



Rolling back the clock:

IS THE TIME RIGHT TO REVISIT SIMULATION?

Every quarter, it seems there is news of yet another pulp and paper mill in Canada closing. The prevailing notion is that it is apparently easier to build a brand new mill in places like Latin America than make an existing North American structure more profitable. That prevailing notion is not always accurate.

BY PETER HENDERSON

There are tools available today that can help existing 20- and 30-year-old mills restore, maintain and even improve their profitability. One key is improving reliability by making better business decisions on the floor and teaching future operators how to make these decisions. In the 1980s and 90s, offline simulation emerged as a tool to help mill operators be better prepared for their jobs. But these early systems were often hard to

maintain and upkeep. The result was that the training simulator became an expensive cost in the overall system.

Today, however, it is a different story. The increase of PC-based systems, as well as technological advancements over the past several decades, has made simulation a much more practical technology. And with the economical state of Canada's (and even all of North America's) pulp and paper industry, perhaps it is time to revisit the idea of using tools such as simu-

lation to train operators of the future. It could be a guard against the erosion of the long-term investments in these facilities.

What is simulation?

Aside from some obvious differences, process simulators should be thought of no differently than flight simulators. Both technologies are used to train people whose professions could very well one day place them in a dangerous situation that will affect the lives of many people. An upset, for instance, can start a chain of events within a mill that could lead to a safety incident or lost production, which in turn means lost revenue, injury, damages and penalties. If too much revenue is lost, the mill's profitability is affected over a long period of time, leading to eventual closures such as those common in North America.

As with all manufacturers, pulp and paper companies only profit when they produce products at a price that is greater than the cost of production. The benefit of simulation to manufacturers is improved mill profitability, which is a function of product margins and production rates. Table 1 presents a typical economic equation for any mill.

Mill Profitability (\$/yr) =
Product Margin (\$/#) X Production Rate (#/yr)

Where:

Product Margin (\$/#) =
Product Revenue (\$/#) – Cost of Revenue (\$/#)
Production Rate (#/yr) =
Capacity max (#/yr) X Mill Uptime (%) X Mill Efficiency (%)

Example – at risk from plant upsets
\$150k / day = \$750 / metric ton X 200 metric ton / day

TABLE 1: Typical Mill Economic Equation

Production costs can be broken down in terms of energy expenditures, material waste/rerun, labour, overheads, damage, injury and penalties. Conversely, mill production rates are influenced by a balance of the mill reliability (up/downtime), design capacity and production efficiency.

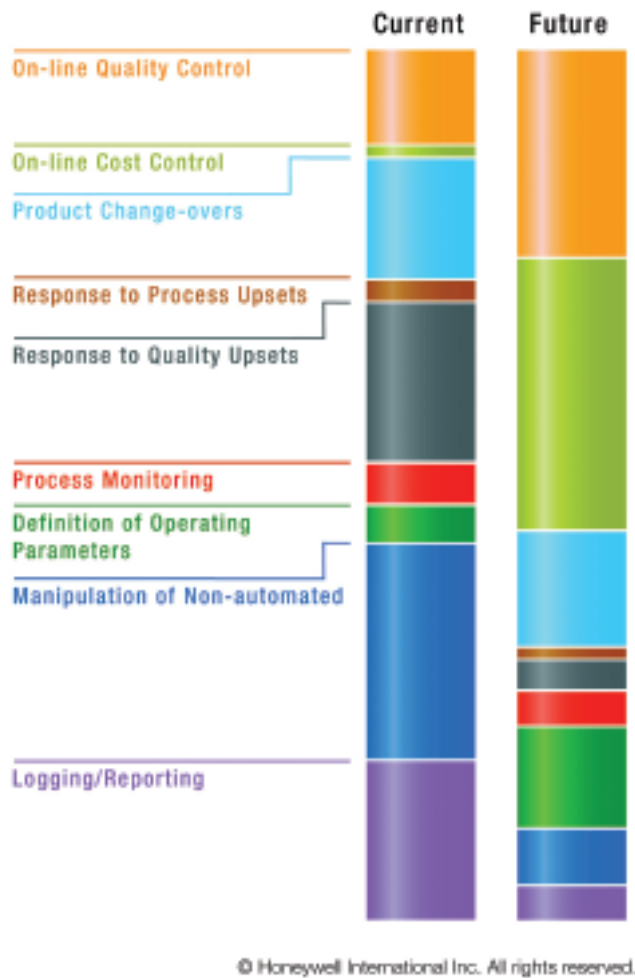
Preparing mill assets (operators, control systems, operating procedures) for operation can strongly influence:

- The cost side of the equation by minimizing resource requirements, energy expenditures, material waste/rerun, equipment damage, personnel injury, operating penalties from hazards.
- Production through increased mill reliability / uptime, operating efficiency and quality.

Why is simulation better today?

The concept of simulation and lifecycle modeling certainly sounded novel when it emerged, but in reality, older systems did

CHANGING ROLE OF THE OPERATOR



not prove very practical and failed to meet expectations for several reasons. For instance, some used sequential-modular flow-sheeting tools used primarily for design and were incapable of meeting the speed and robustness demands of real-time execution. Other solutions were comprised of poorly integrated tools that required models to be rewritten for different applications. Additionally, slow solution speeds required models to be kept simple, which meant they could not capture the full complexity of operations.

Most simulation environments had limited or no model validation capabilities, meaning it was very difficult to keep the model close to the current state of the mill. Even more limiting, many simulation applications were restricted to steady-state solutions. Therefore, training had a very limited range of operation in and around a normal “steady state.” The resulting restrictions of these systems severely limited the quality of training over broad operating scenarios like a mill startup/shutdown.

Today, those shortcomings are addressed through “true lifecycle” tools based on advanced process modeling — as opposed to traditional simulation — technology. These tools use a single modeling framework to perform many different online activities using high-accuracy models from engineering design. For instance, they can be used to identify differences between the mill and related models (steady-state or transient), simulate historical incidents in the mill and enhance DCS configurations (controllers, displays, alarms, trend groups).

These activities use a single underlying master model that embeds proprietary process knowledge of the actual mill. This master model can generate models of appropriate complexity for different activities such as dynamic simulation models for operator training.

Another key advantage is that today’s advanced process modeling systems are built on modern software principles. For example:

- Open software architecture enables applications to be embedded within process automation and knowledge systems.
- Open models allow easy maintenance and extension and enable companies to take control of their proprietary process knowledge and easily transfer it between groups across the organization.
- Equation-based solution techniques provide solution speed, robustness and power, plus the ability to perform many different types of calculations on the same model.

These new environments vastly expand the amount of high-quality information available to operators and the control and decision support systems.

True lifecycle modeling

The strategy for truly improving business performance through simulation involves much more than teaching an operator how to control a process. Pulp and paper companies should seek out an effective simulation solution that addresses three key areas:

- Improved mill design
- Better operations and control implementation
- Mill optimization and online performance monitoring

Improved mill design

When mills were designed 30 years ago, many engineers relied more on their experience than they did technology. The technological evolutions since then allow mill engineers to evaluate process designs with much more detail through computer simulations.

The ability to create steady-state and dynamic models can have a significant impact on mill design, performance monitoring, troubleshooting, operational improvement, business planning and asset management. In the past, process bottlenecks were usually encountered during initial operations of a new unit or mill. Today’s advanced technology empowers users to interactively make decisions by immediately validating design assumptions using a high-speed engine with backward calculation capabilities.

For newly constructed mills, these simulation design tools are used to facilitate faster startups. For existing mills, however, the same design technology can be used for de-bottlenecking and revamping operations. Today, if a mill aims to increase its output without adding new construction, a company must squeeze as much extra production as it can out of existing infrastructure by making mill equipment work harder. Simulation design tools can start this process by identifying typical bottlenecks within the mill, such as the recovery boiler, evaporators or brown stock washing operation in the pulp mill, or the dryer section, coating or calendering operations in the paper mill. With dynamic simulation, the process engineer can evaluate equipment performance problems across a broad range of operations throughout an entire mill startup, and at many conditions far away from the design case. Thus, operational problems can be addressed in the office during the engineering phase rather than in the mill. This can improve equipment selection during capital equipment expenditures while avoiding costly workarounds and delayed profit recognition from timely production.

Additionally, new dynamic simulation capabilities allow steady state models to be extended to transient models, allowing consistent thermodynamics and model configurations to be used for process transient analysis, controllability studies and operator training applications. Additional benefits are realized through model reuse and reduction in the overall lifecycle cost/benefit.

Some of today’s advanced simulation design technology also

includes applications and features that improve the design and optimization of process equipment such as heat exchanger networks and the ability to predict corrosion.

Better operations through better-trained operators

New automation systems make it possible for operators to assume more responsibility for process operations at the mill. However, an increase in responsibility means the amount of information to monitor and interpret also increases. Offline training simulators provide an environment that presents operating scenarios to prepare operators for production.

Example training scenario – digester operation

Pulp digesters are operated to standard procedures and production targets (temperatures, flow rates) which are supported by online instruments that the operator monitors to ensure the effluent is of the proper consistency. Poor process operation can lead to wasted energy and chemical utilities required to reprocess recycled off-spec pulp. Proper training in this kind of process can lead to better mill operation. There are several important aspects in training:

- Experiencing the full severity of the upset in a simulated environment to reinforce its significance without harming production or the mill
- Learning to recognize the onset of the upset
- Learning to follow procedural recovery to minimize the impact of the upset
- Learning to avoid similar upsets in the future
- Practice, practice, practice leads to an almost rehearsed, reflexive, instinctive response to a recognized stimulus

In this way, offline training goes a long way in improving mill reliability — an economically significant event.

Better control implementation

Operator Human Machine Interface (HMI) is a critical portal to the process. It is a collection of graphic displays and control targets intended to convey information used by the operator to make well-informed decisions about mill operations. How well the HMI is crafted determines how the operator will perform in meeting operating objectives and avoiding mill upsets. Simulation helps recreate realistic operating scenarios that allow engineers to assess the HMI configuration under dynamic conditions rather than traditional methods of static validation. In a similar way, engineers can assess the ability of:

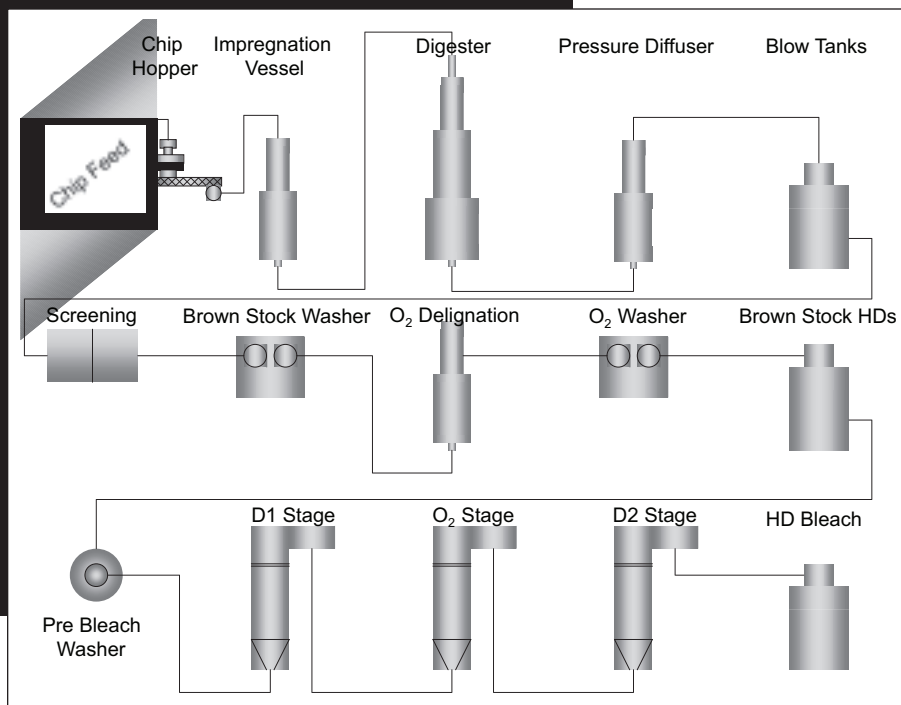
- regulatory controls to sustain reliable operating conditions.
- alarms to effectively bring the operator's attention to a potential upset rather than distract the operator with a burst of information.
- safety systems to protect the mill from straying outside safe bounds of operation.

Mill optimization and online performance monitoring

When the job becomes real, these offline models can be implemented with an online link to the automation system and used in conjunction with real-time mill data to provide high-quality information for rapid decision support at all levels.

Simulation tools can be applied to help engineers and operators assess various operating scenarios in three states of mill operations (past, current and future states):

- Past incidents captured by the historian can be run in the simulator to evaluate root cause.
- Equipment and process monitoring applications use simulation to improve decision-making process in real time.
- Look-head assessments and what-if scenarios can be performed by mill operations to predict future outcomes of current operator actions to help plan better transitions through operating procedures.



Incident Assessment

Process upsets happen without warning many times. In some cases, the process takes hours to bring back online, which can negatively impact product quality. The cause of the problem is not always discernible from process measurements. In this case, a dynamic simulation synchronized to the process can be a valuable tool in such post-event analysis. These captured scenarios can then be introduced to the training curriculum in order to avoid repeat incidents in the future.

Equipment performance monitoring

Squeezing extra production out of a mill is not the lone answer to increasing profits. If the mill becomes unreliable or the equipment works harder, it inevitably runs the risk of breakdown. What good is an extra 5% of production if a unit must be shut down for three days for repairs?

Many older automation systems rely on sensor data to gauge performance of the mill — but not all can take measurements in real time. This is another area where simulation has greatly advanced and can reduce costs from what they were in the 1980s and 90s.

With today's simulation technology embedded inside automation systems, current process conditions can be used to initialize simulation in order to predict other equipment and production parameters that cannot be measured in real time. Modern simulation technology interprets transmitter values as a means of predicting variables that are not easily measured.

Example of Performance Monitoring

It is a typical scenario faced in any kind of manufacturing facility: An operator deals

with recurring alarms and the unit is not achieving maximum production. The operator can use today's advanced simulation software to examine details about performance factors of a certain piece of equipment, the digester for example, in the mill.

Improving mill reliability through informed decision making in design and operations is critical to success.

Say, for example, a certain digester is breaking down wood chips into a solution of wood fibres. Digester properties, such as fibre lengths and fluid consistencies, cannot be measured and must be predicted by rules of thumb or by inferred variables. In the past, simulation was not available for this; operators used simple equations or referred to tables for information. With today's simulation technology, a simple right click can bring up customized-online equipment data sheets that are linked to simulated predictions that can be monitored to provide the operator with an improved perspective of what is happening in the digester. The operator can then make better-informed decisions based upon those improved perceptions. For example, he can decide if he needs to turn up the circulating liquid flows, whether to recycle, etc. This accelerates the decision making process instead of waiting for digester quality issues to be

realized hours later in downstream units.

All in all, it is a much timelier and far less expensive process.

Look-ahead assessments

When known production changes are planned, look-ahead simulation or optimization can help determine the most economic course of action for effecting those changes.

Consider a change-of-feed case. A quick assessment in a simulated environment allows operators to visualize interactions between process units. This helps them make informed decisions about coordinated operation of refiners and digesters to compensate for feed changes in the upstream areas of the mill — long before it affects the control of pulp and paper quality in downstream machinery. This shortens the transition period while reducing the recycle of off-spec product during a feed change.

The key is making sure the evaluation is easy to set up, formulate and assess.

Simulation and the changing role of the operator

As process automation systems have evolved into process knowledge systems, the role of the operator has changed. Before, operators focused on achieving production objectives, monitoring processes, reacting to upsets and reporting. These days, operator responsibilities are increasing — they are required to make fast decisions that can impact product quality, mill cost control and production changeovers.

Simulation and training programs can contribute significantly to the introduction of these new systems and work practices.

Operating performance is the balance between production efficiency and reliability. Improving mill reliability through informed decision making in design and operations is critical to this success. When this is achieved, mill managers can accelerate profits through faster mill turn-arounds, sustain operating profits through incident avoidance and protect mill assets and the environment.

These benefits, and the technological advancements that made them possible, are the prime reasons why simulation should be reconsidered as companies mull decisions on how to improve production at aging mills.

Simulation itself has become more practical. Maybe it can help these mills become more practical, as well. **P&PC**

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