Signal.X TECHNOLOGIES LLC

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CASE STUDY

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Title:
High-Volume Automated Production Test with NI CompactRIO

Author:

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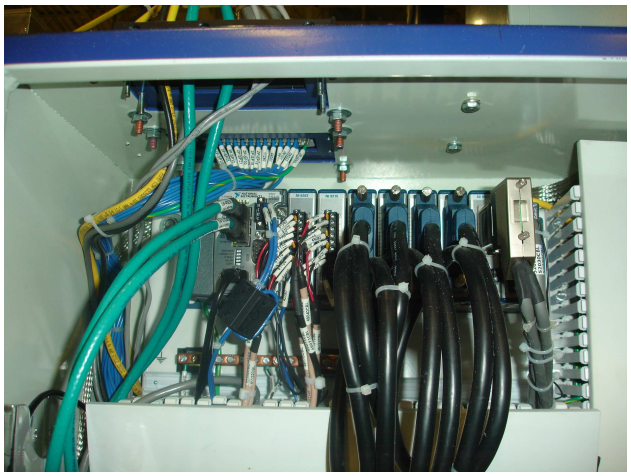
Industry:

Automotive, Automated Test

Products:

National Instruments LabVIEW, CompactRIO



The Challenge:

Create a custom end-of-line functional and performance test system for a powertrain component.
Two independent test cells are responsible for all systems, including part handling, motion control, data acquisition and analysis, and communications to a PLC.

The Solution:

Use the power of CompactRIO to generate a fully autonomous automated test system capable of testing 1000 parts per day, generating 2GB of data running 24/7 in a plant environment.

Overview:

A Tier I supplier of valvetrain components needed a reliable system for executing functional and performance tests at the end-of-line to verify proper assembly and machining of a complex powertrain component. Reliability and maximum total throughput was a key metric in designing the system to support production volume requirements. Signal.X supplied a compactRIO based system that uses the power of the CompactRIO

Figure 1: CompactRIO System

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as a Programmable Automation Controller (PAC) to execute many functions that in the past would have required several different controllers or PLC's.

Two independent CRIO's each run a test station inside a single test cell. A Windows PC is used for configuration and viewing of the data from each CRIO, but is not required for test operation. As data is acquired, data files are transferred from the CRIO to the PC, then from the PC to a server that runs the Signal.X DataManager software for final storage, archival and database operations.

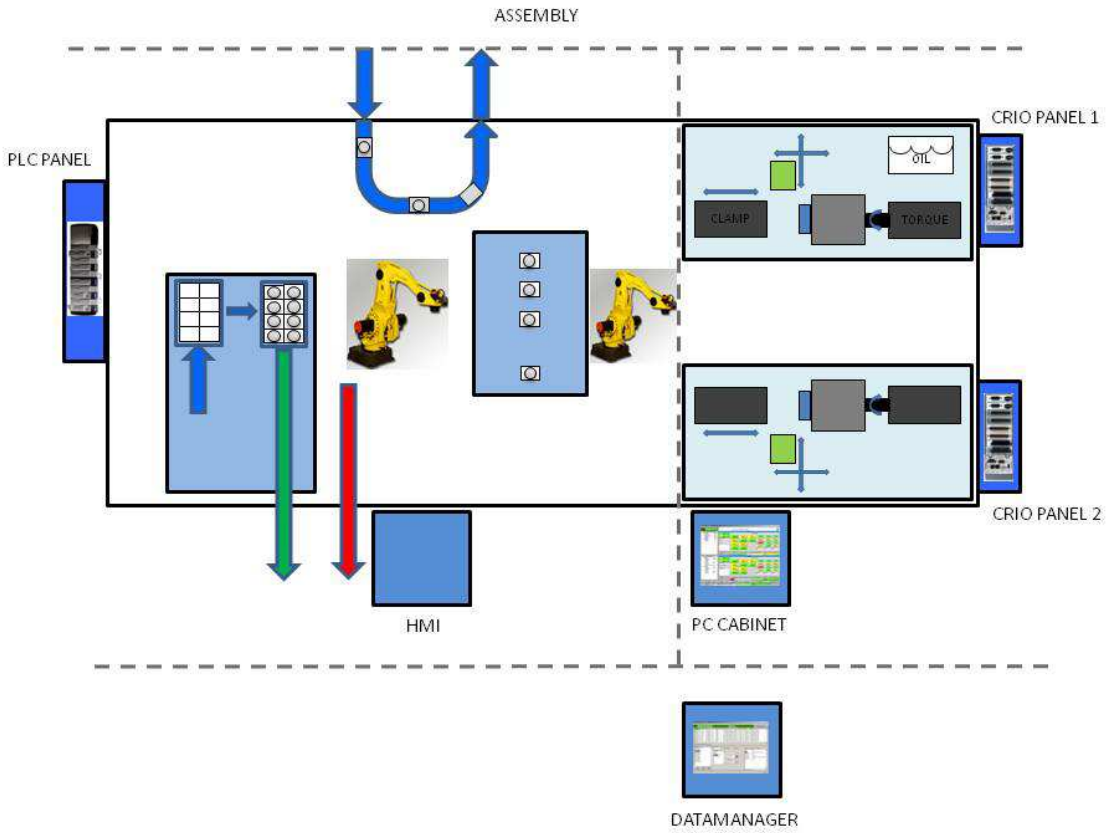

Figure 2: Test cell layout

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Motion Control:

Signal.X developed a multi-axis, multi-rate motion control subsystem to manage four axes of control with configurable PID parameters, limits and interlocks. Based on the SofttMotion toolkit, it uses a real-time update rate of 8 milliseconds with spline interpolation on the FPGA of the CompactRIO between 125 microseconds and 8 milliseconds depending on the axis.

Data Acquisition and Processing:

Although the test cycle is short (~25 seconds), there are approximately 30 to 40 metrics calculated on that data, which translates to ensuring that data is available for processing immediately as it is collected. Signal.X implemented processing that used concurrent file reading and writing to maximize efficiency while keeping data available as the test is being conducted.

The implications of this decision mean that processing of the data happens in parallel to the actual test, allowing the customer to configure the system to abort the test early if a metric fails, increasing overall throughput and minimizing wasted time on testing failed parts. A custom limit definition editor was created to setup this processing definition, including filtering, triggering, and revision control for traceability.

Part Handling:

In order to create a configurable automation controller, Signal.X developed a unique methodology for emulating a ladder logic routine for discrete tasks in manual and automatic mode, as well as fault and error handling in the test station. A simple editor allowing for modification of the part handling tasks allows users to edit sequences that include slide motions, PLC part transfer, interlocks and safeties.

Communications:

Signal.X used the Ethernet/IP toolkit from NI labs in order to communicate directly with the AllenBradley PLC. The STM protocol was used to communicate to the CRIO from the PC for live data streaming and commands. These two items allowed Signal.X to simplify the communications and provide a simple and reliable method of connecting to those external devices.

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Data Management:

The volume of data that is being collected on each CompactRIO presented a development challenge and required planning to ensure reliability and long-term stability. Approximately 12 channels of data are stored for 25 seconds for each test, resulting in approximately 1.5 MB TDMS data files. At full production rate, each CRIO produces approximately 2 GB of data per day. Due to the volume, Signal.X uses an external hard drive for storing the data. Data is automatically uploaded to the PC when connected, but a local buffer is stored on the CRIO's drive in case the PC or network is down. Similarly, data is automatically transferred from the PC to the DataManager when the server is connected. The PC maintains its own buffer of data for quick access and storage if the server is disconnected.

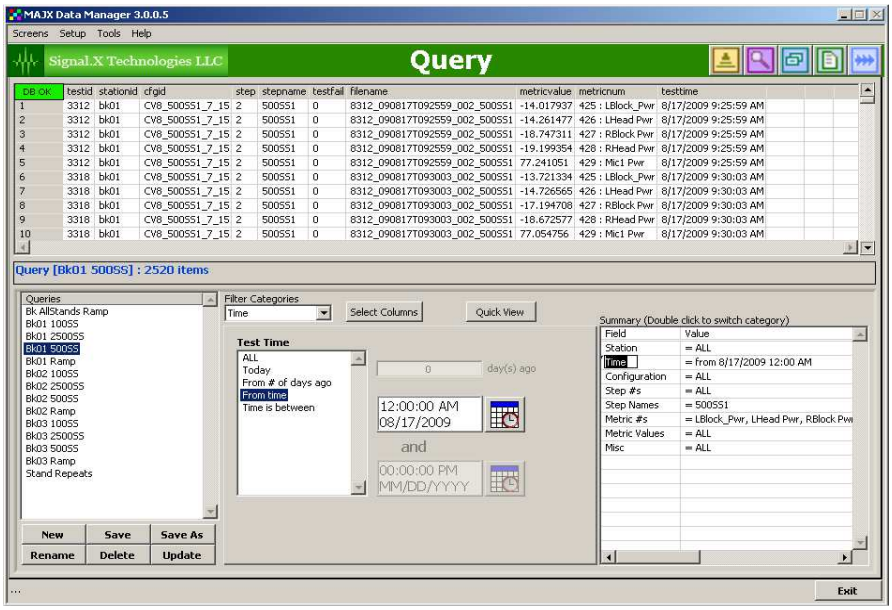

Figure 3: Signal.X DataManager sample screen

Signal.X DataManager:

This project used an off-the-shelf product from Signal.X for storing, querying, reporting and archiving data from the test stands. Based on a SQL database, the DataManager server scans all configured stations on a predetermined schedule, retrieves and archives data files and inserts the results of each test in the database. Users can query the database to return a subset of the production data, create reports to be auto-generated

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and alarmed for trending purposes. In addition, engineers can run historical data on the server against new limits for evaluating new metrics and "what –if" scenarios.

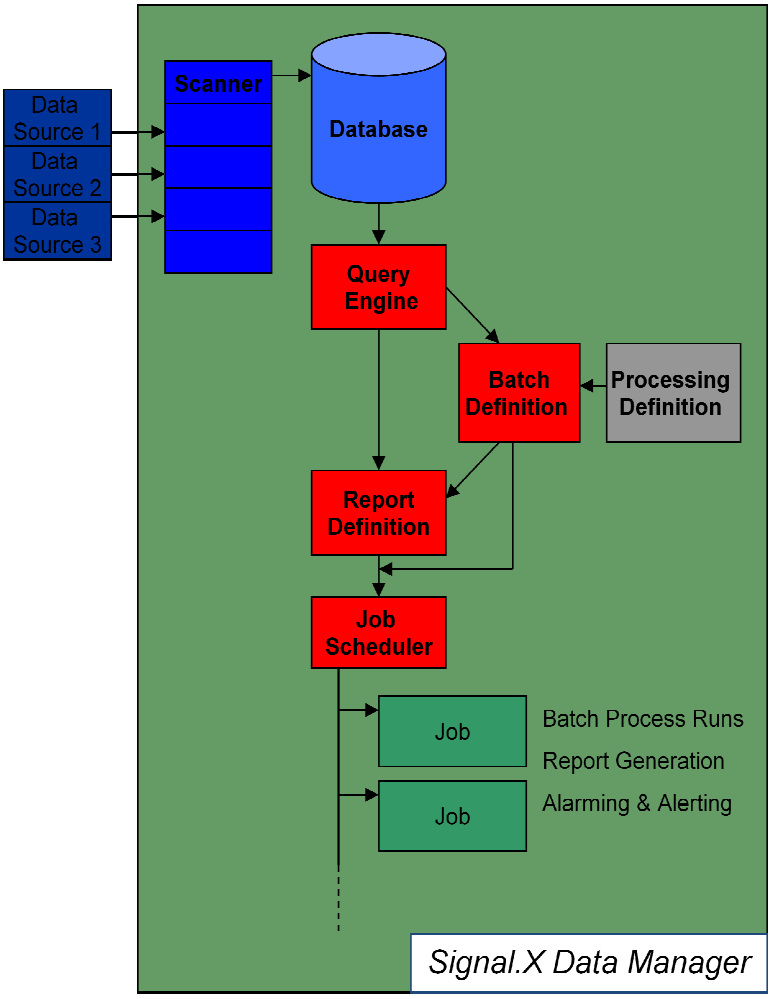

Figure 4: DataManager software operation

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The Complete Package:

When all of this is combined, the CRIO forms a complete automated test system controller that is reliable, quick and reconfigurable. Quick cycle time and efficient use of the data has maximized overall production throughput that ultimately saves the custom process. By adding a complete data management solution, Signal.X has also improved the storing, querying, reporting and archiving of data from the test stands.

The Benefits of an NI Solution:

In the past, customers would have been required to separate the functionality of all of these processes into individual controllers and PLC's, increasing complexity and cost. By using the CompactRIO, all of those functions can be brought into one hardware component, managed by a single process. The flexibility of programming in LabVIEW means that the customer has the ability to adjust any of those processes from one set of source code or configuration screen.

Figure 5: Main station panel

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The Bottom Line:
Several key technologies used in this project have resulted in clear and tangible process improvements and efficiencies for this customer.

- Removing the Windows PC from the critical path of production has resulted in less downtime and greater reliability from a Real-Time Operating System embedded in the CompactRIO.
- Parallel processing of data during the test enabled the test system to make pass/fail decisions quicker, rejecting parts as soon as they fail rather than completing an entire test. With an auto-retest functionality, this improvement has resulted in an average of 5% overall higher throughput.
- Bringing all of the data into the DataManager with automated reporting, batch processing and data archival has eliminated key sources of frustration in the plant by giving engineers and managers up to date information on the production process and automating tasks that used to be done manually.

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