LabVIEW™ Real-Time

NI-DAQ™

NI-Switch

PXI-1000B

PXI-8156B

PXI-7030/6030E

PXI-6025E

PXI-2565

SCB100

SCB68

LabVIEW™ Real-Time Provides Quality Compliance for Steel Mills

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The Challenge: Replacing the control electronics for an isotope, non-contact gauge, which measures the thickness of metal in a steel mill, with an effective solution in a minimal amount of time. The system must provide accuracy, deterministic control, flexibility, and an intuitive graphical user interface (GUI).

The Solution: Using a PXI-based measurement and control system with LabVIEW Real-Time graphical programming to streamline the development of complicated systems for the factory floor.

PXI Provides Deterministic Control

Steel mills typically operate at up to 2,000 feet per minute and require a non-contact thickness gauge to measure and document compliance with quality standards. In a strip mill, a gauge emits radiation on one side of the metal. The amount of radiation that is absorbed by the metal is proportional to its composition and thickness. The resulting radiation sensed on the detector, which is opposite the emitter, yields a voltage that is used to accurately calculate the thickness.

The heart of the gauging system is the radiation measurement and the subsequent control algorithms. The control loop depends on the radiation voltage, encoder value, look-up table, and many other parameters that are set by an operator or remote computer. The control loop must perform all calculations, make notifications of out-of-tolerance conditions, and provide an analog representation of the thickness within five milliseconds. The system must also perform these functions in the event that the PC crashes. This is the foundation for ensuring quality production.

Blue Sky Industries and SES Technology Integration (SES) developed the Peak 2000 System, a robust, cost-effective solution for modernizing older thickness gauges. Because the new system is an upgrade to existing equipment, the radiation source and detector remained intact. The control electronics were replaced with a PXI solution that includes the PXI-7030/6030E real-time data acquisition hardware.

LabVIEW Real-Time and PXI hardware seamlessly integrate both real-time deterministic control with non-deterministic control and monitoring. With this architecture, we can meet our control loop rate requirements on a robust and reliable platform. By downloading our critical control loop program to the PXI-7030/6030E real-time data acquisition module, we ensure that the system continues to operate in the event the PC crashes. Choosing LabVIEW as the software platform, gave us rapid development, efficient processing, and the ability to integrate all components of the system.

PXI and LabVIEW Provide Flexibility and Cost Savings

One critical issue for upgrading older systems is the need for flexibility. With the PXI solution, we developed a core platform that we could customize for each installation. Most systems require a number of control lines for alerting operators about the gauge health and quality status of the metal. PXI uses a compact, robust architecture that minimizes the complexity of wiring. The net result is that a system modernization based on NI tools can save the customer at least 50 percent of the typical cost.

	Base System	High-End System
Typical Cost of Existing Solution	$80,000	$175,000
Cost for LabVIEW/PXI Solution	$35,000	$60,000

Table 1. Cost Savings Estimates for a LabVIEW/PXI Based Modernization of an Americium Thickness Gauge

LabVIEW Real-Time was our ideal software solution. Even though the control software runs on the real-time hardware, many simultaneous processes must run on the host PC. The system accepts operator input, receives process parameters from a remote computer, logs data, computes statistics, changes setpoints and scaling on the control loop, performs calibrations, sets alarms, and generates reports. Only a compiled programming language can provide the required performance.

To accomplish all of these tasks, SES implemented multiple, queued state machines. A primary state machine handled the operator input and controlled the secondary state machine that managed the measurements and data logging. Both of these could then place alarm conditions on the third state machine. Several other tasks, such as monitoring the 232 ports for setup parameters from another PC, had to run concurrently. LabVIEW Real-Time handled the multiple processes in an elegant software design.

LabVIEW Simplifies Development

The two primary considerations during development were to maintain performance while writing code that we could easily modify. As such, SES established a goal of minimizing the use of global variables. At completion, the code included only one boolean global variable that is written to and read from once. To accomplish this, SES used the capabilities of VI Server. In the primary state machine there are many subVIs, which have front panels that open for operator input. These subVIs, which were implemented with a state machine, must communicate with the calling VI. The cleanest solution was to exit the state machine while leaving the front panel open and reenter at a specified state. VI Server ensured that the front panel always closed at the appropriate time.

Because the system is operated on the plant floor with no keyboard or mouse, a touch screen monitor was required. By using LabVIEW, we rapidly developed an intuitive GUI. A sensible use of decorations and colors help direct the operator. All navigation buttons are yellow, digital displays are white, and digital controls are blue. Operators set values with pop-up keyboards and keypads. We also used color to alert the operator to which control is currently being modified by the pop-up keypad.

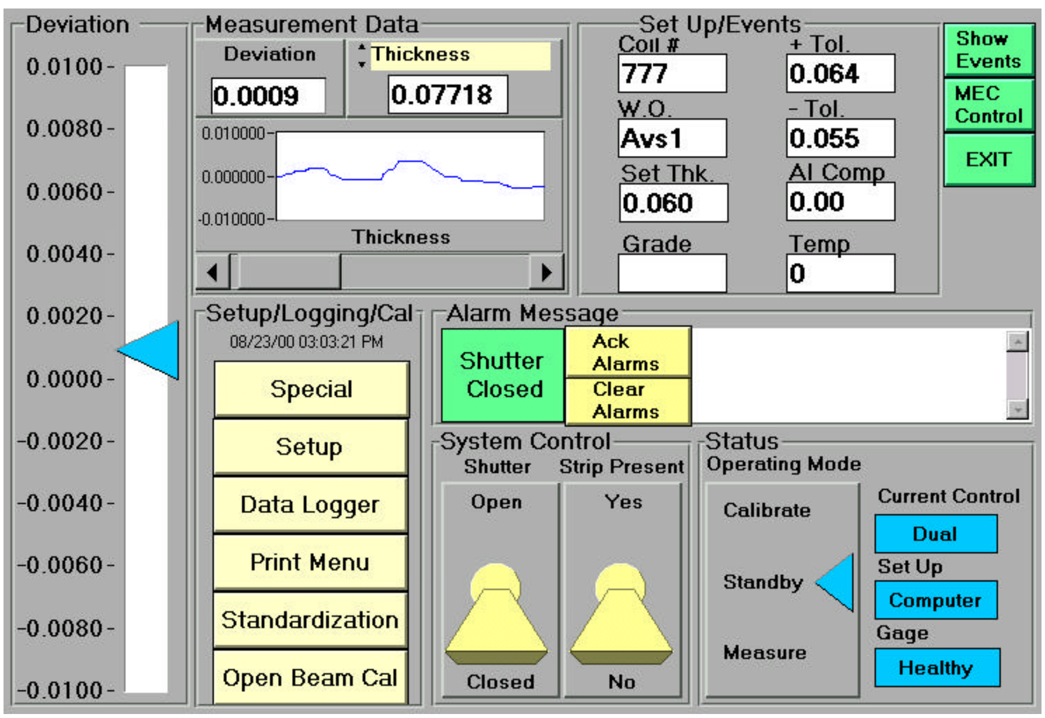

Figure 1. Colors and decorations facilitate system operation.

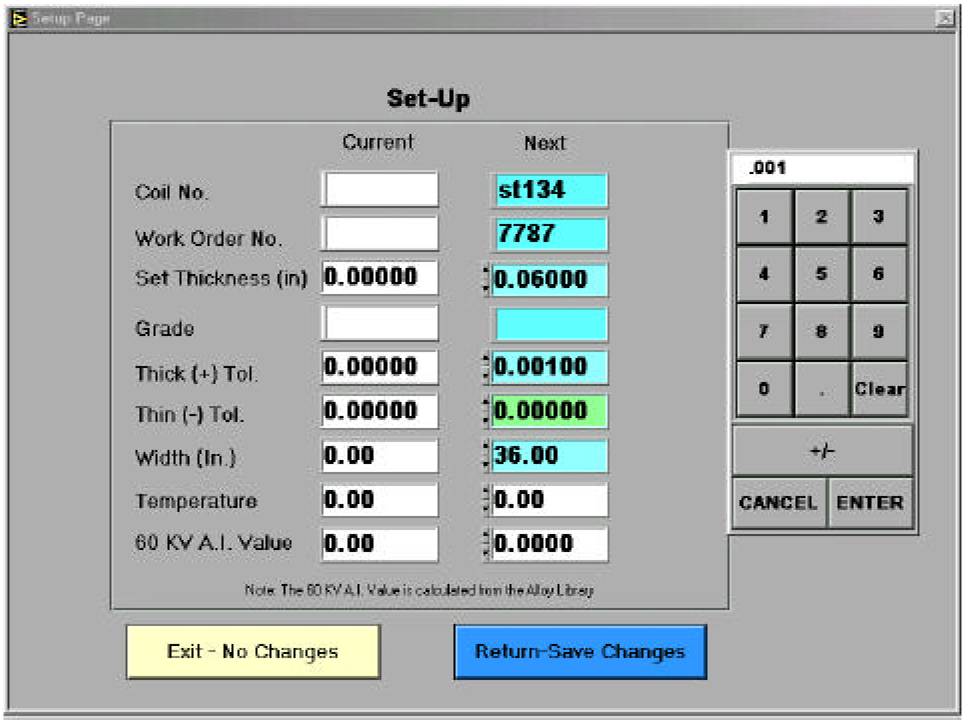

Figure 2. Operators always know which parameter they are changing.

National Instruments provides several tools that assisted in the development of this steel mill quality-compliance system. First, the Profile Window in LabVIEW helped identify areas where the real-time control software had to be modified. Even though the Profile Window must run on the engine, and running in this mode is slower, it created a list of relative times that aided in identifying the trouble spots.

NI also developed Shared Memory VIs for passing data back and forth from the host to the real-time engine. These are efficient and easy to use. (The wise developer puts in a lot of thought at the beginning of the program to map out exactly how he will use these registers). NI also includes the ability to use shared memory for passing error clusters from the real-time engine to the host. Using these VIs is essential for testing and ensuring performance.

NI conveniently included light emitting diodes (LEDs) on the front of the PXI-7030/6030E hardware. By manipulating these LEDs, the operator could confirm operation of the real-time board to understand which mode, measurement, or calibration, is currently running.

Conclusion

National Instruments was an ideal partner for this application. By using NI software and hardware tools, we developed a system that exceeds performance requirements and reduces modernization costs by at least 50 percent, and because the tools came from a single vendor, the integration required only ten weeks of effort.