 2 for the company as a whole coincides with Table 2 for FP, as far as the cash requirements generated by material flows are concerned.

Clearly the latter will not hold in general however.

Usually 1 company produces/delivers more than 1 FP for/to more than 1 customer, whereas the production of 1 FP usually requires several SPs and RMs, where some or all of the SPs and RMs may have to be obtained from one or a number of other companies (under different conditions).

In order to arrive at Table 2 for the company as a whole in this case, first all its sales items and purchase items have to be estimated (and registered in the sales/purchase indicator data field of each item).

Next starting from the planned (and realised) production/selling of the sales items, the time-phased requirements for the different purchase items are calculated, using the bill of resources (materials) of the sales items. Offsetting the figures in the rows "scheduled receipts" and "planned due" (or "planned release", depending upon the delivery conditions) of the Tables 1
corresponding to the purchase items with the credit times of their suppliers, and multiplying the so obtained time-phased requirements with their prices, results in the figures in the row "gross Requirements" of Table 2.

Analogously the figures in the rows "scheduled receipts" can be obtained from the planned (and realised) selling of sales items, offset with their "cash receipt lead times".

The figures in the remaining rows of Table 2 can be calculated from the foregoing 2 rows of figures, as described for our simple 1 FP company example.

CASH FLOWS ARISING FROM NON-MATERIAL RESOURCE REQUIREMENTS

Upto here we paid attention to the time-phased cash requirements resulting from the material flows to and from a given company only. A complete overview of all in-coming and out-going cash flows of a company during a given period of time would require to take into account the cash flows corresponding with the buying/hiring/maintenance/selling of machines, tools, buildings, operators etc. as well. Besides the above mentioned operational (primary) in-coming and out-going cash flows, also the (secondary) cash flows resulting from taxes, returns upon capitals etc. during this period would have to be included.

Clearly the above mentioned time-phased cash requirements can be added to the time-phased cash requirements arising from material flows. Then a figure similar to Fig.3. could be generated for the total time-phased cash requirements of the company for the period of time concerned.

Within the context of this paper no further attention will be paid to the above mentioned, very important, cash flows however.

DISCUSSION

Having outlined how the time-phased cash requirements arising from time-phased material requirements (forecasts) can be derived (forecasted), the merit of the here proposed system is discussed.

For this purpose the extra in-coming and out-going cash flows resulting from setting up and using the here proposed system have to be estimated.

What may be gained from using the here proposed system, i.e. savings on interest and more (better) investments, has already been discussed in the Introduction.

In order to estimate the costs (expenditures) concerned in setting up and using the here proposed system, first the presently used systems for forecasting/controlling time-phased cash flows based upon the most important activities of a purchase and a sales department as well as the information required for undertaking these activities, are summarised briefly.

Purchase departments take care of realising the timely delivery of all required resources of a given quality that have to be bought from external suppliers at "the lowest possible price". For this purpose purchase orders are generated.

In order to generate purchase orders, a purchase department will have to use lists (computer files) stating for each purchase item all its (possible)
suppliers, and for each of these (possible) suppliers the conditions under which the item is delivered, like the price that has to be paid for the item, its delivery time, as well as the maximum quantity that may be delivered (during a given period).

Besides a purchase department will generally use an overview of all its suppliers, stating for each supplier o.a. the discounts that may apply when the total value of all goods (belonging to a certain group of products), ordered from that supplier (at once or during a certain period of time), exceeds a certain amount of money. This overview is used to combine purchase orders for different (groups of) purchase items in order to take advantage of special discounts.

Sales departments take care of realising the timely delivery of the products and/or services produced by the company and the timely receipt of the cash receipts resulting from the above mentioned deliveries. For this purpose sales orders are generated. In order to generate sales orders, a sales department will use lists (computer files) stating for each sales item for each of its customers (customer groups) the conditions under which the item is delivered, like the price that has to be paid for the item, its delivery time, etc.

Generally a sales department also uses an overview of all its customers, stating for each customer o.a. the discounts that are agreed upon when the total value of all goods (belonging to a certain group of products) ordered by that customer (at once or during a certain period of time) exceeds a certain amount of money, as well as an overview, showing for each customer its purchases (during a certain period of time) and its payments. Based upon the above mentioned 3 sources of information, the time-phased cash receipts resulting from sales orders can be estimated.

If the company uses a production planning and control system that generates time-phased material requirements already, and if the company does have a purchase and a sales department working as described above, the extra activities and information that are required to setup and use the net operational cash flow planning and control system as proposed above are

The activities and information required for estimating the cash disbursements/receipts that are expected to be generated by planned purchases/sales.

(For realised purchases/sales, orders are generated already. So part of the cash disbursements/receipts is known in advance already.)

The extra expenditures arising from these activities and information requirements will depend upon many things like

a) the number of different (groups of) items,
b) the number of planned purchases/sales orders,
c) the number of different (groups of) suppliers/customers (for 1 (group of) product(s)),
d) the characteristics of the contracts with each of them (like discounts based upon the total value of the purchases/sales from a given supplier/to a given customer during a given period of time),
e) the present work load of people and machines that have to take care of the above mentioned activities.
The usefulness of the here proposed system may be limited because both the credit time supplier/customer and the price that have to be paid for a given product by either the company or a customer, may depend upon many more things than just upon the product itself.

1) For a given purchase (sales) item there may be more than 1 supplier (customer), each having its own payment conditions which may involve a.o. different credit time supplier (customer) and different prices for the same product.

At the moment many companies have more than 1 supplier for a given raw material or (semi-finished) product, each with its own supply conditions. (There is a tendency to setup joint-ventures however). Most companies have more than 1 customer for one of its final products, whereas different (groups of these) customers may have their own delivery conditions.

For the above mentioned raw materials, semi-finished and final products, at least in principle, it is possible to define 1 credit time supplier/customer for each (group of) product(s), by using weighted averages of the different credit times as THE credit time supplier or THE credit time customer for a given (group of) product(s).

Clearly these artificial "lead times" have a meaning only when the weights to be used are "more or less self-evident", and the different "lead times" involved don't differ "too much" from each other. What is to be meant by "more or less self-evident" and "too much" is and will remain a highly subjective matter. This is a weak point of the here proposed system, that holds for any other presently used registration system in this field however (see also Note 2).

Also in case of 1 supplier (customer) only, the credit time supplier/customer as well as the price of a given product may vary.

2) The credit time supplier/customer and price may e.g. depend upon the total quantity bought (sold) of a given (group of) product(s) or upon the total value of the products bought during a certain period of time from a given supplier (to a given customer).

3) The price of a given product may depend upon the credit time supplier/customer. Quite often one has to pay less if one pays earlier.

4) The credit time supplier/customer and the price of a given product may also depend upon the season.

Clearly apart from each of the above mentioned dependencies, all sorts of combinations of these may appear.

(Apart from the foregoing more or less wellknown influences upon the prices and the credit times supplier/customer, the latter may also be (drastically) influenced by lost harvests, due to bad weather or animals, strikes and the like. The influence of these events can't not always be avoided by the presence of more than 1 supplier (customer).)

Concluding it can be stated that the information obtained from the here proposed system will be most reliable for (groups of) products and/or services to which only 1 price and only 1 credit time apply for all the periods of time.
that are involved in a given cash requirement planning period, and for which all in-coming or out-going payments are performed (just-)in-time. Only then the here proposed registration system will give a really correct overview of the time-phased requirements for the periods of time considered. In all other cases it may give useful estimates only.

Herewith both the (extra) expenditures that may result from the above indicated (extra) activities and data (information) required for realising the here proposed net operational cash flow planning and control system, and the decreases in expenditures that may result from using the latter system, have been indicated.

Based upon the above mentioned pro's and con's it should be possible to determine the usefulness of the here proposed system for forecasting/controlling (parts) of the cash flows of a given company.

SUMMARY AND CONCLUSIONS

In this paper it has been examined what may be gained from using short term term information on time-phased resource requirements for improving short term time-phased cash flow requirements plans. Thereby special attention has been paid to the part played by time-phased material requirements.

A very straight forward and simple system for forecasting and controlling time-phased net operational cash requirements was presented.

This system will be useful if

- the discrepancies between realised and planned cash flows are ("almost") completely due to the delivery of more or less products than expected, and
- these discrepancies can be forecasted so much in advance that it still will be possible to amend financial contracts, and
- the latter amendments will give rise to an increase of the in-coming cash flows (and/or decrease of the outgoing cash flows) that outweigh the increase of the out-going cash flows resulting from the setup and usage of the above mentioned system.

Its 2 main advantages over existing systems for cash disbursements (and receipts) are

1) It provides better short term forecasts with respect to the cash flows resulting from time-phased material requirements (purchases) and sales.
2) It provides earlier insight into the future behaviour of the cash level, thereby creating more time for taking short term financial decisions. The latter may improve the quality of these decisions.

From a data(processing) point of view setting up and using the system will not require much effort in companies that are using MRP-I (MRP-II) like software already.

There may be problems with respect to the implementation of the here proposed system, due to the characteristics of the prices and the "payment lead times" of the products, as well as to the characteristics of the suppliers (delivery reliability with respect to time, quantity, quality) and customers (ordering, paying reliability) of these products.
These are the same types of problems that (will) appear for whatever system for forecasting and controlling cash flows however.

This paper at least should have provide us with more insight into some of the problems that may be met when trying to relate cash disbursements/receipts (automatically and) directly to their generating in-coming/out-going resource flows.

NOTES

Note 1).

From a data (base) structure point of view, we can use 1 data element for registering either the "cash expenditure" or the "cash receipt" lead time, if there is also a data element defined for indicating whether a given item is a purchase or a sales item. (In most MRP systems it can be indicated whether an item is a make or a buy item.)

A remark is due here with respect to products that have to be paid for (partly) in advance.

In order to take this into account, negative "cash expenditure"/"receipt" lead times have to be allowed. Thereby a lead time -2 means that 2 days in advance of a planned delivery, this delivery should have been paid for.

An extra data element may be required for each purchase/sales item to indicate which part of a purchase/sales order for that item has to be paid in advance.

Note 2).

An alternative that overcomes the problems related to using weighted credit times supplier/customer, is to treat the raw materials, semi-finished products that are the same from the company's production department point of view, but are supplied by different (groups of) suppliers from the company's finance department point of view, as different items.

This doesn't have to be a problem from a data (processing) point of view, if for some reason or another the quantities of a given purchase item required for the production of a given (group of) product(s), "always" are (may be) bought from a given (group of) supplier(s).

If the latter doesn't apply, it may be possible to subdivide (automatically) the total requirements of a company for a given purchase item into requirements for the different (groups of) suppliers. Starting from this subdivision the different time phased cash disbursements can be generated as described before.

REFERENCES


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