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EXPERIENCING VIRTUAL FACTORIES OF THE FUTURE

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ABSTRACT

This paper explains the latest project work being undertaken at the Ford Motor Company in the generation of simulation models from spreadsheet interfaces and in particular the latest advances in the automatic creation of virtual reality worlds based on these model layouts. The ease of creation is the key to the use of the third dimension but being able to visualise a facility more accurately overcomes obstacles to understanding and discussion. The paper explains the technical process involved in creating these worlds using the WITNESS VR simulation package from the Lanner Group.

1 INTRODUCTION

Ford Motor Company are pioneering the latest virtual reality technology together with their factory simulation system to create living, moving virtual factory worlds.

Ford are using the latest technology developed by the Lanner Group, a UK based specialist simulation company. Their WITNESS simulation system is used by Ford throughout the world to model new and changing facilities in order to answer such standard simulation questions as "What is the throughput achievable for a line?" or "How large should a buffer storage area be?"

Ford have developed several systems whereby simulation models are created automatically from spreadsheet entry by engineers. This effectively makes a simulation model easier to construct for an engineer through an interface that explains the data required in exactly the form that is understood. The spreadsheet typically contains the different operation numbers, cycle times, breakdown and setup rates and times and other key data.

Some of the spreadsheet systems developed by Ford create 2D schematics of factory layouts (for early design this is often not necessary as layout diagrams at this stage would be highly theoretical). For the models for which layouts are required simple positioning data in the spreadsheet places the next operation in a production line in a relative position to the current operation. A whole production layout is created automatically using direct input of the spreadsheet data into the WITNESS model – the whole process is controlled using a visual basic program which creates the model dynamically and visually.

This paper is mainly focussed however on the next step in this process. The latest development of WITNESS VR takes the 2D Schematic and links each element to a highly realistic 3D image. The whole layout is created in seconds as a flythrough virtual world – directly linked to the 2D diagram. Control rules in the model then generate part, labour and vehicle movement through the factory both in 2 and 3 dimensions.

The effect is astonishing. A convincing working Factory from simple spreadsheet entry! The system also outputs to even higher quality rendering systems to produce fully photorealistic static flythroughs with true physical lighting, reflections and shadows.

An example of a photorealistic layout is shown in figure 1.

2 HOW THE PROCESS WORKS

The typical entry into a spreadsheet from an engineer represents the design for the process. The spreadsheet information is then translated into a layout diagram in WITNESS. This appears as a normal WITNESS siumulation display similar to the one shown in figure 2. where a simple conveyor system is represented. In addition figure 2 shows a detail dialog behind one of the operations on the conveyor system. All detail shown on the dialog is automatically created from that filled in by the engineer on the spreadsheet including the labor rules and input and output rules to the next conveyor/operation.

The Fastbuild facility within WITNESS VR is then chosen to create, almost instantaneously, the virtual world. The single fastbuild dialog is shown below in figure 3.

Each 2D element is automatically linked to a 3D geometry using its name or the icon used in the model.

For example a machine using icon 17 from the WITNESS icon library will automatically pick up the default geometry dg-icon-17. All the default geometries are

Figure 1: Virtual World Created by WITNESS VR

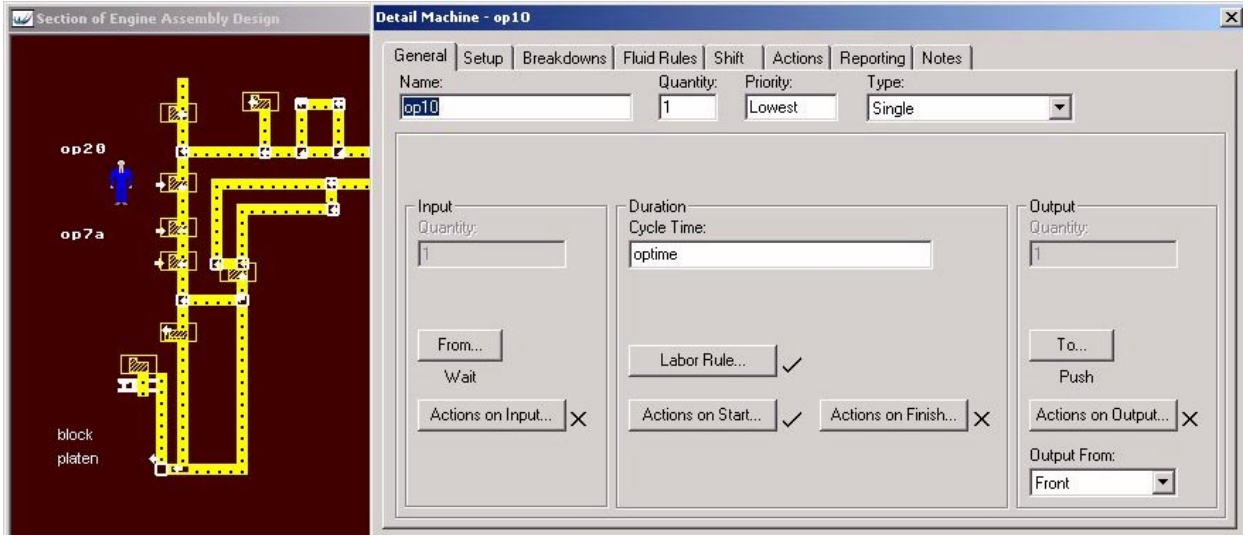

Figure 2: A Sample WITNESS Layout Diagram from a Ford Simulation Model Showing a Typical Simulation Dialog which Contains Control Rules and Timings for the Each Operation and Facility within the Factory

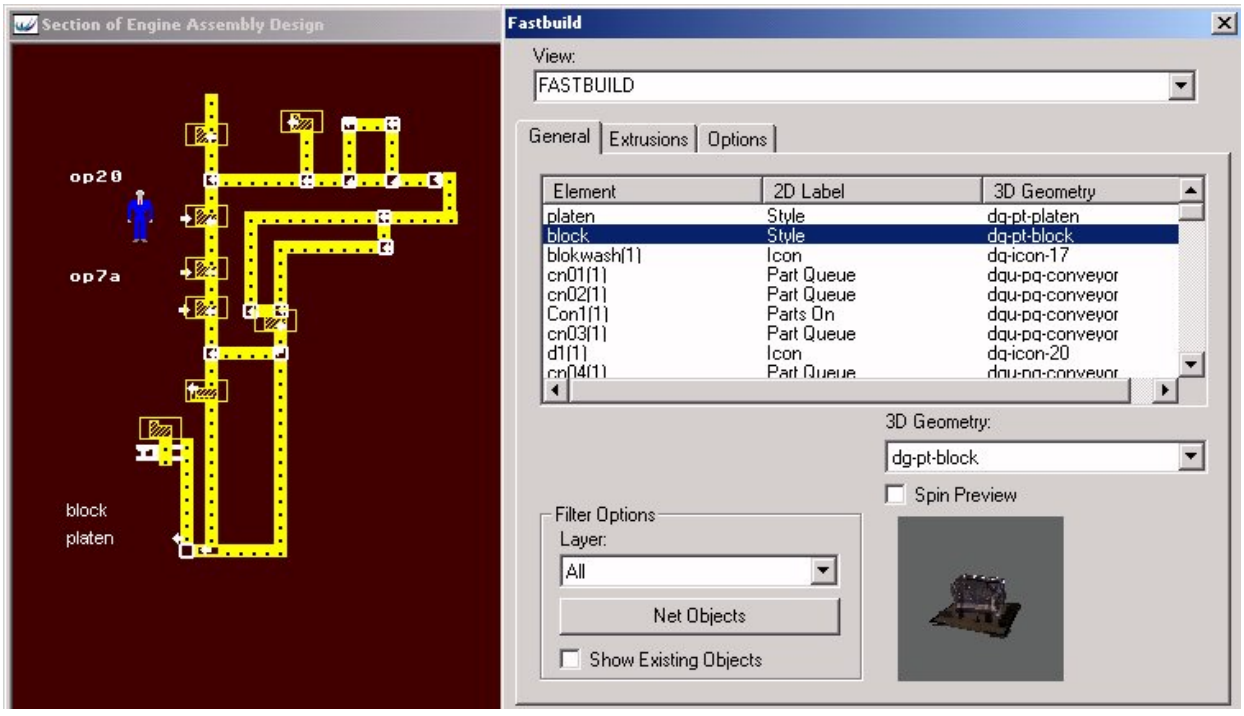

Figure 3: The WITNESS Layout Diagram and Fastbuild Dialog Showing the Automatic Linking of the 2D Elements with the 3D Geometries, Enabling Direct Creation of Professional VR from the 2D Schematic

objects that have been created and placed in a file chosen for use with this fastbuild. This file can contain empty factory shells too into which to build the model – or simple lines drawn in 2D can be automatically extruded to create walls. The completed fastbuild is shown in figure 4.

The 2D position on the diagram places the object in the 3D world. From this it can be seen that it is vital that each icon used in the 2D layout is scaled carefully to enable the 3D objects to snap together correctly in the 3D layout. However with carefully prepared elements this automatic joining in the VR world is guaranteed.

For WITNESS models some machining operations must also include in 3D the section of conveyor where the operation takes place and that conveyor section too must fit exactly with other conveyor sections. Each placement of a machine or a conveyor is bolted automatically to the floor.

3 VR OBJECT CREATION

One of the keys to making this system work is the creation of the 3D objects. For the VR world the objects must look good and be simple enough to render in real time – for easy flight this really means the capability to draw all the objects in the view over 15 times per second. To understand the difficulties of this **each frame** of a normal architect rendered video will often take seconds, if not minutes to calculate.

The problem is overcome through the clever use of several techniques including use of images on flat surfaces to trick the eye and level of detail whereby something in the distance is drawn less well than something close to. The use of the latest graphics technology available on standard PC's is also key to obtaining good performance.

The creation of objects is often better done from photographs rather than from CAD output. For the visualisation of a simulation model of a factory CAD often offers too much detail and would often need enhancing with appropriate textures to create the correct look. Better are the objects created especially for the purpose of visualisation.

Of course creating such objects is a skilled task with the best objects created by technical graphical personnel. With the latest Lanner technology all created objects for use with the real-time simulation view are also saved in a high precision format to create quality video output using an accurate physical based lighting system. This takes the 3D simulation layout and swaps object types in order to create the photorealism shown in figure 5.

4 THE FUTURE

Many simulation practitioners in the past have avoided the complexities of virtual reality. The debate will continue as to the benefits of such views. It is true that they offer little or nothing to the solution of the mathematical simulation. At Ford it is thought that the benefits lie in the understanding of a layout under discussion – it is easier to discuss the real issues if the basic layout of a model is more self evident. For others it is a valuable tool to convey ideas at sen-

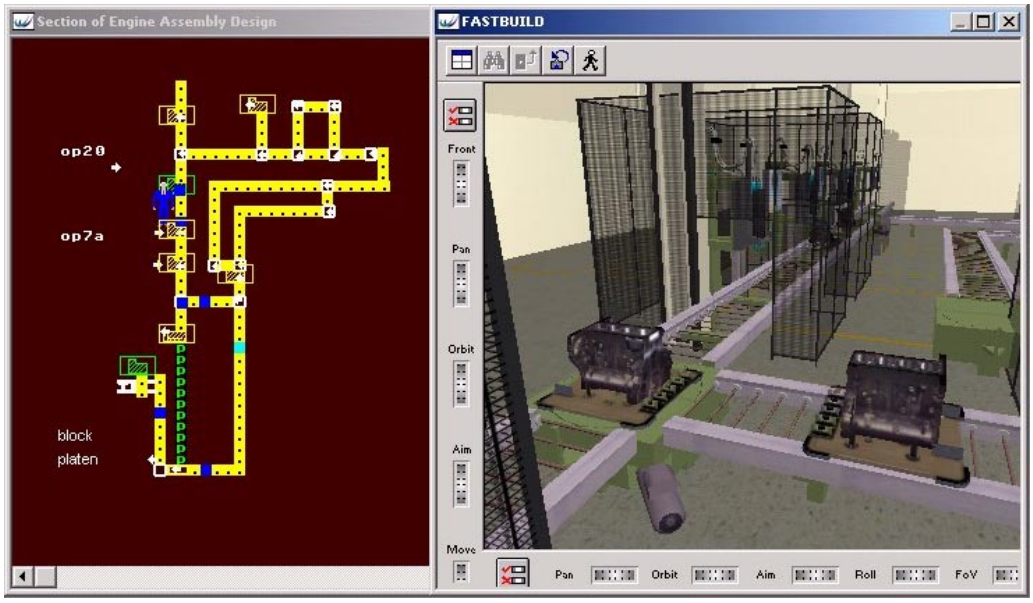

Figure 4: The Resulting Fastbuild View Showing a Model Run in Progress, the VR View is Fully Integrated with the Working Model with Flyaround by Thumbwheel or Mouse Control

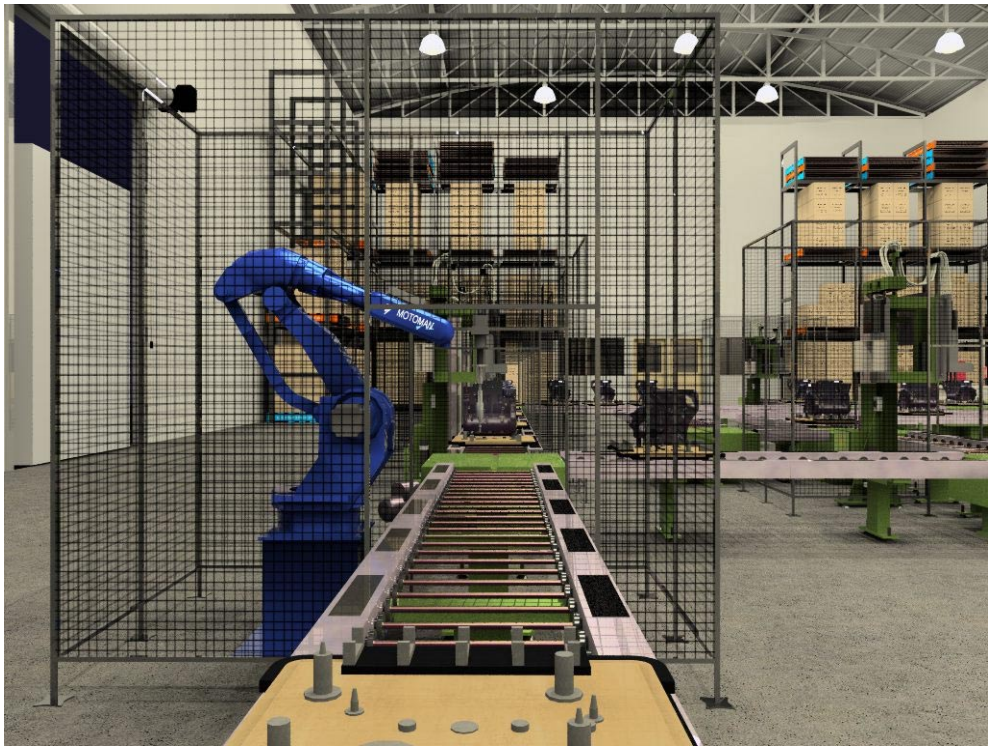

Figure 5: An Example of a Photorealistic Output from the Same Layout

ior management and board level where undoubtedly higher and higher standards of presentation are demanded.

The easier that 3D views are to construct and the better they look, the more they will be used. The new opportunities that are described in this paper for truly outstanding quality and performance are steps towards greater acceptance. 3D object creation is becoming more developed as an art form and offering greater accuracy and performance, and standard computers are becoming more and more capable. In time fully interactive 3D views in all simulation models may well become an easy and accepted norm.

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JOHN LADBROOK has worked for Ford Motor Company since 1968 where his current position is Simulation Technical Specialist. In 1998 after 4 years research into modelling breakdowns he gained a M. Phil. (Eng.) at the University of Birmingham where he has lectured on a part time basis since 1996. In his time at Ford he has served his apprenticeship, worked in Thames Foundry Quality Control before training to be an Industrial Engineer. Since 1982 he has used and promoted the use of Discrete Event Simulation. In this role he has been responsible for sponsoring many projects with various universities this resulted in anappointment as a Fellow with Cranfield University in 2001. He is also Chair of the WITNESS Automotive Special Interest Group. His email address is <jladbroo@ford.com>
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