# Sage Line 500 - Production Scheduling

**Sage's new Production Scheduling system is built around the market-leading Advanced Planning and Scheduling solutions developed by Preactor International. In the past, manufacturers have often been reluctant to embrace APS because of the perceived complexity of integrating the technology with their existing business systems. Sage has overcome this problem by offering a powerful APS solution that has been pre-configured to provide tight integration with Line 500.**

## Records Kept

### Work Centres

- Machines are grouped into work centres which define machines that carry out similar tasks. In the Sage Routing module, for each operation in a process route you can define which work centre group can carry out the operation.

### Skill groups and operators

- Sage Line 500 Routing allows you to define the required labour resources for an operation by entering a skill group. In Production Scheduling you can define secondary constraints as skill groups. The constraint may be individual operators. Operators are organised into skill groups having the capability to carry out a specific operation. When Production Scheduling schedules it will assign the operation to a member of the skill group. It is also possible to create a Secondary Resource Gantt chart where the operations assigned to each member of staff are displayed. A Work-to list report for each staff member may also be created.

### Preferred resource selection

- You can define preferred resources within a work centre or skill group. For example, you may have two machines that can carry out an operation. Machine A is a new machine; machine B is older. You would prefer to use machine A and will wait for this machine in preference to machine B.

### Operation Setup Time

- Each operation can have a set up time assigned. The set up time appears as a thinner black bar in front of the operation bar in the graphical planning window.

### Shift patterns, vacations, shutdowns

- For each resource you can define standard shift patterns for each day of the week. In addition you can define in advance holidays, vacations or shutdowns when the normal shift pattern is not valid.

### User defined resource states and efficiencies

- In Production Scheduling you can define many different states for a resource. Examples are on shift, off shift, breakdown, planned maintenance. Each state can be given an efficiency value; for example, on-shift would be 100% and offshift zero percent. Production Scheduling uses this when calculating an operation start and finish time. Each state can be given a colour and shading in the sequencer overview for ease of identification. The user can also add more states for example, "Half Speed". Perhaps resources run slow for a period of time after a weekend so you might want to have a state of "Half Speed" for the first two hours every Monday morning. These states are also used for manual insertion of calendar exceptions such as an unforeseen breakdown.

### Process rate by item, per hour and per batch

- You can define how you wish Production Scheduling to calculate the run time for an operation by specifying the process rate as time per item, rate per hour or a fixed time for the batch. This data is read from the Sage Line 500 Routing module during the “Import Dynamic Data” run but may be modified within Production Scheduling.

### User definable maximum operation span

- You can define a maximum span for an operation. For example, a process may take 4 hours but, due to breaks or other zero efficiency periods the span has been increased to 6 hours. This may not be allowed and by setting the Split run-time field to Yes or No the user can control how Production Scheduling will manage this condition.

### Finite and infinite resources

- In most cases you will want to define resources as having finite capacity however in some circumstances infinite resources are used to model certain processes. For example, a sub-contract operation may always have a 2 day lead time no matter how many batches are sent and in this case an infinite resource called “Sub-Contract” might be used to model the delay. A third alternative “Infinite with Shift Patterns” Is also available. This might be used for example, if our sub-contractor did not work at weekends so that the 2 day lead time would be extended if sent on a Friday.

### Manual and interactive breakdowns & downtime schedules

- You can add calendar exceptions to any resource using the resource time window. An example of a calendar exception is a breakdown when the resource will not be available for an expected period of time. It could be minutes, days or weeks. Exceptions can be extended or reduced by dragging and dropping the “edge” of the exception time period.
- Another exception would be a planned maintenance period

### Icon editor

- Each operation in the sequencer is displayed as a coloured icon when in the unallocated jobs window or in the resource time windows. These icons may be customised using the icon editor.

### Order Status Indicator

- An order can be given a status such as Suggested, Released, Confirmed. The user can associate a pattern change to the operation bars in the sequence overview for each order status type.

### Constraints for an operation

- The user can define multiple finite constraints per operation.

### Product dependant changeover times

- The user can define a Like to Like set up time against the Product Group attributes table. This will give an alternate set up time to be used if an operation follows a previous operation having the same attribute code. For example, the set up time for an operation linked to product A is 30 minutes but if this follows an operation on product B, where product A and B have the same attribute, then the set up time is taken as only 5 minutes.

## Tasks Supported

### Schedule Despite Shortages

- Where shortages of materials occur in a schedule, by default Production Scheduling will not schedule orders that are affected. With this feature the user has the option to allow orders to be scheduled despite shortages. The sequence in the BOM structure is still respected in terms of timing. A Custom plot is available to show when a shortage occurs.

### Converting MRP Recommendations into Work Orders

- In Production Scheduling you can select an MRP Recommendation and automatically create the works order, updated with the selected machine and operator. When the schedule has been optimised a range of MRP Recommendations may be selected by product group or date range and converted into works orders.

### Updating Works Order operations

- When a works order has been rescheduled on the planning board you can update this immediately or update all orders by confirming the entire schedule.

### Sub-contract operations

- When a works order or route contains sub-contract operations, Production Scheduling will base the schedule on the greater of:
  - The expected elapsed time (MRP Operation time in the Line 500 Route module), OR
  - The calculated operation duration (i.e. the sum of set up, run and delay times).

### Comparative Gantt chart

- Many schedule alternatives can be saved. Using the Gantt chart you can compare one schedule with another. This can also be used to compare actual start and finish times for each operation on each resource and compare with a reference schedule.

### Comparative order trace chart

- This option offers similar facilities to the comparative Gantt chart except that the vertical axis is based on order number. The “Normalise” feature in this chart positions all operations for each order relative to its due date.

### Resource waiting time plots

- Provides a plot for each resource showing the amount of work waiting for the resource across the period of the schedule. This feature can be particularly useful for highlighting bottlenecks over time.

### Schedule performance metrics

- For any schedule the user may look at a standard set of statistics. The schedule performance metrics button will show for the currently loaded schedule:
  - Job Count Date (Number and Percentage) - Early, Late, Incomplete, Started.
  - Job Completion Date (Total, Minimum, Average & Maximum) - Early Time, Late Time, Setup Time, Lead Time, Value Added.

- Resource Data (Percentage Minimum, Maximum & Average) - Working, Setup, Unavailable, Idle, Utilisation.
- Schedule Span.

**Additional constraints usage by resource plots**

- The user can define a number of additional or secondary resources used by a resource. For example, a machine may require an operator or a tool to carry out an operation. In Sage Production Scheduling the Skill Groups linked with operation are read by the scheduler and the operator is selected during the scheduling run. A plot for each additional resource is available. The user can also define the colour of the plot and a colour change when the usage is above a defined level. Each additional resource can have an assigned capacity e.g. 2 operators. This capacity can be varied over time by assigning a shift pattern or calendar to the additional resource, e.g. you have 2 operations in an early shift and 3 operators in a late shift.

**Operation Progress and Hold**

- The user can set operations to be in different states e.g. Not Started, Setup, Running and Complete. Depending on the operation progress selected the user can edit the Setup Start, Start and End Times for an operation.
- Any operation can be set to “Hold” using the toggle check box. When unallocated, this operation (and later operations in that order) will not be scheduled.

**Multiple batch matching**

- Multiple operations from different orders can be loaded onto a resource at the same time. The number loaded can be controlled using finite secondary constraints. You can also specify an attribute of the operation that must be common as an additional constraint. This is called a match property. An example would be that multiple orders can be processed in the same oven. The quantity would be controlled by a secondary constraint and the match property might be the cycle time in the oven.

**Sequential and parallel loading of operations from different orders**

- In Production Scheduling you can elect to load one operation at a time and use “dispatching” or “parallel loading” rules to select which operation to load next. Dispatching or Parallel loading rules are resource specific. Operations that are ready to load are put in one or more queues that can be ranked according to the rule assigned to the resource. As a resource becomes free it looks at the queue of waiting operations and selects the best one to process next. The inbuilt preferred sequence rule uses this logic. It also has a global “Look-ahead window”. This is the period that will be used to determine if an operation should be allowed into a queue for a specific resource. When a resource becomes free the rule determines what its look-ahead window is from the current time. If an operation from an order has a due date within that window then it is allowed into the rule queue.

**Standard dispatching rules e.g. preferred sequence, critical ratio**

- In Production Scheduling you can set up in the resource database the ranking of operations when running the preferred sequence rule. The in-built attributes are:

- Due date, Priority, Critical ratio, Dynamic critical ratio, Process time, Setup time.
- You can select any of these to rank the queue for a resource (either highest value first or lowest value first). You can select more than one attribute to deal with ties. So for example, you might select Due date, lowest value first and add priority, lowest value first. In this case the queue is ranked by due date and those operations with the same due date are ranked by priority. Another example is to use Setup time, lowest value first. Then as a resource completes an operation it will select the operation in the queue that will result in the lowest setup time.

- Two other attributes, critical ratio and dynamic critical ratio are also important in minimising lateness. The critical ratio attribute is calculated by Production Scheduling for each operation in a queue as a resource becomes free. It is the ratio of time to due date compared to the sum of remaining operation times for the order. As this ratio falls to one it become more critical. Dynamic critical ratio goes one step further. Rather than just summing remaining operation process time, Production Scheduling calculates the remaining lead time by test loading operations onto the planning board taking into account all constraints and shift patterns. This is a more accurate estimate of criticality but takes longer to run.

**Standard algorithmic rules, minimise WIP, dynamic bottleneck, selective bottleneck**

- In Production Scheduling there are rules that are a combination of 'operation at a time' sequencing as in the preferred sequence rule engine but without using parallel loading dispatching rules.
- There are standard in-built rules in Production Scheduling. These are Forward, Backward, Minimise WIP Forward, Minimise WIP Backward, Selective Bottleneck and Dynamic Bottleneck. Minimise WIP forward is a combination of forward and backward sequencing. First all operations for an order is forward sequenced. The last operation is then locked and all previous operation backward sequenced. This in effect minimises the make-span period and thus reduces work in process. Minimise WIP backward starts by backward sequencing from the due date. The first operation is locked and subsequent operations forward sequenced.
- Dynamic bottleneck is a variation on the Minimise WIP forward rule. Each order is forward sequenced. Production Scheduling then finds the operation that waited longest to be processed. This is the bottleneck operation and defines the bottleneck resource for this order. Production Scheduling then locks the last operation and backward sequences the other operations except that an additional buffer time is used on the bottleneck resource. Thus if there are any delays to operations up to the bottleneck operation, the buffer will prevent starvation of work on the bottleneck resource.
- The Selective Bottleneck rule is based on the Theory of Constraints (TOC) philosophy. It works by the user selecting the "Bottleneck Resource" or "Bottleneck Resource Group". Each order is then backward scheduled from the Due Date (less Delivery Buffer). Any operations loaded onto a bottleneck resource are offset by the Bottleneck Buffer time (defined in the Resource dat table for each resource) which is designed to give some "slack" such that any delays to operations before the bottleneck resource will not result in it being "starved" of work. Production Scheduling then detects whether any operations in that job must start before current time. If so, these operations are rescheduled forwards using up some, or all, of the bottleneck buffer. If this is consumed then some or all of the delivery buffer may also be used up and the "At Risk" or "Late" flag is set.

### Mid-batch update and calculations

- You can enter a mid-batch update for a batch at an operation. For example, you may wish to enter the quantity complete and time for part of a batch. Production Scheduling re-calculates the process time per item.
- Operation Progress Indicator. Production Scheduling provides a convenient and visual way of tracking the progress of an operation. As a mid-batch quantity and time is entered for an operation, part of the bar colour will change equivalent to the progress made. The change colour is definable by the user.

### Automated Functions:

### Automatic allocation of materials during download from MRP

- Orders are passed to Production Scheduling by the Import Dynamic data function. The process route information and BOM structure are included as part of the download.
- These 'orders' are MRP work order recommendations and work orders for each level of the BOM, sales orders, sales forecasts and MRP purchase order recommendations and purchase orders. Production Scheduling runs its SMC (Static Material Control) functionality automatically as part of the import process. When SMC runs it uses the BOM information to link orders together using SMC rules that decide which orders are linked where there is more than one option. So a purchase order for raw materials may be linked or pegged to one or more manufacturing orders. This manufacturing order may be linked to one or more manufacturing orders at a different level of the BOM. One "final assembly" manufacturing order may feed one or more sales orders. These links and dependencies are used when Production Scheduling schedules so that material constraints and other resource constraints are taken account of and in addition it keeps a record of the links to provide traceability.

### Automatic linking or pegging of operations from different orders

- In Production Scheduling the user has access to a function called SMC, Static Material Control. SMC uses order information and BOM information together with an SMC rule to peg or allocate materials between different orders.

### Material allocation rules linking consuming and producing orders

- SMC uses a concept of producing orders and consuming orders. By using SMC rules the user can define which orders are linked together assuming there is more than one option. SMC rules work as a series of passes where it examines the contents of producing orders and consuming orders and attempts to match them. Where acceptable matches are made then these are removed from the queue for the next pass. Quite complex links can be set up in this way. An example would be to match sales orders with manufacturing orders. There could be multiple batches of the same product but with different quality levels. A rule could be set up to allocate product to customer orders based on the quality of the batches available.
- Once the SMC tool has been run you can choose to lock the links that have been made between orders. This can be on a link by link basis or all links. Even if orders are unallocated and SMC re-run, these links are not re-assigned.

### Automatic transfer batching between operations

- The user can allow transfer batching between operations. For example, a batch of 100 could have a transfer quantity of 20. Then as soon as 20 parts have been completed the next operation can be scheduled for the subsequent operation. (Production Scheduling automatically calculates the transfer quantity using the operation details held in the Sage Routing and Works Order ‘Percentage lead in’ field and the order quantity.)

### Automatic schedule repair

- The user has access to a schedule repair button. Schedule repair can be used to correct a schedule where small alterations to actual start and finish times for an operation has caused operations within an order to overlap (assuming transfer batching has not been defined as allowed). Schedule repair will keep operations on the same resource (where possible) but adjust the start and finish times for un-started operations to maintain the correct operation sequencewithin an order.

## Reporting

### Standard reports

- Schedule Performance.
- Work-to list for each resource.
- Orders and Orders by Customer.
- Route cards for each order.
- To do Operation list by day.
- Late operations and orders.
- Shift patterns for each resource.
- Shortages.

### Customised Report Writer

- The user can modify and save the in-built standard reports and create additional reports using the in-built Report Writer.

### Schedule Analysis Reports

- The user has access to schedule comparison tables that provide additional data over and above the Schedule Performance Metrics report. This configurable tool generates tables in XML format to compare schedules based on defined criteria.

### Additional Schedule Analysis Reports

- This goes beyond the Schedule comparison tables in that it contains information on utilisation by day and week by resource, by resource group and by secondary constraint.

### Additional job status report

- The user has another in-built report called Job Status. This displays the current status of each operation in an order and the critical ratio (a ratio of remaining process time compared to time till due date). In addition as each operation is completed or part completed for an order the recalculated process time per item is available in this status report. The user can then compare the expected time with the actual time for each operation in each order.

### E-mail Gantt charts and reports

- The user can automatically e-mail Gantt charts (as a bitmap) or reports (in RTF format) from within Production Scheduling.

### Schedule export to Excel

- The user can export user defined schedule data to an Excel spreadsheet.

### Web Publisher

- The user can automatically create reports and Gantt charts in HTML format to display on a web page. These can be viewed using Microsoft Internet Explorer.

## Integration with other modules

### Accounts Receivable and Sales Order Processing

- Integrates Sales Orders and Customers which are demand elements in the Production Schedule.

### Accounts Payable and Purchase Order Processing

- Integrates Purchase Orders and Suppliers which are replenishment elements in the Production Schedule.

### Inventory Control

- Integrates with Inventory to determine initial stock levels and to retrieve product attributes.

### Bills of Materials

- Integrates with the Bill of Materials to establish parent-child relationships and component requirements.

### Routing

- Integrates with the Routing module to determine resource and time requirements.

### Works Order Processing

- Integrates with Works Orders to determine replenishments and demands. Updates works orders with selected resources and planned operation start and end dates and times.

### Material Requirements Planning (MRP)

- Integrates with MRP to determine replenishments and demands. Automates the conversion of MRP recommendations to Works Orders.

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