# ACHIEVING RELIABLE INLINE MEASUREMENTS IN PRODUCTION ENVIRONMENTS

**Author:** Jean-François Larue, Quality Control market manager

One of the most important changes in metrology in the past few decades has been the development of portable measuring devices. This has brought inspection right to the production line, as close to the part as possible. The change—sparked by the development of portable measuring arms and the emergence of laser trackers—has turned conventional industry inspection methods completely upside down.

However, portable measurement is still facing numerous challenges, particularly in real-world conditions. In production environments, digital CMMs are faced with permanent vibrations generated by production equipment (e.g., machining centers, presses, carriage equipment, cranes), stringent equipment setups, fluctuations in temperature and humidity levels, and different levels of user experience and skills. Indeed, sophisticated, yet easy-to-use, solutions are needed for accurate and reliable in-line measurements.

## MEASURING IN MOVING PRODUCTION ENVIRONMENTS

To begin with, let's look more closely into one of the main measurement challenges on the shop floor: measuring on a moving line. The challenge is to measure parts in a very short time (typically less than one minute) with a level of accuracy usually achievable only with fixed parts (better than one tenth of a millimeter). Except for automated systems, the measurement has to be conducted by a production line operator who is usually not a metrology expert. This can have a huge impact on measurement quality as shown in CMSC's 2011 Measurement Study Report entitled "How Behavior Impacts Your Measurement." One of the study's conclusions is that human error is a major factor in poor quality measurements.[1]

Creaform's portable optical CMMs are now opening a new chapter in portable 3D measurement with their *TRUaccuracy* technology, making measuring in moving production environments much easier. *TRUaccuracy* technology features self-positioning and dynamic referencing that enables the measuring device to be continuously locked to the part by an optical link. This fully protects the measurement process from vibrations that are always present on shop floor—vibrations that are subsequently transmitted to the measuring system and the object being measured, and may even be amplified if an unstable tripod or non-rigid base is being used[2]. Moreover, *TRUaccuracy*

[1]The CMSC study on "How Behavior Impacts Your Measurement" is available here: http://www.cmsc.org/stuff/contentmgr/files/0/f7dbf9282c3245d7573d89eb82030080/files/cmsmeasurementreport2011.pdf

[2]For the complete paper presented at CMSC conference: http://www.creaform3d.com/fr/centre-dinformation/fondements-technologiques/truaccurracy-solutions-de-mesure-exactes-en-conditions

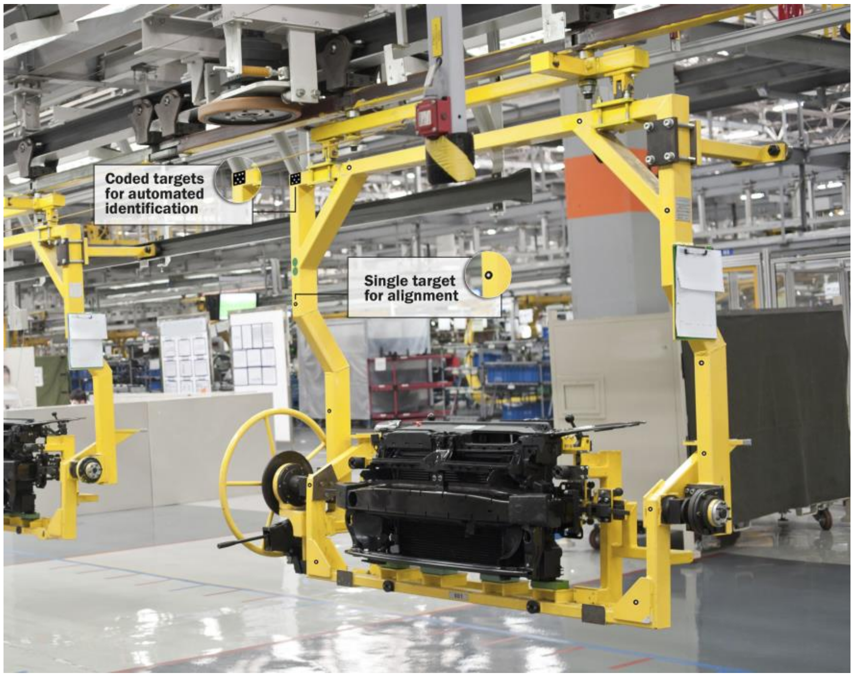
technology is also insensitive to any displacements, which enables operators to measure moving parts, such as on a continuous moving production line.

## HOW IT WORKS

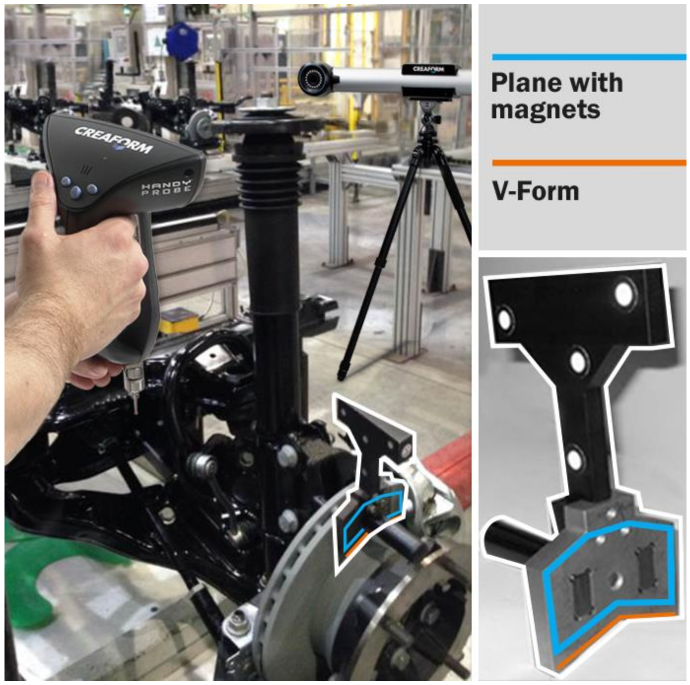
### Step 1: Automatic alignment

As for any 3D measurement, the first step is the alignment, which sets all measurements in the same datum and enables operators to compare between measured values and theoretical values extracted from CAD files. When only one minute is available to take the complete measurement, performing the alignment manually would be nonsense in term of time and reliability (high risk of errors).

The only logical way for the alignment is to perform an automatic alignment; this can only be achieved with an optical CMM. With only few reflective targets placed on a jig, which have been optically measured once before with a portable CMM and then linked once to the part datum by probing only a few points, it is possible to automatically align the portable CMM on the part each time the pattern is recognized.




As many different jigs move along the same line—each with different target patterns and alignment data—a coded target is placed on the jig in order to perform an automatic identification of the jig. It is also possible to automatically identify the part (which could be from different models on the same line) and load the right theoretical values. This way, the alignment is automatically performed. The values between the updated part and measurement can then be compared. Automatic alignment can also be performed by using a simple tool, equipped with targets that can be quickly and easily clamped on the part and removed after the measurement. The targets have to be registered in a reference frame common to the part and tool. In the images shown, the tools are comprised of a plane, V-Shape and T-form equipped with targets. The plane will fit with the face of the disc brake. The V-form will fit on the big cylinder near the disc brake.



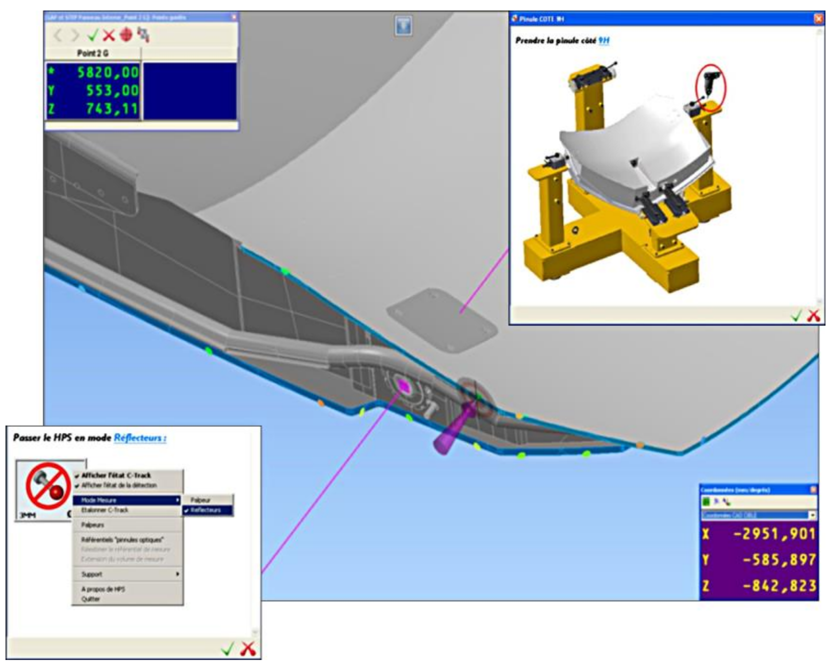

Automatic alignment drastically reduces measurement times and eliminates major sources of errors. For example, an inline inspection system was installed by Creaform at Aircelle (Safran Group) to verify the inline of an aircraft's reverser doors. The inspection time was reduced by three and the number of errors by more than five compared with a mechanical portable CMM.

## Step 2: Measuring in line with a manual portable CMM

Once the part has been aligned, the operator can start to measure points on the part. As the measurement time is very short, especially when the production line is continuously moving, the measurement is usually limited to few points (typically 10). For example at a well-known German car manufacturer, Creaform’s system is used on a production line to verify the lengths of sub-assemblies in order to optimize the centering of parts in the final assemblies. For this to be achieved, four points are taken at each end of the part. One additional point is taken to define a zero. On another production line of the same manufacturer, the system is used to control the position of fixture points in order to detect—in advance—a defective part that could stop the line later on during the ensuing assembly steps.

In the previous use case (brake system), only four points are taken in order to verify the angle between shock absorber leg and the disc brake after assembly. Again, this will avoid detecting the problem later on during the final quality control steps and having to make repairs on a completed car. By repairing the part before being assembled, substantial costs savings can be achieved.

To make taking measurements extremely easy for production line operators, specific programs can be developed—using standard measurement software—in order to guide them throughout process. Just by looking at the screen, operators can see exactly where they have to probe. For higher measurement reliability, points can be taken only where required. If operators try to probe points outside the pre-defined areas, the points will be refused. Results are then automatically saved using the report formats defined customers.




All previous examples are using a probe; however, it is also possible to achieve exactly the same results by using a 3D scanner along with a portable CMM.

## HOW WERE MEASUREMENTS TAKEN IN THE PAST?

Before the introduction of new technologies and methods, two methods were used in the past to take measurements on production lines.

The **first method** (and the most frequent) was to take sample parts off the production line and bring them to a conventional CMM for inspection. The main limitations of this method were:

- Not all parts can be controlled. Only drifts of the manufacturing process can be detected. Moreover, a unique defective part can continue throughout the complete process without being detected.

- The CMM became a bottleneck as the inspection time was much longer than the cycle time.

- There was a loss of coherence resulting from a part removed out of the production line; if the part is not reintroduced at the right place in the sequence (car n°123567 could be delivered with the sound system ordered for car n°123568), quality control issues ensue.

The **second method** was based on control jigs equipped with manual or electronic gages. These jigs could be used to check every parts or sampling. The main limitations were:

- The global cost was prohibitive as a new jig needed to be developed (or adapted from an old one) for each part model.

## ON THE WAY TO AUTOMATED MEASUREMENT!

Creaform's portable CMM has the capability to accurately and instantly measure hundreds of targets. This feature is very useful for tracking parts during an assembly process. For example, Creaform's solution is used by an important rocket manufacturer to dynamically drive the positioning of the ignition system inside the top part of the powder booster—all with an accuracy of 20 µm. Such accuracy is reached with a setup operating at the last stage of an assembly building over 50 m high and with a floor made only out of metal grids placed on a metallic structure.

Thanks to all these exciting features, it is also possible to put a scanner at the end of a robot arm and to use a portable CMM to simultaneously track the scanner and measured parts, whether they moving or not. This way the inspection process becomes fully automated.