Opto 22 Saves Flying J $2 Million Per Year

It was "automate or die" for a Utah oil refinery, but a conventional Distributed Control System was too expensive. So Flying J turned to Opto 22 and personal computers. Result: a superior control solution at a savings of $2 million a year.

Background

Flying J is a near-$1 billion vertically-integrated oil company with everything from service stations and motels to oil fields. Flying J bought its North Salt Lake City refinery in 1986 as part of its expansion.

The Flying J refinery's capacity is 25,000 barrels per day. The refinery takes crude oil, natural gas liquids, and other feedstocks from company fields in Utah, Wyoming, and Colorado and turns them into gasoline, diesel fuel, propane, jet fuel, and specialty wax. Some of the diesel fuel and gasoline is sold through the company's own outlets and the rest is sold on the open market.

Flying J is especially strong at marketing diesel fuel because it is a leader in the truck stop business. The triggering event for automation was the need to install diesel desulfurizing equipment at the refinery to increase the output of diesel fuel.

Problem

In 1992, at the same time it decided to add diesel desulfurizing to its refinery, Flying J decided to upgrade the refinery's existing manual control system. Almost immediately, the company discovered it had a problem. Refinery automation is usually accomplished with a conventional Distributed Control System (DCS) of the sort offered by vendors such as Honeywell and Fisher-Rosemont. However, traditional DCS vendors have "one-size-fits-all" designs. At 25,000 barrels a day, Flying J's refinery was well below the size that these DCS systems were designed to automate. This lack of scalability made the DCS solution economically unreasonable for Flying J.

Though outside the conventional DCS target market, Flying J refinery is not small for a refinery. Of the 700 or so refineries in the world today, about 60 percent of them (420) are comparable in size to Flying J. All of them face the same harsh economic reality.

Not automating the refinery wasn't an option, according to Karl Judkins, a process control engineer at Flying J. "If you're going to compete in the refinery business, it's do it [automate] or go out of business in the next decade."

A traditional DCS is "distributed" only in comparison to highly centralized plants run by a single large computer. DCS solutions are usually built around minicomputers. They are also extremely expensive and proprietary. One large DCS vendor quoted Flying J a price of $8 million for their system.

"There would be no payback on the system with that unit." In other words, the refinery couldn't earn back enough to pay for the cost of the DCS, ever.

The other problem with a DCS was support costs. Most refineries with a DCS have at least one person from the DCS supplier stationed full-time at the refinery. The overhead as well as the initial cost of a conventional system was simply too high.

Clearly a conventional solution would not work for Flying J. The question was, what would? To find out, the company decided to go back to square one to examine its options.

Environment

Oil refining is an extremely competitive business in the United States.

An oil refinery represents a process control project with extremely tight parameters.

It combines both refining and chemical processing. Crude oil is separated into fractions by molecular weight. These fractions are broken apart by heat and catalysts and transformed into other, more useful, products.

For example, the Flying J refinery takes butane (a gas often used for heating and cooking), runs it through a

"butamer" unit to turn it into a chemical variant called iso-butane and then feeds the iso-butane into an alkylation unit. What comes out is a liquid called iso-octane, which is an important additive in gasoline.

Staying competitive in the business comes down to what Judkins calls "the last 10 percent of the barrel." In other words, a refinery's opportunity to profit lies in its ability to get the absolute maximum of high-quality product out of every barrel of crude.

Tight control is also important for getting the most out of each barrel of crude.

"The reaction kinetics are really dynamic," Judkins says. What that means in practical terms is that if the temperature, pressure and other conditions are not very carefully controlled, you don't get the maximum yield of good product.

Efficiency was an important goal in automating the refinery. Flying J wanted better control of its processes. For example, the refinery's ability to make diesel fuel was constrained by the inefficient manual control system.

Or, in the words of Vince Memmot, General Manager of refining and engineering for Flying J, "We have to try to keep up with our neighbors and be a little bit better than they are."

There are also major safety considerations. The only difference between an oil refinery and a large bomb is the control system. Some processes in an oil refinery must be very tightly controlled because of the risks

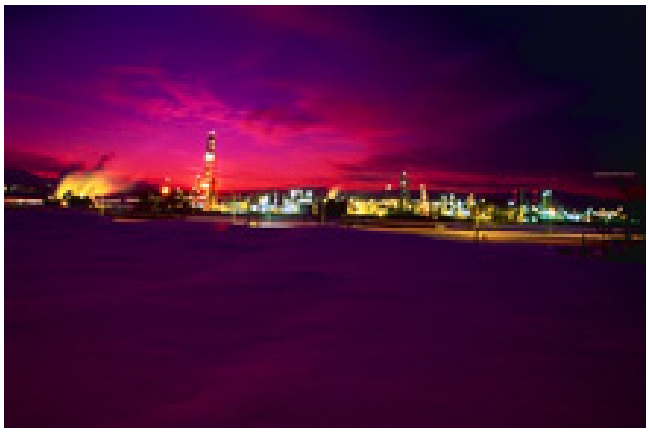
of fire or explosion. High reliability is a life-critical requirement, necessitating an extremely reliable control system.

All this process must be done on a large scale. The process control system at an oil refinery has thousands of I/O points and must be able to deal with literally hundreds of PID loops at one time. Because of the critical nature of the processes, system performance on basic jobs such as PID loops cannot be allowed to degrade as the number of I/O points grows. The Opto 22 control system is designed to take full advantage of its Brain Board-distributed I/O processors. This design allows jobs such as PID loops and flow measurements to be done on the I/O rack. This insulates response time from the size of the system. Alternatively, consultants of Flying J found that PLC-based systems were not constructed to support this type of processing environment and would bog down under Flying J's concurrent PID requirements.

Solution

Flying J instructed its consultants, Ford, Bacon and Davis (FB&D) to go beyond the usual DCS sources in search of a solution. After scouring the market, FB&D came up with one company that could meet the combination of low cost, high capability and high reliability: Opto 22.

"Our consultants didn't take long to come up with Opto 22 as the only good solution for us."
This was not without risk. As far as Flying J knew, no one had ever automated a refinery with PC-based control automation equipment before. The cost savings Flying J needed certainly appeared to be there, but could PC-based equipment handle the demands of a refinery control system?



Even if it could be done, what would it cost to develop such a system? Once the system was developed, could it be supported cost-effectively? Flying J didn't have the answers and neither did FB&D.

"We gave them some criteria we felt had to be met if we were going to roll our own system rather than buy it off the shelf like most refineries," Memmot says. "We needed a certain comfort level and our consultants couldn't answer those questions."

Both Flying J and the consultants felt they had to make sure they had made the right choice before they went ahead. Because Flying J was breaking new ground, the company decided to test the Opto 22 solution extensively. The consultants assembled a team of specialists with extensive experience in refinery operation, process chemistry, advanced control mathematics, computers, communications and systems installation. Next, they set up a prototyping area and tested the system on real hardware in a simulated operation.

At the end of months of testing, the consultants and Flying J were both satisfied. Opto 22 could do the job as well as a conventional DCS and at a much lower cost. Not only could the hardware handle the 3,000 or so I/O points and the speed of operations involved, but Opto 22's software proved to be an excellent choice as well. The engineers found that with Opto 22 software, they could address any type of control problem found in the refinery.

Another advantage of Opto 22's modular design was that the refinery could be automated one piece at a time. The first piece to be automated was the reformer unit, which involved about 200 I/O points. Because of scheduling constraints, it had to be brought on-line without being shut down for the conversion - a "hot switch-over." Further, the transition to the new system was restricted to just control of one control loop at a time.

In preparation for the switch-over, the control equipment was set up and tested beforehand. Every I/O point was simulated from the hardware to the graphics on the MMI screens, assuring that the programming was accurate. Thanks to the self-documenting nature of the Opto 22 programming language, it was easy to check and verify the control software.

With the power of the Opto 22 hardware and the ease of use of Opto 22's programming language, the consultants were able to convert a dozen loops per day with very little process disturbance.

This testing added about 15 percent to the overall cost of the project, but greatly increased the company's confidence in the Opto 22 solution. The final cost of the Opto 22 control system hardware at the Flying J refinery was about 25 percent of what a conventional DCS would have cost and the total cost was about 35 percent of the total cost of a conventional DCS.

Results

Since 1993, the company has been phasing in the Opto 22 control system, one major component at a time. Currently, the company has five Opto 22 controllers running various pieces of equipment in the refinery and another handling the refinery's tank farm. Only two other pieces of the refinery are left to automate, and they will be completed in 1996.

The system makes extensive use of the distributed configurable intelligence of Opto 22's Brain Boards on the I/O racks.

By design, there are usually no more than four PID loops per rack. This makes the control fast and highly distributed and provides safety benefits as well. Since primary control takes place at the rack level, a basic process malfunction is be restricted to a single I/O rack. At present, there are two Opto 22 controllers on the diesel desulfurization unit, two more on the crude handling unit and one on the reformer. The controllers feed back to 486- and Pentium-based personal computers in the refinery control room running MMIs. Because of the open architecture of Opto 22's system,

Flying J was able to use an MMI from Wonderware — another example of the freedom of choice provided by Opto 22's commitment to open systems.

Today, Opto 22's FactoryFloor Total Control Solution suite includes an integrated MMI, OptoDisplay, that can be used as a stand-alone MMI, or in conjunction with all popular third-party solutions, such as Wonderware and Intellution.

Using Opto 22 is saving the Flying J refinery an estimated $2 million per year. The systems had paid for themselves in the first 14 months of operation. In addition to the major cost savings, the Opto 22 system dramatically improved Flying J's process control as well.

"There were improvements we didn't even realize we could achieve."

Judkins says, "For example, there was the furnace on the reformer unit. The temperature on our furnace generally swung 20 or 30 degrees Fahrenheit when we manually controlled it, Now we have less than a five-degree swing and quite often less than one degree." The result is better control and a more consistent product. "When you can keep the temperature steady, it makes a big difference in the reaction kinetics. "We're able to keep the product on spec over 99 percent of the time."

About Opto 22

Opto 22 manufactures and develops hardware and software products for applications in industrial automation, remote monitoring, and enterprise data acquisition. Using standard, commercially available Internet, networking, and computer technologies, Opto 22's SNAP systems allow customers to monitor, control, and acquire data from all of the mechanical, electrical, or electronic assets that are key to their business operations. Opto 22's products and services support automation end users, OEMs, and information technology and operations personnel. Founded in 1974 and with over 85 million Opto 22-connected devices deployed worldwide, the company has an established reputation for quality and reliability. Opto 22 products are sold through a worldwide network of distributors, partners, and system integrators. For more information, contact Opto 22 headquarters at 800-321-OPTO or visit our Web site at www.opto22.com.

Opto 22 • 43044 Business Park Drive • Temecula, CA 92590-3614 • Phone: (951) 695-3000 • (800) 321-OPTO • Fax: (951) 695-3095 • www.opto22.com
Inside Sales: (800) 321-OPTO • Product Support: (800) TEK-OPTO • (951) 695-3080 • Fax: (951) 695-3017 • Email: sales@opto22.com • Form 0814-050926