



User Guide

Volume 3

MANUFACTURING

PRODUCT STRUCTURES
ROUTINGS/WORK CENTERS
FORMULA/PROCESS
CO-PRODUCTS/BY-PRODUCTS
WORK ORDERS
SHOP FLOOR CONTROL
ADVANCED REPETITIVE
REPETITIVE
QUALITY MANAGEMENT
FORECASTING/MASTER SCHEDULE PLANNING
MATERIAL REQUIREMENTS PLANNING
CAPACITY REQUIREMENTS PLANNING



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param91.p 14.13.2 Routing Maintenance (Main Screen)

Routing Code:	10-15000	NONAD(75) COOLING
Operation:	20	
Standard Operation		
Work Center	1030	INSPECTION, ALL SITES
Machine		
Description	INSPEC PER PROC-005	
Machines per Op	1	Milestone P
Overlap Units	1	
Queue Time	1.0	
Wait Time	0.0	
Setup Time	0.0	
Done by	Production B	14.13.2

What Is in This Guide?

This guide covers features of the MFG/PRO Version 9.0 manufacturing modules.

Other 9.0 Documentation

- For an overview of new features and software updates, see the *9.0 Release Bulletin*.
- For software installation instructions, refer to the *9.0 Installation Guides*.
- For instructions on navigating the MFG/PRO environment, refer to the *9.0 User Interface Guide*.
- For information on using MFG/PRO, refer to the *9.0 User Guides*.
- For technical details, refer to the *9.0 File Relationships* and *9.0 Database Definitions*.
- To review MFG/PRO program screens, refer to the *Screen Book, Volumes 1–3*.
- To view documents online in PDF format, see the *9.0 Documents on CD*.

Online Help

MFG/PRO has an extensive online help system. Help is available for most fields found on a screen. Procedure help is available for most programs that update the database. Most inquiries, reports, and browses do not have procedure help.

For information on using the help system, refer to the *9.0 User Interface Guide*.

QAD Web Site

or MFG/PRO users with a QAD Web account, MFG/PRO documentation is available for viewing or downloading at:

<http://support.qad.com/documentation/>

To obtain a QAD Web account, go to:

<http://support.qad.com/>

The QAD Web site also has information about training classes and other services that can help you learn about MFG/PRO.

Conventions

MFG/PRO 9.0 is available in several interfaces: Windows, character, Web browser, and an interface for object-oriented programs. To standardize presentation, the documentation uses the following conventions:

- MFG/PRO screen captures reflect the Windows interface.
- References to keyboard commands are generic. For example, choose Go refers to F2 in the Windows interface and to F1 in the character interface. The following tables identify the keyboard commands for the Windows and character interfaces.

Windows Keyboard Commands

Navigation Commands	Keyboard Entry	Description
Go	F2	Moves to next frame.
End	Esc	Exits a frame, program, or menu.
Previous	F9 or Up Arrow	Retrieves previous record in a key data field.
Next	F10 or Down Arrow	Retrieves next record in a key data field.
Enter	Enter	Moves to next field within a frame.
Tab	Tab	Moves to next field within a frame.
Back Tab	Shift+Tab	Moves back one field within a frame.
Exit	Alt+X	Closes a program.

Navigation Commands	Keyboard Entry	Description
Run	Ctrl+R	Starts a program by name.
Save (object)	F12	In a key frame, moves to data entry; in data entry, saves and returns to key frame.
Print (object)	Ctrl+P	Prints browse or maintenance information.

Help Commands	Keyboard Entry	Description
Field Help	F1	Opens help on current field.
Procedure Help	Shift+F1	Opens help on current program.
Browse	Alt+F1	Displays choice of records.
Look-Up Browse	Alt+F2	Displays choice of records.
About	Ctrl+F1	Displays the program name.
Browse Options	F7	Opens the browse options window.
Browse Options Toggle	Alt+F	Turns the browse options on and off.
Browse Graph	Shift+F11	Opens the browse graphing window.
Field Name	Ctrl+F	Displays the field name.

Edit Commands	Keyboard Entry	Description
Delete Record	F5	Deletes an open record.
Cut	Ctrl+X	Cuts a field or selection to clipboard.
Copy	Ctrl+C	Copies a field or selection to clipboard.
Paste	Ctrl+V	Pastes data from the clipboard.

Character Keyboard Commands

Navigation Commands	Keyboard Entry	Control Key Entry	Description
Go	F1	Ctrl+X	Moves to next frame.
End	F4	Ctrl+E	Exits a frame, program, or menu.

Navigation Commands	Keyboard Entry	Control Key Entry	Description
User Menu	F6	Ctrl+P	Displays list of user-selected programs.
Previous	F9 or Up Arrow	Ctrl+K	Retrieves previous record in a key data field and scrolls up in look-up browses.
Next	F10 or Down Arrow	Ctrl+J	Retrieves next record in a key data field and scrolls down in look-up browses.
Enter	Enter		Moves to next field within a frame.
Tab	Tab		Moves to next field within a frame.
Back Tab	Shift+Tab	Ctrl+U	Moves back one field within a frame.
Menu Bar (object)	Esc, M		Accesses the menu bar.
Save (object)	F12		In a key frame, moves to data entry; in data entry, saves and returns to key frame.
Print (object)	Ctrl+P		Prints browse or maintenance information.

Help Commands	Keyboard Entry	Control Key Entry	Description
Field Help	F2	Ctrl+W	Opens help on current field.
Procedure Help	F2	Ctrl+W	Opens help on current program.
Look-Up Browse	F2	Ctrl+W	Displays choice of records.
Browse Options	F7		Opens the browse options window.
Browse Options Toggle	Alt+F		Turns the browse options on and off.
Field Name	Ctrl+F	Ctrl+F	Displays the field name.

Edit Commands	Keyboard Entry	Control Key Entry	Description
Insert	F3	Ctrl+T	Enables text insertion.
Delete Record	F5	Ctrl+D	Deletes an open record.

Edit Commands	Keyboard Entry	Control Key Entry	Description
Recall (standard)	F7	Ctrl+R	Recalls last saved value in a field.
Cut	F8		Clears a field.
Copy	F11	Ctrl+B	Copies a field.
Paste	F11	Ctrl+B	Inserts value that you copied.
Multiple Copy (standard)	F12	Ctrl+A	Copies values from one or more fields and pastes them into the same fields of another record.
Clear Date	Shift+?		Clears the value in date fields.

CHAPTER 1

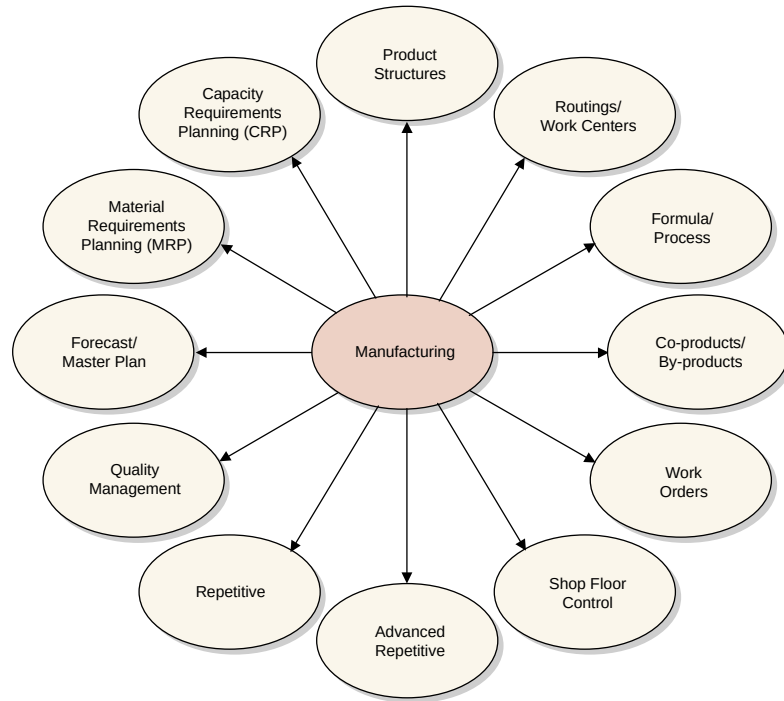
Introduction to Manufacturing

Manufacturing modules handle internal supply and demand—material is moved out of inventory into production, or finished goods or components are moved from production into inventory. These modules are used by make-to-stock, assemble-to-order, process, batch process, and repetitive operations.

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Figure 1.1 illustrates the manufacturing modules.

Fig. 1.1
Manufacturing



Product Structures

♦ See “Product Structures” on page 11.

Once items such as products, components, materials are identified in Master Files, the Product Structures module adds and maintains the bills of material for each product, assembly, subassembly, intermediate, and fabricated part.

Routings/Work Centers

♦ See “Routings/ Work Centers” on page 25.

The Routings/Work Centers module defines the areas where manufacturing activities are performed (departments, work centers) and the manufacturing process itself (operations and routings).

Formula/Process

The Formula/Process module defines and maintains the relationships between products and the ingredients that go into them, as well as the process by which they are created.

▶ See “Formula/Process” on page 43.

Other Formula/Process functionality is discussed in conjunction with co-products and by-products. Co-products/By-products is used to manage processes that create more than one product.

Co-products/By-products

MFG/PRO’s Co-products/By-products features manage processes that create more than one product. The module includes tools for setting up items, structures, and routings and supports MRP, work orders, shop floor control, and costing.

▶ See “Co-products/By-products” on page 51.

Work Orders

The Work Orders module is used in discrete production environments to control manufacturing orders. Create work orders manually or generate them from MRP planned orders. Generate work orders for configured products directly from a sales order. The Work Order module supports co-product and by-product manufacturing.

▶ See “Work Orders” on page 89.

Shop Floor Control

The Shop Floor Control module tracks activities and records operation status and labor times for manufacturing jobs released through the Work Orders module.

▶ See “Shop Floor Control” on page 125.

Advanced Repetitive

The Advanced Repetitive module supports high-volume manufacturing where lead times are more than a day and up to a month or more, where work is continuous and lines are dedicated to one item for days, weeks, or months, and where work in process (WIP) costs are either variable or high enough to track closely.

▶ See “Advanced Repetitive” on page 135.

Repetitive

- ◆ See “Repetitive” on page 183.

The Repetitive module supports high-volume manufacturing where lead times are one day or less, where WIP is complete at the end of each day, where WIP costs are tracked and batches do not overlap, or where WIP costs are insignificant or fairly constant.

Quality Management

- ◆ See “Quality Management” on page 191.

The Quality Management module defines standard testing procedures, applies tests to work orders and repetitive schedules, holds quality test results, and manages inventory sampling and quality work orders.

Forecasting/Master Schedule Planning

- ◆ See “Forecasting/Master Schedule Planning” on page 205.

The Forecast/Master Schedule Planning Module lets create and maintain shipment forecasts and master production schedules. Using this module, you can analyze sales shipment history, calculate forecasts, and update demand for material requirements planning (MRP), creating a closed-loop system.

Material Requirements Planning (MRP)

- ◆ See “Material Requirements Planning” on page 239.

MRP is a key manufacturing planning function. It assesses supply and demand and generates planned order and action messages. For organizations with multiple sites, MRP can be used in conjunction with distributed requirements planning (DRP), which balances supply and demand among sites.

Capacity Requirements Planning (CRP)

- ◆ See “Capacity Requirements Planning” on page 257.

The Capacity Requirements Planning (CRP) module uses MRP planned orders, other work orders, and repetitive schedules to determine work center load and generate a capacity requirements plan for a department, work center, or machine.

Product Structures

This chapter discusses how product structures—also known as bills of material—are defined and used in MFG/PRO during MRP and other planning activities to determine what materials are required for manufacturing.

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Routing Code: 10-15000 OPERATION: 20 STANDARD OPERATION: 1030 WORK CENTER: Machine DESCRIPTION: INSPEC PER PROX-005 MACHINES PER OP: 1 OVERLAP UNITS: 1 QUEUE TIME: 1.0 WAIT TIME: 0.0 SETUP TIME: 0.0

Introduction

Product structures and formulas are much like the list of ingredients for a recipe—they indicate the components and quantities needed to make a product. Unlike a recipe, in many cases, these documents also list the ingredients for each component. Graphically, if a formula or product structure is considered in its entirety, it looks like a tree, with the parent item at the top (level 0) and all the components branching off down to the raw material level (levels 1, 2, 3, and so on).

See Chapter 4, “Formula/Process,” on page 43.

In MFG/PRO, product structures are recorded as single-level relationships between parent (or higher-level items) and component items. For formulas, these would be the relationships between products and ingredients.

Product structures are modular. Separate structures are entered for finished goods and lower-level assemblies or intermediate products. So, a component in a higher-level structure might be a parent in a lower-level structure. Looking in the other direction, a parent in a lower-level structure can be a component in a higher-level structure. MFG/PRO can display product structures as either indented, multilevel bills of material or as single-level bills.

This chapter uses an example of a manufactured product with both a product structure and a formula: sports sunglasses with specially coated lenses.

Viewed from the top, three components make up the parent product: a frame assembly, a left lens, and a right lens. Each component has its own structure. The frame assembly includes a lens frame, left and right sides, and so on. Table 2.1 illustrates this two-level product structure.

Table 2.1
Product Structure
for Sunglasses with
Coated Lenses

Frame Assembly	Left Lens	Right Lens
Lens frame	Lens blank	Lens blank
Left temple	Tint	Tint
Left hinge kit	Coating	Coating
Right temple		
Right hinge kit		
Screws (2)		
Adhesive		

If a single company manufactures the whole product, each structure has its own specific manufacturing steps.

- Assemble frames.
- Grind lenses to size, polish, tint, and coat.
- Assemble sunglasses from frames and lenses.

Or the company might buy the frames, only doing lens grinding, coating, and final assembly. Because it might be necessary to ensure a supply of spare screws, the frame can have its own product structure so the product structure reports show which frames require these screws.

You can enter product structures for purchased products without affecting planning or product costing programs. This way, you can use all the product structure reporting tools for component and parent items, regardless of the source of the items.

The system also uses product structure records to store alternate bills of material, planning bills, and configuration bills. Separate these from standard bills by using a structure code.

♦ See “BOM Codes” on page 14.

Figure 2.1 shows data records associated with product structures and formulas that are discussed in this chapter. Not every system uses all of these.

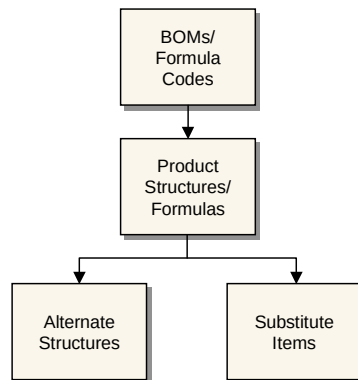


Fig. 2.1
Product Structure/
Formula Flow

BOM Codes

Sometimes, a single product structure or formula can produce more than one kind of product.

Example A company uses the same formula for a beverage or a cheese, but depending on how it is processed and aged, different products result. In this case, it does not make sense to define the formula with respect to one specific product.

In another case, one product can be produced with several different product structures or formulas.

Example A computer workstation is assembled in different countries around the world. Several different product structures use slightly different components produced by different manufacturers. No matter which product structure is used, the end product is functionally equivalent. Depending on where the product is manufactured, one structure may be more favorable as a result of cost differences due to price and/or tax considerations.

In both cases, enter product structures and formulas by using a product structure/formula—or bill of material (BOM)—code as the parent item instead of an item number. Use two programs to set up BOM codes.

- Product Structure Code Maintenance (13.1)
- Formula Code Maintenance (15.1)

Tip

The system automatically creates BOM codes for parent items that exist in the item master file when adding product structures and formulas.

BOM codes and item numbers are entirely independent. You can use the same product structure or formula for multiple items, and any one of several product structures or formulas to make the same item.

When an item number and its BOM code are the same, they are automatically linked. If an item's BOM code is blank, the item number is used as the BOM code. When they are different, you can change the BOM code in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Alternate Structures/Formulas

An item can use a product structure that is defined for a BOM code different from the item number. After you have defined a BOM code and a product structure or formula, link it to an item based on how it will be used.

- If the structure/formula should be the default for an item, update the BOM code in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). The system uses this BOM code for MRP, work orders, repetitive manufacturing, and costing.
- If the structure/formula should be the default for an item at a particular site, update the BOM code in Item-Site Planning Maintenance (1.4.17). The system uses this BOM code for MRP, work orders, repetitive manufacturing, and costing for an item at a site. This overrides the BOM code set up at the item level.
- If the structure/formula should be available as an alternate for an item at any site, use Alternate Structure Maintenance (13.15) to link the BOM code with an item. You can then change the BOM code on a work order to this alternate structure/formula.
- If the structure/formula should be available as an alternate for an item at a specific site when a specific routing is used, use Alternate Routing Maintenance (14.15.1) to link a BOM code and routing code to an item-site. You can then change the BOM code on a work order to this alternate structure/formula when using the specified routing code.

Phantoms

Sometimes engineering drawings and bills define transient product items that exist independently for a relatively short time and are not stocked. Instead, they are immediately consumed by higher-level products. These are called *phantom structures*.

Example Frames for sunglasses are assembled or purchased, but before final assembly, the company name is printed on the side. An engineering drawing specifies the exact location. The product structure now has one more level—a labeled frame. In practice, when the sunglasses are being manufactured, the labeling and final assembly processes may be so close together that the labeled frames (without lenses) exist for only a short time.

A product that starts out as a normal subassembly that is kitted, manufactured, and stocked can later evolve into a phantom. If manufacturing engineering can support changes to the manufacturing flow, you can use phantoms to reduce inventory movement, shorten lead times, and effectively reduce the levels in a bill of material. Using phantoms may require changes in manufacturing technology, or something as simple as introducing kanban to control the movement of components and phantoms.

Use Item Planning Maintenance (1.4.7) to identify an item as a phantom for all sites. When an item is a phantom at one site but not at another, indicate exceptions in Item-Site Planning Maintenance (1.4.17). If an item is a phantom only when assembled as a component of a specific parent item, use a product structure code of X within the product structure or formula.

Simulated BOM Inquiries

Quantities-on-hand of local phantoms do not impact the Simulated Picklist Item Check (13.8.17) or the Simulated Batch Ingredient Check (15.7.17). Use-up logic is typically not applied to local phantoms. This is one of the reasons you would define them as local, rather than global, phantoms. Quantities-on-hand of global phantoms still decrement quantity requirements when you select use-up logic by setting Use up Ph to Yes on these two inquiries.

Setting Up a Product Structure

Define product structures in Product Structure Maintenance (13.5).

The screenshot shows the 'Product Structure Maintenance' window. At the top, it has a menu bar with 'User Menu', 'Edit', 'Queue', 'Options', and 'Help'. Below the menu bar, there are several icons. The main area is divided into two columns. The left column contains fields for 'Parent Item: 10-10000', 'Description: Sunglasses', 'Component Item: 44-100', 'Rev: AC', 'Reference:', 'Start Effective:', 'Qty Per: 2.0', 'Structure Type:', 'Start Effective: / /', 'End Effective: / /', and 'Remarks:'. The right column contains fields for 'Lens', 'End Effective:', 'Scrap: 0.00%', 'LT Offset:', 'Op:', 'Sequence Number:', 'Forecast: 100.00%', 'Option Group:', and 'Process:'.

Fig. 2.2
Product Structure
Maintenance (13.5)

Important fields include the following.

Qty Per. Specify how much of this component is needed to make the parent item. In discrete manufacturing, items are made in individual units, and the component quantity is the amount needed for a single unit of a parent product. For example, two screws are required for one pair of sunglass frames.

In process manufacturing, products are made in batches and the component quantity per parent on a formula or recipe is stated with respect to a batch quantity for the parent product. Since the only economical way to coat lenses is in batches, the amount of a particular coating might be specified for a batch of several hundred lenses.

Reference. On a complex assembly that contains many components, an item may appear several times on the same drawing and product structure. Use Reference to identify a component that appears multiple times on the same parts list.

The reference code can be a drawing reference number that helps to relate a component to a specific position on a drawing, or a code associated with an engineering change order or an engineering change notice. The system uses parent, component, reference, and start date to define a unique product structure record. A component can have

the same parent and same reference as long as the start dates are different.

▶ See *User Guide Volume 6: Master Files* for more information on PCC.

▶ See “Engineering Effectivity” on page 23.

Tip
A relationship is effective through the end date and becomes obsolete the next day.

Note If you use the Product Change Control (PCC) module, engineering change notice functions in Product Structures are disabled.

Since the system uses product structures to store configuration bills, you can also enter the feature code for configured products in Reference.

Start and End Effective. The way an item is manufactured can change over time. New components can be added or unnecessary ones deleted. Use effective dates used to store relationships for historical, current, and future product structures.

All parent-component relationships are identified by a start and an end effective date. The start and end effective dates indicate the time period a relationship is active.

Example The hinges and fasteners for a frame are being upgraded. The obsolescent components have an end effective date of March 14, and the new components have a start date of March 15. If an adhesive is added to prevent the screws from coming loose, then the product structure can be recorded with the start date when it became effective.

Scrap. Depending on the product, some components may be lost or unusable as a result of the manufacturing process. There are two ways to anticipate this loss.

- Use the scrap factor
- Change the component quantity per

The scrap factor is the percentage of a component expected to be lost during manufacturing. The system uses this with the quantity per to calculate component requirements for work orders and MRP. When a scrap factor is used, component quantities are almost always extended into fractional amounts and not whole units, making it difficult to use on items always handled in discrete quantities.

Example One left lens is required for a pair of sunglasses and the scrap factor is 5%. The system calculates a requirement for 105.2631 left lenses to make 100 sunglasses.

Using scrap percentages other than zero promotes waste and can conceal quality problems. If additional quantities are consistently

required, consider changing the component quantity per directly. This avoids the problem of fractional quantities but may result in even greater waste than using the scrap factor. Continuing the example of the sunglasses, it is not realistic to change the quantity per on the left lens to 2. If you did so, the system would always plan that 200 left lenses would be necessary to make 100 pairs of sunglasses.

Structure Type. Product structure relationships normally have a blank structure type code. Other codes are used for special applications.

Code	Description
Blank	A normal product structure relationship.
X	A local phantom. Costed and exploded, but never planned as component requirements.
D	Document. Records miscellaneous expense items or documents associated with this bill that are not planned, exploded, or costed.
O	Option. An optional component. Normally defined using Configured Product Maintenance (8.1), options may also be entered in planning bills.
P	Plan. Planning bill used for multilevel master scheduling. Not planned, exploded, or costed.
A	Alternate. Automatically created by the system for an alternate structure for this parent. Not planned, exploded, or costed.

Table 2.2
Structure Type
Codes

Option and planning bills are used to create production forecasts.

LT Offset. Not all of the components of a manufactured item are always required at the beginning. Normally, the differences in timing are not significant. However, if components are required long after the start date and/or the cost of those components is significant, consider using lead time offset.

Enter a positive or negative number, indicating the number of days after or before the start of an order when this component is required. MRP uses lead time offset to determine the need date for components and segregate them on separate picklists for individual work orders.

Op. Enter an operation code to affect processing in three ways.

See “Forecasting/
Master Schedule
Planning” on
page 205.

▶ See “Backflush Transaction” on page 169.

▶ See *User Guide Volume 4: Financials*.

- Determine whether this component is backflushed in repetitive manufacturing operations. If you enter the operation number here, this component is automatically issued when you report quantities for the parent. If Op is blank or does not match a defined operation, this component is not backflushed.
- Enable component yield cost calculations. Product Structure Cost Roll-Up (13.12.13) and Routing Cost Roll-Up (14.13.13) use this field when calculating material costs. If the operation yield is less than 100% in Routing Maintenance (14.13.1), then material costs are increased to reflect yield loss. If blank, MFG/PRO assumes components are issued at the first operation.
- Determine whether this component prints on Repetitive Picklist Print (18.22.3.5). If you enter an operation code, the component can be picked.

Related Topics

This section discusses a number of topics related to product structures and how they are used in the system.

Floor Stock

Continuing the example of the sunglasses, most items such as frame pieces and lenses are issued from an inventory location based on a formal document such as a work order picklist. However, some inexpensive, easily replenished components, such as the screws, may be held on the factory floor and used as needed. Such items are called *floor stock*.

Use Issues–Unplanned (3.7) to record floor stock issued from stores to a work-in-process expense account. To prevent these items from being picked, they should have an issue policy of No in the item master and item-site planning data.

Do not confuse floor stock with expensed items. Expensed items do not appear in the item master or product structure and are expensed immediately when they are received from the supplier. Enter expensed items on a purchase order as non-inventory (memo) purchases with type code M.

Relationship with Configured Products

Product structure records are also used to store information on product configurations. A configured product is an item with a purchase/manufacture code of Configured. The system uses the Reference field to store the option's feature group, and the Structure Code field defaults to Option.

In some instances, it may be appropriate to change the structure code to Planning.

▶ See *User Guide Volume 2: Distribution* for information on configured products.

▶ See “Material Requirements Planning” on page 239.

Component Substitutions

When an item is not available, you can sometimes issue a different item. For example, for the sunglasses, it may be possible to substitute Phillips-head screws for slotted-head screws. Substitute components during work order issues or when modifying a backflush transaction. Before substituting components, use Item Substitution Maintenance (13.19) to define the relationships between standard items and substitute items.

You can define a substitute item relationship for a component within a specific assembly as a global relationship. Specify a quantity of the alternate item that is equivalent to a single unit of the reference item. For example:

- Deionized water and sterile water can be defined as alternates for equivalent quantities of distilled water.
- Two 6-pin connectors can be defined as an alternate for a single 12-pin connector.
- A fast-setting adhesive can be defined as a substitute for a slower-setting adhesive for a specific assembly.

The MRP process and work order picking logic do not check substitute item relationships. Substitute items that are phantoms are not exploded when issued on an inventory transaction.

Fig. 2.3
Item Substitution
Maintenance
(13.19)

Item Substitution Maintenance

User Menu Edit Queue Options Help

Parent/Base Process Item: 10-10000EA

OASIS(TM) COOLING SY:
HOME/INDUST MODEL

Item Number: 10-15001EA

NOMAD(TM) SOLAR POV
COOLING SYSTEM

Substitute Item: 44-100EA

CONTROL UNIT, HOME I

Substitute Qty: 1.0

Remarks:

Comments: no

Cumulative Lead Time

When a product is planned, it is sometimes necessary to know its cumulative lead time—the longest time required to produce it. The cumulative lead time determines the minimum planning horizon for the master schedule and material requirements planning.

Cumulative lead time is calculated by first determining the composite lead times between the product and each of the lowest level components. The longest of these composite lead times determines the critical path and sets the cumulative lead time. When a product structure contains a BOM code in a lower level, the cumulative lead time of the end item includes lead times for components of the BOM code.

Example Sunglasses are manufactured from a purchased frame assembly. Table 2.3 shows the lead time for each item.

Table 2.3
Manufacturing
Lead Times

Sunglasses with Coated Lenses (1)					
Frame assembly	(28)	Left lens	(2)	Right lens	(2)
		Blank	(7)	Blank	(7)
		Tint	(28)	Tint	(28)
		Coating	(35)	Coating	(35)

The composite lead times for the sunglasses are calculated for each of the component lead time paths starting from the top-level assembly and going down to the component, as illustrated in Table 2.4.

Table 2.4
Composite Lead
Times

Assembly or Component	Lead Time
Sunglasses with coated lenses	1
Frame assembly	29 (1 + 28)
Left or right lenses	3 (1 + 2)
Lens blank	10 (1 + 2 + 7)
Tint	31 (1 + 2 + 28)
Coating	38 (1 + 2 + 35)

The cumulative lead time, the longest of these lead time paths, is the lead time for coating (38 days). It could take up to 38 days to produce sunglasses if the critical components (left or right lenses and coating) are not available.

Use Cumulative Lead Time Roll-Up (13.12.14) to calculate and store the cumulative lead time in the item planning data for either the item master or the item-site.

Engineering Effectivity

In some instances, you can use an engineering change order or engineering change notice so that existing inventory of an old component is consumed before a new component can be used.

Note If you are using Product Change Control, you can use the Incorporation Planning Report (1.9.7.3) to determine the best time to introduce an engineering change.

Example A particular coating material is to be replaced by new coating material after the old material runs out.

- Set up the new material up as a component of the existing coating material.
- Change the existing coating material to a phantom item in Item Planning Maintenance (1.4.7) and/or Item-Site Planning Maintenance (1.4.17).

Work order picklists use phantom use-up logic to pick available inventory of the existing coating material until it runs out. Afterward, the system explodes the product structure/formula to pick the new coating material.

There are three trade-offs to doing this.

- Product costs and cumulative lead times are not calculated correctly.
- Phantom use-up logic is not used when backflushing components in the Repetitive module. However, it is used when backflushing work orders and in Receipts Backward Exploded.
- The product structure will not conform to the engineering structure, so the where-used and product structure programs will be less accurate.

Avoid these potential problems by managing the use of effective dates for engineering changes.

CHAPTER 3

Routings/Work Centers

This chapter discusses the elements associated with routings, including departments, standard operations, and work centers. Many of these concepts are also common to process definitions.

Introduction 26

Departments 28

Work Centers 29

Standard Operations 32

Routings 34

Lead Times 37

Subcontract Operations 40

Yield 41

The screenshot displays a software window titled "14.13.2 Routing Maintenance (Main Screen)". It contains a table with routing details:

Routing Code	Operation	Standard Operation	Work Center	Description
10-15000	20	10.30	INSPECTION, ALL SITE	INSPEC PER PROC-005
Machines per Op: 1				
Overlap Units: 1				
Queue Time: 1.0				
Wait Time: 0.0				
Setup Time: 0.0				

At the bottom, it indicates "Routings: Production, Build to Stock".

Introduction

To manufacture an item or product, it is always necessary to complete one or more activities or operations. The listing of required operations is called a routing, which basically defines the process needed to make the item. If a product structure is the list of ingredients in a recipe, a routing is the directions. The routing operations indicate the machines, expected times, and instructions for completing specific tasks.

For example, in manufacturing sunglass lenses, there might be a routing with four operations with instructions to grind, polish, tint, and coat the lenses. These would be separate operations because they involve different machines, tools, skills, and tasks.

Tip
Routings are required if you use the Repetitive module.

In the Shop Floor Control and Repetitive modules, you record actual statistics on what happens during production. This might include how long it takes to produce items, what quantities are produced and by whom, whether there was downtime or some other interruption to production, and so on. These statistics are always recorded against a routing operation.

In addition to providing manufacturing instructions, routings contain data used as a standard for evaluating production, operation times, yield percentages, the number of machines normally needed, and so on. The department and work center codes associated with routing operations link actual production results with capacity planning, cost accounting, payroll, and other programs.

Specifically, routings can be used to:

- Calculate the cost of producing an item
- Calculate the time it takes to manufacture an item
- Schedule operations for work orders and repetitive schedules
- Backflush components in the Repetitive module
- Calculate work center and department load
- Print routings for work orders
- Obtain operation feedback using programs in Shop Floor Control and Repetitive

Some of these capabilities are especially important when there is a combination of medium to long operation lead times, a significant labor component of cost, many operations, and bottleneck operations.

Routing operations may not be necessary when:

- Item lead times are very short.
- Total item costs consist mostly of material and overhead and the labor component is relatively small.
- Capacity can be easily managed.
- Repetitive module is not used.

Figure 3.1 summarizes the steps required to set up routings.

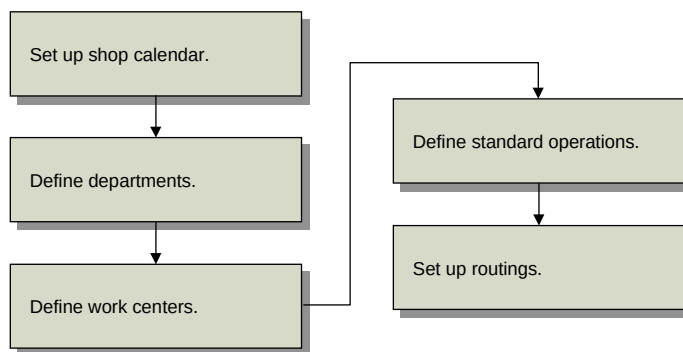


Fig. 3.1
Routing Setup
Work Flow

Important Work centers and operations work in conjunction with the shop calendar, which determines the work days and hours for the plant. Use Calendar Maintenance (36.3.5) to add work center-specific calendars. Before you begin defining the elements needed to create routings, make sure you set up the shop calendar.

▶ See *User Guide Volume 11: Manager Functions* for more information on calendars.

Departments

In MFG/PRO, a department groups similar work centers. Departments are like product lines because they are used to organize information on planning reports and to determine the GL accounts on transactions. Each department is set up with a fixed daily labor capacity and a set of GL accounts.

Example A manufacturer of sunglasses has a department for lens fabrication with several work centers for lens grinding and lens polishing. A separate department does lens coating.

▶ See Chapter 13, “Capacity Requirements Planning,” on page 257.

The department load reports in the Capacity Requirements Planning (CRP) module use the department labor capacity when calculating the total department capacity for a period of time. The labor capacity should correspond to the sum of the total capacities of all work centers in the department.

Department account codes are similar to the GL account codes for product lines. They are used:

- When reporting labor and downtime in the Shop Floor Control and Repetitive modules
- When backflushing inventory and closing the accounting for completed work orders

A department code is independent of the general ledger (GL) accounts, sub-accounts, and cost centers defined for it. In the General Ledger module, cost center codes are often used to organize transactions by department. However, you do not have to use the same code for the cost center and department.

Table 3.1 lists the accounts for a department, the account type, and the transactions the accounts may appear on.

Table 3.1
Department
GL Accounts

Account	Type	Use
Cost of Production	Expense	Non-Prod Labor, SFC Transfer
Labor (Absorbed)	Expense	SFC, Repetitive, WO Close
Burden (Absorbed)	Expense	SFC, Repetitive, WO Close
Labor Usage Var	Expense	SFC, Repetitive
Labor Rate Var	Expense	SFC, Repetitive, WO Receipt

Account	Type	Use
Burden Usage Var	Expense	SFC, Repetitive
Burden Rate Var	Expense	SFC, Repetitive, WO Receipt

Use Department Maintenance (14.1) to set up departments. Account numbers default from the System/Account Control File (36.1). You can change them.

Note You must define at least one department before setting up work centers or routings.

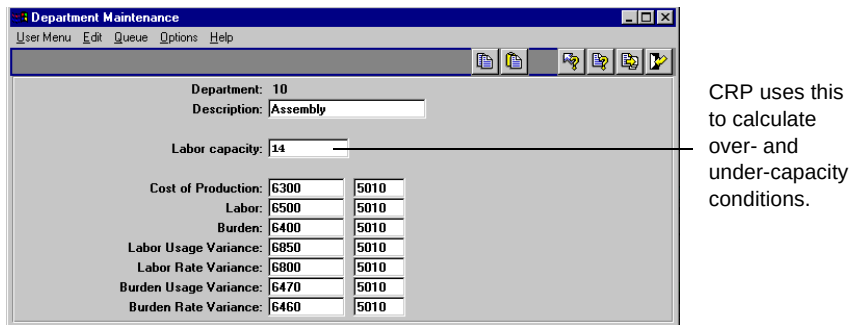


Fig. 3.2
Department
Maintenance (14.1)

Work Centers

A work center is a group of people and/or machines. Work centers also link departments with routing operations.

Work centers are the basic unit for operation scheduling and CRP. Depending on how you plan and schedule work, you can set up work centers for an individual machine or for groups of similar machines. If, for example, there are separate machines for polishing plastic lenses and polishing glass lenses, they would be set up as separate work centers. MFG/PRO uses work centers for scheduling, planning, and determining costs for GL transactions.

Use Work Center Maintenance (14.5) to set up work centers.

Fig. 3.3
Work Center
Maintenance (14.5)

Work Center and Machine. Uniquely identify a work center by a work center code along with an optional machine code. Leave Machine Code blank if there is only one type of machine in the work center. If there are multiple machine types or models, set up a different record for each machine, using the same work center ID.

Department. Enter a department code, set up in Department Maintenance (14.1). You must assign each work center to a department.

Work Location. Enter a work location code for the work center—created in Work Location Maintenance (29.7)—only if you are using the U.S. Payroll module.

Queue Time and Wait Time. Enter the standard time, in decimal hours, a job normally spends waiting at this work center before it is set up and processed and after processing has been completed. These values display as defaults when you reference this work center as part of a standard, routing, or process operation.

Machines/Op. Enter the number of machines at this work center that can work at the same time to process a given operation. CRP uses this number to calculate work center capacity. This value displays as the default when you reference this work center as part of a standard, routing, or process.

Setup and Run Crew. Optionally, enter the number of people required to set up and run this work center. These fields are for reference only.

▶ U.S. Payroll is described in *User Guide Volume 4: Financials*.

▶ See “Work Center Capacity” on page 31.

Machines. Enter the number of machines or people in this work center. CRP calculates the total capacity for a work center by multiplying the number of working hours, defined in the shop calendar, by the number of machines.

Setup and Labor Rate. Enter the average labor rates paid per labor hour to set up and run this work center. These values are used by item cost calculations and by labor feedback functions to calculate and post actual costs and variances.

Mach and Lbr Bdn Rate. The burden rates per hour applicable to machine and labor run time and setup at this work center. These values are used by item cost calculations and by labor feedback functions to calculate and post actual costs and variances.

Lbr Bdn %. Enter the labor burden percentage applicable to the total labor cost at this work center.

Tip

Rates apply to all operations carried out at this work center. You cannot change them for individual operations.

Important Changes to work center labor and burden fields affect how transaction amounts and product costs are calculated. They should be authorized by Cost Accounting.

Work Center Capacity

CRP uses work center capacity when evaluating work center load. It is the total number of hours the work center is available to do work. Capacity varies with the work center calendar or shop calendar and the number of machines or people in the work center.

The formula is:

$$\text{Work Center Capacity} = \text{Calendar Hours Available} \times \text{Machines}$$

The work center number of machines should be at least as high as the number of machines per operation for this work center and for operations that use this work center.

Standard Operations

Often, routings share one or more operations that are essentially the same. For example, an automated packaging process may be the same regardless of the color of the products packaged. To save work when entering new routing operations, you can create template steps called *standard operations*.

When you enter a new routing operation, automatically copy the standard data to the routing by referencing the standard operation code. Then edit the standard information as needed. Changes apply only to the new routing—not to the standard operation you copied.

Note If you change a standard operation after referencing it on a routing, the changes do not automatically apply to the existing routing. Use Routing Update (14.13.7) to apply any changes you made to standard operations and work centers to existing routings.

Use Standard Operation Maintenance (14.9) to set up standard operations.

Fig. 3.4
Standard Operation
Maintenance (14.9)

Standard Operation: 1011
Description: PENCIL ASSEMBLY
Work Center: 1010
Machine:
Setup Time: 1.0
Run Time: 0.001
Move Time: 0.0
Yield%: 100.00%
Tool Code:
Supplier:
Milestone Operation: yes
Inventory Value: 0.00
Subcontract Cost: 0.00
Subcontract LT: 0
Overlap Units: 0
Comments: no

Work Center and Machine. Enter codes for the work center and machine that normally perform this operation.

Setup, Run, and Move Time. Enter the normal times, in decimal hours, to process items during this operation. Run time is per unit; setup and move time are independent of order size.

See “Lead Times” on page 37.

Yield %. Enter the order percentage expected to be in usable condition after this operation.

♦ See “Yield” on page 41.

Tool Code. Optionally, enter the code for a tool normally used during this operation. This is for reference only. To standardize tool codes, set them up in Generalized Codes Maintenance (36.2.13) for field *ro_tool*.

Supplier. If this is a subcontract operation, enter the code of the supplier doing the work.

Milestone Operation. Enter Yes to define this as a repetitive labor reporting operation and to backflush all previous operations since the last milestone operation. The field only affects repetitive manufacturing operations.

♦ See Chapter 9, “Repetitive,” on page 183.

Inventory Value. Optionally, enter accumulated cost through this operation. Only used by the Repetitive WIP Cost Report (18.21.12).

Subcontract Cost and LT. If this is a subcontract operation, enter the normal average cost per unit charged by the subcontractor and the normal number of calendar days the subcontractor takes to complete the operation.

Overlap Units. Enter the number of units that must be completed before they are moved to the next operation. When there are two consecutive operations, you can sometimes save time by moving partial quantities from one operation to the next before the first operation has been completed.

Operation Capacity

As the number of machines increases, work center capacity and the number of hours a work center is available for work also increases. If there are 8 hours in a work day and an operation has 2 machines per operation, the work center has 16 hours of capacity for that operation.

$$\text{Operation Capacity} = \text{Calendar Hours Available} \times \text{Machines per Operation}$$

The number of machines per operation is also used for calculating the lead time and machine burden cost for an operation.

Routings

A routing consists of one or more operations—steps needed to make an item. Each operation is identified by a routing code and an operation number.

Typically, you use Routing Maintenance (14.13.1) to define routings where production run time is in hours per unit. However, in high-volume environments, you can use two other programs.

- Use Routing Maintenance (Rate Based) (14.13.2) to define run time in units per hour.
- Use Process Definition Maintenance (15.13) to define run time in time per batch.

See “Defining Processes” on page 47.

Fig. 3.5
Routing Maintenance
(14.13.1)

The screenshot shows the 'Routing Maintenance' window with the following fields and values:

Routing Code:	02-0005	MECHANICAL PENCIL			
Operation:	10	Start Date:		End Date:	
Standard Operation:	1012				
Work Center:	1020	BLISTER PACK			
Machine:					
Description:	BLISTER PACK				
Machines per Op:	1	Milestone Operation:	no		
Overlap Units:	10	Subcontract LT:	0		
Queue Time:	1.0	Setup Crew:	1.00		
Wait Time:	0.0	Run Crew:	1.00		
Setup Time:	1.0	Tool Code:			
Run Time:	0.005	Supplier:			
Move Time:	0.0	Inventory Value:	0.00		
Start Date:		Subcontract Cost:	0.00		
End Date:		Comments:	no		
Yield%:	100.00%				

See page 32.

Many of the fields in Routing Maintenance are the same as in Standard Operation Maintenance (14.9). Additional fields are described below.

See “Alternate Routings” on page 36.

Routing Code. This is typically the same as the item number, but routing codes and item numbers are entirely independent. This allows the same routing to be used for multiple items. One item can also be made using one of several routings.

An identical item number and the routing code are automatically linked to each other. When an item’s routing code is blank in the item or item-site planning data, the system uses the item number as the routing code. If they are different, specify the routing code in Item

Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Operation. Each routing consists of a series of steps. Enter a number to identify this step within this specific routing code. Operation numbers must be unique within a routing. Routing operations are always printed in ascending sequence by operation—operation 20 follows operation 10.

Tip

Number by 10s or 100s, so you can add new intermediate steps without renumbering existing ones.

At least one operation is required to process repetitive labor feedback.

Start and End Date. Optionally, define effective dates for this operation. This lets you phase in engineering changes and maintain history online.

Functions that reference the routing always use the routing steps in effect on the current date. Most reports and inquiries can be selected for a specific effective date.

Standard Operation. Enter the code for the standard operation to use as the basis of this operation step. Many values then default from that standard operation. You can then modify them as needed to create the specific operation for this routing.

See “Standard Operations” on page 32.

Machines per Op. Enter the number of machines that can process work at the same time at this operation. This value defaults from the work center machines per operation.

Queue and Wait Time. Enter the times, in decimal hours, a job normally waits at this work center before this operation is set up and processed and after this operation has been completed.

Setup and Run Crew. Enter the number of people normally required to set up and run this operation. These fields are for reference only.

WIP Item:		Move Next Op:	no
Purchase Order:		Auto Labor Report:	no
Line:	0		

Fig. 3.6
Routing
Maintenance
(14.13.1)

WIP Item. Optionally, enter an item number to represent work in process material for subcontract shipments. This field is used by Sub Shipper Print (18.22.5.9) when processing repetitive subcontracts. The description and unit weight of the WIP item display on the subcontract shipper.

See “Sub Shipper Print” on page 180.

Purchase Order, Line. If this operation is for subcontract services, enter the number of a scheduled purchase order and a corresponding line number. Schedule Update from MRP (5.5.3.1) uses this information when supplier schedules are generated for subcontract service suppliers. This value is also used by repetitive subcontract processing.

Move Next Op. Enter Yes or Not to determine the default for the same field in Backflush Transaction (18.22.13) and the Move Transaction (18.22.19).

▶ See “Automatic Labor Reporting” on page 147 for details.

Auto Labor Report. This field is used in the Advanced Repetitive module to determine if standard labor is reported automatically by the Backflush Transaction (18.22.13).

Alternate Routings

After you have entered a routing, you can link it to an item in several ways, depending on whether it should be used as the default routing code or available for use as an alternate routing.

- If the routing should be the default for an item, update the routing code in Item Planning Maintenance (1.4.7). This is the routing code used for MRP, work orders, repetitive, and costing.
- If the routing should be the default for an item at a particular site, update the routing code using Item-Site Planning Maintenance (1.4.17). This is the routing code used for MRP, work orders, repetitive, and costing for an item at a site. It overrides the routing code set up in Item Planning Maintenance.
- If the routing should be available as an alternate for an item at any site but not used as the default, use Alternate Routing Maintenance (14.15.1) to link it with an item. This allows the routing code on a work order to be changed to this alternate routing.
- If the routing should be available as an alternate for an item at a specific site, use Alternate Routing Maintenance to link a routing code to an item-site. This allows the routing code on a work order to be changed to this alternate routing.

Work Center Routing Standards

Sometimes work is actually performed at a different work center than appears on a routing operation. If the work center where the work was completed has different equipment, it may not be meaningful to compare actual hours with standard hours calculated using the normal work center.

When alternate work centers can be used for specific operations, you can use Work Center/Routing Standards Maintenance (14.17.1) to record the expected run times for the alternate work centers. This cross-reference is used for reporting actual run times on efficiency reports in the Repetitive module.

Routing Cost Roll-Up

Use Routing Cost Roll-Up (14.13.13) to update the costs for items based on their routing (process) operations.

◆ For details on costing, see *User Guide Volume 4: Financials*.

Lead Times

In MFG/PRO, lead times for operations and manufacturing are expressed in terms of several components.

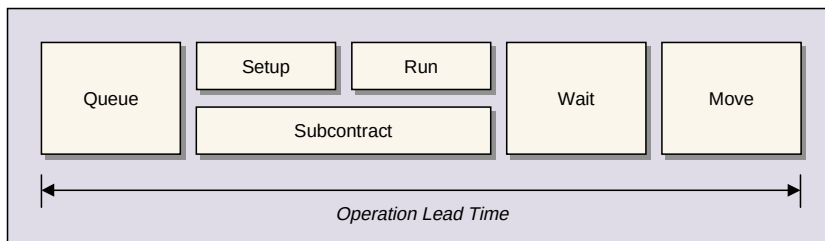


Fig. 3.7
Lead Time
Components

- Queue. Amount of time a lot must wait at a work center before the operation is set up and production begins. Occurs when there is a backlog of jobs at a work center and is frequently the single longest component of manufacturing lead time.
- Setup. Time required to prepare a work center to process a lot or batch quantity for a specific operation.

- Run
 - In Routing Maintenance (14.13.1), the average time required to manufacture a single unit.
 - In Process Definition Maintenance (15.13), the average time to process an entire batch.
 - In Routing Maintenance (Rate Based) (14.13.2), run time is expressed in terms of an hourly production rate.

In all cases, the system stores run time internally as the run time per unit.

- Wait. Amount of time a lot or batch must remain at a work center after production is completed before it can be moved to the next operation.
- Move. Time a lot or batch spends in transit from one operation to the next.
- Subcontract. Number of days required for an outside supplier to process the lot.

Operation Lead Time

Planning programs use these lead times to determine the duration of an operation and the time between successive operations. The amount of time a work center is actively involved in producing an item is determined by setup, run, and subcontract times. The time between operations—interoperation time—is determined by queue, wait, and move times. Most of these times are stated in hours, except for subcontract, which is stated in days.

The operation lead time is calculated using each of the lead time components, the number of machines per operation, and the item order quantity. The work center or shop calendar is used to convert queue, setup, run, and move times from hours to manufacturing days.

$$\text{Operation LT} = \frac{\text{Queue} + \text{Setup} + \text{Move}}{\text{Hours Available}} + \frac{\text{Run} \times \text{Order Quantity}}{\text{Hrs. Avail.} \times \text{Mach. per Op.}} + \frac{\text{Wait}}{24} + \text{Subcontract LT}$$

If you examine this formula, several concepts become apparent.

- Queue, setup, and move times are completely independent of the order quantity or lot size.
- Queue, setup, and move times are also independent of machines per operation, since these do not require that a machine be available.
- Queue, setup, and move times are a function of available work center or shop calendar hours since the operation can only be performed during working hours. If queue, setup, and move times add up to 16 hours and there are 8 working hours in a day, 2 manufacturing days are needed.
- The total run time for an operation is a function of order quantity. If the unit run time is 1 hour and the item order quantity is 48, a total of 48 hours of run time is needed.
- The run time for an operation is a function of total run time, work center or shop calendar hours, and the machines per operation. If a work center is open for 8 hours per day and there is one machine per operation, run time is 6 manufacturing days (48 hours over 6 days with 8 machine hours per day). However, if there are 3 machines per operation, run time will take only 2 days (48 hours over 2 days with 24 machine hours per day).
- Wait time is the amount of time a lot must remain at a work center after an operation is completed before it can be moved to the next operation. It is calculated from a straight 24-hour clock, since no machines or people are required.
- Subcontract lead time is stated in days. It is added directly to the other lead time components.

MFG/PRO schedules work order and repetitive operations sequentially, assigning start and due dates for each operation. The duration of a specific operation—the time between its start date and due date—is determined by the setup, run, and subcontract times for the operation. The interoperation lead time—the time between the due date of one operation and the start date of the next operation—is calculated using the first operation's wait and move times and the following operation's queue time.

Note Setup and run times are used for operation scheduling, lead time calculations, product costing calculations, and GL transactions created by activities such as reporting labor and completing repetitive operations in the manufacturing modules. Changes to setup and run times should be coordinated to prevent adverse effects in any one of these areas.

Manufacturing Lead Time

The manufacturing lead time for an item is the sum of its operation lead times, stated in manufacturing days. Capacity planning uses manufacturing lead time, in conjunction with the work center or shop calendar, to determine order release dates.

There may be differences between operation schedules for an order and the manufacturing lead time for an item due to any one of several reasons.

- The item order quantity used to calculate the manufacturing lead time may be different than the actual order quantity for an operation, resulting in differences in the run time for an operation.
- The shop and/or work center calendars may be scheduled for more (or less) hours than the default calendars used to calculate manufacturing lead time.
- Queue time for the first operation does not affect its start date; therefore, it may fall after the release date of an order.
- Two successive operations may overlap.

Subcontract Operations

Some operations may be performed by an outside supplier or subcontractor rather than by a work center. This requires some special setup, particularly if you want to include subcontracted operations in supplier load and capacity reports.

Set up at least one department for outside processing and a separate work center for each type of subcontract operation. Each supplier or type of subcontract operation should have at least one work center defined for it. This lets you specify the work center on dispatch reports, which provide visibility of upcoming operations.

Set the work center labor and burden rates to zero to prevent GL transactions from being created. You can express work center lead times in subcontract days if load reporting is not a requirement. Otherwise, use queue, setup, run, wait, and move times in conjunction with a work center calendar.

You can also add one or more departments for specific suppliers for whom capacity is a major concern. Review capacity for these departments by printing the department load reports in the CRP module.

Yield

Depending on the manufacturing process, the percentage of a lot that is expected to be of acceptable quality may fall below 100 percent. The system can calculate the total yield for an item from the yield for each of its operations using Routing Cost Roll-Up (14.13.13). The MRP planning process uses the item yield percentage to plan additional supply.

The expected yield for an operation can be expressed as:

$$\text{Yield} = \text{Acceptable Units at Operation End} \times 100$$

The total manufacturing yield for a product is determined by multiplying the yield percentages for each of its operations.

$$\text{Manufacturing Yield} = \text{Yield \% for Op10} \times \text{Yield \% for Op20} \times \dots$$

Take care when setting yield to anything but 100%—particularly when yield is used for multiple operations.

Example There are four operations, each having a yield of 90%. The system calculates the item yield as 66% ($90\% \times 90\% \times 90\% \times 90\%$)—an expected loss of one in three units. If MRP plans this item and there is a demand for 100 units, the system creates a scrap requirement for 51 units (100 divided by 66%) and a planned order for 151 units.

Operation and item yield are different than the component scrap percentage in product structures. Component scrap results in additional requirements for individual components of a parent item. When an item's yield is less than 100%, MRP creates additional scrap requirements for the item, causing the item and all of its components to be overplanned.

▶ See “Scrap” on page 18 for a more detailed description of how the component scrap percentage is used.

CHAPTER 4

Formula/Process

The Formula/Process module defines and maintains the relationships between products, ingredients, and materials, as well as the processes required to manufacture a product in a batch.

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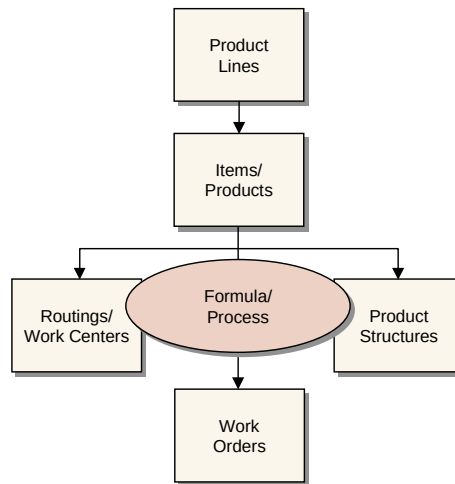
Routing Code: 10-15000
Operation: 20
Standard Operation: 1030
Work Center: Machine
Description: INSPEC PER PROC-005
Machines per Op: 1
Overlap Units: 1
Queue Time: 1.0
Wait Time: 0.0
Setup Time: 0.0
Inspection: ALL SITES

Introduction

See Chapter 3, “Routings/Work Centers,” on page 25.

A formula (or recipe) is another way to define a product structure. A process definition is identical to a routing. In fact, there is no difference to the system between defining a set of operations in Routing Maintenance (14.13.1) or Process Definition Maintenance (15.13). Before you set up a process definition, you must set up the shop calendar, departments, and work centers.

Fig. 4.1
Formula/Process
Module



But while Routing Maintenance sets up operation run time in hours per unit, and Routing Maintenance (Rate Based) (14.13.2) in terms of units per hour, Formula/Process lets you define a formula in terms of batch size and process it in hours per batch. The batch size is expressed in the parent item’s unit of measure and represents the quantity in which the item is to be produced.

In Formula/Process, all definitions reference a specific batch size. You can specify ingredient quantities as a quantity per batch or as percent of a batch. Process definitions are always expressed as run times per batch. Unlike product structures, formulas relate to a particular batch size.

See Chapter 5, “Co-products/By-products,” on page 51.

The Formula/Process module also manages processes that create co-products and by-products, along with the base process that produces them.

The Formula/Process module works in conjunction with lot/serial control, which is sometimes necessary to comply with government regulations. Lot control can also help companies improve quality, process control, and inventory accuracy.

Defining Formulas

MFG/PRO stores formulas as parent item/component relationships. To define a formula for a product, enter the product as the parent, and the formula ingredients as components of the product.

Once a formula has been defined for a particular product, that product can produce a higher-level product. This is typical of a master batch or an oven heat, which processes other items.

When discrete components are issued—such as packaging and labels—closing the process batch work order and issuing the batch to a discrete packaging work order can be useful. The system offers process, discrete, and model/option work orders, or paperless repetitive scheduling in a single environment. You can backflush components for any of these types of production scheduling.

A formula—sometimes called a recipe—defines the ingredients for a manufactured item. Use Formula Maintenance (15.5) to define formulas. The system automatically assigns the item number to the BOM.

The screenshot shows the 'Formula Maintenance' window. At the top, the menu bar includes 'User Menu', 'Edit', 'Queue', 'Options', and 'Help'. Below the menu, there are icons for file operations and help. The main area is divided into two sections. The top section is for the 'Parent Item' (88-4000) with the description 'PLASTIC PELLETS' and a 'Batch Size' of '1 KG'. The bottom section is for the 'Component Item' (88-5000) with the description 'RESIN BASE' and 'Rev: AA'. Below this, there are fields for 'Reference' (Effective: To:), 'Qty Per' (0.0 KG), 'Scrap' (0.00%), 'Qty Type' (B), 'LT Offset', 'Batch Percent' (0.0), 'Op', 'Structure Type', 'Sequence Number', 'Start Effective' (//), 'Forecast' (100.00%), 'End Effective' (//), 'Option Group', 'Remarks', and 'Process'.

Fig. 4.2
Formula
Maintenance (15.5)

This program is very similar to Product Structure Maintenance. Additional fields are described below.

See page 17.

Batch Size. Enter the production batch quantity for this formula, usually the item batch quantity. This field lets you maintain multiple formulas for different production batch quantities of the same item.

Qty Type. Specify how the component or co-product/by-product quantity is used for this formula or base process.

- Blank: parent unit of measure. Defines quantity in terms of a single unit of the parent, in the parent's unit of measure. For example, if the unit of measure of ink is liters and the quantity per of ink concentrate is 10g, 10 grams of concentrate are needed for each liter of ink.
- B: standard batch size. Defines quantity in terms of the parent's batch quantity. For example, if the batch size of ink is 50 liters and the quantity per of ink concentrate is 10g, 10 grams of concentrate are needed for each batch.
- P: percentage of batch. Defines quantity as a percentage of batch, specified in Batch Percent field. For example, if batch size of ink is 50 liters and water makes up 90% of the batch, 45 liters of water are needed for each batch.

Tip
If the batch and component quantities are not in the same unit of measure, set up a UM conversion.

Batch Percent. Enter the quantity of the component ingredient required to manufacture a batch of the parent item, expressed as a percentage of the batch. Use this field only if Qty Type is P.

Use Formula Code Maintenance (15.1) to set up a BOM/Formula that is not an item number.

Tip
For simplicity, use the item number followed by site code.

- Site-specific formulas. Set up a BOM/Formula for each required site. Then use Formula Maintenance to attach the ingredients list. Finally, use Item-Site Planning Maintenance to assign the normal BOM/Formula to each item-site. This designates the formula used for planning and manufacturing at that site.
- Common formulas. Several products can use exactly the same ingredients, the only difference being processing or aging. Set up a BOM/Formula and attach the formula to it. Then assign that BOM/Formula to each of the items in Item Planning Maintenance as the default formula.
- Alternate formulas. One item can have several formulas, common for different batch sizes. Set up a BOM/Formula for each batch size and attach the formula to that BOM/Formula. Associate these with each

BOM/Formula as an alternate using Alternate Structure Maintenance, or link them to items and processes using Alternate Routing Maintenance. Designate one formula in Item Planning Maintenance as the default for planning.

- Co-product/by-product formulas. The BOM/Formula code or base process for a co-product/by-product structure is actually a component of the co-products and by-products that it produces. The unit of measure (UM) for the BOM/Formula when it is a base process item should be the same as the UM in the item master for the base process.

See Chapter 5, “Co-products/By-products,” on page 51.

Fig. 4.3
Formula Code
Maintenance (15.1)

Formula Copy (15.8) creates a new formula by copying another one—useful when items share similar formulas or to create alternates. After copying, use Formula Maintenance to modify the new formula by adding, deleting, or changing requirements.

Defining Processes

A process, like a routing, is a sequence of steps to follow in the production of an item. A process definition, however, defines its control information in terms of a batch rather than a completed unit.

Process Definition Maintenance (15.13) is very similar to Routing Maintenance. Only a few fields are different.

See page 34.

Fig. 4.4
Process Definition
Maintenance
(15.13)

The screenshot shows the 'Process Definition Maintenance' window. At the top, it has a menu bar with 'User Menu', 'Edit', 'Queue', 'Options', and 'Help'. Below the menu bar, there are several icons. The main area contains the following fields:

Routing Code: 0411	Vanilla Ice Cream
Operation: 10	Batch Qty: 1.0
Start Date:	End Date:
CS	
Standard Operation:	
Work Center: FILL1	Line 1 Carton Filler
Machine:	
Description:	
Machines per Op: 1	Milestone Operation: yes
Overlap Units: 0	Subcontract LT: 0
Queue Time: 0.0	Setup Crew: 0.00
Wait Time: 0.0	Run Crew: 1.00
Setup Time: 0.0	Yield%: 100.00%
Run Time/Batch Qty: 0.0	Tool Code:
Move Time: 0.0	Supplier:
Start Date: / /	Subcontract Cost: 0.00
End Date: / /	Comments: no

Batch Qty. A system-maintained field recording the normal batch quantity for an item. If the formula was entered in Formula Maintenance, Batch Qty defaults from the item master. Otherwise, it defaults from Formula Code Maintenance. Use Batch Quantity Change (15.9) to change the value.

Ingredient quantity per and process operation run times are stated in terms of this batch quantity.

Run Time/Batch Qty. Enter the process operation run time in terms of the batch quantity for the item/product.

To save data-entry time when defining processes for items that share similar operations or when creating alternates, copy an existing definition record with Process Definition Copy (15.16). Then add, change, or delete operations as needed.

Process/Formula Maintenance

See Chapter 5, "Co-products/By-products," on page 51.

Process/Formula Maintenance (15.18) lets you enter formula, batch, process, and co-product/by-product information from a single menu program. This is particularly useful when you are setting up processing for co-products/by-products.

Use this frame to specify which screens display.

Fig. 4.5
Process/Formula
Maintenance
(15.18)

There are four main screens, in addition to a transactions comments screen.

- The Formula/BOM Code screen records the code for the parent item. It is the same as Formula Code Maintenance (15.1).
- The Process Operation Detail records information about the operations associated with the formula's process definition. It is the same as Process Definition Maintenance (15.13).
- The Formula Components screen records information about the components used at each operation. It is the same as Formula Maintenance (15.5).
- The Co/By-Products screen records information about co-products/by-products. This is the same as Co/By-Product Maintenance (15.12.1).

See "Setting Up a Co/By-product Structure" on page 60.

CHAPTER 5

Co-products/ By-products

This chapter describes how to use MFG/PRO to manage processes that create more than one product. Topics related to material requirements planning (MRP) and work orders for co-products and by-products are also discussed.

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Setting Up a Co/By-product Operation 56

Calculating Costs and Lead Times 66

MRP for Co-products/By-products 74

Managing Joint Work Order Sets 78

Restrictions 86

Introduction

MFG/PRO provides a special set of features for managing processes that create more than one product. Such products are referred to as co-products or by-products. Processes that create only one product are supported by regular bills of material (BOM) and formulas.

Co-product/By-product features support a variety of manufacturing operations, including:

Batch processing. Production of items by mixing, blending, and refining component ingredients, such as pharmaceuticals, processed foods, and wine.

Sorting. Separation of items by characteristics such as size, weight, or quality, such as clothing, computer chips, and produce.

Disassembly. Separation of items from larger items, such as juice and seeds from oranges.

Molding. Production of items using multiple-cavity molds such as plastics and confections.

Features include support for MRP, work orders, shop floor control, and costing, as well as tools for setting up items, structures, and routings. Great flexibility is provided in defining alternate products structures and routings. As a result, perhaps even more than with regular processes, careful planning is critical.

Implementing and managing co-products/by-products involves:

- Setting up an operation for co-products and by-products
- Developing standard and simulation costs
- Implementing material requirements planning (MRP)
- Managing the work order life cycle for the related products

Overview

A *base process* is a manufacturing operation that creates more than one product. These products are called *co-products* or *by-products*. For this discussion, a co-product is an intended result of a base process and generally has significant value. In contrast, a by-product is an incidental result of a base process. Figure 5.1 illustrates a typical base process that produces two co-products.

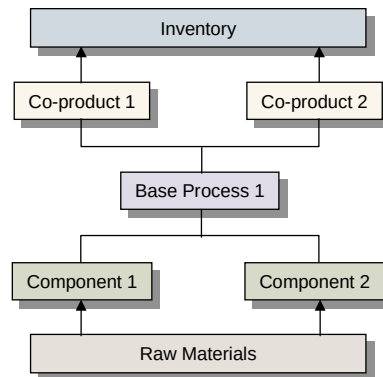


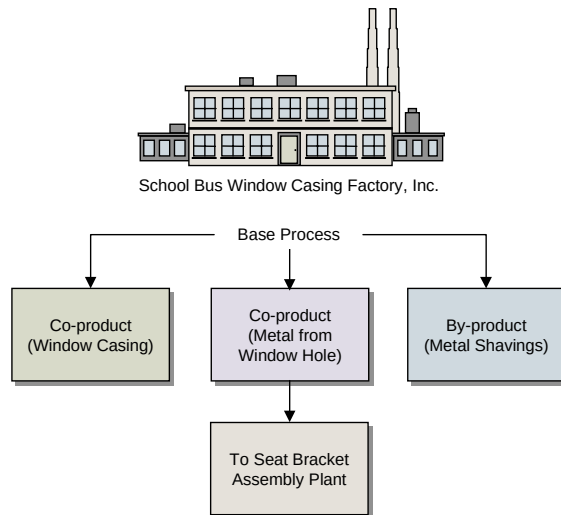
Fig. 5.1
A Base Process
Produces Multiple
Products

Example A sheet metal stamping process yields a piece of sheet metal used to make school bus window casings. The stamping process also yields two other products:

- Pieces of metal that are removed from the window hole and used to make seat brackets in another process
- Metal shavings that are swept up and disposed of at a cost

The pieces cut from the window hole have value, and are considered a co-product. The metal shavings have little value and an associated disposal cost, and are considered a by-product. If the shavings can be sold as scrap, the manufacturer may decide to define them as a co-product instead. See Figure 5.2.

Fig. 5.2
Defining
Co-products and
By-products



The co-products and by-products of a base process do not have their own product structures or routings. These are defined in the base process. In MFG/PRO, base processes are items containing formulas for co/by-product operations, and are defined in the same way as regular items. A base process has:

- An associated item record
- A product structure listing its co-products and by-products
- A formula (product structure) listing its component requirements (optional)
- A routing listing its operations (optional)

The BOM/formula code for a co-product is the item number of the co-product's base process.

There are some important distinctions between base process items and regular items.

- Base process items are never regarded as items to be stocked. Item status codes are used to restrict inventory transactions related to base process items and to ensure that these items never appear on sales or purchase orders. Should base process items end up in inventory, or on sales or purchase orders, they are ignored by MRP.
- Base process items cannot be used as components in another process.

More About Co-products and By-products

Demand for co-products drives the planning of base processes, and the co-product that has the most demand is the one planned for.

Example Base process X produces two co-products, Y and Z. Since there is greater demand for Y than for Z, base process X is planned to produce the desired quantity of Y. The quantity of Z produced will therefore exceed demand.

A co-product can be a component of another process or product structure. For instance, for Company Q, nonvintage wine may be a co-product of the wine manufacturing process and a component of the wine cooler manufacturing process, as shown in Figure 5.3.

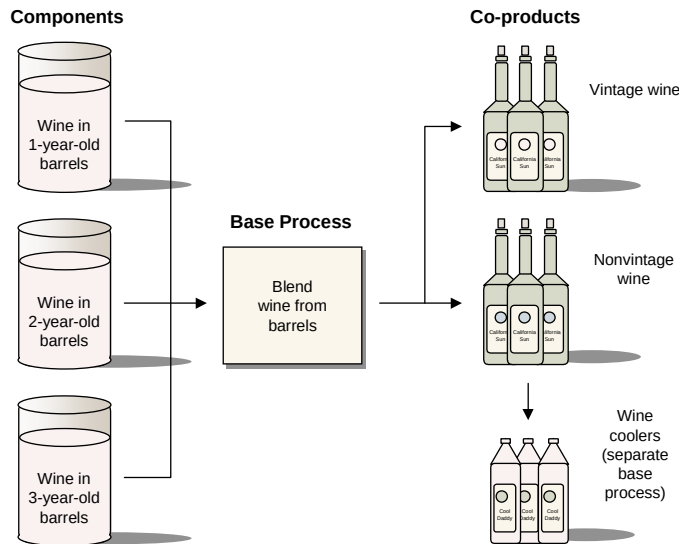


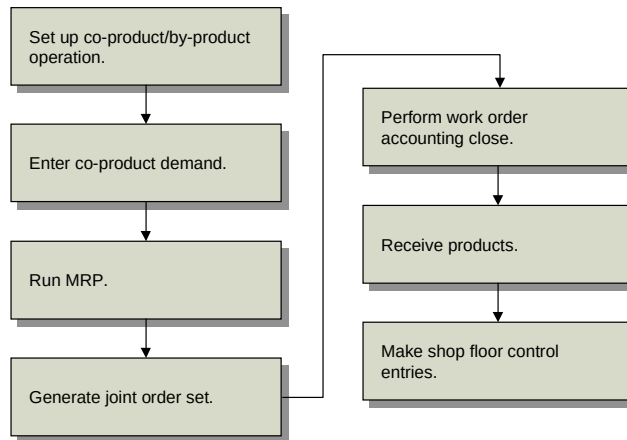
Fig. 5.3
A Co-product Used
as a Component in
Another Structure

By definition, demand for by-products is not expected. If demand for a by-product is generated, MRP treats it as demand for a normal item. MRP does not plan work orders to satisfy by-product demand.

Co-product/By-product Work Flow

Figure 5.4 shows steps for setting up and managing a typical operation involving a base process with co-products and by-products.

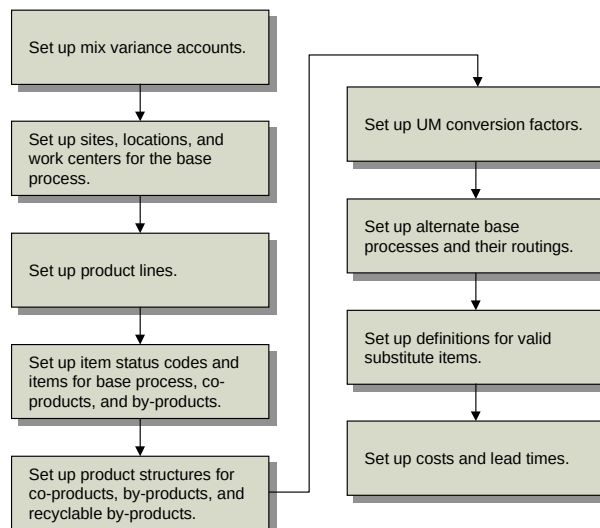
Fig. 5.4
General Work Flow
for Co-products/
By-products



Setting Up a Co/By-product Operation

Figure 5.5 shows steps for setting up a typical operation for co-products and by-products. Each step is discussed in detail in the following sections.

Fig. 5.5
Setting up for
Co-products/
By-products



Setting Up Mix Variance Accounts

If the quantity of a co-product received to stock differs from the quantity expected, a variance occurs. To properly account for such variances, called *mix variances*, a mix variance account must be established. Even if you do not plan to use the co-product/by-product features, a mix variance account must be established before any work orders can be generated.

Mix/yield variance is the costed difference between the quantity received and scrapped for a product and its expected (order) quantity. The formula is as follows:

$$\text{Mix Variance} = [\text{Order Qty} - (\text{Received Qty} + \text{Scrapped Qty})] \times \text{Unit Cost}$$

Mix/yield variances are always calculated as the result of unplanned receipts because the expected (order) quantity is zero.

- 1 Set up mix variance accounts in Account Code Maintenance (25.3.13).
- 2 Verify that mix variance account numbers appear in the variances frame of the System/Account Control File (36.1).

Mix variance amounts (if any) are updated on the affected co/by-product work order, and subtracted from the work-in-process (WIP) amount of the base process work order. A general ledger (GL) transaction is created debiting the mix variance account specified on the co/by-product work order and crediting the WIP account specified on the base process work order. The work order close procedure can be performed more than once on a work order, and the work order amounts are cumulative. The GL transaction is additive.

Setting Up Sites and Locations for the Base Process

Establish sites for the base process in Site Maintenance (1.1.13). A location is an area within a site. A site can have an unlimited number of locations. You can use the same location code for different sites. Use Location Maintenance (1.1.18) to set up locations for the base process.

Setting Up Work Centers

A work center is a production facility capable of performing a certain task. A work center might be a place, a machine or group of machines, a person or group of people. In MFG/PRO, work centers are the most basic units used for operation scheduling, capacity requirements planning, and cost determinations for GL transactions.

In Work Center Maintenance (14.5), set up work centers by entering for each a unique work center code and a unique machine code.

Setting Up Product Lines

A product line is a group of similar items or products. At many companies, sales and operations are planned, reported, and analyzed by product line rather than by individual item or product. To establish a product line, use Product Line Maintenance (1.2.1).

Setting Up Item Status Codes for the Base Process

Tip
Item status codes are created and maintained in Item Status Code Maintenance (1.1.5).

Base process items are never stocked in inventory. As a result, although base processes are entered as regular items, they are not processed as inventory items. Use item status codes to prevent any inventory transactions related to base process items. Only two transactions should be allowed for the base item:

- ADD-PS, which occurs when the item is added to a product structure.
- ADD-WO, which occurs when the item is added to a work order.

Setting Up an Item for the Base Process

- 1 Create a base process item in Item Master Maintenance (1.4.1). Enter the unit of measure for each batch. Assign an item status that restricts inventory transactions.

- 2 Enter the following information in the Item Planning Data frame.

Batch Qty. This is established in Formula Code Maintenance (15.1) or Process/Formula Maintenance (15.18).

Plan Orders. Enter Yes.

Order Policy. Enter POQ or FOQ. MRP does not use LFL or OTO for base processes.

Pur/Mfg Code. Enter M (manufactured) or leave blank.

BOM/Formula. Leave blank. A base process item cannot refer to another BOM/Formula.

Phantom. Enter No.

Setting Up Items for Co-products and By-products

Create items for co-products and by-products using standard procedures. For co-products, it is important to set the BOM/Formula field equal to a base process item number.

In Item Master Maintenance (1.4.1), Item Planning Maintenance (1.4.7), or Item-Site Planning Maintenance (1.4.17), enter the following for each co-product and by-product of a given base process.

Item Number. Enter an item number for the co-product or by-product.

Planning Parameters. Normally, you accept default values for these fields. MRP does not use planning parameters for co-products. Instead, it uses the parameters of the base process. MRP does not plan the base process to satisfy demand for a by-product. Rather, it plans by-products using the conventional method.

Pur/Mfg. Leave blank or enter M (manufactured) for co-products. Enter any value for by-products.

BOM/Formula. Enter the item number for the base process normally used to produce this co-product or by-product. This field is used for planning, work orders, and cost roll-up. An item can be a by-product and have a normal BOM/Formula code.

Note For items that are always by-products, BOM/Formula codes are optional. Entering the base process item number as the BOM/Formula code for by-products and co-products enables you to sort MRP Summary and Detail Reports by BOM/Formula code.

Routing Code. This should be left blank in most cases. If a co-product has a preferred routing different from the base process routing, enter

that preferred routing. This routing must be set up as an alternate routing for the base process.

Phantom. Enter No. A co-product can be a component in a regular product structure, but the structure type cannot be X (phantom).

Setting Up a Co/By-product Structure

A co-product/by-product structure defines the items that result from a base process and specifies whether they are co-products or by-products. These product structures can be set up in several ways. The easiest way is through Process/Formula Maintenance (15.18), which combines the features of the following programs.

- Master Comment Maintenance (14.12)
- Routing Maintenance (14.13.1)
- Formula Code Maintenance (15.1)
- Formula Maintenance (15.5)
- Co/By-Product Maintenance (15.12.1)

Tip

You can have the system create BOM/Formula codes automatically when you define formulas and product structures.

- 1 Set up BOM/Formula Codes using Process/Formula Maintenance (15.18) or Formula Code Maintenance (15.1).

BOM Code. Enter the base process item number.

Batch Size. Displays the batch quantity. The default is 1. To modify this field, use Batch Quantity Change (15.9).

UM. The BOM unit of measure. Should be the same as the item unit of measure for the base process item.

- 2 Set up the co/by-product structure using Process/Formula Maintenance (15.18) or Co/By-Product Maintenance (15.12.1).

Backflush Method. Enter 1 or 2. This determines the calculation method used to backflush base process components.

Co/By Type. Enter C for co-product or B for by-product.

Quantity. Enter the quantity per batch if Qty Type is Batch, or the quantity per base process unit if Qty Type is blank. The system calculates this field automatically when Qty Type is Percent.

▶ See “Backflush Calculation Methods” on page 83.

Qty Type. Enter B for batch, P for percent, or leave blank to indicate per base process unit.

Process. Enter the percent per batch when Qty Type is Percent. This is calculated automatically when Qty Type is Batch.

Cost Allocation. Enter the percentage of base process cost to be allocated to this co-product. If Co/By Type is B, an allocation percentage cannot be entered.

The costs for co-products and by-products are calculated using the same MFG/PRO programs used to calculate regular costs. Once costs are rolled up for a base process (yielding gross cost), by-product costs are subtracted to arrive at the base process net cost. The entire net cost is then allocated to co-products of the base process. Allocation percentages for all co-products of a base process should, therefore, add up to 100 percent.

▶ See “Allocating Costs to Co-products” on page 66.

Structure Type. This field is display-only and always set to J (Joint).

- 3 Set up formulas or product structures used to define the ingredients or components required for a base process. You can use Process/Formula Maintenance (15.18) or Formula Maintenance (15.5). To enter a product structure, use Product Structure Maintenance (13.5).

Parent Item. Enter the base process item number.

Component Item. Enter components of the base process item.

When adding a formula, you can enter a batch size. Use Batch Quantity Change (15.9) to modify a formula's batch size.

- 4 Set up routings for the base process using Process/Formula Maintenance (15.18), Process Definition Maintenance (15.13), or Routing Maintenance (14.13.1).
 - In Process/Formula Maintenance, enter the base process in the BOM/Formula Code field.
 - In Process Definition Maintenance or Routing Maintenance, enter the base process in the Routing Code field.

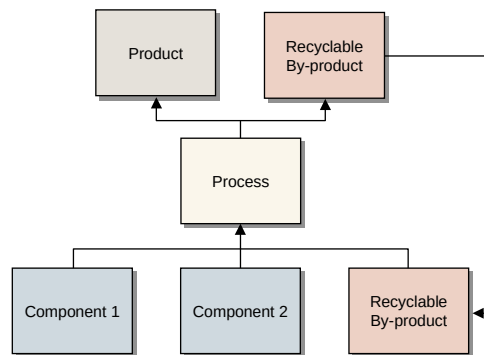
Setting Up Structures for Recyclable By-products

A recyclable by-product is reused in a manufacturing process.

Example In a manufacturing process, dry paint is sprayed onto charged sheet metal. The paint powder adheres to the metal and, after baking in a kiln, becomes a painted surface. Upon application, some of the dry paint falls to the floor, where it is collected by a vacuum funnel and eventually returned to the spraying machine.

Although recyclable materials are technically by-products, MFG/PRO does not treat them as part of the co-product/by-product structure, but as regular components. Thus, they should be defined as regular components and managed accordingly. Figure 5.6 illustrates a recyclable by-product process.

Fig. 5.6
A Recyclable
By-product Process



You set up a structure for a recyclable by-product by:

- Entering an item number for the recyclable item.
- Adding a recyclable item to a product structure/formula. Typically, you enter two product structure/formula records for each recyclable by-product:
 - One for the component requirement—a component going into the process—entered as a positive quantity.
 - One for a recyclable by-product—a component coming out of the process—entered as a negative quantity.

To set up a structure for a recyclable by-product, complete the following steps.

1 In Item Master Maintenance (1.4.1), enter:

Item Number. Enter an item number for each recyclable by-product. Use a single item number even if the item requires reprocessing after it is received as a by-product and before it is reintroduced as an ingredient of a process.

2 In Product Structure Maintenance (13.5) or Formula Maintenance (15.5), enter:

Component Item. Enter the item number of the recyclable material.

Reference. Enter a code to differentiate between a component requirement and a recyclable by-product. Typically, component requirements have blank reference codes. Recyclable by-product codes are user defined.

Qty Per. Enter a quantity for this product structure or formula. For a recyclable by-product, enter a negative number to indicate the quantity expected to be recovered from the process. For a component requirement, enter a positive number to indicate the full amount required.

LT Offset. Enter the number of days to be added to the work order start date to determine when the by-product is available for supply.

Op. Enter the operation for which the by-product is available or the operation for which the component is required.

Once these steps are complete, you can:

- Print work order picklists with component requirements summarized by operation.
- Roll up costs using the net material requirement for the component (quantity required less the quantity produced).
- Run MRP and have it recognize the demand and supply of the recyclable materials—by-product supply is negative demand.
- Receive by-products using Work Order Component Issue (16.10) or Work Order Receipt Backflush (16.12) for the operation where a by-product is expected, by entering a negative quantity to receive.

Setting Up Unit of Measure Conversion Factors

When the base process unit of measure (UM) differs from the UM for a co-product or by-product, UM conversion factors must be defined. Conversions are from the base process UM to the co-product or by-product UM.

Example If the base process UM is liters and the co-product UM is kilograms, a UM conversion is required where the UM is liters and the alternate UM is kilograms.

Set up UM conversion factors in Unit of Measure Maintenance (1.13).

Unit of Measure. Enter the base process unit of measure.

Alternate UM. Enter the co-product or by-product unit of measure.

Item Number. Enter the base process item number, or leave blank.

UM Conversion. Enter the conversion factor converting quantities from Alternate UM to Unit of Measure.

Setting Up Alternate Base Processes

An item can be a co-product or by-product of more than one base process. The base process for that item is its BOM/Formula code defined in Item Master Maintenance (1.4.1) or Item-Site Planning Maintenance (1.4.17).

Set up alternate base processes using Alternate Structure Maintenance (13.15).

Item Number. Enter the co-product item number.

BOM/Formula. Enter the base process item number.

Setting Up Alternate Base Process Routings

Alternate routings are useful for managing variations in the manufacturing process of an item. For example, a substitute machine is used while the primary machine for a process is being repaired. Like routings for regular items, alternate routings for co-products are assigned when work orders are generated. Routings are not required and are not used in MRP or for developing standard costs.

Only a base process can have alternate processes or routings. This is not true for co-products and by-products because they do not have a formula or process independent of the base process.

Define alternate routings for a base process in Alternate Routing Maintenance (14.15.1).

Item Number. Enter the base process item number.

Routing Code. Enter the alternate routing number previously defined in Routing Maintenance (14.13.1) or Process Definition Maintenance (15.13).

Bill of Material. Leave blank.

Setting Up Definitions for Valid Substitute Items

Receipt of items on joint work orders is not limited to items set up as co-products or by-products of a base process. Set Modify Co/By Product Receipts in the Compliance Control File (1.22.24) to Yes to allow any item to be received on a joint work order. Set to No to have only valid substitutes received on a joint work order.

- 1 In Item Substitution Maintenance (13.19), do the following.

Parent/Base Process Item. Enter the base process item number or leave blank.

Item Number. Enter the co-product or by-product item number.

Substitute Item. Enter the item number of valid substitutes for the standard co-product or by-product.

- 2 For users who have the Compliance module, go to the Compliance Control File (1.22.24).

Modify Co/By-Product Receipts. The default is Yes. This allows receipt of any item from a base process work order. Enter No to restrict receipts to either items defined as part of the structure of the base process or to valid substitute items defined in Item Substitution Maintenance (13.19).

Tip

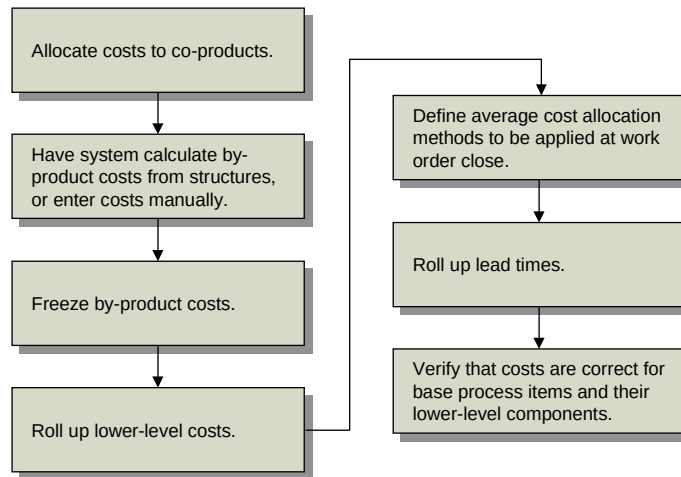
This feature is provided as a means of complying with FDA and other agency regulations. You can use co-products/by-products without setting this field.

▶ See *User Guide Volume 9: Compliance* for details.

Calculating Costs and Lead Times

Co-product costs and lead times are calculated by the same MFG/PRO programs that calculate regular costs. Figure 5.7 outlines some typical steps for calculating and allocating co-product costs and lead times. Each step is discussed in more detail in the sections that follow.

Fig. 5.7
Typical Cost
Calculation Work
Flow for
Co-products



Allocating Costs to Co-products

▶ See “Setting Up a Co/By-product Structure” on page 60.

Assign cost allocation percentages in Process/Formula Maintenance (15.18) or Co/By-Product Maintenance (15.12.1).

The same co-product can result from more than one base process, but only one base process determines a co-product’s cost at a particular site. That is, a co-product receives costs only from the base process specified in the BOM/Formula field of the co-product’s item record.

Example Base Process A produces three co-products—pitted prunes, prune juice, and prune purée used to make Danish pastry. It also produces one by-product, pits. The net cost calculation for Base Process A is as follows.

Gross Cost (Base Process A)	\$105
By-product Costs	5
Net Cost (Base Process A)	<u>\$100</u>

Although prune juice is a significant co-product of Base Process A, it is also a co-product of Base Process B and, as defined in the BOM/Formula field of Item Master Maintenance (1.4.1), takes its costs from Base Process B. For Base Process A, cost allocation percentages are:

Co-product 1 (Pitted Prunes)	80%
Co-product 2 (Prune Juice)	0%
Co-product 3 (Prune Purée)	20%

Final allocated costs are:

Co-product 1 (Pitted Prunes)	$\$100 \times 80\% = \$80$
Co-product 2 (Prune Juice)	$\$100 \times 0\% = \$0$
Co-product 3 (Prune Purée)	$\$100 \times 20\% = \$20$

By-product costs are calculated the same way as regular costs. That is, they are determined separately from the base process cost roll-up.

Once by-product costs are established, freeze them to ensure they are not changed during cost roll-up. Changing by-product costs after net base process costs have been calculated may result in unanticipated variances.

As in the previous example, the net cost for the base process should equal the sum of the costs allocated to the co-products. If these amounts are not equal, one or more of the following is likely.

- By-product costs were not frozen once subtracted from the base process gross cost. The system recalculated the by-product costs, changing the value of the base process net cost.
- Cost allocation percentages did not add up to 100%.
- Costs were allocated to a co-product whose cost was determined from a different base process than the one being rolled up. This can happen when a co-product is in the product structure of more than one base process.

If co-product costs do not add up to the base process net cost when work orders are closed, method change variances result.

The cost calculations related to base processes, by-products, and co-products are shown in the equations below.

Batch size	x	Base proc. unit cost	=	Base proc. batch cost
Batch size	x	By-prod. unit cost	=	By-prod. batch cost
Base proc. batch cost	–	By-prod. batch cost	=	Net base proc. batch cost
Net base proc. batch cost	x	Allocation %	=	Co-prod. batch cost
Co-prod. batch cost	÷	Quantity per batch	=	Co-prod. unit cost

Entering By-product Costs

By-product costs are calculated separately from the base process cost roll-up. You can enter by-product costs manually or have the system calculate them from regular product structures or formulas.

Since by-product costs are to be deducted from base process gross cost on an element-by-element basis, there must be sufficient cost in each cost element of the base process to cover the amounts established in corresponding cost elements of the by-product.

Tip

As an alternative to entering by-product costs manually, roll up by-product costs from normal product structures using Routing Cost Roll-Up (14.13.13).

If by-product costs are to be entered manually, use Item Master Maintenance (1.4.1), Item Cost Maintenance (1.4.9), or Item-Site Cost Maintenance (1.4.18). Enter costs for by-products of a base process, using the same cost elements as the base process item.

Freezing By-product Costs

Freeze by-product costs using Roll-Up Freeze/Unfreeze (13.12.1).

Site. Enter the site to which these by-product costs apply.

Cost Set. Enter the cost set to be frozen.

Item Number. Enter item numbers for all by-products whose costs are to be frozen.

Freeze/Unfreeze. Enter Freeze.

Rolling Up Costs

Roll up lower-level costs using Product Structure Cost Roll-Up (13.12.13) or Simulation Structure Cost Roll-Up (30.13.19). Keep in mind that the BOM/Formula code associated in the item master determines the base process for a co-product.

Item Number/To. Typically, this program is run for all items. The system only updates base process item costs when roll-up selection criteria include all items in the co/by-product structure.

Site. Enter the site to which these costs apply.

Cost Set. Enter the cost set to which these costs apply. This is normally the GL or current cost set at the selected site.

Choose Go to begin roll-up and End when roll-up is complete. To see the results of the roll-up, use Co/By-Products Cost Report (13.12.7).

Tip

During roll-up, the system calculates and updates base process item costs using the unit of measure (UM) of the BOM/Formula code for the base process. This UM must be the same as the item UM for the base process.

Calculating Average Costs for Co-products

Cost averaging for co-products happens when you close a work order using the following programs.

- Work Order Receipt (16.11)
- Work Order Receipt Backflush (16.12)
- Work Order Accounting Close (16.21)

When you run Work Order Accounting Close, the following occurs.

- Co-product costs are re-averaged by taking any remaining positive or negative WIP costs and allocating them to the co-products. If additional costs are recorded for a work order after costs are allocated, the remaining costs can be reallocated by reopening the closed work order, applying the transaction, and closing it again.
- General ledger (GL) and current costs are updated.

Some typical steps for calculating average GL costs and average current costs for co-products follow.

- 1 Define the average cost allocation methods in Average Cost Method Maintenance (15.12.5).
- 2 Verify that the following are correct:
 - Co-product/by-product definitions
 - Prices for co-products, if allocation method involves price
 - By-product costs
 - Base process batch size
 - UM of the BOM/Formula code for the base process equals the item UM for the base process
 - Site setups for cost sets (GL Cost Set and Current Cost Set)
 - Unit of measure conversions from base process to co-products and by-products

Defining the Average Cost Allocation Methods

Define the average cost allocation methods using Average Cost Method Maintenance (15.12.5). The system provides three methods for allocating costs from a joint order set to co-products.

- Price
- Receipt Quantity
- Receipt Quantity and Price

If other methods are needed, users can provide their own programs. If no method is specified for a site, the Receipt Quantity method is used.

Allocation of base process costs to co-products is based on the cost of a standard batch size. All allocation percentages are calculated using equivalent units of measure based on the unit of measure for the base process. Where co-product units of measure differ from the unit of measure for the base process, the system employs conversion factors in order to express all costs in the base process unit of measure.

Allocation by Price

The percentage of cost to allocate to a co-product is determined by its price, relative to the prices for the other co-products from a base process. Table 5.1 shows how costs are allocated by price.

Item	UM	Conv	Price	Price (KG)	Price Based Allocation
P1	KG	1.00	2.00	2.00	25%
P2	KG	1.00	4.00	4.00	50%
P3	LT	0.50	1.00	2.00	25%

Table 5.1
Co-product Costs
Allocated by Price

Allocation by Receipt Quantity

The percentage of cost allocated to a co-product is determined by the total quantity produced (plus reject) for the co-product, relative to the receipt (plus reject) quantities for other co-products of the base process. Table 5.2 shows how costs are allocated by receipt quantity.

Item	UM	Conv	Receipt Qty	Receipt Qty (KG)	Receipt Based Allocation
P1	KG	1.00	50.00	50.00	50%
P2	KG	1.00	30.00	30.00	30%
P3	LT	0.50	40.00	20.00	20%

Table 5.2
Co-product Costs
Allocated by
Receipt Quantity

Allocation by Receipt Quantity and Price

The percentage of cost allocated to a co-product is determined by the extended price of the total quantity received plus reject for that co-product, relative to the prices and receipt plus reject quantities for the other co-products from a base process. All quantities are converted to the base process unit of measure.

Table 5.3 shows how costs are allocated by receipt quantity and price.

Table 5.3
Co-product Costs
Allocated by Price
and Receipt
Quantity

Item	UM	Conv	Rcpt Qty	Rcpt Qty (KG)	Price	Price (KG)	Price Qty	Price/Rcpt Allocation
P1	KG	1.00	50.00	50.00	2.00	2.00	100	38.48%
P2	KG	1.00	30.00	30.00	4.00	4.00	120	48.15%
P3	LT	0.50	40.00	20.00	1.00	2.00	40	15.38%

Average Cost Accounting

WIP costs are the sum of component costs and shop floor control costs, and are reduced by the cost of co-products and by-products received plus reject quantity. These transactions do not update GL or current costs.

Costs are averaged by taking the costs accumulated in WIP and adjusting the costs of items in inventory received from WIP. MFG/PRO does this in two steps.

- 1 Co-products and by-products are received from work orders into inventory using their current average costs.
- 2 Average GL costs and average current costs are re-averaged based on the costs accumulated for an item's work order when the work order is closed. Co-product costs are re-averaged based on any WIP costs accumulated by this process. Costs can be accumulated when the Work Order Accounting Close program closes any work order operations that have not been closed.

Costs are not re-averaged for quantities received to sites other than the work order (WIP) site. Receipts are handled in two ways depending on whether the work order status is closed or not closed.

- *Not closed.* Co-product costs are not re-averaged. Items are received to the work order WIP site using current average costs. These costs are deducted from WIP. If quantities are received at a different site, they are received at the work order WIP site using current average costs, then transferred to the indicated site.

- *Closed.* Co-product costs are re-averaged. Items are received to the work order WIP site using current average costs. These costs are deducted from WIP. The re-averaging process takes into account quantities received during previous receipt transactions for the same work order.

If quantities are received to a different site than the work order WIP site, it is likely that the inventory quantity on hand is less than the quantity received. This increases the chance that some of the costs cannot be allocated and re-averaged at the WIP site and that costs will be booked to the discrepancy account for the base process.

To maximize the accuracy of average costs and reduce costs booked to discrepancy accounts, the following should be emphasized.

- Complete reporting of co-product and by-product quantities when all quantities for all items are completed.
- Setting of work order status to Closed when receipt quantities are reported.
- Running of Work Order Accounting Close on a regular basis to process recently closed work orders.

Tip

Re-averaging of co-product costs is time-sensitive. The greater the time between receipt and close, the greater the probability that some of the products produced have been consumed.

The cost change taken to inventory is bounded as follows.

- *Upper limit.* Greater of the existing average cost or calculated work order unit cost.
- *Lower limit.* Lesser of the existing average cost or calculated work order unit cost.

Rolling Up Lead Times

The lead time to produce the co-products resulting from a base process is the same as the lead time for the base process. Cumulative Lead Time Roll-Up (13.12.14) copies the manufacturing lead time and the cumulative lead time for a base process to its co-products. Typically, the roll-up program is run for all items, not just those involved in co-product/by-product structures.

By-product lead times are not derived from the base process, but from roll-ups of regular product structures and routings. Enter by-product lead times in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Reviewing Product Costs

To verify that costs are correct for base process items and their lower-level components, review costs using one of the following.

- Product Structure Cost Report (13.12.4). This report identifies an item as a co-product or a base process.
- Co/By-Products Cost Report (13.12.7). This report shows you how co-product costs were calculated from a base process and its by-products.

MRP for Co-products/By-products

Because planned orders for co-products and by-products can be from more than one base process, overplanning of some items can result. This is because MRP plans each base process individually, based on unsatisfied demand for its co-products, rather than evaluating multiple base processes and delivering an optimum plan. Careful planning and setup of these operations by the manufacturer is therefore essential.

Planning for By-products

MRP plans orders for a by-product as a result of creating planned orders for a base process. By-product demand is not considered when planning a base process, but unsatisfied demand for a by-product can result in a normal planned order if the item is purchased, distributed, or has a BOM/Formula code for a regular formula or product structure.

Planning for Co-products

MRP creates base process demand records from the unsatisfied demand for a co-product. An item is a co-product if two conditions are met:

- It is manufactured—its Pur/Mfg code is Manufactured, Routable, or blank.
- Its BOM/Formula code is a base process that has the item as a co-product.

MRP evaluates the beginning inventory, demand, supply, and safety stock for a co-product, and when there is unsatisfied demand, creates a demand

Tip
If these conditions are not met, the item is planned like a regular item.

record for its base process. This demand record reflects the amount of the base process required to meet the unsatisfied demand for the co-product.

As shown in Figure 5.8, MRP passes demand records directly from the co-product to the base process without using the co-product's order policy or related planning parameters.

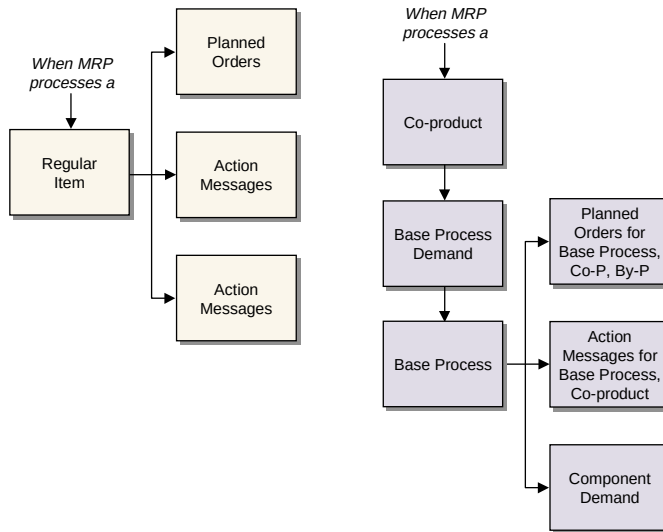


Fig. 5.8
MRP Processing of
Co-products

A co-product is like a parent of its base process. MRP plans all items in a site by low-level code, then by item number. Low-level codes are determined by parent/component relationships.

Planning for Base Processes

MRP plans for a base process by determining the unsatisfied co-product demand for all co-products that reference the base process as their BOM/Formula code. MRP then creates planned orders to fill the unsatisfied co-product demand without regard to projected quantities on hand for the base process.

Unlike the planning process for regular items, MRP does not consider base process inventory. There should never be an on-hand balance for a base process. Use item status codes to prohibit inventory movements, sales, purchases, and repetitive orders on base process items.

♦ See “Setting Up Item Status Codes for the Base Process” on page 58.

MRP does use the order policy and order modifiers for the base process, except safety stock, when creating planned orders. If the order policy is not period order quantity (POQ) or fixed order quantity (FOQ), MRP uses an order policy of POQ. If no order period is specified, MRP uses an order period of seven days.

When MRP plans a base process, it searches for the first unsatisfied demand record for a co-product. Then, depending on whether the order policy is POQ or FOQ, MRP evaluates unsatisfied demand records for all co-products of the base process:

POQ. MRP searches from the first unsatisfied demand record through the end of the order period.

FOQ. MRP looks at all unsatisfied demand records for all co-products that fall on the same date as the first unsatisfied demand record.

MRP creates one or more planned orders to satisfy demand for the co-product that presents the greatest demand for the base process for a specific date or date range. As a result, planned orders for the other co-products of the base process are also created.

Reviewing, Updating, and Reporting Action Messages

MRP creates action messages for base processes and co-products, but not for by-products. Action Message Review/Update (23.5) and Action Message Report (23.7) allow reporting of action messages using various selection criteria, including BOM/Formula code. You can also exclude action messages for base process orders.

Approving Planned Work Orders

To approve planned work orders, use Planned Work Order Approval (23.10). Specify base processes by entering a BOM/Formula code range. This program changes the status on all orders in a joint set from Planned to Firm. The joint set is not updated based on effectivity dates for the co-product/by-product structure (as is done when using Work Order Maintenance or Multiple Work Order Status Change), and work order detail is not re-created.

When a planned purchase order is approved, the system creates a regular firm planned work order, even if the item has a BOM/Formula code for a base process. If an MRP-planned order is originally purchased, MRP does not create a joint order set when it is approved as a work order.

Creating Planned Order Reports

To create planned order reports, use Planned Order Report (23.12). To support features related to base processes, you can:

- Select planned orders by BOM/Formula code
- Include/exclude base process planned orders
- Include/exclude by-product planned orders
- Sort the report output by item number or BOM/Formula code

Creating MRP Summary Reports

To create MRP summary reports, use MRP Summary Report (23.14). To support features related to base processes, you can:

- Select planned orders by BOM/Formula code
- Include/exclude base process planned orders
- Sort the report output by item number or BOM/Formula code

Identifying the Source of Demand for a Co-product

To get detailed MRP information for co-products, by-products, and base processes, use MRP Detail Report (23.17). This feature provides pegging, which enables you to identify the source of demand for co-products.

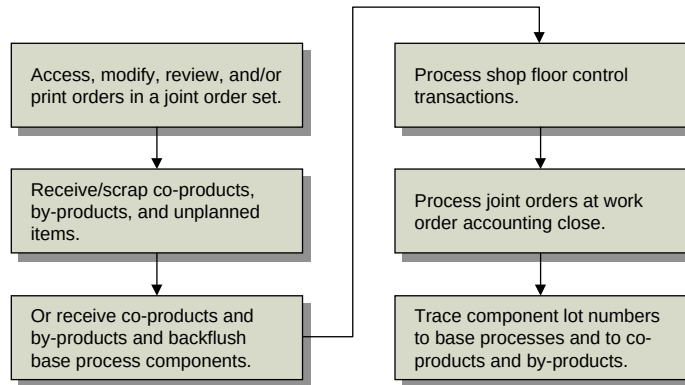
Indicate co-products by item number. You can also:

- Select planned orders by BOM/Formula code
- Include/exclude base process orders
- Sort the report by item number or BOM/Formula code within site

Managing Joint Work Order Sets

Figure 5.9 outlines some typical steps for managing joint work order sets.

Fig. 5.9
Typical Work Flow
for Joint Work
Order Sets



Joint Work Order Sets

Tip
While Rework and Expense work orders may retain the work order number shared by the joint order set, they have a different status and are not considered part of the joint order set.

When you enter a work order for a base process or co-product, the system creates a *joint order set* comprised of a work order for the base process and one for each of its co-products and by-products. All work orders in the joint set (called *joint orders*) share the same work order number, site, and status, but have different work order IDs.

A joint order set consists of the following.

- A work order for the base process
- A work order for each co-product and by-product
- A work order bill for the base process
- A work order routing for the base process

Accessing and Modifying Joint Order Sets

Joint orders for co-products and by-products can be added or deleted from a joint set when the status of the set is Exploded, Allocated, or Released. Status codes determine when and how joint work orders can be modified relative to each other. Status codes are always the same for all orders in a joint set. The processing and restrictions applied are similar to those applied to work order bills.

Table 5.4 describes how work order status codes affect joint work orders.

Code	Status	Description
P	Planned	MRP creates an imploded joint order set reflecting the base product structure as of the order release date.
B	Batch	An order is created for a single co-product or base process item. Orders are not imploded.
F	Firm	Orders are imploded to reflect the base product structure as of the order release date. You can modify co-product/by-product quantities and the base process quantity. All quantities are automatically rescaled. When an MRP-planned order in a joint order set is approved, all joint orders in the set are changed to status Firm.
E	Exploded	The same as Firm, except you can modify quantities for co-product or by-product orders without automatically rescaling other orders. You can add or delete orders from a joint order set. Delete is not allowed if quantities or costs have been received for an item on that order.
A	Allocated	Same as exploded.
R	Released	Same as exploded.
C	Closed	When the status of a joint order set is changed to Closed, and average cost method is used, updates are made to current AVG, current LAST, and GL average costs.

Table 5.4
Effect of Work
Order Status Codes

Joint order sets can be created for regular work orders (where Type is blank), but not for work order types such as Expense, Rework, Scheduled, Cumulative, and Final Assembly. Joint orders can be added to or deleted from a joint set when the status is Exploded, Allocated, or Released.

Tip
A joint order set must have only one base process order and at least one co-product order. If you delete the base process order or the only co-product order, the entire set is deleted.

To access and modify a joint order set, use Work Order Maintenance (16.1).

Item Number. Enter the item number for a base process or a co-product.

Type. Leave blank.

Routing Code. Optionally, enter an alternate routing code set up for the base process in Alternate Routing Maintenance (14.15.1).

BOM/Formula. Optionally, enter an alternate base process item number. To enter this field, the work order must be for a co-product, *and* the base process must be set up as an alternate product structure in Alternate Structure Maintenance (13.15).

Adjust Co/By Order Quantities. Enter Yes or No. This field does not appear on base process work orders. If the order quantity changes, entering Yes automatically rescales all order quantities in the joint order set. The work order status must be E, A, R, or C to optionally rescale quantities. Joint order quantities are recalculated automatically when:

- Order quantity changes on a joint order whose status is Firm.
- Status of a work order changes from any status to Firm.
- Status of a work order changes from Batch, Planned, or Firm, to Exploded, Allocated, or Released.

The system calculates the quantities for joint orders from quantities entered in Co/By-Product Maintenance (15.12.1). Order quantities for a joint order set can be recalculated automatically or maintained manually, depending on the work order status.

Adjust Co/By Order Dates. Enter Yes or No. This prompt does not appear on base process work orders. If the order, release, or due date changes, entering Yes resynchronizes the dates for all orders in the joint order set. The work order status must be E, A, R, or C to optionally adjust dates. Firm status orders always resynchronize the dates for all orders in the set.

Default due dates for orders in a joint set are calculated using the manufacturing lead time for the base process.

Mix Variance Acct. Enter the account number for Mix Variance. This field defaults from the product line of the item and may be different for work orders within a joint order set. If this field is blank, it should be defined in Product Line Maintenance (1.2.1).

Creating a Joint Order Set from an Alternate Base Process

To create a joint order set using an alternate base process, use Work Order Maintenance (16.1).

- Enter a work order using the item number for the alternate base process.
- Enter a work order for a co-product and specify an alternate base process as its BOM/Formula code. Define valid alternate base processes using Alternate Structure Maintenance (13.15). Enter the co-product item as the item number and the base process as the BOM/Formula.

Reviewing, Printing, and Releasing Joint Orders

To review joint work orders, use Joint Work Order Inquiry (16.3.13). Orders can be specified by item number, work order number, work order ID, BOM/Formula code, due date, and/or site.

To print a joint order set, use Work Order Release/Print (16.6) or Multiple Work Order Release/Print (16.7). Both programs release the joint order set, provided one order in the set is selected for processing. Documents listing the co-products and by-products expected for a base process can be printed, as well as standard work order picklists and routings. You can print the list of co-products and by-products before the picklist or after the routing operations.

- When a joint order's status changes to Release and the associated base process has a component that is routable (the Pur/Mfg Code for the component item is R), a routable work order is automatically created. When created, the routable work order's status is Batch.

Routable work orders created from a joint order set use the joint set work order number, but are given a unique suffix. For example, a joint order set with work order number 1234 can create routable work orders 1234-1 and 1234-2.

- When a routable work order is created from a regular work order, the routable work order uses the work order number of the parent, but has a unique work order ID.

To select closed work orders and print summary data on each, use Work Order History Report (16.3.6). You have the option to Print Bill of Material Detail and Print Routing Detail. Enter Yes for Print Co/By-Product Orders to print joint order sets. If Yes, the report displays information for each of the co-product and by-product orders for a base process work order.

To print information for each order related to a base process work order, use Work Order WIP Cost Report (16.3.5). To print information on items received and scrapped from a joint order set, use Work Order Cost Report (16.3.4). These reports show the costs for joint order sets once they have been closed in Work Order Accounting Close (16.21).

Receiving, Scrapping, and Backflushing

To receive and scrap co-product and by-products in a joint order set, use Work Order Receipt (16.11) or Work Order Receipt Backflush (16.12). You can initiate these programs using any work order in a joint order set.

In Work Order Receipt (16.11):

Work Order. Enter any work order number in the joint order set.

ID. Enter the specific ID desired, or leave blank to retrieve the first ID in the joint order set.

Receive All Co/By-Products. Enter Yes if all co-products and by-products are to be received. Enter No if only this particular order is to be received. This prompt only applies if the order being received is not for the base process. When the base process order is received, all related work orders are received by default.

Use Work Order Receipt Backflush (16.12) to:

- Modify the backflush quantity and method.
- Initiate transactions to receive co-products and by-products.
- Backflush (issue) base process components. When components are backflushed, the receipt and scrapped quantities are used to calculate default issue quantities for the components.

Backflush Calculation Methods

Specify one of two backflush methods for the base process in Co/By-Product Maintenance (15.12.1) or Process/Formula Maintenance (15.18). The backflush quantity for the base process is used to calculate backflush (issue) quantities for the components of a joint order set.

In Work Order Receipt Backflush (16.12):

Work Order. Enter any work order number in the joint order set.

ID. Enter the specific ID desired, or leave blank to retrieve the first ID in the joint order set.

Receive All Co/By-Products. Enter Yes if all co-products and by-products are to be received. Enter No if only the items on this particular order are to be received.

Backflush Method. Enter 1 or 2. Method 1 backflushes based on the co- and by-product quantities received. Method 2 backflushes based on the order quantity of the base process. The following two sections describe each method in more detail.

Backflush Method 1

The backflush (base process) quantity is calculated from the receipt quantities processed for all the co-products and by-products. Unit of measure conversion factors are used to express all item quantities in base process units.

Use Method 1 when the quantity for a batch is directly related to the sum of its output. For example, for a process that sorts fruit into different sizes and grades, the batch quantity can be calculated from the total amount of fruit processed for all sizes and grades. This method is generally used when there is greater variability in output percentages for products.

Backflush Method 2

The default backflush (base process) quantity is the order quantity for the base process work order. You can change the backflush quantity to reflect the actual quantity processed for a batch.

Use Method 2 when the batch quantity is closely related to the expected output of a particular co-product. For example, for a process that makes ice cream, the batch quantity can be calculated from the amount of ice cream processed. Any by-products, such as waste water, are not necessary for the calculation of the batch quantity.

Receiving Unexpected Items

Occasionally, an item produced from a joint order has a different grade or quality than expected. When this is the case, and the item assumes a different item number than the expected item, it can be received even without a joint order in the set for the unexpected item. These items are received in Work Order Receipt (16.11) or Work Order Backflush (16.12) as substitutes. A new order with a quantity of zero is added to the joint set.

♦ See “Setting Up Definitions for Valid Substitute Items” on page 65.

The Compliance Control File (1.22.24) setting for Modify Co/By-Product Receipts determines what items can be received by Work Order Receipt (16.11) or Work Order Receipt Backflush (16.12). When an item does not have a joint order in the joint order set being processed:

- *Yes* enables a receipt to be processed for any item number, even if it is not defined as a co-product or by-product of the base process.
- *No* enables you to receive only the expected items or valid substitute items. Valid substitute items are defined in Item Substitution Maintenance (13.19).

When a substitute item is received instead of an expected one, change the status of the joint set to Closed, shortly after recording the receipt. The order and open quantities for the expected item remain unchanged when another item is received as an unplanned receipt. Closing the joint order set effectively changes the open or expected quantities for all items to zero. Since the order quantity does not change, mix variances can be calculated for each co-product or by-product.

Receiving Unplanned Items

Use Unplanned Receipts (3.9) to receive an item that has no work order. Related items in the co-product/by-product structure cannot be received with the item.

Processing Shop Floor Control Transactions

Shop floor control transactions are processed using the base process order for a joint order set.

Processing Joint Orders at Work Order Close

Use Work Order Accounting Close (16.21) to process joint orders when a base process order is selected to be closed. This procedure calculates mix variances, updates current average and last costs, and updates GL average costs for co-products and by-products.

Deleting and Archiving Joint Orders

Use Work Order Delete/Archive (16.23) to process all orders in a joint set when any one of the work orders in the set is selected for processing.

Tracing Lots

The lot number for a base process is its work order ID number or the lot number assigned to that order using Work Order Attribute Maintenance (16.19). The system automatically maintains lot-to-lot relationships for joint orders by creating receipt and issue transactions between a base process and its joint order set. These are memo transactions that do not update inventory or create GL transactions.

- Use Lot Where-Used Inquiry (3.22.4) to trace a component lot number to a base process and trace upward from the base process to the co-product and by-product lots produced from it.
- Use Lot Actual Bill Inquiry (3.22.3) to trace a co-product or by-product lot number to the base process that produced it and trace downward to the component lots for the base process.

Accounting for Joint Orders

All GL transactions for issues, receipts, and shop floor control transactions update the WIP account for the base process work order. Table 5.5 shows the origins of account and cost center information for work order transactions.

Table 5.5
Origins of Account
and Cost Center
Information

Account/Cost Center	Base Process	Co-product By-product	Component
Inventory		Product Line	Product Line
Scrap		Product Line	
WIP	Work Order		
Material Usage Variance	Work Order		
Material Rate Variance	Work Order		
Subcontract Usage Variance	Work Order		
Mix Variance		Work Order	
Floor Stock	Work Order		

Restrictions

Inventory

Receipts–Backward Exploded (3.12). The inventory backflush program can be used to receive an item using a normal BOM/Formula code, but cannot be used to receive a base process item or process an item with a base process as its BOM/Formula code.

Purchasing

Purchase Order Maintenance (5.7). A subcontract purchase order line (Type is Subcontract) cannot reference a work order that is a co-product, by-product, or base process work order.

Purchase Order Receipts (5.13.1). A joint work order cannot be referenced when processing a receipt of an item on a subcontract purchase order line.

(Supplier) Schedule Update from MRP (5.5.3.1). A supplier schedule cannot be updated with an MRP-planned order for a co-product or base process from a joint order set.

Repetitive

The Repetitive module does not support joint schedules like the Work Orders module supports joint order sets.

Line Schedule Maintenance (18.1.10). The line schedule (workbench) can be updated using normal MRP-planned orders for an item on a production line, but not using MRP-planned orders for a co-product or base process from a joint order set.

Repetitive Schedule Maintenance (18.3) and Repetitive Schedule Explosion (18.6). A repetitive schedule can be entered for a co-product, but the schedule that is exploded from it does not include the other co-products and/or by-products for its base process.

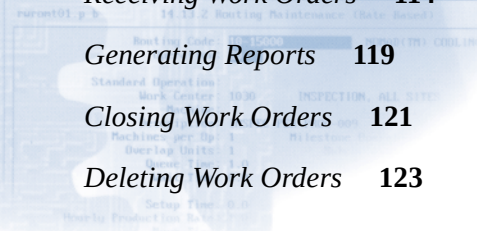
Similarly, a repetitive schedule can be entered for a base process, but the schedule that is exploded from it does not include co-products or by-products.

CHAPTER 6

Work Orders

The Work Orders module enables you to manage manufacturing orders in discrete manufacturing environments.

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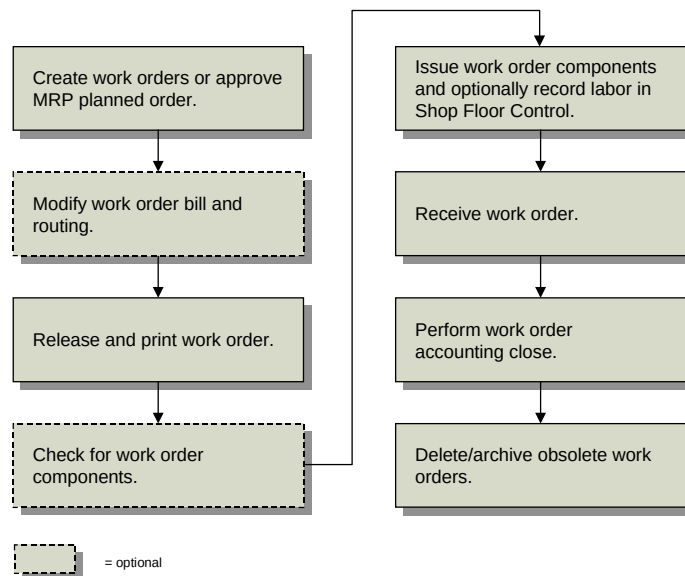
Introduction

A work order is an authorization to produce a specific quantity of an item for a specific date. A work order may represent a manufacturing production order, a repetitive schedule, or a sequenced production line.

Work orders are typically created in response to current or projected demand for an item. You can also use them to build up inventory in anticipation of future demand when there is unused manufacturing capacity.

Figure 6.1 illustrates a typical work order life cycle.

Fig. 6.1
Work Order Life
Cycle



Work orders are tightly integrated with other MFG/PRO manufacturing modules.

♦ See page 11.

- Define bills of material and product structures for work orders in the Product Structures module.

♦ See page 25.

- Define routings and operations for work orders in the Routings/Work Centers module.

♦ See page 239.

- Create planned orders to fill demand with Material Requirements Planning.

- Schedule operations with Capacity Requirements Plan. See page 257.
- Monitor and report on the progress of a work order in the Shop Floor Control module. See page 125.

MFG/PRO provides features that support different manufacturing environments. The Work Orders and Shop Floor Control modules are typically used to manage job shop manufacturing. The Advanced Repetitive or Repetitive modules manage manufacturing in an assembly line environment. Table 6.1 compares and contrasts the two types of environments. See Chapter 8 and Chapter 9 for details.

	Work Orders	Repetitive
Plant Organization	Variable by product	Fixed by assembly line
Routing	Functional departments	Fixed by line
Material Handling	Fork lifts, tote bins	Conveyors, containers
Product Mix	Many products	Similar products
Amount of Work in Process	High	Low
Time to Manufacture	Variable by product	Short
Examples	Tools, furniture	Auto assembly, tires

Table 6.1
Manufacturing
Environments

Some features of work orders are affected if you are using the Compliance module. When compliance is active, you can update inventory attributes, assign batch numbers, restrict items issued to an order, and enforce stricter lot/serial control rules. These features are described in detail in the discussion of the Compliance module. The description of work orders in this chapter assumes that compliance features are not active. See User Guide Volume 9: Compliance for details.

Defining Control File Settings

Enter appropriate values in the Work Order Control File (16.24). Most of the settings affect numbering and comment defaults.

Fig. 6.2
Work Order
Control File (16.24)

Work Order Control File	
Auto W/O Numbers:	yes
Next W/O Nbr:	1007
Work Order Comments:	no
Routing Comments:	no
Move First Operation:	yes
Post variances at SFC:	yes

Move First Operation. This field determines whether the work order release function sets the status of the first operation to Queue. If No, the operation status is left blank and must be changed manually.

This field is typically set to Yes. The released order then appears on the dispatch list for the specified work center and the Queue status indicates it is waiting to be started. If a lengthy picking effort is required, the work order may not be ready as soon as it is released. In this case, set this flag to No. Use Operation Move to change the status later.

Post variances at SFC. This field sets the default for the same field in Work Order Maintenance.

If Yes, labor and burden variances are calculated and posted whenever shop floor labor feedback transactions are entered. If No, variances are suppressed and not calculated or posted until the work order is received.

Setting this flag to No reduces the number of variance transactions posted to the general ledger, particularly if there are many shop floor labor transactions processed before material receipts are recorded.

If you have very long run times, set this flag to No, suppressing variance calculations until finished product is received. If you have short run times, set this flag to Yes.

Creating Work Orders

Work orders are created directly in MFG/PRO using Work Order Maintenance (16.1). For convenience, you can also create them in Master Schedule Order Maintenance (22.13). The two programs are identical.

Work orders are also created as the result of executing other functions.

- Running MRP generates planned orders. Once approved in Planned Work Order Approval (23.10), these orders can be managed in the Work Orders module.
- Releasing a sales order or service return material authorization (RMA) for a configured item to a work order in Sales Order Release to Work Order (8.13).
- Releasing an RMA receipt line to a work order with RMA Release to Work Order (11.7.1.5).
- Releasing a parent work order for an item with a routable component creates a related work order for the component.

Some work orders are created and managed in other modules. These cannot be updated in Work Order Maintenance.

- Work orders created by entering repetitive schedules are managed in the repetitive module.
- Work orders created to manage call repairs are managed with Call Activity Recording (11.1.1.13) in the Service/Support Management module. Call work orders are included on standard work order reports.

▶ See *User Guide Volume 8A and B* for details.

Fig. 6.3
Work Order
Maintenance (16.1)

Type determines how the order is processed.

Status indicates the position in the order life cycle.

Work Order Maintenance	
Work Order: 1006	ID: 1011
Item Number: 02-0005	MECHANICAL PENCIL
Type:	(5MM) BLISTER PACKED
Site: 10000	
Qty Ordered: 10.0	Order Date: 07/16/98
Qty Completed: 0.0	Release Date: 07/16/98
Qty Reject: 0.0	Due Date: 07/20/98
Status: R	Site: 10000
Sales/Job:	Routing Code: 02-0005
Supplier:	BOM/Formula: 02-0005
Yield: 100.00%	
Remarks:	
Comments: no	Post variances at SFC: yes

Important elements of a work order include:

- The type, which identifies the source of the order and indicates how it should be processed.
- The status, which determines where a work order is in its life cycle.
- The bill of material (BOM), which lists the quantities of components required to fulfill an order.
- The routing, which lists the operations required to complete the order.

These elements are discussed in the following sections.

Work Order Type

Most work orders are entered with a blank type. These represent normal manufacturing orders with a standard product structure and routing. The other types indicate special kinds of work orders.

Tip
The BOM and routing are also called a process sheet.

Table 6.2 lists work order type codes.

Type Code	Description
Blank	Standard
F	Final Assembly
R	Rework
E	Expense
S	Scheduled
C	Cumulative

Table 6.2
Work Order Types

All work order types are similar in terms of planning, inventory, and accounting. They differ in their default bills, routings, and status codes. These defaults are shown in Table 6.3 for each order type.

See “Work Order Status” on page 98 for more details.

Note Scheduled and cumulative orders are managed using repetitive functions and are not included in this table.

Work Order Type	Type Code	Default Bill	Default Routing	Default Status
Standard	blank	Standard	Standard	Firm Planned
Rework	R	Parent Item	None	Allocated
Final Assembly	F	Sales Order	Standard	Exploded
Expense	E	None	None	Released

Table 6.3
Work Order Type Defaults

Rework Work Orders

Use rework orders to manage repair, reprocessing, or completion of non-conforming items. A rework order has the parent item as its only component, and no routing.

After creating a rework order, you can modify its bill and routing by adding components and operations before it is released. If additional items are needed, use Work Order Component Issue (16.10) or directly modify the bill using Work Order Bill Maintenance (16.13.1).

If rework activity is a common procedure, consider establishing a rework routing in Routing Maintenance (14.13.1) and attaching it in Work Order Maintenance (16.1), or create one in Work Order Bill Maintenance (16.13.1).

If you are using the Service/Support Management module to receive items from customers and rework them, you can establish default service routings in Service Item Maintenance (11.3.7).

In Work Order Maintenance (16.1), set the WIP account/cost center and project to an appropriate expense account for posting rework costs.

Final Assembly Work Orders

◆ See *User Guide Volume 2: Distribution* for more information about configured items.

Final assembly (FAS) orders are used to manufacture configured products. These are indicated by a Pur/Mfg code of Configured in Item Master Maintenance (1.4.1). FAS orders are generated when a sales order for a configured product is released to manufacturing using Sales Order Release to Work Order (8.13).

An FAS order uses the standard item routing, but its BOM contain only the items specified in the sales order configuration. Release and process FAS orders the same as regular work orders.

Expense Work Orders

Use expense work orders for non-inventory jobs, such as engineering prototypes or design projects. Expense work orders have no bill or routing, but you can attach these manually as needed.

Note You should define a separate site, item code, and product line for expense orders to keep their planning and manufacturing separate from regular manufacturing.

To separate cost accounting, specify an expense account rather than the default WIP account. Or use the Project field to track expenses in the GL.

If you process expense work orders frequently, streamline the process by:

- 1 Creating a product line with account numbers for this type of work.
- 2 Creating an item of type E to use for expense orders. Define a blank order quantity to prevent planning functions from treating it like a normal item.
- 3 Creating a status code that restricts all inventory transactions and assign it to the item.

Scheduled Work Orders

Scheduled work orders are generated by the system when repetitive schedules are entered. Like standard work orders, they have a standard work order bill and routing.

A scheduled work order cannot be processed as a standard work order unless you change its status to Allocated or Released. Changing a scheduled order to a regular order automatically updates the repetitive schedule to exclude it; however, the work order type remains Scheduled.

▶ See Chapter 8, “Advanced Repetitive,” and Chapter 9, “Repetitive,” for more information on scheduled orders.

Cumulative Work Orders

Cumulative orders are generated by the system to track repetitive production costs. They cannot be processed using work order functions.

▶ See “Managing Cumulative Orders” on page 160.

Routable Work Orders

MFG/PRO manages one other kind of work order that is not represented by a separate type code. Subassemblies can be set up in MFG/PRO so that work orders are automatically created for them when a parent item is allocated or released using:

- Work Order Release/Print (16.6)
- Multiple Work Order Release/Print (16.7)

To do this, set the Pur/Mfg code for the item to Routable in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). A work order for a routable item has the same number as the parent work order, but a unique work order ID.

These work orders can be allocated, released, and used for processing component issues, inventory receipts, and shop floor control transactions. When the subassembly is finished,

- Process a work order receipt from the routable work order.
- Then issue the subassembly as a component to the parent work order.

Work Order Status

Work order status codes correspond to stages in a work order's life cycle.

- Planned
- Firm planned
- Batch
- Exploded
- Allocated
- Released
- Closed

The status of a work order determines how much control you have over its bill, routing, inventory allocations, inventory transactions, and labor feedback.

- You cannot make any changes to orders with status Planned. These are managed by MRP.
- For orders with status Firm Planned, you can change the dates and quantities as needed, and specify an approved alternate bill or routing.
- For orders with status Exploded, Allocated, or Released, bills and routings can be modified or alternate ones specified.

A work order progresses from one status code to the next and, unless prematurely released, does not return to an earlier status.

Table 6.4
Work Order
Life Cycle

Type Code	Description	Life Cycle
[Blank]	Standard	Planned—Firm Planned—Exploded—Allocated—Released—Closed
F	Final Assembly	Exploded—Allocated—Released—Closed
R	Rework	Allocated—Released—Closed
E	Expense	Released—Closed
S	Scheduled	Exploded—Closed
C	Cumulative	Released—Closed

After entering an order, change its status to Firm Planned, Exploded, or Allocated using Multiple Work Order Status Change (16.8). Table 6.5 shows how the status changes affect a work order's BOM and routing.

	Planned	Firm Planned	Exploded	Allocated	Released	Closed
Bills	Bill created		Components frozen	Inventory allocated	Inventory picked	
Routings		Routing created and scheduled	Routing operations frozen			

Table 6.5
Effect of Status
Change on Bill and
Routing

Planned

Planned orders are generated by MRP and are replanned as requirements change. You cannot record inventory transactions or labor feedback against them, or change quantities, dates, bills of material, or routings.

Approving a planned work order with Planned Work Order Approval (23.10) changes its status to firm planned.

Note Work orders with statuses other than Planned have fixed quantities and due dates and are therefore not replanned by MRP.

See Chapter 12, “Material Requirements Planning,” for more information about planned orders.

Firm Planned

A firm planned order has been approved. MRP does not replan these orders, but instead, generates action messages as needed.

A firm planned order has a work order bill and a routing with scheduled operations. These are not fixed. Bills are re-exploded by MRP, while routings are re-exploded by CRP. Both are re-exploded when the status is changed to Exploded, Allocated, or Released. This allows entry of a work order for a fixed quantity and date, while enabling future engineering changes to be reflected in the bill or routing as the order advances toward release.

You cannot record inventory transactions or labor feedback against firm planned orders.

Tip
This is the default status for an order you create in Work Order Maintenance.

Batch

A batch status indicates that this is a firm planned order entered in batch. This method speeds up processing for large numbers of orders. The system does not create and explode bills or routings for these orders until

their status changes. As a result, MRP does not recognize any component demand.

Enter batch work orders manually as needed, or create them automatically for routable components when changing the order status to Allocated or Released. Use Multiple WO Status Change (16.8) to change order status at the appropriate time.

You cannot record inventory transactions or labor feedback against a batch order.

Exploded

Exploding a work order recalculates the work order bill and freezes the bill along with the routing. The bill and routing can only be changed manually—until the order is released.

Note When the explosion takes place, any requirements for phantom items are not exploded into requirements for their lower-level components.

You cannot record inventory transactions or labor feedback against work orders with status Exploded.

Allocated

Allocated orders are extensions of exploded orders and are used for inventory transactions. You cannot record labor feedback against orders with status Allocated. Allocated orders differ from exploded orders in the following ways.

- Inventory allocations are made for all of the required components.
- When the work order bill is created, MFG/PRO explodes through the requirements for phantoms if needed, using up quantities of phantom items already in inventory before creating requirements for their components.
- Work orders are automatically created for components with Pur/Mfg codes set to Routable in Item Planning Maintenance (1.4.7). These orders normally have a status of Batch.

Released

A released order is like an allocated order except that detail allocations are made for its components and its operations are scheduled. Depending on which program is used, a picklist or routing can be printed when an order is released. The picklist uses detail allocations to indicate the specific inventory detail records to pick for the order.

You can record inventory transactions or labor feedback against work orders with status Released.

Closed

Work orders are typically closed when the items are received. For most purposes, this ends the life cycle. You cannot process inventory transactions for closed orders. However, additional labor can be reported until either:

- The operations are closed in Shop Floor Control.
- Work Order Accounting Close (16.21) is executed.

Tip

This status is useful for reporting.

Routing Code

Work order routings, identified by routing codes, specify the operations, or steps, required to manufacture an item. Set up routings and operations using the Routings/Work Centers module. Link routings to items using Item Master Maintenance (1.4.1) or Item Data Maintenance (1.4.3).

When a work order is created, the standard routing is copied into it. As work progresses, required changes can be made to this copy using Work Order Routing Maintenance (16.13.13). This way, what actually happens can be compared to the standard. Monitor work order operations using the Shop Floor Control module.

▶ See “Routings/Work Centers” on page 25.

▶ See Chapter 7, “Shop Floor Control,” on page 125.

Once the work order status is Exploded, Allocated, or Released, no more changes can be made to the routing.

BOM/Formula

▶ See “Material Requirements Planning” on page 239.

The work order BOM is derived from the item’s product structure, defined in Product Structure Maintenance (13.5) or Formula Maintenance (15.5), and the quantity ordered. Inventory allocations and issues are based on the bill. MRP uses the bill of material to calculate component demand.

As work progresses, you can make any required changes to the work order BOM. This way, you can compare what you actually use with the standard. Item quantities allocated, issued, or picked are also maintained in the BOM.

Once the work order status is Exploded, Allocated, or Released, no more changes can be made to the BOM. However, you can reassign the picking location for items on the bill even if the work order status is Allocated or Released. Use Work Order Bill Maintenance (16.13.1) to make adjustments.

Scheduling Work Orders

MRP uses a combination of work order due date, release date, and manufacturing lead time to schedule work orders.

Fig. 6.4
Work Order
Maintenance (16.1)

The screenshot shows the 'Work Order Maintenance' window. The title bar is 'Work Order Maintenance'. The menu bar includes 'User Menu', 'Edit', 'Queue', 'Options', and 'Help'. The window contains the following fields:

Work Order: 1006	ID: 1011
Item Number: 02-0005	MECHANICAL PENCIL
Type:	(5MM) BLISTER PACKED
Site: 10000	
Qty Ordered: 10.0	Order Date: 07/16/98
Qty Completed: 0.0	Release Date: 07/16/98
Qty Reject: 0.0	Due Date: 07/20/98
Status: R	Site: 10000
Sales/Job:	Routing Code: 02-0005
Supplier:	BOM/Formula: 02-0005
Yield: 100.00%	
Remarks:	
Comments: no	Post variances at SFC: yes

Release and Due Dates are used in scheduling.

- The due date determines the date when inventory is needed and an order should be complete. MRP uses order due dates to determine when quantities will be available to replenish inventory.

- The release date is the date when an order is scheduled for release to the shop floor. MRP uses the release date to determine when components are required. When an order is released, the scheduled release date is changed to the date actually released.
- The release and due dates for an order are offset by the lead time for the item produced. For example, if it takes an average of five working days to manufacture an item, the release and due dates are separated by one week. This ensures that an order for that item will be completed on time provided that it is released on time.

◆ For more details, see “Releasing Work Orders” on page 107.

Manually Controlling Due Dates

When you create an order in Work Order Maintenance, the due date is calculated from the release date. The calculation begins by setting the release date to the current date, then uses the manufacturing lead time and shop calendar to calculate the due date.

To define either the release or due date and have the program calculate the undefined date, enter the defined date and enter a question mark for the date you want calculated. The system calculates the date for the field containing the question mark using the date from the other field and the operation times from the item routing.

- If you enter a release date and enter a question mark in the Due Date field, the system calculates the due date by starting at the beginning of the release date and forward scheduling starting with queue time for the first operation.
- If you enter a due date and enter a question mark in the Release Date field, the system starts at the end of the due date and backward schedules by starting with the last move time for the last operation.
- If you leave both dates blank, the release date is set to today’s date and forward scheduling is used.

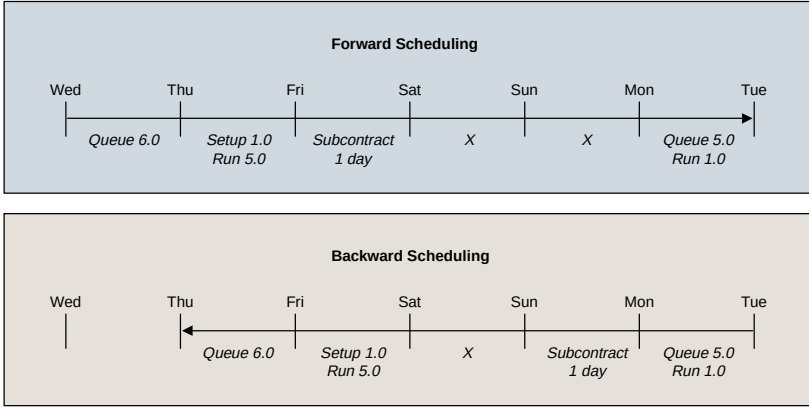
Tip
In all cases, the order quantity is used in calculating run time.

Example Figure 6.5 illustrates two schedules created based on the data listed in Figure 6.6. The schedule is generated for 100 items, assuming six-hour shop days.

Table 6.6
Sample Schedule
Setup

	Queue	Setup	Run	Subcontract
Operation 10	6	1	.05	
Operation 20				1 day
Operation 30	5		.01	

Fig. 6.5
Operation Times



Different release and due dates are possible using forward versus backward scheduling. This is because some lead time components are scheduled in shop days and some in calendar days. A shop day lead time component may be in effect over a weekend in one direction, whereas in the opposite direction, a calendar day component may be in effect.

Lead Time Calculations

See “Lead Times” on page 37 for details.

The system uses an average manufacturing lead time calculated from averages of queue, setup, run, subcontract, wait, and move times for routings. The calculation assumes the average order quantity for the item-site or item.

The operation start and stop dates indicate when an order will occupy a work center. Queue time precedes the start date. Setup, run, and subcontract times fall between the start and stop dates. Wait and move times follow the stop date.

When an order quantity differs significantly from the average order quantity, the system may allow too little or too much time to complete the order. The greater the difference between the actual quantity ordered and

the average order quantity, the less likely it is that these dates will be realistic or reasonable.

Scheduling Operations

The distinction between setup and run time is important when more than one machine is used to perform an operation.

Example Each machine takes four hours to perform an operation on 100 units and each requires an hour of setup time.

	Setup	Run	Packaging	Inspection
One Machine	1 hour	8 hours	16 hours	8 hours
Two Machines	1 hour	4 hours	16 hours	8 hours
	1 hour	4 hours		

Table 6.7
Operation Lead
Time with Multiple
Components

In Table 6.7, if you decide to make 200 units with one machine, it takes nine hours (setup plus run). If you then decide to use two machines, it takes five hours for each machine, because the setup time is the same for each, but the run time is halved.

Some adjustments may be necessary when operations overlap. This occurs when some units proceed from one operation to the next before all units for that operation are complete. This reduces the aggregate lead time for completing multiple operations. Specify the number of overlap units in Routing Maintenance (14.13.1).

Rescheduling Operations

If you modify the operation start and end dates, changes are reflected on CRP and work order dispatch reports. However, executing Recalculate Capacity Plan (24.1) will return the schedule to the original dates.

To prevent this, do not recalculate Exploded, Allocated, or Released orders. You can also modify the queue or wait time for the operation, rather than its start date.

See “Executing CRP” on page 258 for more details.

Modifying Work Orders

Tip

When a routing or BOM code is blank, it defaults to the item number value.

Every work order has a BOM and a routing code, which determine the order's product structure and routing. You can specify these for each daily scheduled requirement. Modify these codes as needed in Work Order Maintenance (16.1) and then re-explode the order.

Re-explode Planned, Firm Planned, or Batch orders as needed by running MRP or by changing the work order status to Exploded, Allocated, or Released.

Modifying Work Order Bills

Often you must modify the bill of a rework order by adding components. Sometimes, as well, you must modify the bill of a regular work order. For example, there may be an engineering change order needing immediate implementation for all work-in-process, including orders that have been exploded, allocated, or released.

How you make a replace an existing component with a new one depends on the work order status.

- If an order has been released, you can issue the new component and return the old one. This results in an unfavorable material usage variance for the new component and a favorable usage variance for the old one. Use Work Order Bill Maintenance (16.13.1) to add the new component to the work order before issuing it.
- If an order is allocated or exploded, use Work Order Bill Maintenance to add the new component, updating the quantity required and quantity allocated, and delete the old one.

After modifying a work order bill, you should not change the status back to Firm Planned, since that causes the standard bill to be re-exploded.

Modifying Work Order Routings

Use Work Order Routing Maintenance (16.13.13) to add, delete, or change the routing of a work order that is exploded, allocated, or released.

In general, the start and stop dates for work order operations are not frozen. The system automatically reschedules the operations from the due date in any of the following situations:

- A work order is processed in Work Order Maintenance (16.1) and the initial status is Batch, Planned, or Firm Planned.
- A work order is processed using Work Order Maintenance and the final status is Firm Planned.
- A work order's due date changes.
- A work order is replanned by CRP.

Note If you are using the Advanced Repetitive module, you cannot add a routing operation to a cumulative order using Work Order Routing Maintenance. Instead, you must change the routing and roll up the cost again.

▶ See "Advanced Repetitive" on page 135.

Releasing Work Orders

Inventory can only be issued or received against a released work order.

- Release orders one at a time using Work Order Release/Print.
- Release multiple orders at the same time using Multiple Work Order Release/Print.
- Release orders in Work Order Maintenance by changing their status to Released. This method does not let you print a picklist or routing, but it still explodes phantom components and creates work orders for routable components.

Releasing a work order has the following effect:

- Items not previously allocated are detail allocated. The system uses the default picking logic defined in the Inventory Control File (3.24).
- The picklist is printed, showing the location and quantity of the material in Picked status for this order.
- The first operation is moved to the queue status.

Key Items

If there are shortages of important work order components, you can prevent the system from releasing an order or printing a picklist. Do this by designating these items as key items in:

- Item Master Maintenance (1.4.1)
- Item Inventory Data Maintenance (1.4.5)
- Item-Site Inventory Data Maintenance (1.4.6)

You can also change any component on a work order bill to a key item using Work Order Bill Maintenance (16.13.1).

If detail allocations cannot be made for the total quantity required for a key item, the order is not released. To check availability of non-key items before releasing an order, use Work Order Component Check (16.5).

Splitting Work Orders

Even if you check for potential shortages before an order is released, quality problems and inaccurate inventory balances may result in a shortage of components. These shortages can be monitored using Work Order Bill Shortage Report (16.16) and Work Order Bill Shortage by Item Report (16.17).

If necessary, use Work Order Split (16.9) to move part of a work order through remaining operations, while the rest waits for needed components. You can split open operations between the original and new work order.

Tip
Labor is tracked separately for each ID on the work order.

When an order is split, each portion keeps the same work order number, but has a unique ID. Component costs are typically tracked under the original ID. However, when you split the order, you are prompted to divide the components between the original work order and the new work order. You can divide component only if they have not been issued. Use Work Order Bill Maintenance (16.13.1) to adjust the bills as required.

Creating Picklists

After you release a work order, you can print its picklist. The picklist lists the component requirements and the sites, locations, lot/serial numbers, and reference numbers for the items to be issued. The system creates detail allocations when an order is released, regardless of whether or not you print a picklist. Detail allocations reserve specific quantities in inventory for a work order.

The picking logic used is determined by settings in the Inventory Control File.

▶ See *User Guide Volume 6: Master Files* for details.

You can release an order without printing a picklist and routing, but you cannot print a picklist for an order without releasing it.

In a picklist, floor stock appears separately, without site or location. Floor stock should have issue policy set to No for the item-site or item.

For an order with several operations, components can be grouped together on separate picklists by setting their lead time offset (LT Offset) to indicate when they are required with respect to the release date. Define lead time offset in Product Structure Maintenance (13.5) or Formula Maintenance (15.5).

Reprinting Picklists

You may need to reprint a picklist if not all items were available when it was first issued. Use Work Order Release/Print (16.6) and set Reprint Picked Quantities to No (the default). All items that were not available before are listed.

Another way to reprint a picklist while tracking components already issued to an order is to change the status to Allocated, then re-release the order.

Changing the status to Exploded is possible, but this can cause differences in how phantom use-up logic is applied. If no components have been issued and no changes made to the work order bill or routing, then the status can be changed to Firm Planned, Exploded, or Allocated before re-releasing. Changing the status to Firm Planned eliminates changes entered manually to the work order bill or routing.

Issuing Components

◆ See Chapter 7, “Shop Floor Control,” on page 125.

◆ For more on using Work Order Receipt Backflush, see “Subcontract Operations” on page 113.

Work order operations begin when a work order is released and its components issued. Monitor operations using the Shop Floor Control module.

There are two ways to issue inventory to a work order:

- Issue inventory directly with Work Order Component Issue (16.10).
- Issue inventory as completed products are received with Work Order Receipt Backflush (16.12).

Inventory transactions occur at different points depending on which method you use. Component QOH is reduced at a later time using the backflush method.

Work Order Receipt Backflush combines the functions of Work Order Component Issue and Work Order Receipt. You can also backflush quantities different from those received. Either method keeps track of the inventory transactions used to issue components to a work order and excludes floor stock, which is issued using an unplanned issue transaction.

Work Order Component Issue

If all components were picked from the locations printed on the work order picklist, they can be issued automatically by setting Issue Picked to Yes. This reduces manual entry because it sets the default sites, locations, lot/serial numbers, references, and quantities from the detail allocations on the picklist.

Work Order Component Issue

User Menu Edit Queue Options Help

Work Order: 1007ID: 1014Op:Effective: 07/20/98

Item Number: 02-0005Status: RIssue Alloc: no

MECHANICAL PENCILIssue Picked: yes

Item Number	Qty Open	Qty Alloc	Qty Picked	Qty to Iss	Qty B/O
04-0005	10.0	0.0	10.0	10.0	0.0
09-0001	10.0	10.0	0.0	0.0	10.0
09-0035	10.0	10.0	0.0	0.0	10.0
10-0040	0.0	0.0	0.0	0.0	0.0

Item Number:

Site:

Description:

Lot/Serial:

Quantity:

UM:

Ref:

Substitute:

Cancel B/O:

Multi Entry:

Fig. 6.6
Work Order
Component Issue
(16.10)

Set Yes to
streamline
data entry.

Issues are not restricted to what the system has allocated. You can override the selections manually. The work order and inventory balances are updated only after approval of the quantities to issue from inventory.

The system does not prohibit shipments from using inventory already allocated to another order. This makes timing important. The longer the period between the time a picklist is printed and the time it is picked for shipment, the greater the chances inventory will not be available when you finally try to pick it.

In some instances, when an item is not available, it is possible to substitute a different item—Philips head screws for slotted head screws, for example. When this is required, first set up valid substitute relationships in Alternate Structure Maintenance (13.15) or Item Substitution Maintenance (13.19). When a substitute item is issued to a work order, the requirement for the original component item is reduced.

Note If you enter additional quantities or negative quantities for an item during Work Order Component Issue or a Work Order Receipt Backflush, the quantity allocated cannot become more than the quantity required or less than zero (0). It is set to the quantity required or the quantity open, whichever is less.

Components issued to a work order are posted to WIP at GL cost.

Issuing and Receiving Between Sites

You can receive or issue items at a site other than the order creation site. There are two basic scenarios:

- Receive completed items at a site other than the order.
- Issue items to a site other than the order site.

In the first scenario, you receive at Site 2 a work order created at Site 1. First, a receipt transaction is created at Site 1, the order site. Then an issue transfer transaction is created at Site 1, subtracting the received quantity. A balancing receipt transfer transaction is then created at the receiving site, Site 2. Table 6.8 shows this transaction for a quantity of 100.

Table 6.8
Scenario One

Site 1		Site 2	
RCT-WO	100.0		
ISS-TR	-100.0		
		RCT-TR	100.0

In the second scenario, if you issue components from Site 2 for an order created at Site 1, an issue transfer is first created at Site 2, the issuing site. Then a receipt transfer is created at the order site, Site 1, and then the issue work order transaction is created, again at Site 1.

Table 6.9
Scenario Two

Site 1		Site 2	
		ISS-TR	-100.0
		RCT-TR	100.0
ISS-WO	-100.0		

You can specify the issue or receipt location and site on any of these transactions. However, if the order site is defined with automatic locations set to No, the item’s default location—defined in Item Master Maintenance—must exist at the order site. For example, if the part master site and location are Site 3 and Location 99, you would need to create Location 99 at the order site, Site 1, before you could execute the issue or receipt transaction.

Subcontract Operations

Work orders with subcontract operations can be used in conjunction with special subcontract purchase orders. When units are returned from a supplier with a subcontract purchase order, the system recognizes the value added to the work order, completes units for that operation, and debits the WIP account.

Separate departments, and possibly work centers, should be set up for outside processing to distinguish them from internal operations. For example, if all subcontract work center codes begin with a common character such as S, it is easy to identify them on Work Order Dispatch Report (16.18) and other reports. Departments and work centers can be defined more specifically for individual suppliers, depending on whether operations are performed by a single supplier.

▶ See “Subcontract Operations” on page 40 for more setup details.

Subcontract Life Cycle

When the Work Orders, Shop Floor Control, and Purchasing modules are used together, the subcontract cycle includes the following steps:

- Work Order Maintenance (16.1) or Planned Work Order Approval (23.10)
- Work Order Component Check (16.5)
- Work Order Release/Print (16.6)
- Work Order Component Issue (16.10)
- Work Order Dispatch Report (16.18)
- Purchase Order Maintenance (5.7)
- Purchase Order Receipts (5.13.1)
- Labor Feedback by Work Center (17.1) (optional)
- Work Order Receipt (16.11)
- Work Order Accounting Close (16.21)

Requirements for Subcontract Purchase Orders

Use Work Order Dispatch Report (16.18) and Work Center Dispatch Report (18.21.8) to determine when purchase orders for subcontract operations should be released.

The Work Order Dispatch Report displays the operations scheduled at a work center, sorted by start date. The report includes the item being built, the work order that authorizes the work, standard setup and run times, and the open quantity on the order at that work center.

Use this report to provide work visibility for a specified number of days, determined by the Window Days field. Also use it as a measurement tool for comparing production progress with production plans.

Receiving Work Orders

When a work order is completed on the shop floor, the items are typically sent to the stockroom.

- Use Work Order Receipt (16.11) to receive items, close the order, and backflush components of final assembly work orders.
- If you did not issue items previously, issue them when completed products are received with Work Order Receipt Backflush (16.12).

If you use the Shop Floor Control module, you can enter labor feedback and test results at receipt, and report individual operations as completed.

When a work order is received:

- Inventory increases by the amount of the receipt.
- The open order quantity decreases by the amount of the receipt.
- Any reject quantity is written off to the scrap account and not placed in inventory.

If Auto Lot Numbers is Yes in Item Inventory Data Maintenance (1.4.5), the system automatically assigns the work order ID as the lot number for inventory received from a work order. This is true regardless of the value of Lot/Serial Control for the item.

♦ See “Closing Work Orders” on page 121.

During receipt, you can set the work order status to Closed. Once closed, no further component issues or completions can be recorded against the order. However, closing a work order does not clear the balance in WIP. This action is done by using Work Order Accounting Close (16.21).

Receiving and Backflushing

When you backflush components at work order receipt, the system explodes the item product structure by the quantity of the parent item received to calculate the standard component quantities used.

Two fields in Work Order Receipt Backflush (16.12) enable you to control the default values for quantity to issue, depending on the history of the work order.

Work Order: 1007 ID: 1014 Effective: 07/20/98
 Item Number: 02-0005 Status: R Receive: yes
 MECHANICAL PENCIL Backflush: yes

Qty Ordered: 10.0
 Qty Completed: 0.0
 Backflush Qty: 10.0

Issue Alloc: no
 Issue Picked: yes
 Cancel B/O: no

Quantity Calculation Method: Component Required Quantity
 Backflush Method: Standard Backflush

Fig. 6.7
Work Order
Receipt Backflush
(16.12)

These fields
control
issue
quantity
defaults.

Quantity Calculation Method. Sets the calculation method used to determine the quantity to issue for all components. The default is Component Required Quantity. Other valid choices are Work Order Bill Qty Per and Phantoms First. You can still adjust each issue quantity on a line-by-line basis in the detail screen.

Backflush Method. Defines whether to use the backflush quantity you entered (the default standard backflush) or to include prior issues and receipts against this order.

The two fields work in conjunction with each other. In most cases, you should accept the default. However, in three instances, you obtain more accurate issue quantities by resetting these values.

- The first instance occurs when you issued components to the order or made a partial receipt without issuing all components. In this instance, set the backflush method to Net of Prior Issues and Receipts. This setting factors in prior receipts and issues to derive the Quantity to Issue value.

Example If you issue all of a component or more than you need, the quantity to issue is 0. If, however, you receive and backflush 50 out of 100 parents and then receive the remaining 50, the quantity to issue for a component with a Qty Per of 1 is 50. When this is the only special condition, leave Quantity Calculation Method set to Component Required Quantity.

- A variation on the previous example occurs when you complete a partial receipt and then modify the Qty Required and/or the Qty Per values for a component in Work Order Bill Maintenance (16.13.1). For the quantity to issue calculation to take into account full requirements for prior completions, use Net of Prior Issues and Receipts in the Backflush Method field. Otherwise, the quantity to issue reflects component requirements for the open order quantity only.
- The last instance occurs when you change the work order bill Qty Per for a component without recalculating the quantity required. To recalculate the quantity to issue including the revised component Qty Per, use the Work Order Bill Qty Per in the Quantity Calculation Method field.

Example The work order bill quantity is reset from 1.0 to 1.5 on an order for 100. With a calculation method of Work Order Bill Qty Per, the quantity to issue is 150. Otherwise, it remains 100. If this is the only special condition on an order, leave Backflush Method set to Standard Backflush.

If you have a combination of the two circumstances, use Net of Prior Issues and Receipts and Work Order Bill Qty Per.

Use the Component Required Quantity option for the Quantity Calculation Method field when rounding or truncation errors may occur during backflush as a result of a component having a small or non-evenly divisible quantity relative to the bill.

If you are completing a partial receipt and want to use up global phantoms before issuing components for the phantom, enter Phantoms First in the Quantity Calculation Method field.

Example Ten phantoms are in stock. If you complete a partial receipt backflush for 10 items and the phantom and its components have a quantity per of 1, the phantom quantity to issue is 10. Otherwise, the phantom and its components are calculated proportionally, each with a quantity to issue of 5.

Since phantoms are not defined as phantoms in the work order bill, the Phantoms First option uses the current product structure to identify phantom items.

Managing Scrap

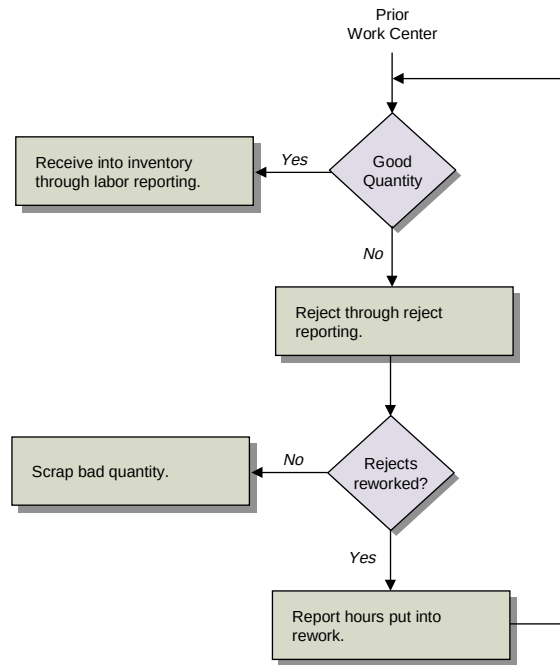
Scrap refers to unusable items. In the manufacturing process, there can be two kinds of scrap:

- Components issued to the work order.
- Items built by the work order that are unusable.

Component Loss

When additional components are required for a work order because items were lost or unusable, the replacement components should be issued to the work order. This results in an unfavorable material usage variance for the order.

Fig. 6.8
Scrap Cycle



Product Loss

When products are lost during manufacturing, you can record the loss for the work order when it is received. For an operation, you can record the loss using Shop Floor Control. However, only units recorded as rejects during work order receipt affect the general ledger, debiting scrap and crediting WIP. Rejects recorded in Shop Floor Control are for reporting only, and have no GL effect.

Another way to scrap items is using an unplanned issue to scrap and changing the default accounts to the scrap account.

Scrap Quantities by Order

To view scrap quantities by order, regardless of costing method, use Work Order by Order Report (16.3.1).

Generating Reports

Many of the Work Order Reports (16.3) reflect activities supported by the Repetitive module.

Table 6.10
Work Order
Reports

Menu	Report	Description
16.3.1	Work Order by Order Report	Designed for managers who need the information available in Work Order Maintenance (16.1), without work order bill or routing details.
16.3.2	Work Order by Item Report	Designed for managers who need the information available in Work Order Maintenance (16.1), without work order bill or routing detail.
16.3.3	Work Order Status Report	Designed for managers who need information on the current status of open work orders, including bills and routings. Information is displayed by work order.
16.3.4	Work Order Cost Report	Designed for accountants and managers who need to analyze the costs and variances associated with work orders. This report is normally used for closed work orders. It identifies work order costs, grouping them into five categories: material, labor, burden, subcontract, and method change. Material costs are supported by inventory transaction data for work order components. Labor, burden, and subcontract costs are supported by transactions for operations. If this report is run for work orders that have not been processed by Work Order Accounting Close (16.21), the variances calculated may be incomplete.

Menu	Report	Description
16.3.5	Work Order WIP Cost Report	Designed for accountants who need to see how the WIP balance is supported by work order activity. It sorts first by WIP account, then work order, displaying the accumulated material, labor, burden, and subcontract costs, and the cost of receipts and rejects, to arrive at the cost currently in WIP for each order and each WIP account. Activities affecting these costs include component issues, labor feedback, operation completions, purchase order receipts (for subcontract orders), and work order receipts.
16.3.6	Work Order History Report	This report, designed for managers and accountants, documents closed work orders with their bills and routings. Components are reported with the quantities required and issued. Operations are reported with the number of units completed, and the expected and actual hours for setup and run time.
16.18	Work Order Dispatch Report	In a job shop, it is important to know which work orders will arrive at a work center and which orders are already there. This information helps you determine priorities and anticipate work load. This report groups this type of information by work center. The Window field lets you control and screen incoming orders based on the start date of the operation and today's date. For example, when the window is three days, the report includes open work order operations that should be started within three days of today.

Note Most of the reports in the Work Orders and Shop Floor Control modules can also be used for Repetitive. In particular, Work Order Cost Report (16.3.4), Work Order WIP Cost Report (16.3.5), and Work Order History Report (16.3.6) play an important role in reporting activity against cumulative work orders.

Closing Work Orders

To close a work order, you must do the following two things:

- 1 Change the order's status to Closed.
You can do this by setting Close to Yes when completed units are received, or by using Work Order Maintenance (16.1).
- 2 Run Work Order Accounting Close (16.21) to post variances, clear WIP, and close outstanding operations. Execute this program regularly, at least at the end of each fiscal month, for completed orders.

The system prevents component issues and work order receipts for a closed work order. If you want to process inventory for a closed work order, you must change its status back to Released.

Work Order Accounting Close

Work Order Accounting Close (16.21):

- Completes open work order operations.
- Calculates and posts work order variances for material, labor, burden, and subcontract costs.
 - Calculates and posts usage variances when the labor quantity used differs from the standard.
For example, if it took six hours to complete an operation scheduled for five hours, a labor usage variance of one hour is posted.
 - Calculates and posts rate variances for material and subcontract when cost used differs from standard cost. If the Payroll module or Actual Pay Rate Maintenance (14.13.21) is used, rate variances are also calculated for labor.
For example, when the standard subcontract cost is \$10 and the PO cost is \$12, the subcontract rate variance is \$2.
- Reconciles the WIP account for closed work orders by calculating and posting method change variances for any residual variances. WIP balances cannot be changed after the work order variances are posted.
- Updates current labor and subcontract costs.

- Posts floor stock amounts.

For Repetitive programs, Cumulative Order Accounting Close (18.12) performs the same operations, but only for repetitive work orders. Work Order Accounting Close (16.21) closes both repetitive work orders and standard work orders.

General Ledger Period End

Since you can enter a GL effective date work order, shop floor control, and repetitive transactions, a strict procedure is not required to account correctly for activity in the general ledger. Some reports, such as Work Order WIP Cost Report (16.3.5), are sensitive to period-end procedures. Use the following outline to write a procedure that fits your needs.

- 1 All work order, shop floor control, and repetitive transactions should be completed and reviewed before starting the new period, including the following:
 - Work Order Component Issues (16.10)
 - Work Order Receipts (16.11)
 - Work Order Receipt Backflush (16.12)
 - Labor Feedback by Work Order (17.1), by Employee (17.2), by Work Center (17.3)
 - Operation Complete Transaction (17.5)
 - Repetitive Setup Transaction (18.13)
 - Repetitive Labor Transaction (18.14)
 - Non-Productive Labor Feedback (17.4)
- 2 The status of all closed work orders should be changed to Closed.
- 3 All open cumulative work orders in the Repetitive module should be changed to Closed.
- 4 Run WIP Material Cost Revaluation (16.22) to update allocated, released, and closed work orders.
- 5 Run Work Order Accounting Close (16.21) and Cumulative Order Accounting Close (18.12).

- 6 Print Work Order WIP Cost Report (16.3.5) and any other time-sensitive reports required.
- 7 After reviewing these reports, proceed with the new period.

Deleting Work Orders

You can delete work orders using Work Order Maintenance under two conditions:

- They have a status of P (Planned), B (Batch Input Firm Planned), or F (Firm Planned) with a WIP total of zero.
- They have a status of C (Closed), a WIP total of zero, and a valid accounting close record.

Obsolete work orders can also be deleted and/or archived with Work Order Delete/Archive. Only orders closed with Work Order Accounting Close) can be deleted.

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Introduction

Use Shop Floor Control to report setup time, hours worked, and the number of units completed for a specific work order operation. This information is used to track the status of work order operations, monitor performance of work centers, and update the general ledger (GL) for manufacturing costs.

▶ See Chapter 8, “Advanced Repetitive,” and Chapter 9, “Repetitive,” for more information.

Note The Repetitive and Advanced Repetitive modules contain reports and transactions similar to those in Shop Floor Control.

Reporting Labor by Operation

You can report labor in Shop Floor Control by work order, employee, or work center, using Labor Feedback by Work Order (17.1), Labor Feedback by Employee (17.2), or Labor Feedback by Work Center (17.3).

For each feedback transaction, you must specify an employee code, a department code, and a work center or production line code.

Fig. 7.1
Labor Feedback by
Work Order (17.1)

Labor Feedback by Work Order

User Menu Edit Queue Options Help

Work Order: 3647 ID: 1070
Operation: 10 BLISTER PACK Op Status: QUEUE

Employee: 00000001 WHITEHEAD Pay Code: REG
Dept: 20 Work Center: 1020 Time Ind: Decimal Hour
Shift: Machine: Project:

Qty Completed: 96.0 Effective Date: 07/15/98
Rejects: yes Operation Complete: yes
Rework: no Move Next Operation: yes
Previous Ops Complete: yes

Start Setup: 0.000
Elapsed/Stop Setup: 2.000 Elapsed Setup: 0.000
Start Run: 0.000
Elapsed/Stop Run: 1.500 Elapsed Run: 0.000
Comment:
Down Time: 0.000 Down Time Reason:

Employee

Some companies summarize the hours worked by all employees for an operation and record them in a single transaction. Others record the hours worked by each employee. Use the second method if you want to report on employee efficiency or examine labor rate variances, or if you use the Payroll module.

You can calculate employee efficiency when you report labor by employee, provided that only one employee works on any given operation.

♦ See “Utilization and Efficiency” on page 133 for more information.

The system calculates labor rate variances by comparing the labor rate defined for an employee in Employee Maintenance (29.15.1) or Actual Pay Rate Maintenance (14.13.21) to the standard labor rate for the operation’s work center, defined in Work Center Maintenance (14.5).

Note The employee code specified for a transaction does not need to correspond to an actual person. You can set up an employee code in Employee Maintenance (2.7.1) to be used for reporting purposes only.

Department

The department code defaults from the work order routing. The system creates GL transactions using the accounts associated with this department code. Changing the department code changes the accounts used for the GL transactions created by these programs.

Work Center

The work center code defaults from the work order routing. The system uses the work center setup, labor, and burden rates to calculate costs and create GL transactions. Changing the work center code results in method change variances when the work center rates differ.

Item Quantities

For each work order operation, you can record the item quantities completed, rejected, and reworked.

Note Labor feedback transactions cannot be modified or deleted once they have been processed. To reverse the effect of incorrect transactions, you can enter transactions for negative values.

When you enter a transaction, the system moves either the quantity ordered or the quantity reported complete at the last operation to the operation being reported. Which quantity displays depends on the setting of the Move Next Operation flag for the previous operation. The quantity

open for an operation is this starting quantity minus the quantities completed and rejected at that operation.

Quantity Completed. The number of acceptable units produced at this operation, used to calculate variances, work center efficiency, and GL transactions.

- If Move Next Operation is Yes, the quantity completed for an operation automatically moves to the next operation. This occurs regardless of whether the previous operation is complete.
- If Move Next Operation is No, the quantity completed for an operation does not affect the quantity open at the next operation.

Set the default value for this field in the Shop Floor Control File (17.24).

Quantity Rejected. The number of unacceptable units produced at this operation that cannot be moved to the next operation.

Quantity Reworked. The number of unacceptable units requiring additional processing produced at this operation. These do not all need to result in good units that can be moved to the next operation.

Quantities reported as completed, rejected, and reworked do not affect the quantity open for a work order. If the reject quantity significantly reduces the expected receipt quantity for an order, you should use Work Order Maintenance (16.1) to reduce the order quantity to the expected quantity so that MRP plans based on the correct order quantity.

Rejected and reworked quantities are independent of each other. For example, if you report 25 units as rejected and later report 25 units as reworked, the system shows both the reject and rework quantities as 25. If you want to change the reject quantity to zero, you must specify a reject quantity of -25 units.

Reject and rework quantities have no impact on GL, since no transactions are created when they are reported. They are not used to calculate variances or work center efficiency.

Times

You can enter setup times, run times, and downtimes in decimal hours (D) or clock hours (H). For example, an hour and 15 minutes can be entered as 1.25 decimal hours or 01:15:00.

Enter elapsed setup and run times directly, or let the system calculate them from the start and stop times. For example, for a start time of 08:00:00 and a stop time of 14:45:00, the system calculates an elapsed time of 6.75 decimal hours.

Operation Status

Operation status codes indicate the detailed status of individual operations. The system automatically assigns status codes to operations as transactions are processed.

Queue. An operation's status is automatically set to Queue when material is moved to that operation, either by releasing a work order, entering labor feedback for that operation, or using Operation Move Transaction (17.6) to manually move material.

When Move Next Operation is Yes in a labor feedback transaction, the next operation is automatically set to status Queue and quantities reported complete are moved to that operation.

Setup. An operation's status changes to Setup when you report setup time for that operation.

Running. An operation's status changes to Running when you report run time for that operation. This is not affected by the number of units reported as completed, rejected, or reworked.

Complete. An operation's status changes to Complete when you:

- Report it as completed using one of the labor feedback transactions.
- Close it using Operation Complete Transaction (17.5).
- Run Work Order Accounting Close (16.21).

When an operation is complete, you cannot process additional transactions against it. However, you can reopen operations if required using Work Order Routing Maintenance (16.13.13).

◆ For more information, see "Closing Operations" on page 131.

Hold. Indicates the operation is on hold. This status can only be set manually in Work Order Routing Maintenance.

A blank status indicates an inactive operation. An operation's status is blank when the work order routing is first exploded and remains blank until you record activity for it.

Use Work Order Routing Maintenance to manually change an operation's status, if required.

Recording Nonproductive Labor

Shop floor control functions let you record nonproductive or indirect labor for employees—for example, preventive maintenance and meetings—and downtime for work centers—for example, machine failures. Shop floor reports use this information when calculating utilization and efficiency.

For nonproductive labor or downtime not associated with a specific work order, use Non-Productive Labor Feedback (17.4). Otherwise, record nonproductive labor and downtime using the Down Time field in standard labor feedback transactions.

Nonproductive labor transactions reference reason codes set up in Reason Codes Maintenance (36.2.17) with a reason type of Down.

Note Many types of nonproductive labor, such as paid vacations, paid holidays, and paid sick leave, should be handled in a payroll system.

Fig. 7.2
Non-Productive
Labor Feedback
(17.4)

The screenshot shows the 'Non-Productive Labor Feedback' window. The form is populated with the following data:

Employee:	00000001	WHITEHEAD
Shift:	1	
Pay Code:	REG	Project:
Effective Date:	07/15/98	
Work Center:	1020	Machine:
Site:	10000	Dept:
		10 Assembly
Reason:	2	
Type:	DOWN	
Time Ind:	Decimal Hours	
Start Down:		
Elapsed/Stop Down:	1.25	Elapsed Down: 0.000
Comment:	Plant meeting	

You can review recorded downtime using Down Time Report (17.16) or Down Time by Reason Report (17.17).

Closing Operations

You can close an operation by running Operations Complete Transaction (17.5). Quantity completed for an operation needs to be entered in any of the Labor Feedback Transactions (by Work Order, Employee, or Work Center). Setting Previous Ops Complete to Yes closes all previous open operations. For these operations, the system reflects quantity completed at the current operation being closed. The system calculates labor using the standard setup and run times for the change in completed quantity in prior operations.

Operation Complete Transaction

User Menu Edit Queue Options Help

Work Order: 3647ID: 1070

Item Number: 02-0005MECHANICAL PENCIL
(5MM) BLISTER PACKED

Operation: 10BLISTER PACK

Op Status: RUNNING

Work Center: 1020Machine:

Dept: 20

Project:

Qty Ordered: 100.0

Qty Complete: 96.0

Qty Reject: 4.0

Effective Date: 07/15/98

Previous Ops Complete: yes

Comment:

Fig. 7.3
Operation
Complete
Transaction (17.5)

For example, if a work order has five open operations: 10, 20, 30, 40, and 50, and no completions were reported for any of these operations, when operation 50 is closed for a quantity of 100, the system optionally closes operations 10, 20, 30, and 40 for 100 units. However, if operation 50 is closed for 75 units and 90 units had been previously reported as complete at operation 20, the system closes operations 10 and 20 for a quantity of 90 units, and operations 30 and 40 for a quantity of 75 units.

Operation	Previously Completed	Completed
10	0	90
20	90	90

Operation	Previously Completed	Completed
30	0	75
40	0	75
50	0	75

If operation 40 was closed for a quantity of 85 units, the system closes operation 30 for a quantity of 85, and operations 10 and 20 for a quantity of 90.

Operation	Previously Completed	Completed
10	0	90
20	90	90
30	0	85
40	85	85
50	0	75

Note Work Order Accounting Close (16.21) closes open operations using the same logic.

Closed operations do not contribute to the projected load for a work center.

Generating Reports

Shop floor control reports display data based on the following:

- Transactions
- Downtime
- Input and output
- Utilization and efficiency

Transactions

Transactions are created when you record labor feedback, nonproductive labor, downtime, and operation completions. You can review these transactions by work center, work order, or employee.

Downtime

Review recorded downtime by work center or reason code.

▶ See “Recording Nonproductive Labor” on page 130.

Input and Output

Use Input/Output Report (17.12) to review the load at work centers. You can use this function to compare planned input and output with actual input and output for a given period. The planned input and output data are based on work order operation start dates, standard setup and run times, and the work center or shop calendar. Actual input is based on the quantities moved to a work center, while actual output is based on the quantities completed at a work center.

Utilization and Efficiency

Two key measures of performance are utilization and efficiency.

Utilization is the ratio of the total number of hours worked to the total number of hours available to be worked, as defined in the shop calendar.

$$\text{Utilization \%} = \text{Actual Hours Worked} / \text{Clock Time Scheduled} \times 100$$

Efficiency is the ratio of the total number of standard hours earned by completing units at operations to the total number of hours worked.

$$\text{Efficiency} = \text{Standard Hours Earned} / \text{Actual Hours Worked} \times 100$$

Productivity is the ratio of standard hours earned divided by the number of available hours. It is not reported, but can be manually calculated by multiplying utilization by efficiency.

$$\text{Productivity \%} = \text{Standard Hours Earned} / \text{Clock Time Scheduled} \times 100$$

Advanced Repetitive

Repetitive schedules perform the same functions as work orders in a process environment. This chapter discusses how repetitive schedules are created and exploded, and how inventory is issued when the process is complete.

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Introduction

Repetitive manufacturing is executed with schedules rather than work orders. Schedules require fewer steps and less paperwork to execute and are typical in manufacturing environments that use assembly lines to produce similar products using the same process. Since the same activities are repeated regularly, there is little variation.

Repetitive scheduling enables you to:

- Build to a repetitive schedule.
- Run a production line without finite schedules.
- Run a production line with repetitive schedules, forward scheduled to capacity limits.
- Report production and let MRP adjust inventory plans.

Advanced Repetitive and Repetitive

MFG/PRO provides two ways of managing repetitive production, appropriate in different business environments. The Repetitive module works well when one or more of the following is true.

- Manufacturing lead times are relatively short and batches do not overlap.
- All work in process is complete by the end of each day.
- Work-in-process (WIP) costs are either insignificant or fairly constant.
- The routing does not include subcontract operations.

The Advanced Repetitive module supports manufacturing environments where the following apply.

- Manufacturing lead times are long.
- Continuous processing is in use; lines are dedicated to one item for days, weeks, or months.
- WIP costs are variable or high.
- Subcontracting operations are managed in a release management (just-in-time) environment.

- Batches can overlap and visibility of and control over WIP are necessary.

Distinctive Features of Advanced Repetitive

Advanced Repetitive provides features that are not available in the basic Repetitive module.

Cumulative Work Order Processing

- Ability to post usage variances without having to close a cumulative order.
- Ability to close a cumulative order and transfer work-in-process (WIP) balances to a new cumulative order for easy phase-in of product structure or routing changes. This also supports accounting period cutoffs.
- Automatic start and end effective date assignment for cumulative order expiration dates.
- Expanded WIP inventory visibility and control.
- Addition of WIP accumulators to track cumulative work moved, rejected, reworked, scrapped, and adjusted.

Scrap, Reject, Rework, and Adjustments Reporting

- Scrap or adjust from either the input, output, or reject queue.
- Record multiple scrap, reject, and rework quantities with reason codes.
- Generate analysis reports, scrap and adjustments usage variance reports, and scrap and adjustments valuation reports.

Subcontract Processing

- Integration of supplier scheduled orders with Advanced Repetitive supports repetitive purchasing of subcontract services.
- Subcontract shippers let you create shipment paperwork and register the physical shipment of materials to the subcontractor.
- The integration of electronic data interchange (EDI) lets you receive an advance shipment notice (ASN) from your supplier to register the receipt of processed materials.

Tip

This replaces the Repetitive Labor Transaction in basic Repetitive.

Non-Milestone Operation Processing

- The Backflush Transaction and subcontract processing activities let you use non-milestone backflushing.
- Non-milestone backflushing uses a demand-pull strategy to determine the units needed from non-milestone operations. The amount depends on the net requirement of the processing milestone operations. The net requirement is satisfied by finding units in the output and input queues of preceding non-milestone operations until either the requirement is satisfied or another milestone operation is encountered.
- You can use any repetitive transaction as a non-milestone operation.

Scheduling

- In Advanced Repetitive, the earliest open schedule is always consumed—not just completions over the scheduled quantity for that date.
- Cumulative Completed Maintenance (18.22.2.6) lets you modify the quantity completed on a repetitive schedule. Changes to a schedule's cumulative completed are reapplied to the schedule using the Consume Earliest Open logic.
- WIP inventory is now visible to the Schedule Explosion (18.22.2.4) and MRP programs. This prevents overplanning for components that might result from not including WIP.
- Schedule Delete (18.22.2.7) enables easy deletion of repetitive schedules and their planned work orders. Limit schedule consumption in the past by deleting schedules left open that fall before a specific date. In Schedule Delete, the date defaults to Monday's date. Use this to establish the earliest open schedule.

♦ See “Repetitive” on page 183.

Many activities in the two modules are exactly the same or similar. This chapter describes how to use Advanced Repetitive. Chapter 9 describes the features of basic Repetitive that differ.

Setting Up Advanced Repetitive

Repetitive activities assume that base data is already set up. Much of this is the same data that is required by work orders.

- Define items, site, locations, using functions in Master Files. Also set up each employee who will be reporting labor.
- Define bills of material and product structures in the Product Structures module for each item to be scheduled. Also associate each component in the product structure with a routing operation. ▶ See page 11.
- Define departments and work centers, routings, and operations in the Routings/Work Centers module. Each work center must have a corresponding location with the same ID as the work center. ▶ See page 25.
- Define operations and routings in the Routings/Work Centers module for each item to be scheduled.

Within the Advanced Repetitive module, you must complete additional setup activities.

- Set up values in the Repetitive Control File.
- Set up production lines by defining line allocations, shifts (if you use them), production line capacities, and changeovers.

Defining Control File Settings

If you have previously used the Repetitive module, you must run Cumulative Ord Accounting Close (18.12) to close out any open cumulative orders. Then, set the Enable New Repetitive field in the Repetitive Control File (18.22.24) to Yes.

Fig. 8.1
Repetitive Control
File (18.22.24)

Next Picklist and P/L Prefix. Enter values to be used for automatic numbering of repetitive picklists.

Transfer WIP. Enter Yes or No to set the default for the same field in Cumulative Order Close (18.22.10).

WIP Transfer Account and Cost Center. Enter the GL account and cost center debited or credited when closing a cumulative order and transferring WIP to a new cumulative order.

End Eff Default Method. Specify the method you normally use to set end effective dates on cumulative orders. Choices are:

Blank, indicating that start and end effective dates are not set.

1, indicating that start and end effective dates match the dates of the GL period in effect during the transaction.

2, indicating that start and end effective dates match the calendar start and end effective dates of the month of the transaction.

3, indicating that start and end effective dates cover a number of days, so the transaction effective date falls in that interval.

The setting determines effective date calculation for orders created in the background by repetitive transactions or in batch using Cumulative Order Create (18.22.11).

End Eff Days. If End Eff Def Method is 3, specify the number of days that the start and end effective dates cover.

Include Yield. Set this to Yes to have the system include the yield percent established in Routing Maintenance (14.13.1) in the cumulative order standard cost. It should match the setting for Include Yield % used normally when running other cost rollup functions.

For example, if there is a yield of less than 100% at an operation, this will cause the overall cost to manufacture to increase, since not all the material produced is expected to be good.

If No, then 100% is substituted for the Yield% field.

Zero Balance WIP. This flag affects processing in:

- Backflush Transaction (18.22.13)
- Rework Transaction (18.22.17)
- Sub Shipper Issue (18.22.5.11)

- PO Shipper Receipt (5.5.5.5)

When Yes (the default), WIP quantities present at the current operation and prior non-milestone operations are zero balanced. The system considers the quantity processed at the current milestone/non-milestone operation to be the quantity processed through all the prior non-milestone operation up to the current operation.

If Zero Balance WIP is No, a pulling WIP logic is executed as follows:

- When the quantity processed at any milestone or non-milestone operation is more than the quantity processed at earlier non-milestone operations, WIP quantity in the input queue of the current operation and input/output queues of prior non-milestone operations are pulled appropriately. Component are backflushed at earlier non-milestone operations in order to balance the component quantity backflushed at the current operation.
- When quantity processed at any operation is the same or less than the quantity processed at prior non-milestone operations, only the input queue of the current operation is relieved.
- For a correcting transaction at any operation, the correction quantity affects the input queue of the current operation and any components associated with this operation are received back into inventory. When Move To Next Op is Yes at the current operation, an appropriate quantity is pulled from the input queue of the following operation and added to the output queue of current operation. If the current operation is the last operation, parent quantity corresponding to the correcting transaction quantity is issued out of inventory.

Figure 8.2 shows how the system uses the End Eff Days field to set the start and end effective dates. In this example, an End Eff Days value of 10 days is entered, as indicated by the diagonally shaded boxes.

Fig. 8.2
Example of End Eff
Days Use



Setting Up Production Lines

A production line is defined at a site by specifying the hourly production rate for items produced on that line during a normal shift. One or more items can be made on the same production line, and the same item can be produced on several production lines, all at the same or at different production rates.

Fig. 8.3
Production Line
Maintenance
(18.22.1.1)

Production Line Maintenance

User Menu Edit Queue Options Help

Production Line: 88-100
Site: 10000

Description: test
Units/Hour: 1.00

Items

Item Number: 44-100
Start Date: 01/29/99

CONTROL UNIT, HOME I

Units/Hour: 1.00

Primary Line: no

Setup Crew: Size: 0

Run Crew: Size: 0

Tool ID:

Comments: no

See “Setting Up
Line Allocations”
on page 143.

When an item is produced on one line only, this line can be assigned a primary line status for that item. A primary line produces all orders for an item. To indicate a primary line, set the Primary Line field to Yes. Optionally, orders for an item can be allocated to several different

production lines. To set up multiple production lines for an item, set the Primary Line field to No and use Line Allocation Maintenance (18.22.1.11) to set the percent of an item’s production for each line.

The production rate for an item on a production line is equal to that of the operation with the lowest production rate. A production line is no faster than its slowest operation.

Production rates can vary by shift or day. You can adjust the basic production rate for an item by changing the rate factor in the Productivity field in Shift Maintenance (18.22.1.22).

Use the effective date associated with the production rate to indicate changes in a line when items are phased in or out of production or when rates increase or decrease at a certain date.

Setting Up Line Allocations

Within a supply site, items can be produced on one or more production lines. The line allocation specifies how production is distributed among multiple lines.

To set up production line allocations, use Line Allocation Maintenance (18.22.1.11). Set up line allocations for items that can be produced on multiple production lines within a site. The line percentages must total 100%.

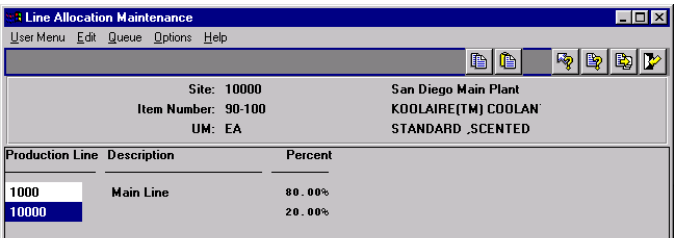


Fig. 8.4
Line Allocation
Maintenance
(18.22.1.11)

Use Line Allocation Inquiry (18.22.1.12) to view line allocations by site and item number.

Setting Up Shifts

Use Shift Maintenance (18.22.1.22) to define the normal hours and production rate factor for each shift during a day. You can also define any exceptions to that normal pattern.

Set up shifts for a site or for a production line at a site. You can define up to four shifts for a day of the week. A working day should have at least one shift with some number of hours greater than zero and a rate adjustment factor also greater than zero.

Fig. 8.5
Shift Maintenance
(18.22.1.22)

The screenshot shows the 'Shift Maintenance' window. At the top, it displays 'Site: 30000' and 'Production Line: 90-1XX KOOLAIRE/CONDITIONE'. Below this is a table for the week's shifts:

Shifts	Modify
Sunday: no	no
Monday: yes	no
Tuesday: yes	no
Wednesday: yes	no
Thursday: yes	no
Friday: yes	no
Saturday: no	no

Below the table is a section titled 'Sunday Shifts' with a table:

Shift	Start Time	Hours	Pattern	Productivity
1				
2				
3				
4				

The system rates shift capacity as:

$$\text{Shift Capacity} = \text{Production Rate} \times \text{Hours} \times \text{Productivity}$$

The hours per shift is the number of hours the shift is capable of producing, rather than the total number of working hours for the shift. Shifts can overlap—so the total number of hours for all shifts can exceed 24 hours.

Tip
This Productivity field has no connection to productivity measures elsewhere in the system.

When a shift is more or less productive than a normal shift, enter an adjustment factor in Productivity.

Example A production line has three shifts, and the third shift has only 20% of the employees of the first two shifts. Enter a shift adjustment factor of 20% for that shift.

If the production rate is 100 units per hour, a shift is capable of production for seven hours, and the productivity factor is 100.00%, then its capacity

is 700 units per shift. If a second shift has a productivity factor of 50%, then its capacity is 350 units.

The hours worked by a particular shift can change because of holidays, planned shutdowns, or periods with planned overtime. Manage exceptions by adding reference hours to shifts by effective date, in the same way you modify the shop calendar.

Example A shutdown is planned for shifts 2 and 3, which normally work seven hours a day. Add –7 hours to those shifts for the affected date range. If overtime is planned for shift 4, then specify additional hours for that shift.

Unlike with the shop calendar, you can add shifts that do not fall on normal working days.

Use Shift Report (18.22.1.23) to see active shift status, exception dates, and shift hours.

Setting Up Changeover Times

Define changeover times for a production line in Line Changeover Maintenance (18.22.1.6). For the system to work correctly, you should define changeover times between each pair of items. For instance, on a line where red, green, and gray items are manufactured, the changeover time can vary depending on whether red is being switched to green or to gray.

Example If a line manufactures three items—A, B, and C—define changeover times for each of the following.

From	To
A	B
B	A
A	C
C	A
B	C
C	B

♦ See *User Guide Volume 11: Manager Functions* for details on CIM.

A large number of changeover times might be more effectively managed outside of MFG/PRO using spreadsheet software. Use the CIM interface programs to load the data into Line Changeover Maintenance.

Setting Up Routings and Operations

♦ See “Routings” on page 34 for more details.

Items on a repetitive schedule must have a routing. The operations of a routing are used to backflush components and receive completed products into inventory. When you define a routing, you do not have to specify every operation performed on a product. The manufacturing lead time, the length and number of operations, and capacity planning at work center operations must all be considered. Tracking, measuring, and accounting for labor by work center and operation are also factors to consider when specifying a routing.

In some cases, it is appropriate to set up a routing with a single operation used for backflushing and receiving material.

- Product lead times are short—less than two or three days.
- Capacity is planned by production line.
- Labor is collected and reported in aggregates, such as by department or production line.

The routing operations for an item must be integrated with the item's product structure for components to be backflushed. All components backflushed from inventory must reference a routing operation. However, all components do not have to refer to the same operation number. With long lead times, different components can be backflushed when different operations are completed.

A number of fields in Routing Maintenance have special significance for repetitive processing.

The screenshot shows a 'Routing Maintenance' window with the following fields and values:

Field	Value
Routing Code	02-0005
Operation	10
MECHANICAL PENCIL	
Start Date	
End Date	
Standard Operation	1012
Work Center	1020
Machine	BLISTER PACK
Description	BLISTER PACK
Machines per Op	1
Milestone Operation	no
Overlap Units	10
Subcontract LT	0
Queue Time	1.0
Setup Crew	1.00
Wait Time	0.0
Run Crew	1.00
Setup Time	1.0
Tool Code	
Run Time	0.005
Supplier	
WIP Item	
Purchase Order	
Line	0
Move Next Op	no
Auto Labor Report	no

Fig. 8.6
Routing
Maintenance
(14.13.1)

Repetitive
reporting
typically uses
milestone
operations.

Determines
how labor is
reported.

Milestone and Non-Milestone Operations

Milestone operations are routing operations where production counts are recorded. Milestone operations are normally used to report all labor and completions. However, you can also use non-milestone operations to report scrap, rejects, rework, or discrepant labor. In this case, you create WIP balances at non-milestones. This allows for more accurate tracking of WIP costs and quantities.

Normally, however, non-milestones are maintained at zero inventory. Therefore, MFG/PRO zeros out all prior non-milestones when you report completions at a subsequent milestone operation.

Tip
The last operation
is always treated as
a milestone.

Automatic Labor Reporting

The Auto Labor Report field determines if standard labor is reported automatically by Backflush Transaction (18.22.13).

If Yes, Backflush Transaction automatically reports the standard number of run hours for the quantity processed. Any hours specified directly are considered as additional to the standard. Negative numbers are subtracted from the standard. Backflush Transaction also automatically reports standard hours for each prior non-milestone operation that also has this field set to Yes.

Set this field to No if you do not want MFG/PRO to generate labor reporting automatically. In this case, you should report labor explicitly in either the Backflush Transaction or the Run Labor Transaction (18.22.14).

In either case, all setup labor must be reported using the Setup Labor Transaction (18.22.15).

Subcontract Routings

◆ See “Managing Subcontracts” on page 178 for more details.

The way the routing is defined affects subcontracting for repetitive operations, including subcontract lead time and subcontract cost. You can also specify an item to represent the material in WIP for subcontract shipments. The description and unit weight of this item are printed by Sub Shipper Print (18.22.5.9).

The Move Next Op field also affects subcontract operations.

- When Yes, the receipt of the subcontract PO or confirmation of the shipper moves WIP to the input queue of the next operation.
- When No, WIP is maintained in the output queue of the subcontract operation after the PO receipt or shipper confirm.

Note Move Next Op at the milestone operation before the subcontracting operation must be No. The subcontract shipper transfers WIP from the output queue of the previous milestone (reported) operation before the subcontract operation into the input queue of the subcontract operation.

Setting Up Locations

The locations used to backflush inventory vary depending on the number of production lines and how items are supplied. The flow of inventory to the production line usually follows one of two patterns.

- Inventory is received from a supplier or WIP into a central storage location, then transferred from storage to the production line as needed.
- Inventory is received directly from a supplier or WIP to the production line where it is consumed.

In the first, there is a primary stocking location and one or more locations where the item is eventually consumed. In the second, there may be a single stocking location on the production line.

A production line location, instead of the primary stocking location, can be set up to backflush material. To do this, set up an inventory location for the production line and give it a location code that is the same as the work center code for the backflush operation.

Tip

An item's primary stocking location is defined in Item Data Maintenance (1.4.3).

Simulating Schedules in the Workbench

You can use a single repetitive schedule for a single item that is made on a single production line with a known rate of production. However, Line Schedule Workbench (18.22.1.10) lets you simulate schedules:

- When many different items are produced on a single line
- When several lines produce the same item
- When the production rate of a line varies

Use Line Schedule Workbench to update or create repetitive schedules from MRP planned orders. When planned orders for line-manufactured items are approved, these orders are automatically added to the item's line schedule. You can review and modify sequences, quantities, and dates as needed.

♦ See "Approving Planned Orders" on page 255.

Simulation usually takes place during production planning. The planner creates a line schedule that meets production requirements and balances line utilization and then uses it to generate repetitive production schedules.

The sequences you create in the workbench are not considered by MRP until you convert the schedule using Repetitive Schedule Update (18.22.1.18).

♦ See "Updating a Repetitive Schedule from a Line Schedule" on page 153.

To create a simulated schedule, specify the production line, site, start date, and multiple. Then, enter production quantities and dates into the workbench. Each entry has a sequence number. By manipulating the sequence number, you can change the order in which items are made.

Fig. 8.7
Line Schedule
Workbench
(18.22.1.10)

Sequence	Item Number	Quantity	Due Date	New Seq No	Delete
2.00	88-200	480.00	03/11/97		
3.00	88-200	250.00	03/12/97		
4.00	88-100	20.00	03/12/97	4.0	

Unlike most MFG/PRO screens, the initial entry for these records uses a scrolling window bar. To add a new record, use the insert key. This allows entry of a sequence number, item, production quantity, and due date.

Determining Order Multiples

The Multiple field controls the minimum divisible schedule quantity for a workbench session. The default setting of 1.00 lets you create schedules with whole integer quantities only. When set to zero, Line Schedule Workbench attempts to use all available time to build scheduled quantities. As a result, it will schedule decimal quantities if necessary.

You can set Multiple to any other quantity, as needed. This is useful if you plan orders in single units and schedule in multiples. Or you can set Multiple to any meaningful decimal quantity such as 0.5. Then, you can enter schedule quantities in units of 0.5. A negative value is not allowed.

You cannot change the value of Multiple on existing schedules if non-divisible quantities would result.

Sequence Numbers and Due Dates

The workbench uses the sequence number and due dates to resolve scheduling conflicts. When two production runs are scheduled for the same due date but there is only enough capacity for one, the system gives priority to the one with the lower sequence number. After planning the first production run and making adjustments for changeover time, it plans output for the second production run. Because the system uses finite loading, the first scheduled due date for the second production run may be later than the date originally entered.

Whenever you create or modify a sequence record, the system automatically reschedules the production quantities and dates and reassigns new sequence numbers. To insert a new production quantity between two existing quantities, enter a sequence number with a value between the two and a due date equal to the earlier of the two dates.

Production Quantities

Add production quantities to the workbench directly or select from MRP planned orders. The system converts the quantities on the planned orders to schedule quantities and deletes the selected orders.

As a general rule, production quantities should be directly related to the period used for scheduling production. If production is scheduled by day, the production quantity should not be sufficient to cover an entire week. This becomes important when a production line is scheduled to process different products during a given week.

If MRP uses a POQ order policy and the period is a week or longer, the production quantities recommended by MRP planned orders might cover a week. In this case, separate the quantity recommended by MRP into smaller quantities.

In MFG/PRO, one day is the shortest period you can use to schedule production. You can schedule multiple items each day, but if scheduled production is by shift, then you must summarize production into daily quantities before entering it into the workbench.

Scheduling and Lead Times

In some situations, different products manufactured on a line have significantly different lead times. Even if flow rates are similar through most of the line, some products might spend more or less time at an operation—for example, products that are burned-in, dried, aged, or cured.

When a line is changed over from processing one product to another with a significantly longer lead time, the line's output is interrupted by the changeover time plus the new lead time. This might not be important if you are manually determining the due date for expected output from a

line. But if the system encounters a scheduling conflict and reschedules due dates, these dates will not take into account the new lead time.

There are two ways to avoid this.

- Assign due dates manually and then monitor the line schedule to see if any due dates following a changeover have been automatically rescheduled.
- Increase the changeover time to reflect the increased lead time between two products. This way the changeover time reflects the total time a line is disrupted between model changes.

Deleting Sequence Records

Delete records from the workbench in three ways.

- Select a sequence record by pressing Enter, then the delete key (F5).
- Mark one or more records for deletion using the delete key, then process them using Go.
- Reverse the original production quantity by entering a negative value. For example, enter a quantity of –2000 for a production quantity of 2000. The system deletes all of the scheduled quantities and dates created by that entry.

Reviewing Line Schedules

Use Line Utilization Report (18.22.1.15) to review the results generated by the workbench. This report provides information for evaluating the load placed by a line schedule on a production line if it replaced the existing repetitive schedule. It also shows the changeover load between shifts, when appropriate.

Creating Repetitive Schedules

A repetitive schedule is a statement of planned output for a production line for one day. It consists of a list of scheduled quantities and due dates. A repetitive schedule controls the same activities as a work order. However, because it is used for continuous process manufacturing, it issues components from inventory by backflushing. This method deducts the required quantities from inventory when order quantities are reported as complete.

If you used Line Schedule Workbench (18.22.1.10) to create a line schedule, use Repetitive Schedule Update (18.22.1.18) to turn the line schedule into a repetitive schedule. Otherwise, create repetitive schedules using Schedule Maintenance (18.22.2.1).

See “Simulating Schedules in the Workbench” on page 149.

Updating a Repetitive Schedule from a Line Schedule

Once you are satisfied with a line schedule in the workbench, use Repetitive Schedule Update (18.22.1.18) to create the repetitive schedule or append to an existing one.

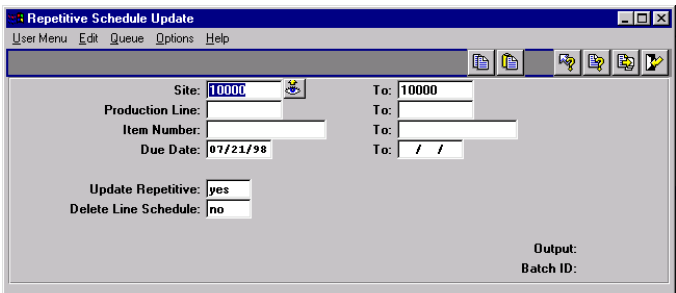


Fig. 8.8
Repetitive Schedule Update (18.22.1.18)

You can delete the line schedule as you update, or retain it. Typically, you retain the line schedule, since you can continuously maintain it by adding new MRP orders. However, you can use this function to delete an unneeded simulation by setting Update Repetitive to No and Delete Line Schedule to Yes.

Example A four-week repetitive schedule for an item on a production line needs an additional week added every week. Use the workbench to schedule the new week, and Repetitive Schedule Update to add the new schedule to the existing one.

If you need to replace an existing schedule, delete it manually in Schedule Maintenance, then run Repetitive Schedule Update to create a new schedule.

After updating repetitive schedules, run MRP to synchronize planned orders with the schedule changes.

Schedule Maintenance

Use Schedule Maintenance (18.22.2.1) to enter or maintain daily schedules for each production line at a site. If the production line has multiple shifts, the schedule represents the total for all shifts. If there are no production lines at the site, you can enter a schedule for the whole site.

Fig. 8.9
Schedule
Maintenance
(18.22.2.1)

	Due Date	Scheduled	Routing	Bom Code
Monday :	07/20/98	100.0	44-100	44-100
Tuesday :	07/21/98	100.0	44-100	44-100
Wednesday :	07/22/98	100.0	44-100	44-100
Thursday :	07/23/98	100.0	44-100	44-100
Friday :	07/24/98	100.0	44-100	44-100
Saturday :	07/25/98	0.0		
Sunday :	07/26/98	0.0		
Total :		0.0		

The bill of material and routing for an item on a repetitive schedule default from Item Master Maintenance (1.4.1) or Item-Site Planning Maintenance (1.4.17). You can specify valid alternates, but you cannot combine different BOMs and routings on one order.

Exploding Repetitive Schedules

Once you establish a schedule, you must explode it using Schedule Explosion (18.22.2.4). The explosion creates the material and work center operation requirements necessary to support the schedule.

Until exploded, changes to the schedule are not reflected in component demand or work center load. MRP reports for the components or CRP reports for the affected work centers do not reflect the current repetitive schedule until it is exploded.

The schedule explodes automatically when MRP plans the item and site or when you run Schedule Explosion. An exploded schedule creates scheduled work orders for each day of production. Review these work orders in the Work Orders module. They have a type of S (scheduled).

Run Repetitive Picklist Calculation (18.22.3.1) to see if shortages at work centers need to be corrected.

Using Repetitive Picklists

In most repetitive operations, issues are managed solely by backflushing. However, in many operations, you also need to manage the movement of inventory to the point where it is used. In environments where inventory is stored on the production line, the repetitive picklist lets you easily replenish the line's work centers.

Use repetitive picklists to move inventory from stocking locations to a work center. To use this method, you must define work centers as inventory locations.

Each repetitive schedule creates inventory requirements at the work centers in its routing. When you run Repetitive Picklist Calculation (18.22.3.1), the system:

- Determines the available inventory and requirements at each work center for the specified range of parent items
- Determines where shortages exist
- Allocates inventory to meet shortages
- Creates a picklist for each work center shortage

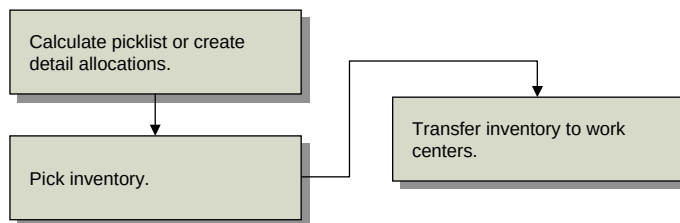


Fig. 8.10
Picklist Processing
Flow

The system creates a picklist if there is a shortage and inventory is available to be picked. When you print the picklist, the inventory is picked. Use Repetitive Picklist Transfer (18.22.3.6) to transfer the

inventory from its current inventory location to the work center. This move is a location transfer, not an issue to WIP, so there are no GL transactions until the inventory is backflushed.

Example Item A is installed in four different end items at work center OPS. The work center has 900 of Item A on location. For the next week, the repetitive schedules for these items have a total requirement of 1,000. The repetitive picklist calculation will show a shortage of 100 of Item A at OPS and detail allocates 100 at the inventory location. When the picklist is printed, the 100 will be shown as picked, and 100 will be moved to location OPS when the transfer is run. The inventory will not be issued until labor is reported for each operation.

Note To use picklists, you must set up a location with the same name as the work center.

Calculate the Picklist

Calculate the picklist and create detail allocations using Repetitive Picklist Calculation (18.22.3.1). The calculation considers component requirements from the exploded repetitive schedules that match the sites, items, work centers, and production dates specified.

Fig. 8.11
Repetitive Picklist
Calculation
(18.22.3.1)

For a new schedule creating requirements at a work center with no shortages, Repetitive Picklist Calculation uses the following equation.

$$\text{Shortage at Work Center} = \text{New Requirements} - \text{Net Available}$$

Where net available equals:

$$\text{Actual OH} - \text{Qty Alloc} - \text{Qty Req by Other Scheds} + \text{Untransferred Picked}$$

The Net Available is the material available for these requirements at the work center, consisting of the material already there (Actual OH) and the material to be transferred (Untransferred Picked) minus the existing requirements. The existing requirements consist of the Qty Req by Other Scheds and the quantity allocated at that work center to work orders or sales orders (Qty Alloc).

As the equation shows, the picklist supplies material for the work center, not individual schedules. You can ensure that picklists supply individual schedules by running the picklist calculation immediately after exploding each new schedule. The picklist calculation already considers all existing picklists, so the new picklist will only meet the new requirements.

Choosing Options

Repetitive Picklist Calculation offers several options to control the picklist calculation.

Use Work Center Inventory. When Yes, the system counts inventory in a work center as inventory.

Detail Requirements. When Yes, the system prints all repetitive schedules generating requirements for a component, including the quantity required, parent item, due and start dates, machine, and operation.

Delete When Done. When Yes, the picklist is automatically deleted after the calculation. Use this option to review shortages without actually allocating inventory. The Next Picklist field in the Repetitive Control File (18.22.24) is not incremented.

Troubleshooting Problems

If problems occur with the picklist calculation, remember the following.

- A location must be created with the same name as the work center.
- The calculation does not create a picklist if there is no inventory to detail allocate. You cannot allocate negative quantities. The system does not warn you if inventory is insufficient to meet the requirements—it just does not create a picklist.

- The system does not create a picklist if there is sufficient inventory at the work center.
- Detail allocation is not tied to an order, so no order is shown in the allocated inventory inquiry.
- The schedule treats all existing picklists as supply. To recalculate total requirements at a work center, delete all untransferred picklists. A picklist remains open until deleted or inventory is transferred, even if the schedule changes.
- The picklist calculation blows through phantoms. There is no phantom use-up logic.
- The picklist does not calculate requirements by shift.
- Since the calculation is based on requirements from an exploded repetitive schedule, it is not affected by changes in structures or routings.
- You can further control the quantities on a picklist using the item-site planning parameters Order Maximum and Order.

Print the Picklist

Print the picklist in Repetitive Picklist Print (18.22.3.5). Printing changes the status of the detail-allocated inventory to picked. The picking logic is the same logic used elsewhere in the system, set in the Inventory Control File (3.24). You can reprint the picklist without affecting inventory status.

Use Repetitive Picklist Undo (18.22.3.8) to cancel a picklist and reprint it later. It changes the inventory status back to detail allocated.

When a picklist exists, it is considered supply by later picklist calculations. If you want to start over, you must delete the outstanding picklists with Repetitive Picklist Delete (18.22.3.9). Deleting reverses all effects of running any picklist function. If the inventory is picked or allocated, it is returned to unallocated status.

Transfer the Inventory

Use Repetitive Picklist Transfer (18.22.3.6) to transfer inventory from the stocking location to the work center. The new location must exist and must have the same name as the work center. After transferring the inventory, the system deletes the picklist.

Tip
Inventory is transferred, not issued.

Specify the date of the transfer in a pop-up window after selecting Go from the header. The default is the system date.

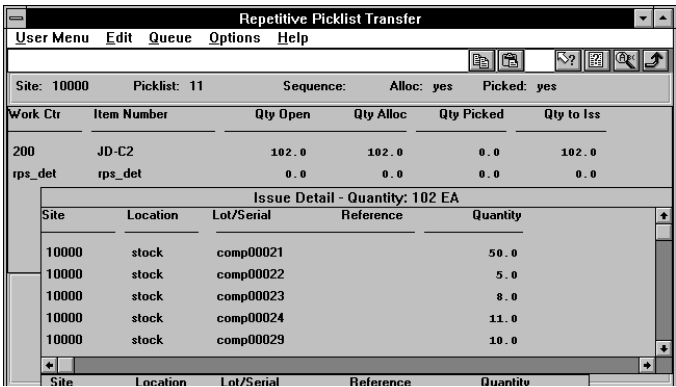


Fig. 8.12
Repetitive Picklist Transfer (18.22.3.6)

Use the Sequence code to transfer only part of the total if space at the work center is limited.

Example If a work center holds 1,000 of an item, but the total requirements are 5,000, one picklist is created allocating 5,000, while the material is picked and transferred in sequences of 1,000 (sequence 1 for 1,000, sequence 2 for 1,000, and so on).

Set the maximum order quantity for an item in the Order Multiple field (Ord Mult) in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

To transfer specified quantities other than the order maximum, set the amount in Order Mult.

Example If the stocking unit of an item is liters but the item is delivered to the work center in 500-liter barrels, set an order multiple of 500 to ensure the item is transferred 500 liters at a time.

You can transfer inventory even if a picklist has not been created or printed. Use the Alloc and Picked fields to set the default for your transfers. You can also directly specify inventory to issue.

After issuing inventory, the system records an ISS-TR transaction and a RCT-TR transaction in the transaction history file.

Managing Cumulative Orders

The system keeps a running total for each combination of items, sites, production lines, product structures, and routings using a cumulative order. The cumulative order tracks costs and quantities for work-in-process (WIP) for repetitive production. A cumulative order is created for a profile that defines the site, item number, production line, routing code, BOM/formula code for the order, and start and end effective dates.

Cumulative orders can be created three ways.

- Automatically by the system when you execute a repetitive transaction (18.22.13 –18.22.21)
- One at a time with Cumulative Order Maintenance (18.22.6)
- In a batch with Cumulative Order Create (18.22.11)

When a cumulative order is created, a cost rollup establishes the cumulative order cost. Cumulative orders have an assigned ID number, but no order number.

Repetitive transactions create a cumulative order when they cannot find one with the same profile (site, item, production line, routing, BOM/formula code) where the transaction effective date does not fall within the effective date range of an existing cumulative order. The start and end effective dates are determined using the parameters in the Repetitive Control File.

During transaction processing, the system captures rate variances and creates GL entries. Usage/method variances are accumulated and posted when you run one of the following.

- Post Accumulated Usage Variances (18.22.9) creates GL entries for usage and method variances accumulated since the previous Post Accumulated Usage Variances report. The report gives you the option to update.

- Cumulative Order Close (18.22.10) closes the cumulative order, and creates GL entries for usage and method variances accumulated since the previous Post Accumulated Usage Variances report. The report has an update option. You can transfer WIP balances to another cumulative order or write off balances to method variance.

All rate and usage variances are measured against the cumulative order cost. GL scrap entries are not created until you run either Post Accumulative Usage Variances or Cumulative Order Close.

Use Cumulative Order Browse (18.22.7) or Cumulative Order Report (18.22.8) to see the cumulative order start and end effective dates and status.

Cumulative Order Create

Use Cumulative Order Create (18.22.11) to create new cumulative orders in advance in a batch-oriented setting. This prevents the system from having to create them during repetitive transactions, and ensures a better response time for items with many components.

To use this function, orders must already exist in the system. The new one is based on the old, with a different effective date. For each cumulative order selected, the system checks to see if a cumulative order exists with an effective date range that includes the day after the entered End Effective date. A new cumulative order is created if none exists. The Start and End Effective dates of the new cumulative order are set based on the End Eff Default Method in the Repetitive Control File.

A cumulative order is created for a profile that defines the site, item number, production line, routing code, and BOM/formula code for the order, and start and end effective dates. Two orders that have the same profile cannot have overlapping effective dates. When a cumulative order is entered:

- The work order ID is automatically assigned.
- The work order number is blank.
- The work order type is C.
- The work order status is R.

Cumulative Order Close

Use Cumulative Order Close (18.22.10) to select unclosed cumulative orders according to various criteria. You can optionally create successive cumulative orders and transfer WIP queue balances to them. Cumulative orders must have an End Effective date on or before the End Effective value you enter. Orders with a blank End Effective date will not be selected.

Note To close orders with blank End Effective dates, first enter an End Effective date using Cumulative Order Maintenance (18.22.6).

Closing a cumulative order performs the same processing as the Post Accumulated Usage Variances transaction. Variances are calculated, posted, and reported. If the Transfer WIP field is Yes in the Repetitive Control File, WIP queue balances are transferred.

To close a cumulative order before its end effective date, use Cumulative Order Maintenance to set the end effective date to yesterday’s date. The system creates a new cumulative order for the balance of the period if the End Eff Default Method is set to 1 or 2 in the Repetitive Control File (18.22.24).

Transferring WIP

To transfer WIP, enter the data in Cumulative Order Close. The system finds a cumulative order for the site, item, production line, routing, and product structure code with an effective date range immediately following the End Effective date entered.

Table 8.1
Transferring WIP

If	Then
There is a cumulative order, and it is not closed,	it receives the WIP quantities of the cumulative order being closed.
There is a cumulative order, but it is closed,	it does not transfer.
There is no cumulative order,	it creates a new one to which WIP is transferred.

Processing Steps

Cumulative Order Close follows these steps.

Old Cumulative Order

For each operation in the cumulative order being closed.

- 1 The system posts the value of the WIP queue inventory to scrap or the WIP transfer account specified in the Repetitive Control File.
- 2 The system records the posting event by creating an operation history record of type Close.
- 3 The cumulative order is flagged closed.

New Cumulative Order

If Transfer WIP is Yes, the system transfers WIP balances.

- 1 The system looks for an operation in the receiving order with the same number as this operation. If there is one, it proceeds with the transfer. Otherwise, it ignores this operation, and does not transfer the WIP.
- 2 If this operation is not the first operation, and the same operation in the receiving order is the first operation, the system ignores this operation, and does not transfer WIP.
- 3 The system adds the WIP queue quantities in this operation to the WIP begin queue balance quantities in the receiving order operation.
- 4 The system records the transfer by creating an operation history record of type Transfer.
- 5 The system reinstates the WIP value by debiting the new cumulative order WIP account, and crediting the old cumulative order scrap account, or the WIP transfer account specified in the Repetitive Control File.
- 6 If the cost of the WIP queue inventory at this operation is different from the cost of the receiving operation, the system calculates and posts the differences to Method Change Variance.

At the end of the report, the system displays any remaining amount in the WIP as Residual WIP Value. Residual WIP Value at this point should be close to zero, if it is the result of a rounding error.

You can run this program in a non-update mode. The system generates the report but does not update the database.

Cumulative Order Maintenance

Use Cumulative Order Maintenance (18.22.6) to create new orders manually or maintain the Start and End Effective dates of an existing order. You cannot change effective dates so that they overlap another cumulative order for the same profile. You can also delete closed cumulative orders.

Executing Repetitive Transactions

As work is performed, labor and movement of WIP units are reported. You can report these activities using various types of transactions, including downtime, scrap, rework, move, and rejects. There are nine transaction types and several purchase order functions for subcontract activities.

Repetitive transactions affect other areas of the system. As quantities are moved through repetitive operations, inventory transactions are recorded and posted as backflushing occurs. Labor and burden costs are recorded by manual entry or as a result of backflushing.

Transactions generate cost variances and create GL entries. Most transactions generate quantity and cost posting to the cumulative order and associated operation and bill of material (BOM) records.

Transactions affect any one of the three quantity queues associated with a routing operations:

- The input queue, which holds quantities from the previous operation.
- The output queue, which holds quantities from the current operation that have not been moved to the next operation.
- The reject queue, which holds quantities rejected by the current or a subsequent operation.

Common Transaction Data

All repetitive transactions use common information entered in the first frame. Figure 8.13 shows the first frame of Backflush Transaction (18.22.13).

The screenshot shows a software window titled "Backflush Transaction". It has a menu bar with "User", "Menu", "Edit", "Queue", "Options", and "Help". Below the menu bar is a toolbar with several icons. The main area of the window contains the following fields and values:

Employee:	BJW	Bill Whitehead	
Effective:	03/05/96	Shift:	Site: 10000
Item Number:	10-10000	OASIS(TM) COOLING SY	
Operation:	20	INSPECT PER PROC-009	
Line:	10000		
Routing:		BOM:	ID: 532

Fig. 8.13
Transaction
Programs—
Common
Information

The Employee field is mandatory. Enter a valid employee set up either in Employee Maintenance (29.15.1) or Actual Pay Rate Maintenance (14.13.21). A valid effective date, site, item number, and operation are required. Shift is optional.

If the item number is associated with a production line, you must enter a valid production line in the Line field. Enter Routing and BOM only if you are not using the default. ID is a system-generated cumulative order ID and cannot be modified.

The system uses the values entered in the Effective, Site, Item Number, Operation, (Production) Line, BOM, and Routing fields to locate the appropriate cumulative order.

The selected cumulative order has start and end effective dates that include the transaction effective date. Table 8.2 describes the way a cumulative order is selected, based on the effective date entered.

If	Then
a cumulative order has a blank start effective date, its effective interval is from the end effective date into the indefinite past	it will always be selected if the transaction effective date is on or before the end effective date.
a cumulative order has a blank end effective date	its effective interval is from its start effective date into the indefinite future, and will always be selected if the transaction effective date is on or after the start effective date.

Table 8.2
How a Cumulative
Order is Selected

If	Then
a cumulative order has blank Start and End Effective dates	the cumulative order will always be selected.
no cumulative order is found matching the above criteria	one is immediately created. The start and end effective dates are set according to the control variables described in Repetitive Control File Maintenance.
the dates in the new order overlap with the dates in some other cumulative order	the dates in the new order are adjusted forward or backward to prevent overlap.

The cumulative order creation process retrieves the routing in effect as of the transaction effective date and copies it to the cumulative order. For each operation in the routing, this process retrieves the product structure in effect as of the transaction effective date and copies it to the cumulative order operation. Any phantoms are blown through.

A cost rollup is then performed in the new cumulative order, and the calculated operation costs are recorded by operation in the cumulative order routing. These costs are used for WIP valuation reporting and calculating variances.

The costs are independent of the item cost and routing cost files. The Cumulative Order Cost Report (18.22.4.10) displays the operation costs stored in the cumulative order.

Warning Messages

All transaction programs issue warning messages when one of the following occurs.

- The operation being accessed is a non-milestone operation.
- A transaction would cause a WIP queue for an operation to become negative.

All transaction programs write operation history records to record the transaction events.

Rate Variance

All transactions consuming resources immediately calculate and post rate variance. Rate variances are calculated as the difference between the cost of the resources as contained within the cumulative order and the current cost of the resources.

Component costs contained in the cumulative order are taken from the GL standards in effect when the order is created. Labor, burden, and subcontract standards contained in the cumulative order are taken from the routing and work center files in effect when the order was created.

For component material, rate variance is calculated as the difference between the GL standard cost currently in effect and the GL standard cost captured in the cumulative order. Usually, there will not be a component material rate variance. It occurs if the GL standard cost of the component material changes during the life of the cumulative order.

Labor and burden rate variance is calculated in a similar way. When a cumulative order is created, standard labor and burden rates are captured from the routing and work center files in effect. When labor is reported at a cumulative order operation work center, rate variance is calculated as the difference between the employee pay rate and the captured labor standard.

Subcontract rate variance is the difference between the PO price per unit and the subcontract cost per unit as captured in the cumulative order. This is posted by Purchase Order Receipts (5.13.1). This program establishes the purchase price variance as the difference between the actual purchase price and the GL standard cost.

Rate variances are posted only if GL standard costing is in effect for the finished item. Rate variances are not posted if GL average costing is in effect.

Method Change Variance

Method change variance (MCV), when calculated, is posted by the following transactions.

- Cumulative Order Close (18.22.10)
- Backflush Transaction (18.22.13)
- Run Labor Transaction (18.22.14)
- Setup Labor Transaction (18.22.15)
- Rework Transaction (18.22.17)
- Move Transaction (18.22.19)

In the backflush and move transactions, MCV can be posted when moving from the output queue of the last operation to finished material inventory. MCV is calculated as the difference between the final operation cost contained in the cumulative order and the current GL standard cost of the finished material, extended by the quantity being reported.

In the transactions where labor is reported, MCV can be posted when reporting at a work center other than the cumulative order operation work center. MCV is calculated as the difference between the standard labor and burden rates of the work center being reported and the standard labor and burden rates of the cumulative order operation work center, extended by the number of hours reported. This prevents charging unexpected rate variances to the work centers.

In Cumulative Order Close, MCV can be posted when transferring WIP quantities to new cumulative orders. MCV is calculated as the difference between the operation cost in the former cumulative order operation and the operation cost of the future cumulative order operation, extended by the quantity transferred.

Method change variances are posted only if GL standard costing is in effect for the finished item. MCV is not posted if GL average costing is in effect.

Repetitive Transaction Programs

The following sections describe the use and application of various transaction programs on the Advanced Repetitive menu.

Backflush Transaction

Backflush Transaction (18.22.13) is the primary tool for reporting production line activity and the only transaction that automatically backflushes component inventory. You can report the number of gross units processed, scrapped units, rejected units, and labor hours. If the transaction is made from the last operation, you can receive items into inventory.

You can backflush components of the current operation and any preceding non-milestone operations. You backflushing occurs is affected by the setting of Zero Balance WIP in the Repetitive Control File.

You can also backflush standard labor and burden if the routing record of the reporting operation, or any preceding non-milestone operation, has Auto Labor Report set to Yes.

When you report you have completed and moved items at the final operation, the quantity is posted as complete at the operation, and is also posted to the repetitive schedule and the related work order. If there are multiple schedules for an item, the system determines the earliest open schedule date and posts the completed quantities from that point forward.

If the system cannot find enough open balances, the operation is posted with the transaction quantity. However, the repetitive schedule and work order record are posted with the open quantity available.

You can modify repetitive schedule completions using Cumulative Completed Maintenance (18.22.2.6). You can view the repetitive schedule completions using either Schedule Inquiry (18.22.2.2) or Operation Schedule Report (18.22.2.5). You can view work order completions using Work Order Browse (16.2).

When units are moved to stock or scrapped, information is posted to the repetitive schedule and the MRP exploded work order. When MRP is run, issued component quantities remaining on the production line are visible for requirement planning. Purchase order receipts and supplier schedule

Tip

Backflush Transaction can be used at both milestone and non-milestone operations.

▶ See “Zero Balance WIP” on page 140 for details.

receipts are integrated with the Repetitive module generating GL entries. Components are then backflushed and posted to various repetitive files.

Fig. 8.14
Backflush
Transaction
(18.22.13)

The following are fields in the second frame of Backflush Transaction (18.22.13). Work Center, Machine, and Department default to data referenced from the routing operation, and can be overridden.

Tip
This value includes any quantity entered to the Qty Scrapped and Qty Rejected fields.

Qty Processed. Shows the quantity processed through the operation. Entering a value in this field has two effects.

- Input queue quantity is reduced by the amount entered.
- Output queue quantity is increased by the amount entered.

Components for the operation are backflushed by the quantities per unit extended by the quantity processed.

Qty Scrapped, Reason Code, Multi Entry. Report scrap quantity along with the processed quantity. Enter up to 10 reject quantities and reason codes in a separate pop-up.

Qty Rejected, Reason Code, Multi Entry, Reject to Op. Report reject quantity along with the processed quantity. Enter up to 10 reject quantities and reason codes in a separate pop-up. Reject To Op must reference either the current operation or the one that precedes it. The default is the current operation.

Modify Backflush. If Yes, the Component Issue frame displays so you can modify the default list of sites, locations, lot and serial numbers, and quantities used for component backflush and finished material receipt.

The component backflush logic looks at the product structure in effect as of the transaction effective date. If components are added, changed, or removed from the current product structure during the life of a cumulative order, and backflush transactions occur, the differences cause material usage variances. Product structure and routing changes can be phased into cumulative orders by setting the cumulative order effective dates to match the product structure and routing effective dates.

Move Next Op. If Yes, the Receipt Data frame displays when reporting the last operation. The Move Next Op field indicates if the quantity processed—less rejected and scrapped quantities—is to be moved to the input queue of the next operation. If the operation being reported is the last operation, the move causes an increase in the quantity of finished material inventory. This field defaults from the routing operation.

Note You cannot add an operation to the routing for an open cumulative order. You must close the cumulative order, make the routing changes, roll up the cost, then open a new cumulative order.

Run and Setup Labor Transactions

Use these programs to easily report run and setup labor only for non-milestone or milestone operations.

- Use Run Labor Transaction (18.22.14) to report regular labor chargeable against WIP.
- Use Setup Labor Transaction (18.22.15) to enter separate setup times, also charged against WIP.
- Use Down Time Transaction (18.22.20) and Non-productive Labor Feedback (18.22.22) to report indirect labor. These transactions are not subject to applied burden.

Reject Transaction

Reject Transaction (18.22.16) has two uses:

- To reject previously backflushed units from an operation's output queue to the same operation's reject queue or to the reject queue of any preceding operation

- To reject units from an operation's input queue and record the reject at the previous operation

Enter up to 10 different reject codes at a time. You cannot report hours, and no backflushing takes place.

Use Backflush Transaction (18.22.13) for most reject reporting. This transaction backflushes the rejected units and records all costs at the operation. When you use this transaction to report rejects at a milestone operation, the quantity must be in the input queue of the current operation or in the input/output queues of prior non-milestone operations.

Note If you are rejecting with backflush at a non-milestone operation, the quantity to be rejected must be in the input queue of that non-milestone operation.

Rework Transaction

When you first report rejected quantities, use the Reject to Op field in Backflush Transaction (18.22.13) or the To Operation field in Reject Transaction (18.22.16) to send the quantity to the operation where rework occurs. In WIP Status Browse/Inquiry (18.22.12), the rejected quantities appear as negative numbers in the output queue of the operation where the reject occurred, and as a positive number in the reject queue of the receiving operation.

Reworked units are backflushed at the operation rejecting them. After reworking items, use Rework Transaction (18.22.17) to move rejected items back into the production line. Use the To Operation and To Queue fields to select the operation and queue, typically:

- From an operation's reject queue back to the rejecting operation's output queue, or
- To the input queue of the operation following the rejecting operation.

Tip
This method requires an additional Move Transaction (18.22.19).

You can enter rework hours and issue additional components. However, no automatic backflushing takes place. Enter up to 10 reject quantities and reason codes at a time.

Scrap Transaction

Use Backflush Transaction (18.22.13) for most of your scrap transactions. It backflushes the scrapped units and records all costs at the operation. There must be a quantity in the input queue operation in order to record scrap with this transaction.

Use Scrap Transaction (18.22.18) to scrap or remove quantities from any queue of an operation without backflushing. Enter up to 10 scrap quantities and reason codes at a time.

When scrapping from the input queue, the scrap quantity is first moved back to the prior operation's output queue and then posted as scrap at that operation. This ensures a proper balance in the queues and cumulative quantities (as seen in the WIP Status Report and Browse).

You cannot report hours, and no backflushing takes place with this transaction.

Tip

This transaction is often used to scrap previously rejected units.

WIP Adjust Transaction

You can reconcile actual WIP quantities with those stated in MFG/PRO using the WIP Status Inquiry (18.22.12) or WIP Status Report (18.22.4.11). When quantities do not match, use WIP Adjust Transaction (18.22.21) to adjust quantities at an operation's input, output, or reject queues. The current queue balances display when you run the program.

- When you adjust the output or reject queues, you change their balances at the current operation.
- When you adjust the input queue, the net change is made to the prior operation's output queue as well as to the current operation's input queue.

Each adjustment creates operation history records and generates GL transactions. A queue increase debits WIP and credits the inventory discrepancy account. Negative adjustments credit WIP and debit the inventory discrepancy account. You can designate a GL account and cost center for the transaction. The default is the inventory discrepancy account.

Tip

Labor hours cannot be entered, and there are no backflushing capabilities.

Open schedule quantities are also updated. Increases in the balances of the final operation's output queue increase scheduled completions and vice versa.

Move Transaction

Move Transaction (18.22.19) transfers quantities from an operation's output queue to the following operation's input queue. For the final operation, items are moved to finished material inventory. In this case, the Modify Receive field lets you modify the default list of sites, locations, lot and serial numbers, and quantities.

You cannot report labor hours. This transaction normally has limited use, since an operation can be set to have the backflush transaction and rework transaction perform this task automatically.

Reporting Downtime and Non-productive Labor

Use Down Time Transaction (18.22.20) and Non-productive Labor Feedback (18.22.22) for reporting. These transactions do not charge costs against WIP. Both debit cost of production and credit labor.

Down Time Transaction references the cumulative order, operation, item, production line, and site. Non-productive Labor Feedback allows you to enter a project ID and record comments.

You can enter reason codes for both transactions, with type Downtime for Down Time Transaction and type Down for Non-productive Labor Feedback.

Post Accumulated Usage Variances

Post Accumulated Usage Variances (18.22.9) calculates and posts accumulated usage variances in cumulative orders, according to the criteria entered. You can post usage variances on demand without having to close the cumulative order.

For each open cumulative order selected, usage variances are calculated by operation for component material, WIP material, labor, burden, and subcontract. The variances calculated are for the entire life of the

cumulative order. The amounts to post are reduced by any amounts previously posted. Additionally, floor stock expense is posted.

Component Material Usage Variances

Component material usage variance is calculated as the difference between the actual and expected quantities issued, extended by the cumulative order operation component cost. The expected issue quantity is the cumulative order operation standard quantity required per unit times the quantity processed at the operation. Component materials issued that are not in the cumulative order operation product structure are considered nonstandard and are treated entirely as usage variance.

WIP Material Scrap Usage Variances

WIP material scrap usage variance is calculated as the difference between the actual and expected scrap quantities, extended by the cumulative order operation cost. The expected scrap quantity is the quantity processed, less the cumulative order yielded quantity processed at the operation. For example, if the yield factor at an operation is 75%, and 100 were processed at the operation, the expected scrap quantity would be 100 less 75%, or 25. The amount of variance is posted to the scrap account of the product line of the finished material item number.

You can scrap a quantity without producing a scrap posting. Consider the above example where yield is 75% and the expected scrap quantity is 25. If the actual quantity scrapped is 25, then no variance results. If there is no labor or component usage variance elsewhere, WIP is charged with exactly the amount of resources expected to produce 75. This is reflected in the fact that the operation cost has already been yielded.

If scrap is always posted regardless of yield, then Include Yield in the Repetitive Control File should be No. This sets the cumulative order yields to 100%.

Usage variances are posted only if GL standard costing is in effect for the finished item. Usage variances are not posted if GL average costing is in effect.

Labor and Burden Usage Variances

Labor and burden usage variances are calculated as the difference between actual and expected labor hours, extended by the cumulative order operation labor or burden rate. The expected labor hours equal the cumulative order operation standard labor hours per unit, times the quantity processed at the operation.

Usage Variance Transaction Records

The system records the usage variance posting by creating operation history records with one of the following types:

- MUV-CMP (material usage variance—component)
- MUV-WIP (material usage variance—work in process)
- FLOORSTK (floor stock expense)
- RLUV (run labor usage variance)
- RBUV (run labor burden usage variance)
- SLUV (setup labor usage variance)
- SBUV (setup labor burden usage variance)
- SUV (subcontract usage variance)

You can run this program in a non-update mode. In this case, the report is generated, but no database updates occur.

Generating Repetitive Reports

Table 8.3 lists reports on the Reports Menu, with a brief description of their purpose.

Table 8.3
Repetitive Reports

Report	Description
WIP Status Inquiry (18.22.12)	Displays quantities in the input, output, and reject queues for an operation.
WIP Status Report (18.22.4.11)	Generates a report for WIP queue quantities for all operations in selected cumulative orders. The report also shows the cumulative activities affecting each of the queue quantities, such as cumulative completed, scrapped, adjusted, rejected, reworked and moved to next operation.
Operation Transaction Inquiry (18.22.4.1)	Displays repetitive operation history records.
Scrap Analysis Report (18.22.4.3)	Displays percentages scrapped, by reason code over an interval of time vs the quantity completed in the interval.
Reject Analysis Report (18.22.4.4)	Displays percentages rejected by reason code over an interval of time vs the quantity completed in the interval.
Rework Analysis Report (18.22.4.5)	Displays percentage reworked by reason code over an interval of time vs the quantity completed in the interval.
WIP Adjustments Analysis Reports (18.22.4.6)	Displays adjustments over an interval of time.
Cumulative Order Cost Report (18.22.4.10)	Displays all data relating to costing captured in the cumulative order when it is created. It reports by operation the product structure and component costs, labor hours per operation, labor cost per hour, burden factors, yield factor, subcontract cost, and the group of costs.

Report	Description
WIP Valuation Report (18.22.4.13)	Reports the value of the WIP queues at the operation cost contained in the selected cumulative orders. Either the cumulative order operation standard costs, the cumulative order average costs, or the current GL standard operation costs can be used for valuation. Cost elements can optionally be displayed.
Scrap/Adjust Valuation Reports (18.22.4.14 and 18.22.4.15)	Report the value of material scrapped/adjusted within an interval of time. The data can be sorted by either Site and Item or by descending value. Either the cumulative order operation, the cumulative order average costs, or the current GL standard operation costs can be used for valuation. You have the option of displaying cost elements.

Managing Subcontracts

Use Advanced Repetitive with other programs in MFG/PRO to manage subcontract operations.

- You can use supplier-scheduled orders to support repetitive purchasing of subcontract services.
- You can use subcontract shippers to create shipment paperwork and register the physical shipment of materials to the subcontractor.
- You can receive an advance shipment notice (ASN) via electronic data interchange (EDI) to register the receipt of processed materials.

All of the processing that occurs prior to the subcontract operation uses standard Advanced Repetitive functions. The last operation reported just prior to the subcontract operation (milestone or non-milestone) must have Move Next Op set to No. This leaves the WIP in that output queue. Items are then ready to be processed through the subcontract operation.

Using Scheduled Orders

You can handle the purchasing side of a subcontract operation through a supplier schedule. Create supplier-scheduled purchase orders using Scheduled Order Maintenance (5.5.1.13). Enter a purchase order line record type, work order ID, and operation, as in Purchase Order Maintenance. You can also set the Type field to S (subcontract) or blank.

These fields are used by PO Receipts, Supplier Schedule Update from MRP, and PO Shipper Receipt. Use an item number in the subcontract scheduled PO order line to show the service being purchased, such as CRANKSHAFT-HEAT-TREAT-SERVICE. This ensures consistent pricing for what is being purchased.

Tip
For Purchase Cost, enter the subcontract cost per item.

At this point, you can update the routing with the scheduled order number if it does not exist there already.

Next, create a cumulative order using Cumulative Order Maintenance (18.22.6), or by completing the first window of Backflush Transaction (18.22.13). Then, enter the cumulative order ID in the work order ID of Scheduled Order Maintenance.

Note The work order ID represents a cumulative ID for the part number being sent to a subcontractor.

When you execute Supplier Schedule Update from MRP, scheduled PO lines with type S (subcontract) are processed. The system passes through work order routing records (for released work orders) and routing file records (for planned work orders) and collects operation demand data used to create an updated supplier schedule.

Shipping Subcontract Items

Shipments to subcontractors can be recorded using functions on the Subcontract Shipping Menu (18.22.5). These programs create shippers in the same way as the container and shipper maintenance programs associated with sales orders and customer schedules. The major difference is in the Contents Items frame. Work Order ID, Operation, and Item replace Item, PO, Order, and Line. The Work Order ID and Operation fields identify a subcontract operation record on a cumulative order. The Item field identifies any component items used at the

operation. If Item is blank, it represents the input WIP material to the operation.

Sub Container Maintenance

Use Sub Container Maintenance (18.22.5.4) to create containers for shipping the items to the subcontract supplier. The logic for creating subcontract containers is similar to the logic in customer and supplier schedules. The item placed into the container would be the WIP item, and any other components set to backflush at this operation.

Container maintenance is optional and is used only if you need to containerize your data.

Sub Shipper Maintenance

Use Sub Shipper Maintenance (18.22.5.5) to create shippers for shipping the items to the subcontract supplier. The shipper consists of either container items or WIP items, and the components used at this operation that are also being shipped to the supplier. If WIP items are not being used, leave the item number blank to indicate the item being shipped is the parent assembly.

Sub Shipper/Container Inquiry

Use Subshipper/Container Inquiry (18.22.5.6) to view shipper information. This program is virtually the same as the shipper and container inquiries in Customer Schedules, except that Work Order ID, Operation, and Item replace Item, PO, Order, and Line.

Sub Shipper Print

Sub Shipper Print (18.22.5.9) is similar to SO Shipper Print in Customer Schedules. For WIP Material, the WIP Item number entered in Routing Maintenance locates an item master item record. The description and weight fields for this item are used to print the shipper. The system also displays item and routing descriptions. Any component items entered in the shipper are also printed. The system prints the shipper number on the shipper.

If there is no WIP item number entered on the routing, the system displays the finished material item number.

Sub Shipper Issuer

Confirm the shipper using Sub Shipper Issue (18.22.5.11). For the quantities identified in the subcontract shipper, the equivalent of a Move Transaction is performed from the output queue of the operation preceding the subcontract operation. If the preceding operation is a non-milestone, then non-milestone backflushing takes place for that operation and any other preceding non-milestone until the quantity requirement is either satisfied or another milestone operation is encountered.

For component material requirements of the subcontract operation, the system performs the equivalent of an inventory location transfer. Inventory is transferred from the site and location entered in the shipper to the cumulative order site and operation work center location, if there is a corresponding record in the location master. Otherwise, the inventory is transferred to the item default location.

Component materials are backflushed by Purchase Order Receipt (5.13.1) and PO Shipper Receipt (5.13.20) in the Purchasing module. An unplanned issue of the container inventory is performed for container items (if containerization is used).

Sub Shipper Delete/Archive

Use Sub Shipper Delete and Archive (18.22.5.23) to delete and/or archive subcontract type shippers.

Receiving Completed Purchase Orders

Receive shipments from subcontractors using the functions of the Receipts Processing Menu (5.5.5) or Purchase Order Receipts (5.13.1). Any components associated with the subcontract operation are automatically backflushed.

For scheduled orders, create a shipper in PO Shipper Maintenance (5.5.5.5). Reference the item that is on the supplier schedule. Confirm the shipper using PO Shipper Receipt (5.5.5.11). This moves the WIP to the input queue of the next operation, if the move flag is Yes, backflushes the

components tagged to that operation, and closes out the subcontract operation for the quantity. The appropriate GL transactions are generated to the transaction history file and the operation history file.

Alternately, receive the purchase order using Purchase Order Receipts (5.13.1). This creates the same GL transactions and backflushes the components. With this approach, the purchase order does not need to be a scheduled order. You can create it using Purchase Order Maintenance (5.7) as a type S (subcontract operation) order.

Be aware of some restrictions when using these programs.

- The system attempts to backflush all possible components. However, lot or serial-controlled items must be backflushed separately using Backflush Transaction.
- You cannot modify the component backflush list as you can in Backflush Transaction.
- If the subcontract operation is the last operation in a routing, the items are not transferred from the output queue to Finished Material inventory. Use Move Transaction for that task.
- These programs do not post subcontract usage variance. That is posted by Post Accumulated Usage Variances.

The system automatically locates the active cumulative order if the cumulative order recorded on the purchase order is expired. To locate the active cumulative order, it uses the item, site, operation, line, routing, and product structure code of the cumulative order in the PO detail record, along with the effective date of the transaction.

Therefore, receiving dock personnel do not have to enter the cumulative order ID and operation, as long as there is only one line, routing, and product structure code for the site and item being received against.

Repetitive

The Repetitive module supports high-volume manufacturing where lead times are one day or less, WIP is complete at the end of each day, WIP costs are tracked and batches do not overlap, or WIP costs are insignificant or fairly constant.

This chapter outlines the differences between Repetitive and Advanced Repetitive functions. Refer to Chapter 8, “Advanced Repetitive,” for a full discussion of repetitive functionality in MFG/PRO.

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Executing Repetitive Transactions **186**

Routing Code	10-15000	NONREP(75) CDD IN
Operation	20	
Standard Operation	10.00	INSPECTION, ALL SITE
Work Center		
Machine		
Description	INSPEC PER PROX-000	
Machines per Op	1	Allocation
Overlap Units	1	
Queue Time	1.0	
Wait Time	0.0	
Setup Time	0.0	
Ready for Production	0.0	

Introduction

▶ See “Distinctive Features of Advanced Repetitive” on page 137.

The Repetitive module provides many of the basic features of Advanced Repetitive, but differs in some significant respects.

- You can only post usage variances when you close a cumulative order.
- You do not have the same control over the assignment of start and end effective dates.
- You do not have as many options for reporting and tracking WIP throughout the life of the cumulative order. In addition, you cannot transfer WIP from an order that is being closed to a new order.
- You cannot report detailed information about scrap, reject, and rework quantities or enter multiple reason codes.
- Repetitive does not have the integrated support for managing subcontracting operations— from shipping to receiving.
- You can only report against milestone operations.
- Repetitive uses a consume forward or backward logic when completions exceed scheduled quantities. Advanced Repetitive always uses the earliest open schedule.
- Advanced Repetitive has additional utility programs that let you modify the quantity completed on a repetitive schedule and delete schedules as needed.

Setting Up Repetitive

Setup activities for Repetitive are almost exactly the same as for Advanced Repetitive. You need the same kind of base data such as items, sites, locations, employees, product structures, and routings.

▶ See “Setting Up Production Lines” on page 142.

The programs used to set up production lines, allocation percentages, shifts, and changeover times are identical in both modules.

Defining Control File Settings

Settings in the Repetitive Control File (18.24) differ from those in Advanced Repetitive.

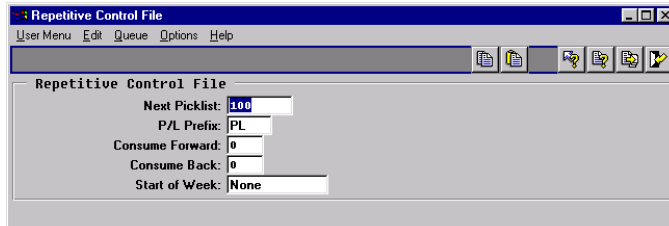


Fig. 9.1
Repetitive Control
File (18.24)

Next Picklist and P/L Prefix. Same as the Advanced Repetitive Control File (18.22.24).

Consume Forward and Consume Back. Determines how MFG/PRO handles excess completions on a given day. These quantities may be for schedules other than today's.

When Consume Back or Consume Forward is nonzero, MFG/PRO looks backward, then forward the specified number of calendar days for orders with open quantities, and uses the excess to increment the quantity completed. This process stops when the excess is consumed or when all days have been searched. If Start of Week is specified, MFG/PRO stops looking backward when that day is reached.

When Consume Back and Consume Forward are 0, the excess is placed in inventory and not counted against a schedule.

Start of Week. This field determines how far back to consume excess completions and count open orders as supply. Values are None, Sunday–Saturday, or today.

Regardless of the value of Consume Back, MFG/PRO goes back only as far as the Start of Week. Use this field when you want to bucket completions by week. Setting Start of Week to Monday and Consume Back to 7 ensures that all completions count against scheduled orders for the week.

Simulating Schedules in the Workbench

♦ See “Simulating Schedules in the Workbench” on page 149.

Line Schedule Workbench (18.1.10) is exactly the same as the workbench (18.22.1.10) in Advanced Repetitive.

Creating and Exploding Repetitive Schedules

♦ See “Creating Repetitive Schedules” on page 153.

These functions are almost identical in the two modules. Internally, the system processes additional information for Advanced Repetitive schedules, but the interface and input values are the same.

Using Repetitive Picklists

♦ See “Using Repetitive Picklists” on page 155.

The functions on Repetitive Picklist Menu (18.8) are identical to the functions on Picklist Menu (18.23.3).

Managing Cumulative Orders

♦ See “Managing Cumulative Orders” on page 160.

Cumulative orders track repetitive activities in much the same way as in Advanced Repetitive. Cumulative orders can be added manually using Cumulative Order Maintenance (18.9). However, its primary purpose is to change the status of an existing cumulative order to Closed so that Cumulative Order Accounting Close (18.12) can be used. Cumulative orders should remain open for the periods used by accounting to monitor WIP costs. Procedures should be in place to ensure they are closed at the end of each fiscal month or period.

Executing Repetitive Transactions

♦ See Chapter 7, “Shop Floor Control,” on page 125.

Repetitive transactions provide feedback for repetitive operations. Like those in the Shop Floor Control module, they require use of an employee code. Repetitive Labor Transaction is an exception, because it triggers inventory transactions to backflush components and receive completed units.

Operation Reporting

The reporting of setup hours, labor hours, downtime, reject quantities, rework quantities, and scrap quantities works much the same in Repetitive as in the Shop Floor Control Module but with the following differences:

- The reason codes for nonproductive labor should use DOWNTIME instead of DOWN.
- Operation scrap can be reported in Repetitive but not in Shop Floor Control. Like the reporting of reject and rework quantities, scrap quantities have no impact on the general ledger and do not affect costing.
- Reports for reporting reject quantities are available in Repetitive.
- The Repetitive module includes some reports specific to that module.

Repetitive Completions

When a routing has many operations, there may be a few that are used to report completions, called milestone operations.

Milestone Operations

In Routing Maintenance (14.13.1), you can define any operation—including standard operations—to be a milestone. At a milestone operation, that operation and all previous non-milestone operations are backflushed when repetitive labor is reported. The last operation is always treated as a milestone.

The following rules govern reporting:

- You cannot report labor against a non-milestone operation.
- You can report setup, downtime, reject, and scrap against a non-milestone operation. However, this reporting does not affect WIP.
- If you report scrap or reject at a non-milestone operation, it will backflush at that operation.

If you do not report setup at non-milestone operations and report labor at milestone operations, the standard setup will be backflushed. If you report setup at the milestone operation, then no setup will be backflushed.

Reporting Completions

Completed units are received into inventory when quantities are reported as complete for the last operation for an item, using Repetitive Labor Transaction (18.14). The components can be backflushed when completed units are received if the components are linked to the last operation.

As completions are recorded on nonscheduled dates, the reporting of quantities on these dates causes entries to be automatically added to the repetitive schedule.

If you report completions for today's date using Repetitive Labor Transaction, the report has the following effects.

- Inventory is incremented by the completion amount. A backflush occurs. Component inventory is shown as issued to the repetitive order. The requirements for components at all previous non-milestone operations are decremented. Floor stock items are accounted for.
- If there is a scheduled amount for today, the Quantity Completed is incremented and the Quantity Open decremented until the scheduled quantity is reached. These quantities can be reviewed in Repetitive Operation Schedule Report (18.7).
- If there are previous non-milestone operations, the Quantity Completed at each previous operation is also incremented, up to the amount required to make the scheduled amount of the finished item.
- If the quantity open at the last operation is still nonzero, indicating the quantity completed is less than the quantity scheduled, the quantity open is treated as supply by MRP, and shown as the current amount of the planned order in MRP Detail Inquiry (23.16).

♦ See Chapter 12, "Material Requirements Planning," on page 239.

♦ See "Defining Control File Settings" on page 185.

You can change the Consume Forward, Consume Back, and Start of Week values in the Repetitive Control File (18.24) so that the extra completions will show up as Quantity Complete on other days. When a repetitive labor transaction is reported for an operation, the following occurs.

- The Quantity Complete on the effective date of the report is incremented up to the scheduled amount. This amount is then subtracted from the reported quantity completed.

- If the remainder is positive, the system then looks at the Consume Back and Start of Week flags. If Consume Back is nonzero (and the Start of Week flag allows), the system moves to the previous calendar day and increments Quantity Complete up to the amount of the schedule.
- The previous step is repeated until the limits of Consume Back or Start of Week are reached. When that happens, the system looks at the Consume Forward flag. If this is nonzero, it moves to the calendar day after the report effective date, incrementing Quantity Complete until the total completed is exhausted or it runs out of Consume Forward days.
- For each change in the Quantity Complete at a milestone operation, the Quantity Complete at all of the previous non-milestone operations is changed to reflect the fact that the later operation was completed.

Completed planned orders are ignored by MRP.

Repetitive Scrap Transaction

An item scrapped in the first operation may have a lower cost than one scrapped on receipt. It will not have the accumulated labor, burden, and additional material costs that accrue during subsequent operations.

Repetitive Scrap Transaction (18.18) reports scrap at the item's accumulated cost through the operation where it is scrapped. The system uses the standard cost created by the most recent use of Operation Cost Calculation (14.13.17). However, if no operation costs exist for the item/routing/cost set, Repetitive Scrap Transaction automatically rolls up and totals the material, labor, burden, and subcontract costs by operation. It also does this for scrap reported for alternate BOMs/routings not included in Operation Cost Calculation.

The item cost by operation can be reviewed using the Operation Cost Browse, (14.13.18) or the Operation Cost Report (14.13.19). After the scrap transaction is recorded, the scrap cost can be verified using the Repetitive Operations Accounting Report (18.21.10). Repetitive Scrap Transaction debits scrap and credits WIP for the operation cost multiplied by the quantity scrapped.

Quality Management

MFG/PRO Quality Management supports testing of incoming material, finished products, and inventory; inspection of first articles, processes, and items in-process; and destructive testing.

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Executing Stand-Alone Tests **197**

Conducting Process Inspections **201**

Conducting Other Tests **202**

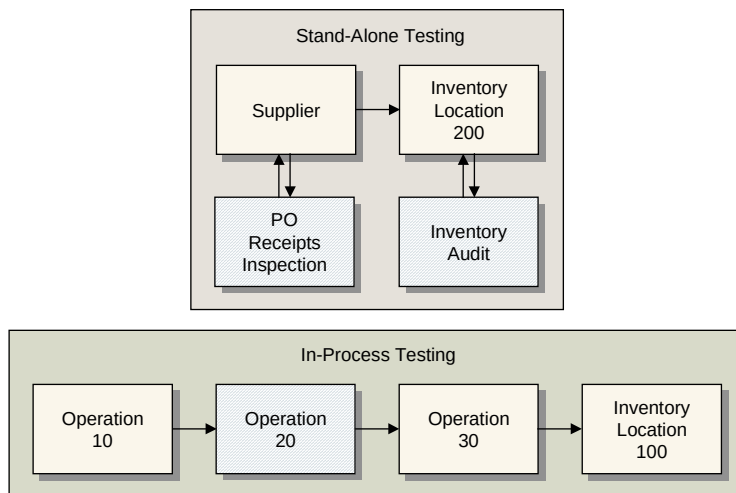
Printing Test Results **204**

The screenshot displays the 'Routing Maintenance (Main Screen)' window in MFG/PRO. It includes fields for 'Routing Code' (10-15000), 'Operation' (20), and 'Standard Operation' (1030). The 'Description' field contains 'INSPEC PER PROC-005'. Other fields include 'Machines per Op' (1), 'Overlap Units' (1), 'Queue Time' (1.0), 'Wait Time' (0.0), and 'Setup Time' (0.0). The 'Milestone' field is set to 'INSPECTION, ALL SITE'. The window title is 'routm91.p'.

Introduction

The Quality Management module (19) enables you to test incoming material, finished products, and inventory; inspect first articles, processes, or items in-process; and perform destructive testing. For all but in-process inspection, you manage quality with quality orders: documents that specify what is tested, how, and when. You can define specifications, test procedures, and inventory sampling, and record the results of testing.

Fig. 10.1
Inspection Methods



Testing is generally done in one of two ways:

- As a stand-alone task—at purchase receipt or at an inspection station. For this method, you create a quality order to control quantities and dates. The order provides authority to move inventory, perform work, and route items to various locations after the work is completed.
- As an operation within a work order or repetitive schedule routing. In this case, material is moved to a location where the quality tests are performed. Reporting occurs in the Shop Floor Control or Repetitive modules. For work orders without shop floor control reporting, use Test Results Maintenance (19.13) to record results.

Material that is spoiled, damaged, or made obsolete by an engineering change can be quarantined by changing its inventory status code in Inventory Detail Maintenance (3.1.1) to restrict inventory transactions.

Setting Up Quality Management

Before using Quality Management, set up appropriate control file values. Before you can report quality test results in MFG/PRO, you must define a quality document, called a *specification*. Test specifications control the testing process, describing each test step, the characteristic to be measured, the measurement tolerance, and the sequence for conducting tests.

If you have tests that apply to more than one item, you can define master specifications. These serve as templates for defining specifications for individual items.

If multiple steps are required for a stand-alone quality test, define them as a procedure in Procedure Maintenance (19.2.1).

You may also want to establish a sampling pattern. These define how items will be selected for testing if all items are not to be tested. The two options are lot intervals and number of days before expiration.

Setting Up the Control File

Enter appropriate values in the Quality Management Control File (19.24). Most of the settings affect quality orders.

Fig. 10.2
Quality
Management
Control File (19.24)

If you want quality orders to be numbered automatically, set Auto Order Numbers to Yes. The system then uses the Next Order Number and Next Batch when new orders are created.

Specify the default inspection site and location for new quality orders. Items being inspected are transferred from their current site and location to the inspection site and location specified on the order.

Defining Specifications

When a set of tests apply to more than one item, set up the specification in Master Specification Maintenance (19.1.1). A master specification is a list of index numbers, characteristics, specifications, and units of measure, and additional information entered as transaction comments.

You can include tolerances, or acceptable deviations from standard value. These specifications are used by quality orders and in-process inspection operations.

Fig. 10.3
Master
Specification
Maintenance
(19.1.1)

The screenshot shows a window titled "Master Specification Maintenance" with a menu bar (User Menu, Edit, Queue, Options, Help) and a toolbar. Below the menu bar, the following information is displayed:

- Document: PROC-001
- Expire Date: 01/01/94
- Description: Standard Test Procedure

Below this information is a table with four columns: Number, Characteristic, Specification, and Measure.

Number	Characteristic	Specification	Measure
1	Enter your name	*	Actual value
2	Purity	>99.9	%

The index numbers associated with characteristics and specifications must be unique but need not correspond to an actual test or inspection sequence.

Specification Values

A specification can take any of the following forms.

A character string. This is a list of elements separated by commas. For example, if acceptable colors for an item are gray and black, the specification is gray, black.

A numeric value with a tolerance. This is stated as a range, with minimum and maximum values separated by the pipe (|) character. For example, if the idle speed of an engine is 1000 +/- 150 rpm, the specification is 850 | 1150. To generate the pipe character, press Shift-\.

You can also designate a range within a range. In the previous example, a range of +/- 50 rpm, together with a tolerance of +/- 150, is designated by the string 850 | 950 | 1050 | 1150. The system looks only at minimum and maximum values, but this format allows you to see the optimal range within a tolerance.

A comparative symbol (<, >, <=, or >=) and a numeric value. This type of specification provides a value against which a measurement is seen as less than, more than, less than or equal to, or more than or equal to. For example, if the acceptable weight for an item is less than 25 grams, the specification is entered as <25.

An asterisk (*), indicating a wildcard value. This allows any value to be recorded and accepted, a useful feature for collecting data for failure analysis.

Tip
You can record the name of a tester by calling the first test Name and defining its specification as the wildcard. The first required test result is then the tester's name.

Defining Item Specifications

Use Item Specification Maintenance (19.1.13) to attach a set of specifications to a routing or quality control operation. You can use a master specification as a template. You can change and add to the information that comes from a master specification.

An item specification can list several characteristics and specifications, but only for a single item and a single operation. Also, a quality control operation is linked to only one item specification. Each specification can include any number of steps, indicated by the Number field.

If several item specifications are required to inspect an item, they must be spread out over several operations, one operation for each specification.

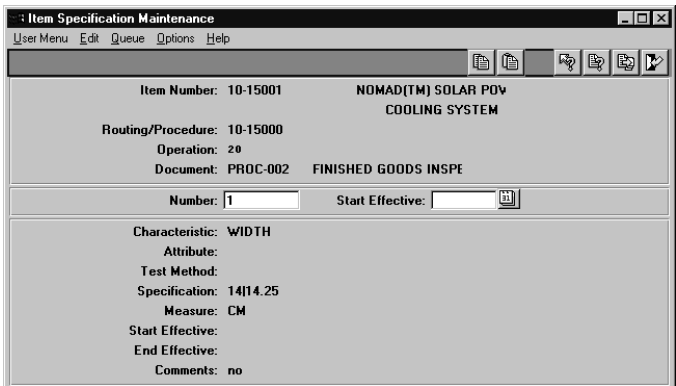


Fig. 10.4
Item Specification Maintenance (19.1.13)

If an item does not have a routing or procedure, you can still link it to a specification by leaving Routing/Procedure blank and Operation as zero (the default).

Use specifications to record information about sample size. For instance, you can set up an item specification with three test steps:

- One for sample size
- One for quantity accepted
- One for quantity rejected

▶ See *User Guide Volume 6: Master Files* for information about the PCC module.

Item specifications can be maintained in the Product Change Control module. The effective date is used to phase in changes managed with product change orders.

Setting Up Procedures

▶ See “Executing Stand-Alone Tests” on page 197.

A quality procedure consists of one or more operations—generally, inspection or testing operations—linked to a work center. Define quality procedures in Procedure Maintenance (19.2.1). Quality procedures are used by quality orders in the same way routings are used by work orders.

Fig. 10.5
Procedure
Maintenance
(19.2.1)

The screenshot shows the 'Procedure Maintenance' window with the following fields and values:

Procedure Maintenance	
User Menu Edit Queue Options Help	
Procedure:	test
Operation:	10
Work Center:	100 rep1
Machine:	
Description:	test procedure
Machines per Op:	1
Operation Time:	2.0
Tool Code:	
Comments:	no

Tip
There is no integration between quality procedures and capacity requirements plan (CRP).

Operation lead time indicates the time, stated in decimal hours, this test operation normally takes. Operation time is independent of the number of units being tested. Make sure you enter it consistently as either time per unit or time per test batch.

You can link each operation of a procedure to one or more items in the Procedure Supplies pop-up window. These items are consumed during testing or inspection, and are issued from inventory. They are not issued to WIP, but are treated as floor stock and expensed to cost of production when quality orders are processed.

Defining Sampling Patterns

Define sampling patterns for items in inventory in Sampling Pattern Maintenance (19.3.1). Patterns can be defined so that an audit selects inventory based on expiration dates or lot interval.

▶ See “Inventory Audits” on page 202 for more details.

Days to Expire. Use this method for items with a limited shelf life, as defined in Item Master Maintenance (1.4.1). Enter a number of days to set an expiration date pattern.

For example, set Days to Expire to 7, then run Sample by Expire Days Inquiry (19.3.13) to see items that expire within seven days.

Lot Interval. Use this method for sampling items that are stored at more than one site or location *and* that are stored with lot/serial or lot reference numbers. Enter a value *n* to pick every *n*th lot from inventory.

For example, if there are 16 unique inventory records for an item and Lot Interval is 2, Sample by Lot Interval Inquiry (19.3.14) selects every second record, for a total of eight records.

Inventory selection based on a sampling is not automatically entered into a quality order. You must run Sample by Expire Days Inquiry or Sample by Lot Interval Inquiry to see which items are to be sampled.

Executing Stand-Alone Tests

Use quality orders to conduct stand-alone inspections of incoming material or material already in inventory. A quality order authorizes a test or inspection and specifies how much to test, where, when, and how. After testing, enter results in Quality Order Results Entry (19.11).

The immediate effect of a quality order is to transfer material from its current inventory location to an inspection location at the same site. This is where the procedure designated on the quality order is run, and test results recorded. Quality orders link:

- The quantity of an item
- A set of testing procedures, and
- A set of test specifications for those procedures

Fig. 10.6
Quality Orders

Quality Order

Order 51
Item 101
Batch 506
Site 1000
Procedure 400

Qty Accepted ____
Qty Rejected ____

Procedure 400

Operation		Accepted	Rejected
10	Physical	____	____
20	Electrical	____	____
30	Mechanical	____	____
...		____	____

Specification

Item 101
Procedure 400
Operation 10

No.	Specification	Results
1	Height	____
2	Weight	____
3	Length	____
...		____

Tip
You must set
Inspect to No in
Item Planning
Maintenance
(1.4.7).

You can use quality orders to manage inspection of incoming materials. When material arrives at a receiving location, create a quality order to transfer the material to an inspection location. After inspection, the accepted material is transferred to inventory. Rejected material is issued from the inspection location and expensed using the product line scrap account.

Creating Quality Orders

Create quality orders in Quality Order Maintenance (19.7).

Fig. 10.7
Quality Order
Maintenance (19.7)

Quality Order Maintenance

User Menu Edit Queue Options Help

Quality Order: 1001 Batch: 2

Item Number: j0bk ECO j0bk

Type: 1

Site: 10000

Auto Issue: yes

Qty Pending: 100.0

Start Date: 01/26/96

Qty Accepted: 0.0

Release Date: 01/26/96

Qty Rejected: 0.0

Due Date: 01/26/96

Status:

Procedure: j0bk

PO/Job:

Project:

Remarks:

Type. Specify the type of testing to be done.

- **I (Inspection).** The quantity to inspect is transferred to the inspection location specified in the Quality Management Control File. Any quantity rejected is issued from this location and expensed to the scrap account. Quantity accepted is transferred back to regular inventory.
- **D (Destructive).** The quantity to inspect is transferred to the inspection location, but both accepted and rejected quantities are issued and expensed to cost of production.

Site. This site defaults from the inspection site defined in the Quality Management Control File.

Auto Issue. Enter Yes to have supplies required for an inspection automatically issued. The quantity issued is the Quantity Per for the supply item, multiplied by the change in the quantity pending inspection. Enter No to have supplies issued during Quality Order Results Entry (19.11).

Tip
Supplies are specified in the associated procedure.

Qty Pending. This is the quantity to be transferred to inspection. If the quantity pending is changed on a quality order, the difference is calculated and transferred, either to inspection or to inventory.

Qty Accepted, Qty Rejected. These quantities default from Quality Order Results Entry.

Status. The status of a quality order. Values are either blank, Open, or Closed. An order remains open until quantity pending is zero.

Procedure. A quality order can reference a procedure the same way a work order can reference a routing.

Entering Quality Order Results

Enter results of a test or inspection in Quality Order Results Entry (19.11). This program also moves material out of inspection and issues supplies required by inspection.

Fig. 10.8
Quality Order
Results Entry
(19.11)

Quality Order Results Entry				
User Menu Edit Queue Options Help				
Quality Order: 1001		Batch: 2	Effective: 03/06/96	
Item Number: j0bk		Status:	Procedure: j0bk	
ECO j0bk				
Test Steps				
Item Number	Op	Qty Pending	Qty Accepted	Qty Rejected
j0bk	10	10.0	0.0	0.0
Operation: 10 Qty Pending: 10.0 Work Center: 100 Machine: Qty Accepted: 10.0 Qty Rejected: 0.0 Status: Op Time: 1.0 Act Op: 0.0				

You can record results for an order, for each operation on an order, or for each specification for an operation. For an order, you can record total quantity accepted and rejected. For an operation, you can record quantity accepted and rejected, actual time required for testing, and comments. For each specification, you can enter results and comments.

You can also change the quantity pending for an operation. You might do this if the quantity rejected at a previous operation results in units being scrapped, and thereby made unavailable for inspection at the current operation.

Deleting Quality Orders

If no results are entered for an order, you can change the quantity pending to zero and delete the order in Quality Order Maintenance. If dispositions or results have been entered, you can close the order and delete it with Quality Order Delete/Archive (19.23).

Conducting Process Inspections

When inspection occurs in process, work orders and repetitive schedules control the movement of material. Quality orders are not needed.

Process inspections are typically performed on a factory floor. You can do this by defining inspection operations in an item's routing in Routing Maintenance (14.13.1). These operations are linked to test specifications in the same way that test steps in quality orders are linked.

Reporting test results can be part of regular labor reporting. For work orders with routings, enter inspection results in:

- The labor feedback transactions in Shop Floor Control (17)
- For a repetitive schedule, in Repetitive Labor Transaction (18.14)
- For an advanced repetitive schedule, in Backflush Transaction (18.22.13)

For scheduled work orders or work orders without routings, enter test results manually in Test Results Maintenance (19.13). Results entered here are processed in the same way as in Quality Order Results Entry.

Figure 10.9 illustrates how test results are reported as part of labor feedback.

Specification Tests				
Characteristic	Measure	Actual Results	Pass	Cmnt
Adherence of Glue	Movement		no	

Fig. 10.9
Reporting Test
Results in Labor
Feedback by Work
Order (17.1)

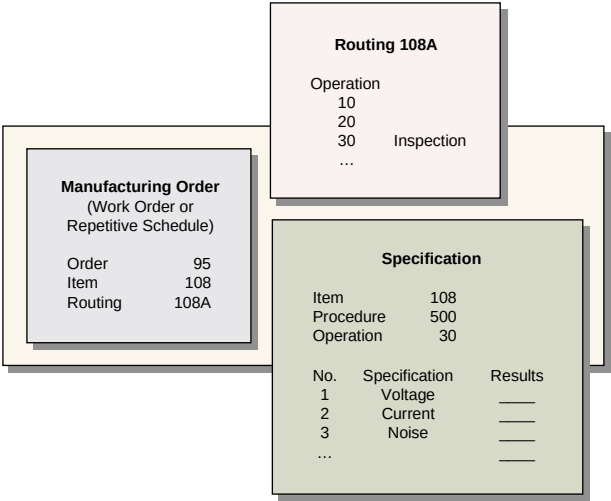
Enter the results while reporting labor for the inspection operation.

After you enter the quantities accepted and rejected for an operation, the system prompts you to record results and comments. The system compares your entry with the specification for the result. If the result is out of tolerance, a warning displays.

As with quality orders, you can enter only one result per specification. Enter additional information as comments. If you have several samples, you may want to enter the best, worst, or typical case for each group.

During inspection, process material remains in WIP. After an inspection is complete, material moves to the next operation. From the last operation the accepted material is received back into inventory and rejected material is scrapped. Figure 10.10 illustrates the process inspection.

Fig. 10.10
Process Inspection



Conducting Other Tests

You can use quality orders to conduct other specialized kinds of tests.

Inventory Audits

Material subject to an inventory audit is like material processed by incoming inspection. Both use quality orders, and material never leaves inventory. The difference is that material is selected from inventory for audit based on criteria such as expiration date or item.

Use inventory sampling patterns to determine which items are to be audited. Sampling is based on expiration dates or lot intervals. You can also use Inventory Detail Report (3.6.5) to identify inventory items based on expiration date, site, location, assay percentage or grade.

◆ See “Defining Sampling Patterns” on page 197 for more details.

It is not always practical to move an entire lot from inventory for testing. As an alternative, you can test a sample and leave the remainder in inventory. To prevent these from being issued or transferred before results are available, change the inventory status to a code that restricts issues or transfers.

The quantity for a quality order must reflect the quantity of an item moved to inspection for testing. This quantity is the same as the lot size if an entire lot is moved to inspection, and it is the lot sample size if only a portion is tested.

First Article Inspection

First article inspections are used to qualify a machine, a tool, or the setup of a machine or tool by determining whether it can produce items within design limits. It is assumed that if a few items can be produced correctly, the machine or tool is set up properly.

First article inspection differs from regular inspection in that it examines a sample by comparing it to most, if not all, of the engineering specifications appropriate for a specific level of processing.

First article inspection and process validation can use either quality orders or in-process inspection. The selection depends on whether or not the units evaluated are obtained from a supplier or from an internal manufacturing process.

Process Validation

Process validation—an extension of first article inspection—is used to qualify a manufacturing process. Rather than use a single sample or unique lot, process validation requires one or more large batches, each of them a typical manufacturing lot. Samples from the beginning, middle, and end of production can be examined to determine the stability of a manufacturing process and its ability to consistently produce quality material.

Quality orders can handle process validations, since they record inventory transactions and allow unplanned issue of testing supplies.

Destructive Testing

On a regular quality order, the quantity subjected to destructive testing should be reported in Quality Order Results Entry (19.11) as rejected, regardless of whether it passed or failed. This causes the quantity to be issued from inspection and expensed to scrap.

The lot quantity subjected to destructive testing can have its own quality order with a type code of D. When results are entered, quantities accepted and rejected are issued from inspection and expensed to cost of production.

For process inspection, there is no special provision for destructive testing. If rejected or scrapped quantities exist at an inspection operation, they remain in WIP. Quantities are taken out of WIP when received or rejected by a work order receipt function or by Repetitive Labor Transaction (18.14) or Backflush Operation (18.22.13). Nonconforming components can be returned from WIP by processing a Work Order Component Issue (16.10) for a negative quantity.

Printing Test Results

Print test results for quality or manufacturing orders with Certificate of Analysis Print (19.20). An option to disregard the test results lets you print a certificate whether or not an order has passed all specifications. Printing certificates for materials that have failed to meet specifications provides a record when dispositioning non-conforming material. The certificate can be attached to the material and used as data entry to take the material out of inventory.

CHAPTER 11

Forecasting/Master Schedule Planning

This Forecast/Master Schedule Planning module lets you create and maintain shipment forecasts and master production schedules.

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Creating Forecasts **206**

Consuming Forecasts **225**

Creating Master Production Schedules **228**

Routing Code: 10-15000 NONAD (75) CDD IN

Operation: 20

Standard Operation: 10.30 INSPECTION, ALL SITE

Work Center: Machine

Description: INSPEC PER PROX-005

Machines per Op: 1 Milestone: 1

Overlap Units: 1

Queue Time: 1.0

Wait Time: 0.0

Setup Time: 0.0

Route by Production Build

Introduction

Using functions in the Forecast/Master Schedule Planning module, you can calculate and record the number of units of a given item you expect to ship each week from a given site.

These forecasts are used to develop the master production schedule and drive material requirements planning (MRP).

Forecasts and master schedules can be created for any item, but are usually created for end items, critical subassemblies, and service parts.

Creating Forecasts

You can create shipment forecasts using one of the following methods.

- ▶ See page 207.
 - Use the forecasting simulation functions to calculate item forecasts using sales history data and the forecast method you specify.
- ▶ See page 215.
 - Use the CIM interface to load forecasts generated outside MFG/PRO into forecast detail records.
- ▶ See page 224.
 - Use Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2) to manually enter forecasts.
- ▶ See page 217.
 - Use Simulation-to-Simulation Copy (22.7.11) or Single Item Simulation Copy (22.7.12) to create new forecasts based on existing forecasts.

Forecast Creation Work Flow

- 1** Create a criteria template.
- 2** Do one of the following to create a forecast detail record.
 - Run the simulated forecast calculation.
 - Manually enter a forecast generated outside of MFG/PRO.
- 3** Manually modify forecast detail records as needed.
- 4** Optionally copy or combine detail forecast records.
- 5** Generate reports to review the cost, price, and profit margin for monthly forecast quantities.

- 6 Load the detail forecast records into summary forecast files to become a source of demand for MRP.
- 7 If required, manually create forecasts or adjust quantities for forecasts generated by forecast simulation functions using Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).
- 8 Run MRP.

Forecasting Simulation

Forecasting simulation functions enable you to analyze sales shipment history, calculate forecasts, and update demand for material requirements planning (MRP), creating a closed-loop system.

Forecasting simulation functions generate forecasts based on shipment history. They use statistical methods and extrapolation techniques to evaluate underlying patterns in sales history data and predict future demand.

Forecasting assumes that historical sales patterns are repeated to varying degrees in the future. The accuracy of any forecast depends on the value of the sales information used to create it. The more sales history available, the more accurate the forecast.

Figure 11.1 outlines the flow of information in forecasting simulation functions.

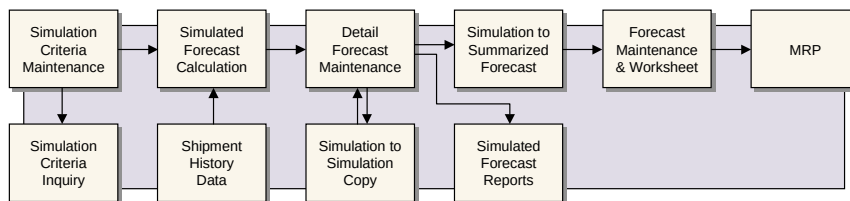


Fig. 11.1
Forecasting
Simulation
Information Flow

Forecasting Horizon

Forecasts generated using forecasting simulation functions are produced in monthly buckets. They can either be for a given year or for the next 12 months, beginning with the current month. The latter is called a *rolling forecast*.

To produce a forecast for a given year, you must specify a forecast ending year that is earlier than the forecast year. To produce a 12-month rolling forecast beginning in the current month, the ending year must be the same as the forecast year.

Note MFG/PRO defines the first week of a new calendar year as the first Thursday in January, in accordance with ISO standards.

Setting Up Forecasting Simulation

Forecasting simulation programs analyze shipment history data in the customer-product sales history (cph_hist) file. For shipment history to post to cph_hist, Integrate with SA in the Sales Order Control File (7.1.24) must be Yes.

Creating Criteria Templates

Producing a forecast begins with defining a criteria template. Criteria templates indicate which sales history to analyze and how the system should perform the forecast calculation. You can define criteria templates using Simulation Criteria Maintenance (22.7.1), or use Simulated Forecast Calculation (22.7.5) to define them at the time of forecast calculation.

Once you use a criteria template in a forecast calculation, you cannot modify it using Simulation Criteria Maintenance. However, you can modify previously used criteria templates when performing forecast calculations in Simulated Forecast Calculation.

Fig. 11.2
Simulation Criteria
Maintenance
(22.7.1)

The screenshot shows the 'Simulation Criteria Maintenance' window with the following fields and values:

- Forecast ID:** 0875
- Description:**
- Forecast Year:** 1998
- Years of History:** 5
- Ending:** 1998
- Forecast Method:** 02
- Alpha factor:** .40
- Trend:** .10
- User factor[1]:** .00
- [2]:** .00
- Item Number:** 02-0001
- To:** 02-0020
- Prod Line:**
- To:**
- Group:**
- To:**
- Item Type:**
- To:**
- Order Line Site:**
- To:**
- Use Ship To/Sold To:** Sold To
- List Type:**
- Customer:**
- To:**
- Region:**
- To:**

Forecast Year. For a rolling forecast starting this month, this year must be identical to the ending year.

▶ See “Forecasting Horizon” on page 207.

Years of History. Number of years of shipment history to analyze, up to five years. The system reduces this number if there are no sales data for a given year.

Ending. Must be the same or earlier than the forecast year.

Forecast Method. Specify either a predefined forecast method (01–06) or your own forecast method.

▶ See “Forecast Methods” on page 211.

Alpha factor, Trend, User factor [1], User Factor [2]. Weighting factors used by the specified forecast method.

▶ See “Alpha and Trend Factors” on page 212.

Item Number, Product Line, Group, Item Type. Use these fields to identify a single item or range of items for which to forecast.

Order Line Site. The order line site on sales orders or ship-from site on a customer schedule, used to further define items to forecast.

Use Ship-To/Sold-To. Determines whether the system selects sales history to analyze based on the customer’s ship-to or sold-to address.

Customer, Region, List Type. Use these fields to identify subsets of customers for which the system selects sales data to analyze.

Note When you specify both Ship-To and Region as criteria for selecting sales history data, only permanent ship-to addresses—that is, those defined in Customer Maintenance (2.1.1)—are in the selected region range.

Demand Patterns

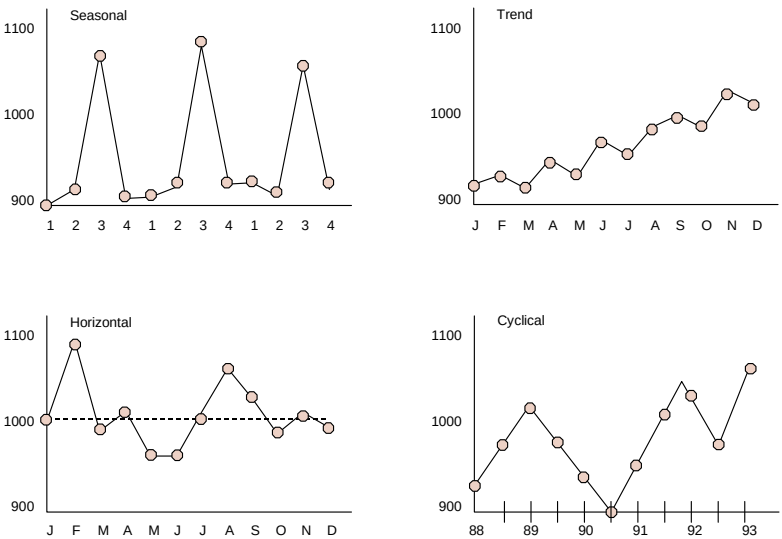
Sales history can contain four underlying patterns of demand. Forecasting methods quantify these patterns.

Table 11.1
Demand Patterns

Pattern	Description	Example
Trend	Sales quantities increase or decrease over time.	The growth pattern of a new product.
Seasonal	Sales quantities fluctuate according to some seasonal factor, such as weather or the way a firm handles its operations.	Sales of soft drinks, which increase in the summer months.
Cyclical	This pattern is similar to seasonal, but the length is greater than one year. The pattern does not repeat at constant intervals and is the hardest to predict.	The sale of houses.
Horizontal	Sales quantities do not increase or decrease substantially.	A stable product with consistent demand.

Figure 11.3 shows examples of these demand patterns in graph format.

Fig. 11.3
Demand Patterns



Forecast Methods

Forecast methods are identified by two-digit method numbers. Table 11.2 lists the forecast method numbers available in MFG/PRO.

Table 11.2
Method Numbers

Method Number	Usage
00	Indicates that a forecast detail record was not generated by the system, but was created manually using the copy programs or using CIM interface.
01–06	MFG/PRO predefined forecast methods.
07–50	Reserved for QAD usage.
51–99	Use these numbers to identify your own forecasting methods.

There are six predefined forecast methods, described in Table 11.3. You can create additional methods using User Forecast Method Maintenance (22.7.17). [See page 213.](#)

Table 11.3
Predefined Forecast Methods

Method #	Type	Description
01	Best Fit	Uses all predefined methods—02 through 06—and selects the results with the least mean absolute deviation. This is the default forecast method.
02	Double Moving Average	The simplest of the forecasting techniques. It uses a set of simple moving averages based on historical data and then computes another set of moving averages based on the first set. The moving averages are based on four months of data. This method produces a forecast that lags behind trend effects.
03	Double Exponential Smoothing	The most popular of the forecast techniques. It is similar to Double Moving Average, except that it uses the alpha factor to weigh the most recent sales data more heavily than the older sales data. This method produces a forecast that lags behind trends effects.
04	Winter’s Linear Exponential Smoothing	Produces results similar to Double Exponential Smoothing, but incorporates a seasonal/trend adjustment factor. This method can be used to forecast based on sales history containing both trends and seasonal patterns. Uses the trend and alpha factors. Requires two years of history.

Method #	Type	Description
05	Classic Decomposition	Recognizes three separate elements of demand patterns in sales history: trend, seasonal, and cyclical factors. See Table 11.1 on page 210 for information about demand patterns. Classic Decomposition is usually the preferred method for forecasting seasonal, high-cost items. It requires at least two years of history.
06	Simple Regression	Also called the least squared method, this method analyzes the relationship between sales and time span to ensure that the forecast quantity is equally likely to be higher or lower than the actual quantity sold. Useful for products with a stable history, or horizontal demand pattern.

Table 11.4 shows each of the predefined forecast methods and indicates the sales patterns they are typically used to quantify, the number of years of shipment history required for calculation, and whether they use alpha and trend factors.

Table 11.4
Overview of
Forecast Methods

	01	02	03	04	05	06
Cyclical					Yes	
Trend		Lags	Lags	Yes	Yes	
Seasonal				Yes	Yes	
Horizontal						Yes
Years of History	1	1	1	2	2–3	1
Trend Factor				Yes		
Alpha Factor			Yes	Yes		

Alpha and Trend Factors

Some forecast methods use alpha and trend factors to weight shipment history when calculating forecasts.

When method 03 or 04 is used to calculate forecasts, alpha factors determine the relative importance given to more recent sales history. For new products with rapidly changing sales quantities, you may want to enter an alpha value closer to one to give more weight to recent sales history. However, for products with long and stable sales histories, you might specify a smaller alpha value to produce smoother forecast results.

When method 04 is used to calculate forecasts, trend factors determine the relative weight given to sharp increases or decreases in sales history when calculating forecasts.

Table 11.5 shows the effects of alpha and trend factors on forecasting calculations. Alpha and trend values must be between zero and one.

Factor	Zero	One
Alpha Factor	Equal weight on all history.	Weights recent history.
Trend Factor	Ignores sharp changes in history.	Weights heavily sharp changes in history.

Table 11.5
Alpha and
Trend Factors

Creating Additional Forecast Methods

Forecast methods identify the PROGRESS program the system uses to calculate forecasts. Different programs employ different statistical methods.

You can create specialized forecast methods for the system to use in producing forecast quantities. User Forecast Method Maintenance (22.7.17) lets you add your forecast methods, in the form of PROGRESS programs you supply, to the existing MFG/PRO forecast methods.

The criteria template includes two variables that can be set to interact with your own forecast method: User factor1 and User factor2. These are reserved for your forecast methods and do not operate with any of the predefined methods.

For user-defined forecast methods:

- The name of the program must be `ffcalcXX.p` where `XX` is a forecast method number between 51 and 99.
- The PROGRESS program must be written and accessible to MFG/PRO before you can define the method number in User Forecast Method Maintenance.
- Your PROGRESS program must use an array named `calc[1-60]` for the historical data input and an array named `fcast[1-12]` for the calculated output.
- Your PROGRESS program must include the following files at the beginning of the program: `fcalvar.i` and `ffvar.i`.

Compare your forecast method program to the existing programs `ffcalc[02-06].p`, as needed.

Calculating Forecasts

Run forecast calculations using Simulated Forecast Calculation (22.7.5).

Fig. 11.4
Simulated Forecast
Calculation (22.7.5)

Forecast ID: 0875

Forecast Year: 1998 Years of History: 5 Ending: 1998
Forecast Method: 02 Alpha factor: .40 Trend: .10
User factor[1]: .00 User factor[2]: .00

Item Number: 02-0001 To: 02-0020
Prod Line: To:
Group: To:
Item Type: To:
Order Line Site: To:

Use Ship To/Sold To: Sold To List Type:
Customer: To:
Region: To:
Output:
Batch ID:

Simulated Forecast Calculation analyzes an item's shipment history data and produces a forecast detail record that predicts what quantity of the item will be sold in the future.

See "Creating Criteria Templates" on page 208.

This calculation requires a criteria template. You can either specify a criteria template defined in Simulation Criteria Maintenance (22.7.1) in the Forecast ID field or define a new criteria template at this time.

Tip
At least one sales record is required to produce a nonzero forecast quantity.

When insufficient shipment history exists to generate a valid forecast for an item, the detailed forecast record for that item is created for a quantity of zero. Negative results also display as zero quantities.

Running Simulated Forecast Calculation generates sales predictions for each specified item for a one-year period. If you specify an entire product line, product type, or product group for which to forecast, each individual item is forecasted separately. Also included in the report are the number of items calculated and insufficient items—that is, items that lack enough historical data to generate an accurate forecast.

The calculated forecast quantities are stored in forecast detail records, identified by the forecast ID, year, and item. You can manually modify forecast detail records as needed.

Note You must enter forecast detail records created outside of MFG/PRO manually using Detail Forecast Maintenance (22.7.7) or load them into MFG/PRO using the CIM interface.

♦ See “Manually Creating Forecasts” on page 215.

When you run a forecast calculation, any existing criteria templates or forecast detail records with the same forecast ID are automatically deleted.

Criteria templates used to calculate forecasts can be further modified only when doing another calculation using Simulated Forecast Calculation.

Manually Creating Forecasts

You can use Forecast Detail Maintenance (22.7.7) to manually create forecast detail records.

Note You cannot manually create a rolling forecast.

When loading forecast results using the CIM interface or manually entering forecasts using Forecast Detail Maintenance, you must specify a forecast ID, year, and item number. The system automatically sets the forecast method to 00 and generates a criteria template, which is stored under the same forecast ID as the detail record.

♦ See *User Guide Volume 11: Manager Functions* for information about the CIM interface.

Modifying Forecast Results

Forecast quantities may require modification to be more reflective of future market demand. This is especially true when forecast results are based on historical data that included unprecedented sales—for example, sales due to a sales promotion or a natural disaster. When you believe that future demand will not be similar to sales history, you can adjust existing forecast detail records accordingly.

Note Modify forecast detail records as needed *before* copying forecast quantities to the summary forecast files used by MRP.

You can use Detail Forecast Maintenance (22.7.7) to modify forecast detail records produced by forecast calculations or loaded into the system using the CIM interface.

Fig. 11.5
Forecast Detail
Maintenance
(22.7.7)

Month	Orig Fcst	Adjust Fcst
January	22106	22100
February	21876	21876
March	21751	21751
April	21592	21592
May	21507	21507
June	21305	21305
July	21084	21084
August	21122	21122
September	23567	23567
October	22125	22125
November	21972	21972
December	22988	22988
Total	262995	262995

Select a forecast detail record to modify by specifying a forecast ID and forecast year. To select a forecast detail record created for a product group, you must also specify an item number.

Forecast detail records display in three columns:

- Month
- Orig. Fcst
- Adjust. Fcst

The quantities in the Orig. Fcst column are the original forecast quantities, either the result of the system forecast calculation or the original quantity you manually entered or loaded.

You can modify the forecast as needed by changing the quantities in the Adjust. Fcst column.

Warning All changes to forecast detail records are permanent. To reproduce original forecasts, you must rerun the forecast calculation. Before modifying forecast detail records, you should archive the original forecast or copy it to another forecast ID.

Copying and Combining Forecasts

To create new forecasts by copying or combining existing detail records, use Simulation to Simulation Copy (22.7.11) or Single Item Simulation Copy (22.7.12).

Fig. 11.6
Simulation to
Simulation Copy
(22.7.11)

These functions let you copy, replace, or combine forecast detail records. With Simulation to Simulation Copy, you can copy forecast records for multiple items in a single transaction, whereas with Single Item to Simulation Copy you can copy only for a single item.

Note To manually adjust forecast detail records created using these functions, use Detail Forecast Maintenance (22.7.7).

♦ See “Modifying Forecast Results” on page 215.

Multipliers

When copying or combining forecast detail records using Simulation to Simulation Copy (22.7.11) or Single Item Simulation Copy (22.7.12), you can apply multipliers to the resulting forecast quantities. Multipliers, also called multiplicative factors, allow you to increase, decrease, or scale forecast quantities by a specified percentage. Multipliers can be useful when you have prior knowledge of an unscheduled demand, such as a future sales promotion.

There are three types of multipliers:

- Base Increase/Decrease
- Scale
- Trend

In Single Item Simulation Copy, multipliers let you scale the forecast results for a new item as some percentage of an old item. This is useful when you want to match the seasonal demand, but not the quantity, of an old item for a new item.

Simulation to Simulation Copy lets you apply multipliers to a range of items.

Base Increase/Decrease. The percentage by which a forecast quantity is increased or decreased. A negative percentage indicates that the quantity is decreased.

Table 11.6
Base Increase/
Decrease Multiplier

Month	Units	10%	-10%
January	100	110	90
February	150	165	135
March	120	132	108

Scale. The percentage by which a forecast quantity is multiplied, or scaled. This value cannot be negative.

Table 11.7
Scale Multiplier

Month	Units	10%	-10%
January	100	10	n/a
February	150	15	n/a
March	120	12	n/a

Trend. The percentage by which a forecast quantity increases each month. A negative percentage decreases the quantity over time.

Table 11.8
Trend Multiplier

Month	Units	10%	-10%	
January	100	110	90	= 100 +/- (100 x 10%)
February	150	180	120	= 150 +/- (150 x 20%)
March	120	156	84	= 120 +/- (120 x 30%)

You can use more than one multiplier at a time. The effect of multiple factors is cumulative. Base Increase/Decrease is applied first, Scale second, and Trend third.

When you are replacing an existing detail record and apply multipliers to the source quantities, the results overwrite the quantities in the target detail record.

When you are combining records and use a multiplier, the multiplier is applied to the source quantity and the result added to the target quantity. The factor is *not* applied to the combined source and target quantity.

Simulation To Simulation Copy

Use Simulation to Simulation Copy (22.7.11) to copy an existing forecast detail record to another forecast ID or to combine several forecast detail records into a single detail record.

To use this function, you must specify a source forecast ID identifying the forecast detail record to copy to or combine with the target record, and a target forecast ID identifying the forecast detail record to which the source information is copied. A criteria template must exist for the specified source forecast ID.

The target forecast ID you specify does not need to correspond to an existing forecast detail record or criteria template. If a corresponding record does exist for the specified target ID, its forecast method must be 00. If no such record exists, the system creates a target forecast detail record with a method of 00.

If you want to copy detail records for a subset of the items in the source record, you can also specify an item range to be copied.

Note If the item ranges for the target and source records differ, then the target record's range is expanded.

The system combines or copies forecast records only in terms of item units. The Combine/Replace field indicates whether to replace the target forecast quantity with the source quantity or combine the target and source quantities. When you combine forecast quantities, the quantity for an item in the source detail record is added to the quantity for that item in the target detail record. When you replace forecast quantities, the quantity for an item in the source record replaces the quantity for that item in the target detail record.

Note You cannot separate combined forecast records.

You can increase, decrease, or scale the resulting detail record, or multiply the detail record by a trend factor.

♦ See "Multipliers" on page 217 for details.

Using this function to copy or combine forecast detail records automatically deletes the original, or target, forecast record and replaces it with the copied or combined record. The source detail record and criteria template remain unchanged.

Single Item Simulation Copy

Single Item Simulation Copy (22.7.12) enables you to create a forecast for a single item based on the historical sales data for another item. Since there is often little or no sales history for new items, you may want to use the demand history for a similar product to produce forecasts for a new product.

Note If the Target Forecast ID, Item Number, or Forecast Year fields are left blank, the system sets them to the target values.

You must specify an item number to copy from the source detail record. This item must exist in the item master.

Forecast records are copied only in terms of units. The source and target items must have identical units of measure, or a unit of measure conversion must exist.

If the specified target forecast detail record already exists in the system, its forecast method must be 00. If the target does not exist, the system creates a forecast detail record with a method of 00.

▶ See “Multipliers”
on page 217.

When copying forecast records, forecast amounts can be multiplied by a Base Increase/Decrease, Scale, or Trend factor.

During a combine or replace, the original target forecast record and criteria template are overwritten. The source record is not altered.

Generating Reports

MFG/PRO does not generate forecasts in currency values. However, Detail Forecast Report (22.7.9) lets you review forecast quantities along with the production cost and sales price by month. You must specify the cost set, site, price list, and currency in which to display the monetary amounts.

If both the cost and price are in the same currency, the report displays the profit margin, calculated as price minus cost. The number of units, the extended cost value, and the extended price value are also totaled for the entire 12-month reporting period.

Table 11.9 illustrates a sample forecast report, assuming the forecasted item has a unit cost of \$15.36 and a unit price of \$25.00.

Forecast ID	Year	Item No.	Mo.	Units	Ext Cost	Ext Price	Margin
j205095	1995	j2050	Jan	1336	20,520.96	33,400.00	12,879.04
			Feb	1568	24,084.48	39,200.00	15,115.52
			Mar	1839	28,247.04	45,975.00	17,727.96
			Apr	1970	30,259.20	49,250.00	18,990.80
			May	2182	33,515.52	54,625.00	21,109.48
			Jun	1995	30,643.20	49,875.00	19,231.80
			Jul	2003	30,766.08	50,075.00	19,308.92
			Aug	2134	32,778.24	53,350.00	20,571.76
			Sep	1984	30,474.24	49,600.00	19,125.76
			Oct	1781	27,356.16	44,525.00	17,168.84
			Nov	1634	25,098.24	40,850.00	15,751.76
			Dec	1457	22,379.52	36,425.00	14,045.48
Total				21883	336,122.88	547,075.00	210,952.12

Table 11.9
Sample Forecast
Report

Making Forecast Data Visible to MRP

See Chapter 12, “Material Requirements Planning,” on page 239.

Forecasts generated using forecast simulation functions or loaded into forecasting simulation functions using the CIM interface are stored in forecast detail records, whereas MRP uses summary forecast files to drive its demand calculations.

Use Simulation to Summarized Forecast (22.7.13) to load forecast quantities into the summary forecast files used by MRP. This program uses the forecast detail records to create new summary forecast files, replace old summary files, or combine with existing summary forecast files.

Fig. 11.7
Simulation to
Summarized
Forecast (22.7.13)

Simulation To Summarized Fcst

User Menu Edit Queue Options Help

Forecast ID: 0875

Item Number: 02-0001 To: 02-0020

Prod Line: To:

Group: To:

Item Type: To:

Summarized Site: 8000

Forecast Year: 1998

Loading Method: 1 Autospread

Start: 07/22/98

Replace/Combine: Replace

Update/Report: Update

Output: Batch ID:

Forecast detail records are identified by forecast ID, year, and item, whereas summary forecast files are identified by item, site, and year.

See “Creating Criteria Templates” on page 208.

Since MRP is site-specific, you must specify a summary site to update. This site may be different from the order line site specified on the criteria template. When a forecast is for a group of items, you can generate summary forecast files for one item, a subset of items, or all items in the detail record.

Forecast detail records are copied to summary forecast files only in terms of units.

Note You can combine detail records into one summary forecast file, but this is not recommended, since the combined result is not a valid forecast.

Updates to the summary forecast files are permanent and cannot be undone. You should run Simulation to Summarized Forecast in report mode before performing the update.

You can manually modify summary forecast quantities as needed, using Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

◆ See page 224.

Loading Methods

When loading forecast detail records into summary forecast files, you can specify one of three loading methods which the system uses to break the monthly forecast quantities into the weekly quantities used by MRP. The three loading methods are:

- *Autospread (1)*. Monthly forecasts are broken into daily averages and summed into weekly buckets starting on Monday. Unless the day that you are loading forecast into the summarized file is a Monday, the loaded forecast begins on the following Monday. This is the default loading method.
- *Load Last Week (2)*. Monthly forecast is loaded into the last Monday of the forecast month.
- *Load First Week (3)*. Monthly forecast is loaded into the first Monday of the forecast month.

Deleting and Archiving Forecasting Detail Records

Use Detail Forecast Delete/Archive (22.7.23) to delete forecasting detail records or archive them to file as needed. You can also delete and archive criteria templates.

Maintaining Forecasts Outside of Forecast Simulation

If you need to manually enter or modify item shipment forecasts outside of forecasting simulation functions, use Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

Fig. 11.8
Forecast Worksheet
Maintenance (22.2)

Week	Forecast	Sales	Abnormal	Prod Fcst	Net Fcst
40 10/05/98	4,996	0	0	0	4,996
41 10/12/98	4,996	0	0	0	4,996
42 10/19/98	4,996	0	0	0	4,996
43 10/26/98	5,015	0	0	0	5,015
44 11/02/98	5,126	0	0	0	5,126
45 11/09/98	5,127	0	0	0	5,127
46 11/16/98	5,127	0	0	0	5,127
47 11/23/98	5,127	0	0	0	5,127
48 11/30/98	5,182	0	0	0	5,182
49 12/07/98	5,190	0	0	0	5,190
50 12/14/98	5,191	0	0	0	5,191
51 12/21/98	5,191	0	0	0	5,191
52 12/28/98	2,966	0	0	0	2,966
Totals	64,230	0	0	0	64,230

Forecast quantities entered using these functions display in weekly buckets and appear as a demand requirement for the Monday of that week.

To create new item forecasts for a given site and year, enter expected weekly shipment quantities expressed in the item's unit of measure.

You should forecast at least as many weeks as are required to cover the cumulative lead time of the item, which is the maximum time it takes to produce that item if none of its lower-level components are in stock. Forecasting an item based on cumulative lead time ensures sufficient time to respond to changes in the requirements for that item.

Note Shipment forecasts do not represent the quantity of incoming orders, but rather the quantity expected to be shipped during a one-week period.

Forecast Worksheet Maintenance (22.2) includes the following display fields:

Forecast. The shipment forecast for a given week.

Sales. The quantity of an item on confirmed sales orders and required ship schedules to be shipped this week.

Abnormal. Confirmed sales for this week that should not consume forecast.

◆ See page 225.

Production Forecast. A system-calculated forecast quantity used in multilevel master scheduling.

◆ See page 232.

Net Forecast. The total forecast quantity seen as demand by MRP.

◆ See Chapter 11.

Consuming Forecasts

MRP and master production scheduling use shipment forecasts to calculate net forecasts. This is done by consuming the forecast—that is, subtracting sales order demand from the shipment forecast. MRP and master production scheduling then use the calculated net forecasts to determine gross item requirements.

◆ See Chapter 12, “Material Requirements Planning,” on page 239.

Sales Order Demand

Sales order demand is the quantity of an item sold, as recorded on confirmed sales orders or required ship schedules. The system recognizes item quantities ordered as demand when a sales order has been confirmed—that is, Confirmed is Yes in Sales Order Maintenance (7.1.1) or a customer planning or shipping schedule has been changed to a required ship schedule using Required Ship Schedule Update (7.5.5) or Selective Required Ship Schedule Update (7.5.6).

Tip
Confirmed issue lines and service RMAs are treated like sales order lines.

Sales order demand consumes shipment forecasts based on the item number, site, quantity, and due date recorded on the sales order or customer schedule.

Abnormal Sales Demand

Sales order demand is considered abnormal if the quantity or source of demand is not characteristic of quantities anticipated by the current forecast and it should not be used to plan forecasts in the future.

You can designate sales order demand as abnormal by setting the Consume Forecast option to No for that sales order or customer schedule

line. Abnormal sales demand is added to the net forecast rather than being subtracted from the shipment forecast.

Net Forecast Calculation

Master production scheduling and MRP use the net forecast and abnormal sales order demand to calculate total demand. The net forecast is calculated as follows.

$$\text{Net Forecast} = \text{Forecast} - \text{Sales Order Demand}$$

Note When the shipment forecast is oversold—that is, the quantity sold exceeds the forecast amount, the net forecast will not go below zero.

Forward and Backward Forecast Consumption

Typically, shipment forecasts are more accurate over a month than over a week. You can lessen the effects of inaccurate forecasts using forward and backward consumption.

Confirmed sales order and required ship schedule quantities automatically consume forecast in the week they are due. However, if there is no remaining unconsumed forecast for that week, the system can be set to consume remaining forecast quantities for a number of weeks before or after that week.

You can specify the number of forward and backward weeks over which to consume using the Consume Forward and Consume Back fields in the Sales Order Control File (7.1.24). The system consumes forecast first by going back, then forward, one period from the original forecast period. Consumption continues alternately backward and forward until the specified number of previous and future periods is exhausted. If there are sales quantities still left over, MRP recognizes them as additional demand.

MRP and master schedule planning recognize prior period unconsumed forecast as demand for the number of weeks specified in Consume Back.

If the Consume Back and Consume Forward values change, the system automatically recalculates the net forecast based on the changes.

Figure 11.9 shows an example for which the Consume Forward and Consume Back values in the Sales Order Control File are both 2 weeks.

- Excess sales in week 2 consume the forecast in week 1.
- Excess sales in week 3 consume the forecast in week 4, then week 1.
- Excess sales in week 5 consume the forecast in week 4, then week 7.
- Excess sales in week 6 consume the forecast in week 7.

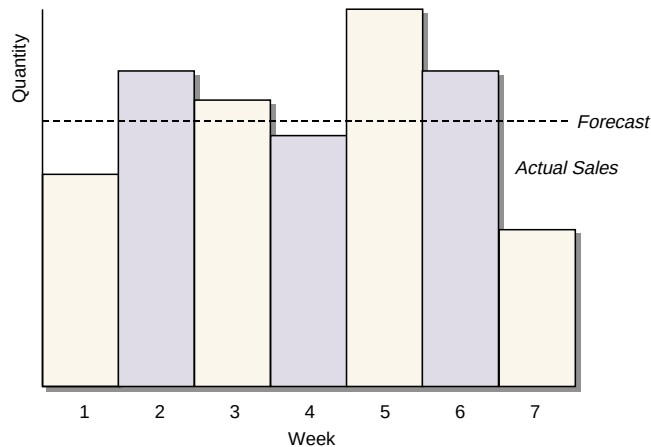


Fig. 11.9
Forecast
Consumption

MRP and Prior Period Forecasts

When you set up the system to consume forecast in previous periods, MRP recognizes prior period unconsumed forecast as additional demand in the current period. When this occurs, you can:

- Delete the forecast for prior periods.

This assumes that if the forecast was not fully consumed for a prior period, it was faulty and should not be considered additional demand for the current period. Use this approach to avoid manufacturing excess inventory for items for which demand will not be generated in the near future.

- Make no changes to the prior period forecast.

This assumes that unsold inventory will be shipped to fulfill future demand exceeding the current, and possibly future, forecast.

- Update the forecast for future periods.

When prior period forecasts are undersold, you can revise forecasts for future periods to reflect the difference.

Master schedulers typically use a combination of these techniques. For example, past due forecasts may be maintained for four weeks and then deleted, whereas forecasts for future periods may be reviewed and updated once a month.

Creating Master Production Schedules

Master schedulers use detailed forecasts to determine what to produce, when to produce it, and in what quantities. These three things define a statement of production that becomes the master production schedule (MPS).

Master Scheduled Items

Master schedule items are typically end items, critical subassemblies, spares, service items, critical components, or key resources.

To define an item as master scheduled, set Master Schedule to Yes for that item in Item Master Maintenance (1.4.1), Item Planning Maintenance (1.4.7), or Item-Site Planning Maintenance (1.4.17) for multisite environments.

Approaches to Master Scheduling

There are several possible approaches to creating and managing master production schedules, each allowing a different amount of control by the system:

- Fully automatic
- Fully manual
- Computer-assisted

Fully Automatic Scheduling

The master schedule can be generated entirely by MRP. This means that the system has complete control over master scheduled items, with no distinction between master scheduled and MRP items.

▶ See Chapter 12, “Material Requirements Planning,” on page 239.

Note When this approach is used, material plans may change dramatically each time MRP is run. For example, a master schedule order may be expedited one day and canceled the next.

To use the fully automatic approach to master scheduling items, set the following values for each master scheduled item in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. Yes.

Order Policy. Any option other than blank.

Fully Manual Scheduling

The master schedule can be created and maintained entirely by a master scheduler, who enters firm planned orders using Master Schedule Order Maintenance (22.13) or Work Order Maintenance (16.1). MRP can be set up to generate action messages to assist the master scheduler in creating orders for master scheduled items.

▶ See Chapter 12, “Material Requirements Planning,” on page 239.

To have MRP review master scheduled items and produce action messages, but not plan orders, for those items, set the following values for each master scheduled item in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. No.

Order Policy. Any option other than blank.

Note If an item’s Order Policy is blank, MRP does not generate action messages for that item.

Computer-Assisted Master Scheduling

▶ See Chapter 12, “Material Requirements Planning,” on page 239.

By defining time fences for master scheduled items, you can let MRP control orders outside of a specified time period and allow the master scheduler to control orders within that time period. To use this approach to master scheduling, in the Time Fence field in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7), specify a planning horizon, in calendar days, for each master scheduled item. When MRP plans orders for these items, it will not schedule order due dates within this time fence.

Note The time fence for an item should generally be equal to the cumulative lead time for that item.

To use the computer-assisted approach for master scheduling, set the following values for each master scheduled item in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. No.

Order Policy. Any option other than blank.

Time Fence. The cumulative item lead time.

Selective Materials Plan

Selective Materials Plan (23.3) lets you plan master scheduled items separately from MRP items. If you use the computer-assisted approach to master scheduling, you may want to run Selective Materials Plan as follows.

- 1 Run Selective Materials Plan for master schedule items only.
- 2 Adjust the master schedule and rerun Selective Materials Plan as needed.
- 3 Run Selective Materials Plan for MRP-scheduled items only.

Available-to-Promise

Available-to-promise (ATP) is the uncommitted portion of inventory or planned production which is available to be promised to new sales orders. The system displays ATP quantities on master schedule reports and inquiries.

ATP can be used to verify whether a sales order can be filled within a specific time frame given other demands and currently scheduled supply orders.

The system calculates ATP by time period by deducting real demand from real supply. Real demand includes requirements for work order components, sales orders, and required ship schedules, but excludes forecast and production forecast. Real supply includes quantity on hand, purchase orders, work orders, and repetitive schedules. A net decrease in demand increases ATP, while a net increase in demand decreases ATP.

Note The system regards seasonal build quantities as real demand.

▶ See page 235.

The system performs the following calculation for each date when a Master Scheduled receipt is due or a seasonal build quantity is made available, causing a net increase in supply. It takes into account all sales order and required ship schedule demand and gross requirements up to the next increase in available supply.

Master Scheduled Receipt – Sales Orders and Required Ship Schedules – Gross Item Requirements – Seasonal Build Net Increases + Seasonal Build Net Decreases = ATP.

If demand exceeds supply, ATP for that period is zero, and the excess demand is applied as real demand against the ATP quantity for previous periods until all excess demand is eliminated or the ATP quantities for previous periods are exhausted. If the latter occurs, the system displays a negative ATP quantity for first period.

ATP and the master schedule are bucketless because they are calculated using dates rather than fixed periods. However, master schedule report functions let you report ATP quantities in monthly, weekly, daily, or GL calendar period buckets.

▶ See “Generating Master Schedule Reports” on page 237.

Multilevel Master Scheduling

Sometimes, demand for an item is dependent on demand for another item. This is typical in assemble-to-order environments where it is unrealistic to stock all of the possible combinations of end items included in the selection of available models and options.

In these cases, it is impossible to accurately forecast all of these possible combinations for master production scheduling purposes. Instead, you can forecast items at the family-item and planning or option-item levels. Multilevel master scheduling enables you to perform this type of forecasting for planning purposes.

Planning Bills

You can establish the relationship between family-level items and planning or option items by defining planning bills in Product Structure Maintenance (13.5) or Formula Maintenance (15.5).

Usually, the top-level item of a multilevel master schedule product structure, or planning bill, represents the entire group, or family, of products that can be configured from a set of available models and options. Family items are never manufactured or stocked. You must define family items with a Pur/Mfg code of Family (F) in Item Master Maintenance (1.4.1) Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17).

Components of the family item in the planning bill can be either:

- The actual manufactured items or configured products
- Item groups representing common components or selected options

A planning bill also contains a forecast percentage and a structure code.

The forecast percentage is the probability that a component of the family-level or parent item will be required, given the requirements for its parent.

The structure code determines whether or not the sale of a component should also cause the forecast to be consumed for its parent. Components with structure code Planning consume the forecast for their parent, while those with structure code Option do not.

Example The sale of a specific type of computer, entered in the planning bill with a structure code of Planning, consumes the computer family forecast, but the sale of an extended keyboard, an option, does not.

Production Forecasts

When you establish planning bills and forecast and master schedule at the family-item level, the system automatically calculates the derived demand for components of the family or upper-level item. These calculations are based on the ATP quantities for the family-level item and the quantity per and forecast percentage for the components of that family item. The result is called a *production forecast*, since it derives from the master production schedule and the forecast percentage specified in the planning bill.

Production forecasts are only created for components with structure codes P and O. Production forecast amounts display in MPS reports and inquiries and contribute to the total demand that MRP regards as input.

As forecast for the family-level item is consumed, the ATP quantity for that item changes, resulting in revised calculations for the production forecast the next time MRP is run.

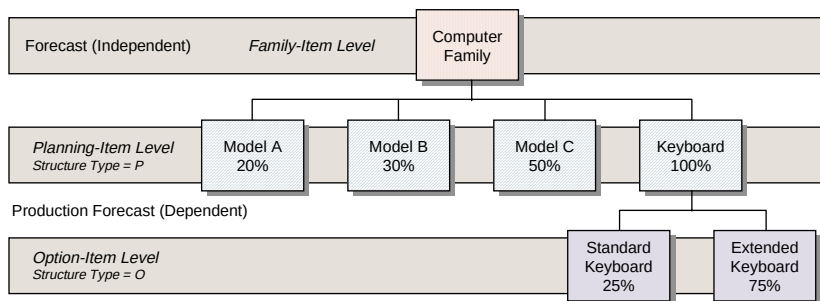


Fig. 11.10
Multilevel Master
Scheduling
Example

Multilevel Scheduling Techniques

When using multilevel master scheduling, you can plan family-level items using either the fully automatic or the computer-assisted technique. Either way, you must use MRP to plan orders in order to generate production forecasts for the components of these family items.

See “Approaches to Master Scheduling” on page 228.

Set the following values for family-level items in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7).

Master Schedule. Yes.

Plan Orders. Yes.

Order Policy. Any option other than blank.

Time Fence. Optional.

The components of a multilevel master schedule can be planned using either the fully manual or computer-assisted technique.

Maintaining Master Schedule Orders

You can enter master schedule orders as firm planned work orders or create them using repetitive schedules.

Work Orders

◆ See Chapter 6, “Work Orders,” on page 89.

You can enter master schedule orders as firm planned orders using Master Schedule Order Maintenance (22.13) or Work Order Maintenance (16.1). When you set the order status to Firm Planned, MRP explodes the parent item’s product structure when planning the gross requirements for its components. Master schedule orders are managed and released like normal work orders.

Repetitive Schedules

◆ See Chapter 8, “Advanced Repetitive,” on page 135 and Chapter 9, “Repetitive,” on page 183.

If you use the Advanced Repetitive or Repetitive module to manage your manufacturing processes rather than the Work Orders module, you can enter your master schedule as a repetitive schedule.

Do this using Schedule Maintenance (18.22.2.1) or Repetitive Schedule Maintenance (18.3) for basic repetitive. Then, explode the repetitive schedule to create scheduled orders by running Net Change MRP (23.1), Regenerative MRP (23.2), Schedule Explosion (18.22.2.4), or, for basic repetitive, Repetitive Schedule Explosion (18.6). Exploding the repetitive schedule creates new scheduled orders and revises existing orders to support the repetitive schedule.

Note You can modify the master production schedule by modifying the repetitive schedule and then re-exploding it.

Scheduled orders are work orders with a type code of Scheduled and a status of Exploded. They have their own bills of material.

To produce the master scheduled items, you can use the programs in the Advanced Repetitive or Repetitive module or convert the scheduled orders to regular work orders, if required.

Note When a scheduled order is converted to a regular work order, it is no longer part of the repetitive schedule.

Verifying Capacity for Master Schedules

You can verify master schedule orders against user-defined resources, as for product lines, using the Resource Plan module. The resource plan functions convert ordered end-item quantities into resource units to calculate resource consumption.

◆ See *User Guide Volume 5: Supply Chain Management* for more information.

You can also verify capacity for master schedule orders by department, work center, or machine using the Capacity Requirements Planning (CRP) functions.

◆ See Chapter 13.

Master Scheduling for Seasonality

For products with seasonal demand cycles, you may need to build up inventory in advance of periods of peak demand. You can do this using work orders or repetitive schedules, or you can use seasonal build requirements to build up inventory to a predetermined level prior to its expected demand.

Seasonal build requirements let master schedulers specify a target inventory level for seasonal demand items that is not included when calculating ATP quantities, but can still be allocated and shipped on sales orders and customer schedules. Seasonal build quantities appear separately on master schedule reports that display ATP quantities.

Example 600 snowmobiles are scheduled to be completed in July due to a seasonal build requirement. A rush order for 200 snowmobiles arrives from Australia for shipment in July. The current production of snowmobiles would not be promised to that order, since it would be excluded from the ATP calculation.

MRP plans for the target inventory levels set by seasonal build requirements. Specifying seasonal build requirements causes MRP to plan orders to satisfy those requirements and prevents it from issuing action messages to cancel or delay orders for seasonal build items when their demand is not yet apparent.

Use Seasonal Build Maintenance (22.9) to create seasonal build forecasts for items by site. You must define an end date by which you need items in inventory and a seasonal inventory quantity needed by that end date.

Fig. 11.11
Seasonal Build
Maintenance (22.9)

Site: 10000 San Diego Main Plant
Item Number: 02-0005 MECHANICAL PENCIL
(5MM) BLISTER PACKED
Date: 08/31/98
Reference:
Seasonal Inventory: 10,000.0

Example If you need 600 snowmobiles available in inventory by December 1st, you may decide to build them during the previous three months at a rate of 200 per month. You would then enter the following values.

Date	Seasonal Inventory
09/30/99	200
10/31/99	400
11/30/99	600
12/1/99	1

See “Available-to-Promise” on page 231.

Setting the seasonal inventory quantity to zero (0) for December 1st indicates to MFG/PRO that the seasonal build requirement is complete. This means that the item is now included in ATP calculations and is considered a source of supply by MRP.

Generating Master Schedule Reports

The Master Schedule Summary Inquiry and Report (22.18 and 22.19) and Master Schedule Detail Inquiry and Report (22.21 and 22.22) functions display the following information.

Production Forecast. System-calculated forecast used in multilevel master scheduling.

▶ See page 232.

Forecast. Forecast quantity for an item, either loaded into forecast summary files using Simulation to Summarized Forecast (22.7.13) or manually entered using Forecast Maintenance (22.1) or Forecast Worksheet Maintenance (22.2).

Sales Orders. Demand derived from confirmed sales orders and required ship schedules.

▶ See page 225.

Gross Requirements. The sum of an item's requirements from forecasts, higher-level products, confirmed sales orders, required ship schedules, service items, and intersite orders generated by DRP. Gross requirements do not take into account inventory on hand or scheduled receipts.

▶ See Chapter 12.

Master Scheduled Receipts. Total scheduled receipts for an item from work orders, repetitive schedules, purchase orders, and distribution orders.

Projected QOH. Projected item quantity on hand, calculated by the system. This is a projection by period of an item's on-hand balance plus scheduled receipts minus gross requirements.

Available-to-Promise. The uncommitted portion of inventory or planned production, calculated by deducting real demand from real supply.

▶ See page 231.

Seasonal Build. Seasonal build quantity in inventory for that period, not included in the ATP quantity.

▶ See page 235.

The Master Schedule Detail Inquiry and Report functions (22.21 and 22.22) display the same information as the Master Schedule Summary Inquiry and Report, sequenced by due date. They also include source-to-demand pegging details, allowing you to identify the actual work order or sales order generating a particular item requirement.

Material Requirements Planning

Material Requirements Planning (MRP) is a key manufacturing planning process that uses a site's master schedule and all other sources of demand and supply to:

- Calculate gross item requirements and projected on-hand inventory
- Schedule and plan orders
- Produce action messages

This chapter explains how to use MFG/PRO to create and maintain a material requirements plan.

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Routing Code: 10-15000
Operation: 20
Standard Operation: 1030
Work Center: Machine
Description: INSPEC PER PROX-000
Machines per Op: 1
Overlap Units: 1
Queue Time: 1.0
Wait Time: 0.0
Setup Time: 0.0
Priority Production: 0.0

Check Master

Introduction

Material requirements planning (MRP) balances supply and demand for purchased and manufactured items. Given a set of demands or requirements, MRP automatically calculates a time-phased schedule of planned supply orders or replenishments to satisfy those demands.

MRP looks at demand for finished items and uses product structure information to calculate demand for component items. For each item, MRP looks at the ordering information, the amount currently on hand, and lead times, and generates planned orders suggesting how many of that item to buy or make and when to do so.

MRP and Sites

MRP's planning activity is performed by site. Each site's material plan is completely independent from inventory, demand, and supply at other sites. You can run MRP for several sites in succession, but it does not plan for these sites as a group.

◆ See *User Guide Volume 5: Supply Chain Management*.

For organizations with multiple sites, MRP can be used in conjunction with distribution requirements planning (DRP), which balances supply and demand among sites.

Sources of Demand and Supply

MRP uses the master production schedule (MPS) to calculate dependent component demand. Dependent demand is directly derived from the demand for other items, and includes demand for components items, raw materials, and subassemblies.

◆ See Chapter 11, "Forecasting/Master Schedule Planning," for more detail.

Independent demand is demand that cannot be calculated or derived from demand for other products. It is represented through forecasts and sales orders, and includes demand for end products and replacement items. Independent demand generally passes to MRP through the master production schedule.

Sources of Demand

MRP considers the following as sources of demand:

- Forecasts
- Sales orders
- Customer scheduled orders from a required ship schedule
- Intersite orders, generated by DRP
- Component requirements from manufacturing
- Production forecasts
- Safety stock requirements

MRP does not consider unconfirmed sales orders or component requirements from batch firm planned orders as sources of demand.

Sources of Supply

MRP considers the following as sources of supply:

- Nettable quantity on hand (QOH)
- Purchase orders
- Intersite requests, generated by DRP
- Manufacturing orders (work orders and repetitive schedules)
- Quality orders
- Supplier scheduled orders

MRP does not consider blanket purchase orders or non-nettable inventory as sources of supply.

Setting Up MRP

Before running MRP, set up the following data in your system:

- Control file parameters in the MRP Control File.
- Item planning parameters
- Inventory status codes
- Product structures and formulas

MRP Control File

Enter appropriate values in the MRP Control File (23.24).

Fig. 12.1
MRP Control File
(23.24)

MRP Control File	
MRP Horizon:	365
MRP/DRP Combined:	no
Summary Default:	Monday
Order Release Horizon:	0

MRP Planning Horizon. Enter the period of time, in calendar days, which MRP should plan. MRP calculations ignore data outside this time period. The horizon should be at least one day longer than the longest item cumulative lead time in the database.

If you change the MRP planning horizon, impacted items are not automatically replanned when you run net change MRP. Ensure that all items are replanned by running MRP in regenerative mode.

MRP/DRP Combined. Enter Yes to indicate that MRP planned items can be planned using DRP functions. Enter No if they can only be planned using MRP functions.

Summary Default. Specify the day of the week used by all MRP summary reports and inquiries when displaying item requirements summarized by week.

Order Release Horizon. Enter the number of calendar days before a planned order's release date that the Release Due For action message should appear on.

The order release horizon should be based on your normal paperwork lead time and how often you run MRP. For example, if you run MRP weekly, you should set the order release horizon to at least seven days. If you run MRP daily, you can set it to zero.

See User Guide
Volume 5:
Supply Chain
Management.

Item Planning Data

MRP uses item planning data to plan items. Define this data in Item Master Maintenance (1.4.1) or Item Planning Maintenance (1.4.7). If an item is used at multiple sites, you can set up planning data differently for each site using Item-Site Planning Maintenance (1.4.17). Data not defined in Item-Site Planning Maintenance defaults from Item Master Maintenance or Item Planning Maintenance.

Item Planning Maintenance

User Menu Edit Queue Options Help

Item Number: 10-10000 Description: OASIS(TM) COOLING SY:
UM: EA HOME/INDUST MODEL

Item Planning Data

Master Sched: yes

Plan Orders: yes

Time Fence: 0

MRP Required: yes

Order Policy: POQ

Order Qty: 0

Batch Qty: 1.0

Order Period: 7

Safety Stk: 0

Safety Time: 0

Reorder Point: 0

Rev: AB

Buyer/Planner:

Supplier:

PO Site: 10000

Pur/Mfg: C

Configuration: KIT

Mfg LT: 1

Pur LT: 0

Inspect: no

Ins LT: 0

Cum LT: 8

Network Code:

Routing Code:

BOM/Formula:

Issue Policy: yes

Phantom: no

Min Ord: 0

Max Ord: 0

Ord Mult: 0

Yield%: 100.00%

Run Time: 2.000

Setup Time: 0.000

EMT Type: NON-EMT

Auto EMT Processing: no

Fig. 12.2
Item Planning
Maintenance
(1.4.7)

Master Schedule

For non-master scheduled items planned by MRP, set Master Schedule to No. This lets you plan master scheduled and MRP-planned items separately, if required, using Selective Materials Plan (23.3). Items with Master Schedule set to No are excluded from reports and inquiries in the Forecasting/Master Plan (22) module.

For master scheduled items, set Master Schedule to Yes. Items subject to independent demand, such as end products or service parts, are usually master scheduled.

Plan Orders

When Plan Orders is Yes and a value is specified in the Order Policy field, MRP generates planned purchase and work orders to satisfy net requirements for this item.

See “Creating Master Production Schedules” on page 228.

If Plan Orders is No and an order policy is specified, MRP plans this item but does not generate planned orders for it. Only action messages, suggesting orders that should be placed, are generated.

Pur/Mfg Code

MRP uses the Pur/Mfg code to distinguish manufactured items from purchased items. A code of Manufactured, Routable, Configurable, Family, Line, or blank indicates that an item is usually manufactured, while a code of Purchased indicates that it is usually purchased.

MRP generates planned work or line orders for manufactured items and planned purchase orders for purchased items. However, you can create and approve planned work or line orders for purchased items or planned purchase orders for manufactured items. This field indicates only what the normal procedure is, not what it must be.

Order Policy

The order policy determines the number and size of each MRP planned order. If an item’s Order Policy is blank, it is ignored by MRP, and planned orders or action messages are not generated for it. Any value entered in the Order Policy field other than those listed in Table 12.1 is processed by MRP as lot-for-lot.

Leave Order Policy blank for items planned manually based on a reorder point.

Table 12.1
Order Policy

Order Policy	Description
Period order quantity (POQ)	MRP calculates demand for this item over the number of calendar days specified as the Order Period and creates one order to satisfy this demand.
Fixed order quantity (FOQ)	MRP generates planned orders for the quantity specified as the Order Quantity. If the quantity required exceeds this quantity, multiple orders are generated. If the quantity in the Min Ord field is greater than the specified order quantity, planned orders are generated for this minimum quantity.

Order Policy	Description
Lot-for-lot (LFL)	MRP generates a separate planned order to satisfy each net requirement. If there are many sources of demand, MRP creates many planned orders. When LFL policies are used across multiple product levels, running MRP may produce unmanageable numbers of manufacturing orders.
One time only (OTO)	MRP generates a single planned order with a quantity of one unit. As long as one order for this item exists, the system will not create another. OTO can be used for prototype items, or for planning project activities and one-time events.

Order Modifiers

MRP uses order modifiers along with order policies to determine planned order quantities.

Table 12.2
Order Modifiers

Order Modifier	Description
Order Quantity	The quantity for which all MRP planned orders are created for an item with an order policy of FOQ.
Safety Stock	The quantity of this item maintained in inventory as protection against fluctuations in demand or supply. MRP processing considers safety stock a requirement, and schedules planned orders to cover this requirement. You should not designate safety stock levels for non-master scheduled items because it may cause MRP to overplan inventory.
Minimum Order Quantity	The minimum quantity allowed for a planned order. If the net requirement is below this amount, MRP creates an order for this minimum quantity. To ensure that items that have decimal demand values due to yield or scrap calculations are ordered in whole number quantities, set this value to 1, or to any whole number.
Maximum Order Quantity	When a net requirement exceeds this amount, MRP generates the action message Order Exceeds Maximum for the order created to fill this requirement.
Order Multiple	When order policy is POQ or LFL, planned orders are created in multiples of this quantity. For example, if the order multiple is 100, planned orders are only created for quantities of 100, 200, 300, and so on.

Order Modifier	Description
Yield %	The percentage of an order expected to be in usable condition. If Yield % is less than 100%, MRP plans orders for more than needed. For example, if the net requirement is 100 and the item Yield % is 50%, then the planned order quantity will be 200. You can enter this value manually or use Routing Cost Roll-Up (14.13.13) to calculate yield percent based on the yield percentages at each operation in the item routing. If an item's Yield % is less than 100%, MRP may generate planned orders for fractional quantities. To prevent this, set Order Minimum or Order Multiple to 1, or any whole number.
Scrap %	The percentage of a component item expected to be scrapped during manufacture of the parent item. This value increases the component requirements for planned orders for that component-parent pair. Specify scrap % values for components in Product Structure Maintenance (13.5). When scrap percentage is greater than zero, MRP may calculate fractional component quantities, even if the component is a discrete item. For example, if one housing is required to build an item and the scrap factor is 5%, the system will calculate a requirement for 105.2631 housings to make 100 units. To prevent MRP from generating planned orders for fractional quantities, set Order Minimum or Order Multiple to 1, or any whole number.

Lead Times

Lead time determines when MRP planned orders are due—manufacturing lead time for manufactured items, and purchasing lead time plus inspection lead time for purchased items.

For both purchased and manufactured items, if the lead time varies, you can define a safety time. MRP then calculates the planned order due date by adding safety time to the lead time.

Table 12.3
Lead Times

Lead Time	Description
Manufacturing Lead Time	The number of working days it takes to manufacture an item, including the time it takes to process paperwork, issue components, inspect the finished product, and receive it into stock. For DRP items, enter DRP transit and order time in this field so that this value is included in the cumulative lead time for this item.
Purchasing Lead Time	The number of calendar days it takes to complete a purchasing cycle for an item, from the date the need for a purchase is recognized to the date the item is received.
Inspection Lead Time	The number of working days it takes to inspect a purchased item after it is received.
Safety Lead Time	The number of working days early that MRP plans to receive orders for an item, to allow for late deliveries.
Cumulative Lead Time	The longest number of calendar days it takes to obtain an item, assuming that neither it nor any of its components are in stock. The system calculates this value, by converting manufacturing, inspection, and safety lead time to calendar days.

Time Fence

The time fence is the number of calendar days inside of which MRP will not generate or adjust any planned orders, even if there are net requirements within that period. MRP still deletes a planned order, even if it is inside the time fence, if no demand is generated for that item.

Time fences are often used with master scheduled items and are usually set to greater than or equal to the manufacturing lead time.

MRP Required

The MRP Required flag is set by the system to indicate whether this item has had changes made against it and will be replanned the next time you run net change MRP. Yes indicates that the item will be replanned; No indicates that it will not.

See “Net Change Materials Plan” on page 252.

Inventory Status Codes

Assign a non-nettable inventory status code to inventories that should not be considered quantity on hand by MRP. This might include inventory to be returned to a supplier or designated as scrap or salvage.

Product Structures and Formulas

♦ See Chapter 2, “Product Structures,” on page 11 and Chapter 4, “Formula/Process,” on page 43.

Product structures and formulas provide some of the information used in MRP calculations, including component quantities, lead times, and effective dates. Enter and modify product structure and formula information in Product Structure Maintenance (13.5) and Formula Maintenance (15.5).

Component Quantity

To calculate component requirements for planned orders, MRP multiplies each component’s quantity per assembly value by the planned order release quantity.

Component Lead Time

MRP determines a component’s due or required date using the scheduled release date of the parent item and the component lead time offset specified in the product structure.

Example When a component’s lead time offset is 10 days, its due date will be 10 manufacturing days after the planned release date of the assembly. When it is –5 days, the due date is 5 manufacturing days before the planned release date of the assembly.

If no lead time offset is specified for a component, the component release date will be the same as the release date for the parent item.

Component Effective Dates

MRP uses component effective dates to determine which components are required for a given order due date. Components are active beginning on the start date specified in the product structure and remain active through the stop date, the last day a component will be used.

▶ See “Engineering Effectivity” on page 23 for more information on how MRP handles component effective dates.

Executing MRP

MRP Processing

MRP reports and inquiries can optionally display item requirements summarized by week. The beginning day of the week is specified in the Summary Default field of the MRP Control File. Calculations are based on this weekly period.

MRP calculates net requirements for items using three variables:

- Gross item requirements are the sum of an item’s requirements from forecasts, higher level products, customer orders, service items, and intersite orders. They do not take into account inventory on hand or scheduled receipts.
- Scheduled receipts for that item, including open purchase orders, open work orders with a quantity open and a status of R, and intersite requests for DRP items.
- Quantity on hand from the previous period.

MRP uses these three variables in the following calculation:

$$\text{Net Requirements} = \text{Gross Requirements} - \text{Quantity on Hand for the previous period} - \text{Scheduled Receipts}$$

MRP schedules planned purchase orders and work orders to fill these net requirements. Planned work orders generated by MRP are exploded into gross requirements for their components. This process continues until there are no more planned work orders to explode.

Note MRP does not explode product structures for purchased and distribution items or components with structure code Document.

▶ See Chapter 5, “Co-products/By-products,” for more details.

MRP Processing for Co-products and Base Processes

MRP plans co-products and base processes differently than other items. Net requirements for co-products are passed down to their respective base process items. MRP then generates planned orders for base process items to meet these requirements. These planned orders are imploded, creating planned orders for each of the co-products and by-products.

MRP Processing for Routable Assemblies

For routable assemblies, MRP generates a separate routable work order when an order for the parent item is released. Usually, you should not approve these orders or change their status to firm planned.

MRP Scheduling

When MRP runs, it compares each item's demand with existing supply orders for each period. It automatically reschedules planned orders to reflect changes in the plan and generates an action message for each rescheduled order. Some orders MRP cannot change because they are firm planned or within the time fence specified in the item planning data. For these, it generates action messages suggesting that these orders be rescheduled to balance supply with demand.

When MRP reschedules planned orders for higher-level end items, lower-level components dependent on the rescheduled demand remain associated with the original supply order date. They are not automatically rescheduled based on where action messages say parent orders should be moved. To adjust for this:

- 1 Run Selective MRP for master scheduled items and review and handle action messages.
- 2 Run Selective MRP again at this level to ensure that all action messages have been dealt with.
- 3 Then, run Regenerative or Net Change MRP for all dependent demand items.

MRP Pegged Requirements

MRP source-to-requirement pegging makes it possible to review each of the sources of demand for gross requirements. Use MRP Detail Inquiry (23.16) or MRP Detail Report (23.17) to:

- Trace the requirement for a particular end item to the forecast or sales order creating the demand.
- Identify the specific parent item creating the need for a component item.

Pegging is made possible by low-level codes, which maintain a numeric value for each item relative to its parent item, including items planned across sites using DRP. For example, a purchased component might be a -4, built into a -3, shipped to another site where it arrives as a -2, and is built into an end item, -1, then packaged, resulting in a 0.

Because item planning, BOM, MRP, or DRP transactions can alter low-level codes, they must be updated before you run MRP. You can use:

- Low Level Code Update (23.22)
- Selective Materials Plan (23.3), by setting Resolve Low Level Codes to Yes

MRP Detail Inquiry (23.16) and MRP Detail Report (23.17) display each source of demand for an item with the due date, item quantity, parent item number, and type of requirement—whether forecast, production forecast, sales order, customer schedule, work order, or repetitive.

Tip
Run MRP reports and inquiries immediately after MRP, since they are sensitive to changes in inventory, demand, and supply.

MRP Planning Modes

MRP can be run in three operational modes:

- Net change
- Regenerative
- Selective

Net Change Materials Plan

Net Change Materials Plan (23.1) calculates demand and plans supply only for items that have changed since MRP was last run. These changes could involve any of the following:

- Item or item-site planning data
- Product structures
- Sales or purchase orders
- Work orders or repetitive schedules
- Inventory
- Forecasts
- Master production schedule
- Intersite demand

Tip
Typically, Net Change MRP is run daily.

In addition to planning items that have changed, net change MRP recalculates lower-level requirements for items planned.

Both net change and regenerative MRP plan items based on low-level codes. They determine requirements at the top level first, then continue down through the item structure, one level at a time.

Regenerative MRP

Regenerate Materials Plan (23.2) recalculates demand and plans supply for all items in the site. The outputs of net change and regenerative MRP are the same. However, net change MRP generally runs faster than regenerative, since it only plans for items that changed since MRP was last run.

Tip
The first time you run MRP, it should be regenerative.

You should always schedule periodic regenerative MRP runs, even if you primarily use net change MRP, since net change MRP does not consider demand or forecast for items entering the MRP horizon over time.

Selective Materials Plan

Selective Materials Plan (23.3) plans only for items and sites you select. It can be run in net change mode by setting the Required Items Only field to Yes, or in regenerative mode by setting Required Items Only to No.

You can use Selective Materials Plan to plan master schedule items separately from other items, or to plan small groups of items by using buyer/planner, product line, group, type, supplier, or any combination of these, as selection criteria.

Set MRP Items to Yes to generate planned orders for items at the specified sites and gross requirements for DRP items. Set DRP items to Yes to generate intersite requests for DRP items.

◆ See *User Guide Volume 5: Supply Chain Management*.

Selective MRP recalculates demand and plans supply only for selected items, passing down gross requirements to the next non-selected level, but not replanning orders. It does not implode product structures to replan higher-level items before planning selected items, nor does it explode resulting orders to calculate component demand.

Reviewing MRP Output

The primary outputs of MRP are planned orders and action messages. These are generated if MRP sees an imbalance of supply and demand.

- If supply exceeds demand, MRP automatically reschedules or cancels planned orders and generates messages suggesting you de-expedite or cancel open orders.
- If demand exceeds supply, MRP reschedules or creates planned orders and generates messages suggesting you expedite or create orders.

Action Messages

MRP generates action messages for all items with non-blank order policies. Action messages recommend the actions a planner should take to balance supply with demand, such as rescheduling, canceling, or releasing orders.

Review action messages using Action Message Review/Update (23.5). Or use Action Message Report (23.7) to review messages by item, site, buyer/planner, Pur/Mfg code, or action message number.

Table 12.4 lists the messages generated by MRP with a brief explanation. In the explanation, a *supply order* can be a work order, purchase order, repetitive schedule, or intersite request.

Table 12.4
MRP Action
Messages

Message	Meaning
Beginning Quantity Less Than Zero	Indicates that the initial nettable quantity on hand is negative.
Beginning Available Less Than Zero	Indicates that the quantity on hand less safety stock is negative.
Create	Indicates that a supply order should be created to satisfy a negative projected on hand balance. This message is only generated if Plan Orders is No or if a new requirement appears within the time fence.
De-Expedite	Indicates that a scheduled supply order is due before it is needed and should be delayed, or demand rescheduled to an earlier date.
Expedite	Indicates that a scheduled supply order is due after it is needed and should be rescheduled to an earlier date, or demand rescheduled to a later date.
Cancel	Indicates that a scheduled supply order is no longer needed and should be deleted.
Release Due For	Indicates that a supply order should be released. If it is a planned order, it must also be approved. Use the Order Release Horizon field in the MRP Control File (23.24) to specify the number of days prior to the order release date for this action message to display.
Release Past Due For	Indicates that a supply order was not released when it was due, and should be either released or expedited now, or the demand rescheduled for a later date.
Quantity Less than Minimum	Indicates that a supply order was created for a quantity less than the minimum quantity set in the item planning data.
Quantity Exceeds Maximum	Indicates that a supply order was created for a quantity greater than the maximum quantity set in the item planning data.
Past Due	Indicates that a scheduled supply order receipt is past due.
Time Fence Conflict	Indicates that there is an unsatisfied material requirement inside the planning time fence for this item. You should either manually schedule and expedite orders to fill this demand or delay fulfillment of the requirement that created the demand.
Shipment Due	Indicates that a shipment for an intersite request item is due. Action should be taken at the source site to ensure that the order is received on time.

Message	Meaning
Shipment Past Due	Indicates that a shipment for an intersite request item is past due. You should either delay the orders that created the requirement for the item or expedite them when the item does arrive.
No Source Of Supply	Indicates that the planning data for an intersite request item does not specify a valid source network for the date an intersite request is required.
Planned Order Count Exceeds Maximum	Indicates that the maximum allowable number of 1000 planned orders has been generated by an item-site. Calculation for other items is not affected.

Planned Orders

MRP generates planned orders to satisfy net requirements for items with Plan Orders set to Yes and non-blank order policies specified in the item planning data. MRP generates planned work orders for manufactured items, planned line orders for items manufactured on production lines, and planned purchase orders for purchased items based on the item Pur/Mfg code.

▶ See “Pur/Mfg Code” on page 244.

The scheduled release date for a planned order is the item due date minus the purchasing or manufacturing lead time. For manufactured items, MRP calculates planned order release dates using the manufacturing lead time. For planned purchase orders, both the inspection lead time and the purchasing lead time are used. If a planned order release date falls on a non-workday, MRP schedules it for the last prior workday.

▶ See “Lead Times” on page 246.

When MRP plans orders, it uses the default shop calendar for the site. If there is no shop calendar, MRP does not plan orders for that site.

Planned purchase, work, and line orders are stored with status Planned. Work orders and line orders are created with work order bills; purchase orders are not. A planned order, regardless of its type, can be approved using any of the planned order approval programs.

Approving Planned Orders

To approve planned purchase, work, and line orders, use Planned Purchase Order Approval (23.11), Planned Work Order Approval (23.10), or Planned Repetitive Schedule Approval (23.8). Once approved, planned

orders become either purchase requisitions, firm-planned work orders, or are added to the item's production line schedule.

Approving a planned purchase order deletes the planned order and creates a purchase requisition, which can be filled by a purchase order.

▶ See "Creating Work Orders" on page 93.

Approving a planned work order changes its status to firm planned. MRP does not replan firm planned orders, but instead, generates action messages as needed. A firm planned order has a work order bill and a routing with scheduled operations. These are not fixed. Bills are re-exploded by MRP, while routings are re-exploded by CRP. Both are re-exploded when the status is changed to Exploded, Allocated, or Released.

▶ See "Simulating Schedules in the Workbench" on page 149.

Approving a planned line order adds the order amount to the schedule for that item's production line. The production schedule sequence for a given line can be viewed and modified using Line Schedule Workbench. Once a production line's schedule is established, run Repetitive Schedule Update (18.1.18 or 18.22.1.18) to remove the planned line order from MRP.

After a planned order is approved, MRP does not change the quantity or due date on the order the next time it is run. Instead, it generates action messages suggesting changes to the order. You can modify firm planned order due dates and quantities as needed in Work Order Maintenance (16.1), Purchase Requisition Maintenance (5.1.4), and Line Schedule Workbench (18.1.10 or 18.22.1.10).

CHAPTER 13

Capacity Requirements Planning

The Capacity Requirements Planning (CRP) module uses MRP planned orders, other work orders, and repetitive schedules to determine work center load and generate a capacity requirements plan for a department, work center, or machine.

This chapter explains how to use MFG/PRO to generate and maintain a capacity requirements plan.

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Executing CRP 258

Generating Load Reports 261

Adjusting Capacity and Load 263

param91.p 14.13.2 Routing Maintenance (Main Screen)

Routing Code:	10-15000	NONAD (75) CDR IN
Operation:	20	
Standard Operation		
Work Center	1030	INSPECTION, ALL SITE
Machine		
Description	INSPEC PER PROX-000	
Machines per Op	1	Attention
Overlap Units	1	
Queue Time	1.0	
Wait Time	0.0	
Setup Time	0.0	
Ready Production	0.0	

Introduction

CRP calculates workload for a department, work center, or machine. It does this by exploding the routings and processes for MRP planned and firm planned orders and determining start and due dates for each operation, using the work center and shop calendars and a technique called back scheduling.

Defining Capacities

▶ See “Departments” on page 28 for details.

The resources used to process orders on the shop floor are work centers, departments, and machines. The capacity of a department or work center is the time available for production in that location.

The capacity of a department is the total number of available labor hours per day for all work centers in that department, defined in Department Maintenance (14.1).

▶ See *User Guide Volume 11: Manager Functions* for more information about shop calendars.

The capacity for a work center is the number of machines or personnel available for that work center, defined in Work Center Maintenance (14.5), multiplied by work hours, defined in the shop floor calendar. You can define and maintain shop floor calendars using Calendar Maintenance (36.2.5).

Executing CRP

Tip
Generally, you should run CRP after running MRP.

Generate capacity requirements for manufacturing orders using Recalculate Capacity Plan (24.1).

Recalculate Capacity Plan

User Menu Edit Queue Options Help

Site: To:

Work Order: To:

Item Number: To:

Release Date: To:

Due Date: To:

Sales/Job: To:

ID:

Supplier:

Planned Orders: ☒ yes

Firm Planned Orders: ☒ yes

Exploded Orders: ☒ yes

Allocated Orders: ☒ yes

Released Orders: ☒ yes

Output:

Batch ID:

Fig. 13.1
Recalculate
Capacity Plan
(24.1)

CRP determines capacities based on the available hours or machines for a work center or department. It multiplies working days, defined in the shop calendar, by work center machine capacity to calculate capacity per CRP reporting period.

CRP explodes the routings and processes for the orders you select. It then determines capacity requirements for selected manufacturing orders by scheduling their operations. CRP determines operation start and due dates using the work center and shop calendars and a technique called back scheduling.

Back Scheduling

When CRP back-schedules orders, it takes the due date of an order or repetitive schedule and schedules each of its operations from the last operation in the order routing or process backward to the first one.

CRP assigns each operation a start date and a due date, using the operation lead time components—queue, setup, run, wait, and move—to calculate operation start dates. The start date of an operation is the same as the due date of the previous operation.

Note CRP calculates run times based on the actual order quantity—that is, the order quantity less the quantity completed.

When manufacturing order operations overlap, the system smoothes the scheduled start and due dates to prevent the scheduled due date for one operation from occurring later than the due date for a subsequent operation.

Schedule Discrepancies

▶ See Chapter 12, “Material Requirements Planning,” on page 239.

MRP calculates manufacturing order release dates using a manufacturing lead time that is based on an average order quantity defined in Item Planning Maintenance (1.4.7) or Item-Site Planning Maintenance (1.4.17). If the order quantities used in CRP calculations differ from this average quantity, CRP may schedule the start date for an order’s first operation before the release date for that order.

When this occurs, a message displays to alert you of the conflict. You can resolve such conflicts by adjusting the order release or due date and rerunning CRP.

Note Exceptions to the normal work week in the work center and shop calendars—for example, planned overtime—may also cause schedule discrepancies in CRP.

CRP and Order Statuses

CRP is normally executed for Planned and Firm Planned orders. For these orders, CRP explodes the standard item routing and schedules the operations to create work center/machine load.

Tip
Repetitive schedules are treated like Exploded orders.

You can also choose to include orders with other statuses. For Exploded and Allocated orders, the work order routing is scheduled. For Released orders, only open operations are rescheduled.

When you run CRP, all open operations for selected work orders are rescheduled. That means that if you have manually adjusted your operation start and stop dates, they will probably be changed unless you also adjusted the work order release and due date to match.

Generating Load Reports

You can generate load reports by department, work center, or machine using the work center and department load inquiries and reports.

CRP determines load hours for a work center based on setup and run times. Queue, wait, and move times are excluded from load calculations. To include queue times in load calculations, set up separate operations for queue. CRP then considers these operations when calculating load.

CRP determines the load an operation exerts on a work center using the following calculation:

$$\text{Operation Load} = \text{Setup Time} + (\text{Run Hours/Unit} \times \text{Quantity Open})$$

The quantity open for an operation is the order quantity minus any quantities reported complete.

Note The system assigns the entire load for an operation to its scheduled start date. Even for operations with run times longer than one day, load is not spread between operation start and due dates.

Reviewing Input and Output

You can compare the planned input and output for a work center or machine with actual input and output using Input/Output Report (24.4) and Input/Output Inquiry (24.5). These functions help you evaluate a work center or machine's response to planned loads.

You can display planned and actual input and output in daily, weekly, or monthly periods.

Planned Input

Planned input is load on a work center or machine represented by work order operations scheduled to start in a reporting period. It is determined using the following calculation:

$$\text{Standard Setup} + (\text{Standard Run} \times \text{Quantity Ordered})$$

Actual Input

Actual input is load that has been moved to the first and subsequent order operations. It is calculated for a reporting period based on move transactions entered using work order release and shop floor control functions. Actual input is determined using the following calculation:

$$\text{Standard Run Hours} \times \text{Quantity Moved}$$

Planned Output

Planned output is load calculated based on order operations scheduled to be completed in a reporting period. It is determined using the following calculation:

$$\text{Standard Setup} + (\text{Standard Run} \times \text{Quantity Ordered})$$

Actual Output

Actual output is load calculated for a reporting period based on operation quantity completed transactions for work orders and repetitive schedules. You can report completed quantities for order operations using labor feedback transactions in the Shop Floor Control, Advanced Repetitive, and Repetitive modules, or using Work Order Accounting Close (16.21).

Actual output is determined using the following calculation:

$$\text{Actual Setup} + (\text{Standard Run} \times \text{Quantity Completed})$$

Planned Queue

The difference between planned input and planned output.

Actual Queue

The difference between actual input and actual output.

Adjusting Capacity and Load

If a work center or machine is over- or under-loaded, you can modify either its capacity or the timing or amount of the load.

Adjusting Capacity

Adjust capacity using one of the following functions:

- Calendar Maintenance (36.2.5)
- Holiday Maintenance (36.2.1)

Add or subtract workday hours as needed for work center or shop calendars.

Adjusting Load

Adjust the timing or amount of load by modifying:

- Work order due dates
- Operation lead time components
- Repetitive schedules

Note If you manually adjust operation start or stop dates, CRP reschedules them the next time it is run.

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