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The Global Business of Fuels

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Putting Predictability Back into Business

By Steve Sonnenberg
President, Emerson Process Management

Much of the world's economy is finally showing signs of promise. Though the past two years have been tough, many businesses used this period of demand sluggishness to invest in their infrastructure – to retool their operations. As we will see, those organizations will enter the recovery from a position of strength.

Hopefully, one lesson we've learned is how unpredictable life can be. Despite our best long-range planning, situations can arise that disrupt our thoughtfully engineered game plan and throw us into a reactive state. On one extreme, this reaction may be a global economic meltdown; on the other, it may be a small asset failure that disrupts an otherwise stable production.

At a macro-economic level, this is the nature of global business. But when you're running a volatile operation like a refinery, having the predictability to minimize unplanned situations is critical to safe, reliable and profitable operations. Having the insight and foresight – the vision – to "see around the corner" is the hallmark of a world-class operation. It means being smarter about each decision we make and action we take.

In reality, "smart" technologies have been around the refining industry for a couple of decades. In fact, process automation, control and monitoring technologies get smarter every year. But are they actually improving your business? Are they helping you address the impending workforce crisis we are all facing? Are they helping provide you with the flexibility to change your production strategies to deal with varying crude slates? Are they giving you the confidence to run your refinery at your rated capacities while ensuring safe operating conditions, which are non-negotiable?

In the following pages, we have combined our experience with leading refiners with the knowledge and perspective of our leading technology and applications specialists to stimulate insights and ideas for bringing predictability into your operation. These are not blue-sky ideas. They are down-to-earth and practical, yet advanced ideas for harnessing the power of technology to enable your staff to be their most effective and efficient. We call it the "Smart Refinery."

This brief guide aspires to provide insight into how you can harness these new technologies to gain value from improving your plant's operation. Let us know what you think… ■

Steve Sonnenberg
President, Emerson Process Management

With over 30 years in the industry and a wealth of global experience, Steve Sonnenberg became president of Emerson Process Management in 2008. Sonnenberg holds a B.S.E.E. from Georgia Tech and an MBA from the University of Virginia.

What's So Smart about Smart Refining?

During the past few years, the turbulent economy has sent refinery profit margins plunging.

Amid the most significant reduction in worldwide refining product demand in the past 30 years, almost 2 million b/d of new, highly efficient refinery production capacity has been commissioned. The result has been shutdowns or mothballing of less efficient refineries or those with disadvantaged locations. While market demand is forecast to slowly recover, even more new refining capacity is scheduled for commissioning in the next few years, maintaining the economic pressure on existing refineries. One result is reduced refining margins. Still, the complexity in refinery operations continues to increase with refiners adding units to provide flexibility in processing heavier and higher sulfur feedstocks. Product specifications have simultaneously become more geographically complicated and restrictive. The increased use of biofuels often leads to multiple product blending steps and transport restrictions. Clients require special processing for their unique needs in asphalts and lubricating oils. Complying with new and existing government regulations is consuming ever-increasing resources. Now, more than ever, efficiency and productivity are the names of the refining game.

Advances in automation are enabling the smart refiners to achieve these efficiencies and improve the overall performance of their plants. These technologies enable more efficient operations, decreasing costs and increasing profit levels. The cost and size of computing elements, the continuing increase in communication bandwidths, advances in software and mathematical analyses and better modeling capabilities have provided new optimizing tools for increasingly reliable refining operations.

This is not just a vision of the future – it is fast becoming today's reality. Many new developments such as improved process sensors and measurement devices are already being applied. The era of the "smart refinery" has begun.

SMART REFINERY SIMILARITIES, DIFFERENCES, IMPROVEMENTS

How is the smart refinery different? In a very important way, it isn't. The operating objectives for the refinery still include:

- Maintaining safe operations;
- Enhancing environmental stewardship;
- Sustaining high equipment availability and reliability; and
- Maximizing plant and product value through efficient and optimized operation.

While refinery objectives are mostly unchanged, the performance against these objectives can be dramatically improved while reducing costs. For example, a U.S. Gulf Coast refiner showed sustained 50% reduction in reliability risk – increased availability – by incorporating a smart refinery process to use the additional information from smart technology. Similarly, a West Coast refiner implemented wireless vibration sensors on essential pumps to monitor asset health where a wired solution was not cost effective.

The new smart refinery will complement the board operator, control engineer and maintenance tech, improving their efficiency. "With any new technology, ease of use and ease of integration with existing operations are key factors," said Dr. Douglas White, director of refining industry solutions with Emerson Process Management in Houston. "We carefully consider the possible effects of our smart refinery technologies, not only on present staff, but also on successfully transferring critical knowledge to younger operators as a significant number of older operators reach retirement age.

"The continuing evolution in digital computing and communication capabilities – and the application of these technologies – has led to fundamental differences in the way refineries operate and will continue to change the way they operate in the future," White said. "But people are still the most important resource. New operating methods must be introduced without any disruption to production – and they can be."

"The smart refinery is getting smarter," said Herman Storey, chief technology officer of Herman Storey Consulting Inc. "Many new functions that add value are now available, but these new features also add complexity. In addition, the pace of change has accelerated, so we have ever-more complex systems that are changing faster and faster."

Industry expert Cliff Pedersen agreed. "The financial situation, strengths and weaknesses of each plant must be assessed to determine where the benefit opportunities really are. However, the right systems applied by the right people should be able to increase plant efficiencies by as much as 20%, depending on how a given plant is actually running," Pedersen said. "That gain or more could very well be achieved in a relatively poorly run plant. Even in a very well run plant, the opportunity will exist to increase efficiencies by at least a couple percent, and that can still be worth multi-million dollars a year."

IT'S THE BOTTOM LINE THAT COUNTS

In today's economic environment, management demands that new investments provide a clearly superior rate of return and that returns are maximized on new and existing assets, particularly automation assets. Investments in smart refinery technology often provide some of the highest potential economic paybacks of any possible investments, and these expected returns can be determined in advance and demonstrated after installation.

Both new and existing plants can get quick return on investment and sustainable value by investing in smart refinery technology. New plants can easily take advantage of state-of-the-art technology, but existing plants can also benefit. Existing facilities can start small and gain experience by implementing upgrade programs at a measured pace that can be self-funding with benefits from early installations paying for the later stages. Smart refinery operators now have the opportunity to leverage these investments to enhance the safety, productivity and prosperity of their plants. ■

To determine which smart refinery solutions are right for your plant, visit www.SmartRefinery.com.

Making the Old New—Managing Legacy Systems

Refiners often need assistance in evaluating where to start on a migration project. They should seek the greatest economic benefit from automation upgrades.

During the past 20 years, technology has taken huge leaps. Remember the clunky portable phone the size of a toaster that you were so keen to lug around in the 1980s? Compare that to the smart phone in your pocket right now – smaller, faster, sleeker, more powerful, and most importantly, far more useful. This analogy also applies to modern refinery technology. What once was state-of-the-art now brings – at best – a chuckle of nostalgia, and at worse, reliability headaches, safety issues, breakdowns, forced turnarounds and efficiency nightmares.

"Older refineries are faced with unique challenges," said Edward Schodowski, director of industry solutions for Emerson Process Management. "With a considerable amount of legacy assets in place that may provide suboptimal operating performance, opportunities are being missed to run at the highest productivity levels. You also run the risk of installed technologies becoming obsolete, and with obsolescence comes, among other things, the difficulty in getting spare parts, downtime, and challenges with maintenance – all of which could result in high cost of ownership."

The majority of installed control system technology in brownfield refineries is of design vintage circa 1985. The age of this technology inhibits improved productivity through the inability to effectively integrate predictive diagnostics, asset health applications, and integrated safety systems. With enhanced technology applications, you – and your refinery – can do things that were previously impossible.

There are a number of reasons a refiner should consider modernizing. Many plants face outdated legacy process automation control systems. Field wiring terminations and wiring are complex, and those in poor condition could result in inaccurate feedback.

Every refinery is competing daily with newer global capacity that uses the latest integrated safety, wireless and asset management solutions, giving newer plants a distinct competitive advantage. ARC Advisory Group reported that the total installed base of systems reaching the end of its useful life is currently valued around US$65 billion, and the value of the total installed base of systems older than 20 years is about $53 billion. ARC said the average impact of unscheduled downtime in the process industries equates to almost 5% of production, or a staggering $20 billion.

Refiners often need assistance in evaluating where to start on a modernization project. Every plant situation is unique. The optimum time to look at new "smart refinery" strategies is during the conceptual design of a major automation upgrade. Refiners should strive to obtain the greatest economic benefit from automation upgrades by using modernization consulting studies and system life planning audits to make risk challenges understandable and to outline pathways for transition. In many cases, migration plans can be scaled and implemented in stages. Failing to modernize can cause significant financial problems for refineries as operating, maintenance, safety mitigation and other costs rise, which can mean a negative return on investment.

Of major concern to refiners is the actual, physical amount of work required to upgrade an older operating system. If a complete wiring network requires replacement, not only are costs a factor, but the logistics and potential downtime can create headaches when considering migration projects.

Field marshalling is a traditional practice with legacy Input/Output (I/O) systems, requiring significant wiring to match the field input with the proper physical I/O card. The result is a spaghetti wiring exercise that adds cost and risk to hot cutovers of legacy control systems. New "electronic marshalling" technology eliminates this hazardous and time-consuming exercise by making simplified electronic I/O assignments. Electronic marshalling reduces the risk and cost in legacy control system hot cutovers.

"One of the barriers to making a migration is the fear of having to modify all that wiring, the junction box, the terminal box, the I/O card, the controllers," Schodowski said. "There is always the question: 'Is going to a new system going to create an engineering and wiring nightmare?"

With virtual I/O and electronic marshalling, refiners can bypass the wiring nightmare and go from a junction box to the new virtual I/O – straight into a controller panel.

Refiners are starting to see the benefits of this enhanced technology. "In our case, we intend to use [this] I/O technology to replace the legacy I/O cards and reuse the existing wiring and enclosures," said Steve Elwart, director of systems engineering at Mississippi-based Ergon Refining. "This should result in huge cost savings."

Brownfield situations bring a unique set of challenges and many business drivers to consider. Refiners must evaluate whether maintaining a legacy asset system is more effective –

both operationally and cost-wise – than migrating to newer and more efficient technologies. In the end, economic factors are usually the primary drivers.

To improve depth in service execution of refining systems migration projects, Emerson acquired TAG (The Automation Group) in 2008. "Services are a critical element in successful refinery migrations," said Steve Paulson, TAG president. "Emerson's advanced technologies like electronic marshalling and smart wireless, combined with the refining migration experience of TAG, make it easy for our clients to move to a 'smart refinery' strategy." With these enhancements to the portfolio, Emerson will continue to proactively improve productivity at major refineries.

THE BIG PICTURE

Viewing the value of the integrated system holistically can solve specific issues. Reliability and equipment health are high priorities when considering refinery upgrades. For example, one operator needed to integrate an interface to rotating equipment after the equipment manufacturer recommended a stand-alone machinery health system. According to industry experts, it is easier to run that equipment without exceeding operating limits if process control and machinery health predictive diagnostics are combined and online.

"The conventional process controller tells the machinery how hard to run," Schodowski said. "On large turbo machinery, a protection system acts to prevent damage by shutting down the machine on detection of extreme conditions.

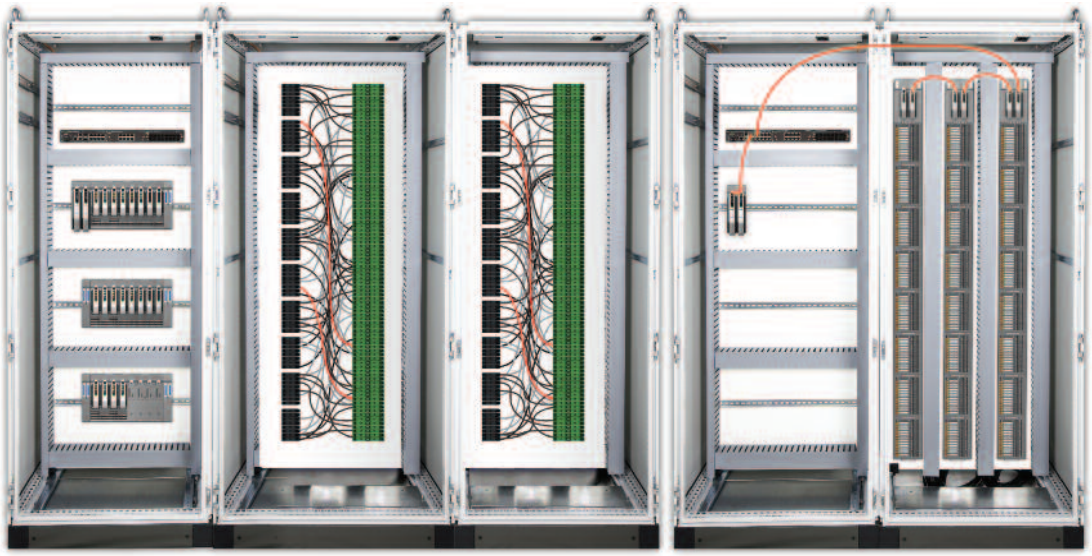
"Alternatively, an integrated control and machinery health reliability system makes it easier to configure the two systems to work together, perhaps backing off on process demands before an unintended shutdown occurs. It's always better to keep the plant running at its constraints than push it over the line and risk a shutdown or equipment damage."

Predictive diagnostics allow users to detect underlying problems early so issues are corrected before they cause severe problems. Modern control systems have integrated prediction, protection, and asset management for critical rotating equipment to allow engineers to validate optimum performance nearly instantaneously.

PROVEN RESULTS AT MAJOR REFINERIES

The Petropiar refinery (Chevron/PDVSA joint venture) in Mejorador Jose, Barcelona, Venezuela, installed predictive management software in conjunction with 4,500 HART field instruments. Using these technologies enabled the refinery to increase production, reduce costs, and improve profitability.

The elimination of repetitive problems and the ability to predict unexpected instrument failures and associated downtime resulted in a documented financial benefit at the refinery of $70 million during a two-year period. In addition to flawless



160 Classic Card I/O with Traditional Marshalling **288 Electronic Marshalling I/O**

Modern technology allows smaller footprint and easier manageability

plant startups, by using the predictive management software, Petropiar's pre-commissioning and commissioning time was reduced by 40%, lost profit opportunities caused by instrument faults were reduced by 60%, and 95% of problem-causing components were eliminated.

"The HART technology, along with [the software], has delivered significant savings, and we believe there are even more opportunities for increased reliability and improved performance in our facility," said Mariela León, instrumentation leader, reliability team, at Petropiar.

Elsewhere, Petrobras is investing $1.5 billion to make its Replan refinery more competitive in international markets. Refinery capacity is being increased to 390,000 b/d and reliability/availability improvements are in the works. Part of this expansion was the retrofit of old controls.

The results of these upgrades include significant benefits, including "increased utilization of our plant, enabling them to operate closer to their capacity limits," said Petrobras manager of Electro Instrumentation, Rogerio Daisson. "This has helped us reduce energy costs by reducing the consumption of energy per unit of charge, and we have improved the optimization of lower-volume products and re-processing of final products."

Petrobras is particularly pleased with the increase in efficiency and time savings the company is experiencing since the upgrade. "Since we began implementing new control and automation technologies, our refinery has nearly doubled in size," said Petrobras' Ederson Marcos Divinio Faustino. "On the other hand, the team that works with instruments and automation has been streamlined to almost half the number of people. We have experienced major improvements in reliability."

Technology advances of modern control systems have also allowed new innovations to improve refinery reliability through advanced diagnostics. Risks are mitigated because of experience, tools and standard procedures. Specialized companies have completed thousands of migrations from a number of systems, making "risk-free migration" a reality.

"In a gasifier plant where I worked, we installed an integrated DeltaVSIS and control system," said George Cushon, an industry consultant and automation expert based in Calgary "The system contained an amazing number of protection routines and really optimized start-up and shut-down while integrating safety controls, giving the ability to monitor safety and process together. And, using [this] technology, we were able to configure in six months what had previously taken two years or longer with other systems. It was very cost-effective."

BP also recently decided to upgrade controls on 18 units at three U.S. refineries. "Following an extensive evaluation of the supply market and available technologies, BP has taken a strategic decision to introduce Emerson digital control systems into its refining base," said Patrick Gower, BP's refining vice president for the U.S.

Advanced engineering tools and methodologies allow easy hot cutover with reduced safety and downtime risk, and modern software solutions speed migration. Electronic marshalling provides flexibility in field wiring cutover during system transition, and data highway and legacy I/O hardware interfaces to simplify system transition. Industry solution experts can work with plant personnel to justify and plan projects to meet the plant's business and operational objectives, improve performance, and increase operational efficiency.

"This is not a theoretical exercise," Schodowski said. "In the next five years, many systems will be going obsolete. Competitive market pressure will continue to drive the need for improved profitability at refineries with legacy systems. The status quo is no longer an option. The new technology is here today to take refiners to the next level of performance. No refiner wants to leave money on the table." ■

Is there an automation upgrade in your future? To find out more, contact Emerson at SmartRefinery@Emerson.com.

Design to Run—Smart Refinery 'Greenfield' Projects

Strategy and risk drive capital projects. Mitigating the risk and having the right project mindset helps achieve better return on investment – design-to-run, rather than design-to-build.

As in every industry, new capital construction projects in the refinery sector are decided upon and dictated by economics today and forecast for tomorrow. Capital expenditure is the most visible and arguably the most critical facet of undertaking a new refinery project. Risk mitigation is a high priority; leveraging experienced resources and key stakeholders early in the project can mitigate risk.

To identify potential risks, and mitigate and align on operating objectives and capital constraints, the best time to get key stakeholders – including strategic partners – involved is at the very outset. The early phases of a project are the most crucial since they provide a blueprint for the entire project. Project alignment among all stakeholders early in the game can make the difference between meeting or exceeding budget and schedule constraints, and getting a faster return on investment (ROI) once the project is complete. The goal is to mitigate risk during the project design and implementation, while maximizing profitability once operating.

"People will penny-pinch on an initial quote, and integration is one of those areas that falls into the cracks," said Steve Elwart, director of systems engineering at Mississippi-based Ergon Refining. "You've got all sorts of new equipment and new vendors, and you're heading in a completely new direction with brand-new, unknown quantities – you forgot that all of these new systems need to talk to each other. If you're not careful, it can really get ugly."

The continuing evolution in digital computing and communication capabilities as well as the application of these technologies has led to fundamental differences in the way refineries are designed, commissioned, operated, and maintained. When implementing a greenfield project, owners should thoroughly understand the project incentives setup for engineering, procurement and construction (EPC); capital project managers; and procurement compared with post-project operations objectives.

"Don't lose track of the objective of a project," said Tim Olsen, Emerson's refining performance consultant. "The objective is to meet a consumer demand and get the expected return on the investment."

A recent trend is using automation providers as a main automation contractor (MAC) to be involved early with the front-end engineering and design (FEED), and then throughout the project. FEED (or "A FEED phase") provides a well-defined scope for the project, which results in better alignment with key stakeholder expectations, more accurate estimates, lower contingency and typically lower overall project costs. The effort and upfront cost of FEED is just an earlier investment as this is work that would otherwise be done in the first 10% to 25% of detailed engineering. The resulting blueprint is further refined during the detailed engineering and design phase of the project. The project plan is defined from start to finish including engineering, resource requirements, hardware procurement, implementation and startup.

Projects with a thorough FEED are more likely to be completed on time and within budget. Identifying potential problem areas and/or necessary changes early allows for immediate resolution, resulting in less impact further into the project. With key stakeholder alignment, business drivers and constraints defined, the project risk is identified and mitigated. Business management can proceed with full disclosure of opportunities to evaluate project alternatives and mitigate risk.

Early planning, project definition and goal setting are major factors in gaining user involvement and management support. These factors greatly increase the opportunity for a successful process automation project. Changes in scope are best made when they have the least financial impact on the project. It is more difficult to improve project costs later in the project lifecycle when project execution and operation of the facility are already in place.

One example of how an automation solutions provider is working with an EPC is how Emerson Process Management and Fluor use PEpC (the **P**rocurement of Strategic Suppliers, **E**ngineering, **p**rocurement of commodity items and **C**onstruction) as a partnership from the FEED throughout the project. Using a PEpC strategy instead of a traditional EPC model has shown time savings of 10% to 15% and cost savings of 4% to 8% compared with the traditional EPC process. "Clients today are recognizing the importance of developing their automation platforms early during the project development phase to ensure a fit-for-purpose solution," said Fluor's Vincent Grindlay, senior project director of supply chain solutions. "As a consequence, the process for evaluating suppliers is somewhat different from that used during a competitively bid scenario. Therefore, to ensure a successful PEpC implementation, it is important to develop a

commercial model that supports early supplier integration as well as demonstrating the benefits technically to drive cost and schedule certainty. Working with our strategic partners, such as Emerson, allows Fluor to develop these models, methodologies and work processes to support the PEpC process."

If strategic suppliers and partners are identified early and synergies of these are leveraged into the concept and design process, time and cost of new projects are reduced, according to a study by the Construction Industry Institute (CII). In addition, risk is reduced if key partners are committed to deliver a broader scope of supply and take ownership of performance.

Not all items benefit from early procurement, however. Some truly are commodities and can be purchased inexpensively. However, some – including process automation – are critical components in the early phases of planning and construction. Early selection of these technologies and a partnership with a MAC, for example, can reduce cost and schedule while lowering risk. In short, early selection ensures alignment, risk is identified and mitigated and the project has a better probability of being delivered on time and within budget.

DIGITAL IS OPTIMAL

Choosing digital technology ensures ROI is achieved. Benefits of smart instrumentation are achieved during the project with commissioning, calibration and startup completed more quickly, more accurately and more efficiently. The same smart instruments continue to capture value by monitoring their own status, which allows immediate alert of abnormal asset health and the ability to predict required maintenance. Using these smart digital technologies has led to fundamental differences in the way refineries are designed, commissioned, operated and maintained.

For example, more than US$4.5 billion was invested at the Fujian refining and petrochemical (FREP) facility in China, a joint venture with ExxonMobil, Saudi Aramco and Sinopec, tripling the capacity of the existing refinery to 240,000 b/d to produce transportation fuels and other refined products. FREP digitally automated the existing refinery with eight distributed control automation systems, predictive maintenance software, safety instrumented systems (SIS), fire and gas systems, pressure and temperature transmitters and digital valve controllers – all using FOUNDATION™ fieldbus, HART, OPC and Modbus communication technologies and delivering information to a real-time database, as part of the largest integrated refining and petrochemicals project ever undertaken in China.

In addition, the project added a new petrochemical complex that included an 800,000-ton-per-year ethylene steam cracker, 800,000-ton-per-year polyethylene unit, 400,000-ton-per-year polypropylene unit and a 700,000-ton-per-year paraxylene unit. The complex also features a state-of-the-art 250MW cogeneration facility, which will meet the majority of the site's power demands and lower operating costs as well as significantly reduce greenhouse gas emissions. China's first integrated refining and petrochemical facility with foreign partners was officially opened in November 2009.

The plant's digital architecture networks intelligent field devices, and sensors throughout the facilities continuously collect and report real-time predictive data about the process, instruments and equipment. Operators and maintenance personnel use this predictive data to optimize performance, anticipate issues and correct them before operations are interrupted or shut down. The digital architecture is based on open systems, which keep pace with new technologies and enable refiners to preserve the capital investment in their control systems. Digital architecture also makes it possible to lower startup and commissioning costs by reducing wiring costs and streamlining device installation, communications verification and troubleshooting.

WAVE OF THE FUTURE

When a greenfield project is given the green light, today's technologies can bring the future into the present. A well designed new plant will include key control loops and applications equipped with smart instrumentation to ensure optimal operation, performance and reliability.

Control rooms may be hundreds of miles from the physical plant, but because of new technologies, more information about the state of the plant will be available in real time. For example, suppose low instrument air pressure on a digital control valve positioner is detected. Alerts – along with root cause information – are sent to the appropriate personnel in a timely manner, allowing an opportunity to repair the low instrument air pressure before it affects the process.

Technical support will likely be remote from the plant and depend on communication to convey data and information about critical operational issues. Predictive diagnostics on all equipment will identify problems early. Enhanced model-based control analysis will bring better decision support and more efficient and adaptive response capabilities to abnormal situations.

Modern automation systems with smart instruments can shorten the amount of time required to identify, commission and calibrate in preparation for an on time startup.

"A constant frustration to automation professionals is that most project people still do not seem to have a good grasp of the capability and value of the control systems and application software that are becoming increasingly necessary to operate process plants at optimum efficiency and effectiveness," said Cliff Pedersen, president of Pedersen Enterprises Inc. "In most capital projects, process control and automation is added as an afterthought with the minimum required for safe operation, and the plants must then be enhanced later by the owner/operators to achieve its 'right-time' objectives. A good example of this is alarm management, where systems are installed with the same alarms as were used in previous projects, with little new analysis for cost control reasons – a situation which then has to be rectified after plant commissioning."

Involving automation experts early helps uncover potential design and implementation risks, which can affect project budget and schedule. It is important all players understand the "end game of the project – the ROI," Olsen said. "These new plants must be approached from the design-to-run viewpoint, rather than the design-to-build mindset – only then can the refinery meet or exceed estimated ROI long term." ■

Is ROI important to you? To discover how Emerson's Smart Refinery solution can maximize your automation ROI, visit www.SmartRefinery.com.

Emerson's Global Project Management Office

In 2005, Emerson created the Global Project Management Office (GPMO) to provide predictability and consistency in its global project execution services. The GPMO develops processes, standards and tools for use by Emerson's engineering centers worldwide. For Emerson's clients, the GPMO initiatives provide a methodology for consistent project execution, with lower risk and improved efficiency and the ability to add Emerson project resources globally and integrate them into each project quickly.

"The GPMO processes offer our engineering centers step-by-step instructions on how to execute projects the 'Emerson way,'" said Tim Prickette, director, GPMO – Americas for Emerson Process Management. "The processes cover project management and our technical disciplines. In each process, templates are available as the starting point for the creation of project deliverables to the client. Each template contains best practice information culled from previous projects.

"Our projects start with an estimate to the client on project cost," Prickette said. "All of our projects globally are estimated using our Enterprise Estimating Tool, which allows users to estimate a bill of material for equipment and software and services hours to provide the automation solution. Using a common estimating tool provides clients with confidence that they will get a consistent estimate from any Emerson engineering center around the world."

Tools are available for project managers to schedule project tasks, assign and manage resources, manage project financials and provide a variety of project status reports based on earned value, project cost and project hours. The project manager tools have been integrated to allow for automated data flow to enhance data accuracy and reduce administration. ■

Advanced Control and Optimization

Model predictive control applications have been streamlined for maximum efficiency and performance. Today's embedded tools are more efficient, ultra-integrated, and easy to use – no Ph.D. required.

For many years, refineries have demonstrated the value of advanced process control (APC) to optimize processes and push constraints. Traditional APC tools are mature and feature-rich, but complicated to use and difficult to maintain.

"In the refining sector, advanced control applications have traditionally been implemented and maintained by a very specialized group of individuals with deep knowledge of APC applications, supported by a whole host of specialists who can deal with separate computer systems connected to the control system, software interface drivers, customized graphics, DCS programming, database administration and networking," said Pete Sharpe, director of refinery and chemical industry solutions at Emerson Process Management in Virginia. "As a result, APC projects were expensive to engineer, install and maintain. They do make money, and they've certainly demonstrated very quick payback. But they also carry an associated overhead cost, which can become a hurdle to getting them done."

All of that is about to change now that automation companies have entered the game. Embedded APC tools are designed to be easier to use, lower cost and dramatically shorten implementation schedules. Modern APC applications require no additional hardware or software because they are additional control blocks seamlessly configured in the DCS, similar to configuring DCS-based PID controllers. There are no files to transfer, no communications to link up and no historians to configure.

"While there are certainly a number of large, complex process units like FCCs [fluid catalytic crackers], reformers and cokers that warrant a large-scale, multivariable approach, there is also a whole class of problems where small, high-speed and redundant embedded APC tools are an ideal fit," Sharpe said. "There are the very fast dynamic problems like fired heaters and compressors, where one-second execution-frequency for an MPC loop is required for safe operations. And you have the long time frame, highly-constrained single variable controllers, such as setting the feed rate to the hydrogen plant to balance the hydrogen system in the face of disturbances from the users. Each of these is a small application in terms of matrix size and implementation effort, but a large application in terms of economic impact.

"Even though the basic designs may differ between units from site to site, you find that the control objectives, key performance calculations and basic control strategies are very similar from one to the next," Sharpe said. "By engineering the solution into reusable libraries integrated with the control system, we have reduced the time to implement one of the 'canned' applications to a matter of weeks. And using 'standard' applications makes it supportable for the future."

KEEPING IT RUNNING

There are many reasons advanced controls get turned off or go unused. Soon after the commissioning team leaves and the project is declared a success, many applications are not working or are not used. Up to 50% of the APC applications implemented during the past decade were turned off within two years from their initial implementations.

How do you prevent the APC from becoming an expensive set of CDs and software folders? Sharpe suggests spending some of the annual control system maintenance budget to keep it alive.

"Modifications, additions and enhancements are inevitable for an advanced control application," Sharpe said. "With only a little bit of training, the plant's engineers become quite proficient at using embedded tools to keep the system evergreen – without much assistance from us."

Lack of training is another reason that APC applications fall into disuse. While staff development is a responsibility of the refiners, automation vendors are taking strides in making training easier and more accessible to all types of users.

Automation developments will continue to enable the refining industry's response to future challenges. Modern process control systems include embedded tools that continuously monitor loop performance, identify issues and proactively address loop-tuning issues. Adaptive tuning for non-linear processes is built in and can be tuned online. Automatic alerts, reports and historical data highlight and prioritize control problems. ■

To discover how Emerson's Smart Refinery solution can get you started on your path to becoming a smart refinery, visit www.SmartRefinery.com or contact Emerson at SmartRefinery@Emerson.com.

Discovering Your Hidden Plant — The Virtue of Increased Reliability

Refineries have always been concerned with improving the reliability of major equipment and avoiding unscheduled production slowdowns or shutdowns. Every refiner knows reliable and efficient equipment operation is essential for profitable production. As refineries get larger, the cost of downtime increases dramatically.

Modern smart refining technology can significantly improve equipment availability and return on investment (ROI). One major refiner even gained capacity equivalent to a new refinery by increasing equipment reliability and availability at its existing refineries.

PREDICTIVE INTELLIGENCE WORKS SMARTER, NOT HARDER

There are several approaches to maintenance in refineries. The "break-fix" approach is to wait until the equipment breaks and then – if it is really important – fix it. Preventive maintenance uses average times until predicted equipment failure to schedule maintenance before the expected failure time. Since equipment can vary in actual performance, some scheduled maintenance is unnecessary, while some equipment fails before its scheduled shutdown.

Predictive maintenance, on the other hand, can determine more precisely whether equipment is underperforming or about to fail and can save as much as 30% of unscheduled maintenance costs while improving equipment reliability.

The more technology develops, grows and evolves, the more "smart" information can be obtained from facilities. Instead of dispatching personnel to collect information with the right predictive applications, information can be viewed remotely, diagnosed and corrected with little or no downtime. High-performance computing equipment continues to decrease in size, while communication and bandwidth capabilities continue to grow. Sensors on equipment are becoming cheaper and can now include enhanced computing and communication features. With these improved computing and communication capabilities, predictive maintenance can be based on actual device performance data, obtained and analyzed in near real time. The objective is to identify potential equipment problems early, before catastrophic failures occur, which minimizes downtime and repair costs.

MAINTENANCE MADE EASIER

Optimal production is the goal for any processing facility. With today's slim operating margins and increased global competition, increased performance is becoming a Holy Grail. Unplanned shutdowns due to equipment failures, higher-than-expected maintenance costs and lack of experienced personnel can seriously affect the bottom line.

"Surveys conducted by different sources at different times reveal that more than 80% of maintenance is reactive (too late) or preventive (unnecessary)," said Emerson Business Development Manager Chuck Miller. "In fact, typical maintenance practices have not changed in over 15 years. This is primarily the result of an insufficient tool set capable of improving maintenance practices – a situation that a modern integrated control and safety system (ICSS) can change.

"An ICSS solution lowers upfront costs of engineering, installation, and commissioning, and it certainly will also reduce ongoing maintenance and management costs to satisfy any safety and regulatory requirements."

Emerson's AMS Suite predictive maintenance software initially focused on intelligent field devices and applications to manage them. During the past decade, through strategic acquisitions and internal development, the company extended the scope of predictive diagnostics to cover critical refinery production assets. These assets include mechanical equipment (turbines, compressors, pumps), electrical equipment (switchgear, electric motors), process equipment (boilers, heat exchanges, furnaces), instruments and valves. If the systems are operating smoothly and predictably, planning becomes more reliable, saving time and money at all stages.

Rotating equipment (turbines, motors, pumps, compressors and fans) is critical to plant operations. Failures can significantly affect plant production capacity. Maintenance costs on this equipment can also be high. Deteriorating rotating machinery health and performance is usually associated with misalignment or imbalance, corrosion and wear, fouling, sediment build-up or poorly lubricated parts. Detecting these underlying problems early allows refineries to correct issues before they affect processes. With modern predictive maintenance software solutions, smart refineries can reduce maintenance costs, while increasing availability. Online machinery monitoring extends protection, prediction and performance monitoring capabilities to a plant's most critical machinery, which allows the staff to diagnose problems before they become critical issues.

What are the enabling technologies that permit refineries to move from reacting to predicting?

"A dream I had fulfilled was to have an instrument tech come

into the control room to tell the operator they are going to work on an end device that was failing," said Ergon Refining's Steve Elwart. "The operator replied, 'Oh, I didn't know anything was wrong with it.' At that point, we knew we had moved from breakdown maintenance to predictive maintenance."

NO MORE OBSTRUCTIONS

The ability to move from a reactive to a predictive reliability approach is a major component of smart refinery technology. Predictive diagnostics enable early identification of equipment problems and create "self-aware" assets and smart field devices. With today's wireless technology, the cost of adding these smart devices and sensors to monitor important plant assets has decreased dramatically. These smart devices analyze data in real time to provide diagnostic information and integrate it into maintenance procedures, providing an opportunity to act on the information before a failure or safety incident occurs. The reliability and safety of the entire smart refinery is improved by preventing unplanned shutdowns.

Remote locations, physical obstructions and the high cost of engineering and integrating new technologies are no longer the barriers they once were. With traditional point-to-point wireless solutions or where network reliability is a concern, site surveys are required to define line-of-sight communication paths. These surveys can be time-consuming, especially if equipment or other obstacles limit available communication paths.

Recent advances in smart wireless technology provide access to parts of the facility that were previously out of reach. With smart wireless, sophisticated planning and costly site surveys are unnecessary. As long a device or gateway is within range of at least one other wireless device, it can communicate with the network. The self-organizing mesh technology overcomes the barriers, obstructions and limitations of typical line-of-sight wireless installations.

Self-organizing mesh networks continuously monitor transmissions from a variety of measurement devices that keep track of pressure, temperature, flow and vibration. The network automatically finds the best communication route back to the network gateway (receiver). If a connection is temporarily blocked, signals are rerouted to adjacent wireless devices, which act as transceivers or repeaters that maintain connectivity. These redundant data pathways eliminate single points of failure and, since the system is automatically reconfigured, no user intervention is required.

This mesh technology is the basis for the IEC 62591 (WirelessHART®). IEC 62591 enables users to quickly and easily gain the benefits of wireless technology while maintaining compatibility with existing devices, tools and systems. A large number of field devices, valve and equipment position monitors, vibration data transmitters and smart gateways meeting this standard are currently in use throughout the industry.

Smart wireless technology using IEC 62591 opens the door for new possibilities in predictive maintenance and smart refinery reliability. Because these smart wireless devices have the same process connections as traditional wired HART devices, existing procedures can be used to complete the installation. Smart wireless sensors can be calibrated using the same configuration tools as for the traditional HART devices. And digital HART communication provides device diagnostic and equipment health information to enable predictive maintenance, increased reliability, and perhaps even the discovery of your hidden plant. ■

To discover how Emerson's Smart Refinery solution can improve the reliability of your plant, contact Emerson at SmartRefinery@Emerson.com.

Improving Safety in the Smart Refinery

According to the U.S. Department of Labor, during the past 15 years, the U.S. petroleum refining industry has had more fatal or catastrophic incidents related to the release of highly hazardous chemicals than any other industry sector.

Safety-related incidents – including explosions, fires, heavy equipment-related accidents, and falls – have caused an alarming number of injuries and fatalities in the refinery setting. While these facts are serious and sobering, much can be done to improve the safety aspects of refinery operations. Providing safe and environmentally benign operations not only for plant personnel, but also the surrounding communities, is an essential part of a refinery's bottom line. Achieving safety-related goals at the lowest effective cost with optimized process reliability is imperative in today's economic environment.

"In the refinery setting, there are so many risks and threats to safe reliable operation that refiners are forced to take on the credo of the Hippocratic Oath: 'First do no harm,'" said Gary Hawkins, global refining business consultant at Emerson Process Management. "Improving reliability and safety, protecting people, your investment, the community and your production are all lofty goals, but how does an operation achieve all of this while maintaining profitability? It's a juggling act around being operationally nimble, being able to dial up and dial down depending on market changes and crude slate changes and having the flexibility in your production – which includes your people – to be able to respond to those changing conditions safely and with predictable success."

Employing state-of-the-art safety logic solvers can create a safer work environment. Integrating equipment diagnostics and status information within the safety logic solvers permits improvements in availability and reliability of the safety instrumented system (SIS). Most SIS in a refinery are applied to the process heaters, and the most frequent causes of SIS failure on demand or spurious trips are due to failures of the instrumentation or the final element (shutdown valve), not a failure of the logic solver. Integration of smart devices within the SIS – integrated, but within separate architecture – provides device status and alerts that can be used to increase the reliability of the SIS, reducing spurious trips and avoiding unexpected shutdowns.

"Safety instrumented systems perform a critical role in providing safer, more reliable process operations," said Emerson's Joanne Salazar, manager of the company's DeltaV SIS marketing program. "Based on industry research, over 92% of all faults in SIS applications occur in field instruments and control elements. Therefore, it is critical to consider the entire safety instrumented function (SIF) – from sensor, to logic solver, to final control element – as a complete entity. This approach increases process availability and reduces lifecycle costs for end users.

"Digital HART communication is the enabler," Salazar said. "It provides device diagnostic and health information to enable predictive intelligence and allows appropriate action to be taken before the process is unnecessarily shut down – resulting in significant savings of time, labor and lost throughput."

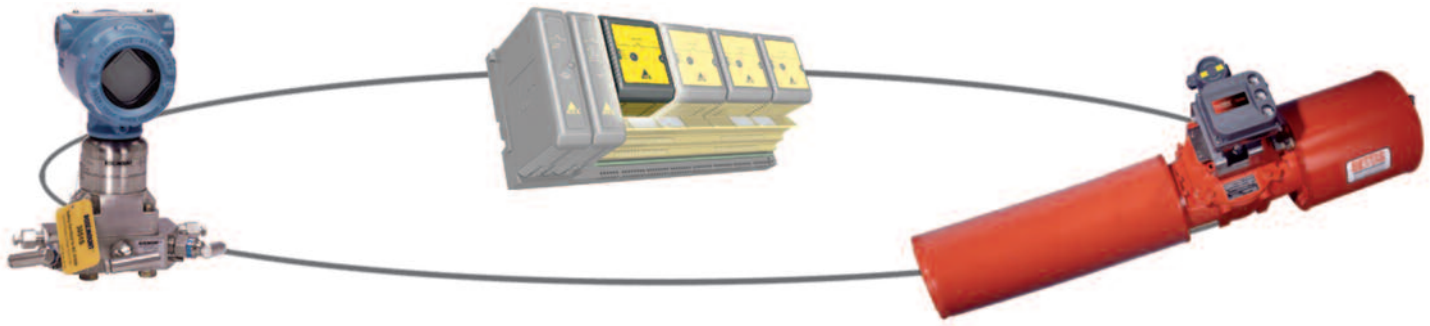
Integration of smart devices within the SIS provides device status and alerts that can be used to increase the reliability of the SIS, reducing spurious trips and avoiding unexpected shutdowns. Operator interfaces that employ human-centered design principles can now increase operator attention and avoid alarm overload (or "alarm flooding") during abnormal situations.

"Integrated equipment performance monitoring gives early indication of efficiency loss and potential equipment failure," Hawkins said. "For instance, light-off of a fired heater is generally considered the most dangerous time of fired heater operation. Therefore minimizing spurious trips of the heater also increases safety. And integration permits many startup activities to be performed remotely rather than in the field – reducing man-hours and time to startup."

BIG BROTHER IS WATCHING

Nearly every process plant is subject to some form of regulatory compliance. In the U.S, these include OSHA, NFPA, API, ASME, CSD and FM. Additionally, most plants have committed to complying with ISO 9000, and where safety system conformance is required, the governing safety standard is ANSI/ISA 84.00.01-2004 (IEC 61511-Mod.), Functional Safety: Safety Instrumented Systems for the Process Industry Sector. Even the U.S. Department of Homeland Security is starting to get into the act.

A modern SIS provides an audit trail to ease change management with automated testing documentation to demonstrate regulatory compliance. The ideal SIS solution should provide considerable assistance in complying with mandated and voluntary regulations by completely integrating change management and generating – on demand – detailed documentation from several aspects, including the device audit trail, calibration history, control and/or safety configuration audit trail, process history and event history.



Safety loop (sensor, logic solver and final control element)

SAFETY IS AS SAFETY DOES

New technologies require new or additional training requirements. A modern refinery's staff is cross functional, and its safety team often includes safety, operations and maintenance personnel, as well as the process licensor and a representative from the safety system provider. Process and safety experts may be remote from the plant site. While all staff should be cognizant of the refiner's safety schema, those with potential safety roles need specific and detailed training and mentoring.

"With the predicted retirement and turnover of experienced staff in the upcoming years, operator training in not only normal unit operations, but also in infrequent events like startups and shutdowns and emergency procedures will be key to maintaining safety in the refinery," Hawkins said. "Safe equipment operations and employee safety is rarely taught in schools. It is something that is primarily learned in the work environment for specialized situations. Safety begins at the top, and our expanding offerings in the realm of safety are designed for top operating managers as well as safety professionals." ■

To discover how Emerson's Smart Refinery solution can get you started on your path to becoming a safer, more secure smart refinery, visit www.SmartRefinery.com or contact Emerson at SmartRefinery@Emerson.com.

Cyber Security in the Refinery

The vulnerability of critical infrastructure is of major concern, both to operators and government entities. Refineries and chemical plants, power plants and oil and gas pipelines are particularly attractive targets to hackers and terrorists – not only for the potential economic impact, but for the "big boom" and visible damage that can occur, drawing coveted media attention. Are you doing everything you can to protect your facility?

In remote locations, ramming a pipeline with a truck or throwing a bomb over a fence are the easy ways to damage critical assets. But if the adversary is more sophisticated, the target may be the control systems that monitor and control facilities. By accessing a control center, an attacker can gain access to critical operations and wreak real havoc.

"Many people don't understand how cyber security fits into control systems," said Steve Elwart, director of systems engineering at Ergon Refining, and chairman of the Energy Sector Control Systems Working Group for the U.S. Department of Homeland Security (DHS). "We're at a point in cyber security now where safety and environment were 20 years ago. Back then, environment and safety were considered overhead, a nuisance – and that's how many view cyber security today. It is perceived to have no return on investment, so it gets relegated to the IT department to handle – and with all due respect to the IT teams, they don't know much about control systems. We need to get to the point where cyber security is everybody's business."

Elwart gave an example of walking into an unnamed refinery for a DHS "red team assessment," and within seven minutes, the team had gained administrative access and the ability to control the plant's operating systems. "That's how weak some systems are," Elwart said. "Simple things can trip you up, like never changing the default password, which is often published in manuals that can be downloaded off the Web. Control systems personnel are finally taking things seriously, but there is still a long way to go."

Unless the plant in question is a new-build, most plants can't begin with a blank slate where security is concerned. Instead, security solutions must be integrated into existing systems, networks and equipment, which can pose a formidable challenge. Tying in remote locations without influencing production can add further complications for security upgrades.

The U.S. government is currently spending about US$12 billion on cyber security for critical infrastructures. Cyber security bills are in the works that would bring more government influence and control into the private arena. The U.S. Department of Homeland Security has started a voluntary certification program for infrastructure personnel involved in cyber security, but it is only a matter of time before mandatory standards are put into place. ■

Energy Efficiency and the Greenhouse Gas Conundrum

As the global warming debate heats up, increasingly strict regulations on greenhouse gas emissions are becoming potentially more costly for U.S. and European refiners. Energy efficiency can help keep plants competitive globally, while maintaining regulatory compliance.

In March 2010, the United Nations launched the first common system of calculating the amount of greenhouse gas (GHG) emissions produced by specific sector. This sparked speculation about impending global pressure for mandatory emissions reductions. As the industry keeps potential regulations under surveillance, and refiners strive to increase efficiency within changing market conditions, how can today's refineries meet tomorrow's environmental standards?

"Right now, with the new regulations regarding CO_2 [carbon dioxide], the focus is all about measuring greenhouse gas and equivalents, and the new greenhouse gas mandatory reporting requirements," said Tim Olsen, Emerson's refinery performance consultant. "We are taking a proactive stance, talking to our clients about preparing themselves for what might next be in store, especially here in the United States with the [U.S.] Environmental Protection Agency [EPA]. The EPA will probably want to limit greenhouse gases, so from our point of view it is no longer just about taking measurements, it's about applying some of these applications to improve operations and reduce emissions at the same time."

Because U.S. operators are now mandated to report GHG emissions, control systems are increasingly more important for obtaining accurate information. "On the safety side, control systems now act as a watchdog – if the H_2S [hydrogen sulfide] sensor goes off, or if a calculated quantity or prediction holds true, pagers and cell phones start ringing the alarms," said Steve Elwart of Ergon Refining. "I predict we'll see the same thing soon for greenhouse gas emissions."

According to Joel Lemke, Emerson's Americas marketing manager, flow rate is one of the most challenging GHG-related process measurements. Performance depends on matching the meter to the application, installing and operating it properly, ensuring it is robust to changes in operating conditions and meeting Capex and Opex economic constraints.

"The new regulation requires ongoing data collection from a variety of measurement points located throughout the plant," Lemke said. "Multivariable technology in flowmeters enables accurate reporting even if process conditions change, and wireless can create a dedicated, central GHG data network to collect the data and make it easy to compile into an annual report."

SOLOMON SAYS...

The Energy Intensity Index (EII) as benchmarked by Solomon Associates generally measures energy efficiency in the North American refining market. The EII is an aggregate value that essentially indicates how much energy is expended to process each barrel of crude oil – the lower the number, the more efficient the operation. A Solomon EII value of 100 is standard; a Solomon EII plant-specific value below 100 indicates a more efficient plant, while a value above 100 indicates a less efficient plant.

"Many different factors can affect energy use in a plant, and in nearly every plant, there is the potential for energy efficiency improvement. Automated process controls can really have long-term benefits not only for helping to control and monitor CO_2 emissions, but also when it comes to complying with CO_2 regulations," Lemke said. "Automated process controls are quick to install and maintain, easy for the operators to understand and use, and many tools built into the system help operators do a better job of managing the regulatory layers."

According to the Solomon guidelines, differences in crude characterization, petroleum products generated, technology and general practices can be significant in determining a plant's energy use. Because reducing energy consumption is important to society and the environment, as well as industrial competitiveness, energy efficiency improvements deserve attention.

Shell Refining representatives said their plants have improved energy efficiency steadily since 2002 due to operating their refineries closer to full production capacity, running their energy efficiency program and conducting business improvement reviews.

"Since 2002, our programs have reduced our GHG emissions by approximately 1.7 million tons a year and saved us a combined [US]$180 million annually at our refineries and chemical plants," the company said.

However, Shell representatives did note that in 2008, energy efficiency at the company's plants worsened, partly because of more unplanned shutdowns.

"It was also due to refineries running below their full production capacity, hence less efficiently, as demand for their output dropped during the year," the company said. "However, we are stepping up our efforts to improve energy efficiency in our refineries and chemicals plants. For example, we are rolling out energy management systems that allow plant operators to spot energy losses faster and immediately make small corrections to stop the losses. These systems have already improved efficiency by more than 8% at our Geismar chemical plant in the United States. They were implemented at four more plants in 2008. We plan to install them at a further five plants in 2009."

ROOM FOR IMPROVEMENT

Many factors impact energy efficiency, and there is plenty of room for improvement across the refining industry.

"Sustaining improvements is definitely a challenge," said Emerson's Gary Hawkins. "There is value in tracking emissions, and there is value in implementing systems to make energy consumption more visible to plant operations. This makes it easier for plants to take corrective action when necessary or to automate systems to take the operator intervention factor out of the process."

Hawkins said process units are designed around a certain 100% throughput value. This is generally the most efficient operation, excluding details of "best efficiency point" for pumps. A typical plant is designed to also operate at 60% of this throughput, but it won't be as efficient.

"This is mostly due to the operation of fractionation columns," Hawkins said. "Given the diameter of the fractionation columns to process the 100% value (plus some contingency), a certain vapor-liquid traffic is required as a minimum for proper contacting and hence separation of the feed into the desired products. This vapor liquid traffic is generated by the heat input in the reboiler – or in the case of crude, vacuum and hydrocracking fractionators, the heat comes from a feed heater and the feed is introduced toward the bottom of the column."

INVESTING IN THE FUTURE

Delaying investment in energy conservation programs can wreak havoc down the road. A low-cost interim solution such as repairing steam traps and other steam leaks will inevitably bring low return. Conversely, higher-cost options such as installation of integrated gas turbines, fluid catalytic cracking power-recovery turbines (vapor) and hydrocracking charge pump power recovery turbines (liquid) can bring higher returns, but are not automation-based solutions. Smart refineries should invest in automation technology, which involves low to medium initial cost, but enables substantial returns in the long run – including better flow and analytical monitoring.

"With modern process controls, you should expect to see enhanced control loop dynamic performance: measurement improvement, control valve improvement and faster control algorithm execution, not to mention the benefits of better steam management," Hawkins said. "Modern process controls save time, effort and money and reduce the occurrences of expensive unplanned shutdowns."

Plant flexibility can be readily achieved, according to Emerson, with their SmartProcess applications, which command a basic process control system with high dynamic performance. These advanced automated controls can help operators of smart refineries reduce variability, minimize energy usage and increase product yield. An added benefit of this small step is a giant leap toward energy efficiency and reduced GHG emissions. ■

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Does Your ERP System Provide Enough Bang for Your Buck?

As global competition forces refineries to improve efficiency, supply chain management has become an increasingly important cost-saving strategy.

For integrated oil companies, supply chain management means integrating business processes and lowering inventories across traditional boundaries – from crude oil production to intermediate components, product blending, transportation and final product deliveries at the retail outlet.

Major integrated oil companies were early adopters of enterprise resource planning (ERP) systems, spending significant amounts to better control costs and to streamline and fine-tune global operations. Although companies have spent billions of dollars on ERP systems, they are still struggling to get the full value from these applications. During the past 10 years, the processing industry alone has spent more than US$17 billion for SAP licenses and services. Factoring in the various system integrators, hardware, training and other costs, the total industry tab for their SAP systems could easily be three to five times that amount over the life of their systems.

A 2010 Panorama Consulting Group survey asked 1,600 global organizations what they thought about their ERP investments. The survey revealed that:

- 35% of ERP implementations take longer than expected;
- 51% of ERP implementations cost more than initially assumed;
- 67.5% failed to realize 50% or more of their projected benefits;
- 40% of participants suffered operational stoppages upon implementation;
- only 39% said ERP implementation standardized their business practices to their expectations; and
- only 39% responded that ERP implementation made employees' jobs easier.

Surprisingly, the survey also revealed that 56% of the participants plan to implement new ERP systems in 2010. Clearly, ERP is here to stay, but how can today's smart refinery take full advantage of what these systems have to offer?

"In order for these ERP systems to achieve their full potential, it's important to know what material is where within the supply chain," said Emerson's Pete Sharpe. "As a result, we see refiners moving toward a more comprehensive automation of the tank farms, terminals and logistics around their refineries. With more stringent ultra-low sulfur specifications now in play, we often see oil movement infrastructure becoming more of an operating constraint, where small mistakes, like contaminating a transfer line, can cost a lot of money."

Investing in automation for tank farms is usually low priority because coverage for such large areas is expensive to implement. However, as offsite infrastructure becomes stretched with unit expansions and new units come online, error frequency and financial risk increase dramatically.

STRATEGIZE TO OPTIMIZE

"Unexpected outages of equipment in major process units cause disruptions to the whole refinery supply and demand picture," Sharpe said. "As a result, spot purchases or sales at distressed prices when the refinery is long or short on a blending component can have a large financial impact on operating margins. The flexibility to make operating adjustments and change or communicate plans quickly – responding to upsets or taking advantage of market opportunities – can be extremely valuable to in a refinery environment."

Leading refiners are implementing new and innovative operations management systems that automate the linkage between planning and scheduling functions and field operations. Daily orders, shipments and receipts are downloaded, executed and reported electronically. Information on performance

against plan is immediately available to the entire organization for strategic decision-making and responses to upsets.

"The logistics for operating a refinery can be quite complex and dynamic," Sharpe said. "For instance, decisions on which crude to run and how much to buy must be made months in advance. If you get it wrong, it could cost the company millions of dollars per incident."

Most refinery operations are usually planned using a customized linear program (LP) based on the expected product lifting schedule, crude availability, refinery configuration, equipment condition and economic parameters. Ideally, the LP models should reflect the actual capabilities of the process units under various operating scenarios and feedstocks. The ability to compare actual vs. expected unit performance and "backcast" the LP models to predict the period that just completed can be complex and time consuming. Model errors can cause planner results to be suboptimal or unachievable.

THE BEST LAID PLANS...

A primary consequence of the operating uncertainties refineries face is the amount of inventory held in the supply chain. Whether it's crude in ships, tanks or pipelines; intermediate components ahead of the blenders; or finished products waiting for certification and shipping, inventory ties up fixed and working capital. Reducing uncertainty by better planning and real-time adjustments to field instructions and targets allows companies to reduce total inventory substantially.

"In the area of supply chain and operations management integration, we see refiners moving from reactive to a predictive operation with better models, accurately calibrated with current equipment status, supported by on-line measurements of actual versus plan," Sharpe said.

KEEPING IT REAL

To survive in a highly competitive global economy, enterprises must transform themselves into "real-time enterprises." They must monitor and control their enterprises in time increments that allow them to operate optimally under any circumstances, while demonstrating sustainably high levels of community and fiscal accountability.

"Those time increments vary by industry, market and where the enterprise operates in that industry/market," said Cliff Pedersen, president of Pedersen Enterprises Inc. "The most successful enterprises will optimize that time increment according to the velocity of the processes generating competitive saleable output, the magnitude of the consequences of losing control, and the maximum speed of change with which they can influence business drivers. In so doing, they will become 'right-time enterprises,' which will demand that application software and systems across the length, breadth and height of the enterprise be seamlessly integrated and interoperable. In order to achieve that heightened level of operation/interoperability, it will be absolutely necessary that standards-based integration be implemented in all applications and systems, beginning in the design and construction of the plant itself. These standards exist today (e.g., The Open O&M Initiative), and enterprises and suppliers who fail to recognize and implement them will be risking their very future."

When the condition of an asset can be tied to plant-level key performance indicators, users are better empowered to make informed decisions about how to operate their facilities.

"If a refiner chooses an integrated operations management system to manage the operating and logistics orders from an ERP, the plant will see the benefits immediately by eliminating manual steps, providing validated, reconciled production data and improving order-to-invoice time for product shipments," Sharpe said. "The same system can then be used as the basis for real-time decision making, improving a refiner's flexibility and agility as well as better managing the workflow between planning and scheduling functions with the field operations. Frankly, there is a lot of opportunity here." ■

To learn how to get more bang for your ERP buck, contact Emerson at SmartRefinery@Emerson.com.

Meridium, Emerson: A Strategic Fit for Supply Chain Optimization

In an ideal world, refineries can optimize maintenance strategies to direct resources to the areas that will deliver the greatest return and eliminate activities that do not create value. When diagnostics can be linked directly to business performance, predictive intelligence delivers its greatest value. When the condition of an asset can be tied to plant-level key performance indicators, users are empowered to make informed decisions about facility operations.

Emerson recently entered a joint relationship with Meridium, a supplier of asset strategy management, reliability analytics and decision support, to provide solutions that tie real-time online predictive intelligence to critical production asset management and maintenance support.

The combined Emerson-Meridium solution also significantly enhances the value of CMMS (computerized maintenance management system) applications such as SAP Plant Maintenance (PM) and IBM Maximo, which are used for maintenance planning and scheduling. Instead of driving work according to time schedules, users can drive activities based on actual equipment condition and its impact on smart refinery operation. ■

The Human Element — Enhancing Operations

A significant number of experienced workers will retire in the next five years. Will your refinery continue to operate safely, reliably and efficiently?

Manufacturers are faced with a demographic challenge: a generation gap between the seasoned people who are retiring and the younger people coming in, who may be highly knowledgeable but without the experience of their older counterparts. There is a significant loss of knowledge and lack of replenishment, and those with whom they do replenish don't have the necessary experience or perspective. Consequently, it is vital that automation manufacturers develop intuitive technologies. These new technologies must become the knowledge base that captures legacy knowledge and makes it available and usable to these new operators, maintenance techs and reliability engineers.

"The workforce is changing," said Steve Elwart of Ergon Refining. "People are retiring, and working in a refinery setting is just not perceived as glamorous to the new generation of workers. There is hope for the future, however – with automation, you don't need an advanced degree anymore. A plant engineer or a sharp instrument person can easily and effectively use these tools."

While the younger generation generally embraces new technology as a fact of life, seasoned operators are sometimes resistant to change, remaining content to operate with older, less efficient technologies because they already understand how to use them. New technology has "human-centered design" built into its capabilities, allowing operators, engineers, maintenance techs and office staff to be much more effective in their roles.

"People who were born before 1953 are more comfortable with text – they like log books and manuals," Elwart said. "The ones born after 1953 – the 'TV' generation – would rather use visual aids, like graphics, pictures and video. Generation Xers are much better at assimilating information from multiple sources and at multi-tasking. Modern automation systems fit perfectly with their way of operating."

Modern systems also use this same technology to train console operators on infrequent events such as startup, shutdown and emergency situations. Simulation software is used to train operators in a controlled environment without damaging the equipment or causing a shutdown. Training simulators mimic actual processes and are easily maintained.

"To my mind, the biggest impact of modern automation is the ability to bring the capability and tools that enable a more efficient, effective, reliable, sustainable and safe operation," said Pedersen Enterprises Inc. President and Automation Consultant Cliff Pedersen. "However, the tools in themselves are not enough – that capability must be applied by intelligent and knowledgeable people, so it is only as good and as effective as the people who apply it and use it. There are so many things that can be done, have been tried and shown to add value, but unless they are applied smartly in a sustainable manner, they lose their value and have even introduced new problems that weren't previously present.

"For modern automation to achieve its potential impact in reality," Pedersen said, "the system must be robust, reliable and sustainable with the available human resources so that the operators gain confidence that their plant is being well run and managed. Once that confidence is achieved, they are more willing to try new ideas and methods, which may be as simple as operating control loops in 'auto' instead of 'manual.' Once they are confident in the automation system, they become less likely to blame the system during a process incident, which usually wastes time and effort and diverts attention away from diagnosing and correcting the root cause, and trust it to operate the plant better."

HUMAN TECHNOLOGY

In smart refineries, tools that make tasks more time effective and efficient such as advanced handheld field communicators, vibration analyzers and predictive maintenance software can now interface seamlessly with automation systems and the assets they control, better preventing breakdowns and unexpected process shutdowns. Newly designed interfaces known as device dashboards are now available from technology providers for many field devices. Information is provided in real time with enough advance warning to act on the information to prevent a safety or shutdown incident.

"We evaluated device interfaces across the industry and found a common problem," said Peter Zornio, chief strategic officer at Emerson. "Routine steps operators and maintenance personnel perform frequently were cumbersome, confusing and illogically laid out. It's an endemic problem in the industry. Based on user input, we believe the changes we've made to the Device Dashboard will improve speed and accuracy of confidently performing these tasks.

Engineers and engineering contractors can have unprecedented flexibility in Input/Output engineering thanks to electronic marshalling. Hard-wiring each device as a unique connection from field to controller means intermediate con-

nections are eliminated. This means less engineering up front and fewer change orders later in the project.

"We observed that client project engineering and design processes across the industry put too much emphasis on locking down designs very early in the project, often before the process design was complete. Not only does this increase FEED [front-end engineering and design] and detailed design cost and time, but it also exposes the project to increased labor and potentially significant change-order costs during construction."

"The main issue now is not the engineering, technology, installations or systems," Pedersen said. "Rather, it is having enough people in the owner/operator companies and the operating plants that understand both the processes and the technologies well enough to apply the systems intelligently and effectively. When that is achieved and the systems are applied appropriately to address the right objectives, they will then capture a better return on investment and be easier for both operations and management to understand and adopt."

MAINTAIN TO SUSTAIN

Although every smart field device offers diagnostics, not all devices provide the same information. As a result, multiple and often confusing instrument displays confront plant maintenance personnel. State-of-the-art dashboards inherent in modern predictive maintenance software give workers an instant view of the critical items they need to evaluate, diagnose and act upon. Expert guidance is provided to streamline the most important and frequently performed tasks by plant operations, engineering and maintenance personnel. The dashboards are designed to make complex information easier to understand, including screen displays that provide information to cover 80% of the most common tasks.

"In evaluating how people use maintenance tools, we found a common problem," Zornio said. "The routine steps required by plant personnel to work through automation system issues were often cumbersome and confusing, and the interfaces were very product and feature-oriented instead of task-centric. They assumed the user had a detailed knowledge of the product. Based on the inputs of many process industry workers, we have initiated an across-the-board overhaul of our products intended to improve the speed and accuracy of their job performance and to increase each individual's productivity." ■

How will the reality of the changing workforce affect your plant? To find out how human-centered design can help you through this transition, visit www.SmartRefinery.com.

A New Level of Efficiency

Within petroleum refining, much of today's technology complements control room operators to make them more efficient, safer and effective.

"You can't appreciate how good design is in a human context – how good 'good' is – until you see 'bad' next to it," said Emerson's Tim Olsen.

Human-centered design promotes improved job performance. Work practice studies show personnel are often overwhelmed with multiple systems and user interfaces, making it difficult to find crucial information, especially in the field. For example, the need for easier access to the diagnostics available in smart field instrumentation has become critical, along with clear presentation of that information and standard "action" procedures to follow in case trouble is indicated.

As Emerson developed its Smart Wireless technologies, the need for more improvement in ease-of-use and workforce productivity products became apparent. The company took its ideas to Carnegie Melon University's (CMU) Human Computer Interaction Institute, a recognized leader in the study of how humans interact with technology, to study in depth how best to tailor automation products and services to the company's human users.

Armed with knowledge gained by the joint venture with CMU, five years later, Emerson launched its own Human Centered Design Institute (HCDI), incorporating human-centered design specifically into its automation products and services suite with a goal of making process controls easier to use. HDCI's objective is to ensure Emerson products are engineered to enhance workforce productivity and ease of use while maintaining cost-effectiveness and compatibility with other systems. So far, Emerson has trained 65 product development teams on the science of human-centered design.

"Process control technologies have come a long way in the past 40 years," said Peter Zornio, chief strategic officer at Emerson. "But the industry has invested almost exclusively in feature and technology enhancement, instead of designing around how people actually use this technology. We believe it is time technology began serving people, instead of the other way around."

"There is a demographic paradox facing the industry," Zornio said. "In mature markets, knowledgeable workers are retiring. In emerging markets, finding knowledgeable and skilled workers is very difficult. By putting increased emphasis on ease of use, we can meet this demographic challenge head-on and simply make it easier to extract value from technology investments." ■

Making the Smart Refinery of Tomorrow Happen Today

The advanced smart refinery is not just a vision of the future – it is quickly becoming today's reality.

In refining, efficiency and productivity are no longer idyllic goals – they are necessities. This is true now more than ever. Increasing regulatory requirements, refinery complexity and demands for higher quality continue to place higher economic demands on refineries while reducing operational margins.

The new smart refinery can offset these barriers. Technology enables and enhances this smart refinery. For example, wireless technology extends sensor reach, enabling smart refinery operators to monitor areas of the plant that were previously inaccessible due to location or wiring installation costs. Because of automation, the smart refinery has the ability to predict maintenance issues, prevent failures and greatly improve plant and process reliability. Not only does this translate into more efficient operation, higher product quality and reduced maintenance costs, it also means that the smart refinery has improved and increased uptime, which adds dollars to both the top and bottom lines.

Smart refining offers more – and requires more – than just leveraging state-of-the-art technology. Evolving developments are leading to new methods and procedures for plant operation; increased monitoring capabilities that continually check the pulse of the refinery; advanced modeling and analytics that compare refinery production against expectations; earlier detection of anomalous conditions; and tools that can plan future operation with increased confidence. These developments synergistically enable significant changes in the way refineries operate.

THE FUTURE IS NOW

"Most refineries were originally constructed with the minimal amount of instrumentation required to operate the plant," said Dr. Douglas White, director of refining industry solutions with Emerson Process Management in Houston. "What we see in the future is more use of collaborative software tools, and standards-based software and hardware to reduce ongoing support costs. The operating systems of the future will process, store and analyze much more data and information, including many more sensors in primary and secondary locations and a wider range of live video and spectral data. This data will be analyzed and displayed as information to be acted on in a timely manner.

"Even 10 years ago, when we talked about technologies like pervasive wireless in a plant, people thought of it as a dream – something way off. Now it's becoming a reality, and the next 10 years will really bring some exciting changes. The technologies that are being put into the marketplace today are only the stepping stones to that future."

Another smart refinery trend is toward increasing levels of remote operation. Individual refineries can be geographically dispersed. Control rooms can be many miles from the physical units. Complete information on the state of the plant can be communicated to the remote control room. Fully reliable automated plant startup and shutdown systems enable safe remote operations. Today, major sites operate across hundreds of miles.

In the future, smart refineries will continue this trend, placing greater demands on reliable automation and communication. Fortunately, the automation developments that support these remote operations have kept pace.

While smart sensors, wireless, predictive technologies and automation continue to make the smart refinery even smarter, these enablers do not replace the power of the human decision-making process, nor the accompanying responsibilities. Technology must be used, not only to make the smart refinery more productive and more profitable, but to make it safer as well.

We have the technology to make this happen. Smart refinery operators have the opportunity to deploy these technologies to ensure the safety of their personnel, communities and the environment, while enhancing the productivity and prosperity of the enterprise. It takes a dedicated and deliberate level of commitment and vision on the part of refinery owners/operators to leverage this smart enabling technology to allow it to transform their facilities into safe and profitable smart refineries.

Emerson has taken a leading role in providing smart refinery solutions, including improvements to energy efficiency, safety, health and environmental issues, value addition, cost control, mass and energy balance and overall energy conservation.

"Our smart refinery solution addresses each of these in new and differentiated ways," White said. "We also have experienced refining consultants who can help clients prepare strategies to enhance operational excellence, improve refinery operations and reliability and maximize plant performance." ■

To discover how Emerson's Smart Refinery solution can get you started on your path to becoming a smart refinery, visit www.SmartRefinery.com or contact Emerson at SmartRefinery@Emerson.com.

The Pathway to Your Smart Refinery is Just a Click Away

Discover how Emerson's Smart Refinery solution can help you improve energy efficiency, enhance safety, improve logistics, achieve overall cost effectiveness, and extend asset reliability and utilization. Contact us to learn how we can strategically enhance your operational excellence.

To start on your path to becoming a top quartile smart refinery, visit
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