Flat Glass Optical Distortion Analyzer

By Data Science Automation, Inc.
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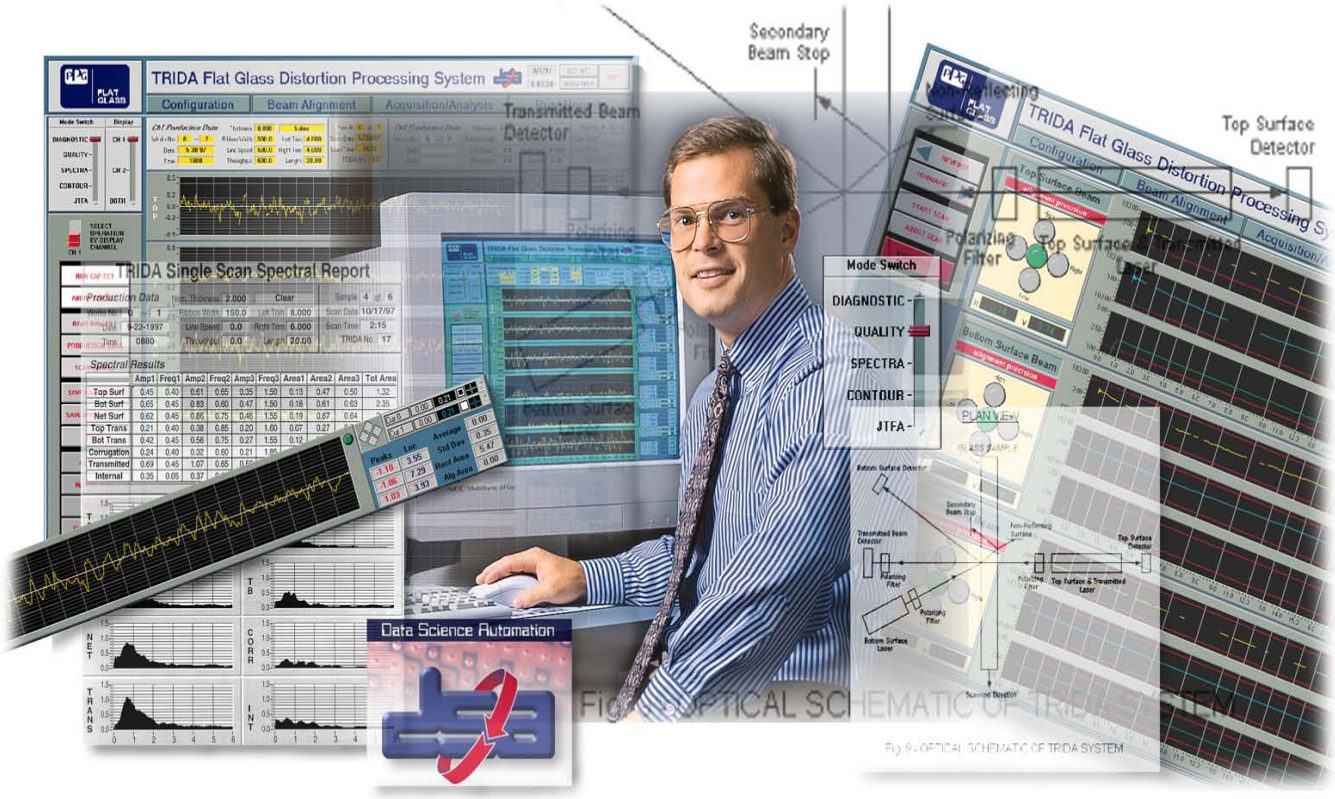
The Challenge: Replace an obsolete, labor-intensive quality control inspection system for flat glass distortion analysis with an automated system which performs the motion control, data acquisition and analysis tasks with greater accuracy, repeatability, and efficiency.

The Solution: Data Science Automation uses National Instruments LabVIEW, PXI, SCXI, Database Connectivity Toolkit, and the Signal Processing Toolkit to create a custom application that combines flexibility and ease-of-use with reliable motion control, data acquisition, high speed accurate analysis, comprehensive reporting, trending, and archiving capabilities.



Introduction

Flat glass is manufactured worldwide and used in products as diverse as automotive windshields, furniture and architectural glazing. Optical quality requirements are critical for safety and aesthetics alike.

In glass manufacturing, two aspects of the analysis of the distortion in flat glass are important. Expedient and accurate measurements are required for routine determinations of conformance to quality specifications. And, in the event that excessive optical distortion is found, it is essential to ascertain the most likely causes of the distortion in the manufacturing process.

A multi-laser scanning system with obsolete electronics, inaccurate measures, and manual data processing was used to detect, characterize and correct surface and internal inhomogeneities in the glass. Although these objectives were being met using the obsolete manual system, numerous hardware problems and labor-intensive operational requirements resulted in the loss of efficiency and reliability of the system. With increasing quality standards, reduced staff at manufacturing and research facilities, and the need to correct quality problems with urgency, Data Science Automation was contracted to overhaul the system and put more diagnostic capabilities in the glass manufacturing facilities.

Data Science Automation, Inc. (DSA) replaced an existing manual analysis system with a LabVIEW-based system that exploits state-of-the-art computer-based instrumentation techniques for improved performance, greater reliability, and reduced maintenance. DSA's flat glass distortion processing system offers expedient and accurate data acquisition, extensive data analysis and process correlations, flexible trending, full database archiving capability, and comprehensive reporting features combined with an intuitive user interface.

System Configuration

The new distortion analysis system developed by DSA includes National Instruments LabVIEW, DAQ, PXI, and SCXI, as well as various third-party manufacturer's components for interlocks, motion, and laser position detection.

Using the graphical user interfaces, operators can easily configure the production data, printing parameters, and data acquisition settings; align the detector beams; acquire the distortion data; edit and analyze the acquired waveforms; archive selected raw and processed data sets; trend the archived data; and produce diagnostic, quality, spectral, and summary reports, and learn from the comparison of samples produced with similar or different process parameters.

Upon startup, the application titlebar (Figure 1) offers several option buttons that are used to navigate the primary application features appears. Flexible configuration screen allows users to modify many of the default data collection and process variable display and printing parameters.

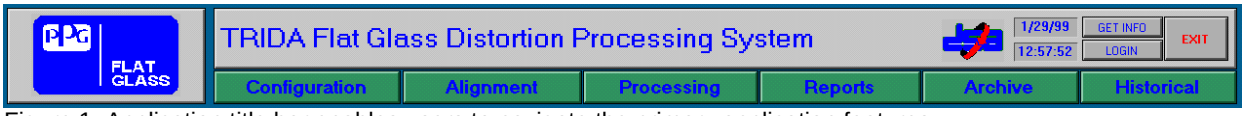


Figure 1: Application title bar enables users to navigate the primary application features.

Alignment of the laser beams in the center of the position-sensitive photodiode detectors is an important procedure that should be performed regularly to ensure the accurate and reliable distortion results. The Beam Alignment option enables users to perform this task quickly and easily. For example, beam position palettes (Figure 2) indicate each laser beam's position relative to the center of the corresponding photodetector. If the beam is centered on the detector, within some radius of tolerance, the center LED will show green, while if the beam is outside the radius of tolerance, red LED's will indicate the direction to which the beam is deviated, enabling operators to take corrective actions in the right direction.

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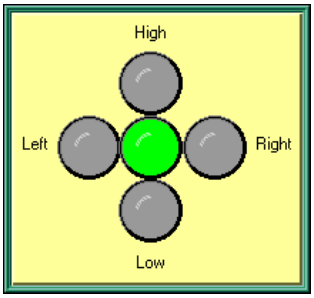

Figure 2: Beam position palette indicates the position of the detector beam and guides users in centering it.

Acquisition/Analysis user interface (Figure 3) manages the data acquisition, editing, analysis and file storage tasks. Users can view one set (or channel) of distortion data at a time or two channels superimposed for comparison purposes. Distortion analysis can be performed on the data acquired from a current run or on a set of saved data. Displayed data can be edited automatically to remove noise spikes from the waveform or manually to remove any other anomalies.

With only a few I/O points for top surface reflection, bottom surface reflection and transmitted laser signals, this application generates and analyzes a significant amount of data for thoroughly characterizing glass distortion quality. Available analysis techniques include diagnostic, quality, contour, spectral and JTFA. Together these provide long wavelength and other visual distortion characteristics that simulate the human eye's response, and time domain and frequency domain information for accurate correlation to manufacturing processes for continuous improvement.

The complicated and time consuming manual calculations, correlations and reporting requirements kept these capabilities isolated in the hands of skilled researchers with limited time to provide remote support to the manufacturing facilities. The automated analysis and reporting available in the LabVIEW system, with expanded capabilities, provided immediate, on-site diagnostic capabilities to the plants.

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Figure 3: Acquisition/Analysis user interface.

Utilizing the Database Connectivity Toolkit, the flat glass distortion processing system software enables users to archive selected group of raw and processed data into a Microsoft Access database. Once the data are stored in the database, users can easily access them using Access's built-in query functions or the historical trending option of the analysis software. Flexible and comprehensive trending user interface allows users to compare distortion data from different plants and study the fluctuations in various production variables over time for better quality control and assurance. A versatile print manager interface lets users produce thirty pages of publication quality reports for any data set.

Conclusions

This solution offers a robust and state-of-the-art data acquisition and sophisticated analysis system. Also the versatile database application and reporting option provide the ability to store and review the analysis results fast and easily. Finally, the intuitive and aesthetically pleasing user interfaces bring these factors together and provides users with a comprehensive optical distortion analysis tool that is easy to use, robust, extremely flexible as well as requires little maintenance and permits easy accommodations of any future improvements. The system was demonstrated in the research environment and proved sufficiently stable and valuable to be installed in multiple primary glass manufacturing facilities.

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