Raychem Reduces Manufacturing Costs with Graphical Programming

The Challenge: Reduce manufacturing production costs and redefine manufacturing techniques.

The Solution: Using LabVIEW for PLC control, statistical data, and as a man-machine interface (MMI).

When engineers at Raychem Corporation’s Thermofit Division (Menlo Park, CA) were researching options to reduce production costs for the expansion and extrusion processes of their division’s heat-shrink plastic tubing product, they decided to include LabVIEW in their automation toolkit lineup.

By using LabVIEW with a modern, PC-based data acquisition (DAQ) system, Thermofit manufacturing engineers can now conduct large-scale statistical experiments involving thousands of data points (something impossible to do by hand) to optimize the expansion and extrusion manufacturing processes. Combining the results of these experiments with the benefits of ongoing trending and productivity feedback to the operators has contributed significantly to Thermofit’s doubling its output without having to add either additional expensive manufacturing lines or personnel. In addition, manufacturing yields are sharply up and product variability is sharply down as a result of the DAQ systems.

With a modern, PC-based DAQ system, engineers can conduct large statistical experiments and refine manufacturing techniques, leading to doubled productivity and improved quality.

Getting Started

Engineers first tackled the Thermofit expansion process. This is one of several steps used to manufacture heat-shrink tubing, a patented “shrink-to-fit” product used by many automotive and aerospace manufacturers to seal and protect splices and terminations in electrical wiring. Manufacturing engineers wanted a system for data trending and production reporting that could interface either with existing Allen Bradley programmable logic controllers (PLCs) or traditional mixes of analog and RS-232 controllers. Other system requirements included intuitive tools for designing friendly graphical user interfaces (GUIs), easy modification for use in other systems, and expandability to meet the company’s rapidly changing automation needs.

Manufacturing Raychem’s heat-shrink tubing involves the precise monitoring and control of many different variables that affect the production volume and quality of the end product. In expansion, the PLCs perform the actual data collection – monitoring parameters such as pressure, temperature, tubing diameter, production speed, and production footage. In extrusion, these duties are handled by traditional analog instruments and RS-232 controllers.

A New PC-Based DAQ System

Al Keeley, an engineer with Raychem for 21 years and member of the Data Acquisition Team, used LabVIEW to develop a DAQ system with industry-standard PCs and general-purpose instrumentation software. The system refines and analyzes data collected by the PLCs and presents the data in a user-friendly fashion so operators can perform real-time production monitoring. The system also trends data over the long term, so engineers can analyze acquired data, study events that transpired during production, and determine how to modify the process for better yield, leading to reduced costs and higher quality.

Keeley selected LabVIEW because of its programming ease, flexibility, expandability, modularity, and multiplatform portability. Although he decided to design his system using an existing Macintosh, he liked the option LabVIEW gave him of using IBM-compatible PCs on other production lines and sharing programs between them.

With the help of LabVIEW consultant Gary Johnson (Livermore, CA), Keeley had a pilot system up and running in about 40 man hours. The pilot system communicated with the PLC and had capabilities for long-term trending of about 40 channels of data, data storage to disk, various GUIs showing the current status of the production line, and an entire screen of graphs showing the last 200 data points of almost all the data channels.

This project also took advantage of two LabVIEW add-on products – HighwayVIEW™ from the Software Engineering Group, a library of LabVIEW virtual instruments (VIs) for linking...
efficient memory utilization and execution time. With this new circular buffer, all charts have scroll-back capability.

Raychem engineers also wanted their manufacturing specification tied to LabVIEW so that an operator could type in a product name and have LabVIEW search a resident database to present manufacturing specifications for that product. The specifications included:

- Product specifications and suggested machine settings
- Parameter targets and control limits used in the LabVIEW charts and alarms
- Parameters downloaded from LabVIEW to the PLC (recipes to the PLC)
- Typical process setup conditions to display to the operator – a form of online help for the operator for the selected product – based on the last five times the product was run.

In addition, Raychem engineers wanted summaries of technical data to be reported at the end of each run with minute-by-minute logs of all production parameters. Production personnel also requested that the DAQ system report production statistics, such as production and scrap footage. These had to be calculated by shift, run, and manufacturing order – an enormous task if performed manually for an entire plant.

“As a result, we incorporated new VIs into the system for reading Raychem manufacturing specifications and writing both technical and production files,” explains Keeley. “We also wrote some VIs that LabVIEW to Allen Bradley PLCs, along with HIST™, a collection of LabVIEW VIs written by Gary Johnson for long-term multichannel data recording to disk. HIST writes to disk using “circular buffers,” a process through which the oldest data is overwritten by newer data after a certain specified amount of time, much like pens overwriting their earlier traces on a recording drum. This permits “infinite” recording time without filling the disk.

Expanding the DAQ System

Once operators and engineers had used the program for a few weeks, they wanted it to do more. Keeley contracted LabVIEW consultant Martin Vasey (San Francisco, CA) to develop the necessary additional LabVIEW VIs.

One important new feature Vasey added was the capability for scrolling the graphs shown in the charts screen back in time to look at the last 6,000 data points, rather than just 200. Now, engineers and operators can review data collected during the last two-and-a-half shifts rather than just 40 minutes. To adeptly juggle the large data sets required for creating this new feature, Vasey implemented a RAM-based, multichannel, circular buffer for LabVIEW panel; at a glance, they can observe most key operating parameters over the last few minutes. They can also scroll these graphs back in time using the Data Time Slider to look at the last 6,000 data points collected over the past two-and-a-half shifts.

Operators frequently use this LabVIEW panel; at a glance, they can observe most key operating parameters over the last few minutes. They can also scroll these graphs back in time using the Data Time Slider to look at the last 6,000 data points collected over the past two-and-a-half shifts.

To check his productivity during a run, the operator uses this screen, which gives all pertinent, up-to-date production information by run, manufacturing order, and shift.
would display to the operator how the run was going at any time during that shift.”

Early Success Leads to More Installations
Based on early success, the DAQ team then conducted an extensive evaluation of LabVIEW and two other, more traditional industrial DAQ packages. They selected LabVIEW based on the same criteria that Keeley had used for the first system: programming ease, flexibility, expandability, modularity, and multi-platform portability.

After the decision to use LabVIEW, Keeley installed the system on six of the heat-shrink tubing expansion lines. He plans to put it on two more lines by the end of 1995. LabVIEW is currently running on a mix of Macintosh computers and PCs.

At the same time, Roger Temple, another manufacturing engineer at Thermofit, had Vasey design a LabVIEW program for the tubing extrusion lines. To date, Temple has equipped four extrusion lines with LabVIEW. Rather than PLCs, all systems use a National Instruments SCXI system for analog signal conditioning and incorporate serial instrument multiplexers for serial instrument signal conditioning. In the extrusion area, LabVIEW is running on PCs only.

Raychem had its first LabVIEW and PLC-based pilot system for monitoring and controlling its heat-shrink tubing production line up and running after only 40 man hours of development time.

The extrusion system used a number of VIs from the expansion system, but employed a different main trending screen that is better suited to the extrusion process. When operators of the expansion system saw this new trending screen, they asked to incorporate it into the expansion system.

Connecting LabVIEW to a File Server
When manufacturing specifications became available on a file server, Vasey created VIs that would read specification files directly from the server. This eliminated the requirement that the engineer change local LabVIEW recipes each time there was a change in the server-based manufacturing specifications. Vasey also wrote VIs that placed both detailed and summary files of production and process data on the server rather than on the local disk.

At this time, three of the programs for the expanders exchange information with the file server. All are slated to do so in the near future.

The News Spreads to Other Divisions
News of Thermofit’s success has spread quickly to other groups and divisions at the company. The Chemex Division has production systems operating and is currently evaluating LabVIEW for other programs. This division also takes advantage of the multiplatform capabilities of LabVIEW - by borrowing LabVIEW VIs written for the Thermofit Division, such as special GUIs and instrument drivers, they have saved valuable development time.

For more information, readers can contact Alan Keeley at akeeley@raychem.com
Add a few more temperature channels to your system without the expense of expanding your DCS. Run lab trials of a new process or build a monitoring system for a pilot plant. Add PC-based monitoring to your PLC-controlled machinery.

PC-Based Hardware and Software
Whatever your application, PC-based hardware and software products from National Instruments give you flexible, cost-effective solutions, ranging from simple data collection, to SCADA, to direct control. A National Instruments plug-in DAQ board and SCXI signal conditioning front end form a modular system for interfacing more than 3,000 I/O points to your PC. Our LabVIEW® and LabWindows/CVI software products give you the tools you need to acquire data, build MMIs, perform SPC, connect to SQL databases, and interface to your client/server network.

Cost-Effective Solutions for Your Application
Whether you’re starting up a new system or expanding the monitoring capability in an existing plant, National Instruments has a cost-effective PC-based DAQ solution for you. Contact us for a free copy of DAQ Designer™, a software tool that helps you select components for your PC-based DAQ system.

Endless Applications.
Discover the Possibilities of PC-Based Data Acquisition in Your Plant

For your FREE DAQ Designer software and catalog call (800) 433-3488 (U.S. and Canada)

Photos on this page courtesy of E. I. DuPont Company, Lubrizol Corporation, RayChem, The University of Texas at Austin Chemical Engineering Department, The Coca-Cola Company, and British Petroleum Research.