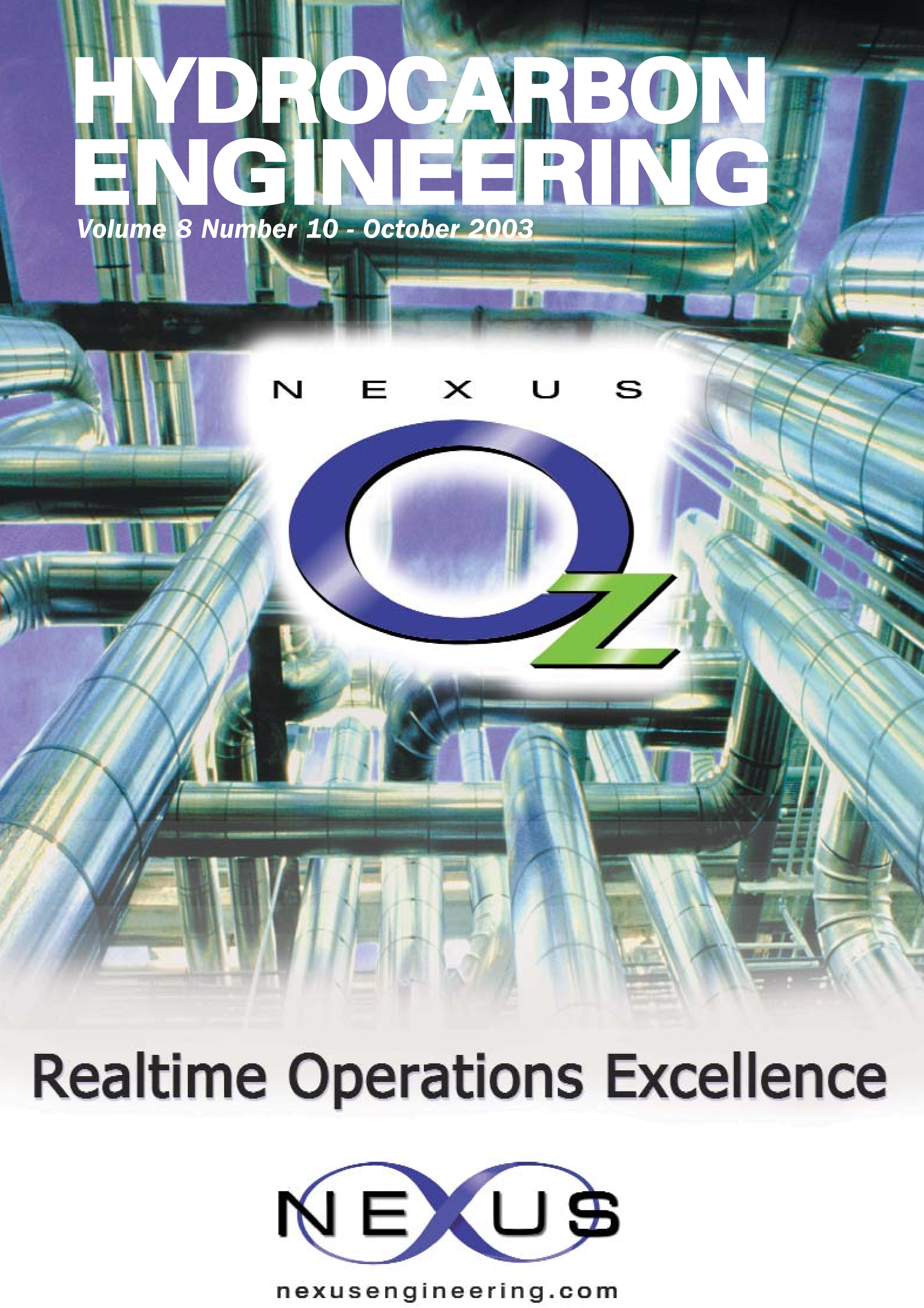
HYDROCARBON ENGINEERING

Volume 8 Number 10 - October 2003



What about operations?

Jack Stout, Nexus Engineering, USA, explains the importance of reliability and operations management to the environment, health and safety and productivity.

As companies are squeezed for tighter margins, plant reliability is strategic to the site and ultimately corporate performance. Industry data confirm that successful maintenance programs are one factor in the performances of benchmarked companies. The corollary is also observed as the well managed company's financial performance being derailed by missteps in the maintenance program. The effective utilisation of the company's assets is core to the delivery of anticipated financial results.

The integration of information technology systems has enabled the role of maintenance to become more comprehensive, focusing on the reliability of the assets versus merely their repair. Companies commit large resources of people, capital and technology to the management of site reliability. Vice presidents of reliability have been added to many organisations reflecting the importance of the positions' contribution to the company's operations. The 'fix-it' mentality of the historical maintenance approach has biased these reliability programs toward the mechanical integrity aspects of the plant assets. Although the reliability scope has evolved from breakdown to predictive maintenance, it is still addressing the condition of the plant equipment without regard to plant operations.

Operations management

Bench marked information reflects that although mechanical integrity is a significant aspect of the reliability issues, up to 70% of the reliability root causes are attributed to operations issues.[1]

Pursuing maintenance centric, mechanical integrity based reliability programs, is partially the result of the reliability organisations comfortably executing the previous strategies, using the same practices and technologies. Companies continue to pursue additional hardware and software applications, monitoring the level of mechanical deterioration, to project when the next preventive maintenance action is required. Under these programs, reliability issues are identified after the damage is done. Although these programs are historically based, they address very specific, measurable activities. The consequences of a mechanical failure and the cost of repair can be determined with a fundamental analysis from a historical stand alone basis. The mechanical reliability initiatives have enabled the sites to manage the assets based on their historical performance. However they have done little to enable the operations personnel to impact the real time operational issues which are the main contributors to the plant assets' mechanical problems.

So what about the 70% of the reliability issues caused by the day to day operations? How are they addressed? What about personnel issues? How do you address losing best operations practices when the best operators retire or are promoted? The link with operations must be established. The 'missing people' must be found.

Additionally, plant managers are being directed to run more environmentally friendly, safer and more cost effective

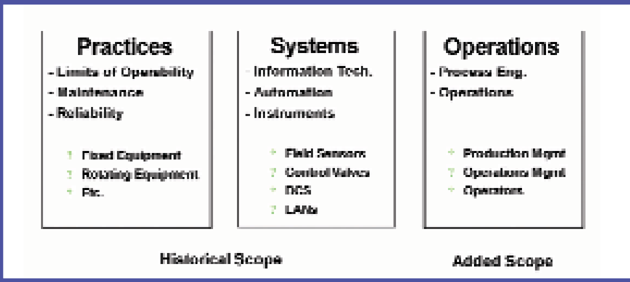


Figure 1. Independent asset management strategies.

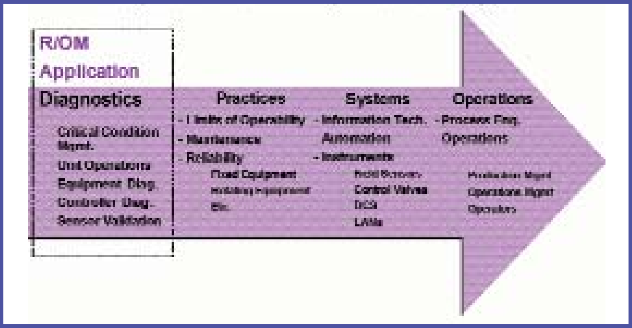


Figure 2. Integrated asset management strategies.

operations. For example, Process Safety Management (PSM) initiatives are requiring companies to define operations management in terms of operations procedures for normal and abnormal situations. The failure modes and effects analysis of the HAZOPs (hazardous operations) process enables companies to define operations in terms of events and event management. Additionally, the quality initiatives are driving companies to define production improvement and cost reduction in terms of measurable performances. Six Sigma programs enable companies to identify key control points in their processes that must be managed to deliver the expected operations results.

These operations considerations are demanding a new view of asset management. From the historical view of practices and systems implemented on an independent basis, the first step is the addition of an operational perspective on a real time basis (Figure 1). Real time reliability and operations management enables companies to deploy the knowledge base developed through the PSM and quality programs to impact the real time operations of the process units.

The real benefits are realised when an integrated perspective of asset management is pursued (Figure 2).

Reliability and operations management

An integrated reliability and operations management (R/OM) solution must:

- Evaluate the health of the entire process on a real time basis.
- Identify the root cause of process problems early (before the DCS alarm is activated).
- Couple diagnosis of the problem with a suggested action response to avoid the upset entirely.
- Encompass the plant from the individual sensor to the total enterprise.
- Provides advisory messaging to minimise the effects of upsets that do occur.
- Digitise the best practices of operations.
- Advise on real time economic operational opportunities.

An integrated R/OM solution starts at the plant sensor level by providing:

- Sensor validation: algorithms which monitor for changes within alarm limits, limit excursions, blips, spikes, and most importantly, dead sensors.
- Cascade loop monitoring: monitors the variation between the 'remote set points' and 'process variables' for cascade loops. A deviation in this relationship could indicate a need for tuning of the loop or uncover an upstream process problem.
- Control loop modeling: models the relationship between the 'process variable' and 'output' of all control loops. This allows windup conditions to be detected.
- Process data correlation: this function allows calculated values to be compared with actual signals to provide additional validation. For example, the level in a tank can be compared with a calculated value based on inflows, outflows, and tank volume. Or analyser values can be correlated against the expected calculated values based on operating conditions.

The R/OM system diagnostics package adds value by identifying the problem early, coupling the diagnostics with advisory messaging allowing the operator to focus on corrective actions rather than process troubleshooting.

The R/OM system requirements are based on a hierarchy of requirements, starting with sensor validation. At the basic level the sensor validation consists of data analysis for the high/low limit checking, 'blipped', 'dead', and simple model inferences. Another benefit of the sensor validation is realised when the R/OM system is integrated with other applications such as multivariable controls (MVC). Although most of the current MVC implementations use some form of data reconciliation to check the process data, they are still vulnerable to process upsets propagated by the inappropriate control response to a dead sensor. The demand for more rigorous sensor validation is increasing with the proliferation of the MVC applications and as users strive to maintain the high service factors on which the applications were justified. The integration of the enterprise applications creates additional demand for sensor validation as consequences of erroneous process data extend beyond the process unit, or the site, to the corporation.

The more advanced system features address fundamental chemical engineering principals, operational heuristics, and data response patterns. Although the benefits of production management applications can be very significant, the real benefit of the system is fewer process upsets. The benefits of the advanced control applications are based on incremental improvements over long runtimes, high unit capacities, and high application service factors. A week of unscheduled downtime costs the refinery more than a year's worth of advanced control benefits. Process manufacturing companies are learning that the management of their abnormal situations provides greater benefits than their advanced

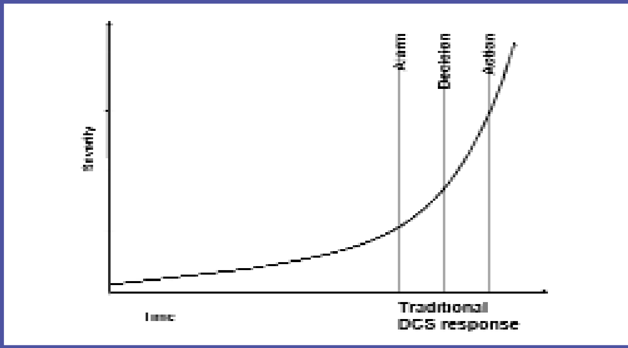


Figure 3. Traditional DCS response.

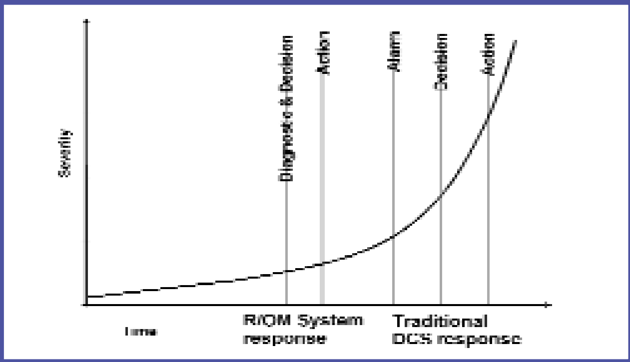


Figure 4. R/OM system response.

process control (APC) applications. This is achieved by addressing a more fundamental function: keeping their process units running. Unlike the advanced control applications, R/OM applications target the reduction in unit downtime, which represents a total loss of production.

The next level: unit operation

The operations management applications address process unit level functions by monitoring for operating conditions that would adversely impact production. The rules are based on the standard operations procedures for the units, first principal models, and the accumulated best practices knowledge of the operations personnel. Examples of these diagnostics are:

- Operations diagnostics: distillation column flooding, furnace over firing, catalyst poisoning, filter plugging, etc.
- Operational changes: feed composition, cooling water and air temperature, foaming, plugged (frozen) pipes, fuel quality, etc.
- Utilities failures: electrical, air, cooling water, steam, fuel gas, etc.
- Equipment failures: pumps, compressors, heat exchangers, furnaces, columns, etc.

An integrated enterprise solution is achieved after the individual units are characterised and combined into an integrated view of the entire plant. This permits new levels, and perspectives, of operations management to be achieved.

Finding the 'missing people'

In a recent example, key supervisors were preparing to retire from a client's plants. The personnel were involved with the knowledge engineering phase of a R/OM project, contributing to the definition of diagnostics, facilitating how they managed the process operations. These procedures were transposed into the R/OM system knowledge base and commissioned on the process unit. The client has not only retained the expertise of their best operations personnel but have also provided a mechanism to impart this experience to junior level operations staff. The intellectual capital captured during the knowledge engineering phase is then available to support consistent operations across shifts and the client's asset base.

Intellectual property management allows the operations philosophy of an organisation to be propagated globally, creating consistently profitable operations and allowing for support from a central location.

Operations scenarios

An operator with a conventional control system is usually first aware of a process event when a process value has exceeded a predefined alarm limit, generating an alarm in the control system (Figure 3). The alarm may be specific to a single parameter issue or may be one of many alarms.

The operator must then assess the alarms to determine what has occurred before deciding on the appropriate action. Assuming that the operator correctly assesses the situation, understands the numerous response possibilities, and decides to take the 'best action'; the operator will then initiate a corrective response. Meanwhile the severity of the problem has escalated and a flood of alarms associated with subsequent, follow on problems occur. The operator is left to discern what is actually happening, what caused the problem, and what is an appropriate response.

This is a simplified view of the operator's world. The real world scenario is that there are numerous other alarms on the control system at the same time. The operator may have observed the problem before, or may have heard about it occurring on another shift. The corrective response may have been recorded in the standard operations procedure for the unit, or in the emergency response procedures. The operator may decide to look up the information either electronically or in the binder of documents stored near the control console, if this particular upset has been clearly referenced and documented. With time ticking away, the severity of the upset progresses from merely an alarm condition toward a more severe condition. The operator is now responding to a more elevated situation over the initial alarm, with process operation consequences of varying impacts.

The R/OM system takes a different approach by detecting process events before they reach the alarm conditions on the control system (Figure 4). The system monitors the status of the instrumentation, equipment, and the process unit operations. The sensor validation identifies suspect values before they can escalate into larger process upsets. Before the control system experiences the alarm, a controller has gone out of control or reached its limit of control, moving the process to an undesirable condition. If the operator or the operations engineer were closely monitoring that particular area of the process, they may have been able to observe and respond to the problem before the process triggered a system limit alarm. In the 'real world', the operator's scope of responsibilities does not permit them to scrutinise the unit operations at this level.

The operator advisory components provide the messaging and alarm management for the process analysis performed by the expert system rules. In response to the OSHA process safety management initiatives, clients have invested a significant amount of knowledge, engineering effort and time in the development of these. Incorporating this information into the operator advisory system allows documents to be more effectively accessed by operators, during abnormal operating situations, when they were needed most. The integration of the emergency response procedures enhances the operator's interface by presenting the appropriate procedure for a detected abnormal situation in real time. The system has established a new 'best practices' by providing a management of change environment for the OSHA required documents. The ability of the operator to effectively use and provide feedback to the documents is improving the quality to the documents and, more importantly, the value to the operations personnel.

As the operator selects the advisory message displayed on the control system console, the trended information related to the detected failure and the emergency response procedure are automatically displayed, advising the corrective action required. The diagnostics and suggested responses are presented to the operator in a clear, concise, fashion using descriptive language. Should the operator require additional information relative to the explanations and response procedures for an event or equipment type, the system automatically displays the appropriate OSHA documentation and highlights the correct response advisory text. The documents can be process safety management documents, material data safety sheets, HAZOPS procedures etc. The significance of this function is that the R/OM system fully leverages the client's investment in OSHA regulatory compliance and environmental health and safety initiatives.

At the more advanced diagnostic levels, the rules in the system monitor for symptoms that would indicate imminent process upsets of a more significant scale such as distillation column flooding, over firing a furnace, blocking in a running pump, catalyst poisoning, etc.

Conclusion

Knowledge management and transfer

The reliability and operations management system diagnoses process problems and couples operator advisory messaging to avoid process upsets. Furthermore the system captures the best practices of operations, engineering and management staff and allows this knowledge to be deployed to operators on a continual basis. The result is increased process uptime and decreased incidents, reducing potentially hazardous situations to personnel and the environment. Benefit areas the package addresses include:

Process availability

The R/OM system diagnoses potential reliability incidents and, coupled with the appropriate operator response, avoids the upset condition and the resulting downtime. This is especially important in dealing with operator turnover and the resultant inexperienced operator responses. Although advanced automation technologies such as APC and optimisation can lead to longer run times and fewer process upsets, when they do occur the operator will be much less able to handle the situation.

Environmental, health and safety

The R/OM system provides the right information, and guidance, to allow operations staff to diagnose process problems and respond in a safe and orderly fashion.

Increased production

The R/OM system enables the operator to push production through the management of abnormal conditions. Operators are able to manage the process operations to operate closer to the correct constraints, achieving more cost effective production.

Reliability and operations management systems drive toward a safer, more environmentally friendly operation. They also serve to improve the bottom line. These systems will continue to evolve and will become the standard for safe economic production.

References

1. BIRCHFIELD, GEORGE S., 'Olefin Plant Reliability', 2/2000, Solomon Associates.