The Challenge
A multinational manufacturer of seamless steel pipe needed help enhancing their basic LabVIEW data acquisition application. In order to be of maximum benefit the application needed to interface to the steel mills Manufacturing Execution System (MES). Detailed wall thickness data from their ultrasonic test system needed to acquire 2048 data points over each inch of pipe over the entire forty five foot length, and be available in a convenient form to all personnel throughout the plant in real-time.

The Solution
Data Science Automation (DSA) was chosen to implement the requirements of this integrated system. Roundtable discussions were held that included production engineers, instrumentation engineers, quality control (QC) engineers, plant operations personnel and information systems (IS) personnel. As a result of the insight gained in these meetings, four areas of application enhancement were identified:

- Integrate access to the plant MES system to prevent redundant transcription of information available elsewhere.
- Modify the data acquisition task to acquire the data using a rotary encoder as an external clock source.
- Place summary statistical information in a database for multi-client access.
- Prototype a three-dimensional visualization of each pipe’s wall thickness data.

The Details
A simple process was written that exposed only the information required by the QC operators of the ultrasonic test system. The information identified the queue of test articles (and their associated characteristics) that had been pulled from the production line and routed to the ultrasonic test station. Each time the test system loaded a test article, the operator was presented with the Task Tally window. The Task Tally was designed to allow the operator to handle the typical exceptions to the standard operating procedures such as modifying queue orders, overriding pipe information read from the MES, or changes necessary to avoid product or instrumentation damage.

The ultrasonic testing process consisted of placing the pipe to be tested in the test fixture, rotating the pipe about its longitudinal axis, and moving the sensor end-to-end.
end in a line along the outer surface of the pipe while the pipe rotated. This resulted in a helical path of the sensor relative to the pipe surface. In order to know the axial and circumferential position of the sensor, rotary and linear encoders were used.

A complicating factor was the fact that the rotary encoder was not directly coupled to the rotational drive. It was rather connected to a three inch diameter wheel that was held against the outer surface of the rotating pipe at a fixed axial location along the pipe. This resulted in the rotary encoder pulses being associated with the outer circumference of the pipe. But due to pipe non-uniformities, only the nominal circumference of the pipe was known.

In order to determine the actual number of rotary counts per rotation of a particular pipe, the cyclic repetition of the non-uniformity was used by monitoring the ultrasonic sensor signal over several rotations while holding sensor at a fixed axial location. The nominal circumference of the pipe was used to ensemble average the rotations based upon the cyclic repetition of the non-uniform shape of the signal.

The waveform data for each pipe was summarized in a database. The database allowed multi-client access to the trends of wall thickness statistics for the last thirty pipes tested. The LabVIEW executable that was developed to query the database and display the trends could be run on many computers concurrently throughout the steel mill.

Finally, a 3-D visualization of the helical data was prototyped with actual production data. Both circumferential and axial non-uniformities are easily seen with this software visualization technique.

The Benefits
By using some of the advanced enterprise connectivity tools and an in-depth understanding of the client’s processes and systems, DSA developed a plant wide integrated application using LabVIEW that conveniently and immediately exposed critical quality data and trends to the production engineers and plant operations personnel. Easy access to this information allowed them to make adjustments to the steel mill manufacturing process. This information allowed significant improvements in the quality and uniformity of the seamless steel pipe across a broad range of diameters covering the client’s entire product line.