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Case Study

Lightning strike sparks a major machine upgrade using Siemens Motion Control Technology, plus lots of Siemens teamwork

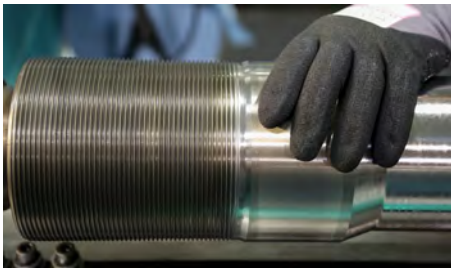
A Siemens plant making reciprocating compressors upgraded the controls of its critical roll-threader machine with the Siemens SIMATIC S7-1500TF CPU and other Siemens technology, improving quality, cost and cycle times.

In 2015, lightning struck outside a Dresser-Rand plant in upstate New York that makes massive reciprocating compressors for the oil and gas industry and other applications. The resulting power surge blew out the plant's circuit protections, causing the control electronics and programming of a critical roll-threader machine to go haywire, with more than 400 error messages. This triggered a host of problems that took ingenuity, teamwork and the latest Siemens motion control technology to resolve.

Challenge: Resuscitate a damaged $1.7 million machine, prone to down-time and orphaned by its manufacturer

Dresser-Rand, acquired by Siemens in the same year as the lightning strike and now a part of Siemens Energy, Inc., is one of the world's leading suppliers of reciprocating compressors. Large piston rods are key parts in each compressor. They range in size from 6–15 feet in length and from 1.5–10 inches in diameter, with the largest ones weighing up to 1,000 pounds. The rods are made from sophisticated and expensive steel alloys, so they can operate reliably under enormous, push-pull stresses at thousands of RPMs for decades.

"The roll-threader machine uses a pair of expensive metal dies costing thousands of dollars each and with several tons of pressure to precisely metal-form threads on the ends of the rods," explains Lukas Lohmann, who heads Manufacturing Engineering. "This provides our next-stage assemblers a way to securely bolt them to the pistons inside the compressors. Downtime or slow-downs in this process can cause assembly delays, rework, overtime and late deliveries to customers."



Lohmann adds that because the machine is a unique application, there aren't many in the world –and even fewer OEMs making them. "That was big part of our problem when the power surge damaged its controls," he says. "The German OEM had sold that part of its business to another company, which then closed it, leaving us figure out how to fix all those error messages on our own. Unfortunately, both the code and documentation were in German, leaving us stranded."

With 800–1,000 rods needing threads a year, the machine's operators continued running it as best they could, using workarounds much of the time. Still, its operational problems slowed the process down and quality issues occasionally caused rods to be scrapped despite having up to $15,000 in labor and materials in them. Other times, the assemblers would have to send the rods back for rework because the threads weren't to specification.

Downtime could range from hours to days, prompting the plant to outsource the threading to an outside machine shop. "This added cost, time, and logistics to our threading process," Lohmann says. "Sometimes the rods could take weeks or longer to get back, so our shipment schedules were being impacted. And, of course, this was affecting our customers and reputation."

Solution: Install an upgraded control system using advanced Siemens motion control technology, including the SIMATIC S7-1500T, and plenty of teamwork

While one option was to commission a qualified OEM to design, engineer, and build a new machine, Dresser-Rand decided to find a solution that would keep the existing machine's mechanicals and electricals intact as much as possible but replace and upgrade the controls.

"A new machine would have cost us more than a million dollars, but because it's such a niche application, few OEMs in the world could build us one, so we'd have the same support problem if the OEM ran into problems like our previous supplier did," Lohmann says.

For help, he turned to Ellen Greathouse, his contact at the Digital Factory division of Siemens Industry, Inc., who put him in touch with Digitronik Labs in Rochester, New York.

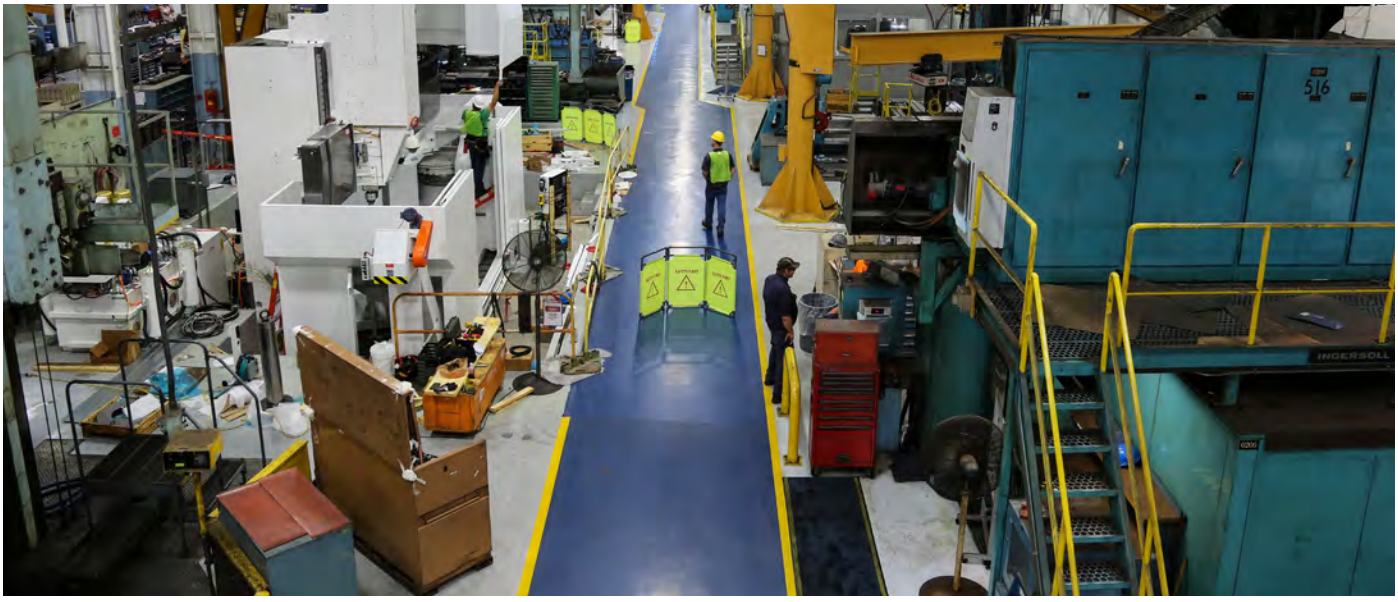
One of Digitronik Labs' specialties is hard-to-solve industrial production problems. According to Shawn Mott, the company founder and senior applications engineer, the roll-threader machine qualified as one.

In fact, the complexity of the machine's issues required an investment of almost 18 months of onsite discovery and planning ahead of solution development. "We had to document every one of the 400 error messages, to determine what each meant, while also testing the machine," Mott says. "There was little documentation to go on, so input from its operators was especially important."

Mott successfully analyzed all of the errors and targeted which of the machine's control elements to keep and which to replace. He also developed the electrical system's installation plans. The result of his investigation and planning was a new controls system consisting of the following Siemens components:

- **SIMATIC S7-1500TF CPU**, an advanced programmable logic controller (PLC) providing both motion and hydraulic control
- **SIMATIC ET200SP**, a compact, high-performance I/O system for connecting the machine's process signals to the S7-1500TF via PROFINET
- **SIMATIC TP1500 Comfort Panel**, a 15-inch TFT widescreen, color HMI display with eight interfaces, including PROFINET and PROFIBUS
- **SIMOTICS M-1PH8 Main Motor**, a compact, low-noise, squirrel-cage motor specifically engineered for use in production machines, such as the roll-threader
- **SINAMICS S120 Drives**, designed for the roll-threader's multi-axis applications

To program all of these devices, Dresser-Rand employed Siemens Totally Integrated Automation (TIA) Portal, a common software engineering framework as well as a source of digital simulation tools and transparent production operations.



Once Digitronik Labs installed the base system, they determined the need for someone to help with the hydraulic controls. Ellen Greathouse connected Mott with Floyd Daoust, who supervises the Siemens Application Center. In turn, he assigned Ken Mongelluzzo to the project because of his expertise with hydraulic systems and the LSimaHyd library for the TIA portal.

Mongelluzzo used the LSimaHyd library for programming the machine's hydraulic axis. For its spindles, he used the LAxisCntrl library for the TIA Portal's motion-control of technology objects governing velocity motion, positioning, absolute relative positioning, relative gearing, absolute gearing, and camming.

Motion-control technology objects contain all the software programming and representation of a machine's mechanical-component configurations and functionality, while simplifying the connections across PLCs, drives, and I/O.

"The technology objects, LAxisCntrl, and the LSimaHyd software really cut the time and effort involved in programming the roll threader's new controls and drives, so they could precisely position the rods for accurate threading," Mongelluzzo says.

"We incorporated all of this intelligence into the S7-1500TF, which now has more than 70 recipes across five sets of dies that operators can use, depending on a piston rod's specs," he adds.

According to Greathouse, the technical difficulty of developing the hydraulic part of the solution was extreme. "Ken did a great job of it," she says, "spending almost a month onsite to implement and commission it."

Lohmann commends the teamwork between Siemens companies as well as the machine's operators – Lee Brooks and Josh Weiler – along with Mott's Digitronik Labs engineers for making the project a success. It was especially critical in implementing the new controls, which were installed in tandem to the old controls, so the latter could be used during production hours despite its issues.

"Because we couldn't take the machine out of production, members of the project team were in the plant on nights and weekends to do the installation, testing, and final commissioning," he says.

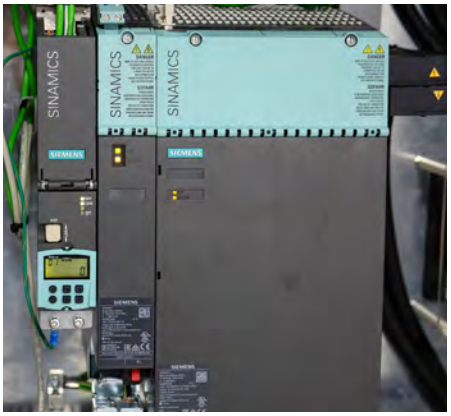
Results: Gained greater threading quality and repeatability, plus faster throughput and simpler operation, while saving the costs of rework, outsourcing, and scrapped rods

Today, with the Siemens controls having fully upgraded the roll-threader machine, the plant no longer has to worry about the accuracy and precision of the threads on the piston rods.

Rework has been cut to virtually zero, along with outsourcing, scrapped rods, and above all, assembly delays due to rod-threading issues. This has improved cycle times and reduced production delays that were undermining customer delivery commitments. "Of course, consistently making our delivery dates is a top priority for us," Lohmann says, "and we can now do so with a lot more confidence than we could when the roll threader wasn't working properly."

These quality and time savings are due to the Siemens control system's responsiveness, commanded by the recipes programmed into the SIMATIC S7-1500TF PLC. It can continually adjust the angle of the machine's dies and the applied hydraulic pressure within milliseconds to ensure good threads on every rod passing through.

"Quality has improved 100 percent overall," says Brooks, one of the machine's two operators. "As soon as we switched over to the new Siemens control system, we ran three rods through the threader, and they went right into production."



He adds that the machine is much simpler to operate, too: "The user interface is much easier and more straightforward. Before, we had six HMI screens we had to juggle to run the machine, and now we have just two – one for operation and one for recipe management. This also helps keep us from making errors."

Lohmann was impressed by the amount of customization that the Digitronik Labs and Siemens engineers were able to put into the Siemens control system upgrade. “Our operators know the roll-threader process extremely well and worked closely with their engineering counterparts to add features to the HMI that would make the machine easier to operate, and that never posed a problem.

”The upgraded controls that Digitronik Labs and Siemens designed, engineered, and installed on the roll-threader machine solved what had become a huge headache for the plant and a dilemma how to resolve it, given that its maker had gone bankrupt, effectively orphaning the machine.

> “We know that with Siemens behind the solution, we not only improved the performance and extended the useful life of a critical production asset, but we also can count on Siemens for support, service, and further upgrades for as long as the roll-threader machine is in service.”
>
> Lucas Lohmann

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Siemens Industry, Inc.
5300 Triangle Parkway
Norcross, GA 30092

For more information, please contact
our Customer Support Center
Phone: 1-800-241-4453
E-mail: info.us@siemens.com

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