

## WITNESS SIMULATION SOFTWARE

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### ABSTRACT

This paper introduces WITNESS 12, the latest version of the simulation software from the Lanner Group. 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, direct links and wizards for links to Excel and 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.

### 1 INTRODUCTION

WITNESS is a software package with pedigree. It has been successfully used by thousands of modelers over the past 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 current, 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. It is available in English, French, German, Polish, Chinese, Japanese and Spanish versions at the time of writing.

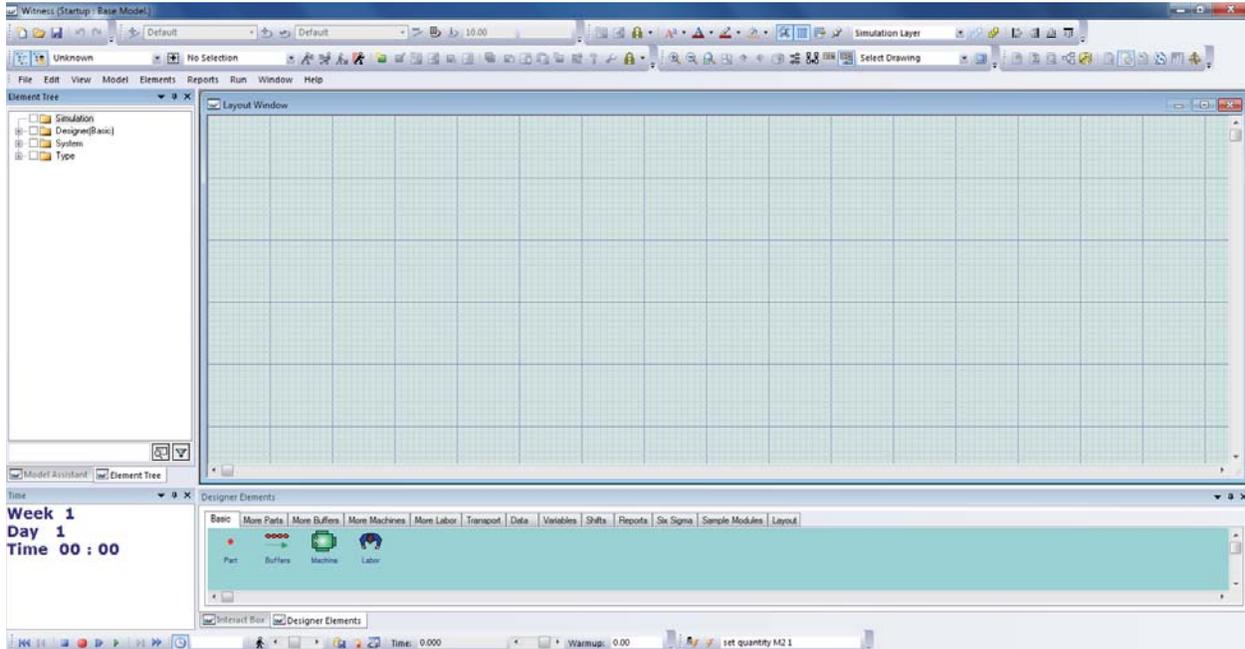


Figure 2: WITNESS Manufacturing Edition – Default Layout

## 2 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 Customers, both new palettes and new elements.

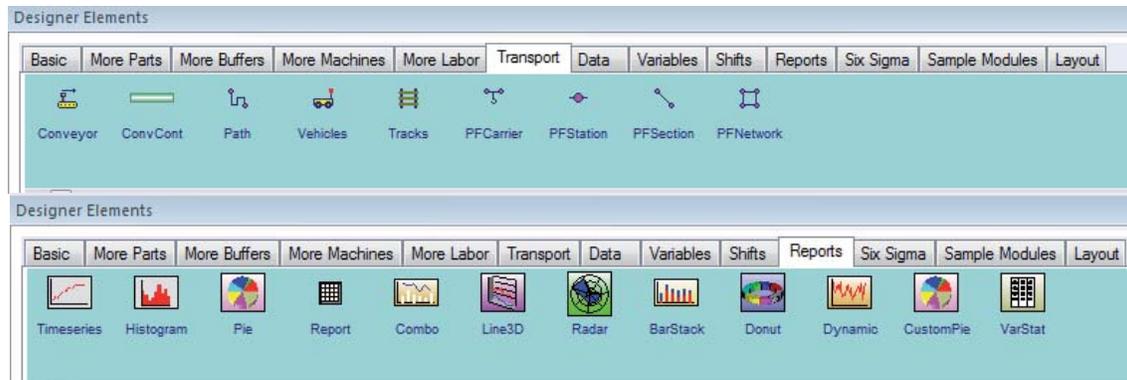


Figure 3: Further Designer Element Examples

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.

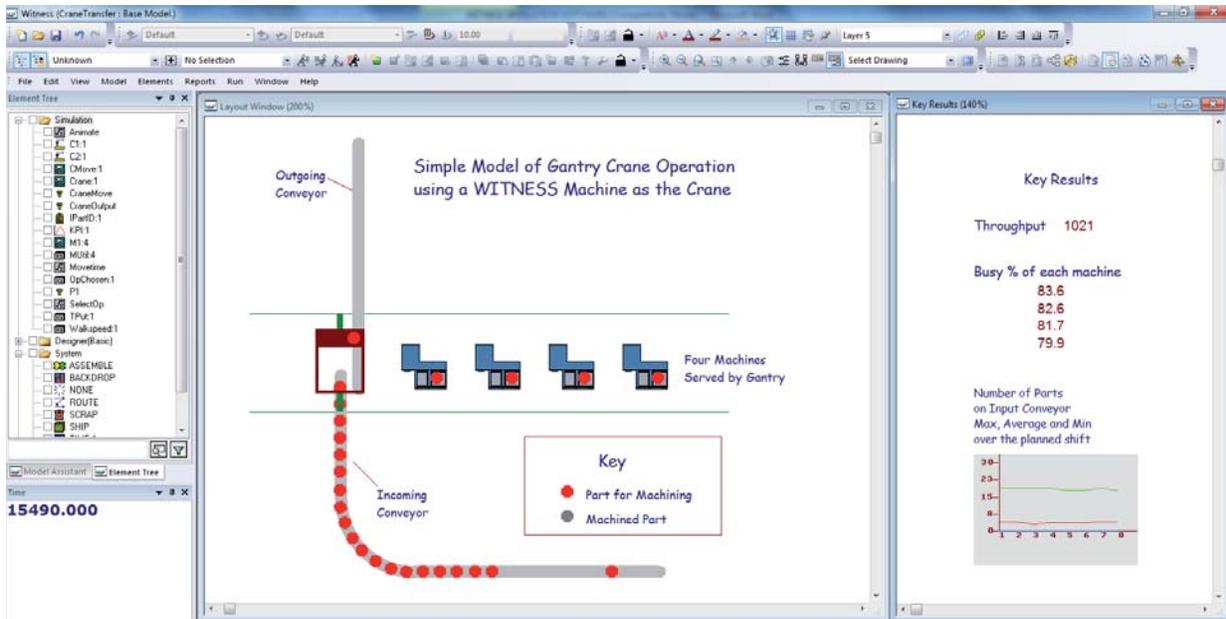


Figure 4: A simple facility layout model example in WITNESS

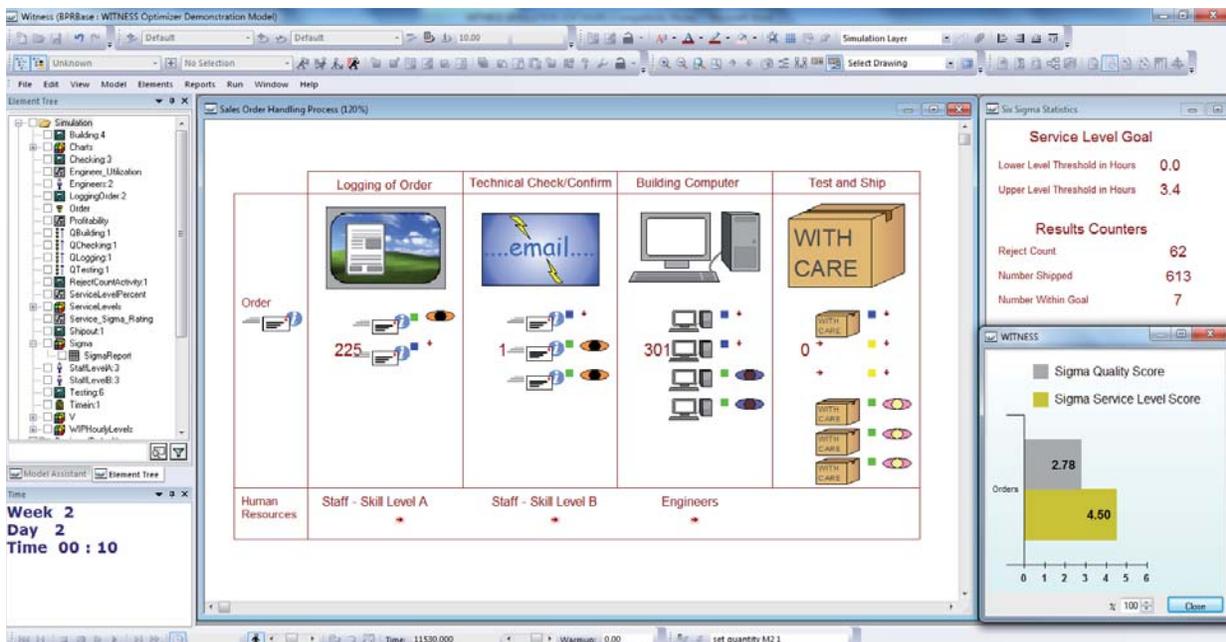


Figure 5: A simple process model example in WITNESS

Graphics are very important to how models are communicated and accepted. WITNESS allows use of many different graphics formats in both vector and bitmap options. CAD layouts too can be brought directly into the software with a preview and choice of layers to make things easy. Figure 6 shows an example of effective CAD display in an airport model.

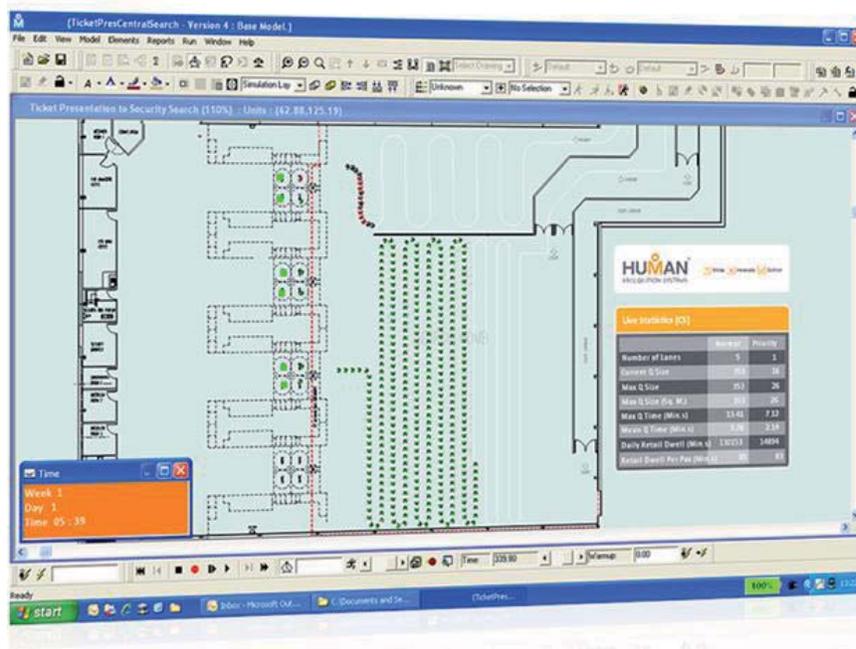


Figure 6: A model overlaid on a CAD backdrop (courtesy of Human Recognition Systems Ltd)

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, and for simulation elements direct editing of, for example, path displays and access to setup display dialogs is within easy reach – examples shown in Figure 8.



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

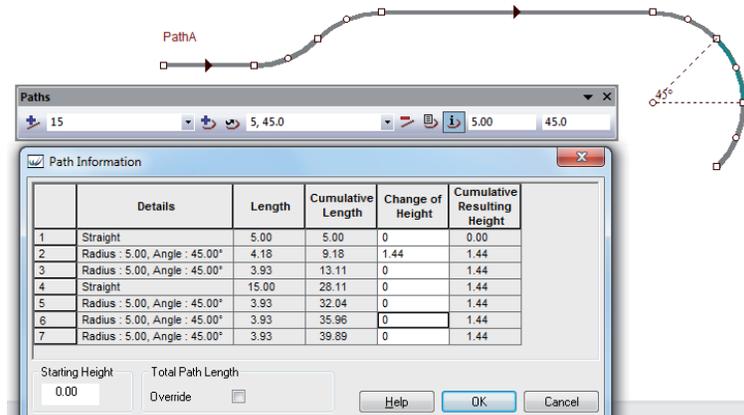


Figure 8: On screen editing and dialog for displays for conveyors, queues and paths

Specifying the logic flow in WITNESS involves WITNESS rules. These offer Push, Pull, Percent, Sequence, Least, Most and Match options. All of these can be nested within multiple levels of IF, ELSE, ENDIF conditions. Simple rules are defined fully by a few mouse clicks – more complex rules are typed in in the chosen element dialog.

Other element details are altered in the detail (logic) or display dialogs – accessed by simple double click on the modeling screen or via the tree, toolbars, menus, right mouse context menu, etc.

The elements in WITNESS are its 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 is well tried and tested and has proven itself in thousands of projects. The key is in the breadth and depth of elements available to the modeler.

The range of elements 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 continuous flows such as fluids, tanks and pipes). The machine element serves as a good example of depth with the dialog offering multi tab entry of setups, breakdowns, shifts, etc as well as the general page – context sensitive to the 7 types of machine – single, batch, assembly, production, general, multi-station and multi-cycle. 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. It is this power that makes WITNESS such a productive model building environment.

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.

An event 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. This provides a powerful time saving tool to support effective model documentation.

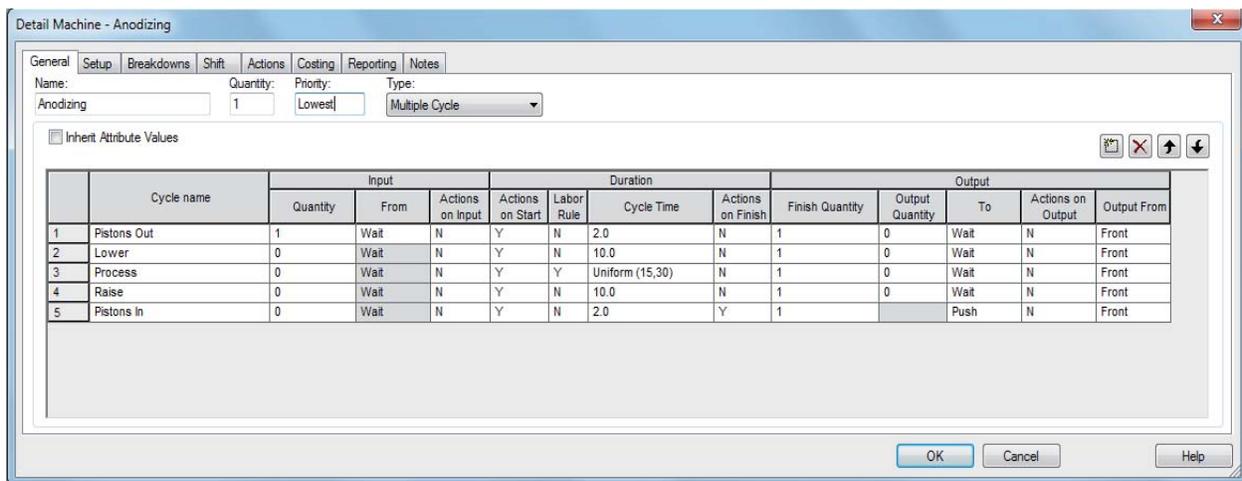


Figure 9: A WITNESS machine detail dialog showing multi-cycle definition flexibility

### 3 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 running the wizard data will be read in each time WITNESS runs if desired. For any OLE DB database WITNESS offers another wizard to set up the link as seen in Figure 10. This creates a WITNESS module that populates data into WITNESS variables as you step through the extracted records.

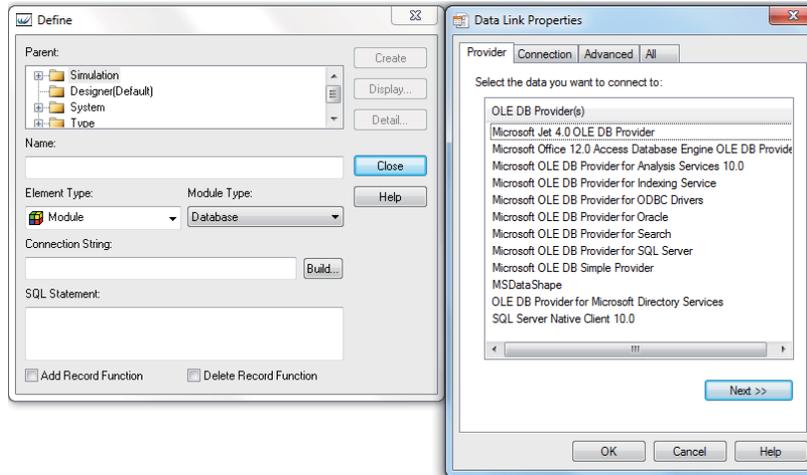


Figure 10: Part of the Database link setup wizard

For the simulation Power User 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 or as a full custom application. Excel is a common choice used extensively by Lanner consultants. An example of such an interface is shown in Figure 11.

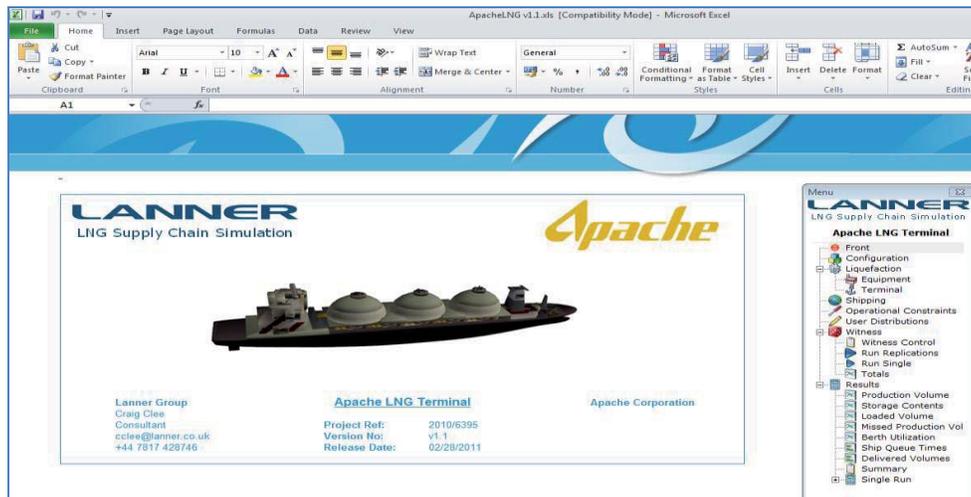


Figure 11: Example Excel Interface – menu, data, run control, results – courtesy Apache Corporation

## 4 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 rewind 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 or separate design/run modes – 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.

## 5 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.

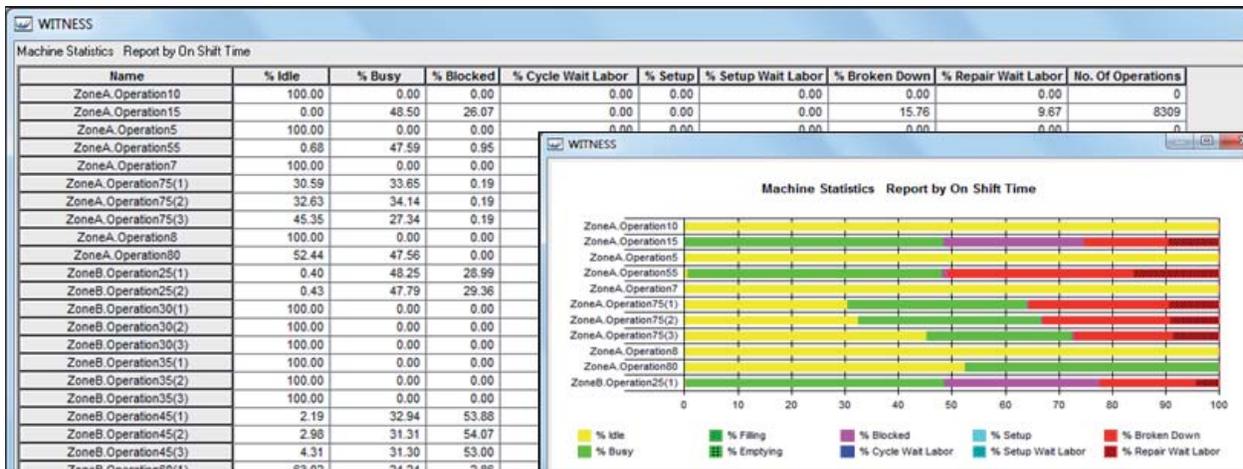


Figure 13: Example standard Statistics from a model run

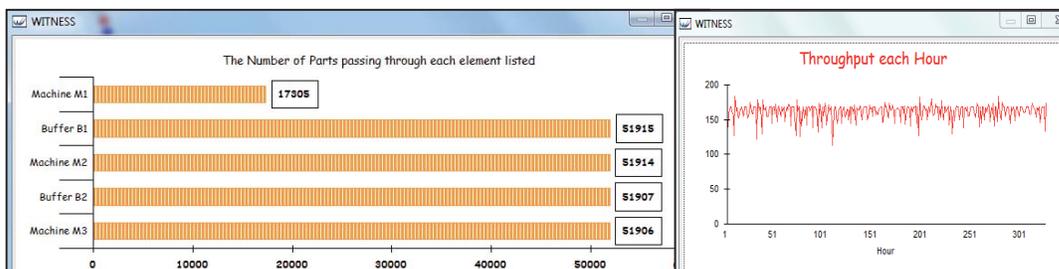


Figure 14: Simple custom reports defined as report elements

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.

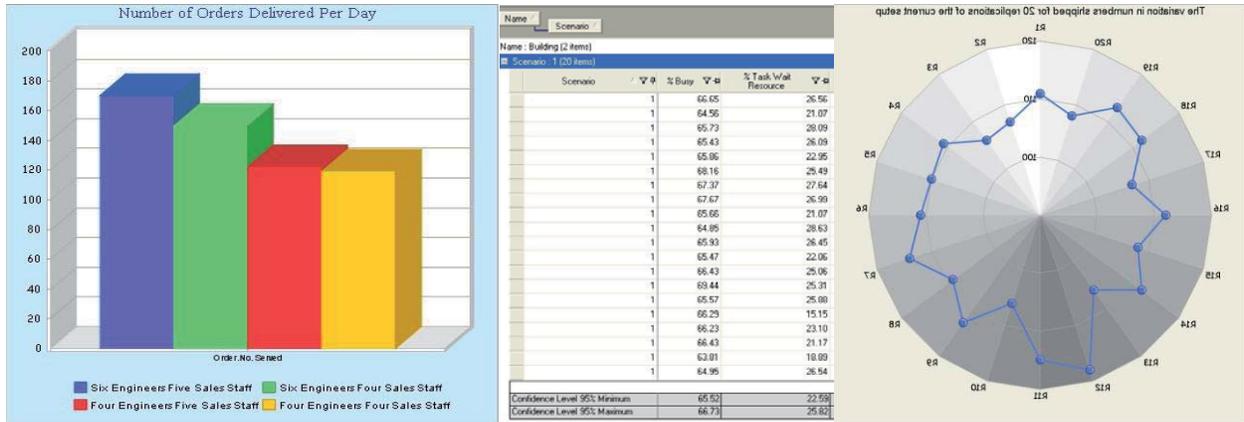


Figure 15: A few examples of the many tables and charts available in the Scenario Manager

## 7 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 designs.

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.

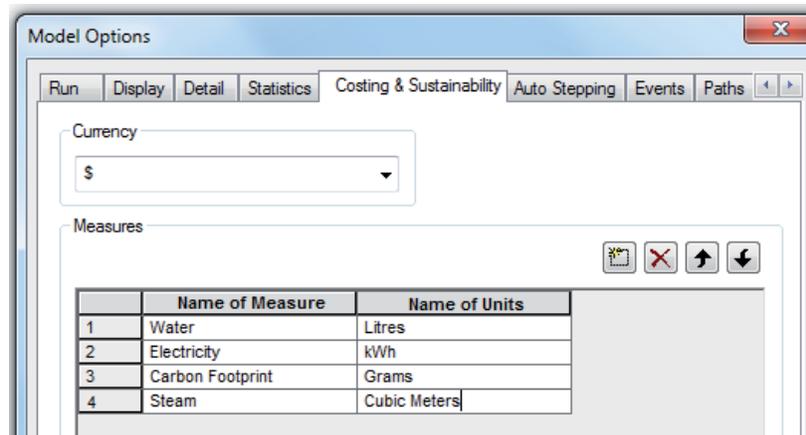


Figure 16: Costing and Sustainability measures definition in WITNESS

Then relevant dialogs have a costing tab with many different opportunities to record figures, distributions, indeed full expressions of how much resource is being used (or indeed generated). A range of functions to define use at any other point in the model complete this comprehensive capability. 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.

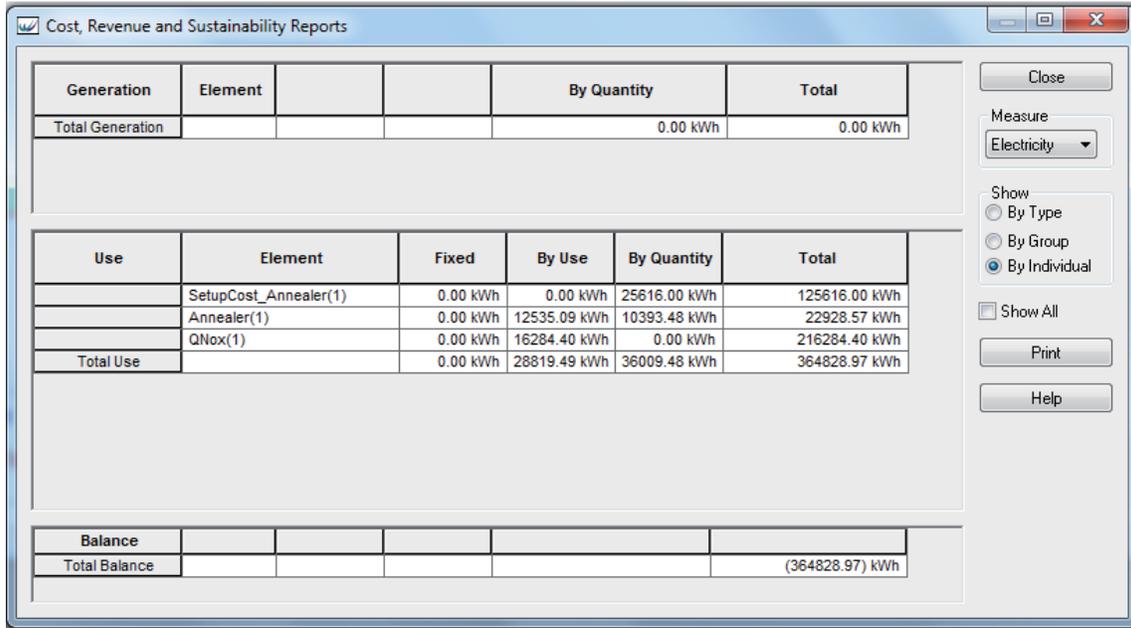


Figure 17: Costing and Sustainability Balance Sheet example

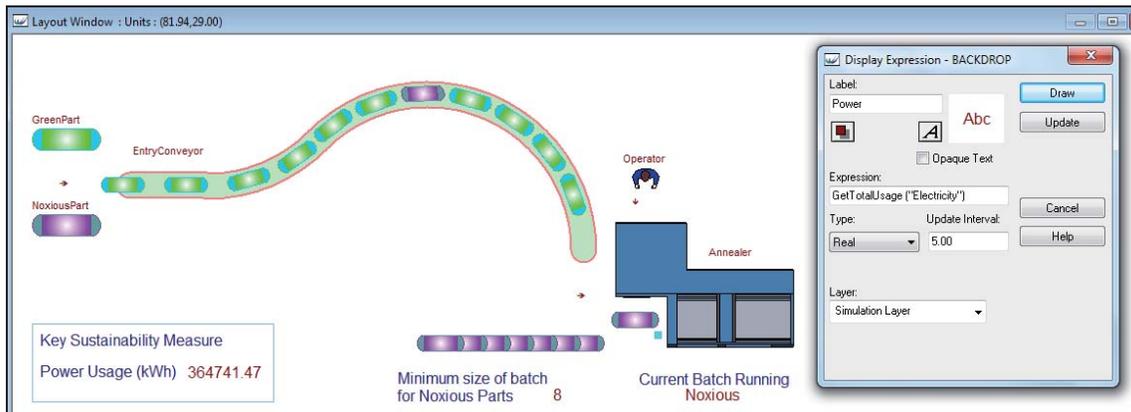


Figure 18: Costing and Sustainability model with KPI measure definition for model screen

## 8 SIX SIGMA

WITNESS directly helps Six Sigma analysis in a number of ways. The 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 a Six Sigma score simply by 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.

## 9 VIRTUAL REALITY

WITNESS offers much in the field of virtual reality but does not mandate or impose its use. Lanner believes that 3D can get in the way of the technical solving of complex problems using simulation and that virtual reality can be better deployed as an additional display layer when important for communication.

WITNESS includes the time efficient 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

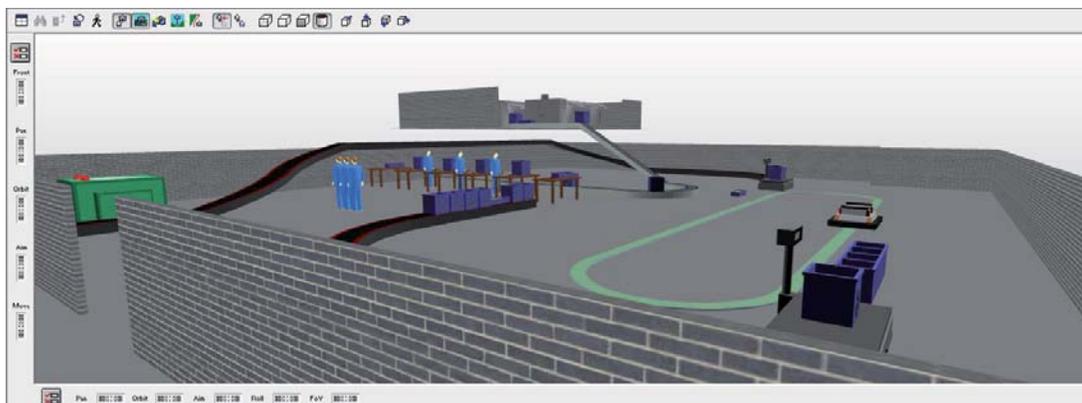


Figure 20: A Quick3D view of a manufacturing layout – multi floors, conveyor elevations, etc.



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

## 10 OPTIMIZATION

Organizations need optimization more than ever before. The competitive edge is ever more pressing and extracting extra performance out of a process can mean a significant payback. 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 where processes have already been improved and ‘leaned’.

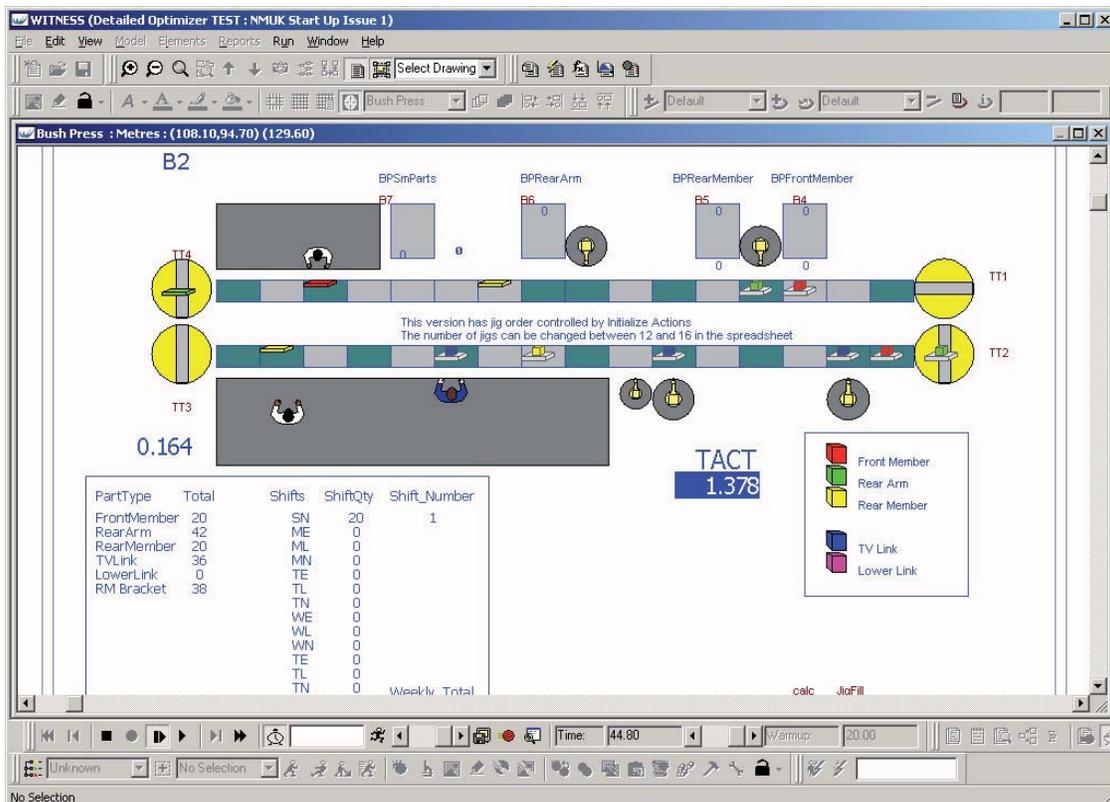


Figure 22: WITNESS Optimization in action – an Automotive example courtesy of Nissan

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.

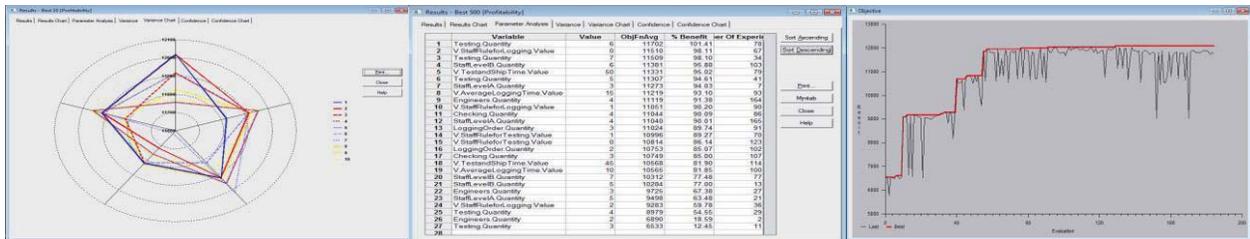


Figure 23: WITNESS Optimizer – variance chart, sensitivity table and objective search chart.

## AUTHOR BIOGRAPHIES

**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 the Laner Group. He is on the editorial board of the Journal of Simulation.