

PROCESS CONTROL AND INFORMATION SYSTEMS

**SPECIALREPORT**

# Improving refinery reliability, performance and utilization

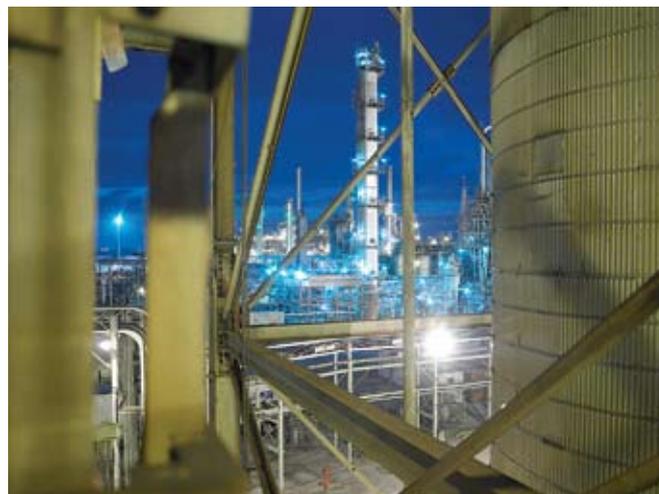
**A new digital control system incorporating fieldbus provided substantial benefits**

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**M**otiva's Norco refinery produces about 7 million gallons of gasoline on a typical day for New Orleans and nearby states, ranking it among the largest refineries in the world. Blending dynamically requires the refinery to be on spec with all blending components 24/7. Several years ago, Norco management realized that the modernization of instrumentation and controls had not kept pace with other improvements to key units at the refinery. Management was determined to increase the refinery reliability by using predictive monitoring of the plant and its assets, avoiding upsets, improving instrument reliability, and improving maintenance and operations effectiveness.

Norco selected an advanced digital plant architecture and main automation contractor for the modernization which proved highly successful. The refinery has moved away from reactive maintenance and toward preventive maintenance using diagnostics and predictive maintenance to, for example, determine before a turnaround what valves need to be pulled for repair. This past year the Norco refinery delivered its best ever refinery reliability, operational performance and utilization, and the benefits that were achieved from reinstrumentation have played a key role in these successes.

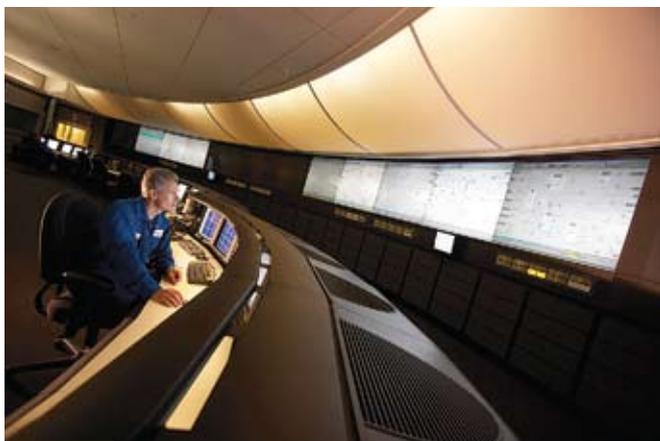
Motiva Enterprises LLC is an oil refining, lubricants and retail business operation owned by Shell and Saudi Refining Inc. Motiva's refinery in Norco, Louisiana, processes 10.1 million gallons of crude and produces 7.1 million gallons of gasoline, 1.9 million gallons of jet fuel, 2.1 million gallons of diesel fuel and 1,000 tons of coke daily. Motiva's primary customer is the New Orleans market, but it also serves nearby states including Georgia and Florida.



**FIG. 1** Motiva's Norco, Louisiana, refinery produces 7 million gallons of gasoline per day.

The distilling unit (DU) takes in crude oil and distills it to lighter fractions that undergo further processing in other units, and heavier fractions that are sent to the residual catalytic cracking unit (RCCU) and hydrocracking unit (HCU) as feedstocks. The RCCU uses heat and catalyst to convert heavy oils into more valuable lower-molecular-weight products such as propylene, butylene, gasoline and distillates. The HCU converts heavier fractions from the DU to gasoline and lighter byproducts in a hydrogen-rich atmosphere. The coker thermally cracks heavy oils to produce lighter hydrocarbons and coke. The alkylation and MTBE treaters produce the gasoline additives needed for boosting octane. The kerosine treater upgrades kerosine for jet fuel usage.

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**FIG. 2** Motiva's new control room was a focal point of the modernization project.

**Challenges faced by Norco.** One of the greatest challenges faced by Motiva is the need to increase crude flexibility. In the past, the refinery processed primarily sweet crudes from the Gulf of Mexico, but is increasingly being forced to rely upon more sour crudes, particularly from Africa. Adding to the challenge is the practice at Motiva Norco of blending finished product directly to pipeline. As an inline blender of finished products, the Norco refinery has no shipping tanks. Blending dynamically makes it necessary to be on spec with all the blending components. There is no room for mistakes. Finally, with demand nearing, and in some cases exceeding, refining capacity, the Norco refinery faces the challenge of maintaining reliable operations to avoid interruptions in supply to major markets.

Norco management recognized that the only way to meet these challenges is through the smart application of technology to achieve economical, reliable and productive operations. A broad cut is no longer acceptable; rather, excellence is required 24 hr a day, 7 days a week. Several years ago Norco management looked at how to utilize this refinery asset more fully and determined that it was well positioned from a configuration standpoint without a lot of major capital investment needs. But there was one major exception. The instrumentation was not up to the challenge of the 21st century. Cokers, reformers and hydrotreaters were running with antiquated pneumatic controls. Increased sulfur content in crude demanded better hydrotreater and coker performance. MTBE removal as an additive placed increased demands on the reformer. All this resulted in poor reliability and frequent shutdowns.

**Initiating a modernization project.** Refinery management initiated a modernization project to improve equipment reliability, avoid abnormal situations, speed response to upsets and improve maintenance practices. Norco selected a digital plant architecture with a network of intelligent field devices that provide advanced diagnostic information about themselves and the process. The architecture also includes an automation system that is built for busses and fully supports FOUNDATION fieldbus and other bus technologies, and software that delivers information wherever it's needed—from the control room to the maintenance shop to engineering and management offices.

**Centralized control room plays key role.** The project scope encompassed eight major process units, 6,000 I/O



**FIG. 3** Intelligent digital valve controllers provide diagnostics to speed repairs.

points and 636 control valves, and consolidated five separate control rooms into one centralized, integrated control room. The new central control room was a focal point of the project. The design radiates from the operator outward, increasing his or her awareness. An overview layer is always present on the big wall screens, giving the operators a bird's eye view of the entire plant. When an alarm occurs, operators can quickly drill down to get full details on the problem as well as the ability to take action to correct it.

Norco's workforce, and changes in its work processes, have been the key to the success of the project. Motiva Norco management understands the need to invest in people to take full advantage of technology. For example, the new control room includes training simulators for each of the refinery's units that were upgraded. Norco personnel have been trained by standard training courses and by using the products in the field.

The digital architecture includes digital automation systems and asset optimization software that have been used extensively to improve reliability and control performance. Predictive capabilities have been improved so that maintenance can be performed proactively. Communications have been streamlined which reduces response times. Maintenance direction and focus have been improved, empowering the workforce to own reliability. Much more information is available from each unit than in the past through the use of the new digital architecture. Predictive diagnostics make it possible to identify and correct problems in the instrumentation or other equipment before they actually become a problem in the field. In this way the new instrumentation improves reliability by avoiding problems that otherwise might force the plant to be shut down.

**Reducing problem diagnosis time.** The new instrumentation greatly reduces the time required to diagnose problems. For example, in the past if an operator noticed a problem on a unit at night he or she would call an engineer at home and ask him or her to come into the plant to diagnose the problem.

Two or three hours later the engineer would be at the site of the problem and could begin troubleshooting. Now, the operator can drill down from the control room and obtain quite a detailed picture of the situation. The operator may be able to understand and solve the problem without the engineer's input. If the engineer is needed, the operator can call on the phone and the engineer can immediately log into the instrument to see the same readings that the operator is seeing. In most cases, the engineer can diagnose the problem without ever coming to the plant. The result is that the problem can be fixed in much less time. This helps avoid upsets.

Improvements in the processing units translate into overall operational excellence at the Norco refinery. In one typical example, a valve positioner had been physically damaged by construction work. Every control valve in the HCU has been completely outfitted with digital valve controllers (DVCs). The DVCs have a feature called pressure control mode that essentially memorizes the pressure that has to be put on the actuator to move the valve. The DVCs also have sensors so if they lose travel feedback they will automatically switch over to pressure control mode and continue to control the process. About a month after starting up the HCU, the operator got a traveler sensor failure alarm but an intelligent DVC had previously identified the problem and provided diagnostics that were used to speed repairs. Maintenance was already on the way to the field to solve the problem before the operator could put a request in.

**Substantial improvement in reliability.** Operations, maintenance and management all like working with the new digital plant architecture. Troubleshooting is more effective and it occurs before it affects operation. Engineering changes are easier to make and so improvement ideas tend to be implemented instead of being put on a backlog. The result has been a substantial improvement in reliability—the main driver of refinery operations. In a world where the global demand for fuel is almost equal to the global capacity, any time that a plant is down it's a problem. So reliability is the most important thing in petroleum industries.

The teamwork and the cooperation between the Norco project team and the automation supplier has been extraordinary. They worked together 24 hr a day, 7 days a week to resolve any issues that arose. Problems were quickly and efficiently resolved without Norco management ever having to become involved. At the end of the day there are a lot of things going on in the plant that require the attention of highly skilled professionals. When those folks work together in a way that is seamless from a management perspective, the refinery's needs are well-served.

**Dramatic improvements in refinery performance.**

The reinstrumentation project was about achieving our current and future business goals and it has accomplished exactly that. Norco is currently turning in its best ever reliability utilization year on record. This improvement has provided increased output without adding new units and the huge investment and lead-time that would have been required. Based on Motiva's global standards, Norco is tracking among the best in class. These achievements have results from the refinery's strategic investment in reliable technology, the skills of our people and the development of a platform of work processes that run 24 hr a day.

Norco managers are proud that with a relatively small amount of capital investment we have created what we refer to as a "gasoline machine," capable of reliably meeting the market's needs. The refinery is shipping its products dynamically up pipelines throughout the Southeast and the East Coast. Recently, the refinery supplied the city of Atlanta on a weekend when it was nearly out of premium gasoline, and others were unable to deliver. Earlier this year on a holiday weekend the refinery did the same thing for markets around Washington, DC, when they were nearly out. In both cases, the refinery met the specs, by the way, without MTBE.

Through its investment in smart technology, the refinery is able to blend gasoline 24 hr a day with minimal downtime. The Norco refinery is an asset that is ready to meet the needs of the country and its stakeholders by reliably, efficiently and safely delivering products in the 21st century. **HP**