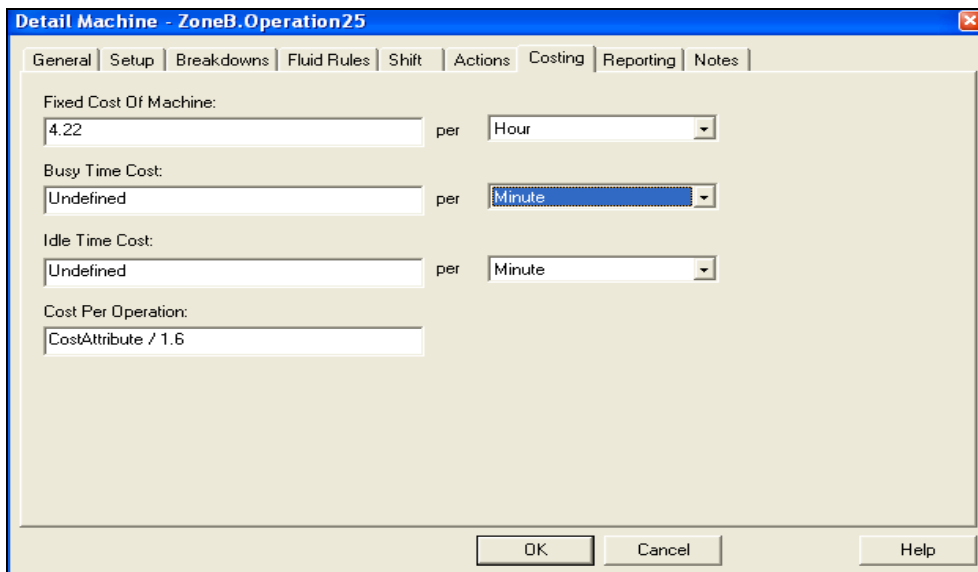


Welcome to the Manufacturing Performance Edition of WITNESS 2007 Release 1.

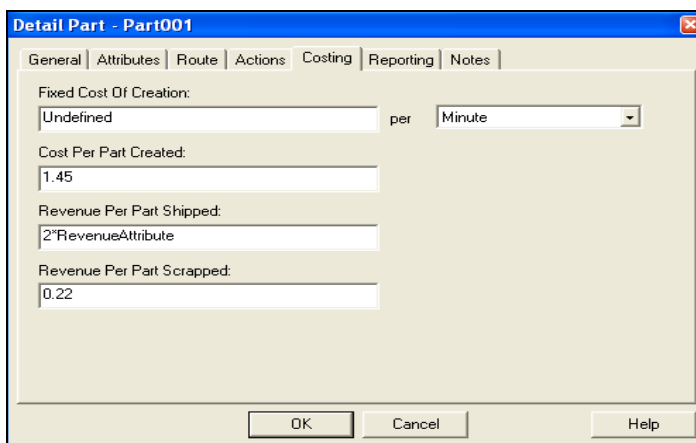
This release contains many new features including balance sheet analysis incorporating flexible revenue and cost assignments, new model initialization options, actions language debugging assistance, breakdown and setup flex options and curved path displays. Added to this are several ease of use and new display options, and additional functions requested by users including the ability to change tank warning levels, access the maximum value of an array, actions options on entry and exit from pseudo paths and more.

Balance Sheet Analysis

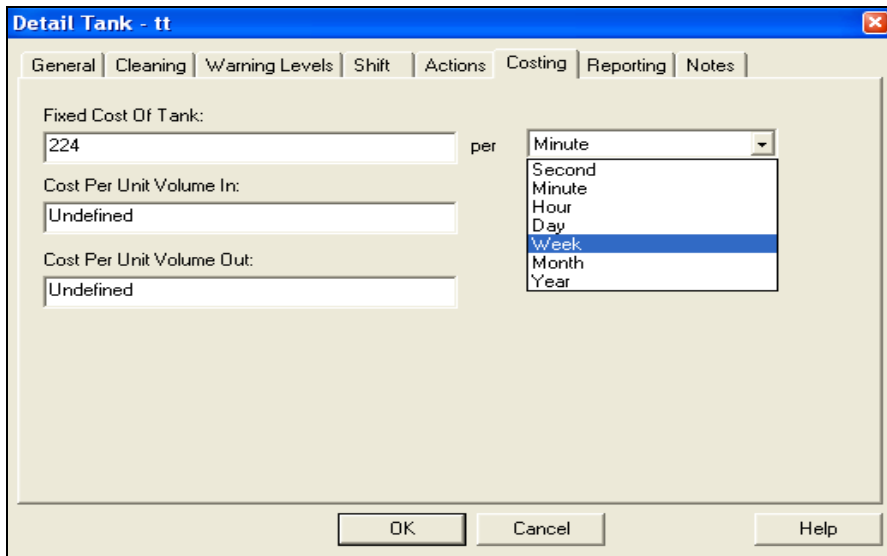
A major addition that is visible throughout the WITNESS elements is the addition of costing and revenue information. Located directly on element detail dialogs a new costing tab provides many different ways to apply costing. It is extremely unlikely that all the different places and methods where costing can be applied will be used in a single model – rather they give a choice of how and where you choose to apply these factors for an accurate reflection of model financial performance.




Here we show a typical costing tab on the detail dialog for a machine where the fixed cost of the machine is 4.22 currency units per hour and the cost per operation is the cost attribute of the part being processed divided by 1.6. In this example the options to assign costs separately for busy and idle time costs have not been used. In addition costings for resource use may apply at this machine – this would be defined separately on the labor costing dialog.



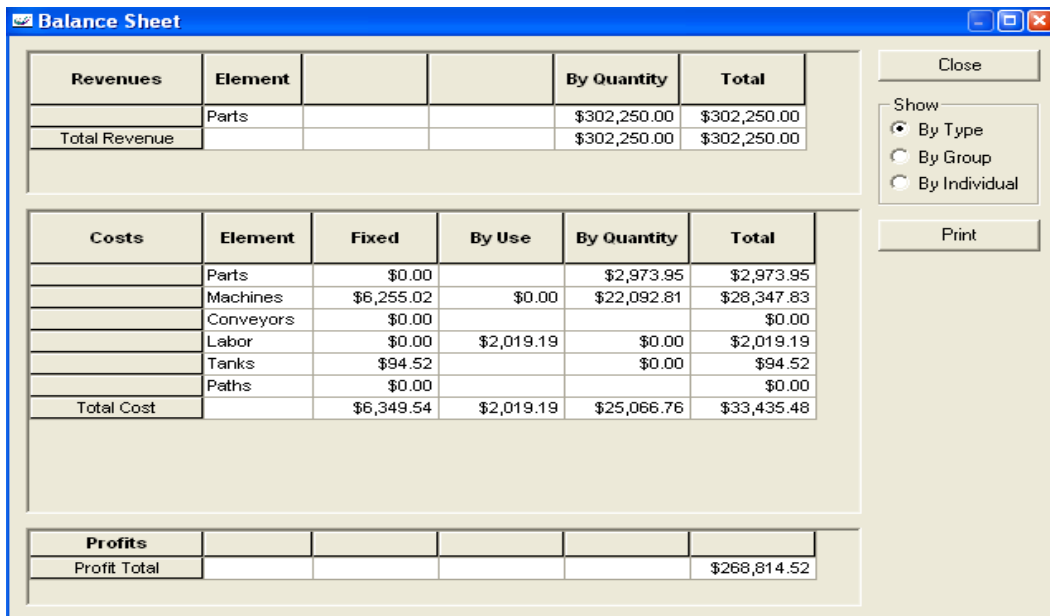
This is the costing tab on the detail dialog for a part offering different cost and revenue options – again as may be seen there are options for expressions in the dialog making this a very powerful and flexible costing tool.



This is the costing tab on the detail dialog for a tank showing some of the options available for continuous modeling elements inside WITNESS 2007.

Costings may be applied to most WITNESS modeling elements. When costs and revenues have been assigned and the model run then there is a new balance sheet report available via the toolbar  or report menu options.

The level of detail of the report can be chosen at an element type level, element name level or even an element index level.



An example of a balance sheet report at the element type level. Note the currency support which is selectable in model options and is saved with the model. In the startup model the default currency is set to US\$.

All values from the table can be copied and pasted into other applications.

	A	B	C	D	E	F
1	Revenues	Element			By Quantity	Total
2		Parts			\$302,250.00	\$302,250.00
3	Total Revenue				\$302,250.00	\$302,250.00
4						
5						
6	Costs	Element	Fixed	By Use	By Quantity	Total
7		Parts	\$0.00		\$2,973.95	\$2,973.95
8		Machines	\$6,255.02	\$0.00	\$22,092.81	\$28,347.83
9		Conveyors	\$0.00		\$0.00	\$0.00
10		Labor	\$0.00	\$2,019.19	\$0.00	\$2,019.19
11		Tanks	\$94.52		\$0.00	\$94.52
12		Paths	\$0.00			\$0.00
13	Total Cost		\$6,349.54	\$2,019.19	\$25,066.76	\$33,435.48
14						
15						
16	Profits					
17	Profit Total					\$268,814.52
18						

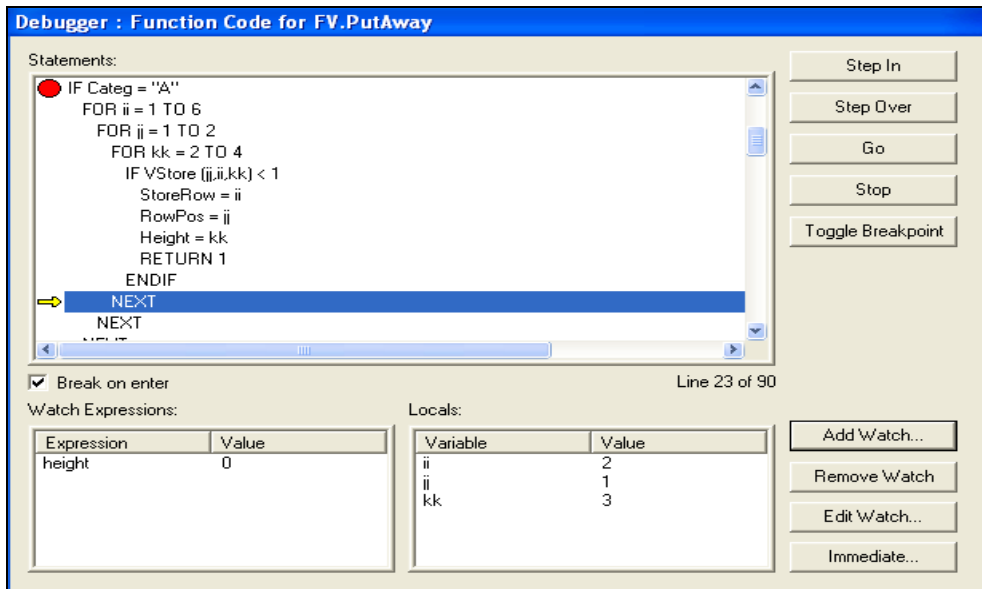
The same report cut and pasted into Excel for further analysis

New Actions Language debugger

For the first time in WITNESS it is now possible to step through actions code, as the model is run, line by line and observe the changing value of chosen expressions.

To stop the model running at any point in actions code there is an option in the edit box to enable debugging and to create a breakpoint on entry.

When the model is run and a breakpoint is accessed the following dialog appears with a choice of stepping and monitoring options.



A model running where a breakpoint has been set. Here the actions code is that inside a function – by default local variables are monitored and any other expression can be added to the watch expressions (here the attribute height has been added and so far in stepping through this function the value of height is set to 0.

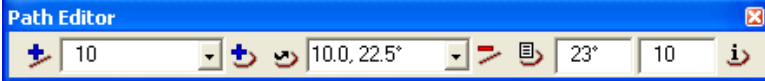
This new functionality makes it easier to spot errors in modeling logic and hence speeds up complex model development.

Debug settings are not stored when a model is saved to a .MOD format – and when this is done all debug settings are lost, but they ARE retained when a model is saved to a .SIM format. This allows you to maintain a set of debug settings when desired.

New Path Editor Toolbar and Path Display Options

The path type displays for conveyors, tracks, paths, sections and buffers can now incorporate curved sections and there is a totally new option for the way in which path displays can be drawn.

The path editor toolbar gives access to many of these new options:




Using this new sections of straight or curved path can be added using the + buttons shown:



adds a new straight section of the length specified in the drop down list

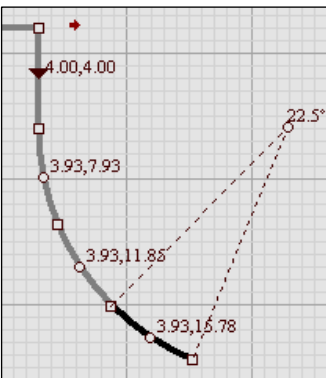


adds a new curved section – curved in the direction shown by  toggle button. The curve added is of the length and radius angle shown in the drop down list.

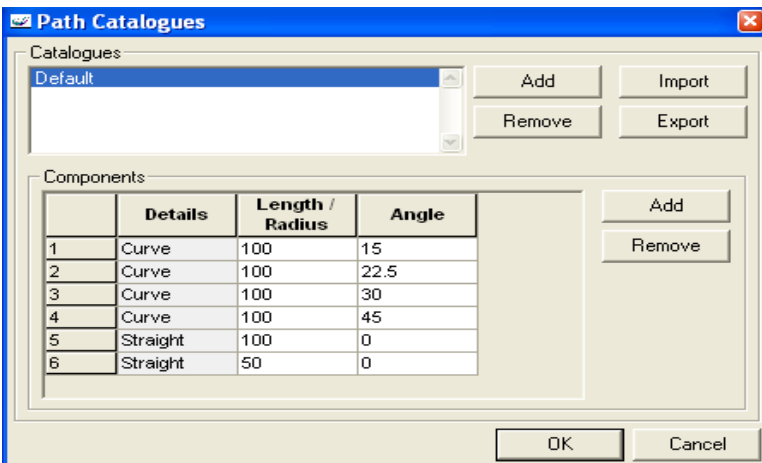
For all sections added the length corresponds to the co-ordinate settings in the Model / Options / Co-ordinate tab. This enables all kinds of scaling and units of measurement to be used.

After adding the length and/or angle of radius can be changed by typing in the value into the third set of boxes on the toolbar.


Of course the method of editing paths that existed in WITNESS 2006 is also still available and a straight section can be changed to a curved section by using the left mouse button in conjunction with the Shift key by clicking on the arrow in the middle of a path segment. (The correct position is obtained when the four headed arrow changes to a 2 headed arrow). For curved segments the angle of radius can then be changed by dragging the same position using the Ctrl key at the same time.




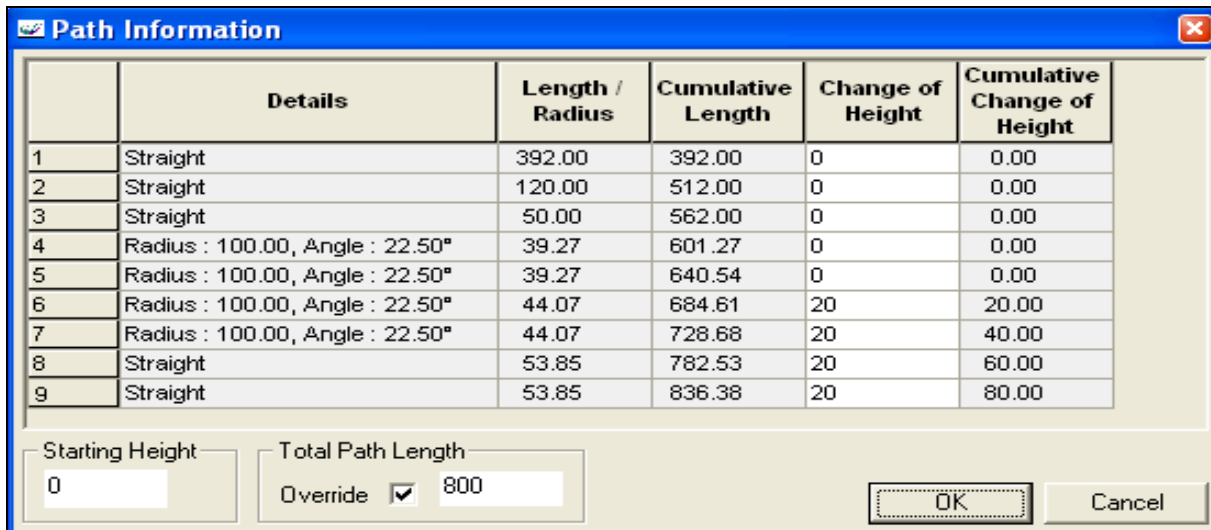
The curved display shown here shows the angle of radius and how the intermediate arrow changes to a small circle when the path segment is a curved segment.



The list of options in the pull down list can be set up in the path display catalog

accessed via the  button on the path editor toolbar.

When a path display has been defined for an element the details of that path can be viewed in a dialog – accessed using the  button on the path editor toolbar



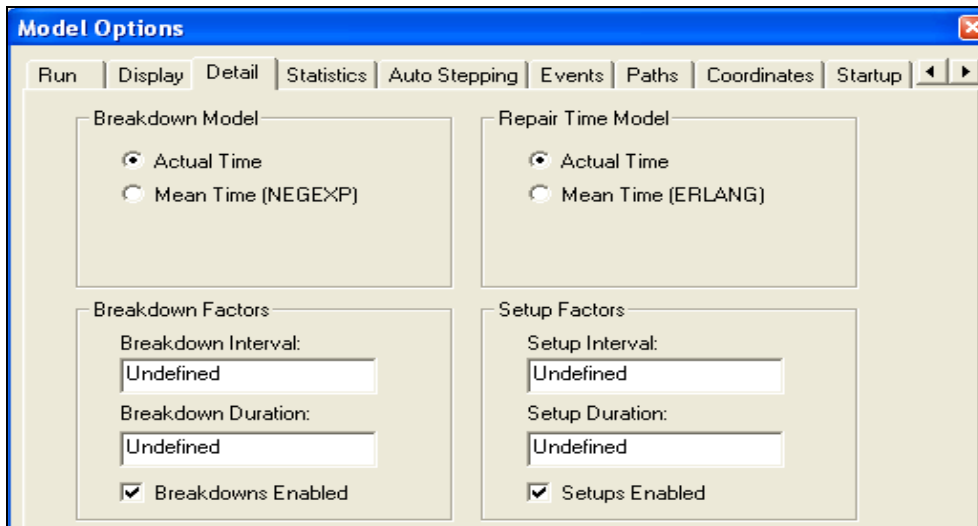
The Path Information dialog box displays a table with 6 columns: Details, Length / Radius, Cumulative Length, Change of Height, and Cumulative Change of Height. It also includes input fields for Starting Height (0) and Total Path Length (800) with an Override checkbox checked. Buttons for OK and Cancel are at the bottom right.

	Details	Length / Radius	Cumulative Length	Change of Height	Cumulative Change of Height
1	Straight	392.00	392.00	0	0.00
2	Straight	120.00	512.00	0	0.00
3	Straight	50.00	562.00	0	0.00
4	Radius : 100.00, Angle : 22.50°	39.27	601.27	0	0.00
5	Radius : 100.00, Angle : 22.50°	39.27	640.54	0	0.00
6	Radius : 100.00, Angle : 22.50°	44.07	684.61	20	20.00
7	Radius : 100.00, Angle : 22.50°	44.07	728.68	20	40.00
8	Straight	53.85	782.53	20	60.00
9	Straight	53.85	836.38	20	80.00

This shows the details for each section and also allows the addition of height information. This can be added against any node and the calculation of path length will include the change in this dimension too. This dialog gives an additional option – the overall total path length that would be calculated and returned by the **Pathlength** function can be overridden and a value entered that will be returned. This gives extra flexibility with the display being able to be separate from a required timing calculation.

Breakdown and Setup Rate Adjustment

This release introduces a number of new ways to quickly adjust all breakdown and setup timings in a WITNESS model. From the Model/Options menu simply select the Detail tab. In addition to the existing options there are two new sections entitled "Breakdown Factors" and "Setup Factors".



The Model Options dialog box has tabs for Run, Display, Detail, Statistics, Auto Stepping, Events, Paths, Coordinates, and Startup. The Detail tab is active, showing Breakdown Model, Repair Time Model, Breakdown Factors, and Setup Factors sections. Each section has radio buttons for Actual Time and Mean Time, and input fields for Interval and Duration. Checkboxes for Breakdowns Enabled and Setups Enabled are at the bottom.

Using the check box in either of these sections you can turn off all breakdowns or all setups in a model. In this way you can run a model to see what could be achieved if these types of stoppages could be eradicated from a process.

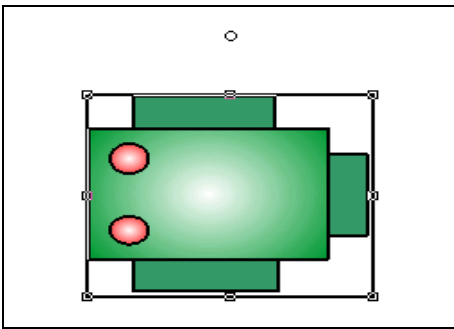
Alternatively you may wish to flex either setup or breakdown timings to evaluate improved repair performance, improved reliability, faster tool changes, etc. The factors are applied to either the intervals or the durations of the stoppage and are a quick way to evaluate the sensitivity of such data to a model result. Factors are applied, where applicable, by multiplying the time (or number of operations) by the factor. Therefore a factor of 1.1 in the breakdown interval will increase the time calculated for any breakdown in a model by 10 %.


Where the fields represent integer values then the result will also be an integer. E.g. a factor of 1.23 applied to a breakdown interval of 10 operations will result in an interval of 12 operations.

New 2D Icon Rotation Option

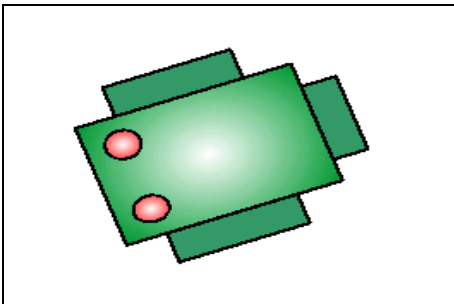
Options for icon rotation have been extended to fixed icons – for example for machines. It is now possible to edit the rotation of these icons directly on the screen.

An example machine icon is shown below. The small circle above the icon is shown when an icon is displayed. This can be used to rotate the icon display.



To rotate the icon press the Ctrl key and move the mouse cursor near this circle. When it is correctly located the cursor will change to a rotation handle. 

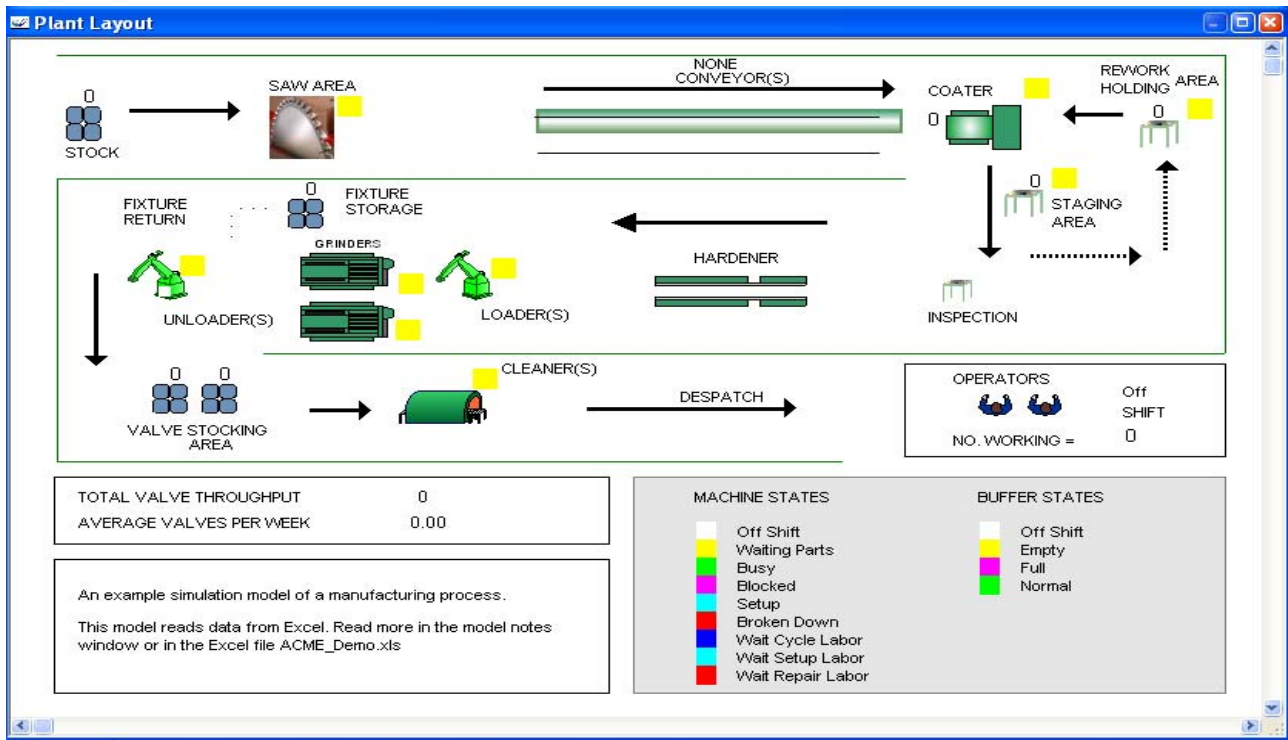
Then by clicking the left mouse button and dragging the icon may be rotated to the desired orientation.



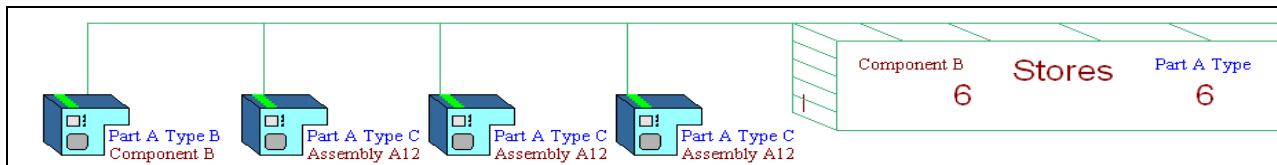
Upgraded Font options

This release offers a number of improvements for choosing font displays.

- Key displays can now be in a chosen font
- Vehicle Demand lists can now be displayed in a chosen font
- Part Description displays can now be displayed in a chosen font



A screen display from the new ACME model in this release illustrating use of the new key font displays.

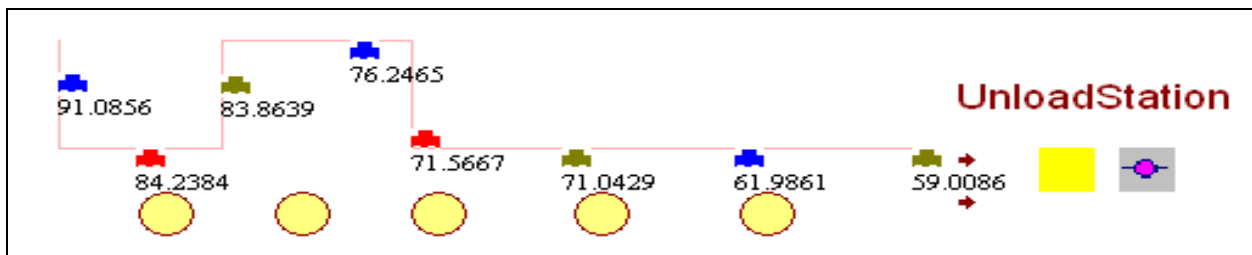


A screen display from a modified version of shuttle.mod showing new DESC font options for part displays.

Extended Tag Displays

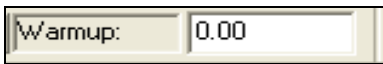
Following the successful introduction of tag displays for parts in WITNESS 2006 this functionality has now been extended to allow tag displays to show when parts are loaded on vehicles or carriers.

To enable this you need to choose a part type display for the style of the carrier or the vehicle and also enable tag displays for these elements.



A section of power and free conveyor with tag displays indicating a time attribute shown below carriers.

New Model Warmup System variable and display position



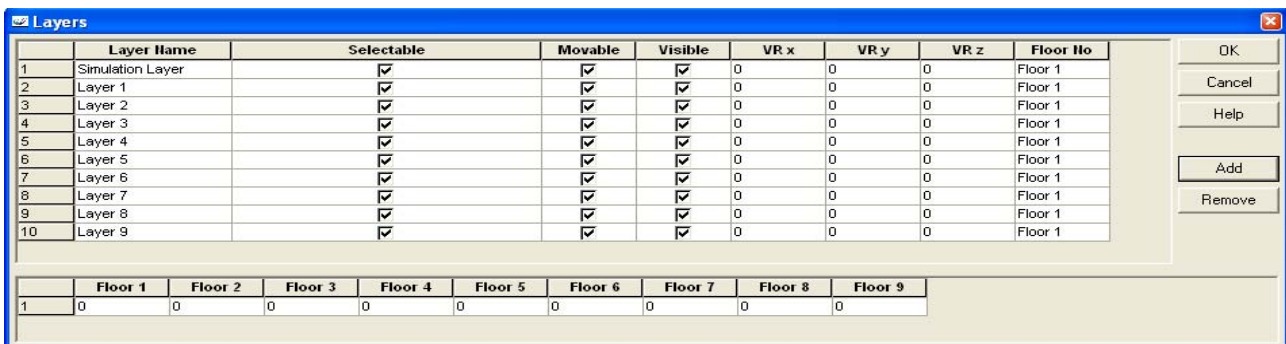
This display is now included on the run toolbar by default. The value can be edited to alter the setting for the warm-up period for a model.

In addition the value of this setting can be accessed using the new system variable WARMUP.

New Layers Dialog

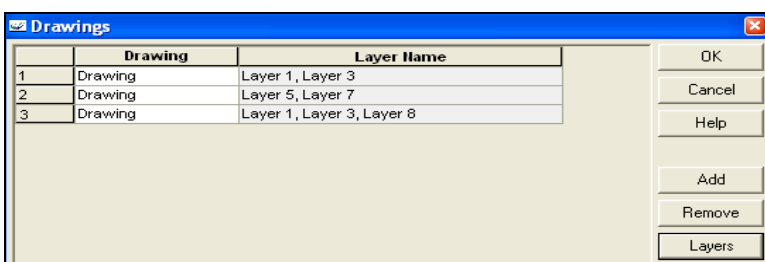
A new look display offering check box selection of layer characteristics. This is accessible via the View/Layers menu option.

The existing layer characteristics of Selectable, Moveable and Visible can be easily selected and the values of new options (mainly affecting WITNESS VR) can be set.



New Drawings Dialog

A new look display for the drawings dialog offering better visibility of the layers which have been selected for each drawing. Drawings are convenient ways to group layers and then each drawing can be selected from a single pull down toolbar list to show the chosen view. All names are completely customizable.



New Max and Min functions for variables

Two New functions have been introduced for variable arrays:

- i) **MinVariable(Variable Name)** returns the minimum value in the array
- ii) **MaxVariable(Variable Name)** returns the maximum value in the array

In addition the functions MeanVariable and StdDevVariable have been extended to work with multi-dimensional arrays.

New Model Initialization Options

Some great new options have been added to allow more flexible model initialization. These include the automatic loading of parts into buffers, machines and conveyors, the allocation of labor to these elements and the setting of status information and timings for the different types of activity at machines and conveyors.

For example a machine can finish its cycle after x minutes or its breakdown after y minutes. Further details such as the time of the next breakdown or next setup can also be added where applicable.

This is all effected by the loading of an initialization file (.STA) via the 'Intialize from file....' option from the file menu. The STA file has a defined format that must be adhered to including the order of different lines of the file. Although it is possible to identify most errors in this file there is also some emphasis on the file creator to check that the whole file defines a status correctly with no logical errors. A new function **ImportState()** is also provided to enable initialization from actions.

```
!Location of Parts
Part001,ZoneA.Operation75(2)
Part001,ZoneA.Operation75(3),ICON=113
Part001,Conveyor001@33,PEN=0,ICON=113
!Location of Labor
Man(2),ZoneA.Operation75(2),ICON=21
!State of Elements
ZoneA.Operation75(1),State="Idle"
ZoneA.Operation75(2),State="Down/Time=3.612047"
ZoneA.Operation75(3),State="Busy/Time=1.100000"
Set Failure ZoneA.Operation75(1) 1 32.433306
Set Failure ZoneA.Operation75(3) 1 106.883084
Conveyor001,State="Queued/Time=0.100000"
```

Section of a typical status file

The file above would load the following status for elements:

- A part Part001 is added to the second indexed machine ZoneA.Operation75
- A part Part001 is added to the third indexed machine ZoneA.Operation75, the parts attribute ICON is set
- A part Part001 is added to the 33rd position of conveyor Conveyor001, the parts attributes PEN and ICON are set
- A labor element Man (second indexed item) is added to the same machine as the first part ZoneA.Operation75(2), the labor element's ICON attributes is set
- The first indexed machine ZoneA.Operation75 is set to be idle
- The second indexed machine ZoneA.Operation75 is set to be broken down with 3.612047 time units remaining
- The third indexed machine ZoneA.Operation75 is set to be busy with 1.1 time units remaining until end of cycle
- The next breakdown number 1 of ZoneA.Operation75(1) is set for 32.433306 time units after initialization (if breakdown is set to number of operations then this can also be set).
- The next breakdown number 1 of ZONEA.Operation75(3) is set for 106.883084 time units after initialization.
- The status of the conveyor Conveyor001 is set to be queued with a cycle after 0.1 time units.

If importing at time zero initialize actions will not be run when the model is started UNLESS the function to import status (**ImportState()**) is used WITHIN initialize actions when the rest of the actions in initialize actions WILL be run. In all cases the actions Import Actions (available from the Model menu) will be run.

New Quick Rule Mode



The new quick rule mode is accessed via the button on the Element toolbar.

This then enables extremely quick and easy definitions of simple model rules for part flow. Once the mode is selected then the definition of a rule is completed in two mouse clicks, one where parts should flow from and one where parts should flow to. The rule defined will depend on the elements selected. When elements are selected the existing rules are shown where applicable and the new rules are shown when created – until the next element is clicked. The quick rule model is turned off by pressing the toolbar button again.

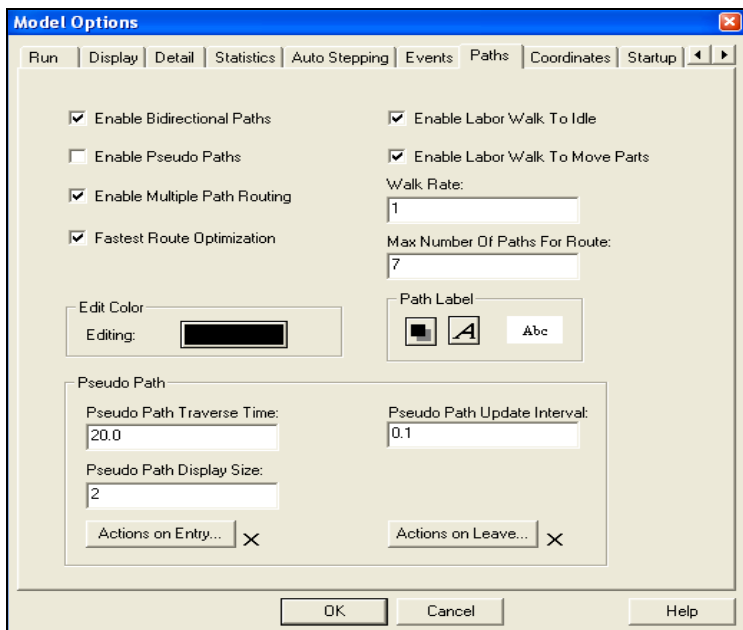
Element From	Element To	Rule Defined
Part, Machine, Conveyor, Track, Section, Station	Any Valid Element	PUSH
Buffer	Any Valid Element	PULL from Element

Where a PUSH or PULL rule is already defined to or from an element the rule will be amended automatically. The rules for this are as follows:

- i) Where a single PUSH destination was already in force the rule will be changed to PERCENT with equal chance of each route.
- ii) Where any other output rules were already in force (including multiple PUSH A,B) then the new destination will be tagged on to the end of the rule
- iii) Where a PULL rule was already in force the new source will be tagged on to the end of the rule.

Actions on and off pseudo path

New options have been added to the Model/Options dialog Paths tab as shown below. These have reorganised the dialog to an improved format and introduced Actions on Entry and Actions on Leave for pseudo path elements. The system variable TYPE referring to the labor or part element using the path is set for these actions.



New Function to change Warning Levels

To complement the function WRNLEVEL which returns the value of a specified warning level a new function has been added to set a warning level. This is only allowed at time zero in a model.

The new function is **SetWarnLevel(Element Name, Rising Flag, Index, Value)**

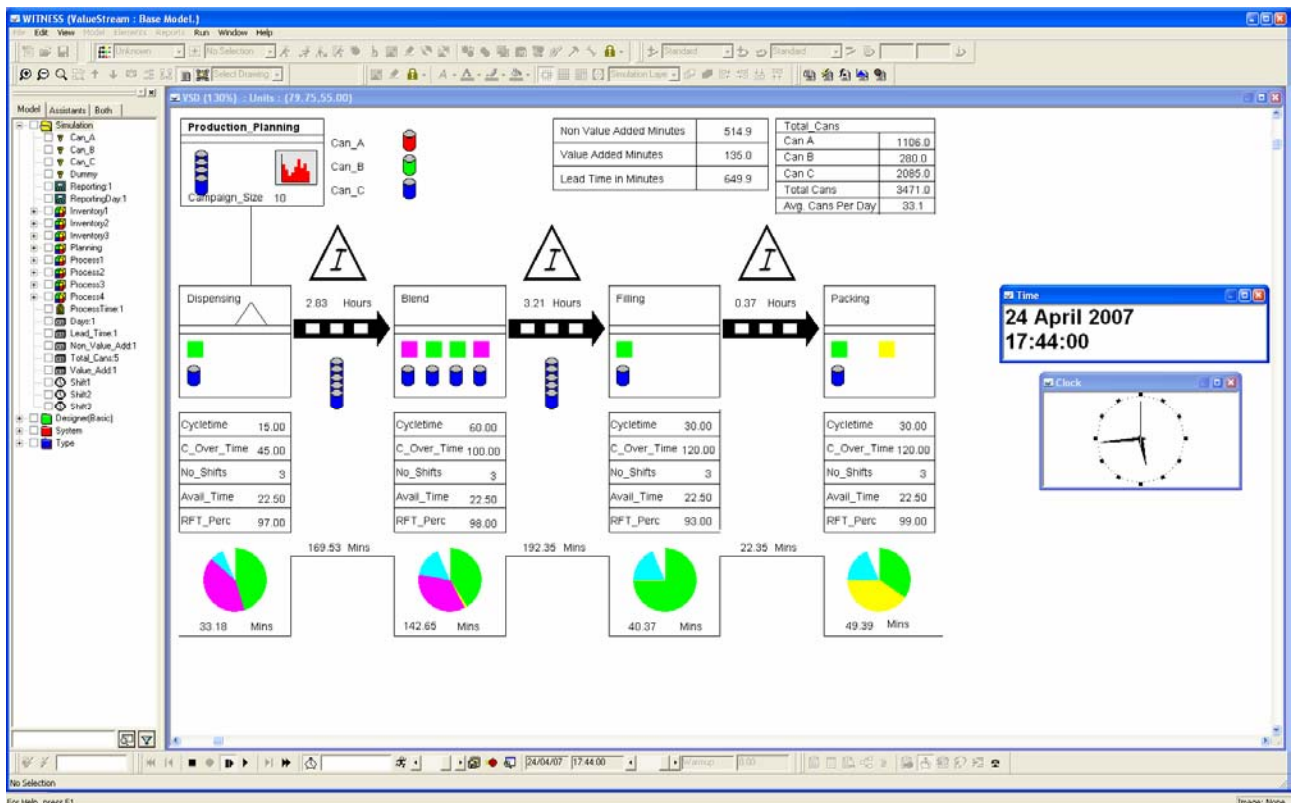
- Rising flag is set to 0 if falling level and 1 if a rising level
- Index is the number in definition order (rising or falling order if set via the dialog)
- Value is the new value that the warning level should be (either absolute or percentage depending on how originally defined in the model)

Please note that the order of the warning levels is NOT changed by this function AND the dialog for adding warning levels has also be changed NOT to alter the order of levels. Therefore levels are now allowed to be out of sequence but will all operate correctly.

New Demonstration models and workbook

A new version of the manufacturing performance workbook is installed in the demo/tutorial directory under your WITNESS installation. This 2007 edition contains many new sections including information on curved paths and discussions on the new warehousing model and value stream mapping model.

These new models are included in the demo directory too together with new versions of ACME.MOD and BELLS.MOD. ACME now reads much data in from Excel and indeed can be run from Excel too. Bells incorporates curved path displays. Both include new key displays in alternative fonts and other upgraded vector icons.



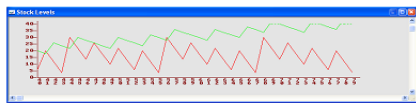
The new value stream mapping demonstration model highlighting non-value added work

Running the model

Run the model and observe the predicted saw-tooth patterns of the timeseries. Experiment with different timings in the model and observe the effects.

In this model if you set your re-order levels too low then customers have no goods to buy sometimes and there is no compensation in manufacture. Hence Warehouse stock levels rise and rise in this scenario. Try setting the reorder level to 10 (this is in the Actions on output of the Retailer Buffer - simply set NumberNeeded=10)

The green level of goods in the warehouse is rising



A valid question here is why is the red line, stock at the retailer, not showing zero sometimes? This is due to the sequence of events in the model. Most of the events are taking place at the same time - therefore the order is crucial in determining the result recorded. The reading is taking place just after delivery and as the stockout does not last over a day it is not recorded.

To see the difference try setting the update interval of the timeseries to 0.999999 - essentially the same for the first 1000 or more days - now the zero stock positions are recorded.

In models of supply chains like this which are essentially timeslice simulations the sequence of events is important. Of course you have full choice - some events can be more accurately modeled - e.g. customer demand could occur at exact times within the day - as could re-ordering. It is important to find out how the real system works before modeling it.

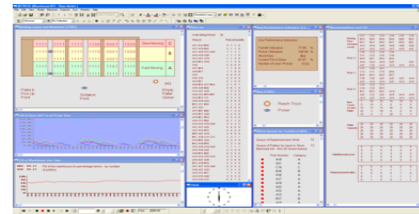
Further Logistics Model Examples

There are a number of the standard WITNESS demonstration models installed in the DEMO and EXAMPLE directories under your WITNESS installation that include aspects of logistical modeling.

These include WAREHOUSE.MOD and WAREHOUSESTOCK.MOD

WAREHOUSE.MOD is described in some detail in the tracks and vehicles section of this workbook.

WAREHOUSESTOCK.MOD



This model is in the standard demo directory which is situated under the directory where you installed WITNESS. It illustrates how WITNESS can be used to examine aspects of stockholding, storage layout, pallet positioning, picking routes, replenishment strategies, staffing levels and more.

Warehouses can be complex environments with a wide choice of control options. This model is certainly one of the most complex in the WITNESS demonstration directory for that exact reason.

The model includes a single area of racking with 3 aisles. Each aisle has pallet positions on each side of it. The pallet positions in the store extend 5 deep along the aisles and 4 high in all positions. Therefore the capacity of the warehouse is 5*4*6= 120 pallets.

Picking is arranged in this warehouse on the bottom floor only (30 pallet positions). All the pallet positions above the floor level are used to hold more stock with which to replenish the picking positions on the ground when needed.

There are 30 lines (types of goods) stocked in this warehouse. Each has a single picking position. The lines are labeled with a letter and a number - the letter represents the stock turnover category for the line. The number is just a unique identifier. The stock turnover categories are A, B and C. A is for high turnover items - i.e. ones that are picked most frequently in the warehouse. B is for moderate turnover items and C is for slow turnover items. The parts are numbered from A1 to A12, B1 to B12 and C1 to C6. (There are only 6 slow turnover lines).

A lot of data is read into the model from an Excel spreadsheet called warestockdata.xls. This includes the picking positions in the store, the initial fill of full pallets, the initial item counts on the picking pallets, the pallet capacities, etc - and then on other tabs picking lists and numbers of pickers, cranes and some logic choices.

Much of the data from the spreadsheet is read in the initialize actions section of individual variables - such as FV.PartsFloor1 where the following line can be seen:

```
FLReadArray ("WarestockData.xls", "Warehouse Setup", "Sb52:5g56", "PartsFloor1.1")
```

There are two work lists that drive the model:

- i) pallets arriving to put away - from partfile Jobsin.bt
ii) pick lists - read in from the Excel file warestockdata.xls in picklist and picklistquantity arrays

Each will provide unlimited work as they recycle automatically when the work or arrival pattern is finished.

The single reach truck puts arriving pallets away and undertakes replenishment. It is modeled as a multi cycle machine and the priorities on this can be seen in the input rule for its first cycle.

```
IF FV.SpaceInStore () = 1
  PULL from QRReplenish, QPalletsIn
ELSE
  PULL from QRReplenish
ENDIF
```

Here a function is used to calculate whether there is space in the store before any job that may require space is accepted (in this case from the buffer of pallets).

For putting away it travels to pick up the pallet and then takes it to a location chosen by the PutAway function - this takes account of the category of the part A, B or C.

For replenishment it travels to the replacement pallet position and takes the replacement pallet to the empty/low stock pallet location and then takes the empty pallet to the outbound empty pallet queue.

Sample pages from the new workbook - including part of the discussion on the new warehousing model