



# INTRO TO METROLOGY SYSTEMS

Including Optical Comparators, CMMS, Non-Contact Measuring Systems, and Multisensor Measuring Machines

This article examines the differences between four different types of metrology systems and the advantages of each. It also seeks to prove how multisensor metrology can improve production efficiency in any industry.

## TRADITIONAL TOOLS

Traditional handheld metrology tools have been used in manufacturing for decades, allowing quality assurance teams to measure and test parts with high accuracy and precision. These tools rely on a variety of techniques, such as hand-gauging the size and shape of objects. But while traditional methods may work well for certain applications, they do not provide the accuracy and precision obtained with modern digital sensors.

Traditional metrology tools are limited in their ability to quantify dimensional characteristics of objects as they move through the production line. This can lead to delays and inaccuracy in the measurement process and ultimately reduce the efficiency and productivity in manufacturing. To solve this problem, many manufacturers have turned to sensor-based metrology.

Modern metrology systems generally fit into four categories as described in this report:



# 1 OPTICAL COMPARATORS

Also known as profile projectors, optical comparators were first patented in 1929 for screw thread inspection. The machine projects light onto the part being measured and the resulting silhouette is magnified onto a large upright glass viewing screen. The silhouette can then be measured in various ways, such as with superimposed graduations on the screen that act as rulers. The user can move the part stage and read the distances the stage moved relative to a zeroed point.

Traditional comparators rely on human eyesight for measurement. But recent advancements have added digital capabilities and advanced analysis software that can detect edges and measurements automatically. These improvements have even given rise to digital comparators, which completely replace the glass viewing screen with high resolution monitors.

Optical comparators are still popular due to the simplicity of their operation and ability to be used for quick walk-up measurements in rugged shop floor environments. However, comparators only measure in 2D, and in the context of modern manufacturing, as parts grow smaller and more complex with tighter tolerances, the manual technology of visual comparators can present throughput and accuracy limitations.

A skilled operator can still gather a lot of information from a comparator, but when compared to faster, more accurate metrology systems with the capacity to analyze multiple parts with full CAD programming support, the former becomes almost entirely obsolete.



OGP® QL-20™  
Contour Projector®



OGP c-vision™ Video  
Contour Projector –  
combines the speed  
and accuracy of  
video measurement  
with the rugged  
capacity of an optical  
comparator.

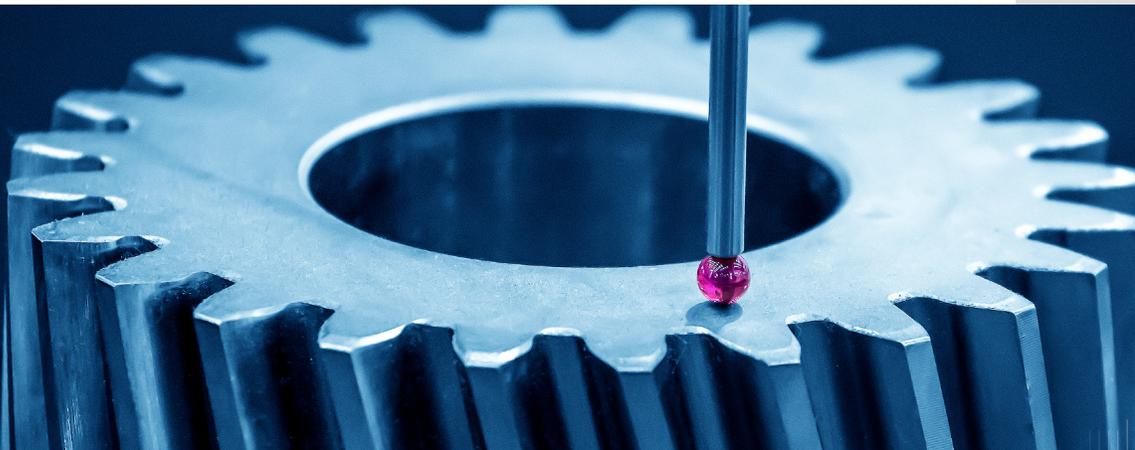
# 2 COORDINATE MEASURING MACHINES (CMMS)

Coordinate Measurement Machines became popular in the early 1970's with the introduction of electromechanical touch trigger probes. Known for accurate measurements in 3D, these machines position probes along the XYZ axes to measure particularly complex parts with hard-to-reach features. Modern CMMs can be equipped with additional laser and video sensors so that tricky features such as blind holes and easily deformable materials can be measured accurately without contact.

The benefits of CMM systems are plentiful, as they have distinct productivity and accuracy advantages compared to using traditional metrology methods. Rarely causing problems on the shop floor, a good rigid, sturdy, and reliable CMM can last for many years.

CMMs range in size from portable to huge stationary platforms, often built with bridge designs that allow a wide range of movement.

**The most effective use of a CMM within a manufacturing environment is placed as an in-line metrology solution, measuring parts as they are created to check against tolerances and specifications.**



# 3 NON-CONTACT MEASUREMENT SYSTEMS

Non-contact measurements can typically be made using lasers or optical measuring machines as follows:

## OPTICAL MEASURING MACHINES (OMM)

Optical measuring machines (OMM) – including video measurement systems and white light sensor systems – typically employ high-quality optics to measure parts. Paired with sophisticated lighting, large fields-of-view, and technologies such as distortion-free telecentric lenses, these machines are exceptionally equipped for measuring parts. They are also ideal for analyzing parts that are fragile and easily deformed, or for selections of parts that have differing geometries.

Video measurement systems use a video metrology camera in a large field of view to capture single snapshot images. White light sensors typically harness specially designed lenses to differentially refract white light depending on wavelengths. Distance measurements can be made by sensors that capture this light, allowing depth and thickness readings to be taken from translucent materials, as well as surface measurements.



OGP® SNAP™ Large Field-of-View Video Measurement System

## 3D LASER SCANNERS

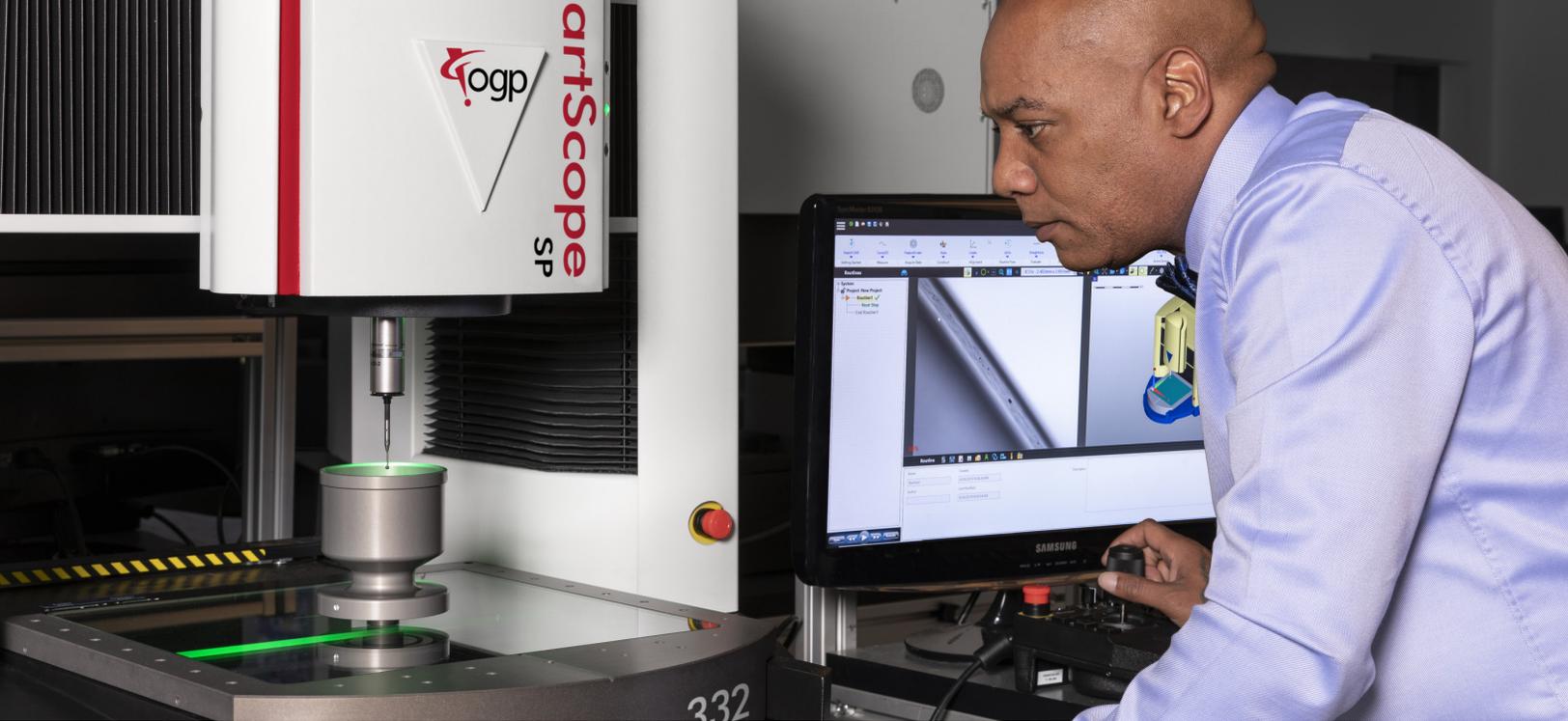
3D Laser scanners are able to obtain detailed surface characterizations of parts. They do this quickly and accurately without software alignment or registration. Scanners such as OGP ShapeGrabber® systems obtain their readings with great ease of use and are ideal for molded plastics, castings, and machined parts. This fidelity is applicable across a range of materials, colors, and finishes.

With the right configuration, a ShapeGrabber machine can gather over 1.5 million data points per second. After an initial scan, the same scanning parameters may be used for subsequent parts, delivering consistent results regardless of operator skill or experience. For the right workflow, applied metrology in the form of a scanner is a fast and easy process that delivers a wealth of important data and quality assurance.



ShapeGrabber Ai320 Automated 3D Laser Scanning System

Non-contact measurement machines lead to a rapid processing rate that makes them desirable for their repeatability and throughput. For businesses manufacturing small, fragile, or observationally challenging parts, non-contact measurement may yield better results than even a multisensor CMM, depending upon the machine.

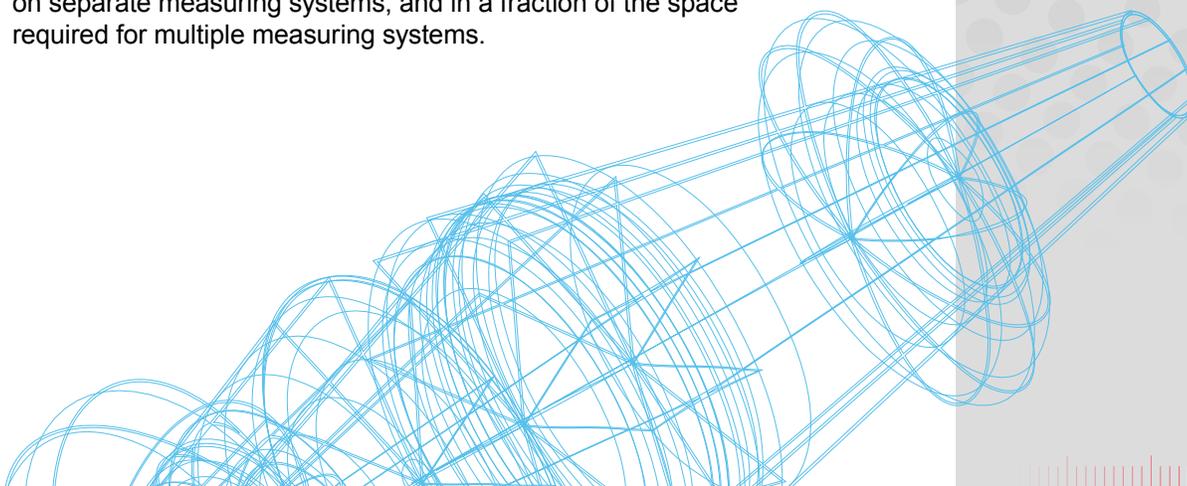


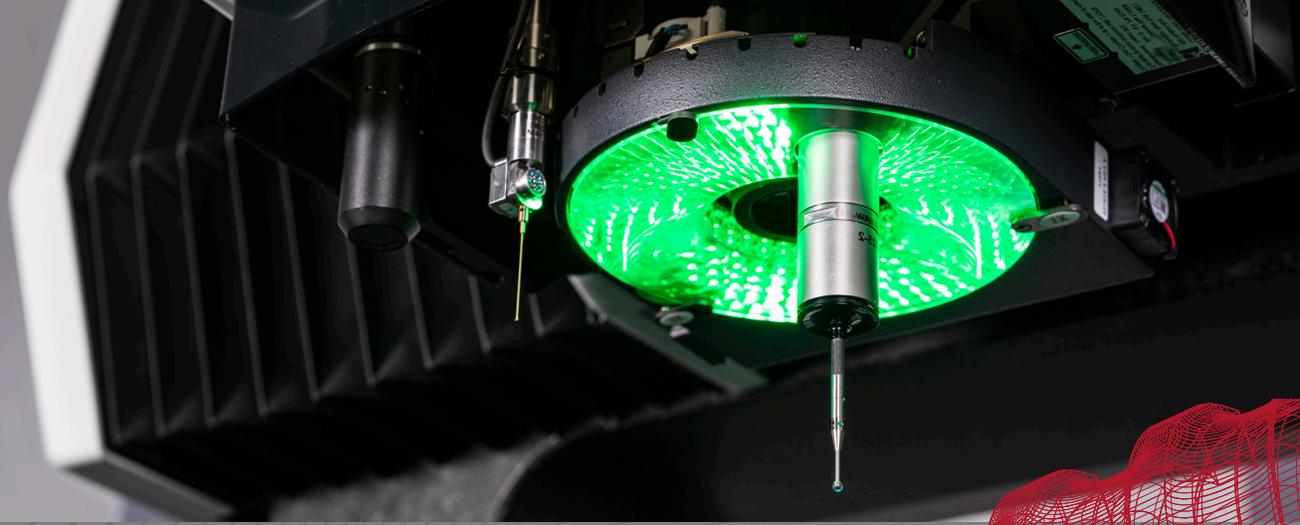
# 4 MULTISENSOR MEASURING MACHINES

Multisensor metrology systems provide the advantages of complete 3D measurement data from a single measuring machine. They combine fast video measurement optics, contact probes (touch-trigger and scanning), laser, and micro-probes, along with advanced lighting and motion control, for total part characterization. Grid projectors are also available to enhance video images of parts with little to no contrast. Finally, dual axis-rotaries, comprised of two rotaries mounted together, provide full five-axis capabilities for multisensor systems.

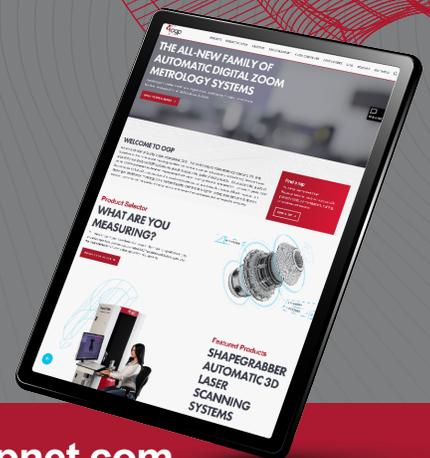
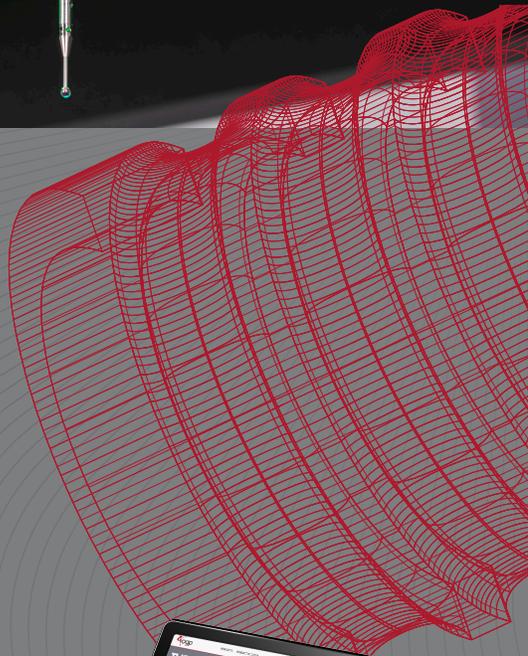
Because multisensor systems combine multiple measurement types into a single solution, they are able to provide highly accurate measurement results in a fraction of the time it would take to do on separate measuring systems, and in a fraction of the space required for multiple measuring systems.

OGP Quest™ 650  
Multisensor Measuring  
System





Metrology tools have come a long way since the early inventions of manual handheld tools and optical comparators. Advancements in both coordinate measuring machine technology and non-contact measurement – including video measurement and 3D laser scanning – have paved the way for multisensor machines to become mainstream. As a result, manufacturers worldwide are now benefiting from improved production efficiencies, product specification accuracy, and overall greater consumer satisfaction.



Learn more about OGP Measurement Systems at [ogpnet.com](http://ogpnet.com)

OGP (Optical Gaging Products) is a division of Quality Vision International Inc (QVI®), a world leading manufacturer of precision multisensor metrology systems for industrial Quality Control. Our metrology systems focus on measurement technologies that help manufacturers monitor dimensional compliance to design specifications. First introduced in 1992, the famous OGP SmartScope® product family has become one of the world's most popular and versatile dimensional measurement systems. SmartScope systems are designed and produced at QVI corporate headquarters in Rochester, NY, USA. Flash branded systems are sold in North America while Flash CNC and CNC systems are found outside North America.



**World Headquarters:**  
Rochester, NY, USA  
585.544.0400  
[www.ogpnet.com](http://www.ogpnet.com)

**OGP Shanghai Co, Ltd:**  
Shanghai, China  
86.21.5045.8383/8989  
[www.smartscope.com.cn](http://www.smartscope.com.cn)

**OGP Messtechnik GmbH:**  
Hofheim-Wallau, Germany  
49.6122.9968.0  
[www.ogpmesstechnik.de](http://www.ogpmesstechnik.de)

**Optical Gaging (S) Pte Ltd:**  
Singapore  
65.6741.8880  
[www.smartscope.com.sg](http://www.smartscope.com.sg)