



Infor LN Manufacturing User Guide for Manufacturing

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About this Guide

This document provides an overview of the Manufacturing package and setup process. Various manufacturing options are described as well as costing, configuration and routing settings that must be configured before production.

Document summary

How to read this document

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Chapter 1: Introduction Manufacturing

Manufacturing

You can use Manufacturing to manage the production of items.

Use Manufacturing to:

- Define *bills of material (BOMs)*, *routings*, and tool requirements.
- Calculate cost and sales prices.
- Plan projects and carry out *network planning*.
- Control the execution of *production orders*.
- Configure large numbers of variants of finished products with CPQ Configurator set up.
- Plan and generate assembly orders.

Manufacturing also contains functionality for:

- *Mass BOM changes*
- *Product classification*
- Repetitive production
- Definition of *customized items*

Job Shop Control (JSC)

The job shop control module handles the creation of *production orders*, planning of production orders, and the procedure related to the execution of these orders.

You can manually create and modify production orders in the Job Shop Control module. To create production orders automatically, you must use Enterprise Planning.

At macro level, the procedure consists of availability of materials and capacity, determining the order sequence, providing the necessary information through the help of various documents to the operators in the job shop, recording all transactions of issuing material, and receiving the finished product in the warehouse. The time spent by a worker on a production order is also recorded, so the actual cost of a production order and the production efficiency can be obtained.

The Job Shop Control module can be used to replan production orders, especially to alter the timing of operations to take account of delays and changes in priorities. If you are unable to complete certain operations yourself, you can use the Job Shop Control module to *subcontract* operations.

Assembly control overview

The Assembly Control module in LN is used to control processes in the job shop when producing *FAS items*.

Assembly Lines

Assembly lines consist of a set of consecutive line stations. The items are manufactured by passing them from line station to line station and by carrying out operations at each line station. An assembly line is subdivided into a number of line segments separated by buffers. You must define this structure in the Assembly Control module. An assembly line can be either a main line or a supplying line.

Assembly Orders

Assembly orders can either be generated from sales orders (demand), or by your configurator. They pass through a series of statuses, in an analogous manner to JSC production orders. Before you can carry out the order, assembly parts are allocated to the shop-floor warehouses of the line stations. When you have completed the order you can backflush the materials and hours.

Line-Station Variants

When an assembly order is transferred to the Assembly Control module, *line-station orders*, *line-station variants* (LSVs) and *exchangeable configurations* are generated. LSVs are used to reduce data, by combining all the operations and materials with the same specifications for a particular line station.

Line Sequencing

The orders that come from your configurator have an initial sequence (that is, the order in which they are processed on the assembly line). In Assembly Control you use a set of rules to place these orders and the demand orders in a final sequence. The rules include priority (for example, sold orders have a higher priority than stock orders) and operational considerations (for example, place orders with the same paint color next to each other, to avoid time wasted in changing paint nozzles).

Assembly line costing

There are a number of important differences in the financial calculations carried out for assembly orders compared with JSC production orders. For example, results are not split into *price variances* and *efficiency variances* and there is no calculation of end-item unit costs.

Origin of production orders

In the **Production Orders (tisfc0501m000)** session, you can manually define production orders. However, production orders generally originate from one of these packages :

- Enterprise Planning
- Warehousing

Orders generated in Enterprise Planning and Warehousing are transferred to the **Production Orders (tisfc0501m000)** session in Manufacturing. This session also allows you to manually enter production orders.

Production orders from Enterprise Planning

Items with the order system **Created** are processed in the Order Planning module of Enterprise Planning. The item's Customized check box in the **Items (tcibd0501m000)** session defines the way Enterprise Planning handles the planning.

- If **No** is selected in the **Customized** field, Enterprise Planning creates planned production orders based on forecast. *Planned production orders* are generated in the **Generate Order Planning (cprrp1210m000)** session. You can also manually enter planned production orders in the **Planned Orders (cprrp1100m000)** session.
- If **Yes** is selected in the **Customized** field, the item is a *customized item*. Enterprise Planning can plan the requirements for these item types. Planned production orders are generated based on the customer orders that you enter in Sales.

You can transfer the planned production orders to the Job Shop Control module in the **Transfer Order Planning (cppat1210m000)** session in the Plan Transfer module of Enterprise Planning. In this session, you can also transfer *production plans* to the Job Shop Control module. LN converts these plans into planned production orders before they are transferred.

Production orders from Warehouse Management

Items with order system *statistical inventory control* (**sic**) are processed in Warehousing. You can use the **Generate Order Advice (SIC) (whina3200m000)** session to generate *production-order advices*.

However, the item's supply system defined in the **Item Data by Warehouse (whwmd2510m000)** session also determines how production orders are generated in Warehousing:

- If the supply system is **Kanban**, you must use the **Generate Orders (Kanban) (whinh2200m000)** session.
- If the supply system is **Time-Phased Order Point**, you must use the **Generate Orders (TPOP) (whinh2201m000)** session.

Use the **Transfer Production Order Advice (whina3202m000)** session to transfer production order advices with status **Confirmed** to the Job Shop Control module.

Production orders - functional overview

A production order comprises the order to produce an item and the conditions under which manufacturing takes place, such as the *routing* that is used, the *delivery date*, and the order quantity.

A production order can be used for:

- Production of *anonymous items*
- *Standard-to-order* production
- Production of *customized items*

Note:

If *multisite* functionality is active, production orders are generated for one or more *sites*.

Manufacture details may vary between sites.

- Origin of production orders

A *production order* is usually generated by a planning algorithm, such as *master-based planning* or *order-based planning*, and is subsequently transferred to a manufacturing module. You can also manually create production orders in Enterprise Planning

- Processing new production orders

When a new *production order* is created, the master data for the product is copied from the company level to the site where production takes place.

For more information on item data with multisite activated see: Item data

- Duplicating production orders

Click **Duplicate** in the menu or the toolbar to duplicate the production order, which means that the production header information is copied. The production order's original material and operations are not copied for a number of reasons:

- Some materials in the job shop bill of material, or some operations may be invalid because of engineering changes or changes in the *planning cluster*.
- The warehouses, item definition, standard cost, may have changed, which can lead to inconsistent orders.
- Operation texts or drawings can be linked to the production order. Note: LN cannot determine which data must be copied because this can differ for every occasion. LN cannot make a distinction between original and modified data.
- Production order costing can be different for the original and the duplicated production order, the production order may be manufactured at a different *site* in the same *planning cluster*, but linked to a different *enterprise unit*.
- All warehouse orders and related data must always be regenerated.

- Order status

Production orders go through a number of order statuses, such as:

- **Created**
- **Printed**
- **Released**

The order status determines which actions can be performed on a production order.

- Estimated and actual costs

The estimated costs for a production order are based on the *BOM* and the *routing* (estimated costing). During production, the hours that are actually spent and the materials that are actually used are posted (actual costing). When the production order is closed, the *result* of the production order is calculated.

Chapter 2: Production orders

Production order status

The order status determines which actions can be performed on a production order. The order status is shown in the sessions in which production orders are handled.

These statuses are available for production orders

- **Created**

The initial status of a production order. All data of the production order can still be changed. Materials have not yet been issued. Materials can be added or removed, and quantities can be changed.

- **Printed**

The documents that accompany the production order have been printed. If the **Printing Production Order Documents Mandatory** check box in the **Production Order Parameters (tisfc0100s000)** session is selected, the production order cannot be released before the order documents have been printed. The **Printing Production Order Documents Mandatory** check box is not valid for *repetitive items* because printing order documents is never mandatory for repetitive items. For a description of the types of order documents, see Contents of order documents.

- **Released**

If a production order is released for production, materials are issued to the job shop for production, and hours can be posted.

You can still do the following:

- Adjust planning data
- Change the estimated materials and estimated operation cost as long as the cost estimates have not been frozen

Production orders can be released by using the **Release Production Orders (tisfc0204m000)** session.

- **Active**

Work on the production order has started. The order status becomes **Active** when a transaction takes place for the production order.

- **Production Completed**

The order has been reported completed. As soon as Warehousing finishes the inbound procedure for produced items that must be delivered into inventory, the production order status will be **Completed**.

- **Completed**

The order has been reported as complete and all completed products have been delivered into inventory. It is still possible to account hours and issue materials for the production order.

You report an order as complete in one of these sessions:

- The **Report Orders Completed (tisfc0520m000)** session to report one or more orders, partly or entirely, as complete.
- The **Report Operations Completed (tisfc0130m000)** session to report the final operation of an order as complete.
- The **Report Operations Complete by Order Group (tisfc0205m000)** session to report orders as complete by order group.
- The **Report Production Schedules Completed (tirpt1201m000)** session or the **Report Production Orders Completed from Production Schedule (tirpt1502m000)** session to report production orders in production schedules as complete for *RPT items*.
- **Closed**

The financial results of the production order have been calculated. Before a production order is closed, all materials for the order must have been issued and all hours must have been accounted. After an order has been closed, materials can no longer be issued nor can hours be accounted unless the order status is reset. You can close production orders with the **Close Production Orders (ticst0201m000)** session.
- **Archived**

The data of the production order has been moved to the archive.

Product variants - Purchased configurable items

This topic explains the following functionality that pertains to purchased configurable items:

- Compare any configured item of the variant.
- Define product variant purchase price structure.

Compare variants

You can compare two product variants to check the following:

- The inventory of a configured purchased subassembly.
- The possibility of using inventory of a matching configuration rather than order a new configured item.

Note: You can consider two configured items as interchangeable if all the options are the same.

You can compare the following configured items of a product variant:

- The configured end item
- Any configurable child

To compare the configured items of a product variant, you can use the Option List ID. The *configurable items* are compared at the option set level. Two configured items that are created by a variant are considered as interchangeable if they have the same Option List ID.

The Option List ID is used for the following types of transactions:

- Manufactured assembly item transactions
- Purchased configured item transactions
- Inventory transactions

Variant numbers and Option list IDs

The matching of demand and supply of purchased configurable items is based on the Option List ID.

The matching of the demand and supply of a manufactured assembly end item is based on the product variant. Example the demand for the manufactured assembly end item is generated when a product variant is created for a new sales order. The Option List ID for this variant matches with a redundant variant which is in stock. An assembly order is created to meet this demand is created as the variant numbers differ.

The variants numbers and Option List IDs are used in the following processes:

- Create assembly planning (**Calculate Assembly Part Requirements (tiapl2221m000)**)
- Generate assembly orders
- Generate warehouse outbound advice.

Product variant purchase price structure

You can set up the purchase price for a configured item. The purchase price depends on the options of a configured item. You can calculate the purchase price of a variant during the configuration process. You can do so, after you calculate the sales price. If you update the variant, you are prompted to re-calculate the sales price.

To re-calculate the sales price, the configuration date is used as the reference date for price list validation. You can set the configuration date in the **Sales Parameters (tdsls0500m000)** session in the Sales package. The **Configuration Date (PCS)** can be:

- **Order Date**
- **System Date**
- **Delivery Date**

To calculate the purchase price for a set of variants, you can use the **Calculate Product Variant Purchase Price Structure (tipcf5235m000)**

To calculate the purchase price for the current variant, you can use the following sessions:

- **Product Variants (tipcf5501m000)**
- **Product Variant Purchase Price Structure (tipcf5535m000)**

The purchase price for the schedule is retrieved from the **Generic Price Lists (tipcf4101m000)** session and is based on the value selected in the **Purchase Price Date Type** field in the **Pricing Parameters (tdpcg0100m000)** session. Allowed values

- **Order Date**
- **System Date**
- **Delivery Date**

Important: The purchase price structure is used for analysis only.

Note: Since different dates are used as reference date for sales price/purchase price calculation, the price on the schedule can differ from the price displayed in the variant data.

Processing production orders

When a new production order is transferred to the Job Shop Control module or created manually, LN executes the following actions:

- 1** The relevant data from the Bill of Material, Routing, and Tools Requirement Planning modules is retrieved.
If the materials include a *phantom item*, the materials and operations of that item are also retrieved.
- 2** The material costs are estimated. In the calculation of the required material quantities, the scrap and yield factors are taken into account.
If it concerns a *rework order* or a production order for an item with item type **Purchased** or **Product**, the materials estimate is filled with the item itself.
- 3** The hours that are needed for each operation are estimated, based on the routing of the item.
Operations of phantom items are also taken into consideration. Exception: if it concerns a rework order or a production order for a purchased item, the hours are not estimated. In that case the hours must be entered manually.
- 4** The tools requirements are calculated.
- 5** The production orders are planned.
This implies that the start and finish dates and times of the operations are set, except for rework orders.
- 6** If a production order has no operations, the order lead time defined for the manufactured item is used to plan the production order.
- 7** Capacity utilization of work centers is determined, but not for rework orders.
- 8** The planned inventory transactions in Warehousing are updated: allocations for materials and planned receipts for products are recorded.
- 9** The calculation of the planned receipt date for the end product is made.
For more information see the To determine on order dates topic.
- 10** Order-specific inspection data are generated in Quality.
- 11** A workflow instance is created.

Note: If the **Moment Freezing Estimates** field has the value **During Creating Order**, the estimated order costs are frozen immediately, and the estimated end item unit costs are calculated.

Releasing production orders

Releasing production orders

When you release a production order, the production order gets the order status **Released**. This means that the production can start: materials can be issued and spent hours can be accounted.

When you release a production order, LN performs the following actions:

- Warehousing orders are created in Warehousing. Through these warehousing orders, the issue of materials and receipt into inventory of end products are handled.
- Allocations of materials are moved to the *shop-floor* warehouse.
- Inspection orders are created in Quality.
- If the **Moment Freezing Estimates** field has the value **During Releasing Order**, the estimated order costs are frozen, and the estimated end-item unit costs are calculated.

How to release production orders

You can release production orders by means of the Release Production Orders (tisfc0204m000) session.

Note: If the Printing Production Order Documents Mandatory check box in the **Production Order Parameters (tisfc0100s000)** session is selected, the order status of a production order must be **Printed** before you can release it.

Reporting operations as completed

When all items are processed in an operation, you can report the operation as complete. This is not mandatory, unless the operation is a *count point*.

You can do this in the Report Operations Completed (tisfc0130m000) session.

If you report an operation completed, the *operation status* changes to **Completed**. If necessary, you can reset the operation status to **Started**.

Quality management

In certain situations you cannot report an operation completed before the *inspection order* for the operation has been processed. This is explained in the Using QM for manufacturing operations topic.

Blocked operations

If an operation is blocked, you cannot report it completed.

Quantities completed and rejected

You must specify which quantity of the item has been completed successfully and how much must be rejected for not meeting the required quality. For more information, refer to Reporting quantities as completed and rejected.

If you want to report an operation completed, while the reported quantities do not match the quantities reported in the previous operation, the previous operation can be updated automatically. This depends on the **Reporting Method for Previous Operations** field in the **Production Order Parameters (tisfc0100s000)** session.

If an operation has been reported completed, all previous operations must have been completed.

You can also report all previous operations completed in the same way. However, a *count point* operation cannot be reported automatically via a follow-up operation. Report these operations individually.

If you report items as *rejected*, LN sometimes requires you to enter a reason for the rejection.

JSC Order groups

You can report the operations for all the production orders in an JSC order group completed in the Report Operations Complete by Order Group (tisfc0205m000) session.

Put away to quarantine in Manufacturing

During the production process some end products may not be compliant with the desired specifications. When a defect is established, the non-conforming items must be handled. When a defect on the manufactured item is detected during an operation step in the production process, you have the option to scrap the item on the applicable operation of the production order or send the defective item to a quarantine location to be reworked at a later date.

Set up put away to Quarantine

Select your preferred method of quarantine inventory handling for Enterprise Planning by selecting one of the options of the Available for Planning parameter in the **Inventory Handling Parameters (whinh0100m000)** session.

If a quantity is rejected into quarantine during production, the transfer to the quarantine warehouse must be supported by a production warehouse order. The PWO's used to trigger the warehouse order for the booking of the defective items are different from the regular PWO's.

If the Quality module is implemented, you must enter blocking reasons in the Blocking Reasons (tisfc2100m000) session. When you use a reason code while the Block Quantity Rejected check box is selected, it is not possible to reject items in the Report Operations Completed (tisfc0130m000) session.

For the warehousing parameters that are needed to make use of the quarantine functionality see Quarantine inventory setup

Exceptions

- Project pegging

If project *pegging* is used in the production process, one or more pegging distributions are present. The pegging distribution must be updated if a pegged item is rejected to quarantine. Once the quantity that is rejected is selected, the pegs that go along with it are automatically transferred to the quarantine inventory.

The parameters selected in the Enterprise Planning influence the priority in which the pegged quarantine items are handled: in case of "reworking" or "use as is" items with pegs that have the highest priority are handled first, if you chose to scrap the quarantined items the items with the lowest peg priority are selected first.

If the quarantined goods have the status 'not available for planning', it is not possible to determine the priority of the pegs in Enterprise Planning and the pegs are handled in alphabetical order.

- Effectivity units

If the end item has an effectivity unit, it must be reported to the quarantined location.

- **Serials**

If the rejected end item is serialized, and the serials are registered in inventory the serial must be reported to the quarantined inventory location.

When the manufactured item is serialized, the status of the applicable serials is registered in the 'as-built'. Note: it is not possible to create a rework order for a serial with the status rejected. To rework serialized items, the defective items must be placed in quarantine.

- **Customer owned**

If one or more materials used in the production order are customer furnished, the order is designated as customer owned in the quarantine inventory. This designation is applied even if the customer furnished materials are not yet issued.

Reporting production orders as completed

Reporting orders completed

When production is ready, you must report the production order completed. You can do this in the following sessions:

- Report Orders Completed (tisfc0520m000)
- Report Orders Completed Globally (tisfc0206m000)
- Production Schedules (tirpt1500m000) (only for *repetitive items*)

After you have reported a production order completed, you can still process material issues for the production order, or post hours to it.

Quality management

In certain situations you cannot report a production order completed before the *inspection order* for the operation has been processed.

Blocked operations

You cannot report a production order completed, if one of its operations is blocked.

Completion of operations

If the Reporting Method for Previous Operations field in the **Production Order Parameters (tisfc0100s000)** session is **None**, all operations must be reported completed before you can report the production order completed. If the **Reporting Method for Previous Operations** field in the **Production Order Parameters (tisfc0100s000)** session is **Automatic** or **Interactive** you can report a production order and its operations completed at the same time.

Posting of end products

If you use the Report Orders Completed Globally (tisfc0206m000) session, LN posts the current planned quantity of the product to inventory.

The Tools Requirement Planning (TRP) module

When you report a production order completed, the tool's life of the used tools is reduced.

JSC order groups

If you are using order groups, you can report completed all the production orders in a group simultaneously. Use the Report Orders Completed Globally (tisfc0206m000) session and select the **Production Order Group** check box.

Archiving production orders

Closed production orders can be archived for future reference. This means that the production order is moved to another *company* number, which serves as archive. The order status changes to **Archived**.

General data and costing history data can also be archived. General data, for example work center data, does not pertain to a particular production order. Costing history data is about material usage, spent hours, and so on.

The archive company must be defined in the **Implemented Software Components (tccom0500m000)** session in Common.

Data can be archived by means of the following session:

- **Archive/Delete Production Orders (ticst0250m000)**

You must change to the company number of the archive company to print or display archived information.

Note:

When the main item of the production order is a standard item then you can use the **Archive/Delete Production Orders (ticst0250m000)** session to delete the records in the table Production Order Operations (tisfc010).

When the main item of the production order is a customized item then you can use the **Archive/Delete Projects (tipcs2260m000)** session to archive the production order and as a result the records in the table Production Order Operations (tisfc010) are deleted from the original company.

Integrations of JSC with warehousing

The following integrations exist between the Job Shop Control module and Warehousing:

- The Inventory Planning module stores on-order quantities and planned inventory transactions.

- The Warehouse Orders module handles the issue of materials and receipts of finished products.
- The Warehouse Orders module is also involved in the posting of financial transactions and the handling of inspection orders.
- The Inventory Analysis module plans items with order system SIC and generates production orders.

Planned inventory transactions

When you create production orders in the Job Shop Control module, the Inventory Planning module registers the order's *planned inventory transactions*. The Inventory Planning module also registers:

- *Material allocations*
- *Inventory on order*. For more information, refer to To determine on order dates.

Warehousing orders

The Warehouse Orders module handles the issue of materials and receipts of finished products with *warehousing orders*. The warehousing order determines:

- *Inbound and outbound procedures*
- *Lot selection and identification*
- *Warehouse locations*.

LN creates a warehousing order when you release a production order. When you modify the estimated materials, the warehousing order is updated automatically. You can control the issue of materials in several ways. For more information, refer to Overview of material issue.

Inventory transactions

LN records all *inventory transactions* in the Warehouse Orders module in Warehousing. LN uses these inventory transactions to create the appropriate *financial transactions*. For more information, refer to Integrations of JSC with finance.

When a component is issued, or when an end product is received, the warehousing order triggers the inspection order associated with the production order.

Generation of production orders

Items with *order system* SIC are planned in the Inventory Analysis module in Warehousing. You can transfer these orders to the Job Shop Control module.

Integrations of JSC with Configurator

Use Configurator to configure *generic items*. The configuration of a generic item results in a *product* variant for which you can create production orders.

The way LN plans generic items depends on the *order system*. *Generic items* with **FAS** order system are called *FAS items*. You control the planning of FAS items completely in Configurator. Planned orders for FAS items

are transferred directly from Configurator to the Job Shop Control module. You must carry out these orders with the *line-sequencing* functionality in the Assembly Control module.

Generic items with an order system other than **FAS** can be configured in Configurator, but the production orders for these items are planned in another package (as determined by the order system). LN creates a *project* for these items which you control in the Project Control module.

Integrations of JSC with enterprise planning

LN plans items with **Planned order system** in Enterprise Planning. You can plan the item with *master-based planning* or *order-based planning*. You can transfer the generated *planned production orders* to the Job Shop Control module with the **Transfer Order Planning (cppat1210m000)** session.

You can also use Enterprise Planning to plan the replenishment of *shop floor warehouses*.

Integrations of JSC with finance

Every *inventory transaction* and everything that changes the value of items results in a *financial transaction*. These transactions are posted to the General Ledger module in Financials.

The most important transactions for production orders are:

- The issue of materials for a production order.
- The booking of hours on a production order.
- The delivery into inventory of finished products.
- The *WIP transfers* between work centers.
- The application of a surcharge.

The selection of the *financial company* where LN posts the transactions depends on a number of parameters. See Multisite overview

For details about the setup of the *ledger accounts*, see Financial integrations - overview.

Integration with JSC

Quality can be used to inspect the quality of

- Materials for production orders
- Intermediate products between operations (*subassemblies*)
- Finished goods of production orders

In Quality you specify the required tests and the quality standards.

You can control the inspections by means of inspection orders. LN creates the inspection orders when you release a production order. The inspection orders for materials and end products are based on the warehouse orders by which you move the items from and to the warehouse.

An inspection order can in some cases (depending on the parameters) block a production order, until the inspections have finished. You can override these parameters for individual production orders, operations, or materials, by means of the **Order Specific Test Procedures (qmptc0149m000)** session.

Quality sends the results of the inspections of subassemblies and end products back to the Job Shop Control module. These results determine how much of a product you can report completed or *rejected*.

Integrations of JSC with Tool Requirements Planning

You can define the tool requirements for the production of an item in the **Operation (Step) - Tools (tirou0110m000)** session in the Routing module.

Tool requirements for a particular production order can be maintained in the **Estimated Tool Requirements (titrp0111m000)** session in the Tools Requirement Planning module.

When a new production order is transferred to the Job Shop Control module or created manually, LN calculates the tool requirements.

MES Integration With Job Shop

The primary functionality of the integration between LN and the Manufacturing Execution System (MES) is the reporting of the production progress by the MES on the production orders that are released by LN to the shop floor.

Using MES reporting allows for more automation and accuracy in the reporting process.

Production reporting comprises of reporting of produced quantities, the actual machine hours, the labor hours and the status of the machine.

Make sure this master data is available in LN before integrating MES:

- Items data
- Shop floor layout and calendar
- Employees

Note: The MES integration is only available if the **Sites** parameter is Active and the **Job Shop by Site** parameter Inactive in the **Implemented Software Components (tccom0100s000)** session.

- 1 Select the MES Reporting for Job Shop parameter in the **Implemented Software Components (tccom0100s000)** session
- 2 Select the **MES Reporting** check box in the **Production Settings by Site (timfc0180m000)** session.
The check box activates MES Reporting for the selected site.
- 3 The MES workplace must be represented in LN.

You must create a work center with one machine to represent MES.

To be integrated with MES, all operations must be performed on a work center with a machine linked to it. Note: only one machine should be linked to the work center.

- 4 Set the **Number of Machines** field in the **Work Centers (tirou0101m000)** to 1, and define a **Backflush Employee** field for the specified work center.
- 5 Select MES in **Machines (Machine Types) (tirou0102m000)** session.
The **MES Reporting** check box must be selected and the name of the physical machine entered in the **MES Workplace** field.
- 6 The hours on operations must be backflushed.
While you can book both machine and labor hours in the **Production Order Hours (bptmm1120m000)** session, the employee work time BOD only supports booking labor hours.
The backflushing check box must be selected on both the operation and as a production parameter.
The **Hours** check box must be selected in the **Item - Production by Site (tiipd0151m000)** and the **Production Order (tisfc0101m100)** sessions and set in the **Routing Operations (tirou1102m000)** session.
- 7 The operations needed for production must be designated count points.
To maintain data consistency of the progress reporting, operations need to be marked count points in the **Production Planning (tisfc0110m000)** session.
- 8 The **MES Reporting** indicator in the **Report Operations Completed (tisfc0130m000)** session shows which operations are controlled by MES and do not need to be reported on in the current session. You can make corrections to the data.
The indicator prevents unintentional reporting from both MES and LN.
- 9 Make sure none of the operations are blocked.
If an operation is blocked, it is not possible to report on quantities.

Note:

It is possible to add additional information to an operation but this information is not send to the MES and cannot reported by the MES.

- Process variables
- Inspection orders
- Tools
- Skills
- Operation steps

Chapter 3: Production order planning

Production order priority

Use the **Print Production Order Planning by Priority (tisfc1410m000)** session to identify *production orders*, *work centers*, machines, or *tasks* that require special attention.

LN prints the data in the order specified in the **Print Priority** field. You can also set limits for the criterion specified in the **Print Priority** field. For example, you can print all production orders which are more than five days behind schedule.

You can sort the data by one of the following criteria:

- **Critical Ratio**
- **Earliest Due Date**
- **Priority of Prdn Order**
- **Shortest Total Rem.Prd.Tm**
- **Slack Time**

The **Critical Ratio** criterion is the ratio of the number of days available for production until the *delivery date*, against the number of days needed for production. If **Critical Ratio** is less than 1, the production order is behind schedule.

The **Earliest Due Date** criterion is the time left up to the production order's delivery date.

The **Priority of Prdn Order** criterion is the value of the **Priority** field in the **Production Order (tisfc0101s000)** session.

The **Shortest Total Rem.Prd.Tm** criterion is the total number of days still required to work on a production order. You can use this to print orders which are almost finished.

The **Slack Time** criterion equals the number of days available for production until the delivery date minus the number of days needed for production. If the **Critical Ratio** is negative, the production order is behind schedule.

For more information, see the online help for the Print Production Order Planning by Priority (tisfc1410m000) session.

The **Priority** is also used to decide which order to return a tool to.

Planning production orders in JSC

Production order planning provides the facility to modify and preplan the production order. The planning is a process of determining the start and end dates of the individual operation and production order. When the production order is planned, the lead-time of the operations and the production order is calculated. The load on the corresponding machines and work centers is also calculated and displayed.

Production orders can come to the Job Shop Control module from a variety of Origin of production orders including:

- Enterprise Planning
- Warehousing
- Configurator

You can also create production orders manually in the **Production Orders (tisfc0501m000)** session.

Note:

Orders generated by Configurator are normally used only for assembly lines, but you can use the sessions covered in this topic to adjust the planning of operations carried out at non-assembly line work centers after the assembly line. These are known as post-process operations. You can use these, for example, to customize products for customers that require extra features.

However, you might want to modify the planning of these orders in the job shop, for example to cope with a backlog, or an order gaining a higher priority because of customer demand for the end item.

Overview sessions

The **Utilization by Week (tisfc1502m000)** session gives an overview of each week of what capacity you have planned to use, including:

- planned orders
- work centers and operations for the orders
- quantities planned for the orders
- estimated production time to complete the orders.

If you have selected the **Update Method Day Utilization** check box in the **Production Order Parameters (tisfc0100s000)** session, you can use the **Utilization by Day (tisfc1503m000)** session to give similar information to the above session.

You can also see a similar overview organized by work center or machine and by week or day in the following sessions:

- **Work Center Utilization by Week (tisfc1501m000)**
- **Work Center Utilization by Day (tisfc1506m000)**
- **Machine Utilization by Week (tisfc1504m000)**
- **Machine Utilization by Day (tisfc1505m000)**

Editing Job Shop Planning

A production order has one or more operations planned. You can alter the order in which the operations are carried out, in the Operation Relationships by Order (tisfc1102m000) session. You can use the Production

Planning (tisfc0110m000) session to modify the network routing for one operation, by changing the **Next Operation** and the **Task** assigned to the current operation.

To change the dates for the uncompleted operations of several production orders collectively, use the Shift Production Planning (tisfc1202m000) session. You select the earliest operation that is not yet completed, and adjust its Shift Planning to Date. LN adjusts the dates of the other operations in that production order, and of the other production orders that you have selected, to take account of your change.

If you want to change the dates of an individual operation, you can use the Production Planning (tisfc0110m000) session. You can alter several variables, including:

- Remaining Production Time (if you change this, other dates for the operations are updated by LN)
- **Cycle Time (min)** and **Average Setup Time**
- **Production Rate** unit time

You can also adjust the Shift Planning to Date by starting the graphical planning board from the **Production Planning by Planning Board (tisfc1120m000)** session. This lets you reschedule operations by dragging a graphical representation of them with your mouse. You can see a graphical representation of machine planning with the **Machine Planning by Planning Board (tisfc1140m000)** session and of work center planning with the **Work Center Planning by Planning Board (tisfc1130m000)** session.

If you discover that your scrap or yield is different from expected, you can also modify this in the **Production Planning (tisfc0110m000)** session, and LN will modify the planned quantities to take account of your changes.

After you have made changes to the BOM or routing, you will need to use the Reprocess Production Orders (tisfc1203m000) session to make new production orders to take account of the changes you have made.

Calendars in Manufacturing

To plan production orders or to calculate available capacity in Manufacturing, LN needs to know the hours that are available. In LN, *calendars* are used to record the availability of resources.

Lead times and production planning

In production planning, LN uses *lead times* to determine when an operation is finished, and the next operation starts. To obtain reliable planning dates, the availability of resources must be taken into account. For example, a work center can be occasionally unavailable, due to weekends, holidays, or maintenance.

For more information, refer to the online manual topic Lead times in Manufacturing.

Calendar codes

The following table shows how to link calendars to various resources.

To do this...	Use this session...
To define the company calendar	Companies (tcomm1170m000)
To define an <i>enterprise unit's</i> calendar	Enterprise Units (tcomm0130m000)

To do this...	Use this session...
To define a <i>work center's</i> calendar	Work Centers (tirou0101m000)

Note: It makes no difference whether you define a work center's calendar in the **Work Centers (tirou0101m000)** session or the **Departments (tcmcs0565m000)** session. Every work center is also a *department*. What you enter in one session is also visible in the other.

Availability types

To do this...	Use this session...
To specify the <i>availability type</i> for production order planning	Job Shop Master Data Parameters (tirou0100m000)
To specify the availability type for Assembly Control	Assembly Control Parameters (tiasc0100m000)

To view the available combinations of calendar codes and availability types, start the Calendar Availability Types (tcccp0150m000) session. You can sort the records by calendar code or by availability type.

To view a calendar's working times, *efficiency factors*, and *capacity percentage*, use the Calendar Working Hours (tcccp0120m000) session and find the applicable calendar code and availability type.

If a planning date is not within the period defined by the start date and finish date of the selected calendar, that is, no calendar working hours are available for a specific date, LN uses the *workweek*.

Lead times in Manufacturing

In LN, the lead time is the time to produce an item, from the production start date till the delivery date. Lead times are used for production planning purposes in Enterprise Planning and Manufacturing.

Lead time elements

The lead time consists of the following lead time elements:

- *Queue time*
- *Setup time*
- *Run time*
- *Wait time*
- *Move time*

Operation lead time

In Manufacturing, you can define lead time elements for every routing operation. LN uses the lead time elements to calculate the operation lead time.

LN defaults the *queue time*, *wait time*, and *move time* in the Job Shop Routing Operations (tirou4101m000) session from the **Work Centers (tirou0101m000)** session. You can change the defaulted values in the Job Shop Routing Operations (tirou4101m000) session.

Production order lead time

LN calculates production-order lead times by adding up all operation lead times. If operation overlap takes place because *transfer batch quantities* are defined, LN uses more complex calculations to determine lead times and production order planning. For more information, refer to Production order lead-times (transfer batch quantity).

Critical items

An item that you define as critical is one that can cause a bottleneck in a production process, such as an item with a long or uncertain lead time.

How to define a critical item

- Create an item in the **Items (tcibd0501m000)** session. You can also create the item using Engineering data management summary.
- Define the item as a *plan item* in the **Items - Planning (cprpd1100m000)** session. You can zoom to the **Items - Planning (cprpd1100m000)** session from the **Items (tcibd0501m000)** session. You must define an item as a plan item, before you can define it as a critical item. Note the *plan level* of the plan item. You must use the same plan level for the critical item.
- In the **Items - Planning (cprpd1100m000)** session, select the Critical in Master Planning check box.

A critical item can be either **Manufactured** OR **Purchased**.

How to use a critical item

To define relationships between plan items and critical items:

- Use the **Planning Bill of Critical Material (cprpd3120m000)** session to define the relationship structure. The structure is similar to that of a Structure of a multilevel BOM.
- Generate the structure (that is, the critical bill of material) in the **Generate Bill of Critical Materials (cprpd3220m000)** session.

You can print the relationships you have defined in the **Print Bill of Critical Materials (cprpd3420m000)** session.

You can use *master planning* to plan the requirements of critical items.

How to define a product model

Carry out the following steps to define a product model:

1 Product Configuration Parameters

In the Product Configuration Parameters (tipcf0100m000) session, determine the version of the product configurator. If the product model is in the creation stage, you must use the interpreter version. The advantage of this version is that the generic product model can be tested immediately if new *constraints* are created. If changes are made to these constraints, the constraints need not be *recompiled* first. Refer to the Product Configurator Version field in the **Product Configuration Parameters (tipcf0100m000)** session.

2 Items - General

In the **Items (tcibd0501m000)** session, enter the *generic items* that you need for the *product model*. If the item is a generic item, the following characters are not allowed in the item code:

```
% ' " ^ \ ! @ # $ % & * ( ) | / ; ~ ` ? { } [ ] < >
```

The reason is that object files that are generated for constraints in the Product Configuration module cannot contain these characters.

You must decide whether you want to use a PCS budget and/or a PCS project when producing product variants, or you want to use PCF without PCS. A PCS budget is used to calculate the standard cost. A PCS project is used to plan, produce, and control the manufacturing process. Consequently, the structure of the product variant is generated by budget or project. The advantage of using PCS is that it provides an item with a detailed cost roll-up, and the possibility of pegging. However, in high volume environments, a detailed cost roll-up is often not necessary. Furthermore, using PCS requires extra time to calculate the project costs and to delete the project structure afterwards.

- If you want to use Project Control for Product Configuration, the Customizable check box must be selected in the **Items (tcibd0501m000)** session.
- If you want to use Product Configuration without Project Control, the Customizable check box must be cleared in the **Items (tcibd0501m000)** session.

If you configure items without PCS projects, standard items are generated instead of customized items. Pegging functionality is secured by the unique item codes of the configured items that can be related back to the sales order.

3 Product Features

In the Product Feature (tipcf0150m000) session, enter the required *product features*. You must define all required product features with possible options in this session.

4 Product Features by Generic Item and Constraints by Generic Item

In the Product Features by Configurable Item (tipcf1101m000) session, the product features are linked to a generic item. Product features are controlled by *constraints*, which you can define in the Configurable Item - Constraints (tipcf2110m000) session.

5 Generic BOMs and Generic Routing

In the Generic Bill of Material (tipcf3110m000) session and the Generic Routing (tipcf3120m000) session, you can enter respectively the *product structure* and the routing. The constraints in step 4 are used to ensure that the product structure and routing are in accordance with the selected options.

6 Price-List Matrix Codes, Price-List Matrices and Generic Price Lists

The Price List Matrix Codes (tipcf4110s000) session, the Price List Matrices (tipcf4120m000) session, and the Generic Price Lists (tipcf4101m000) session are not mandatory. If a sales price or a purchase price for a generic purchase item must be generated, the price list can be used to define a price list. You can use matrices for different features that have mutual relationships associated to the price. By defining the price list code and the price list matrices, the features and values in the matrices can be entered.

7 Settings for Generic Item-Data Generation

The Generic Item - Settings for Data Generation (tipcf3101m000) session is not mandatory. The item data that arises when configuring *product variants* can be defined generically according to your own wishes and insights. You can use this session to create generic settings on how to generate the item code, item description, material, size, text, or standard for a generic item.

8 Product Configuration Parameters

After you defined the product model, you must change the product configurator version from **Interpreter Version** to **Object Version** in the **Product Configuration Parameters (tipcf0100m000)** session.

9 Compile Constraints by Generic Item

The last step is to *compile* the constraints to generate objects for each item in the Compile Constraints by Configurable Item (tipcf2201m000) session.

Production order splits - overview

With the split-off functionality you can split a production order. By splitting an in-process production order you divided it into multiple production orders. You can select the split-off quantity that goes to the new child order, or split off rejected items.

A split can be required in situations such as the following:

- The total order quantity cannot be completed in time due to capacity issues.
- Insufficient material is available to complete the total order quantity in time.
- A part of the total order quantity is nonconforming, expedited, or delayed.

Note:

- After a child order is created, it is independent of the parent order, and its inherited characteristics can be manually adjusted. A child and parent order will always reference each other. A parent order can reference several children, whereas a child order references only the parent.
- To automatically split off the rejected quantity of a production order, you must select the Split Order when Reporting Rejected Quantity check box in the **Production Order Parameters (tisfc0100s000)** session.

Caution:

Splitting production orders may affect efficiency variances in several ways including:

- A production order accounts for a certain fixed amount of *scrap* during production. If the order is split into two separate production orders, the scrap quantity can increase because the new order will generate additional scrap upon completion.

- Setup times are doubled when an order is split: active operations also have a queue time. For example, if the original order has a setup time of one hour, after the split, both the parent and child order have this setup time, which increases the total setup time by one hour. This means capacity needed after the split is increased as well.

If Production Order Reference on Subassemblies check box in the Production Order Parameters (tisfc0100s000) is selected, the order split process is affected, see example.

- Master data

Before you can split production orders, you must select the Allow Production Order Splits check box in the **Production Order Parameters (tisfc0100s000)** session.

With the production order split functionality activated, these settings become available in the **Production Order Parameters (tisfc0100s000)** session:

- Print Order Documents At Order Split
- Reason Code for Order Split
- Split Order when Reporting Rejected Quantity
- Actual Material Costs breakdown for Transfer Postings

- Splitting production orders

You can split production orders in the Split Production Order (tisfc0208m000) session, which can be started from the Production Orders (tisfc0501m000) session or, if the split off concerns rejected items, from the Report Operations Completed (tisfc0130m000) and Report Orders Completed (tisfc0520m000) sessions.

In turn, a child order can be split. Therefore, a production order can be both a parent and a child order at the same time. You can start the Order Split Tree View (tisfc0708m000) session to view all levels of a split in a *graphical browser framework*.

Production orders with a serialized or unit effective end item can be split by serial number or effectivity unit. When you click Select behind the **Split Quantity** in the **Split Production Order (tisfc0208m000)** session, one of these sessions is started in which you can select the serial number or effectivity unit that must be split off to a child order:

- Select Serial Numbers to Split Off (tisfc0208m100)
- Select Effectivity Units to Split Off (tisfc0208m200)

These conditions must be met to split an order:

- A production order can be split only when the production order has the **Released** or **Active** status
- A split is possible only when a greater or equal to the *routing quantity (unit)* remains with the parent order.
- When an order is split, a new production order or child order is created with the order quantity equal to the (user-defined) split-off quantity from the original production order. The child order inherits order characteristics, such as delivery date, production planning, operation steps, and material requirements, from the parent production order.
- The total order quantity on the production order from which the order split was initiated, is decreased based on the order split quantity.
- The *bill of material (BOM)* or *routing* is checked to determine the estimated materials or the JSC production planning. The data is copied from the parent order.
- If the parent order contains a project cost distribution, the child obtains the distribution lines which have the latest requirement dates.

- Along with the order characteristics, the child order inherits the *order status* and the operation status from the parent order.
- There are no restrictions on the number of splits that can be applied to a single production order as long as the order fulfils the split conditions.
- Order quantities already completed and delivered to a warehouse cannot be split off. Completed quantities on order level or operation level always stay with the parent order at split.
- Splitting off rejected items

When reporting operations or orders are completed, they may contain rejected items. Instead of reporting these items as rejected in the Report Operations Completed (tisfc0130m000) or Report Orders Completed (tisfc0520m000) sessions, you can split off the rejected parts of the order. When the rejected items are split off, they can be reworked as a separate order.

If you start the Split Production Order (tisfc0208m000) session from the **Report Operations Completed (tisfc0130m000)** or **Report Orders Completed (tisfc0520m000)** sessions, the Split Quantity is already defaulted from the Additional Rejected field.

The advantage of splitting off the rejected items is, that no quantity rejected will be reported on the original production order at closing.

- Splitting production orders with a project peg distribution

If a production order contains a project peg distribution, this must be taken into account on order split. The split-off quantity is derived from the distribution lines selected by these criteria:

- The distribution lines with the latest need dates are split off first.
- If all need dates on the distribution lines are equal, anonymous demand is split off first. Distribution lines for project cost-pegged demand are split off if no anonymous demand is on hand.
- If only project cost pegged demand distribution lines exist and the need dates are equal, the lines are moved based on the last distribution line sequence.

In contrast with a production order that does not contain a project-pegged distribution, the planned delivery date is based on the earliest need date of the linked project pegs.

Note:

- After a quantity is split off from a production order with a project-pegged distribution, LN updates the order pegging for both parent and child to acquire updated need dates.
- The project pegs that are copied to the child order are generated by LN. You cannot manually adjust them.
- Recalculation of estimated materials at order split

An order split requires an update of the estimated materials on the parent order, even if the estimated materials lines are already frozen.

Based on the initial production order materials of the manufactured item and order quantity that remain on the parent order after the split, operation input quantities are recalculated and *estimated quantities* are updated for each required material. This update is done against initial *valuation price*, as estimated costs only change based on the adjustment of the estimated quantity.

If a project-pegged production order contains project cost pegged materials, the estimated materials line and the estimated material distribution are updated.

For a newly created child order, the estimated material lines are created based on the estimated materials of the parent production order, the production order quantity, and the calculated input quantity of the operation.

- Material issues and (production) warehouse orders

At order split, all material lines on the parent order are updated. If required, this update, in turn, triggers an update of the related production warehouse orders for materials with the type **Issue**, based on these rules:

- **Parent Order**
All materials issued on a production warehouse order are registered as the actual quantity shipped to the parent production order.
- If an order is split, but the full quantity of a required material was already shipped, you must manually redistribute the materials between the parent and child order by returning the excess from the parent, and then issuing it to the child order.
- After the split, the total actual quantity issued to the operations is checked. If the actual quantity issued to an operation is less than the updated material quantity required by the operation, the warehouse issue orders are updated to reflect the quantity of the material still to be issued to the operation on the parent order.
- If the total actual quantity of a material issued to an operation is greater than the updated quantity that is required by the operation, any outstanding material requests for this material must be manually removed.
- **Child Order**
If, at the time of split, the full quantity of required materials has already been shipped to the operation on the parent order and no more unfilled warehouse orders exist, no child order level warehouse orders to issue materials need to be created for the same operation. A portion of the actual material costs (based on the order split quantity proration) will be acquired from the parent order.
- If only a portion of the required materials had been shipped to an operation at order split, warehouse orders are created for the quantity of materials to be issued to the operation on the child order level.

Note: If, on operation level, the quantity of the manufactured item is completely delivered, LN creates a warehouse order for material if both these conditions are met:

- At the time of splitting, the actual quantity of material issued against the parent order is lower than the quantity required
- Outstanding warehouse orders to issue the remaining quantity are present
- If both conditions are met, on the child order level a warehouse order is created that contains a quantity to be issued which equals the outstanding quantity that was supposed to be issued on the parent order level.

When the operation status becomes **Completed**, a portion of the actual material costs is obtained from the parent order. The exact portion of the material costs to be transferred is determined based on the value of the Actual Material Costs breakdown for Transfer Postings field in the **Production Order Parameters (tisfc0100s000)** session, which is applied to completed operations.

Issued materials can be returned only from the production order that holds the actual warehouse issue for the material. Even if materials were issued to the parent production order, and at order split actual material costs were transferred to a child production order, the return can only be executed from the parent production order, as the warehouse order lines were linked to the parent.

- **Splitting production orders with multiple subcontracted subassemblies**
Production orders with subcontracted operations can be split only if the subcontracted operation is not yet active, or the operation necessary for production have been completed. If subcontracting with material flow is used, the returned subassemblies must be processed and completed as well.
If the Production Order Reference on Subassemblies check box in the **Production Order Parameters (tisfc0100s000)** session is selected, all subassemblies must be issued before the order can be split as the subassemblies can only be issued to the order they are linked to.

Example

In the following situation, errors will occur:

- A production order has two subsequent operations that are subcontracted to different subcontractors. The first operation was completed and the subassembly received.
- If the Production Order Reference on Subassemblies check box is selected, the received subassembly has a production order reference.
- You decide to split off the remainder of the production order, including the second subcontracted operation.

A subassembly returning from the subcontractor can only be issued to an operation on the same production order as it was shipped from. If the production order was split, the returning subassembly cannot be issued to the child production order as the child order has a different production order number than is referenced on the returning subassembly.

Material supply lines can only be handled and the subassembly transferred and issued to the shopfloor warehouse linked to the receiving operation, if a subcontracting purchase order with the status **Active**.

Note: A production order with a subcontracting purchase order with the status **Active** cannot be split.

Production order splitting with Line Side Labeling

If line side labeling is activated for the production or selected for splitting, handling units generated for the production order stay with the parent order in a split. You must generate new handling units for the child order.

Chapter 4: Production orders with project

Project types

The following project types exist:

Main Project

A main project is a separate project that is made up of several subprojects. Main projects and subprojects are both defined as projects. A main project acts as the driver for the planning of its subprojects or as the aggregate for the financial results of the subprojects. Recording a project structure using main projects and subprojects is especially important for extensive projects in an engineering-to-order situation. For main projects, only a limited number of project control functions is feasible.

Sub Project

A subproject is part of a main project. The *network* planning for the subproject is derived from the planning for the main project. Several parameters can be defined at main project level for a subproject. The project control functions for a subproject are also applicable for the single project.

Single Project

A single project is a separate project that is not divided into several subprojects.

Budget

A budget is used for planning and estimating, not for production execution.

Main project and subproject parts

Working with main projects and subprojects has the following consequences:

- The main project contains the overall planning for its subprojects. This means that the start and delivery dates for the network planning of the subprojects are directly derived from the overall network planning for the main project! Umbrella activities can be defined for the main project in order to control the subprojects. This allows you to perform a rough cut of capacity requirements planning, depending on

the value of the rough capacity requirement which can be recorded for each activity by means of the **Activities (tipcs4101m000)** session.

- Logistically, the main project lets you perform rough-cut planning and control the subprojects. A main project is not clearly relevant for detailed planning of the flow of materials and capacities. Therefore, NO customized product structures can be recorded for a main project.

For a main project, a variety of project data can be recorded which is also applicable for subprojects, unless data has been recorded separately for the subprojects. This data includes:

- Operation rates
- Subcontracting rates
- Cost-price surcharges
- Chart of accounts

The umbrella activities of the main project can be included in the estimated data of the (main) project. The main project acts as the aggregate project for the subprojects. So, some data of the subprojects is automatically aggregated to the main projects, that is:

- Rough capacity, aggregated capacity and hours spent by means of the **Generate Network Planning (tipcs4210m000)** session.
- Budgeted costs, estimated costs, actual costs and total invoice amount by means of the **Calculate Standard Costs by Project (tipcs3250m000)** session.

Various functions are performed for the main project. This is performed for the subprojects as well, that is:

- Network planning
- Cost price accounting
- Closing project
- Archiving project

The following cost and revenue transactions are possible for main projects:

- Hours that are or are not directly posted to an activity of the main project
- Sales orders or sales invoices for services rendered

Network planning

Maintain the following data in order to carry out a network planning:

- General project data
- Activities by project
- Activity relations
- Capacity load table codes
- Capacity load tables

A network planning consists of all the activities required to execute a *project* (but not a budget). An activity may represent one or more operations. Each activity has a specific lead time. The relations within the network indicate which activities depend on each other. Analyzing the network will inform you about the total duration of the project. The method used is the Precedence Method.

The advantages of a network planning are as follows:

- The project planning is independent of the *project* structure as recorded in LN
- A network planning can be generated when the project structure is only partly-defined
- Network planning offers optimum facilities to monitor the project's progress. If activities are behind schedule, the influence on the project's finish date can be directly calculated and the appropriate measures taken in order to make up for the delay.

When you set up a network planning, the sequence order in which operations and activities are to be carried out is an important aspect. Activities can relate to other activities. They can be executed consecutively or they can overlap.

Depending on the planning method recorded in the **Projects (tipcs2101m000)** session, you can plan forwards (based on the start date) or backwards (based on the finish date).

The relations between activities determine whether there is any float in the planning. Free float is the number of days by which you can delay an activity without affecting the next activity. Total float is the number of days by which you can delay an activity without affecting the project's start or finish date.

The capacity required for the activity can be distributed over the activity's duration in terms of a percentage of the total capacity via the capacity load table.

You can indicate in the table whether customized operations must be automatically linked to activities when this has not yet been done. If the customized operation cannot be linked to an activity, it will be reported by LN.

The setup time, cycle time, man occupation for setup, man occupation for production, and machine occupation are recorded per operation by means of the **Routing Operations (tirou1102m000)** session.

The following examples show how the capacity requirements for a project activity are planned:

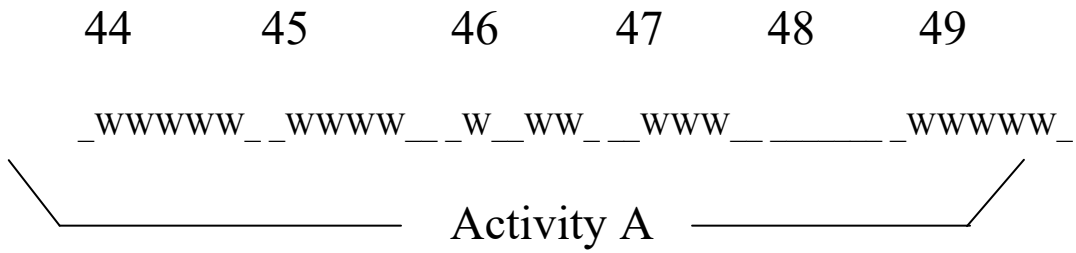
Example 1: Example 1: Activity has not yet started Example 2: Example 2: Activity has already started

Example 1: Activity has not yet started

Activity A has not yet started. No hours have been spent, there is no project structure, and there is no detailed capacity planning.

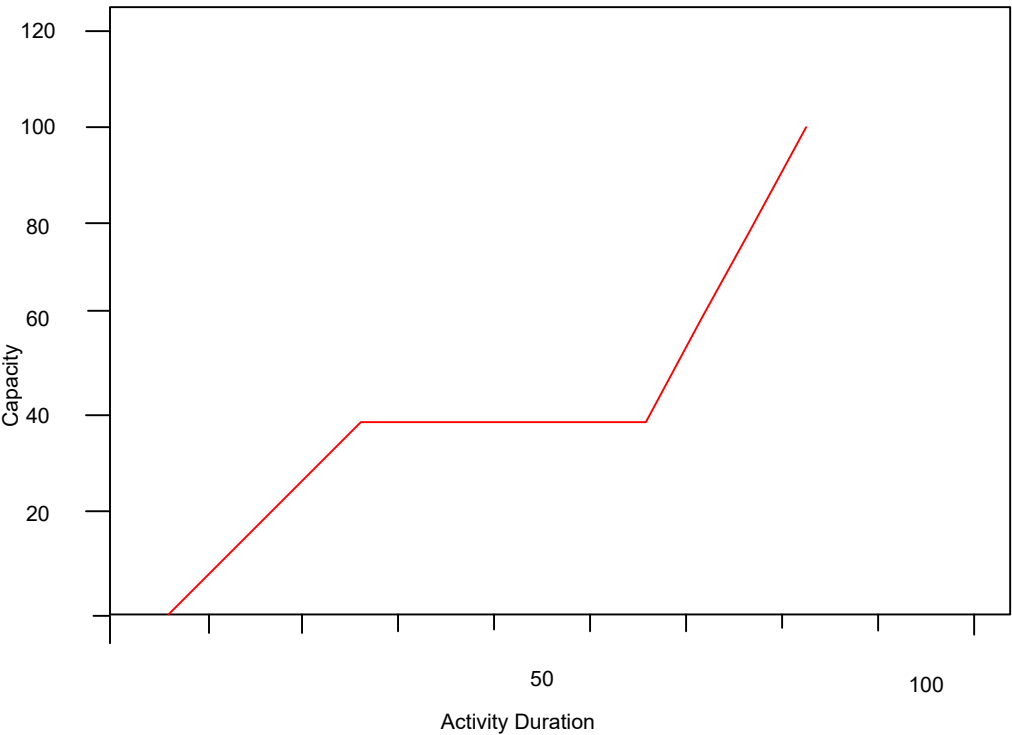
- Activity duration (project days): 15
- Rough capacity requirement : 200
- Earliest start date : day 4 week 44 year 92
- Percentage completed : 0%

The current date lies before the earliest start date. The following figure depicts activity A being carried out:



W	Workdays
_	Non-workdays

The capacity load table assigned to the activity is shown in the following figure:



The capacity for activity A is 200 hours. The capacity load per week is as follows:

Week	Number of days	Percentage of Activity Duration	Percentage of Capacity Requirement	Difference Compared to Prev. Wk.	Capacity Requirement (per Week)
44-92	2	13%	17.3%	17.3%	34.6

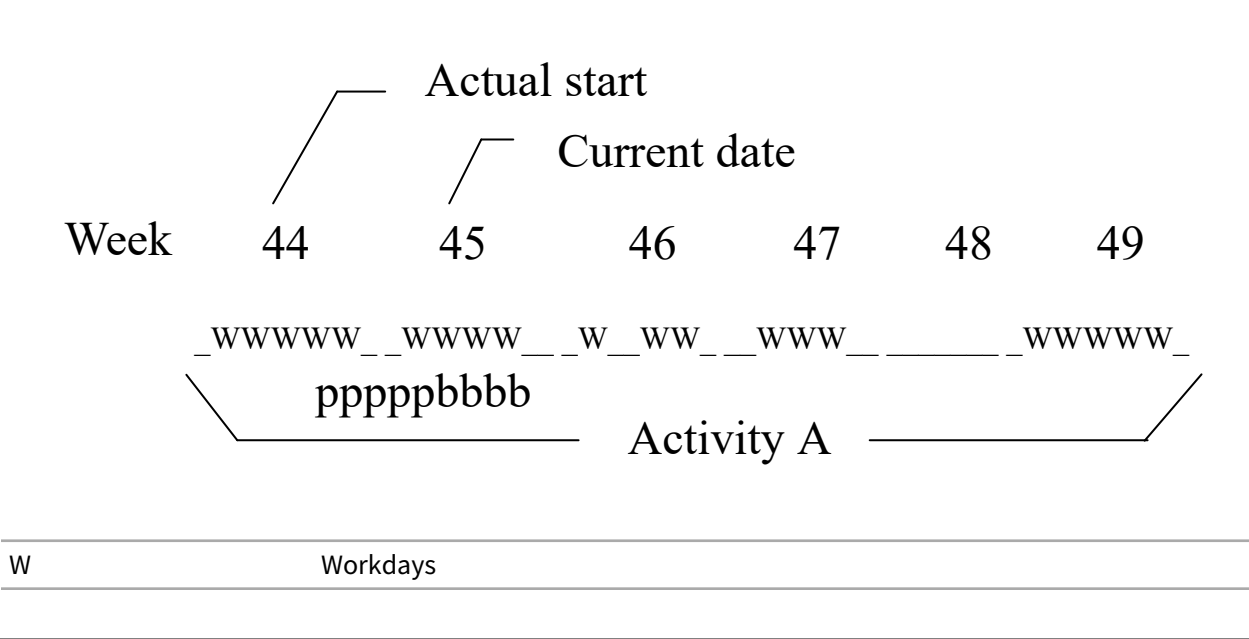
Production orders with project					
45-92	6	40%	40.0%	22.7%	45.4
46-92	9	60%	40.0%	0.0%	0.0
47-92	12	80%	70.0%	30.0%	60.0
48-92	12	80%	70.0%	0.0%	0.0
49-92	15	100%	100.0%	30.0%	60.0

Example 2: Activity has already started

Activity A has been started, hours have been spent, and a capacity planning has been carried out per project.

Activity duration (project days)	15
Rough capacity requirement	200 in work center 10
Actual start date	day 4 week 44 year 92
Hours spent	30 in work center 10
Detailed capacity requirement	100 in work center 10
Percentage completed	20%

The following figure depicts activity A being carried out:



–	Non-workdays
p	progress
b	backlog

20 percent of activity A has been completed. In other words, 20 percent of the planned capacity for activity A is ready. Hours to be spent: $0.8 \times 200 = 160$ hours. Based on the capacity load table, LN computes what percentage of the activity duration has lapsed. The capacity load table shows that 20 percent corresponds to 15 percent of progress in activity duration.

This progress is equal to $0.15 \times 15 = 2.3$ days of the lead time. Planned progress (6 days) is $6/15 \times 100\% = 40\%$ of the activity duration. The backlog = $6 - 2.3 = 3.7$ days. According to the capacity load table, this corresponds to a capacity backlog of $20\% = 40$ hours. These 40 hours must be added to the remaining lead time of 9 days. Capacity to be utilized according to the original planning: $60\% = 120$ hours. To achieve the finish date of the activity, extra capacity must be added: $40/120 = 33\%$. The capacity load per week is then as follows:

Week	Number of days	Percentage of Activity Duration	Capacity Requirement (per Week)
46-92	9	60%	0
47-92	12	80%	$60+20=80$
48-92	12	80%	0
49-92	100%	100%	$60+20=80$

Lean PCS projects

In a make-to-order production environment, production only starts when a customer places an order. Contrary to an engineer-to-order environment, a product in a make-to-order environment has, for the most part, fixed features and specifications that are unlikely to be changed. In LN, the type of make-to-order without any engineering is also called standard-to-order. The product then has a standard BOM and a standard routing, and is, therefore, a standard product.

Standard-to-order products are mostly products that are not desired to keep in stock, for example, because the product is very expensive or very voluminous. If you produce standard-to-order, the finished products can be transported directly to the customer that ordered them, which saves you most of the inventory costs.

There are two types of projects you can use in Project Control for the production of to-order standard items:

- You can set up a standard project
- You can set up a lean PCS project

Using a lean PCS project, you can peg activities to specific sales orders, with cost known by the PCS project. When a project is generated to manufacture the specified item, no BOM or routing is copied in to the project as those are standard and no engineering is possible once the item goes in projection.

The BOM and routing of a standard to order item are stored independently of the projects making use of them, preventing redundant data.

1 Create a sales order for the standard-to-order item.

The order policy of the item in the sales order line must have the **Customizable** check box selected, which you can define in the **Items (tcibd0501m000)** session. As a result, the **Make Customized** check box in the **Sales Order Lines (tdsls4101m000)** details session is selected, which indicates that a PCS project can be generated.

2 Trigger the production of a standard-to-order item

In LN, you can trigger the production of a standard-to-order item directly from the sales order. Select a sales order line, and start the **Generate (Project PCS) Structure for Sales Orders (tdsls4244m000)** session from the *appropriate* menu to generate the project structure for the standard item. You must select **Standard-to-Order** in the **Generation Method** field. The item in the sales order line is copied as a customized item to the PCS project. In other words, a project code is added to the standard item, which makes the item a customized item. However, the BOM and the routing are not copied to the project, so no customized BOM or routing is created at any level in the project structure.

Dependent on the settings in the **Generate (Project PCS) Structure for Sales Orders (tdsls4244m000)** session, the project code for the newly created customized item is based on the sales order number, if the **Equate Project (PCS) with Sales Order** check box is selected, or on a project series, if the **Project Series** field is filled.

3 Generate planned orders

After a project structure is created for the standard-to-order item by running the **Generate (Project PCS) Structure for Sales Orders (tdsls4244m000)** session, planned orders can be generated for all items under the PCS project in the **Generate Order Planning (cprrp1210m000)** session in Enterprise Planning. Planned orders are created for materials in the project that are standard-to-order items, but also for materials that are **no**. For this purpose, the BOM is exploded. The BOM that is used for the BOM explosion is the standard BOM of the item from which the customized item is derived. The item from which the customized item is derived can be found in the **Derived-from Item** field in the **Items (tcibd0501m000)** details session for the customized item.

The BOM is exploded in the following way: if the encountered material in the BOM is a customized item, Enterprise Planning checks the item's inventory to determine the lowest inventory level in the future. The calculation is as follows:

```
on hand inventory + future receipts - future deliveries
```

Excluded in the calculation are:

- Production plans
- Purchase plans
- Planned orders

If sufficient inventory is available, Enterprise Planning creates a customized item for the standard-to-order item, and allocates inventory for the customized item instead of for the standard item. After this, the BOM explosion comes to a halt.

If inventory is insufficient, Enterprise Planning creates a customized item for the standard-to-order item, and BOM explosion continues.

If the material on the BOM line is an anonymous item, a planned order is created in case of insufficient inventory. However, the item is not customized.

In short, every material in the BOM with **Customizable** check box selected that is encountered during BOM explosion, is changed by Enterprise Planning into a customized item. BOM explosion stops when sufficient inventory is available for a material.

Float times

The *float time* is the time in working days between activities. Float times can vary.

Float times that concern an activity:

- **Total Float:** The extension allowed for an activity expressed in working days.
- **Free Float:** The free float-time between one activity and the next. The free float-time indicates how many days the activity can be extended without jeopardizing the progress of other related activities.

The calculation is done as follows: If the value of the **Relationship Type** field is equal to **ES (End-Start)** (the next activity starts when the preceding activity has ended) then

```
free float-time (ES)= Earliest start date of the next activity - relation float times - activity
                        duration - earliest start date
```

If the value of the **Relationship Type** field is **SS (Start-Start)** (the next activity and the preceding activity start simultaneously) then

```
free float-time (SS)= Earliest start date of the next activity - relation float times - earliest
                        start date
```

Both float times are calculated after you run the **Generate Network Planning (tipcs4210m000)** session. If both float times are zero, the activity belongs to the critical path. The absolute relational float between activities is maintained in the **Activity Relationships (tipcs4110m000)** session.

Float times can be entered in two ways:

- **Float Time (Day)** The float time between the preceding activity and the next one expressed in working days. This float time is used to determine the start date of the next activity. The relation type is an important factor: The value **ES (End-Start)** indicates that the start date of the next activity is equal to the finish date of the preceding activity plus the relative float-time. The value **SS (Start-Start)** indicates that the start date of the next activity is equal to the start date of the preceding activity plus the relative float-time.
- **Float Time (in Perc)** The same float time as the **Float Time (Day)**, but expressed as a percentage of the duration of the preceding activity.

One of the two sorts float-times can be entered in the **Activity Relationships (tipcs4110m000)** session.

Rough capacity consumption in PCS

If you use PCS network planning, the work center capacity displayed in the **Resource Order Plan (cprrp0530m000)** session or the **Resource Master Plan (cprmp3501m000)** session can be undesirably consumed by the PCS rough capacity (defined for the activities in PCS) and the capacity required for JSC production orders and planned production orders in Enterprise Planning.

This online manual topic describes the usage of the **Use rough PCS capacity requirement** check box in the **Work Centers (tirou0101m000)** session. You can use the check box to prevent double consumption of work center capacity.

Backgrounds on activities and network planning

In PCS, you can define *activities*. An activity represents a stage in the execution of a project, for example, engineering, production, final assembly, or inspection. After defining activities, you must define activity relationships to indicate dependencies between the activities. You can use activities and activity relationships to perform a network planning to represent an overall planning of the PCS project.

If you define an activity in the **Activities (tipcs4101m000)** session, you must enter a work center for the activity. You must enter the number of hours that represent the work center's rough capacity requirements. After you perform network planning, you can view the work center's capacity in the **Resource Order Plan (cprrp0530m000)** session, or the **Resource Master Plan (cprmp3501m000)** session. The rough capacity requirements from the **Activities (tipcs4101m000)** session is expressed by the **Capacity Used for PCS Activities** field. The work center's **Free Capacity** is calculated by subtracting the **Capacity Used for PCS Activities** from the **Available Capacity**.

If an activity involves production, JSC production orders and/or planned production in Enterprise Planning are present. Capacity on a work center is demanded by the activity and by the production orders. If the work center on the production order(s) is the same as the work center defined on the activity, double consumption of work center capacity can occur. In the **Resource Order Plan (cprrp0530m000)** session or the **Resource Master Plan (cprmp3501m000)** session you can view the required JSC capacity in the **Capacity Used for Production Orders** field as well as the rough capacity in the **Capacity Used for PCS Activities** field. With double consumption, the **Available Capacity** of the work center is reduced by both the **Capacity Used for Production Orders** and the **Capacity Used for PCS Activities**.

Usage of the Use rough PCS capacity requirement check box

Double consumption of work center capacity is not always desirable. Using the **Use rough PCS capacity requirement** check box in the **Work Centers (tirou0101m000)** session prevents this:

- If the **Use rough PCS capacity requirement** check box is selected, the PCS rough capacity defined for activities in PCS, and the capacity required for JSC production orders and planned production orders in Enterprise Planning are subtracted from the work center's available capacity. Therefore, double consumption of work center capacity occurs.
- If the **Use rough PCS capacity requirement** check box is cleared, the work center's available capacity is consumed by the capacity required for the JSC production orders and planned production orders in Enterprise Planning. The rough capacity requirements defined in the **Activities (tipcs4101m000)** session are not taken into account.

Closing a project

Before a project is closed, LN checks the current status of the project. Only projects with the status **Finished** can be closed.

LN checks that:

- All subprojects have the status **closed**, if there is a main project.
- All production orders for the project are closed.
- All purchase orders have the status **closed**.
- All purchase receipts are invoiced, and the invoice matching procedure are carried out in the financial accounting.
- All sales orders are closed with the **Process Delivered Sales Orders (tdsls4223m000)** session.
- All service orders for the project are processed in history.
- All transaction hours for the project are processed.
- No project inventory is still present. The project inventory value cannot exceed the value entered by the users. Remaining inventory less than this value is automatically deleted.
- All internal invoices from the PCS project to the financial companies of the sales office, service department, and/or warehouse are sent and completed.

If these conditions are not met, the project cannot be closed.

If the project can be closed, the following steps are taken:

- 1 Any current inbound and outbound advice for warehousing orders in the **Inventory by Warehouse, Item and Effectivity Unit (whwmd2116s000)** session is deleted.
- 2 Project costs and results are calculated. To do this, LN automatically starts the **Calculate Standard Costs by Project (tipcs3250m000)** session.
- 3 The project status is changed to **closed**.

Note:

- If there is a main project, before the main project is closed, all subprojects are closed first according to the previous procedure.
- If you select the **COS and Revenues Restricted to Financial Company of PCS Project** check box in the **Project Control Parameters (tipcs0100m000)** session, financial transactions are posted on the financial companies of the sales office, service department, and/or warehouse instead of on the financial company of the PCS project. If internal invoices are sent from the PCS project to those departments, and the internal invoices are not completed yet, the **Close Project (tipcs2250m000)** session sets the project status to **to be closed** instead of to **closed**. You must first complete the internal invoices, and then run the **Close Project (tipcs2250m000)** session again to set the project status to **closed**.

Delete and archive in Project Control

With respect to Project Control within Manufacturing, the following is of importance.

- Delete financial data in Project Control
If a PCS project is closed, you can use the Delete Financial Transactions by Project (tipcs3200m000) session to remove financial data. After removal of the financial data, you cannot print WIP and costs

anymore. The PCS project is definitively closed and cannot be reopened. Note that after the data is deleted, you cannot use the Archive/Delete Projects (tipcs2260m000) session anymore to archive the data.

- Archive projects

Use the Archive/Delete Projects (tipcs2260m000) session to archive or delete closed PCS projects. This includes the financial data, so running this session makes using the Delete Financial Transactions by Project (tipcs3200m000) session superfluous.

Note: For more information, refer to the *User's Guide for Archiving* (U9352* US).

Performance aspects

- Effect on CPU: Not applicable
- Effect on database growth: Yes

Unit effectivity in PCS

In the Project Control module in Manufacturing, *effectivity units* can be assigned to:

- Project parts
- Module planning by project

Project parts

Project parts are used to determine the estimated costs of a project. They are entered manually, or generated from the sales order line (generate project structure from product variant). The PCS calculation of estimated costs uses the standard cost from CPR to calculate the estimated costs for a standard project part. However, when a standard part has an effectivity unit then the standard cost of the part is recalculated to determine the unit effective standard cost of that part. In case the BOM of the part has any exceptions for optional material, the unit effective standard cost can be substantially different from the standard cost.

Module planning

Module planning is always entered manually. It is used to trigger Enterprise Planning to create demand when a sales order is not yet available. The effectivity number on the module is used by Enterprise Planning during explosion of the BOM and usage of the routing to determine which objects are valid.

BOMs and routings of customized items

When items are copied to a new structure, an user can choose between two options:

- Copy all BOM lines and routings with all linked *exceptions*.
- Copy only BOM lines and routings that are valid for a specific effectivity unit. Attached exceptions are not copied.

You can choose those options from the following sessions:

- **Copy Standard Product Structure to Customized Structure (tipcs2230m000)**

- **Copy Customized Product Structure to Customized Structure (tipcs2231m000)**
- **Copy Customized Product Structure to Standard Structure (tipcs2232m000)**

To customize unit effective items on a sales order

If you want to *customize* a unit effective item on a sales order by using the **Generate (Project PCS) Structure for Sales Orders (tdsls4244m000)** session, a full copy method is used. This means that the complete bill of material as well as all operations, applicable to all effectivity units, are copied to the PCS project. In addition, all exceptions linked to BOM lines and operations are copied.

If you make changes to an effectivity unit in a PCS project, for example, by changing the effectivity unit on the linked sales order, you do not need to regenerate the PCS project because all data related to the unit effective item is already present. Furthermore, the changed design of an effectivity unit is automatically taken into account for the next order planning run in Enterprise Planning.

Note: Unit effective routings are not copied to the PCS project. Similar to routings that are not unit effective, either the default routing of the unit effective item, or a routing based on fixed order quantity or economic order quantity is copied to the PCS project.

Chapter 5: Assembly planning

Assembly planning overview

You can use the Assembly Planning module to plan the assembly of product variants, and to generate *assembly orders* in Assembly Control. Assembly Planning does this for assembly lines in a mixed model flow production environment, which is characterized by high volumes, and many variants of complex products.

The main processes in Assembly Planning are as follows:

- 1 The product variant is generated
- 2 The product variant structure is generated
- 3 The *assembly part* requirements are calculated
- 4 The *assembly orders* are created

The following sections provide an overview of these processes.

1 Set parameters

Before you can use Assembly Planning, you must set the APL parameters in the **Assembly Planning Parameters (tiapl0500m000)** details session. Note that the behavior of several sessions depends on one or more of the following parameters:

- **Is Master Company**
If this check box is selected, your current company is defined as the *master company*. The master company can be one of the companies of the assembly line, or a separate company. The master company is used to store master data, such as product variants and BOMs.
If this check box is cleared, all the fields in the Configurable Item - Assembly Line (tiapl2500m000) session are disabled.
- **External Assembly Parts and Operations**
If this check box is selected, an external source delivers the flattened assembly parts and operations to Assembly Planning.
If this check box is cleared, the assembly parts and operation are flattened during the calculation of the assembly parts requirements.
- **External Product Variant Structure**
If this check box is selected, the *generic BOM* relations between the generic *end item* and the engineering modules are delivered to Assembly Planning from an external source. LN provides no functionality to copy this information to the *product variant structure*.
If this check box is cleared, the generic BOM relations between the generic end item and the engineering modules are copied from the generic BOM to the order-specific BOM when you run the **Generate Product Variant Structures (tiapl3210m000)** session.

- Test Mode

If this check box is selected, the Assembly Planning module operates in test mode. You can maintain data that is otherwise maintained by external packages.

If the **External Assembly Parts and Operations** check box is selected, this data is maintained externally:

- Operations, that are displayed in the Operations (tiapl1500m000) session.
- Operation assignments, that are displayed in the Operation Assignments (tiapl1510m000) session.
- Product variant structures, that are displayed in the **Product Variant Structures (tiapl3510m000)** session.

If the **External Assembly Parts and Operations** check box is selected, you cannot maintain this data from within LN, unless you operate in test mode.

You can also run the Actualize Assembly Line Costing Data (ticpr0215m000) session for a manually chosen effective date.

2 The product variant is generated

The product variant is generated on sales order entry. In the **Sales Order Lines (tdsls4101m000)** session, the *sales order line* specifies the generic item that is sold, and other data, such as the required offline date, price, and so on. One of the specifications can also be the *effectivity unit*, which can be used to configure the product variant.

For production purposes, the information that is entered on the sales order line is stored in a product variant. The product variant represents the specific product that is sold. You can view the product variant in the Product Variants (Assembly) (tiapl3500m000) session.

3 The product variant structure is generated

So far, the product variant is only a reference to the product without production data. This production data must be determined by generating the relations between the generic sub-items and *engineering modules* that make up the generic end item. These relations are solved based on effective dates and/or units.

When Product Configuration is not used the generic sub-items and engineering modules are retrieved from the generic BOM, which you can view in the Generic Assembly Bill of Material (Assembly) (tiapl2510m000) session. The result of this process is stored in the product variant structure, which is displayed in the **Product Variant Structures (tiapl3510m000)** session.

If you use Product Configuration, the relations to the generic sub-items and *engineering modules* that make up the generic end item are resolved against the *generic BOM* in the Product Configuration module.

The relations between the *generic BOM* and generic *sub-items* are resolved when you enter a *sales order*. The relationships to engineering modules are resolved in a separate process.

You can generate product variant structures in the following sessions:

- Generate Product Variant Structures (tiapl3210m000)
- Calculate Assembly Part Requirements (tiapl2221m000)
- Generate Assembly Orders (tiapl3201m000)
- Refresh and Freeze Assembly Orders (tiapl3203m000)

The assembly parts and operations that are required to assemble the end item are stored below the level of the engineering modules. In the **Assembly BOM and Operations (tiapl2520m000)** session, you can view the parts and operations per engineering module. The operations are defined in the **Operations (tiapl1500m000)** session. Operations are assigned to line stations in the **Operation Assignments (tiapl1510m000)** session.

Note the following

- Generic sub-items can also have their own generic sub-items. To each generic item one or more engineering modules can be related.
- If the **External Product Variant Structure** check box is selected in the details of the **Assembly Planning Parameters (tiapl0500m000)** session, only the relations between the generic items are solved. The relations to the engineering modules are delivered from an external source.
- In LN, there are three ways to retrieve the flattened parts:
 - Import
To import the *flattened* parts and operations, you must select the **External Assembly Parts and Operations** check box in the **Assembly Planning Parameters (tiapl0500m000)** session.
 - Manually
You can define the flattened parts and operations manually in the **Assembly BOM and Operations (tiapl2520m000)** session.
 - Through EDM
You can obtain the flattened parts through EDM, which involves a flattening procedure.
- In LN, the *flattened* parts and operations are delivered from an external source. Therefore, the **External Assembly Parts and Operations** check box in the **Assembly Planning Parameters (tiapl0500m000)** session is always selected. As a result, you can maintain the data in several sessions only if you work in test mode.
- Product variants that are no longer required, can be deleted by means of the **Purge Product Variants (tiapl3200m000)** session.

4 The assembly part requirements are calculated

If the product variants and product variant structures are generated, the assembly part requirements can be calculated, and assembly orders can be created. Assembly part requirements are calculated, based on the product variant structures and the *flattened* assembly parts.

The assembly part requirements are calculated for product variants whose planned offline date falls in the demand *time fence*. The demand time fence is defined in the details of the **Assembly Planning Parameters (tiapl0500m000)** session.

The calculation is based on *segment schedules* that indicate on which date the assembly parts are required for each segment, based on the offline date of the assembly order. Segment schedules are displayed in the **Segment Schedules (tiapl4500m000)** session.

When the assembly part requirements are calculated, they are transferred to Enterprise Planning.

5 The assembly orders are created

Assembly orders are created for product variants whose planned offline date falls in the assembly order time fence of the roll-off line. The assembly orders are created by Assembly Planning, but are stored and executed in Assembly Control. In a multicompany situation, assembly orders are created for each company.

Assembly orders can only be created for assembly lines that are actualized, which means that the lines are released for use in the production process. Only assembly lines that are valid can be actualized. You can both validate and actualize assembly lines in the **Actualize Assembly Lines (tiasl1231m000)** session. You can also validate the assembly lines in a separate session: the **Validate Assembly Lines (tiasl1230m000)** session.

Assembly order creation uses the concept of *line-station variants (LSVs)*. LSVs store the materials and operations per line station. You can use the **Refresh and Freeze Assembly Orders (tiapl3203m000)** session to refresh and freeze assembly orders. Orders that are refreshed, are updated with changes in

the product variant or product variant structure. Orders that are frozen, are no longer updated automatically. Frozen orders can only be updated manually in Assembly Control.

The update of assembly orders also applies the concept of LSVs. The update actually determines whether the LSVs that can be created based on the new product variant and/or product variant structure, would differ from the existing LSVs. If that is the case, new LSVs are created, where required, and sent to Assembly Control.

In the **Product Variant - Assembly Lines (tiapl3520m000)** session, you can view on which assembly lines a product variant is assembled. The session also displays whether the required assembly parts are already allocated in Assembly Control, and whether the assembly order on the specified assembly line is frozen. Note that on another assembly line, the same order can be not frozen or only partly frozen.

Note:

- If you use LN integrations for some integrations, you must specify the *bus components* in the Company - Bus Components (tiapl0501m000) session.
- The Is Master Company check box can only be selected if no assembly orders are present in the company.
- The check box can only be cleared if no *product variants* are present in the company.

Segment schedules

Segment schedules are schedules that indicate when the *assembly parts* that are required for the work in a particular *line segment* must be delivered to the job shop warehouse. For each segment on a line, a range of offline periods is defined. And, for each period, a date is scheduled on which the assembly parts are required. As a result, every *product variant* whose *requested offline date* falls within one of these periods requires its assembly parts for the segment in question on that date.

The advantage of *segment schedules* is that the assembly part requirements can be determined right from the schedule, if only the requested offline date of the product variant and the segment of the assembly parts is known. Compare this to the following procedure, which applies if no segment schedules are used:

- 1 Determine in which segment a part is required.
- 2 Offset that line segment by calculating the time between the start of the segment and the end of the roll-off line
- 3 Calculate the date on which the assembly part is required.
- 4 Determine the plan period in which this date falls.
- 5 Determine the delivery date of the part, which is the start date of the plan period.

Segment schedules are used for a rough planning of assembly part requirements, especially in the more distant future, that is, the period after the allocation *time fence* but before the demand time fence. However, the schedules cover the entire period in the demand time fence, including the allocation time fence. The segment schedules appear in the **Segment Schedules (tiapl4500m000)** session.

The assembly part requirements for product variants whose requested offline date falls in the allocation time fence are allocated by Assembly Control for each line station, in the **Build Allocations (Server) (tiasc7240m001)** session.

The assembly part requirements for product variants whose requested offline date falls in the demand time fence are calculated by the **Calculate Assembly Part Requirements (tiapl2221m000)** session per segment,

and for a range of product variants at once. This is a simplified calculation with a high performance for large volumes.

The allocation time fence is defined in the details of the **Assembly Control Parameters (tiasc0100m000)** session. The **Demand Horizon** is defined in the details of the **Assembly Planning Parameters (tiapl0500m000)** session.

The segment schedules are determined as follows:

- 1 The plan periods for the current scenario are determined. The current scenario is selected in the **Scenario** field of the details of the **Segment Schedules (tiapl4502m000)** session. The plan periods are defined in the **Scenario - Periods (cprpd4120m000)** session.
- 2 The segments of the assembly lines are offset, which means that the time between the the start of the line segment and end of the roll-off line is calculated, according to the lead times of the segments.
- 3 Now, for each plan period and each segment the offset time of the segment is added to the start time of the plan period. This way, for each segment, a new series of periods is created. These periods correspond with the original plan periods, but the new periods are shifted into the future a time span equal to the offset time of the segment concerned. Therefore, these periods indicate that a product variant whose requested offline date falls in one of these periods, requires his assembly parts for the segment in question on the start date of the corresponding original plan period.

Example

Imagine an assembly line and plan periods with the following characteristics:

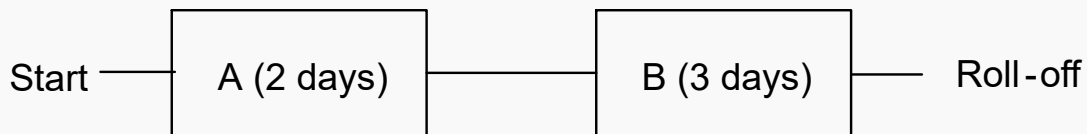
- The assembly line has no supply lines, so it is a roll-off line.
- The line has two segments.
- The lead time of segment A, where the assembly process starts, is 2 days.
- The lead time of segment B, which is the roll-off segment, is three days.
- The plan periods are defined as weeks.
- The first plan period starts on January 1, at 00:00:00.

If the segments are offset, the offset time of segment A is five days. The offset time of segment B is three days. Now the offset times of these segments are added to the start times of the plan periods. As a result, for plan period 1 and segment A, a new period is created that starts on January 6, at 00:00:00, which is the first moment after the five days offset time of segment A, which were added to January 1, 00:00:00. The second period starts on January 13, at 00:00:00, because this is the first moment after the five days offset time of segment A, which were added to the start of plan period 2, which is January 8, at 00:00:00. So, the first period ended on January 12, at 23:59:59.

For plan period 1 and segment B, a new period is created that starts on January 4, at 00:00:00, because this is the first moment after the three days offset time of segment B, which were added to January 1, at 00:00:00. The second period starts on January 11, 00:00:00, which is the first moment after the three days offset time of segment B, which were added to the start of plan period 2, which is January 8, at 00:00:00. So, the first period ended on January 10, at 23:59:59.

Now, if you have a product variant with a requested offline date of January 12, this date falls in period I for segment A, but in period II for segment B. As a result, assembly parts that are required in segment A, are required on the start date of plan period I, which is January 1. Assembly parts that are required in segment B, are required on the start date of plan period II, which is January 8. Refer to the following picture, in which the date of January 12 is marked with an X.

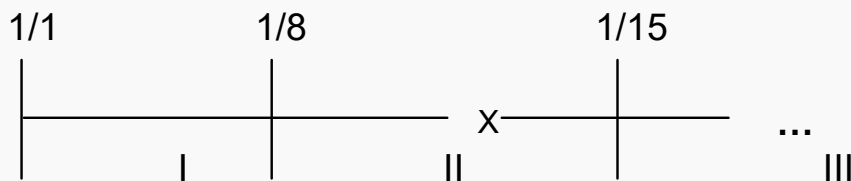
Assembly line:



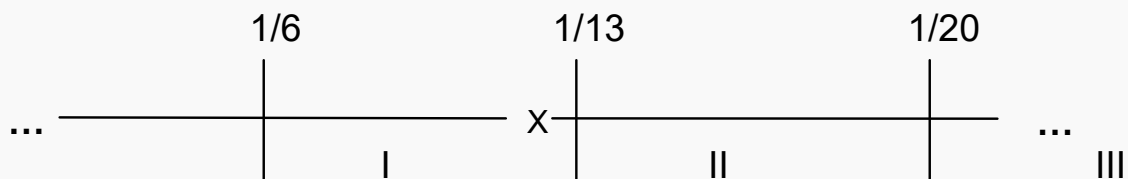
Offset time segment A: $3 + 2 = 5$ days

Offset time segment B: 3 days

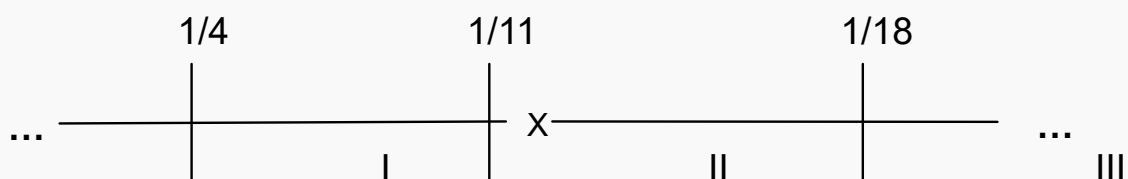
Plan periods:



Periods for segment A:



Periods for segment B:



It is important that the **Calculate Assembly Part Requirements (tiapl2221m000)** session uses the most up-to-date schedule. Several types of changes require an update. Sometimes the **Calculate Assembly Part**

Requirements (tiapl2221m000) session detects these changes and updates the schedule automatically. However, sometimes the update must be performed manually. You can update the schedule manually through the Update command on the *appropriate* menu of the **Segment Schedules (tiapl4500m000)** session, or you can select the **Update Segment Schedules** check box in the **Calculate Assembly Part Requirements (tiapl2221m000)** session to enforce an update when that session runs.

The schedule must be updated in the following cases:

- The line structure is changed. You must update the schedule manually.
- The calendar that is linked to one of the assembly lines is changed. The schedule is updated automatically when you run the **Calculate Assembly Part Requirements (tiapl2221m000)** session. The calendar is selected in the **Calendar Code** field in the **Assembly Lines (tiasl1530m000)** session.
- The scenario is changed, or the plan periods in the scenario are changed. If you use a rolling scenario, the plan periods change every period. The schedule is updated automatically when you run the **Calculate Assembly Part Requirements (tiapl2221m000)** session. However, if the plan period definition is changed, while the reference date is not changed, you must update the schedule manually.

Chapter 6: Assembly orders

Assembly orders

Assembly orders are created for product variants whose planned offline date falls in the assembly order time fence of the roll-off line. The assembly orders are created by Assembly Planning, but are stored and executed in Assembly Control.

In a multicompany situation, assembly orders are created for each company. Assembly orders can only be created for assembly lines that are actualized, which means that the lines are released for use in the production process.

Assembly order statuses

An assembly order can have one of the following statuses:

- **Created**
- **Sequenced**
- **In Progress**
- **Production Completed**
- **Completed**
- **Closed**
- **Canceled**

Assembly order progress

- An assembly order has the status **Created** when it is initially generated by **Generate Assembly Orders (tiapl3201m000)** session. When this happens, *line-station orders*, *line-station variants* and *exchangable configurations* are generated. The line station orders are generated both for the main line and the supplying lines of the same company. You must have already defined the assembly line structure (segments and line stations).
- The assembly order is **Sequenced** as described in the Line sequencing and rule types in Assembly Control online manual topic. When the order is sequenced, you can start it from the *appropriate* menu of the **Buffer - Assembly Orders (tiasl6520m000)** session. You can arrange for a request from another line station, for an order to be started, using the Request Start - Assembly Order on Line Station (tiasc4200m000) session (or as part of workflows with the Process Trigger Definition (tiasl8100m000) session).
- When the first line-station order is reported complete, the status of the assembly order becomes **In Progress**. You can report a line station order complete with the **Line Station - Assembly Orders (tiasl6510m000)** or **Report Line Station Order Complete Using Bar Code (tiasc2211m000)** session. If the lines station orders are reported complete in a different sequence from the planned sequence, LN automatically reschedules the orders.

Before you can carry out the assembly order, you must allocate assembly parts. See the Help of the Build Assembly Part Allocation (tiasc7240m000) session for more details.

You can swap orders after they have been started, as long as they still have *exchangable configurations*. Use the Exchange Configurations (tiasl4240m000) session.

Production Completed: If the order is reported completed, LN sets the assembly order to **Production Completed** status.

Completed: As soon as Warehouse Management finishes the inbound procedure for produced items that must be delivered into inventory, the assembly order will get the **Completed** status. When line-station orders are reported complete, you can Assembly backflushing their hours and materials.

closed: You can close assembly orders with the **Close Assembly Orders (tiasc7210m000)** session (from the **Assembly Line - Line Mix (tiasc2501m000)** *appropriate* menu). When you close the assembly order, LN creates the financial transactions for that assembly order. If that is impossible, LN produces error messages. The *WIP transfer* bookings are recorded in the *calculation office* of the assembly order.

Serialized items in assembly control

The as-built structure for assembly lines is generated when you have confirmed the line sequence. If you are using serialized items (that is, the **Serialized** check box is selected in the **Items (tcibd0501m000)** session), the serial numbers (for example the VIN of a car) are generated at this stage.

The following actions you perform on assembly orders, affect the status of the as-built structure (that is, the serial numbers) of the serialized items of the assembly order:

- Confirm line sequence
- Report assembly order complete
- Close assembly order
- Reopen assembly order
- Undo completed line station order

Assembly Order Costing

Costing is a crucial aspect of the Assembly Control module. The manner in which costing is performed depends partially on how you define your cost components. Other aspects of costing that are described here are:

- Transaction-processing methods
- WIP transfers
- Calculation of final results
- Differences between Assembly Control module costing and Job Shop Control (JSC) module costing.
- Where to view financial data in the Assembly Control module.

Note: The aspects of financial costing that are described here have no relation to the theoretical, mathematical costs associated with line sequencing.

- Cost components

There are four types of cost components:

- Materials
- Operations
- Surcharges
- General Costs

Cost components must be posted on the aggregated and collect levels of the cost scheme, the detailed level is optional.

- Transaction-processing methods

The Assembly Control module is intended for use by companies that produce many variants of complex products in a flow-assembly line. Assembly Control can also be used for low-volume assembly if you select **Order Based** transaction processing. Select your transaction-processing method in the Transaction Processing field in the **Assembly Control Parameters (tiasc0100m000)** session.

- Use **Line Station Based** transaction processing when you do not need to trace back to the original assembly order. Costs are posted to the assembly line. Results are calculated by period by assembly line.
- Use **Order Based** transaction processing when you want your costing performed on the basis of individual assembly orders. Costs are posted by order by assembly line. Results are calculated by order by assembly line.

- WIP transfers

WIP transfers consist of:

- Generating the transfer order

A WIP transfer generates a transfer order. However, if the transfer occurs between line stations that are in different logistical companies, a sales order and a purchase order are generated.

- Performing the material issue

A WIP issue may unblock or immediately process the transfer warehousing order, dependent on your parameter settings. In multicompany situations, the normal sales procedure must be followed in order to ship the goods.

- Performing the receipt

A WIP receipt acknowledges the receipt of the WIP transfer order at a main assembly line that has received work from a supplying assembly line. Warehousing processes the inbound line automatically. If the assembly lines are from two different logistical companies, it is necessary to use sales orders and purchase orders (rather than WIP transfer orders). In multicompany situations, the normal receipt procedure must be followed in order to receive the goods.

You can select whether you want these processes to occur automatically, semiautomatically, or manually.

- Calculation of financial results

When you close an assembly line with the Close Assembly Lines (tiasc7220m000) session, the production results of the line are calculated. All the line station orders must have the status **closed**. The financial results are the WIP transactions (which are estimated costs) minus the actual costs.

Differences between costing in Job Shop Control and Assembly Control

- In Assembly Control, the quantity completed is always one.
- There is no *scrap* and *yield* in Assembly Control.

- *WIP transfers* are only created between different *assembly lines*, and not between line stations (of the same line).
- There is no set-up time in Assembly Control.
- End item unit costs (estimated material costs and hours costs for an order) are not calculated for an assembly order. This is not necessary because each end item uses the same assembly line, so there is no point in creating separate surcharges for each item.
- In case of **Line Station Based** transaction processing, variances are calculated for an assembly order and not for a generic item.
- Production results are not split into *price variances* and *efficiency variances* in Assembly Control.
- Financial results in Assembly Control are posted to the *cost component* of the assembly line.

Where to view financial data in Assembly Control

- Financial Transactions (tiasc7510m000)
- Print Financial Transactions (tiasc7410m000)
- Print Financial Transactions by Assembly Line (tiasc7414m000)
- Print Costing by Assembly Order or Assembly Line (tiasc7411m000)

Assembly backflushing

When a line station order is reported complete in the **Line Station - Assembly Orders (tiasl6510m000)** session or the **Report Line Station Order Complete Using Bar Code (tiasc2211m000)** session, the material requirements and hours budgeted for that order can be *backflushed*. You can backflush the materials and hours with the Backflush Requirements (tiasc7241m000) session.

The backflushing topics discussed here are:

- Floor stock
- Backflushing mode
- Quantity of parts backflushed
- Number of hours backflushed

Floor stock

Floor stock items such as nuts and bolts are not backflushed in assembly control. To define an item as floor stock, select the Floor Stock check box in the **Item - Warehousing (whwmd4600m000)** session.

Backflushing mode

Backflushing is carried out for each *clustered line-station order (CLSO)* (see the Clustered Line Station Orders (tiasc7530m000) session). The number of CLSOs produced each day, depends on the mode you select with the **Transaction Processing** parameter, which you define in the **Assembly Control Parameters (tiasc0100m000)** session. For **Order Based** processing, each individual assembly order provides a CLSO for each line station, creating many CLSOs each day. For **Line Station Based** processing, there is only one CLSO each day, for each line station. All the hours and materials for all buckets, all line-station variants, and all line-station orders are clustered into one CLSO for each line station. This mode is for high-volume production environments.

Assembly parts

The parts required by the *line station variant* can be backflushed after the line station order is reported complete, with the Backflush Requirements (tiasc7241m000) session. The quantities required are calculated as described for the Build Assembly Part Allocation (tiasc7240m000) session. LN activates a *warehousing order* line which ensures the parts are delivered to the correct *shop floor warehouse*.

Floor stock items such as nuts and bolts are not backflushed in assembly control. To define an item as floor stock, select the Floor Stock check box in the **Item - Warehousing (whwmd4600m000)** session.

Man hours and machine hours

Man hours (also known as person hours) and machine hours are backflushed to People.

The number of hours backflushed is the sum of $CT \times MO$ (*Cycle Time* x Man Occupation or Machine Occupation) for each line station variant, summed for either the assembly line, if **Line Station Based**, or for the line station, if **Order Based**.

- If it is **Line Station Based**, the cycle time comes from the Assembly Line - Assignments (tiasc5510m000) session.
- If it is **Order Based**, the cycle time comes from the Line Station Variant - Operations (tiasc2122m000) details session. You define the occupation in the **Assembly Line - Assignments and Line Stations (tiasc5520m000)** session, if **Line Station Based**, and in the **Line Station Variant - Operations (tiasc2122m000)** session, if **Order Based**.

If hours are present, the hours transactions with the status Closed are posted to People and processed automatically. The hours are posted to the employee linked to the line station. You can view the hours with the Assembly Hours (bptmm1160m000) session. You can also enter additional hours with this session.

Note:

In the **Assembly Control Parameters (tiasc0100m000)** session, the **Transaction Processing** field determines how hours are booked:

- **Order Based**
Hours are booked for an individual assembly order. **Order Based** is used in low-volume environments.
- **Line Station Based**
The hours for line-station orders is added together, for each line station, to form one clustered line-station order (CLSO) for each day. **Line Station Based** is used in high-volume environments.

The values that are visible in the **Clustered Line Station Orders (tiasc7530m000)** session are used by Warehouse Management. When material backflushing is performed, the inventory for the assembly part is backflushed from Warehousing, and the Planned stock transactions in the Order - Planned Inventory Transactions (whinp1501m000) are reduced.

Line sequencing and rule types in Assembly Control

Assembly orders generated by Assembly Planning can be sequenced by using the sequencing engine, resulting in a line mix and line sequence. During this sequencing process, line rules are taken in to account like clustering assembly orders based on items characteristics, or blocking assembly orders based on capacity rules.

The assembly line can be dedicated to one model, or to a mixed model, producing either one product variant or a large number of product variants on the same *assembly line*.

Four major aspects of line sequencing are discussed:

- Sequence rules
- Sequence process
- Rescheduling
- Line sequence status

SEQUENCE RULES

Sequence rules are made up of the following elements:

Mixing process

Mix rules, which exist in three types:

- Capacity restriction rules
- Proportional rules
- Relative proportional rules

Placement rules

There are three types of rules:

- Clustering rules
- Blocking rules
- Priority rules

The (re)mixing process in Assembly Control

You can remix the orders within the Assembly Control module by using the Remix Line Mix (tiasl3220m000) session. Rules are defined for particular *option combinations*. Remixing attempts to schedule the orders so that the number of orders for each option combination is as close as possible to the maximum number of orders for each option combination. The better the mix, the better the sequence quality.

Mix rules

There are three types of mix rules:

- **Capacity Restriction**

The total capacity of the line is limited, for example: maximum 500 cars with option combination CityCar in one day.

For **Capacity Restriction** rules, you can select one of three types of dispersion:

- **Average Dispersion** The option combination is spread evenly throughout the line sequence.
- **Sliding Window Avg. Disp.** A window is a certain number of adjacent sequence positions. That window is being slid position by position. Within each window the product sequence is optimized. Adjacent sequence positions means a continuous range of sequence positions. In each window the option combination is dispersed as evenly as possible. For example, each group of 10 positions should have the same number of RedCars.

- **Sliding Window Cap. Resr.** Within each window, there is a limit to the number of orders for the option combination. For example, no more than two RedCars in any window of 10 positions.
- **Proportional**
Option combinations must be present in fixed proportion of the total order, for example, the ratio of CityCar to other orders must be 1:2.
You can define two dispersion types for **Proportional** rules:
 - **Average Dispersion** The option combination is spread evenly throughout the line sequence.
 - **Sliding Window Avg. Disp.** In each window, there is a maximum ratio of a given option combination and any other option combination. For example, for every RedCar option combination, there must be at least one other option combination within any four option combinations (ratio = 1:2, window =4).
- **Relative Proportional**
The same as **Proportional**, except that the **Method of Dispersion** is always **Relative Dispersion**. You must specify a second option combination in which the first option combination is dispersed in relation to. The option combination is placed in a particular relation to another option combination. For example, red cars and blue cars can only be assembled alternately; you cannot assemble two red cars in a row.

During remixing, the priority of orders is taken into account, as described in one of the following paragraphs.

Because rules can conflict with each other, it is possible that not all sequence rules can be met. In that case you can give some rules a higher priority. However, this results in a less efficient order sequence, and you must solve these conflicts by redesigning the assembly process, not by performing more line sequencing.

Placement rules

Placement rules are used to determine how products are placed in relation to other products. There are three types of placement rules:

- **Clustering**
Use this rule to group specific option combinations, for example, group all the blue cars because changing paint color takes a long time. This rule also allows you to sequence the clusters based on the characteristics defined in the Option Combination Lists (tiasl1511m000) session in Assembly Control on the option combination list that is attached to each cluster.
Using the options defined in the combination list, Assembly Control can sequence the clusters as efficiently as possible.
You can assign each cluster a priority (0 to 99). Additionally, priority can be given to sequencing specifically by selecting high priority numbers in the sequence in the clustered option combination list.
- **Blocking**
Certain option combinations must not be placed next to other option combinations. For example, light colors must not be painted after dark colors to minimize effects of paint contamination.

Clustering Example

In this example, the assembly orders and their option combinations are planned for a day on line segment 1.

Order 1	Option combination red
---------	------------------------

Order 2	Option combination blue
Order 3	Option combination black
Order 4	Option combination red
Order 5	Option combination blue
Order 6	Option combination black
Order 7	Option combination red
Order 8	Option combination blue
Order 9	Option combination black
Order 10	Option combination red

The option combination list Color is defined in Assembly Control as:

Option combination red	sequence 1
Option combination black	sequence 2
Option combination blue	sequence 3

When the assembly orders are sequenced in Assembly Control, based only on the clustering rule Color, the result for line segment 1 is:

Order 1	Option combination red
Order 4	Option combination red
Order 7	Option combination red
Order 10	Option combination red
Order 3	Option combination black
Order 6	Option combination black
Order 9	Option combination black
Order 2	Option combination blue
Order 5	Option combination blue
Order 8	Option combination blue

Blocking Example

In this example, the assembly orders and their option combinations are planned for a day on line segment 1.

Order 1	Option combination red
---------	------------------------

Order 2	Option combination blue
Order 3	Option combination black
Order 4	Option combination red
Order 5	Option combination blue
Order 6	Option combination black
Order 7	Option combination red
Order 8	Option combination blue
Order 9	Option combination black
Order 10	Option combination red

The option combination list Color is defined in Assembly Control as:

Option combination red	Option combination blue
Option combination red	Option combination red

The list Color is linked to the blocking rule Color, which is linked to assembly line 1. This rule says that the color red cannot be followed by the color blue or by the color red.

One result of this rule is the following sequence:

Order 1	Option combination red
Order 3	Option combination black
Order 2	Option combination blue
Order 4	Option combination red
Order 6	Option combination black
Order 5	Option combination blue
Order 8	Option combination blue
Order 7	Option combination red
Order 9	Option combination black
Order 10	Option combination red

Priority

Priority rules are enforced in the following order:

- 1 Orders with a later **Requested Offline Date** are given a lower priority.
- 2 Orders that are sold (a demand order) have priority over orders not yet sold.

- 3 Assembly orders with a lower priority number are processed first (for example, orders with a priority number of 1 are processed before orders with a priority number of 4). You define the order priority in the **Assembly Order (tiasc2100s000)** session.
- 4 Cost function value.

THE SEQUENCING PROCESS

When you add new orders to an assembly line, LN generates in the Simulate and Create Line Sequences (tiasl4200m000) session an initial sequence for the line for the appropriate offline date.

A *line segment* that follows a *buffer* can only be sequenced, if the buffer has more than one random access place. To define a buffer's number of random access places, enter a value in the **Number of Random Access Places** field in the **Stations (tiasl1545m000)** session.

Note: When you confirm a sequence, LN generates the As-built structure for the end item, such as the VIN number and header in the case of a car. You can edit the structure with the Serial End Item - As-Built Headers (timfc0110m000) and Serial End Item - As-Built Components (timfc0111m000) sessions. The serial numbers of the components are generated when you freeze the sequence. When you use the **Print Work Instructions (tiasc5450m000)** session, a space is provided on the printed form for you to enter the serial number of the components.

RESCHEDULING

You can also manually alter the sequence with the Reschedule Assembly Orders (tiasl4220m000) session. The session uses two types of rules:

- **Move**
An order is taken from one position and inserted into another position. All orders in between the two positions are shifted one position towards the initial position.
- **Swap**
Two orders are interchanged, and nothing else is changed.

The automatic sequencing process uses the swap method. You can change the maximum swap/insert distance that is used in the automatic sequence generation in the **Remix/Sequence Parameters (tiasl4110m000)** session.

When you have swapped orders to another line mix, you can run the Remix Line Mix (tiasl3220m000) session for a better sequence.

LINE SEQUENCE STATUS

A line sequence can have one of the following statuses:

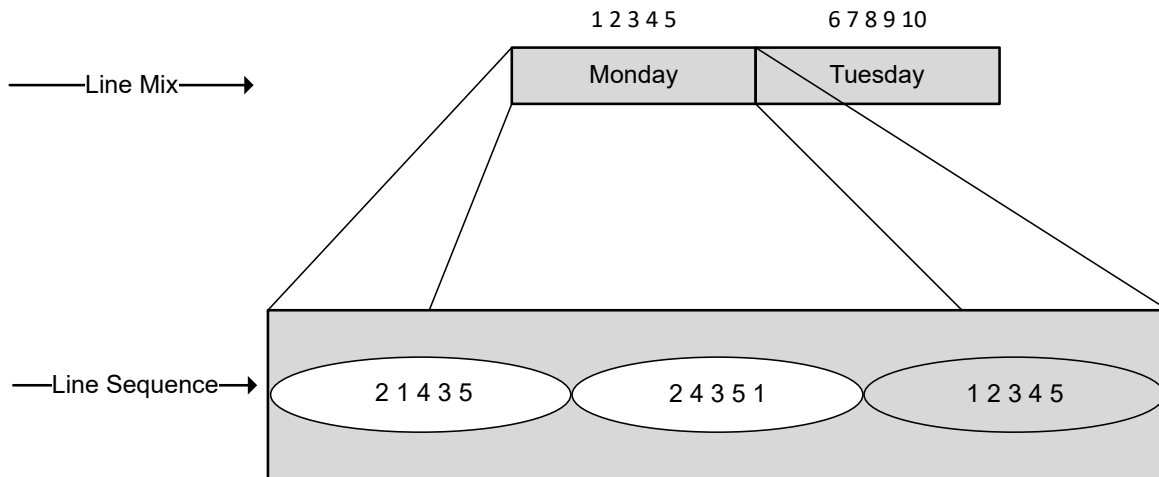
- **Planned**
- **Started**
- **Completed**

A line sequence has the status **Planned** when it is first created. When the first line-station order is completed, the status becomes **Started**. When the last line station order is completed, the status of that segment becomes **Completed**.

You can see the status in the **Line Segment - Line Sequence (tiasl4500m000)** session.

You can sequence the assembly orders on two levels:

- Assembly line level (line mix)
- Line segment level (line sequence)

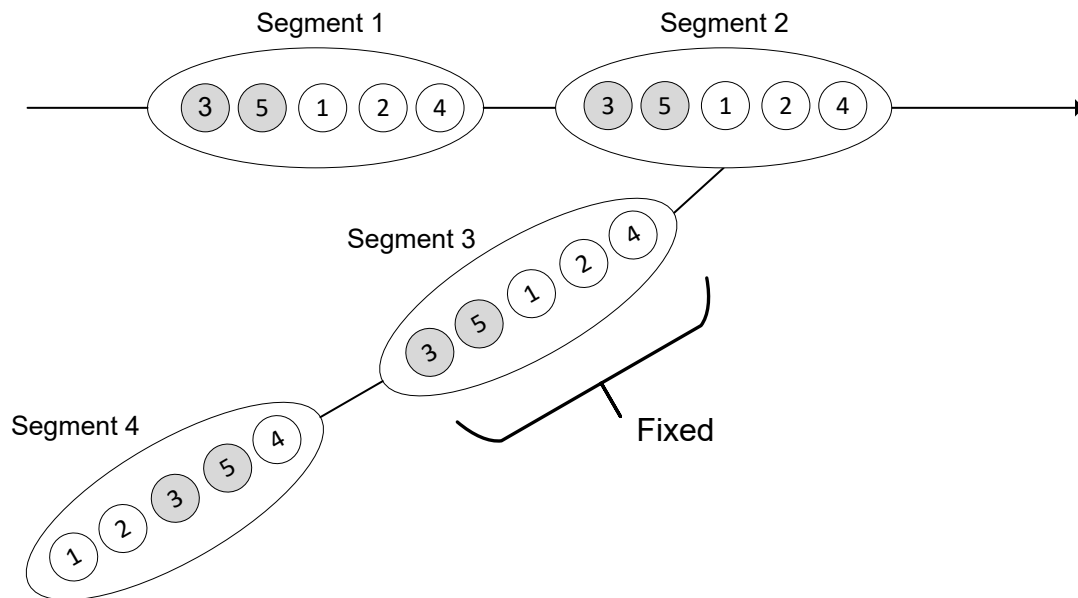


An initial line mix is generated by Assembly Planning. Remix assembly orders consider assembly orders with the status Planned and Sequenced, and use the existing assembly line mix as the starting point.

The remix process is important under these circumstances:

- When a backlog must be cleared.
- When an existing mix must be improved.
- Because offline dates of assembly orders have changed.
- Priority on assembly orders is altered.

A line sequence is generated based on the line mix. A line sequence specifies the order in which assembly orders must start on the corresponding line segments. For each line segment that is present in the assembly process, a line sequence must be generated. The line sequence algorithm takes the assembly order with the status Planned and Sequenced within a specific production period as input. On the last line segment of a supplying line, a line sequence is fixed. The line sequence of the connected line segment on the parent line determines the line sequence of the last line segment on the supplying line.



After sequencing, you can manually reschedule the assembly orders per line segment. Two types of rescheduling are possible:

- Move assembly orders

Initial	1	2	3	4	5
New	2	3	4	1	5

- Swap assembly orders (1 and 4)

Initial	1	2	3	4	5
New	4	2	3	1	5

View Assembly BOM and Operations

Restrictions

If the **External Assembly Parts and Operations** check box in the **Assembly Planning Parameters (tiapl0500m000)** session is selected, the *flattened* parts and operations are delivered from an external source. As a result, you cannot change the data in the current session, except when you work in **Test Mode**. If that

check box is cleared, the assembly parts and operations are flattened during the calculation of the assembly part requirements.

You can modify data in this session only if your current *company* is defined as *master company*.

Procedure

After you change the data in this session, you must run the following sessions:

- Calculate Assembly Part Requirements (tiapl2221m000) or **Calculate Assembly Part Requirements (Multiple Bshells) (tiapl2222m000)**
- Refresh and Freeze Assembly Orders (tiapl3203m000) or **Refresh and Freeze Assembly Orders (Multiple Bshells) (tiapl3204m000)**

Operations independent from assembly parts

To define operations which are not linked to a specific assembly part, leave the **Assembly Part** field empty. LN takes these operations into account when it creates *line-station variants*.

Delete Assembly Orders

You can delete the *assembly orders* for which the work has not started yet. The assembly orders that you want to delete must not be frozen which implies that none of the related *line station orders* are frozen.

You can delete the assembly orders from the following sessions:

- **Assembly Line - Line Mix (tiasc2501m000):** *appropriate* > **Delete Assembly Orders**
- **Assembly Orders (tiasc2502m000):** *appropriate* > **Delete Assembly Orders**

Important:

Deletion of assembly orders - Required conditions

The assembly order must be in the **Created** or **Sequenced** status and

- None of its related line station orders are frozen.
- No supply messages for assembly parts are already generated and transferred to Warehousing or Order Management.

Assembly order deletion-Important Points

- The deletion of an assembly order can only be initiated from the *main assembly line* also known as the *roll-off line*. In case of a *multicompany* assembly model, when you delete the assembly order on the main line, the related assembly orders on the *supplying assembly lines* are also deleted provided all related assembly orders on the supplying lines fulfill the conditions specified above. If one of the linked assembly orders on supplying lines cannot be deleted, the assembly order on the main line cannot be deleted either.
- The deletion of an assembly order is not allowed if the assembly order or one of its linked supplying assembly order is blocked. A message is displayed to inform the user about the order that has a blocking reason that must be resolved first before the assembly order can be deleted.

- The deletion of an assembly order means that the assembly order including its contents (operations, material requirements and so on) is deleted from the system. The assembly part requirements (part allocation) are updated accordingly.
- The deletion of an assembly order results in its removal from the line mix and line segment sequence. This means that the position of the deleted assembly order is made available again for line mixing and sequencing.
You must (re)generate line mix and/or use sequencing engine to also reflect the changes in the line mix and line segment sequence.
- The deletion of an assembly order results in the update of line utilization to reflect the new line utilization.
- The deletion of an assembly order that has the **Sequenced** status results in the item serial inventory being set to 0 as the item on an assembly order is always serialized.

Selling multiples of product variants for assembly

For *assembly items*, two types of sales order lines exist. Depending on the type of end item, Assembly Planning must be configured differently for both types of sales order lines.

Depending on the setting of the Sell Multiples of Same Configuration check box in the **Assembly Planning Parameters (tiapl0100s000)** session you either:

- **Sell single**
If this check box is cleared, the order quantity on the sales order line has a fixed value of one. To sell multiple end items, you must create multiple sales order lines.
- **Sell multiples**
If this check box is selected, the order quantity on the sales order line is one or more.

The following table displays the differences:

Sell single	Sell multiples
The Sell Multiples of Same Configuration check box in the Assembly Planning Parameters (tiapl0100s000) session is cleared.	The Sell Multiples of Same Configuration check box in the Assembly Planning Parameters (tiapl0100s000) session is selected.
The sales order line has a fixed quantity of one. You maintain sales order lines in the Sales Order Lines (tdsls4101m000) session.	The sales order line has a quantity of one or more. Specified quantities must be whole numbers.
The end item has <i>item type</i> Generic, Manufactured or Product .	The item must be storable in inventory and have <i>item type</i> Manufactured, or Product . To store items with this item type, they must be linked to items of the type Generic in the Configurable Item - Assembly Line (tiapl2500m000) session. To keep track of information on the link between sales order, product variant and assembly line, use <i>demand pegging</i> .

Sell single	Sell multiples
Each sales order line corresponds with one <i>assembly order</i> .	Each sales order line corresponds with one or more <i>assembly orders</i> . All assembly orders have an order quantity of one.
The item's <i>serial number</i> is used to determine which completed item is delivered to the customer.	The item's <i>specification</i> is used to determine which completed item is delivered to the customer.
The Assembly Status field of the Product Variants (Assembly) (tiapl3500m000) session displays the progress of the assembly order for the product variant of the sales order line.	The Assembly Status field of the Product Variants (Assembly) (tiapl3500m000) session always has value Open .
The <i>requested offline date</i> and <i>planned offline date</i> for the associated assembly order are displayed in the Product Variants (Assembly) (tiapl3500m000) session.	No <i>requested offline date</i> or <i>planned offline date</i> can be displayed for the assembly order, the product variant may be in use on multiple assembly orders at once.
The product variant's <i>reference type</i> is Sales Order .	The product variant's <i>reference type</i> is Standard Variant .
You can view demand related date in the Assembly Orders (tiasc2502m000) session for the assembly orders with the Demand Order Type Sales Order .	Assembly orders for multiples do not have demand order information.

Note:

- Selecting Sell Multiples of Same Configuration check box does not affect product variants already in use.
- You can configure product variants that contain purchased configurable items. Usually these items are configurable subassemblies that are part of the item structure and issued at the assembly link similarly to other assembly parts.

Chapter 7: Assembly line configuration

Assembly control overview

The Assembly Control module in LN is used to control processes in the job shop when producing *FAS items*.

Assembly Lines

Assembly lines consist of a set of consecutive line stations. The items are manufactured by passing them from line station to line station and by carrying out operations at each line station. An assembly line is subdivided into a number of line segments separated by buffers. You must define this structure in the Assembly Control module. An assembly line can be either a main line or a supplying line.

Assembly Orders

Assembly orders can either be generated from sales orders (demand), or by your configurator. They pass through a series of statuses, in an analogous manner to JSC production orders. Before you can carry out the order, assembly parts are allocated to the shop-floor warehouses of the line stations. When you have completed the order you can backflush the materials and hours.

Line-Station Variants

When an assembly order is transferred to the Assembly Control module, *line-station orders*, *line-station variants* (LSVs) and *exchangeable configurations* are generated. LSVs are used to reduce data, by combining all the operations and materials with the same specifications for a particular line station.

Line Sequencing

The orders that come from your configurator have an initial sequence (that is, the order in which they are processed on the assembly line). In Assembly Control you use a set of rules to place these orders and the demand orders in a final sequence. The rules include priority (for example, sold orders have a higher priority than stock orders) and operational considerations (for example, place orders with the same paint color next to each other, to avoid time wasted in changing paint nozzles).

Assembly line costing

There are a number of important differences in the financial calculations carried out for assembly orders compared with JSC production orders. For example, results are not split into *price variances* and *efficiency variances* and there is no calculation of end-item unit costs.

Assembly line station utilization

The utilization of an assembly line is the ratio of the actual number of orders for that line divided by the maximum number of orders for that line. You can display the utilization in the **Assembly Line - Line Utilization (tiasl3500m000)** session. If you have changed your order data, you must run the **Rebuild Line Utilization (tiasl3200m000)** session before you can see the utilization.

You can read further details about the number of orders planned for a line in the Assembly orders online manual topic.

The maximum number of orders for a line (for an option combination) is determined by:

- The line mix rules (see the Line sequencing and rule types in Assembly Control online manual topic).
- The assembly assignment of a line.

The assembly assignment is made up of the following factors:

- The *cycle time* for each period (non-average) or for the whole day (average).
- Man and machine resources for each line station.
- The time that the line station requires to process one assembly order. This time is expressed as a number of cycles. For instance, if the cycle time is two minutes, ten minutes is expressed as five cycles.

You define assembly assignments in the **Assembly Line - Assignments (tiasc5510m000)** session and link them to a particular line station in the **Assembly Line - Assignments and Line Stations (tiasc5520m000)** session.

When you have manually rescheduled orders, the utilization of the assembly line is altered.

You can use the **Utilization by Critical Option Combination (tiasl3510m000)** session to view the number of planned orders and the maximum number of orders on an assembly line for a given date, for option combinations that are used for line mix rules (that is, critical option combinations). You can also view this data as a graph with the **Assembly Line - Line Utilization - Chart (tiasl3700m000)** session.

Line station variants and line station orders

Using the similarity of order data per line station line station variants reduce the data storage and improve performance in the execution system. When the order content on a specific line station is the same for multiple orders, that content is only stored once. This similar information is stored in a line station variant. The assembly orders only have a link to Line Station Variants.

Example

You are making cars with many different features, including two types of wheels (broad and narrow). For the line station where the wheels are fitted, all cars with broad wheels are one line station variant, all cars with narrow wheels are another LSV, no matter what other specifications they have, because the other specifications are not relevant to the wheel line station.

An LSV can be shared by a number of assembly orders. That means that operations and material usage on that line station is the same of all of those assembly orders.

Purpose

An LSV is a device to reduce unnecessary data, and so enhance performance. If you have one thousand orders for products, and the operations and materials at the first line station of the line are all identical, there is no point in storing identical information one thousand times. LN determines that the orders are all identical, and makes one LSV. When a new assembly order is generated, LN check the materials and operations for the order. If these are the different from exisiting LSVs, a new LSV is created.

Sessions

You can display LSVs in the Line Station Variants (tiasc2520m000) session and print them in the Print Line Station Variants (tiasc2420m000) session. You can display and update the materials linked to LSVs in the Line Station Variant - Assembly Parts (tiasc2121m000) session, and display and update the operations in the Line Station Variant - Operations (tiasc2122m000) session (if the LSVs are order specific).

Order-specific LSVs

LSVs are automatically generated by LN. If you want to alter the operations or components of an LSV, you must make the LSV order specific, by carrying out the following procedure:

- 1 In the Assembly Order - Line Station Orders (tiasc2510m000) session, select the LSV. The *line station order* must be **Frozen**.
- 2 On the *appropriate* menu, click **Make Order Specific**. LN makes a unique line station variant, which you can see in the **Assembly Order - Line Station Orders (tiasc2510m000)** session.
- 3 On the *appropriate* menu, click **Line Station Variants**.
- 4 The **Line Station Variants (tiasc2520m000)** session starts.
- 5 Select the LSV.
- 6 On the *appropriate* menu, click **Operations**.
- 7 The **Line Station Variant - Operations (tiasc2122m000)** session starts. Modify the operations as required.
- 8 You can modify the assembly parts linked to the operations from the *appropriate* menu of the **Line Station Variant - Operations (tiasc2122m000)** session.

Line station order

When assembly orders are generated, line station orders are also created. A *line station order* is a production order for an assembly line station.

A line station order can have the following status:

- **Planned**
- **Frozen**
- **Ready to Start**
- **Completed**
- **Closed**

When line station orders are generated, the status is set to **Planned**.

Clustered line station order

Represents all the material requirements for a line station for a day. A CLSO consists of user-defined buckets. The material requirements are combined for each bucket.

In Assembly Control, transactions can be carried out per line station and per period, instead of per order. LN can combine the same materials for a specific period into one material line. After doing so, the cumulated quantity is stored in the CLSO. This accumulation reduces the number of transactions that are necessary, because the transactions are performed for a specific bucket.

CLSOs are used in assembly part allocation and in backflushing to combine materials for a line-station order (for a day).

ParametersThe **Transaction Processing** parameter determines the use of CLSOs. This parameter is defined in the Assembly Control Parameters (tiasc0100m000) session, and can have the following values:

- **Line Station Based** Only one CLSO is created for each line station each day.
- **Order Based** One CLSO is created for each assembly order.

CLSOs are used in assembly part allocation and in backflushing to combine materials for a line station order. A CLSO covers an entire day, in line-station based transaction processing, or an assembly order, in order-based transaction processing. The data for each time bucket is kept separate. In line-station based transaction processing, each time bucket results in a separated warehousing order line for the assembly part allocation. In order-based transaction processing, an individual warehouse order is generated for each CLSO.

Through the *appropriate* menu you can perform the following actions:

- Change the status of a CLSO from **closed** to **Open**.
- Start the Clustered Line Station Order - Assembly Part Requirements (tiasc7140m000) session to view the assembly part requirements for each CLSO.

Bucket Definition

Allocation and *backflushing* are done per line station per bucket when you use **Line Station Based Transaction Processing**, which means that all the line station orders in one bucket are combined. This reduces the number of transaction, compared with **Order Based** transaction processing. The performance is further enhanced if you use larger buckets, because this reduces the number of transactions.

After you define the buckets, you must run **Generate Buckets**, which is available from the *appropriate* menu, to generate the buckets for the full allocation time fence in Assembly Control . The buckets for the period length must be the same as for the **Allocation Horizon**, which is defined in the **Assembly Control Parameters (tiasc0100m000)** session, because allocation is done within the allocation time fence.

It is best to define a whole number of buckets per day. If not, your buckets will be of different lengths. For example, if you enter 10 hours into this field, LN will generate two buckets each of ten hours and one bucket of four hours (for one day of 24 hours). If you make many changes to assembly orders you should make your buckets smaller than if you make few changes.

Example

In the current session you enter the following:

Period	No. days	Bucket length	Unit
1	1	4	hour
2	1	8	hour
3	1	12	hour

In the **Allocation Horizon** field of the **Assembly Control Parameters (tiasc0100m000)** session you can enter, for example, 5 days.

When you select the **Generate Buckets** option, the following buckets are generated:

Bucket	Day number	Start	End
1	1	00:00	04:00
2	1	04:00	08:00
3	1	08:00	12:00
4	1	12:00	16:00
5	1	16:00	20:00
6	1	20:00	24:00
7	2	00:00	08:00
8	2	08:00	16:00
9	2	16:00	24:00
10	3	00:00	12:00
11	3	12:00	24:00
12	4	00:00	12:00
13	4	12:00	24:00
14	5	00:00	12:00
15	5	12:00	24:00

The final two lines were created because the allocation time fence was filled.

Note: You can view the buckets you have defined with the **Buckets (tiasl1501m000)** session. You can print out the data you have entered in this session, by selecting **Print Bucket Definition** from the **File** menu.

Clustering Line Station Order - Assembly Part Requirements

Parameters

The **Transaction Processing** parameter determines the use of CLSOs. This parameter is defined in the Assembly Control Parameters (tiasc0100m000) session, and can have the following values:

- **Line Station Based** Only one CLSO is created for each line station each day.
- **Order Based** One CLSO is created for each assembly order.

So, in **Line Station Based** transaction processing mode, a CLSO is used for an entire day. However, the data for each *bucket* are kept separate, and each bucket gives rise to a separate *warehousing order* line, for planned stock transactions for the assembly part allocation in Warehousing. You can see that data in the current session.

You can see the CLSOs in the Clustered Line Station Orders (tiasc7530m000) session. You can define buckets in the Bucket Definition (tiasl1100m000) session.

Note: In this session, you see only the assembly parts that have not yet been backflushed.

Assembly Line Material Supply

Different supply methods are available for the supply of *shop floor warehouse* which are related to one or multiple line stations on the assembly line.

The internal and/or external supply methods are as follows:

- Supplier
- Internal warehouse
- Production

The material supply methods are as follows:

- Push

The shop floor warehouse is supplied based on planning information.
- Pull

The shop floor warehouse is supplied based on a supply trigger.

 - KANBAN

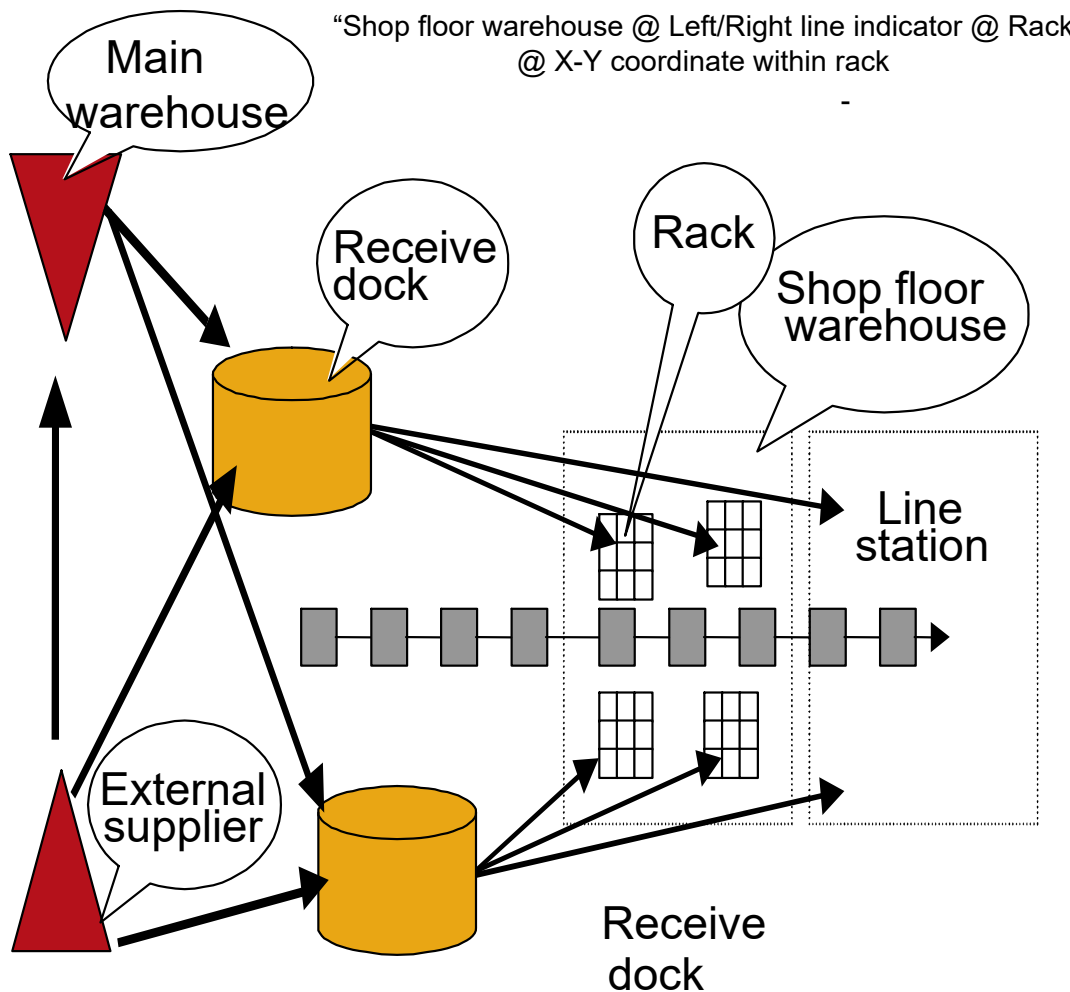
The supply is based on a manual trigger, such as the scan of a bar code. This method is mostly used for floor stock items for which no registration at shop floor warehouse is required.
 - TPOP

The supply is triggered by a SIC run for the shop floor warehouse concerned.
 - Order Controlled / Batch (OCB)

The supply is completed anonymously for multiple assembly orders together, based on triggers in the assembly process.

- Order Controlled / SILS (Supply In Line Sequence)

The supply is completed for every assembly order separately, based on triggers in the assembly process. The parts are delivered Just-in-time in the sequence that products are passing along the assembly line.



Linking generic items to assembly lines

Use this session to define which *generic item* can be produced on which assembly lines. LN requires this information to determine the master company of the generic item. Several processes can run only in the master company. For example, if you enter a sales order, LN creates a product variant in the master company. In the **Configurable Item - Assembly Line (tiapl2100s000)** details session, you can specify a basic sales price and standard cost.

Assembled items through warehousing after roll-off from main line

Store finished generic items - setup

This topic describes how to set up the items to be able to store the finished end product of an *assembly order* in inventory.

To store a finished generic item in inventory, you must define two items: a generic item and a standard item.

Both items represent the same physical item. In Assembly Control, you use the generic item. In Sales Control and Warehousing, you use the associated standard item.

To specify which standard item is associated with the generic item, use the **Configurable Item - Assembly Line (tiapl2500m000)** session.

Item settings

For the generic item and the standard item, use the following item settings:

Session	Field	Generic item	Standard item
Items (tcibd0501m000)	Item Type	Generic	Manufactured Or Product
Items (tcibd0501m000)	Serialized	Yes	Yes
Items (tcibd0501m000)	Revision Controlled	(Not used)	No
Items (tcibd0501m000)	Order System	FAS	FAS
Item - Warehousing (whwmd4500m000)	Serials in Inventory	(Not applicable)	Yes
Item - Warehousing (whwmd4500m000)	Lots in Inventory	(Not applicable)	(See below)

The Serials in Inventory check box must be selected because Warehousing would otherwise not be able to distinguish between *product variants*.

Additional instructions

- The generic item and the standard item must have the same *inventory unit*.
- If you use unit effectivity, you must define both items as *unit effective items* in the **Items (tcibd0501m000)** session.
- If the standard item is *lot controlled*, you must use the lot-in-inventory type of lot control.
To make an item lot controlled, select the Lot Controlled check box in the **Items (tcibd0501m000)** session.
To use the lot-in-inventory type of lot control, select the Lots in Inventory check box in the **Item - Warehousing (whwmd4500m000)** session.

Standard cost calculation of the standard item

The standard item must have an effective *cost component* structure. The standard inventory valuation functionality for items in inventory requires such a cost component structure.

To specify the *inventory valuation method*, in the **Item Data by Warehouse (whwmd2510m000)** session, select a value in the Inventory Valuation Method field.

To obtain the most accurate inventory valuation, select an inventory valuation method based on actual costing. The recommended inventory valuation method is **Serial Price (Serial)**.

If the inventory valuation method is **Standard Cost**, which is not an actual costing method, you must calculate a *standard cost* in the Standard Cost Calculation module. In this case, LN values the item against the calculated *fixed transfer price (FTP)* of the standard item and ignores differences between the product variants.

Storing finished generic items

Introduction

In LN, an item of type *generic* cannot be stored in inventory. To store a finished generic item in inventory, you must associate the generic item with a standard item. The *item type* of the standard item is **Manufactured** or **Product**.

Both items represent the same physical item. In Assembly Control, you use the generic item. In Sales Control and Warehousing, you use the associated standard item.

You can use this setup to carry out post-assembly operations in regular work centers after an item leaves the *assembly line*.

Note: If you send the item to the customer immediately upon completion of the assembly order, you only need the generic item.

Setup

The items must have the following properties:

- The *order system* of the generic item and the standard item must be *FAS*.
- Both items must be *serialized items*.
- If you use unit effectivity, both items must be *unit effective items*.

To specify which standard item is associated with the generic item, use the **Configurable Item - Assembly Line (tiapl2500m000)** session.

Restrictions

If a manufactured item is associated with a generic item, you cannot do the following with that item:

- Use the item in Purchase Control
- Create a *bill of material (BOM)* for the item, or use the item as a component in another BOM
- Create a production order for the item, other than a *rework order*
- Plan the item in Enterprise Planning, because the item's order system is **FAS**

You cannot return an *FAS item* to the assembly line for rework.

Note: You can create routings for post-assembly operations of the standard manufactured **FAS** item.

Procedure

Sales order entry

To define a *sales order line* for a generic item that must be stored in inventory after completion, enter the associated standard item on the sales order line.

Based on the standard item that you entered, LN retrieves the generic item that is linked to this standard item in the **Configurable Item - Assembly Line (tiapl2500m000)** session.

LN sets the Delivery Type field on the sales order line to **Warehouse**.

You must define the *generic item's product variant* in one of the following ways:

- Configure the generic item in Product Configuration or in Assembly Planning, as determined in the Configurator check box in the **Assembly Planning Parameters (tiapl0100s000)** session.
- Select a previously configured product variant.
- Use an external tool/system to deliver the configured product variant to LN.

Note: If a generic item has an associated standard item, you can still enter the generic item on a sales order line. If you enter the generic item on a sales order line, LN sets the Delivery Type field on the sales order line to **Work Center** and you cannot store the finished item in inventory.

Assembly order handling

If a sales order line has an item with the order system **FAS**, LN creates an *assembly order* in the Assembly Control module by running the **Generate Assembly Orders (tiapl3201m000)** session. The item on the assembly order is the *generic item*.

When the assembly order is *sequenced*, LN generates the end item's *serial number*.

When the assembly order's final operation is completed, LN completes the following actions:

- 1 LN generates a *warehousing order* to receive the finished item in inventory. The item on the warehousing order is the standard item.

The assembly order status becomes **Production Completed**.

- 2 LN sets the Ownership field on the *inbound-order line* to **Company Owned**.
- 3 After the item is received in inventory, and any required inbound *inspection* has been performed, the assembly order gets the status **Completed**.

If the item is rejected or destroyed after inspection, the relevant product variant obtains the status **Canceled**. If a product variant obtained the status **Canceled**, to continue processing the assembly order, manually cancel the sales order and create a sales order by using another product variant.

The product variant is **Canceled** only when the following conditions are met:

- The **Sell Multiples of Same Configuration** check box is selected.
- A manufactured **FAS** item is listed on the sales order line.

LN links the *as-built structure* to the standard item instead of to the generic item.

Note: Before you can release the sales order line to Warehousing, a sales order line for a standard **FAS** item must have a *serial number*.

Post-assembly operations

To perform additional operations on an item after the item comes off the *assembly line*, create a *rework order*.

Delivering to customers directly from the assembly line

Delivering to customers directly from the assembly line process is based on generic assembly items. For sales order processing, the **Delivery Type** field on the sales order is **Work Center**. A warehouse order is created and will be delivered from the work center to the customer.

For more information, refer to Product variants in Warehousing

Offsetting Line Station Orders

An assembly order consists of several LSOs. These LSOs are linked to line stations that are grouped in line segments. These orders and segments all have their own start times and end times. These times are calculated on the following occasions:

- An assembly order is offset when you plan the order, that is, when LAC creates the assembly order in ASC.
- A line segment is offset when you confirm a line sequence in the Simulate and Create Line Sequences (tiasl4200m000) session.
- An LSO is offset in two instances:
 - When you plan the assembly order.
 - When you run the current session. This last instance is, of course, what we focus on now.

If you offset LSOs in the current session, the calculation depends on the status of the assembly orders. These statuses are:

- **Created**. If you only planned an assembly order, and you did not yet confirm a line sequence, the assembly order has the **Created** status.
- **Sequenced**. After you confirm a line sequence, the assembly order has the **Sequenced** status.

According to these statuses, offsetting is based on the following information:

- For **Created** assembly orders, the calculation is based on the lead-time of the line segments, as defined in the Line Segments (tiasl1540m000) session.
- For **Sequenced** assembly orders, the calculation is based on the sequence, assembly line calendar, and the assembly assignments of the assembly line.

The previous information implies that the start times and end times of LSOs can vary, according to the offset method that is used. Therefore, an LSO can have start times and end times on one of the following three levels:

- If the LSOs of a **Created** assembly order are not yet offset in the current session, they have the start times and end times of the assembly order. Of course these values are initial values that cannot be calculated in the current session.
- If you offset LSOs for assembly orders with the **Created** status, these LSOs get the same start times and end times as the line segments. This is because the start times and end times of the LSOs are calculated, based on the lead-times of the line segments.

- If you offset LSOs for assembly orders with the **Sequenced** status, these LSOs receive the start times and end times of the line stations.

To offset LSOs in the current session, you must specify a range, an **Offline Date To**, and the order type for which the LSOs must be offset. However, not all assembly orders that match these criteria are offset, but only those assembly orders that require offsetting. Assembly orders that require offsetting have the Offsetting Required check box selected. This check box is displayed in the following sessions:

- For **Created** orders, in the Assembly Order (tiasc2100s000) session, on the General tab. If the **Assembly Order Status** is not **Created**, the **Offsetting Required** check box is not displayed.
- For **Sequenced** orders, in the **Line Segment - Line Sequence (tiasl4500m000)** session.

Offsetting is required as soon as a change in the dates or times of an order occurs, or, in other words, as soon as the actual dates and times no longer match the planned dates and times. The Offsetting Required check box, therefore, is selected in the following instances:

- When LAC generates the assembly order in ASC.
- If you mix or manually move planned orders and, as a result, these orders receive another offline date/time.
- If you offset the LSOs of a parent order and as a result, this order receives another offline date/time, the check box is selected for the child orders; because the child orders must be synchronized with the parent order. Note that offsetting the LSOs of a parent order does not result in new start times and end times for the LSOs of the child orders. The LSOs of the child orders must be offset themselves too.
- If you confirm a line sequence, in the Simulate and Create Line Sequences (tiasl4200m000) session, or manually change a confirmed line sequence, the line segments receive new start times and end times. As a result, offsetting is required for the LSOs. If the order has child orders, the check box is selected for the child orders too; because the child orders must be synchronized with the parent order.

Note that in all these instances, it is necessary to offset the LSOs of the orders in question, using the current session. The error messages for offsetting can be viewed in the Assembly Messages (tiasc0501m000) session.

Assembly kits

An assembly kit is an order-dependent set of items that must be supplied together to the shop-floor warehouse.

You can define assembly kits in the **Assembly Kit (whwmd4550m000)** session. To specify which items are part of an assembly kit, you must link the assembly kit to a warehouse and item combination in the **Item Data by Warehouse (whwmd2110s000)** session. You can only make use of assembly kits if the supply method for the warehouse and item combination is *order-controlled/SILS*.

The items that are supplied to the shop-floor warehouse by means of an assembly kit can differ per order, however it is the same assembly kit.

Assembly Control can trigger a *call-off* of items for a specific item. If the called-off items are part of the same assembly kit, Warehousing must deliver the items together to the shop-floor warehouse.

To view the sequence in which the items must be delivered to the shop-floor warehouse, use the **Shipping Sequence (whinh4520m000)** session.

To view assembly kits call-offs and quantities, use the Assembly Part Supply Transfer (SILS) (tiasc8520m000) session.

Example

Cars are manufactured with an option to fit a radio. If the assembly line requires the radio's components, they are delivered in the form of an assembly kit, called Radio. However, different radio sets can be ordered for the cars. These radio sets can all belong to the assembly kit Radio. For example, the assembly kit Radio contains the following items:

- Three types of radios: Radio 1, Radio 2, and Radio 3
- Three types of frames: Frame 1, Frame 2, and Frame 3
- Two types of aerials: Aerial 1 and Aerial 2
- Four types of speakers: Speaker 20W, Speaker 30W, Speaker 40W, Speaker 50W
- Cables

For item Car100, the following items that are part of assembly kit Radio, are called off by call-off 100:

- Radio 2
- Frame 2
- Aerial 1
- 2 Speaker 20W
- 2 Speaker 40W
- Cables

These items are delivered to the shop-floor warehouse together as assembly kit Radio for parent serialized item Car100 and call-off 100.

For item Car101, the following items that are part of the assembly kit Radio, are called off by call-off 101:

- Radio 3
- Frame 3
- Aerial 2
- 2 Speaker 30W
- Cables

These items are delivered to the shop-floor warehouse together as assembly kit Radio for parent serialized item Car101 and call-off 101.

Chapter 8: Material issue

Overview of material issue

The entering of issues as part of the order procedure for production orders is required to issue the necessary materials from the warehouse to the job shop. Issuing can be done manually or by the system while the estimate is being built up.

When backflushing applies, issuing of inventory is automatically carried out.

Note: If *multisite* is activated, material issue is performed for a item linked to a specific *planning cluster*.

- **Backflushing**
The automatic issue of materials from inventory, or accounting for the hours spent manufacturing an item, based on theoretical usage and the quantity of the item reported as complete. For more information, refer to Backflushing.
- **Floor stock**
A stock of inexpensive material present on the job shop that can be used in production without recording each issue of material individually. *Floor stock* is not backflushed and is not part of the estimated costs. To account for floor stock materials, a surcharge is added to the standard cost of an end item. A Kanban triggers the supply of floor-stock items to the job shop. You can create a warehousing order of type **JSC Production** in which you determine from which warehouse and to what work center the material must be shipped.
- **Controlled material issue**
Material is issued from the warehouse to the job shop in a user-defined way. You can choose to take tight control over the issue process, or you can choose to control the issue process more loosely. In general, the issue of material goes through the following stages:
 - **Allocate material in the warehouse**
A planned production order results in planned inventory transactions. These transactions are used for planning purposes by the MRP planning engine. As soon as a production order is released, *warehouse orders* are created, which means that the material in the warehouse is *allocated* for the production order.
All materials specified in the bill of material (BOM) are *allocated* in the warehouses, which is reflected in the **Estimated Materials (ticst0101m000)** session.
If you use *job shop warehouses*, you can determine the moment that the material is allocated in the job shop warehouse.
 - **Specify quantity to be issued**
You must specify the material quantity that you want to issue. Depending on the setting of the **Manual Issuing** check box in the **Production Order Parameters (tisfc0100s000)** session, LN automatically

specifies the planned quantity, or you can manually specify the material quantity. Note that the material quantity is still blocked in the warehouse.

- **Release material**
If you release the material in the warehouse, the material becomes unblocked, which is a signal for the warehouse employees to start the warehouse outbound procedure.
- **Carry out the warehousing procedure**
A user-defined warehouse outbound procedure is carried out.
- **Receive material**
The desired material quantity is received on the job shop.

To handle material from the warehouse to the job shop, and from the job shop to the warehouse, you can use the Material to Issue for Production Orders (ticst0101m100) session.

To handle material in a more detailed way, you must use the Production Warehouse Orders (timfc0101m000) session. Particularly in case of serialized items or lot-controlled items, it is recommended that you use this session. All actions on material are laid out in so-called production warehouse orders, which you can view in the **Production Warehouse Orders (timfc0101m000)** session.

Material issue parameters

The following fields and parameters influence the way LN issues materials:

- **Floor Stock**
Determines whether the material is *floor stock*. The Floor Stock check box is located in the Item - Warehousing (whwmd4600m000) session.
- **Materials**
Determines that LN issues material through *backflushing*. You can find this parameter in the **Item - Production (tiipd0101m000)** session. For more information refer to Setting up backflushing.
- **Manual Issuing**
Determines whether you need to manually specify the material quantity that must be issued. For more information, refer to Material issue setup.
- **Direct Initiate Inventory Issue**
Determines whether material is automatically unblocked in the warehouse after the production order is released. For more information, refer to Releasing material.
- **Direct Process Warehouse Order Line**
Determines whether the warehouse procedure is carried out automatically when you issue material. For more information, refer to Automatic processing warehouse order lines.

Link materials to operations

Linking an operation to a material allows for:

- Phased issue of materials.
- Use of *job shop warehouses*.
- Application of operation *scrap* and *yield*.

- Phased issue of materials

Linking operations to materials reduces stockpiling of raw materials and intermediates, as it allows to determine accurate delivery dates. For instance, the Order Planning module in Enterprise Planning uses the operation by material to determine the delivery time concerning planned purchase and production.

- If a material is not linked to an operation, LN will assume that the material is needed at the start of the first operation.
- If a production order has no operations, LN will assume that the material is needed at the start of the production.

- Use of job shop warehouses

By linking an operation to a material, LN determines from which *job shop warehouse* the material is to be issued. A work center is linked to an operation, and a job shop warehouse is linked to a work center.

- Application of operation scrap and yield

The calculation of the estimated quantity of a material is affected by the scrap quantity and yield percentage of the operation where it is used. Materials must be linked to the operations where they are used in order to achieve an accurate estimate.

Linking materials to operations You can link materials to operations in two ways:

- In the BOM

In the **Bill of Material (tibom1110m000)** session, enter the operation in the **Operation** field.

- In the **BOM Line - Material-Routing Relationships (tibom0140m000)** session

In the **BOM Line - Material-Routing Relationships (tibom0140m000)** session, specify the *routing code* and the operation.

Note:

- All warehouses and operations must be linked to the same site as the production order for which the materials are needed.
- An item can have several *routings* per *site*. In the *bill of material (BOM)*, you can enter one operation number, which then applies to all routings of an item.

Defining BOM Line - Material - Routing Relationships

For a manufactured item, you can define multiple routings. Every routing consists of a different series of operations. You can use the material-routing relationships defined in this session to determine for every routing on which operation a specific material must be present on the job shop.

In the **Bill of Material (tibom1110m000)** session, you must specify for a BOM line on which operation the material of the BOM line is issued to the job shop:

- If you enter zero (0) in the **Operation** field, the **BOM Line - Material-Routing Relationships (tibom0140m000)** session is used to determine on which operation the material is issued. If no material-routing relationship exists, the material is issued at the first operation.
- If you enter a value other than zero (0) in the **Operation** field, for example, 10, the material is issued at operation 10. This operation applies to all routings that are defined for the manufactured item. If the operation does not exist for the manufactured item's routing(s), the BOM line material is issued at the first operation of the routing.

Note:

- Material-routing relationship information is used in Enterprise Planning, the Standard Cost Calculation module, and job shop order generation.
- You can start this session from the **Bill of Material (tibom1110m000)** session. You can start the **BOM Line - Material-Routing Relationships (tibom0140s000)** session from a BOM line in the GBF browser for item engineering data. The GBF browser is invoked from the **Item Engineering Data (GBF) (tiipd0203m000)** session.

Material issue strategies

Methods

LN offers you various levels of control for the issue of materials. You can specify a different method for each material.

- Available methods to control the quantity of the issue:
 - Direct user control over the quantities to issue
 - Quantities determined by the *allocations*
- Available methods to control the time of the issue. LN issues the material:
 - After a user gives a command
 - At the allocation date
 - Immediately when the production order is released
- Special methods:
 - *Backflushing*
 - *Floor stock*

You can influence the issue process with parameters such as:

- Direct Process Warehouse Order Line
- Materials

The Manual Issuing check box in the **Production Order Parameters (tisfc0100s000)** session influences the issuing process of all materials. Materials are issued when you choose the Transfer Subseq. Delivery to Issue command in the **Material to Issue for Production Orders (ticst0101m100)** session.

If you apply *backflushing*, LN issues the material when you report a quantity of the end product as **Completed** or **Rejected**.

You can keep inexpensive materials present in the job shop as *floor stock*. Floor stock is not allocated to a warehouse and is not included in material costs. To account for floor stock materials, a *surcharge* is added to the *standard cost* of an end item. The supply of floor-stock items to the job shop is triggered by Kanban. A warehousing order of the **Production** type can be created in which you determine from which warehouse and to what work center the material must be shipped.

Material issue setup

In the **Production Order Parameters (tisfc0100s000)** session, you can use the Manual Issuing check box to specify whether you want to specify the material quantity that must be issued to the job shop floor manually or automatically.

If you select the **Manual Issuing** check box, you must use the Material to Issue for Production Orders (ticst0101m100) details session or the Production Warehouse Orders (timfc0101m000) session to specify manually the material quantity that you want to issue from the warehouse to the job shop.

The **Subsequent Delivery** field contains the planned quantity that is allocated. After the production order is released, you must specify the material quantity that you want to issue in the **To Issue** field in the Material to Issue for Production Orders (ticst0101m100) details session or the Estimated Materials (ticst0101m000) session.

The process to perform manual issuing consists of the following steps:

- 1 Release the production order. LN copies the estimated quantity to the **Subsequent Delivery** field.
- 2 Enter the quantity to issue in the **To Issue** field in the **Material to Issue for Production Orders (ticst0101m100)** details session. If you want to issue all materials for the order simultaneously, you must click Transfer Subseq. Delivery to Issue on the *appropriate* menu.

If you manually specify the material quantity, you are in full control of the issue process. You explicitly decide about the material quantity that is issued, which can be useful, for example, in case of expensive material.

Automatic issuing

If you clear the **Manual Issuing** check box while you release a production order, LN automatically fills the **To Issue** field with the planned material quantity. You no longer need to specify the material quantity manually in the **Material to Issue for Production Orders (ticst0101m100)** details session or the **Production Warehouse Orders (timfc0101m000)** session, which saves time. LN issues the entire estimated quantity as soon as the warehousing order line is unblocked.

However, if you want to issue a different material quantity, or you must deal with partial deliveries, you can manually overrule the material quantity. Enter the desired quantity in the **To Issue** field in the **Material to Issue for Production Orders (ticst0101m100)** details session.

Inventory shortage

If an item's inventory is insufficient, you cannot issue inventory unless the **Negative Inventory** check box is selected in the **Inventory Handling Parameters (whinh0100m000)** session. If a shortage arises, and the **Negative Inventory** check box is cleared, the issued quantity remains in the **To Issue by Warehousing** field, and a shortage report is printed. After the inventory is replenished, you must manually process the unblocked warehousing order.

Releasing material

Unblock or release material in the warehouse is part of the material issue procedure. If material is released, the warehouse employees are notified to start the warehouse outbound procedure.

To specify whether the material must be released manually or automatically:

- Direct Initiate Inventory Issue selected
LN automatically unblocks the warehouse order line for the material during production order release.
- Direct Initiate Inventory Issue cleared
You must release the material manually. To unblock the material's warehouse order line, you must either use the Initiate Inventory Issue (tisfc0207m000) session, or click Transfer Subseq. Delivery to Issue in the **Material to Issue for Production Orders (ticst0101m100)** session. LN now moves the material quantity from the **To Issue** field to the **To Issue by Warehousing** field.
- The activated warehousing order line:
 - Issues the requested quantity.
 - Increases the value in the **Actual Quantity** field by the issued quantity.
 - Subtracts the issued quantity from the **To Issue by Warehousing** field.

Set the **Direct Initiate Inventory Issue** check box You can set the **Direct Initiate Inventory Issue** check box on three levels to determine whether the material must be unblocked manually or automatically:

- In the Item - Production (tiipd0101m000) session, where you can set the default value for a specific item, or in the Item - Production Defaults (tiipd0102m000) session, where you can set the default value for a specific item group.
- In the Estimated Materials (ticst0101m000) session, where a production planner can determine whether the material must be unblocked manually or automatically.
- In the Material to Issue for Production Orders (ticst0101m100) session, where a person on the job shop can determine whether the material must be unblocked manually or automatically.

Initiate Inventory Issuing

The **Initiate Inventory Issue (tisfc0207m000)** session is used to manually issue materials from inventory. Enter a date in the **To Date/Time** field until which materials must be issued. Materials with an allocation date that is later than the date in the **To Date/Time** field, are not issued.

You do not have to manually issue materials if:

- The **Manual Issuing** check box in the **Production Order Parameters (tisfc0100s000)** session is cleared:
- The item is defined as floor stock
- The materials are backflushed

You can issue inventory if the production order status is one of the following:

- **Released**
- **Active**
- **Production Completed**
- **Completed**

Select a range of orders and specify the operations for which you want to issue materials from inventory. You can only do this if you have specified an operation for the material on the BOM line.

If you are using JSC order groups, you can issue inventory for all the production orders in an order group at once. Select the **Production Order Group** check box and enter the JSC order group.

Note: If the **Direct Process Warehouse Order Line** check box in the **Estimated Materials (ticst0101m000)** session is cleared, the inventory will not be issued automatically. Only the warehouse order line will become unblocked.

Process backflushed materials

LN backflushes the materials linked to the operations for which quantities are reported as completed. If a production order has no operations, LN backflushes all materials.

For details about the calculation of the quantities to issue through backflushing, see Calculate backflush quantity.

You can see the result of backflushing materials in the **Production Order (tisfc0101s000)** session.

LN subtracts the backflushed material quantity from the **Subsequent Delivery** field and adds the same quantity to the **To Issue** field. The corresponding warehousing order is immediately initiated.

Assembly backflushing

When a line station order is reported complete in the **Line Station - Assembly Orders (tiasl6510m000)** session or the **Report Line Station Order Complete Using Bar Code (tiasc2211m000)** session, the material requirements and hours budgeted for that order can be *backflushed*. You can backflush the materials and hours with the Backflush Requirements (tiasc7241m000) session.

The backflushing topics discussed here are:

- Floor stock
- Backflushing mode

- Quantity of parts backflushed
- Number of hours backflushed

Floor stock

Floor stock items such as nuts and bolts are not backflushed in assembly control. To define an item as floor stock, select the Floor Stock check box in the **Item - Warehousing (whwmd4600m000)** session.

Backflushing mode

Backflushing is carried out for each *clustered line-station order (CLSO)* (see the Clustered Line Station Orders (tiasc7530m000) session). The number of CLSOs produced each day, depends on the mode you select with the **Transaction Processing** parameter, which you define in the **Assembly Control Parameters (tiasc0100m000)** session. For **Order Based** processing, each individual assembly order provides a CLSO for each line station, creating many CLSOs each day. For **Line Station Based** processing, there is only one CLSO each day, for each line station. All the hours and materials for all buckets, all line-station variants, and all line-station orders are clustered into one CLSO for each line station. This mode is for high-volume production environments.

Assembly parts

The parts required by the *line station variant* can be backflushed after the line station order is reported complete, with the Backflush Requirements (tiasc7241m000) session. The quantities required are calculated as described for the Build Assembly Part Allocation (tiasc7240m000) session. LN activates a *warehousing order* line which ensures the parts are delivered to the correct *shop floor warehouse*.

Floor stock items such as nuts and bolts are not backflushed in assembly control. To define an item as floor stock, select the Floor Stock check box in the **Item - Warehousing (whwmd4600m000)** session.

Man hours and machine hours

Man hours (also known as person hours) and machine hours are backflushed to People.

The number of hours backflushed is the sum of $CT \times MO$ (*Cycle Time* x Man Occupation or Machine Occupation) for each line station variant, summed for either the assembly line, if **Line Station Based**, or for the line station, if **Order Based**.

- If it is **Line Station Based**, the cycle time comes from the Assembly Line - Assignments (tiasc5510m000) session.
- If it is **Order Based**, the cycle time comes from the Line Station Variant - Operations (tiasc2122m000) details session. You define the occupation in the **Assembly Line - Assignments and Line Stations (tiasc5520m000)** session, if **Line Station Based**, and in the **Line Station Variant - Operations (tiasc2122m000)** session, if **Order Based**.

If hours are present, the hours transactions with the status Closed are posted to People and processed automatically. The hours are posted to the employee linked to the line station. You can view the hours with the Assembly Hours (bptmm1160m000) session. You can also enter additional hours with this session.

Note:

In the **Assembly Control Parameters (tiasc0100m000)** session, the **Transaction Processing** field determines how hours are booked:

- **Order Based**

Hours are booked for an individual assembly order. **Order Based** is used in low-volume environments.

- **Line Station Based**

The hours for line-station orders is added together, for each line station, to form one clustered line-station order (CLSO) for each day. **Line Station Based** is used in high-volume environments.

The values that are visible in the **Clustered Line Station Orders (tiasc7530m000)** session are used by Warehouse Management. When material backflushing is performed, the inventory for the assembly part is backflushed from Warehousing, and the Planned stock transactions in the Order - Planned Inventory Transactions (whinp1501m000) are reduced.

Chapter 9: Bills of Material

Production Bill of Material (PBOM)

Use the production bills of material (p-bom) models to model how the product is built, in multiple levels and sites.

This applies to:

- The way the product is produced
- The materials that are used
- The logistic handling
- The standard cost

The production bill of material differs from the E-BOM in structure, width and depth.

The structure of the P-BOM is based on the way the product is manufactured and you can add standard materials used across all sites.

Once a P-BOM is complete, a job shop bill of materials for a specific site is generated that will also contain the available machines and or subcontractors, sub-assemblies built or specific materials for the specified site along with a routing.

The production bill of material is revision controlled.

You can use the models to define *aggregation* relationships for planning purposes and a *bill of critical materials* for items that can cause bottlenecks in the production process.

From the Production Bill of Material (timfc3600m000) session, you can create production models for various types of manufacture:

- A job shop bill of material in the Generate Production and Job Shop Bills of Material (tibom3200m400) session.
- A production model for repetitive manufacture in the Generate Production Model (tirpt2230m000) session.
- A subcontracting model in the Generate Product Subcontracting Model (tisub1220m000) session.

The following online manual topics are available:

- Modeling the Shop Floor
- Operation rates
- Production Bill of Material (PBOM) Setup And Generation
- Job Shop Bill of Materials
- Job Shop Routing
- Alternative materials in JSBOMs

Note: If the *multisite* functionality is active, the combination of product and *site* specifies which *bill of material (BOM)* is used for the manufacture of the end item.

Production Bill of Material (PBOM) Setup And Generation

The global bill of material models the way the item is built, in multiple levels and in multiple sites, and contains all information that is intrinsic to the item.

P-boms are identified by the combination of an item code and the revision number of the p-bom.

The production bill of materials can be maintained manually or generated using the Engineering Data Management module.

To generate a new production bill of material:

- 1 Generate new revision

In the Production Bills of Material (timfc3100m000) session, use the **New Revision** command to generate a new production bill of material this will start the Production Bill of Material (timfc3600m000) session.

The generated production bill of material is generated with the status **New** and revision number 000001 in the **Revision** field.

- 2 Specify product

Click on the **Product** field in the **Production Bill of Material (timfc3600m000)** session to open the **Item - Production (tiipd0101m000)** session for which you want to define a new p-bom.

- 3 Assign revision

LN automatically assigns revision number 001 to a new p-bom.

- 4 Default the effective date

Unless otherwise specified the effective date is defaulted to the current date, with the expiry date set to 9999.

- 5 Add the production bill of material lines to the materials tab

Add the p-bom lines containing the materials.

Note: changes to the material lines can only be made as long as the p-bom status is **New**.

- 6 Validate p-bom

Use the **Validate Production Bill of Material (timfc3200m000)** session to check the new p-bom for consistency and generate a report.

- 7 Check production bill of material for consistency

Use the **Check Production Bill of Material Consistency (timfc3200m400)** session to check for loops in the p-bom structure, updates of the order system, unit effective supply and commingling restrictions, as well as project peg indicators and trade compliance.

- 8 Approve revision

In the **Job Shop Bills of Material (tibom3100m000)** session, select the p-bom revision and use the **Approve Revision** command to change the status from **New** to **Approved**.

Note: Only applicable if the **Job Shop by Site** parameter in the **Concept Activation (tcomm4600m000)** session is set to **Active Or In Preparation**.

New Production Bill of Material from a E-BOM

You can generate a production bill of material from an E-BOM:

- 1 Start the **Engineering Item (tiedm0110m000)** session.
- 2 Select the E-BOM you want to generate a production bill of material from.
- 3 Use the **Engineering Item Revisions** command to start the **Engineering Item Revision (tiedm1100m000)** session.
- 4 Select the revision you want to copy to a production bill of material.
- 5 Copy E-BOM header and lines to the production bill of material.
- 6 The new production bill of material is automatically assigned the status **New**, with the current date as the default effective date.

Changing an existing production bill of material

To make changes to an existing production bill of material:

- 1 Start the Production Bills of Material (timfc3100m000) session.
- 2 Select the production bill of material you want to edit.
- 3 Use the **New Revision** command to generate a new revision.
- 4 Use the Copy Production Bill of Material (timfc3200m100) session to copy the PBOM header data and material lines to the new revision.
- 5 The revision is automatically assigned the status **New**, with the current date as the default effective date.
- 6 Make the necessary changes to the production bill of material header and BOM lines.
- 7 Use the Validate Production Bill of Material (timfc3200m000) session to check the new p-bom for consistency and if the materials needed are present before the status is changed to **Approved**.
- 8 Once the new production bill of material is approved, LN adjusts the expiry date of the previous revision in accordance with the effective date of the new revision.

Job Shop Bill of Materials

With job shop bills of materials it is possible to plan and control production on all sites individually.

Prerequisite to generating a job shop BOM header:

- The site where manufacture will take place defined in the Sites (tcomm0150m000) session.
- The employees defined in the Employees - General (tccom0101m000) session.
- The units in which the quantities of product are measured in the Units (tcmcs0101m000) session.
- Products defined in the Items - Production by Site (tiipd0151m000) session.
- The production bill of material for the product defined in the Production Bills of Material (timfc3100m000) session.
- The *reference designators* in the Production Bill of Material Reference Designators (timfc3130m000) session.

To generate a job shop bill of materials

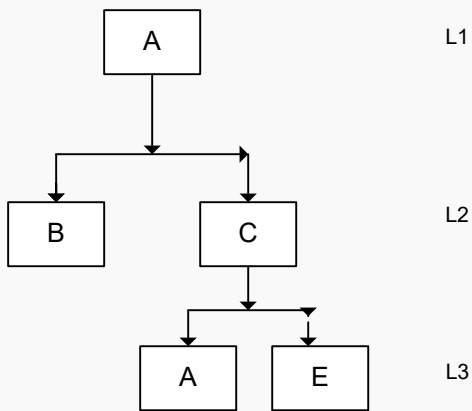
- 1** Start the Generate Job Shop Bill of Material (tibom3200m300) session.
- 2** Clicking on the **Product** field opens Production Bills of Material (timfc3100m000) session. In this session, you must select the PBOM from which the JSBOM will be generated.
Note: the PBOM must have the status **Approved** and be effective.
- 3** In the **Revision** field select the PBOM revision from which the JSBOM is generated.
Note: A PBOM may have several revisions. The new JSBOM will automatically be designated revision 000001 on generation. If changes are made after it receives the status **Approved**, the revision number will go up.
- 4** Specify the *site* where the product will be manufactured.
- 5** Specify the production model in the **Bill of Material** field, from the Job Shop Bills of Material (tibom3100m000) session. You can select a production model from the list of models available for the specified site. The production model contains the list of materials and routing for the job shop
If you want to create a new production model range, select the **Create New Bill of Material** check box. You can define a new number group in the First Free Numbers (tcmcs0150m000) session that will start when you click on the **Bill of Material** field.
- 6** If you select the **Initialize Logistic Data** check box, routing data will be copied from the previous JSBOM revision.
- 7** If you select the **Remove Manual Material Lines** check box, material lines manually added to the previous revision are deleted from the list of materials.
- 8** Use the **Generate** command.
- 9** The new Job Shop Bill of Material can be selected in the **Job Shop Bill of Material (tibom3600m000)** session.

Detecting Loops in Bill of Material

When you calculate cost prices and material requirements, LN checks multilevel bills of material for loops. You are therefore advised to run this session regularly, as it allows you to correct incorrect data at an early stage.

Example

Manufactured item A is made up of purchased part B and manufactured item C. Manufactured item C in turn consists of manufactured item A and purchased part E.



A	Wheel
B	Rim
C	Hub
E	Ball bearing
L1, L2, L3	Level 1, 2, 3

The loop is A-C-A

Chapter 10: Tools Requirements Planning

Tools Requirement Planning (TRP)

Use the Tools Requirement Planning module to control the *tools* that are required by *production orders* and *service orders*.

The Tools Requirement Planning module supports the following functions:

- Identification and marking
- Requirements planning
- Procurement (together with the Purchase Control module)
- Dispensing and scheduling
- Refurbishing
- Tracking and disposal
- Performance measurement

Tools are defined as *purchased items* with **tool** item type specification. These items can be purchased and stored in a warehouse like any other item.

Listing Tools Requirement Planning Parameters

To view the parameters, select the parameter settings and click Open on the File menu.

To change the parameters, select the first record without an effective date, and click Open on the File menu. The TRP Parameters (**Tool Planning Parameters (titrp0100s000)** details session starts with the current parameter settings. You can use the Tools Requirement Planning (TRP) parameter (titrp0100s000) details session to change and save the new parameters. LN sets the effective date of the new parameters to the current date and time.

You can also use the **Print Tools Requirement Planning Parameters (titrp0400m000)** session to print and compare the parameter settings.

Defining tools

To define a tool, perform the following steps:

1 Create a tool

Use the Items (tcibd0501m000) session to create a *tool*. You must define an item of the type **Tool** with the supply source **Purchase** or **Job Shop**. From the **Items (tcibd0501m000)** session, you must also define subentities, such as, costing data, warehousing data, purchase data, and ordering data. Calculate the standard cost for the newly defined tool.

2 Define tool type

Use the Tools (titrp0101m000) session to define the *tool* type in the Tools Requirement Planning module. Here, you can specify the general and refurbishing details of the tool type.

3 Set status to **Active**

Set the **Item Warehouse Status** field in the Item Data by Warehouse (whwmd2510m000) session to **Active**.

4 Define tools

Use the Tool Numbers (titrp0102m000) session to define tools for the tool type. Every tool type gets a *tool serial number*. You can specify the general and refurbishing details of each tool.

Note: The serial number of a tool is displayed in the Serialized Items (tcibd4501m000) session.

Tools planning method

The purpose of tools planning is to estimate the tools that are needed for production orders, service orders, and work orders. If a production order is planned, the required tools are determined using the routing that is linked to the item.

After the tools are planned, the **Estimated Tool Requirements (titrp0111m000)** session checks the availability of the planned tools.

The tools planning procedure is used in the following sessions:

- **Plan Tools Globally (titrp0211m000)** session. The method is only used if the tool serial number is not specified.
- **Replan Tools (titrp1202m000)** session.
- **Availability Check for Tools (titrp0213m000)** session. This method is only used if the tool serial number is not specified.

The tools planning method takes into account the Tools Usage field in the **Tool Numbers (titrp0102m000)** session. The number of tools to be planned is determined by the Maximum Number of Tools to be planned. When LN plans tools with the **Plan Tools Globally (titrp0211m000)** session and with the **Replan Tools (titrp1202m000)** session, LN considers the alternative tool types. LN also takes into account the **Planning Method** field in the **Tools (titrp0101m000)** session. Depending on the value of this field, LN uses the following methods when planning:

- **Least Remaining Tool Life.** LN first considers tools with the least remaining life.

- Maximum Remaining Tool Life. LN selects tools with the maximum remaining tool life.
- Based on Order Quantity. For the planning, LN selects tools with a remaining tool life equal to or greater than the requirement considered for the planning.
- Not Applicable. The planning method is not applicable, which means the tool life is not applicable.

The tools planning method procedure considers all the previously-mentioned input and plans the tools. If the requirement cannot be satisfied in one check-availability procedure, a purchase quantity is recommended. If LN fails to plan the tools for the requirement, the requirement is not changed.

Tool requirements planning

The tool requirement planning module is used to check the availability of tools for:

- **Planned Production Order** from the Order Planning module in Enterprise Planning.
- **Production Order Advice** from the Inventory Analysis module in Warehousing.
- **Production Order** from the Job Shop Control module in Manufacturing.
- **Service Order** from the Service Order Control module in Service.

Tools planning is based on the material resource concept. It is critical to plan tools at the right place, at the right time, and in the right quantity. Tools are considered items.

Note: The scope of the Tools Requirement Planning module does not include revision control and renting of tools.

The Service module allows for (field) service orders and (maintenance) work orders. Both are reflected in Tools Requirement Planning if tools are used.

LN updates the tool requirement planning in the Availability Planning (titrp0513m000) session if one of the following is true:

- The production order planning is entered or updated in the Production Orders (tisfc0501m000) session.
- A **Service Order** from the Service Order Control module in the Service is entered or maintained.
- The tool type of an estimated tool requirement in the Estimated Tool Requirements (titrp0111m000) session is changed.
- The tool number of a tool type in the **Estimated Tool Requirements (titrp0111m000)** session is changed.
- The **Tool Usage** field in the **Estimated Tool Requirements (titrp0111m000)** session is changed.
- The **Generate Availability Planning (Planned Production Orders) (titrp1213m000)** session is used.
- The **Generate Tools Availability Planning (whina3205m000)** session is used.
- When a maintenance work order is entered.
- When you run the **Service Order Resource Planning (tssoc2260m000)** session in Service.

Store availability planning of tools in the **Availability Planning (titrp0513m000)** session. When you run the **Availability Check for Tools (titrp0213m000)** session, LN prints a report with the following information:

- Required tool usages, to check how many tools are actually required for the appropriate date of the operation, line number, or activity line.
- Planned tool usages available to complete the operation.
- The shortages of tools for each operation.

- Recommended purchase quantity required. LN calculates this quantity by LN with the following formula:

Shortage of the tool type / Tool life

If there is a shortage of tools, the data in the **Production Orders (tisfc0501m000)** session is not affected.

Tools planning and tracking

Use tools planning and tracking to determine the planned and current locations of tools and the tooling historical data.

The tools defined in LN can be:

- Present in a warehouse.
- Planned or issued for a **Production Order**.
- Planned or issued for a **Service Order**.
- In maintenance.

The tools planning and tracking information is generated for the production order when the operations to which the tool is assigned are planned in the Job Shop Control module. The data is generated for service orders when the service activities are planned in Service.

In tool planning and tracking you can:

- Maintain the estimated requirements of tools for production orders/operations and service orders/activities.
- Check the availability of tools before the planned production is transferred from:
 - The Order Planning module.
 - The Inventory Analysis module to the Job Shop Control module.

You can also print the time-phased availability for planning of tools, for planned and actual production orders, and for service orders.

Tool tracking

Tool tracking contains the tooling data related to the requests for tools that are linked to the planned production order and operation, or that are linked to the planned service order, line number, and activity line.

The tool tracking is updated when the tools are returned with the **Request and Return Tools (titrp0215m000)** session. Tools are printed by order in the **Print Tools Used by Order (titrp1412m000)** session.

Request tools

When a tool is requested, LN checks if there is a *tool* request present in the **Tool Requests (titrp0515m000)** session for the tool work-center combination.

If there is no request present at the work center, LN creates a request. Next, LN plans the tool requests available in the **Tool Requests (titrp0515m000)** session, based on the earliest request date and the highest priority.

Note: If there is no request for the tool at any other work center or service center, this request has the **Available** status.

If the tool has already been requested at another work center or service center, the new request has the **Requested** status.

LN updates the **Tool Requirement Status** field in the **Estimated Tool Requirements (titrp0111m000)** session and the **Status** field in the **Tool Numbers (titrp0102m000)** session.

Transfer tools to the next requirement

LN checks if there are more tool request details present at the work center where the tool is currently in use.

If there are more *tool request details* present in the **Tool Request - Lines (titrp0516m000)** session, tools are transferred to these requirements. If there are no more request details present, tools are assigned to a new request.

The new request to which the tool is assigned is priority-dependent:

- First, tools are assigned to orders for work centers of type *line station*. The tool is transferred to the order with the earliest **Request Date/Time** and the highest order priority.
- Next, tools are assigned to orders for work centers of type *line segment*. The tool is transferred to the order with the earliest **Request Date/Time** and the highest order priority.
- If there are no requests from work centers of type line station or line segment the tool is allocated to the order with the earliest **Request Date/Time** and the highest order priority.

Note: If there is no request for the tool, the status of the tool is set to **Available**.

When a tool is transferred to the next requirement for a tool request detail or for a new tool request, the status of the request is set to **Available**. The request status **Available** means that the tool is present at the work center or the service center that is linked to the request. LN selects the **Tool Present** check box.

Transfer tools to the warehouse

When a tool is returned to the warehouse, LN checks if *tool request details* are present for the same *tool request* at the warehouse where the tool was currently in use.

If there are no additional request details:

- The request is deleted.
- The **Tool Present** check box in the **Tool Request - Lines (titrp0516m000)** session is selected.
- The **Tool Tracking (titrp0512m000)** session is updated.

If there are additional request details for the same request:

- The **Request Status** field in the **Tool Requests (titrp0515m000)** session is **Requested**.
- The status of the tool is **AvaiLable**.

Transfer tools to the work center/service center

Before a tool is transferred to a warehouse, LN checks if there are additional *tool request details* present for the *tool request*.

If there are no additional request details for the same request:

- The request from the **Tool Requests (titrp0515m000)** session is deleted.
- The tracking data in the **Tool Tracking (titrp0512m000)** session is updated.

If there are additional request details for the same request:

- The **Request Status** field in the **Tool Requests (titrp0515m000)** session is set to **Requested**.
- LN checks if there is a request present for the tool at the specified work center.

If there is a request at the work center:

- The **Request Status** field in the **Tool Requests (titrp0515m000)** session is set to **AvaiLable**.
- Request details with the earliest request date and the highest order priority are planned first.
- The **Tool Present** check box in the **Tool Request - Lines (titrp0516m000)** session is selected.

If there is no request at the work center:

- The **Tool Present** check box in the **Tool Request - Lines (titrp0516m000)** session is cleared.
- The **Request Status** field in the **Tool Requests (titrp0515m000)** session is **Allocated**.

Tool status

A tool can have the following statuses:

Note: If the tool is **BLocked**, the tool is not considered when new estimated requirements are planned, or while performing the availability check for tools.

New

When you enter a tool, the status is **New** status. You can change the status from **New** to **AvaiLable**, or to **BLocked**.

Available

To allocate the status to a **Production Order** or **Service Order**, the status must be **Available**. You can manually change the status to **Blocked** or to **In Refurbishing**.

Blocked

Tools with this status cannot be planned or issued to a **Production Order** or to a **Service Order**. The status of the tool is set to **Blocked** if:

- The *tool's life* becomes less or equal to the total number of hours/times the tool is used.
- The status is manually changed in the **Tool Numbers (titrp0102m000)** session to **Available** or to **In Refurbishing**.

Allocated

The **Allocated** status is assigned to a tool when it is issued to either a **Production Order** or a **Service Order**. You cannot manually assign the **Allocated** status in the **Tool Numbers (titrp0102m000)** session.

In Refurbishing

The **In Refurbishing** status is assigned to a tool when the tool is requested by means of the **Request and Return Tools (titrp0215m000)** session for refurbishment. Tools with this status are not planned for issue to a **Production Order** or to a **Service Order** within the planned period of maintenance.

If the tool is returned with the **Request and Return Tools (titrp0215m000)** session, the status of the tool changes from **In Refurbishing** to **Available**.

Tool identification

The master data of tools to be used in LN is first defined in this business object. The following data related to tools can be defined:

- *Tool*
- *Tool types*
- *Tool types by tool kit*
- *Tool number*
- *Tool components*

The first step is to define the tools. In the master data, tools are defined as a combination of tool type and tool number. The *tool's life*, *refurbishing* data, and the planning method can be specified for each tool type. Tools are considered as items.

If more than one tool is required to perform an operation, you can group tools to form a tool kit. To use tools interchangeably, alternative tools can be defined. Alternative tools are tools that can perform the same operation.

The tool component list can be maintained in this business object for multipiece tools that can have detachable components.

Request status

A request can have the following statuses:

Requested

The tool is requested at the work center or the service center.

Available

The tool is available at the work center or the service center.

Return tools to an order

LN checks the requests for the work center or service center of the specific combination of order and operation. If the request is found, the request has the **Available** status.

If the *tool request details* or the request are not present, LN adds the missing request or missing details. The tool is then sent to this request.

Note: If the next operation of the order also requires the tool used by previous operations of the order, the tool is transferred to this operation without considering the earliest request date and highest priority.

Maintaining Tools by Tool Type

For each tool you record:

- Usage data
- Refurbishing data
- Status

If you add a tool, LN generates an adjustment order which can be viewed in the **Adjustment Orders (whinh5120m000)** session. The adjustment order is generated and automatically processed for the warehouse that you entered in the **Tool Numbers (titrp0102m000)** session. The reason for adjustment equals the reason defined in the **Reason for Adjustment Order** field in the **Tool Planning Parameters (titrp0100s000)** session. The available inventory for the tool in the **Warehouse - Item Inventory (whwmd2515m000)** session is increased when you add a tool.

When a tool is scrapped, LN also generates an adjustment order which can be viewed in the **Adjustment Orders (whinh5120m000)** session. The adjustment reason equals the reason defined in the **Default Scrap Reason** field in the **Tool Planning Parameters (titrp0100s000)** session.

Due to financial transactions, you must enter a *purchase office* for the particular tool. You can define a purchase office as follows:

- Use the **Item - Purchase** session to enter the item purchase data for this tool.
- Use the **Procurement User Profiles (tdpur0143m000)** session to check the user defaults.
- Use the **Buy-from Business Partners (tccom4520m000)** session to maintain the business partner data for this tool.

If you plan production orders, *operations* of the routing are also planned. If you plan service orders, the tools linked to the service activities are also planned. The planning is based on the *tool type* and the **Planning Method** session specified for the tool type.

If you close operations of a **Production Order** and/or service activities of an **Service Order**, and actual costing took place, the tool's usage field is updated.

Modifying Estimated Tool Requirements

Tool requirements include data about the tool, and about the number of hours or times that the tool is required to perform an operation or activity. You can maintain tools that are estimated to be issued, or tools that are planned for the job shop or the service center.

The availability planning for actual orders is generated by means of the Availability Planning (titrp0513m000) session, after the orders have been entered in Estimated Tool Requirements (titrp0111m000) session.

Specific menu

The estimated tool requirements can be returned to the next requirement, to a warehouse, work center, or another order by using the **Request and Return Tools (titrp0215m000)** session. This session is started by clicking **Request and Return Tools** from the *appropriate* menu.

Click **Tool Requests** from the specific menu to start the **Tool Requests (titrp0515m000)** session. In this session you can view whether a tool is available at the work center or the service center.

Planning Tools Globally

If the *tool serial number* is planned in the **Estimated Tool Requirements (titrp0111m000)** session, you do not need to run this session.

Specify the order type, order, operation, activity line, or line number ranges. If you click **Plan Tools**, LN scans all tool types linked to the order, and plans the tool types for which the tool-serial number is not present.

Note: If no tools of the required tool type are available, the alternative tool type is planned based on the required tool usages, planning method, and maximum tools to be planned. If the required usages for a tool type are not fulfilled by the maximum number of tools specified, no tools are planned for that requirement.

Scrapping Tools Globally

After you clicked **Scrap Tools**, two types of reports can appear:

- A success report, which prints the tools that are successfully removed from LN.
- An error report, which prints the tools that cannot be removed from LN, due to the tool's existing reference in Service or in Manufacturing.

Note:

To scrap a tool, you must:

- Process the estimated tool requirements of the tool in the **Estimated Tool Requirements (titrp0111m000)** session.
- Delete the tool serial number in the **Operation (Step) - Tools (tirou1110m000)** session and the **Machines (Machine Types) (tirou0102m000)** session.

If you scrap a tool, LN generates an adjustment order which can be viewed in the **Adjustment Orders (whinh5120m000)** session. The adjustment order is generated and automatically processed for the warehouse that you entered in the **Tool Numbers (titrp0102m000)** session. The reason for adjustment equals the reason defined in the **Default Scrap Reason** field in the **Tool Planning Parameters (titrp0100s000)** session.

Due to financial transactions you must enter a *purchase office* for the particular tool. You can define a purchase office as follows:

- Use the **Item - Purchase** session to enter the item purchase data for this tool.
- Use the **Procurement User Profiles (tdpur0143m000)** session to check the user defaults.
- Use the **Buy-from Business Partners (tccom4520m000)** session to maintain the business partner data for this tool.

Requesting and Returning Tools

You can request or return one or more tools for a specific range of:

- Orders
- Operations
- Operation steps
- Line numbers
- Activity lines

If you select **Return** in the **Action** field, you can indicate on the second tab of the session to where you want to return the tool:

- Transfer tools to the warehouse
- Transfer tools to the work center/service center
- Return tools to an order

If you do not indicate to where a tool is transferred, the tool is transferred by default to the next requirement. For more information, refer to Transfer tools to the next requirement.

Request status

If a tool is requested or returned, the status of the request changes. If a tool is requested, the status changes from **Available** to **Requested**. If a tool is returned, the status changes from **Requested** to **Available**.

Defining Calculations Details

For each calculation you can define various calculation lines, according to a specific syntax. This syntax defines how the calculation must be performed. The result of a calculation is always one single figure: the final result.

In a calculation you can use constant values and three types of variables:

- Answers to calculation questions (for type Dialog)
- Aspect values (for type Constraint)
- Intermediate results (results of a part of the calculation)

You can further use:

- Operators
- Brackets
- Functions

Example

Calculate the angle of a triangle by using the following formula:

```
Angle = asin (length of side a/length of side c)
```

The following questions can be defined in the **Calculation Questions (tigrt0131m000)** session:

Question	Description
LA	Specify the length of side A
LC	Specify the length of side C

The formula is recorded by using two calculation lines:

Function	Question	Operator	Result
asin	(LA)	/	.

...	(LB)	=	Final result
-----	---	----	---	---	--------------

Note If you start the **Calculations (translated) (tigrt0585m000)** session from the *appropriate* menu, you see a more user-friendly translation of the calculation.

Listing Availability Planning

For the following orders the critical tool data is displayed:

- Production orders from Manufacturing.
- Service orders and work orders from Service.
- Planned Order Planning orders from Enterprise Planning. To include the critical tool data of planned RRP orders in the **Availability Planning (titrp0513m000)** session, you must run the **Generate Availability Planning (Planned Production Orders) (titrp1213m000)** session. Only the actual *scenario* is considered.
- *Production-order advices* in Warehousing. To include critical tool data of advices in the **Availability Planning (titrp0513m000)** session, you must run the **Generate Tools Availability Planning (whina3205m000)** session.

You can indicate that a tool is critical by selecting the **Critical in Availability Planning** check box in the **Tools (titrp0101m000)** session.

Chapter 11: Job Shop Scheduler

Job Shop Scheduler Overview

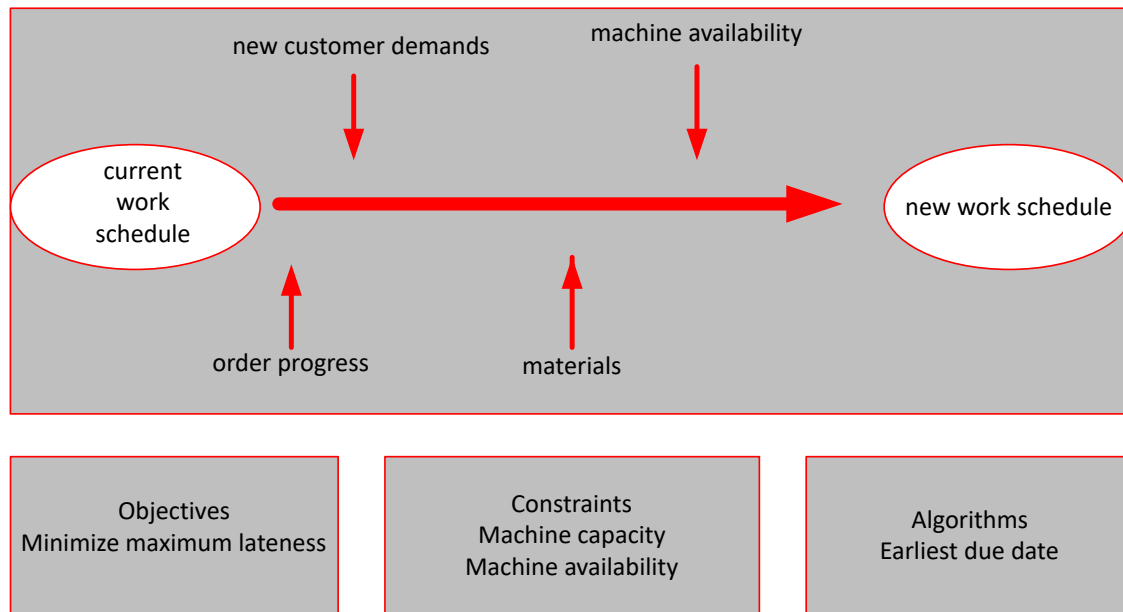
The job shop scheduler can optimize your planned production order schedule by generating production schedules considering material availability and machine capacity constraints.

In the Production Scheduler module production orders are manipulated, whereas Enterprise Planning handles production orders. The scheduler covers the very near future, up to a few weeks. The objective of the scheduler is to minimize the consequences of disruptions during production such as:

- Additional sales orders accepted within the agreed lead time
- Late material deliveries
- Machine breakdowns
- Production backlog

To achieve this, the scheduler:

- Schedules work only after materials are available
- Prioritizing and sequencing work according to specifically defined rules
- Schedules work on bottleneck machines against finite capacity



The objective of minimizing the maximum lateness means that the scheduler strives to keep the highest lateness of all the production orders as low as possible.

Lateness is defined as the time which is short between the scheduled finish date of an order in relation to the due date at which the production order must be completed in order to be on time for its upstream demand.

The algorithm for the minimize maximum lateness objective is the Earliest Due Date algorithm. The Earliest Due Date algorithm is based on the priority rule which states that the operation with the earliest due date should be scheduled first.

Scheduling Setup

The job shop scheduler relies on a few prerequisites to function efficiently.

To use the job shop scheduler:

- Every *work center* must be part of a *plan group*
- At least one bottleneck machine must be defined on the *shop floor*
- All operations for the bottleneck machine must be defined at the machine capacity group level
- Machine time-outs must be defined

The *plan group* determines the range of the scheduler.

Note: If the scheduler is enabled for a *site*, plan groups are mandatory and every *work center* in the applicable site must be part of a plan group.

All *production orders* within a site are either part of the same supply chain, use the same materials or the same machines. To generate a feasible production plan all production orders within the site must be scheduled in one run.

One of the primary objectives of the scheduler is to take the available capacity of a possible bottleneck machine into account. A bottleneck in the production process when a machine with limited capacity is a vital part of the production process.

Scheduling bottleneck machines minimizes their impact on the production process. To schedule machines, they must be modeled with a *machine number* and part of a *machine capacity group*. You can specify that a machine capacity group contains bottleneck machines, which is taken into consideration during scheduling.

LN machine operations are generated automatically when the production order has operations for a machine capacity group with machines.

You can use machine time-out to define machine unavailability due to maintenance, breakdown, or replacement. The time-out is superimposed on the availability of the calendar used by the work center to which the machine belongs.

- 1 To enable job shop scheduler, you must select the **Production Scheduler** parameter in the **Implemented Software Components (tccom0100s000)** session.
- 2 To enable job shop scheduler for a specific site you must activate Job Shop Scheduler in two steps by first setting the **Production Scheduler** parameter in the **Production Settings by Site (timfc0180m000)** session to **In Preparation**.
 - a Once the production scheduler parameter is set to **In Preparation** for the selected site, it will be possible to define plan groups for the site in the **Work Center Plan Groups (tisch0140m000)** session.
Note: The *plan group* must have the **Scheduler Controlled** check box selected to indicate that it is Scheduler controlled.
 - b Use the **Work Centers by Plan Group (tirou0101m400)** session to assign work centers to plan groups.
Note: You must manually define the plan group if the production order has a routing without operations.
 - c When all work centers are part of a plan group, you can set the **Production Scheduler** parameter in the **Production Settings by Site (timfc0180m000)** session to Active.
Note: You can only set the **Production Scheduler** parameter status to Active if all work centers of a *routing* are within the same plan group. Once the Job Shop Scheduler is active, all production orders and routings are assigned to the corresponding plan group automatically.

Machine Model

The machines present on the shop floor must be modeled to the scheduler.

- 1 Use the **Machine Numbers (tirou4162m000)** session to add designations to machines on the shop floor. Only machines with designations can be added to machine capacity groups.
- 2 You can define machine capacity groups in the **Machine Capacity Groups (tirou4161m000)** session. Each capacity group contains one or several parallel machines. If a machine capacity group is a potential bottleneck in production, you must select the **Critical for Scheduler** check box.

- 3** Machines can be unavailable due to maintenance, breakdown or replacement. Planned and unplanned unavailability is defined in the **Machine Time-out (tirou4165m000)** session.

Plan Group

The plan group determines the boundaries of the scheduler. If the scheduler is enabled for a *site*, the *plan group* is mandatory for all *work centers* of the site.

Production orders within a site are interwoven, they are either part of the same supply chain, use the same materials, or the same machines.

Consequently, for a feasible production plan, all production orders for the site must be scheduled in one run.

It remains possible to also schedule a set of production orders independently.

Example: A site where plastic injection molding parts (plan group 1), metal injection molding parts (plan group 2) and metal machined parts (plan group 3) are produced and delivered directly to the customer, can be run separately for each plan group with different scheduler settings.

Bottleneck Machines

The scheduler considers the available capacity of the bottleneck machines.

To schedule the work on an actual machine, that machine must be modeled by the *machine number*.

A machine number is part of a machine capacity group that can be marked as critical for scheduler. If marked as critical, the machines in the group are possible bottlenecks whose availability is considered by the scheduler.

Machine Operations

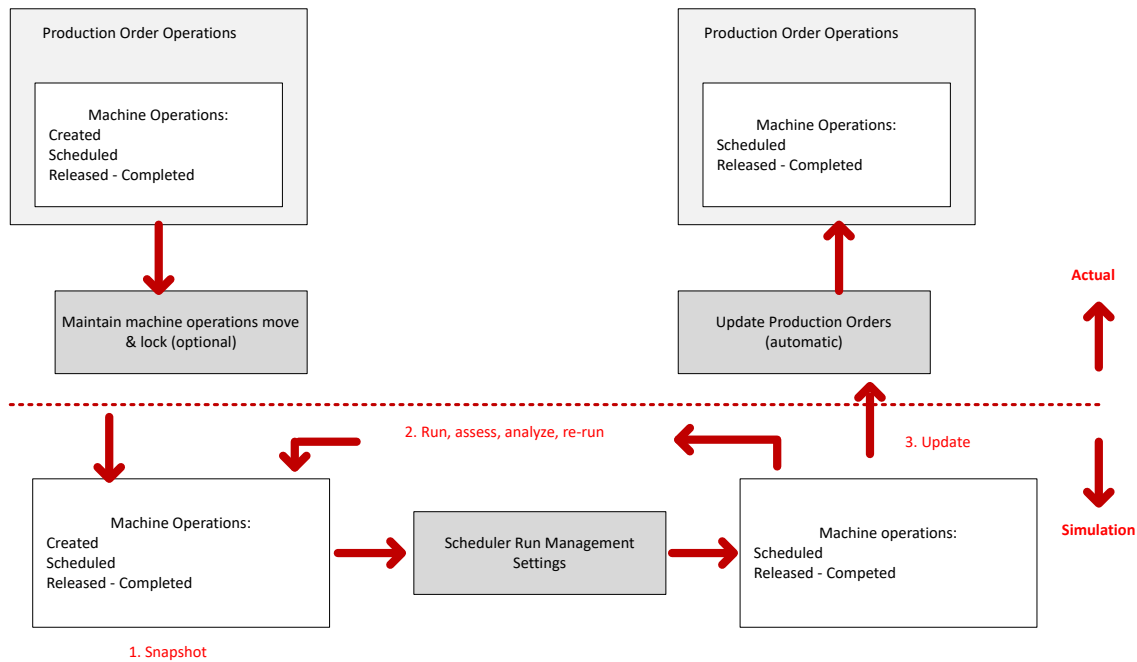
The work on the actual machine is modeled as one or more *machine operations*. If a production order has operations for a machine capacity group, machine operations are created automatically. The operation quantity is divided over the machine operations. Initially the machine operations start at the same time the operation starts.

Machine Time-Outs

The unavailability of a machine due to maintenance, breakdown, or replacement must be modeled as a machine time-out for the machine number. Machine time-outs in combination with machine availability defined in the work center calendar define machine capacity used in scheduling.

Scheduling Process

The scheduling process is a simulation stored in a schedule run.



Scheduling comprises of these steps:

- 1** Ensuring all reporting is up to date.
 - All received purchased materials must be booked in inventory
 - All production progress is booked, checked and corrected
 - All produced products are booked in inventory
 - All pegging relations are generated
 - All (order) operations which cannot be rescheduled are locked.
- 2** Running the job shop scheduler leads to:
 - The creation of a starting point based on the current situation (snapshot)
 - The calculation and storage of KPIs for the starting point
 - The storage of the settings for the run
 - The generation of a schedule is based on the snapshot of the current situation the results of which are stored
 - The calculation and storage of KPIs for the result
- 3** You can analyze the scheduling results by:
 - Comparing key performance indicators between input and output schedules
 - Comparing *machine operation* schedules
 - Comparing machine utilization between the input and output schedules
 - Comparing the lateness of specific orders
 - Comparing the number of conflicts in input and output schedules
- 4** Use the results to update:
 - *Machine operations*

- *Order operations*
- *Production orders*

Note:

- Use of the job shop scheduling is optional.
- Comparisons between different scheduler setups are best done long term. You can run an alternative setup parallel to your current scheduler setup while it is used for actual production.
- A *shop floor planner* can overrule the scheduler output.
- Machine operations can be locked to keep them from being moved during scheduling.
- The scheduler input data is a snapshot, the operational environment might have changed between the moment of taking the snapshot and the update based on the scheduler output. Consequently, the update process may partly fail and a report with the discrepancies is generated.

Job Shop Scheduler

The job shop scheduler input is specified in the **Job Shop Scheduler (tisch1200m000)** session. Depending on the settings various schedules and reports are generated.

- 1 Use the **New** command in the **Job Shop Schedule Runs (tisch1100m000)** session.
- 2 The **Job Shop Scheduler (tisch1200m000)** session starts with the *site* for which scheduling is done defaulted from your user profile.
Note: You must be authorized to perform scheduling for the specified site in your user profile.
- 3 Select the *plan group* you want to schedule..
 - a Specifying the plan group opens the Work Center Plan Groups (tisch0140m000) session. You will be able to select one of the plan groups of the site you are authorized to schedule.
Note: Only orders that are part of a plan group can be scheduled. If a production order is not part of a plan group it is considered fixed and cannot be moved.
- 4 The **Run** and iteration are automatically generated.
- 5 The **Creation Date** of the run is always the current date.
- 6 Specify the **Time Fence** in days. The *time fence* indicates the start of the production schedule. The time fence is defaulted from the selected *plan group*.
- 7 Specify the **Horizon** in days. The horizon indicates the end of the time frame for which production orders are selected to schedule. The horizon is defaulted from the selected plan group.
- 8 Select the **Objectives** of the scheduling run.
- 9 Select the **Algorithms** that will be used to optimize the scheduling.
- 10 Select production order update options.
 - a If the **Actual Run** check box is selected, the marked schedule is used to update the production planning. Use the check box if more than one schedule was generated from the same input for analysis.
 - b If the **Automatic Update Production Orders** check box is selected, the scheduler output is used to update the production orders that are part of the run. If the check box is cleared, you can update the production orders using the **Update Production Orders (tisch1200m100)** session.
 - c Select if you want a process or error report for the run.
- 11 Select the Options for the run.
 - a Select the **Error Report** check box to have an error report for scheduler generated.

- b** Select the **Update Pegging Relations** check box to update the pegging relations on the production orders before scheduling.

12 Use the **Schedule** command.

13 You can see the results in the **Job Shop Schedule Runs (tisch1100m000)** session.

- Are part of a *plan group*
- Start after the *time fence* and before the *horizon*
- Have the status **Created** or **Printed**

Production orders are considered fixed if they:

- Have orders with the status **Created, Printed, Released** or **Active** that are scheduled in the time fence and finish after the time fence
- Have orders that have the status **Released** or **Active** inside the time fence
- Have machine operations that are locked inside the time fence

The machine operations performed on bottleneck machines are scheduled against finite capacity. This means that the machine availability of the machine operations is considered.

Each machine operation is scheduled on an available machine group.

The choice of algorithm and objective determine the way the machine operations, operations and orders are scheduled.

All *machine operations*, operations and orders not performed on bottleneck machines, are scheduled forward in time, against infinite capacity. The lead times of non-critical machine operations, operations and orders are considered to insure the schedule is feasible, but machine capacity is not taking into account.

The table shows the *lead time* components and related calendar which are considered by the scheduler.

Lead-time component	Calendar
Queue Time	Work Center Calendar
Setup Time	Work Center Calendar + Machine Unavailability
Production Run Time	Work Center Calendar + Machine Unavailability
Wait Time	Real Calendar Time
Move Time	Work Center Calendar
Inbound Time	Warehouse Calendar
Outbound Time	Warehouse Calendar
Order Lead Time	Calculation Office Calendar

The job shop scheduler respects the *routing* of the *production order* when possible accounting the *lead times* and machine capacity.

During scheduling *order pegging* is used to guarantee that all materials are present at the start of a production order. The job shop scheduler uses the downstream pegging of the production orders in order to determine when an operation can start at the earliest. The due date of the production order is determined using upstream pegging.

Job Shop Schedule Run

You can run all schedule functionality from the **Job Shop Schedule Runs (tisch1100m000)** session, it also provides an overview of all performed runs with their applicable statistics.

A job shop schedule run contains:

- The date on which the input for the run (snapshot) was created
- The settings for the scheduler, such as the horizon, the objective, and the algorithm
- The snapshot, including the input schedule
- The output data, including the output schedule
- The KPIs of the input (snapshot)
- The KPIs of the output (result)

You can start the **Job Shop Scheduler (tisch1200m000)** session by:

- Clicking the **New** in the *appropriate* menu in the **Job Shop Schedule Runs (tisch1100m000)** session to start the scheduler for a specific *site* and all **Options** are available for use.
- You can select a run from the **Job Shop Schedule Runs (tisch1100m000)** overview, the runs are sorted in reverse order with the newest at the top of the list, and clicking the **Run** command in the *appropriate* menu. The job shop scheduler starts with the input data such as **Creation Date**, **Time Fence Date** and **Horizon Date** copied from the originally selected run and fixed. The other parameters and options are editable.
- You can select a run from the **Job Shop Schedule Runs (tisch1100m000)** overview and use the **Run** command from the *appropriate* menu. The job shop scheduler will start rerunning the same input as the original run. You will be able to specify different **Options** and reports.

Analyzing Scheduler Results

You can use the **Schedule Viewer (tisch8350m000)** session to display and analyze the output and input data used to generate schedules by the job shop scheduler.

The input and output schedules of the job shop scheduler run can be analyzed via the **Schedule Viewer (tisch8350m000)** session. You can start the session by selecting a run and using the **Analyze Input Schedule** or **Analyze Output Schedule** commands from the *appropriate* menu in the **Job Shop Schedule Runs (tisch1100m000)**.

Note:

- The **Analyze Input Schedule** is available when an input schedule is present for the selected run.
- The **Analyze Output Schedule** is available when an output schedule is present for the selected run.

In the **Schedule Viewer (tisch8350m000)** session, you can view a graphic of the scheduled machine operations, machine unavailability and machine capacity, machines are grouped by *machine capacity group* and *work center*.

The key performance indicators you can use for analysis are:

- **Average Lateness:** expressed in the (fractional) number of days.

The lateness of an order is defined as the time difference between the due date and planned finish date, expressed in days. The average lateness is the total days late divided by the number of orders, expressed in days (1 decimal).

Example: the average lateness is +1.2 days.

- **Average Bottleneck Utilization:** expressed as a percentage.

The sum of all used capacity of the machines divided by the sum of all available capacity of the machines.

Example: the average bottleneck utilization is 98%.

- **Predicted Orders Completed in Time:** expressed as a percentage.

The numbers of orders that are on time or early divided by the total number of orders.

Example: the predicted orders completed in time is 32%.

- **Number of Orders:** expressed as a number.

The total number of the production orders with the status **Created**, **Printed**, **Released**, or **Active** and that are within the time frame of the scheduler run.

Example: the number of orders is 600.

- **Number of Operations:** expressed as a number.

The total number of machine operations of the production orders that are defined as within the time frame. An order operation without machine operations is considered as one machine operation. An order without operations is considered as one machine operation.

Example: The number of operations is 800.

- **Number of Conflicting Operations:** expressed as a number.

The total number of conflicting machine operations. The objective of scheduling is to minimize problems on the production floor. A conflict is a situation which lessens the feasibility of the generated schedule.

Example: the number of conflicting operations is 20

Updating Production Orders

You can use the output schedule of the job shop schedule to update existing production orders, order operations and machine operations. The **Update Production Orders** command in the *appropriate* menu of the **Job Shop Schedule Runs (tisch1100m000)** session to start the **Update Production Orders (tisch1200m100)** session to update a selected schedule.

Note: The **Update Production Orders (tisch1200m100)** session cannot be started stand alone. The session is enabled if the output schedule is available and the job shop schedule run is Actual. On the updated production orders the check box **Scheduled** is set.

Deleting Job Shop Schedules

You can use the **Delete Job Shop Schedule Runs (tisch1200m200)** session to delete schedule runs that are no longer in use. For a specified range of dates, runs can be deleted completely or some of the schedule information can be retained.

Using the **Delete Job Shop Schedule Runs (tisch1200m200)** you can:

- **Delete Job Shop Schedule Run**
If the check box is selected, the selected job shop schedule, including the objectives, algorithms, key performance indicators, the input and output schedules are deleted.
- **Delete Input Schedule**
If the check box is selected, the input schedule of the selected job shop schedule is deleted.
Available if the **Delete Job Shop Schedule Run** check box is cleared.
- **Delete Output Schedule**
If the check box is selected, the output schedule of the selected job shop schedule is deleted.
Available if the **Delete Job Shop Schedule Run** check box is cleared.

You can start the session as a standalone specifying a range of runs you want to delete. It is also possible to start the session from the *appropriate* menu in the **Job Shop Schedule Runs (tisch1100m000)** session for one specific run.

Chapter 12: Routing

Routing

The planning data for the method of manufacturing is defined in Routing. A routing consists of operations, with each operation identifying the last to be carried out in a work center and/or on a certain machine defined for a specific site..

Routings can be as follows:

- Standard Routing
A generic routing that can be attached to multiple items
- Item specific
A routing that is applied to one item
- Network routing
A routing containing sequentially ordered operations and parallel operations
- Order quantity dependent routing
A routing that is defined for a specific quantity of items

You use the Routing module to record *routings* for manufactured items. You can define the following:

- Work centers
A work center is where production activities are performed. Resources, such as people and machines, are lined to a work center. A work center is a group of resource units used as a functional planning unit. The operation rate code, which is linked to the work center, is used to calculate the standard cost of an item or the estimated and actual costs. The capacity load on a work center is used in the planning of production. Work centers can be part of enterprise units used for multicompany modeling purposes.
- Machines
Machines are linked to work centers and are used to plan operations. The rate defined for a machine is used to calculate the actual machine costs. The capacity load on a machine is used for production planning. Machines are modeled with *machine numbers*.
- Reference operations
Classified according to the nature of the work performed, reference operations are used to describe activities that take place on the job shop. Reference operations are linked to operation rate codes, which are used to calculate the standard cost of an item or the estimated and actual costs. Reference operations are used in production planning.
- Operations
The operation data for standard and customized manufactured items is maintained with operations. Operation data is stored and maintained for standard items and customized items. A series of operations

is performed to manufacture an item. The sequence of operations is defined as a routing in operations. Yield and scrap is defined per operation.

- *Norm times*

The run time and production rate of an operation are determined using norm tables. After a matrix is defined for two physical characteristics, such as length and width you can maintain a set of standard operation times for the X-Y coordinates. When tasks and routings are defined, the run time and production rate can be calculated by using a norm table.

- *Skills*

Certain skills may be mandatory to perform a specific operation. To ensure employees assigned to an operation possess the necessary knowledge, skills are linked to both employees and operations.

Job Shop Routing

To support multi-site production, routings are now linked to product per site.

Note: If *multisite* is implemented, you must be authorized to define and maintain routings for the selected *site*.

Routing Master Data

To be able to define a routing, these must already be defined:

- 1 Define reference operations

Prerequisite:

- The *work centers for site* are defined in the Sites (tceem0150m000) and the Work Centers (tirou0101m000) session.
For more information, refer to Activating sites and Defining entities for sites.
- *Machine type (s)* is defined in the Machine Types (tirou4160m000) session.
- The *Machine capacity group(s)* is defined in the Machine Capacity Groups (tirou4161m000) session.

- 2 Link skills and tools.

Prerequisite:

- *Skills* are defined in the Skills (tcppl0110m000) session.
- *Tools* defined in the Tools (titrp0101m000) session.

- 3 Link process variables

Prerequisite:

- *Process variable* defined in the Process Variables (tirou0105m000) session.

New Routing

Note: A routing is always site specific and quantity dependent.

To define a routing for a product:

- 1 Use the Job Shop Routing (tirou4600m000) session to generate a new routing revision.

The revision is assigned the status **New** on generation.

- 2 Specify the site to which the routing will apply in the **Site** field.
- 3 Specify the product for which the routing will be used in the **Product** field.

Once the product is selected, the routing ID number and revision will automatically be generated. If a previous routing for this product and site combination exists, the revision number will be upped by one.

The new routing revision automatically receives the status **New**.

- 4 Edit the routing header as necessary.

- 5 Add operations to the routing

Note: Prerequisite to adding operations that reference operations have been defined in the **Reference Operations (tirou4150m000)** session.

- 6 Once all operations are added use the **Validate** command to check for consistency.
- 7 After validation use the **Approve Revision** command to change the revision status to **Approved**.

Standard Routing by Site

A standard routing is a routing that can be coupled to multiple products. Using a standard routing can reduce maintenance.

Use the **Standard Job Shop Routings (tirou4100m100)** or **Standard Job Shop Routing (tirou4600m100)** sessions to define standard routings that can be used either globally or for a specific site.

When you have a standard routing defined, you can define a job shop routing in the **Job Shop Routings (tirou4100m000)** or **Job Shop Routing (tirou4600m000)** sessions for a specific item.

Later on, you can link the standard routing to one or multiple items in the **Item - Routings (tirou1101m000)** session by selecting a manufactured item and site when you record a new item routing code. First, select the **Standard** checkbox in the **Item - Routings (tirou1101m000)** details session. Next, select a standard routing to which the new routing can be linked. The operation data is adopted from the standard routing during the input of a production order.

Maintaining Routing Operations

A routing is the sequence of operations required to manufacture an item. Different types of routings can be used for different types of manufacture.

Note:

- If *multisite* functionality is activated the routing is defined for an item and *site* combination.
- You must be authorised to manage the site for which you are creating a routing.
- You cannot use the same routing for more than one site.

In the **References** menu of the Items - Production by Site (tiipd0151m000) session use the **Routings** command to start the Item - Routings (tirou1101m000) session after you have selected an item and site. This will allow you to manage routings for the selected item.

- For a nonstandard routing

Enter the code of an operation and manufactured item

- For a standard routing
Select the routing from the list in the Item - Routings (tirou1101m000) session.
- Choose the first operation number and the associated reference operation.
The other data is then displayed as default data from the **Reference Operations (tirou4150m000)** session. **Note:** You can only select tasks linked to the site.
- You can enter and maintain a routing operations for a specific item and site combination directly in the Job Shop Routing Operations (tirou4101m000) overview session, by double-clicking the BOM line to access the detail session.

Changing the number of resources on operation You can change the number of resources on an operation by changing the value of the **Labor Resources for Production (FTE)** field in the Production Planning (tisfc0110m000) session. **Note:** While changing the number of resources does not affect the *cycle time*, and the production time remains the same, the total production costs are affected due to the cost of the extra resources.

-

Changing the number of resources on an operation

To prevent production costs changing when you change the man occupation, or the machine occupation, the cycle time must be recalculated. You can choose to do so, because when changing the man or machine occupation, a question pops up to ask you whether you want the cycle time to be recalculated:

- If you click Yes, the cycle time is recalculated. So, the man occupation or machine occupation is changed, including the total production time, but the costs stay the same. For more information on how the cycle time is recalculated, refer to Recalculation of cycle time when changing man occupation or machine occupation.
- If you click No, the changed man occupation or machine occupation does not affect the cycle time and the production time. However, the total production costs will change to reflect the change in man occupation or machine occupation.

Place and functions of operations

To manufacture an item, a series of *operations* must be performed. The sequence order of such operations is called a routing in LN.

The Routing module lets you:

- define routings for standard items
- define item-independent routing (that is, a standard routing)
- define multiple routings for an item per site
- define an order quantity for each routing
- determine the work center (that is, the bottleneck work center) that governs the production rate of repetitive items
- calculate the production rate

Routings are important for production order planning in the Order Planning module of Enterprise Planning, and in the Job Shop Control module and the Standard Cost Calculation module.

You can define both standard routings and item routings. Item routings can refer to standard routings. For each item, you can record multiple routings per site.

Defining Operation Steps

The operation steps are linked to a combination of an item, a routing, and a routing operation. For every routing operation you can define one or more operation steps.

The serial numbers of the operation steps indicate the sequence of the operation steps. You can also link a *reference designator* to the operation step to indicate where a specific components must be mounted on the item.

You can choose:

- To link process variables to the operation step in the Job Shop Routing Operation - Process Variables (tirou4113m000) session.
- Instructions, to link instructions to the operation step in the Routing Operation - Instructions (tirou4115m000) session.
- To link tools to the operation step in the Job Shop Routing Operation - Tools (tirou4111m000) session.

Standard Routing

A standard routing is a routing that can apply to multiple items. By using the Item - Routings (tirou1101m000) session, you can predefine a routing code.

Note: Only applicable if the **Job Shop by Site** parameter in the **Concept Activation (tcemm4600m000)** session must be set to **Active** or **In Preparation**.

- 1 Start the Items - Production by Site (tiipd0151m000)
- 2 Select the item for which you want to manage the routings.
- 3 Select the site for which you are creating a routing. **Note:** You must be authorised to manage the site for which you are creating a routing.
- 4 In the **References** menu use the **Routings** command to start the Item - Routings (tirou1101m000) session. This will allow you to manage routings for the selected item.
- 5 Specify the required routing code and its description in the **Routing** field. The **Standard** field is now **yes**.

Manufactured item

Routing	111
Standard Routing	Yes

Later on, you can link the standard routing to one or multiple items in the **Item - Routings (tirou1101m000)** session by selecting a manufactured item and site when you record a new item routing code. First, select the

Standard checkbox in the **Item - Routings (tirou1101m000)** details session. Next, select a standard routing to which the new routing can be linked. The operation data is adopted from the standard routing during the input of a production order.

Manufactured item: bicycle saddle	
Routing	222
Standard Routing	Yes, 101
item routing	standard routing

Note: If the **Standard** check box is cleared, the routing is not linked to the standard routing. As a result, you must manually enter a routing.

Order quantity dependent routings

Having an automatically selected routing tailored to a specific production order quantity can be useful. For example, if the production order quantity is large, a routing with high production rates is used. If the order quantity is small, another routing is selected.

You can set up these quantity dependent routings:

- Select the **Quantity-dependent Routing** check box in the **Item - Production (tiipd0101m000)** session.
- Enter the routing codes in the **Item - Routings (tirou1101m000)** session. Enter the maximum quantity for which a routing is valid in the **Up to Quantity** field.

Note: If *multisite* functionality is activated, the *routings* available may vary per *site* on job shop bill of material selected. Differences in routings have impact on the standard cost calculation.

Default routing

If the **Quantity-dependent Routing** check box is not selected, the default routing applies to an item. However, this default routing must also be linked to the item. To find out, LN checks the default routing code in the **Default Routing** field of **Job Shop Master Data Parameters (tirou0100m000)** session. Next, LN checks whether the default routing code is linked to the item in the **Item - Routings (tirou1101m000)** session. If so, the default routing applies to the item. If the default routing is not linked to the item, no routing is used.

Network routings

A simple *routing* contains only sequentially ordered *operations*. A network routing can contain sequentially ordered operations and parallel operations.

LN offers three methods to define parallel operations:

- Manually, in the **Operation Relationships by Order (tisfc1102m000)** session.
- By inserting *phantom* components that have a routing.

- By defining parallel operations in the Job Shop Routing Operations (tirou4101m000) or Generic Routing (tipcf3120m000) session.

Note:

- If the Sites and Job Shop by Site parameters in the **Concept Activation (tceem4600m000)** are in **Preparation** or **Active** routings are maintained on site level.
- Only converging network routings are supported: two operations can a common succeeding operation, but they cannot have a common preceding operation. Every network routing has one final operation.

To manually define parallel operations

To manually define parallel operations in the production order planning, complete the following steps:

- 1 Create a production order with a sequentially-ordered routing.
- 2 Start the **Operation Relationships by Order (tisfc1102m000)** session.
- 3 For each operation, enter the number of the next operation in the Next Operation. Enter 0 in the production order's final operation.

To define parallel operations using phantom components

To define a routing that has a secondary branch that joins the main routing halfway, complete the following steps:

- 1 Define a *phantom* item that represents the subassembly created in the secondary routing branch.
- 2 Define the phantom item's routing, which is the secondary branch.
- 3 Add the phantom to the job shop bill of material of the *main item*.
- 4 In the **Job Shop Bills of Material (tibom3100m000)** session, link the phantom to the operation that follows the secondary branch of the routing.

Alternatively, you can link the phantom to a specific operation for each routing in the **BOM Line - Material-Routing Relationships (tibom0140m000)** session.

LN connects the routing of the phantom item to the main item routing immediately before the main item operation that is linked to the phantom. For more information, see Example network routing.

To link an operation to phantom for a specific production order, in the **Estimated Materials (ticst0101m000)** session, specify that operation in the **Operation** field. For an example, see Example network routing.

To define parallel operations in a routing

If the **Allow Parallel Operations in Routing** check box in the **Job Shop Master Data Parameters (tirou0100m000)** session is selected, you can define parallel routings in the **Job Shop Routing Operations (tirou4101m000)** session.

To define parallel operations in a routing, complete the following steps:

- 1 Before you enter the operations, roughly order the operations from first to last. Ensure no operation is followed by an operation that must be performed earlier.
- 2 Start the **Job Shop Routing Operations (tirou4101m000)** session.
- 3 Define all routing operations. At first, leave the **Next Operation** field at the default value, 0 (zero).
- 4 For each operation, in the **Next Operation** field, enter the operation that is performed next.

The operation number of the next operation must be greater than the number of the current operation. For example, operation 40 cannot follow operation 50.

For the final operation, enter 0 (zero) in the **Next Operation** field.

After you complete the routing, validate the routing and correct any errors. To validate the routing, on the *appropriate* menu, click **Validate Sequence**.

Note: When a production order is created, LN validates the routing and stops the process if the routing is incorrect.

To define parallel operations in a generic routing

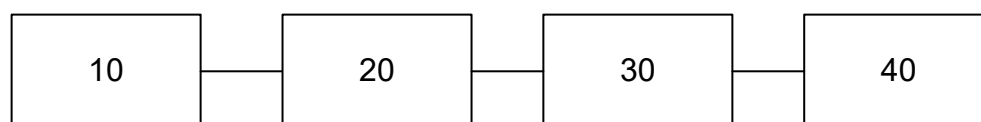
The procedure to define parallel operations in a generic routing is almost the same as that for regular routings. Instead of the **Routing Operations (tirou1102m000)** session, you must use the **Generic Routing (tipcf3120m000)** session.

Caution: If you specified an operation in the **Next Operation** field, and that operation is skipped for a particular *product variant*, LN does not automatically replace that operation with the correct operation. Instead of the operation that follows the skipped operation, LN selects the operation with next higher operation number. After LN generated the routing for the product variant, correct the operation sequence for the *customized item* or configured standard item in the **Routing Operations (tirou1102m000)** session.

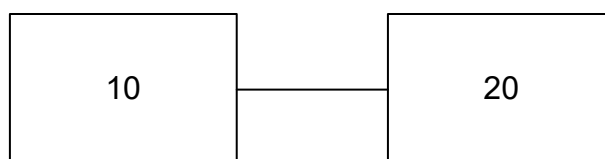
Example network routing

Main item: Refrigerator

Component: Door (Phantom)



Main item routing:

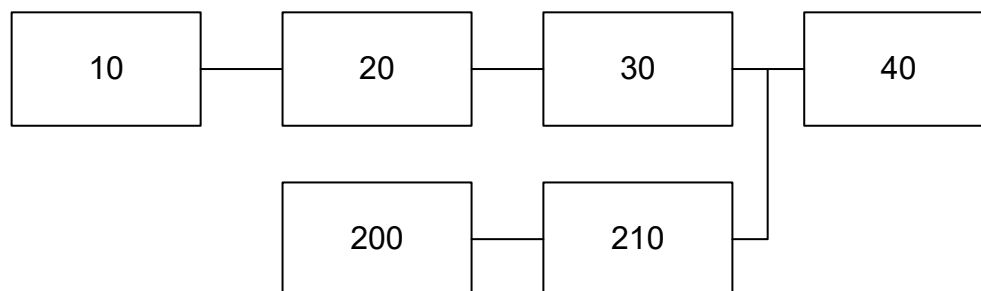


Phantom item routing:

Initial value for renumbering operations: 200

Step size for renumbering operations: 10

The phantom item is linked to operation 40 in the main item routing.



Network routing:

Linking Operation/Operation Step - Tools

To link tools to an operation

- If the sequence in which the tools are presented on the production order documents is not important, you can link tools directly to an operation.
To link tools to an operation:
 - Select a record in the Routing Operations (tirou1102m000) session.
 - On the *appropriate* menu, click **Tools**.
 - The **Operation (Step) - Tools (tirou1110m000)** session starts, in which you can link one or more tools to an operation.
- These tools are presented directly below the operation number on production order documents.

To link tools to an operation step

Tools information linked to operation steps can indicate, for example, which tools are required to carry out a specific operation.

To add several tools to a specific operation in a specified order, you must link a tool to an operation step. After you defined operation steps for the operation in the Operation Steps (tirou1105m000) session, you can link one or more tools to each operation step.

- Select an operation step in the **Operation Steps (tirou1105m000)** session for the correct item/routing/operation combination.
- On the *appropriate* menu, click **Tools**.
- The **Operation (Step) - Tools (tirou1110m000)** session starts, in which you can link one or more tools to an operation step.

Default value

If the current session is started for an operation that makes use of a task relationship to which tools are linked in the Task Relationship - Tools (tirou0115m000) session, the tools from the **Task Relationship - Tools (tirou0115m000)** session are defaulted to the current session. When operation steps are added, these defaults are removed again.

You can list and define the tools that are required for an actual production order's operation in the Estimated Tool Requirements (titrp0111m000) session. Based on the data in the current session, tools information is defaulted to the **Estimated Tool Requirements (titrp0111m000)** session on operation level, or on operation step level.

However, in the **Estimated Tool Requirements (titrp0111m000)** session, you can link additional tools to an operation, or to an operation step of an actual production order in the following ways:

- By inserting a new record
- By starting the **Operation (Step) - Tools (tirou1110m000)** session, in which you can define additional default tools information. To start the **Operation (Step) - Tools (tirou1110m000)** session, select a record in the **Estimated Tool Requirements (titrp0111m000)** session and on the *appropriate* menu, click Operation/Operation Step - Tools.

Note: If you add additional tools to the production order by means of the **Operation (Step) - Tools (tirou1110m000)** session, the inserted tools are defaulted to future production orders that make use of the relevant operation or the relevant operation step.

Overview of reference designators

In LN, one or more *reference designator* can be linked to the items on a bill of material (BOM), or an EBOM line to indicate where the items must be inserted on the *main item*.

Reference designators and (E)BOM

You can do the following:

- Link a single reference designator to a single (E)BOM line.
One or more identical items on the (E)BOM line have the same reference designator.
- Link multiple reference designators to a single (E)BOM line.
The identical items on an (E)BOM line have different reference designators.
- Link a single reference designator to multiple (E)BOM lines.
Different items, on several (E)BOM lines have the same reference designator.
- Link a single reference designator to multiple (E)BOM lines that contain the same item.
In other words, identical items in multiple (E)BOMs have the same reference designator.
- In EBOMs, you can use *mass BOM change (MBCs)* to add, delete, or replace (engineering) items in the EBOM. If reference designators are linked to items in the EBOM, you can also add, delete, or replace the reference designators.

- You can view and maintain reference designators for a production order's estimated material lines in the Reference Designators by Estimated Material (ticst0106m000) session, which you can start from the **Estimated Materials (ticst0101m000)** session.
- If you defined reference designators for (E)BOM lines, those reference designators are automatically present in the **Reference Designators by Estimated Material (ticst0106m000)** session. You can also define new reference designators for estimated material.

You can link stepwise information to the operation steps, for example, procedures and work instructions. This information, which can also relate to the reference designator, is printed on the operation notes, and can be used by operators in the job shop to do their work. In the instructions, you can explain, for example, how work must be carried out when you mount a specific item on the location indicated by the reference designator.

Note: Instructions are only printed on operation notes if the **Print Instructions** field in the **Work Centers (tirou0101m000)** session is **Yes**.

If reference designators are defined in the (E)BOM of a serialized (engineering) item, the reference designators are present in the as-built structure in the Serial End Item - As-Built Components (timfc0111m000) session. ERP creates a separate as-built component line for every reference designator. In case of reference designators, even for a non-serialized component in the (E)BOM, separate as-built component lines are created. You can view, maintain, and add reference designators.

Chapter 13: Engineering Data Management

Engineering Data Management (EDM)

You can use the Engineering Data Management module to create and modify data for items in development, and change that data into actual production data.

Engineering data mainly consists of:

- *Engineering items (E-items).*
- Engineering item *revisions*.
- Engineering BOMs (EBOMs).
- Relationships between engineering items and manufactured items.

You can either copy individual engineering items to actual items, or carry out multiple changes simultaneously using *mass BOM changes (MBCs)*.

The following online manual topics are available:

- Engineering data management summary
- Engineering items
- Engineering BOMs
- Changing EBOMs - Manual procedure
- Changing EBOMs - Automatic procedure
- Changing EBOMs - Semi-automatic procedure
- Copying E-items to items
- Finalizing engineering data
- Unit effectivity in EDM
- Import CAD application data with the Exchange module

Engineering data management summary

You can use the Engineering Data Management module in Manufacturing to support the registration of a product's design process, dealing with different versions of products. In addition, this module is used to transfer the design data to production.

Engineering items

Engineering items are items to which you make design changes. If the design process is finished, you can transfer the changes to actual items. An E-item can exist as several *revisions*. Each revision is an improved version of the item.

You can attach drawings to E-item revisions with the Document Management module of Data Management.

Engineering bills of material

An engineering bill of material (EBOM) describes the relationships of components to their parent items the same way as a *production bill of material (PBOM)*. The main difference between an EBOM and a PBOM is that EBOMs use different *revisions* of E-items, rather than having a *sequence number* to account for items that are valid on different dates. Record the components of E-items in an EBOM with the **Engineering Bill of Material (tiedm1110m000)** session.

You can use unit effectivity to model various product configurations of the E-item. For more information on unit effectivity, refer to Unit effectivity in EDM.

You can use reference designators in the EBOM to indicate where a component must be mounted on the main item. For more information, refer to Procedure for linking reference designators in the EBOM.

Changing the EBOM

- **Manual changes**
You manually create or change an EBOM for a specific engineering item revision. After approving the revision, the EBOM can be copied to a PBOM. The effective date of the revision is linked to the PBOM lines. The expiry date equals the effective date of the next revision. For more information, refer to Changing EBOMs - Manual procedure.
- **Automatic changes**
You use *MBCs* to simultaneously perform multiple modifications of engineering data. For an MBC, you can define several actions to add, delete, and replace components in a series of EBOMs. If you have correctly defined your MBCs, you can process several of them together in the Process MBC (tiedm3250m000) session. For more information, refer to Changing EBOMs - Automatic procedure.
- **Semi-automatic changes**
You manually create or change an EBOM, after which you use an MBC to approve the changes. For more information, refer to Changing EBOMs - Semi-automatic procedure.

Unit effectivity in EDM

Unit effectivity can be used to model variations in the design of E-items. You can transfer the unit-effective data to the production environment so the variations are modelled in the production environment.

Engineering items

Engineering items (E-items) are theoretical items that form the basis for real items that you can produce. An E-item usually has several *revisions*, or versions, that range from a prototype, to the item you manufacture, to an obsolete item. You can define revisions in the **Engineering Item Revision (tiedm1100m000)** session.

Use the **Engineering Item - Item Relationship (tiedm1101m000)** session to link an approved revision to a production item. You can copy the E-Item revision to a production item in the **Copy Engineering Item to Item (tiedm1201m000)** session.

Record E-item components in an EBOM with the **Engineering Bill of Material (tiedm1110m000)** session. An EBOM has the same structure as a PBOM, but the revisions perform a similar function to the *sequence number* in a PBOM; that is, validity on different dates.

You can copy an EBOM to a *production BOM*.

You can copy E-items and EBOMs individually, or you can copy them using mass bill of material changes (*MBCs*), which enable you to perform several actions simultaneously.

E-Item Relationships

Relationships between E-items and items form the link between an E-item revision and one or more items.

You can use the link to copy a design change that you have made to an E-item to an actual standard or customized item.

Example

E-item: Mountain bike E-MB01

Revision	Description	Status
A1	Draft prototype of bike	In-design
A2	Prototype bike	Approved for Engineering
A3	Parent E-item of bike MB01	Approved for Production
A4	Obsolete bike	Canceled

Note that until the revision with the **In-design** status has been approved, you cannot create another revision. The actual revision for items is the most recent revision for which all the following conditions are met:

- A relationship between a production item and an engineering item must be present.
- For an item linked to an MBC, the effective date of the revision must be before today.
- Either no MBC is used or a related MBC with status **Approved by Production** must exist

E-item - Item relationships

You can define the relationship between an E-item and a production item in the Engineering Item - Item Relationship (tiedm1101m000) session.

E-item/item relationships are used to:

- Determine the actual revision of a manufactured or purchased item that is linked to an E-item.
- Carry through revisions of E-items to the production of manufactured items.

Revision status

LN takes into account the revision status in the following situations:

- A revision can only be linked to an MBC (in the **E-Item by MBC (tiedm3122m000)** session) if the status is **In-design**.
- You can use the **Print Where-Used Revision by MBC (tiedm3470m000)** session to print a signal list.
- When you copy EBOMs with the **EBOM Copy Data (tiedm1120m000)** session, the revision of the parent E-item in the EBOM must have the **Approved by Production** status.
- LN sometimes uses relationships that you have defined in the **Engineering Item - Item Relationship (tiedm1101m000)** session to determine the values of the following fields in the **EBOM Copy Data (tiedm1120m000)** session:
 - **EBOM Copy Method**
 - **To Item**
 - **Item Category**This is only possible if the revisions for which these relationships exist, have the status **Approved by Production**.
- You can only copy single-level EBOMs to PBOMs if the revision of the parent E-item has the status **Approved by Production**.

Engineering BOMs

An engineering bill of material (EBOM) describes the relationships of components to their parent items in the same way that a *production* bill of material (PBOM) does. The main difference between an EBOM and a PBOM is that rather than having a *sequence number* to take account of items valid on different dates, EBOMs use different *revisions* of E-items.

Copying an EBOM

A single-level EBOM can be copied to a single-level PBOM by one of the following three methods:

- **All Available Lines.** All PBOM lines expire and are replaced by the EBOM lines and non-EBOM lines. Non-EBOM lines are lines from a non-project PBOM that are copied to a project. See the copy method **NonProj Item to Proj Item**.
- **Only Corresponding Pos..** Lines in the PBOM whose line numbers match the line numbers in the EBOM are replaced by the corresponding EBOM lines and non-EBOM lines. The other PBOM lines remain unchanged.
- **Corresp. and Linked Pos..** Both lines in the PBOM whose line numbers match the EBOM line numbers, and lines which do not match but have been created by previous finalizing actions performed on engineering data (the **Link with EDM** check box in the Bill of Material (tibom1110m000) session is selected, are replaced by the EBOM lines and non-EBOM lines.

The other lines from the PBOM remain unchanged. These unchanged lines are not engineering-related. An example of one of these lines could be packing materials. In this way, you can make a clear distinction in production BOMs between engineering-related components and logistics components that do not relate to engineering.

If you copy the EBOM to the PBOM, the expiry date of the PBOM component is filled by either:

- The effective date of the revision for the parent E-item from the EBOM.
- The effective date of the PBOM line, if it expires later.

The effective date of the PBOM line expires later than that of the EBOM line if:

- A line is removed from the PBOM.
- A line is replaced by a line from the EBOM, and the **PBOM History** check box in the Engineering Data Management Parameters (tiedm0100m000) session is selected.

To include the line from the EBOM, a new serial number is created for the line in the PBOM.

Determining engineering BOM copy data

When you copy an EBOM line to a PBOM using the **EBOM Copy Data (tiedm1120m000)** session, LN copies default values to the new BOM from the EBOM from the following fields:

- **EBOM Copy Method.**
- **To Item.**
- **Item Category.**

An EBOM's parent item is a particular *revision* of an E-item. The components can be items or E-items.

When you copy a component from an EBOM to a PBOM, you can use the **EBOM Copy Data (tiedm1120m000)** session to define one of the following copy methods:

- **No Copy Action**
No components are copied.
This occurs in the following circumstances:
 - The units of the components in the Component and To Item fields do not match.
 - There is no valid released revision of the E-item.
 - The component in the EBOM is not a physical E-item.
 - A project item is copied to another project item, for which there is no relationship with either the item or with the project.
- **Copy E-Item to Item**
Copy the E-item to an item and copy the relevant EBOM line to the PBOM line.
- **NonProj Item to Proj Item**
Do not copy an E-item or EBOM, but copy a non-project item to a project item (that is, a standard item to a customized item). Also copy the non-project item's bill of material and routing to the project item's bill of material and routing.
- **EBOM to Production BOM Only**
Copy only one line from the EBOM to the PBOM.

Which copying method should I use?

To determine which copying method you must use, answer question 1 and follow the instructions.

- Question 1
Is the source component a project item (that is, is a project defined in the first segment of the item code)?
 - If the answer is yes, proceed with question 3.
 - If the answer is no, proceed with question 2.
- Question 2
Is the target component a project item?
 - If the answer is yes, select copy method **NonProj Item to Proj Item**.
 - If the answer is no, proceed with question 4.
- Question 3
Is there a relationship with the same project?
 - If the answer is yes, select copy method **EBOM to Production BOM Only**.
 - If the answer is no, proceed with question 4.
- Question 4
Is there a relationship with the target item?
 - If the answer is yes, proceed with question 5.
 - If the answer is no, select copy method **No Copy Action**.
- Question 5
Does the item exist already?
 - If the answer is yes, select copy method **EBOM to Production BOM Only**.
 - If the answer is no, select copy method **Copy E-Item to Item**.

Relationships

When searching for items using relationships defined in **Engineering Item Revision (tiedm1100m000)** session, LN uses the following rules:

- When data is copied to a project, relationships with project items take priority over relationships with non-project items.
- When data is not copied to a project, only relationships with non-project items apply.

When searching for relationships, the following priorities apply:

- relationships created by, or used in, copying from an EBOM have priority over relationships created by, or used in, copying an E-item to an item.
- Relationships created by, or used in, copying an E-item to an item have priority over relationships not used in copying.

Changing EBOMs - Manual procedure

If you want to change and approve the BOM of an *engineering item (E-item)*, you can do this in three ways:

- Change and approve EBOMs by means of an *mass BOM change (MBC)*. For more information, refer to Changing EBOMs - Automatic procedure
- Make changes in EBOMs manually, and approve the EBOMs by means of an MBC. For more information, refer to Changing EBOMs - Semi-automatic procedure.
- Change and approve the EBOM manually. For more information, refer to the procedure below..

1 Engineering Item (tiedm0110m000)

Define a new E-item in the **Engineering Item (tiedm0110m000)** session, or transfer an existing production item to Engineering Data Management by using the **Copy Shop Floor PBOM to EBOM (tiedm0205m000)** session. If you want to implement an approval procedure for the E-item, select the **CHM Control** check box in the **Engineering Item (tiedm0110m000)** session. You must use Change Management in Data Management to carry out the approval procedure.

2 Engineering Item Revision (tiedm1100m000)

Select the E-item in the **Engineering Item (tiedm0110m000)** session, and start the **Engineering Item Revision (tiedm1100m000)** session in the *appropriate* menu. A new revision is now defined for the E-item. The revision status is **In Design**.

3 Engineering Bill of Material (tiedm1110m000)

Select the E-item revision in the **Engineering Item Revision (tiedm1100m000)** session and start the **Engineering Bill of Material (tiedm1110m000)** session. You can now manually define or change the EBOM according to your wishes.

4 Approve for engineering

If you have carried out the changes in the EBOM, you can approve the revision for engineering. To do so, select the revision in the **Engineering Item Revision (tiedm1100m000)** session, and click **Approve by Engineering** in the *appropriate* menu. The revision status changes to **Approved by Engineering** to indicate that the EBOM is approved.

5 Engineering Item - Item Relationship (tiedm1101m000)

If desired, you can now define for which (production) item(s) the revision is meant. Select the revision in the **Engineering Item Revision (tiedm1100m000)** session, and click **Relationships** in the *appropriate* menu. The **Engineering Item - Item Relationship (tiedm1101m000)** session is started. In this session, you can define one or more items. This can be existing items, selected from the **Items (tcibd0501m000)** session, or new items for which you enter the item name. Note that it is not mandatory to define relationships manually in this stage. Item relationships can also be automatically generated in step 8. For more information, refer to step 8.

6 CHM control

If your E-item is CHM-controlled, that is, if the **CHM Control** check box in the **Engineering Item (tiedm0110m000)** session is selected, you must complete the approval procedure in Data Management. Otherwise, you cannot approve the revision for production as described in the next step.

7 Approve for production

Approve the revision for production. Select the E-item in the **Engineering Item Revision (tiedm1100m000)** session, and click **Approve by Production** in the *appropriate* menu. The revision status changes to **Approved by Production**.

8 Copy Engineering Item to Item (tiedm1201m000)

Copy the E-item data for production. Select the E-item in the **Engineering Item Revision (tiedm1100m000)** session, and click **Copy Engineering Item to Item** in the *appropriate* menu. The **Copy**

Engineering Item to Item (tiedm1201m000) session is started. The source item in this session is the E-item you are working on. In the **Item** field, you can enter one of the items you defined in **Engineering Item - Item Relationship (tiedm1101m000)** session. However, if you did not define any relationships, you can enter a new name or the same name as the source item in the **Item** field. A production item with this name is automatically created. The newly created product item is also displayed in the **Engineering Item - Item Relationship (tiedm1101m000)** session. Note that you must enter an item group in the **Copy Engineering Item to Item (tiedm1201m000)** session to get defaults for the newly created items.

9 **Generate EBOM Copy Data (Multilevel) (tiedm1230m000)**

Select the E-item in the **Engineering Item Revision (tiedm1100m000)** session, and click **Generate EBOM Copy Data (Multilevel)** in the *appropriate* menu. The **Generate EBOM Copy Data (Multilevel) (tiedm1230m000)** session is started. You must enter the source item and the target item. If you click **Generate**, the E-item's EBOM data is collected and put in a buffer for copying. If desired, you can now make some changes using the **EBOM Copy Data (tiedm1120m000)** session, which you can start from the **Engineering Item - Item Relationship (tiedm1101m000)** session.

10 **Finalize Engineering Data (tiedm3240m000)**

Select the E-item in the **Engineering Item Revision (tiedm1100m000)** session, and click **Finalize Engineering Data** in the *appropriate* menu. The **Finalize Engineering Data (tiedm3240m000)** session is started. The EBOM is copied to the (new) production item.

11 **Archive/Delete Engineering Data (tiedm1250m000)**

If desired, you can archive the E-item data in the **Archive/Delete Engineering Data (tiedm1250m000)** session.

Note: You can reset the revision status by selecting the revision in the **Engineering Item Revision (tiedm1100m000)** session, and then click **Reset Revision Status** from the *appropriate* menu.

Changing EBOMs - Semi-automatic procedure

If you want to change and approve the BOM of an *engineering item (E-item)*, you can do this in three ways:

- Change and approve the EBOM manually. For more information, refer to Changing EBOMs - Manual procedure.
- Change and approve EBOMs by means of an *mass BOM change (MBC)*. For more information, refer to Changing EBOMs - Automatic procedure.
- Make changes in EBOMs manually, and approve the EBOMs by means of an MBC. For more information, refer to the procedure below.

1 **Engineering Item (tiedm0110m000)**

Define a new E-item in the **Engineering Item (tiedm0110m000)** session, or transfer an existing production item to Engineering Data Management by using the **Copy Shop Floor PBOM to EBOM (tiedm0205m000)** session.

If you want to implement an approval procedure for the E-item, select the **CHM Control** check box in the **Engineering Item (tiedm0110m000)** session. You must use Change Management in Data Management to carry out the approval procedure. However, an approval procedure on the MBC level (refer to step 2), overrules an approval procedure on the E-item level.

2 **MBC (tiedm3110m000)**

Define a new MBC in the **MBC (tiedm3110m000)** session. If you are manually linking E-item revisions to the MBC in the semi-automatic EDM procedure, you must clear the **Automatic Generation of EBOMs** check box in the **MBC (tiedm3110m000)** details session. The date in the **Effective Date for Revisions created by this MBC** field is the date that the revisions linked to the MBC become effective after the MBC is finalized.

If you want to implement an approval procedure for an MBC, select the **CHM Control** check box in the **MBC (tiedm3110m000)** session. You must use Change Management in Data Management to carry out the approval procedure. The setting of the **CHM Control** check box in this session overrules the setting of the **CHM Control** check box for an E-item in the **Engineering Item (tiedm0110m000)** session.

3 **Engineering Item Revision (tiedm1100m000)**

Select the E-item for which you want to make changes in the **Engineering Item (tiedm0110m000)** session, and start the **Engineering Item Revision (tiedm1100m000)** session in the *appropriate* menu. A new revision is now defined for the E-item. The revision status is **In Design**.

4 **Engineering Bill of Material (tiedm1110m000)**

Select the E-item revision in the **Engineering Item Revision (tiedm1100m000)** session and start the **Engineering Bill of Material (tiedm1110m000)** session. You can now manually define or change the EBOM according to your wishes.

You must repeat step 3 and 4 until you have created all desired revisions for the E-items and EBOM changes.

5 **E-Item by MBC (tiedm3122m000)**

Select the MBC, and start the **E-Item by MBC (tiedm3122m000)** session. In this session, you can manually link the E-items and their revisions to the MBC. If you save the linked E-items, you can view and maintain the date that the revision becomes effective in the **Effective Date of New Revision** field. This date is defined in the **MBC (tiedm3110m000)** details session. For more information, refer to step 2.

6 **Approve MBC by Engineering**

If you have carried out the changes in the EBOMs, and you linked the E-items to the MBC, you can approve the revisions for engineering. To do so, select the MBC in the **MBC (tiedm3110m000)** session, and click **Approve MBC by Engineering** in the *appropriate* menu.

The MBC status changes to **Approved by Engineering** to indicate that the revisions linked to the MBC are approved.

7 **CHM control**

If your E-item or MBC is CHM-controlled, that is, if the **CHM Control** check box for the E-item or MBC is selected, you must first complete the approval procedure in Data Management. Otherwise, you cannot approve the MBC for production as described in the next step.

8 **Approve for production**

Approve the MBC for production. Select the MBC in the **MBC (tiedm3110m000)** session, and click **Approve MBC by Production** in the *appropriate* menu. The MBC status changes to **Approved by Production**.

If you approve the MBC, a question pops up: **E-BOM Changes not processed for all E-Items by MBC; Approving by Production not allowed..** If you click No, you must run the **Generate EBOM Copy Data by MBC (tiedm3235m000)** session in step 10. If you click Yes, EBOM copy data is generated, so you can skip step 10.

9 **Engineering Item - Item Relationship (tiedm1101m000)**

If an E-item revision is created for the first time, you must define for which (production) item(s) the revision is meant. Select the revision in the **Engineering Item Revision (tiedm1100m000)** session, and click **Relationships** in the *appropriate* menu. The **Engineering Item - Item Relationship (tiedm1101m000)** session is started. In this session, you can define items that are related to the E-items. The items that you define can be existing items, selected from the **Items (tcibd0501m000)** session, or new items for which you enter the item name.

10 Generate EBOM Copy Data by MBC (tiedm3235m000)

Select the MBC in the **MBC (tiedm3110m000)** session, and click **Generate EBOM Copy Data by MBC** in the *appropriate* menu. The **Generate EBOM Copy Data by MBC (tiedm3235m000)** session is started. You must enter a range of MBCs. If you click **Generate**, the EBOM data for the revisions linked to the MBC is collected and put in a buffer for copying. If desired, you can now make some changes using the **EBOM Copy Data (tiedm1120m000)** session, which you can start from the **Engineering Item - Item Relationship (tiedm1101m000)** session.

11 Finalize Engineering Data (tiedm3240m000)

Select the MBC in the **MBC (tiedm3110m000)** session, and click **Finalize Engineering Data** in the *appropriate* menu. The **Finalize Engineering Data (tiedm3240m000)** session is started. The EBOMs of the E-items linked to the MBC are copied to the (new) production items.

12 Archive/Delete Engineering Data (tiedm1250m000)

If desired, you can archive the E-item data in the **Archive/Delete Engineering Data (tiedm1250m000)** session.

Changing EBOMs - Automatic procedure

If you want to change and approve the BOM of an *engineering item (E-item)*, you can do this in three ways:

- Change and approve the EBOM manually. For more information, refer to Changing EBOMs - Manual procedure.
- Make changes in EBOMs manually, and approve the EBOMs by means of an MBC. For more information, refer to Changing EBOMs - Semi-automatic procedure.
- Change and approve EBOMs by means of an *mass BOM change (MBC)*. For more information, refer to the procedure below.

1 Engineering Item (tiedm0110m000)

If required, define new E-items in the Engineering Item (tiedm0110m000) session, or transfer existing production items to Engineering Data Management by using the Copy Shop Floor PBOM to EBOM (tiedm0205m000) session.

2 MBC (tiedm3110m000)

Define a new MBC in the MBC (tiedm3110m000) session. In step 3, you must link actions to the MBC. These actions stand for the changes that are performed on (E)-items. The **Include/Exclude E-Items per Action** check box in the **MBC (tiedm3110m000)** session is an important check box in this respect:

- If the Include/Exclude E-Items per Action check box is cleared, the action(s) linked to an MBC apply to the items that are defined for the MBC.

- If the **Include/Exclude E-Items per Action** check box is selected, you must define for every, separate action to which item(s) the action applies.

You must link items to an MBC or an action in the **Include/Exclude E-Items (tiedm3121m000)** session (refer to step 4). If the **Include/Exclude E-Items** field in the **MBC (tiedm3110m000)** session or the **MBC Action (tiedm3120m000)** session is **Include**, the **Include/Exclude E-Items (tiedm3121m000)** session lists the items on which the MBC or the action is performed. If the **Include/Exclude E-Items** field in the **MBC (tiedm3110m000)** session or the **MBC Action (tiedm3120m000)** session is **Exclude**, the **Include/Exclude E-Items (tiedm3121m000)** session lists the items on which the MBC or the action is not performed. In other words, the MBC or action is performed on all items, except for the items listed in the **Include/Exclude E-Items (tiedm3121m000)** session.

If you want to implement an approval procedure for an MBC, select the **CHM Control** check box in the **MBC (tiedm3110m000)** session. You must use Change Management in Data Management to carry out the approval procedure.

3 MBC Action (tiedm3120m000)

Select the MBC in the **MBC (tiedm3110m000)** session, and click **MBC Actions** from the *appropriate* menu. The **MBC Action (tiedm3120m000)** session is started. You can define one or more actions that belong to the MBC, and which are performed on E-items. The type of actions that can be distinguished are adding, deleting, or replacing an item in an E-item's BOM.

The **All Actions Must Apply to Item** check box in the **MBC Action (tiedm3120m000)** session indicates whether all actions must have an effect on a specific item before the changes take place on the item, or that only part of the actions have to apply. If this check box is selected, only items in the **Include/Exclude E-Items (tiedm3121m000)** session to which all actions apply are changed by means of the actions. The items to which only part of the actions apply are not changed. If this check box is cleared, the items in the **Include/Exclude E-Items (tiedm3121m000)** session to which all actions apply are changed by means of the actions. However, also items to which only part of the actions apply are changed by the actions. You must set the **All Actions Must Apply to Item** check box in the **MBC (tiedm3110m000)** session.

4 Include/Exclude E-Items (tiedm3121m000)

Define the items that are affected by the actions linked to the MBC. Dependent on the **Include/Exclude E-Items per Action** check box in the **MBC (tiedm3110m000)** session you must define items by action or by MBC:

- If you selected the **Include/Exclude E-Items per Action** check box in the **MBC (tiedm3110m000)** session, you must define items by action. To do so, select the appropriate action in the **MBC Action (tiedm3120m000)** session, and click **Include/Exclude E-Items** from the *appropriate* menu. The **Include/Exclude E-Items (tiedm3121m000)** session is started. Define the E-items to which the action is applied.
- If you cleared the **Include/Exclude E-Items per Action** check box in the **MBC (tiedm3110m000)** session, you must define items by MBC. To do so, select the appropriate MBC in the **MBC (tiedm3110m000)** session, and click **Include/Exclude E-items** from the *appropriate* menu. The **Include/Exclude E-Items (tiedm3121m000)** session is started. Define the E-items to which the actions are applied.

If the **Include/Exclude E-Items** field in the **MBC (tiedm3110m000)** session or the **MBC Action (tiedm3120m000)** session is **Include**, the **Include/Exclude E-Items (tiedm3121m000)** session lists the items on which the MBC or the action is performed. If the **Include/Exclude E-Items** field in the **MBC (tiedm3110m000)** session or the **MBC Action (tiedm3120m000)** session is **Exclude**, the **Include/Exclude E-Items (tiedm3121m000)** session lists the items on which the MBC or the action is not performed. In

other words, the MBC or action is performed on all items, except for the items listed in the **Include/Exclude E-Items (tiedm3121m000)** session.

5 **Generate E-Items by MBC (tiedm3201m000)**

Select the appropriate MBC in the **MBC (tiedm3110m000)** session, and click **Generate E-Items by MBC** from the *appropriate* menu. The Generate E-Items by MBC (tiedm3201m000) session is started. The E-items that are affected by the MBC actions are collected. You can view the list of E-items in the **E-Item by MBC (tiedm3122m000)** session.

6 Approve MBC for engineering

You can now approve the MBC for engineering. To do so, select the MBC in the **MBC (tiedm3110m000)** session, and click **Approve MBC by Engineering** in the *appropriate* menu. You must decide processing the EBOM changes for the MBC by clicking Yes or No, and you must decide to approve the E-items' revisions by MBC for engineering by clicking Yes or No. The MBC status changes from **In Design** to **Approved by Engineering**.

7 CHM control

If your E-item or MBC is CHM-controlled, that is, if the **CHM Control** check box for the E-item or MBC is selected, you must first complete the approval procedure in Data Management. Otherwise, you cannot approve the MBC for production as described in the next step.

At this point in the procedure, you must decide whether to carry out separate steps to finalize the engineering data (refer to step 8), or to use the **Process MBC (tiedm3250m000)** session to carry out all the steps in one go (refer to step 9).

8 Separate steps to finalize engineering data

Carry out the following separate steps to finalize the engineering data:

- a Select the appropriate MBC in the **MBC (tiedm3110m000)** session, and click **Process EBOM Changes** in the *appropriate* menu. The **Process EBOM Changes (tiedm3205m000)** session is started. If you run this session, the actions linked to the MBC are carried out, which results in modified EBOMs.
- b Select the appropriate MBC in the **MBC (tiedm3110m000)** session, and click **Approve MBC by Production** from the *appropriate* menu. The MBC status changes to **Approved by Production**.
- c If the MBC contains an E-item for which a revision does not exist yet, you must define a relationship in the **Engineering Item - Item Relationship (tiedm1101m000)** session.
- d Select the appropriate MBC in the **MBC (tiedm3110m000)** session, and click **Generate EBOM Copy Data by MBC** in the *appropriate* menu. The **Generate EBOM Copy Data by MBC (tiedm3235m000)** session is started, and you can enter one or more MBC numbers. If you click Generate, the EBOM data of the E-items affected by the MBC(s) is collected and put in a buffer for copying.
- e Select the appropriate MBC in the **MBC (tiedm3110m000)** session, and click **Finalize Engineering Data** in the *appropriate* menu. The Finalize Engineering Data (tiedm3240m000) session is started. The EBOM data is copied to production items.
- f Continue with step 10.

9 **Process MBC (tiedm3250m000)**

Use the Process MBC (tiedm3250m000) session to carry out all steps to finalize the engineering data in one go. In the session, you can select check boxes to do the following:

- Process EBOM changes, that is, to carry out the MBC actions
- Approve the new revisions for production
- Generate EBOM copy data
- Finalize the engineering data

Click **Process** to process the MBC. Continue with step 10.

10 Archive/Delete Engineering Data (tiedm1250m000)

If desired, you can archive the E-item data in the **Archive/Delete Engineering Data (tiedm1250m000)** session.

Note:

If the Manual Revision Numbering check box in the **Engineering Data Management Parameters (tiedm0100m000)** session is selected, you must manually enter revision numbers for the MBC. To do so, select the MBC in the **MBC (tiedm3110m000)** session, and click **E-Items by MBC**. Double click the E-items in the **E-Item by MBC (tiedm3122m000)** session, and enter the desired revision number.

You can reset the MBC status by selecting the MBC in the **MBC (tiedm3110m000)** session, and then click **Reset MBC Status** from the *appropriate* menu.

Copying E-items to items

You can copy E-items individually. You can also copy EBOMs and E-items using MBCs. For more information on MBCs, see the Changing EBOMs - Automatic procedure topic.

How to copy an E-item to an item

- Make sure that an E-item *revision* has the status **Approved by Production**.
- Create a link between the E-item revision and a standard or customized item using the Engineering Item - Item Relationship (tiedm1101m000) session. If the item does not already exist, LN provides the option to create it.
- Copy the E-item to the production item with the Copy Engineering Item to Item (tiedm1201m000) session.
- You can check whether the new or revised item is the same as the original E-item using the EBOM Copy Data (tiedm1120m000) session.

What happens when you copy an E-item?

When you copy an *E-item*, LN carries out the following actions:

- If the production item does not exist, LN creates it.
- An already existing relationship between an E-item and an item is updated in the session **Engineering Item - Item Relationship (tiedm1101m000)**. When the item relationship is updated, the **E-Item Copied** check box is selected, and the **E-Item Copy Date** field is given the value of the date of copying.
- LN checks if a valid revision has the status **Approved by Production**. If it does not, a relationship cannot be established.

Note: The result of copying an E-item to an item depends on the value of the item's Update Engineering Item Relations field in the **Items (tcibd0501m000)** session. You can alter that with the Update Engineering Relationship (tiedm3220m000) session.

Finalizing engineering data

You can *finalize* engineering data with the following sessions:

- **EBOM Copy Data (tiedm1120m000)** (for a single-level EBOM).
- **Finalize Engineering Data (tiedm3240m000)**.
- **Process MBC (tiedm3250m000)**.

Finalizing individual items

When you want to finalize individual E-items using the Finalize Engineering Data (tiedm3240m000) session, you can enter selections of E-items, revisions, and items.

Before you run the Finalize Engineering Data (tiedm3240m000) session, you must record the EBOM copy data for E-items that you want to finalize, using:

- The **EBOM Copy Data (tiedm1120m000)** session, or
- The **Generate EBOM Copy Data by MBC (tiedm3235m000)** session.

Finalizing with mass bill of material changes (MBCs)

- Before you finalize E-items with an MBC using the Finalize Engineering Data (tiedm3240m000) session, you must record the EBOM copy data using the **Generate EBOM Copy Data by MBC (tiedm3235m000)** session.
- If you finalize using an MBC, the **Finalization Date** field is filled and the MBC status becomes **Finalized**.
- If the method of finalizing is **with MBC**, the data is removed from the **E-Item by MBC (tiedm3122m000)** session.

If you want to finalize using an MBC, you can select the MBCs you want to use. The status of those MBCs must then be **Approved by Production**.

Actions during finalizing

- You can create a new item while you copy from the E-item.
- LN creates a relationship between an E-item *Revision* and the item if no relationship already exists.
- LN copies E-items to items, if you selected the method copying an E-item to an Item (depending on the **EBOM Copy Method** that you defined in **EBOM Copy Data (tiedm1120m000)** session).
- LN copies the positions of the single-level EBOM to a PBOM, if you selected EBOM to PBOM (depending on the **EBOM Copy Method** that you defined in **EBOM Copy Data (tiedm1120m000)** session).
- LN selects the **Link with EDM** check box for each position in the PBOM that is copied from the EBOM.
- LN selects the **EBOM Copied** check box in the **EBOM Copy Data (tiedm1120m000)** session, and the **EBOM Copy Date** field is filled by the date that the MBC is finalized.

You can determine which production BOM lines are replaced by EBOM lines by either:

- Altering the production BOM Update Method in the **Finalize Engineering Data (tiedm3240m000)** or **Process MBC (tiedm3250m000)** session.
- Selecting different choices, such as Recopy BOM lines or Copy E-item to Items from the *appropriate* menu in the **EBOM Copy Data (tiedm1120m000)** session.

The circumstances in which you cannot finalize an EBOM

A single-level EBOM will not be finalized for an E-item if any of the following conditions apply:

- The project to which the item is copied has the status **Canceled, Finished, Closed, Archived**.
- The project to which the item is copied is a main project.
- The revision of the parent E-item is not **Approved by Engineering**.
- The units of measurement of the parent E-item and the item are different.

A single-level EBOM will not be finalized for a component if any of the following conditions apply: The EBOM Copy Method in the **EBOM Copy Data (tiedm1120m000)** session is **EBOM to Production BOM Only** and if one of the following criteria are met:

- The method is **EBOM to Production BOM Only**
- The component's unit of measurement differs from the unit of the EBOM component.

The EBOM Copy Method in the **EBOM Copy Data (tiedm1120m000)** session is **NonProj Item to Proj Item** and if one of the following conditions is true:

- The nonproject item is copied to a project item that does not exist.
- The unit that is used differs from the unit of the EBOM component.

The EBOM component is an E-item and does not have a valid **Approved by Engineering**

Unit effectivity in EDM

To set up and use *unit effectivity* in Engineering Data Management you must use the Unit Effectivity module in Common. To set up data, refer to To set up unit effectivity.

To use unit effectivity when engineering an item, carry out the following steps:

- 1 Define the engineering bill of material (EBOM) in the **Engineering Bill of Material (tiedm1110m000)** session. To link exceptions to a BOM line, select the BOM line and click **Exceptions** from the *appropriate* menu. The **Exceptions (tcuef0105m000)** session is started. If the end item is already defined, you can use effectivity units of the end item. Otherwise, use effectivity units of engineering items.
- 2 The purpose of exceptions in an EBOM is to engineer a generic design. This means that when the design is finished, all exceptions must be copied to the *production BOM*. Use the **Copy Engineering BOM** session to copy the EBOM and its linked exceptions to the PBOM. During the copy process, LN provides the user with the possibility to replace the engineering item in the item – effectivity series with a general end item. To do so, LN starts the **Relink Item - Effectivity Series (tcuef0201m000)** session.
- 3 At a certain point of time, a general end item must be defined. This is the item that is used on the sales order line. For reasons of clearness, you must link the item – effectivity series that is still linked to the engineering item to the end item. Use the **Relink Item - Effectivity Series (tcuef0201m000)** session to relink the effectivity series from the engineering item to the end item. You can start this session from the *appropriate* menu in the **Items - Effectivity Series (tcuef0101m000)** session.

Finalizing Engineering Data

If you copy an E-BOM to a *PBOM* by using the **Finalize Engineering Data (tiedm3240m000)** session, LN proceeds as follows. If the Unit Effective Supply check box in the **Items (tcibd0501m000)** session is selected for the end item, LN does not copy the *effectivity statements*.

Engineering BOM for assembly production

You can create an Engineering BOMs for *engineering modules*.

To create an engineering *bill of material (BOM)* for *engineering modules*:

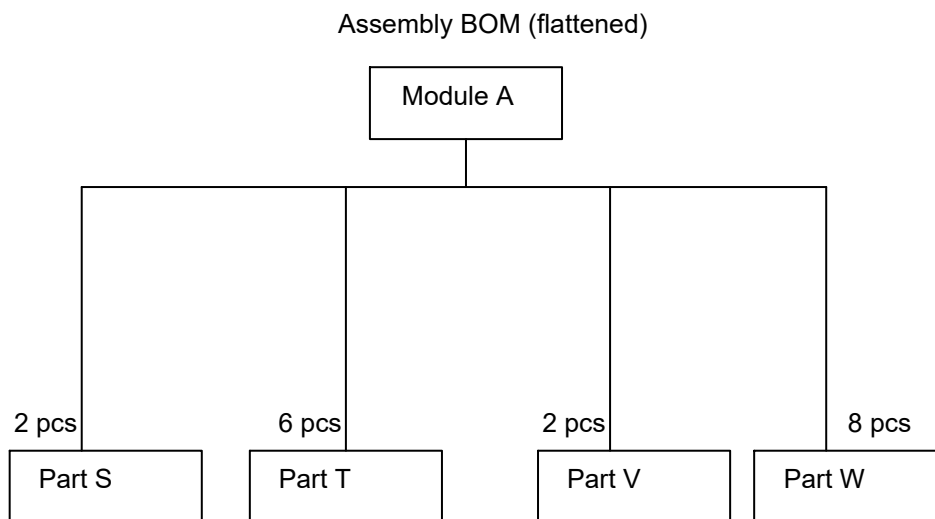
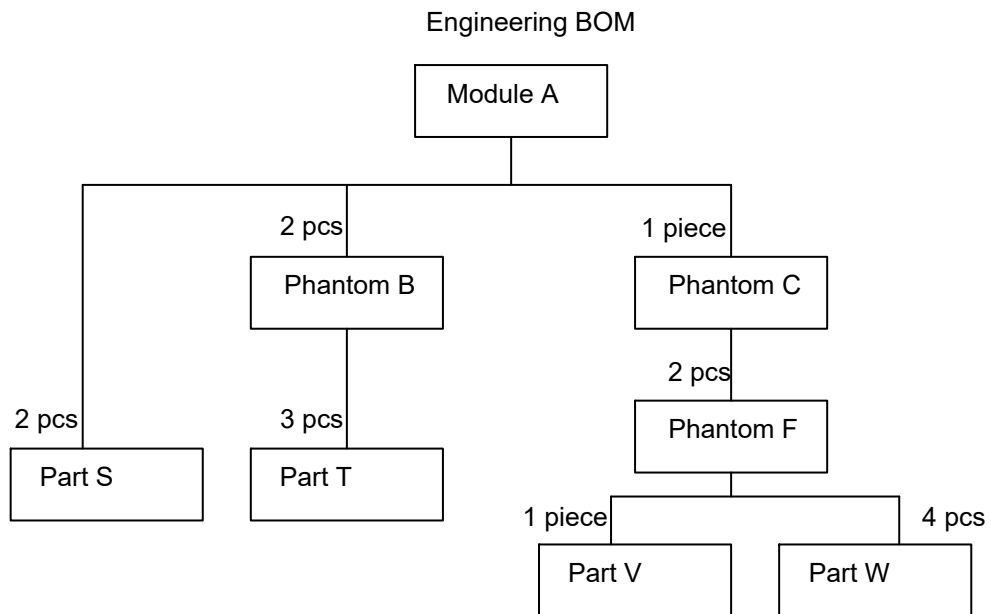
- 1 Start the Generate EBOM Copy Data (Multilevel) (tiedm1230m000) session. Generate copy data for an EBOM for an *engineering item* of type Engineering Module.
- 2 Start the Finalize Engineering Data (tiedm3240m000) session. *Finalize* copying the data which you have generated in the previous step.

Note: Items of the type **Manufactured** or **Product** with the default supply source set to **Assembly** are produced in the Engineering Data Management module. These items are considered *phantom subassemblies*: they are not copied to Assembly Control or Job Shop Control, and are not defined in the Items (tcibd0501m000) session.

Flattening

The copy process flattens the structure of the engineering *bill of material (BOM)*. Flattening means all intermediate *phantom subassemblies*, are skipped. Multilevel BOM relations are reduced to a single level relation, with quantities multiplied and effective dates combined.

This figure shows an example of flattening:



The following multilevel BOM relations are reduced to a single level relation:

- Module A -> Phantom B -> Part T
Combined to Module A -> Part T
- Module A -> Phantom C -> Phantom F -> Part V
Combined to Module A -> Part V
- Module A -> Phantom C -> Phantom F -> Part W
Combined to Module A -> Part W

Engineering Item Revision

To define new revisions for an E-item in the **Engineering Item Revision (tiedm1100m000)** session, click the **New** button. You can insert multiple revisions that have the **In-design** status. You cannot insert a new revision if the previous revision is linked to an *MBC*, and EBOM changes have not yet been processed for that *MBC*.

To select a different *E-item* for which you can define new revisions, click the **Find a record** button. The E-item must be defined in the **Engineering Item (tiedm0110m000)** session.

If the revision is valid, it can affect a standard or customized item. The revision is valid if:

- The revision's status is **Approved by Production**.
- The revision is linked to a standard item or to a customized item defined in the **Engineering Item - Item Relationship (tiedm1101m000)** session.
- The revision's current date falls between the effective date and the expiry date. The default effective date of a new revision is the current date. This date is used as the expiry date for the previous revision.

To delete a revision with **In-design** status, select the revision and then select **Cancel Revision** from the **Edit** menu.

You cannot change the status to **Approved by Engineering** or **Approved by Production** if the revision is created by an *MBC* for which EBOM changes are not yet processed.

Specific menu

You can alter the status of an E-item revision in the **Status** field to:

- **Frozen**, if the revision status is **In-design**.
- **In-design**, if the revision status is **Frozen**.
- **Approved by Engineering**, if the revision status is **Frozen** or **In-design**.
- **Approved by Production**, if the revision status is **Approved by Engineering** or **In-design**.
- **Canceled**, if the revision status is **Approved by Engineering**. If you cancel an *MBC* in the **MBC (tiedm3110m000)** session, all the revisions that are linked to that order are also cancelled. **In-design** revisions can be deleted and **Canceled** revisions can be archived. You can not cancel a revision that is **Approved by Engineering** if the revision is linked to an *MBC* for which the EBOM changes are not yet been processed.

You can also start the following sessions from the *appropriate* menu:

- Archive/Delete Engineering Data (tiedm1250m000)
- Copy Engineering Item to Item (tiedm1201m000)
- Generate EBOM Copy Data (Multilevel) (tiedm1230m000)
- Finalize Engineering Data (tiedm3240m000)
- Engineering Bill of Material (tiedm1110m000)
- Engineering Item - Item Relationship (tiedm1101m000)
- Reference Designators by Engineering Item (tiedm0120m000)

Reports

If you click **Print**, you can select a session to produce reports about revisions:

- Print Engineering Item - Revisions (tiedm1400m000).

- Print Where-Used E-Item Revision (tiedm3460m000).

Chapter 14: Product Classification

Product Classification (GRT)

Many companies spend too much time searching for items in their information system. Although the information is available, the item cannot be found immediately because the information is not organized coherently. The Product Classification module helps you increase the accessibility of your item data as it enables you to set up a classification and coding system that quickly retrieves items.

The Product Classification module offers the following facilities:

- Item classification and coding. By defining groups (families) and characteristics (features), you are able to categorize items and describe their properties (both for standard and customized items). Item family and property data is stored by means of a classification code.
- Item search. Items are searched for by family and properties.
- Item code generation. You can include parts of the classification code in the code of a new item, which allows for systematic item coding.

Setting up a classification structure in GRT

It can be difficult to find specific items in a company when there is no coherent classification system. The Product Classification module enables you to set up a classification and coding system that can help you quickly retrieve items.

Classification serves to distinguish and summarize objects by relevant characteristics. In other words, to classify objects into groups. In the Product Classification module, groups are called families. The GRT word for the characteristics of a group is features.

To set up a classification structure, the subjects that follow are crucial:

- Families (refer to Families in GRT).
- Features (refer to Features in GRT).
- User data (authorizations).
- Interaction data (refer to Interaction data in GRT).
- Item code structure.

You can classify items after you have set a classification structure. First check whether the item exists in LN. If it does exist in LN, you can start classifying the item (refer to Classifying items in GRT). If the item does not

exist, you can code and classify the new item. You can also include parts of the classification code in the code of the new item (refer to Coding and classifying items in GRT).

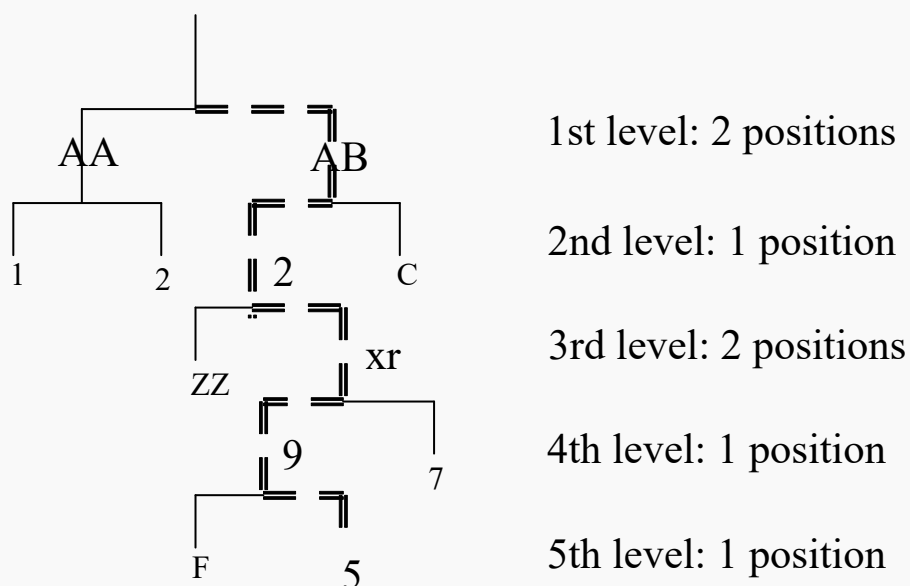
Note: If you use the Enterprise Modeler Content Pack with LN, consider using the MCO1010 (Item Classification) wizard to set up an item classification. You can execute this predefined wizard from the **Wizards by Project Model (tgwzr4502m000)** session after you specified the *business function model* for your company. See Business function model .

Families in GRT

Define the number of levels in the family code.

A family is identified by an 8-position family code. These eight positions allow for a levelled structure (1 up to 8 layers), that you define in the **Structure Levels (tigrt0199m000)** session.

Example



The family code is divided to five levels. For each level, a number of positions has been reserved. By following the === line, you obtain the family code: AB2xr95.

Define family groups and family structure.

After you define the structure levels, you have to set up the family structure that consists of family groups. For each family group one or more families are selected. For example, the family group vehicles can consist

of the families cars and buses. If a selection involves subselections, the family group one lower is also entered. Use the **Family Groups (tigrt0198m000)** session and the **Family Structure (tigrt0193m000)** session to complete the family structure.

Define families

Once the family structure has been set up, you must define families with codes. Only the end of the family structure can be defined as families, and receive a family code. Use the **Families (tigrt0103m000)** session to define the families (refer to Composing a family code - an example).

Features in GRT

Features

Features are used to describe the characteristics of families. The family 'Cars' can have, for example, the features engine and colour.

Each feature has an 8-position classification code used to store its values. These eight positions can be subdivided again by means of aspects. A maximum of eight aspects can be assigned to a feature. For example, the aspects of the feature engine can be:

- Number of cylinders
- Number of valves per cylinder
- Cylinder capacity

You can link a maximum of 99 features to a family.

Use the **Features (tigrt0101m000)** session to define the features. Together with the feature, an aspect is created (code length 8). Use the **Aspects by Feature (tigrt0104m000)** session to change the length of an aspect, and to define additional aspects for a feature.

Use the **Features by Family (tigrt0102m000)** session to link features to a family.

Interaction data in GRT

Interaction data

The classification and coding of items can be accomplished by questions and answers about the features of the item, or by calculation. Specify which interaction type (question and answer, or calculation) you want to use in the **Aspects by Feature (tigrt0104m000)** session.

When you use question and answer to classify items, one question allows for various answers (defined in an answer group), and each answer is linked to a specific code. That code (or return value) is included in the

classification code for the item. Use the **Questions (tigrt0120m000)** session to create the questions. Use the **Answer Groups (tigrt0125m000)** session to create answer groups.

Another way to classify items is with the help of calculations. You are prompted for a series of numbers. LN uses them to perform a calculation, the result of which is included in the classification code. You may have the calculation result compared with an answer group. The return value of the answer is included in the classification code. Use the **Calculation ID (tigrt0130m000)** session to define the calculation data. Use the **Calculation Questions (tigrt0131m000)** session to compose calculation questions. Use the **Calculations (tigrt0132m000)** session to define the calculation.

Constraints enable you to define conditions before an aspect is being coded. The condition must be based on the preceding values in the classification code. A constraint always corresponds to one specific aspect linked to a family. Use the **Constraints by Family Feature (tigrt0135m000)** session to define the aspect-family combination(s) the constraint is linked with. Use the **Constraint ID (tigrt0136m000)** session to define the constraint ID. Use the **Constraints (tigrt0137m000)** session to define the constraint.

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