

WITNESS SIMULATION SOFTWARE

BY
LANNER

witness 12



This paper introduces WITNESS 12, the latest version of Lanner’s simulation software platform. It explores the structure of the software and the key features that make building simulation models in WITNESS highly productive. These include elements with great breadth and depth, wizards for links to Excel and other databases, informative displays of great variety, modern interface structure, comprehensive reports, powerful range of logic options with full scripting extensions and more. Some of the latest functionality, such as sustainability modeling, Six Sigma tables and algorithms and advances in virtual reality are summarized together with recent experiences in the use of optimization using the WITNESS Optimizer, a unique module offered by Lanner.

OVERVIEW

WITNESS is a software package with pedigree. It has been successfully used by thousands of modelers over 20 years and it has kept pace with modern software development platforms and interface design as witnessed by Lanner's Microsoft Gold Partner status and Windows 7 badging. This ensures that the environment for the modeler is convenient, intuitive and can be customized.

Opening WITNESS 12 reveals a Start Page with access to a range of helpful information. This can be seen in Figure 1.



Figure 1: The WITNESS Start Page

The vanilla layout of WITNESS, when first opened, shows the following toolbar, modeling window and dockable supporting window structure shown in Figure 2. There are places for a tree view of the model, an assistant tree, time displays, a multi-tabbed designer element palette and more. WITNESS supports several simultaneous views of a model in different windows – but at first the simplicity of a single view is shown. WITNESS offers two editions, the Manufacturing Performance Edition and the Service and Process Performance Edition. WITNESS 12 is available in English, French, German, Polish, Chinese, Japanese and Spanish.

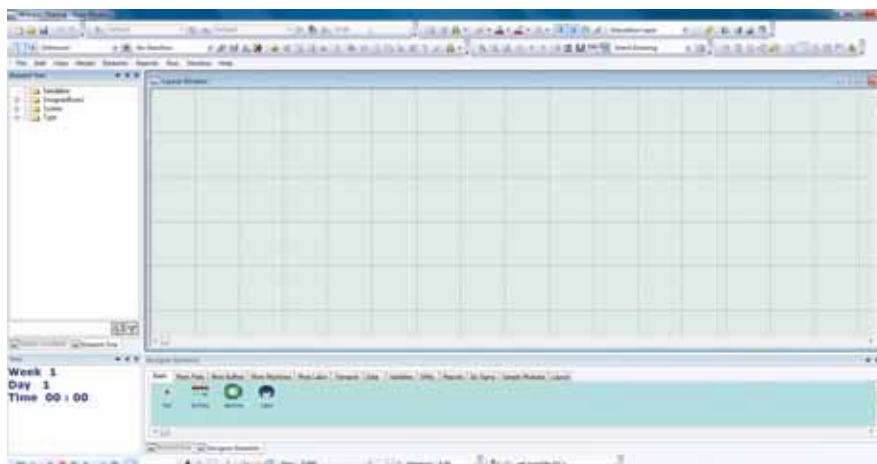


Figure 2: WITNESS Manufacturing Edition – Default Layout

BUILDING MODELS

Models are built in WITNESS using the elements displayed in the many tabs of the designer elements window. Figure 3 shows two further examples of the designer element palettes. These palettes can be added to by Customers, both new palettes and new elements.

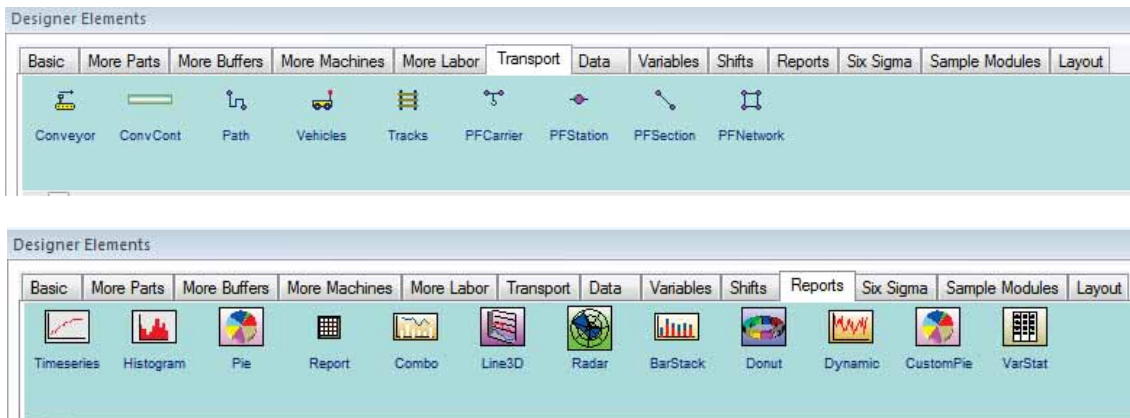


Figure 3: Further Designer Element Example

Building models uses a simple click and place method to place elements from the designer palettes onto the modeling windows. The elements can be simple or may be complex modules. Any collection of model elements can be converted to a designer module, the easiest method for this is to drag the module created into the designer element section of the tree view whilst holding down the Ctrl key. Layouts can be created quickly using this method to arrive at a required model display. It should be noted that there are generally two types of model display chosen – one where a facility layout is shown and one where a process is visualized quite separately from any layout or facility design. Examples are shown below in Figures 4 and 5.

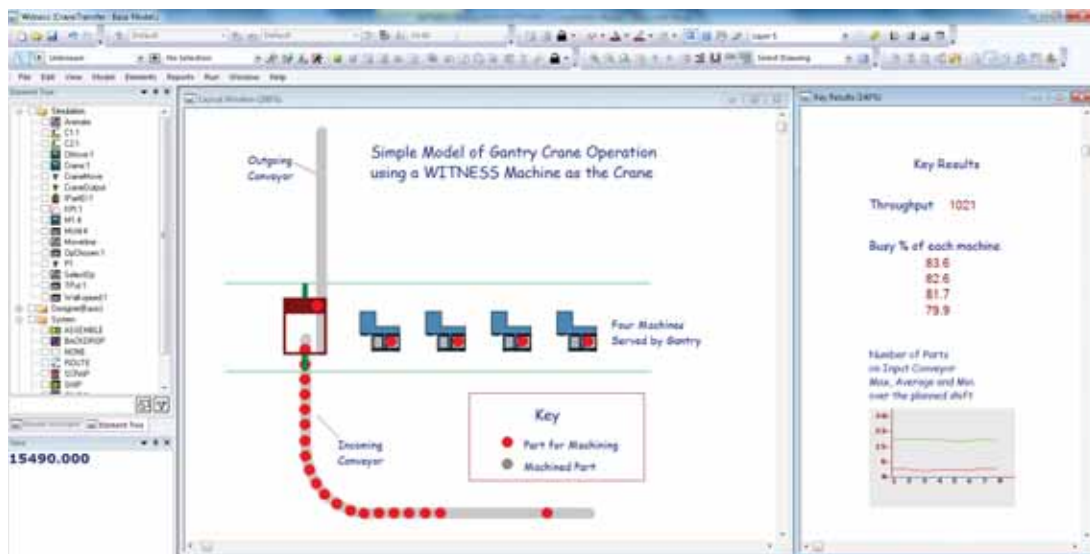


Figure 4: A simple facility layout model example in WITNESS

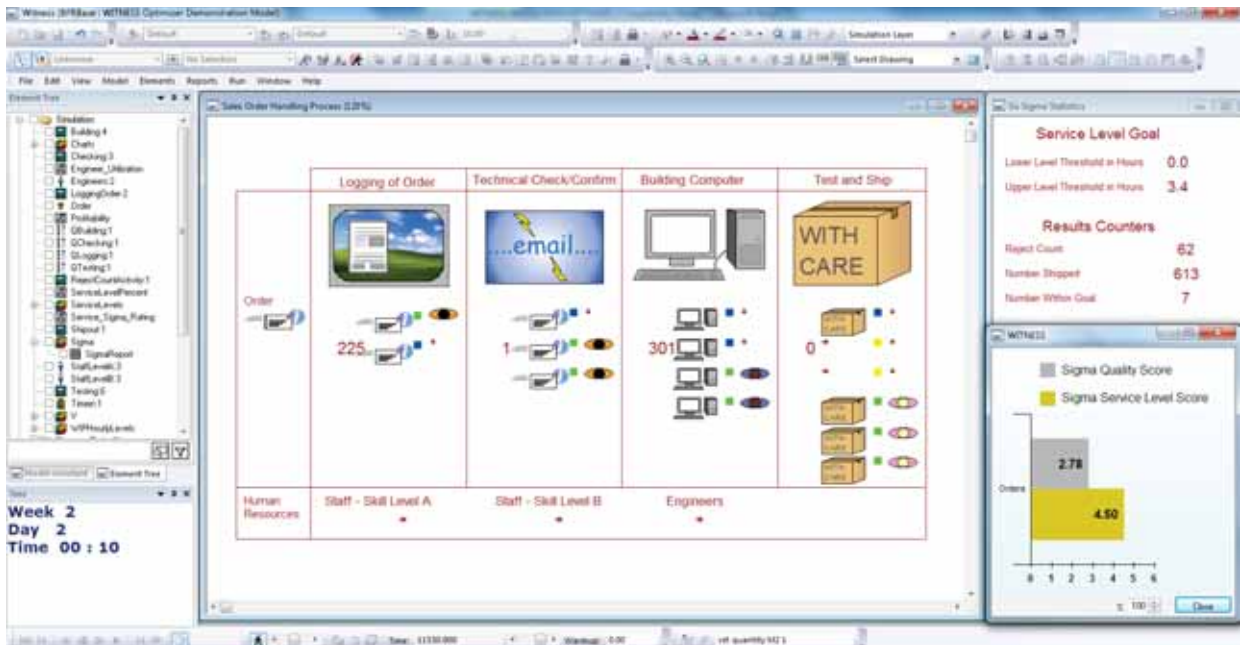


Figure 5: A simple process model example in WITNESS

Graphics are very important for model communication and acceptance. WITNESS allows the use of many different graphics formats with both vector and bitmap options. CAD layouts can be brought directly into the software with preview and layer options that make overlaying elements easy. Figure 6 shows an example of an effective CAD display in an airport model.

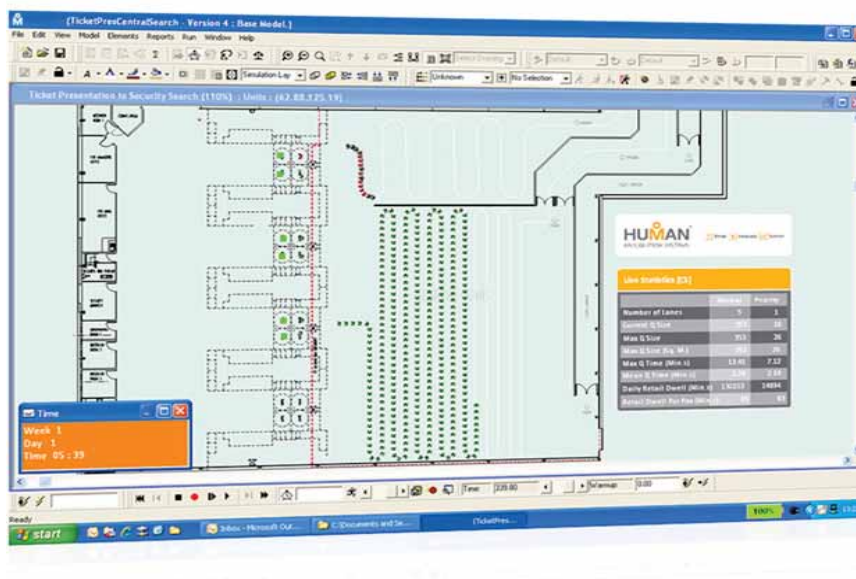


Figure 6: A model overlaid on a CAD backdrop (courtesy of Human Recognition Systems Ltd)

On-screen editing enables changes to be easily made. For example the display bar offers many of the standard choices as seen in Figure 7. Directly editing simulation elements, such as path displays, and access to setup display dialogs can be accessed easily by clicking on the model – an example shown in Figure 8.



Figure 7: Full range of toolbar functionality for easy on-screen editing

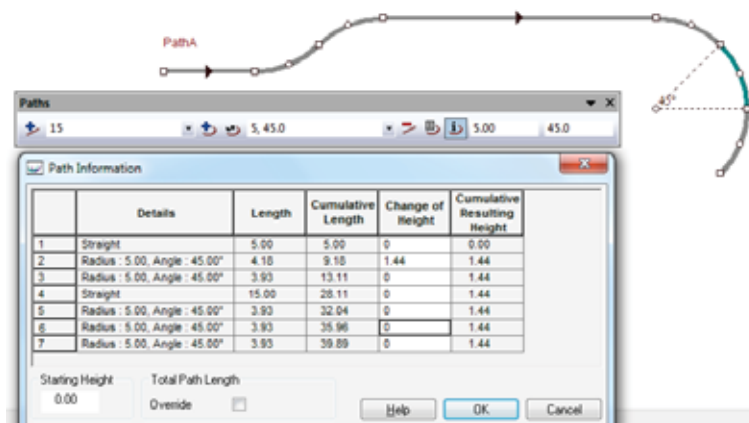


Figure 8: On screen editing and dialog for displays for conveyors, queues and paths

Specifying the model's logic flow in WITNESS incorporates WITNESS rules which include Push, Pull, Percent, Sequence, Least, Most and Match options. All of these can be nested within multiple levels of IF, ELSE, ENDIF constructs.

Simple rules can be built using point and click functionality, while more complex rules are generally entered within dialog boxes attached to model elements ensuring any coded logic is contained at the point of use within a model. Coded logic residing in element detail dialog boxes can also be accessed via the tree sidebar.

Elements are WITNESS's key strength. Only by having the right set of building blocks can you build what is needed quickly and accurately. Every simulation package has its own structure and there are many similarities between packages but no two are the same and the structure matters. The WITNESS element set has been well tried and tested, proving itself within thousands of projects over many years.

The WITNESS element range is wide with a number of specialized extensions to the core set (e.g. specialized elements for Power and Free Systems and elements to model flow such as fluids, tanks and pipes). The machine element serves as an excellent example of the depth of WITNESS. Delivering rich dialogs offering multi tab entry of setups, breakdowns, shifts all dependent upon the type of machine – single, batch, assembly, production, general, multi-station and multi-cycle are all available.

The dialog in Figure 9 shows an example of the complexity that is handled efficiently by the multi-cycle machine with each cycle having different resource requirements, timings (see the distributional timing too as an example), input and output options and plenty of places to set other actions that can affect other parts of the model. Most fields accept expressions. This is key to the power of WITNESS as a complex decision can be made in several lines of logic code by having a function in the expression field. This power is what makes WITNESS productive.

A simple language (similar to Basic) is used in Actions – this includes FOR/NEXT loops, IF/ENDIF options and similar so that complex logic can be included where needed. WITNESS has a full debugger integrated to step through actions at run time so that logic can be followed and any problems readily identified in the model control.

A profiler is included that allows modelers to see which events and rules are the most commonly being used and when rules (In, Out and Resource) succeed and fail. This can help to identify where models can be made more efficient.

The WITNESS Documentor module provides a great way to gain a record of the setup of all fields and logic included in a model. It's good to be able to record this easily.

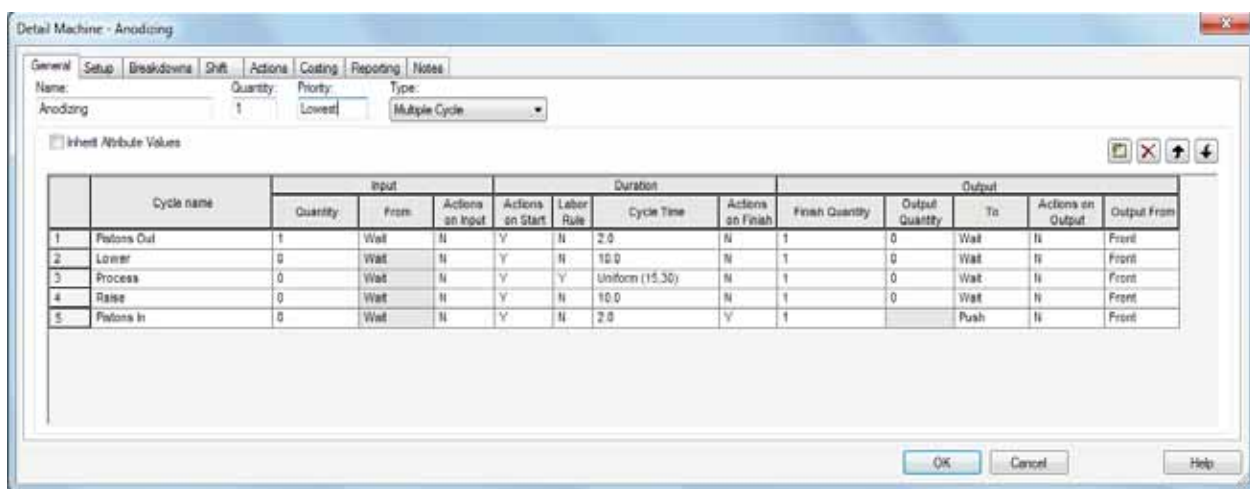


Figure 9: A WITNESS machine detail dialog showing multi-cycle definition flexibility

LINKS TO DATA AND MORE

WITNESS enables quick and easy access to data. For Excel WITNESS offers a simple wizard to select the spreadsheet file and worksheet and then swipe the cells required. After this is done data will be read in each time WITNESS runs if desired. For any OLE DB database WITNESS offers a wizard to set up the link as seen in Figure 10 and also creates a WITNESS module that populates data into WITNESS variables as you step through the extracted records.

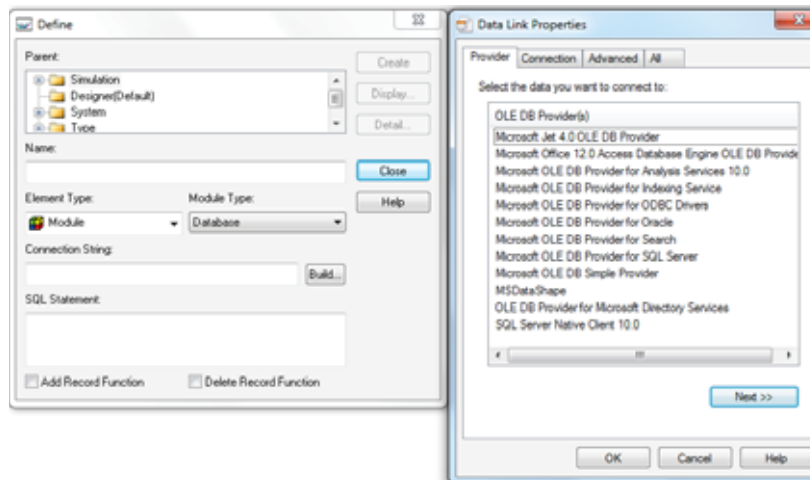


Figure 10: Part of the Database link setup wizard

For the Power User of simulation SIMBA, the WITNESS object model offers programming control through a plethora of methods and properties if the standard OLE links do not offer the simplicity of link required. In addition code from other languages can be linked to and called by WITNESS at any point in a model run – this is done using WITNESS component modules where any COM enabled DLL or EXE can be incorporated. WITNESS automatically handles the handshakes required and a wizard automatically provides WITNESS functions to call the routines in the outside code.

With the options for external control of WITNESS it is common for simulation specialists to provide models for others to use with a customized interface. Excel is a common choice used extensively by Lanner consultants. An example of such an interface is shown in Figure 11.

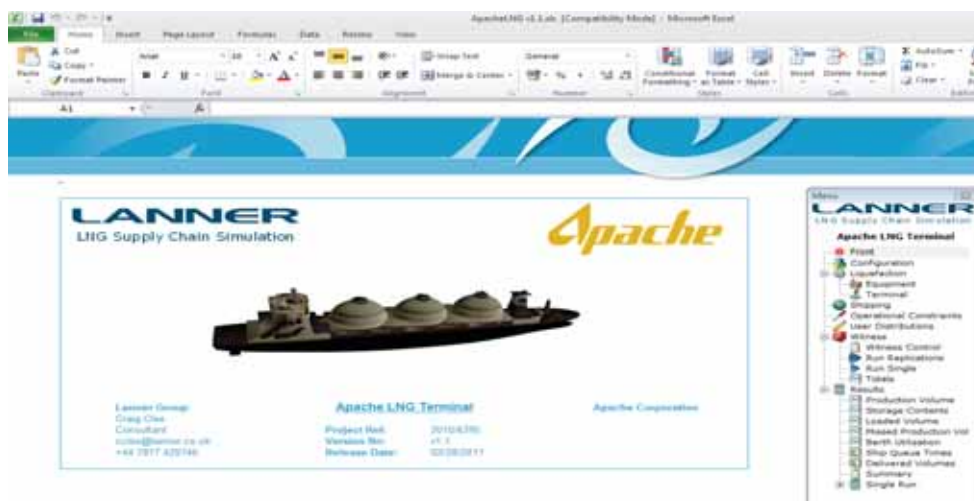


Figure 11: Example Excel Interface – menu, data, run control, results – courtesy Apache Corporation

RUNNING THE SIMULATION

Video style buttons allow a model built in WITNESS to be run. See these in Figure 12. WITNESS is very interactive in that simulation models can be run, stopped, changed and run on from that point. Models can be stepped one event at a time, batched with no display and even rewound using the record feature.



Figure 12: Run Toolbar controls

Models can be stopped at any time and saved in a format that remembers exactly the simulation status. At a later time this file can be reloaded and the model run forward again from that point, or the statistics revisited. There is no compilation step with WITNESS – models just run immediately when needed. There is a variety of experimentation methods from interactive runs to the full Scenario Manager module that stores all experimentation setup and results in an SQL database.

RESULTS

WITNESS automatically creates a wide range of statistics for the elements being used in a model. At any stage in a model run the model can be stopped and the statistical reports viewed. A typical standard report and the associated status chart is shown in Figure 13. The charting component allows for a wide range of standard chart types. Any further key performance indicators can be calculated and displayed (even dynamically as the model runs) and a custom report element is available for the inclusion of a chart or a table in a re-usable module. Examples shown in Figure 14.

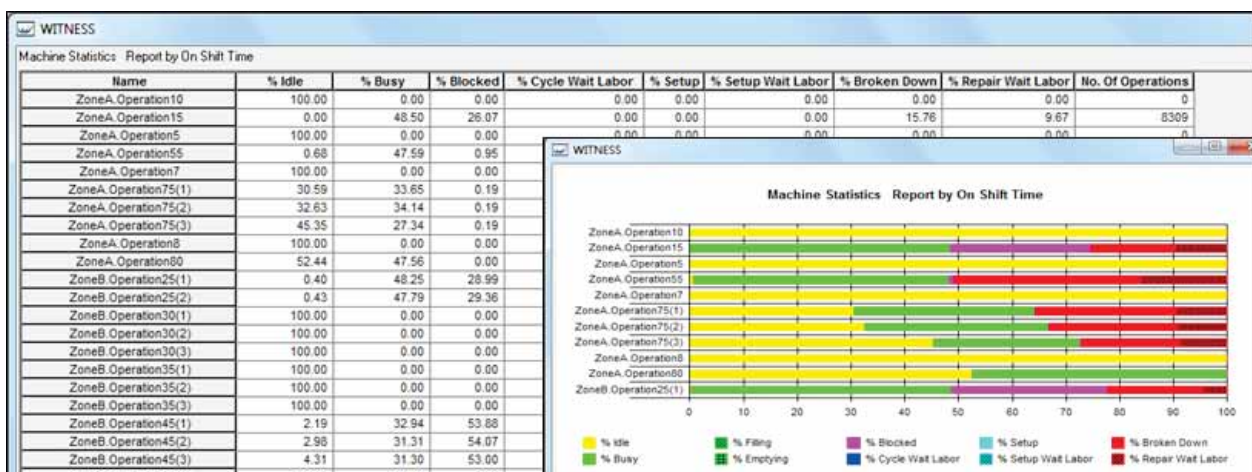


Figure 13: Example standard Statistics from a model run

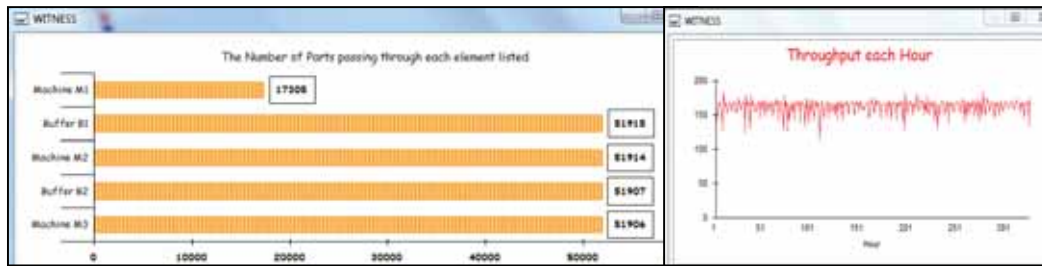


Figure 14: Simple custom reports defined as report elements

There are a number of ways to choose to run and analyze experiments from interactively to the full WITNESS Scenario Manager. This offers a SQL repository that stores and sorts all experimentation and results in a library. Examples of standard charts available are shown below in Figure 15.

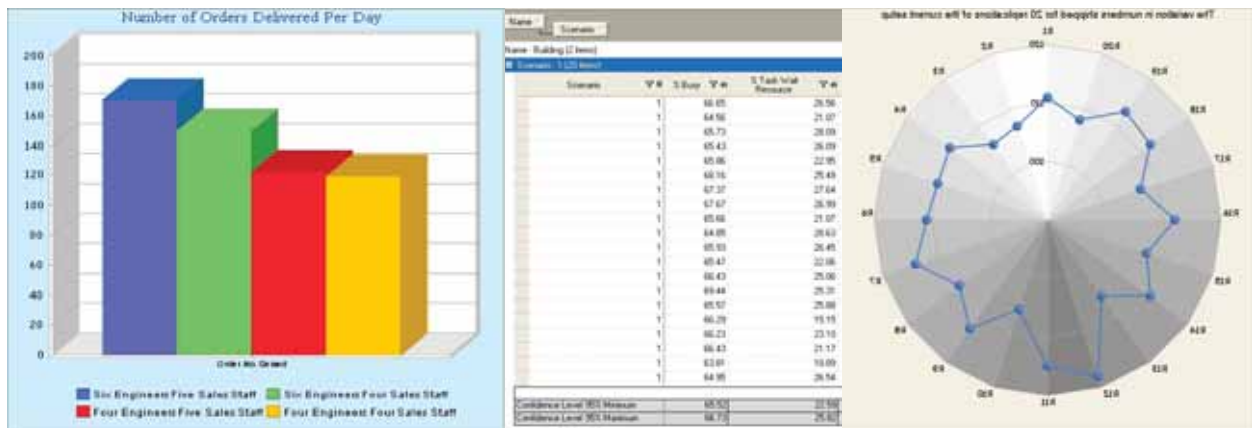


Figure 15: A few examples of the many tables and charts available in the Scenario Manager

SUSTAINABILITY

One of the most exciting and interesting areas of research and application in recent years has been the growth of interest in sustainability. Organizations are more interested than ever before in knowing the impact of their plans on the environment.

Lanner have recognized this trend and made available in WITNESS a comprehensive way to see the impact on measures of sustainability of different process choices.

The first step in WITNESS is to define the measures of interest. This is done on the Costing and Sustainability dialog shown in Figure 16. Any measure can be defined together with the name of the units that it is measured in.

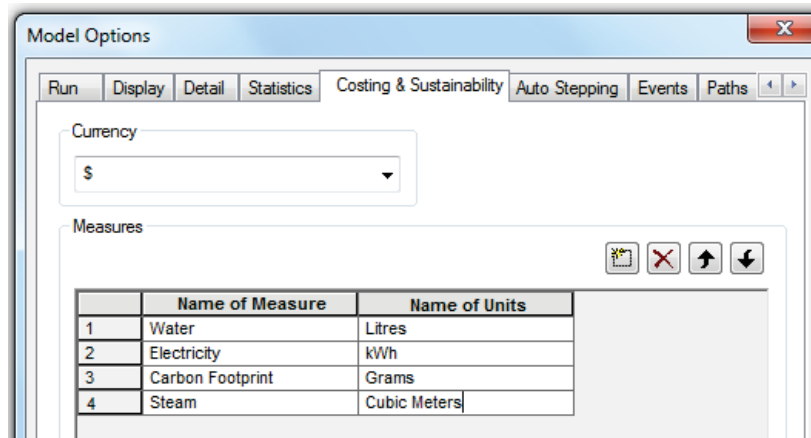


Figure 16: Costing and Sustainability measures definition in WITNESS

Then many dialogs have a costing tab with many different pigeon holes to put figures, distributions, indeed full expressions of how much resource is being used (or generated). A range of functions to define use at any other point in the model make the usage definition comprehensive. A full balance report can be generated at any point in a model run and more functions give access to all the results for easy export. An example balance report is shown in Figure 17. The model from which this simple report stems is shown in Figure 18 including the dialog to display the key performance indicator on the model screen. In this model there are only three things consuming electricity – the buffer before the machine needs to keep the parts warm, the machine when it is switched on and more when it cycles, and the machine when the tools are changed for a setup.

Generation	Element			By Quantity	Total
Total Generation				0.00 kWh	0.00 kWh

Use	Element	Fixed	By Use	By Quantity	Total
	SetupCost_Annealer(1)	0.00 kWh	0.00 kWh	25616.00 kWh	125616.00 kWh
	Annealer(1)	0.00 kWh	12535.09 kWh	10393.48 kWh	22928.57 kWh
	QNox(1)	0.00 kWh	16284.40 kWh	0.00 kWh	216284.40 kWh
Total Use		0.00 kWh	28819.49 kWh	36009.48 kWh	364828.97 kWh

Balance					
Total Balance					(364828.97) kWh

Figure 17: Costing and Sustainability Balance Sheet example

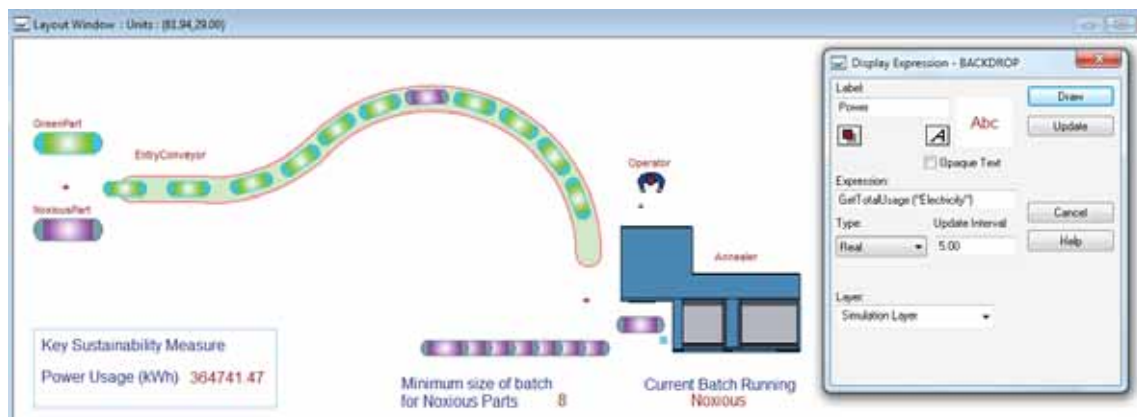


Figure 18: Costing and Sustainability model with KPI measure definition for model screen

SIX SIGMA

WITNESS helps Six Sigma analysis directly in a number of ways. The three most important of these are as follows:

- Firstly the Six Sigma normal probability table is embedded in WITNESS. Therefore any measure can be converted to Six Sigma score by simply telling WITNESS the number of defects per million opportunities (DPMO).
- Secondly the WITNESS Optimizer includes a special Six Sigma algorithm. For an explanation of this please see the following section on Optimization.
- Thirdly all WITNESS reports have a MINITAB button directly on the screen next to the tabular report. A single click and the selected data is automatically copied into a new MINITAB worksheet for further analysis.

Simulation is a great way for Six Sigma practitioners to calculate the impact of their proposals, providing assurance of the impact on the bottom line.

VIRTUAL REALITY

WITNESS offers much in the field of virtual reality but does not impose its use. Lanner believes that 3D can get in the way of the simple solving of mathematics using simulation and that therefore virtual reality should be deployed as a display layer when important for communication.

WITNESS includes Quick3D as standard – this offers the automatic creation of a 3D view from any 2D model display. Examples are shown below in Figures 19 to 21.



Figure 19: A Quick3D view of a banking model



Figure 20: A Quick3D view of a manufacturing layout – multi floors, conveyor elevations, etc.



Figure 21: Quick3D of a crane transfer model in an example supplied workshop environment

OPTIMIZATION

Organizations need optimization more than ever before. The competitive edge is ever more pressing and to get the extra bit out a simulation model can mean a lot. With WITNESS recently we have seen much use of the WITNESS Optimizer. Application areas include the optimization of a Bush Press Process in Auto suspension production – see Figure 22. This optimization essentially was a sequencing problem with four types of pallet and multiple part types being processed through a series of manual and robotic operations. The Optimization improved best overall cycle time by 3%, a major saving in this type of facility.

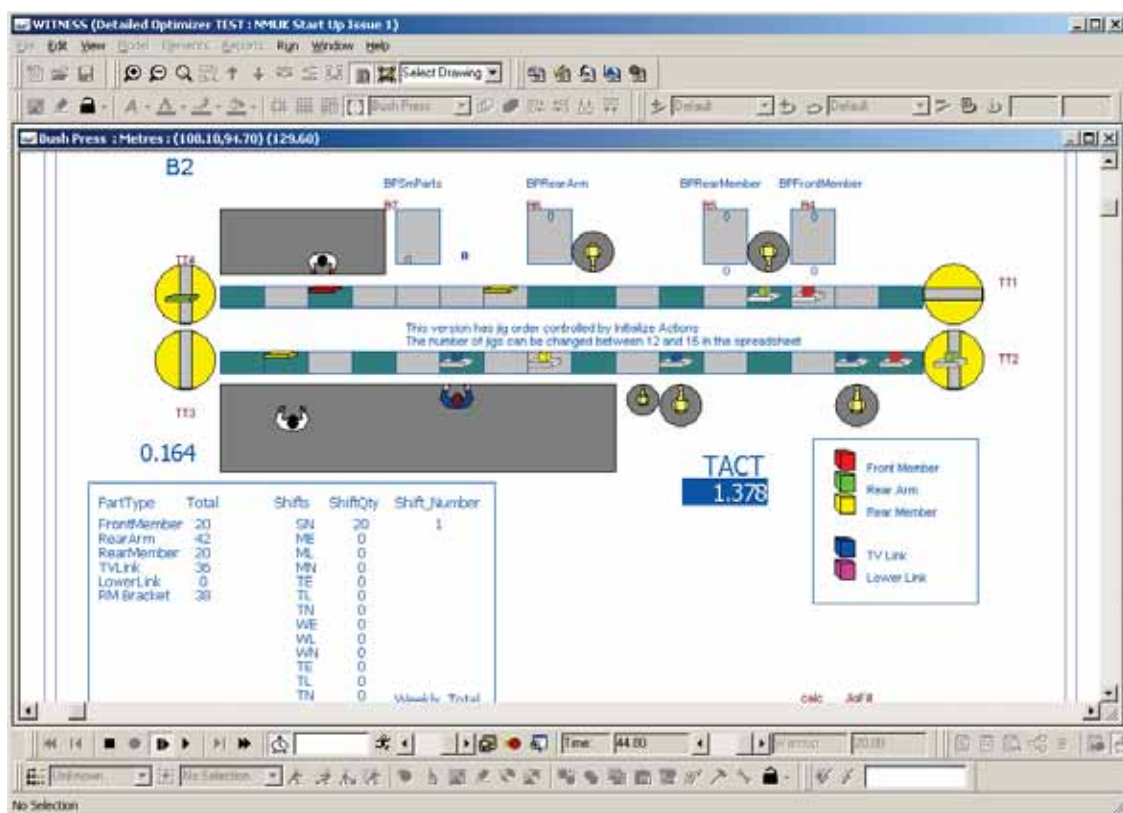


Figure 22: WITNESS Optimization in action – an automotive example courtesy of Nissan

The WITNESS Optimizer allows the definition of an objective function, parameter ranges and/or parameters with set values, combination constraints of parameters, runtime, replications, etc. There is a choice of algorithm including the option to link in your own Optimization algorithm from your own compiled code. Algorithms provided include a unique heuristic search algorithm based on simulated annealing and tabu search methods. A variant of this algorithm is the WITNESS Six Sigma algorithm which applies the same heuristic search but only allows a fixed number of parameters to vary at time – identifying the best options for process improvement where the change options need to be selected without a complete redesign.

Reports include tables and charts for objective function and other tracked measures, variance and confidence intervals and a parameter values/results table providing a sensitivity analysis. Selected Charts are shown in Figure 23.

Other recent examples have incorporated the new sustainability measures – optimizing the use of energy and analyses of a final large layout design where buffers/conveyors capacities were flexed up and down a little to gain an extra half a percent of throughput.

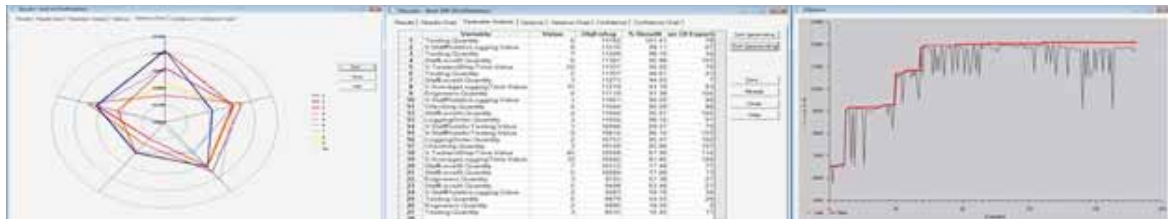


Figure 23: WITNESS Optimizer – variance chart, sensitivity table and objective search chart.

AUTHOR BIOGRAPHY

ANTHONY WALLER received a BSc (Hons) in Statistics from the University of St. Andrews in 1981 and has worked in the field of Operational Research and particularly simulation ever since. He has worked on many diverse international assignments as a consultant and has helped develop simulation software in a product management role. He is currently the Customer Development Manager at Lanner. He is on the editorial board of the Journal of Simulation.

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