

Weathering the Perfect Storm at National Oilwell Varco



The QRM Center is a university-industry partnership dedicated to improving manufacturing competitiveness through research and implementation of lead time reduction principles.

Quick Response Manufacturing Survives and Thrives Amidst Disruptions

by Kathleen Watson

Twenty years ago, a forward-looking president wanted to take oil- and gas-drilling equipment company Varco International to the next level of performance and profitability.

Seeking to glean insights about what other successful companies were doing, he created teams by first selecting a manufacturing representative from each of four major facilities: two from Houston, Texas, and one each from Orange, California, and The Netherlands. He added a corporate representative and sent the pairs in search of new ideas — best practices of top companies that potentially could be adapted to Varco.

Owen Unruh, now a 40-year industry veteran and director of plant operations in Orange for the last 10, was part of one team. Joining APQC, the American Productivity Quality Center, provided access for Unruh and his colleagues to member companies that made, as did Varco, highly customized equipment.

“We were producing engineered-to-order, configured-to-order, build-to-stock and build-to-order products for both land and offshore drilling,” Unruh explains. “We had tried a number of improvement programs — the flavor of the month, you might say. They mostly failed.

Yet we knew we didn’t want to be stuck in a we-do-it-this-way-because-we’ve-always-done-it-this-way mentality.

“We wanted to see a wide range of companies with like challenges and not be constrained by viewing only companies in heavy manufacturing. We wanted to look at a variety of high-mix, low-volume operations.” John Deere, Dell computers, Caterpillar and JLG were among APQC members willing to allow visits and close examination of their operations.

Team visits enlighten, inspire NOV reps

Using a customized master interview document, the teams visited a number of facilities, starting with the office at the front end where order entry began, through the entire manufacturing process, and ending with shipping of the final product. “We were especially interested in inventory turns — how to better use assets — and in on-time delivery, with its implications for customer satisfaction,” Unruh says.

“We gathered a lot of great information and insights,” Unruh says of the visits. He describes a stop at a JLG facility early in the process where huge man-lifts are made for work on high-tension wires. “This



Company Profile

Multinational corporation
Headquarters: Houston, Texas
Approximately 50,000 employees at over 700 facilities in 65+ countries.

NOV-Orange, California,
facility part of NOV Rig
Systems Segment
750-plus people
295,000-square-foot campus
ISO 9001:2008 Certified

NOV-Orange Products & Services

Capital equipment and integrated systems for oil and gas exploration and drilling:
Top drives
Racking systems
Roughnecks/conveyors

Markets Served

Oil and gas equipment,
onshore and offshore

Awards & Recognitions

American Petroleum Institute
Spec Q1 compliant
American Bureau of Shipping
Certificate of Manufacturing
Assessment
TDX-1500 product finalist
for 2014 World Oil Awards

www.nov.com

Cover, upper left: Constructed in 2012–13, this building in Orange, California, is dedicated to production of the TDX top drive. Its cavernous interior bay (right) has an 80-ton crane capacity. Below, corporate management and customers gather at the hundredth TDX-1250 to be shipped from the NOV facility in Orange, recognized as the world’s center for top-drive excellence. This model, introduced in 2008, supports extreme-reach drilling programs with maximal reliability and uptime.

plant had virtually no raw material storage on-site. A truck would pull up every day with point-of-use inventory. In comparison, we had this huge yard of raw-material inventory.”

The comparison opened the door to considering not only how massive amounts of raw material were contributing to overhead costs; it also prompted thoughts about the amount of square footage devoted to storing it — and demonstrated that there was a better way to source materials.

Inspired by this revelation, Unruh’s facility eventually was able to eliminate the yard and inventory, reducing material costs, eliminating storage and handling costs, and gaining space.

John Deere demonstrates QRM in action

A visit to a John Deere facility in Horicon, Wisconsin, provided another eye-opening experience that had a far-reaching effect on manufacturing giant Varco’s operations. Mowers produced there went to golf courses and required special blades for fairways and greens. A spike in business in the early ’90s greatly increased demand and stress in the factory.

Deere had embraced Quick Response Manufacturing methodology in the late 1990s to deal with the influx of orders and as a means to gain a competitive advantage by reducing manufacturing lead time. Because the production cycle is in part governed by availability of outsourced parts, Deere had, in addition to implementing internal QRM practices, taken steps to develop strategic cooperative

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relationships with its supply chain. It convinced blade supplier Fisher Barton, for example, to enter into a unique relationship that enabled Deere to place orders for rapid delivery.

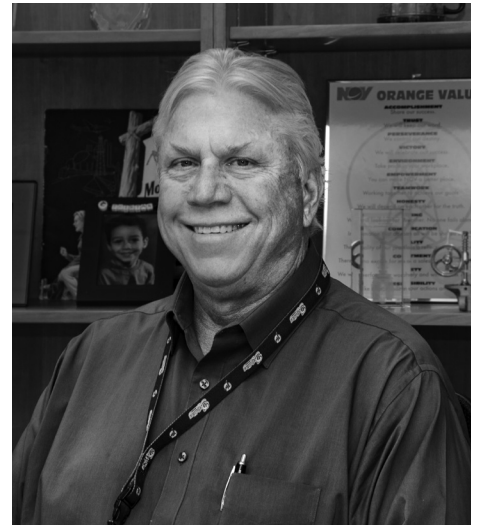
Fisher Barton invested in new equipment and modified its manufacturing steps to meet Deere’s needs and expectations, efforts that paid off in greater production flexibility, lower costs — and a solid, long-term partnership with a valued customer.

Staff members at Unruh’s plant in Orange studied the Deere operation and its supply chain outreach. They also started to study QRM tenets by reading QRM founder Rajan Suri’s seminal book, *Quick Response Manufacturing, A Companywide Approach to Reducing Lead Times*.

As the visiting teams compared results of their observations, they began to define the focus for Varco’s way forward:

- teaming and cellular manufacturing
- employee training
- supply chain management and connectivity

Results also yielded a best-practices roadmap. “We began conducting quarterly audits of all of our operations. The subject plant had the role of host, creating presentations to report what



Owen Unruh, Director of Plant Operations at NOV facility in Orange, California

progress had been made,” Unruh says. Lessons learned were shared throughout the Varco organization.

Companywide QRM training orients workers for launch

Varco brought Suri on-site for targeted staff training. To prepare for their move toward transforming their operations, other workers traveled across the country to attend workshops and seminars conducted by the University of Wisconsin-Madison’s Center for Quick Response Manufacturing.

“We wanted to start our QRM implementation with a product cell, and we picked what we call the IBOP, an internal blowout preventer valve,” Unruh says. “Customers were unhappy with our lead times, costs to produce

the valve were high, and our competitors were penetrating the market.”

“It ended up being a virtual cell because we couldn’t afford to collocate equipment. We simply dedicated certain equipment to cell operations and reorganized the flow on the factory floor,” Unruh recalls of the 2001 effort. In hindsight, he says, “It wasn’t a real cell or a real team. We made minor gains, but improvements were marginal.”

More-thorough preparation, collocation yield better results

As funds became available, the IBOP cell was reconfigured to include all necessary equipment, and a true team was formed by



An internal blowout preventer valve, or IBOP, is an integral part of every top drive. IBOPs, which are produced in NOV’s first QRM cell, weigh from 180–632 pounds, are from 21.25–40 inches long, and have diameters from 8–11 inches.

step back and developed a more-thorough approach before going forward,” Unruh says. A steering committee led the effort.

A steering committee is a key component in a transition to QRM. At Varco, this group spent six

The group also set goals and outlined a detailed course of action that would allow time for acceptance, recognizing that there would be snags along the way. A daily plan review and highlighting successes all factored into the Orange facility’s QRM launch.

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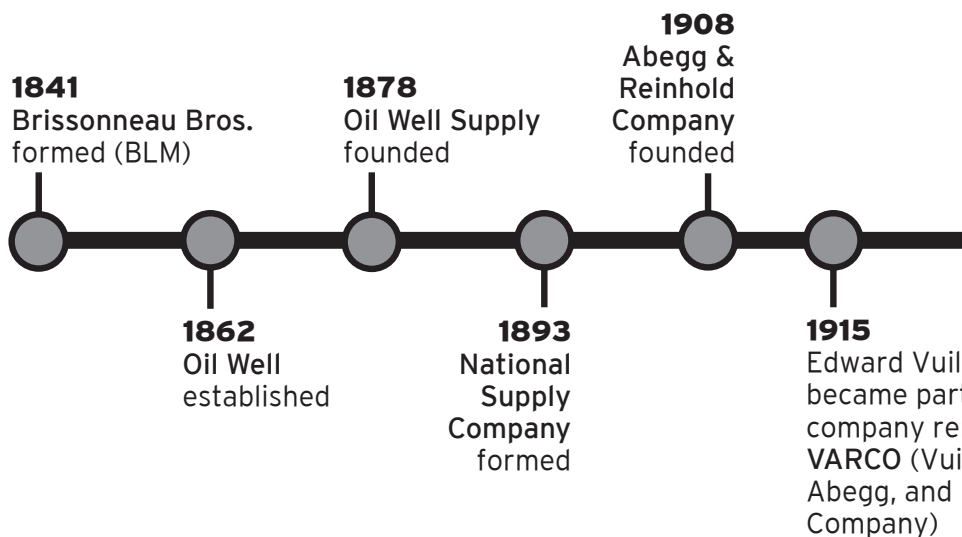
collocating the cell members and cross-training them in direct and indirect skills. (Direct skills represent activities where labor is applied to a job such as welding, machining and/or assembling a product. Indirect skills can include activities such as running and reviewing a report, participating on a problem-solving team, and/or performing 5S — organization and housekeeping tasks.)

This time, the pilot cell was a huge success. Manufacturing time dropped from 75 to just 4 days, costs were reduced by 50%, and the product was 99% defect-free.

In preparation to transform the rest of the factory, “We took a

months statistically analyzing over 160,000 part numbers, identifying demand variability from the previous 12 months and projecting future capacity requirements.

From Unruh’s shop-floor perspective, “We looked at the whole factory and created a plan that would require cultural and organizational changes, more and different kinds of communication, cell performance measurements, finance and accounting adjustments, and three years plus a \$3 million investment to implement.”



From 2001–2007, Varco created over 40 cells at the Orange facility. Although the original plan allowed for a three-year implementation, the 2005 merger of National Oilwell and Varco to become what is now National Oilwell Varco, known as NOV, resulted in the Orange implementation stretching to six years.

Team health top priority

Unruh considers team health vital to the success of QRM — and to NOV. He points to Bruce Tuckman's 1965 Forming, Storming, Norming, Performing model of team development and behavior, where authority, freedom and autonomy of team members increase as the leader's role lessens. The team leader becomes more of a facilitator as cohesion, commitment and unity grow among members.

For starters, a cooperative, collaborative team is vital to the QRM tenet of cross-training; the absence of a team member or an influx of work can require others on the team to fill in and adapt in order to maintain a smooth flow and expected cell output.



Operator machines a TDX-1250 IBOP on a newly installed WFL M80 x 3m Millturn Machine.

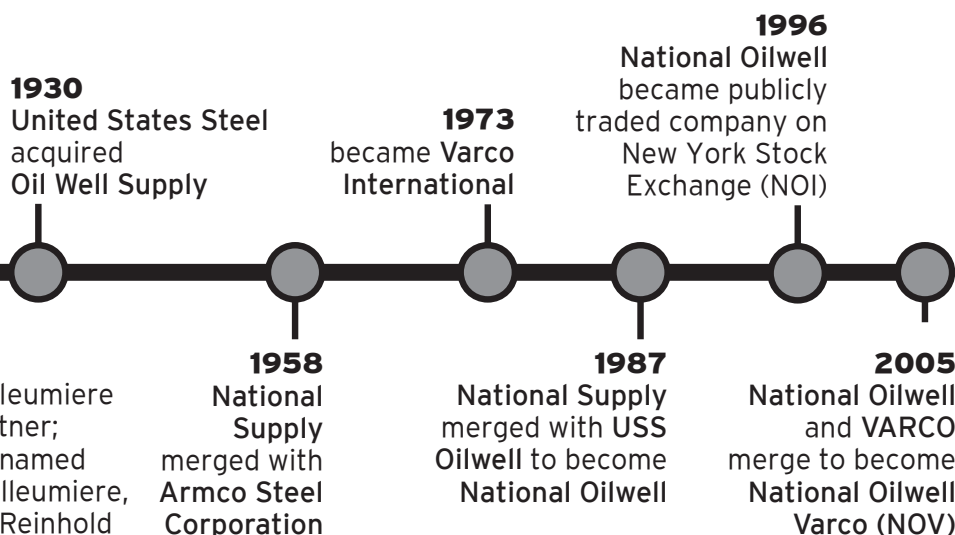
And because modern manufacturing equipment does not always require an operator to be present at the machine after initial setup, cross-training enables this team member to lend a hand elsewhere.

Even the aspect of having an operation viewed through a new set of eyes during cross-training can yield results; repetition can preclude the potential for new ideas, but a new person might bring a fresh perspective, suggesting ways to improve a step or process.

Team members have structured roles at meetings — leader, timekeeper, scribe to take notes — and they are responsible for, or “own,” as Unruh says, all of the cell's processes.

“The QRM concept of cross-training means that team members learn not only hands-on manufacturing skills; they also learn support skills,” he explains. This list shows the multiple functions for which cell members are cross-trained. Responsibility for their oversight and execution is shared by all:

- materials: scheduling, outside processing, inventory management
- quality: writing non-conformance reports and conducting root-cause analysis to prevent recurrence
- manufacturing engineering: creating how-to instructions for product manufacture and process flow within the cell



“We lost some people, but lots of others enjoy it. Potential for team participation now is part of our hiring requirement.” — Owen Unruh

- skills matrices and training: defining requisite skills and training team members
- cellular cost structure: establishing budgets for and tracking salaries, support, supplies, machine depreciation, and space and energy costs

“Teams continue to meet every two weeks to problem-solve and set their agenda and goals, actions necessary for continuous improvement,” Unruh says.

Unruh admits that not every employee bought into the team concept. “We lost some people, but lots of others enjoy it. Potential for team participation now is part of our hiring requirement.”

Lead-time reduction measures extend to supply chain

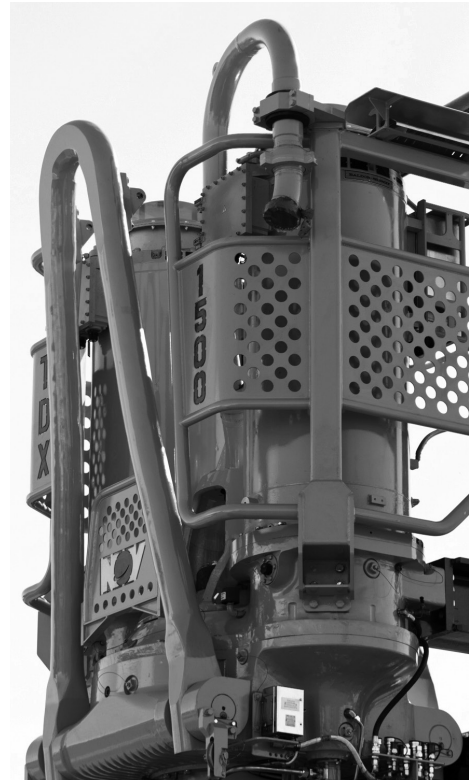
In the early 2000s, as Varco began its evolution into a time-based organization, its suppliers were struggling to keep pace. Despite incremental improvements, wait time for key components was

adding to existing challenges that were hurting market share: long lead times, inconsistent quality, and competitors’ products that sold for close to Varco’s costs to produce.

“We achieved great results internally with QRM, but that’s only part of the picture,” Unruh confirms. “A top-drive product can have 1,872 items on a bill of material. Of those, we produce 35%, and approximately 65% are sourced. We needed to involve more of our supply chain.

“Of 50 or so major suppliers, about half are on board with QRM to date, and most of those tend to be medium-size companies. We’ve been especially successful with our steel (forgings and castings) suppliers; we’re able to pull in inventory only as it’s needed.”

The inventory reduction made possible when a supplier tightens its lead time is only one benefit. With smaller orders, quality issues can be detected and remedied quickly, and parts that arrive just as they are needed help avoid obsolete inventory that results from



At the 2014 World Oil Awards, the NOV TDX-1500 was nominated in the New Horizons Ideas category. Although it didn’t win, it was viewed as a significant achievement.

engineering changes prior to a production run.

Perfect storm wreaks havoc in 2012

By 2011, the NOV facility in Orange, California, had undergone its complete cellular transformation and had successfully navigated several tidal waves in the oil market.

NOV-Orange Results

Here are the effects of NOV in Orange adopting and implementing the QRM philosophy. Since the 1997 inception of QRM:

- Revenue per headcount has tripled
- Average assembly lead times have been reduced by 60%
- QRM cellular cost-reduction efforts have mitigated inflationary forces, helping to sustain a consistent shop rate

Then the perfect storm appeared on the horizon — a gigantic disruption. Unruh faced the most significant combination of challenges in his career: Corporate executive management decided to expand the Orange facility, to combine a product-mix change with a production increase, and to bring multiple NOV locations under one overarching Enterprise Resource Planning system — all at the same time.

This combination of events required redirecting critical time, talent and funds to implementing and managing change. The usual attention, resources and personnel devoted to key production activities — cells and teams — were transitioned to helping accomplish the massive evolution underway.

Manufacturing support functions such as supply chain management, manufacturing engineering, industrial engineering and quality engineering concentrated on ensuring a successful transition. Leadership resources were necessarily diverted to change management. Construction

activities reduced workspace. There was new, highly engineered equipment to install and master, and approximately 400 new employees to assimilate and train. Describing NOV facilities as “in flux” systemwide was a gross understatement.

As the storm worked its way through the Orange operation, the fury wreaked havoc. Analytical tools and reports changed under the new

transformation at hand, cell ownership and decision-making autonomy, concepts at the heart of QRM, faltered. The focus on QRM weakened. “We struggled just to keep QRM going,” Unruh recalls.

Strong teams facilitate rebuilding of cell functions

Although cell ownership had fragmented with the disruption of massive change, NOV’s strong

“The transformation [to the new ERP system] not only reduced the focus on QRM; we no longer had our standard means of analyzing, measuring and reporting results.”
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ERP system, leaving information voids. “The transformation not only reduced the focus on QRM; we no longer had our standard means of analyzing, measuring and reporting results,” Unruh says.

As company leadership and support functions directed their energy and efforts into the overall

emphasis on teaming helped the remnants rebuild. “Teams continued to focus on products and processes. New employees were welcomed, oriented and trained by experienced cell members,” Unruh says.

To counteract the threat of teams losing momentum, Unruh was able to maintain Cell Team of the Month recognition, although he had to revert to metrics less QRM-related than had been originally used to determine the honor. Other adaptations contributed to QRM’s survival:

- To make up for the lack of clear and relatable metrics, reports and analytical tools, the Orange facility hired its own internal business analyst group to create custom reports relevant to the cells. New, bright monitors electronically displayed the latest progress and accomplishments in color



Worker puts together a hose assembly for the TDS-11, NOV-Orange’s “bread-and-butter” product. To date, 2,000 have been shipped and are operating in the field.

and in real time. The improved, enhanced approach was more effective and accurate than the paper reports that used to provide more of a rear-view image than a look ahead.

- To renew the focus on QRM, Center Director Prof. Ananth Krishnamurthy traveled to the Orange facility at different times to present three sessions of the two-day QRM basics training for those in management as well as team leaders and key cell personnel.
- To rebuild cell and team strength and cohesiveness, the engineering support functions that had been routed to other needs eventually were reintegrated into the cells
- To renew cell integrity and formalize team structure and purpose, a Cell Process Team was created. Its mission: *Provide clear direction for*

“If you’re afraid to change, you’re not going to progress.”
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developing skills, motivating the workforce, and continuously improving processes, culture, and people in support of high-performance teams.

- To regain multiskilled cell workers, new charts defined skills needed in that setting, and cross-training gradually restored cell strength and flexibility.

Calm and order follow storm

The storm began subsiding in early 2015. Order has returned, and cells and teams are flourishing. The business analyst group initiated to help support cells continues to work with the corporate IT group that performs QRM analyses companywide to benefit all NOV facilities. Metrics continue to tell

the story and to affirm the role teams, cells and lead-time reduction play in NOV’s success. The rough seas have calmed, and Unruh considers the NOV facility in Orange to be in a better place than before the storm. He acknowledges, “If you’re afraid to change, you’re not going to progress.”

This NOV veteran also admits that he’d hoped he wouldn’t have to deal with such massive change during his tenure. On the other hand, he is grateful to have been able to play a role in helping to right the ship.

The powerful winds of change have eased, the heaving storm surge has passed, and NOV in Orange and QRM are back on an even keel.

Center for Quick Response Manufacturing (QRM)

Established in 1993, the Center for Quick Response Manufacturing at the University of Wisconsin-Madison is a partnership between industry, faculty and students, dedicated to the development and implementation of lead time reduction principles.

For over two decades, the QRM Center has helped more than 200 companies of varying sizes from a wide array of industries reduce lead times in all aspects of their operations to become more competitive in the global marketplace. The Center can point to a respectable track record, with several member companies realizing lead time reductions exceeding 80%, cost reductions of up to 30% and on-time delivery improvements to over 99%.

For more information, check www.qrmcenter.org, join our QRM LinkedIn group or contact us directly at 608-262-4709.



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