Evaluating process profitability

Case studies from the energy industry explain strategies for extending the benefits of simulation and modelling across the value chain. Benefits include the ability to make the decision-making process more efficient using an intuitive bidirectional interface

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The refining industry today has a unique opportunity to capitalise on increased margins. A shortage of refining capacity in the current market provides unprecedented opportunities for operators to utilise their refining processes to the fullest. Facing a shrinking workforce, however, many managers are left wondering if they will have the manpower to take full advantage of that opportunity. In addition to the ever-present need to run the refinery safely, refineries must find new ways to operate at peak efficiency and at maximum capacity. The ability to know more and act faster is imperative. Getting the right information to the right decision-makers at the right time and in an easily accessible format can provide a true competitive advantage.

The problem

Simulation software holds significant potential for helping refiners increase profit margins. It helps them make better decisions that can lower capital and operating costs, while decreasing the potential for plant shutdowns. Simulation has been proven useful across numerous refining applications, including steady-state simulation for process design, revamp and case studies; dynamic simulation for control system checkout, startup/shutdown and operator training; and online simulation for real-time plant monitoring and optimisation. The building of fundamental simulations for such applications is a complex task best left to the simulation experts, of which there is limited number in most plants.

Building a simulation is one thing; using it is another. The information that simulations produce can help business managers, market analysts, process engineers and many other plant officials and specialists to make more accurate, quicker decisions. In the past, getting at that information involved either learning to use the simulation software or requisitioning appropriate analyses from someone trained in using the software. Either way, by the time users determined what information they needed, requested it through the proper channels and received the result, the window for a truly strategic decision could have passed.

Refiners need to benefit from simulation software without having to rely on the simulation experts. They need to empower key decision-makers who are not simulation and modelling professionals, to be able to access and manipulate simulation data within a familiar, intuitive interface.

The solution

The simulation software industry has responded by providing spreadsheet-based interfaces that enable managers, planners and others not trained in advance simulation techniques to access and manipulate powerful simulation data and analyse that data to make better decisions. The fact that most people in today's business environment know how to use spreadsheet software makes an interface between simulation software and a spreadsheet not only attractive, but also extremely valuable. One example of such software is the SIM4ME Portal, developed by the SimSci-Esscor unit of Invensys Process Systems. This software is an integration application that links a simulation model to a Microsoft Excel spreadsheet, essentially allowing the simulation to be accessed and controlled from an Excel interface. This effectively extends the use of simulation software to non-traditional users such as operators, engineers and business management, allowing them to be more efficient, make better decisions based on proven technology and have a better understanding of the process.

The SIM4ME Portal provides an alternative, more familiar interface to SimSci-Esscor's simulation software via Microsoft Excel, but it is not intended to replace the traditional graphical user interface (GUI) for an individual simulator. The complexities involved in a simulation cannot be effectively utilised in such a simplified Excel interface. However, these limitations do not limit the potential of the portal. Instead, an Excel interface opens up a whole new world of functionality, accessibility and control of a simulation that has previously been difficult to obtain. The bidirectional nature of the portal allows control and manipulation of the unit operating conditions and configuration data. The base simulation and connectivity cannot be changed, but the portal interface gives the novice and expert user alike the ability to use the simulation in highly effective ways.

Once the simulation information is in Excel, the data can be formatted, manipulated and transferred using the standard functionality within Excel. Simulation data can be used as an operator interface, formatted and arranged for custom displays, algebraically manipulated, or passed on to other programs that interface with Excel directly from the portal.

Interfacing simulation software with Excel is nothing new; companies have been transferring simulation data to Excel for years. The value of doing so has been proven time and time again, but despite the familiarity of the interface the applications were still challenging for the average user. Creating interfaces with Excel still required significant programming, and each variable that the Excel interface needed required a hard-coded link back to the main program. This time-intensive task slowed the development of interfaces and limited the return on investment (ROI). Current interfaces, like the SIM4ME Portal, however, allow variables to be added quickly without time-intensive programming.

Case study 1

Crude unit column modeling

The most important feature of the SIM4ME Portal is that it allows Excel to be used as an operator interface, controlling the model without having to open the simulation software. The user can connect to the simulation, change

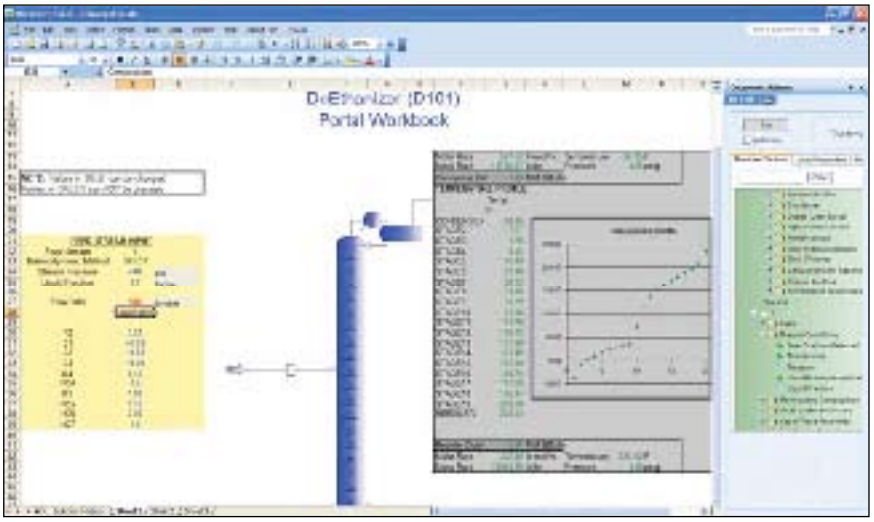

Figure 1 *Excel interface for analysing operational changes in a fractionation column*

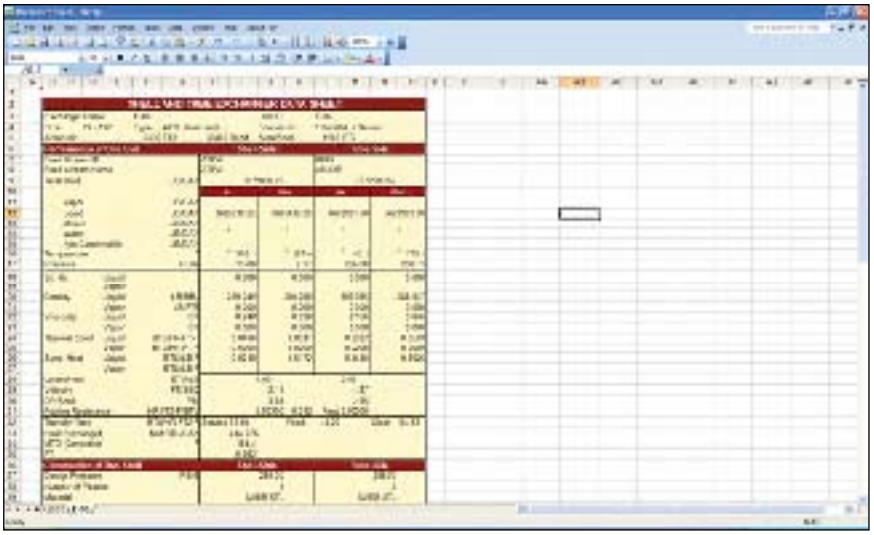

Figure 2 *Heat exchanger simulation data transferred directly to spreadsheet form using the Excel interface*

specific variables and run the simulation to see how those changes affect the results. Although the engineer responsible for the crude unit no doubt has a working, relatively current model of the existing crude column, that model is probably used sparingly, only to troubleshoot operational problems as they arise. And each time they do use it, they must update to reflect the operating conditions that existed before the process problem occurred, so they can see how the situation has changed. This is not, however, the most efficient or productive use for this model.

In contrast, using an Excel operator interface linked to SimSci-Esscor's general-purpose simulator, PRO/II, anyone with access to and a working knowledge of Excel can update the model constantly. Operators not only can keep the model up-to-date via Excel, they can also run case studies that analyse different operational changes and how they will affect the unit (Figure 1).

An operator can, for instance, study the effects of reducing the column feed flow rate and how that will affect the separation within the column and the flow rates out of the column. Running a simulation analysis of this change will provide operators with a better understanding of what they might expect so they can change downstream operations in anticipation of the reduced column feed rate. The time and effort involved in creating a simulation model does not provide a high ROI unless that model is used. Keeping a model up-to-date with current operating conditions or continuously using it to run case studies allows it to provide value to the organisation, increasing the ROI from its creation.

Case study 2

Upstream operations

Operator user interfaces are not, however, relegated to downstream operations only. In this second example, Excel was linked to the SimSci-Esscor multiphase fluid flow simulator, Pipephase. Instead of using the software, the Excel interface can be developed to display pertinent input and calculated parameters such as permeability, choke inside-diameter (ID), tubing true-vertical depth and geothermal temperature gradient. All such variables can be changed directly in the Excel interface, which can also update and run the simulation software without ever opening the simulator. Using this interface, engineers and operators who are not familiar with a simulator are able to manipulate the simulation model to gain valuable information about performance. An engineer might, for example, analyse how much production will be lost if the choke ID is varied.

These two examples illustrate the value in being able to control a simulation via Excel. They show how extending the user base of simulation models contributes positively to the ROI in your process model. However, controlling the simulation from Excel is not the only way the interface creates value. The next four examples show how simplifying the transfer of accurate information from a simulation to Excel expands the ability to use simulation data. Once simulation data is transferred into Excel, the spreadsheet can use it in a variety of ways, including populating data sheets, feeding data to custom calculations or calculating process performance.

Case study 3

Modelling heat exchanger performance

Manually transferring data to populate data sheets is a time-intensive and inefficient task. Automating the transfer of simulation data to Excel alleviates the pain of populating data sheets. Heat exchanger information is typically passed on to vendors in the standard form of a shell and tube data sheet. Once obtained, the vendor can analyse and fabricate the exchanger. Transferring the simulation data into the shell and tube data sheet has always been the most tedious task. Using the Excel interface, however, that heat exchanger information will transfer directly from the simulation into specified cells in Excel, with information required for a standard coming in automatically as the design changes to accommodate different operating conditions (Figure 2). This eliminates the need to recopy the data if the simulation changes. All data transfer is automatic and seamless, eliminating the possibility of data-transfer mistakes and ensuring use of data from the most recent simulation run. Using simulation data to populate data sheets automatically increases efficiency and productivity, and reduces the effort required to provide a heat exchanger vendor with a completed shell and tube data sheet.

Case study 4

Custom calculations

Simulation data can also be transferred into Excel to feed formulas for custom calculations. Automating the data

transfer of simulation data to feed formulas in Excel directly ensures the calculations are done consistently. The numbers will update accordingly as the simulation data changes. In the case of sizing a vessel, information on variables such as vapour and liquid flow rates along each stream's density transfer from the simulation into vessel-sizing calculations within the Excel spreadsheet. Once all the information is in Excel, it can feed user-entered formulas for calculating vessel parameters. This ensures not only that the same formulas are being used each time, but also that they draw on the most current simulation data. This is useful to engineers designing equipment, as it automates a large portion of their sizing calculations and enables reuse of existing spreadsheets.

Case study 5

Minimising project design engineering

An Excel interface can also help reduce the engineering effort required to complete a process design by automating trial-and-error looped calculations. The trial-and-error approach of line sizing can be very tedious when done manually. You can automate these calculations by putting them into a spreadsheet and updating the simulation to check the results. It is possible, however, to create a trial-and-error loop in the SIM4ME Portal using a small VBA program that runs through a standard set of diameters, using the simulator to calculate the pressure drop across the pipe each time. The pipe diameter in each run then runs the simulation with the updated information and continues this iterative process until the pressure drop threshold is met. This solution saves time and money, increases consistency and reduces the possibility for errors due to manual data transfer.

Case study 6

Calculating net profit

The SIM4ME Portal extends the use of simulation to business managers as well, by allowing them to use the data for business calculations. The ability to control a simulation from Excel allows managers to run case studies on the current state of operations. Simulating different operating configurations and conditions enables managers to envision the consequences of different decisions.

A manager can, for instance, simulate a propane/propylene splitter operation to evaluate the process's profitability. The properties of the feed stream, column, heaters and coolers, and the product streams would be linked from the simulation to Excel. Additionally, the costs of the steam and cooling water, along with the selling prices of the two products, propylene and propane, would be entered into the spreadsheet. Then, using simple mathematical formulas in Excel, the overall costs of the cooling water and steam are calculated by multiplying the duties from the simulation with the associated cost of that utility. Next, the profits of the two products are calculated by multiplying the respective product mass flow rates (obtained from the simulation) with their corresponding market price. Using this information, the net profit can be calculated. This allows the user to see whether the system is cost efficient for the specified separation. If the process is inefficient, the user can test various scenarios directly from the portal interface to determine if the simulation might predict economically desirable results under new conditions. As costs and revenue are associated with different modes of operation, a manager can make an educated decision, because he will have all of the financial information necessary to compare alternatives.

The previous six examples have illustrated the value of having the ability to be bidirectionally linked to simulation software from the standpoint of using that information within Excel. However, there is one more valuable benefit of having simulation data linked to Excel: it can typically communicate with other pieces of software that will be useful to engineers.

Case study 7

Interacting with the enterprise

Since Excel also has the ability to interface with many programs, it enables data transfer between Excel-based engineering tools or compatible tools. These tools typically include costing and sizing programs and plant data repositories. This allows the simulation data to be collected and dispersed from a central location. Information collected in Excel can also be passed to in-house costing and sizing programs, or plant information can be passed from Excel into the simulation. Excel also has the ability to receive data from sources like plant historians. This would allow plant data to be sent directly to the simulation via the Excel interface, which would keep the simulation model up-to-date.

The value provided by Excel-based interfaces to simulation software has been illustrated in the previous seven examples. Simplifying the interface to complex software extends the potential user base of the simulation and the potential uses for the data contained in that simulation. The current generation of Excel interfaces is extremely powerful and is driving up the value of simulation by getting the right information to the right decision-makers at the right time and in an easily accessible format. The refiners who harness the power behind these tools will see a vast improvement in their productivity and efficiency.

Interfacing

The potential for the Excel interfaces is limited only by the imagination. As long as Excel remains the standard business tool, interfacing with it will be a valuable feature. Currently integrated with two different simulators, PRO/II and Pipephase, the portal is under development to be further integrated into other simulators as well as being further enhanced. In the future, there will exist the ability to use the Excel interface to run automated case studies that will record the results of several parameters while varying numerous variables. This will allow users to run several scenarios at once to study the behaviour of the process in the simulation. The future will also see a single Excel interface controlling several simulations, even from different simulators. Linking several simulations together by passing stream information from simulation to simulation will ensure accuracy and increase efficiency by reducing manual data transfer.

Conclusion

The SIM4ME Portal increases the ROI of a given simulation as well as the software itself, by expanding the use of the simulation to non-traditional users and by extending the functionality currently available within the simulation software itself. The portal can aid in the following:

— Offloading workload of simulation experts by allowing simple and repetitive tasks in a simplified Microsoft Excel GUI

— Creating operator interfaces to increase process understanding and enhance response time

— Increasing efficiency and reduce errors by automating data transfer

— Increasing consistency by using calculations in Excel using simulation data.

All of these features are only possible with an accurate model. While the portal extends the use of simulation software, the core of the functionality is derived from having an accurate, efficient and properly designed model. While achieving such a high-quality model will require the work of a skilled expert, the competitive advantage will only be achieved by extending the use of that simulation to the masses.

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