

# **Oracle® Production Scheduling**

Implementation Guide

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Oracle Production Scheduling Implementation Guide, Release 12.2

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Primary Author: Margot Murray, Jason Lansdowne

Contributing Author: Paul Fenwick, Alex Kim

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## **Oracle Production Scheduling Implementation Guide, Release 12.2**

### **Part No. E48797-04**

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# Preface

## Intended Audience

Welcome to Release 12.2 of the *Oracle Production Scheduling Implementation Guide*.

See Related Information Sources on page x for more Oracle E-Business Suite product information.

## Documentation Accessibility

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## **Related Information Sources**

### **Integration Repository**

The Oracle Integration Repository is a compilation of information about the service endpoints exposed by the Oracle E-Business Suite of applications. It provides a complete catalog of Oracle E-Business Suite's business service interfaces. The tool lets users easily discover and deploy the appropriate business service interface for integration with any system, application, or business partner.

The Oracle Integration Repository is shipped as part of the Oracle E-Business Suite. As your instance is patched, the repository is automatically updated with content appropriate for the precise revisions of interfaces in your environment.

### **Oracle Advanced Supply Chain Planning Implementation and User's Guide**

Oracle Advanced Supply Chain Planning provides information about integration between Oracle Production Scheduling and other Oracle applications.

### **Oracle Strategic Networking Optimization Implementation Guide**

This guide provides information on implementing and using Strategic Network Optimization.

## **Do Not Use Database Tools to Modify Oracle E-Business Suite Data**

Oracle **STRONGLY RECOMMENDS** that you never use SQL\*Plus, Oracle Data Browser, database triggers, or any other tool to modify Oracle E-Business Suite data unless otherwise instructed.

Oracle provides powerful tools you can use to create, store, change, retrieve, and maintain information in an Oracle database. But if you use Oracle tools such as SQL\*Plus to modify Oracle E-Business Suite data, you risk destroying the integrity of your data and you lose the ability to audit changes to your data.

Because Oracle E-Business Suite tables are interrelated, any change you make using an Oracle E-Business Suite form can update many tables at once. But when you modify Oracle E-Business Suite data using anything other than Oracle E-Business Suite, you may change a row in one table without making corresponding changes in related tables. If your tables get out of synchronization with each other, you risk retrieving erroneous information and you risk unpredictable results throughout Oracle E-Business Suite.

When you use Oracle E-Business Suite to modify your data, Oracle E-Business Suite automatically checks that your changes are valid. Oracle E-Business Suite also keeps track of who changes information. If you enter information into database tables using database tools, you may store invalid information. You also lose the ability to track who has changed your information because SQL\*Plus and other database tools do not keep a record of changes.



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## Getting Started

This chapter covers the following topics:

- Production Scheduling Overview
- Production Scheduling Businesses Processes
- Production Scheduling Implementation

### Production Scheduling Overview

Production Scheduling uses a constraint-based approach to automated scheduling. Unlike traditional automated scheduling tools that are limited to simple dispatch rules and have known bottlenecks, constraints in Production Scheduling can be assigned to every element-resource, operation, and due date in a schedule. Through advanced solver technology, feasible solutions can be found for virtually any constraint.

Production Scheduling is a finite scheduling product that addresses discrete batch processing with floating multistage problems. Production Scheduling can process an almost limitless number of variables and constraints. Using the Windows NT operating system, the total cost of ownership decreases.

Using the advanced scheduling capabilities of Production Scheduling you can:

- Create a model.
- Solve a model.
- Publish a production schedule.
- Dispatch schedule information.

Production Scheduling is designed to schedule discrete manufacturing environments that have the following characteristics:

- Many components comprise each product.

- Few final products exist in relation to the large number of components.
- Subassemblies can be out-sourced to third-party manufacturers.
- Many production stages exist.
- Multistage, floating production bottlenecks exist.
- Large numbers of customer orders exist, often make-to-order as opposed to make-to-stock.
- Products are produced in discrete batches or consistent lot sizes.
- Multiple operations and routings can exist for the production of an item, and the user is able to specify a preference.
- Minimum and maximum delays exist between work center operations.
- Setups, changeovers, and cleanups are required.
- Capacity constrained resources exist in production routings.

Unlike other scheduling systems, Production Scheduling has a self-configuring solver. This technology enables the solver to adapt as the model changes. It also includes item propagation, which immediately determines item feasibility; adaptive propagation, which starts and stops propagation only as it is needed; and effective backtracking.

## Production Scheduling Businesses Processes

Through the seamless integration of Production Scheduling (PS) with Oracle Value Chain Planning (VCP) suite, you can create high level supply chain plans and refine these plans to create optimal production schedules that can be implemented using Oracle transaction systems.

Using data from Oracle transaction systems and, if available, demand forecasts from Oracle Demand Planning, Oracle Advanced Supply Chain Planning (ASCP) can create planned orders with a granular horizon and detailed multi-level pegging of supply and demand. Production Scheduling can then take planned orders from ASCP and produce an optimized production schedule. You can then review and release the production schedule to Oracle transaction applications for implementation.

Using data from Oracle transaction systems and forecasts from Oracle Demand Planning, you can balance the conflicting objectives and limitations of supply, production, and distribution in your supply chain to determine how to meet demand with the least cost or with the most profit. You can also determine which facilities should be opened or closed, and in what order, throughout the horizon of a model.

Production Scheduling business processes are a part of the Oracle Value Chain

Planning Plan to Produce business process. The Value Chain Planning Plan to Produce business process fulfills an organization's requirements for planning, deploying, producing, and assessing production. Production Scheduling is a part of the manufacturing execution phase of Plan to Produce. Production schedules produced by Production Scheduling are used as a basis for production deployment. To create a production schedule used to deploy production in an enterprise, this application relies on a series of interactive and non-interactive events.

## Non-Interactive Events

Production Scheduling business processes rely on non-interactive events to extract enterprise data from an Enterprise Resource Planning (ERP) system and import it into the application. As a result of these non-interactive events, Production Scheduling is kept up to date with enterprise data in order to produce a production schedule that will be reviewed each morning to determine the daily production.

The following non-interactive events typically occur overnight or after the daily production shift has ended:

1. Enterprise data is automatically extracted from an ERP system.
2. Enterprise data is translated into an acceptable format for Production Scheduling.
3. Enterprise data is loaded into Production Scheduling.
4. The initial production schedule is produced and awaits review.

## Interactive Events

After non-interactive events are complete for the scheduling cycle, interactive scheduling tasks can be performed to modify or streamline the schedule according to business needs. Interactive scheduling tasks begin with the initial production schedule that is created as a result of the non-interactive events that occur overnight.

1. Review the production schedule.
2. Decide if it is acceptable or not acceptable.
3. Perform manual scheduling and simulations that enable you to evaluate different scenarios (for unacceptable initial schedules).
4. Run a repair solve to incorporate the manual scheduling changes (for unacceptable initial schedules).
5. Perform simulations that represent the introduction of priority orders or extra production capacity into the schedule.
6. Publish the production schedule to the shop floor using the web dispatch list.

7. Publish the schedule to an ERP system.

## Creating or Importing a Model

The creation of a production schedule requires a model of your production process to be either created or imported from an external system. The model represents the production capacity of your enterprise. A working model is the first step towards creating a feasible production schedule. It consists of the resources, operations, and routings that combine to form a representation of your production process.

An accurate production schedule requires up-to-date model data, including starting item levels, safety stocks, work orders, and supply and demand information. Model data is often updated on a daily basis.

The steps for building models, which are explained in more detail throughout the rest of this document, are only suggestions. You might find a different sequence that is better suited to your organization's needs.

## Solving a Model

Solving the model produces a production schedule. You can make changes to the model and solve the model until a schedule that meets your requirements is produced. You can resolve scheduling problems by making changes to the data model including changing order priorities, increasing capacity, or by making manual changes to operations using what-if scenarios.

Additional information from the shop floor or other sources can also be reflected in the schedule. For example, real-time capacity changes, maintenance requirements, or supply and demand changes can exist.

## Production Scheduling as a Service Call

Production Scheduling can be called as a service - the solver and application have been decoupled such that the import and solve process can optionally be run on the server - this includes Windows, Linux, Sun Solaris, HP-UX, and AIX platforms.

This feature enables Production Scheduling users to have their models pre-solved on the server - saving time and improving efficiency. It also allows for batch solving of multiple plans (for example, automation of the "what if" process).

The server-side functionality creates a deployable solved model which includes import and solver statistics in log files. The log files are all downloaded to the client desktop on planner request. This feature also includes improved application status logging and filtering - including access to various event statuses and solver statistics log from within Production Scheduling for events that took place on the server.

See *Integrating Production Scheduling, Oracle Advanced Supply Chain Planning Implementation and User's Guide*.

## Publishing a Production Schedule

Once you are satisfied with a production schedule, you can publish it for use on the shop floor. Once the schedule has been committed and published, Production Scheduling enables you to export operation schedules and reports to external systems.

## Production Scheduling Implementation

The Production Scheduling implementation can be divided into the following phases:

- Install Production Scheduling.
- Define production data.
- Import enterprise data.
- Deploy production schedules.

## Installing Production Scheduling

To install Oracle Production Scheduling on Microsoft Windows, refer to the *Production Scheduling Installation Guide*. This installation guide is for installing a standalone, nonintegrated version of Oracle Production Scheduling on your client.

## Defining Production Data

**To define production data, perform the following:**

1. Define resources.
2. Define operations.
3. Define routings.

See *Creating Production Scheduling Models*, page 5-1, *Production Scheduling*.

## Implementing Enterprise Data

Data can be imported into Production Scheduling in various formats.

See *Integrating With Oracle Value Chain Planning Suite*, page 12-1, *Production Scheduling*.



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# Production Scheduling Overview

This chapter covers the following topics:

- Automatic Bottleneck Detection
- Advanced Analytical Decision Support
- Direct Scenario Comparisons

## Automatic Bottleneck Detection

This section discusses:

- Production scheduling implementation.
- Constraint-based scheduling limitations.
- Constraint-directed search advantages.

## Production Scheduling Implementation

Production Scheduling reduces initial implementation and ongoing maintenance costs through a self-configuring solver. To understand this next-generation technology, you must consider current-generation approaches and their inherent limitations.

To implement current-generation scheduling products, you must adjust production schedules to make them usable. During this implementation adjustment phase, consultants hard-code rules for many aspects of the scheduling problem. By specifying bottlenecks, sequencing rules, and so on, you create a usable schedule. However, this approach is expensive and time consuming. Furthermore, the quality of the solution can degrade as the underlying assumptions of the hard-coded rules change. For example, changes to demand mix and capacity constraints are normal in any business, but they change the assumptions of the original rules and, subsequently, reduce the quality of the schedule. As schedule quality degrades, planners try to maintain quality by overriding the system with time consuming and subjective manual schedule changes.

Planners often stop using the system entirely and revert to their previous planning methods.

Production Scheduling provides the ability to detect resource bottlenecks automatically, even when they dynamically float, or move, within a given schedule. Resource bottlenecks may float from crew to tool, and then to materials, to machine, and so on throughout the scheduling horizon. Using knowledge about resource bottlenecks, the Production Scheduling solver employs a scheduling strategy that exploits each type of bottleneck and maximizes manufacturing throughput. As a result, no initial rule configuration and schedule quality remains consistent over the life cycle of the implementation. Instead of focusing on customizing and maintaining rules, the planner can focus on scheduling. Dynamic bottleneck detection is such an important concept in Production Scheduling that a specific view is dedicated to the visualization of bottlenecks while schedules are being solved. The Resource Contention view enables planners to watch the Production Scheduling solver dynamically detect and exploit resource bottlenecks. Red indicates serious resource criticality. Shades of orange, yellow, and green indicate decreasing criticality, with green indicating the least criticality. Once the solve finishes, the Resource Contention view displays a histogram of the resources that drove the majority of scheduling decisions.

For example, in this example, the planner can see that the red Electrical Tester machine is the dominant resource bottleneck at that point in the solve:



The technology that enables users to detect bottlenecks automatically is called Constraint Directed Search (CDS). CDS is the logical evolution of constraint-based scheduling, but it does not have the limitations that historically affected constraint-based approaches.

## Constraint-Based Scheduling Limitations

Constraint-based schedules provide an accurate and detailed model of the factory. Constraint propagation is also an efficient method for determining the consequences of scheduling decisions. However, although propagation usually finds a feasible solution, it often requires an excessive amount of time, particularly for large problems. These large problems are relatively common; therefore, the application of this technology in the real world has been slow because:

- A constraint-based scheduler must assign a start time to each operation and resolve resulting conflicts before a feasible solution can be reached.

This delay causes the system to move data around rather than performing useful computation (known as thrashing ) and leads to backtracking (undoing unworkable decisions), which significantly increases the time needed to find a solution.

- To prevent thrashing, implementation personnel must customize algorithms for each implementation.

Because this approach takes an existing set of rules and tries to fit those rules to a new problem, the algorithm requires numerous adjustments. These adjustments often require changes to the application source code, which compromises future upgrades and increases the time and cost of the implementation. In addition, custom algorithms cannot respond satisfactorily to automatic floating bottleneck detection.

- As a result of customization, current-generation technology is not generally applicable.

If business requirements change, the technology cannot respond without further customization, delays, and expense.

- In many cases, current generation solvers cannot find good solutions even when they exist.

## Constraint Directed Search Advantages

Constraint Directed Search (CDS) provides the advantages of constraint-based scheduling without the disadvantages of performance problems. This improved technology, which reduces guesswork and prevents wrong decisions, uses:

- Texture measurements to:
  - Determine which decision is most critical by measuring local schedule conditions, which identify bottlenecks before a decision is made.
  - Minimize or eliminate backtracking by returning to the last decision made or to the most uncertain decision that was previously made.
  - Allow larger problems to be solved.
  - Reduce solve time.
- Least commitment to:
  - Assign operation precedence constraints so that a start time does not need to be assigned.

These constraints allow operations to float within a time range until the end, when an explicit start time is assigned.

- Find the critical paths in a schedule.
- Allow scheduling flexibility by tracking slack time.
- Avoid deadlocks in the propagation process.
- Optimize start time after sequencing.
- Allow dynamic schedule monitoring, for example, to determine whether a late starting operation will cause the order to be late.

The Production Scheduling application supports both generative scheduling and repair-based scheduling. Production Scheduling allows forward and backward propagation as well as propagation in all dimensions of a scheduling problem, including resource utilization and inventory.

## Advanced Analytical Decision Support

This section discusses:

- Production Pegging view.
- Resource Gantt and Resource Utilization combined view.
- Resource Gantt and Operation Gantt combined view.
- Resource Gantt, Operation Gantt, and Item Graph combined view.

**Note:** The views listed are only a subset of the analytical views that the Production Scheduling application supports. The eight basic views can be used on their own or combined through the use of a Wizard.

### Production Pegging View

From Production Scheduling, you can analyze your schedule in various views. The Production Pegging view is used to analyze projected customer service levels and the supply constraints that dictate those levels. All purchased and manufactured supply is pegged to a demand line item. This view can identify which orders are late and what specific condition is preventing these orders from being on time.

The Production Pegging view supports these key capabilities:

- User-defined demand sorting.

- Graphical-demand fill rates.
- Exceptions with suggested root cause.
- Dynamic-demand filtering.

### **User-Defined Demand Sorting**

Demand sorting (for sales orders, forecasts, and so on) is defined by a user-defined folder structure, which is specified in the Supply & Demand Editor. The folder structure can represent product types, demand types, customer hierarchies, and so on, and it provides an intuitive structure for analyzing the schedule.

### **Graphical-Demand Fill Rates**

The folder summary bars have various colors that indicate the amount of on-time demand or the unit fill percent. Demands or demand folders with red summary bars indicate less than 33 percent of on-time units, orange summary bars indicate between 33 and 66 percent of on-time units, yellow summary bars indicate between 66 and 99 percent of on-time units, and black summary bars indicate 100 percent of on-time units. Position your cursor over a summary bar to see a description of the fill rate and details about late demand.

### **Exceptions with Suggested Root Cause**

When a schedule is solved, Production Scheduling analyzes the results, identifies potential problems and their possible root cause, and generates the appropriate exceptions. Production Scheduling supports a variety of exceptions. One exception type alerts you to projected late orders and their suggested root causes. From the exception message, you can access the Production Pegging view, which automatically opens the Production Pegging view tree to the bottleneck operation that is pegged to the late demand.

### **Dynamic-Demand Filtering**

You can filter thousands of orders by user-specific criteria, which, in turn, enables you to manage by exception. For example, if eight of 31 line items occur late in a schedule, then you can filter the lines that are less than one day late. By filtering, you can learn that only four line items are more than one day late. All other orders are temporarily filtered out.

### **Resource Gantt and Resource Utilization Combined View**

This view displays the details of scheduled operations on their machines, crews, and tools, while viewing resource utilization for the currently selected resource in a bar chart. This view displays utilization by shift, daily, weekly, or monthly buckets. By selecting a particular time bucket, you can view the breakdown of idle, delay, down,

changeover, and run time.

The Resource Utilization view also displays utilization across groups of resources. This view is useful to identify the aggregate utilization of like resources, such as a pool of machines or crew.

## Resource Gantt and Operation Gantt Combined View

This view displays how operations are scheduled. All operations for the selected resource appear in the lower pane, sorted chronologically.

Automatic sorting occurs based on the context of the zoom at the moment the resource is selected. Therefore, when zooming in or out, you can reselect the resource to re-sort the operations.

## Resource Gantt, Operation Gantt and Item Graph Combined View

Although the Production Pegging view is ideal for a Make-to-Order (MTO) environment, the Resource Gantt, Operation Gantt and Item Graph combined view is ideal for a Make-to-Stock (MTS) environment. Examples of Make-to-Stock environments are Consumer Packaged Goods, and Food and Beverage.

The Resource Gantt and Operation Gantt panes in this view display the sequence being run on each resource. In the previous example, you can see that Packer 1 has a weekly campaign cycle for which time lost to sequence-dependent changeovers has been minimized. When you select each packing operation, the Item Graph pane displays the produced and consumed inventory levels, and inventory levels are perfectly supported.

From this view, you can click an item in the Item Graph and the producing and consuming operations are highlighted in the Resource and Operation Gantt.

## Direct Scenario Comparisons

Production Scheduling can compare different schedule scenarios. During one session, a planner can create an unlimited number of scenarios and then compare them using the Key Performance Indicators (KPI) view.

The system provides standard supply chain metrics to assess which scenario best meets your business objectives. Scenarios can be sorted by the Key Performance Indicators of interest and evaluated to identify the best possible schedule solution. Conversely, most competitive products support only a single scenario in one session, which forces planners to repeatedly save the various scenarios and run multiple sessions simultaneously, making the ideal scenario difficult to determine. In addition to KPI comparisons, schedules can be directly compared to each other from a customer service perspective, allowing you to understand which scenario best meets customer service objectives. Scenario comparison can help answer the following questions:

- In this new scenario, which work orders or demands are now on time compared to

my best scenario previously?

- In this new scenario, which work orders or demands are now late compared to my best scenario previously?
- In this new scenario, what is the effect on overall earliness or lateness?

After a planner decides which schedule they prefer, they approve it and then publish it to a resource planning application.



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# Starting the Production Scheduling System

This chapter covers the following topics:

- System Startup Overview
- Starting Production Scheduling
- Creating, Opening, and Importing a Scenario
- Sending Scenario via E-mail

## System Startup Overview

You can start the Production Scheduling application from a Microsoft Windows desktop or from a command prompt, depending on your implementation. Starting the system from the Microsoft Windows desktop enables you to take advantage of the Production Scheduling desktop to create and evaluate scheduling scenarios.

**Note:** This only applies to "standalone" non-integrated versions of Production Scheduling. Startup for integrated versions with E-Business Suite (EBS) or the Process Integration Pack (PIP) occurs from the Workbench.

The Production Scheduling application can be started directly from the command prompt or from a batch routine that can be automatically run at a specific time. The command prompt provides a number of options that enable you to perform any or all of these functions:

- Start the Production Scheduling application.
- Create, name, and save a schedule.
- Write the command and solve details to a log file.
- Terminate the session.

## Starting Production Scheduling

**Note:** The procedures in this section pertain to standalone installations only.

This section discusses how to:

- Start the system from the Microsoft Windows desktop.
- Start the system from a command line prompt.
- Check the version of the software.

### Starting the System from the Microsoft Windows Desktop

**To start the system from the Microsoft Windows desktop:**

1. Access the Microsoft Windows desktop.
2. Click the Start button, and then go to Programs, Oracle Value Chain Planning <version number>.
3. Select Production Scheduling.

### Starting Production Scheduling from a Command Line Prompt

**To start the system from a command line prompt:**

1. Access the command line.
2. Navigate using the path: <PS install directory>\scp\<version>\ps\bin.
3. Enter `ps`.

### Viewing the Installed Production Scheduling Version Number

**To view the version of Production Scheduling:**

1. Select About Production Scheduling from the Help menu.
2. Click Version Information.
3. Click OK to close Production information dialog box.
4. Click OK to close About Production Scheduling screen.

## Creating, Opening, and Importing a Scenario

This section explains how to:

- Create a new scenario.
- Open or import and export an existing scenario.

### Creating a New Scenario

To create a new scenario:

1. Access the Production Scheduling desktop.
2. From the File menu, select New.

A new scenario is created in the Model Workspace.

### Opening or Importing and Exporting an Existing Scenario

This section discusses how to:

- Open or import a scenario.
- Import a scenario.
- Export a scenario.

### Opening or Importing a Scenario

To open or import a scenario:

1. Access the Production Scheduling desktop.
2. From the File menu, select Open and browse to your directory.
3. From the list of scenarios, select the one you want to open and click Open.

Alternatively, if no scenarios are listed, browse to the location where you saved the scenario. The scenario can be an .xml, .xml.gz, .ops, .opz, or .dxt file. A .dxt file is a collection of scenarios. Files with the .ops or .opz extension are equivalent to xml and xml.gz files, respectively.

4. If you have a scenario open and want to open another, the system will ask if you want to import the file into the existing model.

Select one of these options:

- Click Yes if you want the first scenario to remain open.
- Click No if you want to close the first scenario. You are prompted to save the scenario.

If the scenario you are opening or importing is an XML file, the scenario opens along with the associated Gantt charts. If the file is a DXT file, the Gantt chart does not open until a scenario is opened.

### **Importing a Scenario**

There are two options to importing a scenario. You can follow the instructions detailed in the Opening or Importing a Scenario section, or you can:

1. Right-click on a scenario folder.
2. Select Import Scenario.

### **Exporting a Scenario**

To export a scenario:

1. Right-click on the scenario.
2. Select Export Scenario.

## **Sending Scenario via E-mail**

To send a scenario file via e-mail directly from Production Scheduling:

1. From the Model Workspace, right-click a scenario and select Send Scenario to Mail Recipient.

Your e-mail application opens with the scenario file attached to it.

2. Select the appropriate e-mail recipients and send the e-mail.
3. To open the scenario file, double-click the e-mail attachment.

The recipient must have the same version of Production Scheduling installed to view the file.

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# Configuring Desktop Components

This chapter covers the following topics:

- Production Scheduling Desktop Overview
- Configuring the Model Workspace
- Configuring Toolbars
- Customizing Colors
- Configuring Schedule Views

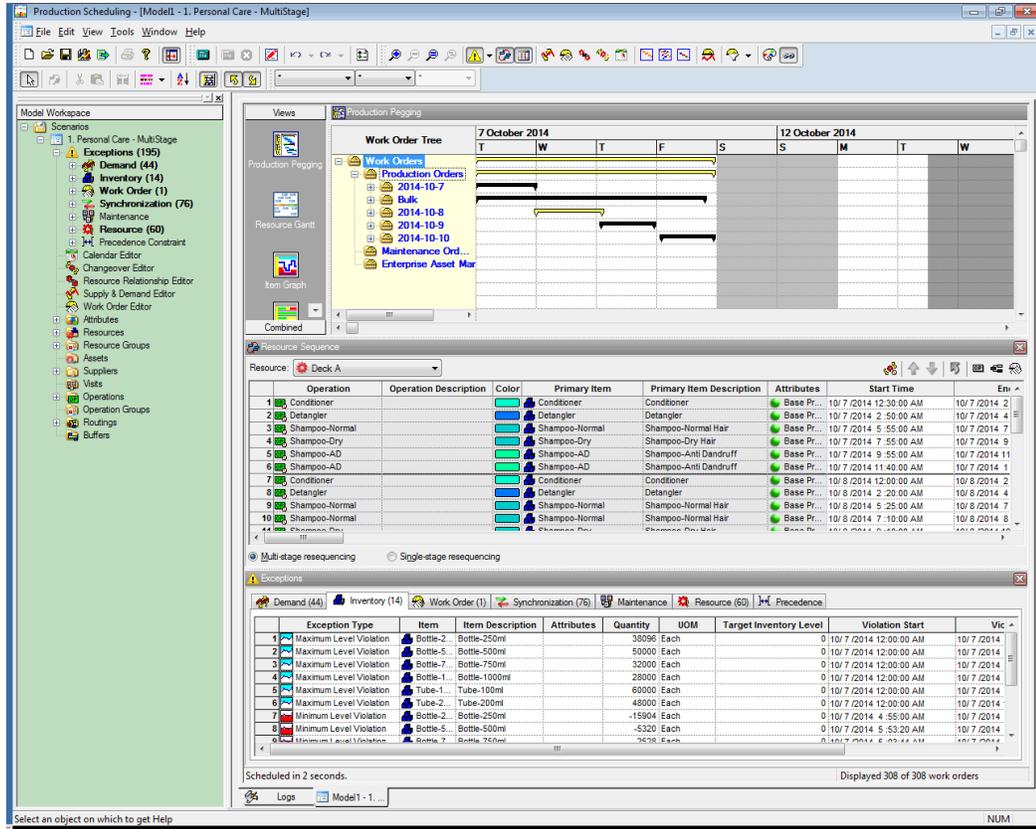
## Production Scheduling Desktop Overview

This section discusses:

- Look & Feel
- Data editors
- Key performance indicators (KPI) view
- Workbook Area and Tabs
- Log window
- System icons

The Production Scheduling desktop is the main user interface for creating production schedules and solving production schedule problems.

The Production Scheduling desktop is the principal user interface for all production scheduling activities. The desktop interface enables you to create and revise production schedules, solve production schedule problems, and view graphical representations of schedule data. This example shows the principal areas of the Production Scheduling desktop:



The File, Edit, View, Tools, Window, and Help menus appear at the top. The application toolbars appear below the window menus. A variety of toolbars are available and display based on the current view. The toolbars display icons to perform a variety of actions when working with your schedule. The Model Workspace, which contains the tree structure of your scenario, appears to the left below the toolbars.

The Workbook area tabs appear at the bottom of the screen and are used to navigate between open view or editors. The Message bar appears in bottom right corner of the window.

The majority of the screen is occupied by your scenario views, such as the Gantt chart, Item graph, and so on.

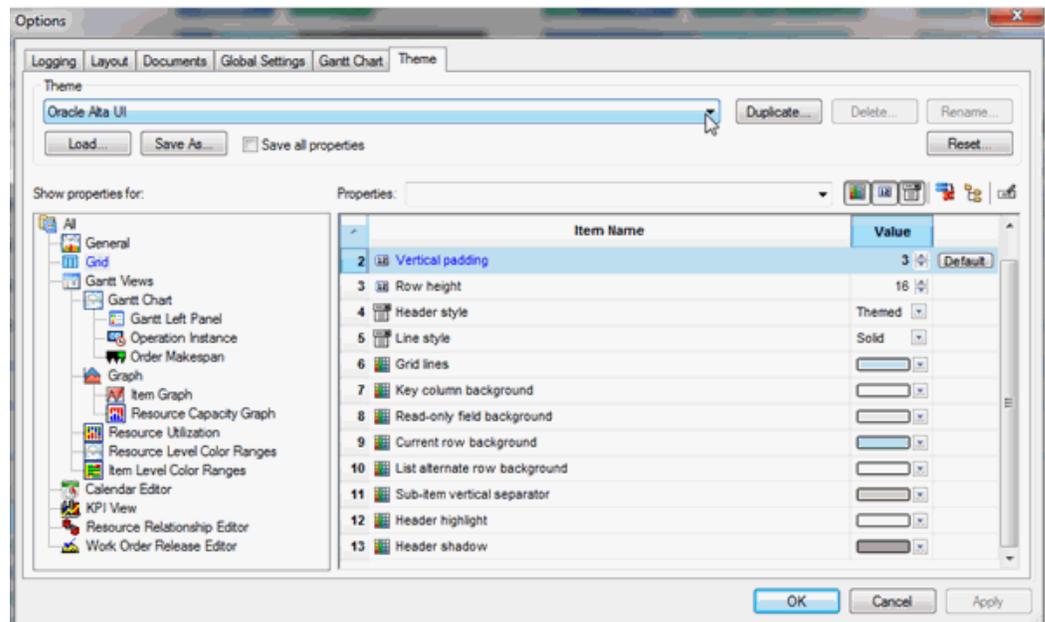
## Look & Feel

The Oracle Alta UI Look and Feel is now incorporated into Production Scheduling. While providing a consistent look with other Oracle applications it provides a cleaner design and more padding to minimize data clutter and a visually pleasing user interface to review application data. The padding is incorporated in the tables and Gantt views which can be configured to accommodate different user preferences.

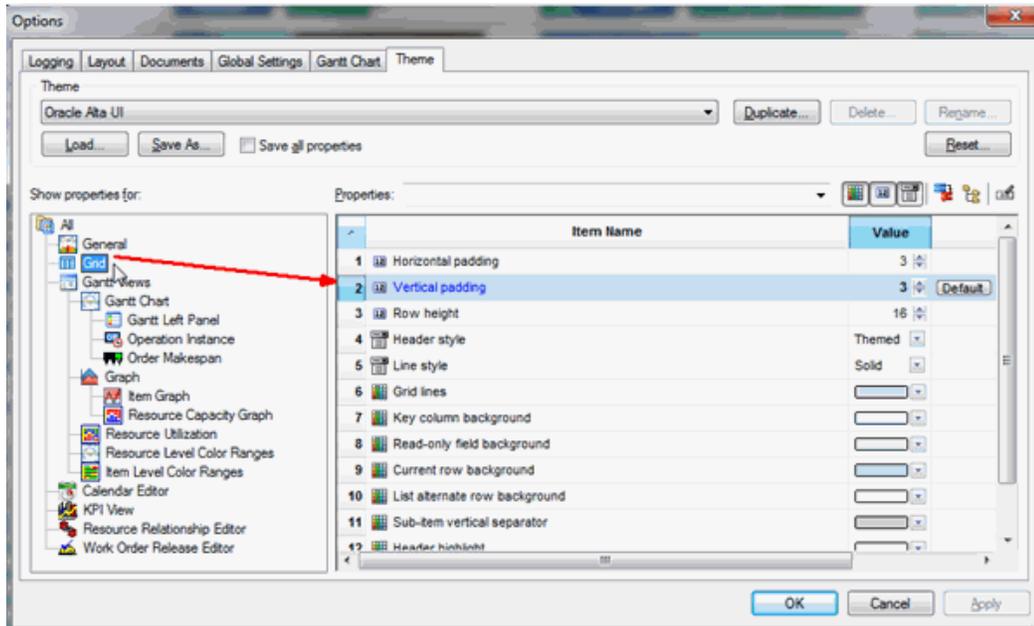
You can revert to the legacy Look & Feel as it does allow the you to view more data on the screen and minimize scrolling. To Control the theme, selection Options from the

Tools menu. The available themes are:

- Oracle Alta UI (Default)
- PS Classic.
- 256 Colors. This option provides some benefits while using some remote access technologies such as remote desktop



Within a theme, you can be configure the various UI elements to further refine the Look & Feel, such as the padding around the data tables to increase or decrease the data density. Padding makes the data tables easier to read, however, there is less data on the screen.



## Data Editors

Data editors are views that enable you to record events, administer orders, and monitor supply and demand information. The following data editors are available:

- Changeover Editor.
- Supply & Demand Editor.
- Work Order Editor.
- Calendar Editor.
- Resource Relationship Editor

### Changeover Editor

The Changeover Editor enables you to record precise information about the time required to modify a machine between different operations. Using the Changeover Editor, you can define relationships that enable you to define sequence dependent changeover relationships. In addition, you can create groups to save time when entering changeover information. All of the information entered into the Changeover Editor is automatically saved in the schedule.

### Supply & Demand Editor

The Supply & Demand Editor enables you to add, delete, change, or view the properties of any supply or demand order or line item. It also enables you to add details about

customers. Supply and demand information is usually imported.

### **Work Order Editor**

Use the Work Order Editor to add, modify, delete, and view production orders, maintenance orders, and Enterprise Asset Management orders.

### **Calendar Editor**

Use the Calendar Editor to view and modify calendar and shifts, and add and modify calendar and shift events.

The Calendar Editor enables you to record downtime events and delay time events. An operation must end before a downtime event starts. An operation may be interrupted by a delay event and will resume after the delay event has completed.

Resource availability for crews, machines, tools, and machine changeovers runs according to a specified calendar and shift, which enables you to create as many calendars and shifts as necessary to accurately define the time constraints that impact your resources. No downtime or delays are scheduled in the default calendar that ships with Production Scheduling.

The Calendar Editor enables you to create recurring patterns, select multiple events in a user-defined range, and edit all events at one time.

### **Resource Relationship Editor**

Use this editor to specify the physical resource connectivity for multi-stage synchronization environments. Each resource relationship must be explicitly defined. These relationships are used by the solver when generating the schedule for a multi-stage synchronization environment. Refer to *Using Multi-Stage Synchronization and the Resource Relationship Editor*, page 5-139 for information and tasks to be performed when generating a multi-stage synchronization schedule.

### **Key Performance Indicators (KPIs) View**

The Key Performance Indicators view displays schedule performance measurements. Performance indicators for all schedules in the model can appear at the same time or be analyzed to view a particular schedule. Key Performance Indicators (KPIs) are organized by the following categories:

- Customer Service
- Materials
- Costs
- Manufacturing

- Maintenance

By adjusting scenarios and then comparing KPIs, you can determine the effect of the adjustments on your schedules. In addition, you can compare a baseline schedule to another schedule using the comparison capabilities at the bottom of the Key Performance Indicators view.

For more information, refer to "Working with Key Performance Indicators, page 9-72," Evaluating Production Scheduling, *Production Scheduling Implementation Guide*.

## Workbook Area and Tabs

The Workbook area displays object windows, model editors, schedule views, and system messages. The Workbook area provides flexibility for viewing different types of Production Scheduling information. Use the Workbook area tabs to identify and navigate to displayed views.

You can display the Workbook area with or without tabs for each open diagram or model editor. You can display up to 26 windows simultaneously.

**To display Workbook tabs, select Workbook on the View menu.**

You can have several views displayed at one time. For example, you can display the Key Performance Indicators view, the Production Pegging view as well as several data editors at the same time. The tabs automatically resize to fit your screen.

**To hide the Workbook area tabs, deselect the Workbook option from the View menu.**

With Workbook tabs hidden, you can still toggle between windows by making a selection from the Window menu.

## Logs Window

The Log window appears by default each time the application is opened. The Log window displays two tabs, the Progress Log and Event Log. The Progress Log displays the solver output results. This output consists of a report about the solve and any problem messages. The Event Log tab is used to access the following solver events:

- Error events
- Warning events
- Informational events
- Headline events

**To access log information:**

1. Select the Logs workbook tab.
2. To view solver output information and details, select the Process Log tab.

To search the contents of the Progress Log, right-click and select Find. Enter your search criteria in the Find dialog and click Find.

3. To view solver events, click the Events Log tab.
4. To filter events from the Event Log tab, perform the following:
  - To filter the event types, use the Show event buttons. Highlighted buttons indicate events appear within the tab.
  - If your model contains multiple scenarios, you can use the **For scenario** list to filter events based on the selected scenario. The wildcard list option (\*) is used to view events within all model scenarios.
  - Use the **Information detail level** list to filter the event details.
5. Click View Log File button to display the event log text file (PsLog.txt).
6. Click View Solver Statistics File button to display the solver statistics text file (SolverStatistics.txt).
7. Click Export to Log File button to save the log results.

The Log file is saved to the location defined in the Logging tab in the Options window. To access the logging options, select Options from the Tools menu, and click the Logging tab.

## Using Model Workspace System Icons

System icons are compact graphical elements that denote items such as activities, groups, folders, and resources in the Model Workspace. These icons help you identify objects in your model. This table describes the available system icons:

Icon Name	Description
Operation or Routing folders	Represents either an operation or a routing folder. Both operations and routings can be organized in folders for better accessibility.
Operation	Represents an operation to which resources are attached. The icon appears automatically in an Object window when the Open Diagram menu option is selected. This icon can be dragged from the Model Workspace into a routing diagram.

Icon Name	Description
Operation Group folder	Represents an operation group folder. Operation groups can be organized into operation group folders for better accessibility.
Operation or Resource Group	Represents resources that are grouped for analysis purposes. Machine resources groups can be available within the Changeover editor. Like resources, operations can be grouped together in operation groups.
Routing	Represents operations and routings that are connected in a specific order.
Operations, Resource, or Visits folder	Represents an organization, resource, or visits folder. Operations, resources, and visits can be organized in folders for better accessibility.
Visit	Represents a group of aircraft maintenance requirements and tasks assigned to a given organization. Visits are typically comprised of logical milestones, which are groups of tasks that must be finished before proceeding with the next milestone, or groups of tasks.
Crew	Displays details about Crew resources, including properties. You can drag Crew resources into operation diagrams from the Model Workspace.
Item	Displays details about Item resources, including properties. You can drag Item resources into operation diagrams from the Model Workspace.
Storage Space	Displays details of Storage spaces, including the name of the Storage space and its properties.
Machine	Displays details of Machine resources, including properties. You can drag Machine resources into operation diagrams from the Model Workspace. Machine resources appear in the Changeover editor.

Icon Name	Description
Vendor	Displays details about Vendor resources, including properties. You can drag Vendor resources into operation diagrams from the Model Workspace.
Tool	Displays details about Tool resources, including properties. You can drag Tool resources into operation diagrams from the Model Workspace.
Schedule folder	Represents schedules that are organized into folders.

## Configuring the Model Workspace

This section provides information about the following:

- Hide the Model Workspace.
- Customize the Model Workspace.
- Displaying workbook tabs.
- Arrange window views.

## Model Workspace Overview

The Model Workspace contains a tree structure, which contains all the scenarios that make up your model, and the operations, resources, and schedule views that make up each scenario.

When you create a new scenario, you need to define all of your resources first, then all of your operations, and finally all of the routings in your model. You can create several different scenarios to optimize your schedule. Create what-if scenarios that duplicate the scenario, and then modify the schedule and see how the modifications affect production. Once you have a satisfactory production schedule, save the modifications as a new model. To increase the available workspace in the Workbook area, hide the scenario workspace.

The Model Workspace contains one or more scenario folders for your model. Each scenario folder contains all of the individual scenarios and schedules that you have created for the current model. Scenarios allow the operations and resources of a model to be manipulated to create what-if situations. You can analyze different scenarios using

various KPIs to determine the ideal schedule.

When you create a new scenario, Production Scheduling automatically sets up these subfolders organize the information:

- All Exceptions  
For more information, refer to "Working with Exceptions, page 9-58," *Evaluating Production Schedules, Production Scheduling Implementation Guide*.
- All Attributes
- All Resources  
For more information, refer to "Defining Resources, page 5-3," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.
- All Resource Groups  
For more information, refer to "Defining Resource Groups, page 5-30," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.
- All Assets
- All Suppliers
- All Visits  
For more information, refer to "Defining Visits, page 5-31," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.
- All Operations  
For more information, refer to "Defining Operations, page 5-37," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.
- All Operation Groups  
For more information, refer to "Defining Operations, page 5-37," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.
- All Routings  
For more information, refer to "Defining Routings, page 5-53," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.
- All Buffers  
For more information, refer to "Defining Routings, page 5-53," *Creating Production Scheduling Models, Production Scheduling Implementation Guide*.

In addition to the folders, the scenario contains the following data editors to manage your schedule:

- **Changeover Editor**  
For more information, refer to "Defining Changeover Rules, page 5-132," Creating Production Scheduling Models, *Production Scheduling Implementation Guide*.
- **Supply & Demand Editor**  
For more information, refer to "Specifying Supply and Demand Events, page 5-73," Creating Production Scheduling Models, *Production Scheduling Implementation Guide*.
- **Work Order Editor**  
For more information, refer to "Working with Work Orders, page 5-93," Creating Production Scheduling Models, *Production Scheduling Implementation Guide*.
- **Calendar Editor**  
For more information, refer to "Defining Work Patterns and Availability (Resource Calendars), page 5-68," Creating Production Scheduling Models, *Production Scheduling Implementation Guide*.
- **Resource Relationship Editor**  
Refer to Using Multi-Stage Synchronization and the Resource Relationship Editor, page 5-139 for information and tasks to be performed when generating a multi-stage synchronization schedule.

## Schedule Groups

Schedule groups enable multiple operations and resources to be combined as a group when viewed in the Model Workspace and in the schedule views. Using the Model Workspace, you can organize resources and operations into logical groupings to help you organize your model data. You can create a default resource group for each schedule that appears when views are first opened.

All schedule views, except the Production Pegging view, have a menu at the top of the view that lists the defined groups. When you select a group from the menu, the schedule view changes to display only those resources or items belonging to the group. Each schedule view can have its own default group view. The current default group in each view appears with a check mark next to its name.

## Hiding the Model Workspace

To hide the Model Workspace, perform one of the following:

- Select Model Workspace from the View menu.
- Click Hide/Toggle Model Workspace button from the toolbar.

## Customizing the Model Workspace

To customizing the Model Workspace:

1. Access the Model Workspace.
2. Right-click the window pane above the Model Workspace heading and below the toolbars.
3. From the menu, select an option.

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<b>Model Workspace Option</b>	<b>Description</b>
Allow Docking	<p>Select to allow the Model Workspace window to move anywhere on the screen and attach to any side. To dock the Model Workspace to a specific side, move the window as close as possible to that side. The window expands to full size and locks in place when you release the mouse.</p> <p>When Allow Docking is cleared and Float in Main Window is selected, the Model Workspace moves anywhere within the Production Scheduling window and does not attach to a side.</p> <p>When this option is not selected, select the Float in Main Window option to ensure that the right-click menu is available in the Model Workspace.</p> <p>Clear the Float in Main Window option and select the Allow Docking option when you want to dock the Model Workspace window again.</p>
Hide	<p>Click the window's close button to hide the Model Workspace. To display the Model Workspace again, select Model Workspace from the View menu.</p>
Float in Main Window	<p>Select to move, or float, the Model Workspace anywhere inside the application window.</p>

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4. To change the background color for the Model Workspace, perform the following:

1. Click the Customize Colors button from the toolbar.
2. Select General from the Show colors for list.
3. Select Model Workspace background from the Display items list.
4. Select a color from the Item color list.
5. To reset the color to the application default, click Default Color.
6. Click Close.

## Displaying Workbook Tabs

Use the workbook tabs across the bottom of Workbook area to navigate between the editors and views currently open.

To display workbook tabs:

1. To display multiple view tabs, select Workbook from the View menu. A check mark appears next to Workbook when selected.

The open workbooks appears as tabs across the bottom of the window. Select a tab to display a workbook.

2. To hide the workbook tabs, deselect Workbook from the View menu. When hidden, you can navigate between open views by selecting the view or editor name from the Window menu.

## Arranging Window Views

To arrange windows within the Workbook area:

1. Access the Model Workspace and double-click the editors you want displayed, or select a the schedule views from the View bar.
2. Select the Windows menu. The Window menu displays all open windows.
3. Select one of the following options:
  - Cascade - Select to display the views stacked on top of each other.
  - Tile - Select to tile the views within the same window.

## Configuring Toolbars

This section provides information on the following:

- Toolbars overview
- Hide toolbar options.
- Create a custom toolbar.

## Toolbars Overview

Use the toolbars to perform tasks within Production Scheduling. Toolbar buttons display tooltips to indicate button name. The status bar, located at the bottom of the window, also displays information about the button.

Production Scheduling enables you to build a model of your process. By using the Production Scheduling tools located in the toolbar, you can create a graphical representation of the model. After the model is built, you can then access and view every element of the model with just one mouse click.

The Production Scheduling toolbars are context-sensitive; therefore, different sets of toolbars appear based on the task that you are performing. For example, the Alignment toolbar appears only when you are working with an Operation or Routing diagram.

Tools are arranged in sets on the toolbar. Use different sets when navigating different views. The following table describes the toolbars that are available in the Production Scheduling desktop:

Toolbar Name	Description
File	Use this toolbar to: <ul style="list-style-type: none"> <li>• Create a new model.</li> <li>• Open or save a model.</li> <li>• Print an active document.</li> <li>• View help files.</li> <li>• Hide or view the Model Workspace.</li> </ul>

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Toolbar Name	Description
Solve	<p>Use this toolbar from the standard or combined views to:</p> <ul style="list-style-type: none"><li>• Perform a solve.</li><li>• Perform a repair solve.</li><li>• Resume a solve.</li><li>• Stop the solver process.</li><li>• Toggle Unconstrained Manual Scheduling Mode on and off.</li><li>• Undo and redo action.</li><li>• Display the Solver Options window.</li></ul>

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Toolbar Name	Description
Gantt Chart	<p>Use this toolbar from the scheduled views to:</p> <ul style="list-style-type: none"> <li>• Zoom in and out of the time grid.</li> <li>• Show or hide the Exceptions grid.  List options to right of button allow you to filter exceptions or define your exception filter criteria.</li> <li>• Display the Resource Sequence view.</li> <li>• Toggle resource buckets on and off in Gantt views.</li> <li>• Open the Supply &amp; Demand Editor.</li> <li>• Open the Work Order Editor.</li> <li>• Open the Resource Relationship Editor.</li> <li>• Open the Changeover Editor.</li> <li>• Open the Global Calendar Editor.</li> <li>• Filter visit critical path information.</li> <li>• Show visit critical path information.</li> <li>• Toggle between demand pegging and work order pegging in Gantt views.</li> <li>• Toggle Work Order Filter.  List options to right of button allow you to view, add, delete or modify filters.</li> <li>• Customize colors used in views.</li> <li>• Show work order links.</li> </ul>

Toolbar Name	Description
Operation Instances	<p>Use this toolbar in operation scheduled views to:</p> <ul style="list-style-type: none"> <li>• Display Resource Sequence view.</li> <li>• Cut or paste operations.</li> <li>• Remove idle time.</li> <li>• Merge operation.</li> </ul> <p>List options to right of button allow you to merge operations or merge work order operation.</p> <ul style="list-style-type: none"> <li>• Sort pegging tree information in ascending or descending order.</li> <li>• Highlight operations changed by repair.</li> <li>• Peg (display) upstream and downstream operations.</li> </ul>
Demand	<p>Use this toolbar from scheduled views to:</p> <ul style="list-style-type: none"> <li>• Filter by order class.</li> <li>• Filter by order punctuality.</li> </ul>
Attributes Filter	<p>Use this toolbar for resource Gantt scheduled view to:</p> <ul style="list-style-type: none"> <li>• Highlight by attribute type.</li> <li>• Highlight by attribute value.</li> </ul>

Toolbar Name	Description
Graph	<p>Use this toolbar from the schedule view graphs to:</p> <ul style="list-style-type: none"> <li>• Display percentage scale to right of graph.</li> <li>• Display full scale to right of graph.</li> <li>• Fit to scale.</li> <li>• Show spikes within graph.</li> </ul>
Item Gantt	<p>Use toolbar from item Gantt schedule views to sort items.</p>
Resource Contention	<p>Use this toolbar in resource contention scheduled views to define the bucket set time period.</p>
Calendar Events	<p>Use this toolbar for calendar scheduled views to:</p> <ul style="list-style-type: none"> <li>• Add new calendar.</li> <li>• Remove a calendar.</li> <li>• Duplicate calendar.</li> <li>• Add or remove calendar event.</li> <li>• Remove all calendar events.</li> <li>• Select matching events.</li> <li>• Edit a calendar event.</li> </ul>

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Toolbar Name	Description
Zoom & Pan	<p>Use this toolbar from the operation and routing diagrams to:</p> <ul style="list-style-type: none"><li>• Zoom in.</li><li>• Zoom to fit all components.</li><li>• Fit the current selection.</li><li>• Move the entire drawing area.</li></ul>
Diagram	<p>Use this toolbar to:</p> <ul style="list-style-type: none"><li>• Select or move a diagram component.</li><li>• Insert text or an image file.</li><li>• Link multiple diagram components.</li><li>• Insert an item set, a resource set, or All of Set.</li><li>• Insert a link or buffer link.</li><li>• Arrange components from top to bottom or from bottom to top.</li><li>• Arrange components from left to right or from right to left.</li></ul>

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Toolbar Name	Description
Alignment	<p>Use this toolbar to:</p> <ul style="list-style-type: none"> <li>• Align the top of two or more objects.</li> <li>• Horizontally center two or more objects.</li> <li>• Align the bottom of two or more objects.</li> <li>• Left align two or more objects.</li> <li>• Right align two or more objects.</li> <li>• Vertically center two or more objects.</li> <li>• Nudge one or more objects up one point.</li> <li>• Nudge one or more objects down one point.</li> <li>• Nudge one or more objects left one point.</li> <li>• Nudge one or more objects right one point.</li> <li>• Move an object to the front.</li> <li>• Move an object to the back.</li> <li>• Bring an object forward.</li> <li>• Move an object backward.</li> </ul>
Changeover	<p>Use this toolbar from the Changeover Editor to:</p> <ul style="list-style-type: none"> <li>• Add or delete rules.</li> <li>• Move a rule up or down.</li> <li>• Toggle rule filter on and off.</li> </ul>

Toolbar Name	Description
Supply and Demand	<p>Use this toolbar from the Supply &amp; Demand Editor to:</p> <ul style="list-style-type: none"> <li>• Show or hide the supply and demand tree.</li> <li>• Copy an order.</li> <li>• Paste an order.</li> <li>• Duplicate an order.</li> <li>• Show or hide demand pegging information.</li> </ul>
Work Order	<p>Use this toolbar from the Work Order Editor or the scheduled views to show or hide the work order tree.</p>
Calendars	<p>Use this toolbar from the Calendar Editor to:</p> <ul style="list-style-type: none"> <li>• Add, remove, or duplicate a calendar.</li> <li>• Set calendar horizon.</li> <li>• Zoom in and out of the calendar time grid.</li> <li>• Add or remove a calendar events.</li> <li>• Remove all calendar events.</li> <li>• Select matching events.</li> <li>• Edit a calendar event.</li> <li>• Edit colors used in the Calendar Editor.</li> </ul>
KPI	<p>Use this toolbar from the Key Performance Indicators view to customize KPI colors.</p>

## Hiding Toolbar Options

### To hide toolbar options:

1. From the menu bar, select Tools, then Customize to display the Customize window.
2. Click the Toolbars tab.
3. Select a toolbar from the list, and then select the toolbar options that you want to use on the toolbar.

Toolbar options that are unchecked do not appear on the toolbar.

4. Click OK.

## Creating a New Toolbar

### To create a new toolbar:

1. From the menu bar, select Tools, then Customize to display the Customize window.
2. Click the Toolbars tab.
3. Click New.
4. Enter a name for the toolbar and click OK. The new toolbar appears.
5. Select the Commands tab, and then select a category.
6. Drag and drop the buttons you want displayed to the new toolbar.
7. Click OK.

## Customizing Your Toolbars

Use the Customize window to show or hide tooltips, change buttons appearance, or reset the toolbar defaults.

### To customize your toolbars:

1. From the menu bar, select Tools, then Customize to display the Customize window.
2. Click the Toolbars tab.
3. Perform the following as needed:
  - Select Show Tooltips to view help about the tool that is currently selected. To hide tooltips, deselect this option.

- Select Cool Look to remove the button-like appearance.
  - Select Reset to restore toolbars to the default setting and layout.
4. Click OK.

## Customizing Colors

Use the Colors window to define the colors used within the Production Scheduling application, its views and editors. Color settings can also be saved and loaded as themes from the Colors window, making them available in other scenarios.

### To customize colors:

1. Select the Customize Colors button from the toolbar.
2. Use the Color theme list to select an existing color theme. Available themes include PS Classic, Oracle Look and Feel, and 256 Colors.

Color themes can be duplicated and then modified to create new themes based on your color selections.

### To duplicate and customize a theme:

1. Select a theme from the Color theme list.
2. Click Duplicate and enter a theme name.
3. Follow the procedures below to select the editor, view, or general color settings and define the item colors as needed.
3. From the Show colors for region, select a view, editor, or general option.  
When the Colors window is accessed from a view or editor, the view or editor is selected by default from the Show colors for region.
4. From the Display items region, select the item to be modified.
5. Use the Item color list to assign a color the item.
6. Use the Item color list options to select the type of color options. Available options include Standard Colors, HTML colors, Window Colors, Color Shades, and More Colors.
7. To set a Display item to its default color, click Default Color button.
8. To save your color preferences as a Production Scheduling color theme, click Save As. Define the file name and location and click OK. Once a theme is saved, it can be applied to other Production Scheduling scenarios as needed.

9. To load a saved Production Scheduling color theme to a scenario, click Load. Locate and select the Production Scheduling Color Theme file, and then click OK. The theme settings are loaded into your scenario and the color settings are applied.
10. When you have finished customizing your color preferences, click Close.

## Configuring Schedule Views

This section discusses how to:

- Create new group views.
- Configure the Production Pegging layout.
- Set Multi-Capacity Resource Graph colors.
- Set Item Graph colors.
- Set Item Gantt colors.
- Set Resource Contention view colors.

## Creating New Group Views

Create a new group view to add to the navigation pane view list bar. By default, Production Scheduling provides to two groups in the navigation list bar, Views and Combined), but you can create additional groups as needed. Once a group is created, you can add schedule views to the group as needed.

### **To create a new group view:**

1. Access a schedule view.
2. Right-click within the schedule view navigation pane list bar and select Add Group. You can right-click from any of the navigation pane view list bars (for example, Views or Combined).
3. Enter a name for the new group and click OK.  
The new group is added to the navigation pane view list bar.
4. Click the new group in the navigation pane view list bar to display its affiliated views or to add new views to your group.

## Configuring the Production Pegging Layout

From the Production Pegging view, access the Production Pegging Layout dialog box to define layout options used within the view.

**To configure the Production Pegging layout:**

1. Access the Production Pegging view.
2. Right-click the Order Tree header and select Layout Options.
3. In the Production Pegging Layout dialog box, select a layout type:
  - Show individual routing instances.  
Each operation and routing instance appears in a single line.
  - Show merged routing instances.  
All routings of the same type are grouped in a single line.
4. If you selected the layout type for merged routing instances, select one or both of these options:
  - Group multiple operation lines in a folder.  
All operations of the same type are grouped together in an operation folder.
  - Automatically expand operation folders.  
Operation folders automatically expand to display their contents. This option is available only if you selected the option to group multiple operation lines in a folder.
5. Show resource alternates as a set.

## **Setting Multi-Capacity Resource Graph Colors**

To set Multi-Capacity Resource Graph colors:

1. Click the Customize Colors button.
2. Double-click one of these options to configure the color scheme:
  - Graph Background
  - Used Capacity Graph
  - Maximum Capacity Graph
3. Click OK to change the color scheme.

## **Setting Item Graph Colors**

To set Item Graph colors:

1. Click the Customize Colors button.
2. Select an appropriate color option from the available options:
  - Graph Color
  - Minimum Level Color
  - Maximum Level Color
  - Background
3. Click the Close button in the Color Selection window to exit.

## Setting Item Gantt Colors

To set Item Gantt colors:

1. Click the Customize Colors button.
2. Click and drag a marker to the desired percentage.  
By default, the system displays color representations of inventory levels between -10 and 110 percent of the minimum and maximum levels.
3. To assign a color to a percentage range, right-click the color bar.
4. In the Color dialog box, select a new color and click OK.
5. Click Update Slider when you have completed the changes to the color scheme.
6. Click Apply and then click OK.

**Note:** To return all of the values to the default colors and to the default number of color markers, click the Default button.

## Setting Resource Usage Level Colors

You can adjust the resource contention and resource Gantt view colors (for multi-capacity resources) assigned to usage levels.

**To set the resource usage level colors:**

1. Click the Customize Colors button.
2. From the Show colors for region, select Resource Level Color Ranges.
3. From the Display items region, select a resource usage range and click Customize,

or double-click the resource usage range.

4. From the Resource Level Color Ranges dialog, set the following as needed:
  - In the End % field, enter the ending percentage value.
  - Use the Color list to change the color assigned to the level.
  - To set the percentage color range values to their default setting, click Reset Ranges.
  - To set levels to their default color, click Reset Colors.
  - To display levels as gradient colors, click Make Color Gradient.

Click OK to save your changes and close the Resource Level Color Ranges dialog.

5. Click Close.



---

# Creating Production Scheduling Models

This chapter covers the following topics:

- Defining Attributes
- Defining Resources
- Defining Visits
- Defining Operations
- Defining Routings
- Defining Work Patterns and Availability (Resource Calendars and Shifts)
- Specifying Supply and Demand Events
- Working with Work Orders
- Defining Changeover Rules
- Using Multi-Stage Synchronization and the Resource Relationship Editor

## Defining Attributes

You can define attributes which can then be assigned to your resources. Attributes identify specific conditions for a resource, such as an oven temperature setting that should be used. You can create an attribute named *Temperature* and then define attribute values such as 350 degrees and 400 degrees as needed for your resources. You can also assign colors to your attributes to make them easier to identify within the schedule views. Once your attributes are defined, they can be assigned to your items or machines.

Attributes assigned to the model appear in the Model Workspace under the All Attributes folder. If the folder cannot be expanded, then no attributes have been defined for the model.

When defining item attributes, you associate one or more attributes and attribute values to the item. Items that share the same attributes and values are grouped together, for example both temperature and duration.

**To define attributes:**

1. From the Model Workspace, right-click All Attributes.
2. Select New Attribute.
3. Enter the name of the attribute.  
Attributes display in alphanumeric order.
4. Right-click the attribute and select Properties.
5. From the General tab, enter these fields:

---

<b>Attribute Properties - General Tab Field</b>	<b>Description</b>
Code	Enter the attribute code.
Notes	Enter relevant notes.

---

6. Select the Values tab, click Add, and enter these fields:

---

<b>Attribute Properties - Values Tab Field</b>	<b>Description</b>
Attribute Value	Enter all valid attribute values. For example, if the resource attribute is Temperature, attribute values could be 500 degrees, 550 degrees, 600 degrees, and so on.  Attribute values appear below the attribute within the tree of the Model Workspace.  <b>Note:</b> You can define as many attribute values as needed. Attribute values can be deleted or renamed.
Notes	Enter relevant notes.

---

Attribute Properties - Values Tab Field	Description
Color	<p>To assign a color to the attribute, select a color from the Color list.</p> <p>To display attribute colors within Production Scheduling, see Setting Up the Scenario Properties - Attribute Highlight Order Tab, page 7-5.</p>

Repeat the step above to create additional values for your attribute.

To remove a value, select the value and click Delete.

7. Select the Where Used tab to view the machines assigned to the attribute and items assigned to an attribute value.
8. Click OK.

## Defining Resources

This section provides an overview of resources and discusses how to:

- Define resource general properties.
- Define resource capacity.
- Define throughput.
- Define resource solver options.
- Define resource availability.
- Define resource costs.
- Define resource attributes.
- Define item constraints.
- Define item costs.
- Define item attributes.
- Assign item suppliers.
- Define resource groups.

## Resources Overview

This section discusses:

- Resources.
- Batchable resources.

## Resources

The first step in creating a model involves setting up the resources to use. Before attempting to create a schedule in Production Scheduling, all of the relevant resources must be entered in the system. Resources are any person, place, or thing that is used to perform an operation. Typically, only constraining resources are setup within your model, non constraining resources may be modeled optionally for visibility purposes.

Production Scheduling enables you to organize resources using resource folders. Resource folders organize your resources into logical groupings for quick access. For example, you can create folders for crews, items, machines, storage spaces, and tools. To keep your model organized, create relevant folders to store all of the resources of a particular type. The resource folders can also be deleted if they are obsolete.

Resources are created in the Resources folder within the Model Workspace. Detailed information about each resource is collected and recorded in its properties, including its capacity, availability, cost, constraints, attached documents, and the operations and work orders where it is used.

You can also set up resource groups. Resource groups let you specify two or more resources that are represented together in schedule views.

After you enter resources, you have to specify resource properties including capacity, availability, costs, and constraints. Depending on the type of resource that you are configuring, the type of details required can vary.

The standard resource categories appear in the table below.

Resource Category	Description
Crews	<p>A crew is an individual or group of people who work together to perform an operation. This individual or group works according to a specific calendar that reflects working hours, down time, or vacation time. Any number of calendars can be maintained by Production Scheduling to ensure that the resource is accurately represented for scheduling purposes. The properties for a crew resource enable you to rename the crew, add notes, and set capacity, availability, define solver options, and costs.</p>
Items	<p>Items can be both produced and consumed in a given manufacturing operation.</p> <p>Production Scheduling records a great deal of information about each item used by the system, including inventory levels, storage locations, and any costs associated with the part. Items can be identified by item type (manufactured purchased, saleable, and rebuildable) and associated with attributes values. You can associate purchased items with suppliers and indicate supplier preferences.</p> <p>Storage spaces typically contain many items. You should define all necessary storage spaces prior to entering your items.</p>
Machines	<p>Machines that are required to perform an operation are defined as resources. Machines are affiliated with a calendar that defines when down time or delays are scheduled to occur.</p>
Shared Storage Spaces	<p>Shared storage spaces are locations where items can be stored. A storage space can contain more than one item.</p>

Resource Category	Description
Tools	<p>Tools are anything required to complete an operation. Tools, such as machines, are available according to a calendar that specifies when down time or delays are expected.</p> <p>The properties for the resource enable you to rename the resource, add notes, and set capacity, availability, and costs.</p>
Suppliers	<p>Suppliers are defined as any vendor who supplies purchased items or materials that are required to complete an operation or routing. Supplier data includes lead times, order multiples, and supplier preference in the event that multiple suppliers are available to supply the same purchased item or material. When you define a purchased item in the model, you can associate the item with a supplier. However, suppliers must be defined in the model before they can be associated with purchased items.</p> <p>This category acts independently of the Supply and Demand Editor where supply events are entered. It can provide a quick way to theoretically replenish inventory from a vendor at a strategic point in the schedule without specifying all of the details necessary for creating a purchase order.</p>

## Batchable Resources

A batchable resource can be described as a machine, oven, or kiln that processes many items simultaneously. Batchable resources must share one or more similar attribute such as temperature, color, or duration. Typically, these resources have several spots, such as locations or racks. When an item is placed within a batchable resource, the item consumes one or more of these spots. Depending on the characteristics of the operation and resource, the door to the batchable resource can be periodically opened throughout the duration of the operation, or the door must remain closed until the operation is complete.

When defining a resource as *Batchable*, you must define a minimum and maximum capacity, and a pull-forward window that allows a resource to be filled to its defined minimum capacity. If a minimum capacity is required before setting up a machine to run a certain job type, then the Production Scheduling solver may require subsequent operations to be pulled forward to achieve the defined minimum capacity. However, it

is important to note that target minimum capacity is considered a soft constraint. This means that if no operations can be pulled forward to fulfill the target minimum usage (due to the pull forward window) or if there is not enough demand in the model, then the minimum capacity can be violated and an exception is displayed.

See "Defining Resource Capacity, page 5-9," *Creating Production Scheduling Models, Production Scheduling*

When defining item attributes, you associate one or more attributes and attribute values to the item. For example when processing aluminum, it is required to cook certain items together at the same temperature for the same duration to achieve certain alloy characteristics. Items that share the same attributes and values are grouped together, for example both temperature and duration. If you decided to group by one attribute type, then the schedule may include several jobs running sequentially within a batchable window, which allows an oven door to open and close to put items in and out during the period in which the oven is heated to a certain temperature.

See "Defining Item Attributes, page 5-26," *Creating Production Scheduling Models, Production Scheduling*.

Operations that use a batchable resource are grouped by attribute. If this is one attribute (such as temperature), then all operations that have the same temperature are grouped together up to the maximum capacity of the resource. If you group by more than one attribute (for example temperature and duration), then all operations sharing the same duration and temperature are run together according to the resource's defined maximum capacity.

See "Defining Resource Attributes, page 5-20," *Creating Production Scheduling Models, Production Scheduling*.

**Note:** A batchable resource can only occur once in a routing.

Setting up batchable resource attributes is a multistep process. The following list provides the high-level steps to setting up batchable resources:

1. Define resource attributes and values using the attribute Properties window.

See "Defining Attributes, page 5-1," *Creating Production Scheduling Models, Production Scheduling*.

2. Assign item attributes using the item Properties window.

See "Defining Item Attributes, page 5-26," *Creating Production Scheduling Models, Production Scheduling*.

3. Set up one or more resources as a batchable resource, and assign the resource attributes using the resource Properties window.

This includes the resource Properties - Capacity tab and the resource Properties - Attribute Processing tab.

See "Defining Resource Attributes, page 5-20," Creating Production Scheduling Models, *Production Scheduling*.

4. Set up the operation.

If more than one resource can run the operation, then a resource set must be defined. When defining the resource set, on the Link Properties page, the Capacity Required field should indicate the number of spots consumed by an item. For example, if an item takes up two spots in an oven, then the Capacity Required field would be set to 2.

See "Creating Item Sets, page 5-47" and "Creating Resource Sets, page 5-48," Creating Production Scheduling Models, *Production Scheduling*.

## Defining Resource General Properties

To define resource general properties:

1. Right-click a resource, and select the General tab.
2. Complete these fields:

**Note:** Item and shared storage space resources display only Code and Notes fields.

---

Resource Properties - General Tab Field	Description
Code	Specify a name or a unique code for the resource.
Department	Enter the department to which the resource belongs.
Last Operation Run	Specify the last operation run for the resource. This value is used to facilitate immediate changeovers, if required. This field requires the definition of an operation that uses this resource. This is an optional field and does not appear for suppliers or items.
Attached Document	Specify the path to document providing additional information. This field is optional and does not appear for suppliers or items.

---

<b>Resource Properties - General Tab Field</b>	<b>Description</b>
Notes	Specify any supplemental information about the resource. This field is optional.

3. Click OK.

## Defining Resource Capacity

This section provides an overview of resource capacity and discusses how to define resource capacity.

### Resource Capacity Overview

Resource capacity is the potential amount of production that a resource can complete. Resource capacity is defined differently for each resource category.

- For crews and tools, capacity indicates the number of simultaneous operations that can be run on that resources.
- For machines, capacity indicates the number of simultaneous functions that can be performed by that resource when available.

Machines can also be designated as Batchable.

See "Batchable Resources, page 5-6," *Creating Production Scheduling Models, Production Scheduling*.

You can also indicate the dynamic capacity of each resource. This feature enables you to specify when and to what level the capacity of the resource might vary, due to varying crew sizes, seasonality, or regularly scheduled maintenance.

### Defining Resource Capacity

Capacity applies to crews, machines, and tools.

#### To define resource capacity:

1. Right-click a resource and select the Capacity tab.
2. Complete these fields:

Resource Properties - Capacity Tab Field	Description
Single	Select this option for single capacity resources.
Multiple	Select this option for multi-capacity resources and specify the Maximum field.
Batchable	<p>Select to indicate that this resource is a batchable resource. When this radio button is selected the Minimum, Maximum, and Pull Forward Window fields are active. This option is only available on machines, not crews and not tools.</p> <p><b>Note:</b> If this option is selected and this resource is a member of a resource set, all members of the resource set must also be Batchable.</p>
Minimum	<p>See "Batchable Resources, page 5-6", <i>Creating Production Scheduling Models, Production Scheduling</i>.</p> <p>Enter the minimum spot capacity limit. The system enters a value of 1 by default. The minimum can not be greater than the maximum. This field is only available when Batchable is selected as the Capacity Type.</p> <p>The minimum spot capacity is a soft constraint, which means that if there is not enough demand within the Pull Forward Window to fill the resource to the minimum, it may be violated. An exception is generated to inform you when this occurs.</p>
Maximum	<p>Enter the maximum spots for this resource if the resource is Batchable. The system enters a value of 2 by default.</p> <p>Enter the maximum number of resources in this pool if the resource type is Multi-Capacity.</p>

---

Resource Properties - Capacity Tab Field	Description
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Pull Forward Window	Enter the period of time that the solver is permitted to pull operations that have the same attributes forward to fill the resource to at least the minimum batch capacity. The system enters a value of 7 days by default. This field is only available when Batchable is selected as the Capacity Type.
---------------------	---

---

3. To define dynamic capacity for multi-capacity resources with a varying capacity level, click Add and enter the following:

---

Resource Properties - Capacity Tab Field	Description
--	-------------

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Date	Enter the date when the capacity changes.
Value	Enter the revised maximum capacity. The value must be less than or equal to the Maximum Capacity value.

---

To define additional dynamic capacity, repeat the step above.

To remove a dynamic capacity entry, select the row and click Delete.

4. Click OK.

## Defining Throughput

This section provides an overview of throughput and an example of throughput rate, and discusses how to define throughput for a resource.

### Throughput Overview

The purpose of defining throughput is to adjust operation time to complete the operation in a given interval. For example, if the speed of a line changes on a daily or weekly basis based on available labor, operation time can be increased or decreased.

Production Scheduling enables a user to define dynamic throughput percentages on a given resource for a specific effective date. It also recognizes when throughput is faster or slower when creating a schedule. On a resource, the throughput is defined as any percentage greater than or equal to 0 (zero) percent. When this resource is utilized in an operation (whether it be in a demand driven or work order driven model), the speed at which the operation runs is dynamically modified based on the defined throughput

percentage. A resource may also run at a rate which is greater than 100 percent throughput.

### Example of Throughput Rate

This example assume that it takes 15 minutes to make a batch of 25 units of Item A, which achieves a 100 percent throughput rate.

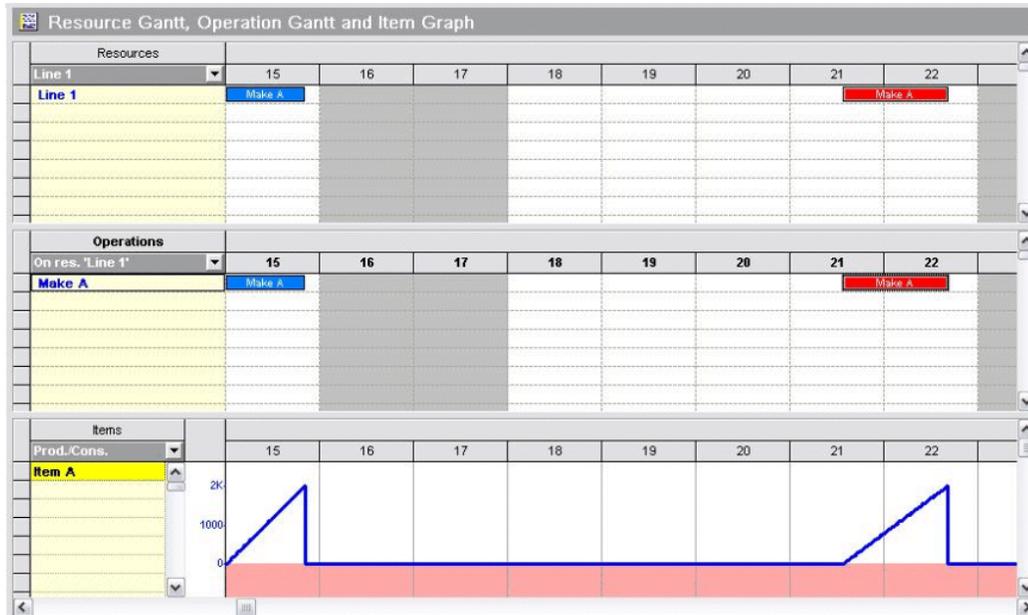
This diagram illustrates this manufacturing process with a throughput rate of 100 percent:



Assume that the user determines that in week two of the schedule horizon, Line 1 will run at a 75 percent throughput rate. Also, an additional order for 2000 units is required on the Friday and the operation will be run JIT.

The first thing that the user must do is access the resource properties for Line 1, select the Throughput tab and define a 75 percent throughput value for the resource.

The user then navigates to a schedule view, performs a solve, and begins analyzing the schedule using the combined Resource Gantt, Operation Gantt, Item Graph. Looking at the item graph, the rate at which Item A is being produced at the end of week 2 is at a slower rate. It is being produced at a 75 percent throughput rate.



## Defining Throughput

**To define throughput for a resource:**

1. Right-click a resource, and select Properties.
2. Select the Throughput tab.
3. Click Add, and complete the fields below.

---

<b>Resource Properties - Throughput Tab Field</b>	<b>Description</b>
Effective Dates	Enter the effective date of the schedule horizon.
Description	Enter a description that explains the change in throughput.
Throughput %	Enter the percent at which you want this line to run. For example, to run at 75 percent, enter 75.00%.

---

4. Click OK.

## Defining Resource Solver Options

Solver Options apply to crews, machines, and tools.

**To define resource solver options:**

1. From the Model Workspace, right-click a resource, and select Properties.
2. Select the Solver Options tab.
3. Complete these fields:

Resource Properties - Solver Option Tab Field	Description
Minimize Changeovers	Select this option if changeover minimization is important for this machine, and if this machine is not considered a campaign run optimized resource. Otherwise, select Minimize Work In Progress.
Use Prebuild Maximum	This option is available if you have selected Minimize Changeovers. When meeting a demand, prebuild maximum is the amount of time prior to the point in time that the resource is required to fulfill the demand that the solver will look to minimize changeovers on this resource. For example, if you specify seven days, the solver considers the operations that are running that resource for the past seven days when minimizing changeovers.
Minimize Work In Progress	Select this option if changeover minimization or campaign run optimization is not required for this resource. The solver considers changeovers if specified, but the changeovers are not considered by the changeover minimization algorithm.
Use Campaign Run Optimization	Select this option to configure this resource to operate in defined run lengths. This option is only available for single-capacity resources, and the Enable Campaign Run Optimization option must be selected in the Model Properties window. Campaign Run Optimization requires a separate license.  See "Setting Up Campaign Run Optimization, page 8-24," <i>Configuring Solver Options, Production Scheduling</i> .
Minimum Cycle Time	Enter a value and select the time measurement required to cycle through demand for the items that are produced. Time measurement options are: <i>Shift, Days, and Weeks</i> .

Resource Properties - Solver Option Tab Field	Description
Minimize Changeovers between cycles	Select to indicate that you want Production Scheduling to consider the operations that ran in the previous cycle. If possible, the application schedules an operation that can run on this resource without a changeover.
Offload Threshold %	Enter the percentage of capacity above which Production Scheduling offloads production to alternate resources in the set.
Use Prebuild Target	Select this option to check utilization when making offloading decisions
Prebuild Target	<p>Specifies the amount of time prior to the point in time that the resource is required to fulfill the demand on time. The prebuild target is used to check utilization when making offloading decisions. You must specify a prebuild target value if this option is selected. Available options are: <i>Minutes</i> , <i>Hours</i>, <i>Shifts</i>, <i>Days</i>, <i>Weeks</i>.</p> <p>Resource offloading enables you to dictate resource load levels prior to the utilization of an alternate resource within a set. Using the Prebuild Target option, you can define the timefence.</p> <p>This option is not enabled automatically. It must be explicitly set. To determine the best value for your needs, you need to experiment with different values and understand the impact on the quality of your schedule.</p>

Resource Properties - Solver Option Tab Field	Description
Use Upstream Operation Buffering	<p>Select to indicate that the solver should attempt to use upstream operation buffering for the resource.</p> <p>In some manufacturing environments, it may be desirable that a resource continues to run for as long as possible. This behavior may be dictated by a physical property of the device, such as a clean-out or purging that must occur after the resource has stopped running for some period of time. Select this option to indicate that the solver may place operations in continuous order so that the resource runs for as long a possible.</p> <p>Production Scheduling strives to create a highly optimized schedule, meeting demands as closely as possible to their request dates in order to avoid unnecessary inventory buildup and carry costs.</p>
Target Buffer Size	<p>Enter a value to indicate that the desired minimum amount of operations that the chosen resource should strive to run continuously before starting. This option is used in conjunction with the Use Upstream Operation Buffering option.</p>
Setup	<p>Applicable to machine resources only. Select this option to define changeovers associated with machine as setup changeovers, which will be displayed to left of operation to indicate it occurs before operation.</p>
Cleanup	<p>Applicable to machine resources only. Select this option to define changeovers associated with machine as cleanup changeovers, which will be displayed to right of operation to indicate it occurs after operation.</p>

Resource Properties - Solver Option Tab Field	Description
Relax Calendar and Capacity Constraints	Select this option to relax all constraints on this resource including any capacity and calendar associated with this resource.
Capacity Constrained Resource	<p>Select this option to designate this resource as a capacity constrained resource. You must select the Use Theory of Constraints Principles option in the Model or in a schedule before you use this option.</p> <p>See "Setting Up the Scenario Properties - General Page, page 7-2," <i>Configuring Scenario Properties, Production Scheduling</i>.</p>
Minimize Resource Idle Time when using Prebuild	<p>Select this option to minimize idle time.</p> <p>When using Prebuild as a scheduling strategy, sometimes the sequence of operations to fulfill demands results in idle time on a resource. Conversely, the best sequence of operations to minimize idle time may not necessarily fulfill demands on time.</p>

4. Click OK.

## Defining Resource Availability

Availability applies to crews, machines, and tools.

### To define resource availability:

1. From the Model Workspace, right-click a resource and select Properties.
2. Select the Availability tab.
3. Complete these fields:

<b>Resource Properties - Availability Tab Field</b>	<b>Description</b>
Calendar	<p>Select an applicable calendar. If no suitable calendar entries appear, click Open Calendar Editor, and create an appropriate calendar for this resource.</p>
Fixed Timefence	<p>For suppliers, enter the fixed amount of time beginning at the start of the scheduling horizon that precedes any supplier lead time. For all other resources, enter the time period that the schedule is to remain fixed for this resource.</p> <p>A timefence is a period of time when operations are not altered for a crew, machine, or tool resource. During the initial solve or subsequent repairs, the solver is only given the freedom to schedule other operations after the timefence ends. Any work order operations that are active or have a firm status of Firm Start, Firm End, or Firm Range and fall within this timefence may be scheduled in within the fixed timefence.</p> <p>Timefences are established to maintain the current schedule for critical resources so that they are not affected by any scheduling changes before the next schedule is finalized. A timefence is depicted in a schedule view using a red line in the Gantt view.</p> <p>When the schedule is modified and solved again, the operations that are assigned to this resource remain the same as the last schedule during the fixed timefence period.</p>

Resource Properties - Availability Tab Field	Description
Enforce Horizon Start	<p>Select to move forward all operations running behind on various machines, without changing the sequence of the operations and consider upstream or downstream dependencies.</p> <p>There are a variety of different scenarios associated with this feature in regards to why operations may appear running in the past. For example, work order operations that have a Firm Start Date, Firm End Date, or Firm Date Range in the past, several work order operations that have an active status on the work order routing operation step that conflicts with another work order, and so on.</p>
Shifts	<p>This region displays the available shift calendars defined in the model. Check the shifts you want to assign to the resource.</p>

4. Click OK.

## Defining Resource Costs

Resource costs are costs incurred when a resource is used and can be defined for a variety of resources including crews, items, machines, and tools. Machine costs are used by the Campaign Run Optimization (CRO) algorithm, which is not the standard base solver in Production Scheduling. Machine, crew, and tool costs are used for reporting purposes if the CRO algorithm is not being used. Carrying and stock-out costs are recorded for items. Setup and operating costs are gathered for all of the other resources. The base Production Scheduling solver does not use these costs.

**Note:** The cost period that appears in the Costs tab is set in scenario properties window. From the Model Workspace, right-click the scenario and select Properties. Use the Fixed Costs field to assign a value and select time unit from the list to the right. This time unit is then used by the resource costs, the item costs, and the operation costs.

### To define a machine, crew, or tool resource costs:

1. From the Model Workspace, right-click a machine resource, and select Properties.

2. Select the Costs tab.
3. Complete these fields:

Resource Properties - Costs Tab Field	Description
Setup Cost	Specify a fixed cost that is incurred each time that the resource is used. This cost applies to crews, machines, and tools only.
Operating Cost	Specify a cost that is incurred over time for the duration that the resource is used. This cost applies to crews, machines, and tools only.

4. Click OK.

## Defining Resource Attributes

Use this procedure to inform the Production Scheduling solver which attributes should be used on this resource when grouping operations of the same type together. This is essentially creating windows of attribute types.

### To define machine resource attributes:

1. From the Model Workspace, right-click a machine resource, and select Properties.
2. Select the Attribute Processing tab.
3. If you are using CRO and want the solve to apply your ideal sequence, select Apply User-Defined Ideal Sequence option.
4. Use the Move Selection Up and Move Selection Down arrows to adjust the order of operations in the Ideal sequence box.
5. Check the attributes you want to assign.  
Available attributes appear to the left.  
See "Defining Resource Capacity, page 5-9," *Creating Production Scheduling Models, Production Scheduling*.
6. Set the attribute-based changeovers as Concurrently or Sequentially if there are multiple attributes.  
Concurrently - If selected, the maximum time and maximum cost is the applicable changeover rule.

Sequentially - If selected, the sum of both time and cost is relevant from a changeover perspective.

It is important to note that in many cases, the traditional manner in which changeovers are evaluated is via the use of wildcard "else" rules and is represented usually by a "\*" to and from rule on the machine. In this case, the rules would likely not want to be summed in terms of time or cost, so these should not be included in the concurrent or sequential calculation IF other rules are applicable.

7. Click OK.

## Changing Multiple Reusable Resources

In Production Scheduling, you can change multiple reusable resources at one time to change solver options, availability, and costs settings.

### To change the properties of multiple resources:

1. From the Model Workspace, select the resources that you want to change by holding down the Shift key and highlighting the appropriate resources or folders. If the resources or folders are not listed sequentially, hold down the Ctrl key and select the individual resources.

**Note:** If you select a folder, all resources in that folder are considered.

2. Right-click and choose Change.
3. Select the Solver Options tab and adjust the necessary solver settings.
4. Select the Availability tab and adjust the availability options.
5. Select the Cost tab and adjust the setup and operation cost settings.
6. Click OK.
7. To view your changes, select one of the modified resources.

## Defining Item Constraints

You can track item and shared storage space constraints including minimum and maximum quantities of items, and shared storage space resources.

The Constraints tab is available for only item and shared storage space resources. When solving, the system attempts to create a schedule that meets the item levels as closely as possible. The minimum stock value is a hard constraint for work in process components and a hard constraint for items with order requirements. Safety stock is a soft constraint that can be violated if necessary. Safety stock should be replenished immediately after a

safety stock violation occurs.

**To define item constraints:**

1. From the Model Workspace, right-click an item and select Properties.
2. Select the Constraints tab.
3. Complete these fields:

---

<b>Item Properties - Constraints Tab Field</b>	<b>Description</b>
Unit of Measure	Select a unit of measure for the item. All units of measure are available from the global list.
Display Precision	Specify the number of decimal places. For example, the number 5.125 has three decimal places so the precision is three. Setting a precision value is required when items are not measured using whole numbers (for example, by weight).
Minimum	For items only, specify the minimum amount of this item to be carried in inventory. If the minimum amount of this item is going to be violated while solving the schedule, the system tries to delay the operation as long as possible to allow replenishment. If restocking does not happen, then the solve fails, generating an error message.
Maximum	For items only, specify the maximum amount of this part to be carried in inventory. Item Maximum constraints are not respected by the solver and are for exception reporting only. If they are violated, then an exception will be issued
Relax Minimum	Select this option to ignore minimum constraint values for this resource during a solve. Relaxing this constraint allows the values for this item to fall below the defined minimum. Replenishment activities are not planned.

---

Item Properties - Constraints Tab Field	Description
Relax Maximum	<p>Select this option to ignore minimum constraint values for this resource during a solve.</p> <p>If you relax the minimum and maximum constraint, you should monitor the item graph for potential violations.</p>
Storage Space	<p>Select a storage location. An item can be assigned to only one shared storage space. The assigned storage space must have the capacity to store the initial inventories for all items allocated to it; otherwise an error message is generated.</p> <p>Storage space is for reporting only. The solver does not respect storage constraints.</p>
units of item per	<p>Specify a value that represents how much of one storage unit of space (for example, a pallet, cubic meters, or other unit of measure) is used for one unit of item. For example, if a tote can store 100 units of this item, then <i>units of item per</i> the storage is represented as .01.</p>

4. Click Add to define safety stock constraints and enter the following:
  - Date - Specify the starting date for the safety level. This field is optional and applicable to when you define safety stock levels. If you always want to have a safety level, set this date to the beginning of your schedule horizon.
  - Safety Level - Specify the item quantity (a number less than the number in the Maximum field) that represents the desired safety stock. You can input varying safety levels (for example, to account for seasonal variations) if required.

To define additional safety stock, repeat the step above. You can enter multiple Safety values. The system uses the first safety stock entry until the next entered date.

To remove a safety stock entry, select the row and click Delete.

5. Click OK.

## Defining Item On Hand

On hand defines the quantity of an item are currently available. You can define the On Hand quantity and display all reservation assigned to the item supply from the On Hand tab in the item Properties window. Reservations may be added from this tab as well for downstream demand types.

### To define item on hand and reservations:

1. From the Model Workspace, right-click an item and select Properties.
2. Select the On Hand tab.
3. Complete these fields:

Item Properties- On Hand Tab Field	Description
On hand (start level)	Displays the current on hand inventory level for the item. Enter a value to update the on hand quantity.
Reserved	Displays the total reservations assigned against the item. This is a display only field that is generated by the total reservation quantities displayed in the Reservation region at the bottom of the window.
Add (button)	Click to create a demand reservation.
Delete (button)	Click to remove a reservation.
Properties (button)	Click to view or modify a reservation.
Name	Displays the reservation name.
Item	Displays the item reserved.
Serial Number	Displays item serial number.
Quantity	Displays the quantity reserved.
Demand Type	Displays the demand side type. Valid values are Sales Order, Forecast, Transfer Order, and Work Order.

<b>Item Properties- On Hand Tab Field</b>	<b>Description</b>
Demand	Displays the supply side code.
Description	Displays the notes or comments assigned to the reservation.

4. Click OK.

Use the On Hand tab to add, delete, or view reservation properties.

**To add a demand reservation:**

1. Click Add.
2. Enter the reservation name. This is not required data and can repeat across for other reservations.
3. In the Quantity field, enter the number of items to be reserved.  
The total quantity of the reservation should not exceed the total quantity of the work order.
4. If applicable, enter serial number.
5. Select the Demand side Type for the reservation.
6. Select the Demand side Code.
7. Enter any notes or description in the Notes field.
8. Click OK.

The total reserved quantity defined in the On Hand tab appears in the Reserved field at the top of the window. On hand item reservations are also reflected in the Work Order Editor - Supply Reservation tab and the Supply and Demand Editor - Demand Reservations tab as appropriate.

9. Solve the model and review the solver log for any reservation errors.  
If the reservations exceed available quantity, an error appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To view or modify a demand reservation:**

1. Select a reservation and click Properties.
2. Modify the demand reservation fields as needed and click OK.

3. If updates are made, solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To remove a demand reservation, select the reservation and click Delete.**

**To view the demand line item in the Supply & Demand Editor, right-click the Demand column for the reservation and select Open.**

**To display the work order in the Production Pegging view, right-click the Demand column for the reservation and select Open Production Pegging Gantt.**

## Defining Item Costs

Item costs are only considered by the Campaign Run Optimization (CRO) solver engine and are also used for reporting Key Performance Indicators. The base solver does not consider these costs when creating a production schedule. If you are using the CRO algorithm, these costs must be defined.

To define item costs:

1. From the Model Workspace, right-click an item and select Properties.
2. Select the Costs tab.
3. Complete these fields:

Item Properties - Costs Tab Field	Description
Carrying	Specify the unit cost of carrying this item for the period. This cost applies to items only.
Stock-out	Specify the unit cost that is associated with running out of stock for this item during the period. This cost applies to items only.
Safety Stock Violation	Specify the cost that is associated with violating the safety stock. This cost applies to items only.

4. Click OK.

## Defining Item Attributes

### To define item attributes:

1. From the Model Workspace, right-click an item and select Properties.
2. Select the Attributes tab.
3. Complete these fields:

Item Properties - Attributes Tab Field	Description
Manufactured	Select this option if the item is manufactured.
Purchased	Select this option if the item is purchased.
Saleable	Select this option to indicate that the item should be available on the item pick list in the Supply and Demand Editor.
Rebuildable	Select this option to identify items that are installed, removed, and refurbished and are often removed from an asset when performing maintenance activities. An example would be rebuilding a motor from a defective fuel pump.

4. To assign an attribute to an item, check the attribute name and, if necessary, assign the appropriate attribute value.

For example, select Duration or Temperature. Any other items sharing the same attribute assignments are eligible to share the same batchable resource.

The Attribute Type and Attribute Value fields are used in conjunction with batchable resources and changeover rules. See *Defining Attributes*, page 5-1 for more information. For example, an attribute type might be Temperature and have several values such as 500 Degrees, 450 Degrees, and so on. Once these are defined, you can associate them to items. Any items that share the same attribute assignments are eligible to share the same batchable resource and changeover rules.

See "Batchable Resources, page 5-6," *Creating Production Scheduling Models, Production Scheduling*.

5. If your model uses synchronization for Make/Pack environment, set the Synchronization fields as follows:

1. Select Use Consumption Time Target.
2. Enter a Consumption Time Target value and select the value duration from list (Seconds, Minutes, Hours, Days, or Weeks)

Production Scheduling uses this information to generate synchronization exceptions and provide key performance indicators (KPIs) for consumption times in the Materials tab of the KPI Editor.

6. Click OK.

## Assigning Item Suppliers

All items in the model must have a source of supply that can be either a manufacturing operation or a supplier item lead time. For purchased items, it is recommended to set up a supplier representing a lead time in which the item can be procured, and a large order multiple. This creates a material constrained schedule.

**Note:** The Suppliers tab only appears if the Purchased option is selected in the item Properties - Attributes tab.

### To assign suppliers for purchased items:

1. From the Model Workspace, right-click an item and select Properties.
2. Select the Suppliers tab.
3. Complete these fields:

Item Properties - Suppliers Tab Field	Description
Receiving Calendar	Select a receiving calendar for the item. By associating the item with a calendar, the item can not be received during certain calendar events, for example during a weekend. If no suitable calendars appear, click the Open Calendar Editor button, and create an appropriate receiving calendar for the item.
Supplier	Check a supplier to associate it with this item if it is a purchased item. Suppliers must be defined as a resource in the model before they appear in this list.

Item Properties - Suppliers Tab Field	Description
Preference	<p>Assign a supplier preference. This value must be a positive integer of 1 or greater. This value is used in the event that multiple suppliers can supply the same item.</p> <p>Production Scheduling selects the preferred supplier unless the secondary supplier has a shorter lead time, and the material is needed within this shorter lead time.</p>
Lead Time	<p>Specify the lead time necessary to supply the purchased item.</p>
Lead Time Unit	<p>Assign the lead time unit of measure. Available options are <i>Seconds</i>, <i>Minutes</i>, <i>Hours</i>, <i>Days</i>, and <i>Weeks</i>.</p>
Order Multiple	<p>Specify the standard order multiple for the purchased item. For example, items must be purchased in batches of 1,000 units.</p>
Buffer	<p>Select a buffer value for the supplier if you are using Theory of Constraints principals to create your schedule. This value represents the time between the supply event and the start of the operation that uses the item. This value is used when Production Scheduling calculates purchase order arrive dates. You must create a buffer before you can select it from this list.</p>

4. Click OK.

## Changing Multiple Items

In Production Scheduling, you can change multiple items at one time to change constraints, costs, attributes, and suppliers.

To change the properties of multiple items:

1. From the Model Workspace, select the items that you want to change by holding down the Shift key and highlighting the appropriate items or folders. If the items or folders are not listed sequentially, hold down the Ctrl key and select the individual items.

**Note:** If you select a folder, all items in that folder are considered.

2. Right-click and choose Change.
3. Select the Constraints tab and adjust the necessary minimum and maximum levels.
4. Select the Costs tab and adjust the carrying, stockout, and safety stock violation settings.
5. Select the Attributes tab and adjust the attributes assigned the items. Check attributes to be assigned and, if necessary, assign the appropriate attribute value.
6. Select the Suppliers tab and adjust the receiving calendar and the supplier attributes.
7. Click OK.
8. To view your changes, select one of the modified items.

## Defining Resource Groups

Resource groups enable multiple resources to be combined as a group when displayed in schedule views or represented in the Changeover Editor (for machines or tools only). Organizing resources into logical groupings can help you to organize your model data. For example, you might want to organize resources by resource type or vendor. Similar to resources, resource groups can be organized in folders. Additionally, resources can belong to more than one resource group.

You can set a default resource group when you first open schedule views. When a schedule view is opened, only those resources in the default group appear in the schedule. Each schedule view can have its own default group, with the currently selected default appearing with a dot beside the name.

### **To define resource groups:**

1. From the Model Workspace, right-click All Resource Groups and select New Group.
2. Right-click the new group, select Properties, and from the General tab, enter group name in the Code field.
3. Select the Attributes tab.
4. In the Used in Views group, select the schedule views for which this resource group will be available.

For groups that consist of only machines or tools, you can also select the Changeover Editor.

5. Click Apply, and then click OK.
6. Expand the All Resources tree.
7. Drag and drop one or more resources into the new group.  
You can assign a resource to more than one group. Press Shift or Ctrl to make multiple selections.

## Defining Visits

This section provides information on the following topics:

- Visit overview.
- Adding a visit.
- Viewing and defining visit properties.
- Creating milestones.
- Modifying milestones.
- Deleting milestones.

## Visit Overview

The scheduling of maintenance resources at a maintenance depot can be quite complex and presents a significant challenge to customers looking to efficiently schedule these resources. Production Scheduling provides the following constructs to provide this functionality:

- Visits - Used to associate to one or more work orders, where the work orders will inherit a Visit "earliest state date" such as the anticipated aircraft arrival into a maintenance depot and the request date associated with the completion of this visit.
- Milestones - Used to specify logical grouping of work orders within a Visit. The combination of Visits and Milestones provide an advanced capability to define task hierarchies and logically and flexibly group work orders together in both concurrent and sequential patterns where work can diverge and converge.
- Work Breakdown Structure - Several new key attributes are added to work orders which can be used for organizing and filtering work orders.

Scheduling visits must take into consideration numerous constraints such as complex task hierarchy relationships, logical groupings of work, maintenance capacity, calendars and more. This becomes increasingly difficult when multiple visits are considered

simultaneously and have competing priorities. You can schedule visits based on the following:

- Visit start/end dates
- Visit status
- Visit milestones
- Task hierarchies
- Crew, machine, tool, and material constraints
- Operation/work order precedence constraints
- Grouping of work based on Work Breakdown Structure (WBS)

See "Scheduling Maintenance Work Orders, page 13-1" for more information.

## Adding a Visit

**To add a visit:**

1. Right-click All Visits from the Model Workspace and select New Visit.  
A new visit appears under All Visits. The visit name is system-generated but can be changed as needed.
2. Enter the appropriate name for the visit and press Enter.  
Visits are sorted alphabetically under the All Visits folder.

## Viewing and Defining Visit Properties

**To view and define visit properties:**

1. Expand the All Visits folder.
2. Right-click the visit you want to view or define and select Properties.
3. From the visit Properties - General tab, review or modify the following fields:

<b>Visit Properties - General Tab Field</b>	<b>Description</b>
Code	Enter the visit code. This is the name of the visit displayed in within Production Scheduling.

Visit Properties - General Tab Field	Description
Earliest Start Date	Represents the earliest date the visit could be scheduled which would typically be the arrival of the aircraft. This is treated as a hard constraint.
Request Date	Represents the desired completion date of the visit.
Start Date	The projected start date of the visit as determined by the Production Scheduling solver based on the various constraints.
Completion Date	The completion date of the visit determined by the Production Scheduling solver.
Type	The visit type associated with the visit. List displays visit types assigned to work orders in the model.  The Visit Type is a user-defined field in cMRO and provides information on the type of Visit being performed. For example, A Checks, B Checks, C Checks are visit types that have very different purposes and characteristics in terms of the scope of work being performed and the resources required to perform the tasks.
Status	The visit status associated with the visit. Available options are Planning, Partially Implemented, and Implemented.  The status of a visit has very important ramifications in cMRO. A visit in "Planning" status essentially has all Work Orders in a draft status where changes can be made liberally. Non-Routine stage work orders are also a part of visits in "Planning" status. Once the visit is pushed to production, it will be in an "Implemented" or "Partially Implemented" status. Work orders are no longer in draft status and non-routine estimates are replaced by actual non-routine work orders.

Visit Properties - General Tab Field	Description
Priority Class	The priority class associated with the visit. Available options are Hot, Committed, or Uncommitted. The highest class is Hot, followed by Committed, and then Uncommitted.
Priority	Represents the relative priority of the Visit compared to other visits. This is important in times where material or resources are constrained and can be used by the solver to resolve conflict. Available options are values 1 to 5. The lower the number, the higher priority that a visit is given.
Notes	Enter relevant notes.

4. Select the Milestones tab to view the milestones assigned to the selected visit. To view milestone properties, select a milestone and click Properties. The Actual Date is the projected completion date of the Milestone determined by Production Scheduling.
5. Select the Work Orders tab to view work orders associated with this visit. Double-click a work order to view it in the Work Order Editor.
6. Select the Operations tab to review operation details and view slack time. To examine slack time details, right-click slack time entry and perform the following as needed:
  - Click Open to display work order in Work Order Editor.
  - Click Open Production Pegging Gantt to display Production Pegging view.
  - Click Open Operation Gantt to display the operation in the Operation Gantt view.
7. Click OK. Click Cancel to close the visit Properties window without saving your changes.

## Creating Milestones

To create milestones:

1. Expand the All Visits folder.
  2. Expand the visit folder. All milestones associated with the visit appear below the visit name in the Model Workspace.
  3. Right-click a visit and select Add Milestone. A milestone appears under the folder with a system-generated number.
  4. Enter the appropriate name for the milestone and press Enter.
- Milestones are sorted alphabetically under the visit.

## Modifying Milestones

To modify milestones:

1. Expand the All Visits folder.
2. Expand the visit folder. All milestones associated with the visit appear below the visit name in the Model Workspace.
3. To rename a milestone, right-click the milestone and select Rename. Enter a new name and press Enter.
4. Right-click a milestone and select Properties.
5. From the milestone Properties - General tab, review or modify the following fields:

Milestone Properties - General Tab Field	Description
Code	Enter the visit code. This is the name of the visit displayed in within Production Scheduling.
Earliest Start Date	<p>The earliest start date of the visit. Earliest Start Date is a hard constraint so work orders which have this as the Next Milestone cannot start before this date. This field is optional.</p> <p>When the Earliest Start Date is defined, the solver will not schedule the Work Order or Milestone before this date.</p>

Milestone Properties - General Tab Field	Description
Target Completion Date	<p>The Target Completion Date is a soft constraint and can be violated due to capacity, material issues or precedent constraints. This field is optional.</p> <p>When the Target Completion Date is defined, the solver will try to respect the Target Completion dates, but it may not be able to due to other constraints such as capacity, calendar, or material constraints.</p>
Actual Start Date	<p>The actual start date of the visit determined by the start time of the earliest operation.</p>
Actual Completion Date	<p>The actual completion date determined by the time of the last operation in the visit.</p>
Actual Date	<p>The projected completion date of the milestone based on the Production Scheduling solver.</p>
Notes	<p>Enter relevant notes.</p>

See to Resequencing Visits, page 13-4 for information on manually resequencing visits and milestones.

6. Select the Work Orders tab to view work orders that are dependent or assigned to this milestone. Double-click a work order to view it in the Work Order Editor.
7. Click OK. Click Cancel to close window without saving your changes.

## Deleting Milestones

To delete milestones:

1. Expand the All Visits folder.
2. Expand the visit folder. All milestones associated with the visit appear below the visit name in the Model Workspace.
3. Right-click a milestone and select Delete. The milestone is removed from the Model Workspace.

## Defining Operations

This section provides information on the following topics:

- Operations overview.
- Creating an operation diagram.
- Designating a primary output.
- Defining operation type.
- Defining operation costs.
- Defining effective dates.
- Defining item requirements.
- Defining requirements for crews, tools, and machines.
- Creating item sets.
- Creating resource sets.
- Creating all of sets.
- Changing multiple operations.

## Operations Overview

This section discusses:

- Operations
- Operation groups
- Duration
- Lot sizes
- Primary outputs
- Identify operations

## Operations

An operation is a production event that consumes and produces items, and uses crews,

machines, tools, and vendor capacity. Operations establish associations between different resources. Operations combine to form routings that are used to produce specific items. An operation can have various inputs and outputs, depending on the complexity of your production process. Model all operations of interest in your production process in order to generate a production schedule.

Operations are defined by the resources that they require. Operations can transform materials; they can consume one or more items when they start, and produce one or more items when they complete. Operations use resources and have durations. All operations have the following characteristics:

Operation Characteristic	Description
Resource requirements	An operation can have capacity requirements for a resource that it needs. An operation can require more than one resource, or one or more of a subset of resources. It can also consume alternate resource sets, for example: crew 1 and machine 1, or crew 2 and machine 2.
Item consumption	All items are consumed when the operation starts. The consumption is a fixed amount that is based on the duration of the operation. An operation can have the flexibility to select from a set of items.
Item production	All items are produced when the operation completes. Production can be a fixed amount or dependent on the duration of the operation. Production rates can also depend upon the resources that are involved.
Costs	Costs can be fixed setup costs or production costs. These costs are used for reporting purposes only.

Once you have set up resources and operations, you can create a diagram by dragging resources from the Model Workspace into an Object Window. If you create item or resource sets, you must also drag buttons from the Resource toolbar into the diagram. All resources are available for use except the shared storage spaces and Attributes.

An operation diagram is a graphic representation of your production environment that enables you to see relationships and make adjustments where necessary. The model also enables you to change the properties of objects so that the application can take into account every detail in your model.

An operation diagram is used to detail all of the resources that are required to complete

the operation and delineate which resource specifies the duration. The capacity and amount of resources that are consumed or produced are also modeled. The operations are created and organized in the Model Workspace. Logical folders are useful for maintaining model structure.

Create operation diagrams, or visual representations of your production environment, by dragging and dropping resources into the diagram, and then connecting them to the operation button. As resources are added to an operation, they appear beneath the operation's button in the Model Workspace.

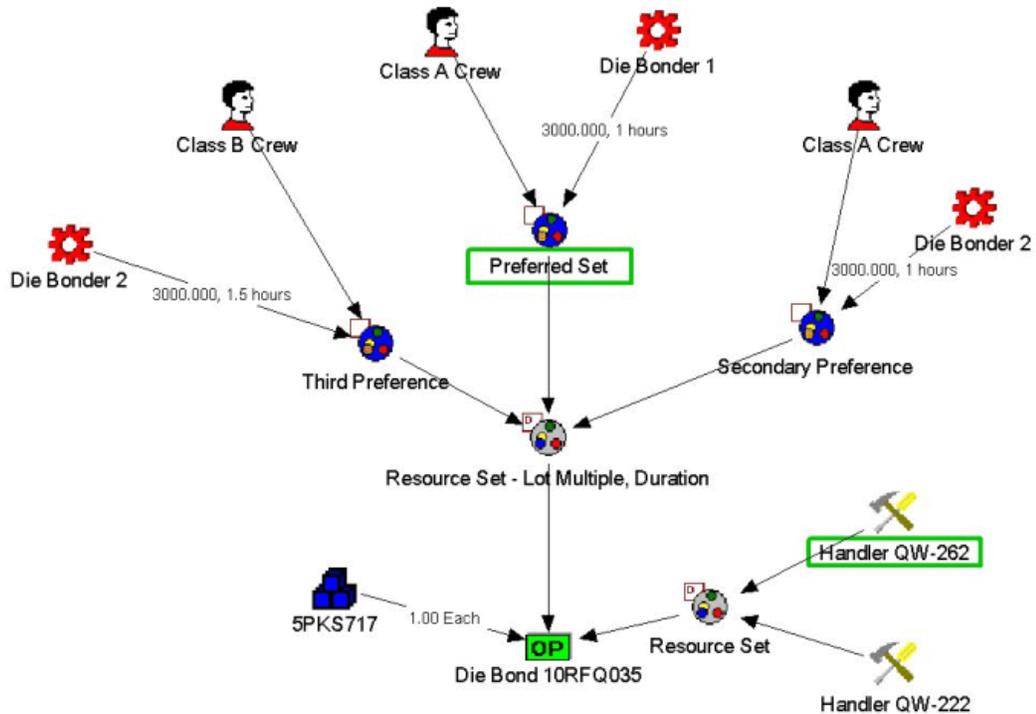
## **Operation Groups**

Operation groups can be created to assist with schedule analysis. Operation groups enable two or more operations to be combined as one within the Operation Gantt schedule view as well as the Changeover Editor. For large models, operation groups filter the schedule views so that you can quickly review those operations, thereby saving time. Applying the same time for changeover to all group members reduces the number of rules required. Create as many groups as you need for your requirements. Operation groups can be organized in folders, similar to operations, if desired. Operations can reside in more than one operation group.

## **Duration**

Every operation must have a defined duration, determined by only one resource or resource set. For example, if an operation uses a machine with a duration of one hour and a crew, Production Scheduling allots one hour for the crew. Using item and resource sets, different durations can be recorded for those resources in the set to complete the same operation. For example, one machine can take much less time to perform an operation than another machine.

This diagram illustrates an operation with a resource-dependent duration specified within a set:



The preferred set, which comprises of Class A Crew and Die Bonder 1 has a duration of one hour. The secondary preference, which comprises of Class A Crew and Die Bonder 2 takes the same amount of time. However, the third preference, which comprises of Class B Crew and Die Bonder 2 has a duration of 1.5 hours to make the same quantity. When run, either Handler QW-222 or Handler QW-262 can be used.

For duration to be attached to elements in a set, the set properties must first have duration selected. Then all of the machines within the set can be defined with a duration attribute. No other durations are permitted in this operation.

## Lot Sizes

Whenever an operation produces more than one identical item, the resulting output is called a lot. For example, consider a stamping machine that produces eight identical items in a single operation. In this example, the lot size is eight.

You can use lots to reduce the total number of operations in your schedule. You can do the following:

- Increase the operation lot-size and duration.
- Define logical lot sizes if physical ones do not exist.

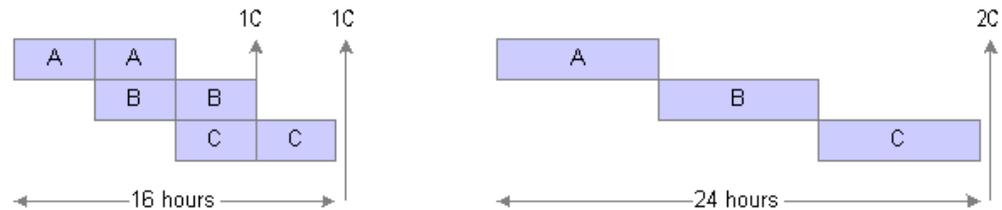
You create a logical lot size by increasing the quantity that an operation produces, as well as increasing its duration. For example, an operation that runs for one minute and produces one item can also be represented as a single operation that runs for ten minutes and produces ten items. By using logical lot sizes, you can dramatically reduce

the total number of operations that the solver must schedule.

**Note:** To avoid excess inventory, lot sizes should be divisible into demand.

Although using logical lot sizes can help you reduce the number of operations in a schedule, it can also artificially increase the amount of time required to produce a specified number of items. Item and precedence relationships are still enforced and because each operation takes longer to complete, subsequent operations are also delayed.

This diagram illustrates the effects of using a logical lot size:



In the first illustration, each operation has a duration of four hours and produces one item. Operations B and C have a precedence relationship of Start after Start. In this example, item C is produced at 12 hours and again at 16 hours. In the second illustration, the number of operations has been reduced using a logical lot size of two. Because operations B and C cannot begin until the previous operation has started, the makespan has been exaggerated to 24 hours.

Crew and machine resources in an operation can, optionally, have a lot multiple attribute. This multiple is applied to all items that are consumed or produced by that operation. A lot multiple is used to specify that an operation can consume or produce different amounts of materials if the operation runs on a different resource. For example, a certain press can have a larger template that enables it to stamp out twice as many items at a time as a smaller template. This situation has a lot multiple of 2. The lot multiple is applied in the same way to all inputs and outputs of the operation, but the lot multiple does not affect the duration of the operation.

Only one resource determines the lot multiple for an operation, although with the use of sets, more than one lot multiple might be specified. Most operations do not need to specify a lot multiple. If a lot multiple is not specified, then the lot multiple is assumed to be 1. With the use of sets, different resource lot multiples can be specified. Within the set configured for a lot multiple, each resource must have a lot multiple recorded. Production Scheduling selects a resource in the set and uses the lot multiple specified for that resource.

Operations can have both a duration and a lot multiple. The duration and lot multiple can depend on different resources. For example, the crew determines the duration of the operation, and the machine determines the lot multiple. Alternatively, they can depend on the same resource. For example, the machine can determine both the

duration and the lot multiple of the operation.

In the event that an operation with an associated work order is offloaded to an alternate machine in a resource set, the item quantity produced by the primary machine will affect the duration of the operation on the alternate machine. The quantity of produced and consumed items will remain the same. The application will calculate the new duration on the alternate machine by applying the production rate of the alternate machine to the item quantity produced by the primary machine.

For example, machine A and machine B are a part of a resource set, and you want to offload an operation with an associated work order from machine A to machine B. The duration of the operation running on machine A is 1 hour, with a lot multiple of 100 units (100 units per hour). The duration of the operation running on machine B is 2 hours, with a lot multiple of 50 units (25 units per hour). The operation produces 1000 units and runs on machine A for 10 hours.

To produce 1000 units on the alternate machine that produces 25 units per hour, the new duration required is 40 hours.

## Primary Outputs

To take advantage of the pegging capabilities of Production Scheduling, the primary output of the operation needs to be identified. Pegging enables you to view all of the item resources and operations associated with each line item in a demand order, and how they have been allocated. In addition, the Resource, Demand, and Operation Gantt views can display all of the resources and operations related to a specific operation "upstream" (backward) or "downstream" (forward). The primary output of an operation can be a specific item . If an operation does not produce any items, a primary output does not need to be designated.

## Identifying Operations

All operations must be identified within Production Scheduling in detail before feasible schedules can be generated. As with resources, when operations are created manually within the application, they are started in the Model Workspace and can be organized with the use of folders.

As with resource folders, operation folders are designed to organize your operations. The organization of operations is defined by you. Production Scheduling does not draw any implications or conclusions from the order. The All Operations and All Resources folders appear in the Model Workspace by default.

Before adding an operation, ensure that all resources have been entered. As with resources, establish a naming convention that clearly and uniquely identifies each operation. Distinctly named operations are helpful when analyzing schedules. Operations in the XML document also have an identifier called `integrationId` , which can be used to ensure uniqueness. The code for the operations can then be named something that is meaningful to the planner.

## Creating an Operation Diagram

### To create an operation diagram:

1. In the Model Workspace, double-click an operation.
2. Select the operation from the drawing window.
3. In the Model Workspace, expand the All Resources and resource subfolders.
4. Click a resource to be added, and drag it into the drawing window.  
Repeat for each resource.
5. From the Resource toolbar, click the Insert Link button.
6. In the operation diagram, click the source button once (produced resource), and then click the destination button (consumed resource).

An arrow appears between the source and the destination with an empty square box in the middle of the line (the resource relationship). When a resource is linked to an operation, the property page for the created arc appears.

7. Specify the following link properties, and then click OK:

Link Property	Description
Capacity Required	Specify the capacity required to run this operation, or accept the default value of 1.
Lot Multiple	Select if the resource uses a lot multiple. A default lot multiple value of 1 is displayed. If you need a larger lot multiple, specify a different value. The value in this field is applicable only if the operation produces an item.
Duration	Select if the resource is determining the duration. If you select this option, select a time unit for the duration. The time unit can be days, hours, minutes, or seconds.
Minimum Run Length - Quantity	Select to specify the size of the production run in terms of quantity of items produced. The value in this field is applicable only if you are using Campaign Run Optimization and the resource type is Machine.

Link Property	Description
Minimum Run Length - Run Time	Specify to specify the size of the production run in terms of run time. The value in this field is applicable only if you are using Campaign Run Optimization and the resource type is Machine.

- Repeat the previous step to link all of the resources with the operation.

**Note:** To have the arrow point in the correct direction, always begin with the source button and end with the destination button. The operation is usually the destination button with one exception: if any items are being produced, then the operation is the source, and the new item button is the destination.

## Designating a Primary Output

To designate a primary output:

- Access the operation diagram.
- Right-click the item that you want to designate as the primary output of the operation.
- Select Primary Output.

## Defining Operation Attributes

There are three activity types of operations: Production, Setup, or Cleanup. Production operations are broken down into units of effort, however, setup and cleanup operations are not broken into units of effort when work orders are scheduled according to their units of effort.

See "Scheduling Work Orders According to Units of Effort Overview, page 8-3," *Configuring Solver Options, Production Scheduling*.

### Example of Setup and Cleanup Operations

A routing produces Item A in a lot multiple of 25 units. The routing includes three operations:

- Operation A, which takes 3 hours.
- Operation B, which takes 2 hours.

- Operation C, which takes 4 hours.

An order for 75 units of Item A is due on January 11th, at 4:30PM. It is scheduled as specified on the work order for a total of 27 hours:

- Operation A for 9 Hours.
- Operation B for 6 Hours.
- Operation C for 12 Hours.

If using the work order units of effort feature, the work order is scheduled how it is executed on the shop floor:

- Inventory is moved between operations in 25 unit increments.
- Makespan is reduced by 10 hours, making the routing run time 17 hours.

See "Scheduling Work Orders According to Units of Effort Overview, page 8-3," *Configuring Solver Options, Production Scheduling*.

If operation A is a setup operation and operation C is a cleanup operation, they only need to be executed once as opposed to three times. Therefore, the setup and cleanup operations only run once per routing. The production operation runs three times, which is according to the routing lot multiple. This reduces the routing run time to a total of 13 hours:

Operation A runs for 3 hours.

Operation B runs for 6 hours.

Operation C runs for 4 hours.

## Defining Operation Attributes

**To define operation attribute:**

1. Access the operation Properties window.
2. Select the Attributes tab.
3. In the Type field, select one of these options: *Production Activity*, *Setup Activity*, or *Cleanup Activity*.
4. Check the operation attributes you want to assign, and, if necessary, assign the appropriate attribute value from the Value list.

## Defining Operation Costs

Operation costs are for reporting purposes only.

**To define operation costs:**

1. Access the operation Properties window.
2. Select the Costs tab.
3. Complete these fields:

<b>Operation Properties - Costs Tab Field</b>	<b>Description</b>
Setup	Specify the one-time cost that is incurred every time that this operation is run (if applicable).
Operating	Specify the cost of running this operation for a specific period of time.

## Defining Item Requirements

When defining item requirements, ensure that the material input quantity specified is according to 1 unit of output of the primary item of operation or the routing. The solver multiplies the quantity specified by the lot multiple, which is specified on the operation resource where lot multiple is specified.

**To define item requirements:**

1. From the operation diagram, access the link Properties window.
2. Complete this field:

<b>Link Properties Field</b>	<b>Description</b>
Quantity	Specify the number of item units that are produced or consumed by one instance of this operation.  The unit of measure that is displayed to the right of the quantity is inherited from the item's property information.

## Defining Requirements for Crews, Tools, and Machines

Use the link Properties window from an operation diagram to define crew, tool, and machine requirements.

**To define requirements for crews, tools and machines:**

1. From the operation diagram, access the link Properties window.
2. Complete these fields:

Link Properties Field	Description
Capacity Required	Specify the capacity required to run this operation, or accept the default value of 1.
Lot Multiple	Select if the resource uses a lot multiple. The system displays a default lot multiple value of 1. If you need a larger lot multiple, specify a different value. The value in this field is only applicable if the operation produces an item.
Duration	Select if the resource is determining the duration. The duration should be specified in accordance to make the defined lot multiple. If you select this option, select a time unit for the duration. The time unit can be days, hours, minutes, or seconds.

## Creating Item Sets

You can define and insert alternate items known as item sets. Item sets (a collection of similar resources) can be used to represent alternatives for items. Production Scheduling selects one component from each set when the operation is scheduled. You can create one or more item set.

**Note:** Since all operations in cMRO are auto-generated, the alternate items imported into Production Scheduling automatically create the necessary item sets.

Sets allow choices to be made that are based on the availability of, and preference for, the operation. Lot multiple specifies the quantity of items produced by an operation while duration specifies how long the operation runs. All operations must have a duration.

To create a item set:

1. Access the operation diagram window.
2. On the Resource toolbar, click Insert Item Set to create an item set.

3. Click an open area of the operation diagram.  
This process creates an empty set. The set button appears in the operation diagram.
4. On the Resource toolbar, click Insert Link.
5. In the operation diagram click the set button, and then click the operation button (in the source-to-destination order).

The set is now linked to the operation, as indicated by a connector line with an arrow pointing to the set.

**Note:** To return the cursor to a pointer at any time, right-click your mouse.

6. On the Model Workspace, drag and drop any item resources into the diagram.
7. On the Resources toolbar, click the Insert Link button.
8. In the operation diagram, click a resource, and then click its Set button.  
Right-click anywhere in the operation diagram to return the cursor to a pointer.
9. To define the properties of resources that are attached to the set, do the following:
  1. Right-click the link between the set and resource button, and select Properties.
  2. In the Preference field, enter a value between 1 and 100 to indicate the priority that you want assigned to this resource.  
The solver selects the resource with the lowest priority, if possible.
  3. In the Capacity Required field, enter the number of that resource that is required to perform the operation.
  4. In the Lot multiple field, enter a value to scale item quantities for the operation.
  5. In the Duration field, enter how long the operation runs.

## Creating Resource Sets

You can define and insert groups of resources known as sets, which can be a resource sets. Resource sets (a collection of similar resources) can be used to represent alternatives for crews, machines, tools, and vendors. Production Scheduling selects one component from each set when the operation is scheduled. Or, if you are using All of sets, it may include several inclusive resources in the set. You can create one or more set. Resource sets enable Production Scheduling to select the most efficient resource for any given point in time, based on preference, capacity, lot multiple, and duration.

Sets allow choices to be made that are based on the availability of, and preference for, the operation. You can also specify lot multiple and duration for resource sets. Lot multiple specifies the quantity of items produced by an operation while duration specifies how long the operation runs. All operations must have a duration.

Sets provide operations with alternatives. For example, Operation A can be designated to use the set of machines M1, M2, and M3. Operation B can be designated to use a different set that also includes the same machines: M1, M2, and M3. By using sets, the schedule has the flexibility of using the most efficient combination of machines M1, M2, and M3 for the two operations. Use item and resource sets whenever options exist for completing part of an operation. By giving the solver alternatives, you have more potential ways of manipulating the schedule.

Lot multiples can appear only once in an operation in either a non-item resource or in a resource set. For the lot multiple attribute to appear in a set, the lot multiple property must be selected in the set's properties. Then all of the elements in the set can be defined with a lot multiple.

**To create a resource set:**

1. Select the Insert "One of" Set button from the toolbar.
2. Move this resource set into the diagram.
3. Right-click on the resource set and select Properties.
4. Select the Attributes tab.
5. Select the Lot Multiple and the Duration check boxes.
6. Click the OK button.
7. Click the Insert button on the toolbar.
8. Click the "1 of" Resource Set icon and then click the operation icon in the operation diagram.

Click the set and operation icons in the source-to-destination order. The set is now linked to the operation, as indicated by a connector line with an arrow pointing to the operation.

**Note:** Right-click your mouse to return the cursor to a pointer at any time.

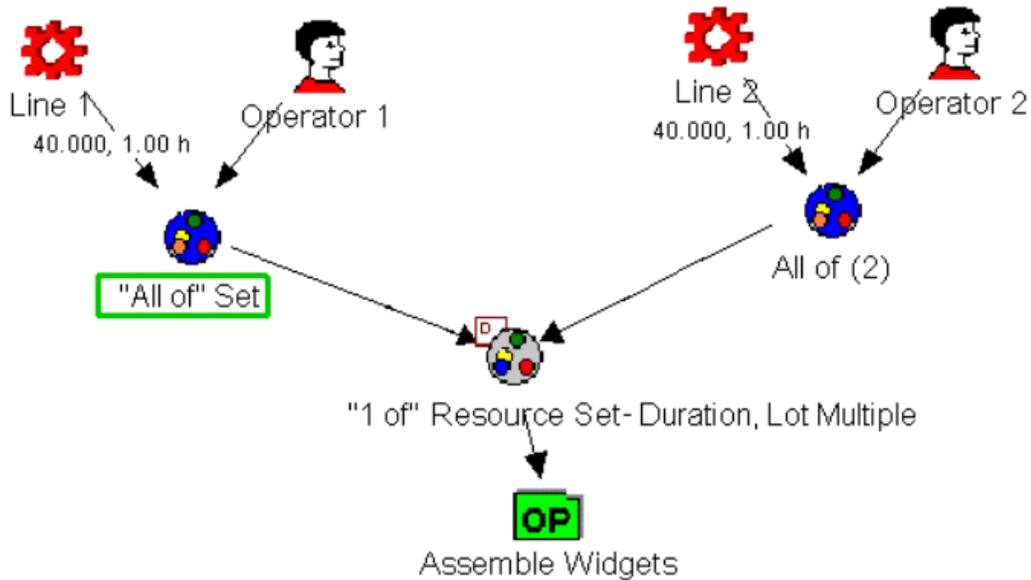
## Creating All of Sets

Resource sets enable you to substitute resources within an operation such as substituting machine 1 for machine 2, or crew 1 for crew 2. All of Set sets enable you to select groups of resources within an operation, such as running an operation on line 1

and operator 1, or running the operation on line 2 and operator 2. In this case, when using All of sets, line 1 can not be run by operator 2, and line 2 cannot be run by operator 1. All of Set is a set type that means all resources in the set are used to run the operation.

**Note:** You must define all possible combinations of resources in your application system for the integration to properly create these sets.

This arc diagram illustrates the example where an operation can be run on line 1 using operator 1, or on line 2 using operator 2.



At the top of the arc diagram, Line 1 and Operator 1 are grouped together as an All of set and Line 2 and Operator 2 are grouped together as an All of set. Line 1 and Operator 1 are the preferred set, which is designated by the green box around the text All of Set. Both All of sets point towards the 1 of Resource Set, which means that only one of the All of set can be selected for the operation.

Please note that:

- Any number of resources, such as one or more, can be included in an "All of" Set. Therefore, it is acceptable to have one resource in an "All of" set.
- When an "All of" set is used, the preference is specified on the arc from the "1 of" set to the "All of" set.
- Any crew, machine, or tool can occur more than one time across a structure, provided that it is included in an "All of" set.
- When consistent resource assignment is enabled for the routing, the same resource

set is used in subsequent operation steps.

See "Setting Routing Properties, page 5-58," *Creating Production Scheduling Models, Production Scheduling*.

**To create All of sets:**

1. Click the Insert "All of" Set button from the toolbar.
2. Move the "All of" Set into the diagram.
3. Click the Insert button on the toolbar.
4. Click the first resource that is to be included in the "All of" set, and then click the "All of" set icon.

Click the resource and All of set icons in the source-to-destination order. The resource is now linked to the set, as indicated by a connector line with an arrow pointing to the set.

5. Determine the duration and lot multiple for the resource as it relates to the operation.

Only one resource of each "All of" set can have the duration and lot multiple defined.

6. Repeat steps 3 and 4 for the remaining resources for the "All of" set.

**Note:** The duration and lot multiple fields are unavailable for additional resources.

Resources can occur in more than one All of Set.

7. Repeat the steps 1 through 6 to create additional "All of" sets for the operation.

The first set created reads "All of" Set. The second set created reads All of Set (2) , and so on. These sets can be renamed, but must remain unique to each other.

**Note:** The All of Set duration and lot multiple can be different across All of Sets.

8. To link the "All of" sets to the "1 of" Resource Set, click the Insert button on the toolbar.

9. Click the first "All of" set icon, and then click the "1 of" Resource Set icon.

Click the "All of" set and "1 of" Resource Set icons in the source-to-destination order. The "All of" set is now linked to the resource set, as indicated by a connector line with an arrow pointing to the set.

When you create the arc between the sets, a Link Properties window appears where you can set a preference for the "All of" set. Enter a 1 in the Preference field to indicate that the set is the preferred set. Enter a 2 in the Preference field to indicate that the set is the second preferred set, and so on for the remaining "All of" sets. The preferred set is indicated with a green box around the "All of" Set text. More than one All of Set can be a preferred set indicated by a 1 in the Preference field.

10. Repeat steps 8 and 9 to link the remaining "All of" sets to the "1 of" Resource Set.

## Changing Multiple Operations

In Production Scheduling, you can change multiple operations at one time to change operation durations and operation lot multiples.

### To change the properties of multiple operations:

1. In the Model Workspace, select the operations that you want to change by holding down the Shift key and selecting the appropriate operations or folders. If the operations or folders are not listed sequentially, hold down the Ctrl key and select the individual operations.

**Note:** If you select a folder, all operations in that folder are considered.

2. Right-click and choose Change
3. Select the General tab and adjust the necessary duration or lot multiples.
  - To modify the Discrete Duration, select the appropriate option as needed.
  - To modify the Discrete Lot Multiple, select the appropriate option as needed.

Adjusting the Discrete Duration or Discrete Lot Multiples updates the corresponding settings in the Attribute tab of the Link window for the selected operations.

4. Select the Attributes tab and adjust the assigned operation attributes. Check the operation attributes you want to assign, and, if necessary, assign the appropriate attribute value from the Value list.
5. Click OK.
6. To view the results of the changes, select one of the modified operations.

## Deleting Multiple Operations

**To delete multiple operations:**

1. In the Model Workspace, select the operations that you want to delete by holding down the Shift key and highlighting the appropriate operations or folders. If the operations or folders are not sequential in the list of demands, hold down the Ctrl key and select the appropriate operations.
2. Right-click and select Delete from the menu.

**Note:** You can also multi-select operation shortcuts in the routing diagrams.

## Defining Routings

This section provides information on the following topics:

- Routings overview.
- Working with routing diagrams.
- Create a new routing and routing diagram.
- Set routing properties.
- Work with buffers.

## Routings Overview

A routing is a sequence of operations that are linked together to represent the production of an item. Instead of each product being composed of many different variables that reside in inventory when complete, this approach provides you with a top-down overview of the process. To minimize inventory, when an order for a finished good is received, a routing or series of routings is scheduled to produce all of the items that are required.

### Example of a Basic Routing

In this example, a bicycle is manufactured. To complete the bike, several processes must occur, among them: cutting the pieces for the frame, milling the pieces, welding the frame together, painting the bike frame, and final assembly. It is also important that some operations are completed before the next operation can start, that is, Starts After End.

This diagram illustrates a basic process:



In the last operation, you can select to produce a subassembly product, which would then be recorded in inventory and may be consumed by a sales order or by another operation.

## Working with Routing Diagrams

This section provides an overview of routing diagrams and precedence relationships, and discusses how to designate primary operations.

### Routing Diagrams Overview

The routing diagram is a graphic representation of the relationships between the operations that make up a routing. Like operations, routings can be organized in folders, if desired. Routings can be oriented in a number of directions for optimal presentation by applying the layout algorithm when you are working in the diagrams.

Within a routing, one operation can be designated as the primary operation. This information is important if you are planning to use the pegging capabilities of Production Scheduling. If you do not select a primary operation in a routing, then you cannot peg "upstream" from the final operation in the routing.

Pegging data is essential for several areas of the application, including various Gantt views, and Key Performance Indicators. To properly generate pegging data, you need to set primary operations in routings and primary output items in operations. The primary operation should be defined as the operation that produces either a subassembly item or the finished product.

The system uses a blue indicator to indicate primary operations in operation diagrams and output items in routing diagrams. You can right-click the operation or item in a diagram and deselect the primary operation option.

### Precedence Relationships Overview

The relationships between the various operations in a routing are specified by the links between operations. These are called precedence relationships, and refer to the relationships and time between operations.

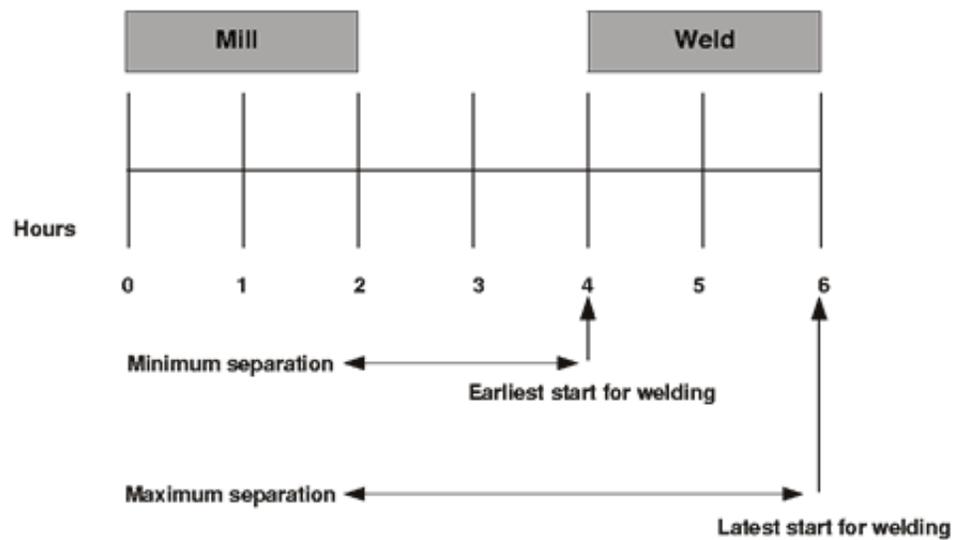
You can specify whether the relationship between two operations is sequential or overlapping. In addition, the amount of time required to move, queue, and set up the next operation is recorded as the minimum separation between the two operations. You can also specify a maximum separation, if required.

In the bike example, if a bike frame must be cut before it is milled, then the relationship

of the weld operation to the mill operation is that milling must start after the cutting has finished. The corresponding precedence constraint properties, resulting from a right-click on the box in the connecting line, indicate that the Mill operation is a Starts After End type of constraint. This type of constraint allows for separation times, which, in this example, are a two-hour minimum separation and a four-hour maximum separation.

Using the diagram below as an additional example, assume that the weld operation starts after the two-hour mill operation has finished and the parts have been cooled for another two hours and the welding must start after a maximum of four hours. This dictates that the weld operation must start after two hours of the end of the mill operation.

This illustration represents the precedence relationship:



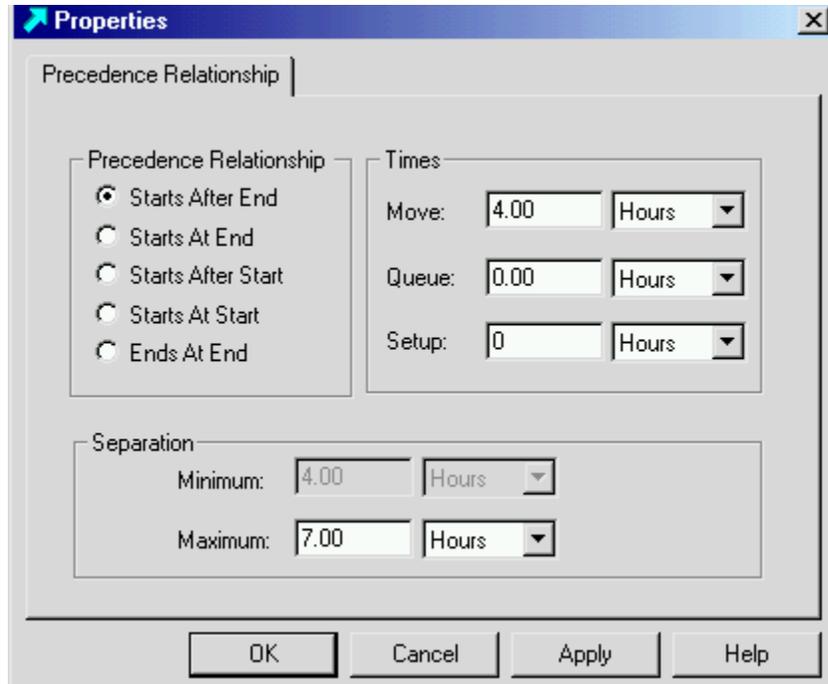
Production Scheduling supports the following precedence relationships:

Name	Diagram Label	Description
Starts After End	S>E	One operation starts after the end of the previous operation, according to the time intervals displayed in the Minimum and Maximum separation fields.
Starts At End	S@E	One operation starts at the exact end of the previous operation.

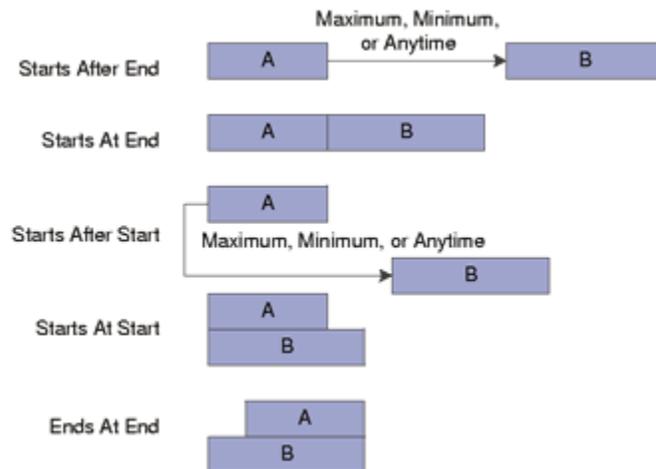
<b>Name</b>	<b>Diagram Label</b>	<b>Description</b>
Starts After Start	S>S	One operation starts after the start of the previous operation, according to the time intervals displayed in the Minimum and Maximum separation fields.
Starts At Start	S@S	One operation starts at the same time as the other operation.
Ends At End	E@E	One operation ends at the same time as the end of the other operation.
Minimum or Maximum	+	When S>S or S>E, indicates that the precedence relationship has a minimum or maximum separation.

In a routing diagram, links between operations display the precedence relationship as text labels on the links between operations.

The following screen shows the properties for a routing link in which you set precedence relationships:



This diagram illustrates the temporal constraints between operations:



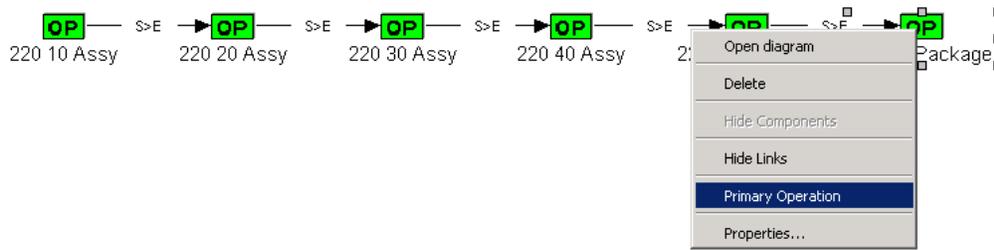
### Designating Primary Operations

To designate primary operations:

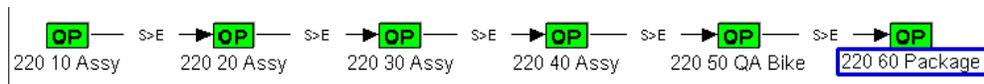
1. Access the routing diagram window.
2. Right-click the operation that you want to designate.
3. Select Primary Operation.

The operation now appears with a blue border around its name.

The following diagrams provide an example of assigning a primary operation.



As a result of selecting Primary Operation, the screen below shows a routing with the last operation designated as the primary operation:



## Creating a New Routing and Routing Diagram

To create a new routing and routing diagram:

1. From the Model Workspace, right-click All Routings or right-click a routing folder and choose New Routing.
2. Type a name for the routing and press Enter.
3. Double-click the new routing.  
An empty workbook tab opens.
4. Open the All Operations folder and drag the operations you want to include in the diagram into the empty work pane.
5. On the toolbar, click the Insert Link icon.
6. To link two operations, click the first operation, and then click the second.

## Setting Routing Properties

Use the routing Properties window to assigning properties.

To access the routing Properties window, right-click a routing from the Model Workspace and select Properties. The routing Properties window display 4 tabs: General, Attributes, Resource Assignments, and Where Used.

### Setting Routing Properties - General Tab

To set general properties complete these fields:

1. From the Model Workspace, right-click a routing and select Properties.
2. Select the General tab.
3. Complete these fields:

Routing Properties - General Tab Field	Description
Code	Enter a unique code for the routing.
Notes	Enter any routing-specific notes.

### Setting Routing Properties - Attributes Tab

To set routing property attributes:

1. From the Model Workspace, right-click a routing and select Properties.
2. Select the Attributes tab.

Complete these fields:

Routing Properties - Attributes Tab Field	Description
Routing Type	<p>Select a routing type from the list. Options are:</p> <ul style="list-style-type: none"> <li>• Production - Select if your routing produces one or more items.</li> <li>• Maintenance - Select if your routing produces no items or is used for cMRO or other maintenance activities. This type of routing consumes time and may consume items. For example, a work order to clean a machine would be a maintenance routing. Routings of this type may produce an item, but are not required to.</li> <li>• EAM - Select if your routing represents activities modeled in the Enterprise Asset Management system.</li> </ul> <p><b>Note:</b> If a routing is currently assigned to a work order, you cannot change the routing type or structure without first removing the associated work orders.</p>
Use this Routing for Work Orders only	<p>Select this option if routing should only run when it is associated with a work order.</p> <p>For special configurations or one-off production, you may want to create an alternate routing that produces an item using a different set of operations. The system identifies these routings so that the solver does not try to use them to fulfill demand. Routings identified for use with work orders are only run when they are specified in a work order. If demand exists for an item, but no associated work order exists, the solver does not run a routing that is marked to be used in work orders only.</p>

Routing Properties - Attributes Tab Field	Description
Schedule Work Order operations according to their unit of effort	<p>This option breaks up associated work order operations into their individual units of effort. By dividing operations into smaller units of effort, scheduling is both more flexible and accurate. This principle is explained in more detail in the examples, which follow this section.</p> <p>See "Scheduling Work Orders According to Units of Effort Overview, page 8-3," <i>Configuring Solver Options, Production Scheduling</i>.</p>
Adjacent operations preferred	<p>When enabled, this flag instructs the Production Scheduling solver to schedule all work order operations adjacent to each other when the operations are broken down into their units of effort.</p>
Ship Buffer	<p>Assign a ship buffer if you have enabled Theory of Constraints.</p> <p>See "Working with Buffers, page 5-62," <i>Creating Production Scheduling Models, Production Scheduling</i>.</p>

### Setting Routing Properties - Resource Assignment Tab

Alternate resources are common in many manufacturing operations. These alternate resources are modeled through the use of resource sets. In many cases, this resource set recurs in an upstream or downstream operation. In many cases, it is important that once a resource is selected in an upstream operation, it must also be selected in a downstream operation.

To perform consistent resource assignment within only a selected group of operations within a routing, setup operation resource assignment groups within a given routing. For example, operation steps 10, 20, and 30 must run on the same resource. However, operation steps 40, 50, and 60, even though they share a common resource with the preceding operations, can run on the alternate.

Use the Routing Properties - Resource Assignment tab to set up alternate resources.

To set routing property resource assignments:

1. From the Model Workspace, right-click a routing and select Properties.

2. Select the Resource Assignment tab.  
All ungrouped operations are listed in the left column and sorted in alphanumeric order.
3. Select the Add New Group button.  
A default group is created.
4. To rename the group, select F2, or double-click the group name.
5. On the left side of the list, highlight the operation, or operations, that you wish to group together.
6. Click the right arrow button to move the highlighted operations to the right side of the list.  
The operations are assigned to the highlighted group in the right column.
7. Repeat the process to create additional resource assignment groups for any operation within a routing.

**Note:** If an operation is not assigned to a group it can run on any resource.

If using All of Sets, for example more than one resource such as a machine 1 and tool 1, or machine 2 and tool 2, consistent resource assignment applies to the group. Meaning the group must be the same.

See "Creating All of Sets, page 5-49," *Creating Production Scheduling Models, Production Scheduling*.

### Setting Routing Properties - Where Used Tab

The Routing Properties - Where Used tab displays:

- Routing in the event that a routing is embedded in another routing.
- Work orders that contain this routing.

You can double-click a routing or a work order in the list to open it.

### Working with Buffers

Production Scheduling provides you with the option to apply Theory of Constraints principles and applicable business processes to your scheduling environment. Theory of Constraints principles can be enabled in a particular schedule in order to take advantage of Buffer Planning functionality.

This section discusses:

- Drum buffer rope.
- Shipping buffers.
- Capacity constrained resource buffers.
- Assembly buffers.
- Supplier buffers
- Buffer validation rules.
- Define buffer attributes.
- Assign buffers to routings.
- Assign buffers in routing diagrams.
- Assign a ship buffer to a routing.

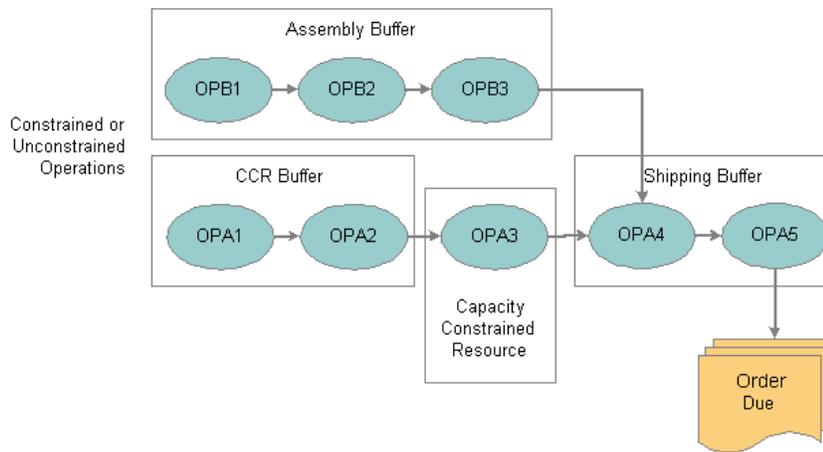
## Drum Buffer Rope

Production Scheduling incorporates Drum Buffer Rope (DBR) methodology through Buffer Planning functionality. The DBR methodology is designed to balance the flow of materials or work in progress items across the production cycle. In order to achieve this balance, production is synchronized with the capacity constrained resource (CCR) that is considered to be the "weakest link" in the production process. The DBR methodology is based on the principle that production in a supply chain is limited to the throughput on the resource or resources with capacity constraints.

The drum represents the production rate of the CCR. All production in the supply chain is determined by the rhythm of the drum. The rope ensures that materials are not inserted into the operation with the CCR at a faster rate than the CCR can process. Shipping, CCR, assembly, and supplier buffers allow you to build protection mechanisms within your production schedule to combat production variability.

You can use buffers in your model to help you manage the schedule variability that can occur in a manufacturing environment that depends on one or more CCRs. When you define buffers in your model, you specify a target buffer value and a minimum buffer value. The solver target buffer value is a soft constraint. The minimum buffer value is a hard resource constraint. In situations where there is insufficient resource capacity to produce a demand item on time, the minimum buffer value can override the target buffer value and cause a delay in the schedule for a demand item. For all buffer types, the buffer value must be greater than or equal to the sum of the durations in the routing and minimum separation times between operations. Although you can create multiple buffers in a linear routing, only one buffer can exist between a pair of operations within the routing.

This diagram illustrates the use of buffers in a routing:



## Shipping Buffers

In a lean manufacturing environment that recognizes Theory of Constraints principles, a shipping buffer can be used to estimate the time between the point where an item is processed by a CCR and the point where the item is shipped. The purpose of the shipping buffer is to protect the shipping due date from downstream variability in the supply chain.

It is necessary to define a CCR in a routing for the solver to respect a shipping buffer. In certain scenarios where two operation paths combine to make a routing, the solver calculates the shipping buffer by identifying the path with the shortest duration between the primary operation and the CCR operation. The solver subtracts the shortest duration from the target and minimum buffer sizes and uses this value as the true buffer value.

## Capacity Constrained Resource Buffers

Capacity constrained resource buffers (CCR buffers) are intervals of time that precede a CCR in a routing. CCR buffers are used to protect the schedule from variability caused by operations that are downstream from the CCR.

You can incorporate CCR buffers into your model in order to avoid CCR overload and CCR starvation. CCR overload occurs when work in progress items accumulate at the CCR due to a rate of material insertion that exceeds the CCR capacity. CCR starvation occurs when a CCR becomes idle due to lack of work in progress items caused by an upstream disruption in the manufacturing process. CCR starvation is often caused by a rate of material insertion that is sufficiently lower than the CCR capacity, causing the CCR to be "starved" for work.

Within a routing, operations that use a CCR are known as CCR operations. CCR buffers

must be defined for CCR operations. In a linear routing, you can define as many CCR buffers as you require to effectively model bottlenecks in your manufacturing process. You must have one or multiple CCRs defined in your model before you begin assigning CCR buffers. Each resource that is designated as a CCR appears highlighted with a red border in the routing diagram.

## Assembly Buffers

Assembly buffers are an extension of shipping buffers that you can use in a model to protect a schedule from variability that may be incurred when a non-constrained item is combined with an item that is processed by a CCR. Assembly buffers specify the amount of lead time from the release of materials to an operation that involves assembling a non-CCR processed item with an item processed by a CCR.

The solver respects assembly buffers that are appropriately defined in the model. The solver does not respect assembly buffer values in the following cases:

- The beginning or terminating operation used to define the buffer value is a CCR operation.
- A CCR operation exists between the beginning or terminating operation used to define the buffer value.

## Supplier Buffers

You can define a supplier buffer for each item that is procured from a supplier. Supplier buffers are used by Production Scheduling to calculate arrival dates for purchase orders. Supplier buffers represent a period of time between the supply event for an item and the beginning of the operation that uses the item. The supplier buffer enables you to build in a buffer to accommodate time between the arrival of the item from the supplier and the use of the item in an operation. Operations involving items with a supplier buffer begin at the end of the supplier buffer. To use the supplier buffer functionality, the Theory of Constraints must be enabled for the model or for a specific schedule.

A supplier buffer is not an extension of the lead time required to supply the item. You can specify a target buffer value and a minimum buffer value when you define supplier buffers in your model. When you define supplier buffers, the following guidelines must be observed:

- The minimum buffer value must be greater than or equal to the lead time of the purchased item.
- The target buffer value must be greater than or equal to the combined values of the minimum buffer and the lead time between the estimated ship date and the arrival date of the purchased item.

## Buffer Validation Rules

Production Scheduling has built in buffer validation rules that govern buffer behavior during a solve. You should observe the following buffer validation rules while you create buffers in a routing:

- Within a resource set, if a CCR is defined, every resource in the set must be defined as a CCR.
- The minimum buffer value must be less than the target buffer value.
- A negative buffer value is not allowed.
- The buffer value in a routing must be greater than the sum of the durations and separation times between connected operations.
- Buffers cannot be defined in reverse in a routing.
- A maximum of one buffer is allowed per relationship.
- The solver ignores buffers in any CCR constrained routing that does not have buffers defined in the routing or associated to the routing.
- All operations using a specific CCR should have a CCR buffer defined.

## Defining Buffer Attributes

To define buffer attributes:

1. Access the Buffer Properties window.
2. Select the Attributes tab.
3. Complete these fields:

Buffer Properties - Attributes Tab Field	Description
Target Buffer Size	Specify a target buffer value. You can specify a period of time in seconds, minutes, hours, and days. The value can include one decimal point. This value is a soft constraint.

<b>Buffer Properties - Attributes Tab Field</b>	<b>Description</b>
Minimum Buffer Size	Specify a minimum buffer value. You can specify a period of time in seconds, minutes, hours, and days. The value can include one decimal point. This value is a hard constraint.

### **Assigning Buffers to Routings**

To assign buffers to routings:

1. Access the Routing Properties window.
2. Select the Attributes tab.
3. Select a predefined buffer from the available options in the list box.
4. Click Apply.
5. Click OK.

### **Assigning Buffers in Routing Diagrams**

To assign buffers in routing diagrams:

1. Access the routing diagram window.
2. Click the Buffer Link button on the toolbar.
3. In the operation diagram, click an operation to select the operation.
4. To create a buffer between two operations, click the first operation, and then click the second operation in the operation diagram.
5. In the Buffer Properties dialog box, select a predefined buffer from the available options in the Buffer list box.
6. Click OK.

### **Assigning a Ship Buffer to a Routing**

To assign a ship buffer to a routing:

1. From the Model Workspace, right-click the routing and select Properties.

2. Select the General tab.

**Note:** In order to assign buffers, the Theory of Constraints option must be enabled on the Scenario Properties - General tab.

See "Setting Up the Scenario Properties - General Tab, page 7-2," *Configuring Scenario Properties, Production Scheduling*.

3. In the Code field, select a pre-defined buffer.

## Defining Work Patterns and Availability (Resource Calendars and Shifts)

This section provides information on the following topics:

- Work patterns and availability overview.
- Create a calendar or shift.
- Setting calendar horizons.
- Add calendar events.
- Modifying calendar events.
- Delete calendar events.

### Work Patterns and Availability Overview

Calendars and shift patterns are imported from Oracle E-Business Suite into Production Scheduling during implementation. Shifts are defined through a calendar, and each shift has its own set of start and stop dates and times with relevant exceptions associated to it.

After implementation, each shift is represented as a specific calendar in Production Scheduling, whether or not it is associated to a resource. Shifts are named as follows:

Shift {Number}: {Description}

Example: Shift 1: Normal Daily Shift

Only shift events that either overlap the horizon boundaries or fall within the scheduling horizon are imported.

Use the Resource Utilization view to view calendar and shifts utilization.

Use the Calendar Editor to view and set up work time, such as work patterns and planned down time. These calendars are assigned to resources on the resource Properties page. You can view calendar event properties to review the start date, end date, and duration. In addition, you can revise the information, but revisions appear

only after the schedule has been repaired.

Work patterns specify the type of work operation, such as two shifts, three shifts, or five days a week. Down time includes interruptible (delay) and non-interruptible (down) times. Operations can start before and continue after a delay. Operations cannot start before and continue after down time.

Planned down time periods include vacation shutdowns, planned maintenance, delays, and scheduled shutdown days. For example, if a plant works only during weekdays, then the calendar displays weekends as down time periods. By creating a calendar for the down times of each resource, you tell the system how to plan production more precisely and allocate resources more effectively. To associate a calendar to a crew, machine, or tool, use the Availability tab on the resource Properties page.

See "Defining Resource Availability, page 5-17," *Creating Production Scheduling Models, Production Scheduling*.

## Creating a Calendar or Shift

Use the Calendar Editor to create calendars and shifts.

### To create a calendar or shift:

1. From the Model Workspace, double-click Access the Calendar Editor, or select Open Global Calendar Editor from the toolbar.
2. Click Add New Calendar.
3. From the General tab of the Calendar Properties window, enter the following information:

Calendar Properties Window Field	Description
Code	Enter the calendar or shift name
Type	Select one of the following options: <ul style="list-style-type: none"><li>• Availability Pattern - Select this option to create a new calendar.</li><li>• Shift Pattern - Select this option to create a new shift.</li></ul>
Resource calendar	The Resource calendar option is a display only field. This option is assigned when a calendar event is edited from the Resource Gantt view and a resource-specific calendar is created.

Calendar Properties Window Field	Description
Notes	Enter relevant notes or comments.

4. Click OK.

## Setting Calendar Horizons

Use the Global Calendar Horizon window from the Calendar Editor to set the calendar horizon.

### To set calendar horizons:

1. From the Model Workspace, double-click the Calendar Editor, or select Open Global Calendar Editor from the toolbar.
2. Click Set Calendar Horizon from the toolbar.
3. Complete these fields:

Global Calendar Horizon Window Field	Description
Start time	Specify the beginning of the calendar horizon. You can enter the date manually in the field or use the calendar tool.
End time	Specify the end of the calendar horizon. You can enter the date manually in the field or use the calendar tool.
Duration	Specify the duration as a value in seconds, minutes, hours, or days.

4. Click OK.

## Adding Calendar Events

Use the Add Calendar Event window from the Calendar Editor to add new events to a calendar or shift.

### To add calendar events:

1. From the Model Workspace, double-click the Calendar Editor, or select Open Global Calendar Editor from the toolbar.

2. Select a calendar or shift from the time grid.
3. Click Add Calendar Event from the toolbar, or right-click and select Add Event.
4. Complete these fields:

<b>Add Calendar Events Window Field</b>	<b>Description</b>
Up time	Select this option to indicate that all machines and activities are available.
Down time	Select this option to indicate down time when all machines and activities are stopped.
Delay time	Select this option to indicate a delay when machines and activities are temporarily suspended.
Start time	Specify the date and time when the event begins. Alternately, you can leave the original date. When the end time and the duration are entered, the start time is automatically calculated.
End time	Specify the date and time when the event ends. Alternately, you can leave the original date. When the start time and the duration are entered, the end time is automatically calculated.
Duration	Specify the event length in seconds, minutes, hours or days. If the start time is specified, the end time is automatically filled in, based on the duration. Similarly, if the end time is specified, the start time is filled in automatically. If both start and end time are specified, the duration is automatically calculated.
Recurring event	Select this option if you want the calendar event to repeat.
Daily	Select this option if you want the calendar event to repeat daily.

Add Calendar Events Window Field	Description
Weekly	Select this option if you want the calendar event to repeat weekly.
Monthly	Select this option if you want the calendar event to repeat monthly.
Yearly	Select this option if you want the calendar event to repeat yearly.
No limit	Select this option if the event occurs throughout the calendar horizon.
End after	Select this option, and select the number of occurrences if the event occurs for a specified number of times and then stops.
End by	Select this option, and select an end date if the event ends by a specified date.
Add (button)	Click Add to create the event you have defined. The Calendar Editor displays the event in the selected calendar or shift.

5. To create another event to the selected calendar or shift, repeat previous step.
6. Click Close to exit Add Calendar Events window.

## Modifying Calendar Events

Use the Modify Calendar Events window from the Calendar Editor to update events for a calendar or shift.

### To modify calendar events:

1. From the Model Workspace, double-click the Calendar Editor, or select Open Global Calendar Editor from the toolbar.
2. Select a calendar or shift from the time grid.
3. Perform one of the following:
  - Click Edit Calendar Event from toolbar.

- Right-click and select Event Properties.
  - Double-click the event in the time grid.
4. Make any modifications to the event type and the event time and duration.
  5. Select one of the following options:
    - Edit Current selection - Select this option to modify only the selected event.
    - Edit Matching Events In Range - Select this option to modify all events within a specified date range. Complete the Start time and End time fields. The default value of the End time field is the end of the scheduling horizon.
  6. Click OK.

## Deleting Calendar Events

Use the Calendar Editor to remove events from a calendar or shift.

### To delete calendar events:

1. From the Model Workspace, double-click the Calendar Editor, or select Open Global Calendar Editor from the toolbar.
2. Select a calendar or shift from the time grid. Use the Shift or Ctrl key to select multiple calendar events.
3. Select one of the following options:
  - Click Remove Calendar Event from the toolbar, or right-click and select Remove Event.  
Only the selected event will be removed from the calendar.
  - Click Remove All Events from the toolbar, or right-click and select Remove All Events.  
All events are removed from the selected calendar or shift.
4. Click Yes to confirm the deletion of the calendar event.

## Specifying Supply and Demand Events

This section provides information on the following topics:

- Supply & Demand Editor overview.

- Demand priorities overview.
- Creating supply and demand folders.
- Creating supply orders.
- Creating demands.
- Defining demand policies.
- Changing multiple demands.
- Deleting multiple demands.
- Creating work orders from demands automatically.

## Supply & Demand Editor Overview

The Supply & Demand Editor enables you to set up supply and demand events for your schedule. Although this data is usually imported into Production Scheduling, you can input supply and demand events directly within the application to facilitate simulations.

You can create demand orders and demand line items by creating a demand folder, adding demand orders, adding line items, specifying demand policies and dates, and completing the line item fields. You can edit demand information in either order view or line item view.

Supply and demand events can be modified globally or for a particular schedule. The global Supply & Demand Editor is launched from the Model Workspace, or an icon on the toolbar. The Supply & Demand Editor can be modified locally for a specific schedule. This ability enables you to revise requirements or purchased parts that are required for a schedule, and analyze what-if scenarios.

In addition to maintaining supply and demand orders and their status, the Supply & Demand Editor also contains an analytical tool that provides pegging information for all demand orders. This pegging grid displays all of the items and processes that are involved in the manufacturing of a product; it also displays when each step is scheduled for completion. This grid provides you with specific production information for a particular line item when such information is required.

## Demand Priorities Overview

In most manufacturing environments, demand priority setting is a common practice. These priorities are generally dictated by various factors, such as customer size, revenue contribution, length of time a sales order has been outstanding, predetermined agreements, as well as other factors. In the event of resource conflicts, higher priority orders are expected to receive preferential treatment over other orders in the system.

Demand priorities often change during planning simulations, such as when a scheduler is doing ad-hoc order promising to facilitate the effect of adding a hot order to the existing production schedule, that is, in which other demands are late or otherwise affected. This can be an iterative process to achieve the schedule and service levels that satisfy the user.

Production Scheduling provides very differentiating scenario comparison capabilities to support these types of scenarios. In the Supply & Demand Editor, there are three order classifications:

- Hot
- Committed
- Uncommitted

Within each classification, you can set a demand priority field from one to five. Therefore, in effect you have fifteen different priorities with which to set your demand. The lower the number in the Demand Priority field, the higher priority that a demand item is given. For example, the solver fills demand orders with a priority of 1 before filling orders with a priority of 2.

If two or more demand orders have the same requested date, then the system considers demand priority for each order. The solver schedules the demand that has the lower priority.

The highest order class is Hot, followed by Committed, and then Uncommitted. The highest Demand Priority is 1, and the lowest Demand Priority is 5. Uncommitted orders are essentially opportunistic orders which look for holes in the schedule and inventory to fill a given demand.

You set the class and priority in either the Rules tab of the order, or in the line item itself.

The Production Scheduling solver schedules higher priority demands first in the event of a resource conflict. If no resource conflict exists, the schedule is driven by due date, which enables the lower priority orders to be scheduled first.

### **Example of Demand Priority**

The importance of supporting these scenarios, and the shortcomings that result when these types of scenarios are not supported is best demonstrated in the following example.

Two demands, Demand 1 and Demand 2, have stated priorities of 2 and 1 respectively. Demand 1 is due on Day 1, and Demand 2 is due on Day 2. Each demand shares a common machine, which is used to manufacture the respective items on the demand.

If there are no resource conflicts, meaning there is sufficient capacity, Demand 1 is scheduled first because the lower priority demand is due earlier. Demand 2 is scheduled next because the higher priority demand is due after Demand 1.

If these demands compete for capacity, the higher priority demand would be fulfilled

first.

## Creating Supply and Demand Folders

**To create supply and demand folders:**

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Right-click All Demands or All Supplies, and select New Folder.
3. Right-click the folder, select Rename, and enter a new name for the folder.
4. Press Enter.

## Creating Supply Orders and Supply Line Items

You can view supply order information from the supply order tree in the Supply & Demand Editor. You can also manually create and define supply order folders and items.

**To create supply order and line item:**

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Right-click the supply folder to define the target location for the new supply order.
3. Select New Supply Order.  
An order appears under the folder with a system-generated number.
4. On the General tab, complete the following fields:

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<b>Supply Order - General Tab Field</b>	<b>Description</b>
Supply Number	The supply order is automatically assigned a supply number. You can edit this value if necessary.
Supplier Name	Specify the supplier name.
Origin Address	Specify the address from which the vendor is shipping the supplies. This field is optional.

---

<b>Supply Order - General Tab Field</b>	<b>Description</b>
Type	When the supplier is manual created in Production Scheduling, this field defaults to Manual Supply. When supplier data is imported into Production Scheduling, this field may display Allocated Supply, Interplant Shipment, or Purchase Order.
Status	Select Approved for the solver to consider the supply order, or select Hold for the solver to ignore the supply order.

5. Right-click the order from the supply order tree, and select New Line Item.
6. Complete the following line item fields:

<b>Line Item Field</b>	<b>Description</b>
Line Item	The line item is automatically assigned a number. You can edit this value if necessary.
Item	Select the item from the list options. Only those items defined as Purchased in the Attributes tab of the item Properties window appear in the list.
Quantity	Specify the quantity being supplied.
Unit of Measure	Displays the unit of measure assigned to the quantity field. This is a display only field.
Status	Select the approval level of items supplied: Approved or Hold.

Line Item Field	Description
Requested Date	<p>Displays expected arrival date of the Purchase Order.</p> <p>Specify a date when the order is expected to arrive. The solver attempts to keep the supply event as close to the due date as possible. The solver is free to select a date within the earliest and latest date range if required.</p>
Earliest Date	<p>Optionally, specify the earliest date when the order can be delivered. The default is the start of the horizon. If the date that is entered precedes the schedule horizon start, then this date is changed to the horizon start when solving. If the date entered follows the schedule horizon end, then the solver ignores this order.</p>
Latest Date	<p>Optionally, specify the latest date when the order must be delivered. The default is the end of the horizon. If the date that is entered falls after the schedule horizon end, then this date is changed to the horizon end when solving. If the date entered precedes the schedule horizon start, then the solver ignores this order.</p>
Satisfaction Date	<p>The date provided by Oracle Advanced Supply Chain Planning (ASCP) that the demand has been fulfilled. This is a display only field.</p>
Available Date	<p>The Production Scheduling solver calculated availability date for the demand. This is display only field and displayed when a solve is performed.</p>

7. Click Save.

**Note:** You must have created or imported item data before a line item can be added.

## Working with Supply Order Reservations

You can view and create supply order reservations from the Supply & Demand Editor. Reservations are viewed from the supply order level of the All Supplies tree. The reservation that appear apply to item lines within the supply order.

### To view supply order reservations:

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Expand the All Supplies tree, and select the supply order. The supply order displays two tabs, General and Reservations.
3. Select the Reservations tab.

Reservations appear at the top of the window and can be modified with the Add, Delete, and Properties buttons. Supply order line items display at the bottom of the window and can be modified by adjusting the line fields.

The buttons, fields, and descriptions in the Work Order - Supply Reservation tab are:

Supply Order - Reservations Tab Field	Description
Add (button)	Click to create a supply reservation.
Delete (button)	Click to remove a supply reservation.
Properties (button)	Click to view or modify a supply reservation.
Name	Displays the reservation name.
Item	Displays the item reserved.
Serial Number	Displays item serial number.
Quantity	Displays the quantity reserved.
Supply	Displays the supply item line code assigned to the reservation. Field is named according to <supply order> - <supply item line>. For example, if the supply order is 1000 and the line item is 2400, then the Supply field displays 1000-2400.
Demand Type	Displays the demand side type. Valid values are Sales Order, Forecast, Transfer Order, and Work Order.

<b>Supply Order - Reservations Tab Field</b>	<b>Description</b>
Demand	Displays the demand side code.
Request Date	Displays the date that the supply is due from the vendor and is equal to the Requested Date = Earliest Date = Latest Date in Production Scheduling. When linked to a demand line item, the request date assigned to the line item appears.
Description	Displays the notes or comments assigned to the reservation.

Use the supply order Reservations tab to add, delete, or view reservation properties.

**To add a supply order reservation:**

1. Click Add.

The Supply side Type is a display only field and displays Supply Line Item since the reservation is being created for a supply folder.

2. Enter the reservation name. This is not required data and can repeat across for other reservations.

3. In the Quantity field, enter the number of items to be reserved.

The total quantity of the reservation should not exceed the total quantity of the work order or purchased item.

4. If applicable, enter serial number.

5. Select the Supply side Code. The list displays the supply line items defined for the supply order.

6. Select the Demand side Type. The list displays options that are applicable to your model.

7. Select the Demand side Code.

The list options available are based on the Demand side Type selected.

8. Enter any notes or description in the Notes field.

9. Click OK.

The reservation is updated in the Reservations tab.

10. Solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To view or modify a supply reservation:**

1. Select a reservation and click Properties.
2. Modify the reservation fields as needed and click OK.
3. If updates are made, solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To remove a supply reservation, select the reservation and click Delete.**

## Creating Demands

To create demand orders:

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Right-click the Demand folder where you want to add the order and select Add Demand.

An order appears under the folder with a system-generated number.

3. On the General tab, complete the following fields:

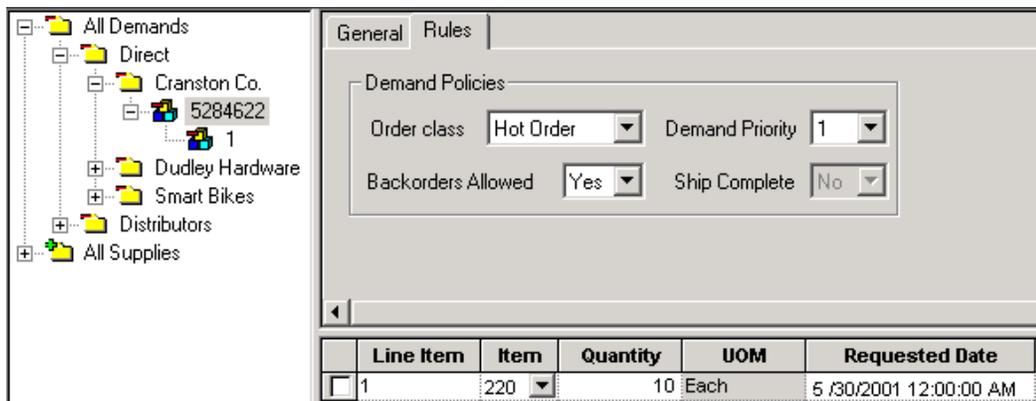
<b>Demand Order - General Tab Field</b>	<b>Description</b>
Demand Number	The demand order is automatically assigned a demand number. This value can be edited, if necessary.
Customer Name	This field is optional.
Customer Number	This field is optional.
Ship To Address	This field is optional.
Type	Select <i>Order</i> , <i>Safety</i> , or <i>Forecast</i> .

Demand Order - General Tab Field	Description
Status	Select <i>Approved</i> for the solver to consider the demand order or <i>Hold</i> for the solver to ignore the demand order.

- Click Save.

## Defining Demand Policies

Use the Rules tab of the Demand Order page to define demand policies.



To define demand policies:

- From the Model Workspace, double-click the Supply & Demand Editor.
- Select a demand order from the tree.
- On the Rules tab, complete the following fields in the Demand Policies section:

Demand Order - Rules Tab Field	Description
Order class	Select <i>Hot Order</i> , <i>Committed</i> , or <i>Uncommitted</i> .
Backorders Allowed	Select <i>Yes</i> to enable the requested date to be violated up to the latest order. Select <i>No</i> if all line items must be available at the requested date.
Demand Priority	Choose a value from 1 to 5.

Demand Order - Rules Tab Field	Description
Ship Complete	Select <i>Yes</i> to ship the order only when all of the line items have been produced. Select <i>No</i> to enable partial shipments of the order.  <b>Note:</b> Available Date is a system-generated, display-only field.

4. To add a new line item to the order, right-click the order in the tree and select Add Line Item.
5. For the line item, complete the following fields:

Line Item Field	Description
Item	Click the arrow by the code for the item and choose from the available options. Only saleable items are displayed.
Quantity	Specify the quantity of the item that is requested.
UOM (unit of measure)	Displays the unit of measure for the item.
Status	Select the approval level of the item that is requested. The status can be <i>Approved</i> or <i>Hold</i> .
Type	Select one of the following options: <ul style="list-style-type: none"> <li>• Forecast - Indicates that the aggregated demand estimates for a specific time period is based on historical sales information.</li> <li>• Orders - Indicates that the actual orders placed by customers. Safety Stock. Items that are needed to maintain safety stock levels.</li> </ul>

Line Item Field	Description
Demand Priority	Specify a relative weighting (degree of build) with 1 being the highest priority. For example, with two JIT orders, the order with demand priority 1 is produced as late as possible, relative to the order with demand priority 2.
Requested Date	Specify the requested date for the item that is requested.
Earliest Date	Optionally, specify the earliest date when the order can be delivered. The default is the start of the horizon. If the date entered precedes the schedule horizon start, then this date is changed to the horizon start when solving. If the date entered follows the schedule horizon end, then the solver ignores this order.
Latest Date	Optionally, specify the latest date when the order can be delivered if backordered. The default is the end of the horizon. If the date entered falls after the schedule horizon end, then this date is changed to the horizon end when solving. If the date entered precedes the schedule horizon start, then the solver ignores this order.

6. Click Save.

## Changing Multiple Demands

In the Supply and Demand Editor, you can change the properties of multiple demands at one time.

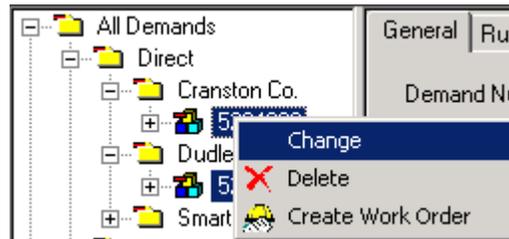
### To change the properties of multiple demands:

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Select the demands that you want to change by holding down the Shift key and highlighting the appropriate demands, folders, or line items. If the demands, folders, or line items are not listed sequentially, hold down the Ctrl key and select the individual demands.

**Note:** If you select a folder, all demands that are in that folder are considered.

3. Right-click, and choose Change.

The menu is shown in the following screen:



### Changing General Properties of Demands

Use General tab of the Change - Demand window to change demand policies and demand priorities.

1. In the General tab, modify the policies and priorities.

The table below provides descriptions of the fields within the General tab of the Change - Demand window.

Change - Demand Window - General Tab Field	Description
Status	Choose <i>Approve</i> or <i>Hold</i> .
Backorders Allowed	Choose <i>No</i> or <i>Yes</i> .
Ship Complete	Choose <i>No</i> or <i>Yes</i> .
Order Class	Choose <i>Hot</i> , <i>Committed</i> , or <i>Uncommitted</i> .
Priority	Choose <i>1, 2, 3, 4, or 5</i> . One is the highest priority and five is the lowest priority.

2. Click OK to save the changes and close the window.
3. To view the results of the changes, click one of the modified demands.

## Changing Detail Properties of Demands

Use the Details tab of the Change - Demand window to change demand quantities, request dates, earliest dates, and latest dates. The changes made are applied to the multiple demands currently selected.

1. In the Details tab, modify the quantity and dates.

The table below provides descriptions of the fields within the Details tab of the Change - Demand window.

---

<b>Change - Demand Window - Detail Tab Fields</b>	<b>Description</b>
Demand Quantity	Region displays the following options: <ul style="list-style-type: none"><li>• Do Not Change - Leave demand unchanged.</li><li>• Set to - If you want all your demands to be the same quantity, enter that quantity in this field.</li><li>• Multiply by - Enter the factor by which you want to multiply the demands. For example, to double demands, enter 2.00. To half the demands, multiply by 0.5.</li></ul>

---

---

**Change - Demand Window - Detail Tab  
Fields****Description**

---

Request Date

Region displays the following options:

- Do Not Change - Leave request date unchanged.
  - Set to - To set all the request dates of the selected demands to the same date, click the up or down arrow in this field to move the date forward or backward, respectively.
  - Advance by - You can bring the request date forward (closer to the current date), or move it back (farther from the current date) by using this field. To move the request dates forward, enter the number by which you want to advance it in the Advance by field. Select the increment of time from the drop-down menu. Valid values are: *minute, hour, day, or week*. For example, to advance the request date by 10 hours, enter 10 in the Advance by field and choose hour from the drop-down menu.
  - Reduce by - You can move the request date back (farther from the current date) by using this field. To move the request dates back, enter the number by which you want to reduce it in this field. For example, to move the request date back by 10 hours, enter 10 in the Reduce by field and select hour from the drop-down menu. Valid values are: *minute, hour, day, or week*.
-

Change - Demand Window - Detail Tab Fields	Description
Earliest Date	<p>Region displays the following options:</p> <ul style="list-style-type: none"> <li>• Do Not Change - Leave earliest date unchanged.</li> <li>• Set to blank - Select this option to change all earliest dates to empty fields, which are optional.</li> <li>• Set to - To set all the earliest dates of the selected demands to the same date, click the up or down arrow in this field to move the date forward or backward, respectively.</li> <li>• Advance by - You can bring the earliest date forward (closer to the current date) by using this field. To move the earliest dates forward, enter the number by which you want to advance it in the Advance by field. Select the increment of time from the drop-down menu. Valid values are: <i>minute, hour, day, or week</i> . For example, to advance the earliest date by 10 hours, enter 10 in the Advance by field and choose hour from the list.</li> <li>• Reduce by - You can move the earliest date back (farther from the current date) by using this field. To move the earliest dates back, enter the number by which you want to reduce it in this field. For example, to move the earliest date back by 10 hours, enter 10 in the Reduce by field and select hour from the drop-down menu. Valid values are: <i>minute, hour, day, or week</i>.</li> </ul>

---

**Change - Demand Window - Detail Tab  
Fields**

---

**Description**

Latest Date

Region displays the following options:

- Do Not Change - Leave latest date unchanged.
  - Set to blank - Select this option to change all latest dates to empty fields, which are optional.
  - Set to - To set all the latest dates of the selected demands to the same date, click the up or down arrow in this field to move the date forward or backward, respectively.
  - Advance by - You can bring the latest date forward (closer to the current date) by using this field. To move the latest dates forward, enter the number by which you want to advance it in the Advance by field. Select the increment of time from the list. Valid values are: *minute, hour, day, or week*. For example, to advance the latest date by 10 hours, enter 10 in the Advance by field and choose hour from the drop-down menu.
  - Reduce by - You can move the latest date back (farther from the current date) by using this field. To move the latest dates back, enter the number by which you want to reduce it in this field. For example, to move the request date back by 10 hours, enter 10 in the Reduce by field and select hour from the drop-down menu. Valid values are: *minute, hour, day, or week*.
- 

2. Click OK.
3. To view the results of the changes, click one of the modified demands.

## Deleting Multiple Demands

In the Supply & Demand Editor, you can delete multiple demands.

### To delete multiple demands:

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Select the demands that you want to delete by holding down the Shift key and highlight the appropriate demands, folders, or line items. If the demands are not sequential in the list of demands, hold down the Ctrl key and select the appropriate demands.
3. Right-click and select Delete.

## Creating Work Orders from Demands Automatically

To automatically create multiple work orders that correspond to one demand line:

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Select demand items or demand folders, right-click, and then and select Create Work Order.

Work orders are created automatically for each demand that you selected.

The folder structure from the Supply & Demand Editor is duplicated for each work order. If a demand can be fulfilled from multiple routings, you are prompted to select which routing the work order should use. All quantities and dates on the work order are inherited from the demand.

If a work order is already linked to a demand, a warning dialog appears and prompts you if another work order for that demand needs to be created. If alternate routings exist, a dialog box appears and prompts you to select a routing.

## Working with Demand Order Reservations

You can view and create demand order reservations from the Supply & Demand Editor. Reservations are viewed from the demand order level of the All Demands tree. The reservations that appear apply to item lines within the demand order.

### To view demand order reservations:

1. From the Model Workspace, double-click the Supply & Demand Editor.
2. Expand the All Demands tree, and select the demand order. The demand order displays three tabs, General, Rules, and Reservations.
3. Select the Reservations tab.

Reservations appear at the top of the window and can be modified with the Add,

Delete, and Properties buttons. Demand order line items display at the bottom of the window and can be modified by adjusting the line fields.

The buttons, fields, and descriptions in the Demand Order - Reservation tab are:

<b>Demand Order - Reservations Tab Field</b>	<b>Description</b>
Add (button)	Click to create a demand reservation.
Delete (button)	Click to remove a demand reservation.
Properties (button)	Click to view or modify a demand reservation.
Name	Displays the reservation name.
Item	Displays the item reserved.
Serial Number	Displays item serial number.
Quantity	Displays the quantity reserved.
Supply Type	Displays the supply side type. Valid values are On Hand, Purchase Order, Transfer Order In, Supply Line Item, and Work Order.
Supply	Based on the Supply Type field, the Supply displays the supply item line or work order code assigned to the reservation. If the Supply Type is On Hand, this field is blank.
Demand	Displays the demand side line code assigned to the reservation.
Request Date	Displays the date that the supply is due from the vendor and is equal to the Requested Date = Earliest Date = Latest Date in Production Scheduling. When linked to a demand line item, the request date assigned to the line item appears.
Description	Displays the notes or comments assigned to the reservation.

Use the demand order Reservations tab to add, delete, or view reservation properties.

**To add a demand order reservation:**

1. Click Add.

The Demand side Type is a display only field and displays Demand Line Item since the reservation is being created for a demand folder. The Demand side Code field defaults to the first demand line item in the demand order.

2. Enter the reservation name. This is not required data and can repeat across for other reservations.

3. In the Quantity field, enter the number of items to be reserved.

The total quantity of the reservation should not exceed the total quantity of the work order or purchased item.

4. If applicable, enter serial number.

5. Select the Supply side Type.

6. If you assigned a Supply side Type of Supply Line Item or Work Order, then select the Supply side Code. The list displays the available supply line items or work orders defined in the model.

If the list is not enabled, select an applicable Demand side Code line item first.

7. Select the Demand side Code.

The list displays the demand line items defined for the demand order.

8. Enter any notes or description in the Notes field.

9. Click OK.

The reservation is updated in the Reservations tab.

10. Solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To view or modify a demand reservation:**

1. Select a reservation and click Properties.

2. Modify the reservation fields as needed and click OK.

3. If updates are made, solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations

exceeds the available item quantity. Correct the issue and re-solve the model.

**To remove a demand reservation, select the reservation row and click Delete.**

## Working with Work Orders

This section provides information on the following topics:

- Work orders overview.
- Working with maintenance work orders.
- Working with Enterprise Asset Management (EAM) work orders.
- Flexible scheduling of work orders.
- Automatically generating routings based on work orders.
- Work order yield and scrap overview.
- Creating a work order.
- Deleting a work order.
- Accessing views from a work order.
- Creating work order folders.
- Creating hard links between work orders.
- Releasing work orders to production.

## Work Orders Overview

Work orders are statements of current or future production for an item. In Production Scheduling, work orders can be linked to demand orders. Work orders are usually imported from a Materials-Requirement Planning (MRP) system, although they can also be entered directly into the application. Production Scheduling supports three types of work orders and are sorted into the following folders within the Work Order Editor:

- Production orders
- Maintenance orders
- Enterprise Asset Management orders

A production work order must specify an item that is produced on completion of all of the operations within the work order. Only manufactured items (as defined in the item

properties) are available for selection. You then select a routing that produces the item.

Maintenance orders and Enterprise Asset Management orders are work orders that may not necessarily produce items, but they still consume production capacity. These orders play a crucial role in the manufacturing process. For example, machines break down if they are not properly maintained, and machines and equipment are subject to enhancement due to technological and engineering advances. Maintenance orders support and repair anything involved in the production process. For example, maintenance orders can be issued to repair a drill press, inspect welding equipment, or lubricate a milling machine.

**Note:** To schedule Maintenance (cMRO) work orders, make sure to set the Schedule CMRO Work Orders option is selected in the Scope tab of Production Scheduling Options form in EBS. Once this option is selected, you have the option of importing close Visit work orders. See *Integrating Production Scheduling, Oracle Advanced Supply Chain Planning Implementation and User's Guide*.

Enterprise Asset Management work orders are predetermined preventative maintenance activities managed in Oracle Enterprise Asset Management (eAM). They are created in eAM and imported into Production Scheduling, but they are NOT scheduled in Production Scheduling. Production Scheduling considers them when it generates schedules, taking into account the resource down time and any common material or resource consumption. The system considers both requirements when the model is scheduled. The actual scheduling of Enterprise Asset Management work orders is still performed by the eAM Scheduler.

Work orders can also be configured individually when they are not in the standard template when imported from an ERP system.

## Working with Maintenance Work Orders

Maintenance work orders in the context of Maintenance activities represent specific tasks to be completed during a maintenance visit. These tasks typically define material and resource requirements and are grouped into logical Stages which are sequential blocks of tasks within a Visit. The completion of a stage represents a Milestone and must be completed before the next Stage can begin. In many cases, there is a sequence of tasks that must be followed and can be serial or parallel in nature. This complex relationship is referred to as the task hierarchy which needs to be respected when defining a maintenance schedule. Maintenance work orders contain this necessary information so that they can be scheduled appropriately.

One of the key differences for Maintenance work order is that it may not necessarily produce an item to stock at when completed. A series of maintenance tasks are often required and it may not be until the last task, or work order, which produces a unit to stock. For example, an engine may require a series of maintenance tasks and it is not until the last work order that the engine can be deemed usable, or produced to stock.

Another fundamental difference of a Maintenance work order in the context of a visit is the Work Order Request date does not guide scheduling of the work order. Instead, the Visit request date is used to drive the start and completion date of the work order considering the various resource and material constraints in addition to the complex task hierarchy and Milestones constraints that are relevant to the Visit. The Visit Request date governs the work order scheduling within the Production Scheduling Solver.

The Maintenance Order folder in the Work Order Editor is organized in the following folders:

- Visit
- Stage
- Department
- Status (such as On Hold or Released when applicable)

**Note:** Maintenance Orders folder is organized as defined in the Production Scheduling Plan Options - Display Parameters tab. See *Integrating Production Scheduling, Oracle Advanced Supply Chain Planning Implementation and User's Guide*.

## Working with Enterprise Asset Management Work Orders

Enterprise Asset Management (EAM) work orders are generated when Production Scheduling is integrated with Oracle Enterprise Asset Management. Enterprise Asset Management (EAM) work orders provide the following features:

- Import EAM Maintenance Work Orders into the Production Scheduling Maintenance (cMRO) schedule to account for common materials and common resources. This includes EAM Rebuild work orders.

In Oracle Enterprise Asset Management, rebuild Work Orders are created as child Work Orders. For example, a Work Order was issued for the inspection of a pump. During the pump inspection, you found that the motor, one of the components of the pump, is problematic. You have two options: You can repair and then reinstall this motor (rebuildable item), or you can replace the rebuildable item by issuing a new motor rebuildable item from inventory. If you choose to perform a material issue from inventory, the old motor rebuildable item attaches to the Work Order, automatically creating the child, rebuild Work Order number associated to the parent Work Order.

Items that are installed, removed, and refurbished are referred to as Rebuildable Items. Examples of Rebuildable Items include motors, control boxes, and computer boards. Rebuildable Items might need to be removed or refurbished while a parent

Asset is maintained. Rebuildable Items are inventory items.

- Production Scheduling respects the maintenance schedule and schedules around the EAM work orders.

EAM work orders will not be scheduled by Production Scheduling. They are maintained by the EAM Scheduler. Since they are not being scheduled, resource and material capacity violations can occur.

- EAM work orders support "float" where the work order header start date can occur before the first operation start date. Similarly, the work order End Date can be later than the last operation completion date.



- Release of EAM work order dates back into EAM to support manual rescheduling.

For information on the Oracle Enterprise Asset Management application or processes, refer to the following:

- *Oracle Enterprise Asset Management Implementation Guide*
- *Oracle Enterprise Asset Management User's Guide*

The Enterprise Asset Management folder in the Work Order Editor is organized into folders based on the maintenance resources.

**Note:** The eAM organization must be the same as the Production or cMRO organization to be considered in the schedule since Production Scheduling is a single organization application.

## Flexible Scheduling of Work Orders

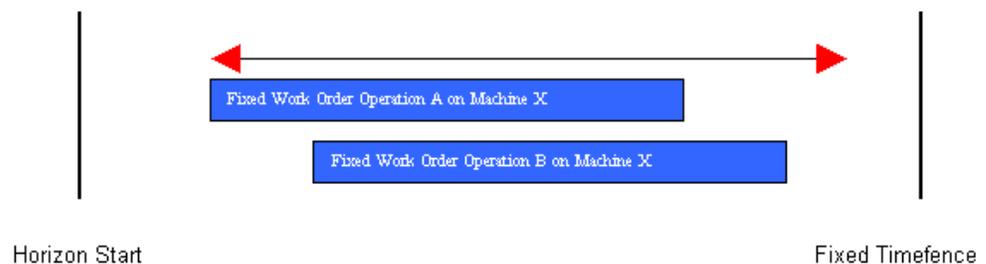
This section discusses:

- Scheduling work orders inside the fixed time fence.
- Scheduling work orders outside the fixed time fence.

## Scheduling Work Orders Inside the Fixed Timefence

In Production Scheduling, you can set a fixed production timefence on a given resource. This fixed production timefence dictates that any new production that is required to fulfill demand must occur beyond the end of the timefence duration.

Within a fixed production timefence, you can have work orders that are specified to run, which are created either from a previous planning cycle or by another process. These work orders may have operations with a fixed earliest start date, a fixed latest end date, or both. Because work order operations within a fixed timefence are considered fixed, a situation may arise where an infeasibility occurs within the solve process. For example, if there are two operations on different work orders that run on the same machine that have overlapping fixed dates, an infeasible solution may occur within the solve process. This diagram illustrates this concept:



**Note:** To fix operations on a work order within the fixed timefence, you must populate the Earliest Start Date field, or the Latest End Date field, or both. The fix dates must dictate that all or some of the operation duration falls within the resources fixed timefence.

To address the possibility of an infeasibility within the fixed timefence, the Production Scheduling solver may move work order operations around and possibly schedule work order operations to occur prior to the start of the planning horizon. This indicates that your shop floor is running behind.

If any open work order operations, within the fixed timefence, are moved to start within the timefence or before the horizon start to avoid an infeasibility, you receive either a Work Order Past Due or Work Order Fixed Date Violation exception. The exception tells you the work order where this situation has occurred, the operation, and the relevant start and end times.

If you receive a Work Order Past Due alert in order to avoid an infeasibility, this indicates that a work order operation has been moved within the timefence and is scheduled to have a start time that occurs prior to the horizon start. The violation start-time is the time the operation starts within the past. The violation end time is the end of the operation.

If you receive a Work Order Fixed Date Violation, this indicates that a work order operation has been moved within the fixed timefence and is scheduled to have a start

time different from the start date that is specified on the work order routing. The violation start time is the time the operation starts. The violation end time is the end of the operation.

You can filter exceptions displayed in the Exception grid by the following types:

- Operation Past Due
- Operation Firm Date Violation
- Request Date Violation

To access these filters, expand the All Exceptions and Work Orders tree from the Model Workspace. Select a filter option displayed under the exception Work Order tree. The Exception grid refreshes to display only exceptions of the selected type.

To evaluate the potential issue from the Exception grid, right-click the exception, select Drill Down to Work Order Editor, and review the Operations tab.

When scheduling work orders in conjunction with a fixed timefence on a resource, the solver behaves in one of the following ways, depending on the circumstances:

1. When work order operations do not have a start date or a latest end date specified, that is, the Earliest Start Date or Latest End Date fields are blank:
  - If a work order request date would suggest a work order be scheduled in the timefence, it is scheduled beyond the timefence.
  - If a work order is attached to a demand and the demand has a latest date that would suggest the work order be scheduled in the timefence, the work order can be scheduled in the timefence.
2. When work order operations have a start date, that is, the Earliest Start Date field is completed.
  - All work order operations ending before the time fence are considered "unfixed" in the solver, so that they can move within the timefence or before the timefence.
  - All work order operations that cross the time fence (start before and finish after the time fence) are fixed to their start times, unless an infeasibility occurs.
  - If the total capacity of all the fixed operations that cross the time fence boundary exceed the machine's capacity, the latest operation is fixed and the others are moved earlier.
  - If there is not enough on-hand inventory, that is, starting inventory, work orders are not moved before the horizon start and are pushed to start after the fixed timefence or the first inventory injection based on supplier lead time or a supply event (which can be another work order producing the material or

supply).

- If a work order operation is fixed to start before the horizon start, it is scheduled at that time.
3. When work order operations have a latest end date field, that is, the Latest End Date on the work order operation is completed.
  4. All work order operations ending before the time fence are considered unfixed in the solver, so that they can move, if necessary, within the timefence or before the timefence.
    - All work order operations that cross the time fence (start before and finish after the time fence) are fixed to their end times.
    - If the total capacity of all these operations that cross the time fence boundary exceed the machine's capacity, based on priority and due date and the earliest start date, the conflicting operations are moved to start before the timefence, when feasible, and not pushed later.
    - If there is not enough on-hand inventory, that is, starting inventory, work orders are not moved before horizon start and if they can not be moved past a given end date, then the application informs the user that there is not enough inventory, that is, no producing operation error message.
    - If a work order operation has a latest end before the horizon start, it should be scheduled at that time if possible.
  5. Active Work Order Operations
    - If work order operations are Active , they are generally scheduled at horizon start even with a fixed timefence. However, if there is no time fence, and two work order operations are marked as active on a single capacity resource, then one of them is moved to avoid an infeasibility.
    - If there is a timefence, then all active work order operations are unfixed and moved around according to due date. If this action pushes other operations out beyond the fixed timefence, then the solver moves it earlier. In this case, the work order attached to the lower priority demand is moved. If there are no demands or the priorities are the same, one of them is moved based on request date, then on alphanumeric key of the order itself.
    - If a work order operation is marked as *Active* and is also considered to be fixed, the fix date is ignored.

## Scheduling Work Orders Outside the Fixed Timefence

The solver resolves conflicts where work orders are outside of the fixed timefence to avoid situations such as:

- More than one work order operation is firm on the same single capacity resource and they have overlapping date and times.

If this occurs, the work order with the highest priority, followed by earliest request date, is scheduled first. An exception is generated to indicate a firm date violation.

- A firm date range on a work order operation is shorter than the total operation run and elapsed time.

For example, if the firm range is 1.5 hours and the operation run time is 9 hours. If this occurs, the work order operation is still scheduled. An exception is generated to indicate an operation firm date violation.

## Automatically Generated Routings Based on Work Orders

Manufacturers generally fall into one of two categories, make-to-order (MTO) or make-to-stock (MTS). Within the MTO category, there are the following subcategories:

- Assemble-to-Order (ATO)
- Configure-to-Order (CTO)
- Engineer-to-Order (ETO)

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<b>Manufacturer Category</b>	<b>Description</b>
Assemble-to-Order (ATO)	An environment in which a product or service is assembled after receiving an order from the customer. The key components that are used in the assembly or finishing process, such as bulk, semi-finished, intermediate, subassembly, fabricated, purchased, and packaging, are planned and generally stocked in anticipation of a customer order. Receipt of an order initiates the assembly of a customized product.

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<b>Manufacturer Category</b>	<b>Description</b>
Configure-to-Order (CTO)	An environment in which designs are created by the manufacturer's engineers, but design options are provided for most of the important components that go into the unit. Custom configurations are typically created by including different combinations of standard items.
Engineer to Order (ETO)	An environment in which products are specifically designed to the specifications of the customer. Sub-Assemblies components can be either standard items or custom items that are designed specifically to the customer order. It is common for ETO environments to utilize mixed mode manufacturing strategies, including elements of MTS, ATO, CTO, and MTO processes.
Make to Stock (MTS)	An environment in which items can be finished and usually are finished before receiving a customer order. Customer orders are typically filled from existing stocks and production orders are used to replenish those stocks.

### **Scheduling Work Orders with Automatically Generated Routings**

For scheduling purposes, the business requirement of effectively dealing with Make-to-Order (MTO) environments presents various challenges to an enterprise looking to create optimal plans based on changing manufacturing processes. In addition, companies that are not a pure MTO environment also deal with dynamic manufacturing processes. This can be as simple as issuing a different material to a work order that was not part of the standard ERP routing, charging for additional machines, crews, or tools for which the jobs were not setup to run on, or running additional operations on a part. For scheduling purposes, any work order that is imported into Production Scheduling and varies from the standard template from ERP, other than from pre-designated alternates, can be considered a configured work order. For Oracle Complex Maintenance, Repair and Overhaul (cMRO) and Oracle Enterprise Asset Management (eAM) implementations, all routings and operations for Maintenance work orders and Enterprise Asset Management work orders are auto-generated and are based on the work orders that come from the cMRO and eAM systems.

## Configured Work Order Scenarios

The following list provides some typical scenarios that present a configured work order to Production Scheduling:

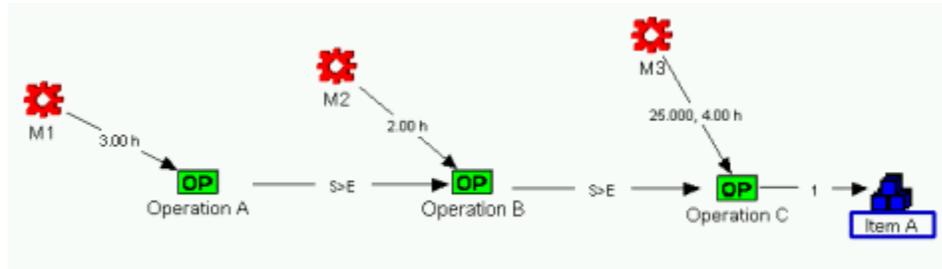
- Maintenance work orders, which are generated from the Oracle Complex Maintenance, Repair, and Overhaul (cMRO) system.
- Enterprise Asset Management work orders, which are generated from the Oracle Enterprise Asset Management (eAM) system.
- Non-standard crews, machines, or tools that are included on the work order bill of resource.
- A work order that is missing crews, machines, or tools on work order operations.
- Non-standard items that are included on the work order bill of material.
- Missing items on the work order bill of material.
- Additional operations that are included on the work order routing.
- Missing operations on the work order routing.

For example, with the exception maintenance (cMRO) work orders associated with Visits, Oracle EBS does not pass "Closed" work order operations to Production Scheduling.

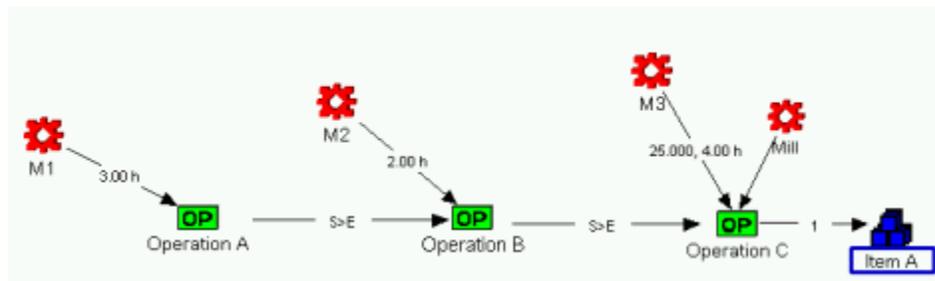
Production Scheduling has the capability to remove the dependency on having a routing template pre-created in the model for every work order in the application. The application dynamically cross references the work order routing against the routing template during the import process. If Production Scheduling encounters one of the problematic scenarios listed above, it creates a new routing, which directly corresponds to the work order in question. If operations differ from their standard templates, Production Scheduling creates a new operation, which is present in the routing.

## Example of a Work Order that Results in a Routing

Assume that the following routing exists in Production Scheduling as a standard template:



Now, assume the work order which is created in ERP contains an additional machine "Mill" on Operation C, which is a non-standard machine for this part.

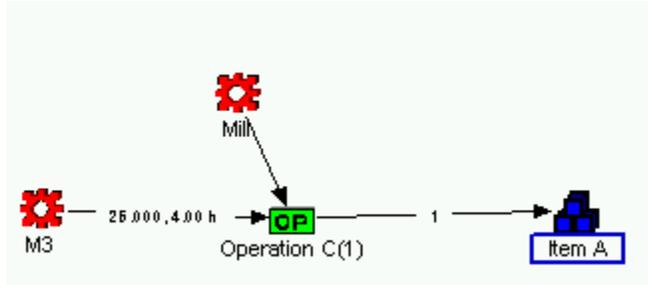


When this work order is imported into Production Scheduling, a subfolder in the All Routings folder is created. This folder is named *Work Order Routings*. The Work Order Routings subfolder contains the newly created routing.

In addition to the new subfolder, the following events occur:

1. A new routing exists in Production Scheduling. The name is specified on the work order header. If the name already exists, Production Scheduling appends the number one in brackets, (1), to the routing code. The integration ID from the XML file is retained and sent back when the schedule is published. In this way, the inbound integration can continue to cross-references the original routing that was returned to fill in any relevant details.
2. The option *Use this routing for Work Orders Only* in the Attribute tab of the routing Properties window is selected. No net new production recommendations use this routing to create new production when total demand is greater than the sum of work order quantities.
3. The All Operations folder contains a subfolder named Work Order Operations, and it contains a newly created Operation C(1). This is the operation that had the additional resource charged to it. If the name is the same as an existing operation, Production Scheduling appends a number one in brackets, (1) to its operation code. The integration ID from the XML is retained and sent back when the schedule is published so the inbound integration continues to function.

The diagram below illustrates that Operation C is redefined:



The Operations tab in the Work Order Editor displays operation information for the routing. The Bill of Resources tab displays the resources assigned to the work order. Access the Production Pegging view to display the scheduled work order.

### Automatically Generated Scenarios and Corresponding Results on Import

The following table outlines several scenarios that result in automatically generated routings and operations:

Scenario	Result
A work order is created in a Configurator program, which contains no corresponding routing in the Production Scheduling data model.	A routing is created and assigned the code that is present on the work order. All operations that are not previously defined are created in the Production Scheduling data model.
Non-standard crews, machines, or tools are included on the work order bill of resource.	A routing is created in Production Scheduling. Each operation has a new operation created in the Production Scheduling data model. If there is an integrationID assigned to the routing code in the model, it is assigned to this routing code. This is the same for any operation created.
The work order operation is missing crews, machines, or tools.	A routing is created in Production Scheduling. Each operation has a new operation created in the Production Scheduling data model. If there is an integrationID assigned to the routing code in the model, the integrationID and the new operations are assigned to this routing code.

Scenario	Result
Non-standard items included on the work order bill of resource.	A routing is created in Production Scheduling. Each operation has a new operation created in the Production Scheduling data model. If there is an integrationID assigned to the routing code in the model, the integrationID and the new operations are assigned to this routing code.
The work order operation is missing items.	A routing is created in Production Scheduling. Each operation has a new operation created in the Production Scheduling data model. If there is an integrationID assigned to the routing code in the model, the integrationID and the new operations are assigned to this routing code.
Additional operations are included on the work order routing.	A routing is created in Production Scheduling. Each operation has a new operation created in the Production Scheduling data model. If there is an integrationID assigned to the routing code in the model, the integrationID and the new operations are assigned to this routing code.
There are missing operations on the work order routing.	A routing is created in Production Scheduling, which contains only the operations on the work order routing. If there is an integrationID assigned to the routing code in the model, it is assigned to this routing code.

## Work Order Yield and Scrap Overview

Work orders in Production Scheduling represent both yield and scrap on a given operation and across operations. Yield applies to operation output and scrap applies to consumed items. These examples illustrate yield and scrap on operations.

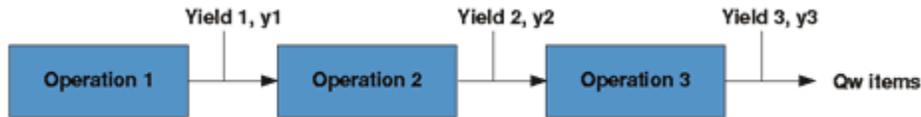
- Example of yield calculation.
- Example of consumed items.

### Example of Yield Calculation

The following criteria is used in this example:

- Work order quantity =  $Q_w$ .
- Work order routing or operation yield =  $y$ .
- Work order parts list scrap factor =  $s$ .
- Work order parts list scrap factor quantity =  $Q_c$ .

This diagram illustrates a manufacturing process, which consists of three operations. Each operation has a quantity of material going into the operation, and a quantity, as a percent yield, coming out.



As a result of each operation, there is material that is unusable. This is represented by  $(1-y) \times Q_w$  (quantity of consumed items) and is expressed as a percent. In this example, we want to produce four bicycles. The yield for each operation is as follows:

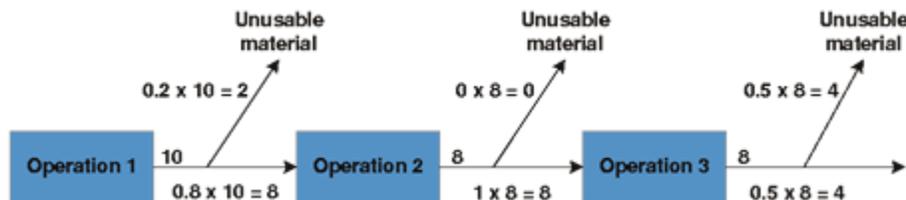
- Operation 1 yield is 80 percent
- Operation 2 yield is 100 percent
- Operation 3 yield is 50 percent

Operation 1 starts by trying to make 10 bikes. The yield for operation 1 is 80 percent so only 8 bikes are successfully produced. That is,  $0.8 \times 10=8$ . Eight good products are successfully produced. Two items are unusable.

Operation 2 continues the process with 8 good bikes because the yield is 100 percent,  $1 \times 8=8$ .

Operation 3 is the last operation in the process. The yield for this operation is 50 percent so 4 good bikes are produced,  $0.5 \times 8=4$ . Four good products are produced. Four items are unusable.

Of the ten bikes that were started in operation 1, the routing delivers four good bikes. The cumulative yield is  $y_1 \times y_2 \times y_3 = 0.8 \times 1 \times 0.5 = 0.4$  This is illustrated in the following diagram:



### Example of Consumed Items

To make the bicycles in this example, each bike needs one handlebar, one seat, two wheels, and one drive train. The operations and their scrap factor are:

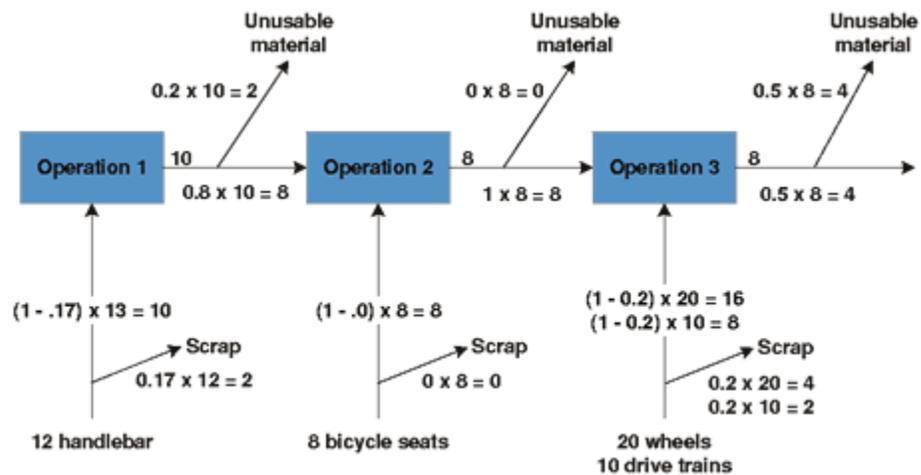
- Operation 1 consumes one handlebar per bike, scrap is 17 percent
- Operation 2 consumes one seat per bike, scrap is 0 percent
- Operation 3 consumes two items:
  - two wheels per bike, scrap is 20 percent
  - 1 drive train per bike, scrap is 20 percent

Operation 1 starts by trying to consume 12 handlebars. The scrap for operation 1 is 87 percent so only 10 handlebars are successfully consumed. That is,  $(1-0.17) \times 12=10$ . Two items are unusable, leaving 12 good products.

Operation 2 starts by trying to consume 8 bicycle seats. The scrap is 100 percent,  $(1-0) \times 8, 8$  seats are consumed.

Operation 3 starts by trying to consume 20 wheels. The scrap for this operation is 80 percent so 16 good wheels are consumed,  $(1-0.2) \times 20=16$ . The same scrap factor applies to making drive trains. It starts by consuming 10. Eight are successfully consumed  $(1 \times 0.2) \times 10 = 8$ .

This is illustrated in the following diagram:



Numerically, the example looks as follows, where:

- AP is Attempted Production
- TP is Targeted Production (4 bicycles)

- QA is Quantity per Assembly
- QRFI is Quantity Removed From Inventory
- S is scrap
- Y is yield

### **Operation 1**

Yield (percent): 80

Removed from Inventory Formula:  $AP = ((SKP/Y\#)Y2)/Y1$

Quantity Removed from Inventory:  $AP = 8/0.8 = 10$

Consumed item: **Handlebar**

Quantity per Attempted Production: 1

Scrap: 17

Removed from Inventory Formula:  $QRFI = AP \times QA / (1 - S)$

Quantity Removed from Inventory:  $QRFI = 10 \times 1 / 0.83 = 12$

### **Operation 2**

Yield (percent): 100

Removed from Inventory Formula:  $AP = (TP/Y3)/Y2$

Quantity Removed from Inventory:  $AP = 8/1 = 8$

Consumed item: **Bicycle Seat**

Quantity per Attempted Production: 1

Scrap: 0

Removed from Inventory Formula:  $QRFI = AP \times QA / (1 - S)$

Quantity Removed from Inventory:  $QRFI = 8 \times 1 / 1 = 8$

### **Operation 3**

Yield (percent): 50

Removed from Inventory Formula:  $AP = (TP/Y3)$

Quantity Removed from Inventory:  $AP = 4/0.5 = 8$

Consumed item: **Wheel**

Quantity per Attempted Production: 2

Scrap: 20

Removed from Inventory Formula:  $QRFI = AP \times QA / (1 - S)$

Quantity Removed from Inventory:  $QRFI = 8 \times 2 / 0.8 = 20$

Consumed item: **Drive Train**

Quantity per Attempted Production: 1

Scrap: 20

Removed from Inventory Formula:  $QRFI = AP \times QA / (1 - S)$

Quantity Removed from Inventory:  $QRFI = 8 \times 1 / 0.8 = 10$

## Creating a Work Order

Use the Work Order Editor to create a work order.

**Note:** Fields that are grayed out are either calculated or predetermined. For example, the Lot Multiple field is grayed out because it is populated from the producing operation of the selected routing.

### To add a work order:

1. Double-click Work Order Editor from the Model Workspace.
2. Expand the work order tree to display the work order type folders. There are three primary work order folders, Production Orders, Maintenance Orders, and Enterprise Asset Management.
3. Right-click the folder where you want to create the new work order, and select new work order option. The work order appears in the selected location.
4. Double-click the new work order.
5. Complete the Work Order header fields in the main window of the Work Order Editor.
6. Complete the necessary fields in the Work Order Editor tabs.
7. Click Save, and exit from the Work Order Editor.

## Work Order Header

When a work order displays in the Work Order Editor, the fields in the work order region, above the tabs, are referred to as the Work Order header. The fields and descriptions in the Work Order header are as follows:

Work Order Header Field	Description
Number	Displays the number assigned to the work order.

Work Order Header Field	Description
Order Class	If the demand is pegged, the order class is preassigned and assumes the class order of the pegged demand. If demand is not pegged, select one of these options: <i>Hot</i> , <i>Committed</i> , or <i>Uncommitted</i> .
Priority	Displays the priority assigned to the work order. If the work order is linked to another, it inherits the demand priority from the linked demand order line item. Use the Priority list to assign the priority of the work order.
Description	Displays the work order description.
Firm	<p>This option indicates if the work order is firm. Check this option to assign a Firm status. Once selected, you can assign a Firm Status, Start Date, and End Date as needed from the Operations tab.</p> <p>If you assign a Firm status and dates, you need to solve the schedule and publish the Release Schedule to update production EBS data.</p>
Item Code	Displays the item assigned to the work order. Use the Item Code list to assign an item to the work order.
Produce to Stock	Indicates whether the item becomes "stockable" after Work Order completion. This option is primarily for Maintenance (cMRO) work order activities where there are a series of work orders but only the final work order produces to stock signifying the completion of the maintenance activities.
Rebuild Item	For EAM Work Orders only, displays the rebuild item assigned to the work order. List is enabled when Rebuild Activity option is checked.

<b>Work Order Header Field</b>	<b>Description</b>
Serial Number	For Production and Maintenance Work Orders, displays serial number for parts which have a specific serial number associated with them. This is an optional field and can be populated for informational purposes.
Activity Item	For EAM Work Order, displays the primary item on the work order and represents the work order activity. For example, "Fuel pump Rebuild" or "500 Hr Maintenance on Aircraft Tow Tractor".
Rebuild Activity	For EAM Work Order, check this option to indicate work order is part of activity for a rebuildable item. When selected, the Rebuild Item list is enabled and used to select the rebuildable item.
Routing	Displays the routing assigned to the work order. Use the Routing list to select the routing for the work order. This field displays all applicable routings and standalone operations that can build the item.
Original Routing	The Original routing is a reference if the work order is offloaded to an alternate routing by the solver. The option displays the original assignment before offloading occurred.
Unit of Measure	Displays the unit of measure for the item.
Required	Displays the quantity of the item that is required to fulfill the work order. This field is not available for Maintenance or EAM work orders.
Completed	Displays the number of items that have been produced out of the total quantity that is specified in the work order. This field is not available for Maintenance or EAM work orders.

Work Order Header Field	Description
Remaining	Displays the number of items that need to be produced to satisfy the work order. This number is calculated by the system. This field is not available for Maintenance or EAM work orders.
Reserved	Displays the number of item reserved.
Lot Multiple	<p>Displays the multiplier based on the selected routing.</p> <p>Displays the lot multiple of the associated routing. If using units of effort and the work order quantity is greater than the routing lot multiple, the work order is divided into these incremental lot multiples to create several routing instances. For example, if your work order quantity is 4000 units and the routing lot multiple is 2000 units, two routing instances are scheduled.</p>
Routing Instances Required	Displays the number of routings needed to satisfy the work order. If Units of Effort is enabled, this displays 1. If Units of Effort is disabled, this number is the quantity or lot multiple.
Earliest Start Date	For Production and Maintenance work orders, this field represents the earliest date the visit could be scheduled which would typically be the arrival of the aircraft. This is treated as a hard constraint.
EAM Start Date	<p>For EAM work orders, this field displays earliest date that maintenance can be scheduled.</p> <p>Select the Link icon to the right of the field to move all operations relative to the Start Date. When link is not selected, each operation dates can be changed for manual scheduling from the Operations tab.</p>

<b>Work Order Header Field</b>	<b>Description</b>
Target Completion Date	Used primarily for Maintenance work orders, this field displays the date assigned to a visit milestone and is used as a soft constraint.
EAM End Date	For EAM work orders, this field displays end date for the maintenance activity.
Request Date	Displays the date that the work order is to be completed. When linked to a demand order, it inherits the requested date from the Supply & Demand Editor.
Start Date	Displays the start date and time of the first operation in the routing. This field is calculated by the Production Scheduling solver.
Completion Date	Displays the end date and time of the last operation in the routing. This field is calculated by the Production Scheduling solver.
Earliest Demand Date	Displays the date if a work order is pegged to this demand.
Created Date	Displays the date that the work order was created in the MRP program.
Status	Displays the current status of the work order.
On Hold	Check to indicate that the work order is on hold.
Maintenance Resource	For EAM work orders, this field displays the resource assigned to the asset maintenance activity. List displays crews, machines, and tools defined in the model.

<b>Work Order Header Field</b>	<b>Description</b>
Asset Number	For EAM work orders, the asset number is an instance of the resource and is referenced on the work order. The asset number refers to an Equipment Item which is linked to the Resource defined in Department   Resources screen in Oracle Enterprise Asset Management.
Shutdown Type	<p>For EAM work orders, this field dictates whether the resource is available during maintenance activities.</p> <p>The following values may be displayed:</p> <ul style="list-style-type: none"> <li>• Required - The asset receiving maintenance is down for the duration of the work order.</li> <li>• Not Required - The operation shutdown status is relevant and can be shut down for specific operations.</li> </ul>
Asset Group	Displays the asset group associated with the asset.

### **Work Order - Operations Tab**

The fields and descriptions in the Work Order - Operations tab are:

<b>Work Order - Operations Tab Field</b>	<b>Description</b>
Operation Code	Displays the operation code for each routing stage. This field comes from the chosen routing.
Operation Description	Displays the description of the operation.

Work Order - Operations Tab Field	Description
Status	<p>Displays the current status of the operation. Valid values are:</p> <ul style="list-style-type: none"> <li>• <i>Open</i> - The operation has not yet started.</li> <li>• <i>Active</i> - The operation is in progress.</li> <li>• <i>Closed</i> - The operation is complete.</li> </ul> <p>When Status is Active or Closed, it is not necessary to have an Actual Start Date or Actual End Date, but if an Actual Start Date exists, then the operation is assumed to be Active. If an Actual Start Date and End Date exists, then the operation is assumed to be closed.</p>
Shutdown Type	<p>Displays if shutdown is required or not required for the operation.</p>
Firm Status	<p>Determines if the start date, end date, or both the start and end date are inflexible. Valid values are:</p> <ul style="list-style-type: none"> <li>• <i>Firm Start</i> - The start date is fixed. When you select this option, the Start Date field becomes active. Set the start date by moving the up and down arrows or by clicking on the large arrow, which brings up a calendar.</li> <li>• <i>Firm End</i> - The end date is fixed. When you select this option, the End Date field becomes active. Set the end date by moving the up and down arrows or by clicking on the large arrow, which brings up a calendar.</li> <li>• <i>Firm Range</i> - The start date and end date are fixed. When you select this option, both the Start Date field and the End Date field become active. Set the date by moving the up and down arrows in the respective date fields or by clicking on the large arrow, which brings up a calendar.</li> </ul>

<b>Work Order - Operations Tab Field</b>	<b>Description</b>
Start Date	The start date for the operation. This field is populated only if you specify a start or firm range.
End Date	The end date for the operation. This field is populated only if you specify an end or firm range.
Actual Start Date	The Actual Start Date of an Operation (as imported from cMRO).
Actual End Date	The Actual End Date of an Operation (as imported from cMRO).
Planned Start Date	Displays or enter the scheduled starting time of an operation as calculated by the solver. When a work order is broken down into its units of effort, this field reflects the start time of the operation instance.
Planned End Date	Displays or enter the scheduled ending time of an operation as calculated by the solver. When a work order is broken down into its units of effort, this field reflects the end time of the operation instance.
Yield Percentage	Enter the percentage of usable output from the operation. If you change this, Production Scheduling scales upstream operation durations and bill of material quantities.
Cumulative Yield	The composite yield percentage from the last operation to the first.

### **Work Order - Precedence Constraints Tab**

Use the Precedence Constraints tab to view and modify the precedence constraints relationship for the work order. The fields and descriptions in the Work Order - Precedence Constraints tab are:

<b>Work Order - Precedence Constraints Tab Field</b>	<b>Description</b>
Source Operation	Displays the source operation assigned to the work order and its precedence relationship.
Destination Description	Displays the description of the operation.
Precedence Relationship	Displays precedence relationship between the source and destination operation.  See "Precedence Relationships Overview, page 5-54," <i>Creating Production Scheduling Models, Production Scheduling</i> .
Min Separation (minimum separation)	Displays the minimum separation time between operations. This overrides the routing template, if it is different. The Min Separation field to the right displays the minimum separation unit of measure.  See "Precedence Relationships Overview, page 5-54," <i>Creating Production Scheduling Models, Production Scheduling</i> .
Max Separation (maximum separation)	Displays the maximum separation time between operations. This overrides the routing template, if it is different. The Max Separation field to the right displays the maximum separation unit of measure.  See "Precedence Relationships Overview, page 5-54," <i>Creating Production Scheduling Models, Production Scheduling</i> .

Maintenance work orders generated from cMRO integration do not support minimum or maximum separation times between operations. Although these columns are available in the Precedence Constraints tab, they are disabled (null) for Maintenance work orders.

### **Work Order - Bill of Resources Tab**

Use the Bill of Resources tab to view the resources assigned to the operations defined in the selected routing. Operation details, such as duration scale and run time, are also displayed. The fields and descriptions in the Work Order - Bill of Resources tab are:

Work Order - Bill of Resources Tab Field	Description
Operation Code	Displays the operation code for each routing stage. This field is populated from the chosen routing.
Planned Resource Set	<p>Displays the preferred resource set. You may select a different "All of" set or single resource. When a different All of set is selected, the Planned Resource field reflects the new resource. If the All of Set has a different number of members, rows are added or deleted in the tab to reflect this.</p> <p>See "Creating All of Sets, page 5-49," <i>Creating Production Scheduling Models, Production Scheduling</i>.</p>
Planned Resource	Displays the resource that was planned to be used to complete this operation.
Resource Type	Displays the resource type.
Capacity Required	Displays the resource quantity required.
Resource Class	Displays the whether the resource is a lot multiple or duration.
Allow Offloading	Displays Yes if the resource permits offloading for alternate resources.
Actual Resource	Displays the resource that was used to complete this operation.
Scale Duration	<p>Select <i>Yes</i> to indicate that the machine run time, in the Routing page, is to be scaled proportionally to changes in quantity. For example, if an operation takes 10 minutes to produce 20 units, and the quantity is reduced to 10 units, then proportionally, the reduced time is 5 minutes. Available options are Yes or No.</p> <p><b>Note:</b> This field is not available for Maintenance and EAM work orders.</p>

<b>Work Order - Bill of Resources Tab Field</b>	<b>Description</b>
Run Time	Displays the duration of the operation.
Run Time Unit	Displays the time frame for the run time. Available options are seconds, minutes, hours, or days.
Remaining Run Time	Displays the amount of time that is required to complete operations that have a status of Active or Open. The remaining run time unit of measure appears to the right.

### **Work Order - Bill of Materials Tab**

The fields and descriptions in the Work Order - Bill of Materials tab are:

<b>Work Order - Bill of Materials Tab</b>	<b>Description</b>
Operation Code	Displays the operation code for each routing stage. This field is populated from the chosen routing.
Planned Item Code	Displays the item that is planned to be consumed by this operation. The Planned Item Code is the preferred item on the work order.
Planned Item Description	A description of the item that is planned to be consumed by this operation.
Actual Item Code	<p>Displays the item that was consumed to complete this operation. The Actual Item Code is the item selected by the Production Scheduling solver for the work order.</p> <p>When releasing the work order from Production Scheduling, the Actual Item Code is updated on the work order in the source EBS system when published.</p>
Actual Item Description	Displays the description of the item that was consumed to complete this operation.

<b>Work Order - Bill of Materials Tab</b>	<b>Description</b>
Scale Parts	Select whether you want to scale parts. Options are Yes or No.  If set to Yes, then the quantity per the component scales, or is adjusted, with the quantity remaining (Remaining field) in the work order header. If set to No, then the quantity remaining does not change, regardless of the quantity required for the work order.
UOM	Displays the unit of measure for the planned item.
Quantity Required	Enter the amount of material required for the operation.
Scrap Percentage	Enter the percentage of input material that is unusable by this operation.
Scrap Adjusted	Displays the amount of material required, adjusted for scrap.
Quantity Issued	Enter the number of items that remain to be issued or consumed.
Quantity Remaining	Displays the number of items that need to be consumed to satisfy the work order.
Actual Quantity	The quantity the solver has consumed (relevant in the case of offloading where the Actual Item is different from the Planned Item).

Alternate items for work orders are imported into Production Scheduling, but only alternate purchased items are imported. Manufactured components are not considered for alternate item selection. Alternate items appear in the Bill of Materials tab in the Planned Item Code and Actual Item Code fields. If these fields are blank, then no alternate items have been defined for the work order.

When alternate items are defined and imported, an item sets is automatically created and displayed in the operation diagram.

To view the item set in the in the operation diagram from the Bill of Materials tab, right-click on the operation and select Open, or double-click the operation.

## Work Order - Produced Items Tab

The fields and descriptions in the Work Order - Produced Items tab are:

<b>Work Order - Produced Items Tab Field</b>	<b>Description</b>
Operation Code	Displays the operation code for each routing stage. This field is populated from the chosen routing.
Item Code	Displays the unique identifier of this item.
Item Description	Displays the contents of the Notes field for the item.
Type	Displays the type of item, such as a primary item or a by-product.
UOM	Displays the unit of measure for the item code.
Quantity Required	The number of items that need to be produced to satisfy the work order.
Quantity Completed	The number of items that have been produced.
Quantity Remaining	Displays the number of items that still need to be produced to satisfy the work order.

## Work Order - Related Work Orders Tab

The buttons, fields, and descriptions in the Work Order - Related Work Orders tab are:

<b>Work Order - Related Work Orders Tab Field</b>	<b>Description</b>
Add (button)	Click Add to define the next work order.
Delete (button)	Click Delete to delete the link to a work order that exists in the list of related work orders.
Work Order	Displays the work order number for related work order.

Work Order - Related Work Orders Tab Field	Description
Type	<p>Displays <i>Next</i> or <i>Previous</i>.</p> <p>You can only add Next work orders, but the other work orders that are selected list the work order as <i>Previous</i>.</p>
Item	<p>Displays the item that is produced from the related work order.</p>
Quantity	<p>Displays the remaining quantity of the requested item from the related work orders.</p>
Request Date	<p>Displays the request date of related work orders.</p>
From Operation	<p>Displays the From Operation of the Previous Work Order.</p>
To Operation	<p>Displays the To Operation of the Next Work Order.</p>
Precedence Relationship	<p>Displays the precedence constraint between the work order header and the related work orders. If you change this field the precedence relationship is updated on the work order header. Valid values are: <i>Starts After End</i>, <i>Starts At End</i>, and <i>Starts After Start</i>.</p>
Min Separation (minimum separation)	<p>Enter the minimum separation time. This field can be changed only if the precedence field has a value of <i>Starts After End</i>. The Min Separation field to the right displays the minimum separation unit of measure.</p>
Max Separation (maximum separation)	<p>Enter the maximum separation time. This field can be changed only if the precedence field has a value of <i>Starts After End</i>. The Max Separation field to the right displays the maximum separation unit of measure.</p>
Completion Date	<p>Displays the completion date of related work orders. This field is populated when the solver runs.</p>

## Work Order - Maintenance Tab

In environments where Production Scheduling is integrated to cMRO, the fields in the Maintenance tab will be populated by default as follows:

<b>Work Order - Maintenance Tab Field</b>	<b>Description</b>
Visit	Displays the visit assigned to the work order.
Previous Milestone	The previous milestone that must be completed before this work order can commence.
Next Milestone	The milestone that is reached upon completion of all work orders in the current milestone.
Stage	The stage the work order belongs to.
Process	Displays field if Maintenance work order uses this field. List displays all the processes assigned to work orders in the model.
System	Displays field if Maintenance work order uses this field. List displays all the systems assigned to work orders in the model.
Access Panel	Displays field if Maintenance work order uses this field. List displays all the access panels assigned to work orders in the model.
Zone	Displays field if Maintenance work order uses this field. List displays all the zones assigned to work orders in the model.
Subzone	Displays field if Maintenance work order uses this field. List displays all the subzones assigned to work orders in the model.
Department	Displays field if Maintenance work order uses this field. List displays all the departments assigned to work orders in the model.

Work Order - Maintenance Tab Field	Description
Unit Name	Displays field if Maintenance work order uses this field. List displays all the unit names assigned to work orders in the model.
Non Routine	Displays field if Maintenance work order uses this field. Valid options are <i>Yes</i> or <i>No</i> . This option is used indicate whether the work order is of type non routine or not.

### Work Order - Supply Reservation Tab

Use the Supply Reservation tab to associate the following supply types to a work order by quantity:

- On Hand Inventory - Create reservations against specific quantities of on-hand inventory is necessary as specific components may have been reserved for qualitative reasons (original part, regulations etc.).
- Supply Events (from the Supply & Demand Editor) - Create reservations to account for supply types from Oracle EBS, which includes Purchase Orders, Transfer Orders (in), and Outside Processing (OSP) orders.

**Note:** OSP orders are only imported when integrated with Oracle cMRO.

- Upstream Work Orders.

The buttons, fields, and descriptions in the Work Order - Supply Reservation tab are:

Work Order - Supply Reservation Tab Field	Description
Add (button)	Click to create a supply reservation.
Delete (button)	Click to remove a supply reservation.
Properties (button)	Click to view or modify a supply reservation.
Name	Displays the reservation name.
Item	Displays the item reserved.

<b>Work Order - Supply Reservation Tab Field</b>	<b>Description</b>
Serial Number	Displays item serial number.
Quantity	Displays the quantity reserved.
Supply Type	Displays the supply side type. Valid values are On Hand, Purchase Order, Transfer Order, and Work Order.
Supply	Displays the supply side code.
Description	Displays the notes or comments assigned to the reservation.

Use the Supply Reservation tab to add, delete, or view reservation properties.

**To add a supply reservation:**

1. Click Add.
2. Select an item from the Items list. The list includes items which are specified on the Work Order Bill of Material.
3. In the Quantity field, enter the number of items to be reserved.  
The total quantity of the reservation should not exceed the total quantity of the work order.
4. If applicable, enter serial number.
5. Select the Supply side Type for the reservation.
6. Select the Supply side Code.
7. Enter any notes or description in the Notes field.
8. Click OK.

Item reservations are reflected in the On Hand tab of the item's Properties window.

9. Solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error is appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To view or modify a supply reservation:**

1. Select a reservation and click Properties.
2. Modify the supply reservation fields as needed and click OK.
3. If updates are made, solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error is appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To remove a supply reservation, select the reservation and click Delete.**

### Work Order - Demand Reservation Tab

Use the Demand Reservation tab to create demand reservations for the work order. Using this tab you can to pre-peg multiple demands to a work order.

The buttons, fields, and descriptions in the Work Order - Demand Reservation tab are:

<b>Work Order - Demand Reservation Tab Field</b>	<b>Description</b>
Add (button)	Click to create a demand reservation.
Delete (button)	Click to remove a demand reservation.
Properties (button)	Click to view or modify a demand reservation.
Name	Display the reservation name.
Item	Displays the item reserved.
Serial Number	Displays item serial number.
Quantity	Displays the quantity reserved.
Demand Type	Displays the demand side type. Valid values are Sales Order, Forecast, Transfer Order, and Work Order.
Demand	Displays the demand side code.
Description	Displays the notes or comments assigned to the reservation.

Use the Demand Reservation tab to add, delete, or view reservation properties.

**To add a demand reservation:**

1. Click Add.
2. Enter the reservation name. This is not required data and can repeat across for other reservations.
3. In the Quantity field, enter the number of items to be reserved.  
The total quantity of the reservation should not exceed the total quantity of the work order.
4. If applicable, enter serial number.
5. Select the Demand side Type for the reservation.
6. Select the Demand side Code.
7. Enter any notes or description in the Notes field.
8. Click OK.

The total reserved quantity defined in the Demand Reservation tab appears in the Work Order header Reserved field. Item reservations are also reflected in the On Hand tab of the item's Properties window.

9. Solve the model and review the solver log for any reservation errors.  
If the reservations exceed available quantity, an error is appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To view or modify a demand reservation:**

1. Select a reservation and click Properties.
2. Modify the demand reservation fields as needed and click OK.
3. If updates are made, solve the model and review the solver log for any reservation errors.

If the reservations exceed demand quantity, an error is appears in the solver log file. All reservations for a given item are ignored when the sum of the reservations exceeds the available item quantity. Correct the issue and re-solve the model.

**To remove a demand reservation, select the reservation and click Delete.**

**To view the demand line item in the Supply & Demand Editor, right-click the Demand column for the reservation and select Open.**

**To display the work order in the Production Pegging view, right-click the Demand column for the reservation and select Open Production Pegging Gantt.**

## Deleting a Work Order

**To delete a work order:**

1. Double-click the Work Order Editor from the Model Workspace.
2. In the Work Order tree, select the work order you want to delete. If you want to delete more than one work order, hold down the Shift key and highlight the appropriate work orders or folders. If the work orders or folders are not listed sequentially, hold down the Ctrl key and select the individual work orders or folders.
3. Right-click and select Delete.

## Accessing Views from a Work Order

You can access the operation drawing view, Production Pegging, or Operation Gantt from the Operations, Bill of Resources, Bill of Materials, or Produced Items tab displayed at the bottom of the Work Order Editor.

**To access a view from a work order:**

1. Double-click the Work Order Editor from the Model Workspace.
2. Expand the necessary folder and double-click a work order.
3. Right-click the Operation Code field from the Operations, Bill of Resources, Bill of Materials, or Produced Items tab and select one of the following:
  - Open - Click to display the work order operation drawing.
  - Open Production Pegging Gantt - Click to display the Production Pegging Gantt view.
  - Open Operation Gantt - Click to display the Operation Gantt view.

The selected view appears. Performing a drill down from the Work Order Editor highlights the selected operation and performs a context sensitive zoom as well, making it easier to find the work order.

## Creating Work Order Folders

To create work order folders:

**Note:** To expand the Work Order Editor window and show or hide the work order tree, click on the Show/Hide icon in the menu bar.

1. Double-click the Work Order Editor from the Model Workspace.

2. Right-click the type of work order folder you want to create and select Add Folder. The Work Order Editor displays the following work order categories:
  - *Production Orders*
  - *Maintenance Orders*
  - *Enterprise Asset Management*
3. Right-click the folder, select Rename, and enter a new name for the folder.
4. Press Enter.

## Organizing Work Orders into Folders

To organize work orders into folders:

1. Double-click the Work Order Editor from the Model Workspace.
2. Expand work order tree until you see the source and target locations for the folders you want to organize.
3. Select the work order or work orders that you wish to move.
4. Drag and drop the work orders into the desired folder.

## Creating and Viewing Work Order Folders

To adjust or view work order folder properties:

1. From the Work Order Editor, right-click the work order folder and select Change. The Change - Work Order dialog appears.
2. Select the General tab to view or modify work order quantity, request date, and hold status.
3. Select the Maintenance tab to view visit information.
4. Click OK. Click Cancel to close dialog box without saving your changes.
5. If the request date for a milestone is modified, a solve or repair solve is required.

## Creating Hard Links Between Work Orders

This section provides an overview of hard links between work orders and discusses how to:

- Create a hard link between work orders.
- View related work orders.

## Hard Links Between Work Orders Overview

The concept of *Next* work orders exists in Production Scheduling. This means that one particular work order must complete before the *next* work can begin. If using the work order units of effort feature, the work orders can overlap but there must be enough inventory produced from the first work order before the start of the first operation instance on the *Next* order that consumes it.

Hard links between work orders enables a user to create a many to many relationship between work orders and provides the ability to specify precedence constraints between these work orders. When the user creates the Next relationship, the details are populated for both work orders in the Related Work Orders tab of the Work Order Editor.

The Related Work Orders tab of the Work Order Editor displays the type of relationship (Next or Previous), the item it produces, quantity, request date, the precedence relationship, the minimum and maximum separation, and a completion date. The Precedence Relationship, Min Separation, and Max Separation fields are open fields. The Completion Date field is populated when the solve completes.

It is possible to have multi-level work orders. For example, a Next work order is also Previous to another work order.

If a user creates a Next relationship between two work orders and the inventory quantity between the two work orders is unbalanced, for example, work order one creates 40 units, but work order two consumes 50 units of the same inventory. Then the solver instantiates net new production to avoid the infeasibility.

## Creating a Hard Link Between Work Orders

To create a hard link between work orders:

1. Double-click the Work Order Editor from the Model Workspace and expand the work order tree.
2. Select the work order that is to become the Next work order.
3. Drag the Next work order and drop it on to the Previous work order.

This action creates a shortcut between the work orders, and the work order tree structure remains intact.

**To view related work orders, select the Related Work Orders tab within the Work Order Editor.**

For button and field definitions, see "Creating a Work Order, page 5-109," Creating Production Scheduling Models, *Production Scheduling*.

## Releasing Work Orders to Production

This section provides an overview of selective work order release and the Release to Production window, and discusses how to:

- View the Release To Production window.
- Release work orders to production.

### Selective Work Order Release Overview

After a schedule is created, optimized, and approved, the master scheduler might choose to pass all the existing work orders to the shop floor and ERP system or decide to selectively release a subset of work orders.

### Release to Production Window Overview

The Release To Production window provides read-only detailed information about all the planned orders and work orders in the model.

The publish horizon of the selected publish profile is displayed as the Release Horizon at the top of the view. All work orders that fall within the publish horizon are selected when you open the Release To Production window. All work orders in the model with start dates within the release time frame are present in the window and are automatically selected.

Use the Select All or Deselect All buttons to make mass changes prior to publishing the schedule. To resize a column, drag a column border. To sort your data, click a column header. When a sort is based on a field that contains non-unique values, a secondary sort is performed based on the Start Date value. A small arrow on the right side of the header field indicates the current sort criteria.

If you extend the publish horizon after selecting the work orders in the view, the original selection is cleared and you have to make your selection again. The work orders that have start dates within the new release horizon are automatically selected. If you run a solve, all selections are reset.

### Viewing the Release to Production Window

To view the Release to Production Window:

1. Right-click the scenario and select Approve. A green check mark displays on the scenario icon in the Model Workspace.
2. Right-click the scenario and select Edit Work Order Release.

**Note:** If the scenario is not approved, the Edit Work Order Release option is not available.

3. To view only those work orders that meet a defined filter, select the appropriate filter from the Work order filter list. The window refreshes to display only those work orders that meet the filter criteria.

## Releasing Work Orders to Production

To release work orders to production:

1. Access the Release to Production window.
2. To automatically display and select related work orders for release, check the Select related work orders for release option.

If a work order has related work orders associated to it, the row is highlighted in blue and all related work order are also highlighted. If the work order is checked to be released, all related work orders are automatically checked for release as well.

3. Select one or more work orders that are ready to be released.
  - Check each work order to be released.
  - Click Select All to check all work orders.
  - Click Deselect All to uncheck all work orders.

4. Click the Publish button from the toolbar, or select Publish from the File menu.

5. Select the profile from the Publish window and click OK.

For more information about publish your schedules, see "Publishing Schedules, page 11-4," Publishing Data, *Production Scheduling*.

## Defining Changeover Rules

This section provides information on the following topics:

- Changeover rules overview.
- Creating changeover rules.
- Re-ordering changeover rules.
- Finding matching changeover rules.
- Filter changeover rules.

## Changeover Rules Overview

You can record precise information about sequence dependent changeover time by using the Changeover Editor. For example, when a machine die is changed to a larger bore or when a printing press changes to a different color, the machine has to be stopped and reconfigured. Using this feature, you can create attribute based rules that record those times when a machine cannot operate because it has to be set up for the next operation. Costs can also be recorded for each changeover rule. These costs are used to calculate the cost-based metrics in the Key Performance Indicators window.

A hierarchical order exists for the rules that are entered in the Changeover Editor. When solving the schedule, the system uses the first rule on the list that applies to the changeover from one machine to another. For example, if you have two rules for the Chain Machines Group from Gold to Bronze, the schedule uses the top rule.

With attribute-based changeovers, it is possible to have one or more rules applicable for a changeover. For example, in a soft drink bottling plant changing the flavor and changing bottling size might have different changeover rules. Because of this it is required to specify whether the changeovers are concurrent or sequential. If they are concurrent, then both changeovers can occur at the same time and the maximum time and cost are used for the changeover rule. Sequential changeovers rules are additive in terms of cost and time. Different calendars can also be applicable for multiple changeovers rules so it is possible to define whether all calendars must be up or just one calendar must be up for scheduling changeovers.

**Note:** If you create a rule at, or move a rule to the top of the Changeover Editor, this rule effectively overwrites all of the other rules.

To save time, you can select groups of attributes or machines when entering changeover rules. For any group other than All Machines or All Attributes to appear, its property attributes must be set to display in the Changeover Editor. You can use the filters at the bottom of the view to find out which changeover rule is applicable to the resource or operation to and from combinations.

## Creating Changeover Rules

**To create a changeover rule:**

1. Double-click the Changeover Editor from the Model Workspace.
2. Click Add new rule.
3. Complete these fields:

Changeover Editor Window Fields	Description
Machine	Select the machine, group, or wildcard (*) for which a changeover entry is being made.
Attribute Type	Select Operation or Group, an attribute, or wildcard (*) for which a changeover entry is being made.
From	Select an operation, attribute value, group, or wildcard (*).
To	Select an operation, attribute value, group, or wildcard (*).
Duration	Specify the amount of time that it takes to set up the machine between the From and the To operation changeover. Select the time value (0 hours by default) and specify the expected time for the changeover.
Duration unit	<p>Displays the duration unit of measure. The following options are available:</p> <ul style="list-style-type: none"> <li>• sec - Seconds</li> <li>• min - Minutes</li> <li>• hr - Hours</li> <li>• day</li> </ul>
Calendar	Select a calendar or shift that applies to the changeover.
Cost	Specify the cost associated with the changeover. When the changeover rule is applied, this cost value is used to calculate KPIs. The Campaign Run Optimization algorithm also uses this cost when determining an ideal sequence dependant setup.

## Re-ordering Changeover Rules

Use the Changeover Editor to arrange your changeover rules according to your needs.

### To re-order changeover rules:

1. Double-click the Changeover Editor from the Model Workspace.
2. Click the row number of the rule that you want to move.
3. Click Move rule up or Move rule down button from the Changeover toolbar to move the changeover rule to its new location.

## Finding Matching Changeover Rules

Use the Changeover Editor to perform a query to locate changeover over rules based on changeover criteria.

### To find matching changeover rules:

1. Double-click the Changeover Editor from the Model Workspace.

Use the Find Matching Changeover Rule region at the bottom of the Changeover Editor window to locate changeover rules that meet your criteria.

2. Use the Machine list to find changeover rules based on a specific machine.
3. Use the From Operation list to find changeover rules based on a specific From Operation attribute.
4. Use the To Operation list to find changeover rules based on a specific To Operation attribute.

The Found field displays the number of Changeover rules that match your search criteria. The Duration and Cost fields display the total duration and cost for all changeover rules that meet your search criteria if multiple changeovers are defined as sequential in the Attributes tab of the resource Properties page. The maximum cost and duration appear if multiple changeovers are defined as concurrent.

## Filtering Changeover Rules

Use the filter feature in the Changeover Editor to locate changeover rules based on filter criteria.

### To filter changeover rules:

1. Double-click the Changeover Editor from the Model Workspace.
2. Click the Toggle Rule Filter button on the toolbar. The Filter row appears at the top of the Changeover Editor and the Toggle Rule Filter button appears highlighted to indicate the filter option is enabled.

3. Click in each cell within the Filter row you that you want to define, and select the appropriate menu option. You can filter on the following fields: Machine, Attribute Type, To, and From.

Select (Show All) to display all options available for the filter field. Select the wildcard option (\*) to display changeover exceptions you have defined using the wildcard feature.

When a filter cell is selected, a list appears and displays all criteria for that field. As each filter field is assigned, the Changeover Editor is updated to display the changeover rules that meet the criteria defined by the filter fields.

4. To turn off the filter option, click the Toggle Rule Filter button. The Filter row at the top of the Changeover Editor is no longer displayed.

## Using Multi-Stage Synchronization and the Resource Relationship Editor

Multi-stage synchronization addresses Make/Pack issues for manufacturing environments. Characteristics for these types of environments are as follows:

- **Make stage:** The production stage that manufactures bulk WIP items, usually in batch-based production. These resources are referred to as *Upstream Resources*.
- **Pack stage:** The production stage that consumes bulk WIP items and delivers a variety of finished goods on packaging lines, which are referred to as *Downstream Resources*. Consequently, one bulk WIP item can be converted into several finished products. Package type, package size, or labels are variations of finished products.
- The two key production stages are decoupled via bulk WIP inventory. Typically, there is limited buffer storage available. For example, hold tanks in front of the packaging lines balance production rate variations between the stages.
- A bulk WIP item can generally be produced on several alternate upstream resources, and it can be packaged away on several alternate downstream resources.
- Batch sizes on the upstream resources may vary. For example, different size tanks may be used. This corresponds to alternate routings.
- The bulk WIP consumption rates usually vary on the downstream resources, since package type and size have an impact. For example, filling small portion control packages generally consumes less bulk WIP inventory per hour than filling large bottles.
- **Physical Resource Connectivity:** An upstream resource may have direct connections via hoses/pipes to downstream resources. Certain downstream resources may be fed both directly from an upstream resource as well as totes. Other downstream resources can only be fed via totes, and again others that can

only be fed directly. The direct fed capability may be based on the speed of a packaging line, which might outrun any kind of tote-feeding.

Direct connectivity includes the following situations:

- Upstream resources may have direct connections via hoses/pipes to downstream resources.
- Downstream resources may be fed both directly from an upstream resource as well as totes.
- Downstream resources can only be fed via totes, while others can only be fed directly.
- The direct feed constraint may, for example, be based on the speed of a packaging line, which might outrun any kind of tote-feeding.
- Product attributes can impact upstream and downstream resources. For example, there may be cleaning or sanitation requirements defined within various stages. Attributes like package type and package size can drive changeovers on the downstream resources. Based on your production environment, you may have a specific ideal sequence in mind to run on the packaging lines. Sequencing is an important aspect in both stages, though more relevant on the downstream packaging stage.
- While there may be further upstream and downstream stages, these stages are usually not constraining from a scheduling perspective.

For example, a pre-mix stage occurs prior to the mix stage, or loading stage for shipment pallets and shrink-wrapping stage that occur after packing stage. Schedule generation therefore focuses on the two key stages, make and pack.

Multi-Stage Synchronization focuses on the following:

- Synchronizing the production and consumption of bulk WIP items by scheduling the upstream make and downstream pack operations close together from a time perspective.
- Minimizing changeovers in both stages, with higher relevance for the downstream packaging stage.
- Maximizing fill rates.

To address multi-stage synchronization, Production Scheduling provides the following features:

- **Resource Relationship Editor:** Use this editor to specify the physical resource connectivity.

- **Multistage Synchronization Pre-build Policy:** In the Schedule Strategy tab of the Solver Options window, if Build Strategy is set to Pre-Build and the Pre-build Policy is set to Multistage Synchronization, then the solver attempts to solve the schedule by synchronizing build and pack stage resources. This is also referred to as using the multi-stage solver algorithm.

Upstream and downstream resources must be defined in the Resource Relationship Editor for this solver component to be enabled.

- **Item Attribute - Consumption Time Target:** You can define the Consumption Time Target for items to generate synchronization exceptions. The Consumption Time Target is defined from the Item Attributes Mass Maintenance screen in the EBS environment. Within Production Scheduling, it is maintained in the Attributes tab of the Item Properties window.

- **Synchronization Exceptions:** Two synchronization exceptions, Consumption Time exceptions and WIP Oversupply exceptions, are available to support multi-stage synchronization. If the consumption time for the item produced by an upstream operation exceeds the Consumption Time Target specified in the item properties window, then a Consumption Time exception will be generated. If an upstream make operation delivers more product than required by all subsequent downstream pack operations in that scheduling bucket, then a WIP Oversupply exception will be generated.

- **Synchronization KPIs:** The quality of the schedule from a synchronization perspective can be evaluated by measuring the time between when a bulk WIP item is produced and when it is consumed. This is referred to as *consumption time*.

The Total Consumption Time and the Average Consumption Time are calculated for all items that have the Consumption Time Target specified in the Attributes tab of the item properties window and can be produced and consumed on upstream and downstream resources listed in the Resource Relationship Editor.

- **Scheduling Bucket:** In tab General of the Solver options window, use the Scheduling Bucket field to define the time interval over which demand event and operations should be grouped for the multi-stage synchronization solver algorithm. It is used to balance changeover optimization against desired run size and service levels.

Production Scheduling synchronization does not currently support the following:

- **Typical Tank Scheduling:** The synchronization feature does not address tank scheduling. Some examples include: Batch ranges, using processing tanks as storage tanks, or modeling several operations with different rates for filling the tank, processing, QC time, and draining the tank.
- **Shelf Life and Minimum Remaining Shelf Life:** These aspects are not considered. The synchronization goal is to minimize the consumption times between the two

main stages. Exceptions will be generated when consumption time targets are violated.

- **Hard inventory maximum constraints:** Forcing better synchronization with a hard inventory maximum constraint on the decoupling bulk WIP item may seem like a valid modeling option to force Production Scheduling to synchronize even more, but this attempt will fail. All inventory maximum constraints are implicitly relaxed.

**To produce a solution for a multi-stage synchronization environment, perform the following tasks:**

1. Make sure your upstream and downstream resources are defined properly in the Resource Relationship Editor.  
  
Refer to Using the Resource Relationship Editor, page 5-140 for more information.
2. If you want to generate synchronization exceptions, make sure Consumption Time Target is defined in the Attributes tab of the item properties window for the necessary items.
3. In tab General of the Solver options window, use the Scheduling Bucket field to define the time interval over which demand event and operations should be grouped.
4. Set the Build Strategy to Pre-Build and set the Pre-build Policy to Multistage Synchronization in the Schedule Strategy tab of the Solver Options window.
5. Perform a solve.
6. Review the Key Performance Indicators view and inspect the consumption time values.
7. Review any synchronization exceptions and make any necessary adjustments.
8. Perform another solve and repeat process above until scenario meets your needs.

## Best Practices

Use the following best practices in modeling these types of synchronization scheduling challenges in Oracle Production Scheduling:

- **Work orders:** Generally, work orders will be present for the downstream pack stage, but not for the upstream make stage. If you want work orders to be included in the upstream stage, then one work order per batch is required to provide flexibility to optimize (for example, each make work order should have only one operation instance).
- **Additional production stages:** Further upstream stages (for example, pre-mixing) or downstream stages (for example, palletizing) are not part of the specific

synchronization feature. While such stages can be modeled and will be scheduled, best practice is to relax the involved resource constraints. Activities performed in these stages are important from an execution perspective, but they are typically not constraining and should not drive the production schedule generation for the two main stages. Using Solve Stages, upstream resources like pre-mixing should be scheduled first.

- **Material constraints:** While materials are relevant on a tactical planning level, they are usually not deemed constraining for short-term finite capacity scheduling, and therefore materials should be relaxed on Constraints tab of the materials properties window.

## Using the Resource Relationship Editor

Use this editor to specify the physical resource connectivity for multi-stage synchronization environments. Each resource relationship must be explicitly defined. These relationships are used by the solver when generating the schedule for a multi-stage synchronization environment. Refer to Using Multi-Stage Synchronization and the Resource Relationship Editor, page 5-139 for information and tasks to be performed when generating a multi-stage synchronization schedule.

**To display the Resource Relationship Editor, perform the following:**

- Click Open Resource Relationship Editor from the toolbar.
- Double-click Resource Relationship Editor from the Model Workspace.

The Resource Relationship Editor displays the following columns:

- **Upstream:** Machine or a machine group, which can be used to produce bulk WIP items.
- **Downstream:** Machine or machine group, which can be used to consume bulk WIP items and convert them into finished good items.
- **Direct Only:** Select Direct Only to indicate the downstream resource can *only* be fed directly. When selected, the solver will not consume any starting inventory on such resource, and will always have to schedule an upstream operation that provides the bulk WIP item. Note that if Direct Only is checked for a downstream resource in any one row, then this will apply to all jobs scheduled on that resource. If the Direct Only option is checked, then this indicates that the respective downstream resource must *not* be fed indirectly (for example via totes).
- **Rank:** Use the Rank field to provide a value indicating priority for synchronization. The lower the value, the higher the synchronization priority when generating a schedule. Downstream resources, which have to be fed directly (Direct Only=Yes), are implicitly considered most important, independent of the assigned Rank value. Downstream resources, which can only be fed indirectly via totes, typically have

the highest Rank values, corresponding to the lowest priority.

### **Production Scheduling and Resource Relationship Editor Rules**

- A machine can either be an upstream resource or a downstream resource, but not both. Production Scheduling runs validation checks to verify resource assignments.
- Use the Resource Relationship Editor to define all upstream and downstream resources to be considered when solving your schedule. If there are upstream resources which do not feed any downstream resources directly, or if there are downstream resources which can only be fed indirectly (for example, via totes), then these resources should be assigned to appropriate groups and entered in the Resource Relationship Editor with a high Rank value (corresponding to a lower relevance).

#### **To create a new resource relationship:**

1. Open the Resource Relationship Editor.
2. Click Add new resource relationship from the toolbar. A new row appears in the editor.
3. Click the Upstream cell and select an upstream resource from the list.
4. Click the Downstream cell and select a downstream resource from the list.
5. Select Direct Only if the downstream resource can *only* consume product sourced directly from an upstream resource's production. This indicates that the downstream resource must not consume on-hand inventory.
6. If necessary, assign the appropriate rank by entering a value in the Rank field.
7. To validate your resource assignments, click Validate resource relations from the toolbar. Any issues appear at the top of the editor.

Use the Show previous error and warning and Show next error or warning buttons to page through your validation issues. The issue is highlighted in red text or the row is selected to indicate resource that needs to be addressed.

8. If you received any validation errors, make the appropriate changes and re-validate the relationships.
9. When you have defined all the relations and have no validation issues, save your changes.

#### **To remove a resource relationship:**

1. Open the Resource Relationship Editor.
2. Select the resource rows you want to remove. You can select one or more rows.

3. Click Delete resource relationship(s) from the toolbar. Your selection is removed from the editor.
4. Save your changes.

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## Setting Up Global Options

This chapter covers the following topics:

- Setting Up System Logging
- Setting Up Diagrams and Toolbar Layouts
- Specifying Supporting Documents
- Defining Global Settings
- Defining Gantt Chart Settings

### Setting Up System Logging

This section discusses how to configure log files to capture scheduling information, performance statistics, and any validation warnings that may occur during a schedule solve.

### Configuring Log Files

**To configure logging options:**

1. Select Options from the Tools menu.
2. Select the Logging tab.
3. To configure log files, use the fields below as necessary:

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Options - Logging Tab Field	Description
Enable logging	Select this option if you want to log system messages. If you do not select this option, no logging occurs.

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Options - Logging Tab Field	Description
Log manual scheduling	Select this option to log information on manual scheduling tasks.
Log performance statistics	Select this option to capture application performance statistics in the log file. Timing for loading, saving, and duplicating schedules are captured.
Log warnings	Select this option to record warnings to the log file.
Log information	Select this option to have additional solver information recorded to the log. When selected, use the Maximum detail level list to define the information level recorded to the log file.
Show validation warnings	Select this option to have the system display validation warnings that occur during the solve process.
Append to log file	Select this option to append log information to the log file each time that the system runs. Use this option to create a single log file that can be reviewed for all solve processes performed for the schedule.
Overwrite log file	Select this option to have the log file overwritten each time that the system runs. To keep old log records, save the log file with a different name each time that you start the system.
Log file	Specify a location to store the log file.
Maximum file size (KB)	Specify a file size or accept the default value of 1000 KB.
Truncate file at (%)	Specify the percentage of the log file that the system omits when the log file reaches the size in the Maximum file size field.

Options - Logging Tab Field	Description
Clear Log (button)	Select this option to clear all information from the log file. New information will be recorded to the log file when the next solve is performed.

4. Click OK.

## Setting Up Diagrams and Toolbar Layouts

This section discusses how to configure the appearance of operation, routing and visit diagrams and display toolbars on multiple rows.

### Configuring Diagram and Toolbar Layout

Use the Options - Layout tab to define diagram and toolbar layout.

**To define diagram and toolbar layout:**

1. Select Options from the Tools menu.
2. Select the Layout tab.
3. To define diagram and toolbar layout, use the fields below as necessary:

Options - Layout Tab Field	Description
Top to bottom	Select this option to display operations and routings vertically beginning at the top of the screen.
Left to right	Select this option to display operations and routings horizontally beginning at the left of the screen.
Bottom to top	Select this option to display operations vertically beginning at the bottom of the screen.
Right to left	Select this option to display operations horizontally beginning at the right of the screen.

Options - Layout Tab Field	Description
Use snake layout	Select this option to display a routing diagram that reads from left to right, and then from right to left on the next row. This option makes long routings easier to view on the screen or in printed form.
Zoom to fit larger diagrams	Select this option to display adjust the zoom options to view diagrams.
Arrange toolbars on multiple rows	Select this options to display toolbars on multiple rows. This feature can make it easier to locate your toolbar buttons.
Show visits in DAG layout	Select this option to display visits in Directed Acyclic Graph (DAG) layout. This is a start-to-end representation of the visit. The routing diagrams use this layout. Most visits should look best with this option since they are similar to large routings in nature.
Show visits in radial layout	Select this option to display visits in radial layout. operation diagrams use this type of layout.

4. Click OK.

## Specifying Supporting Documents

This section discusses how to define a document directory to store supporting documents for various elements in your supply chain. This location is referred to as the Documents base folder.

### Defining the Documents Base Folder

**To define the documents base folder:**

1. Select Options from the Tools menu.
2. Select the Documents tab.
3. Define the following as necessary:

Options - Documents Tab Field	Description
Documents base folder	Specify the default directory for documents, or browse your system and select a document location.

4. Click OK.

## Defining Global Settings

Use the Options - Global Settings tab to define settings used throughout the Production Scheduling application.

### Defining Global Settings

**To define global settings:**

1. Select Options from the Tools menu.
2. Select the Global Settings tab.
3. Define the following as necessary:

Options - Global Settings Tab Field	Description
Generate solver .SIF file	Use this option to generate a Solver Information Format (SIF) file. This file is basically a memory dump of the current solver stage. This file is not useful for a customer to examine and would only be useful if requested by Oracle Support or Development for debugging purposes. The file is saved in the current working directory, which will typically be the location where the model was imported from.

Options - Global Settings Tab Field	Description
Stop solver after	<p>To set a solve maximum time limit, select this option, enter a value and select the time measurement. The time measurement options are as follows:</p> <ul style="list-style-type: none"> <li>• Days</li> <li>• Hours</li> <li>• Minutes</li> <li>• Seconds</li> </ul>
Stop solve after ___ backtracks	<p>To stop the solve if it is performing an excessive number of backtracks while attempting a solution, select this option and enter a value for the maximum number of backtracks a solve can perform. Usually, backtracking is an indicator of a major modeling or data issue.</p> <p>If the solve exceeds the number of backtracks, then the incomplete schedule is displayed. When a solve is stopped, the view title bar appears red to indicate the current schedule is infeasible. From the incomplete schedule, you can review and correct any issues before attempting another solve. You cannot approve or publish the schedule until your issues are addressed and a successful solve is performed.</p>

Options - Global Settings Tab Field	Description
Respect calendar constraints in Unconstrained Manual Scheduling Mode	When in the Unconstrained Scheduling Mode, set this option for the solver to respect any calendar event constraints.
Enable Undo/Redo	Select this option to allow you to undo changes or redo changes. When this feature is selected, you can define the number of history states (changes) you want available.
Maximum history states	Enter a number that sets the maximum number of history states retained when using the Undo/Redo feature. This option is available <i>only</i> if the Enable Undo/Redo option is selected.
Clear History	Select this button to clear the history states for the scenario. This option is available <i>only</i> if the Enable Undo/Redo option is selected.
Select related work order for release	Select option to automatically select related work orders within the Edit Work Order Release (Release to Production) window.

4. Click OK.

## Defining Gantt Chart Settings

Use the Gantt Chart tab in the Options window to define the Gantt Chart view settings.

### To define Gantt chart settings:

1. Select Options from the Tools menu.
2. Select the Gantt Chart tab.
3. Define the following as necessary:

Options - Gantt Chart Tab Field	Description
Solve	Select this option to display a confirmation dialog before performing a solve.

Options - Gantt Chart Tab Field	Description
Repair	Select this option to display a confirmation dialog before performing a repair solve.
Resume Solve	Select this option to display a confirmation dialog before resuming a solve.
Number of rows in bubble help	Enter the maximum number of rows you want displayed from the Notes field for bubble help in the scheduled views and editors. Notes are not included in the bubble help when this value is set to zero (0).
Allow Drag and Drop in Gantt Views	Select to indicate that manual scheduling, such as cut and paste operations, in the Schedule Editor may be performed by dragging selected scheduled operations to their new location. Valid paste locations are highlighted once the dragging operation are started.
Show upstream related work orders in Production Pegging View	Select option to display upstream work orders from Production Pegging view.
Visualize visit operation slack in Gantt Views	Select option to display slack time information from Gantt schedule views. This is relevant for Maintenance (cMRO) plans only.

---

Options - Gantt Chart Tab Field	Description
Item display mode	<p>Use this option to define how items appear in views and editors. The following options are available:</p> <ul style="list-style-type: none"><li>• Code - Select this option to display only the item code.</li><li>• Description - Select this option to display only item description.</li><li>• Code: Description - Select this option to display the item code followed by the item description.</li><li>• Description: Code - Select this option to display the item description followed by the item code.</li></ul>

---

Options - Gantt Chart Tab Field	Description
Work order display mode	<p>Use this option to define how work orders appear in views and editors. The following options are available:</p> <ul style="list-style-type: none"> <li>• Work Order Number - Select this option to display only work order numbers.</li> <li>• Work Order Description - Select this option to display only the work order descriptions.</li> <li>• Work Order Number: Work Order Description - Select this option to display the work order number followed by the work order description.</li> <li>• Work order Description: Work Order Number - Select this option to display work order description followed by the work order number.</li> </ul> <p><b>Note:</b> If no work order description is available, the work order number is displayed by default.</p>
Work order filter display mode	<p>Use this option to define how non-matching operations filter criteria appear in the views. The available options are as follows:</p> <ul style="list-style-type: none"> <li>• Hide operations</li> <li>• Display dimmed operations</li> </ul>
Set Default	<p>Click this button to use the Work order filter display mode as the default setting in Production Scheduling.</p>

---

Options - Gantt Chart Tab Field	Description
Increase color lightness by %	Enter the value to increase color in filter mode. This field is <i>only</i> enabled when Display dimmed operations is selected from Work order filter display mode field.
Desaturate color by %	Enter the value to reduce color saturation in filter mode. This field is <i>only</i> enabled when Display dimmed operations is selected from Work order filter display mode field.

---

4. Click OK.



---

# Configuring Scenario Properties

This chapter covers the following topics:

- Accessing the Scenario Properties Window
- Setting Up the Scenario Properties - General Tab
- Setting Up the Scenario Properties - Horizon Tab
- Setting Up the Scenario Properties - Unit of Measure Tab
- Setting Up the Scenario Properties - Maintenance Display Parameters Tab
- Setting Up the Scenario Properties - Attribute Highlight Order Tab

## Accessing the Scenario Properties Window

Use the scenario Properties window to define settings used in your model and displays the following tabs:

- General - Used to define the scenario name, KPI cost parameters, cost and duration precision, and use of Theory of Constraints Principles.
- Horizon - Used to defined the horizon start and end date and production cycle first start time.
- Unit of Measure - Used to define the unit of measures available in the model.
- Maintenance Display Parameters - Used to define the visit work order maintenance parameters.
- Attribute Highlight Order - Used to enable attributes highlighted within the scenario and define the highlight sequence.

**To access the Scenario Properties window:**

1. From the Model Workspace, right-click on a scenario.

2. Select the Properties option.

## Setting Up the Scenario Properties - General Tab

Use the General tab from the scenario Properties window to define general model information:

### To set up scenario properties:

1. From the Model Workspace, right-click the scenario and select Properties.
2. Complete these fields:

Scenario Properties - General Tab Field	Description
Code	Specify a name for the schedule.
Plan ID	Displays the Plan ID, if one has been assigned.
Branch/Organization	Enter the branch code or organization code for your schedule.
KPI Cost Parameters (key performance indicator cost parameters)	Select a currency symbol. If the desired symbol does not appear, you can enter it in the space provided. Enter the Fixed Cost value. Use the Fixed Cost unit of measure list to select one of the following options: second, minute, hour, day, or week. This field provides the cost time unit for resource and operating costs.
Cost Precision	Specify the number of decimal places for cost. For example, the number 5.125 has three decimal places so the precision is three.
Duration Precision	Specify the number of decimal places for duration.
Use Theory of Constraints Principles	Select this option to enable Theory of Constraints functionality.  See "Working with Buffers, page 5-62," <i>Creating Production Scheduling Models, Production Scheduling</i> .

Scenario Properties - General Tab Field	Description
Notes	Specify relevant information about this model or schedule. For example, if you have made what-if model changes, you can describe these changes here.

3. Click OK.

## Setting Up the Scenario Properties - Horizon Tab

Use the Scenario Properties - Horizon tab to set up the schedule horizon.

To set up the Scenario Properties - Horizon tab:

1. From the Model Workspace, right-click the scenario and select Properties.
2. Select the Horizon tab.
3. Complete these fields:

Scenario Properties - Horizon Tab Field	Description
Start Date	Specify the start date of the schedule horizon.
End Date	Specify the end date of the schedule horizon.
First Cycle Start Time	Specify the start date for the first production cycle. Campaign Run Optimization resources use this time to identify the beginning of a production cycle.

4. Click OK.

## Setting Up the Scenario Properties - Unit of Measure Tab

Use the Unit of Measure tab from the scenario Properties window to define unit of measure for the model. Once the unit of measures are defined, they appear as options on the item Properties - Constraints tab.

To set up the Scenario Properties - Unit Of Measure tab:

1. From the Model Workspace, right-click the scenario and select Properties.
2. Select the Unit of Measure tab.
3. Click the Add button to add a unit of measure.
4. To remove a unit of measure:
  - Select the unit and click the Delete button.
  - Right-click the unit and select Delete.

**Note:** The *Each* unit of measure cannot be deleted, as you need to have at least one in the model.

All data for an item must be in the same unit of measure. For example, you cannot manufacture an item as an each and order the item in cases. Production Scheduling does not perform unit of measure conversion.

5. To rename a unit, right-click and select Rename. Enter the new unit of measure name.
6. Click OK.
7. Associate the unit of measure to an item from the item Properties - Constraints tab.

## Setting Up the Scenario Properties - Maintenance Display Parameters Tab

Use the Maintenance Display Parameters tab from the scenario Properties window to define custom labels for Work Breakdown Structure (WBS) hierarchies for the model. If these fields are updated, the assigned names assigned are reflected in the Maintenance tab in the Work Order Editor.

1. From the Model Workspace, right-click the scenario and select Properties.
2. Select the Maintenance Display Parameters tab.
3. To modify a parameter name, enter the new name.
4. To clear all the parameter field names, Click Clear All. Enter new parameters names as needed.
5. To set all parameters to the default setting, click Default All. The names are changed to Attribute 1, Attribute 2, and so on.

6. Click OK.

## Setting Up the Scenario Properties - Attribute Highlight Order Tab

Use the Attribute Highlight Order tab from the scenario Properties window to enable attributes highlighted within the scenario and define the highlight sequence. This is required if you have assigned colors to your attributes and want them to display within the scheduled views. Since it is possible to have more than one attribute assigned to an operation, the Attribute Highlight Order tab allows you to define the highlight order when multiple attributes appear in a view.

1. From the Model Workspace, right-click the scenario and select Properties.
2. Select the Attribute Highlight Order tab.
3. Check the attributes to be highlight in scenario.
4. Use the Move Selection Up or Move Selection Down buttons to define the highlight sequence order. The sequence order when highlighting is enabled is determined by the attribute's location in the Highlight sequence box. The attribute at the top has higher priority than those below.
5. Click OK.



---

# Configuring Solver Options

This chapter covers the following topics:

- Accessing Scenario Specific Solver Options
- Setting Up General Solver Options
- Setting Up Resource Business Objectives
- Setting Up Schedule Strategy
- Setting Up Campaign Run Optimization (CRO)

## Accessing Scenario Specific Solver Options

To access the Solver Options window:

1. From the Model Workspace, right-click a scenario.
2. Select Solver Options.

You also can use the Solver Options button from the schedule views to access the Solver Options window.

## Setting Up General Solver Options

This section provides an overview of general options, scheduling work orders according to units of effort, resource criticality, and discusses how to set up general solver options.

### General Options Overview

Production Scheduling can govern the scheduling of operations that exist upstream from a bottleneck operation in a routing. For example, consider a routing with five operations: saw, weld, heat, assembly, and test and pack. The bottleneck resource is the oven, which is required for the heating operation. The routing and operations are

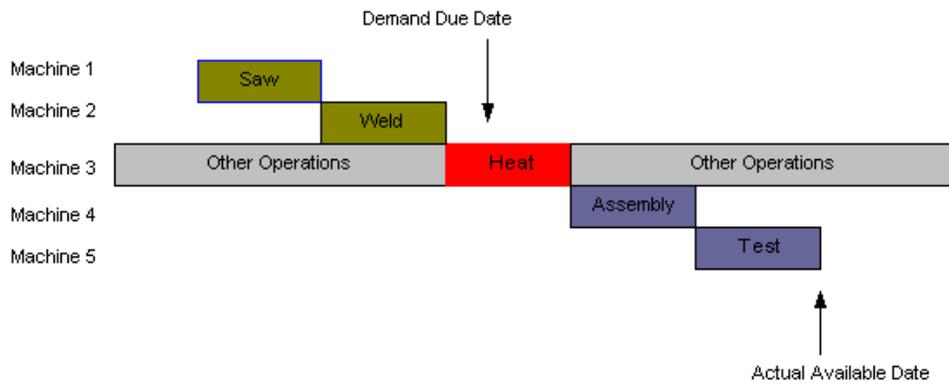
displayed in the following diagram:



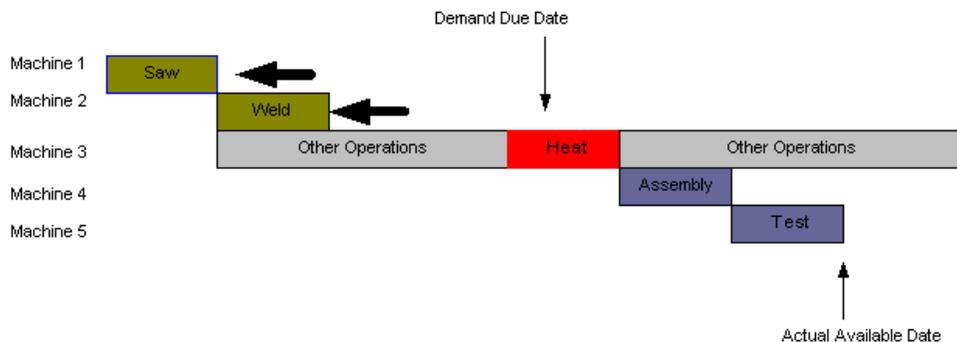
When Production Scheduling creates operations to satisfy demand, it posts earliest date and available date constraints that are associated with the operations. The operations are scheduled in a just in time (JIT) manner, according to their available date. This scheduling behavior is governed by any precedence constraints in the routing and can occur only if precedence constraints permit JIT to available date.

In this example, the saw and weld operations could have been made earlier in the process, however, these operations are scheduled to align with the bottleneck operation, heat. This is the default behavior in Production Scheduling.

Due to the bottleneck created by the oven, the demand is scheduled late. A solve yields the schedule displayed in the following diagram:



Using the solver option, JIT to Due Date, you can pull the saw and weld operations forward and generate a schedule resembling the one in this diagram:



Upstream operation pulled forward

With the saw and weld operations pulled forward, the upstream operations are placed at a point that provides you with a more efficient way to manually schedule the remaining operations in the routing to a time earlier in the process. This helps to make the demand on time and is effective if you want to schedule operations close to the demand due date rather than close to the bottleneck operation on the routing.

**Note:** This tactic may result in a longer makespan for a routing if this solver option is set to Due Date. For example, in the example, if the solver places upstream operations earlier in the scheduling horizon and if the solver cannot move the bottleneck operation without manual intervention, the makespan is longer for this demand.

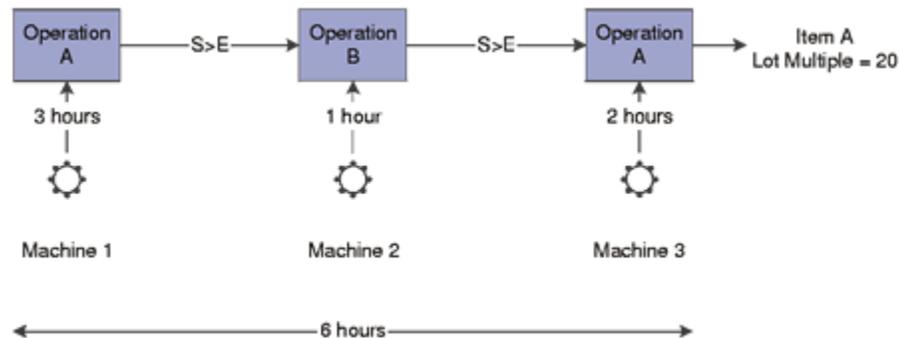
### Scheduling Work Orders According to Units of Effort Overview

This section provides an overview of scheduling work order operations and discusses these scenarios:

1. A schedule that has the Units of Effort option disabled on the routing.
2. A schedule that has the Units of Effort option enabled and adjacent operations disabled on the routing.
3. A schedule that has both the Units of Effort and the adjacent Operations Preferred options enabled on the routing.

### Scheduling Work Order Operations

In each of these examples, producing Item A requires three operations: Operation A, Operation B, and Operation C. Operation A runs on Machine 1 for three hours; Operation B runs on Machine 2 for one hour; Operation C runs on Machine 3 for two hours. The lot multiple is 20 and Item A takes six hours to produce in this schedule. The routing is shown in the following diagram:



Basic routing for producing Item A

### Scenario 1: A Schedule That Has the Units of Effort Flag Disabled on the Routing

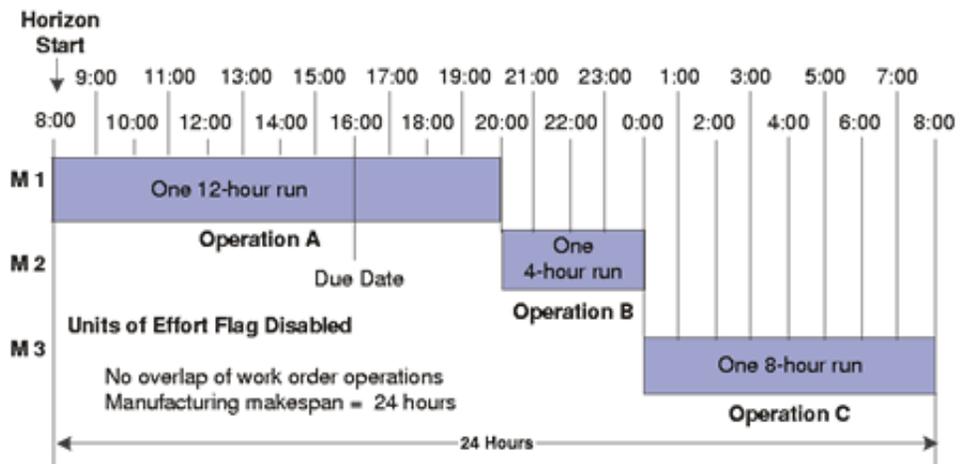
For this scenario, assume the following:

- Order due date: January 1, 4:00 p.m.
- Horizon start: January 1, 8:00 a.m.
- Order quantity: 80
- Enable Units of Effort: NO

The number of hours that each machine can run per operation is:

Machine Number	Runs per Operation
Machine 1	1-12 hour operation
Machine 2	1-4 hour operation
Machine 3	1-8 hour operation

This diagram demonstrates the routing schedule with the Schedule Work Order operation according to the Units of Effort option disabled:



With this option disabled, there is no overlap on work order operations. It takes 24 hours to produce Item A.

## Scenario 2: A Schedule That Has the Units of Effort Flag Enabled and Adjacent Operations Disabled on the Routing

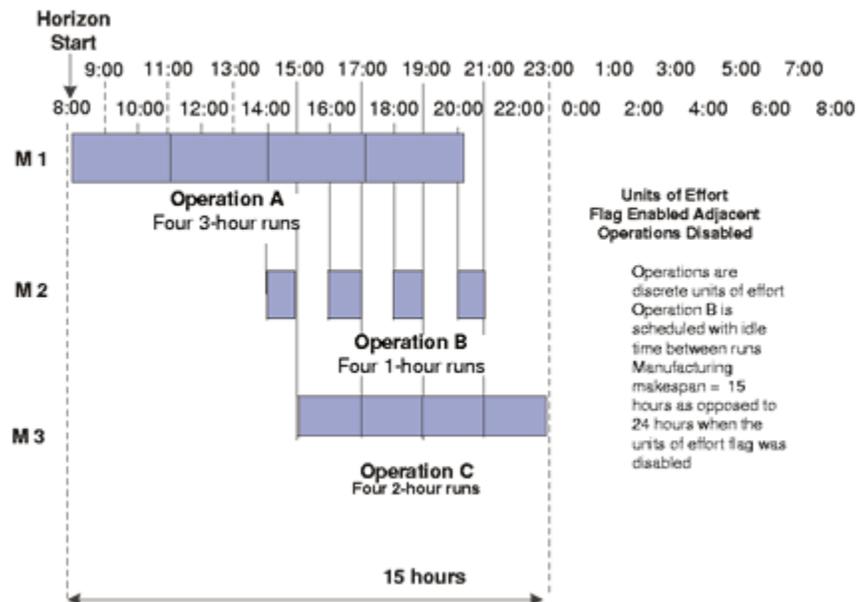
For this scenario, assume the following:

- Order due date: January 1, 4:00 p.m.
- Horizon start: January 1, 8:00 a.m.
- Order quantity: 80
- Enable Units of Effort: YES

The number of hours that each machine can run per operation is:

Machine Number	Runs per Operation
Machine 1	4-3 hour operations
Machine 2	4-1 hour operations
Machine 3	4-2 hour operations

The following diagram demonstrates the routing schedule with the Schedule Work Order operation according to their Units of Effort option enabled:



Routing schedule with units of effort flag enabled adjacent operations flag disabled

By enabling the scheduling to apply work order units of effort, substantial benefits are realized:

- Manufacturing makespan is substantially reduced; manufacturing time is reduced from 24 hours to 15 hours.
- Material consumption and production is more accurate.
- Resource utilization is more accurate.

### Scenario 3: A Schedule That Has Both the Units of Effort and the Adjacent Operations Preferred Flags Enabled on the Routing

For this scenario, assume the following:

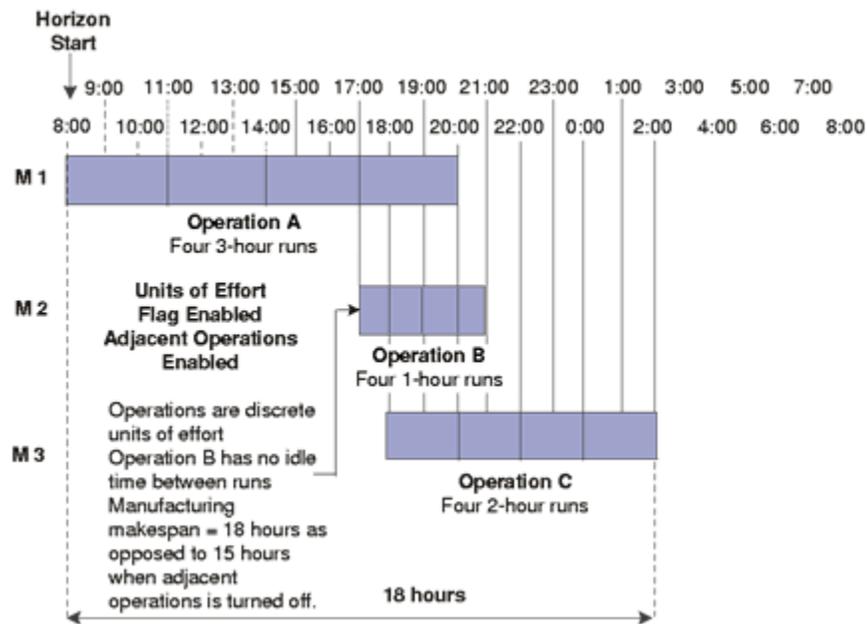
- Order due date: January 1, 4:00 p.m.
- Horizon start: January 1, 8:00 a.m.
- Order quantity: 80
- Enable Units of Effort: YES
- Adjacent operations: YES

**Note:** You cannot enable adjacent operations unless the Units of Effort option is enabled.

The number of hours that each machine can run per operation is:

Machine Number	Runs per Operation
Machine 1	4-3 hour operations
Machine 2	4-1 hour operations
Machine 3	4-2 hour operations

The following diagram demonstrates the routing schedule with both the Schedule Work Order operation according to their Units of Effort and Schedule Adjacent Operations options enabled:

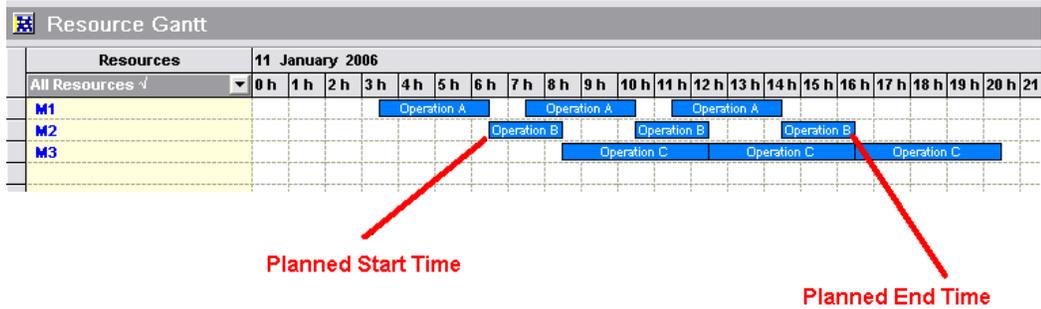


By enabling both work order units of work and adjacent operations flags, you have sacrificed some makespan to keep operations on Machine 2 together. Without adjacent operations enabled, total manufacturing time was 15 hours. With adjacent operations on, total manufacturing time is 18 hours, but you have removed idle time on Machine 2.

### Planned Start and Planned End Times

Because of the nature of work orders, a given operation within a work order cannot be split into several instances. This can pose problems when operations are broken down into their individual units of work. For example, Operation B becomes Operation B1, Operation B2, and Operation B3. Planned start time and Planned end time fields in the Operations tab of the Work Order Editor address this issue. The difference between the two fields is in the logic of how the dates are rolled up into these fields.

When a work order is not broken down into its units of effort, the start and end dates reflect the start and end times of the operation, respectively. However, when a work order is broken down into its units of effort, the planned start date reflects the start time of the first operation instance, Operation B1, and the Planned End Date is the end time of the last operation instance, Operation B3, as illustrated in the following graphic:



When the Work Order units of effort is enabled, the number of routing instances that are scheduled to fulfill the work order quantity, is displayed in the work order header. The number takes into account the routing lot multiple that is required to perform this calculation. For example, if a work order for a routing is for 50 units and the lot multiple is 25, the quantity is displayed in the work order header.

**Note:** The number of routing instances that are schedule to fulfill the work order quantity is displayed only if units of effort is enabled. If this feature is not enabled, the field shows a one ("1").

This field always appears as an integer value and is rounded up if a work order is entered in a non-lot multiple quantity.

## Resource Criticality Overview

Production Scheduling has the ability to configure whether the solver first addresses earliest or most resource criticality during solve sequencing. Resource contention, or criticality, is a measurement that occurs in the solver when two or more operations compete for the same resource at a given point in time in the scheduling horizon. The more operations that need to be scheduled on that resource at that given point in time coupled with its capacity, the higher the resource contention or probability that constraints will be violated. In Production Scheduling, you can set whether the solver first addresses earliest contention or most contention resource criticality during solver sequencing.

Focusing and resolving the most critical constraints in the horizon has generally been regarded as the most effective scheduling strategy to resolve floating bottlenecks when sequencing operations. Addressing the more critical problems first results into the problems being broken down into smaller subproblems which are easier to resolve.

Solving in this fashion provides high quality results for most Production Scheduling client models. However, sometimes resolving the highest levels of criticality in the horizon first may not necessarily be optimal from a scheduling perspective, but rather addressing the earliest instances of resource criticality may be more efficient in some cases, such as (but not limited to):

- Routings that contain recursive resources that are considered manufacturing

bottlenecks.

- Coupled with the recursiveness, a mixture of crewed and noncrewed operations that also require these bottleneck resources.
- Preferred run times for noncrewed operations during non-business hours (for example, evenings and weekends).

It is recommended to implement this feature following the guidelines above and to run some trials with this option enabled and disabled to understand the differences in schedule quality.

## Handling Firm Dates

Production Scheduling takes liberties to move firm work orders to respect constraints. For example, a firm operation could be moved due to the following conditions:

- Capacity violations - For example, two or more operations fixed on the same machine at the same time.
- Material shortages - For example, firm work order operations are defined, but no materials are available.
- Operations out of sequence - For example, sequence defined to pack product before it has been made.

By default, Production Scheduling provides additional flexibility to maintain the "firm" schedule prior to the end of the fixed production timefence and ignore these violations. Before the fixed production timefence, capacity, materials and precedence constraints will be treated as "relaxed". Calendar constraints will still be respected.

The Respect Firm Dates in Timefence option in the Solver Options – General tab is selected by default to enable this improved treatment of firm work orders.

## Setting Up General Solver Options

**To modify the Solver Options for a scenario:**

1. From the Model Workspace, right-click the scenario and select Solver Options.
2. From the General tab, complete these fields:

<b>Solver Options - General Tab Field</b>	<b>Description</b>
Resource Capacity Horizon	Define the resource capacity horizon duration and unit of measure.

Solver Options - General Tab Field	Description
Enable Supply Tolerance Offset	<p>Select to indicate that supply tolerance offset should be used. If this option is selected, there will be no net new production recommendations generated at any level in the BOM (for example, only work order supply production will be scheduled). If there is insufficient work order supply, inventory will be automatically added to prevent levels from falling below zero (demand is permitted to be shorted). A Production Scheduling log message is generated to indicate what inventory quantity adjustments were made. Using this feature assumes work order supply is sufficient to meet demand.</p>
Relax Purchased Items Beyond Lead Time	<p>When this option is enabled, the order multiple is internally set to a very large value and effectively ignored beyond lead time - one will see the addition of a new red line in the item graph to represent the time of the item. Beyond the lead time, the item graph is shaded to indicate infinite supply.</p> <p>This option allows you to control whether or not purchase item multiples are respected beyond supplier lead time or not. Keeping these "relaxed" helps solve performance and is generally recommended.</p> <p>Relax Purchased Items Beyond Lead Time is set to Yes by default. If the option is set to No, the item graph is displayed taking into account the order multiples.</p>
Adjust Post Horizon Demand Quantity	<p>When enabled, this feature uses the "Demand Satisfaction Date" provided by the integrated planning system and allows the solver to remove this demand at the end of the schedule horizon. This feature compensates for late demands that may not have associated work order production in a given scenario.</p>

Solver Options - General Tab Field	Description
Allow Firm Dates to violate Earliest Start Date	Select this option if work order operations have firm start dates (Firm Start or Firm Range status) and you want to allow operations to be scheduled before the work order Earliest Start Date. Default value is unchecked.
Respect Firm Dates in Timefence	Select option to generate a schedule that respects any firm dates defined in the timefence. This option is selected by default.
Respect Calendars in Timefence	<p>Select this option to respect defined calendars within the timefence.</p> <p>This option is available <i>only</i> when the Respect Firm Dates in Timefence option is selected.</p>
Scheduling Bucket	<p>Use this when generating a schedule for a multi-stage synchronization environment. Specify a value for the time interval over which demand and operations should be grouped for the multi-stage synchronization algorithm. It is used to balance changeover optimization against desired run size and service levels.</p> <p>When enabled, it uses the First Cycle Start Time date defined in the Horizon tab of the scenario properties window.</p> <p>Refer to Using Multi-Stage Synchronization and the Resource Relationship Editor, page 5-136 for information and tasks to be performed when generating a multi-stage synchronization schedule.</p>

Solver Options - General Tab Field	Description
Scheduling Work Order operations according to their unit of effort	<p>From the drop-down menu, select one of these options:</p> <ul style="list-style-type: none"> <li>• <i>Yes</i> to enable units of effort.  This option indicates that Production Scheduling should cross reference the work order to the corresponding routing lot multiple. This results in the work order being divided into lot sized quantities for more flexible sequencing, reduced manufacturing makespan, and accurate item consumption profiles.</li> <li>• <i>No</i> to disable units of effort.</li> <li>• <i>Select by Routing</i> to schedule selected routings by units of effort.  When this option is selected, you must configure the applicable routing properties.  See "Setting Routing Properties, page 5-58," <i>Creating Production Scheduling Models, Production Scheduling</i>.</li> </ul> <p>See "Scheduling Work Orders According to Units of Effort Overview, page 8-3," <i>Configuring Solver Options, Production Scheduling</i>.</p>
Adjacent operations referred	<p>Select this option if you want to enable adjacent operations. This option is <i>only</i> enabled if <i>Yes</i> is selected from the Scheduling Work Order operations according to their unit of effort.</p> <p>See "Scheduling Work Orders According to Units of Effort Overview, page 8-3," <i>Configuring Solver Options, Production Scheduling</i>.</p>

3. Click OK to save and close the Solver Options page.

## Setting Up Resource Business Objectives

This section provides information on the following topics:

- Scheduling resource and groups of resources overview.
- Accessing the solve sequence window.
- Creating solve sequence stages.
- Changing solve sequence stages.
- Remove solve sequence stages.
- Rename solve sequence stages.

## Scheduling Resources and Groups of Resources Overview

From a resource perspective, Production Scheduling generically considers all crews, machines, tool capacity and calendar constraints simultaneously when sequencing operations. Focusing in on and resolving the most critical constraints in the scheduling horizon has generally been regarded as the most effective scheduling strategy to resolve multistage floating bottleneck problems when sequencing operations. Addressing the more critical problems first results in the sequencing problems being broken down into smaller subproblems, which are usually easier to resolve.

It is sometimes desirable to be able to dictate which resources the solver should focus on first when creating a schedule as opposed to having the solver simultaneously consider all constraints and potentially jump between resources when contention levels stipulate this behavior. Supporting resources may be considered secondary in terms of the priority of having their constraints considered during the solve process.

Production Scheduling explicitly allows users to dictate to the solver which resource or group of resources should be focused on and in what order they should be considered. This approach enables scheduling in an incremental fashion by means of some simple configurations in the application. It is also possible to stop the solver after a particular solve stage to review the schedule or make manual scheduling changes.

Determining the priorities by which the solver will address resources or groups of resources is achieved by setting up solver stages. The stages are "lined up" in the order in which the solver will address them.

Resources within a schedule can be assigned to solver sequence stages. Solver sequence stages determine the order in which the solver activates constraints during a solve. Different solve parameters can be specified by stage so, for example, Stage 1 can be solved using the build strategy Pre-Build and the other stages can be solved using JIT. By including resources in a stage, you can set the priorities in which the resources are addressed and solved by the solver. The solver addresses Stage 1, followed by Stage 2,

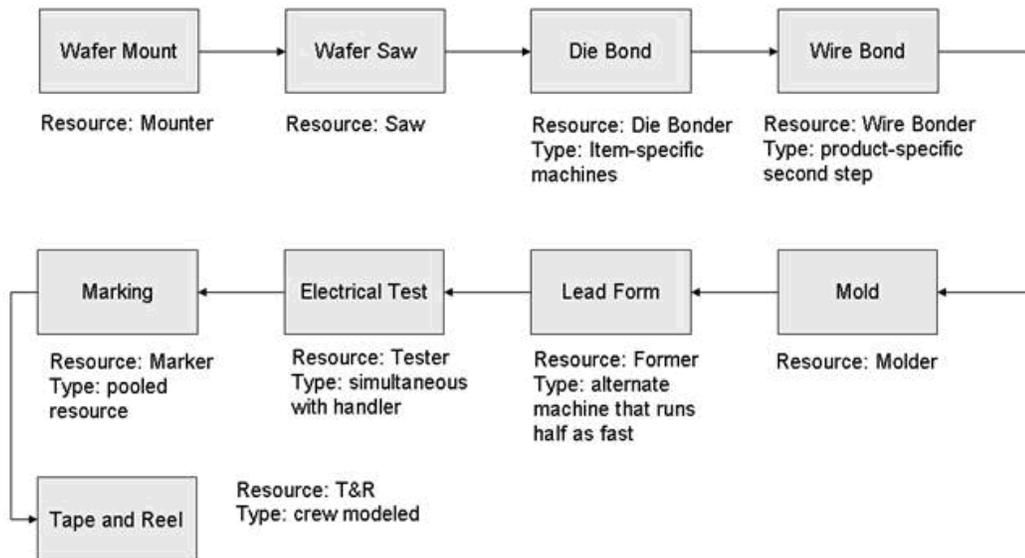
Stage 3, and so on. Resources that are not included in a solve stage are scheduled last. Finally, with solve stages you can enable multi-stage Campaign Run Optimization. If no solver sequence stages are set up, the solver considers all resource constraints simultaneously.

## Example of Using Solver Sequence Stages

The following example demonstrates scheduling resources and resource groups, using a general flow of product through a factory, starting with the Mounter and ending with the Tape and Reel resources.

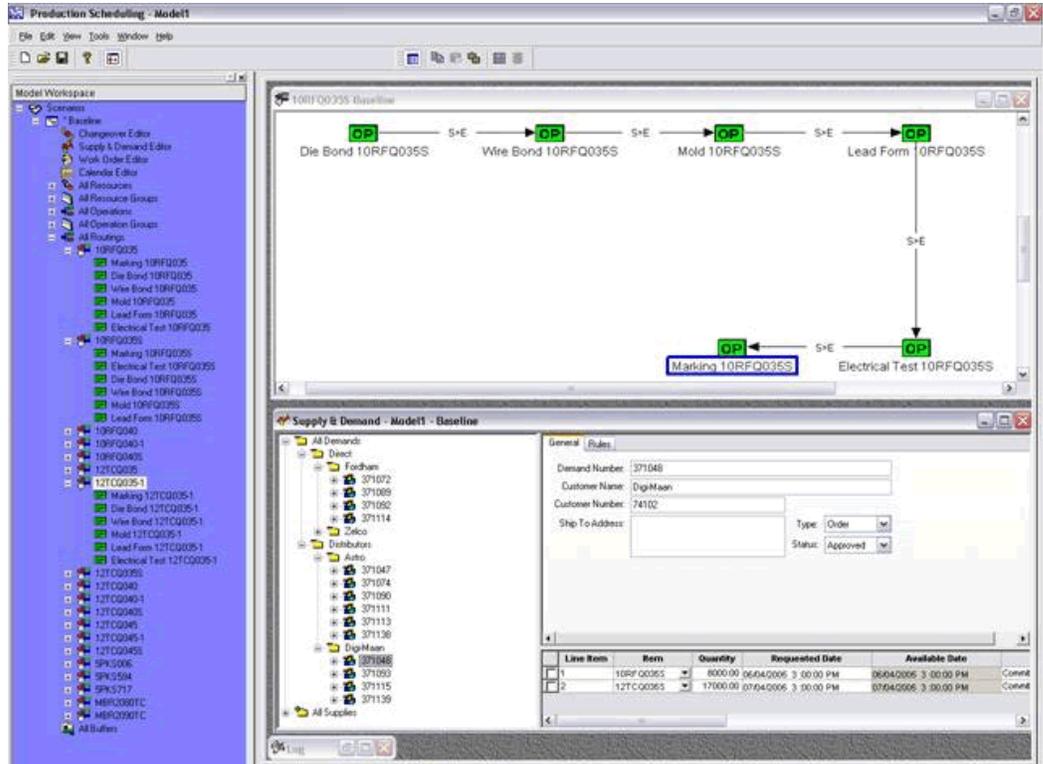
The data for this example is taken from the Semiconductor model, which is shipped with the Production Scheduling application.

The flow of resources is shown below:



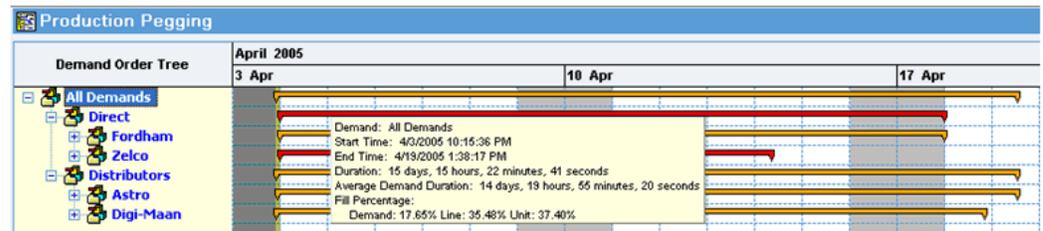
General flow of a product through a factory

The manufacturing processes are set up to resemble the routing shown in the preceding diagram. Demands have been entered for the various products.



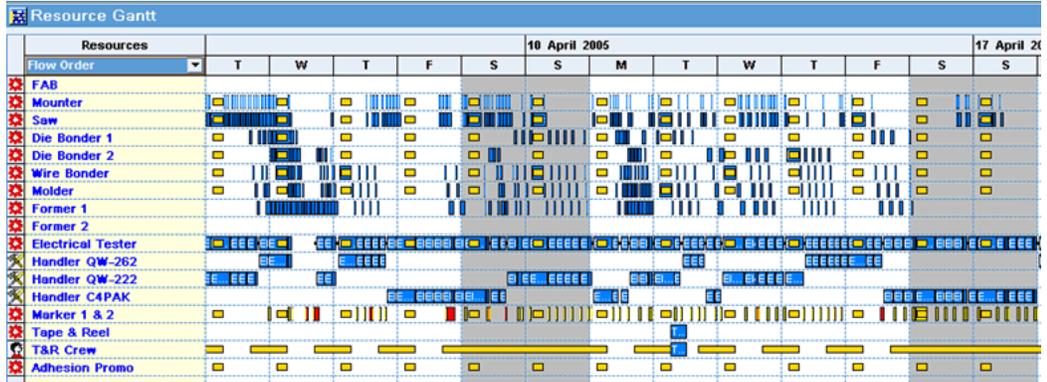
### Routing an incremental schedule

By running a solve with all constraints enabled, the demand fulfillment is really poor on a first pass schedule, as illustrated in the following screen shot.



### Demand fulfillment after a solve

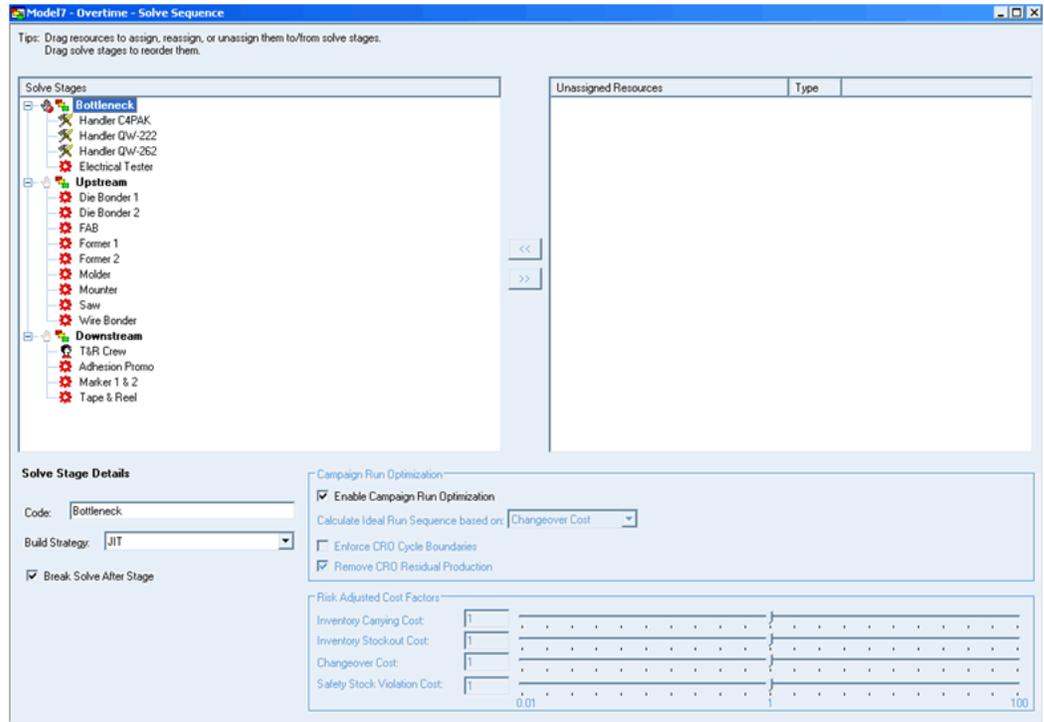
Looking at the Resource Gantt the electrical testing machine is the dominating bottleneck resource in the factory:



### Resource Gantt

By using this feature, you can create a schedule by first solving the bottleneck resource, and then incrementally enabling upstream constraints, followed by downstream constraints.

To set up your schedule to incrementally solve for resources, you need to define the solver sequence and assign the appropriate resources to the respective stages. Create the remaining solve stages and assign the resources appropriately. In this case, the solve stages downstream resources incrementally in order of precedence, followed by working backwards, upstream, from the Electrical Test machine as illustrated.

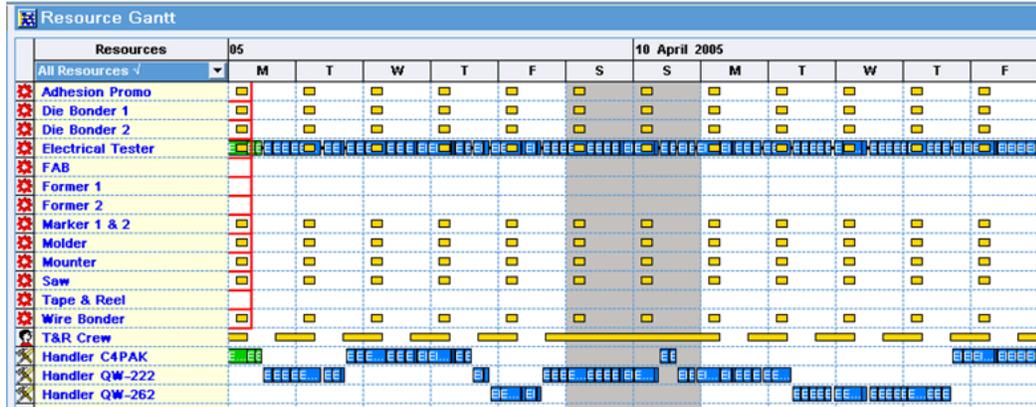


### Creating the remaining solve stages

A break is inserted after the first solve stage to allow for schedule review and possible manual scheduling intervention.

**Note:** All resources that are not assigned to a solve stage are solved last with constraints enabled.

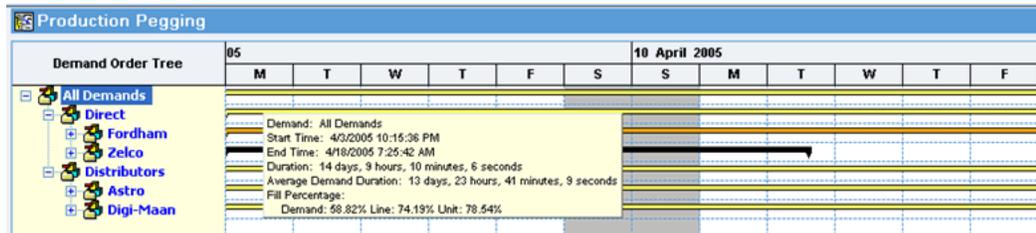
After re-solving with solve stages, the solve will stop at each break. From here, the schedule can be reviewed and changed by manually scheduling.



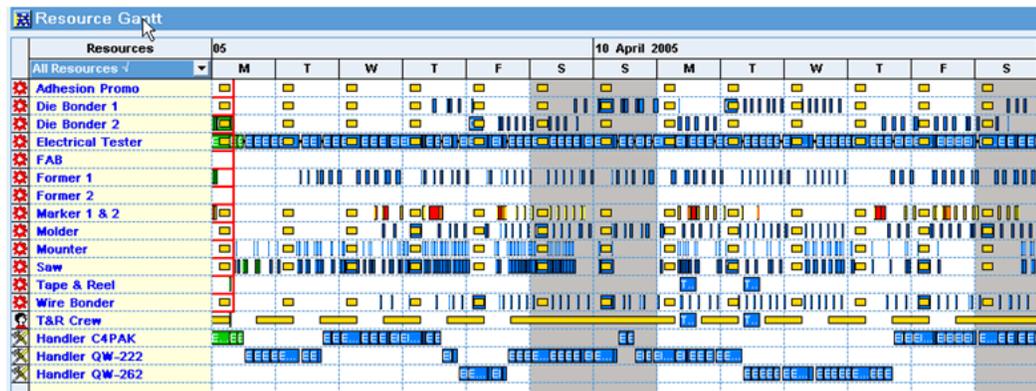
Resource Gantt review after solve break

After making a manual scheduling change, a repair solve is required to reflect the manual change after which the solve can be resumed by clicking the Resume Solve button on the toolbar where it will stop at the next solve break if defined.

After resuming the solve, the demand fulfillment, shown below, has increased significantly on the first pass schedule as illustrated in the following screen shot:



However, the Electrical Test machine is still the bottleneck as shown in the following Resource Gantt:



By looking at the key performance indicators (KPIs) view, shown below, you can see the improvements from both a customer service perspective and changeover minimization perspective. In all cases, fill rates are higher using the incremental approach, total

stockouts and stockout time is lower, and time lost due to changeovers is lower.

Schedule	Customer Service						Materials	Costs ( \$ )		Manufacturing		
	Order Fill %	Line Fill %	Unit Fill %	No. of Stock Outs	Stock Out Time	WorkOrder Fill%	Inv. Turns	Change Over Cost	Inv. Cost	Change Over Time	Machine Util. %	Throughput shifts
1 Baseline	17.65 %	35.48 %	37.40 %	15	42.72	89.50 %	431.559	1050.00	9746607.4	0.66	20.819	5381.241
2 Solve Stage	58.82 %	74.19 %	78.54 %	8	24.13	95.58 %	525.026	950.00	10574417.	0.59	20.819	5852.217

There is no black and white answer as to when the best time to use this functionality may be. Generally, if you are not satisfied with the first schedule using the generic solve logic, it may be a good idea to try incremental schedules for various solver trials. The following are some general guidelines:

- Solve the dominating bottlenecks in the first solve stage.
- Work your way downstream by resource, keeping alternate resources in the same solve stages.
- Once you reach the end, work your way back upstream from the bottleneck resource.

The optimal sequence will result from testing various solve stage permutations and the order in which resources are solved.

## Accessing the Solve Sequence Window

To access to Solve Sequence window, right-click on the Scenario from the Model Workspace and select Solve Sequence. The Solve Sequence window appears.

## Creating Solve Sequence Stages

The Solve Sequence window is used to create, modify and delete Solve Stages. It allows you to assign a resource to the appropriate solve stage. This feature allows you to determine the order in which a solve is generated to resolve bottlenecks and other issues to meet your needs. The left side of the Solve Sequence window is used to define solve stages for your scenario. The right side of the window displays all resource that can be assigned to a solve stage.

### To create a new solver sequence stage:

1. From the Model Workspace, right-click the scenario, and select Solve Sequence.
2. To add a solve stage, click the Add Solve Stage from the toolbar, or right-click in the Solve Stage region and select Add Solve Stage. A new solve stage appears in the Solve Stage region.
3. To rename the stage, select a solve stage and enter the solve stage name in the Code field in the Solve Stage Details area. You can also right-click a solve stage select Rename, and enter a new name.

4. Use the Build Strategy option to assign the solve stage as Pre-built or JIT.
5. To have the solve stopped upon completing the solve stage, select the Break Solve After Stage option. The solve is stopped at the solve stage, allowing you to review the schedule and make manual scheduling changes, if required.
6. If necessary, define the Campaign Run Optimization options for the solve stage. The Campaign Run Optimization options will be enabled if there is an applicable resource in the respective solve stage, otherwise the options are not applicable. This feature allows you to define specific campaign run options to the solve stage, and these can differ from the Solver Option window settings defined for the scenario.  
  
See "Setting Up Campaign Run Options, page 8-35," *Configuring Solver Options, Production Scheduling*.
7. If necessary, define the Risk Adjusted Cost Factors for the solve stage. Use this feature to define specific risk factors to the solve stage, and these can differ from the Solver Option window settings defined for the scenario.  
  
See "Risk Adjusted Costs, page 8-29," *Configuring Solver Options, Production Scheduling*.
8. Create additional solve stages as needed and define their solve stage details.
9. Drag and drop an unassigned resource to a Solve Stage or perform the following:
  - Select a solve stage.
  - Select an unassigned resource and click <<. The resource appears under the solve stage on the Solve Stages regions.
  - Repeat the process until you have assigned the resources to the appropriate solve stage. Resources are arranged alphabetically when they are assigned to a solve stage. The order is not indicative of a work order process.
10. If you want to move an assigned resource to a different Solve Stage, drag and drop the resource to the appropriate solve stage.
11. To remove a resource from a solve stage, select the resource and click >>. The resource is removed from the Solve Stage area and appears in the Unassigned Resource area.

## Changing Solve Sequence Stages

### To change solve sequence stages:

1. From the Model Workspace, right-click the scenario, and select Solve Sequence.
2. Select the solve stage that you want to move.

3. To move the solve stage, click the Move Solve Stage Up or Move Solve Stage Down button on the toolbar, or right-click the solve stage and select the Move Up or Move Down option.
4. To move resource to a different solve stage, drag and drop the resource to the appropriate stage.
5. To remove a resource from a solve stage, select the resource and click >>, or right-click the resource and select the Unassign option. The resource appears in the Unassigned Resources region.
6. To rename the stage, select a solve stage and enter the solve stage name in the Code field in the Solve Stage Details area.
7. Use the Build Strategy option to assign the solve stage as Pre-built or JIT.
8. To have the solve stopped upon completing the solve stage, select the Break Solve After Stage option. The solve is stopped at the solve stage, allowing you to review the schedule and make manual scheduling changes, if required.
9. If necessary, define the Campaign Run Optimization options for the solve stage. The Campaign Run Optimization options will be enabled if there is an applicable resource in the respective solve stage, otherwise the options are not applicable. This features allows you to define specific campaign run options to the solve stage, and these can differ from the Solver Option window settings defined for the scenario.  
See "Setting Up Campaign Run Options, page 8-35," *Configuring Solver Options, Production Scheduling*.
10. If necessary, define the Risk Adjusted Cost Factors for the solve stage. This features allows you to define specific risk factors to the solve stage, and these can differ from the Solver Option window settings defined for the scenario.  
See "Risk Adjusted Costs, page 8-29," *Configuring Solver Options, Production Scheduling*.

## Removing Solve Sequence Stages

### To remove a solve sequence stage:

1. From the Model Workspace, right-click the scenario, and select Solve Sequence.
2. Select the stage that you want to delete, and click the X (Remove Solve Stages) button in the toolbar.

When you delete a solve stage, all of the resources that were assigned to the stage appear in the Unassigned Resources resource.

## Renaming Solve Sequence Stages

To rename a solve sequence stage:

1. From the Model Workspace, right-click the scenario, and select Solve Sequence.
2. Select a solve stage.
3. Enter the new name in the Code field.

## Setting Up Schedule Strategy

This section provides an overview of model configuration options available in the Schedule Strategy tab of the Solver Options window.

To modify the schedule strategy for a scenario:

1. From the Model Workspace, right-click the scenario and select Solver Options.
2. From the Schedule Strategy tab, complete these fields:

Solver Options - Schedule Strategy Tab Field	Description
Build Strategy	<p>When you define demand policies, you can use the Build Strategy field to configure how Production Scheduling fulfills demand.</p> <p>Select <i>JIT</i> to indicate that items are scheduled for production in a just in time fashion. When this option is selected, demands are fulfilled with production occurring as close to the due date as possible. The JIT build strategy is useful if you want to avoid storing inventory.</p> <p>Select <i>Pre-Build</i> to indicate that the solver schedules production at the earliest available opportunity. When this option is selected production is generally started at the beginning of the schedule horizon.</p> <p><b>Note:</b> Pre-Build strategy must be used for scheduling Work Orders in the context of a Visit. It must also be used for scheduling in a multi-stage synchronization environment.</p>

---

**Solver Options - Schedule Strategy Tab  
Field****Description**

---

Pre-build Policy

Use this list to assign one of the following options:

- **Balanced:** Schedules work as early as possible while attempting to maximize order fill rate. Places a smaller emphasis on resource load balancing and changeover minimization.
- **Dynamic Resource Allocation:** Select this pre-build mode to allow more aggressive pre-building and typically results in better resource allocation patterns. In this mode the solver can be directed to choose resources using earliest completion time or least changeover plus idle time optimization strategies.
- **Multistage Synchronization:** Select this option to provide a solve for multi-stage synchronization (make/pack) environment.

Refer to Using Multi-Stage Synchronization and the Resource Relationship Editor, page 5-136 for information and tasks to be performed when generating a multi-stage synchronization schedule.

Resource Allocation Priorities

If Build Strategy is set to Pre-Build and Pre-build policy is set to Dynamic Resource Allocation or Multi-Stage Synchronization, the you can use the adjust the Resource Allocation Priorities. Select a priority and use the Move Selection Up and Move Selection Down arrows to adjust the priorities.

---

Solver Options - Schedule Strategy Tab Field	Description
Work Order Group	<p>This option is only available when using the Dynamic Resource Allocation pre-build policy.</p> <p>Use this field to specify an attribute which will be used to group a series of operation steps (from multiple work orders) together. Scheduling the operations together refers to scheduling together in time and on the same resource alternate selection, and the operations must have the same resource alternates available. This attribute must also be assigned to operations you want to schedule sequentially (in a group).</p> <p>The work orders must be related, either using related work orders or a visit.</p> <p>When this field is used, the solver will try to keep operations together based on the attribute value selected from the Work Order Group list.</p>

3. To open the Solve Sequence page, click Solve Sequence.
4. Click OK to save and close the Solver Options page.

## Setting Up Campaign Run Optimization (CRO)

This section provides an overview of campaign run optimization (CRO) and model configuration options, and discusses how to set up CRO.

### Campaign Run Optimization Overview

This section provides an overview of campaign run optimization (CRO) and provides an example of CRO.

CRO is an optional step to the solve that is run if you have licensed CRO in the application and have configured the data model appropriately. The primary purpose of the CRO solver algorithm in Production Scheduling is to create a production schedule that optimizes campaign run length while minimizing sequence dependent setups on a given machine. Simultaneously, the CRO solver balances the trade-off between the cost of manufacturing and carrying inventory, stocking out or violating safety stock during or across a user defined minimum manufacturing cycle time.

CRO requires separate licensing. This feature is available only if it has been enabled in the License Manager.

To use CRO, you must perform the following:

1. Configure your model to use CRO by enabling this feature in Campaign Run options tab on the Solver Options window.

2. Indicate which resource is campaign run optimized.

If a resource is a member of a set within an operation, ensure that all resources are marked as campaign run optimized and that they share the same minimum cycle size.

3. Indicate the resource and operation minimum run length by time or quantity.

4. Ensure that you define item carrying costs, item stockout costs, and item safety stock violation costs.

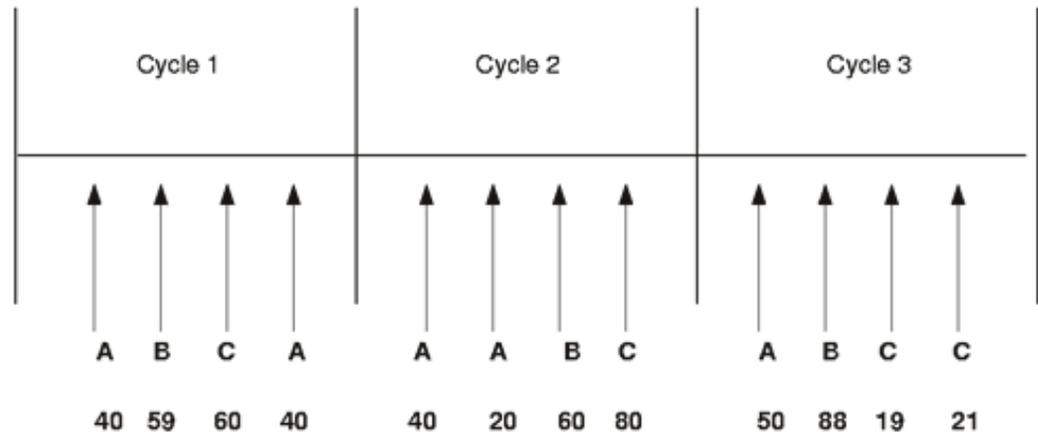
As a general rule, item carrying costs should always be less than item stockout costs.

5. Define machine operating costs.

6. If defining changeovers, define changeover time and cost.

### CRO Example

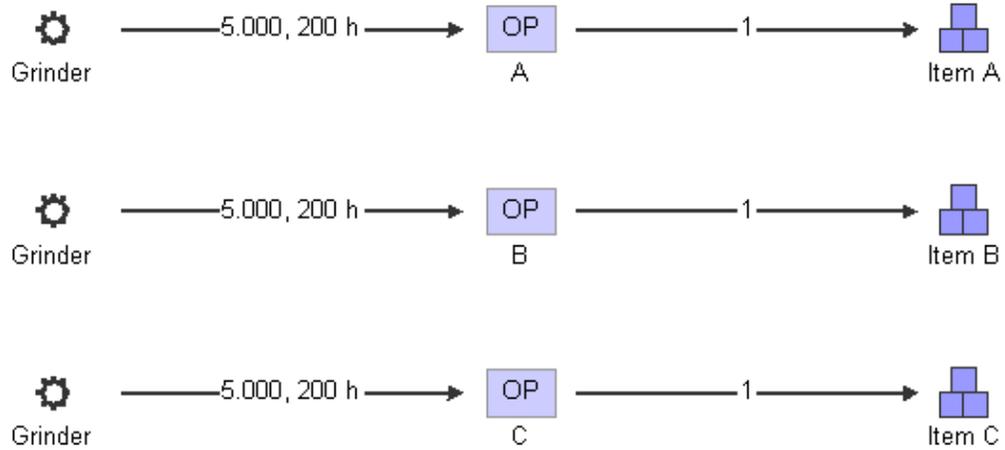
The following diagram provides an example of manufacturing times and demands. This example assumes that we have three weekly manufacturing cycles. Within each cycle, there are demands for Items A, B, and C, in various quantities, which are displayed in the following diagram:



Each item also has a manufacturing process associated with it, which is set up as follows:

- The grinder, which is used in the production of each item, is marked as a campaign run optimized resource.
- The minimum run length is 10 units of any item when run on the grinder
- Operation lot multiple is 5 units.
- The rate is 2 hours to make 5 units of any product on the grinder

This diagram illustrates the processes for each respective item:



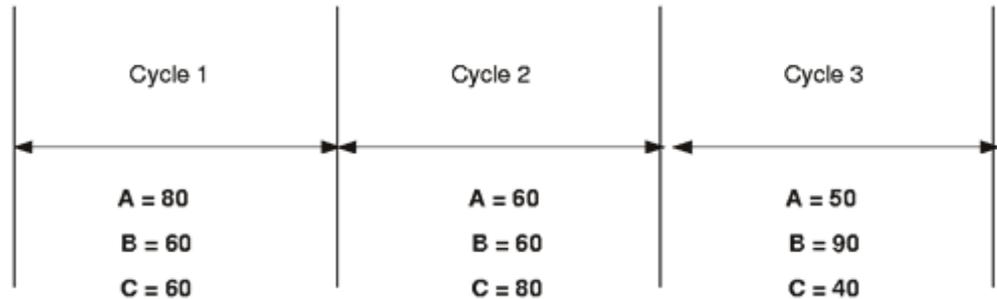
Manufacturing process for items A, B, and C

This table provides the changeover rules for this example:

Machine	From operation	To Operation	Duration (hours)	Calendar	Cost (US\$)
Grinder	A	B	1.00	Default	75.00
Grinder	B	A	1.50	Default	50.00
Grinder	B	C	4.00	Default	250.00
Grinder	A	C	2.00	Default	80.00
Grinder	C	A	4.50	Default	250.00
Grinder	C	B	3.00	Default	150.00

Machine	From operation	To Operation	Duration (hours)	Calendar	Cost (US\$)
Grinder	*	*	1.00	Default	50.00

The CRO first determines how much of each item is needed in a given bucket, for example supply and demand netting. This diagram illustrates the ideal run length, which is calculated by aggregating demands in the user specified cycle:



For example, if there are demands for 125 units for an item in cycle 1, and there is a minimum run length of 100 items, this step creates a series of operations for the same item to be 125 or more, depending on the operation lot multiple. If there is demand for only 25 units in cycle 1, the run length is calculated as 100 units.

Next, the ideal sequence within each cycle is calculated. The purpose of this step is to minimize changeovers within the user-defined manufacturing cycle times. This is based on changeover cost or time, which is user-specified.

Because the CRO algorithm works in buckets, the solver buckets demand for the CRO, based on the bucket boundaries. In this example the bucket boundaries are weeks. CRO then calculates a plan, based on the weekly bucketed demand, and Production Scheduling then sequences the runs according to the recommendations of the CRO.

Resource and Operation Gantt																
Resources		2004														
All Resources	✓	7	8	9	10	11	12	13	14	15	16	17	18	19		
Grinder			B	A	C			B	A	C			B	A	C	
Operations		2004														
On res. "Grinder"		7	8	9	10	11	12	13	14	15	16	17	18	19		
B			B				B					B				
A				A				A					A			
C					C				C						C	

Scenario solve results using CRO

## CRO Options Overview

For each schedule, you must first set up your Model Configuration options before you run the CRO. The options that need to be set up are:

- Minimum cycle time.
- Minimization of changeovers between cycles.
- Ideal run sequence.
- Risk adjusted costs.
- User defined ideal run sequence.

### Minimum Cycle Time

Before you can run the CRO algorithm, you need to specify the manufacturing cycle time that pertains to the run length calculation. Setting a manufacturing cycle time gives the solver insight into your product manufacturing cycle and enables it to determine the appropriate run size that is required to optimize product resources. Generally, the run pattern repeats across cycles.

Minimum Run Cycle is user defined, for example one day, two weeks, and so on. This can be a global option or it can be resource specific.

### Minimize Changeovers Between Cycles

Minimizing changeovers between cycles avoids changeovers between the last operations of the previous manufacturing cycle and the first operation of the of the following cycle. The solver always calculates the optimal sequence based on changeover

durations or cost. The ideal sequence is consistent for each cycle, although Production Scheduling won't always run items in the sequence due to supply and demand variability or pull-forward production.

Minimizing changeovers between cycles enables the solver to weigh the changeover cost between cycles against the carrying cost of an item in the next cycle. Production of the item may be pulled forward into an earlier cycle to eliminate a subsequent changeover.

## Ideal Sequence Run

Ideal run sequence is the order in which events happen within a cycle. If changeovers are specified by cost, it may result in changeovers which are slightly longer, but cost optimal. If changeovers are specified by time, the time spent on changeovers is minimized but the costs may be higher.

**Note:** The costs you specify in your scenario greatly impact the quality of your schedule. Make sure that you have accurately specified the costs of inventory carrying, changeovers, safety stock violation, and inventory stockout. Costs are normally calculated during model prototyping.

## Risk Adjusted Costs

When the CRO algorithm is run, it looks at various costs in the model, including inventory carrying, inventory stockout, changeover, and safety stock violation costs when it attempts to create an optimal production schedule. These costs are typically imported from your ERP system.

The Risk Adjusted Costs functionality in Production Scheduling enables you to quickly scale the relative costs of inventory carrying, inventory stockout, changeover, and safety stock violation costs. The actual costs in the model do not change, but they are "scaled" in the Production Scheduling solver when it makes trade-off decisions in creating a schedule.

The cost factors default to a value of 1. You can quickly and easily change the relative importance of the specific cost by either moving the slider bar to the left or right of 1, or by manually typing in the value in the field beside the slider bar. The acceptable values for each of the respective scale factors range from 0.01 to 100.

## User Defined Ideal Run Sequence

In many environments, you may simply wish to dictate the order of changeovers to run. You can specify the sequence operations should be scheduled in CRO according to attribute (available for CRO resources only). This is an alternate sequencing strategy compared to the current CRO sequencing strategies of Cost or Time.

To define ideal run sequence for the solve stages:

1. From the Model Workspace, right-click the scenario, and select Solve Sequence.
2. Select solve stage.
3. Select User Defined from the Calculate Ideal Run Sequence based on list.

At least one resource within the solve stage needs to be defined to Use Campaign Run Optimization (set from the Solver Options tab in the resource Properties window) for the Calculate Ideal Run Sequence based on list to be enabled.

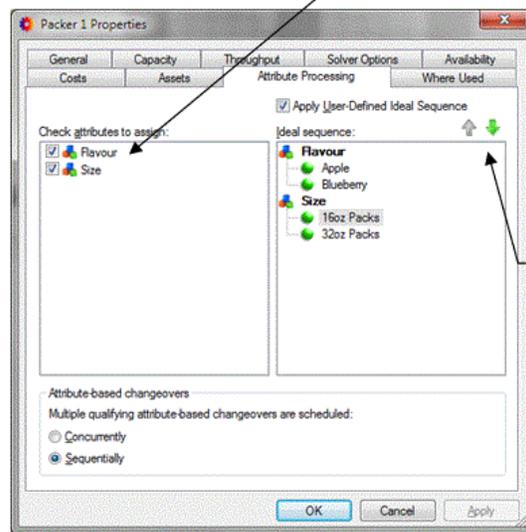
The mechanism in which the "ideal" sequence is defined is by selecting and sorting the associated attributes and their attribute values on CRO resources in the model.

For example, take attributes "Size" and "Grade". Within "Size" there are 1/4 Inch, 1/3 Inch and 1/2 Inch as attribute values. Within the "Grade" attribute, there are Grades A and B.

Assume the user defined Ideal Sequence is to cycle by size and grade within the size, as outlined in the following example:

1/4 Inch-Grade A -> 1/4 Inch Grade B -> 1/3 Inch-Grade A -> 1/3 Inch Grade B -> 1/2 Inch-Grade A -> 1/2 Inch Grade B

Assign attributes to a resource using the Attribute Processing tab in the resource Properties window, as shown in the example below.



Select the attributes you want to include for batching or changeovers. Once selected, the attributes appear in the Ideal sequence box.

Select Apply User-Defined Ideal Sequence to define the operation order.

Use Move Selection Up and Move Selection Down arrows to define the sequence order.

To use Ideal Sequence feature, CRO *must* be enabled in the Solver Options window.

If this resource is defined in the Solve Sequence window, then CRO *must* be enabled in the Solve Sequence window.

Essentially, the order in which the selected attributes and attribute values appear in the Ideal sequence column dictates the ideal sequence of operations (the operations must be associated to these attributes). For example, if Grade was more important than Size, you could move Grade above the Size attribute using the Move Up or Move Down button, located above the Ideal sequence column. The sequence would then cycle by Grade and then Size within the Grade.

## Model Building Considerations

When building models, you should consider certain topics:

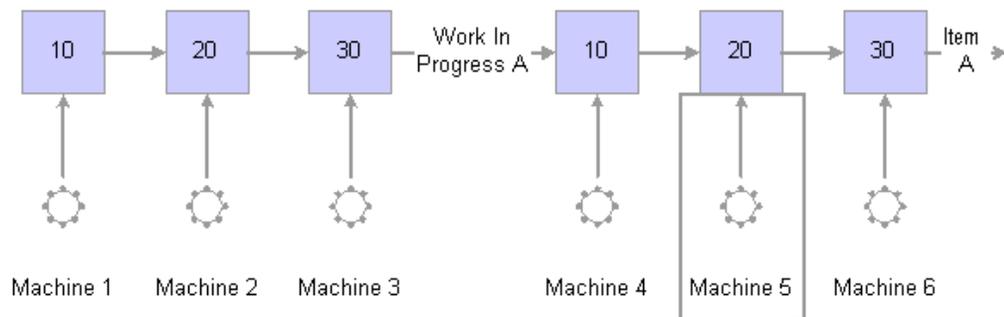
- Optimizing single-capacity machines.
- Late demand.
- Campaign run optimized machines.

Only single-capacity duration machines can be optimized, and no more than one machine per routing can be optimized for repetitive manufacturing. If the machine is part of a resource set, then all machines within the set must be optimized for repetitive manufacturing.

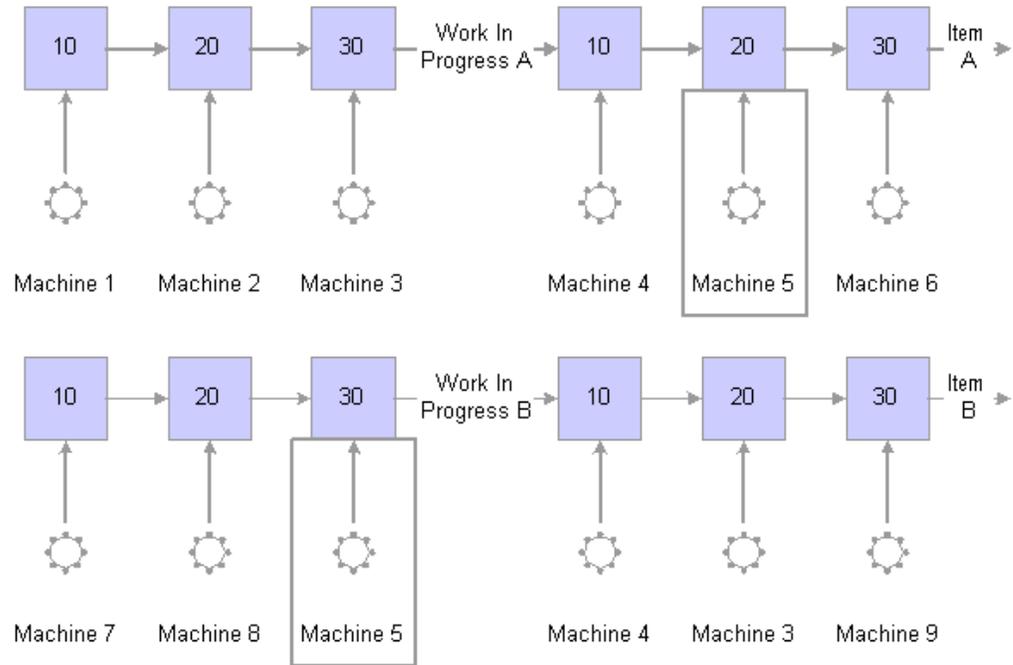
Because the CRO algorithm is based on buckets, it is possible that the algorithm may not recognize demand if a given demand is late within a given bucket. For example, if demand is due at noon within a bucket, the CRO is solving on the basis of daily buckets, and the sequence of operations determines yields on available time of 4:00 p.m., the CRO phase of the solve does not see this demand as late.

Because the sequencing phase of the solver cannot change the operation sequence determined by the CRO, the demand may appear late within a given cycle. If inventory levels are below zero on a cycle boundary, then the CRO sees an item stockout. However, there is logic in the solver that internally sets the due date of the late demand to a previous bucket if there is sufficient idle time on the campaign run optimized machine. The CRO is then internally run again.

Within the manufacturing flow of an item, from raw materials to finished product, you can specify either one resource or resources in a resource set that can be campaign run optimized. This diagram below illustrates run optimization on a single resource, which is Machine 5.



The resource or resources in a resource set that you designate as campaign run optimized may be used in several different operations, if the operations are not producing the same final item. This diagram below illustrates this concept for Machine 5.



**Note:** Only single capacity and batchable machines can be designated as campaign run optimized.

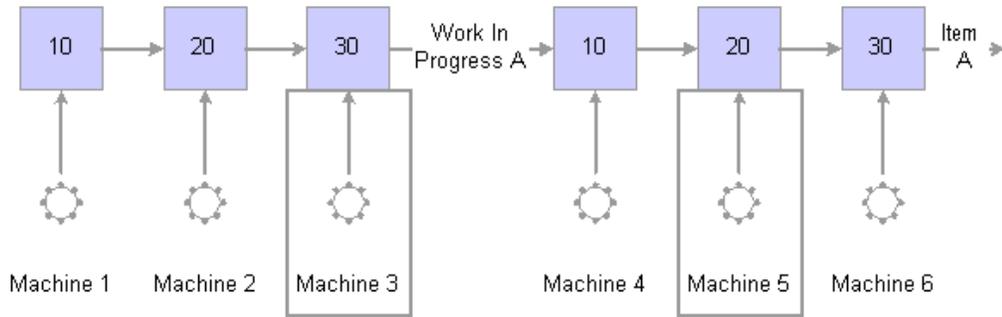
A campaign run optimized resource cannot be set to relaxed.

Some scenarios, which are explained in the following paragraphs, are not conducive to run optimization:

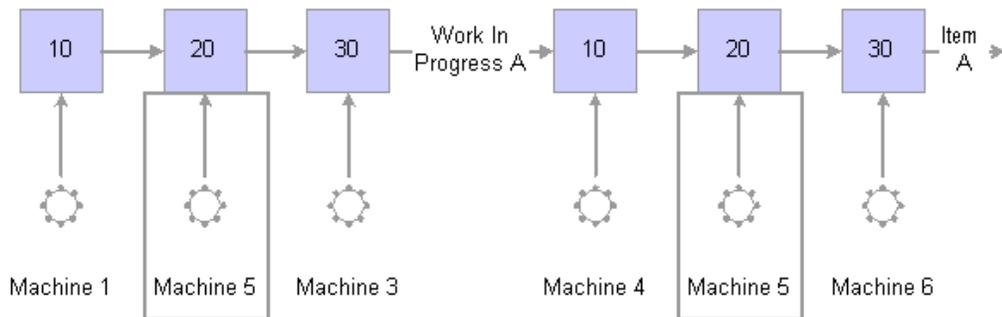
1. You cannot specify a resource as campaign run optimized if the machine is used in a material flow that feeds into another material flow, which has a campaign run optimized machine.
2. A resource can be used only once in the entire material flow.

Multiple runs on the same resource in the same material flow presents conflicting objectives.

The following diagrams illustrate these restrictions on run optimization. The diagram below illustrates a scenario in which Machine 3 is campaign run optimized, but feeds into a material flow in which Machine 5 is also campaign run optimized.



The diagram below illustrates one resource being campaign run optimized more than once in the same material flow.



### Minimum Run Length Specification

In Production Scheduling, you can specify a minimum run length. The minimum run length can be set in units or in time. If you set a minimum run quantity on the resource, the operation, which is producing the item, must run a minimum quantity of the item. Similarly, if you set a minimum run in terms of time, the operation must continue for the specified amount of time.

See "Creating an Operation Diagram, page 5-43," *Creating Production Scheduling Models, Production Scheduling*.

### Multi-Stage Campaign Run Optimization Limitations

When using multi-stage campaign run optimization, it is important to note the following limitations:

- If multi-stage is set up (per item material flow - it can still be single per flow without a solve stage as per existing functionality) but solve stages do not exist, then CRO will be disabled and a warning will appear in the solver log. This is a configuration error (for example, solve using the CSP). Validation should say "Multi-stage Campaign Run Optimization is configured without solve stages. CRO will not be utilized for this schedule".
- Multi-stage CRO within the SAME routing is NOT supported. CRO resources called

in a multi-stage fashion must be in different stages.

- It is best to limit the number of CRO stages. Keep CRO stages to a minimum.
- If alternate resources or alternate routings for the same item are present, they must exist in the same solve stage.
- Resources cannot recur across solve stages. For example, you cannot solve the injection stage more than once.

## Setting Up Campaign Run Options

To set up campaign run options:

1. Right-click a scenario, and select Solve Options.
2. Select the Campaign Run Options tab.
3. Complete these fields:

Campaign Run Options Tab Field	Description
Enable Campaign Run Optimization	Select to indicate that you want to use this feature. When you select this option, the remaining fields on this page are available.
Minimum Cycle Time	Enter a value and select the time measurement required to cycle through demand for the items that are produced. The time measurement options are as follows: <ul style="list-style-type: none"><li>• <i>Seconds</i></li><li>• <i>Minutes</i></li><li>• <i>Hours</i></li><li>• <i>Days</i></li><li>• <i>Weeks</i></li></ul>

Campaign Run Options Tab Field	Description
Resource Specific	Select to indicate that minimum cycle time is different for each resource. When this option is selected, set the cycle time and select the Minimize Changeovers between cycles check box on the resource.
Minimize Changeovers between cycles	Select to indicate that you want Production Scheduling to consider what operations ran in the previous cycle. If possible, the application schedules an operation that can run on this resource without a changeover.
Calculate Ideal Run Sequence based on	<p>Select one of the following options:</p> <ul style="list-style-type: none"> <li>• <i>Changeover Cost</i> - Select if you want to minimize the changeover cost in each cycle.</li> <li>• <i>Changeover Time</i>- Select if you want to minimize the changeover time in each cycle.</li> </ul> <p><b>Note:</b> To accurately minimize changeover costs, you must enter a cost value for each changeover rule.</p> <ul style="list-style-type: none"> <li>• <i>User Defined</i> - Select if you want to define the sequence order used to solve the model.</li> </ul> <p><b>Note:</b> This option is <i>only</i> available when using campaign run optimization.</p>
Enforce CRO Cycle Boundaries	Select this option to enforce the CRO cycle boundaries.
Remove CRO Residual Production	Select this option to remove CRO residual production.

Campaign Run Options Tab Field	Description
View Campaign Run Optimization solution results only	Select to view the CRO solve results only. This helps to understand which decisions have been made by the CRO algorithm prior to them being fed into the base solver. This flag is generally only used in model prototyping and not set within a production environment. This flag is not persisted in the data model and is session specific.
Risk Adjusted Costs	Use the scale to select the appropriate scale factor.  See "Risk Adjusted Costs, page 8-29," <i>Configuring Solver Options, Production Scheduling</i> .

4. Select the Schedule Strategy tab to define the Build Strategy and Pre-build Policy settings.
5. Click OK.



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## Evaluating Production Schedules

This chapter covers the following topics:

- Reviewing Your Production Schedule
- Schedule Views Overview
- Customize Table Data in a View
- Copying Table Data from a View
- Using the Production Pegging View
- Using the Resource Gantt View
- Using the Item Graph View
- Using the Item Gantt View
- Using the Operation Gantt View
- Using the Resource Utilization View
- Using the Resource Contention View
- Using the Multi-Capacity Resource Graph View
- Using Combined Views
- Viewing Critical Path Information
- Filtering Work Orders
- Analyzing Scheduled Resources
- Analyzing Scheduled Items
- Analyzing Scheduled Operations
- Using Combined Views
- Working with Exceptions
- Working with the Resource Sequence View
- Working with Key Performance Indicators

## Reviewing Your Production Schedule

This section discusses:

- Solve status.
- Solver statistics.
- Solver log data.

### Solve Status

When the Production Scheduling is solving a schedule, a number of messages appear in the status bar to indicate what tasks the solver is performing at that moment. Real-time messages enable you to keep track of each phase of the solve process as it occurs. The application produces the following messages while solving a production schedule:

<b>Solver Message</b>	<b>Expanded Definition</b>
Preparing Model	The model is being prepared for the solver.
Calculating Net Demand	If the Campaign Run Optimization (CRO) algorithm is enabled, it first calculates net production requirements on the CRO machine based on the supply and demand picture in the model.
Optimizing Run Length	If the CRO algorithm is enabled, it optimizes sequence dependent setups, run length, and simultaneously balances the trade-off between building and carrying inventory, stocking out and, violating safety stock levels.
Solving - Assigning Operations to Resources	Based on the model information, the solver is creating all of the operations that are required to meet the model demand and assigning them to applicable resources.
Solving - Sequencing	In this phase, the solver is sequencing the operations while respecting all of the constraints and trying to meet demand due dates.

<b>Solver Message</b>	<b>Expanded Definition</b>
Preparing Schedule	In this phase, the solver data is converted into a schedule.
Refreshing Views	The solver is updating any open schedule views to reflect the current schedule.
Scheduled in <x seconds/minutes>	The schedule has been solved in the specified time.
Schedule Infeasible	This message appears if the schedule is infeasible. Check the log window for details.
Solver Stopped	The user has stopped the solver.

## Solver Statistics

Production Scheduling creates a solver statistics file that captures important solver information after solving every schedule. If you have selected the Enable Logging option in the Options window, then solver statistics are written to a SolverStatistics.txt file every time that you solve a schedule. This file can be viewed directly from the Log workbook tab. For additional details, see Configuring Log Files, page 6-1.

You can examine the solver statistics file to obtain more information about the following solve characteristics:

- Determine the solver performance for the solved schedule.
- View demand details for the solved schedule including demand fill percentage, demand total, and on-time and late demand statistics.
- View operation and resource totals for the solved schedule.
- View iterative and heuristic information about the solve.

## Solver Log Data

The solver log provides information about the number of demands that were met on time within each solve that is performed by Production Scheduling during the current session. By viewing these solver statistics in the Log workbook tab, you can determine how successful the solve was.

When the schedule is infeasible, the system displays one of the following messages in the log:

Solver Message	Explanation
Insufficient Resource Capacity	Not enough crew, machine, or tool capacity is available for the specified resource.
No Producing Operation in Model	All items in the model require a source of supply whether it come from a supplier or a manufacturing operation.
Insufficient Item Maximum Storage Capacity	Too much inventory is being produced to fit in the allocated storage space.
Routing Precedence Constraint Error	The solver has encountered an issue with an operation sequence and can not resolve the conflict. For example, Operation B might be firmed to occur before Operation A but it can not feed it sufficient inventory.
Could not Compute Ideal Operation Sequence for Campaign Run Optimization	The solver was unable to generate a sequence of operations based on your choice of using changeover duration or cost.
Unable to Initialize Campaign Run Optimization	An internal or licensing error has prevented the Campaign Run Optimization from initializing.
Specified Minimum Cycle Time too Short for Campaign Run Optimization	An operation's minimum run length parameters cannot fit within one cycle. Decrease the minimum run length.

**Note:** If you have selected the Enable Logging option in the Options window, then these statistics are saved to a SolverStatistics.txt file each time that you solve a schedule. This file is written to the same location as your log file.

## Schedule Views Overview

From a number of schedule views, schedules can be improved using manual scheduling and repairing techniques. Schedules can be compared in the Key Performance Indicators window against a number of objective measures to determine the best schedule. Schedule views is the collective term for Gantt diagrams and graphs in Production Scheduling. The workspace in which these Gantt diagrams and graphs appear is known as schedule view. You can view problems with the schedule by

browsing the exceptions in the Exceptions view.

Using the middle mouse button or scroll wheel, you can identify how related upstream and downstream operations and their timing align with one another, without having to constantly zoom in and out of the view. When the middle mouse button or scroll wheel is pressed, a thin vertical line appears, which helps in identifying upstream and downstream processes.

## Schedule View Groups

Groups enable multiple operations and resources to be combined as a group when viewed in the Model Workspace and schedule views. Organizing resources and operations into logical groupings can help you organize your model data. You can create a default resource group for each schedule that appears when views are first opened.

All schedule views, except the Production Pegging view, provide a list at the top of the window. Use the list to select a display option to focus the content for your view. When you select a list option, the schedule view refreshes to display only those resources or items belonging to the selected option. Each schedule view can have its own default group view. The current default group in each view appears with a check mark beside its name.

## Operations

Within schedule views that display operation information, you can review and modify operation information. Operation run times, duration, and assigned resources (if a resource set is used) can be changed directly from schedule views.

**Note:** In cMRO integrations where operation descriptions are available, the operation description appears in the Notes field of the operation Properties - General tab.

You can view information about all operations from the Demand, Operation and Resource Gantt views. Only information about single-capacity operations is available from the Resource Gantt view.

From operation schedule views, you can select an operation within the time grid to view operational information. Right-click an operation from the time grid, select Properties.

The operation Properties window contains the following tabs:

<b>Operation Properties Window Tabs</b>	<b>Description</b>
General	This tab contains the operation code (name), the demand and work order that it is fulfilling, and any attributes assigned to the operation. From this tab you can launch the Work Order and Supply & Demand editors to view and edit the associated demand and work orders. You can also access the operation and routing using the icons at the top.
Times	This tab contains the selected operation's start and end times, earliest start and latest end times, duration, run, and delay. This tab also indicates whether the operation has been set to run at a specific time.
Resources	This tab contains all of the resources that are associated with this operation, including their quantities. Item resources are displayed as negative when they are consumed, because they are not renewable.
Pegging	This tab contains work orders and demands associated with this operation. Late orders appear in red.
Document	This tab lists associated files and the location of the files.

Operation details are also available from the operation Properties window that can be accessed from the Model Workspace and Work Order Editor. To access the operation Properties, right-click an operation from the Model Workspace and select Properties. You can also display operation Properties from the Work Order Editor. In the Work Order Editor, select the Operations tab, right-click an operation, and select Properties.

The operation Properties window opened from the Work Order Editor contains the following tabs:

<b>Operation Properties Window Tab</b>	<b>Description</b>
General	This tab contains the operation code and notes.

<b>Operation Properties Window Tab</b>	<b>Description</b>
Costs	This tab displays costs associated with the operation.
Attributes	This tab displays the activity type associated with the operation and the attributes assigned to the operation.
Resources	This tab contains all of the resources that are associated with this operation, including their quantities. Item resources are displayed as negative when they are consumed, because they are not renewable.
Documents	This tab lists associated files and the location of the files.
Where Used	This tab displays the routing diagrams and work orders where the operation is used.

A quick summary of an operation can be viewed for single operations. Details including the name, start time, and duration of the operation are included in this quick summary. A quick summary for an operation is available in the Demand, Resource, and Operation Gantt views.

Use the Work Order Editor - Operations tab to display additional operation information such as status, firm status, firm dates, planned start and end times, and yield information.

## Changeovers

The transitional time between one operation running on a specific machine and another operation is called a changeover. Changeovers appear in schedule views as solid black lines between operations.

Changeover events that affect resources appear in the Production Pegging, Resource Gantt, Resource Utilization, and Resource Sequence views, according to the rules set in the Changeover Editor.

## Merging Operations

A production schedule can have several thousands of operation instances. To help simplify your schedule views, you can use two operation merge features. Click the Merge Operation drop-down list on the toolbar and select one of the following options from the Resource and Operation Gantt views:

- Merge Operation - Select this mode to display identical operations as a single operation if they are adjacent to one another, resulting in less busy displays in the various schedule views and simplifying manual scheduling efforts. Adjacent operation instances of identical types are represented as one production run.

As a result, manual scheduling is simplified. Instead of reassigning each batch in a run, you only need to reassign the total production run by using the Cut and Paste buttons. Properties for merged operations can be viewed, but they cannot be modified. The properties for merged items display the aggregated properties for each discrete operation in the merged operation. Pegging can also be performed on merged operations.

- Merge Work Order Operation - Select this mode to merge operation instances *only* if they belong to the same work order. In addition, if a work order requires multiple routing instances and some operation instances are scheduled with separation (idle time) in between, then they are still merged with the idle time indicated by gray shading.

Once operations have been merged, you can view information about these consolidated operations from the Operation and Resource Gantt views. The Resource Gantt views only provide merged information about single operations, whereas the Operation Gantt displays information about all the operations.

If the Resource Sequence view is displayed when performing a merge, the Planned Resource Set and Planned Resource fields are updated as follows:

- If the values for these fields are identical for all operation instances currently merged, then the fields display that value.
- If the values are not identical, then the fields display "N/A".

Click the Merge Operation button again to display the operations separately.

You can also merge operations using the Resource Sequence view. Refer to Merging Operations from the Resource Sequence View, page 9-72 for more information.

## Customize Table Data in a View

Many views display information in a tabular manner. This data can be customized as needed. Use the Choose Columns dialog to customize and arrange the data displayed in the table grid.

### To customize table data in a view

1. Right-click a column header within the view.

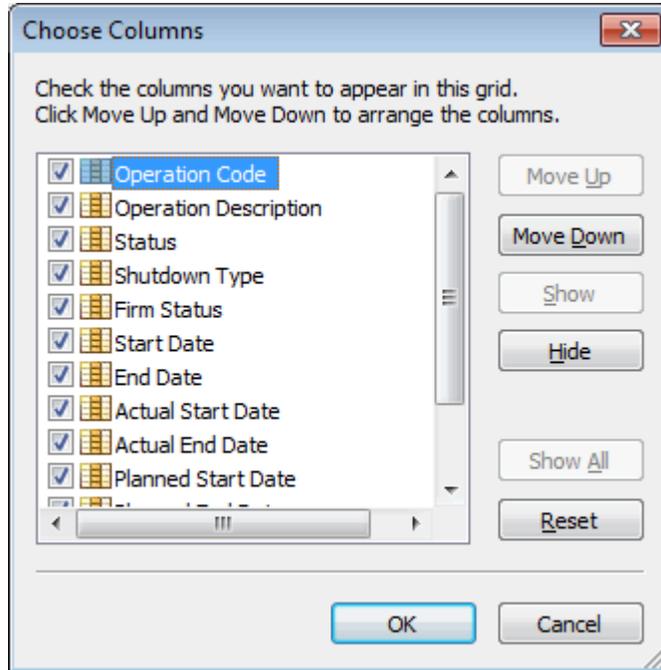
Right-click a column header to display columns available and set column options.

The screenshot shows a software interface for a 'Maintenance Work Order'. The top section contains form fields for 'Number' (1000001), 'Order Class' (Committed), 'Priority' (1), 'Description' (OPEN WING ROOT PANELS, SKIN PANELS, WING TIPS), 'Item Code' (A/C), 'Serial Number', and 'Routing' (DEPANEL - OPEN WING ROOT PANELS, SKIN PANELS, WING TIPS-DE PANEL). Below this is a table with columns: 'Use Of Measure', 'Required', 'Completed', 'Remaining', 'Reserved', and 'Lot Multiple'. The table has one row with values: 'Each', '1', '0', '1', '0', and '1'. Further down are date pickers for 'Earliest Start Date', 'Start Date' (7/29/2009 9:30:00 AM), 'Created Date' (8/11/2009 11:22:02 AM), 'Target Completion Date', 'Completion Date' (7/29/2009 10:30:00 AM), 'Request Date' (7/31/2009 12:00:00 PM), 'Earliest Demand Date', and 'Status' (Attached). At the bottom, there is a 'Maintenance Resource' section with 'Asset Number' and 'Asset Group' fields.

The bottom section of the screenshot shows a table with the following columns: 'Operation Code', 'Operation', 'Status', 'Shutdown Type', 'Firm Status', 'Start Date', 'End Date', and 'Actual Start Date'. A context menu is open over the 'Operation Code' header, listing various columns that can be displayed in the table. The menu items are: 'Copy', 'Choose Columns...', 'Auto Size Columns', 'Reset Columns', 'Operation Code', 'Operation Description', 'Status', 'Shutdown Type', 'Firm Status', 'Start Date', 'End Date', 'Actual Start Date', 'Actual End Date', 'Planned Start Date', 'Planned End Date', 'Yield Percentage', and 'Cumulative Yield Percentage'. Check marks are present next to 'Operation Code', 'Operation Description', 'Status', 'Shutdown Type', 'Firm Status', 'Start Date', 'End Date', 'Actual Start Date', 'Actual End Date', 'Planned Start Date', 'Planned End Date', 'Yield Percentage', and 'Cumulative Yield Percentage'.

The menu displays all columns that can be displayed in the table. Check marks appear next to columns displayed within the table. You can update individual columns by checking the column name displayed at the bottom of the menu. To hide a column, uncheck the column name in the menu.

2. To define all the displayed columns and column order, select Choose Columns.



3. Perform the following as needed:
  - Select the columns you want to appear. Uncheck the columns you want to hide.
  - To display all available columns, click Show All.
  - To reset the columns displayed to the default setting, select Reset.
  - To modify the column order, select column and use the Move Up or Move Down arrow to move column to new location.
4. Click OK.

To resize the column widths in the table, right-click a column header within the view and select Auto Size Columns.

To reset the column in the table to the default settings, right-click a column header within the view and select Reset Columns.

## Copying Table Data from a View

You can copy table data displayed within views to other applications, such as Microsoft Excel.

**To copy all table data from a view:**

1. Right-click a column header within a view.

2. Select Copy, and then select Entire Table.
3. Paste the copied data into another application as needed.

**To copy a portion of table data from a view:**

1. Highlight the table columns to be copied within the view.
2. Right-click a column header.
3. Select Copy, and then choose Selection.
4. Paste the copied data into another application as needed.

## Using the Production Pegging View

In the Production Pegging view, you can display several important elements of your schedule in a simple, easy to use format. Among the many aspects that you can access are:

- Multistage pegging of work orders
- Resource requirements
- Consumed items
- Net new production recommendations
- Purchase order recommendations

Production Pegging lets you view production from a demand point of view (demand centric), or a work order point of view (work order centric), which brings up a Work Order Gantt chart. To alternate between the demand centric and work order centric views, click the View Work Order Pegging or the View Demand Pegging toggle button on the menu bar. This toggle button has descriptive text that changes depending on the view that is displayed.

This section discusses:

- The order tree.
- Expand and collapse Production Pegging tree.
- Production Pegging sorting.
- Makespan bars.
- The Production Pegging - Demand Centric view.

- The Production Pegging - Work Order Centric view.
- Work order links.
- Operations.
- Resources.
- Supply events.
- Partially filled demand.
- Purchase recommendations.

## Using the Order Tree

When open to the demand centric view, the order tree displays all of the scheduled demands as listed in the Supply & Demand Editor. You can expand the tree to display the line items and operations that are associated with each work demand order.

When open to the work order centric view, the tree displays all the scheduled work orders as listed in the Work Order Editor. You can expand the tree to display the details of operations and routings that are used by each work order, and also see pegged upstream work orders. In addition, you can look at the production recommendations and purchase recommendations.

The makespan for each folder and order appears in the time grid, similar to other schedule views. The makespan is represented by a bar with a diamond at each end to indicate the total amount of time that is required to fill an order. This bar appears in a contrasting color to provide information about the percentage of the orders filled either in demand orders or folders.

## Expanding and Collapsing the Production Pegging View Tree

To get a quicker view of your work orders and demands, you can expand and collapse the work order and demand tree in the Production Pegging view. You can expand or collapse the entire tree by selecting the top-level Work Orders or All Demands folder, or expand and collapse by folder or visits by selecting the folder or visit within the tree.

### **To expand the Production Pegging view Work Orders tree:**

Right-click an object from the Work Order Tree, select Expand and select one of the following options:

- Expand Folders - Select this option to expand work order folders.
- Expand Work Orders - Select this option to expand the work order folder and work orders.

- Expand All - Select this option to expand the contents of all work orders folders, visits, work orders, and operations.

**To expand the Production Pegging view Demand Order tree:**

Right-click an object the Demand Order Tree, select Expand and select one of the following options:

- Expand Folders - Select this option to expand demand folders.
- Expand Demand Orders - Select this option to display the demand orders.
- Expand Demand Line Items - Select this option to display the demand line items.
- Expand All - Select this option to display the contents of all demand folders, demand orders and demand line items.

**To collapse the Production Pegging view tree, right-click an object from the Work Order tree or Demand Order Tree, select Expand, and then select Collapse All.**

## Production Pegging Sorting

Use the Pegging Tree Sort Order button to sort Production Pegging data by Start Date, End Date, Visit Risk Index, or alphabetically. This feature allows you to analyze Production Pegging from different perspectives to find the best schedule solution.

**To sort Production Pegging data:**

1. From the Production Pegging view, select the Pegging Tree Sort Order button.
2. From the Pegging Tree Sort Order dialog, select one of the following Sort by options:
  - Start Date
  - End Date
  - Visit Risk Index

The Average Visit Risk Index is the overall Risk indicator for all the Visits and can be viewed from the Key Performance Indicators view. The higher the number, the Riskier the Visit will be. The individual risk index can be displayed from the Visit bubble help in the Production Pegging View. See Key Performance Indicators - Maintenance Tab, page 9-78 for details.

- Alphabetically
3. Select the sort order, Ascending or Descending.
  4. Click OK.

The Production Pegging view refreshes and sorts the order tree based on your selections.

## Makespan Bars

In the Production Pegging view the makespan bars are:

- Folder based.
- Demand based.
- Line item based.
- Routings based.

The makespan bar has a different meaning based on its color.

The makespan and the order of each Work Order Centric or Demand Centric folder in Production Pegging appear in the time grid, similar to other schedule views. The makespan is represented by a bar with a diamond at each end to indicate the scheduled beginning and end of manufacturing for individual demand orders and their associated demand folders. The makespan bar is colored to provide information about the percentage of the orders filled in either orders or folders.

Type	Significance
Solid black bar	100 percent of orders filled, based on unit fill.
Solid yellow bar	Between 66 and 100 percent of orders filled, based on unit fill.
Solid orange bar	Between 33 and 66 percent of orders filled, based on unit fill.
Solid red bar	Less than 33 percent of orders filled, based on unit fill.

Bubble help provides information about each work order and folder when the cursor pauses on its makespan bar. Folder makespan bars represent aggregate information about contained work orders, and work orders summarize line item information. The following data is displayed in bubble help for demand and work orders in Production Pegging:

<b>Field</b>	<b>Description</b>
Demand (demand folders only)	Name of the demand folder.
Demand Number (demand orders only)	Name of the demand order.
Start time	Start time for the first demand order in the demand order or folder.
End time	End time for the latest ending demand order in the demand order or folder.
Duration	Length of time between the start time for the earliest demand order or line item and the latest ending demand order or line item.
Average Demand Duration (demand folders only)	Average makespan for demands within the folder.
Average Line Duration (demand orders only)	Average makespan for line items within the demand order.
Fill Percentage	Demand (only available for folders). Percentage of the orders that are filled in the selected folder.  Line. Percentage of the item lines that are filled within the order or in the folder.  Unit. Percentage of the units that are filled within the order or in the folder.
Instance Count (routings only)	The number of instances of this routing in this work order.

The following data is displayed in bubble help for work orders in Production Pegging:

<b>Work Order Centric View Field</b>	<b>Description</b>
Work Order	Type of work order. For example, Production, Maintenance, Finished Goods, or Distributors.
Start Time	Start date and time of the first operation in the routing or folder.

<b>Work Order Centric View Field</b>	<b>Description</b>
End Time	The end date for the operation.
Average Duration	Average makespan for orders within the folder.
Unit Fill Percentage	Percentage of the units that are filled within the order or in the folder.
Requested Date	The date on which the order is requested.
Available Date	The date on which the order is available.
Duration	The duration of the work order.
Pegged Demands (for work order only)	The demands that are pegged to this work order.

The makespan of each line item and routing is displayed on a time grid. Similar to the makespan for demand orders and folders, the makespan is represented by a bar with diamonds at each end, symbolizing the start and finish of the line item or routing. If the demand line item is running late or is available early, the bar is partially displayed in color. Each line item can be expanded to display the routings and operations that are involved, as well as the resource details and supply events.

Purchase order recommendations are represented by solid green bars with a trailing diamond. The bars for purchase order recommendations represent the lead time required to procure the purchased item. The diamond represents the date when the items in the purchase order become available to use in a routing.

An additional diamond is included on the bar to indicate either the requested date for line orders scheduled to be available late, or the available date for line items scheduled to be available earlier than requested.

In addition to the third diamond, the makespan bar is displayed in color between the second and third diamonds, indicating whether the line item is available earlier or later than its requested date, and by how much.

The following table summarizes the different types of line item makespan bars that are displayed in the Production Pegging:

Type	Significance
Solid black bar	Line item scheduled to be manufactured on time.
Black and red bar	Line item scheduled to be available after the requested date.
Black and green bar	Line item scheduled to be available before the requested date.
Solid red bar	Line item to begin manufacturing after the requested date.
Solid green bar	Line item scheduled to be early.
Green diamond	Line item is procured from a supplier and ready to be used in a routing.

Bubble help displays the following information about each demand order when you place your cursor over a specific demand line item makespan bar:

- Demand Number - Name of the demand order.
- Latest Requested Date - Date when the order has been requested.
- Latest Available Date - Date when the order will be available.
- Start Time - Start time for the line item.
- Duration - Length of time between the start time and the end time.
- Average Line Duration - The average duration of one line item.

Routings are displayed on the time grid by makespan bars. The color of these makespan bars is based on whether the routing is on time or late.

Type	Significance
Solid black bar	Routing is on time.
Solid red bar	Routing contains critical bottleneck operations.

Although subroutings are not displayed with a makespan bar, their operations are displayed on the Production Pegging view.

Bubble help displays the following information:

Type	Significance
Routing	Routing name.
Start time	Start time for the routing.
End time	End time for the routing.
Duration	Length of time between the start time and the end time.

## Production Pegging - Demand Centric View

The Production Pegging - Demand Centric view enables you to visually display the start times, end times, and duration for each demand, along with its associated line items and routings. From this view, you can see how complete the orders in a folder are, how complete a specific order is, and whether scheduled line items are early, on time, or late. The system distinguishes critical routings and operations. The system does not display demand orders on hold.

**Note:** For the Production Pegging demand centric view to properly function, you must specify the primary operation in routings and primary output items in operations. This pegging information is essential to display the sequence of operations and routings that are involved in the production of any order line item.

The Production Pegging - Demand Filter toolbar provides a number of buttons that are available only in Production Pegging. From this toolbar, you can filter demand orders according to their criticality to assist you in analyzing the schedule's handling of demands. You can filter the demand orders to list only orders of a specific type, punctuality, and magnitude of punctuality. The Production Pegging retains the last filtering settings used for future analysis.

To display the Demand Filter toolbar, select View, Toolbars, then choose Demand Filter.

The following criteria are used to filter demand orders from the Demand Filter toolbar:

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Name	Description
Order Class Filter	<p>Enables the demand orders to be filtered by the type of demand. Options include all, orders, forecasts, and safety.</p> <p>The following options are available:</p> <ul style="list-style-type: none"><li>• * - Use the wildcard option to view all order types.</li><li>• Hot</li><li>• Committed</li><li>• Uncommitted</li></ul>
Order Punctuality Filter	<p>Enables the demand orders to be filtered by punctuality.</p> <p>The following options are available:</p> <ul style="list-style-type: none"><li>• * - Use the wildcard option to view all orders.</li><li>• Late</li><li>• Early</li><li>• On-Time</li></ul>

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Name	Description
Order Magnitude Filter	<p>When Late, Early, or On-Time is selected from the Order Punctuality Filter, you can use this filter to specify the magnitude of punctuality when filtering. By following options are available:</p> <ul style="list-style-type: none"> <li>• 0.5 day</li> <li>• 1 day</li> <li>• 2 days</li> <li>• 3 days</li> <li>• 5 days</li> <li>• Customize - Use this option to arrange the order of magnitude values displayed in the list.</li> </ul> <p>When all orders (*) are selected from the Order Punctuality Filter, the Order Magnitude Filter defaults to all (*) as well.</p>

**Note:** The number of late orders is shown in the status bar at the bottom of the screen when you use the filtering in the view.

## The Production Pegging - Work Order Centric View

The Production Pegging - Work Order centric view displays the start times, end times and duration for each work order, along with its associated operations and any pegged work orders. From this view, you can see how complete the orders in a folder are, how complete a specific order is, and whether it is early, on time, or late. The system distinguishes critical routings and operations. The system does not display work orders that are complete or cancelled.

The nested structure of the Work Order Centric view also displays multilevel pegging between work orders, net new production recommendations, and purchase order recommendations.

Production recommendations display Production Scheduling suggested production requirements when your work order quantities are insufficient to fulfill demand or upstream/downstream production requirements.

The Production Pegging - Work Order Centric view has the same folder structure as the Work Order Editor and allows you to drill down into the Work Order Editor from the pegging view.

To open the Work Order Editor from the Production Pegging - Work Order Centric view:

1. Select a work order in the work order tree.
2. Click the Open Work Order Editor icon in the toolbar, or right-click and select Open Work Order Editor.

The Work Order Editor opens and highlights the selected work order number in the Work Order tree.

The Production Pegging - Work Order centric toolbar provides a number of buttons that are available only in Production Pegging. From this toolbar, you can filter work orders according to their criticality to assist you in analyzing the schedule's handling of orders. You can filter work orders to list only those of a specific type, punctuality, and magnitude of punctuality. Production Pegging retains the last filtering settings and uses them for future analysis.

Orders can be filtered to display only those that meet the specific type of criteria that you specify. This information can help you locate any issues and resolve them by modifying the resources or materials involved.

The following criteria are used to filter work orders:

<b>Filter</b>	<b>Name</b>	<b>Description</b>
Primary	Work order filter	Enables the work orders to be filtered by the type of work order. Options are: Production, Maintenance, or Engineering.
Secondary	Order Punctuality filter	Enables the orders to be filtered by punctuality. Options include all, early, on time, and late.
Tertiary	Order Magnitude Filter	Enables the user to specify the magnitude of punctuality when filtering. By default, these options include all, >0.5 days, >1 day, >2 days, >3 days and >5 days. Select Customize to set your own time filters.

**Note:** The number of late orders is shown in the status bar at the bottom of the screen when you use the filtering in the view.

## Show Work Order Links

Use the Show Work Order Links button on the toolbar to display task dependencies between related work orders in the Production Pegging view. The links between tasks are based on the Precedence Relationship assigned in the Related Work Order tab in the Work Order Editor.

### To display work order links in the Production Pegging view:

1. Click the Show Work Order Links button on the toolbar. By default related work orders are identified using red lines to connect the task makespan bars.

You can adjust the following attributes from the related work order links:

- Link weight - Adjust this attribute to adjust the line thickness connecting the work orders.
  - Link Transparency - Adjust this attribute to increase or decrease the link line transparency in the Production Pegging view.
  - Show Link Arrows - Select this option to arrows on work order links.
  - Work Order Link Color - Select this option change the link line color.
2. To adjust link weight, right-click the Production Pegging background, select Link Weight and choose Small, Medium, or Large for the thickness.
  3. To adjust link transparency, right-click the Production Pegging background, select Link Transparency and choose None, Low, Medium, or High for the transparency.
  4. To display arrows for links, right-click the Production Pegging background, select Show Link Arrows.
  5. To adjust the color assigned to work order links, right-click the Production Pegging background, select Work Order Link Color. From the Colors window, use the Item color list to select the link line color. Select Default Color from the Item Color list to set the link line color to return the link line color to red. Click Close to exit the Colors window.

## Operations

For each demand line item and routing, the related operations are displayed. The color of each operation is determined by whether it is a critical bottleneck operation. The start time of critical operations is the same as their earliest start time. No flexibility exists for

the operation to start any earlier than its current start time. The start time for noncritical operations is later than their earliest start time.

Color	Significance
Blue box	Noncritical operation.
Purple box	EAM Work Order Operations are highlighted in purple.
Red box	Critical operation.

From the operation schedule views, you can identify the following occurrences:

- Closed operation - Identified when an operation has completed as indicated by the Actual Start Date and Actual Completion Date. Closed operations are identified by purple double-sided arrows. From the operation schedule view you can view the genealogy of the Visit and the actual time spent performing maintenance operations.
- Active operations - Identified when an operation has started, but not completed as indicated by the Actual Start Date. Active operations show remaining time as a solid green bar in the schedule view. The unshaded region represents the duration already performed. From the operation schedule view, you can easily identify when the operation started and how long it has been running.
- Zero duration operations - Identified when the actual time exceeds the planned time. For example, the planned time for an operation is 1 hour, but after 1.5 hours it is still not completed. Zero duration operations are highlighted with a blue diamond in the schedule view. From the operation schedule views, you can identify work orders that are still in the process of being completed.

Actual Start Date and Actual End Date dictate the status of the operation. If Actual Start Date and Actual End Date are present, the operation is Closed. If Actual Start Date is present and there is no Actual End Date, the operation is Active. Actual Start Date and Actual End Date are assumed to be before the Scheduling Horizon.

**Note:** Actual Start and End Dates are only supported in the standard integration with cMRO. These dates are not populated by collections for OPM, OSFM, and Discrete.

Bubble help displays the following information:

- Operation name - Name of the operation.

- Start time - Start time for the operation.
- End time - End time for the operation.
- Duration - Length of time between the start time and the end time.
- Slack time - The amount of time the operation can move before being on the critical path.

## Resources

The resources for each operation can be viewed in the Production Pegging. These details are similar to those displayed in the Resource Gantt view. The Time grid displays each instance that the resource is used for an operation.

Element	Appearance
Single capacity resource	Blue with operation name.
Maintenance resource	A resource that is in maintenance is indicated by a solid purple line.
Multicapacity resource	Multiple colors, depending on the percentage of capacity being used. Ranges from dark green for low usage to red for full capacity use.
Changeover	Thin black bar.

## Supply Events

At times, you might need to see the demands that are dependent on specific supply events. From Production Pegging, you can peg up from a supply event to all of the associated demands.

Supply events are displayed as diamonds in the Time grid. The color green indicates any supply event.

Bubble help is also available for supply events. The following fields are included:

- Supply Number - Supply event order and line number.
- Item - Inventory item number on the supply order.
- Quantity - Quantity of item that is requested.

- Requested Date - Date when the item is expected to be fulfilled.

## Partially Filled Demand

If an order is filled from production and either starting inventory or a supply event, the starting inventory is displayed in the Production Pegging view by a green diamond. The green diamond at the start of the horizon indicates that some of the order is taken from inventory. The production below the green diamond row indicates that the remaining quantity is from manufacturing activities. Bubble help provides additional details for each event such as pegged quantity, date, and so on.

## Purchase Recommendations

Purchase recommendation are recommended purchase activities for produced items. They appear as a green diamond with a tail that represents the lead time from the supplier. Placing your mouse pointer over the purchase recommendation provides this information:

Recommendation Type	Description
Supplier	Displays the selected supplier.
Item	Displays the purchased item.
Pegged Quantity	Displays the quantity that is required for the order.
PO Recommendation Quantity	Displays the amount ordered that may also supply other orders.
Required Date	Displays when the purchase order is needed for production.
Lead Time	Displays the lead time from the supplier.
Estimated Ship Date	Displays the date that the purchase order is estimated to ship from the supplier.

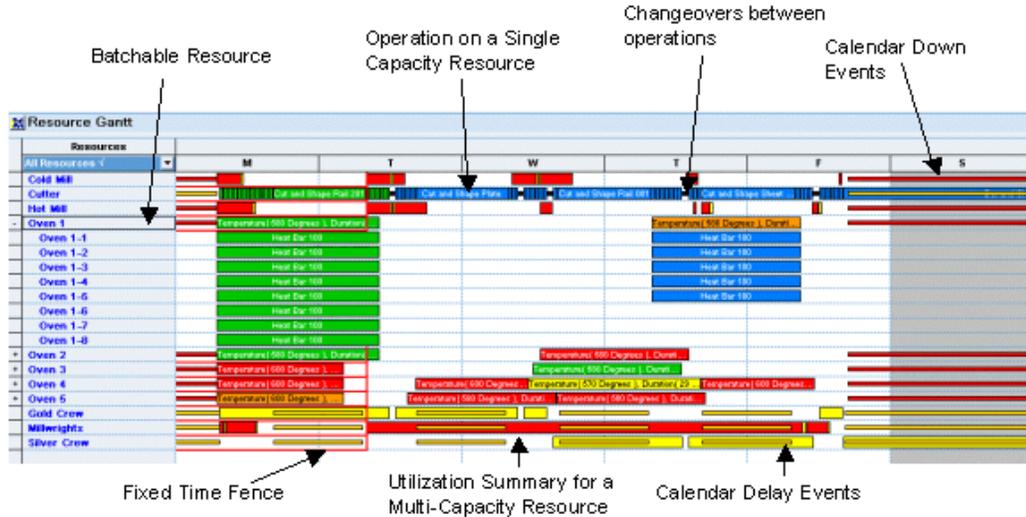
## Using the Resource Gantt View

The Resource Gantt is a resource-centric view of the schedule. It enables the planner to see exactly how machines, crews, and tools are scheduled across the horizon. Operations are displayed with blue rectangles to indicate exactly where they start and

end. You can zoom into any point in the horizon by selecting a range in the upper portion of the horizon bar and then select the Zoom In button on the toolbar.

For multicapacity resources, color is used to represent the percentage of capacity currently being used. The Set Colors button defines these colors. For example, if you have not changed the default color setting, dark green represents low (0 to 10 percent) capacity used, while red represents high capacity (90 to 100 percent).

The example below illustrates the Resource Gantt chart elements that are described in the following table:



This table describes the chart elements:

**Resource Gantt Chart Elements**

Element	Appearance
Batchable Resource	A summary level row which displays information on the planned batch and a little plus arrow beside it that the user can expand or collapse. This provides visibility into the spot usage of the batch. For example, how many operations, which operations, and so on.
Changeover	Thin black bar.
Delay	Thin yellow bar.
Down time	Thin red bar.

Element	Appearance
EAM Work Order Instance	A resource that is in maintenance is indicated by a solid purple line.
Fixed Production Timefence	Thin red line from the start of the horizon on the resource which extends to the end of the fixed production timefence.
Multi-capacity resource	Multiple colors, depending on the percentage of capacity being used. Ranges from dark green for low usage to red for full capacity use.
Single capacity resource	Blue with operation name.
Campaign Run Optimization Cycle Boundaries	Thin brown bar. This represents manufacturing cycle boundaries when using Campaign Run Optimization. This provides for improved visibility to changeover patterns in and across manufacturing cycle boundaries.

You can view all resources in the model at once, or display resources of a particular type. Resource usage is displayed for the entire schedule horizon, and can be zoomed to display a particular time period. You can view any resource group in the Resource Gantt, Resource Utilization, and Resource Contention views. The attributes of the resource group must be appropriately set for the group to be accessible in the Resource Gantt. If the group does not appear in the list, verify that the properties of the group are set to display in the Resource Gantt. If you add a group after the initial solve, you need to close and reopen the schedule, and then open the relevant view.

The default Resource Gantt sort order is alphanumeric by resource type. To more easily locate potential resource conflicts, you can sort the Resource Gantt view based on a resource's utilization as a percentage of its total capacity. When you sort by utilization, resources with the highest utilization appear at the top of the Resource Gantt. You can also change the view back to the default sort order.

**Note:** If a resource is campaign run optimized, its name appears in green.

You can use a variety of manual scheduling options in the Resource Gantt to fine-tune your schedule.

If you right-click on a resource, you have several options:

- You can drill down to the Resource Properties.

- You can relax constraints, which allows capacity and calendar violations during the solve process.
- You can reactivate the calendar and capacity constraints on the resources by performing a right-click and selecting Active Constraints.
- You can select Enforce Horizon Start, which applies to both the cold solve and the repair solve.

This flag automatically reconciles any shop floor backlog, when scheduling, by ensuring all operations start at the beginning of the horizon, even if they have firm dates that are prior to the start of the horizon. The Enforce Horizon Start option enables you to move operations running in the past, as a result of shop floor backlog, to the start of the horizon. Selecting the Enforce Horizon Start option and performing either a repair solve or a cold solve pushes forward all operations on that resource to the start of the horizon, maintains operation sequence, and respects upstream and downstream precedence constraints.

See "Defining Resource Availability, page 5-17," *Creating Production Scheduling Models, Production Scheduling*.

See "Using the Enforce Horizon Start Option, page 10-5," *Manual Scheduling, Production Scheduling*.

### **Creating a Resource Calendar from the Resource Gantt**

You can now remove an event from a resource calendar. When this occurs, a new calendar is created to support this update. The new calendar is named as follows: <original calendar name> - <resource modified in Resource Gantt>.

This feature allows these changes to be collected with the global list of calendars and retained in an XML format for a Production Scheduling Model. It allows resource-specific calendars to be available in Production Scheduling sessions.

To create a resource calendar, right-click an event from the Resource Gantt view and select Remove Event. When prompted to confirm the action, click Yes. This new calendar can be viewed from the Calendar Editor. The Resource calendar option is selected in the General tab of the calendar Properties window to indicate this is a resource-specific calendar.

## **Batchable Resources**

When evaluating a batchable resource in the Resource Gantt, color indicates utilization at the batch level and bubble help indicates the attributes of the batch at the resource level. You can double-click a resource row to expand or collapse visualization of individual spot usage. The toolbar provides an option to highlight certain batches based on the resource attribute type and attribute value. The selected batches are highlighted in orange.

See "Batchable Resources, page 5-6," *Creating Production Scheduling Models*,

## Using the Item Graph View

The Item Graph presents schedule information on item levels in your supply chain using a line graph. This view is a line graph that displays current levels for each item in your model. On the Item Graph, you can select any item and then view levels for that item by moving your cursor to any point on the line.

Using the item graph, you can view inventory levels for a specific item at a specific time and access detailed property information for the item. You can customize the color scheme used in the Item Graph by selecting the color pallet icon in the toolbar.

If you select Relaxing Minimum, Relaxing Maximum, or both in Item Properties, you are giving the Production Scheduling solver permission to temporarily violate item minimum or item maximum levels, respectively, in order to produce a feasible solution.

The color in which an item is displayed depends on whether you have relaxed the minimum constraints, maximum constraints, or both constraints in Item Properties. The colors are outlined in the following table:

Option	Maximum Constraints	Minimum Constraints
Relaxed	Default setting. Items are displayed in dark blue.  If minimum constraints for an item are also set to relaxed, items are displayed in orange.	Items are displayed in the color you chose for item minimum levels. If maximum constraints for an item are also set to relaxed, items are displayed in orange.
Unrelaxed	Items are displayed in the same color as the color you chose for item maximum levels.	Items are displayed in dark blue.

## Using the Item Gantt View

The Item Gantt is a bar chart that displays colored bars representing item levels. The Item Gantt displays a horizontal bar chart that represents items and storage spaces, and how they relate to the defined maximum and minimum levels. It can be filtered for specific resource groups. As with other schedule views, you can view current information at different levels of detail by using the zoom tools. Color-coding enables you to see the current status and problem areas immediately.

From the Item Gantt, you can view the inventory level of each item in relation to its minimum and maximum levels, and also access an item's property pages.

You can view any resource group in the Item Gantt. An item can be in more than one resource group. You can create as many resource groups as necessary to simplify your schedule analysis. To be accessible for the Item Gantt schedule view, the resource group's attributes must be appropriately set.

To view items that could inhibit the smooth implementation of your schedule, you can view the Item Gantt sorted by degree of violation in descending order. Sorting by degree of violation puts the most problematic items at the top of the view for further review and fine-tuning. Items are sorted in the following order:

1. Items with at least one red (inventory that is below minimum levels) segment.
2. Items with at least one violet segment, that is, inventory that is greater than the maximum level, and no red segments.
3. Items with only orange (inventory that is within 10 percent of the maximum or minimum levels) and green segments.
4. Items with only green segments.

**Note:** To get a better view of an item's inventory levels, create a combined Item Gantt and Item Graph view.

The Item Gantt uses colors to represent item levels in relation to their minimum and maximum levels. You can click the Set Colors button to customize the colors that are used in the Item Gantt and to set the thresholds for each item. The following table is a summary of the colors that are used in the Item Gantt:

Color	Definition
Green	The item level is less than 10 percent of the difference between the minimum and maximum levels.
Yellow	The item level is greater than 10 percent of the difference between the minimum and maximum levels.
Red	The item level is below the minimum level.
Violet	The item level is greater than the maximum level.

## Using the Operation Gantt View

The Operation Gantt view displays all scheduled operations. It is typically used in conjunction with the Resource Gantt in the form of a combined view as the contents of the Operation Gantt become context sensitive to what is selected in the Resource Gantt. For example, when selecting a resource in the Resource Gantt, only operations running on the selected resource are displayed in the Operation Gantt: top to bottom, left to right, by start date. Each operation instance in the Operation Gantt indicates when the operation is run, and its duration, including any setup and delay times. You can expand the list of operations to display every operation instance, or you can create operation groups and filter operations by these groups.

Use the manual scheduling tools in the Operation Gantt to make detailed adjustments to your schedule. The Remove Idle Time command enables you to remove idle time between two or more selected operations or all idle time that precedes a selected operation. You can also manually resequence operations using the cut and paste commands or by accessing the Resource Sequence view.

**Note:** The cut, paste, and Remove Idle Time commands are enabled only for multiple instances of the same operation.

### To access other views or detail information from the Operation Gantt view:

Right-click an operation from the time grid to perform the following:

- Select Open Operation Diagram to display the operation diagram.
- Select Open Routing Diagram to display the routing diagram.
- Open Work order to display the work order in the Work Order Editor.
- Select Properties to display the operation Properties window and details.

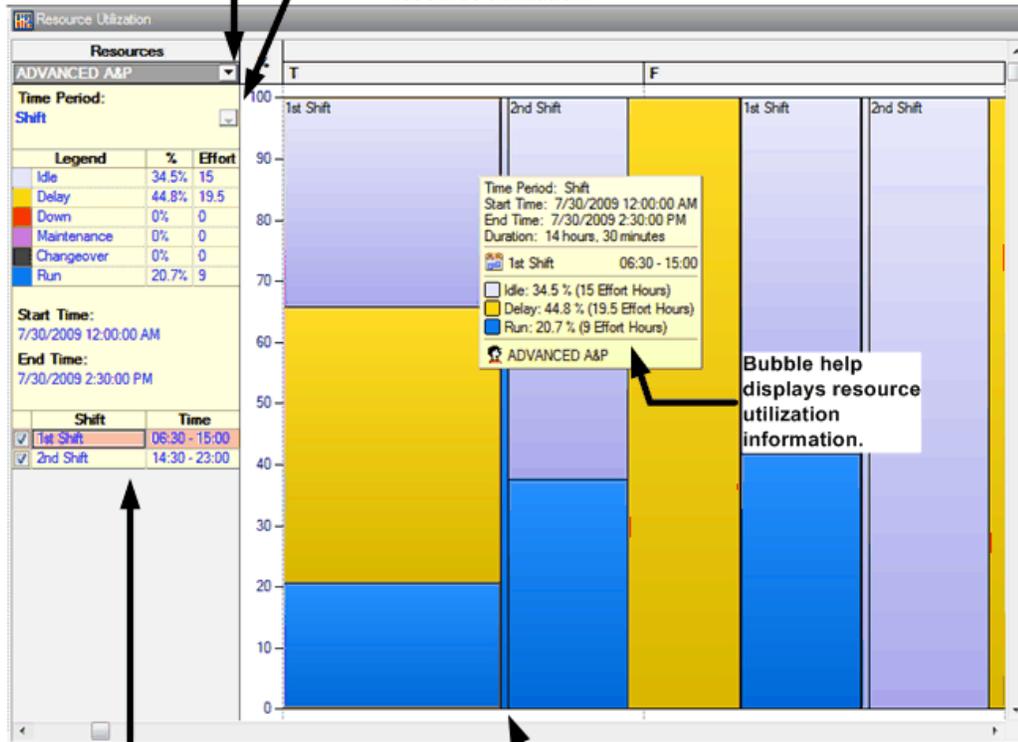
Place your mouse over a pegged operation in the time grid to view bubble help details.

## Using the Resource Utilization View

The Resource Utilization view provides you with precise information about all of the defined resources that are used in the schedule horizon. Information such as idle time, delay time, calendar down time, maintenance time, changeover time, and run time appears in this view. Resource utilization appears as total number of hours utilized and as a percentage. Use the Resource list to display each resource and its utilization. Use the Time Period list to display resource utilization based on the selected time period (day, week, month or shift). If you select a column in the utilization view, summary information for that time period appears on the left side of the view for the specific time bucket.

Use Resources list to select resource and display its resource utilization.

Use Time Period list to select timeframe for resource utilization.



Bubble help displays resource utilization information.

When Shift time period is selected, the available shifts appear below Legend and are highlighted when selected from time grid.

Shift boundaries and overlap can be identified from view.

The following table describes each item displayed in the Legend:

Legend Entry	Description
Idle	The percentage of time and total hours when the resource is available but not utilized.
Delay	The percentage of time and total hours when the resource is not used because of a delay.
Down	The percentage of time and total hours when the resource is not used because of down time.

Legend Entry	Description
Changeover	The percentage of time and total hours that the resource is not used because of a changeover.
Maintenance	The percentage of time and total hours that the resource is not used because of a maintenance activity.
Run	The percentage of time and total hours when the resource is being run.
Start Time	The date and time of the start of the utilization time period.
End Time	The date and time of the end of the utilization time period.

**Note:** If your schedule contains maintenance, changeovers, delays, or down time, utilization statistics appear in the Legend and the corresponding color-coding appears in the columns. If your schedule does not contain maintenance, changeovers, delays, or down time, these events appear as zero percent in the Legend.

When Shift is selected from the Time Period list, the available shifts and shift times appear below the Legend. To display resource utilization for a shift, select a shift from the time grid. Multiple shifts can be selected.

To display resource utilization for shift overlap, select the overlap from the time grid. The overlapping shifts are highlighted below the Legend. The Start Time and End Time display when the overlap occurs.

To view detail information for a time period, place your mouse over the period in the time grid. Bubble help displays the resource utilization information.

Refer to Viewing Resource Utilization, page 9-49.

## Using the Resource Contention View

The Resource Contention view captures the contention encountered for each resource throughout the solve process. This information is useful to find the dominating item or resource bottlenecks during the solve process. The view also serves as a histogram of resource contention if you navigate to it after a solve.

By default, the Resource Contention view displays the contention events that are encountered during the solve using the time bucket.

Schedule Horizon	Default Time Bucket
Greater than 3 months	Month
Between 2 weeks and 3 months	Weeks
Less than 2 weeks	Days

You can change the time bucket used by the Resource Contention view to calculate the contention. Time bucket options include month, week, day, shift, and hour. The time bucket setting is independent of the view that is currently displayed using the zoom buttons.

For example, if you change your time bucket to the day option, then the Resource Contention view evaluates and compares the contention during each day, and displays its findings using the color scale. The colors are representative of the contention for each resource over each day. The smaller the time bucket, the more differentiated the results are, due to the smaller pool of data.

Color is used to represent contention intensity. The Set Colors button defines these colors. There are 10 ranges of colors in 10 percent increments.

Using the Set Colors command, you can set new color levels by adding new sliders or moving existing sliders in either direction. This enables you to assign a color to represent different percentages of contention. The colors that you set in the color bar are displayed in schedule views, so that you can always see a consistent color representation of the schedule.

## Using the Multi-Capacity Resource Graph View

The Multi-Capacity Resource Graph displays a resource's total available production capacity and how much of that capacity is used over time. You can select any resource and then view levels for that resource by moving your pointer to any point on the graph.

The area in red, at the top of the graph, represents the maximum capacity of the resource. The red shaded area, at the bottom of the graph, represents zero utilization point. You can customize the colors in the view using the icon on the toolbar.

## Using Combined Views

To get more detailed information about a generated schedule than from a single schedule view, you can select a combination view. With a combination view, two or

more views are synchronized so that when an item is selected in the main view, the other view displays the related information only about that item. For instance, while reviewing the Resource Gantt, you can select a resource and simultaneously view its utilization, item usage, or operation details during a specific time frame. This powerful feature enables you to quickly analyze key elements of your schedule and determine whether any adjustments need to be made. The following combination views are available:

Combination View Name	Description
Resource and Operation Gantt	Displays operations that run on selected resources in the Resource Gantt.
Resource Gantt and Utilization	Displays the utilization of selected resources in the Resource Gantt.
Item Gantt and Graph	Displays the inventory levels of selected items in the Item Gantt.
Resource Gantt and Item Graph	Displays the inventory level of an item that is produced or consumed by a single operation.
Resource Gantt and Multi-Capacity Resource Graph	Displays the utilization of selected multi-capacity resources.
Resource Gantt, Operation Gantt and Item Graph	<p>Displays operations that run on selected resources in the Resource Gantt, and you can see the inventory level of an item that is produced or consumed by a single operation by selecting an operation in the Resource or Operation Gantt.</p> <p>From this view, you can click an item in the Item Graph and the producing and consuming operations are highlighted in the Resource and Operation Gantt.</p>

Additional combination views can be created and added to the combined group, if necessary. Each view can have the name and button of your choice. To organize your views, you can also set up group views that contain specific schedule views.

While in this view, you can use the scroll bars and zoom options to move to different areas in your view. As long as the synchronized scroll bars feature is active, both views stay synchronized as you move around in the view.

## Viewing Critical Path Information

The critical path is a well understood concept in project management. It is defined as the sequence of activities that must be completed on schedule to meet a specific completion date. In other words, if any of the tasks on the critical path is delayed by one second, then the entire project gets delayed by one second. A Visit, which is analogous to a project, can contain thousands of interrelated tasks in a complex task hierarchy where the tasks can be running sequentially and in parallel. You can use the Show Visit Critical Path and Filter Visit Critical Path toolbar buttons to easily identify and visualize the critical path. This allows you to focus on the tasks that are relevant to determining the Visit Completion Date. This feature is a great benefit when trying to determine why the visit is late.

You can view critical path information with Production Scheduling and dramatically improve your efficiency by quickly identifying tasks that impact the overall schedule and reducing the manual scheduling iterations required to produce an acceptable schedule.

### To view critical path:

1. From the Production Pegging view, click the Show Visit Critical Path button on the toolbar.

The critical path is highlighted in yellow.

2. To hide tasks not on the critical path, click the Filter Visit Critical Path.

Tasks not on the critical path are hidden. The view title bar is highlighted to indicate a filter is applied to the view.

3. To disable critical path highlighting, click the buttons again to deactivate these features.

Production Scheduling determines the critical path by calculating a "slack" time for an operation. Any operations with 0 (zero) slack are on the critical path.

Slack Time can be viewed from the Operations tab in the Visit Properties window. It is also displayed in bubble help in the Gantt views.

### To view operation slack time:

1. Right-click a visit and select Properties.
2. Click the Operations tab. The Slack Time column displays the slack time for each operation assigned to the visit.
3. To examine slack time details, right-click slack time entry and perform the following as needed:
  - Click Open to display work order in Work Order Editor.

- Click Open Production Pegging Gantt to display Production pegging view.
- Click Open Operation Gantt to display the operation in the Operation Gantt view.

You can display slack time within Gantt views by selecting the Visualize visit operation slack in Gantt Views option from the Global Settings tab of the Options window. This is relevant for Maintenance (cMRO) plans only.

**To display slack time for cMRO visits in Gantt views:**

1. Select Options from the Tools menu.
2. Click the Gantt Chart tab.
3. Check the Visualize visit operation slack in Gantt Views option.

A red line on the operation indicates the slack, or the amount of time the operation can move before being on the critical path.

## Filtering Work Orders

This section discusses how to:

- Use the Work Order Advanced Filter.
- Add a new filter.
- Delete a filter.
- View and modify filter properties.
- Save work order filters.
- Load work order filters.
- Assign a filter to a view.
- Remove a filter from a view.

## Using the Work Order Advanced Filter

Use the Work Order Advanced Filter to further "slice and dice" data in the various Gantt, Utilization, and Pegging views in a multi-dimensional fashion and filter the content of these views. You can hone in on specific areas of the schedule. For example, you can create a filter to "show me all work orders in from October 25 - November 5th running on Resource (or Group) which have a Firm Start status". The matching work order results display in the bottom of the window. Once your results display,

double-click a work order number to open it in the Work Order Editor.

This Work Order Advanced Filter is especially useful to filter Maintenance Work Orders scheduled from cMRO based on the Work Breakdown Structure criteria.

## Accessing the Work Order Advanced Filter Window

Use the Work Order Advanced Filter window to view, create, and modify filters for various Production Scheduling views. Once you define a filter, it can be applied to the views.

**To access the Work Order Advanced Filter window, perform the following:**

- If no filters currently exist in your model, click the Toggle Work Order Filter button on the toolbar.
- Select New Filter from Toggle Work Order Filter button list on the toolbar.

From the Work Order Advanced Filter, you can define the filter and view matching work orders.

## Defining a Filter

Use the Work Order Advanced Filter window to choose your filter criteria. Most field lists allow you select from values defined in the current model. Use date lists to define calendar dates and date ranges. Click the left arrow (>) for a field to create a custom query based on text entry. The following query options are available:

- \* Zero or more characters
- ? Any single character
- : Or
- \ Escape special character
- Match case (default)

**To define a filter:**

1. Access the Work Order Advanced Filter window.
2. Use the Work Order Advanced Filter fields at the top of the window to define the filter name and general work order filter criteria. The fields are as follows:

<b>Work Order Advanced Filter Field</b>	<b>Description</b>
Filter Name	Enter the name you want to assign to the filter.
Created in scenario	A display only field that shows the scenario used to originally define the filter.
Clear Filter (button)	Select this button to clear all defined filter criteria.
Work Order	To filter for a specific work order number, select the work order from the list. All work orders within the model display in the list.
Description	To filter by work order description, enter text. You can use the "*" wildcard symbol for contextual text filtering. For example, all work orders which contain the word avionics would be represented as *avionics*.

3. Select the General tab to define a filter based on general work order criteria. The fields are as follows:

<b>Work Order Advanced Filter - General Tab Field</b>	<b>Description</b>
Type	To filter based on work order type, select an option. Valid values are Production, Maintenance, and EAM.
Status	To filter based on work order status, select an option from the list. All work order status values within the model display in the list.
Order Class	To filter based on order class, select a value. Available options are Hot, Committed, and Uncommitted.
Priority	When an Order Class is selected, use this list to filter based on the work order priority. Valid values are 1 - 5.

<b>Work Order Advanced Filter - General Tab Field</b>	<b>Description</b>
Include Related Work Orders	Select this option to have related work orders matching filter criteria displayed in your search results.
Quantity Required	Enter the quantity required range.
Quantity Complete	Enter the quantity complete range.
Quantity Remaining	Enter the quantity remaining range.
Request Date	Enter request date range.
Start Date	Enter work order start date range.
Completion Date	Enter work order completion date range.
Item	To define a filter based on a specific item, select the item from the list.
Description	To define a filter based on an item description, enter the description in the field. You can use the "*" wildcard symbol for contextual text filtering.
Attributes	To define a filter based on specific item attributes, select the attributes. If you want to define the filter for a specific item attribute value, select the attribute and use the Value list the appropriate value.

4. Select the Manufacturing tab to define a filter based on work order manufacturing data. The fields are as follows:

<b>Work Order Advanced Filter - Manufacturing Tab Field</b>	<b>Description</b>
Produced Item	To filter based on produced items in the model, select a list value.

<b>Work Order Advanced Filter - Manufacturing Tab Field</b>	<b>Description</b>
Serial Number	To filter based on serial number in the model, select a list value.
Routing	Select a routing.
Original Routing	In the event a work order was offloaded to an alternate routing, select the original routing option assigned to the work order.
Contains Operation / Group	Select an operation or operation group. If routing filters are assigned, only operations and operation groups assigned to the selected routing filters display.
Contains Operation Status	Select an operation status. Available options are Open, Active, and Closed.
Uses Resource / Group	Select a resource or resource group. Lists all resources and resource groups in the model. If routing and operation filters are assigned, then the values in this list are limited to the resources which are defined in the selected routing and operation filter criteria.
Consumes Material / Group	Select resource material or resource group. Lists displays all items and resource groups in the model. If routing and operation filters are assigned, the values in this list are limited to the resources which are consumed in the selected routing and/or operation filter criteria.
Contains Firm Status	Select a firm status. Use to perform a query based on work order that have an assigned firm status. Valid values are Firm Start, Firm End, and Firm Range.
Firm Start Date	Enter firm start data range.
Firm End	Enter firm end data range.

<b>Work Order Advanced Filter - Manufacturing Tab Field</b>	<b>Description</b>
Shift Calendar	To filter based on a shift calendar in the model, select a list value.
Starting in shift	Select this option to filter work orders that begin in the selected Shift Calendar.
Ending in shift	Select this option to filter work orders that end, or are completed, in the selected Shift Calendar.
Running during shift	Select this option to filter work orders that are running, or are being processed, during in the selected Shift Calendar.

5. Select the Maintenance tab fields to define a filter based on Maintenance work order (cMRO) and Enterprise Asset Management data. The fields are as follows:

<b>Work Order Advanced Filter - Maintenance Tab Field</b>	<b>Description</b>
Visit	Select a visit. List displays all the visits assigned to work orders in the model.
Visit Type	Select a visit type. List displays visit types assigned to work orders in the model.
Visit Status	Select a visit status. Available options are Planning, Partially Implemented, and Implemented.
Visit Priority Class	To filter based on visit priority class, select a value. Available options are Hot, Committed, and Uncommitted.
Priority	When a Visit Priority Class is selected, use this list to filter based on visit priority. Valid values are 1 - 5.

<b>Work Order Advanced Filter - Maintenance Tab Field</b>	<b>Description</b>
Visit Completion	To filter based on visit completion status, select a value. Available options are On time, Early, and Late.
Earliest Start Date	Enter visit's earliest start date range.
Request Date	Enter the visit's request date range.
Start Date	Enter the visit's start date range.
Completion Date	Enter visit's completion date range.
Maintenance Resource	Select a machine resource. Maintenance resource is the name or description assigned to the asset number in eAM.
Asset	Select an asset. This is the asset number assigned in eAM.
Asset Group	Select an asset group.
Stage (Attribute 1)	Select a stage. List displays stages assigned to work orders in the model.
Process (Attribute 2)	Select a process. List displays all processes assigned to work orders in the model.
System (Attribute 3)	Select a system. List displays all the systems assigned to work orders in the model.
Access Panel (Attribute 4)	Select an access panel. List displays all the access panels assigned to work orders in the model.
Zone (Attribute 5)	Select a zone. List displays all the zones assigned to work orders in the model.
Subzone (Attribute 6)	Select a subzone. List displays all the subzones assigned to work orders in the model.

<b>Work Order Advanced Filter - Maintenance Tab Field</b>	<b>Description</b>
Department (Attribute 7)	Select a department. List displays all the departments assigned to work orders in the model.
Unit Name (Attribute 8)	Select a unit name. List displays all the unit names assigned to work orders in the model.
Non Routine (Attribute 9)	Select a nonroutine option. Valid options are Yes, No, or Null. This option is used indicate whether the work order is of type non routine or not. If set to "null", all work orders appear. If set to Yes or No, then filter performs query based on status as selected.

6. Use the Matching work orders region to display matching work order results. The fields are as follows:

<b>Matching work orders Region Field</b>	<b>Description</b>
Find (button)	Click Find to display work orders that match your filter criteria. If the Find matching work orders automatically option is checked, you do not need to click Find. Your work order results are displayed as you define filter criteria.
Find matching work orders automatically	Check this option to display work orders that match your filter criteria automatically.
Work Order Number	<p>This column displays all work orders that match your filter criteria.</p> <p>To view a work order in the Work Order Editor, double-click the work order row, or right-click the work order and select Open.</p> <p>To display the work in the Production Pegging view, right-click the work order and select Open Production Pegging Gantt.</p>

7. Click OK.

## About Filter Views

Once a filter is defined, it can be assigned to the following views:

- Production Pegging - Only work orders which meet the criteria specified should be displayed. Empty folders should not be displayed. In the event a work order has multiple operations and resource level filtering is specified, only the work order operations which meet those criteria are outlined.
- Resource Gantt - Only operations belonging to the work orders in the filter are displayed. This includes the utilization shading for multi-capacity resources.
- Operation Gantt - Only operations belonging to the work orders in the filter are displayed. The Operation Gantt is also filtered to only those operations running on this resource.
- Resource Utilization - Utilization is calculated based on filtered work orders. This view provides utilization contribution.
- Multi-Capacity Resource Utilization - Utilization is calculated based on filtered work orders. This enables users to understand utilization contribution.
- Select Work Orders for Release - A filter can be assigned on an approved scenario when selecting specific orders for release.

When a filter is assigned to a view, only matching data displays. If no information appears in the view, then the filter has no matching data for the view.

You can also adjust how work orders appear when running filters from the Gantt Chart tab in the Options window. From this tab, use the Work order filter display mode to select one of the followings options:

- Hide operations - Operations that do not meet filter criteria are not displayed.
- Display dimmed operations - Operations that do not meet filter criteria are displayed but appear dimmed.

For more information about options in the Gantt Chart tab, refer to Defining Gantt Chart Settings, page 6-7.

## Adding a New Filter

**To create and save filter to your scenario:**

1. Select New Filter from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar.

2. Define the filter as needed from the Work Order Advance Filter window.
3. To save the filter, click OK. The filter is saved to the scenario. To exit the Work Order Advance Filter window without saving the filter, click Cancel.

## Deleting a Filter

### To delete a filter:

1. Select Work Order Filters from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar.
2. Select the filter you want to remove from the Work Order Filters dialog and click Delete.
3. Click Close.

You can also delete a filter by selecting the filter from the from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar. A check mark appears when the filter is selected. Delete the selected filter by selecting Delete Filter from the Work Order Filters list option.

## Viewing and Modifying Filter Properties

### To view and modify filter properties:

1. Select Work Order Filters from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar.
2. Select the filter you want to view and click Properties. The Work Order Advanced Filter window appears and displays the filter criteria.
3. If you want to make changes to the filter, adjust the fields as necessary and click OK.

## Saving Work Order Filters

Once you define a filter, you can save your filter definitions to a Work Order Filter (.wof) file. This file can then be used to load and apply the filters to other Production Scheduling models and scenarios as needed.

### To save work order filters:

1. Select Work Order Filters from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar.
2. Click Save As.
3. Enter the file name you want to assign in the File name field.

4. Navigate to the location where you want to save the file. By default, the file is saved to the same location as the model used to define the filter.
5. Click Save.

## Loading Work Order Filters

Production Scheduling filters defined in Work Order Filter (.wof) files can be loaded and used in your model. Once loaded into your model, you can adjust the filter as needed based on your needs.

### To load work order filters:

1. Select Work Order Filters from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar.
2. Click Load.
3. Navigate to and select the appropriate file.
4. Click Open. All filters defined in the file appear in the Work Order Filters dialog.

## Assigning a Filter to a View

Once a filter is assigned to your model, you can apply it when needed.

### To assign a filter to a view:

1. Open the appropriate view.
2. Select the filter you want to apply from the list options displayed to the right of the Toggle Work Order Filter button on the toolbar. A check mark appears next to the selected filter.

The Toggle Work Order Filter button appears highlighted when a filter is applied to a view, and the selected filter name appears to the right side of the view title bar.

The view is refreshed to display only the results applicable to the filter.

## Removing a Filter from a View

### To remove a filter from a view:

- Click the Toggle Work Filter button on the toolbar.
- Deselect the filter from the list option displayed to the right of the Toggle Work Order Filter button on the toolbar. The view is refreshed to display all data.

## Analyzing Scheduled Resources

This section discusses how to:

- Relax resource constraints.
- View pegging resources.
- Sort resources.
- View resource utilization.
- View resource contention.
- View alternate resources.

## Relaxing Resource Constraints

Resource constraints can be relaxed and reactivated when viewing the Resource Gantt, Resource Utilization, and Resource Calendar.

To relax resource constraints:

1. Access the appropriate schedule view.
2. Right-click the resource and select Relax Constraints.

The relaxed resources appear orange in the schedule views. Click Solve to solve the schedule.

To select more than one resource at a time, hold down the Ctrl key to select individual resources, or press Shift to select a block of resources.

To reactivate resource constraints right-click the resource and select Activate Constraints.

## Viewing Pegged Resources

**To view pegged resources:**

1. Access the Resource Gantt.
2. Select one of the following options from the toolbar:
  - Peg Upstream - Displays upstream operations.
  - Peg Downstream - Displays downstream operations.

**Note:** To display both upstream and downstream operations, select both options.

3. Click the first operation for which you want to view pegging information.  
The Resource Gantt highlights the upstream operations in brown and the downstream operations in purple.
4. Repeat the previous step for other operations to view pegging information.
5. Click the pegging buttons again to turn off this option.

## Sorting Resources

**To sort resources:**

1. Access the Resource Gantt.
2. On the schedule view toolbar, click Zoom In to increase the size of the columns until dates are displayed across the top.
3. On the sort order drop-down list box, select one of the following options:
  - *Default Sort* - Sorts resources in alphanumeric order.
  - *Utilization Sort* - Reorders the resources in the Resource Gantt in order of their utilization. Resources are sorted by utilization from highest to lowest.
  - *Peg Sort* - Reorders the operations in the Resource Gantt according to the routing order and their associated resources. You can turn off this feature when it is not required. Doing so returns the resource order to its original sequence.

## Viewing Resource Utilization

**To view resource utilization:**

1. Select Resource Utilization from the Views list bar.
2. Click Zoom In, Zoom Out, or Zoom to 100 percent from the toolbar to display the view at the required level of detail.
3. Select a resource from the Resources list.  
The vertical bars in the view represent the utilization level for that resource.
4. Select one of the following time periods from the Time Period available options:  
*Daily, Weekly, Monthly, and Shift.*

5. From the view time grid, click a time period to display utilization statistics for that time period.
6. To display resource utilization for a time period, place your mouse over the period in the time grid. Bubble helps displays information about the time period.

## Viewing Resource Contention

To view resource contention:

1. Access the Resource Contention view.
2. Click Zoom In, Zoom Out, or Zoom to 100 percent from the toolbar to view the schedule at the required level of detail.
3. Select a resource from the Resources available options.

The horizontal bars in the graph represent the contention level for that resource.

**Note:** You should refer to the Resource Contention view after the schedule has been solved. Watching the Resource Contention view during the solve slows down the solve because of the necessary graphical updates.

## Viewing Alternate Resources

Use the Production Pegging view to show resource alternates.

**To view alternate resources:**

1. Access the Production Pegging view.
2. Right-click the Work Order Tree or Demand Order Tree header, select Layout and check Show Resource Alternates option.

Alternates for the specific resource are displayed in the Production Pegging view at the resource level when you expand an operation. You can also manually offload to an alternate using cut and paste, or drag and drop, and then running a repair solve.

## Analyzing Scheduled Items

This section discusses how to:

- View item graph data.
- View item properties.

- View item groups.
- View item production and consumption.
- Sort by degree of violation.

## Viewing Item Graph Data

To view item graph data:

1. Access the Item Graph.
2. Select one of the following options from the Items list box:
  - All Items
  - An item group
  - An individual item
3. On the Items list, click an item.

The chosen item is selected, and the level for that item displays as a line in the graph.
4. Move your cursor over any point on the chart line.

Bubble help displays item description, current quantities, and level start and end dates.
5. Click the zoom buttons to display more or less detail.
6. On the toolbar, click the item graph buttons as follows:
  - Click the Scale buttons to change the scaling on the Y axis.
  - Click the Show Spikes button to display overlapping supply and demand events that occur at the same time.

## Viewing Item Properties

To view item properties:

1. Access the Item Graph or Item Gantt.
2. Use the Items list box to view a specific item or display a group of items.
3. Right-click an item and select Properties.

## Viewing Item Groups

To view item groups:

1. Access the Item Gantt.
2. Click All Items drop-down list, located under the Items column in the view.
3. Select the specific item group that you want displayed in the Item Gantt.

**Note:** If the group does not appear in the list, verify that the properties of the group are set to display in the Item Gantt. If you add a group after the initial solve, close and reopen the schedule, and then select the Item Gantt.

## Viewing Item Production and Consumption

To view item production and consumption:

1. Access one of the combined views:
  - Resource Gantt and Item Graph
  - Resource Gantt, Operation Gantt, and Item Graph
2. Click the operation for which item data is displayed.
3. Click the Show Produced Items or Show Consumed Items button from the toolbar.  
The view is filtered for the option that is selected.

## Sorting by Degree of Violation

To sort the degree of violation:

1. Access the Item Gantt.
2. Click Sort Items.  
The items are sorted in descending order with the most contentious items at the top of the view.
3. To return the view back to its original sort order, click Sort Items again.  
The view returns to its original appearance.

## Analyzing Scheduled Operations

This section discusses how to:

- View an operation quick summary.
- View operation groups.
- View producing and consuming operations.
- View pegged operations.
- Modifying firm status and offloading setting.

### Viewing an Operation Quick Summary

To view an operation quick summary:

1. Access the Operation Gantt.
2. Hold your cursor over any operation.

Information about the operation, including its name, start time, and duration, appears in the bubble help.

**Note:** This procedure can be used to view quick summary information in the Production Pegging and Resource Gantt.

### Viewing Operation Groups

To view operation groups:

1. Access the Operation Gantt.
2. On the Operation Gantt, select the operation group that you want to view from the Operations list.
3. Obtain schedule information as described in the following steps.
4. Review any exceptions in the Exception grid. If the grid is not displayed, click Display the exceptions button from the toolbar.
5. Use the zoom buttons view the calendar grid as needed.
6. Right-click any operation to view and make changes to properties.

**Note:** If you rename the group or change properties, you need to close and reopen the schedule, and then select the Operation Gantt.

If the group does not appear in the list, verify that the group properties are set to display in the Operation Gantt.

## Viewing Producing and Consuming Operations

To view producing and consuming operations:

1. Access one of the following combined views:
  - Item Gantt and Graph
  - Resource Gantt and Item Graph
  - Resource Gantt, Operation Gantt, and Item Graph
2. Click the Show Producing Operations or Show Consuming Operations button from the toolbar. You can also right-click an item and select Show Producing Operations or Show Consuming Operations.

The view is filtered for the option that is selected.

## Viewing Pegged Operations

To view pegged operations:

1. Access the Operation Gantt.
2. Select one of the following options:
  - To display pegged operations upstream of the selected operation, click Peg Upstream.
  - To display pegged operations downstream of the selected operation, click Peg Downstream.
  - To display all pegged operations, click the Peg Upstream or Peg Downstream icons on the toolbar.
3. Select the first operation for which you want to display pegging information.

The Operation Gantt view highlights the upstream operations in brown and the downstream operations in purple.

## Modifying Firm Status and Offloading Settings

To adjust firm status and offloading:

1. Access the Operation Gantt.
2. Select an operation.
3. Right-click and select the appropriate firm status. The following options are available:
  - Firm Start - Select this option to use a firm start date.
  - Firm End - Select this option to use a firm end date.
  - Firm Range - Select this option to use a firm date range (start date and end date).
  - Unfirm - Select this option to remove any firm settings.

Firmed operations appear green in the view. To specify a specific firm dates, go to the Operations tab in the Work Order Editor and modify the Start Date and End Date fields as needed.

4. To adjust the offloading setting, select the appropriate offload option. The following options are available:
  - Allow Offloading - Select this option to allow operation to be offloaded to an alternate resource.
  - Disallow Offloading - Select this option to prevent an operation from using an alternate resource.
5. Perform a solve to update your schedule.

You can also elect to manually populate the firm dates from the Operations tab in the Work Order Editor if desired. If you select Firm Range from the Gantt view, Firm End the appropriate values and dates would show up in the Work Order Editor, the main difference being which date(s) are populated. (Firm Start populates Start Date of the Work Order Operation, Firm End populates the End Date and Firm Range populates both start and end dates).

You can also set the offloading from the Bill of Resource tab in the Work Order Editor. Select No from the Allow Offloading list to prevent offloading from occurring.

## Using Combined Views

This section discusses how to:

- Add a combined view.
- View combined views.

### Adding a Combination View

To add a combination view:

1. Access the View Wizard window.
2. In the List of available subviews, select a schedule view that you want to appear in your combination view.
3. Click Next to move the subview to the Selected subviews area.
4. Repeat steps 1 and 2 for each additional view.
5. If necessary, click the Set Order buttons to delete or reorder views.

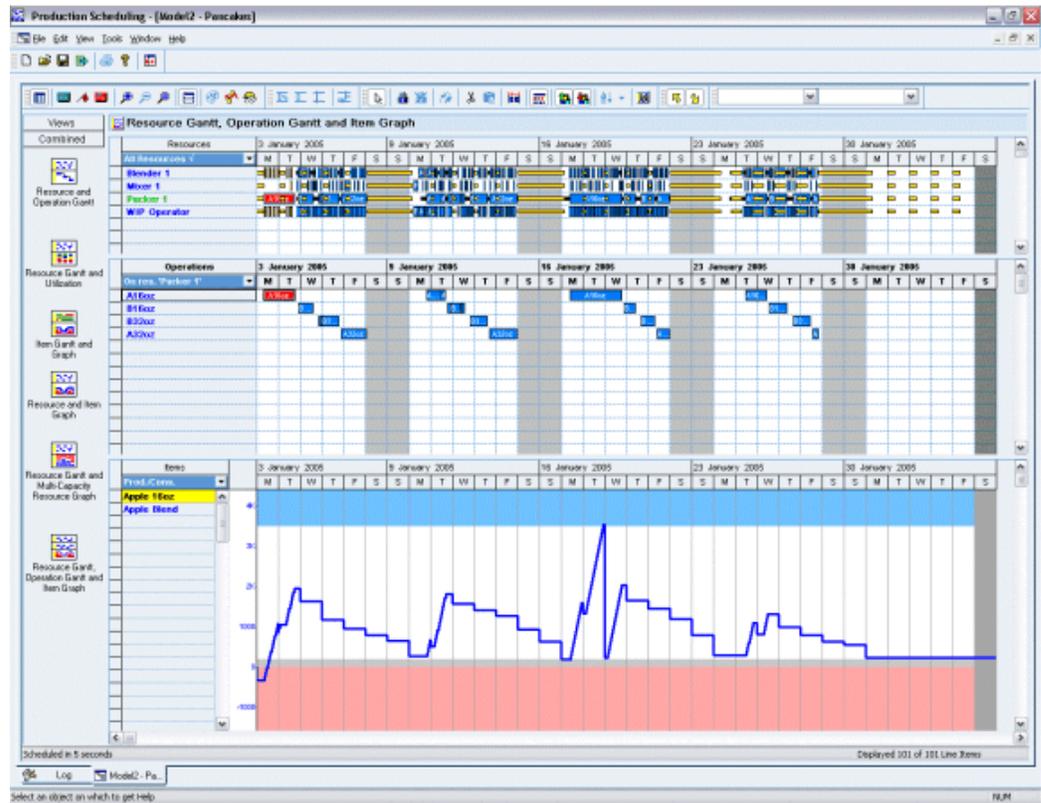
When the new view is created, the views are displayed in the same order that they are displayed in the Selected subviews list. A full description of each button is described in the following table:

View Option	Description
Delete view	This button is available to remove the view from the Selected subviews.
Move up view	This icon is used to move a view up in the Selected subview list.
Move down view	This icon is used to move a view down in the Selected subview list.

6. Click Next, enter a view name, and click Next again.
7. On the View Wizard, select a button for the group, and click End.  
The selected button and the name is added to the bottom of the current view group.

## Viewing Combined Views

Select the Combined button from the View list bar. The following image provides an example of the Resource Gantt, Operation Gantt, and Item Graph combined view.



Combined view

### To view combined views:

1. Select the Combined button from the View list bar. If you created a new group view, select the group name button.
2. Click a view button.
3. Click an element in the main view to display additional details.

In a Resource Gantt, you can click any resource. The detail view might display how this resource is being used or the operations to which it is associated, depending on your choice of detail view.

In the Resource or Operation Gantt views, you can right-click any operation and display either the produced or consumed items, or all of the items that are produced and consumed by the operation.

In the Item Gantt, you can click any item. The detail view (the Item Graph) displays

further information about that item's stock levels.

## Working with Exceptions

This section provides an overview of exceptions and discusses how to:

- Access exception messages.
- Display the Production Pegging view, the Work Order Editor, or Critical Path from the Exception grid.
- Filter exception messages.

## Exceptions Overview

Exceptions are available from either a solved or unsolved schedule. Exceptions display any violations of soft constraints. Exceptions can be accessed from the Model Workspace in a tree format. When you click an exception that is displayed in the Model Workspace tree, the Exception grid appears at the bottom of the schedule view. The Exceptions grid contains the following tabs to identify exception category:

- Demand
- Inventory
- Work Order
- Synchronization
- Maintenance
- Resource
- Precedence

Within each of these categories are various types of exceptions. The Exceptions grid displays information about each violation so that you can resolve the problem.

The Suspected Cause column of the Exceptions grid provides information to guide you to any problem operations. For instance, a message such as "Purchased Part Constraint for Deliver 9011" indicates a possible shortage of purchased parts on hand for the operation called Deliver 9011. To further expand on the operation itself, you can view the operation properties directly from the Exceptions grid. The operations Properties window displays the time when the operation scheduled run time and its associated resources. This information can help to identify the root cause of the problem.

You can navigate from a demand or work order exception in the Exceptions grid to view the violation in the Production Pegging view. When you navigate to the

Production Pegging view, the applicable demand or work order is displayed and the operation in question is highlighted.

## The Exception Tree

In the Model Workspace, the exception tree is arranged into the following categories and types:

Category	Type
Demand	Request Date Violation - An exception is generated when a demand is late.
Inventory	Item Maximum Level Violation - An exception is generated when inventory level exceeds maximum.  Item Minimum Violation - An exception is generated when inventory level is below minimum.  Item Safety Violation - An exception is generated when inventory level is below safety level.
Work Order	Operation Past Due - An exception is generated when a work order operation is late because it was firmed before start of horizon.  Operation Fixed Date Violation - An exception is generated when a work order operation starts outside its firm date constraints.  Request Date Violation - An exception is generated when a work order is late.
Synchronization	Consumption Time - An exception is generated when the time is equal to or greater than the value specified in Consumption Time Target on the item properties page.  WIP Oversupply - An exception is generated when a supply event (work order or production recommendation) exceeds all downstream dependent demand.

Category	Type
Maintenance	<p>Visit Late Exception - An exception is generated when a Visit is late.</p> <p>Visit Production Start Delay - An exception is generated when work on the Visit does not start immediately.</p> <p>Milestone Late Exception - An exception is generated when the Actual Completion Date is greater than the Target Completion Date.</p>
Resource	<p>Minimum Batch Violation - An exception is generated when a batch contains less than the resource's minimum capacity</p> <p>Resource Utilization - An exception is generated when resource utilization exceeds 100% of available capacity.</p>
Precedence	<p>Routing Precedence Constraint - An exception is generated if two operations from the same routing violate their precedence constraint. This can occur in the Unconstrained Manual Scheduling Mode if Single-stage re-sequencing is selected during a Cut and Paste operation or in the Resource Sequence view.</p> <p>Related Work Order Precedence Constraint - An exception is generated in the same manner Routing Precedence Constraint exception in the Unconstrained Manual Scheduling Mode, but in this case the violation is between operations from different work orders (as specified in the Related Work Order Relationship tab in the Work Order Editor).</p>

When an exception is selected in the Model Workspace, the Exceptions grid opens and the applicable exception tab is displayed.

A given exception category, such as Work Orders, may have more than one exception type. If you select a specific exception within the tree, the exceptions within the tab are filtered so that only the selected exception type is displayed. For example, if there are both Operation Fixed Date Violations and Operation Past Due exceptions, and you select only the Operation Past Due exception in the Model Workspace, then only the Work Order tab is displayed with only those exceptions that have Operation Past Due exception types.

The Resource category provides a Resource Utilization exception to indicate when resources which are not part of a bottleneck resource group have capacity violations (when capacity constraints are relaxed).

## The Exceptions Grid

The Exceptions grid displays information about any solver-based constraint violations. These violations do not necessarily mean that the schedule is infeasible but rather that a soft constraint cannot be met. For example, the solver might be required to temporarily violate a minimum inventory level to meet demand. The Exceptions grid displays these violations in detailed tables so that you can investigate and improve the schedule.

The Exceptions grid has seven tabs that correspond to the exception categories. You can view the exceptions from the Model Workspace by expanding the Exception tree. The number of exceptions appears next to the exception category. The number of exceptions also appears in the Exception grid to the right of the exception tab name.

If desired, you can adjust the Exception grid window size and column width.

## Accessing Exception Messages

Use Model Workspace to display exception categories and exceptions, or display the Exceptions grid to access exception categories and messages.

To access exception messages, perform one of the following:

- From the Model Workspace, expand the All Exception tree. Double-click an exception category, or expand the category folder and double-click an exception type. The Exception grid displays the selected category or type.
- Access a schedule view, such as Production Pegging. Select a tab from the Exception grid to review the exception messages for that category. If the Exception grid is not displayed, select the Display the exceptions button from the toolbar.

## Synchronization Exceptions

Synchronization exceptions alert you to potential multistage synchronization issues that can occur in Make/Pack environments. For more information about multistage synchronization, refer to Using Multi-Stage Synchronization and the Resource Relationship Editor, page 5-136.

The Synchronization tab in the exception grid can display two types of exception messages:

- Consumption Time - An exception is generated when the time is equal to or greater than the value specified in Consumption Time Target field on the item properties page.

Consumption Time exceptions will only be generated for the following conditions:

- For items that have consuming operations in the model (that includes items that have both producing and consuming operations).
- If the producing operations and consuming operations use machine resource combinations that were used as Upstream Resource and Downstream Resource in the Resource Relationship Editor.
- If the duration (which is the physical duration) is equal to or greater than the Consumption Time Target of the item.

For a supply event only one Consumption Time exception is generated. Should multiple consuming events be pegged to that supply event, the latest consuming event will be listed in the exception.

- WIP Oversupply - An exception is generated when a supply event (work order or production recommendation) exceeds all downstream dependent demand. For such a supply event that is not consumed, one exception message is generated per pegged downstream consuming event.

The following table describes the fields available in the Synchronization exception tab.

<b>Synchronization Exception Tab Field</b>	<b>Description</b>
Exception Type	Display the exception type, either Consumption Time or WIP Oversupply.
Item	The item code.
Item Description	The item description, if provided.
Attributes	All assigned attributes and their values for this item.
Quantity	Ending inventory level.
UOM	The item unit of measure.
Suspected Cause	Displays the possible cause generating the exception. For Consumption Time exceptions, this field displays Consumption time target violation. For WIP Oversupply exceptions, this field displays Inventory never used by a Consuming operation.
Supply Type	Displays what?

<b>Synchronization Exception Tab Field</b>	<b>Description</b>
Supplied By	<p>If supply event is starting inventory, then field displays Starting Inventory.</p> <p>If supply event is a supply from the Supply &amp; Demand Editor, then field displays the type of supply event from the Supply &amp; Demand Editor followed by the supply event code.</p> <p>If supply event is a work order, then the field displays the producing work order code.</p> <p>If supply event is a Production Scheduling generated production recommendation, then the field display the operation or operation code.</p>
Demand Type	Consumption Time exceptions, this field displays Work Order. For WIP Oversupply exceptions, this field displays Excess Inventory.
Consumed By	<p>If consuming event is a work order code, then the field displays the work order code of consuming operation.</p> <p>If consuming event is Production Scheduling generated production recommendation, then the field displays the operation or operation code.</p>
Consumption Time Target	The Consumption Time Target value assigned to the item, This value is located in the Attributes tab of the item property window.
Violation Start	The supply event time
Violation End	The demand event time.
Violation Duration	Different between Violation Start and Violation End.

## Displaying the Production Pegging View, the Work Order Editor, or Critical Path from the Exception Grid

Use the Exception grid to display the Production Pegging view, the Work Order Editor,

or the Critical Path for an exception alert. Visit and milestone properties are also available from the Maintenance exception tab.

1. From a schedule view, access the Exceptions grid. If the grid is not displayed, select the Display the exceptions button from the toolbar.
2. To drill-down to another view, right-click the exception row and select the appropriate option.
3. To display visit or milestone properties, select the Maintenance tab, right-click a visit or milestone, and select Visit/Milestone Properties.

## Filtering Exception Messages

You can filter exceptions to make it easier to analyze your exception messages and identify potential problems.

### To filter exceptions messages:

1. Access the Exceptions grid.
2. Select the Display the exception button list on the toolbar and select one of the following options.
  - Filter Exception - Use this option to filter the exceptions based on the settings defined in the Exception Filter window. When selected, the window title bar for the exception grid turns orange.
  - Filter Properties - Use this option to display the Exception Filter window and define the filter criteria for your exceptions.

### To define an exception filter:

1. Access the Exceptions grid.
2. Select Filter Properties from the Display the exception button list on the toolbar.
3. Use the Exception Filter fields at the top of the window to define the general exception filter criteria. The table below descriptions the general exception filter criteria available.

Click the left arrow (>) for a field to create a custom query based on text entry. The following query options are available:

- \* Zero or more characters
- ? Any single character
- : Or

- \ Escape special character
- Match case (default)

Exception Filter Field	Description
Violation Starts Within	<p>Use this field to define a filter based on a violation that occurs with a time range of the Horizon Start.</p> <p>Enter a value in the field and select the time duration for the value from the list (Seconds, Minutes, Hours, Days, or Weeks).</p>
Violation Duration	<p>Use this field to define a time frame filter based on the duration of the violation that occurs.</p> <p>Enter values in the fields to define the duration and select the time duration for the value from the list (Seconds, Minutes, Hours, Days, or Weeks). If you want to define a violation duration filter for all exceptions that exceeds the first value, leave the second duration value in the To field blank. For example, to define a filter for all violation durations that exceed 4 hours, enter 4 in the Violation Duration field and leave the To field blank.</p>
Item	<p>To define a filter based on a specific item, select the item from the list.</p>
Description	<p>To define a filter based on an item description, enter the description in the field. You can use the "*" wildcard symbol for contextual text filtering.</p>
Attributes	<p>To define a filter based on specific item attributes, select the attributes. If you want to define the filter for a specific item attribute value, select the attribute and use the Value list the appropriate value.</p>
Clear Filter (button)	<p>Select this button to clear all defined filter criteria.</p>

4. Select the Demand tab to define filter criteria for the Demand exceptions and define the available fields as described in the table below.

<b>Exception Filter - Demand Tab Field</b>	<b>Description</b>
Order	To filter for a specific demand number, select the demand number from the list. All demand orders within the model display in the list.
Customer Name	To define a filter based on customer name , enter the name in the field.
Type	To define a filter based on demand type, select the type from the list.
Order Class	To filter based on order class, select a value. Available options are Hot, Committed, and Uncommitted.
Priority	When an Order Class is selected, use this list to filter based on the work order priority. Valid values are 1 - 5.

5. Select the Work Order tab to define filter criteria for the work Order exceptions and define the available fields as described in the table below.

<b>Exception Filter - Work Order Tab Field</b>	<b>Description</b>
Order Number	To filter for a specific work order number, select the work order from the list. All work orders within the model display in the list.
Type	To filter based on work order type, select an option. Valid values are Production, Maintenance, and EAM.
Order Class	To filter based on order class, select a value. Available options are Hot, Committed, and Uncommitted.

<b>Exception Filter - Work Order Tab Field</b>	<b>Description</b>
Priority	When an Order Class is selected, use this list to filter based on the work order priority. Valid values are 1 - 5.

6. Select the Synchronization tab to define filter criteria for the synchronization exceptions, which pertain to multistage synchronization issues, and define the available fields as described in the table below.

<b>Exception Filter - Synchronization Tab Field</b>	<b>Description</b>
Supply By Type	To filter based on supply type, select a value. Available options are On Hand, Supply Orders, Work Orders, Production Recommendation, and Purchase Recommendation.
Supplied By Object	To filter based on supply type object, select an option. The list of options depends on the supply type selected and your model.
Consumed By Type	To filter based on consumption demand type, select a value. Available options are Demand, Work Orders, Production Recommendation, and Excess Inventory.
Consumed By Object	To filter based on consumed type object, select an option. The list of options depends on the consumed type selected and your model.

7. Select the Maintenance tab to define filter criteria for the maintenance exceptions and define the available fields as described in the table below.

<b>Exception Filter - Maintenance Tab Field</b>	<b>Description</b>
Visit	To filter based on a visit, select a visit from the list. List displays all the visits assigned to work orders in the model.

<b>Exception Filter - Maintenance Tab Field</b>	<b>Description</b>
Type	To filter based on visit type, select a visit type from the list. List displays visit types assigned to work orders in the model.
Milestone	To filter based on a milestone, select an option from the list or enter a milestone name in the field.
Start Date	To filter based on visit's start date, enter the visit's start date range.
Completion Date	To filter based on visit's completion date, enter the visit's completion date range.
Earliest Start Date	To filter based on visit's earliest start date, enter visit's earliest start date range.
Request Date	To filter based on visit's request date, enter the visit's request date range.

8. Select the Resource tab to define filter criteria for the resource exceptions and define the available fields as described in the table below.

<b>Exception Filter - Resource Tab Field</b>	<b>Description</b>
Resource	To filter based on a resource, select a resource from the list.
Utilization Level	To filter based on resource utilization level, enter the resource utilization level range.

9. Click OK to apply your filter criteria. The title bar for the Exceptions window frame turns orange.

## Hiding Exception Data

From the Exception grid, you can hide data columns as needed and rearrange the column order. Customizing the grids can make it easier to analyze your exception messages and identify potential problems.

To hiding exception data:

1. Access the Exceptions grid.
2. Right-click a column header.

The columns displayed within the exception tabs appear checked within the menu.

3. To hide columns, perform one of the following:
  - Deselect the column name.
  - Select Choose Columns. Deselect the columns you want to hide, or click Hide. To reorder to columns displayed, select a column name and use the Move Up and Move Down buttons to arrange the column order. Click OK.

## Working with the Resource Sequence View

The Resource Sequence view is used to display detailed information for resource assignments. It also allows you to perform the following:

- Display resource information based on the selected resource.
- Reschedule operations manually to further improve the schedule generated from Production Scheduling.
- View changeovers between operations.
- Edit operation dates and firm status.
- Access other views and perform tasks by right-clicking on element within view.
- Merge contiguous operations.
- Customize resource information displayed in view.

The Resource Sequence view can be accessed from any of the scheduled views and is embedded in the main workspace so it can be viewed in conjunction with other schedule views.

## Displaying the Resource Sequence View

From a schedule view, click the Display Resource Sequence View button from the toolbar. The view appears within the main workspace below the current view. This view can be displayed with a schedule view and the Exceptions view.

To hide the Resource Schedule view, click the Display Resource Sequence View button again.

If operations do not appear in the view, perform a solve.

Each row in the view represents an operation. If changeovers are displayed, they appear as a row under the operation associated with. Rows are separated with a dotted line when the operations occur on the start date. A solid line appears between rows if the operations occur on different dates. Late work orders or pegged demands are indicated with red font, which appears in the Work Order, Request Date, or Pegged Demands columns.

The Resource Sequence view displays the order of operations assigned to the selected resource as well as operation details. Work order offloading information is also available from the following fields, which are populated from the information displayed in the Bill of Resources tab in the Work Order Editor:

- Planned Resource Set - Displays the preferred resource set.
- Planned Resource - Displays the resource that was planned to be used to complete this operation.

You can customize the view by selecting the columns you want displayed.

The Resource Sequence toolbar displays the following:

- Display Changeovers - Select to display changeover events. Select button again to hide changeovers.
- Resource - Select a resource from the list to display resource assignments.
- Move Selection Up - Select to move a selected operation up in the sequence order.
- Move Selection Down - Select to move a selected operation down in the sequence order.
- Move Selection Before Cursor - Use to move an operation before a specific operation.
- Open Operation Diagram - Click to display the operation diagram view.
- Open Routing Diagram - Click to display routing diagram view.
- Drill down to Work Order Editor - Click to display Work Order Editor.

## Editing Operation Start Time, End Time, and Firm Status

Use the Resource Sequence view to edit an operation Start Time, End Time, and Firm Status.

1. From the Resource Sequence view, use the Resource list to select a resource.
2. Edit the Start Time or End Time fields. Adjusting the Start Time or End Time can

impact the operation sequence. The view automatically moves the operation to the appropriate sequence order based on your changes.

3. Use the Firm Status list to edit the operation's firm status.
4. Click Solve to display your changes.
5. Publish the schedule to update the EBS environment with your changes.

## Resequencing Operations

Use the Resource Sequence view to resequence operations assigned to a resource. From this view, you can change the sequence for one or more operations at a time using the view's toolbar buttons or using drag and drop.

1. From the Resource Sequence view, use the Resource list to select a resource.
2. Select the operations to be reordered. You can use the Ctrl or Shift keys to select multiple operations.
3. Resequence operations using one of the following methods:
  - Select an operation and click the Move Up or Move Down buttons to the top right of the view. You can also reorder the sequence by right-clicking the operation and selecting Move Up or Move Down.
  - To move an operation more than one row up or down (for example to move operation sequence 10 to occur before operation sequence 4), perform the following:
    1. Press the Ctrl key and click the row you want the operation(s) to appear before.
    2. Press the Ctrl key and select a row where the operation(s) will be moved.
    3. Click Move before Cursor button.
  - Drag and drop the operations to the new sequence location.  
Operations impacted by the change appear bold in the view until you perform a solve.
4. Click Solve to display your changes.
5. Publish the schedule to update the EBS environment with your changes.

## Opening Other Views from Resource Sequence View

Use the Resource Sequence view to access other views.

1. From the Resource Sequence view, use the Resource list to select a resource.
2. Select an operation.
3. To display the operation diagram view, perform one of the following:
  - Select Open Operation Diagram button from the view toolbar.
  - Right-click and select Open.
4. To display the Gantt Operation view, right-click and select Open Gantt Operation.
5. To display the routing diagram view, select Open Routing Diagram from the view toolbar.
6. To display the Work Order Editor, select Drill down to Work Order Editor. The Operations tab appears within the editor and the operation is highlighted.

## Merging Operations from the Resource Sequence View

Use the Resource Sequence view to merge the sequential operations assigned to the selected resource.

1. From the Resource Sequence view, use the Resource list to select a resource.
2. Select the operations. Only sequential operations can be merged.
3. Click the Merge Operation drop-down list on the toolbar and select the type of merge you want to perform, Merge Operation or Merge Work Order Operation.

The Planned Resource Set and Planned Resource fields are updated as follows:

- If the values for these fields are identical for all operation instances currently merged, then the fields display that value.
- If the values are not identical, then the fields display "N/A".

Refer to Merging Operations, page 9-7 for more information about the merge options.

## Working with Key Performance Indicators

This section provides overview of Key Performance Indicators (KPIs) and schedule comparison and discusses how to:

- Access the Key Performance Indicators view.
- Compare production schedules.

## Key Performance Indicators Overview

After you create the initial schedule, it can be duplicated as many times as necessary, and you can make different changes to each version using manual scheduling. To determine which version of the schedule is the most cost-efficient or best fulfills customer orders, you can evaluate all the schedules against each other using KPIs. KPIs are objective measures that can provide you with important information about how the schedules perform from a customer service, material, cost, and manufacturing perspective. KPIs are available for solved schedules and are dynamically refreshed each time a schedule is solved or repaired.

Key Performance Indicators are calculated values that enable you to evaluate schedules and select a schedule that best suits your specific criteria. The Key Performance Indicators view can be demand centric or work order centric. The KPIs are categorized into the following tabs within the Key Performance Indicators view:

- Customer Service
- Materials
- Costs
- Manufacturing
- Maintenance

You can sort the schedules according to your choice of KPI, rearrange the order of the columns, or hide specific columns or groups from displaying in this view. The schedules that are displayed in the Key Performance Indicators windows can be returned to the original sorting order if you no longer want to sort by a specific KPI.

Column width and row height can also be changed. If you do not want to view a specific KPI or if you want to keep it from general view, you can hide that column. Hiding all of the columns in a group hides the group. If you prefer to evaluate schedules based on a specific KPI group such as Costs, you can reorder the KPI groups so that the group appears first in the grid.

**Note:** A number of the KPIs depend on pegging information for their calculations. Verify that you have specified the primary operations for each routing and the primary outputs.

## Accessing the Key Performance Indicators View

To access the Key Performance Indicators view:

1. Select Key Performance Indicators from the View menu.
2. Select a tab to view KPI metrics for the following KPI categories:
  - Customer Service
  - Materials
  - Costs
  - Manufacturing
  - Maintenance

## Key Performance Indicators - Customer Service Tab

The Key Performance Indicators - Customer Service tab outlines metric information such as demand fill rates, number of stockouts, and so on.

The following table describes Key Performance Indicators - Customer Service tab metric data:

Column	Description
Order Fill %	This statistic is taken directly from the summary statistics in the Supply & Demand Editor, where these are available by folder, and by subfolder, which makes them even more useful. Order fill rate is calculated by dividing the total number of orders that have all their line items met on time by the total number of orders in the equation.
Line Fill	This statistic is taken directly from the summary statistics in the Supply & Demand Editor, where these are available by folder, and by subfolder, which makes them even more useful. Line fill rate is calculated by dividing the total number of on time line items by the total number of line items in the equation.

<b>Column</b>	<b>Description</b>
Unit Fill %	This statistic is taken directly from the summary statistics in the Supply & Demand Editor, where these are available by folder, and by subfolder, which makes them even more useful. Unit fill rate is calculated by dividing the total number of on time units ordered by the total number of units in the equation. For example, if you have two sales orders that have a total number of units ordered across various items of 10,000 and only 6,000 items are on time, then your unit fill rate is 60 percent.
Number of Stock Outs	This is the total number of times you drop below the greater of item minimum or zero in the horizon for all of your items.
Stock Out Time	This is the total amount of time in the horizon that the schedule is stocked out across all items. The time is expressed in the time unit in the scenario properties.  See "Setting up the Scenario Properties - General Page, page 7-2," <i>Configuring Scenario Properties, Production Scheduling</i> .

## Key Performance Indicators - Costs Tab

The Key Performance Indicators - Costs tab provides various costs associated with the schedule such as changeover cost, manufacturing costs, and so on.

This table explains the Key Performance Indicators - Cost tab metrics data:

<b>Column</b>	<b>Description</b>
Change Over Cost	This is the sum of costs for all scheduled changeovers in the schedule. Each changeover has a cost associated with it in the changeover matrix. Every time a changeover occurs, it is added to the total cost.

Column	Description
Inventory Cost	<p>The inventory cost provides the total carrying cost offset by total stockout costs. You can specify carrying costs, stockout costs, and safety violation costs on an item. You can also specify your time unit. The time is expressed in the time unit in scenario properties. See "Setting up the Scenario Properties - General Page, page 7-2," <i>Configuring Scenario Properties, Production Scheduling</i>.</p> <p>It is calculated as follows: sum of individual inventory costs, <math>C_i</math>, where <math>C_i = (\text{inventory carrying cost} * \text{area above zero}) + (\text{inventory stockout cost} * \text{area below zero})</math> (areas from the Item Graph).</p>
Manufacturing Cost	<p>This cost reports the sum for all operating costs occurred in the schedule. It is calculated as follows: setup cost + (duration of each operation * (resource operating cost + operation operating cost)).</p>

## Key Performance Indicators - Manufacturing Tab

The Key Performance Indicators - Manufacturing tab provides metric information that includes plant throughput and resource utilization.

This table explains the Key Performance Indicators - Manufacturing tab metrics data:

Column	Description
Change Over Time	<p>This is the sum of time for all scheduled changeovers. The time is expressed in the time unit in scenario properties. See "Setting up the Scenario Properties - General Page, page 7-2," <i>Configuring Scenario Properties, Production Scheduling</i>.</p>

Column	Description
Machine Utilization %	This is the average for all reusable resources of run time divided by up time. Run time is the sum of all operations that are run on this machine. Up time is the schedule horizon minus the sum of delay and down calendars on the resource.
Throughput (Can be viewed by shift, day, week, or month.)	This is the sum of the quantity of all demands divided by plant cycle time. Plant cycle time = End Time of last scheduled operation - Start Time of earliest scheduled operation (of all operations in the schedule). For example, if it takes 10 days from the start of the first operation to the end of the last operation to produce 100 units, the shift throughput is 3.33 units, daily throughput is 10 units, weekly throughput is 70 units, and monthly throughput is 280 units.

## Key Performance Indicators - Materials Tab

The Key Performance Indicators - Materials tab provides various metric information that outlines inventory turns, substitutions, and so on.

This table explains the Key Performance Indicators - Materials tab metrics data:

Column	Description
Inventory Turns	Inventory turns are an average for all items that have demand. Inventory turns are calculated as follows: total demand quantity / average item level in the horizon.
Periods of Cover Which can be viewed by shift, day, week, or month.	Average of $P_i$ , where $P_i$ is the number of periods before a demand that is not covered by the current inventory level at the start of a period.
Number of Substitutions	The total number of times a lower priority item is selected from an item set.

Column	Description
Manufacturing Cycle Time	<p>The average amount of time that it takes to manufacture items during the schedule horizon. For each demand routing instance = (End Time of Latest Operation - Start Time of First Operation) / Number of Units of Item Produced. The time is expressed in the time unit in scenario properties. See "Setting up the Scenario Properties - General Page, page 7-2," <i>Configuring Scenario Properties, Production Scheduling</i>.</p> <p>For example, if time is set to days and you can produce 1 unit in 24 hours for an operation, you have demand for 1 unit. If you produce 1 unit, this value is displayed as 1. If you change the time unit to hours, it is displayed as 24.</p>
Total Consumption Time	<p>Total Consumption Time = Sum of Consumption Time for all Supply Events</p> <p><b>Note:</b> The Total Consumption Time and the Average Consumption Time are calculated for all items that have the Consumption Time Target specified and which can be produced and consumed on upstream and downstream resources listed in the Resource Relationship Editor.</p>
Average Consumption Time	<p>Average Consumption Time = Total Consumption Time / Number of Supply Events</p>

## Key Performance Indicators - Maintenance Tab

Use the Key Performance Indicators - Maintenance tab to compare maintenance metrics between scenarios.

Use the Time unit for periods of cover and throughput list to view results based on Days or Weeks.

Use the Maintenance Work Order Filter list to assign a defined filter to the KPI view. When a filter is assigned, the name appears in the data columns to identify difference between filtered and non-filtered data. If a filter is not applied, (no filter) appears below the column name.

This table explains the Key Performance Indicators - Maintenance tab metrics data:

<b>Column</b>	<b>Description</b>
Scenario	Displays the name of the scenario being compared.
Average Visit Duration	Displays the Average duration of a Visit in Days.
Visit On-Time	Displays value based on the following: $(\text{Number of Visits On-Time}) / (\text{Total Number of Visits})$
Average Visit Lateness	Displays value based on the following: $(\text{Sum of Lateness of all Visits}) / (\text{Number of Visits Late})$
Average Visit Risk Index	Displays index indicating the relative risk of the Visits.
Total Resource Utilization	Resource utilization across all utilization types.
Machine Utilization	Resource utilization across all machines.
Crew Utilization	Resource utilization across all crews.
Tool Utilization	Resource utilization across all tools.
Maintenance Utilization	Resource utilization across all maintenance assets.
Total Resource Utilization (filter name)	Resource utilization across all utilization types based on the applied filter.
Machine Utilization (filter name)	Resource utilization across all machines based on the applied filter.
Crew Utilization (filter name)	Resource utilization across all crews based on the applied filter.

Column	Description
Tool Utilization (filter name)	Resource utilization across all tools based on the applied filter.

### Example of Average Visit Risk Index

The Maintenance tab provides an indicator to assess the relative risk of a visit. Conceptually, even though a visit is on time if it is completed 1 day before the Visit request date there is more risk compared to a visit that is completed 7 days before its request date. The amount of remaining work is also a factor. If two visits are completed 7 days before the request date and 1 Visit has 2 days of work remaining and the other visit has 20 days of work remaining the visit with 20 days is more likely to be late since there is more time for unexpected events (non-routines, resource down) to occur.

The Visit Risk Index (VRI) normalizes the amount of time a visit is early (late) over the remaining time of the visit.

Average Visit Risk Index = {Amount of Time a Visit is Early (late)} / {Remaining time of the Visit}

Visit	Remaining Visit duration	Amount of Time Early or Late (-ve = Early, +ve = Late)	Visit Risk Index
Visit 101	36	-1	-0.028
Visit 102	40	15	0.375
Visit 103	60	-1	-0.017

### Based on example, Average Visit Risk Index = 0.11

In the example above, Visit 103 is Riskier than Visit 101 since it has more time remaining. The Average Visit Risk Index is the overall Risk indicator for all the Visits and will be shown in the KPI view. The higher the number, the Riskier the Visit will be. The individual Risk index appears in the bubble help of the Visit in the Production Pegging view, which appears when the mouse is placed over visit makespan bar.

## Schedule Comparison Overview

Comparing schedules is ideal if you want to make a change to an existing schedule and assess its impact to the original schedule. You begin by renaming the original schedule Baseline Schedule. A duplicate of this schedule can be made as many times as necessary. Then, as changes are made to each of the duplicate schedules and repaired,

rename the schedules with more descriptive names. With all the schedules contained in a schedule folder, you can then compare these schedules.

Compare the KPIs for a schedule against a baseline schedule to determine the net difference in customer service between schedules. You can also select the colors used to highlight the baseline and comparison schedules in the Key Performance Indicator window.

Once a comparison is defined, you can customize how the Comparison Criteria appears to better analyze your data.

**To compare scenario results:**

1. Select Key Performance Indicators from the View menu.
2. In the Comparison Criteria region, select the Baseline Schedule. The list displays the scenarios in your model. The selected baseline is highlight in light blue by default.
3. Select Compare to list and choose the scenario you want to compare. The selected comparison is highlighted in light yellow by default.

You can change the highlighting colors by selecting Customize Colors on the toolbar.

4. Use the Show list to define criteria displayed. Available options are Demands, Work Orders, Visits, and Milestones.

The data displayed in the Comparison Criteria region is updated based on the selected Show list option.

Customize the data displayed using the Choose Columns window as described below.

5. Used the Status list to filter your results. Available options are as follows:
  - \* - Displays all data - no filter.
  - Was On-time - Now Late
  - Was late - Less Late
  - Was Late - More Late
6. Use the Choose Columns window to customize the data in the Comparison Criteria region.
  1. Right-click column header from Comparison Criteria region and select Choose Columns.
  2. To display a column, select the column name check box, or select the column name and click Show.

3. To hide a column, deselect the column name, or select the column name and click Hide.
4. To change the order columns appear, select column name and click the Move Up or Move Down buttons to arrange the display order.
5. To display all columns, click Show All.
6. To reset window to default setting, click Reset.
7. To save your settings, click OK.

The Comparison Criteria data is sorted based on your settings.

By comparing and refining schedules in the KPI window, you can continually improve the production planning process and ensure that your enterprise has the materials available to meet the requirements in the production plan. The KPIs displayed in the Key Performance Indicators window are updated automatically when you solve your schedule.

For example, if Demand is selected from the Show list, the following table describes the demand data that displays.

<b>Field</b>	<b>Description</b>
Demand	The demand code for the schedule and the associated line item.
Line Item	The line item number of the demand.
Item	The item that is scheduled for production.
Order Class	The order class of the line item.
Priority	The demand priority of the item that is scheduled for production.
Customer	The customer that is requesting the item.
Change in Makespan	The change in the duration of the demand, including associated line items and routings. The value is expressed in days and hours. A negative value indicates a shorter makespan.

Field	Description
Change in Lateness	The change in lateness between the baseline schedule and the schedule used in a comparison. The value is expressed in days and hours. A negative value indicates that the lateness of the demand is reduced.
Demand Requested Date	The request date indicated by the baseline schedule. For new demand, the request date is taken from the comparison schedule.
Demand Available Date (Baseline Schedule)	The available date indicated by the baseline schedule.
Demand Available Date (Comparison Schedule)	The available date indicated by the comparison schedule.



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## Manual Scheduling

This chapter covers the following topics:

- Solver Schedules Overview
- Performing Manual Schedule Changes
- Performing Unconstrained Manual Scheduling

### Solver Schedules Overview

This section provides an overview of production schedule adjustments and discusses:

- Manual scheduling.
- Operation adjustments.
- Resource adjustments.
- Resource idle time removal.
- Batchable resources.
- Resource calendar event modification.
- Schedule repair.

### Production Schedule Adjustments Overview

After an initial schedule has been created, some adjustments may be required to make improvements. Production Scheduling provides the necessary tools to analyze and modify the schedule.

Any item or demand violations that are identified during the solve are displayed in the Exceptions grid. The suspected operation that is causing the violation is listed in the Exceptions grid and can be expanded and highlighted within the Resource, Demand,

and Operation Gantt schedule views. Once the operation is identified, then the root cause of the violation can be investigated and corrected.

A wide range of changes can be made to the schedule after its initial solve, including changes to the following:

- Operation durations.
- Operation start and end times.
- Assignment of operations to resources.
- Sequence of operations.
- Downtime.
- Demands.
- Quantities.

Operations can also be adjusted to run at a specific time. Changes that are made to the schedule are highlighted for easy identification.

## Manual Scheduling

Manual scheduling enables you to make manual changes to the schedule so that you can respond to new information from the shop floor, exceptions generated by the solver, or changes to the maintenance calendar.

This list shows the wide range of changes that can be made to a schedule after its initial solve:

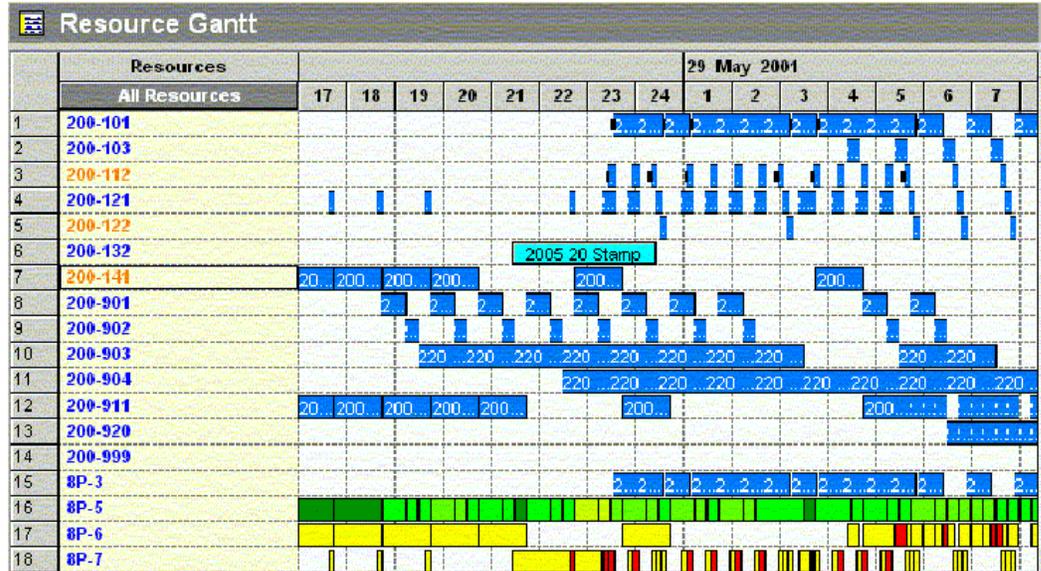
- Add new demands.
- Modify operation durations.
- Modify start and end times.
- Change assignment of operations to resources.
- Resequence operations.
- Modify delay and downtime events in the Resource Calendar.
- Remove idle time between operations.
- Adjust resource capacities.
- Adjust inventory levels.

- Adjust demand quantities.
- Adjust dates.

Operations can also be adjusted to a run at a specific time. Demand can be modified locally for the active schedule.

The toolbar enables you to make some of the manual schedule changes and run a repair solve to update the schedule.

This example illustrates manual scheduling changes in the Resource Gantt:



Manual scheduling changes are highlighted in light blue for easy identification, as displayed with the operation 2005 20 Stamp in the example. In comparison with the original solve, the repair solve focuses only on those areas that are changed in the schedule when producing a new schedule. In many cases, this action can represent a significant time savings. The manual scheduling changes are logged to the log window for later reference. After the repair solve is complete, manual scheduling changes are highlighted in orange in the Resource Gantt.

## Operation Adjustments

Operation adjustments can be made by:

- Using cut and paste commands.
- Using the Enforce Horizon Start option.

## Using Cut and Paste Commands

Production Scheduling uses the following rules when pasting operations:

- In the first scenario, an operation is pasted into idle time.  
In this case, the operation is pasted at that point.
- In the second scenario, operation A is pasted onto operation B.  
In this case, operation A is pasted into idle time immediately following operation B. If another operation immediately follows operation B, then operation A is pasted between these two operations.

When you run a repair, the solver tries to move the operation to the exact point specified. If constraints prevent the operation from moving to the specified start time, then the solver will try to reschedule the operation later during the idle time. If pasting the operation results in an infeasible schedule, then the system cancels the paste command and moves the operation back to its original location.

If you select the Fix option in the Paste Operation dialog box, then the operation must start at the time specified in the Start Time field. Pasting a fixed operation into idle time or on top of an existing operation might result in an infeasible schedule.

**Note:** When you cut and paste multiple operations with at least one operation that has the same target resource as the original resource, the system disables the Ignore paste start time and sequence option.

When an operation is pasted into its new location, the solver can resequence some of the adjacent operations to accommodate this change (for example, if the idle time that the operation being pasted into is not long enough). Production Scheduling gives you the option of performing either multi- or single-stage resequencing.

Single-stage resequencing honors any solver-imposed constraints on the operation. If the resulting paste violates these logical constraints (for example, if an operation that produces an item is moved after the operation that requires the item), then the system does not move the operation.

Multistage resequencing enables the solver to move all of the operations that constrain the pasted operation. For example, assume that an operation is pasted before the operation that produces an item that it requires. In this instance, multistage resequencing enables the solver to move the affected downstream and upstream operations.

The duration of an operation can be quickly modified to display its impact on an existing schedule. If any resources are affiliated with the changed operation, they are also modified to stay consistent with the new duration.

By changing an operation's start and end times you can manually reschedule an operation within the schedule. An operation's start and end times can be changed from the Demand, Operation, or Resource Gantt views.

The Start Time and End Time fields represent the actual times when the operation instance is scheduled. The Earliest Start Time and Latest End Time fields represent the

time frame in which this operation instance could be scheduled without definitely causing infeasibilities. You should select a start time and end time within these parameters to render a feasible schedule.

The start and end times of merged operations can be modified as a single entity. After changing a time, the groups of merged operations are each shifted accordingly. Note that the Run Time, Delay, Earliest Start, Latest End, and Elapsed Time properties cannot be changed for merged operations.

When the start or end times are changed, the duration remains unchanged and the operation is moved to the chosen date and time. To change an operation's duration, modifying the value in the Duration field.

**Note:** You can also modify start and end times by cutting and pasting operations from the Operation and Resource Gantt views.

### Using the Enforce Horizon Start Option

When schedule backlog occurs, you can elect to use the Enforce Horizon Start option from the Resource Gantt view. Select the applicable resource, right-click, and select the Enforce Horizon Start option. Perform a repair solve or a solve when complete.

When the Enforce Horizon Start option is used, all operations for that resource are pushed forward to the start of the horizon. Operation sequence is maintained and precedence constraints for upstream and downstream operations are respected.

When selecting the Enforce Horizon Start option on the Resource Gantt view:

- The resource attribute persists and is added to the data model.  
For example, if you select this option, it is persisted on the resource properties and displays a check mark beside the text in the right-click menu. This indicates that the flag has already been selected.
- Enables the Enforce Horizon Start option on the Resource Properties - Availability tab.
- The fixed timefence changes to a cross hatched pattern for machines, crews, and tools.

You can highlight many resources at once and enable this flag for all highlighted resources. However, if a resource that is highlighted already has this option selected, its state is reversed.

After selecting the Enforce Horizon Start option, click the Repair solve button; all operations are moved forward in time, keeping the same sequence but beginning at horizon start. When this sequence is performed:

- Operations running in the past start at the beginning of the horizon.

- Any adjacent operations are pushed forward to accommodate the operations moved forward in time.
- The sequence of operations on the resource are not changed.  
The sequence of operations on the resource are not changed.
- Any upstream or downstream operations of an operation may need to be pushed forward if precedence constraints dictate.

After selecting the Enforce Horizon Start option, click the Solve button. The solver resolves resource conflicts and enforces horizon start in a one-step process. Operations that appear to be running behind are moved to the horizon start. The difference from a repair solve is that you are not alerted that some operations are running in the past. By selecting the Enforce Horizon Start option and running a solve, this step is performed in one task.

In some cases, the operations running behind are one of several operations that are contained within a routing. Because routings have precedence constraints between operations, moving operations from the past to the horizon start may have consequences on other operations in the routing. For example, an operation is the first operation of a routing and it is pegged to a downstream operation. If Enforce Horizon Start is selected and a repair solve is performed, the pegged operation is moved forward in time to avoid a precedence infeasibility. Similarly, if an operation has been scheduled in the past due to a date conflict with another resource and upstream supporting operations have not yet run, those operations should be pulled forward to start just in time (JIT) to the placement of the operation moved to the start of the horizon.

## Resource Assignments

For operations that use sets, Production Scheduling tries to solve the schedule based on the preferences that you apply to each set, while considering all constraints and priorities in the model. For instance, if you have specified one crew set with the option of using either Crew A or Crew B, the solver creates a schedule trying to use your preferred crew, as indicated in the properties of the operation model. However, after creating the schedule, you might want to change the resource actually used by the operation.

**Note:** You cannot manually change resource assignments for merged operations.

## Resource Idle Time Removal

Although the JIT build method is often a good strategy to avoid excessive prebuilding, it can sometimes cause a fragmented schedule. Running machines nonstop for a period of time is often more efficient, especially if you also remove idle time from the schedule.

You can use the Remove Idle Time command from the Resource Gantt, Production Pegging, and Operation Gantt views to:

- Remove idle time between two or more selected operations.
- Remove a resource's idle time between an operation and a specified time within the schedule horizon.
- Remove all idle time on a selected resource.

**Note:** You can use the Remove Idle Time command on a multicapacity resource only from within the Operation Gantt view. If a multicapacity resource is selected on the Resource or Production Pegging views, the Remove Idle Time button is disabled.

Resource constraints can prevent the solver from removing all idle time. For example, assume that items that are required by an operation must be in inventory or a crew must be available to run a machine at the new time slot. In cases where operations cannot be moved, the solver removes as much idle time as possible.

## Batchable Resources

You can manually move operations between batches or manually move an entire batch. For example, if a sequence on a resource is scheduled to be 10 hours at 500 degrees followed by 12 hours at 400 degrees, you can switch the order. This can be accomplished by using the cut and paste, drag and drop, or resequencing window in the Resource Gantt view.

When manually scheduling, you can move specific operations between batchable resources, known as offloading, to fill up capacity. If you have attributes scheduled on a batchable resource that are different, but they are close enough to be able to run the operation with different attributes, and the final product quality is not affected. For example, some aluminum blocks can be processed at a particular temperature for a given time range. For example, 19 hours at 600 degrees. However, the quality of the final alloy is virtually the same if the job is processed for 20 hours at 590 degrees. Production Scheduling in itself is not able to understand alternate attributes, but you can manually schedule operations between resources, or the same resource, running a different attribute family type.

See "Batchable Resources, page 5-6," *Creating Production Scheduling Models, Production Scheduling*.

## Resource Calendar Event Modification

You can add, delete, or modify calendar events in the Resource Calendar. Alternatively, you can delete or modify calendar events in the Resource Gantt view. This function

enables you to analyze the effect of adding another shift or resource to the schedule. After repairing the schedule, Production Scheduling updates the schedule to reflect the new events.

Calendar events can be added directly from the Production Pegging and Resource Gantt views. This feature is helpful when fine-tuning the schedule once it has been solved. These changes are only reflected in this schedule and are not applied globally to the Calendar Editor.

Calendar events can be deleted directly from the Resource Gantt view, which is helpful when fine-tuning the schedule, once it has been solved. These changes are only reflected in this schedule and are not applied globally to the Calendar Editor.

You can delete calendar events for a resource as required. After repairing the schedule, Production Scheduling updates the schedule to reflect the deleted events. When you delete a calendar event from a resource, the system does not remove the event from the parent calendar.

When an event has been added in a schedule, the resource reassignment is not applied until the schedule is repaired. When a delay event has been deleted in a schedule, the resource reassignment is not reflected until the schedule is repair solved.

## Schedule Repair

Repairing a schedule enables you to implement changes that are made to the schedule. To minimize the effect on the schedule, the repair solve modifies only the schedule for the resources and time periods that are specified. Depending on the changes that are made, a repair usually takes less time to complete than the initial solve.

If a change is made to the schedule that cannot be incorporated with a repair solve, then the Repair button is disabled. If a manual scheduling change results in an infeasible schedule, all of the changes since the last successful solve are reversed. After the repair solve is complete, manual scheduling changes are highlighted in orange in the Resource Gantt view.

## Performing an Undo for Manual Scheduling

Manual scheduling in Production Scheduling includes a variety of activities such as:

- Cut/Paste.
- Resequence.
- Remove idle.
- Change durations of operation instances.
- Change start or end times of operations.

- Change calendar events in the Gantt charts (add/remove/change).
- Change resource assignment (for example, manually offload).
- Fixing/Unfixing operations (single or multiple operations).
- Change lead times for Purchase Order Recommendations.

Following each of these actions, there is a repair-based solve action to institute the change and "repair" any upstream/downstream ramifications this change may have caused. However, it is possible that you may not accept the repaired schedule or simply made a mistake when implementing this change. Should this occur, you can "Undo" these changes. The Undo action reverts back to the previous "solve state" prior to the change. The table below provides examples using the Undo feature.

Action	Result
{manual change}   UNDO	Will undo the manual change.
{manual change}   Repair   UNDO	Will undo the repair and manual change.
{manual change}   {manual change}   UNDO   ...	Will undo both manual changes.
{manual change}   {manual change}   Repair   UNDO	Will undo the repair and manual changes.
{manual change}   Repair   {manual change}   Repair   UNDO	Will undo the 2nd repair and 2nd manual change.
{manual change}   Repair   {manual change}   Repair   UNDO   UNDO	Will undo the both repairs and both manual changes.

Undo also applies to another new feature in Production Scheduling (Resource Business Objectives). Included in this feature is the ability to solve groups of resources in a "Stage" and perform manual scheduling activities between stages (for example, At a breakpoint) in the solve process. Undo can be performed within this context as well. This includes the ability to undo manual changes in the stage itself as well as to completely undo a given "stage" of the solve process - upon which the solution will revert back to the previous solved "stage". The table below provides examples using the Undo feature.

Action	Result
{solve stage   breakpoint}   manual change   Repair   UNDO	Will undo the manual change.
{solve stage}   {solve stage   breakpoint} UNDO	Will undo the 2nd solve stage - result will revert back to the first solve stage.

## Performing Manual Schedule Changes

This section lists prerequisites and discusses how to:

- Move operations within a routing.
- Modify operation durations.
- Modify operation start and end times.
- Modify operation resource assignments.
- Resequence operations.
- Remove resource idle time.
- Repair a schedule.
- View manual schedule changes in the Gantt view.
- Add calendar events in the resource calendar.
- Enforce horizon start time.

## Prerequisites

Before you begin to make manual scheduling changes, ensure that you meet the following prerequisites:

- Solve your schedule.
- Use either the Demand, Resource or Operation Gantt view. Some rescheduling tasks can also be performed from the Resource Sequence view.

## Moving Operations Within a Routing

**Note:** When resequencing, the operation selected must be restricted to a single resource.

Access the Operation Gantt, Resource Gantt, or Production Pegging view.

### To move operations within a routing:

1. Select the operation that you want to move.

To select multiple operations, hold down the left mouse button and drag until the operations are selected. Selected operations appear red.

2. Select Cut Operation from the toolbar or right-click your mouse.

The cursor changes to a horizontal scroll bar that displays the current date and time. Allowable destination resources for the cut operation appear highlighted blue for the same resource selection, or highlighted orange if offloading to a different resource.

**Note:** If you select operations across multiple resources that are not able to run on the same machine, the Cut Operation button is disabled.

3. Click the location corresponding to the date and machine where you want to move the operation.

The selected time appears in the status bar.

4. Right-click and select Paste.

The Paste Operation dialog box appears and displays the selected start and end times.

You can set the operation to start at the earliest available start time by selecting the Earliest Start Time check box or you can manually adjust where you want to paste the operation by changing the Start Time and End Time fields.

5. Select one of the following options to indicate how you want to resequence adjacent operations:
  - Multi-stage Resequencing - Select this option to enable the solver to move all of the operations that constrain the pasted operation.
  - Single-stage Resequencing - Select this option to honor any solver-imposed constraints on the pasted operation.

6. To offload an operation from one machine to another, select Ignore paste start time and sequence.

When you run a repair, the solver schedules the moved operation. This option is only enabled if the machine that you are using is a part of a resource set.

**Note:** When you enable the Ignore paste start time and sequence option, the Start Time, End Time, Duration, and Fix fields are disabled.

7. Select OK.

## Modifying Operation Durations

Use the Operation Merge Properties window to adjust operation times.

### To modify operation durations:

1. From an operation schedule view, right-click an operation from the time grid, and select Properties. From the Merge Operation Properties window, select the Times tab.
2. In the Run field, enter the duration of time that you want to use.  
The End Date field is adjusted to reflect the new operation duration.
3. Click OK.

**Note:** When changing operation duration, the new time must fall within the bounds set by the Earliest Start Time and Latest End Time fields.

## Modifying Operation Start and End Times

Use the Operation Merge Properties window to adjust operation times. You can also use the Resource Sequence view to modify operation properties. Refer to the Edit Operation Start Time, End Time, and Firm Status, page 9-70 for more information.

### To modify operation start and end times:

1. From an operation schedule view, right-click an operation from the time grid, and select Properties. From the Merge Operation Properties window, select the Times tab.
2. In the Start Time field, enter the time when you want the selected operation to begin.
3. In the End Time field, enter the time when you want the selected operation to end.

4. Click OK.

The change in start and end times is displayed on the schedule. Any scheduled operations to be executed after the end of the changed operation are modified as well.

## Modifying Operation Resource Assignments

Access the operation Properties window. Select the Resources tab.

### To modify operation resource assignments:

1. Select the code field for the set with resources that you want to change.
2. Select the down arrow to view the resource options.
3. Select the resource that you want from the list.
4. Click OK.

## Resequencing Operations

**Note:** When resequencing, the operation selected must be restricted to a single resource.

Use the Resource Sequence view to resequence operations. Refer to Resequencing Operations, page 9-71 in Using the Resource Sequence View.

## Removing Resource Idle Time

Access the Production Pegging, Operation Gantt, or Resource Gantt view.

### To remove resource idle time:

1. Select one of the following options:
  - On either the Resource Gantt or Production Pegging view, use the multiselection functionality to select two or more operations on a single-capacity resource.
  - On the Operation Gantt view, use the multiselection functionality to select an operation type.
2. Select Remove Idle Time.

All of the operations within the selected range are moved to an earlier time so that all of the idle time between them is removed. If more than two operations are selected, the solver removes idle time between the earliest and the latest selected operation.

**Note:** If the operations that you select do not run on the same resource, the system disables the Remove Idle Time command.

3. Select Repair to repair the schedule.

**Note:** After a repair, the solver attempts to move all of the selected operations to remove excess idle time. However, resource constraints (for example, an operation running within a fixed timeframe, or an operation that is waiting for inventory) can prevent the solver from removing all idle time. In cases where operations cannot be moved, the solver removes as much idle time as possible.

## Repairing a Schedule

Access the schedule window.

### To repair a schedule:

1. Complete manual scheduling adjustments.
2. Select Repair.

The schedule is refreshed with the incorporated changes. If the repair results in an infeasible schedule, a message appears on the status bar indicating that the schedule is infeasible and the schedule returns to the previous solved state.

**Note:** Some manual scheduling changes require that you perform a solve. For example, schedules containing modifications to routing and operation properties, work orders, and supply and demand data cannot be repaired and require a solve. In these cases, the Repair tool becomes unavailable for input.

## Viewing Manual Schedule Changes in the Gantt Views

### To view manual scheduling changes:

1. Access the Production Pegging, Operation Gantt, or Resource Gantt view.
2. Select Highlight operations changed by Repair on the Gantt toolbar.

The operation that you manually changed before a repair is highlighted in red. Related operations in the routing that have been changed by the solver during a repair are highlighted in orange.

## Adding Calendar Events in the Resource Calendar

### To add calendar events:

1. Access the Resource Calendar.
2. Click the down arrow under Resources, and select the resources or groups that you want to view.
3. Click a resource, and then click the Add Event button.
4. Click one of the following options to specify the event type:

---

Event Type Field	Description
Up Time	All machines and activities are available.
Down Time	Actual downtime when all machines and activities are stopped. This option imposes significant constraints and should be used infrequently. Use the Delay Time option whenever possible.
Delay Time	A delay when machines and activities are temporarily suspended.

---

5. Complete the following fields:

---

Time and Duration Field	Description
Start Time	The date and time when the event begins. Alternately, you can leave the original date. When the end time and the duration are entered, the start time is automatically calculated.
End Time	The date and time when the event ends. Alternately, you can leave the original date. When the start time and the duration are entered, the end time is automatically calculated.

---

<b>Time and Duration Field</b>	<b>Description</b>
Duration	The event length in seconds, minutes, hours, or days. If the start time is specified, the end time is automatically filled in, based on the duration. Similarly, if the end time is specified, the start time is filled in automatically.
Recurring Event	Select this option if you want the calendar event to repeat. Select one of the following options in the Recurrence Pattern section: Daily, Weekly, Monthly, or Yearly.

6. Click one of the following options in the Recurrence Limit section:

<b>Recurrence Limit Field</b>	<b>Description</b>
No end date	Select this option if the event occurs throughout the calendar horizon.
End after occurrences	Select this option and select the number of occurrences if the event occurs for a specified number of times, and then stops.
End by	Select this option and select an end date if the event ends by a specified date.

7. Click Add.

Production Scheduling adds the calendar event to the Resource Calendar.

## Enforcing Horizon Start Time

There are two methods to enforce horizon start time:

- Method 1
  1. Access the Resource Gantt view.
  2. Right-click a resource.
  3. Select the Enforce Horizon Start option.

4. Click Solve.
- Method 2:
    1. From the Model Workspace or Resource Gantt view, right-click a resource and select Properties.
    2. Select the Availability tab.
    3. Select Enforce Horizon Start and click OK.
    4. Click Solve.

## Performing Unconstrained Manual Scheduling

Use the Unconstrained Manual Scheduling Mode to perform specific manual scheduling changes where constraints can be relaxed or violated. When working in this mode, the Repair Solve only attempts a solution for the changes you have made. It will not attempt to make other improvements. This mode provides the following features:

- Production Scheduling respects your modifications, even if constraints are violated. The application does not attempt to improve anything else in the schedule. These manual changes are more specific in nature and limited in scope.
- Routing Precedence Constraint exceptions and Related Work Order Precedence exceptions are generated to indicate constraint violations resulting from unconstrained manual schedule changes.
- Publishing the schedule is possible even if certain constraints are violated. Changeovers can be included in schedule *if* Include unconstrained solution data is selected from the Edit Profile window for the publish profile, which is accessed from the Publish window. If not selected, then changeover data will be excluded from published schedule. This option can *only* be set when the Unconstrained Manual Scheduling Mode is active.

### Constraint Behavior

When in the unconstrained manual schedule mode, constraints are handled as follows:

- Calendar constraints: Calendar events are always respected. Calendar events themselves can be changed if necessary.
- Capacity constraints: All capacity constraints are relaxed in this mode and can be violated. Exceptions will be generated.
- Material constraints: All material constraints are relaxed and can be violated. Exceptions will be generated.

- **Precedence constraints:** By default, precedence constraints within routings or between related work orders and their associated min/max separation times will be respected. For example, if two successive routing step 10 and step 20 with S>E relationship are changed by dragging step 20 earlier in time so that it starts before step 10 ends, then step 10 will be pushed earlier as well. An option is available to allow for violation of these constraints, in which case step 10 remains where it originally was, and an exception is generated. This behavior is controlled via the Single-stage resequencing and Multi-stage resequencing options, which are available in the Paste Operation dialog and in the Resource Sequence view. If Multi-stage resequencing is selected, then routing precedence constraints will be respected. If Single-stage resequencing is selected, then these constraints are relaxed.
- **Reservations:** Supply and demand reservations can be seen as a specific form of material and precedence constraint, given that both supply and demand events are work orders. The precedence relationship can be violated in such case and exceptions will be generated.
- **Changeover Relationships:** In this mode, changeovers will be ignored.
- **Alternate Resource Offloading:** Start time changes will be respected, and the operation duration will be as per the operation template. All-of-Set definitions will be respected.

### **Cut and Paste Behavior**

You can cut and paste operation instances in scheduled views. When performing a paste, the operation instance is inserted after the selected operation. For batchable operations, the paste insertion point will always be the start of the target batch.

**Note:** Pasting an operation instance with attributes different from the target batch is possible. When this occurs, a notification is displayed.

If Multi-stage resequencing is selected, the routing constraints are enforced. If Single-stage resequencing is selected, then routing constraints are relaxed.

### **Resource Sequence View Behavior**

When resequencing operations using the Resource Sequence view, the start time of what had been the first operation will become the start time of the new first operation, and all subsequent operations are placed adjacent to one another. If capacity violations occur at the end of the re-sequenced operations, then exceptions will be generated.

You can modify sequences by moving operations up or down. You can also edit start and end dates of operations in this view. You cannot perform both tasks at the same time without performing a solve in between. The solver must be run in order to avoid potentially creating conflicting directives. Once you edit an operation start or end date, the up/down arrows for resequencing will be disabled. The same is true when

resequencing operations using the up and down arrows; once you re-sequence operations using the up and down arrows, the operation start and end date fields will be non-editable. After you perform a solve, both actions will become enabled again.

For multi-capacity resources, you can only edit start and end dates. The up and down arrows for resequencing will be disabled.

**Note:** Operation instances, which belong to the same work order, are always moved together as a group. Note that this behavior is the same for all manual scheduling.

### **Pegging Data Behavior**

Pegging data will not be recalculated in the Unconstrained Manual Scheduling Mode. Pegging data remains the same as when this mode was activated.

### **Alternate Routing Offloading Behavior**

This will not be possible.

### **Publishing Schedule and Changeovers Behavior**

Since constraint violations are possible in the unconstrained mode, the overall state of the schedule could be infeasible. Nevertheless, you can publish a schedule even in this state, even if some constraints are violated. Changeovers can be included in the schedule if the Include unconstrained solution data option is selected from the Edit Profile window for the publish profile, which is accessed from the Publish window. If not selected, then changeover data will be excluded from the published schedule. This option can *only* be set when the Unconstrained Manual Scheduling Mode is active.

## **Enabling the Unconstrained Manual Scheduling Mode**

**Note:** When working in the unconstrained mode, you should enable the Solve confirmation dialog. To enable user confirmation dialogs, select Options from the Tools menu. Select Gantt Chart tab and select Solve option. Enabling this feature will help avoid losing manual changes should you accidentally click Solve from the toolbar. To generate a schedule and maintain your changes while in the unconstrained mode, you always want to perform a repair solve.

To perform manual scheduling changes using this mode, perform the following:

1. Click Solve from the toolbar. You must first solve your schedule before you can enable the unconstrained mode.
2. Click Unconstrained Manual Scheduling Mode from the toolbar. The window frame appears green to indicate that the view is in the unconstrained scheduling mode.

3. Make your scheduling modifications.
4. Perform a repair solve as needed. Only your changes are considered when the repair solve is run.
5. Select Highlight operations changed by Repair from the toolbar to highlight those operations affected by your manual changes.
6. Review any exceptions and make updates as needed.
7. Perform repair solve as you make manual scheduling changes until all issues are resolved and the schedule meets your needs.
8. Publish your changes.

## **Deactivating the Unconstrained Manual Scheduling Mode**

To exit the unconstrained mode, click Unconstrained Manual Scheduling Mode from the toolbar

After exiting the Unconstrained Manual Scheduling Mode, normal constrained repair solve behavior will be applied. Full constraint propagation and opportunistic improvements will be performed, and previous changes made in unconstrained mode will be lost.

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## Publishing Data

This chapter covers the following topics:

- Production Scheduling Published Reports Overview
- HTML Dispatch Report Overview
- Publishing Schedules
- Publishing a Schedule to Oracle E-Business Suite
- Publishing Schedule to cMRO and eAM
- Post Publish Customization Hook

### Production Scheduling Published Reports Overview

You can publish data from Production Scheduling in any of the following formats:

- CSV
- HTML
- XML

### CSV File Reports

CSV files can be read into an ETL tool of your choice for transformation in preparation for import into other systems. When you publish in .csv file format, you can generate one or more of the following reports:

- Operations Report
- Resource Schedule
- Demand Fulfillment

- Key Performance Indicators (KPIs)

## HTML Dispatch Report

HTML file format generates an HTML Dispatch Report that can be published directly to the shop floor.

## Oracle E-Business Suite Integration

Oracle E-Business Suite Integration file format generates XML files, which are used to release orders to E-Business Suite.

## XML File Reports

The standard XML files, which are exported out of Production Scheduling, are:

- ProductionSchedule.xml
- PurchaseOrderRecommendations.xml
- WorkOrderSchedule.xml

XML files can be compressed when publishing, which reduces the size of the files created.

## HTML Dispatch Report Overview

This section discusses:

- Publishing options.
- Index page.
- Resource details page.

## Publishing Options

You can send production schedule data to the production line using the HTML Dispatch Report. This report eliminates the need to create custom reports and distribute them manually. Any production schedule that has been generated can be dispatched to a specific directory and posted online. Production personnel can access then the HTML Dispatch Report to determine which scheduled operations are in the queue for a specific date range.

When you publish the HTML Dispatch Report, you specify a start date and a publishing horizon. The start date is the first day that you want to publish scheduled operations for resources in your supply chain. The publishing horizon is the length of the HTML

Dispatch Report in days. The publishing horizon determines the size of the report, according to your requirements. You can select publishing options to specify what data should be published in the HTML Dispatch Report. The following publishing options determine the level of data that is published on the resource details page:

<b>Publishing Option</b>	<b>Data Published</b>
Operation Description	A description of the operation that runs on the specific resource.
Start Time	The operation start time from the data model.
End Time	The operation end time from the data model.
Item	The item that is produced using this specific operation.
Item Description	A description of the item that is produced using this specific operation.
Quantity	The quantity of the item produced by this specific operation.
Work Order Number	Pegged work orders for this specific operation, indicating the work order that requires this operation.
Demand Number	Pegged demands for this specific operation, indicating customer demands that require this operation.
Demand Due Date	The due date for the customer demand.
Customer Name	The name of the customer who is requesting the item produced by this operation.
Customer Number	The customer code for the customer who is requesting the item produced by this operation.

## Index Page

After the production schedule data has been published to the HTML Dispatch Report, open index.html file to display scheduled resources that are required for the current

day. The report contains each resource that is required for the current schedule and a description of each resource. Resources are organized by the resource categories defined in the data model. The index page is dynamically generated when you publish the HTML Dispatch Report. You can define the location of the index page when you configure system options during initial system configuration. You must publish the HTML Dispatch Report for each schedule that you generate or after you make manual scheduling changes and re-solve the schedule.

### **Viewing Detailed Resource Information From Index Page**

To view detailed resource information from the index page, click a resource link. The detail resource page displays detailed duration, item, quantity, pegging, and customer data for each operation that runs on that specific resource. Using this information, your production personnel can view an accurate schedule of production activities for a specific scheduling horizon, enabling them to meet the scheduled demands more efficiently.

## **Publishing Schedules**

This section provides an overview of publish profiles, an example of a publish horizon, and describes how to:

- Create a publishing profile.
- Select reports.
- Approve a schedule.
- Publish a schedule using publish profiles.
- Edit an existing publishing profile.
- Delete an existing publishing profile.

## **Publish Profiles Overview**

Before you can publish a schedule, you need a publish profile and you must approve the schedule that you want to publish. Basic publishing profiles are provided with Production Scheduling; however, you may want to create personalized profiles that are more suited to your specific requirements.

When creating a publish profile, you determine general options such as the publish horizon, the format in which the data is to be published, and the output directory. Your data selection is based on the selected format. Data selection options are individual reports, if the output is to be compressed, or report headings.

As part of the Publish process, you have the ability to publish the Production Scheduling model, or selected objects of the data model, in XML format. For example,

you can publish changeover rules, groups, crews, machines, tools, operations, and so on. This is useful when Production Scheduling is the system of record for any data that is not available in the ERP system. The next time that a model is imported into Production Scheduling, integration processes can be extended to reference the various data model elements that were exported from the previous scheduling session, which could amend to the new model prior to import.

When creating a publish profile, use the Model tab to define which data objects to publish. When the Publish Process is called, whether in batch or interactively, the selected data is exported to a user-named XML file. Interactively, the published model is based off of the approved schedule. Because the schedule publish process batch file points to a named scenario, you can export the model from any given scenario that may or may not be the approved schedule.

### Example of a Publish Horizon

For example, assume the following three operations are part of a routing to make item A. A publish timefence of 2 days is in place. This diagram illustrates the scenario:



#### Publish timefence with pegging

The following logic indicates the data that is published when a timefence is being utilized:

- If any of Operation 10, 20 or 30 is inside the publish timefence, the routing and operations for those operations are included in the publish of the production schedule.
- If the routing instance crosses the timefence, the operations are included as part of the publish.

If none of the operations associated with the routing cross or start within the timefence, then the operations are not published.

- In terms of the pegging reports produced from Production Scheduling, only those demands which have operations that take place inside the timefence will have their pegging details published.

If a series of operations do not have any activity within the timefence, the pegging details are not published.

## Creating a Publishing Profile

### To create a publishing profile:

1. Access the Production Scheduling desktop.
2. From the File menu, select Publish.
3. In the Publish window, click Add. The New Profile dialog appears.
4. Complete these fields on the General tab:

General Tab Field	Description
Profile Name	Enter a unique name for the profile. When you publish a schedule, you are asked to select a profile. The profile that you select will follow the criteria you define in this procedure.
Publish Horizon	Enter the number of hours, days, or weeks for the profile. The publish timefence within a publish profile specifies a period of time in which data is published from Production Scheduling.  See "Example of a Publish Horizon, page 11-5," <i>Publishing Data, Production Scheduling</i> .
Format	Select CSV , HTML , or XML. This is the format in which your data is published.
Output directory	Specify the directory where the publish data file output is saved. You can enter the location of the directory or click Browse to select a directory location.
Script	Specify a script that is initiated after the data is published. You can explicitly specify the location of the script or click Browse to select a script. This field is optional.

5. Click Apply and then OK.
6. Select the Data Selection tab.

7. The options available in the Data Selection tab are based on the Format option you selected on the General tab. Set these options as needed.

See "Selecting Reports, page 11-7," Publishing Data, *Production Scheduling*.

- If you selected XML, select the reports that you want to publish, and select Compress Output if you want to compress the output report.

The output is compressed into a GZIP file and .gz is appended to the file name. For example, if you compress the Production Schedule report, the file is ProductionSchedule.xml.gz.

- If you selected CSV, select the reports that you want to publish.
- If you selected HTML, perform the following:
  - Check the work order types included in your report. Available options are Production, Maintenance, and EAM.
  - Select the dispatch report columns you wanted to appear in the Dispatch Report. Columns in the Selected Columns list are displayed on your report. To move an Available Column to the Selected Column, select the column name and click >>. To rearrange column order in the Selected Column, select the column name and use the Move Up and Move Down arrows.
  - To display coproducts and byproducts in your report, check the Display Coproducts/Byproducts option.

8. Click Apply and then OK.

9. Select the Model tab and complete these fields:

Model Tab Field	Description
Export Model	Check this option to export the selected data elements when you publish this profile.
File Name	Enter the export data file name. This file is exported to the Output directory defined in the General tab.
Model Data Selection (check boxes)	Check the data elements that you want to publish.

## Selecting Reports

If you select CVS as the Format in the General tab, you can define the CVS reports you want published from the Data Selection tab.

### To define the CVS reports published:

1. From the Publish window, select the Data Selection tab.
2. Check the reports you want published. The following options are available:
  - Operations Report
  - Resource Schedule
  - Demand Fulfillment
  - KPIs
3. Click OK.

See "Creating a Publishing Profile, page 11-5," Publishing Data, *Production Scheduling*.

## Operations Report

The Operations Report provides the actual start time, end time, and quantity of each item that is produced or consumed for each scheduled operation.

The Operation report is saved in the OperationsSchedule.csv file in the Output directory defined in the General tab.

## Resource Schedule Report

The Resource Schedule produces a report which includes machine and crew information that is published according to the time fence that is selected.

The Resource Schedule is saved in the ResourceSchedule.csv file in the Output directory defined in the General tab.

## Demand Fulfillment Report

The Demand Fulfillment report publishes detailed pegging information for each Demand line item. This report includes the name of the customer, quantity of the desired item, available and requested dates.

The Demand Fulfillment report is saved in the DemandPegging.csv file in the Output directory defined in the General tab.

## Key Performance Indicators Report

You can publish Key Performance Indicators (KPIs) to a .csv file by selecting Publish

from the File menu, and selecting the CVS Production Schedule profile name or by defining a CVS file format publish profile. The KPIs report provides information about KPIs, including fill rate, stock outs, inventory turns, substitutions, resource utilization and throughput is exported.

The KPIs are saved in the KPI.csv file in the Output directory defined in the General tab.

## HTML Dispatch Report

HTML file format generates an HTML Dispatch Report that can be published directly to the shop floor.

Shop floor personnel can use the dispatch list to organize production tasks for the day. The scope of the data that is published to the dispatch list is configurable and can be adjusted depending on the level of schedule data required on the shop floor. Once schedule information is dispatched to the shop floor, it is available to view on any network workstation with a Web browser.

You can define the data published in the HTML Dispatch report by modifying the profile's Data Selection settings.

### To modify the Dispatch Report output:

1. Click Publish from the toolbar, or select Publish from the File menu.
2. Select HTML Dispatch Report from the Profile Name list, and click Properties. The Edit Profile windows appears.
3. Click the General tab to modify to general parameters for the profile and define the Output directory where your report is published.
4. Click the Data Selection tab and set the following options as needed:
  - Check the work order types included in your report. Available options are Production, Maintenance, and EAM.
  - Select the dispatch report columns you wanted to appear in the Dispatch Report. Columns in the Selected Columns list are displayed on your report. To move an Available Column to the Selected Column, select the column name and click >>. To rearrange column order in the Selected Column, select the column name and use the Move Up and Move Down arrows.
  - To display coproducts and byproducts in your report, check the Display Coproducts/Byproducts option.
5. Click the Model tab to export the XML model file. Check Export Model option, enter the XML File Name, and check the model data to be exported from the Model Data Selection region.

6. Click OK.
7. Click Publish. The report is published to the location defined in the Edit Profile - General tab.

The dispatch list index page is a centralized portal for shop floor personnel to view operation, item, work order, demand, and customer information for specific resources in order to plan daily production tasks. The dispatch list homepage is organized by machine, crew, and tool resources. Shop floor personnel can click a resource link to view detailed schedule information for that resource, depending on the scope of data determined prior to the publishing process.

The following schedule data can be published to the shop floor and are defined by the Selected Columns set in the Edit Profile - Data Selection tab mentioned above:

Category	Data
Operations	Operation ID, Description, Start Time, End Time
Items	Item, Item Description, Quantity
Work Orders	Work Order Number
Demand	Demand Number, Demand Due Date, Demand Item, Demand Quantity
Customer	Customer Name, Customer Number

You can choose what headings you want in the report by selecting the check box in the profile's Data Selection window. Production Scheduling enables you to dispatch scheduling information to the shop floor efficiently without the need to write custom reports during the implementation phase. A Web-based dispatch list can be published and deployed to a Web server in your enterprise for shop floor personnel to use.

### Work Order Schedule Report

Work Order Schedule report contains all the necessary information on work orders that you have scheduled.

The Work Order Schedule report is saved as an .xml file in the location that you specify when you create the publish profile.

### Approving a Schedule

The schedule you want to publish must be approved before it is published.

To approve a schedule:

1. Access the Production Scheduling desktop.
2. Right-click the scenario whose schedule you want to publish.
3. Select Approve from the available options.

The green check mark beside the word Approved is set in a small box when the schedule is approved.

## Publishing a Schedule Using Publish Profiles

**Note:** You must approve the schedule before it can be published.

**To publish a schedule:**

1. In the Model Workspace, right-click the scenario that you want to publish.

2. Select Approve.

You cannot publish a schedule until it is approved.

3. From the File menu, select Publish.

The schedule is published to the Output directory location displayed in the Publish window.

4. In the Publish window, select a profile.

5. Click Publish.

6. To view the schedule data, access the output directory location and open the appropriate file.

## Editing an Existing Publishing Profile

**To edit an existing profile:**

1. From the File menu, select Publish.

2. In the Publish window, select the profile that you want to edit.

3. Click Properties.

4. In the Edit Profile window, modify the profile properties.

5. Click Apply, and then click OK.

## Deleting a Publishing Profile

To delete a publishing profile:

1. From the File menu, select Publish.
2. In the Publish window, select the profile that you want to delete.
3. Click Delete.
4. Click OK when prompted to delete the profile.
5. Click OK to close the Publish window.

## Publishing a Schedule to Oracle E-Business Suite

You can publish a schedule to the planning server and to Oracle Applications Manufacturing modules using the Publish process. After the schedule has been solved, you can publish the results to the E-Business Suite. The schedule must be approved before it is published to Oracle E-Business Suite.

To publish a schedule to Oracle E-Business Suite:

1. Right-click the schedule you want to approve for publishing.
2. Click Approve.

The schedule name appears in bold in the Production Scheduling model workspace.

3. From the File menu, select Publish.
4. From the publishing profile list, select Release Schedule.
5. Click Publish.

The schedule, including the sequenced planned orders, jobs, scheduled resource, and specific changeovers, are published to the planning server and automatically released to E-Business Suite.

## Publishing Schedule to cMRO and eAM

The production schedule for maintenance organizations that use cMRO or Enterprise Asset Management (eAM) can be published using the Release Schedule publish profile. You can selectively release work orders once they have been scheduled back into the cMRO and eAM systems with updated dates reflecting the actual schedule and firm status you define.

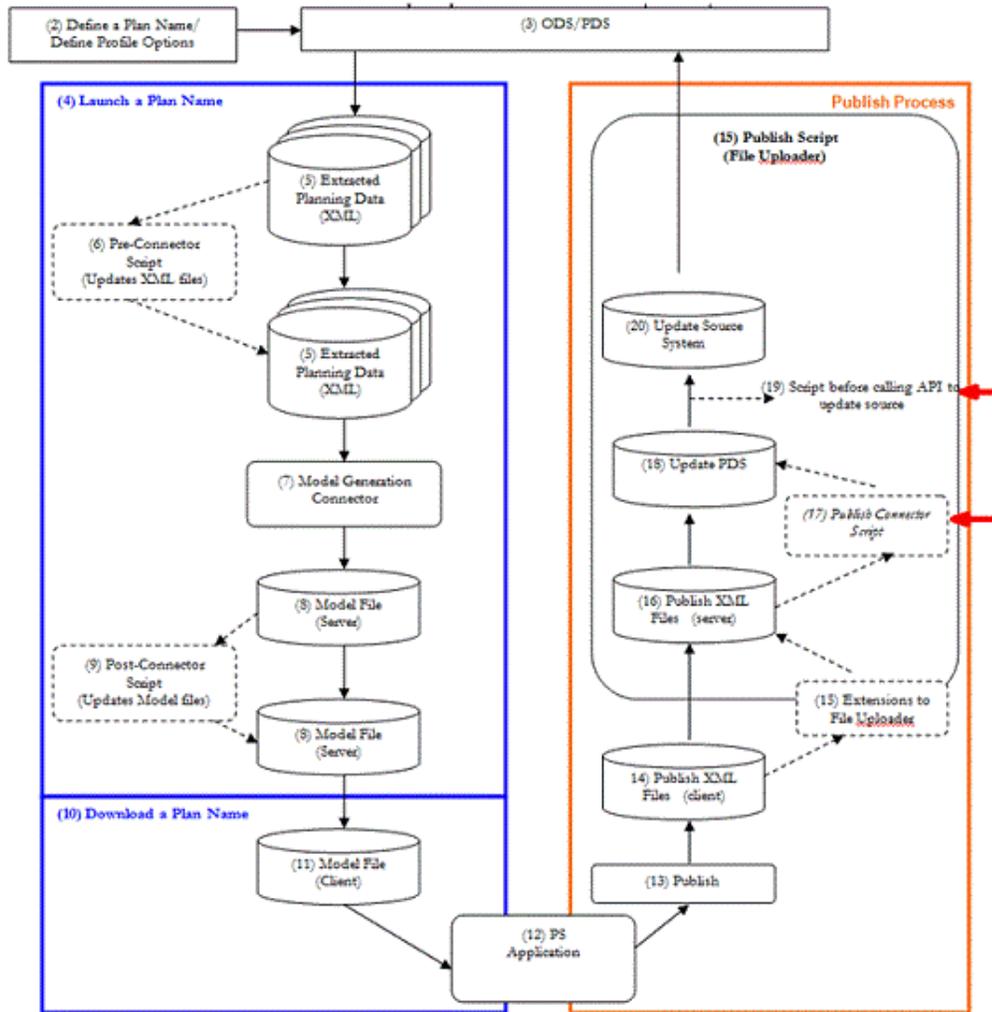
**Note:** For Enterprise Asset Management work orders are always treated as "firm" in source. Production Scheduling just updates scheduled times and resource assignment.

To publish schedule to cMRO and eAM:

1. Right-click the schedule you want to approve for publishing and select Approve.
2. Right-click the schedule, and select Edit Work Order Release.
3. Select the work orders you want to release.
4. Select the Publish icon from the toolbar, or select Publish from the File menu.
5. Select Release Schedule from the Profile Name list and click Publish. Only the selected work orders are released.

## Post Publish Customization Hook

Custom hooks augment and modify inbound data going into the application. On the outbound, or publish process, custom hooks are available so that you can customize the information being passed to the source system. In the diagram below, step 17, Publish Connector Script, and 19, Script before calling API to update source, are added to modify the data prior to updating the Planning Data Store (PDS) and also after loading the PDS tables, but before calling the source system API, that is, WIP\_MASS\_LOAD. Both scripts are explained below. In both cases, customizations are possible to accommodate your specific business requirements.



### Publish Connector Script

Prior to loading the data to PDS, a script can be called to make modifications to the XML data or call any other script. This script is optional

The scripts are kept in the directory: Data Store Path/plan\_id/publish/script

The script file is called pre\_ods.sh on Unix and Linux systems and pre\_ods.bat on windows machines.

### Script before calling API to update source system

Prior to calling the API to update the source system, that is, WIP\_MASS\_LOAD\_API, a script can be called to insert any necessary customizations. This script is optional.

The scripts are kept in the directory: Data Store Path/plan\_id/publish/script

---

## Integrating With Oracle Value Chain Planning Suite

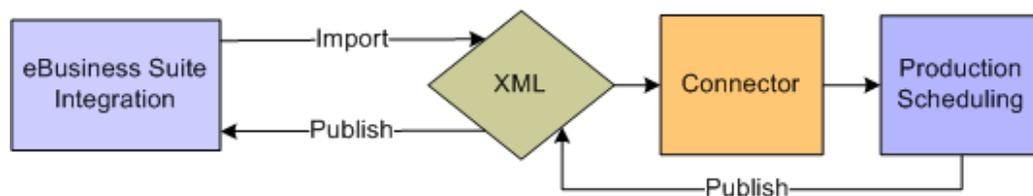
This chapter covers the following topics:

- Production Scheduling Integration with Oracle Value Chain Planning Suite Overview
- Integrating Production Scheduling with the Oracle Value Chain Planning Suite
- Importing Data to Production Scheduling
- Using Batch Commands

### Production Scheduling Integration with Oracle Value Chain Planning Suite Overview

Production Scheduling integrates with the Oracle Value Planning Suite (VCP) and Oracle ERP. This diagram illustrates how the application integrations with Oracle E-Business Suite:

**Note:** Oracle ERP refers to Oracle E-Business Suite and Oracle JD Edwards EnterpriseOne.



Production Scheduling integration with Oracle VCP

# Integrating Production Scheduling with the Oracle Value Chain Planning Suite

This section provides an overview of Production Scheduling in the Oracle Value Chain Planning Suite (VCP) and discusses how to use Production Scheduling in the Oracle Value Chain Planning Suite.

**Note:** Oracle JD Edwards EnterpriseOne customers, please consult the *Value Chain Planning to JD Edwards Process Integration Pack User's Guide* for additional comments.

## Production Scheduling in the Oracle Value Chain Planning Suite Overview

Production Scheduling integrates with the Oracle Value Chain Planning Suite to enhance the capabilities of Oracle Value Chain Planning (VCP).

Production Scheduling uses a constraint-based approach to automated scheduling, to produce optimized production schedules. Unlike traditional automated scheduling tools that are limited to simple dispatch rules and have known bottlenecks, constraints in Production Scheduling can be assigned to every element such as resources, operations, and due dates in a schedule. By employing an advanced solver technology, feasible solutions can be found, if they exist, for virtually any floating constraint.

## Business Processes

Through the seamless integration of Production Scheduling with Oracle VCP, you can create high level supply chain plans and refine these plans to create optimal production schedules that can be implemented using Oracle transaction systems.

Oracle ERP can send data to Production Scheduling one of two ways:

- From Oracle ERP to Production Scheduling.
- From Oracle ERP to ASCP to Production Scheduling.

This allows Production Scheduling to receive planned orders from Advanced Supply Chain Planning (ASCP) when generating detailed production schedules.

When receiving data from ASCP, Production Scheduling receives planned orders. Once Production Scheduling creates a detailed shopfloor schedule, Production Scheduling sends the schedule directly to Oracle ERP. The results from the schedule can then be sent to ASCP to constrain the subsequent run of the ASCP plan.

See *Integrating Production Scheduling, Oracle Advanced Supply Chain Planning Implementation and User's Guide*.

## Implementation

The implementation of Production Scheduling in VCP can be divided into the following steps:

- Setting up the source.
- Setting up the destination.
- Setting up collections.
- Setting up profile options.
- Setting up plan options for Production Scheduling.

## Using Production Scheduling in the Oracle Value Chain Planning Suite

You can use Production Scheduling in the Oracle Value Chain Planning Suite to take orders or planned orders from Oracle systems and create detailed, down-to-the-second manufacturing shop floor schedules and sequences. The Production Scheduling scheduling engine automatically identifies and resolves floating bottleneck problems to help maximize shop floor efficiency and throughput while minimizing cost. You can review the resulting work orders and release them to Oracle transaction applications for implementation, and use them as constraints in subsequent ASCP planning. While ASCP creates plans for entire supply chains, Production Scheduling creates production schedules for individual plants.

To create production schedules, Production Scheduling requires an accurate representation of how your manufacturing plant works, including machines, crews, materials handling and other resource constraints. Because Production Scheduling is integrated with the Oracle Value Chain Planning Suite, you can obtain the required data from Oracle applications by:

1. Running collections to transfer enterprise and transactional data from Oracle transaction applications to the Operational Data Store (ODS).
2. Launching a Production Scheduling plan from Oracle E-Business Suite to transfer enterprise and transactional data from the ODS to create a model of your manufacturing plant in Production Scheduling and, if available, ASCP planned orders or Demand Planning demand forecasts from the Planning Data Store (PDS).

When you launch a Production Scheduling plan, data is then imported into Production Scheduling on the client machine to create a manufacturing plant model.

If ASCP is used in planning, Production Scheduling uses planned sales orders from ASCP as demand in the model. If ASCP is not used, Production Scheduling uses Demand Planning forecasts, if available, and sales orders from the transaction

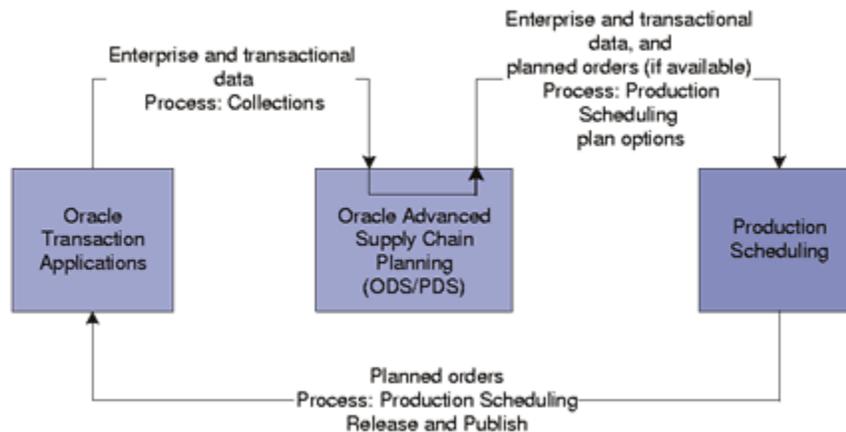
systems in the schedule horizon as demand.

**Note:** When you launch a Production Scheduling plan from Oracle E-Business Suite, Production Scheduling is automatically installed on the client if it is not already installed.

After transferring data to Production Scheduling, you can create optimal production schedules for meeting the demand, review the schedules, and revise the schedules as desired.

You can then publish revised work orders from Production Scheduling to be released to Oracle transaction systems through the Planning Data Store (PDS).

The following diagram shows the integration processes of transferring data from Oracle transaction applications to Production Scheduling and transferring planned order from Production Scheduling to Oracle transaction applications:



Oracle application integration with Production Scheduling

## Importing Data to Production Scheduling

To import data into Production Scheduling, you can create an XML model.

You can create an XML model by using an ETL tool of your choice.

**Note:** This is only necessary when not leveraging the standard integration.

## Using Batch Commands

You can use batch commands to publish data and perform a solve.

To solve and publish in batch mode.

1. Access a command prompt or a batch file.
2. Enter the following command:

```
[directory path] \scp\ [version number] \ps\bin\PsBatch path  
filename
```

where *[directory path]* is the path to where SCP is installed, *[version number]* is the version number of the SCP application, and *path filename* is the path and name of the batch input you have created for the process.

For example:

```
scp\ [version number] \ps\bin\>PSBatch c:/scp/ [version  
number] /ps/sample_data/samplebatchcommands.xml
```

There is a sample batch command file entitled *MyBatchScenarios.xml* in the *installation drive and path \scp\ [version number] \PS\sample\_data* directory.

3. Create your batch file, as displayed in the table below, or you can refer to the example command file entitled *SampleBatchCommands.xml* in the *installation drive and path \scp\ [version number] \PS\sample\_data* directory for the appropriate structure and nomenclature.

Batch file information is displayed in the table below.

Line Number	Input	Description and Values
1	?xml version= "1.0" encoding="utf-8"	SCP supports .xml version 1.0 and utf-8.
2	PSBatch version=	Enter the version of Production Scheduling that you are using.
3	model	The opening tag for the model information.
4	clientDeploymentDir	Specifies the target folder. Note that the client data store is currently a hard-coded subdirectory of the client SCP installation folder.

Line Number	Input	Description and Values
5	outputFileName	This is the name of the location of the output file. You must specify a path and name of the .dxt file if you want to create the file. For example: C:\scp\ [version number] \PS\sample data\Bikes 12.1.1.dxt
6	logFile	Server log file location (not required as the required logs will also be contained within the outputFile).
7	scenarioList	This line begins the specifications for the scenarios that you want to publish. You can publish more than one scenario in a single batch file.
8	scenario	The opening tag for the model information.
9	scenarioName	Optionally, you can enter a name for the scenario. If you leave this field blank, Production Scheduling will automatically assign a name to the scenario.
10	solveSchedule	Directs whether the specified schedule should be solved.
11	inputFile	Enter the directory C:\scp\ [version number] \PS\sample_data\Bikesath and name of your file. The file must be in XML format.

Line Number	Input	Description and Values
12	kpiFile	Specifies the output location for the XML KPI report on the specified scenario.
13	/scenario	Ends the specifications for publishing the scenario. To publish more than one scenario, repeat the same information for the next scenario, beginning at line 8.

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <PSBatch version="12.1.2">
3   <model>
4     <clientDeploymentDir>c:\scp\data_store\1138</clientDeploymentDir>
5     <outputFile>/user/serverDataStore/planDataStore/EbiPsSolved.dxt</outputFile>
6     <logFile>/user/serverDataStore/planDataStore/PSLog.txt</logFile>
7     <scenarioList>
8       <scenario>
9         <scenarioName>Coffee</scenarioName>
10        <solveSchedule>yes</solveSchedule>
11        <inputFile>/user/serverDataStore/planDataStore/EbiPsModel.ops</inputFile>
12        <kpiFile>/user/serverDataStore/planDataStore/PsKpis.xml</kpiFile>
13      </scenario>
14    </scenarioList>
15  </model>
16 </PSBatch>

```

Example of a Production Scheduling batch file



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## Scheduling Maintenance Work Orders

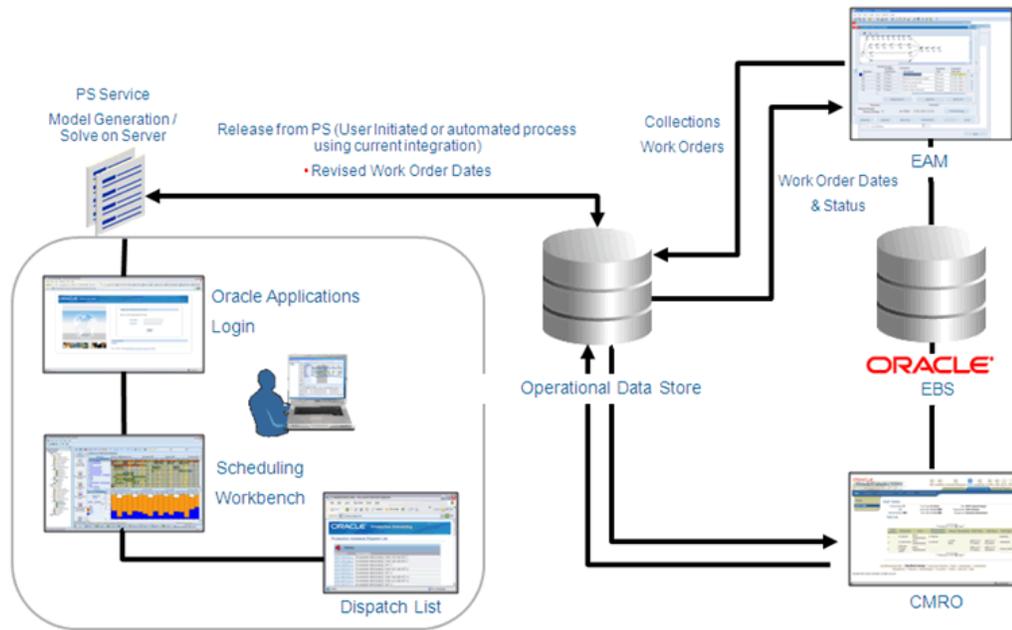
This chapter covers the following topics:

- Scheduling Maintenance Work Orders Taking into Account Visit Details, Milestones, and Work Breakdown Structure
- Supporting of Complex Task Hierarchy Relationships
- Representing the Work Breakdown Structure and Assignment to Work Orders
- Resequencing Visits
- Routings with Maintenance Work Orders Overview
- Releasing Work Orders from Production Scheduling to cMRO

### **Scheduling Maintenance Work Orders Taking into Account Visit Details, Milestones, and Work Breakdown Structure**

Work orders from cMRO can now be imported and scheduled using Oracle Production Scheduling. New tables, housing information such as visits, work breakdown structure, work order relationships, and milestones, have been added to the Operational Data Store (ODS); this information is required to properly schedule cMRO work orders. Currently, this information is not available to standard planning collections from cMRO. An API into these new tables to augment collected data has been added to complement the existing collections framework as Production Scheduling requires this information to generate a maintenance schedule.

The Production Scheduling integration with Oracle cMRO architecture is represented in the diagram below.



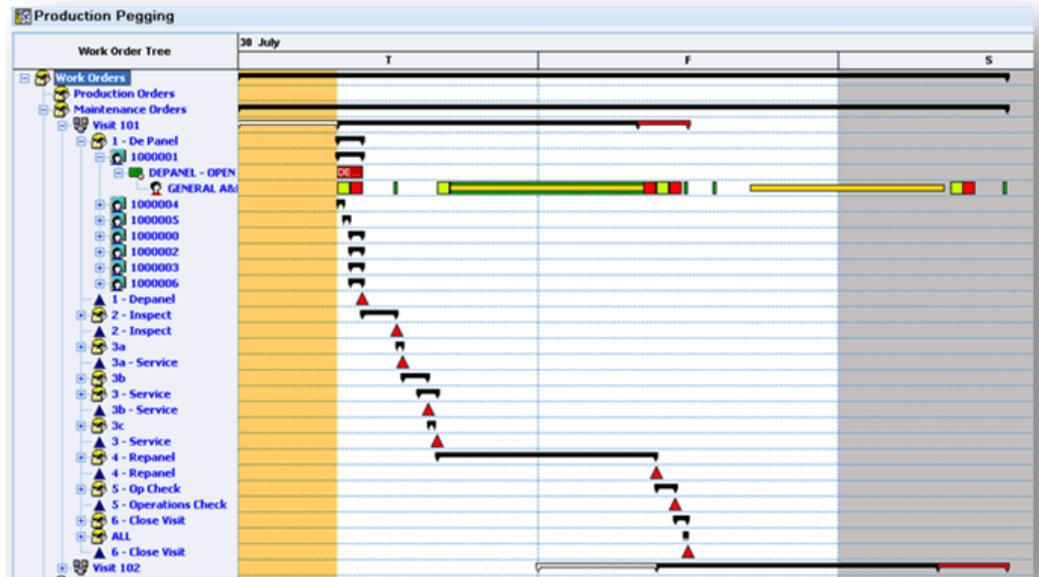
For more information on cMRO, refer to the following:

- *Oracle Complex Maintenance, Repair, and Overhaul Implementation Guide.*
- *Oracle Complex Maintenance, Repair, and Overhaul User's Guide.*

## Supporting of Complex Task Hierarchy Relationships

Visits have been added to Oracle Production Scheduling to allow for the scheduling, tracking, and grouping of tasks in the form of work orders and milestones. Visits and milestones are presented in the various views in Production Scheduling and allow the planner to leverage the rich set of existing functionality to review and refine the schedule. Visits and milestones also present new constraints which govern the production schedule that is generated.

The following image provides an example of the complex task hierarchy for maintenance orders and the visits and milestones that can be assigned to them.



Task hierarchies are also introduced in the form of work order relationships where standard precedence constraints inherent in Production Scheduling can be leveraged to define the relationship between specific tasks.

In order to efficiently review the schedule, work order filters can be used and allow the planner to "slice and dice" the data in the various Gantt, Utilization, and Work Order views. This feature allows the planner to focus on specific tasks and answer questions such as "show me all work orders in stage 3a from July 2 - July 4 utilizing the Advanced Airframe and Power crew which are firm".

You can also filter on many of the existing constructs already available in work orders. Refer to Using the Work Order Advanced Filter, page 9-37 for more information.

Once the cMRO model is reviewed and analyzed in Production Scheduling, work order dates generated by the schedule can then be released back to cMRO for execution by publishing the schedule.

## Representing the Work Breakdown Structure and Assignment to Work Orders

The logical grouping of work can be accomplished by leveraging the cMRO Work Breakdown Structure (WBS), which is passed into Production Scheduling. The Display Parameters tab in the Plan options screen can be used to create logical groupings of work orders. The Selected attributes are used to group work orders into folders within the Work Order Editor in Production Scheduling and allows the planner to group the work orders based on the Work Breakdown Structure.

The Work Breakdown Structure is populated as work order attributes and can be viewed in the Work Order Editor. This allows for enhanced filtering from Work Order Advanced Filters where they can be used to group work orders in the various views

when analyzing the schedule.

See Integrating Production Scheduling, *Oracle Advanced Supply Chain Planning Implementation and User's Guide*.

## Resequencing Visits

In Maintenance Scheduling, it is often necessary to manually reschedule a group of work orders. For example, you may be interested in adjusting the work orders as follows:

- Set work orders in a specific Milestone to start on Wednesday.
- Complete work orders in a given Stage by Friday.

Work orders often share a common attribute, such as Stage, Milestone or other Work Breakdown Structure (WBS) attribute. You may wish to reschedule a group of work orders which are not all within the same milestone, but share some other common attribute.

Production Scheduling allows you to perform the following:

- Set Earliest Start Date and Target Completion Date for a Milestone.
- Select and modify the target start and completion dates for a group of work orders.

**Note:** Publish your schedule if manual changes are made to visit or milestone dates.

## Assigning Earliest Start and Target Completion Date to a Milestone

You can reschedule the work orders **preceding** the milestone by assigning an Earliest Start Date or Target Completion Date. These dates are optional.

Earliest Start Date is a hard constraint (the task cannot start earlier, but it can start later than the date specified). Work orders which have this milestone as a "Next Milestone" cannot start before this date. Target Completion Date is a soft constraint.

### Assigning Dates from the Production Pegging View

1. From the Production Pegging view, expand the visits folder and select the appropriate milestone.
2. Right-click and select Properties.
3. From the General tab, update the Earliest Start Date and Target Completion Date fields.
4. Click OK.

5. Click the Solve button to view your modifications.

#### **Assigning Dates from the Visit Properties Window**

1. From the Production Pegging view or Model Workspace, expand the visits folder.
2. Select a visit.
3. Right-click and select Properties.
4. From the Milestone tab, click in the Earliest Start Date or Target Completion Date column for the milestone you want to modify and enter the date you want to assign.
5. When you have completed your updates, click OK.
6. Click the Solve button to view your modifications.

For more information on visit properties, see *Viewing and Defining Visit Properties*, page 5-32.

#### **Assigning Dates from the Model Workspace**

1. From the Model Workspace, expand the All Visits folder.
2. Expand the visit folders to view the milestones assigned to each visit.
3. To view work orders that precede and follow the milestone, perform the following:
  1. Double-click the milestone. The Milestone Property window appears.
  2. Select the Work Order tab. This tab displays the work orders that precede and follow the selected milestone.
4. Right-click the milestone and select Properties.
5. From the General tab, update the Earliest Start Date and Target Completion Date fields.
6. Click OK.
7. Click the Solve button to view your modifications.

## **Changing Earliest Start Date or Request Date for Multiple Work Orders from the Production Pegging View**

You can modify the Earliest Start Date and Request Date fields for multiple work order from the Production Pegging view.

To Change the Earliest Start Date or Request Date for Multiple Work Orders, perform

the following:

1. Access the Production Pegging view.
2. Expand the Maintenance Orders folder.
3. Expand the visits folder.
4. Select the work orders you want to modify.

Select a work order folder to modify all the work orders within the folder. You can also select multiple work orders from the expanded folders. Select the work order that you want to change by holding down the Shift key and highlighting the appropriate resources or folders. If the work orders or folders are not listed sequentially, hold down the CTRL key and select the individual work orders.

5. Right-click and select Change. The Change - Work Order dialog appears.
6. From the General tab, change the Earliest Start Date and the Request Date.
7. Click OK.
8. Click the Solve button to view your modifications.

## **Changing Earliest Start Date or Request Date for Multiple Work Orders from Work Order Advanced Filter Window**

You can modify the Earliest Start Date and Request Date fields for multiple work order from the Work Order Advanced Filter window. This option allows you to perform a query to retrieve specific work orders based on your filter criteria. Once the query is performed, you can select one or more work orders and modify the Earliest Start Date and Request Date.

To Change the Earliest Start Date or Request Date for Multiple Work Orders, perform the following:

1. Access the Work Order Advanced Filter window.
2. Filter work orders based on the appropriate criteria.
3. Select work orders you want to modify from the Search results at the bottom of the window.
4. Right-click and select Change. The Change - Work Order dialog appears.
5. From the General tab, change the Earliest Start Date and Request Date.
6. Click OK.

7. Click the Solve button to view your modifications.

## Modifying Work Order Folders When Updating Multiple Work Orders

When updating multiple work orders, you can add or change the work order folder assigned to the selected work orders. This feature allows you to organize work orders into folders as needed. For example, you may have work orders in various folders that need to start no earlier than Thursday since they all use the same resource which happens to be down for maintenance until that date. The selected work orders may originally be organized in different folders which makes it difficult to analyze the changes. By placing them all in the same work order folder, you prevent them from being scattered across different views in Production Scheduling, making it easier to see them all together when they are scheduled.

1. From the Production Pegging View or Work Order Editor, expand the Maintenance Orders, visit and milestone folders to view all the work orders you want to update and place in the same work order folder location.
2. Select the work orders.
3. Right-click and select Change. The Change - Work Order dialog appears.
4. From the General tab, select the Change Work Order folder option from the Folder region. When selected, the Maintenance Orders and visits tree below are enabled. This allows you to navigate to the target location where you want store the work orders.
5. To place the work orders in a new work order folder, perform the following:
  1. Expand the Maintenance Orders and visit folders as needed.
  2. Click New Folder. The new folder appears as a subfolder under the selected folder.
  3. Modify the folder name.
6. To change the work orders to an existing work order folder, perform the following:
  1. Expand the Maintenance Orders and visit folders as needed.
  2. Select the location where you want the selected work orders to be stored.
7. Click the Dates tab, and modify the Earliest Start Date, Request Date, and Target Completion Date fields as needed.
8. Click OK.

You can view your changes in the Work Order Editor. The selected work orders

appear in the folder you defined.

## **Routings with Maintenance Work Orders Overview**

When working with maintenance work orders, routings in Production Scheduling are created directly from the work orders themselves. From the Model Workspace, you can view all routings by expanding the All Routings and Work Order Routing folders.

## **Releasing Work Orders from Production Scheduling to cMRO**

Production Scheduling allows you to selectively release work orders once they have been scheduled back into the cMRO system with updated dates reflected by the actual schedule and the firm status you defined. This is performed by approving the schedule, publishing the work orders using the profile setting defined for your cMRO process. The revised Work Order Dates are visible back in cMRO.

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# Considering Enterprise Asset Management Work Orders

This chapter covers the following topics:

- Considering EAM Work Orders Overview
- Enterprise Asset Management Integration
- Manually Scheduling Enterprise Asset Management Work Orders
- Solving Schedules for Enterprise Asset Management Work Orders
- Publishing Work Order Dates to Enterprise Asset Management

## Considering EAM Work Orders Overview

For a maintenance organization, managing maintenance resources that perform maintenance tasks is another important consideration to ensure that the maintenance resources can perform the scheduled tasks when needed, reduce the occurrences of unscheduled downtime, and maximize the overall return on investment for the asset. The Oracle Enterprise Asset Management (eAM) application suite provides for the complete management of these assets and can track the asset using meters, quality plans, and condition monitoring systems, allowing companies to formulate effective preventative maintenance strategies.

A resource that is scheduled for Maintenance in eAM can be considered as a downtime maintenance event by Production Scheduling. The scheduling engine considers the planned availability of the resource when generating a schedule. This consideration is not sufficient when common resources and materials are shared between general maintenance activities, managed by cMRO, and asset maintenance, managed by eAM. For example, a maintenance crew might have the training and skill set to perform maintenance tasks on an aircraft as part of a Visit (cMRO) as well as an Asset (eAM). The schedule must account for these shared resources when generating the maintenance schedule for Visits for release back to cMRO.

Production Scheduling considers the predetermined preventative maintenance

activities managed in eAM while generating the Production Schedule. It is important to note that the maintenance schedule is currently managed in Oracle Enterprise Asset Management's Maintenance Scheduler, which considers factors important and unique to Enterprise Asset Management that are not considered by Production Scheduling, such as usage, meter readings, or calendar days. For example, an aircraft tow tractor may need maintenance after every 200 Motor hours or 6 months, whichever comes first. Since Production Scheduling does not understand these important concepts, it cannot effectively schedule, or reschedule, maintenance work orders. By integrating Production Scheduling and eAM, Production Scheduling respects the eAM maintenance schedule and takes into consideration the resource downtime of the maintenance resource, common resources and common materials required to perform cMRO and eAM maintenance activities. The eAM maintenance schedule will still be generated and managed in eAM.

**Note:** The eAM organization must be the same as the Discrete organization. Because of this, Oracle Process Manufacturing (OPM) integration with eAM is not possible. You can continue to leverage the Simulation set integration with eAM when the organizations are not the same.

Considering Oracle eAM work orders in the maintenance schedule provides the following benefits:

1. Produces a better quality first pass schedule by considering common resources and materials used for equipment maintenance (cMRO) and asset maintenance (eAM).
2. Improves planner efficiency by minimizing the manual intervention required to generate a feasible schedule.
3. Provides for the ability to view the holistic maintenance schedule for equipment maintenance (cMRO) and asset maintenance (eAM) in a single application.

While Production Scheduling will not schedule these work orders, the work orders can be moved via manual scheduling. In this case, the precedence relationship is respected to prevent errors from occurring in eAM. To alleviate this, manual scheduling a work order may require moving the related work order to respect the precedence relationship. All related work orders should be moved in groups so if a child work order is moved 14 hrs forward, then the parent work order should move 14 hrs forward as well.

You can manually schedule Enterprise Asset Management work orders by:

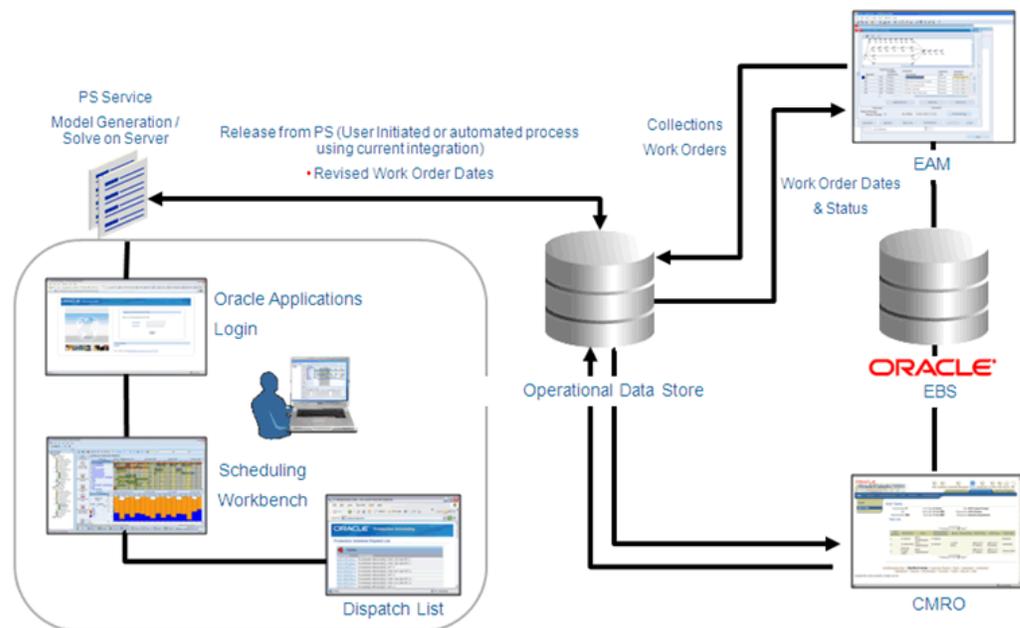
- Dragging and dropping an operation in the Gantt views.
- Changing work order fields in the Work Order Editor such as Work Order Request Date, and operations Start and End Dates.

## EAM Work Order Priorities

Work order priorities in Production Scheduling are used by the scheduling engine to make intelligent decisions when contention exists. Work order priorities in eAM are user-defined lookups so a predefined mapping between systems is not possible. Since the Production Scheduling engine will not be scheduling Enterprise Asset Management work orders, the priorities are not meaningful for EAM work orders and will be defaulted.

## Enterprise Asset Management Integration

The following diagram illustrates the integration architecture between the two systems and is summarized below.



The existing Production Scheduling integration to Oracle EBS architecture has been expanded to accommodate the CMRO and EAM systems.

When Enterprise Asset Management is implemented with Production Scheduling, the following processes are performed:

- EAM Work Orders are collected.
- Set plan options for Production Scheduling to indicate whether to include EAM work orders. For information refer to "Integrating Production Scheduling" in the *Advanced Supply Chain Planning Implementation and User's Guide*.
- The Production Scheduling service can be called manually or via concurrent

program to create and solve the model on the planning server.

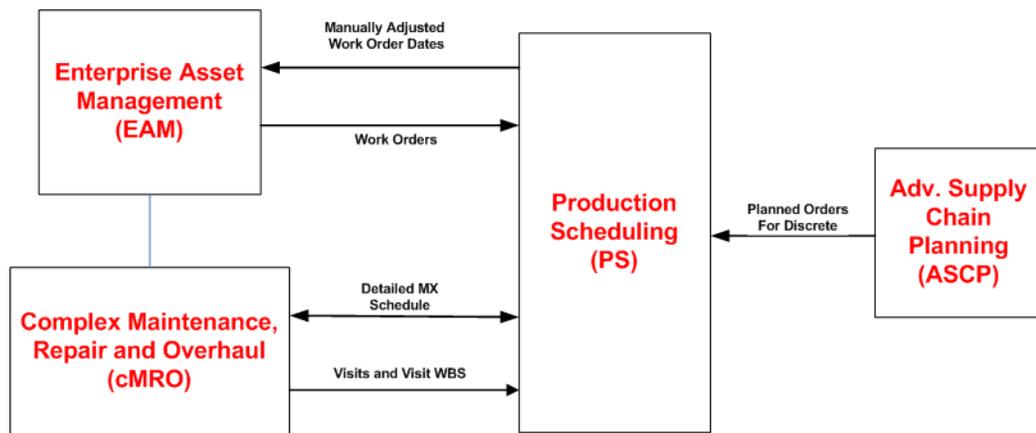
- User logs in using standard Oracle planning application login functionality.
- Release is required to send updated dates back into the WIP Interface tables.

For more information on Oracle Enterprise Asset Management (eAM), refer to the following:

- *Oracle Enterprise Asset Management Implementation Guide*
- *Oracle Enterprise Asset Management User's Guide*

## Data Interaction

The diagram below depicts the overall, high-level workflow and interaction between Oracle eAM, cMRO, ASCP, and Production Scheduling. A description of each of the integration touch points are described below.



**Manually Adjusted Work Order Dates to EAM** - Work order dates can be released from Production Scheduling to EAM if the EAM work orders are manually scheduled in Production Scheduling. This adjustment of the EAM schedule will be respected by EAM.

**Work Orders from EAM** - Work orders from EAM are imported to Production Scheduling for consideration when generating the schedule. The scheduling of these work orders will remain in EAM which can consider Meters to effectively schedule the work orders.

**Detailed Maintenance (MX) Schedule to cMRO** - Production Scheduling will release work order dates back to cMRO after scheduling, considering resource and material constraints. This schedule will also consider the EAM schedule which will account for resource unavailability and common materials and resources.

**Visits & Visit WBS from cMRO** - The integration between cMRO and Production Scheduling passes Visits, Work Breakdown Structure, task hierarchy information, and

associated work orders to Production Scheduling.

**Planned Orders for Discrete** - Planned Orders for Discrete jobs can be passed from ASCP to Production Scheduling.

**Note:** Production Scheduling will schedule by organization. To consider cMRO, EAM, and Discrete work orders simultaneously, they must all exist in a single organization.

## Enterprise Asset Management with OPM

An OPM organization cannot be an EAM organization. Customers who are using both applications must set up separate organizations for this configuration. Since Production Scheduling schedules a single organization only this configuration is not supported.

## Manually Scheduling Enterprise Asset Management Work Orders

While Production Scheduling will not schedule Enterprise Asset Management work orders, the work orders can be moved via manual scheduling. In this case the precedence relationship needs to be respected, otherwise errors will occur in eAM. To alleviate this, manual scheduling a work order may require moving the related work order to respect the precedence relationship. All related work orders should be moved in groups; if a child work order is moved 14 hrs forward, then the parent work order should move 14 hrs forward as well.

## Solving Schedules for Enterprise Asset Management Work Orders

When solving the production schedule, the resource that is receiving Asset Maintenance should be considered down based on the Shutdown Status of the resource. The Solver should never move the EAM work orders and simply schedule around the maintenance activities. Due to this, it is possible for the plan to be capacity and material infeasible for EAM work orders.

EAM work orders should never move during a cold or repair solve which implies that:

- EAM operations can cross calendar delay or down events. For delay events, the operations should not be stretched to span the delay event as it should simply respect the EAM operation times.
- Single capacity resources can be infeasible for EAM operations.
- Multi capacity resources can be infeasible for EAM operations.
- Inventory balances can fall below zero for EAM operations.
- Non-EAM work orders should be scheduled around the maintenance activities.

## Considering Enterprise Asset Management Work Orders When Generating the Production Schedule

When solving the schedule, the EAM work order dates will always be respected and treated implicitly as firm by the Production Scheduling Engine with the remaining Manufacturing or cMRO work orders being scheduled around it. This is true, even if the resulting EAM work orders cause logical infeasibilities in the schedule. For example, overlapping EAM work orders may cause the schedule to be infeasible. These logical infeasibilities are addressed by the Production Scheduling engine. The purpose of importing the Enterprise Asset Management work orders is to account for resource availability of both the asset being maintained and also the supporting resources required to perform the maintenance, including material requirements. These resources can be common across cMRO and EAM. Without accounting for the resource usage for EAM work orders, the resource availability will be overstated when planning Visits for cMRO.

## Publishing Work Order Dates to Enterprise Asset Management

While Production Scheduling will not schedule the EAM work orders, you may need to manually adjust the work order schedule to produce a satisfactory schedule for maintenance activities. The changed work order dates will be released back to EAM to respect these changes with the Scheduled Start Date and Scheduled Completion Date updated for non-complete operations. Work orders that are manually scheduled by Production Scheduling will not be scheduled by EAM as they will be sent back as Firm.

Once the production schedule is reviewed and approved, work order dates can be released back to EAM. Since the Production Scheduling engine will not change the EAM work order dates, it is only relevant to publish back manually scheduled EAM work orders. The Edit Work Order Release view in Production Scheduling should not have EAM work orders selected by default unless they have been manually scheduled. This includes work orders that were moved in the manual scheduling process to respect the precedence relationships defined in the EAM work orders. To aid in reviewing the work orders to be released, work order filters can be leveraged to view to only orders where EAM is the source. To sort work orders, click the Type column. This feature allows you to easily located EAM work orders when they need to be published.

When releasing back to EAM, the work order should be sent back as "Firm," which is an indication by EAM not to schedule the work order in the EAM scheduler. This ensures that manually scheduled work order dates will be respected when re-imported into Production Scheduling. While it is expected that only manually scheduled work orders will be released back to EAM, as they are the only ones selected by default, you can optionally select other work orders which will simply Firm the work order in EAM.

**Note:** When manual scheduling, it is possible to violate EAM precedence constraints which may cause the release back to EAM to

fail, so the scheduler needs to be aware of this when manually moving jobs.

To publish work order changes to Enterprise Asset Management, refer to Publishing a Schedule to Oracle E-Business Suite, page 11-12.



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