NAVISION®

Technical White Paper

Planning Functionality

Microsoft Business Solutions–Navision 4.00

This technical white paper describes how supply planning works in Navision. The document is intended for Navision supply chain professionals supporting the product or implementation at customer sites. The reader will gain knowledge about:

- Understanding the results of the planning.
- The impact of the planning parameters.
- How to adjust the algorithms to meet specific customer needs.

Microsoft Business Solutions

Content

1. Intentions of this Document

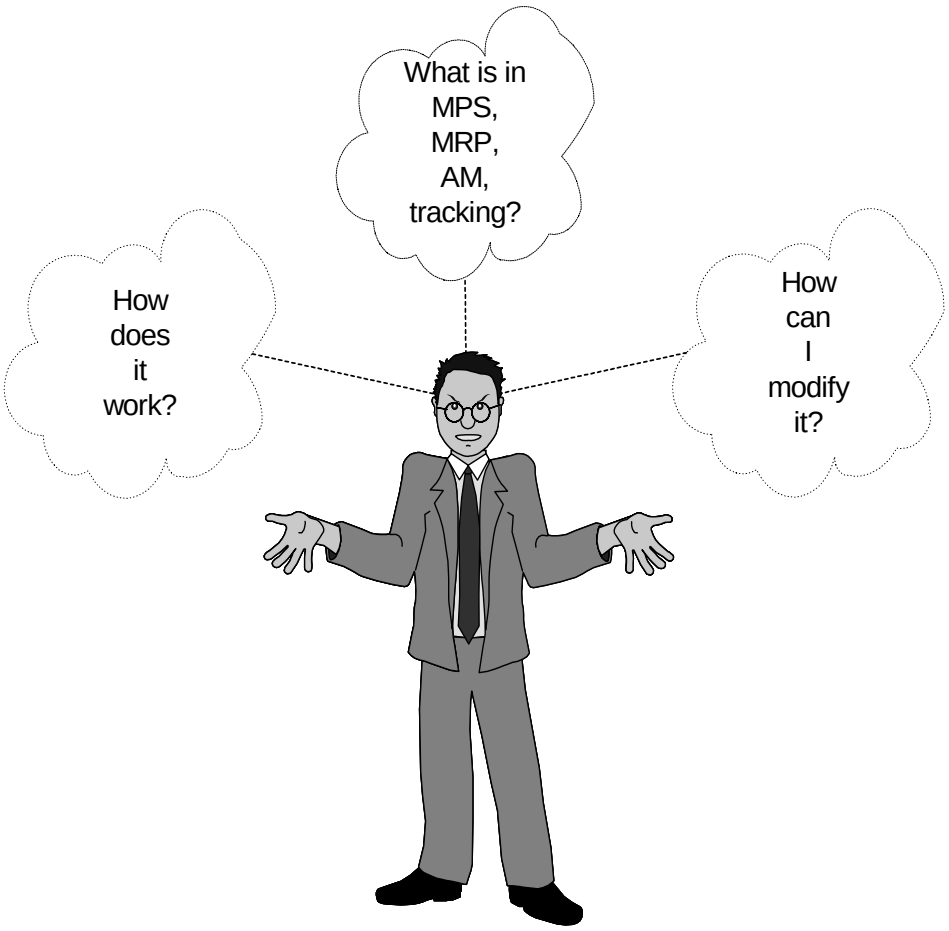
This document is intended for Navision supply chain professionals supporting the product or implementing it at customer sites.

The aim is to describe how Navision supply planning works so that the reader gains sufficient knowledge about:

- understanding the results of the planning.
- the impact of the planning parameters.
- how to adjust the algorithms to meet specific customer needs.

This is a technical document and is not intended to describe general aspects of planning methodologies or theories. These were described in an earlier Navision technical white paper on planning. A variety of published literature on the subject is also available.

The terms ‘planning system,’ ‘action messaging (AM)’ and ‘MRP’ are often used synonymously. To avoid confusion, it should be stated that this document focuses on the planning system, which includes MRP and MPS. Any descriptions of AM are limited to explaining how it works with and supports the planning system.


What is in MPS, MRP, AM, tracking?
How does it work?
How can I modify it?

2. The Planning System and Action Messaging

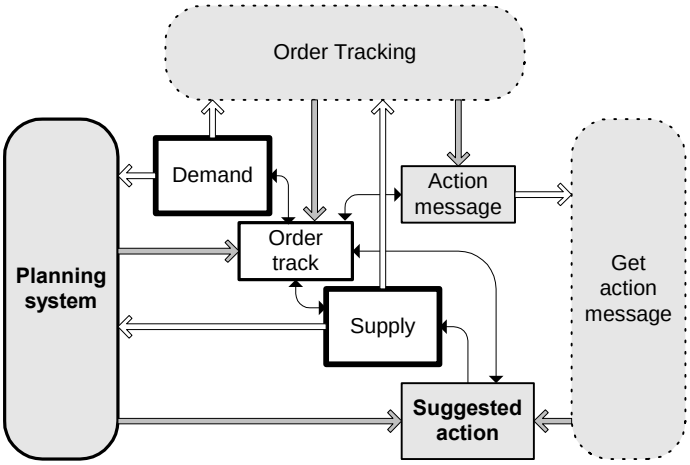
2.1 The Planning System

- The user activates the planning system from the planning worksheet (and in version 3.x, the requisition worksheet as well).

- It consists of a batch job that first selects the relevant items to plan for. Then for each item, the batch job calls a code unit, which calculates a replenishments plan by rearranging order tracking and suggesting possible actions for the user to take.

- The suggested actions appear as lines in the planning worksheet (or in version 3.x, optionally, the requisition worksheet).

- MRP and MPS, Net Change Planning and Regenerative Planning all use the same code unit, which contains the planning logic. However, the calculation involves different items.



2.2 Action Messaging

- Order tracking, with its simultaneous creation of action messages (AM), is not a part of the planning system. This feature interlinks, in real-time, the requirements and the quantities that could cover them, whenever a new requirement or replenishment order is created or changed.

  If, for example, the user enters or changes a sales order, order tracking will instantly search for an appropriate supply to cover the demand. This could be from inventory or an expected replenishment order (such as a purchase or production order). When a supply source is found, a link is created between the demand and the supply. If all of the demand cannot be covered, order tracking will create an action message suggesting what the user could do to address the situation.

- AM are stored in a separate table. The user can retrieve and view them in the planning worksheet by running the Get Action Messages batch job.

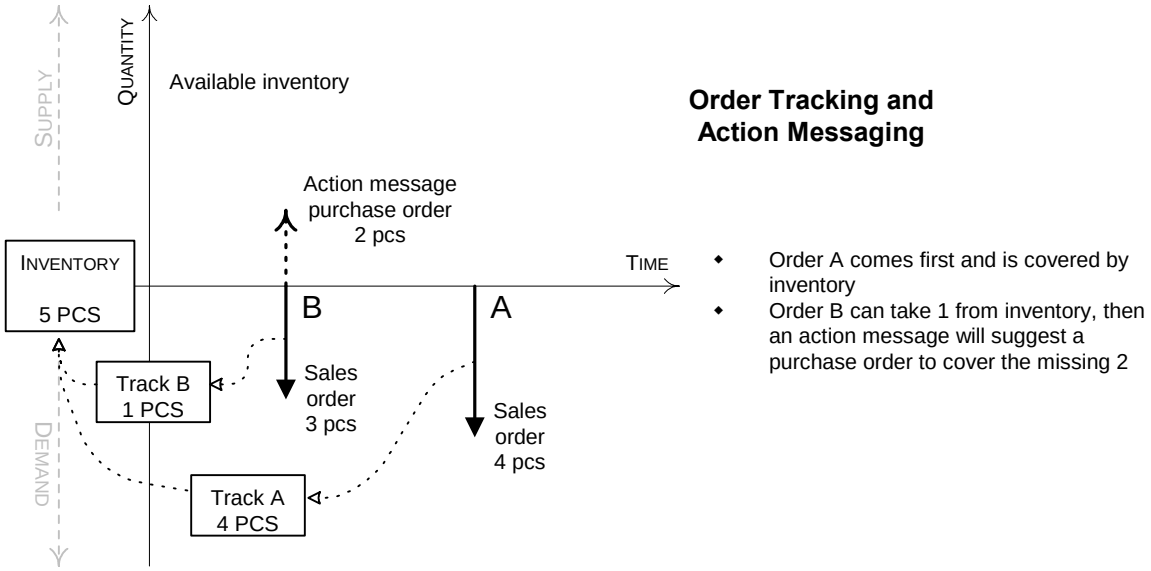
- AM offers a quick response but less comprehensive plan than the planning system.

2.3 Differentiating between Planning and Action Messaging

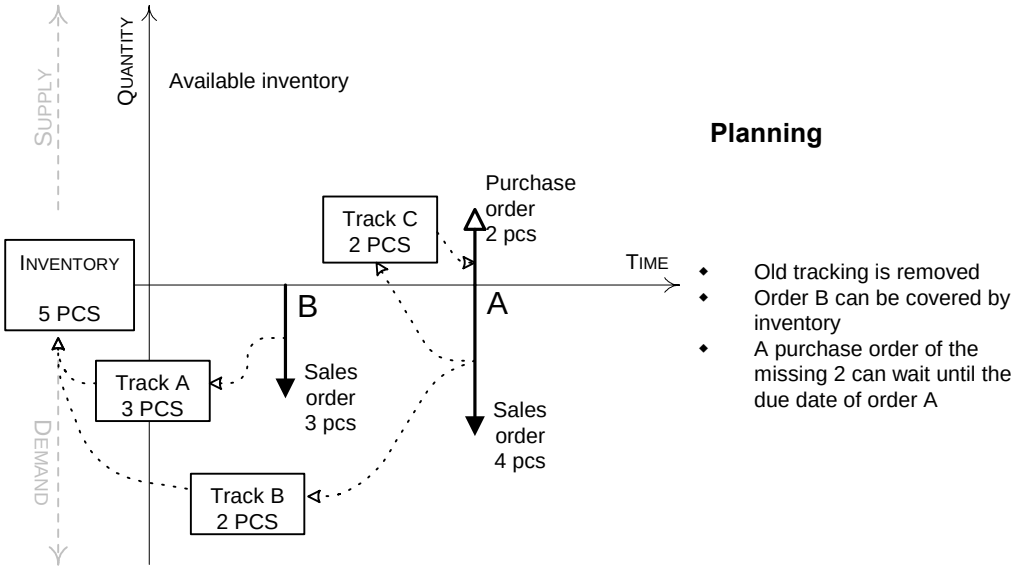
At a quick glance, it may be difficult to differentiate between planning and action messaging. Both features display their output in the planning worksheet. The output – suggested actions for the user to take – is similar but the way this output is produced differs.

- The planning system deals with the entire supply-demand pattern of an item through all levels of the BOM hierarchy, whereas order tracking only addresses the situation of the order that activated it.

- When balancing demand and supply, the planning system creates links in a user-activated batch mode, whereas order tracking creates the links automatically and on the fly whenever the user enters a demand or a supply in the program (for example, a sales or purchase order).



Order tracking establishes links between demand and supply as data is entered, on a first-come basis. This may lead to some disorder in priorities. For example, a sales order entered first but with a due date next month may be linked to the supply in inventory, while the next sales order due tomorrow may cause an action message to create a new purchase order to cover it.



The planning system, on the other hand, deals with all demand and supply orders for a particular item, in prioritized order according to due date. It deletes all links that were created dynamically and reestablishes them

according to due date priority. When the planning system has run, it has solved all imbalances between demand and supply. No action messages remain in the Action Message Entry table, as they have been replaced by the suggestions in the planning worksheet.

3. Concepts in Brief

The planner of a company – the purchaser or production planner – is presumed to be the user of the planning system.

The overall problem that the planning system should resolve is to suggest which actions the user could take to ensure that customer demand is met. It can be a cumbersome task when working with many items. This task increases to a staggering level when you include production due to derived demand that has spread down through the BOM hierarchy.

The planning system assists the user by performing the extensive but rather straightforward calculations of a plan. The user can then concentrate on solving the more difficult problems, such as when things differ from normal.

The planning system is driven by anticipated and actual customer demand – such as forecast and sales orders. Running the planning calculation will result in the program suggesting specific actions for the user to take concerning possible replenishment from vendors, transfers between warehouses, or production. These suggested actions could be to create new replenishment orders (purchase, for example). If replenishment orders already exist, the suggested actions could be to increase or expedite the orders to meet the changes in demand.

Another goal of the planning system is to ensure that the inventory does not grow unnecessarily. In the case of decreasing demand, the planning system will suggest that the user postpone, decrease in quantity or cancel existing replenishment orders.

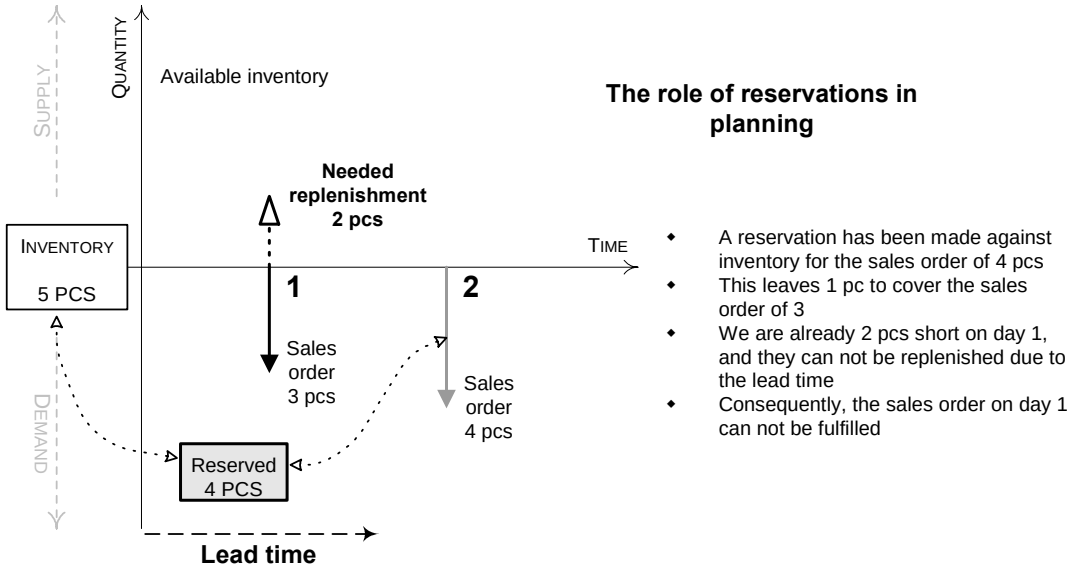
Parameters that the user sets for an item or a group of items control which actions the planning system will suggest in the various situations. The parameters, and how they are applied, are explained in section 4.2 and Appendix B.

3.1 Reservations Are Not Considered

The program does not include any reserved quantities in the planning calculation. Take the example of a sales order that has been totally or partially reserved against the quantity on inventory. The reserved quantity in inventory cannot be used to cover other demand. Also, since the sales order was reserved manually, the planning does not include this requirement, and its corresponding fulfillment, in its calculation.

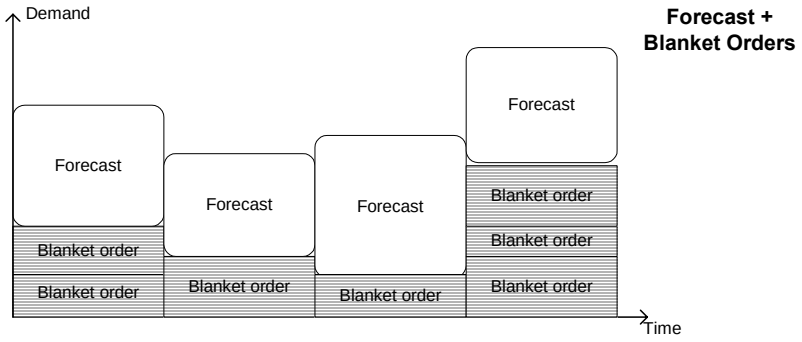
The planning system prioritizes according to shipment date since that is the best way to ensure the lowest possible inventory. Manual reservations tend to prioritize according to order entry date.

The figure below illustrates how reservations can hinder the most feasible plan.



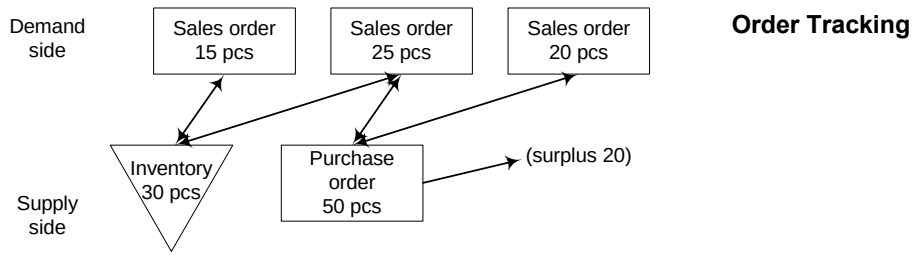
3.2 Forecast and Blanket Orders

Forecast and blanket orders both represent anticipated demand. The blanket order, which covers a customer's intended purchases over a specific period of time, acts to lessen the uncertainty of the overall forecast. The blanket order is a customer-specific forecast on top of the unspecified forecast or vice versa.



3.3 Order Tracking

Order tracking can be considered as a tool that assists the planner in assessing whether or not to accept replenishment suggestions. From the supply side, a planner can see which requirement has given rise to the replenishment and from the demand side, which replenishment should cover the requirement.



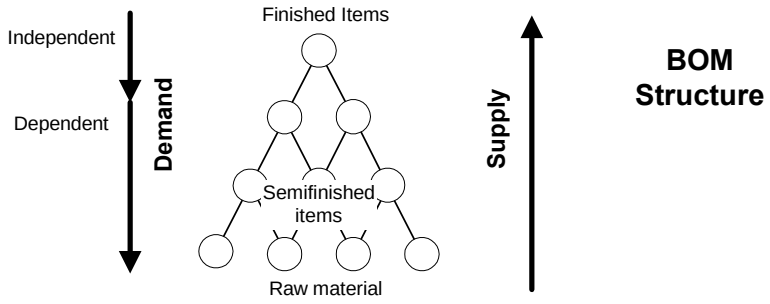
Order tracking links order network entities. Examples of order network entities are sales orders, item ledger entries, purchase orders and anticipated or realized inventory transactions. Forecast or safety stock quantities are not considered order network entities, and are not included in order tracking. The reorder point also represents some sort of forecast, so it is not included either.

3.4 The Manufacturing Environment

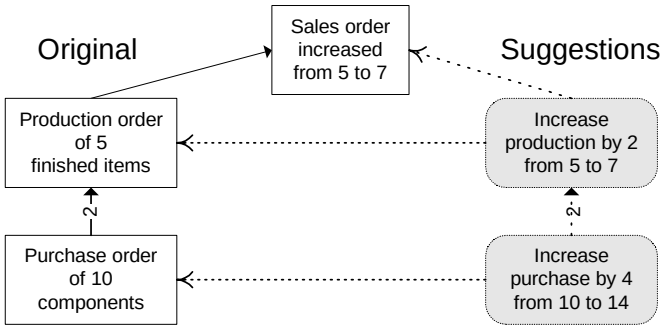
In a manufacturing environment, the demand for a finished, saleable item will result in derived demand for the components that comprise the finished item. The bill-of-material structure controls the component structure and

can cover several levels of semi-finished items. Planning an item at one level will cause derived demand for components at the next level, and so on. Eventually, this will result in derived demand for purchased items.

Consequently, the planning system plans for items in order of their ranking in the total BOM hierarchy, starting with finished saleable items at the top level and continuing down through the product structure to the lower level items.



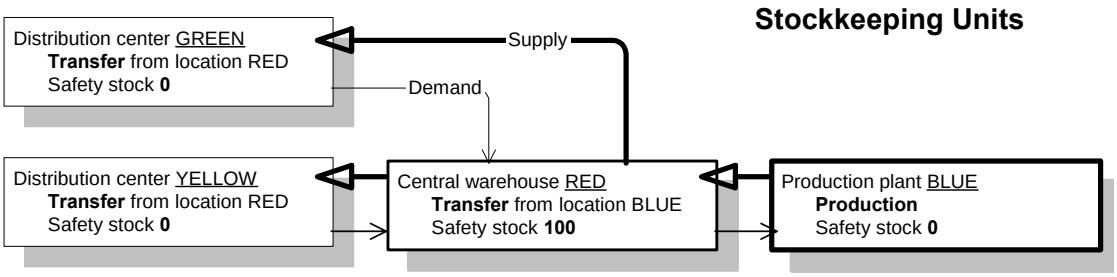
This results in the program making suggestions for replenishment orders at the top level and, assuming that the user will accept these suggestions, also for any lower level items as well.



3.5 Multilocations

Companies that operate at more than one location may need to plan for each location individually. For example, an item's safety stock level, as well as its method of replenishment, may differ from one location to another. In this case, the planning parameters must be specified per item and also per location.

This is an option in version 3.x, where individual planning parameters can be specified at the stockkeeping unit level. A stockkeeping unit can be regarded as an item at a specific location. If the user has not defined a stockkeeping unit for that location, the program will default to the parameters that have been set on the item card. The program calculates a plan for 'active' locations only – where there is existing demand or supply for the given item.



3.6 Which Items Should Be Planned?

Basically, all items should be planned for – in one way or another. In reality, however, there is no reason to calculate a plan for an item unless there has been a change in the demand or supply pattern since the last time a plan was calculated.

If the user has entered a new sales order or changed an existing one, there is reason to recalculate the plan. Other reasons include a change in forecast or the desired safety stock quantity. Changing a bill-of-material by adding or removing a component would most likely indicate a change, but for the component item only.

Navision monitors such events and assigns the appropriate items for planning.
In the case of multilocations, the assignment takes place at the level of item per location combination. If, for example, a sales order has been created at one location only, the program will assign the item at that specific location for planning.

The reason for selecting items for planning is purely a matter of system performance. If no change in an item's demand-supply pattern has occurred, the planning system will not suggest any actions to be taken. However, the program would have to perform the calculations anyway in order to find out, and that would drain system resources.

The planning options in Navision are:

- Regenerative plan: calculate all selected items, whether it is necessary or not
- Net change plan: calculate only those selected items that have had some change in their demand-supply pattern and, therefore, have been assigned for planning[1]

The full list of reasons for assigning an item for planning is given in Appendix A.

In addition to these considerations, the planning system only plans for those items that the user has equipped with appropriate planning parameters. Otherwise, it is assumed that the user will plan the items manually.

3.7 Which Locations and Variants Should Be Planned?

In principle, any item can be handled at any location, but the program's approach to the location concept is quite strict. For example, a sales order at one location cannot just be fulfilled by some quantity on stock at another location. The quantity on stock must first be transferred to the location specified on the sales order.

The program also treats the variant code in a similar way. As with location and bin code, the variant code is just another 'dimension' on a sales order line, inventory ledger entry, and so on.

The planning system works accordingly. It calculates a plan for each combination of variant and location as if the combination were a separate item number.

[1] Some people are of the opinion that net change planning should be performed on the fly, as sales orders are entered, for example. However, that could be quite disturbing.
In Navision, the feature of order tracking and action messaging is calculated on the fly.
Navision also offers real-time, available-to-promise control while the user creates sales orders – providing a pop-up warning if the demand cannot be met by the plan.

Instead of calculating any theoretical combination of variant, location and bin, the program calculates only those combinations that actually exist in the database.

4. Basic Solution Concepts

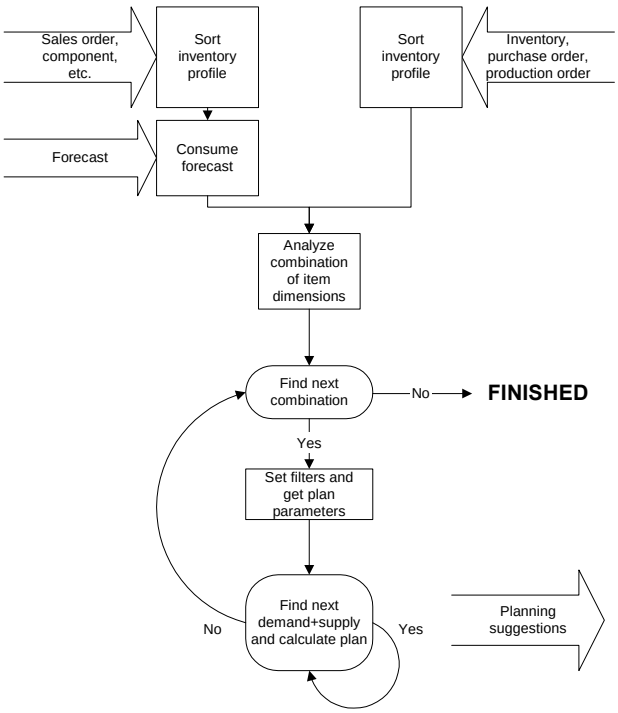
To understand how the planning system works from a technical point of view, it is necessary to recall the prioritized goals of the planning system, the most important of which are to ensure that:

I. any demand will be met by sufficient supply.

II. any supply serves a purpose.

In other words, the objective of the planning mechanism is to counterbalance the demand and supply of an item to ensure that supply events will match each instance of demand in an optimal way and as defined by the planning parameters.

4.1 Program Overview



4.1.1 Lot and Serial Number

In some respects, lot and serial number represent two more dimensions on the item. However, the planning system does not include them in its calculations. If the user wants to use a specific lot number for a production order component, he will have to reserve the lot.

4.2 Planning Parameters, Locations and Variants

The planning parameters control when, how much, and how to replenish. Details about using the planning parameters can be found in Appendices B and C.

In version 3.x the planning parameters can be linked to any combination of item, variant and location. The user can create stockkeeping units for each combination, as needed, and specify individual parameters for it.
(See also Appendix D “Planning with/without Locations”.)

4.3 Demand and Supply

Demand is the common word used for any kind of gross requirement such as a sales order, service order, component need from a production order, outbound transfer, blanket order or forecast. In addition to these, the program allows some other technical types of demand – such as a negative production or purchase order, negative inventory and purchase return.

Supply is the common word used for any kind of replenishment such as inventory, a purchase order, production order or inbound transfer. Correspondingly, there can be a negative sales or service order, negative component need or sales return – all of which in some way also represent supply.

To sort out the many sources of demand and supply, the planning system organizes them on two time-lines called ‘inventory profiles.’ One represents demand events and the other supply events. Thus, a demand or supply represents one event in the relevant inventory profile. Each event represents one order network entity, for example, a sales order line, an item ledger entry or a production order line.

4.3.1 Loading the Demand into the Inventory Profile

The normal types of requirements are loaded into the inventory profile type-by-type and record-by-record.

A requirement could also be negative (the program does not prevent that). This means that it should actually be considered as a supply but, unlike the normal types of supply, we regard this type of supply as 'fixed' – the planning system can take it into account, but it does not suggest any changes to it.

Besides the normal requirements, the planning system deals with two specialties:

- Safety stock
- Production order components

Although in practice, the safety stock can be used to cover requirements if needed, in theory, safety stock is not considered a source of supply in the planning calculation. In fact, the safety stock should remain untouched, and the planning should ensure that it is also replenished, if necessary. Consequently, the planning system enters the safety stock quantity into the demand profile as a special requirement (at the starting date of the period).

When handling production orders, the planning system must monitor the component lines, which represent requirements, before loading them into the demand profile. Component lines that result from an amended production order will replace those of the original order. In this way, the planning system ensures that the component lines are not duplicated.

4.3.2 Consuming the Forecast

A forecast expresses anticipated future demand. As actual demand is entered, typically as sales orders, it consumes the forecast.

The forecast itself is not actually reduced by sales orders; it remains the same. However, the forecast quantities used in the planning calculation are reduced (by the sales order quantities) before the remaining quantity, if any, enters the demand inventory profile. When the planning system examines actual sales during a period, both open sales orders and item ledger entries from sales are included – unless they are derived from a blanket order.

It is prerequisite that the user defines a valid forecast period. The date on the forecasted quantity defines the start, and the date on the next forecast defines the end of that period.

The forecast for periods prior to the planning period is not of interest, regardless of whether it was consumed or not. The first forecast figure of interest is the one on or the closest one prior to the start of the planning period.

The forecast can be for either independent demand, like sales orders, or for dependent demand, like production order components (module-forecast). An item can have both types of forecast. During planning, the consumption takes place separately, first for independent demand and then for dependent demand.

4.3.3 Consuming Blanket Orders

In version 3.x, the forecast has been supplemented by the blanket order as a means of specifying future demand from a specific customer. As with the (unspecified) forecast, actual sales should consume the anticipated demand, and the remaining quantity should enter the demand inventory profile. Again, the consumption does not actually reduce the blanket order.

The planning calculation considers open sales orders linked to the specific blanket order line, but it does not consider any valid time period. Nor does it consider posted orders, since the posting procedure has already reduced the outstanding blanket order quantity.

4.3.4 Loading the Supply into the Inventory Profile

The normal types of replenishment orders and inventory are – as with requirements – loaded into the inventory profile, type-by-type and record-by-record.

Furthermore, a replenishment order or an item ledger entry (inventory) might be negative (the program does not prevent that). This means that it should actually be considered as a demand and therefore, out of scope for any suggested action.

In general, the planning system considers all replenishment orders as subject to change in its objective to fulfill requirements. The planning system does not analyze which orders can be changed and which should be protected – except when something has been posted, that is

- A released production order that has been started
- A transfer order where shipment has been posted
- A purchase order where receipt has been posted

The program considers a released production order to be started if the user has posted any time or consumption. In that case, the planning system takes it for granted that it is too late to suggest any changes.

4.3.5 Separating the Dimensions

The plan must be calculated per combination of the item 'dimensions' such as variant and location. However, there is no reason to calculate any theoretical combination. Only those combinations that carry a demand and/or supply need to be calculated.

The planning system controls that by running through the inventory profile. When a new combination is found, the program creates an internal 'control' record that holds the actual combination information.

In version 3.x, the item master data has been extended by the 'stockkeeping unit' (SKU), on which individual planning parameters per variant/location can be defined. So the program inserts the SKU as the 'control' record, or outer loop. In this way, the proper planning parameters based on combination of variant and location are in place, and the program can proceed to the inner loop.

Note however, that version 3.x does not require the user to enter a SKU record when entering demand and/or supply for a particular combination of variant and location. Thus, if an SKU does not exist for a given combination, the program creates its own temporary SKU record based on the item data. If Location Mandatory is set to Yes in Inventory Setup then either SKU needs to be created or Components at Location in Manufacturing Setup needs to filled in. (See more in Appendix D)

4.4 Balancing/Managing Supply Events

The core of the planning system involves balancing demand and supply by means of suggesting user actions to revise the supply events in the case of imbalance. This takes place per combination of variant and location.

Imagine that each inventory profile contains a string of demand events (sorted by date) and a corresponding string of supply events. Each event refers back to its source type and identification. The rules for counterbalancing the item are straightforward. Four instances of matching demand and supply can occur at any point of time in the process:

1. No demand or supply exists for the item => the planning has finished (or should not start).
2. Demand exists but there is no supply => supply should be suggested.
3. Supply exists but there is no demand for it => supply should be cancelled.
4. Both demand and supply exist => questions should be asked and answered before we can ensure that demand will be met and supply is sufficient.

   If the *timing* of the supply is not suitable, perhaps the supply order can be rescheduled:

   a. If the supply is placed earlier than the demand, perhaps it could be rescheduled out so that inventory is as low as possible, but we can use any possible surplus anyway.
   b. If the supply happens to be later than the demand, perhaps it can be rescheduled in. Otherwise, the planning system should create a suggestion for some new supply.
   c. If the supply meets the demand on the date, the planning system can proceed to investigate whether the quantity of the supply can cover the demand.

   Once the timing is in place, the adequate *quantity* to be supplied can be calculated:

   a. If the supply quantity is less than the demand, it is possible that the supply quantity could be increased (or possibly not, due to a maximum lot size).
   b. If the supply quantity is more than the demand, it is possible that the supply quantity could be decreased (or possibly not, due to a minimum lot size).

   At this point, either of two situations exists:

   a. The current demand can be covered, in which case it can be closed and planning for the next demand can start.
   b. The supply has reached its maximum, leaving some of the demand quantity uncovered. In this case, the planning system can close the current supply and proceed to the next one.

Then the procedure starts all over with the next demand and the current supply or vice versa. The current supply might be able to cover (more or less) this next demand as well, or the current demand has not yet been fully covered.

4.4.1 Rules Concerning Actions for Supply Events

When the program performs a top-down calculation of a plan in which supply shall meet demand, the demand is taken as a given – it lies outside the control of the planning system. However, the supply side can be managed. Therefore, the planning system will suggest user actions to create new replenishment orders, reschedule existing ones and/or change order quantity. In the case of an existing replenishment order becoming superfluous, the planning system will suggest that the user cancel it.

If a user wants to protect an existing replenishment order from the suggestions for change, he can state that it has no 'planning flexibility.' Then, excess supply from that order will be used to cover demand, but no action will be suggested whatsoever.

In general though, all supply has a planning flexibility that is limited by the conditions of each of the suggested actions:

1. **Reschedule out** – an existing supply can, in principle, be scheduled out to meet the demand due date unless:

   - it represents inventory (always on day zero).
   - it is linked directly (order-to-order link, see section 4.6.2) to some other demand.
   - it lies outside the reschedule window defined by the Reorder Cycle.[2]
   - there is an even closer supply that could be used.[3]

   Finally, rescheduling could be ruled out because:

   - the supply has already been tied up to another demand on a previous date.
   - the rescheduling is so minimal that the user has defined it as negligible.4

2. **Reschedule in** – an existing supply can be scheduled in unless:

[2] The reorder cycle can be used to avoid a cascade effect. Imagine a balanced row of demand and supply. An early demand is cancelled, or a new one created. The result would be that every replenishment order (except the last one) should be rescheduled. (The last one should be cancelled or a new order created to cover the last demand).
[3] This could also create a cascade effect.
[4] Defined by APICS as 'dampeners.'

- it is linked directly (order-to-order link, see section 4.6.2) to some other demand.
- it lies outside the reschedule window defined by the Reorder Cycle.2

When using a reorder point policy of planning for an item, the supply can always be scheduled in if necessary. This is the nature of the forward-scheduled reorder point replenishment orders. The planning system would not suggest to decrease/cancel an existing reorder-point order and then create a new one.

3. **Increase quantity** – the quantity of a replenishment order can, in most cases, be increased to meet the demand. The exceptions are when:

   - the supply is linked directly (order-to-order link, see section 4.6.2) to some other demand.

   Note: According to these rules, even though it is possible to increase the supply, it may nonetheless, be limited due to a defined maximum order quantity.

4. **Decrease quantity** – if the current existing supply has a surplus quantity compared to the current demand, it can be decreased to meet the demand unless:

   - the rescheduling is so minimal that the user has defined it as negligible.

   Note: Even though the quantity could be reduced in principle, there may still be some surplus compared to the demand due to a defined minimum order quantity or order multiple.

5. **Cancel supply** – as a special incident of the decrease quantity action, the supply could be cancelled if it has been decreased to zero.

6. **New replenishment order** – if no supply exists beforehand, or an existing one cannot be manipulated to meet the necessary quantity on the demanded due date, a new replenishment order is suggested.

4.4.2 Determining the Supply Quantity

Planning parameters, which are set by the user, control the suggested quantity for each supply event.

When the planning system calculates the quantity for a new replenishment order or the changed quantity on an existing supply order, the suggested quantity may turn out to be different from what is actually required.

In the case of 'maximum inventory' or 'fixed quantity,' the suggested quantity may be increased to meet the fixed quantity or the maximum inventory that the user has defined. In the case of a 'reorder-point' policy, the quantity may be increased at least to meet the reorder point.

Finally, the suggested quantity may be modified in this sequence:

1. Down to the maximum order quantity (if any).
2. Up to the minimum order quantity.
3. Up to meet the nearest order multiple. (In case of erroneous settings, this may violate the maximum order quantity.)

4.5 Closing Demand and Supply

When the balancing exercises (described in 4.4 above) have been performed, there are three possible ending situations:

1. The required quantity and date of the demand event have been met and the planning for them can be closed. The supply event is still open and may be able to cover the next demand event as well, so the balancing act can start over with the current supply and the next demand.
2. The supply event cannot be revised to cover all of the demand. The demand event is still open, with some uncovered quantity that may be covered by the next supply event. Thus the current supply event is closed, so the balancing act can start over with the current demand and the next supply event.
3. All of the demand has been covered; there is no subsequent demand (or there has been no demand at all). If there is any surplus supply, it may be decreased (or cancelled) and then closed. It is possible that additional supply events exist further along in the chain, and they should also be cancelled.

If an action has been suggested to revise a supply event, a corresponding planning line will be created to communicate the suggestion to the user.

Finally, the program will create an order track between the supply and the demand.

4.5.1 Creating the Planning Line (Suggested Action)

If any action – new, reschedule, change quantity or cancel – has been suggested to revise the supply event, the planning system creates a planning line in the planning worksheet (or in the requisition worksheet in version 3.x – depending on where the planning calculation was started from).

Due to order tracking (see section 4.5.2 below), the planning line is created not just when the supply event is closed, but also if the demand event is closed – even though the supply event is still open and may be subject to additional changes when the next demand event is processed. This means that when first created, the planning line may be changed again later on.

To minimize database access when handling production orders, the planning line can be maintained in three levels:

1. Create just the planning line with the current due date and quantity but without the routing and components.
2. Include routing: the planned route is laid out including calculation of starting and ending dates and times. This is quite demanding in terms of database accesses. In order to determine the ending and due dates, it may be necessary to calculate this even if the supply event has not been closed (in the case of forward scheduling).
3. Include BOM explosion: this can always wait until just before the supply event will be closed.

The program always aims to perform the least demanding maintenance level.

4.5.2 Order Tracking

With regard to order tracking, it is important to mention that the planning system rearranges tracking for the relevant item/variant/location combinations regardless of whether action messages have been suggested.

There are two reasons for this:

I. The planning system should be able to justify its suggestions; that all requirements have been covered, and that no replenishment orders are superfluous. (The latter is true only regarding real requirements – the tracking does not show the reason if the replenishment order is meant to cover forecast.)
II. Dynamically created tracking needs to be rebalanced from time to time.

Over time, order tracking may get somewhat out of balance since it does not rearrange the entire tracking network for any demand or supply event. Take for example:

1. An item with a lead time of 7 days, 12 pieces on inventory.
2. A sales order of 9 pieces, created on day 1 to be shipped on day 10, has been dynamically tracked to inventory.
3. The next sales order of 11 pieces, created on day 2 to be shipped on day 5, will cause an action message that a purchase order of 8 pieces, due on day 5, should be created – that would be in conflict with the lead time of 7 days.

Actually, there is no problem when the planning system has recalculated the tracking network:

1. The second sales order, of 11 pieces, due on day 5, will be fully tracked to the inventory.
2. The first sales order, of 9 pieces, due on day 10, will be tracked by 1 piece to the inventory.
3. The planning system will still suggest a purchase order of 8 pieces, but due on day 10 and decided on day 3.

Before balancing supply by demand, the program deletes all existing order tracking. Then during the balancing act, precisely when a demand or supply is being closed, it establishes new tracking between the demand and supply events.

This is straightforward as long as the tracking is just between sales orders, purchase orders, item ledger entries and similar existing order-network entities. It becomes more complicated when some action regarding changing existing replenishment is suggested.

In that case, we have a situation like this:

- demand – sales order or similar – there is no problem.

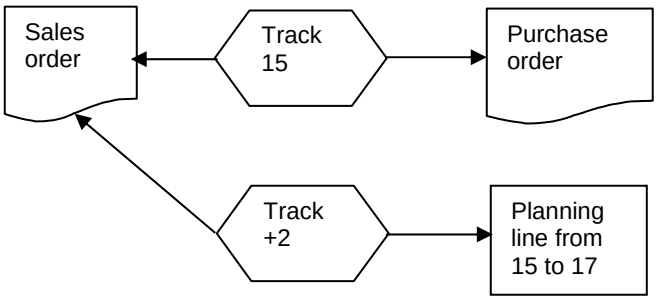
+ original supply – purchase or production order in its original (unchanged) state.

± planning line – suggested action carrying the difference between the original supply and the new suggested supply.

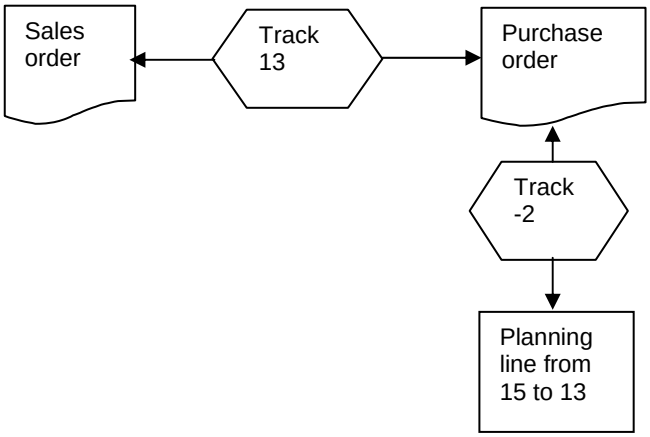
Imagine this situation:

- a sales order of 17 pieces
- an original purchase order of 15 pieces
- a planning line suggesting the action of changing the purchase order by +2, from 15 to 17.

The tracking would look like this:



If the sales order had been reduced by 2, to 13, the situation would look like this:



If the user does not accept the suggested actions and deletes the planning lines, the program attempts to return to the former tracking picture – though reorganized. (This will always work if the user has defined order tracking for the item. If order tracking has not been selected, it will still work in most cases.)

4.6 Additional Solution Concepts

In addition to the general balancing of supply and demand as described in 4.4, the planning system must also deal with two more basic replenishment methods:

- Ordering when passing below a defined reorder point
- Ordering in the make-to-order environment

Despite the fact that they are simpler, they must coexist with the step-by-step balancing and tracking, which makes the planning system appear more complicated.

4.6.1 Handling a Reorder Point

A reorder point represents demand during lead time. When the projected available inventory passes below the inventory level defined by the reorder point, it is time to order more quantity. Meanwhile, the inventory is expected to decrease gradually and reach zero (or the safety stock level) – until the replenishment eventually arrives. This is the theory presented in any textbook on the subject.

Accordingly, the planning system will create a suggestion for a forward-scheduled replenishment order at that point when the projected available inventory passes below the reorder point, but only if this occurs after the start of the planning period. The planning system should not suggest new reorder-point orders for past periods.

This complicates the planning system, because in addition to the process of matching and manipulating supply against demand, the planning system must also monitor the current projected available inventory.

In this connection, the available inventory does not include safety stock (or reservations). It is monitored when the projected inventory changes, and that can be detected when closing demand or supply.

To deal with a situation where a reorder point has been defined but no demand or supply exists, or inventory is already below the reorder point at the start of the planning period, a special reorder point demand is inserted into the demand profile at the starting date of the planning period. This serves as a trigger and, to a certain extent, is treated like any other demand.

4.6.2 Handling Coupled Demand and Supply (Make-to-Order)

In a make-to-order environment, it is likely that a user will make some manual adjustments to the replenishment order. The program should retain this customized information and does so by creating an order-to-order link (a 'soft' reservation), which acts as a preliminary connection between the supply (a replenishment order or inventory) and the demand that it is going to fulfill.

The program makes these order-to-order links in the following cases:

- A production order created from a sales order.
- A production or purchase order created through the planning system when the reordering policy has been defined as 'Order.'
- Multi-level production orders where one or more components of a production order are supplied from different production order lines within the same production order. This can cover several levels of the BOM structure and happens if both the parent item and the child have the manufacturing policy of 'Make-to-Order.'

In these cases, it is assumed that the relevant purchase or production order line is meant to cover a specific requirement – and no other. This may be due to specific physical conditions or proper cost application. When a supply quantity enters the inventory, it is still reserved for its intended purpose. When fulfilling the requirement from inventory, the relevant inventory entries will be used. The reservation system and the common principles of item application ensure this.

The reservation and order tracking system has been designed to connect individual sources of demand and supply, so it is used here for the same purpose. An order-to-order link will ensure that customized information is transferred to the rescheduled or changed replenishment or requirement.

Unlike manually created reservations, an order-to-order link can always be deleted and created by the program when it is appropriate. Order-to-order links are more flexible than both manual reservations and tracking. Whereas the normal tracking or reservation will be broken if a situation becomes impossible (for example, because the user has moved the requirement to a date earlier than the supply), the order-to-order link will remain.

When planning, a supply should not be used for any other requirement than it was originally intended for, and a demand should not be covered by any other random supply, even if – in its present situation – it is available in time and quantity. This would break the rules of the common balancing of supply to meet the demand and, consequently, complicate the balancing algorithm described in 4.4 above.

A Before comparing demand/supply, the planning system must ensure that neither has previously been linked to another supply/demand.

B If they happen to be linked to each other, the normal sequence can continue. However, if one is linked (it could also be both) to another supply/demand, the planning system:

   a intermits the common balancing act,
   b closes the link in a closed loop, balancing the linked subject with all other subjects belonging to that link,
   c and eventually, returns to the common balancing path to deal with all the other demand and supply events.

5. Basic Technical Solution

The program consists of some main procedures or functions. Following are some remarks to supplement the AL code in the planning codeunit, 99000854:

5.1 The Main Program

CalculatePlanFromWorksheet

- This function controls all the other functions below. You could say that it describes the planning logic at the highest level. Note that the local inventory profile is a temporary record – for performance reasons. Due to the merge of demand and supply events, it has to be defined as a record array of 2.

DemandtoInvProfile

- All demand events from order network entities (sales orders, and so on) are inserted into the inventory profile. This information is transferred to the inventory profile from the various sources by corresponding functions on the Inventory Profile table.
- Note that before inserting a production order component, the program checks whether the source production order is already included in the requisition line. If so, the planning components belonging to that line will replace any corresponding production order component lines.

ForecastConsumption

- The forecast period is defined by the dates related to the forecast, which the user enters. Note that there may be several forecast records on a given date because each forecast record contains the difference between what was entered last time and the new entry. Although a forecast record exists on a given date, the forecast (sum) could be zero if a user enters zero without first deleting the existing records. A forecast of zero does not participate in defining the forecast period.
- Actual sales offset or consume the forecast. This goes for open sales orders as well as open component requirements; both will be present in the inventory profile. This also applies to related item ledger entries that are posted within the forecast period.

BlanketOrderConsump

- Blanket orders are included in the planning system starting with version 3.x.
- Quantity on sales orders that are related to a blanket order will offset the outstanding blanket order quantity. (When sales orders are shipped, the shipped and outstanding quantities of the blanket order are updated). If there is a remaining open quantity that is related to the blanket order line, a corresponding demand event is inserted in the inventory profile.

SupplytoInvProfile

- All supply events from order network entities (item ledger entries, purchase orders, and so on) are inserted into the inventory profile. This information is transferred to the inventory profile from the various sources by corresponding functions on the Inventory Profile table.
- Note that the issue of planning flexibility is handled in this function. The user can define the planning flexibility of an item. In some cases however, the system defines non-flexibility. This could be if a quantity has already been received against the order, or if a production order has been started (consumption has been recorded). If it is appropriate to apply other rules, it can quite easily be done here.

FindCombination

- At this point, all the inventory profile records related to demand and supply events have been lined up. This function finds all existing combinations of variant and location, and creates the control records used by the outer loop of the planning to separate demand and the corresponding supply according to item dimensions.

PlanItem

- This is the central logic of the planning.
- It runs in an outer loop of all combinations of variants, locations. The outer loop set filters for the inner loop (see below).
- The inner loop performs the counterbalancing analysis and activities. It is controlled by the basic current state of the demand-supply pattern:
    - StartOver (at next demand or/and supply)
    - CalcMax (calculate Max. Quantity)
    - MatchDates (and try to balance the dates)
    - MatchQty (and try to balance the quantity)
    - CreateSupply (in case of imbalance)

- ReduceSupply (in case of imbalance)
- CloseDemand (and retrieve the next demand)
- CloseSupply (and retrieve the next supply)

These regular states are infiltrated by the states necessary to deal with the 'order-to-order' situations:

- MatchTypes (to see whether one or both are linked to a special purpose)
- MatchLink (to one that has the same purpose)
- CloseLink (to make a 'local' balance within the same purpose)

The code on each state is quite self-explanatory, and the conditions for which the program should take the next step are clear. In order to make the program more readable and customizable, the procedures for rescheduling, changing quantity, and so on, have been established as separate functions. These are foreseen to be subjects of customizations and are explained below.

However, the code on the closing steps is a bit more complicated. At this point, it is interesting to analyze the projected inventory level in relation to the reorder point, and to maintain the quantity on hand. The handling of the quantity on hand may seem more complicated than necessary, but treating it record-by-record makes it possible to maintain the order tracking. The program maintains the order tracking at this point – just before moving on to the next demand or supply.

5.2 Central Supporting Functions

ChkScheduleOut checks the conditions. It reschedules out and returns true if all conditions can be met:

- Rescheduling a supply out in time should not occur for inventory on hand (no due date), or if the supply has been marked for no planning flexibility.
- Rescheduling due to the 'pseudo' reorder-point demand follows its own set of rules and is therefore, terminated here. This type of demand, which is placed on the starting date of the planning period, should normally not touch supply that is placed earlier than the planning period.
- The demand asking for a reschedule-out should not be linked to some other supply.
- The supply should lie within the time frame defined by the reorder cycle. This is an arbitrary condition, and it can quite easily be changed. The possibility of enabling cascade effect should however, be evaluated.

- If some other supply exists between the supply and demand in question, the supply in question should not be rescheduled out. In so doing, it would overtake the next supply (it should be reduced or cancelled instead).

ScheduleOut reschedules the supply out within certain limits:

- The supply might cover several demands. In this case, it carries a 'fixed' date that is equal to the due date of the first demand that it covers. The fixed date is set when closing the demand and during the reschedule activities.
- If the demand is the 'pseudo' reorder-point demand, the system will try to schedule forward.
- The rescheduling should exceed the 'dampener time' that is defined in the setup. The multi-level production order will however, ignore the dampener for its lower-level production order lines.

ScheduleForward tries to schedule forward from the given starting date. Before doing so, the system must ensure that the routing has been laid out (for a produced item). When forward scheduling, the supply does not necessarily serve any particular demand, so the fixed date must be maintained in order to prevent the supply being scheduled even further out at a later point of time.

ChkScheduleIn reschedules in and returns true if all conditions can be met:

- Rescheduling a supply should not happen if the supply has been marked for no planning flexibility.
- The demand asking for a reschedule-in should not be linked to some other supply.
- The supply should lie within the time frame defined by the reorder cycle. This is an arbitrary condition, and it can quite easily be changed. The possibility of enabling cascade effect should however, be evaluated.
- When using a reorder-point planning policy, the order can always be scheduled in as long as it is not prevented by one of the above conditions.
- In other cases, the reorder cycle acts to limit the time frame for rescheduling. This is still quite arbitrary and can be changed.

ScheduleIn simply moves the due date of the supply to meet the due date of the demand. The reorder point situation that deals with forward-scheduled orders needs however, other treatment. If the starting date falls after the demand due date, the supply is scheduled forward; otherwise, it is okay as it is.

ChkIncreaseQty increases the quantity of the supply to meet the demand, and returns true if the demand in question has been covered. The conditions are:

- The supply has a planning flexibility.
- The demand to be covered is not linked to some other supply.
- The demand should not be the 'pseudo' reorder-point demand, as this only has the purpose of ensuring that the system evaluates the inventory at the start of the planning period.

IncreaseQty calculates the new quantity based on the required additional quantity, within the limits defined by the planning parameters. Note that this could result in the quantity not being increased at all (it could be limited by a maximum order quantity).

DecreaseQty attempts to reduce the supply to just meet the demand, in which case it will return true. In other words, it will return false if excess supply still exists. The following conditions and modifiers are:

- The supply has a planning flexibility.
- The quantity to decrease should exceed the 'dampener quantity' defined in the setup, in combination with the lot size for the item. The multi-level production order will however, ignore the dampener for its lower-level production order lines.
- The quantity to decrease should not exceed the free quantity. This means that it should not exceed the untracked quantity, and it should not violate the minimum quantity (there could be a difference due to the order-sizing parameters and a reorder point replenishment policy).
- When calculating the new order quantity, the order modifiers may cause a surplus.

CreateSupply simply inserts a new supply record into the inventory profile.

CreateSupplyForward is used with a reorder point replenishment policy. The function investigates to what degree existing supply, within the lead time, already covers the need. The decision rules are:

- If a future supply exists, it can be rescheduled in unless it has no planning flexibility, or it is linked to another specific demand (but without regard for any limit due to the reorder cycle).
- While looking for this future supply, all other supply quantities will be taken into consideration as long as the due date falls within the lead time (and unless it is linked to some other demand). Actually, it is the start date

that is used; if the supply was started before the reorder point was crossed, it should arrive within the lead time.

- As soon as the first flexible supply is found, the investigation stops.
- If no flexible supply is found, and the needed quantity has not been covered, a new supply will be created instead.
- The flexible supply (the first existing or new one) will then be forward scheduled from the date when the reorder point was crossed.
- Theoretically, this algorithm might not be 100% correct. However, it should give full coverage in all the situations that are found in practice.

5.3 Central Utilities

CalculateReorderQty calculates and returns the suggested reorder quantity according to the requirement and the lot sizing planning parameters. It is called along with a parameter, NeededQty, which tells how far below the safety stock level the projected inventory is. It checks on the reorder point policy, which may add a base quantity that equalizes the difference between the reorder point level and the safety stock level.

AdjustReorderQty handles the order quantity modifiers.

AdjustDemandROP calculates needed quantity on demand for Reorder Point. Quantity on demand reflects trigger quantity, that is Reorder Point, which in most cases is different from needed quantity.

AdjustTrackProfile is used to ensure that Safety Stock is handled as surplus

6. Adjusting Functionality

The way the planning system is structured makes it quite easy to add to the program or change the way that planning suggestions are calculated. The following section illustrates different types of changes by using brief examples.

6.1 MPS/MRP

You can change the way the planning system detects whether an item should be included in the master production schedule or the materials requirement planning by changing the batch job report 99001019, Calculate Plan - Plan. Wksh. Just change the procedure 'PlanThisItem' to whatever has been decided.

If, for example, you have decided that a Boolean 'MPS-Item' set up parameter on the item card should control it instead, then return MPS if the parameter on the item is true. Otherwise, return MRP.

6.2 Adding a New Type of Demand

If you have added a new type of demand, for example an internal project order, you must decide whether:

- this type of demand is part of a forecast.
- it should be tracked (order tracking).
- it is necessary to create a new record for the purpose, or could you suffice with using an existing record, for example a sales line?

If you want to establish order tracking for your new type of demand, it is recommended that you investigate whether an existing demand-type record could be used as a base. Otherwise, you must investigate *very carefully* how the order tracking and reservation system works. It is quite comprehensive and is not explained here.

To feed the new demand into the planning system, you change:

- Table 99000853, Inventory Profile:
  If your feature involves a new table, add a corresponding transfer procedure and define an additional Source Type option. Otherwise, use and eventually change the procedure that applies to the type of record you use.

- Codeunit 99000854, Inventory Profile Offsetting:
  In the procedure DemandtoInvProfile, create a new loop to transfer the demand from the source table into the InventoryProfile. Or investigate the filters already used, if you are using an existing record. If the new type of demand has been forecasted, you should investigate the filters used in the procedure ForecastConsumption.
- Finally, you should check the procedure TransferToTrackingEntry in table 99000853, Inventory Profile to ensure that the tracking entry is treated accordingly. Keep in mind that if you have introduced a new table, the tracking will not work unless you have prepared the appropriate code units for handling reservations and order tracking.

6.3 Introducing a Time Fence for Changes

Define the time fence in the setup, on the item, or easier yet: as a new date parameter on the Options tab of the planning batch jobs, reports 699 and 99001019.
Check on this parameter when loading supply into the inventory profile – function SupplytoInvProfile in codeunit 99000854. Set the planning flexibility accordingly.

6.4 Controlling the Reschedule Time Frame

(to use something other than the reorder cycle)
Changes can be made in function ChkScheduleOut and/or function ChkScheduleIn of codeunit 99000854. However, the customer would have to define or agree on the rules for the change. There can easily be different rules for schedule-out and schedule-in. The rules should consider both the risk of increasing the inventory and the risk of introducing a cascade effect.

6.5 Adjusting the Definition of the Reorder Point

Normally, the reorder point equals the expected demand during the expected lead time. Thus, the reordered quantity should never be less than the span between the reorder point level and the safety stock level. However, if it is appropriate to deviate from this principle and for example, work with a reorder point that is higher than the demand during lead time, it is quite simple to do that.

The reorder quantity should be defined for the item as a fixed quantity, for example.

Then for items carrying a fixed reorder quantity, the base reorder quantity could change in the function CalculateReorderQty, so it does not involve the reorder point.

APPENDIX A PLANNING ASSIGNMENT TABLE

The Planning Assignment table controls the planning process.

The table is arranged according to low-level code and item number. It states a planning imbalance, which can be caused by:

- A new sales order, forecast, component, purchase order, production order, transfer order
- Change of item, quantity, location, bin, variant, or date on a sales order, forecast, component, purchase order, production order, transfer order
- Cancellation of a sales order, forecast, component, purchase order, production order, transfer order
- Consumption of other items or quantities than planned
- Output other than planned (when finishing a production order)
- Unplanned changes in inventory in general

For these direct supply-demand displacements, the tracking and action messaging sub-system maintains the table and states a planning reason as *Action Message*.

Some changes in master data can cause a planning imbalance as well:

- Change of status to *Certified* in the Production BOM Header (for all items using that header)
  - Deleted line (child item)
- Change of status to *Certified* in the Routing Header (for all items using that routing)
- Changes in the following item card fields
  - Safety Stock Quantity or Safety Lead Time
  - Lead Time Calculation
  - Reorder Point
  - Production BOM No. (+ all children of old BOM reference)
  - Routing No.
  - Reordering Policy

In these cases, a new function, Planning Assignment Management, maintains the table and states the planning reason as *NetChange*.

Changes in the following do not cause a planning assignment:

- Calendars
- Other planning parameters on the item card

When calculating an MPS or an MRP, there are some additional restrictions:

- MPS – The planning system checks that the item carries a production forecast or a sales order. If not, the item is not included in the plan.
- MRP – If the planning system detects that the item is being replenished by an MPS planning line or MPS replenishment order, the item will be left out of the planning. However, any requirements from relevant components are included.

APPENDIX B PLANNING PARAMETERS

The way that the planning system controls item supply is dictated by various settings on the item card (or stockkeeping unit – SKU), plus the manufacturing setup. The parameters can be classified as follows (note that field names are in bold type):

A) Plan or not: **Reordering Policy** equal to *blank*

B) Reorder release: **Reorder Point** on the item/SKU
Safety Stock Quantity
Safety Lead Time

C) Lot sizing: **Reordering Policy** options:

1. *Fixed Reorder Qty*. plus **Reorder Quantity** field on the item/SKU
2. *Maximum Qty*. plus **Maximum Inventory** field on the item/SKU
3. *Order*
4. *Lot-for-Lot*

Reorder Cycle

D) Quantity modifiers: **Minimum Order Quantity**, **Maximum Order Quantity**, **Order Multiple**

E) Extension: **Manufacturing Policy** options:

1. *Make-to-Stock*
2. *Make-to-Order*

Re A – Plan or not:

To include an item/SKU in the planning process, it must have a **Reordering Policy** otherwise, it should be planned manually.

Re B – Reorder release:

Reorder proposals are generally released only when the projected available quantity has fallen below a given quantity. This quantity is stated in the **Reorder Point.** Otherwise, it will be zero for the item. Zero can be adjusted by entering a **Safety Stock Quantity**. If the user has defined a **Safety Lead Time**, it will cause the proposal to be delivered in the period prior to the required due date.

Default Safety Lead Time

In version 3.x, the **Default Safety Lead Time** (in the Manufacturing Setup) should be set for at least one day. The due date of the requirement may be known, but not the due time. The planning schedules backward to meet gross requirements, and, if no **Safety Lead Time** has been defined, the goods would probably arrive too late to meet the requirement.

Prior to Navision 3.00, a one-day safety lead time was hard-coded in the program. However, in the case of multi-level production orders (**Reordering Policy**: *Make-to-Order*), the safety lead time will be neglected since the exact time is known by the planning system, and it would be against the just-in-time approach of the multi-level production order.

Re C – Reorder quantity:

When planning detects the need to reorder, it refers to the selected **Reordering Policy** to determine when and how much to order.

Generally, and independent of **Reordering Policy,** planning will react like this:

- The quantity of the order proposal will be calculated to meet the specified inventory level for the item. This is at minimum, the level set by the **Safety Stock Quantity**. If nothing has been specified, this will equal zero. If you state a **Reorder Point**, this will set the release level.

- If the available quantity is below the **Safety Stock Quantity**, the planning will create a *backward scheduled* order proposal. The order quantity will at minimum, fill the **Safety Stock Quantity,** although it can be increased by gross requirements within the **Reorder Cycle**, by **Reordering Policy**, and by the final adjustments.

- If **Reorder Point** > available quantity > **Safety Stock Quantity,** you can expect a *forward scheduled* order proposal. Both the requirements to be met and the **Reordering Policy** will determine the order quantity. At minimum, the order quantity will meet the **Reorder Point**.

- If there are more gross requirements due before the ending date of the forward scheduled order proposal, and these requirements happen to bring the currently calculated available quantity below the **Safety Stock Quantity**, the order quantity will be increased to make up the deficit. The order proposal will now be scheduled *backwards* from the due date of the gross requirement that would have violated the **Safety Stock Quantity**.

- If the **Reorder Cycle** field is not filled in, only the gross requirements for the same date will be added.

The influence of **Reordering Policy**:

1. *Fixed Reorder Qty.:*

   The order quantity will, at minimum, be equal to the **Reorder Quantity**. It can be increased to meet the demand or the desired inventory level.

2. *Maximum Qty.*:

   The order quantity will be calculated to meet **Maximum Inventory**. If quantity modifiers are used, then Maximum Inventory can be violated. It is not recommended to use **Reorder Cycle** together with **Maximum Qty.**, and in most cases the reorder cycle will be overruled.

   This reordering policy is normally used with a **Reorder Point.**

3. *Order*:

   The order quantity will be calculated to meet each single requirement.

   Reorder Cycle is not taken in consideration.

If the inventory falls below the **Safety Stock Quantity** (or below **Reorder Point**), this would represent a requirement as well and would cause an order proposal.

4. *Lot-for-Lot:*

   The quantity is calculated to meet the sum of the requirements that come due within the **Reorder Cycle**.

Note that changing from one reordering policy to another may result in the program disabling some planning parameter fields, which were previously active and still contain the most recently used values. The program will disregard these values. The end user can delete the values in the fields and then change the reordering policy, if this is preferable.

Re D – Adjustments:

When the quantity of the order proposal has been calculated, one or more of the order modifiers can adjust it: **Maximum Order Quantity ≥ Minimum Order Quantity ≥ Order Multiple**.

The quantity is decreased if it exceeds the **Maximum Order Quantity**. Then it is increased if it is below the **Minimum Order Quantity**. Finally, it is rounded up so that it conforms to a specified **Order Multiple**. Any remaining quantity would go through the same adjustments until the total requirement has been converted into order proposals.

Re E – Extension:

Finally, the **Manufacturing Policy** option defines which additional orders the MRP calculation will propose.

If the *Make-to-Stock* option is used, the orders concern only the item in question.

With the *Make-to-Order* option, the planning will investigate the BOM and create additional 1:1 order proposals for those lower level items that are also defined as *Make-to-Order*. This continues as long as there are *Make-to-Order* items in the descending BOM structures.

APPENDIX C EXAMPLES OF PLANNING PARAMETERS

The following examples look at the most common situations using planning parameters. Note that field names are in bold type.

1. Max./min.

You have an item that you store in a box or on a shelf at a store. You want to reorder this item when the inventory drops below a defined **Reorder Point**. The reorder point represents your expectations of the general need for the item during the lead time. If you order as soon as you discover that the item is at or below the **Reorder Point**, the inventory will decrease to +zero (or **Safety Stock Quantity**) when you receive the next shipment.

You have decided that when you reorder the item, you want the stock filled to a certain level – the **Maximum Inventory** – or you may use a fixed **Reorder Quantity**.

To allow for uncertainty regarding the anticipated need, you can define a **Safety Stock Quantity**. To allow for uncertainty regarding the lead time, you can define a **Safety Lead Time** on the item/SKU (only in version 3.x).

Example:
Replenishment System = *Purchase*
Reorder Point = *100*
Lead Time Calculation = *3w*
Safety Stock Quantity = *10*
Manufacturing Policy = *Make-to-Stock*
Reordering Policy = *Maximum Qty*.
Maximum Inventory = *300*
Inventory = 90

In a routine situation, planning proposes an order of 290 to be delivered three weeks after the planning starting date (the order date in version 3.x). This will not be affected if a gross requirement of 70 units, for example, is delivered two weeks after the MRP starting date.

In a distress situation – for example, a gross requirement of 110 units a week after the planning starting date – the planning performs an emergency procedure. In this case, the inventory will pass below the safety stock the gross requirement. It may not be possible to carry out the proposal, but at least it is a reminder for the planner to take action.

In this case, it is unlikely that adjustment parameters would be added (although it is possible to do so in the program). A **Maximum**/**Minimum Order Quantity** does not make much sense if you have already defined a **Reorder Quantity** or a **Maximum Inventory** to be met. However, the MRP will perform the calculations and split or increase the order quantity.

The maximum/minimum rule is made for a *Make-to-Stock* **Manufacturing Policy**. The planning system would handle *Make-to-Order* as well, but it's difficult to imagine the logic behind such a setup.

2. As required/variable **Reorder Quantity**

Here is a situation where you simply want to order the actual required quantity of a particular item, but you also want to keep the number of replenishment orders to a reasonable level. You want to reorder this item when you expect the inventory to pass below zero or the **Safety Stock Quantity**. When you have to reorder something, you want to include additional demands within the nearest future so as to optimize setup time and order handling. You define the nearest future time period in the **Reorder Cycle** on the item card.

Example:

Replenishment System = *Prod. Order*

Safety Stock Quantity = *10*

Manufacturing Policy = *Make-to-Stock*

Reordering Policy = *Lot-for-Lot*

Reorder Cycle = *3w*

Inventory = 90

Gross requirements:

- 20 units to be delivered 3 days after the planning starting date
- 70 units to be delivered 2 weeks after the planning starting date
- 25 units to be delivered 3 weeks after the planning starting date

The planning system calculates that the first demand can be met by the inventory on hand (70 left including 10 as safety stock).

The second demand can be partially covered by inventory, but there is a shortage of 10 units.

Now that there is a need to reorder, the planning system investigates the **Reorder Cycle** for additional requirements and finds the third requirement of 25 units. The order is calculated as 35 units, and it is scheduled backwards from the day of the second demand, when the first 10 units are due.

APPENDIX D PLANNING WITH/WITHOUT LOCATIONS

Concerning planning with or without location codes on demand lines, the planning system operates in a straight forward way when:

- demand lines always carry location codes and the system fully uses stockkeeping units, including the relevant location setup.
- demand lines never carry location codes and the system does not use SKUs or any location setup (see last scenario below).

However, if demand lines sometimes have location codes and other times do not, then the planning system perceives this as a deviation and will then follow certain rules depending on setup. This is covered in the following.

Note: If you often plan for demand at locations, it is strongly advised to use the Stockkeeping Units feature.

Demand at a Location

When the planning system detects demand at a location (a line with a location code), it will behave in different ways depending on 3 critical setup values:

- Is there a check mark in the **Location Mandatory** field (Inventory Setup)?

  If so, then:

  - Do SKUs exist for the item?

    If not, then:

  - Does the **Components at Location** field (Mfg. Setup) contain the demanded location code?

The first rule when planning for demand at locations is to checkmark the **Location Mandatory** field. This is a precondition for planning demand lines with location codes and it governs the planning logic concerning the last 2 setup values.

During a planning run, the system checks for the 2 setup values in sequence and plans accordingly:

1. SKU card(s) exist for the item:
   The item is planned according to planning parameters on the SKU card (including possible transfer).
   If not, then:

2. **Component at Location** field (Manufacturing Setup) contains the demanded location code:
   The item is planned according to planning parameters on the item card.
   If not, then:

3. SKU doesn't exist and **Component at Location** field is empty or has other location code:
   The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.
   Note: This "minimal alternative" only covers the exact demand. Any planning parameters defined are ignored.

See variations in the scenarios below.

Demand at "Blank Location"

Even if the Location Mandatory field is checkmarked, the system will allow demand lines to be created without a location code – also referred to as *BLANK* location. This is a deviation for the system because it has various setup values tuned to dealing with locations (see above) and as a result, the planning engine will not create a planning line for such a demand line. If the **Location Mandatory** field is not checkmarked but any of the location setup values exist, then that is also considered a deviation and the planning system will react by outputting the "minimal alternative":
The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

See variations in the scenarios below.

Scenarios

Setup:

Location Mandatory = *Yes*

SKU is set up for *RED*

Component at Location = *BLUE*

Case 1: Demand is at *RED* location

The item is planned according to planning parameters on the SKU card.

Case 2: Demand is at *BLUE* location

The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

Case 3: Demand is at *GREEN* location

The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

Case 4: Demand is *BLANK* location

The item is not planned because no location is defined on the demand line.

Setup:

Location Mandatory = *Yes*

No SKU exists

Component at Location = *BLUE*

Case 1: Demand is at *RED* location

The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

Case 2: Demand is at *BLUE* location

The item is planned according to planning parameters on the item card.

Setup:

Location Mandatory = *No*

No SKU exists

Component at Location = *BLUE*

Case 1: Demand is at *RED* location

The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

Case 2: Demand is at *BLUE* location

The item is planned according to planning parameters on the item card.

Case 3: Demand is at *BLANK* location

The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

Setup:

Location Mandatory = *No*

No SKU exists

Component at Location = *BLANK*

Case 1: Demand is created at *BLUE*

The item is planned according to: **Reordering Policy** = *Lot-for-Lot*, **Include Inventory** = *Yes*, all other planning parameters = Empty.

Case 2: Demand is created at *BLANK*

The item is planned according to planning parameters on the item card.

As you can see from the last scenario, the only way to get a correct result for a demand line without a location code is to disable all setup values relating to locations. Similarly, the only way to get stable planning results for demand at locations is to use stockkeeping units.

APPENDIX F GLOSSARY

action message

A system message that identifies the need for and the type of action to be taken to correct a current or potential problem.

The goal is to keep the order network in balance. When it's out of balance or changed, action messages are used to suggest changes to reestablish the balance.

There are five types of action messages:

1) New – creates a new order

2) Change Qty. – changes the quantity on an order

3) Reschedule – reschedules an order

4) Reschedule and Change Qty. (resched. & chg. qty.) – reschedules and changes the order quantity

5) Cancel – deletes or cancels an order

backward scheduling

A technique for calculating operation start dates and due dates. The schedule is computed starting with the due date for the order and working backward to determine the required start date and/or due dates for each operation.

bill of materials (BOM)

A listing of all the subassemblies, intermediates, parts, and raw materials that go into a parent assembly showing the quantity of each required to make an assembly. It is used in conjunction with the master production schedule to determine the items for which purchase requisitions and production orders must be released.

bin

A storage device designed to hold small discrete parts…A shelving unit with physical dividers separating the storage locations…

component

Raw material, part, or subassembly that goes into a higher level assembly, compound or other item. This term may also include packaging materials for finished items.

dampeners

User-input parameters to suppress the reporting of insignificant or unimportant action messages caused by changes in the order network…

demand

The need for a particular product or component. The demand could come from any number of sources, for example, customer order or forecast, an interplant requirement or a request from a branch warehouse.

dependent demand

Demand that is directly related to or derived for the bill of material structure for other items or end products. Such demands are therefore calculated and need not and should not be forecast. A given inventory item may have both dependent and independent demand at any given time. For example, a part may simultaneously be the component of an assembly and sold as a service part.

forward scheduling

A scheduling technique where the scheduler proceeds from a known start date and computes the completion date for an order, usually proceeding from the first operation to the last. Dates generated by this technique are generally the earliest start dates for operations.

independent demand

Demand for an item that is unrelated to the demand for other items. Demand for finished goods, parts required for destructive testing, and service parts requirements are examples of independent demand.

inventory profile

A representation of the different order network entities – sales, purchase, transfer and production orders, requisition and component lines – that define the projected available balance in a given time period.

lead time

A span of time required to perform a process or series of operations. 2) The time between the recognition of the need for an order and the receipt of goods.

Individual components of lead time can include order preparation time, queue time, processing time, move or transportation time, and receiving and inspection time.

level

Every part or assembly in a product structure is assigned a level code signifying the relative level in which that part or assembly is used within the product structure. The end items are assigned level 0 with the components and subassembly going into it assigned to level 1, and so on…

low-level code

An integer that identifies the lowest level in any BOM at which a particular component appears. Net requirements for a given component are not calculated until all the gross requirements have been calculated down to that level. Low-level codes are normally calculated and maintained automatically by the computer software.

make-to-order

A manufacturing policy where a product can be made after receipt of a customer's order. The final product is usually a combination of standard items and items custom designed to meet the special needs of the customer.

make-to-stock

A manufacturing policy where products can be and usually are finished before receipt of a customer order. Customer orders are usually filled from existing inventory and production orders are used to replenish inventory.

manufacturing policy

A policy that describes how the product is to be produced. A manufacturing policy could be to produce the product as a standard (make-to-stock) item, or to make it specifically for each customer (make-to-order item).

master production schedule (MPS)

The anticipated build schedule for those items assigned to the master scheduler. The master scheduler maintains this schedule, and in turn, it becomes a set of planning numbers that drives material requirements planning. It represents what the company plans to produce expressed in specific configurations, quantities, and dates. The master production schedule is not a sales forecast that represents a statement of demand. The master production schedule must take into account the forecast, the production plan, and other important considerations such as backlog, availability of material, availability of capacity, and management policies and goals.

material requirements planning (MRP)

A set of techniques that uses bill of materials data, inventory data and the master production schedule to calculate requirements for materials. As an alternative to the MRP-MPS approach, the MRP can be directly based on the production forecast and sales orders.

net change planning

A planning method where only items that have been changed since the last planning run are included; thus avoiding unnecessary replanning of items covered by a valid plan.

order multiple

An order quantity modifier, applied after the order quantity has been calculated, that increases the order quantity to a predetermined multiple

order network

The total supply and demand represented by various entities of inventory, purchase order lines, production order lines, sales order lines and component lines and are connected by the tracking process that exists in the planning system at a given point of time.

order network entity

The building blocks of a planning system, that is, inventory lines, sales order lines, component lines, purchase order lines, and so on.

planning flexibility

A feature that indicates to what degree the planning system is allowed to reschedule or change the quantity of an order. The range of flexibility lies between none and unlimited…

planning system

The planning of net requirements by using MRP logic. This applies to the standard MPS-MRP sequence, but it also applies to the planning sequence that goes directly from the production forecast to MRP…

planning worksheet

Contains proposals about replenishments for both purchase and production orders. It replaces the MRP worksheet and can be used for different types of materials planning, not just MRP.

production forecast

A projected level of customer demand for a feature – for example, an option, accessory, finished item or spare part – of a make-to-order or an assemble-to-order product.

regenerative planning

The act of planning to reorganize the existing planned production orders so that they satisfy the requirements of new production orders. New production orders that satisfy the existing requirements are produced as a result of the regenerative planning. This reorganization is achieved by first deleting all planned production orders in the MRP. This removes all planned accesses and dependent demands of planned production orders from the system. The subsequent planning will now cover all unsatisfied requirements by new production orders.

reorder cycle

The frequency with which the system checks if there is a need for an item to be replenished.

reordering policy

A policy that explains how an item is to be reordered when there is a need to replenish the item.

reschedule

An example of an action message, which is used to reschedule an order to an earlier date – reschedule in – or to a later date – reschedule out…

reservation

The process of designating stock for a specific order or schedule. A reservation can be made against scheduled availability, such as a firm planned production order or a released production order…

safety lead time

An element of time added to normal lead time to protect against fluctuations in lead time so that an order can be completed before its real need date. When used, it sets a buffer between the promised delivery date and the actual delivery date.

stockkeeping unit (SKU)

A unit for inventory control that concerns items and item variants at specific locations.

tracking

A process that shows the logical dependencies between supply and demand in the order network. If the network is in total balance, then every demand can be tracked to a balancing supply…

transfer order

An order to move items from one location to another.

variant

An additional identifying factor for an item that (along with the item number) uniquely identifies the item.

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