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Lean Sigma Delivers

Efficiency tool is on track to deliver \$3 billion in savings.

It started in California in 1998, when a team at our Lost Hills oil field used tools mysteriously named "Lean" and "Six Sigma" to reduce water treatment costs. Two years later in Indonesia, Chevron began training employees in "Lean Sigma" and successfully executing process improvement projects. Not long afterward, the San Joaquin Valley Business Unit (SJVBU) launched Chevron's first formal deployment.

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Left: In control at Tahiti, Gulf of Mexico.





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Since then, hundreds of Lean Sigma process-improvement projects have delivered more than \$2.9 billion in value, mostly in Upstream, and the method is spreading steadily. Gary Luquette, president of Chevron North American Exploration and Production (CNAEP), calls Lean Sigma "a major lever to achieve operational excellence [OE]."

Lean Sigma is a five-stage, process-improvement methodology (Define, Measure, Analyze, Improve, Control – see chart) to eliminate wasteful steps in work and reduce variation through consistent processes. It has become a standard approach to continuous improvement for many, with CNAEP leading the way.

Setting the pace, the SJVBU has captured more than \$160 million in value so far this year, and the Gulf of Mexico Business Unit (GOMBU) has captured about \$370 million.

The Lean Sigma Roadmap

1	2	3	4
Define	Measure	Analyze	Improve
Project purpose and scope; obtain background information	Focus effort by gathering data on current situation	Identify root causes and confirm with data	Develop alternatives, test, and implement solutions

Lean Sigma: how it works.
[Click to enlarge.](#)

Under a disciplined formula, gains include lowered costs, increased revenue, cost avoidance and capital avoidance (avoiding adding facilities). In 2008, mostly in CNAEP, Upstream started 214 Lean Sigma projects; in 2009, 348; and last year, 517. Upstream has already exceeded that number in 2011. Some

CNAEP business units are rolling out Lean Sigma Business Partner Engagement to bring key suppliers on board.

"The surge in projects and value capture further establishes the power of Lean Sigma and reflects two key decisions," says Warner Williams, GOMBU vice president, who initiated Chevron's first top-management-driven deployment when leading the SJVBU. "First, Upstream adopted Lean Sigma as a key Base Business process in 2007. But perhaps more importantly, CNAEP shifted to top-down Lean Sigma deployment in 2009, including a commitment to exceed some very aggressive efficiency improvement targets."

Meanwhile, Upstream's Southern Africa Strategic Business Unit has already exceeded its 2011 goal to save \$40 million with Lean Sigma. And Chevron Upstream Europe's five-year Lean Sigma effort has delivered more

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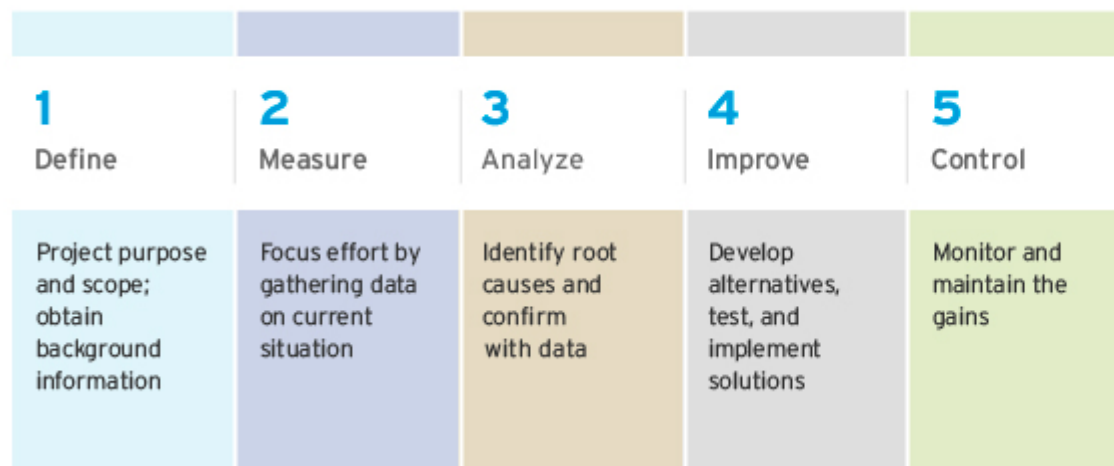
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Lean Sigma: How It Works

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The Lean Sigma Roadmap



In Chevron, we define Lean Sigma as a way of realizing business value by systematically improving existing processes. Structured application of quality and statistical tools leads to improved process knowledge, which in turn can make our processes safer, better, faster, and lower cost.

It's a five-stage process, as shown in this chart, which can eliminate wasteful steps in work and reduce variation through consistent processes.

Because most process improvements are achieved by changes in behaviors and operating procedures, Lean Sigma projects do not require capital expenditures.

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than \$111 million in verified financial benefits from 38 projects. Canada upstream and others are driving programs as well.



Comstock: "We can be world-class at Lean Sigma in five years."

Outside Upstream, Chevron Environmental Management Company started Lean Sigma

last year, capturing approximately \$6 million from seven projects, and this year it aims to close 20 projects with financial value projected at \$10 million as part of its overall cost management. Lean Sigma pilots at the El Segundo Refinery are seeking savings in the machine shop and propane loading process. Chevron Shipping and Chevron Pipe Line companies are using Lean Sigma. And Energy Technology Company is applying it to help optimize the Upstream Workflow Transformation program.

"We've seen a big increase in requests for support now that Lean Sigma is going corporate-wide," says Dave Comstock, who heads Chevron's Lean Sigma team in Upstream Capability with five Lean Sigma facilitators and 30 contractors worldwide. Including business unit specialists, Upstream has 90 people on Lean Sigma full time and will likely need another 50 by 2014. More than 3,500 employees have taken "white belt"

Lean Sigma orientation. Some 1,300 leaders have taken "champion" training. The company has also trained more than 800 "green belts" to lead projects. Another 130 employees hold black belts to facilitate projects.



Lean Sigma has helped drive efficiencies at the Darajat Geothermal plant, Indonesia.

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According to Tom Breedlove, SJVBU's Lean Sigma process adviser, Chevron's Lean Sigma database shows 1,300 projects with a total of \$2.2 billion in savings from 2002 to 2010 – including \$970 million last year from North America upstream and \$300 million from Upstream's international business units. By year-end, cumulative gains should exceed \$3 billion.

"Visible leadership engagement and support have been key to meeting our goals," says Bruce Johnson, SJVBU vice president and executive sponsor for CNAEP's Lean Sigma Leadership Team.

Steve Turnipseed, Chevron's first Lean Sigma adviser a decade ago, now assigned to Nigeria, sees Lean Sigma as an ideal fit within OE, fulfilling the critical element that states: "Optimize operational processes and improve profitability through the efficient use of

people, time, and assets." For example, 44 percent of SJVBU's 2011 Lean Sigma projects enhanced safety; 62 percent increased efficiency; and 26 percent improved reliability. Says Williams: "It's all about becoming better, safer and more efficient."



Canada Business Unit uses Lean Sigma with partners at the Athabasca oil sands project.

Chevron could achieve world-class Lean Sigma performance in five years, notes Comstock, who came from Toyota, one of the companies credited with pioneering Lean. Among top corporations, world class means saving the equivalent of 2 percent of revenue annually. Based on Chevron's 2010 revenue, that would be nearly \$4 billion.

But even with Lean Sigma's dramatic impact and momentum, veteran practitioners insist it's not a new initiative. After all, process improvement is a longstanding priority; part of business as usual at Chevron. Says Williams: "Lean Sigma is not what we do, it's a better way to improve how we do it."

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Disaster recovery project creates first graduates.

Nearly seven years after the earthquake and tsunamis that swept away lives and property across south Asian coasts, a celebration of renewal and achievement has taken place. Politeknik Aceh, a college Chevron helped create in Indonesia as part of our disaster recovery efforts, graduated its first students.

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Left: Aceh graduates celebrate success.



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Firm Foundations

The technical Politeknik Aceh was born out of the Chevron Aceh Recovery Initiative, which provided emergency relief as well as rehabilitation efforts in response to the earthquake and tsunami that devastated parts of northern Sumatra in late 2004. In September 2011, the graduation ceremony took place for the first 140 students from the college.

The building is designed to international standards, and to withstand earthquakes; the foundations are 100 feet (30 m) deep.

"Our company's vision for this polytechnic, and for Chevron's Aceh Recovery Initiative, is as simple as it is bold: Through partnerships, help Aceh achieve and sustain greater economic growth, educational opportunities, and human and institutional capacity than it had before," said Jeff Shellebarger, managing director of the IndoAsia Business Unit (IBU).

"With our partners, we wanted to empower the people of Aceh with the tools and resources to improve the quality of their own lives and those of their communities."

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From Destruction, a Plan for Education

The 8.9 magnitude earthquake was one of the deadliest natural disasters in recorded history. It struck Sunday, Dec. 26, 2004, with an epicenter off the west coast of Sumatra, Indonesia. It triggered tsunamis with waves up to 100 feet (30 m) that killed more than 230,000 people in 14 countries. Indonesia was the hardest hit. The photo shows part of the inundated coast of Sumatra.

By May 2005, Chevron and the United States Agency for International Development (USAID) had signed a memorandum of understanding for the creation of a public-private Vocational Training Alliance to help the people of Aceh province in northern Sumatra.

It was the first step toward fulfilling the \$10 million pledge Chevron made a few months earlier to support longer-term tsunami reconstruction, primarily in Indonesia. The company also contributed \$2 million for immediate humanitarian relief.

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Spreading the Word

In April 2007, Chevron, the government of Aceh, the Rehabilitation and Reconstruction Agency for Aceh and Nias, and USAID, announced plans to develop a polytechnic institute in Aceh province, to be located in the provincial capital city of Banda Aceh.

The initiative followed a short-term vocational training program that enabled 350 students from Aceh and Nias to graduate from Politeknik Caltex Riau, an existing Chevron-supported facility in Riau province.

Shown at the press conference to announce the opening of the college on Aug. 29, 2008, are, from left: Harry Bustaman, manager corporate responsibility, IBU; Mawardy Nurdin, Banda Aceh City mayor; Steve Green, then managing director of IBU and now Policy, Government and Public Affairs (PGPA) vice president, and Danya Dewanti, IBU communication specialist.

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An Upbeat Inauguration

The school was inaugurated by Indonesian President Susilo Bambang Yudhoyono in February 2009. The photo, left, shows participants in the "rabana" (drum) ceremony during the inauguration.

Among the distinguished drummers were local government officials; the U.S. Ambassador for Indonesia, Cameron Hume; and our company representatives, including Rhonda Zygocki, executive vice president of Policy and Planning, then vice president PGPA (sixth from right) and Steve Green (third from right).

Politeknik Aceh is the first international-standard technical college in the province of Nanggroe Aceh Darussalam. The curriculum was developed by Swisscontact, a Swiss foundation that encourages vocational training, and another Indonesian technical institute, Polytechnic State Manufacturing, Bandung. It focuses on subjects that support long-term economic growth in Aceh.

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Shared Goals

"Chevron has not only been a great help during the emergency, but also has a more sophisticated way of thinking," said Aceh's Mayor Mawardy Nurdin in his speech to the new graduates at the recent ceremony. "We had the same goal: That it would be nice if you could make a major investment in the development of the field of education."

"Politeknik Aceh was founded to answer the lack of skilled manpower – men and women who are ready to work in Aceh," said Mr. Zainal Hanafi, director of the college.

The 140 students graduated from several different departments, including information engineering, mechatronics engineering, industrial electronics engineering and accounting. Some are shown, left, being congratulated by Jeff Shellebarger. There are currently 540 students enrolled in Politeknik Aceh.

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The Future of Indonesia

Among the inaugural class of 2011 was Selvi Fhonna (fourth from left in photo), a graduate of the college's industrial electronics engineering course.

"This polytechnic plays a very large role in Aceh; no other school provides the quality of facilities in the province," said Fhonna. "Previously, education in Aceh lagged slightly behind other regions, due to conflicts and disaster. Through this new institution, we receive a polytechnic education and can compete equally with schools in other regions. We are also ready to face the challenges in the 'real world.'"

"My goal is to have a proper job to support my family, and in return, to promote Politeknik Aceh," added Danu Nuwansyah, (second from left) a graduate who lost his mother and siblings in the tsunami disaster.

A. Hamid Batubara, president director of Chevron Pacific Indonesia told the graduates: "What we are actually celebrating is the beginning of the rest of your life. Use your skills. Use them for your future and also for the future of Indonesia."

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How to Load a Tanker

Our crude oil export operation in the Middle East is a textbook example.

Hoisting 12-ton hoses and pumping 45,000 barrels per hour, the Marine Operations team at Saudi Arabian Chevron loads a tanker every four to five days. Safe, reliable operations are keeping a major oil field connected to world markets, and proving again the value of OE culture.



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Left: A supertanker awaits another Chevron cargo.



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The Environment

Close to a popular Kuwait beach resort, a power station and a desalination plant, Saudi Arabian Chevron (SAC) loads massive tankers with crude oil from the company's onshore fields. To the SAC Export Operations team, an oil spill caused by our operations here is unthinkable. With a strong safety culture, anti-spill systems and rigorous loading processes, the team has safely and efficiently moved more than 400 million barrels from SAC's shoreline terminal to the offshore tanker-loading facility over the past decade.



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The Source

SAC Export Operations and its Mina Saud terminal serve the giant Wafra Field and smaller fields located in the area between Saudi Arabia and Kuwait known as the Partitioned Zone, where SAC has operated since 1949. A web of oil-field pipelines continuously gathers both light and heavy crude from a vast network of wells and feeds it to the Wafra Main Gathering Center. Three pipelines then move the oil some 35 miles (50 km) across the desert to Mina Saud.

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At the Terminal

Mina Saud terminal holds 2.8 million barrels in 10 tanks. Wafra's steady flow on one end, and up to 80 tanker loadings per year on the other, keep things in constant flux. Employees use radar gauges and other systems to set, monitor and change tank levels. A lab analyzes samples for quality control. Tank systems automatically remove water, improving oil quality. When tankers are ready, the terminal pumps 45,000 barrels of oil per hour out to the loading area through a 36-inch diameter pipeline buried in the seabed.

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Calculations

Most of the tankers that haul Wafra crude to China, India, Korea, Singapore and the United States are not Chevron vessels. So every ship that comes to Mina Saud has been pre-screened by Chevron Shipping Co. for quality and safety. Coordinating with Chevron's Middle East oil sales group in Houston, Texas, SAC Export Operations contacts each tanker days before scheduled arrival to discuss and verify details of the upcoming cargo. Most tankers at SAC load about 500,000 barrels and take about 12 hours to load.



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Boarding

To initiate loading, two SAC mooring masters and four Export Operations employees board the tanker from a workboat. Directing tugboats and other support vessels in the water below, the mooring masters supervise placing the tanker safely for loading. Throughout the 24-hour task, the mooring masters control every step, ensuring clear communication and strict adherence to safety measures in constant coordination with tanker captains, crews, Export Operations staff on board and the terminal control room on shore.



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Berthing

SAC's berth is a patch of open water about 5 miles (8 km) from shore, with a massive, single-point mooring (SPM) buoy chained to the sea bed. Linked to the terminal pipeline by a riser hose, the SPM is equipped with two 1,100-foot (335-m) loading hoses. Mina Saud's SPM can stop the terminal's pumps automatically if it detects a surge in pressure from an accidental closure of the tanker's intake valves. The SPM can also automatically relieve pressure on hoses and connections by venting oil into a pair of internal tanks.

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Connection

Using workboats and the tanker's crane, Export Operations specialists and ship crews hoist the double-walled loading hoses - equipped with breakaway shutoff devices - to the intake manifolds on deck. About 100 feet (30 m) of each hose is raised out of the water. Full of oil, these sections weigh a combined 24 tons, so great care is taken to secure and inspect the connections. The mooring masters and terminal stay in highly reliable contact via ultra high-frequency radios using a dedicated channel with a backup channel.

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Loading

When all systems to receive oil are checked, the mooring master signals the terminal to start pumping, slowly at first, then gradually increasing the rate when all onboard affirm everything's working right. Workers constantly monitor the hoses and onboard systems (control room pictured) directing the flow into the tanker's 10 to 16 compartments. Finally, each of the compartments is "topped off," requiring precise coordination of terminal pumping rates with the opening and closing of tanker piping and valve systems.



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Future Cargoes

Just as they arrived, loaded tankers depart the berth piloted by an SAC master before captains resume the helm. But as surely as the Middle East sun rises, another tanker for loading will soon appear on the horizon. Training is key. Monthly safety meetings involve everyone from the terminal staff to the workboat contractors. An SAC steamflood pilot project at Wafra may greatly increase production of the field's heavy crude. If this project succeeds as anticipated, Mina Saud's OE culture will matter all the more in the years ahead.



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