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Welcome to the Post-CMM Era

How in-line quality inspection becomes completely digital with Mapvision Absolute Measurement

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Introduction – Unlocking the true potential of in-line measurement

The automotive industry is moving towards mass customization. Model life cycles are getting shorter, technology develops fast, and the number of variants is increasing. When OEMs must assemble a large variety of car models with short life cycles, the demands for all manufacturing tiers grow.

Fierce competition dictates that car manufacturing must be cost-efficient, without sacrificing quality. This puts added pressure on manufacturers to also inspect part quality faster and more reliably.

Currently, quality inspection is struggling to keep up with this change in manufacturing. Fixed and robotized systems cannot inspect complex parts fast enough and do not offer adequate real-time process data.

One of the big challenges of manufacturing quality control has been that, until now, the process has required the use of an expensive and slow Coordinate Measuring Machine (CMM) for correlation checking.

To get any production line adjustments authorized, a round of CMM verification has been required on top of the in-line data. This has largely left the full benefits of in-line measurement, such as faster ramp-ups, undelivered. Even for stable production, the constant correlation checking between two completely different types of machines using different measurement methods is not a value-adding procedure.

Mapvision Absolute Measurement changes the game. It enables manufacturers to perform absolute in-line measurement. For the first time, quality inspection becomes fully digital.

In this brochure, we'll explain the technology behind Mapvision Absolute Measurement and reveal the benefits it brings to different automotive industry players.

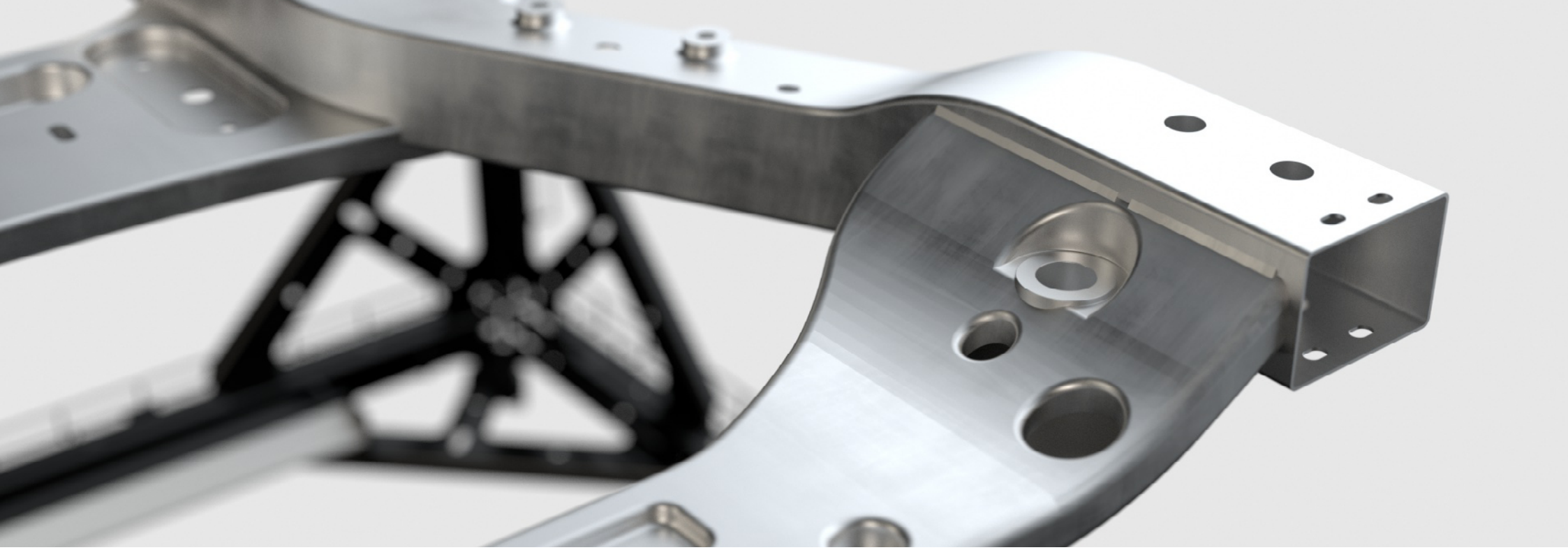
Welcome to the post-CMM era!

The brief history of in-line measurement

Mechanical gauges have been used for decades to define if a part meets certain parameters or fits a specific mold. This mechanical approach, however, is inaccurate, inflexible and, most of all, slow. Quality control that is based on mechanical and manual verification can in practice only be used with samples taken from the production lines.

From sampling to in-line inspection

To remove the limitations of sample-based offline quality inspection, many methods for partial in-line inspection have been introduced. Robotized systems, such as lasers and white light scanners, have made the quality control process faster than old-school sampling. When the parts are simple, the number of features to be inspected is small and the production Takt times are long, robotized solutions make even full in-line



inspection possible. But due to many moving parts, there is an inherent slowness in these solutions. They have to compromise between coverage and cycle time. The history of in-line solutions is, therefore, filled with equipment that cannot provide information fast enough to effectively guide the manufacturing process.

100% x 100% in-line inspection with Mapvision Quality Gate

Mapvision Quality Gate is a fast digital in-line inspection system for complex automotive components. It uses advanced multi-camera technology based on the photogrammetric principle for inspections. The inspection process is fully digital. It is based on measurements from images provided by the fixed multi-camera setup. This enables digital inspection of all features on all parts in under 30 seconds and provides product and process analytics with one simple solution. The solution also creates a visual quality database for retroactive analytics. The database can be used during the whole production lifecycle – before, during, and after production.

The 100% x 100% in-line inspection capability of Mapvision Quality Gate has already changed the world of in-line inspection for good by making the measurements fully digital and allowing even complex parts to be inspected in a short cycle time. Regardless, many customers still demand correlation checks that have to be performed offline. The need to harmonize the data with other systems slows down the process and hinders flexibility. A check with a CMM adds an extra loop that can last a whole day without bringing added value.

This is the challenge Mapvision Quality Gate with Mapvision Absolute Measurement is now solving.

A Measure inline.

B Take some parts 1 off the line and transport them to the CMM room.

C Wait a few days to measure the parts 1 with CMM.

D Use a couple of day to run correlation studies and troubleshoot differences.

E Make tentative adjustements to the line.

F Repeat B-D to see how the adjustment went.

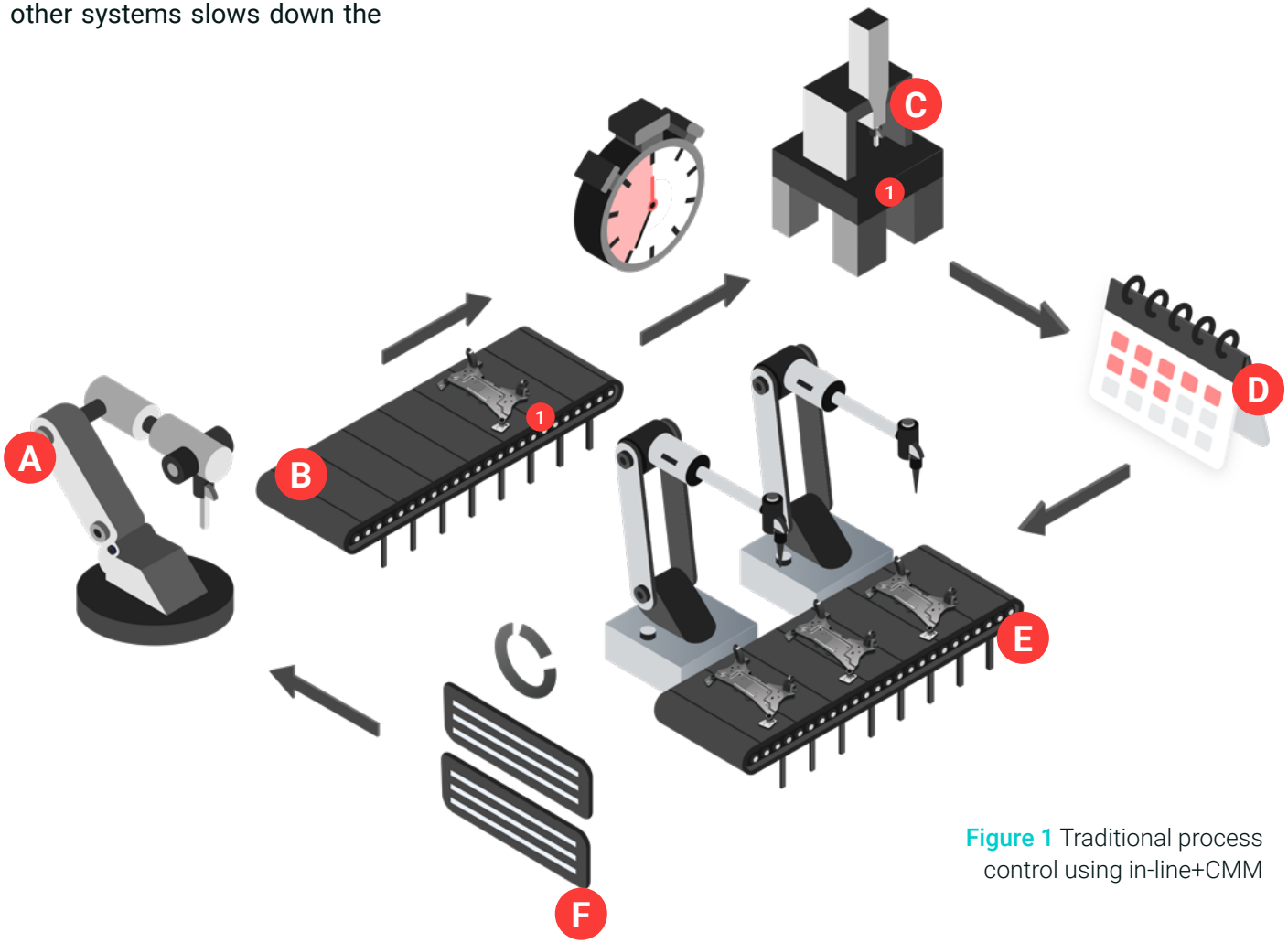


Figure 1 Traditional process control using in-line+CMM

Introducing Mapvision Absolute Measurement

With Mapvision Absolute Measurement, we introduce a CMM-free in-line inspection setup. It uses a new absolute measuring method (CAD referencing) to produce absolute 3D coordinates. The new method is used in combination with an easy-to-use shop-floor artefact, This can then be used for validating the system capability without the traditional CMM correlation studies.

Mapvision Absolute Measurement is an additional feature of Mapvision Quality Gate. It erases the need for separate offline inspections to do correlation checks. Mapvision Absolute Measurement removes the last analog steps of the typical inspection process. It replaces the traditional reference image taken from a CMM-measured reference part (the real photograph) with an image taken from a 3D CAD model that has a perfect reference point for every feature. Even getting absolute 3D coordinates is now digital!

What are the benefits of Mapvision Absolute Measurement?

Mapvision Absolute Measurement makes the manufacturing process of cars significantly smoother and more efficient. The resource savings can be major since there is no need to buy and operate expensive CMM equipment. There are also many benefits for the actual inspection and manufacturing process.

The main benefits are:

- **Speed:** Removing the unnecessary CMM phase improves the reaction time needed for quality control. Thus, it expedites the ramp-up and adjustments of the manufacturing process
- **Accuracy:** Moving from CMM-measured reference parts to absolute 3D CAD model referencing and artefact-based validation removes the problem of deciding which measurement system is giving the correct results

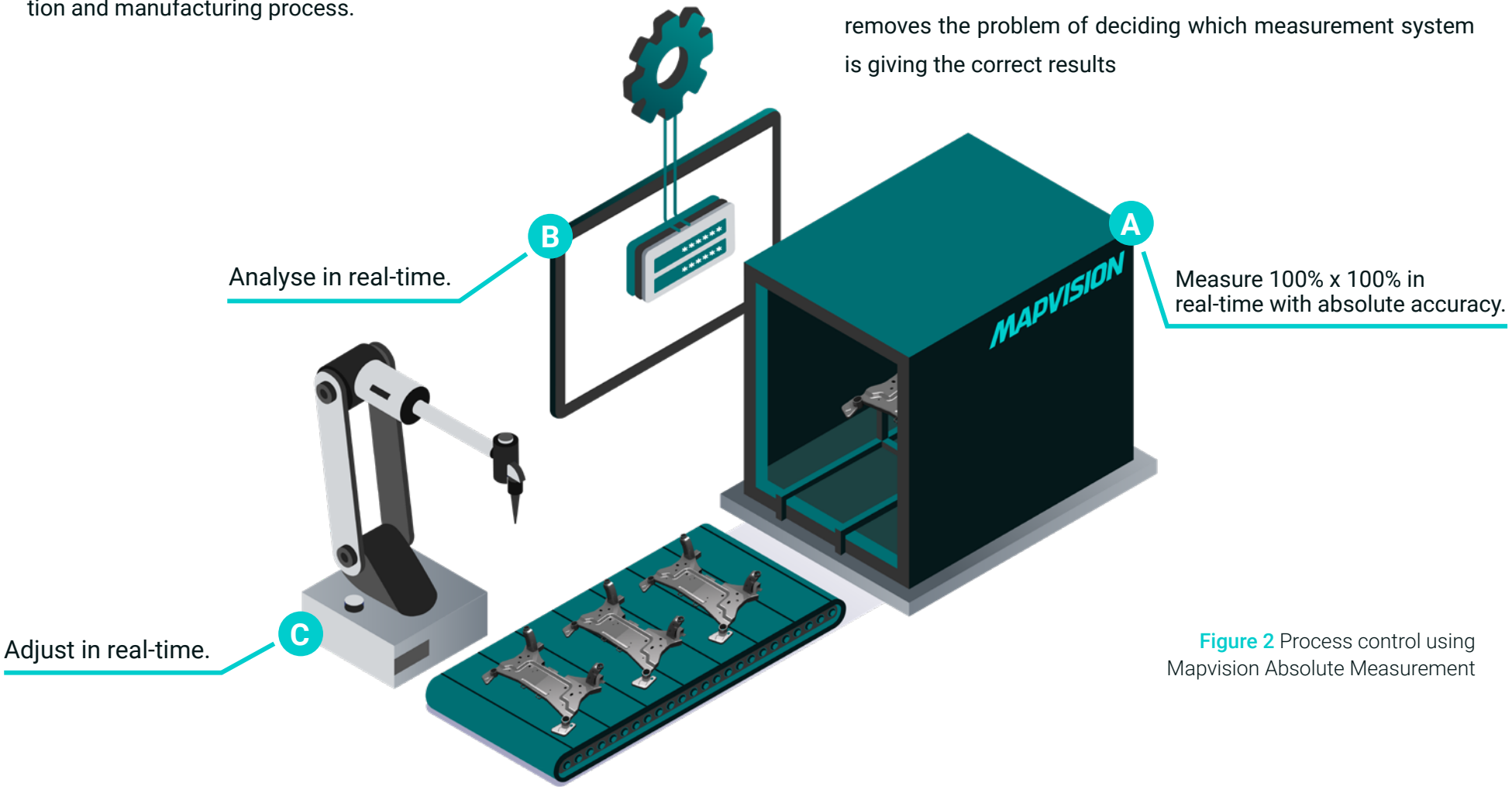


Figure 2 Process control using Mapvision Absolute Measurement

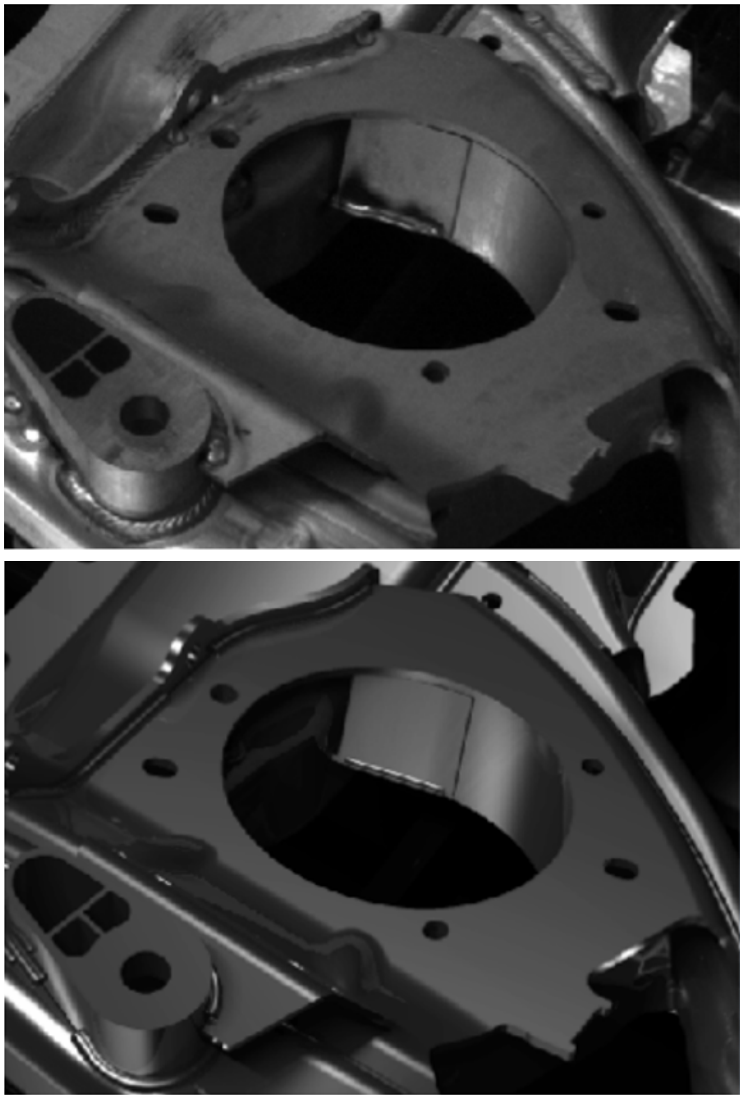


Figure 3 Real and simulated photographs used for feature measuring templates

Flexibility: Easy programming enables measuring many different parts and variants in the same Mapvision Quality Gate.

Next, we'll take a closer look at the technology behind Mapvision Absolute Measurement and the efficient process it enables.

In-line inspection is now completely digital

The Mapvision solution has already long been digital by nature. As we like to say: We measure from images using images. What we mean is that the measurements are made from photographs of the produced parts. And they are based on template photographs of a reference part. Now it is time to drop the reference part and the CMM from the equation and make quality inspection completely digital!

Digitalizing the last physical steps of quality inspection

Mapvision Absolute Measurement switches the traditional template photograph to a simulated image taken from Mapvision 3D CAD simulator. In the simulator, the part geometry is perfect and the reference point (e.g. the center of a hole) can be defined perfectly. Mapvision has an advanced way of synchronizing the relations of the measured objects and the cameras between the simulator and the real world, and modeling the illumination with state-of-the-art ray tracing technology. The camera view in the simulator matches the view in the real world

very accurately (Figure 3). This enables using Mapvision's established machine vision method to locate the features in 2D (on the image) using a template based on the simulated image. Because the measuring templates have their reference points defined in 3D CAD, they are in the absolutely correct location.

Finally, the traditional tried and tested photogrammetry method (Figure 4) is used for intersecting the 2D coordinates to form 3D points. Now with absolute accuracy!

Artefacts provide an easy way for system validation in shop-floor conditions

Mapvision ships a shop-floor artefact with every Mapvision Quality Gate featuring Mapvision Absolute Measurement. The shop-floor artefact is made from standard length carbon bars with targets on them. The distances between the targets are known within a few microns (measured by a DAkkS accredited laboratory).

Using the shop-floor artefact, it can be shown that the maximum error of Mapvision Absolute Measuring is below 0.08 mm.

The shape of the shop-floor artefact is customized to follow the shape of the production part(s). At the same time, it fulfills the requirements of VDI 2634-1. Therefore, it can conveniently be used for checking the absolute accuracy of the system by measuring it in just one position.

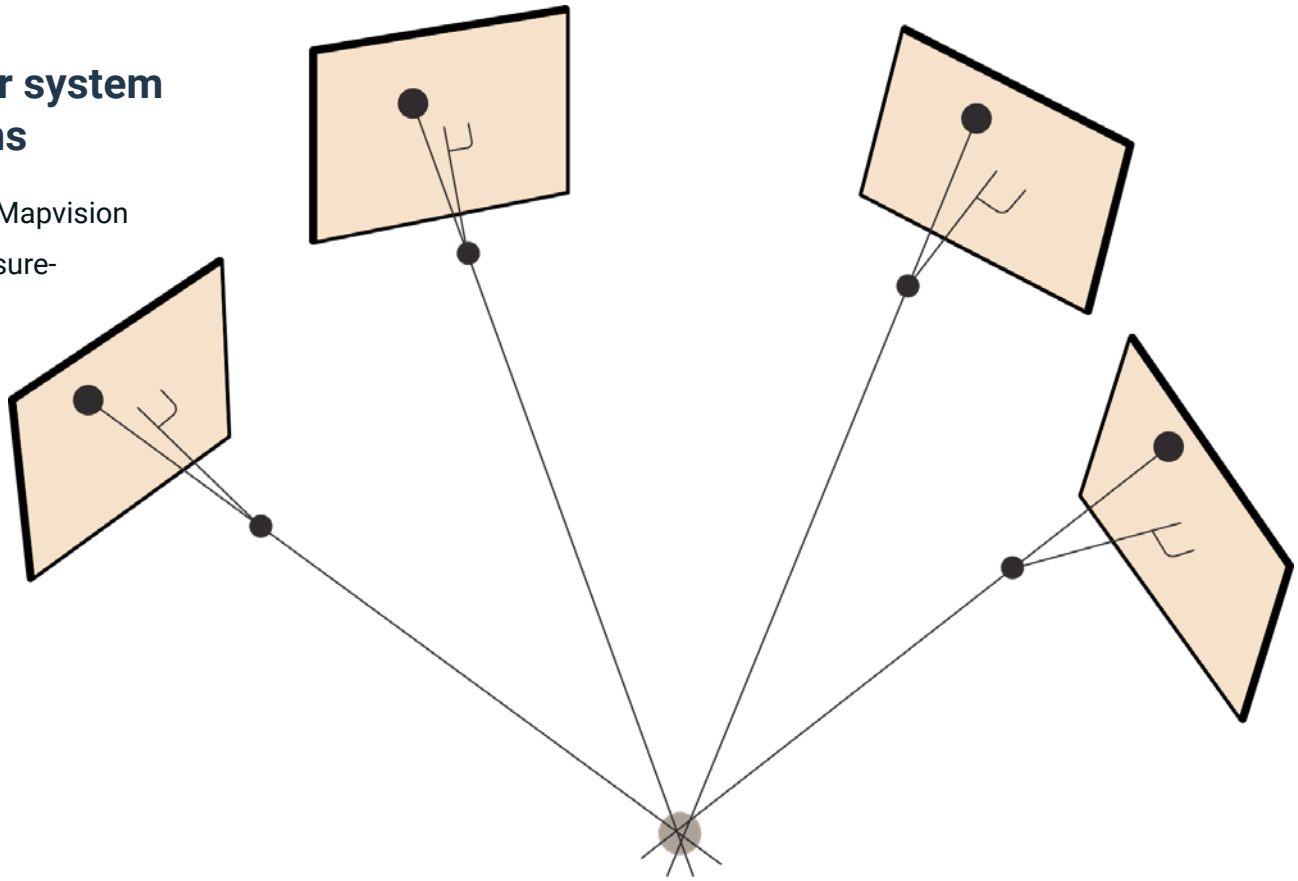


Figure 4 Intersecting absolute 3D coordinates with the multi-camera photogrammetric principle

As it fits the fixture of the production part(s), the procedure is just as simple and quick as measuring any production part. The same artefact can also be used for system calibration when rotated 180 degrees.

Easy programming ensures flexibility

As Mapvision Absolute Measurement is based on CAD referencing, it is easy to reprogram. The Mapvision Editor Suite software enables you to add new features in about 10 minutes and variants in less than an hour.

You can change the setup of a production line weekly if needed, and have dozens of variants in the same system.

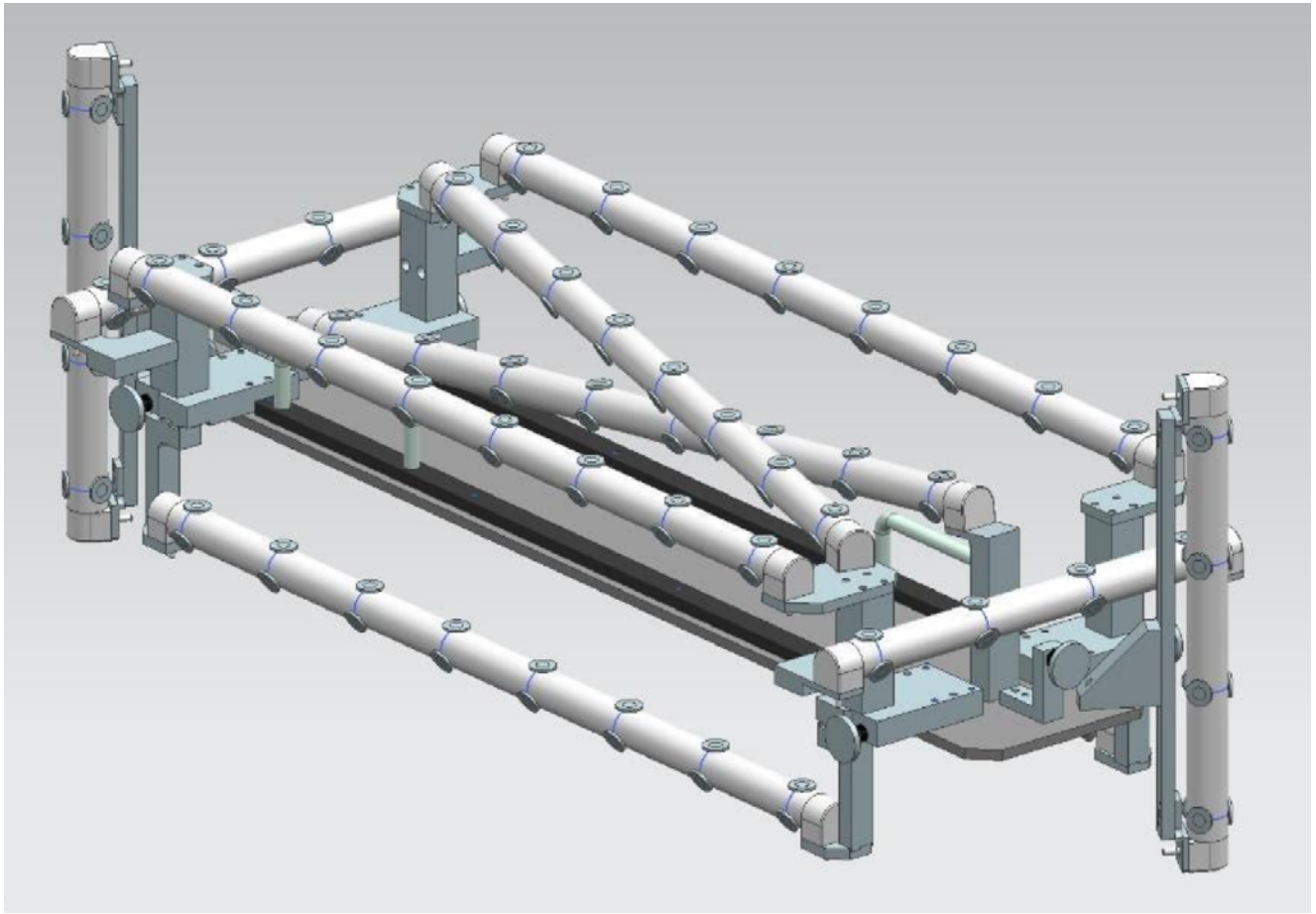


Figure 5 VDI 2634-1 compliant, traceable, one-step, validation and calibration shop-floor artefact.

One solution, various applications

The speed, accuracy and flexibility of Mapvision Absolute Measurement translate to cost-savings and efficiency in most sectors of the car manufacturing industry.

Next, we'll go through its main benefits in the automotive production value chain.

Mapvision Absolute Measurement – SPEED

The high number of inspection features in a car body or a complex car part slows down traditional quality control. Measuring a full car body with a CMM can take an entire day for an OEM.

With smaller parts, the high volume becomes a problem. When the cycle times are short and there are many product variants, Tier 1 and Tier 2 players must constantly balance between inspection coverage and the cycle time.

The ramp-up phase is often a bottleneck for production. It takes plenty of time in the beginning of the production lifecycle to get the parts to an acceptable quality level. CMMs cannot measure every manufactured part. Thus the ramp-up process is slowed down.

When the process is digitalized with Mapvision Absolute Measurement, inspections and ramp-ups become significantly faster. You save time by not having to take parts to a separate room to a slow CMM before and after every production adjustment. As all parts can be inspected, each inspected part also provides accurate data that can be used to make the manufacturing process faster.

Mapvision Absolute Measurement – ACCURACY

Correlation checks create a conflict between different inspection approaches and measurement technologies that are used for defining whether a part is acceptable. The data provided by a CMM and other quality control systems can be hard to correlate. This makes it challenging to decide which data source to believe when optimizing production.

Mapvision Absolute Measurement provides absolute data of each manufactured part. This data can then be used to steer the manufacturing process for better part quality.

Mapvision Absolute Measurement – FLEXIBILITY

The large amount of different car models requires flexibility from quality inspection. The amount of customization available to customers means that manufacturers typically need to produce many variants of the same part. The current paradigm of running non-absolute in-line inspection, backed by a slow CMM, cannot handle the variety. A reliable and fast absolute in-line quality inspection solution has not existed previously.

In contrast with traditional measurement, Mapvision Quality Gate is easy to program and reprogram. One quality control solution can handle different models and variants. This way OEMs can inspect dozens of part variants in the same Mapvision Quality Gate. Whether you have a line with one part or a flexible line with several variants, Mapvision Absolute Measurement inspects big or small parts reliably and fast, regardless of the volume. High-standard in-line quality inspections are for the first time possible also for frequently changing small batches.

Achieve the accuracy and precision of a CMM – without a CMM

At the moment, car part production requires large laboratories and CMMs for quality control. CMMs are, however, expensive and don't bring added value to manufacturing. This creates resource problems for different manufacturing tiers:

- **OEMs:** OEMs manufacture complete cars and big parts, which require big laboratories and CMM rooms. Precious space is wasted on unproductive matters.

- **Tier 1 and Tier 2:** For Tier 1 and Tier 2 manufacturers, ramp-up is a big problem. The demand for CMMs peaks at the beginning of ramp-up but rapidly declines as the ramp-up nears its end. As a result, there are often either too many or too few CMMs depending on the phase.

With Mapvision Absolute Measurement, separate CMM equipment is no longer needed. Plenty of expensive floor space previously dedicated for correlation checks can now be used for more productive purposes. You can say goodbye to expensive equipment that cannot even keep up with the production rate.

Interested in Mapvision Absolute Measurement? Contact us!

Are you ready to embrace the post-CMM manufacturing era? Contact us, and we'll tailor the perfect overall service for your manufacturing needs!

Contact your closest Mapvision office here

Glossary

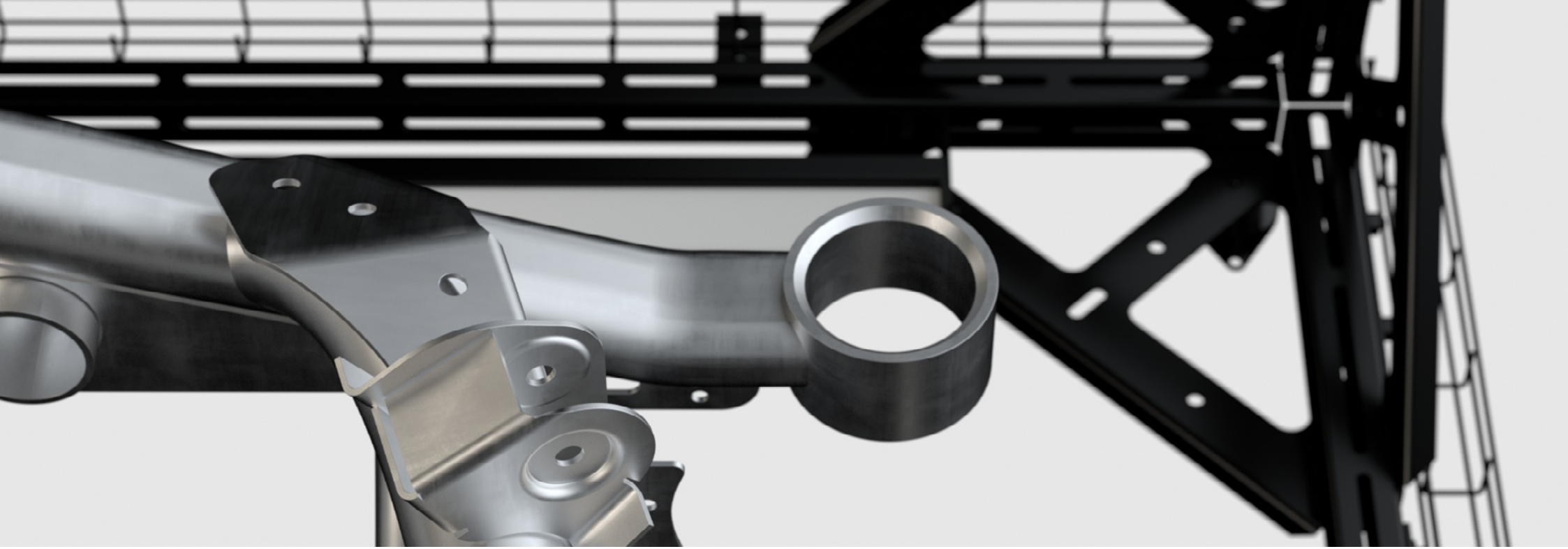
Absolute measurements - Measurements (3D coordinates) that are correct in the absolute sense and can be used as they are for production line adjustment. A system producing absolute measurements has been validated with a traceable artefact

CAD referencing - An absolute measuring method used by Mapvision Absolute Measurement. It uses 3D CAD-rendered, ideal part geometry templates to give the machine vision algorithm absolute reference points

CMM - Coordinate Measuring Machine; the traditional mechanical measuring system

Correlation checking/CMM correlation - A procedure where in-line measuring system results are compared to CMM results of the same parts

In-line inspection - A measuring method where inspection is integrated into the production line; implies that every part is measured



Reference Part - A production part measured by CMM; no longer needed with Mapvision Absolute Measurement

Sampling - An inspection method, where you only measure a fraction of the whole production by taking samples of it. It is typically used with slow measuring systems where measuring all parts would take too long.

Shop-floor artefact - A traceable laboratory-crafted object which is both well known in dimensions and inert in the sense that it holds its dimensions well over time.

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