Make assured decisions. Act economically.

Uncertainty of measurement can finally be made a thing of the past; as tolerances are becoming tighter, the decision as to whether a part is rejected or not becomes highly reliant on the measuring machine with as high a measurement certainty as possible.

How big can a measurement uncertainty be? In order to answer this question clearly, the tolerance that will be checked must also be taken into consideration. With this in mind, a Directive of the Association of the German Automotive Industry (VDA), has this to say: »The capability of the measuring device is determined by the ratio of its measurement uncertainty to the tolerance.« This expert panel requires that the uncertainty of the testing process should only be one-tenth to one-fifth of the feature tolerance.

Economic rules of metrology

With parts becoming more and more complex and tolerances becoming ever smaller, the requirements in metrology are changing. The selection of the correct measuring device is becoming more and more important. In order to make a certain decision for the measuring device to be used, the capability of the measuring device must be proven for every feature that is to be measured.

The high-precision coordinate measuring machines of the Leitz brand from Hexagon Metrology ensure low measurement inaccuracies in production, which remain stable over a long period. They ensure definite decisions in the production process.

...with Leitz, the measurement accuracy in production is perfect, for our stringent requirements. That is why we decided on such a coordinate measuring machine.

Geert van Landuyt, C.O.O., TOELEVERINGSBEDRIJF VAN LANDUYT NV
Optimizing production. Ensuring quality.

Day after day, our commercial decisions are directed at the cost-effective manufacturing of products or the optimization of processes.

The manufacturing costs are influenced by the production costs as well as by the reworking and rejection costs. With that, the costs for quality assurance are an important decisive factor for the correct coordinate measuring machine. Due to the excellent range of capabilities, the Leitz PMM-C from Hexagon Metrology is repeatedly the favored option.

Short measurement times – high throughput
Apart from a correctly selected measurement accuracy, short measurement cycle times and a high throughput are a necessity to satisfy the requirements of production. Important specifications for a coordinate measuring machine with the maximum possible throughput and low testing costs are:

- high probing rates
- High-Speed-Scanning (HSS / VHSS)
- fast axes accelerations
- fast movement speeds

Selecting a measurement uncertainty that is as small as possible, gives the production a greater scope for the exploitation of the permissible component tolerances. Specific savings can be obtained from the correct decisions regarding the measured parts. Additionally, workpiece series can be effectively checked by means of pallet measurements, increasing the effective usage time of the measuring instrument with the setup processes taking place parallel to the measurement process. For this purpose, the Leitz PMM-C offers customized manual or fully automatic pallet feeders.

Measuring device capability \( Cp \):

The ratio of the standard deviation to the tolerance \( (s/T) \) is critical. Measuring device suitability:

\[
Cp = \frac{0.2 \cdot T}{4 \cdot s} \geq 1.33 \quad \text{gives} \quad s \leq \frac{0.2 \cdot 10 \, \mu m}{4 \cdot 1.33}
\]

\[
s = 0.38 \, \mu m
\]

\[
T = \text{smallest tolerance to be measured, e.g. } 10 \, \mu m
\]

\[
Cp = \text{Measuring device capability index for testing devices, e.g. } \, Cp \geq 1.33
\]
It is not just the large companies, but also the medium-sized companies that must master a number of different measurement tasks in their manufacturing in order to be economically successful. The Leitz brand from Hexagon Metrology does this innovatively and reliably.

The coordinate measuring machine Leitz PMM-C is conceived for challenging measurement tasks and ultra-high precision in quality and process control.

**High accuracy – complex geometries**

The high accuracy of the Leitz PMM-C makes it possible in production to make the correct decisions and to keep the costs of producing parts to a minimum. A high parts throughput is achieved from the dynamic discrete-point probings and the serial High-Speed-Scanning (HSS) of known and unknown contours.

The Leitz PMM-C carries out any measurement task with the highest precision; regardless of whether on prismatic workpieces or parts with highly complex geometries – such as cylindrical or globoid stepping gears. In particular, part measurements with narrow tolerances require a coordinate measuring machine such as the Leitz PMM-C.

High accuracy and a high parts throughput have been combined as the definitive requirements – and thus make a decisive contribution to quality assurance in the production.

**Unequaled range of capabilities**

The Leitz PMM-C coordinate measuring machine is available in the following series: PMM-C 600, PMM-C 700 and PMM-C 1000 with measurement ranges from 800 x 1000 x 600 mm up to 2400 x 1600 x 1000 mm.
Variety of applications. Leitz PMM-C.

If the range of applications requiring measurement is extensive, then it means that the coordinate measuring machine should be capable of providing benefits for all areas. Thus, the Leitz PMM-C has a presence in the quality assurance of widely varying branches of industry.

Be it in production areas of optics-precision engineering industry, in machine-building, in the automobile industry or in aviation and aerospace: whenever the reliable measurement of precision parts is involved, one turns to the Leitz PMM-C.

In diverse industries
To fulfill different requirements in various industrial sectors means that a wide spectrum of parts from highly sensitive lenses and prisms through large parts has to be clamped. One of the strengths of the Leitz PMM-C is in the complex application of the powertrain: with regard to the quality, almost all workpieces related to drive technology must be measured reliably. This applies to the entire variety of applications from gear boxes and gears, shafts and multi-step transmissions to manufacturing tools in the industrial sectors of machine building and automobiles, electrical engineering as well as aviation and aerospace.

Whether individual or small series measurement – such as is required for prototype manufacturing – or for specific production inspection in the measurement room: The Leitz PMM-C stands for securing the quality in the production process.

For more economic viability
Due to the wide application scope of the Leitz PMM-C, several conventional single-purpose measuring instruments – such as shape testers, gear measuring devices, camshaft measuring gauges etc. – can be replaced by a single instrument. The Leitz PMM-C thus becomes a vital factor from a standpoint of the economic viability in production.
The definitive material that is used in the base and the crossbeam is granite. Aluminium has been eliminated in all structures that determine the accuracy, in order to ensure insensitivity to temperature and a high degree of stability.

**Solid granite base**
The »Closed Frame« comprises the solid granite base and the fixed portal with cast columns and a granite crossbeam. It provides the rigidity of the measurement axes and the basis for a high and uniform accuracy across the entire measurement volume. Deformations during the movement processes as well as when probing and scanning do not have any effect on the measurement result.

The decisive materials have been selected so that their coefficient of expansion is almost the same. Thus, deflections owing to influences of temperature are not possible. Apart from the fixed portal, the »Moving Table« is a distinctive design for the Leitz PMM-C.

The table is guided in a friction-free manner by means of pre-stressed air bearings. Movement that is free from tilting and twisting is ensured by means of a centrally arranged spindle drive. Additionally, the X and Y – axes are mechanically decoupled. The effect of this is that possible guidance deviations of an axis do not have any effect on the moving of the other axes.

**»Closed Frame« and »Moving Table«**
The precision scales of the Leitz PMM-C consist of steel and are continuously scanned optically. In this manner, the same coefficient of expansion as that of many workpieces is used and measurement deviations in case of temperature changes are avoided. The electronic interpolation of the scale results in a resolution of 20 nanometers.

Through integrated temperature sensors, temperature-dependent residuals of the scales and the workpiece are calculated automatically.
Setting the standards. Stability and durability.

The intelligent and stable construction of the Leitz PMM-C makes precision measurements over a long period possible. Here, mechanical changes are mostly eliminated.

Thus, economical usage in the production process over several years is ensured:

- The machine base of granite, casting and steel components is constructed to be stable over a long period, and the moving drive units work in a wear-free manner.
- Servo-drives with ball screws make high accelerations possible without compromising the positioning accuracy. Very high speeds are reached even on very short paths.
- The supporting as well as the guiding air bearings are equipped with the largest possible bearing base, which results in an accurate and wear-free movement sequence.
- An electronic controller constructed according to the most modern considerations carries out the complex movement sequences and measurement data evaluations. If customer service is required, the »Remote Diagnostics« function facilitates fast assessments and hence keeps the downtimes short. The Leitz PMM-C has the most comprehensive safety and collision protection system amongst all coordinate measuring machines: the probe, stylus and ram are protected by sensors, which set the machine into emergency stop mode in case of a collision. Expensive repairs will not be required, the «Cost of Ownership» is minimal across the operating life.
- As regards the safety of the operator, the electrical contact strips as well as the electrical and mechanical safety functions set new standards.
- The position and arrangement of the scales have been selected so that they take the fundamentals of Abbe’s comparator principle into account to the best extent possible.
- With the unique metrological design of the «Closed Frame» and «Moving Table», the mass ratios remain mostly constant during operation. The electronic controller has thus been optimized to the most favorable machine dynamics.

Scale Resolution

The extremely high resolution of 0.02 µm ensures highest repeatability.

<table>
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<tr>
<th>0.004 µm = 4 nanometer</th>
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<tr>
<td>0.1 µm = 0.0001 mm</td>
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Air bearings with electronic gap width monitoring.
Taking measurements fast and accurately with high-precision sensors – that is what the measurement heads of the LSP-S series have been developed for and are used in the Leitz PMM-C coordinate measuring machine.

The LSP-S-series provides functions like:

- dynamic discrete-point probing
- self-centering probing
- High-Speed-Scanning (HSS / VHSS)
- self-centering scanning

- The deflection of the probing system is acquired and interpolated electromagnetically with high resolution. During the dynamic discrete-point probing, many measurement points are recorded very fast along the linear sensor characteristic. From this, a precise measurement point is calculated.

- The high point reproducibility is obtained from the large bearing base of the collet. This is a precondition for the horizontal stylus extensions up to 800 mm length and 1000 g weight for measurements on large components.

- With the automatic stylus changing system for more throughput, different styli configurations can be changed quickly and without any re-calibration.

- The probe has a large linear-active measurement range with highly sensitive sensors for obtaining the measurement value. Deflection exceeding the linear measurement range leads into a safety zone for protection from damage in case of unwanted deflection.

- With its outstanding P-value*, the Leitz LSP-S2 probing system also makes form and roundness measurements possible, even with very small tolerances.

- The axes of the probe are not clamped during the measurement, this means that the deflection of the measurement system always takes the place perpendicular to the workpiece surface. The actual direction of the normal vector to the surface is determined in every probing point.

- What is involved here is an almost maintenance-free probe since no maintenance-intensive, self-moving parts or active force generators are present.

- There is an optical temperature sensor to automatically achieve workpiece temperatures during the measurement process. This results in more flexibility and a significant time saving.

* P = volumetric probing deviation according to ISO 10360-2

Highly accurate sensors. Dynamic single points.
High-Speed-Scanning. Fast and precise.

**With High-Speed-Scanning, a very large number of measurement points is determined in the shortest possible time. The focus is on the exact evaluation of profiles or contours with a high measurement throughput. With the large quantity of measurement points, stanardized filters can be used for a clearer depiction of the contour.**

Scanning with high speeds places the most stringent demands on the rigidity of the instruments, the electronic controller as well as the application software. With its innovative design, the Leitz PMM-C is among the most accurate and fast measuring instruments.

**HSS / VHSS-Scanning of known contours**

The HSS controls the movements of the machine with maximum speed. Here, known contours from CAD calculations or previous measurements are used. The speed gets set automatically with reference to the specified parts tolerance: The smaller the tolerance, the more precise is the movement. Parts with a greater tolerance are scanned that much faster.

Part contours with different curves are scanned optimally with regard to accuracy and throughput.

Whereas gentle curves can be moved through quickly, the speed through sharp curves is reduced by the Variable High-Speed-Scanning (VHSS): typical examples are holes, turbine blades and gears.

**Unknown contours – freeform surfaces**

Workpiece contours for which there is no desired or set path are often measured, for the highest precision using the »Closed-Loop-Scanning«, scanning in a closed control loop. This applies equally to »Reverse Engineering«. Typical examples are gears, cams, screws and compressors.

**Self-centering scanning**

Often, the task consists of centering in specially shaped recesses or grooves – for example, with a turbine root profile – and scanning along the grooves. The probe controls the measuring machine across its spatial deflection in such a way that the stylus ball remains permanently centered during the scanning process.
Intelligent software. Benefit from alternatives.

The total system is rounded off by an intelligent, powerful software. There is a choice between two solutions here: PC-DMIS or QUINDOS. User-friendly and CAD-based, both guarantee efficient programming as well as a highly efficient evaluation of the measurement data.

**PC-DMIS** is the software for CAD-based, computer-simulated program generation. The software offers: easy programming, use of CAD-data, graphics-oriented, user-friendly interfaces and powerful tools for the presentation of results.

With PC-DMIS CAD++, apart from the measurement of regular geometries, acquisition of free-formed surfaces is also possible. With it, three-dimensional surfaces can be measured very fast using the scanning functions.

**QUINDOS** is the software for almost all industrial applications — from simple parts to complex geometries. With more than thirty options, this software provides a vast selection. Another focal point is the measurement of gears of all types, as well as gear cutting tools. Coordinate measuring machines of the Leitz brand can therefore also be used with the QUINDOS software as gear measurement centers.

**QUINDOS 7** has a built-in CAD-core. Thus, all geometries can be displayed in the 3D-depiction: special target contact points, the probed points, calculated elements and the coordinate measurement systems. With the option »QplusViewer«, 3D-CAD-models can be imported, within the measurement points can be generated, displayed and evaluated.
The choice of the correct coordinate measuring machine for different applications is the first definitive decision ensuring quality in production. The second decision aims at integration and at a concept directed at added value: systems engineering.

The essential features of systems engineering are:

Measurement rooms – innovative climate rooms provide the foundation for ultra-accurate measurement results, possible only on the basis of constant temperatures.

Measurement programs – the generation of part measurement programs together with the training of the personnel involved with the coordinate measuring machine to establish the quality assurance of the production over the long term.

Clamping devices – professional clamping of the workpieces as the basis of repeatability of the measurement results.

Feeding systems – automatic feeding of workpieces to keep idle times as short as possible and if required, to even use unmanned shifts for measurements.

Network integration – linking to databases and CAD systems.

Apart from the procurement costs for a coordinate measuring machine, the associated system integration is a one-off investment decision for ensuring, in the long term, a comprehensive economical viability for the user.

Every measurement that is to be carried out for the quality assurance in production can only be as meaningful as the executing technology allows it and the concept of the system integration actually ensures this.
The Leitz brand as part of Hexagon Metrology stands for high accuracy coordinate measuring machines, gear inspection centers and probes. Leitz measurement systems master quality assurance tasks equally well both in metrology labs as well as on the shop floor. The development and production are located in Wetzlar, Germany. For more than 30 years Leitz has been offering its customers the best innovative measurement technology available. The primary goal remains offering modern solutions for demanding measurement tasks.

Hexagon Metrology
Hexagon Metrology is part of the Hexagon group and brings leading brands from the field of industrial metrology under one roof.

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