

# **On-line Geometry Measurements for Complex Profile Extrusions**

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## **The Problem**

Historically, the measurement systems of choice for complex profile extrusion lines have been non-contact optical width gages. Traditionally, these operate on the principle of measuring the shadow cast by the extrusion when presented under a sweeping point of laser light. The duration of the light blockage (shadow) is precisely timed. The duration of this blockage can then be converted into a width. The precision of such systems is largely influenced by the dynamics of the rotating mirror.

In the ideal scenario, measurements are performed at both ends of an extrusion and curing line. They are performed at the cured end of the line for final product dimensional validation and set-point feedback. They are performed at the hot end of the line to provide more tightly coupled closed-loop process control, with the set-point established by the measurements at the cured end of the line.

The challenge is that many seals have critical features that cannot be recognized with a shadow measurement principle. Multiple compound products, products with inserts and post extrusion processes such as flocking are also problematic for shadow measurement.

Generally, for these types of extrusions, the process feedback is limited to a human operator that manually gauges the final cured product with an optical comparator or digital micrometer. In many cases this is done with off-line gauging instruments.

What is needed to overcome these issues is an on-line profile gauge capable of measuring multiple key dimensions at the hot and cold ends of the extrusion line. Such a system will provide the following opportunities for value enhancement:

1. Recognize and respond to dimensional variation in key geometrical features not recognizable with other on-line measurement technologies.
2. Enable automatic process feedback control, especially on multiple extrusion line processes.
3. Enable faster startups, and thereby reducing scrap and increasing yield.
4. Provide continuous quality data records to meet internal and external quality program requirements.
5. Improve the overall dimensional quality of all extrusions by not only reducing non-conforming products, but making good products better.

## **The Customer**

Poppe+Co of Giessen, Germany has long been an innovator in advanced control and processing techniques for rubber and plastic. As a manufacturer of automotive and industrial rubber products for 90 years, Poppe has maintained a competitive advantage by “innovation and continuous development of quality in all business processes.”

In 1997, Chris Wooge, Technical Director for Poppe+Co, recognized potential value in the profile measurement technology that Bytewise Measurement Systems was providing to the tire industry. Bytewise was offering a line of laser-based non-contact geometry measurement systems to the tire industry that provided value through cost reduction, throughput enhancement, and quality improvements.

Wooge inquired to Bytewise about the applicability of the Bytewise technology to the on-line real-time measurements of extruded complex profile geometry. At the time of the initial discussion, the Bytewise family of products was built upon single-point laser triangulation sensors. Specifically, the extrusion measurement products were designed for the off-line thickness measurement of extruded tire components, which are relatively flat on the bottom side and have a contour on the top side.

Complex profiles, by contrast, generally are multi-sided contours that cannot be characterized meaningfully by a simple thickness profile measurement. Wooge recognized the need for an on-line measurement system that captured the true cross-sectional profile to incorporate into a truly innovative process control system under development at Poppe. The new process control system utilizes neural network processing and has been proven to work with multiple measurement system inputs and multiple control system outputs. The key missing link in the neural net based control system has been the real-time on-line profile monitoring measurement system.

In November of 2001 the first Profile360™ production system was installed at a Poppe manufacturing plant in Giessen, Germany.

## **The Solution**

The Bytewise Profile360 system utilizes either 2 or 4 sheet-of-light triangulation profile sensors. The sensors each take a snapshot simultaneously. The profiles are transformed into a common co-ordinate system and sent to a “measurement server” software component that performs a best-fit match to a reference measurement or CAD template and calculates values for “virtual calipers” which have been defined.

Virtual calipers allow for key dimensions of the profile to be extracted. Target and tolerance values are associated with each key dimension. Numerical outputs are available from the virtual calipers as analog signals, RS232 data records, or PLC network interfaces.

The measurement server results are made available for distributed operator interfaces. Multiple operator interfaces can be running on Win32 platforms showing the current measurement results. This allows the operators at both ends of the process line to see the current measurements. Supervisory and engineering personnel located throughout the facility with network access to the measurement server can also see the measurements.

The operator interface software presents the cross-section template (either CAD or reference measurement data), the measured profile, and virtual calipers. Additionally, a powerful “on-line comparator” view can be enabled which shows the deviation from the current measure and the template in a powerful, intuitive form. A vector from each measurement point to the nearest template point is established. This vector is then drawn with a magnification factor that allows it to be visualized on a higher scale than the raw data. The error vector is color coded with green, yellow, and red to indicate tolerance conformance. Different tolerances can be established for each segment of the template.

## Summary

Bytewise Profile360 technology has demonstrated the ability to capture key dimensional features that cannot be obtained by traditional techniques, in an on-line and real time application. Poppe+Co is implementing new quality programs designed to reduce cost, improve dimensional accuracy, and better serve their customers. This project demonstrated the successful outcomes that can emerge from two companies looking outside their respective industries for solutions to problems and for products to develop.

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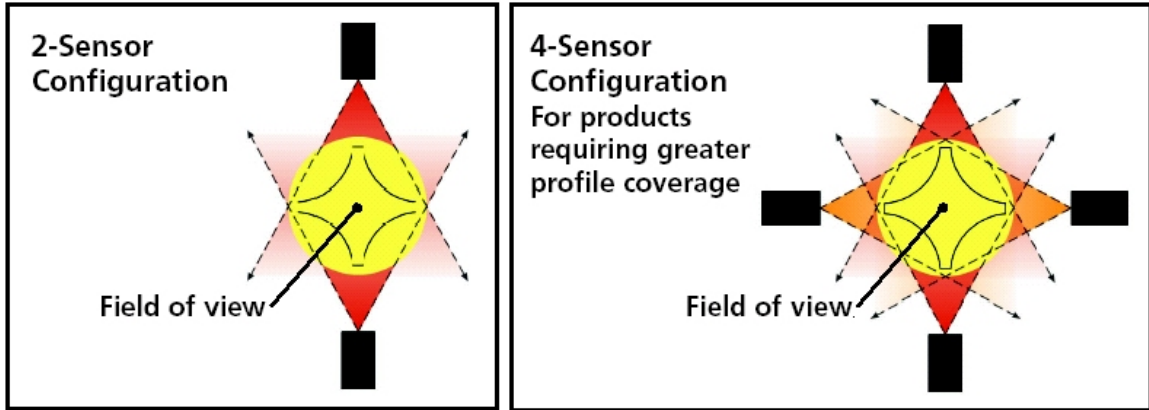


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Figure 2. Profile 360 Pilot Installation

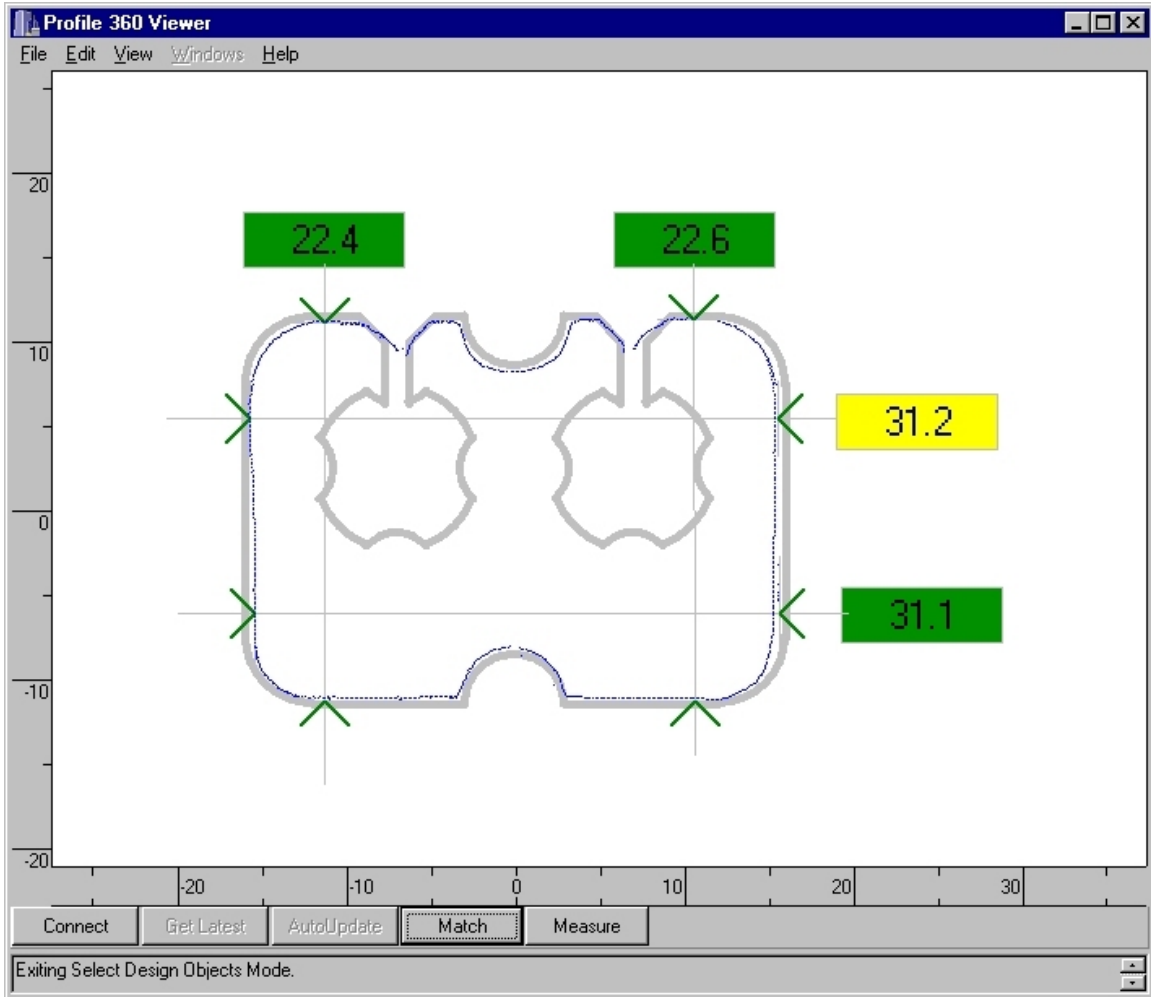


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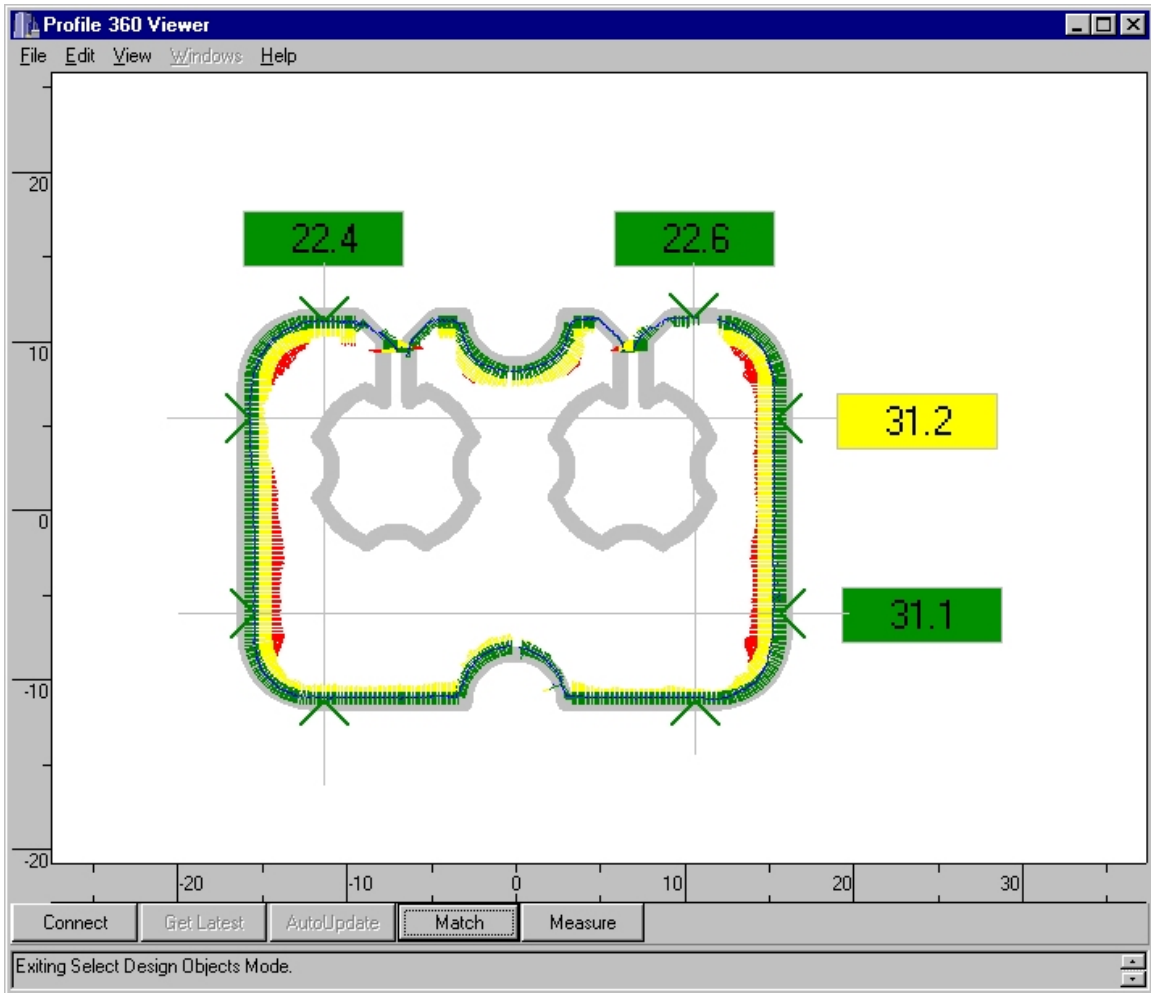


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