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USING WORKFLOW BUSINESS PROCESS TOOLS IN SIMULATION MODELING

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ABSTRACT

This article will present several model automation strategies used to improve the modeling operations such as data maintenance, model analysis and model visualization. There are several new products that have emerged in academics and industry that help reduce the costs of simulation and provide a solution that obtains more ROI from a new and/or existing simulation model. In addition these modeling techniques provide the capability to make models an operational component of a manufacturing system. As an operational component, models can provide planned work schedules, prediction estimates, and an operational decision tool that engineers and managers can used in making better operational decisions.

1 INTRODUCTION

This paper and subsequent presentation will show a case study of:

1. The ability to automate the process of model data maintenance.
2. The ability to automate model analysis using intelligent search techniques within a business intelligence workflow application.
3. Using a simulation model in a web-based environment, giving more users within an organization access to the simulation technology.
4. Using simulation as a prediction analytic for manufacturing

Simulation technology is the most common known engineering tool used for understanding the performance of a warehouse, manufacturing or material handling operation. No other engineering technology can show the interaction between operational components as well as simulation. The only real substitute for simulation has been running the real operation, which is too often preferred by many over developing and maintaining a detailed simulation model of their operation. In the following article we will show several techniques that can be used to automate the model data maintenance and model analysis tasks using a reporting/workflow solution called RealView™ from Brooks Automation. In addition we will present a new modeling concept that uses workflow to intelligently search for a viable, near optimal scheduling solution for a manufacturing operation, and present a web-based portal solution that will drive up the ROI of your simulation modeling efforts and expose this technology to others within your organization.

2 GETTING MORE ROI FROM SIMULATION

The investment for creating a simulation model is often large, and the effort to maintain a model is even larger, and often considered by many as too hard given the benefits of simulation technology. Because models aren't maintained it's typically hard to justify restoring a model to answer a new manufacturing strategy. Have you ever been in the meeting where a new operational strategy is being discussed and can see that this new strategy could easily be simulated to understand its benefits and impact on the existing operation. But you and your management can't justify the modeling effort, because you don't have the time or the resources for the project? It's a common story. Getting management to invest in modeling projects is getting more difficult every day and finding engineers that want to maintain a simulation models' input data is near impossible.

There are new workflow technologies that are being used in industry that can streamline business processes, make those processes more effective utilizing best practices, and reduce the work required by simulation engineers. By applying this technology and practices to simulation modeling, the modeling effort required to maintain a simulation model, and the effort and accuracy of the results that can be obtained during model analysis are improved.

2.1 Automating Model Data Maintenance

Maintaining an accurate data set required by a simulation model has traditionally been a time intensive and error prone operation of a simulation modeling project. By automating this task, one can improve the model data accuracy and reduce the level of effort required to maintain the simulation model. This data automation task is relatively easy. Automating data maintenance requires the following;

1. The model must use external data files for the input data
2. The data context to be maintained must exists electronically
3. A reporting system must exist that can report on engineering and historically manufacturing data
4. A scripting or workflow engine exists that can be used to execute the data automation processes.

These requirements aren't always available, but are becoming more available every day. Brooks Automations RealView™ application provides manufacturing data capture technology, a reporting system and a workflow engine.

Developing an automated data maintenance system, does require that a model be data driven and that the model data to be maintained is available from an external data source, such as excel, text files, or resides in a database. Most manufacturing, warehousing and material handling simulation modelers already attempt to put model data in an external data source. If this was not the case the model would need to be changed to utilize this type of data automation.

There are many data components of a simulation models that can be managed through data automation and others that cannot. For example Work-In-Process inventory data is most often very dynamic, and the objects and data content for this type of data are typically stored in factory databases. But data for equipment behavior or operational strategies may not be. For example an equipment data file, may have equipment information such as state, process rates, scheduling rule and processing capacity. The state, process rate and capacity may be data that can be extracted from a factory data base, but the scheduling rule may not. In this case the non-available information must either be obtained from some supplemented data source or assumptions made if that data doesn't exist in any location. For example if a new piece of equipment came on-line and the supplemented data source doesn't know about that equipment you'd want to have some defaults that can be used to provide the model with at least a starting point. In any case, the times this occurs may be rare and the user either traps this data issue as an error in the model maintenance business logic or catches such issues in the model itself. In our implementations of this technology we have used the original model data input files as the supplement data source, and update certain data elements that require data automation due to their dynamics.

The following shows a few examples of data that could be maintained automatically.

1. Equipment
   (a) Equipment lists
   (b) Current state
   (c) Current setup
   (d) Processing rate distributions
   (e) Setup time distributions
   (f) MCBF/MTTR distributions
2. BOM
   (a) Bill-Of-Material product maps
   (b) Product claim steps
3. Routings
   (a) Step lists
   (b) Process cycle time distributions
   (c) Setup's required
   (d) Setup cycle time distributions
   (e) Tooling/Resources required
4. Orders
   (a) Active orders
   (b) Quantity
   (c) Priority
5. WIP
   (a) Active WIP
   (b) Current step assignments
   (c) Current status
   (d) Current resources claimed

Figure 1 illustrates the mechanics of automating simulation input data maintenance. The reporting application loads information, both engineering process, product and equipment data and operational history collected from plant operations, corporate and other system databases, and populates the dynamic data that is to be updated in the simulation model. In this case study the reporting application used was Brooks Automation RealView™. This application has several features that are enablers for this type of data maintenance, such as;

1. Every data field in the data repository is temporal, allowing the ability to capture history on a data element, even if a history transaction didn't exist.. This temporal repository allows the ability to build the data files based on factory state at any point in time. For example, an engineer can rebuild the data files for yesterdays status and compare the model results to that of the actual operation.
2. The application will manage data from many sources, which is required because much of the data for a simulation model is not always stored in one database.

3. The RealView™ business process workflow tools provides the automation scripts for the data maintenance tasks.

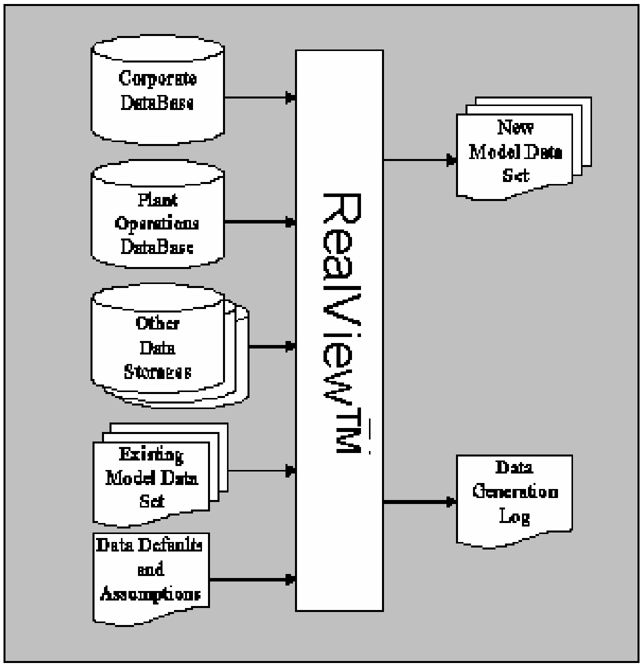

Figure 1: Data Automation Process

This process of developing automation tools to maintain datasets can be used for any type of data intensive application not just simulation models.

2.2 Model Analysis Automation

Another exciting use of workflow business process engines and is the concept of automating model analysis. The components or applications required to do this are the same as the applications used in automating the model data maintenance described in section 2.1.

Much of the business logic that is used in the model analysis phase of a simulation project, can be captured and written in a workflow engine. Much of this comes from experience in using simulation models to address issues such as;

1. Resource ramping plans
2. Short interval resource scheduling
3. Operation sequencing studies
4. Identification of recovery solutions required after catastrophic events
5. Start schedule generators

The above analysis scenarios are typically a process of a simulation analyst running a series of experiments to identify the best solution or at least a solution that satisfies the objectives or goals of the analysis. Most simulation packages today come with some form of statistical analysis package that allows the user to automate a series of experiments, such as DOE, confidence intervals, sensitivity tests, tests of significance, and often some optimization tools to add in finding a near optimal or optimal solution to a model objective. These are useful analysis tools for the engineer that automate run execution, but they do not provide the ability to guide a simulations next experiment based on a previous run or set of runs. Some optimization algorithms attempt to do this, in a general nature, like GA, but without applying the knowledge of the operation, GA tools are often CPU and time intensive solutions in obtaining an optimal or near-optimal solution and often don't achieve the results wanted by the simulation user.

With the advent of workflow technology, users today can build, best known practices and business intelligence into a business workflow engine like RealView. This can enable the automation of many model analysis tasks and provides the infrastructure to use simulation models as a decision engine to support manufacturing systems. The following sections provide some examples of this technology.

2.2.1 Critical Operation Failure

In this example an engineer knows of many operational issues, that when occur, can cause large delays in order deliveries. In this case the user, has built a simulation model that can be used to determine the required corrective action to insure orders are delivered on time. In this solution the simulation analyst designed into the model the ability to test the recovery options from this operational issue by outsourcing manufacturing, adding overtime or adding operators to support the manufacturing operation. The amount of outsourcing, overtime and additional resources needed, is determined through a series of model executions. These are typically short interval scheduling models, so for the most part, the randomness in the operation has been removed from the models execution, but factors can be provided to account for the typical operational effectiveness of the manufacturing systems. Figure 2 illustrates the business process intelligence inside a RealView™ workflow script.

2.2.2 Start Schedule Generator

In this example an engineer needs a solution that can be used to generate a starts plan for the plant. The engineer uses a simulation model to generate a plan that moves the product starts to the latest possible moment and still achieve 100% on-time delivery. The simulation model constructed takes into account, customer orders and order due dates, resource capacity, resource constraints, resource

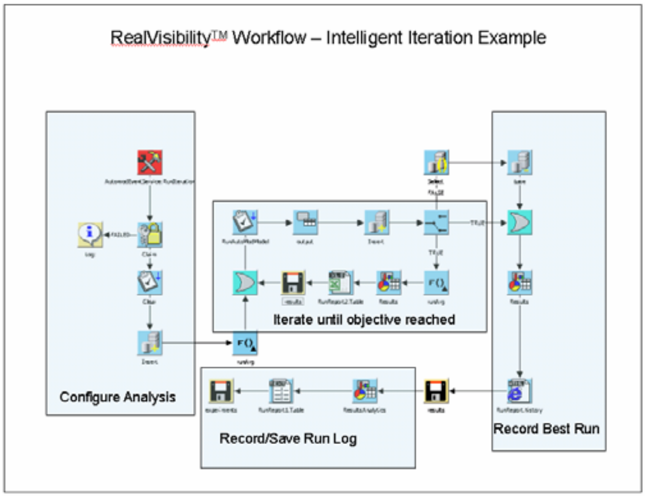

Figure 2: Workflow for Intelligent Iteration

preventive maintenance, setups, product build plans, operation contention and constraints, etc.

Figure 3 provides an example of the workflow operations used in this case study. The workflow engine iterates the simulation model, modifying the lot start's and equipment setup schedule, until the an objective function is met. The business logic exit function is programmable, in this case by the engineer. It may be based on minimizing or maximizing an objective function, until either the iteration logic runs out of alternatives to test, or a max time/run metric is exceeded. The objective function could take into account, on-time delivery, WIP, product build times, or what ever metric that is obtainable from the model output.

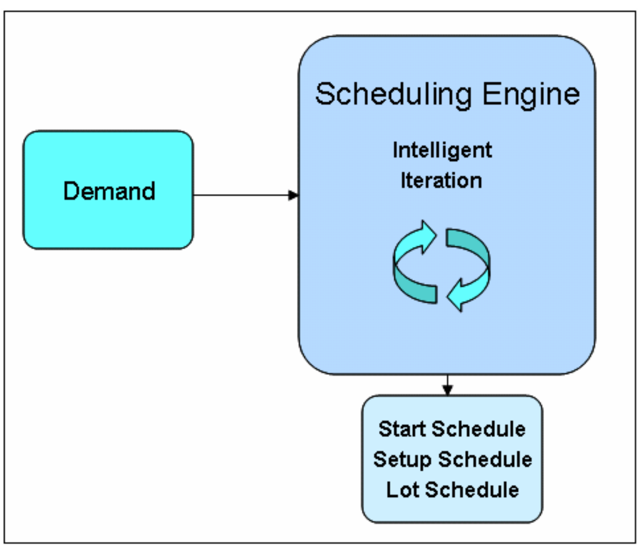

Figure 3: Workflow Schedule Engine

3 WEB BASED MODEL VIEWER AND CONTROLLER

The other feature that can provide more ROI from a simulation model is the ability to distribute results of simulations or the use of simulation via the web. In this case study, we are using a web portal solution provided by Brooks Automation RealView™ application.

1. Reporter application that can be used to provide accurate time based data files.
2. Workflow processes that can enable the launching of models for multiple users and the ability to share model runs among users.
3. Reporting application that can be used to report on the results of a simulation run or set of runs and the ability to compare actual system performance with that of the simulation model.
4. Web based portal solution that enables the ability to edit, run and view a set of simulation runs over the web.

Figure 4 provides an example of a modeling portlet in RealView™.

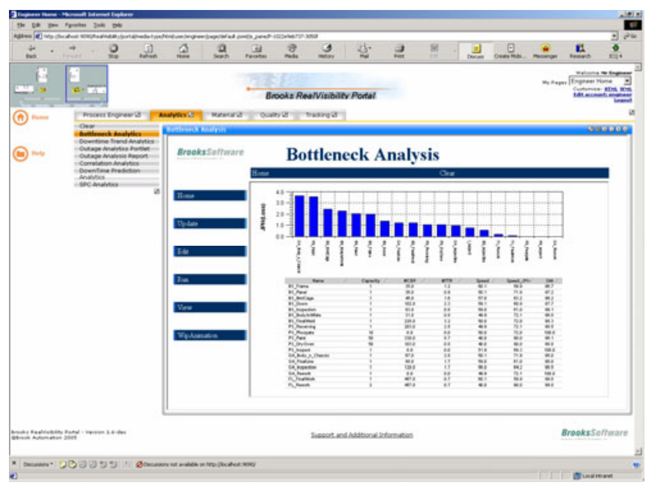

Figure 4: RealView™ Model Controller Portlet

Detailed schedules, production goals and other predictive results are an example of simulation results that could be distributed to the shop floor or to a manager in a web dashboard.

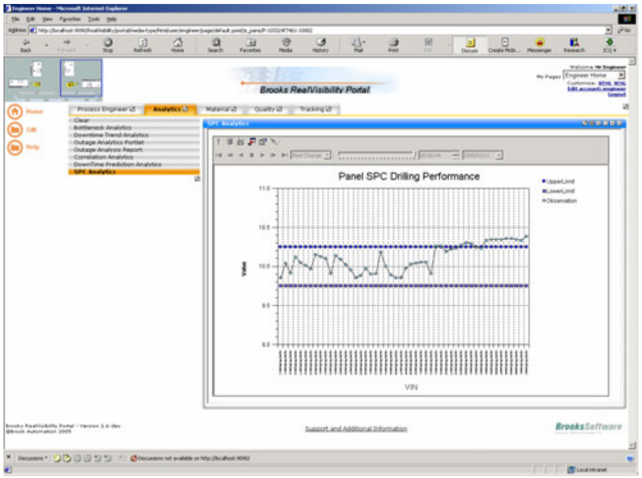

Figure 5: RealView™ Example Model Output

4 REAL TIME APPLICATIONS

The techniques described in this paper also open the door for other real time uses of simulations models, such as;

1. Virtual factory models
2. Real time predication models that can be used to predict target rates or develop operation plans
3. Ability to use modeling technology to derive best case corrective actions when required due to some catastrophic system event.
4. Ability to use real time history to validate a models accuracy and to verify a models operation

5 ENABLING TECHNOLOGY

Figure 6 illustrates a high level architecture of the RealView™ application described in this case study. The application provides, the basic reporting, workflow execution and web-based solutions used in this study.

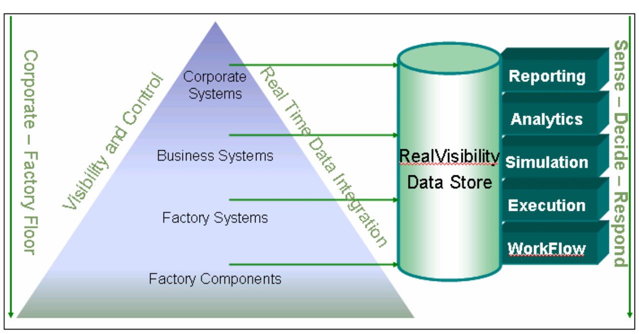

Figure 6: RealView™ Application

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