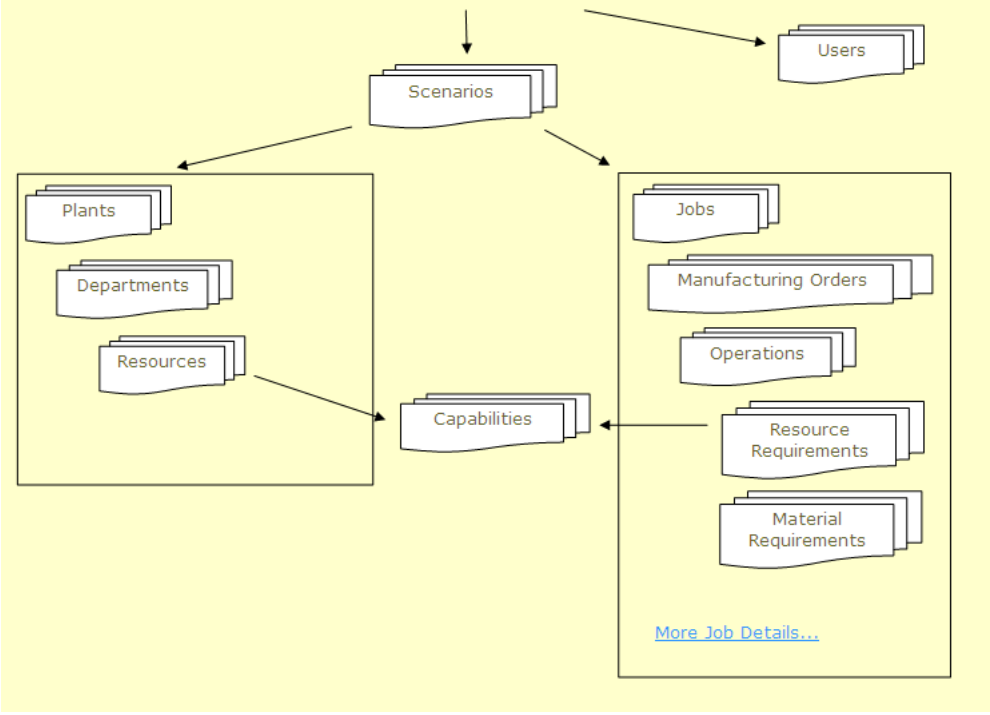
Overview of Constraints and Scheduling Algorithms in PlanetTogether

Data Elements in PlanetTogether

These are the main data elements contained in the PlanetTogether Advanced Planning & Scheduling system. The diagram illustrates:

1. There can be any number of a given object, as shown by each item stacked below. For example, a given Plant can contain any number of Departments, and each Department can contain any number of Resources.
2. The hierarchy of objects is also illustrated. A single Job can contain multiple Manufacturing Orders (MOs). A MO contains Operations, and each Operation can consist of any number of Resource Requirements and Material Requirements.
3. Operations are matched to Resources via Capabilities. Each Resource has a list of Capabilities it can perform, and multiple Resources can share the same Capability. An Operation's Resource Requirements specify any number of Capabilities needed at that particular operation step.

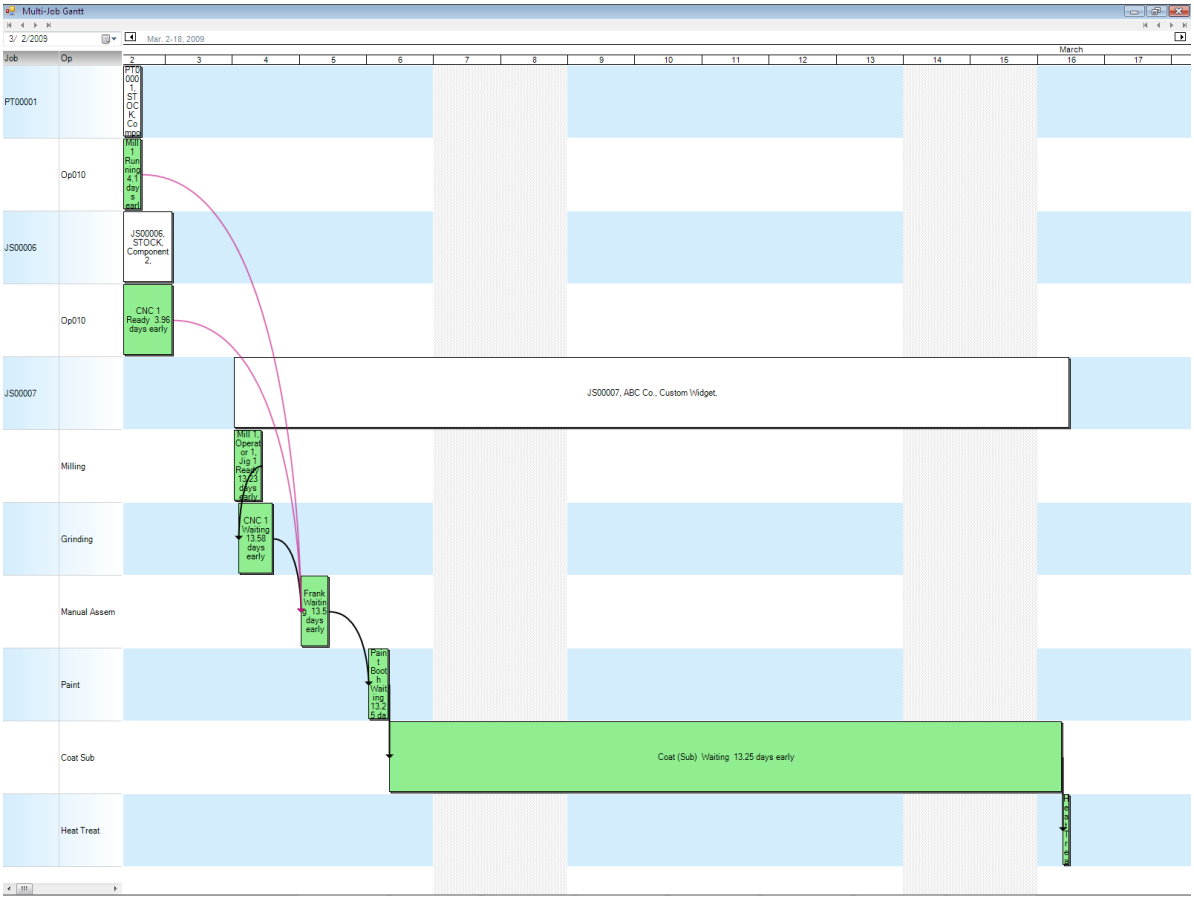


Material and Capacity Constraints in PlanetTogether

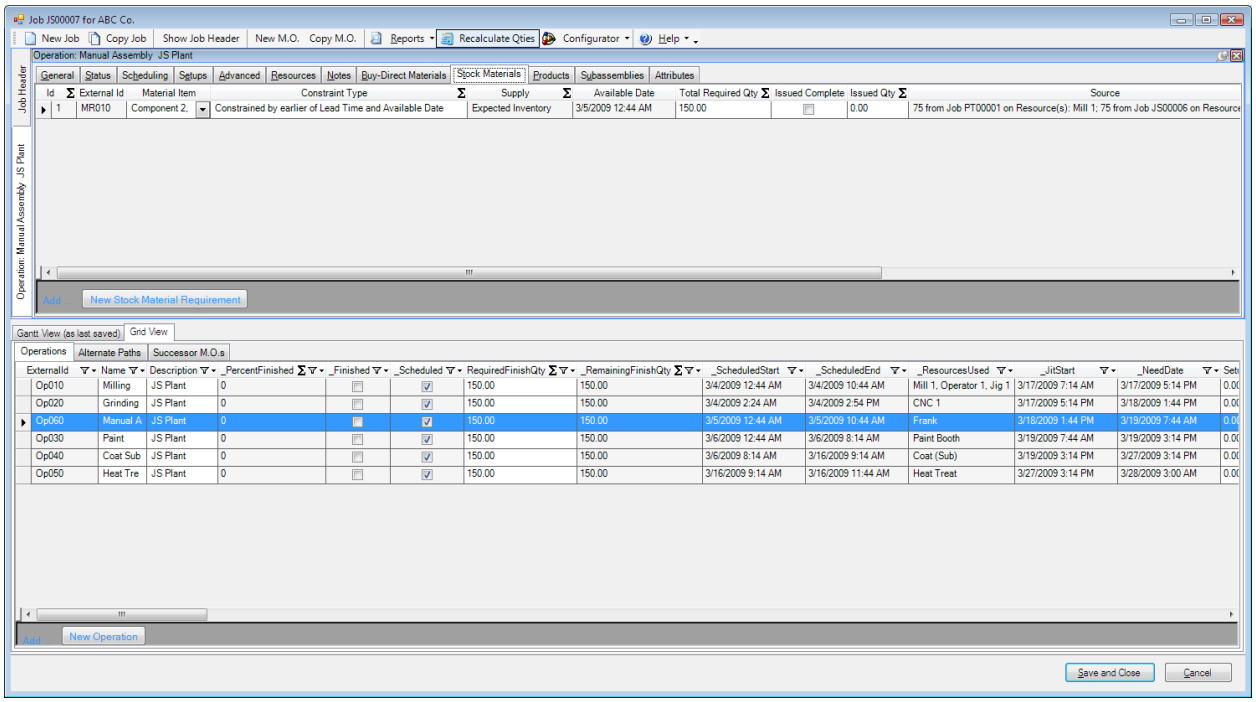
The product structure defined in a business system such as an ERP system, or in another data source such as a product database, is a vital input to PlanetTogether Advanced Planning and Scheduling. One main advantage of using product information from an ERP system is that the same information serves both accounting and production planning purposes, and is automatically connected to PlanetTogether. There are two parts of a product structure that may be considered:

1. Routing – this includes the operations and tasks required to produce a given item, whether the item is a finished good or intermediate/sub-assembly item. The routing defines the time and resource requirements for each operation step, and the relationships and dependencies between operations (the flow of the product through the production process.)
2. Bill of material (or recipe) – this defines the materials and quantities required at a particular routing step. An item in a bill of material can be a constraint or a non-constraint; non-constraint materials are allowed to go into a negative inventory position (shortage) in the plan. If a constraining material is unavailable, and production dependent on that material is automatically planned at a time when the material is available. Constraining materials are not allowed to enter a shortage situation in the plan. Materials can be purchased, manufactured or supplied by either purchasing or manufacturing.

This is a graphical representation of a Job with two manufactured material requirements. Job JS00007 has six operations in its routing, and operational dependencies are shown with black arrows connecting the blocks. The schedule for the two Jobs supplying the Manual Assembly operation are also shown, and the material dependencies are illustrated with violet arrows.



This is the Job detail screen for the assembly Job JS00007. The lower pane in the window shows the schedule and fields for each operation in the routing at this level. The upper pane shows the material requirements at the manual assembly operation and their currently scheduled sources. Thus, the same information is available graphically and in text formats.

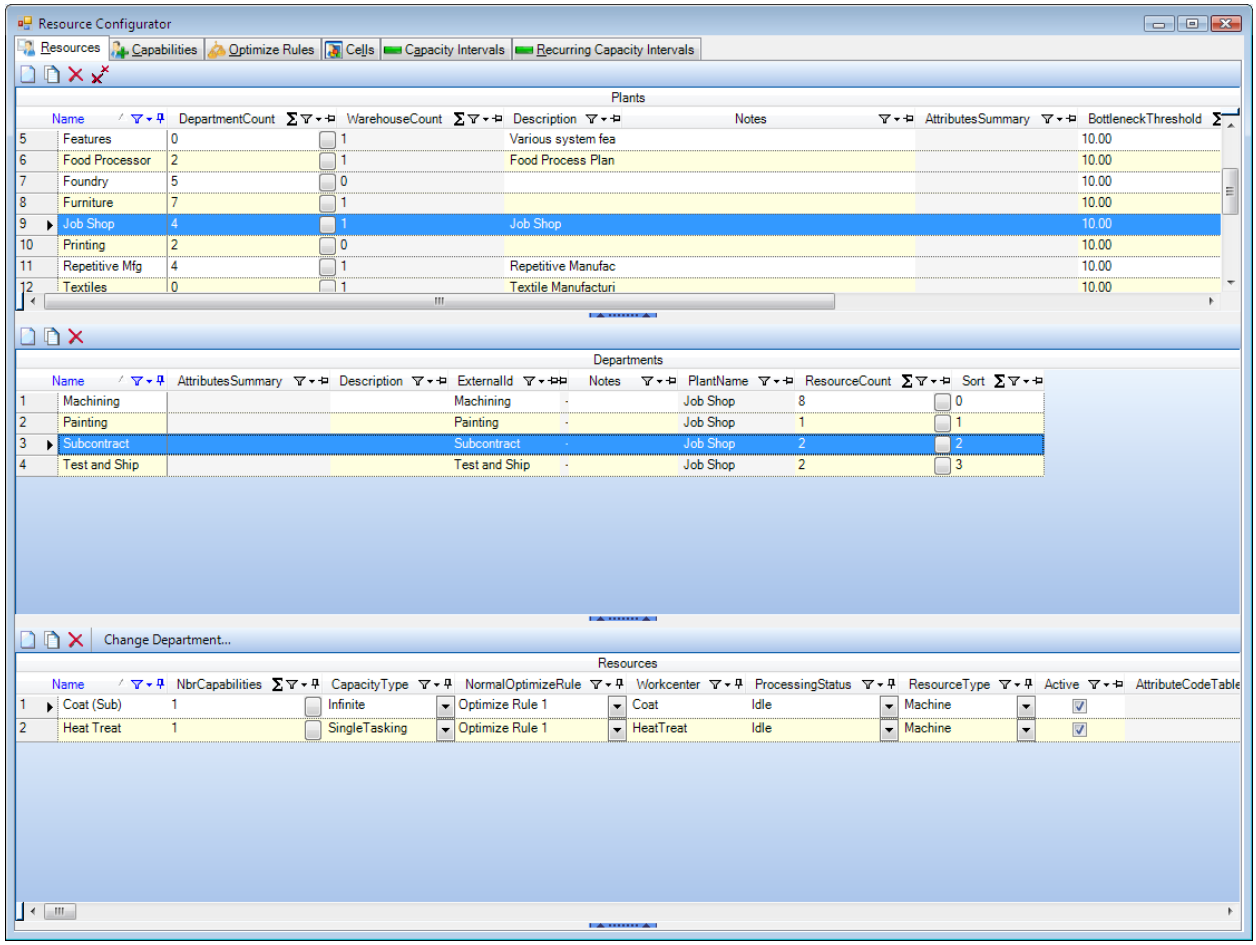


Resources and Capabilities

The resources within the production process are also an important part of creating an accurate representation of the production process. Resources can represent machinery, equipment, labor, tooling, storage, etc. The main points to consider for a resource are:

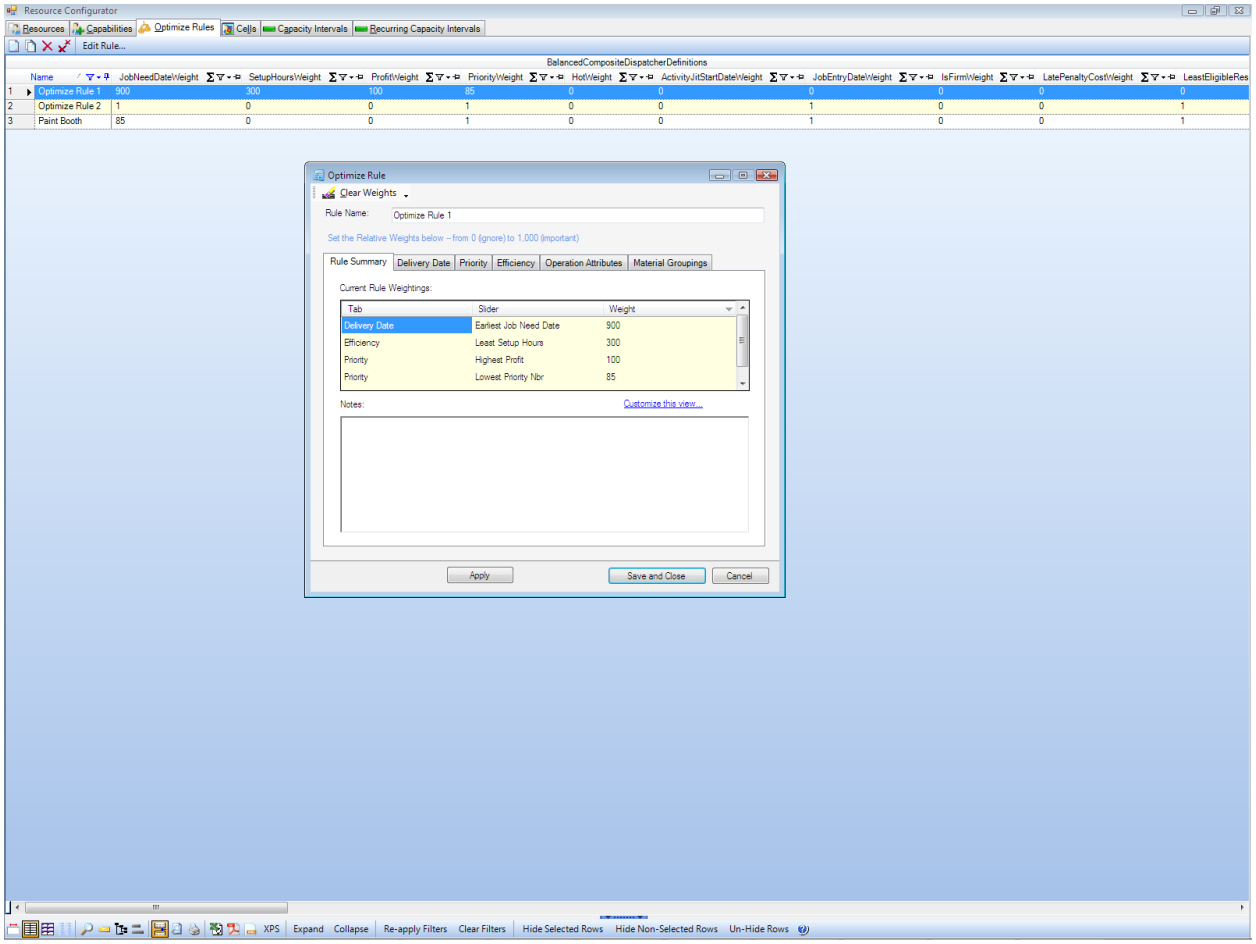
1. How many operations can be scheduled simultaneously. Each resource within the production model can be modeled as single-task (finite capacity), infinite capacity, multi-tasking (finite, but capable of working on more than one operation at a time), and batch.
2. The shift calendar defining when the resource is available and unavailable for work.
3. The Capabilities of the resource. Capabilities control which resources are eligible to work on a given operation. Capabilities are used to search for alternatives during the optimization process, and are also used when the planner makes a drag-and-drop change.
4. Each Resource also has a Normal Optimize Rule that is used by the optimization process. Optional Experimental Optimize Rules may be assigned to Resources as well.

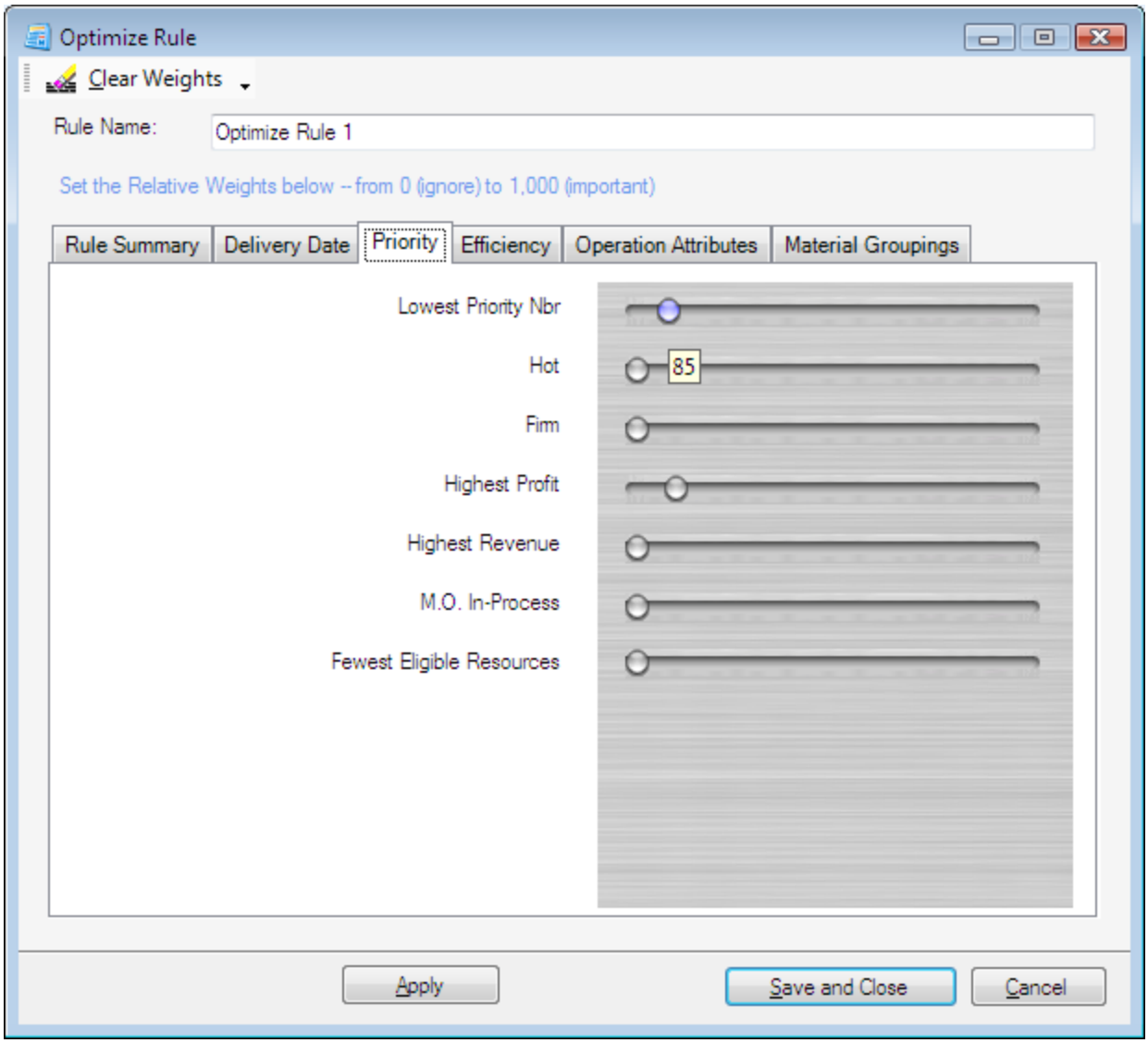
This screen illustrates two Resources within the Subcontract Department of the Job Shop plant. Each Resource in this example has a single Capability, as shown in the NbrCapabilities column.



Optimization

The Optimization process uses the Optimize rules assigned to each Resource to select the next Operation to schedule on a given resource. All constraints are obeyed during this process. Any number of Optimize Rules can be saved, stored, modified, and assigned to Resources in the Live Scenario and What-if scenarios. An optimize rule consists of a balance of factors defined by the user, so the resources using that rule are selecting tasks to meet business goals such as meeting due-dates, while balancing other factors such as costs and efficiencies.





A factor is adjusted by sliding the graphical controls above; or values can be entered directly. A simple rule such as scheduling by due-date would have a factor value greater than zero for "due-date", and a value of zero for all other factors. If it were desired to have a Job priority code as a "tie-breaker" for Jobs with the same due-date, the Priority factor would be adjusted upward from, but less than the due-date factor. In this way, the appropriate balance of all business factors can be accommodated easily, by adjusting the relative importance of each factor.

These rules give each resource a routine for selecting the best available task to work on next, while recognizing constraints. During the optimization, you might think of time being "simulated" as passing during the planning run, from the beginning of the planning horizon to the end (or a subset of that time range). How does this work?

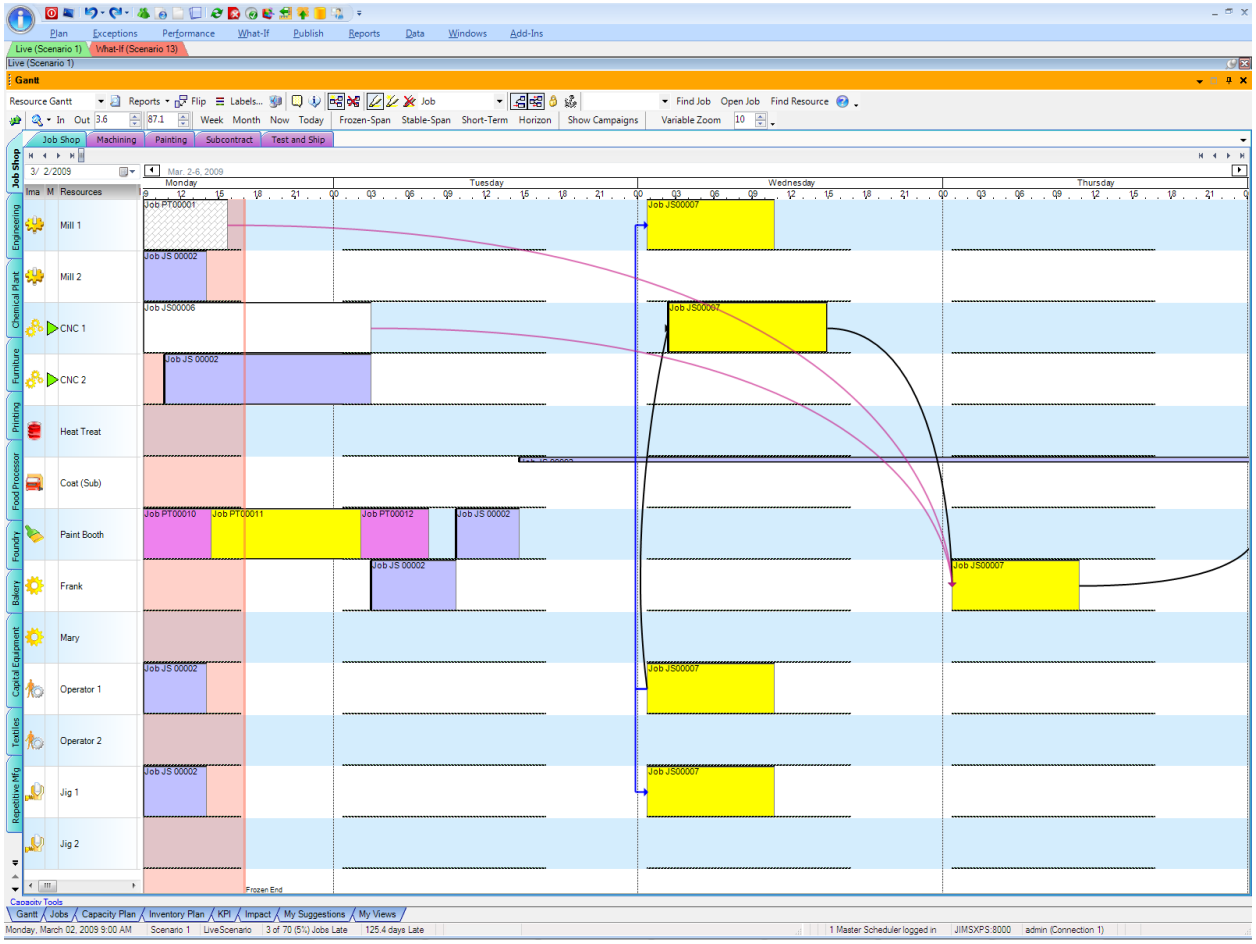
1. A resource needs to be available to work on a task at a given time. If the resource is “busy” at that time, the simulated timeline must pass until the resource is available.
2. Only tasks that are “ready” to be worked on can be considered by that resource. This requires:
    a. An Operation can only be assigned to a Resource that has all of the Capabilities the Operation requires.
    b. An Operation will be “ready” based on the expected availability of materials at that moment in time, as well as any preceding constraints based on subassemblies or other operation steps within a routing or process flow.
3. If a resource has several “ready” tasks to choose from at a given point in time, it uses its Optimization Rule for selecting the best choice. Each attribute of the Operation is considered, and adjusted by the weighting factors specified in the rule.
4. The resource applies its rule, loads the task, and must wait until the expected completion time of that task before beginning again at Step 1.

A single Optimize run can therefore reschedule each Operation to the best available time and resource, based on constraints, calendars, material availability, and appropriate business rules. Many controls are available for managing which Jobs, Resources, and portions of the plan are optimized at a given time; not every Operation must be rescheduled during an Optimization. This provides the best balance between automatically loading resources according to business rules, while allowing the end-user to manage special circumstance in the schedule, and maintain stability over a portion of the planning horizon.

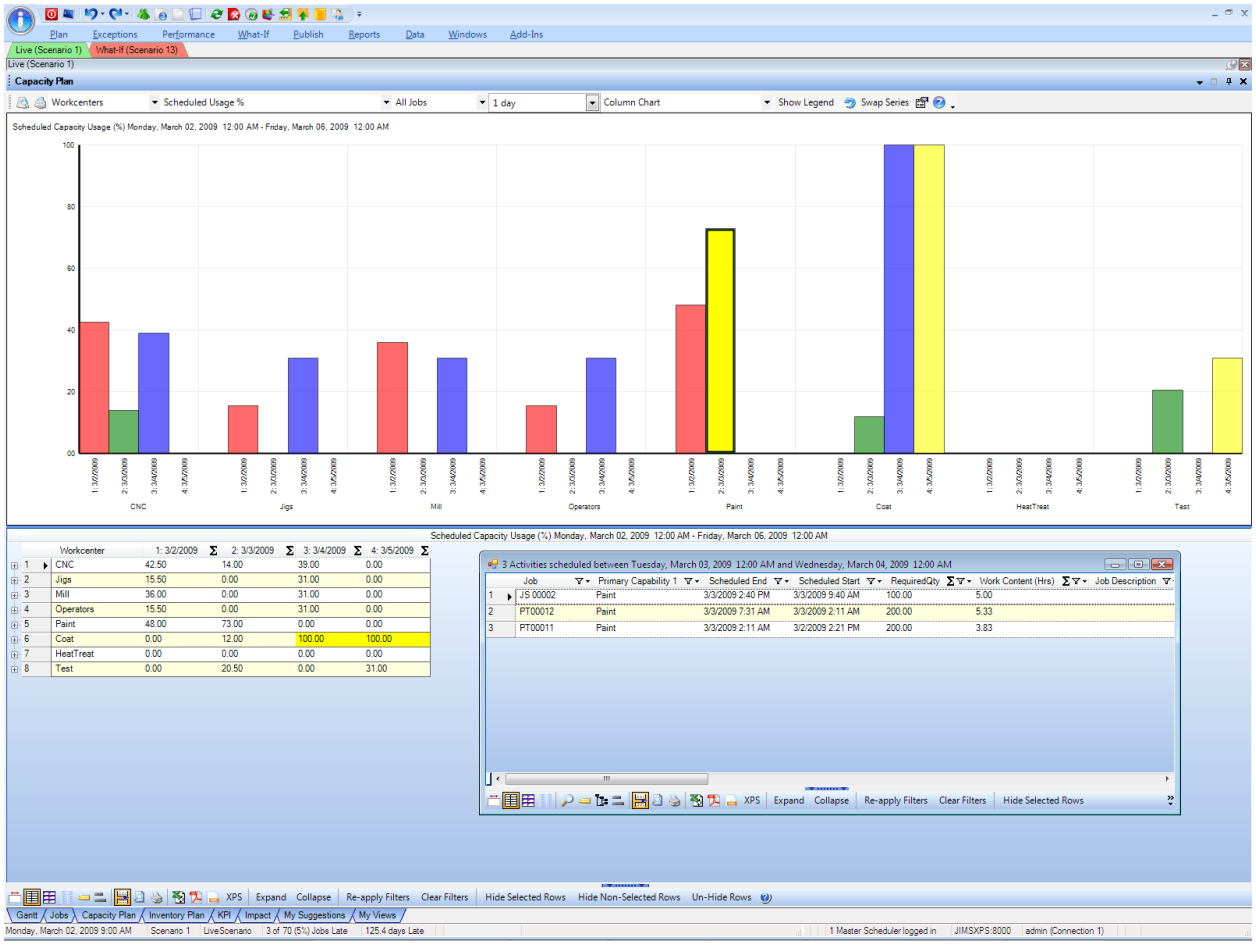
Viewing the Plan

The Gantt chart schedule board, Capacity Plan, and Inventory Plan are interactive screens that are commonly used to view and manage the schedule after an optimization. All screens are configurable to show exactly the information desired by the end user, through filters and controls.

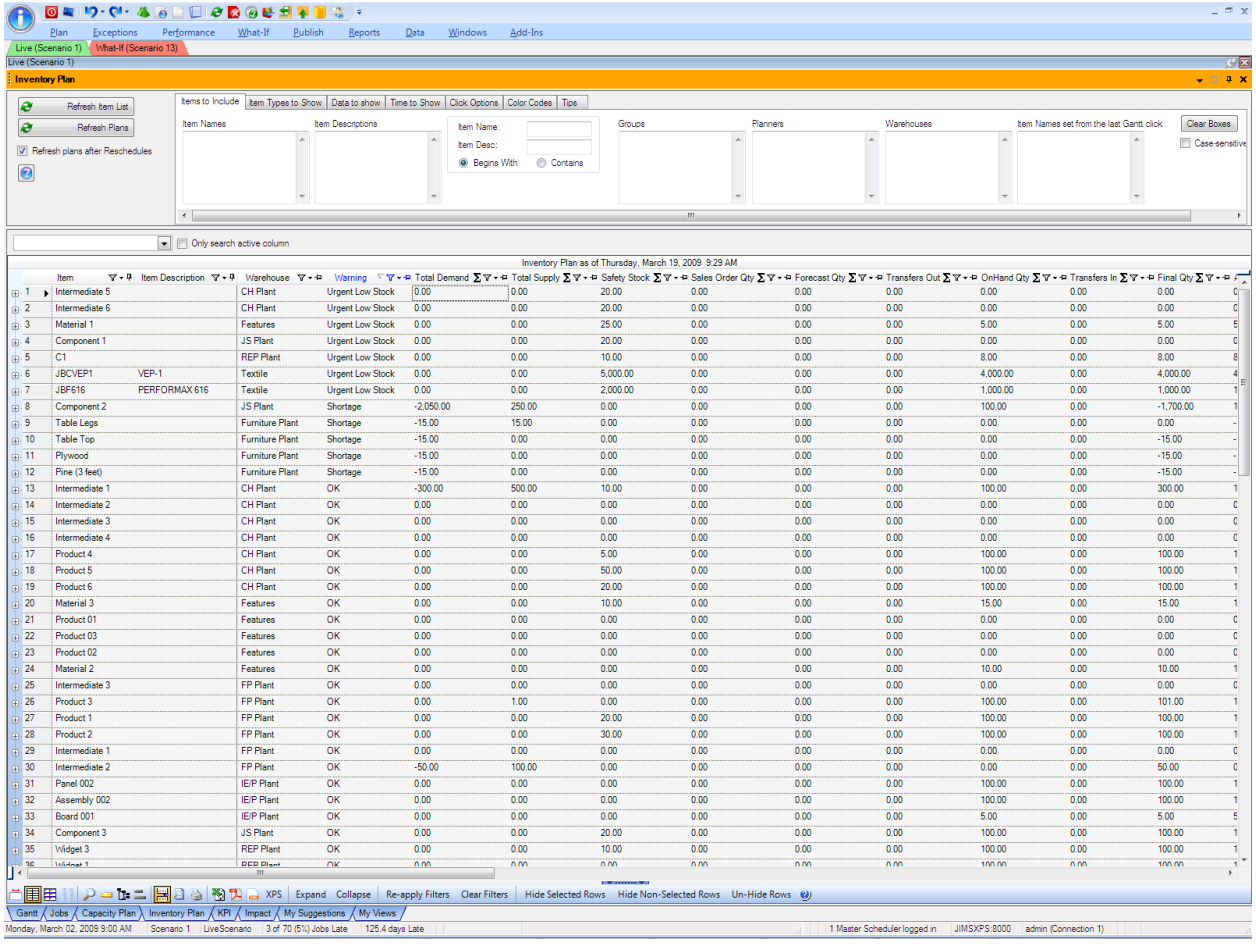
The Gantt chart schedule board shows the load and sequence for each resource, with an adjustable timeline running from left to right. Drag and drop changes can be done here.



The Capacity Planning screen is an alternative view of resource loading. Clicking in a time bucket drills down to show the tasks scheduled in that period on that resource.

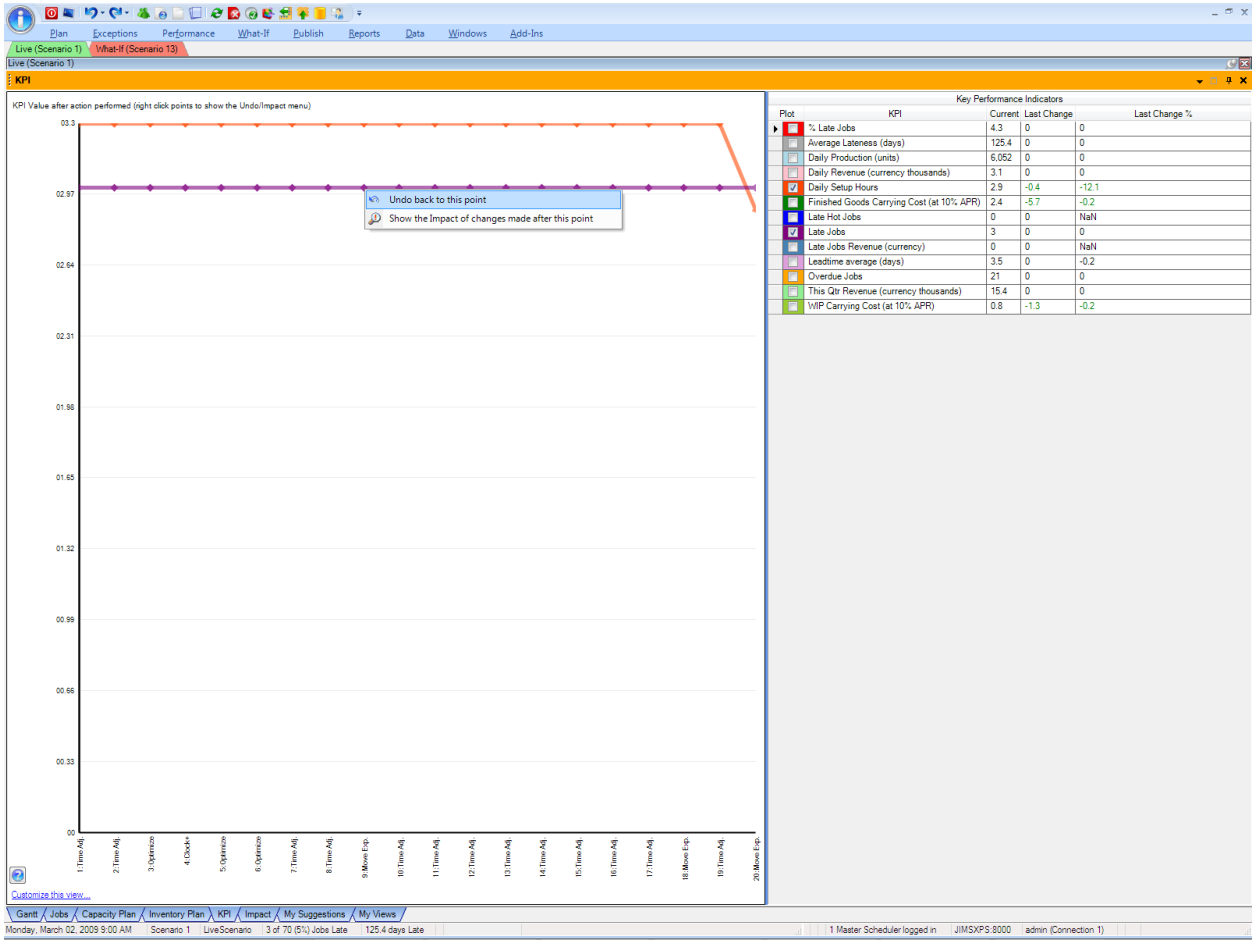


The Inventory Plan shows the projected inventory levels for each item and component. Production runs can be dragged and dropped in this screen as well. All columns can be filtered and sorted, and graphical plots of the projected inventory are displayed by double-clicking an item.

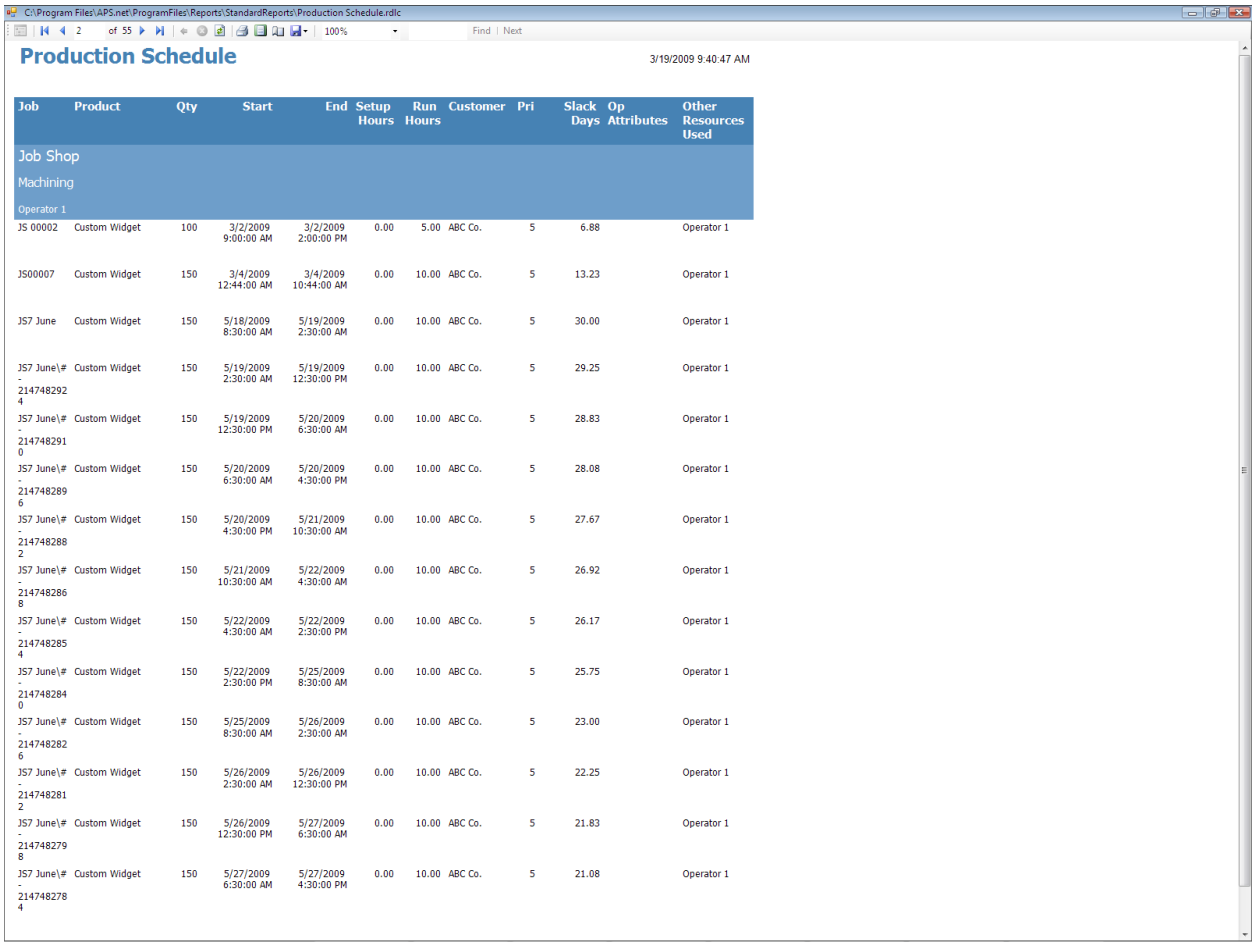


Analysis and Reports

The KPI screen shows Key Performance Indicators, recalculated for each schedule change. The user can undo and redo any number of actions directly from this screen.



Numerous exception screens and built-in reports are available, and popular reporting tools such as Crystal Reports, Microsoft Reporting Services, and desktop software such as Excel can all access and report data generated by PlanetTogether. This is an example of a report created with Microsoft Reporting Services.


C:\Program Files\APS.net\ProgramFiles\Reports\StandardReports\Production Schedule.rdlc

2 of 55 100% Find | Next

Production Schedule 3/19/2009 9:40:47 AM

Job	Product	Qty	Start	End	Setup Hours	Run Hours	Customer	Pri	Slack Days	Op Attributes	Other Resources Used
Job Shop											
Machining											
Operator 1											
JS 00002	Custom Widget	100	3/2/2009 9:00:00 AM	3/2/2009 2:00:00 PM	0.00	5.00	ABC Co.	5	6.88		Operator 1
JS00007	Custom Widget	150	3/4/2009 12:44:00 AM	3/4/2009 10:44:00 AM	0.00	10.00	ABC Co.	5	13.23		Operator 1
JS7 June	Custom Widget	150	5/18/2009 8:30:00 AM	5/19/2009 2:30:00 AM	0.00	10.00	ABC Co.	5	30.00		Operator 1
JS7 June\# - 2147482924	Custom Widget	150	5/19/2009 2:30:00 AM	5/19/2009 12:30:00 PM	0.00	10.00	ABC Co.	5	29.25		Operator 1
JS7 June\# - 2147482910	Custom Widget	150	5/19/2009 12:30:00 PM	5/20/2009 6:30:00 AM	0.00	10.00	ABC Co.	5	28.83		Operator 1
JS7 June\# - 2147482896	Custom Widget	150	5/20/2009 6:30:00 AM	5/20/2009 4:30:00 PM	0.00	10.00	ABC Co.	5	28.08		Operator 1
JS7 June\# - 2147482882	Custom Widget	150	5/20/2009 4:30:00 PM	5/21/2009 10:30:00 AM	0.00	10.00	ABC Co.	5	27.67		Operator 1
JS7 June\# - 2147482868	Custom Widget	150	5/21/2009 10:30:00 AM	5/22/2009 4:30:00 AM	0.00	10.00	ABC Co.	5	26.92		Operator 1
JS7 June\# - 2147482854	Custom Widget	150	5/22/2009 4:30:00 AM	5/22/2009 2:30:00 PM	0.00	10.00	ABC Co.	5	26.17		Operator 1
JS7 June\# - 2147482840	Custom Widget	150	5/22/2009 2:30:00 PM	5/25/2009 8:30:00 AM	0.00	10.00	ABC Co.	5	25.75		Operator 1
JS7 June\# - 2147482826	Custom Widget	150	5/25/2009 8:30:00 AM	5/26/2009 2:30:00 AM	0.00	10.00	ABC Co.	5	23.00		Operator 1
JS7 June\# - 2147482812	Custom Widget	150	5/26/2009 2:30:00 AM	5/26/2009 12:30:00 PM	0.00	10.00	ABC Co.	5	22.25		Operator 1
JS7 June\# - 2147482798	Custom Widget	150	5/26/2009 12:30:00 PM	5/27/2009 6:30:00 AM	0.00	10.00	ABC Co.	5	21.83		Operator 1
JS7 June\# - 2147482784	Custom Widget	150	5/27/2009 6:30:00 AM	5/27/2009 4:30:00 PM	0.00	10.00	ABC Co.	5	21.08		Operator 1

Conclusion

PlanetTogether is designed to model any number and type of capacity and material constraints. This allows manufacturers in a wide variety of industries to take advantage of simple and powerful optimization rules that are balanced to meet business goals. Interactive screens display information in formats that allow end-users to incorporate their own approach to planning and scheduling. All data is available for creating reports and exporting information to other systems.

For more information, call (888) 317-8807 or email info@planettogether.com.