The MultiSensor
The Internal Newsletter of Werth Messtechnik
May 2011

Werth is Back on a Growth Trajectory

Dr. Ralf Christoph: We had positive expectations for Werth Messtechnik GmbH in 2010, that were more than fulfilled. At the end of the year, we enjoyed a new record for booked orders. In addition to the general improvement in the economy, the reasons for this success were the expansion of our market share with innovative products and increased export activities.

The Werth Messtechnik GmbH team is excited that the new developments in recent years have borne fruit. New orders in the field of coordinate measuring technology with X-ray tomography, as well as microfeature measurements, demonstrate that we have been investing in the right direction. Our proposals for turnkey solutions for our customers have also been accepted at an increasing rate. This "complete service" allows the users to concentrate on their core processes, while simultaneously ensuring the highest level of quality assurance. Key prerequisites for this approach are the modularity of our machines and the ability to flexibly configure them as needed for each measurement task.

With the new sensors that have been introduced in recent years, such as the confocal nanofocus probe (NFP), entirely new areas of application were opened up.

This year, of course, Werth will once again present new and interesting products at the Control Trade Fair in Stuttgart, the world's largest Quality Show. Our leading position in the relatively young market for coordinate measuring machines with X-ray tomography will be expanded, with new machine variations and software functions. The newest version of the VideoCheck UA multisensor coordinate measuring machine allows not only the measurement of microstructures with very high precision, but also the calibration of standards.

The principle of the Werth Fiber Probe (WFP), the non-contact optical measurement of the probe sphere position, has been proven in many practical applications. This concept has now been implemented for all spatial directions, and will add more areas of application for the new 3D-WFP, such as the measurement of micro-injection molds.

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Volume 331
X-ray Tomography in Industrial Metrology

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With the Werth Interferometer Probe (WIP), very small structures can be measured with high precision, even in cavities like deep boreholes. Non-contact roughness measurements can also be made with this sensor.

Technical expertise and application oriented consultation for users is very important to Werth. Additional expert employees are therefore reinforcing our team in several countries.

The new volume of the series that includes "Multisensor Metrology" is published in German and will soon appear in English. The latest technical handbook, "X-ray Tomography in Industrial Metrology" is intended to provide technical advice to our customers, along with background information about this new technology.

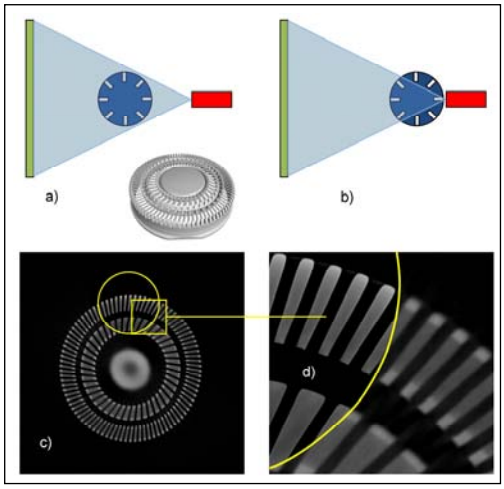
Innovative production technologies require innovative metrology in order to ensure product quality. We are therefore optimistic that Werth Messtechnik products will continue to have a significant position in the field of quality assurance in the years to come. This will continue to drive positive developments for the company.

Segment and Helix CT

Powerful functions

Over the last year, once again, Werth Messtechnik GmbH extended its technical lead in the field of coordinate measuring machines with X-ray tomography. Additional powerful functions for precise measurement have been integrated.

Using Region of Interest, ROI-CT or local tomography, the resolution is increased only for a region within the component, without the need to raster the entire component at a higher resolution. This is a significant time saver. A two stage procedure makes this possible, where the complete component is first captured "in the image" at a low resolution (Fig. a). A second image then records the tomography of the "region of interest" at maximum resolution (Fig. b). The result is a volumetric data set for the high resolution region within the overall component (Fig. c and d).



Local Tomography

The Helix CT (also known, somewhat inaccurately, as spiral tomography) was developed in order to further increase the precision of tomography measurements. This method takes into consideration the fact that truly precise tomography of a component requires the use of a center measurement plane between the X-ray source and the detector, perpendicular to the rotary axis.

Another improvement in accuracy was achieved by integrating a correction for beam hardening artifacts in the reconstruction library. The correction is performed fully automatically during the measurement, using the actual workpiece characteristics.

In "normal" cone beam tomography, so called cone beam artifacts can occur at the edge regions (top and bottom), depending on the angle of the cone, which can lead to deviations in dimensional or visual inspection. For measurement tasks with precision requirements in the micrometer range, these may be significant.

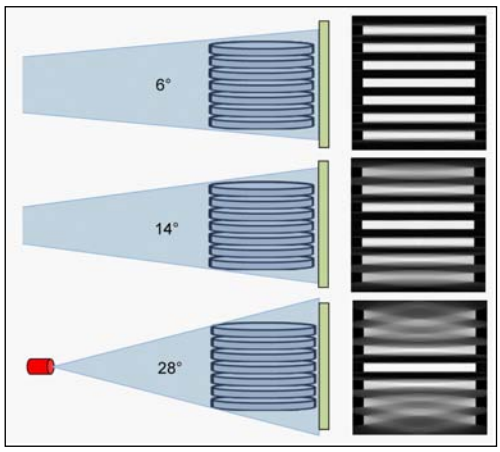
"Turn-key" system solutions

For over 60 years, Werth has provided system solutions that are ready to run immediately after delivery for customers around the world.

Our unique selection of machine technologies and sensors enable us to optimize a measuring machine for the task at hand. A specialized team of engineers and technicians comprehensively develops the entire concept for the measurement process, with the goal of seamless integration in the production process. This includes producing a detailed specification and demonstrating measuring machine capability and measurement process suitability, if desired.

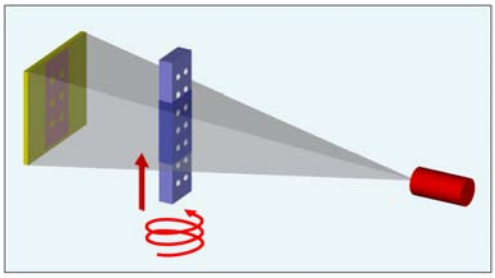
Professional project management ensures that schedules are met and process quality is closely coordinated with the user.

The flexibility of the WinWerth® measurement software allows the creation of user oriented interfaces and corresponding measurement sequences. The programs can also be parameterized, making them easy to adapt to complete part families. The programming code is "upwardly compatible," meaning that it will also run with future operating system updates.



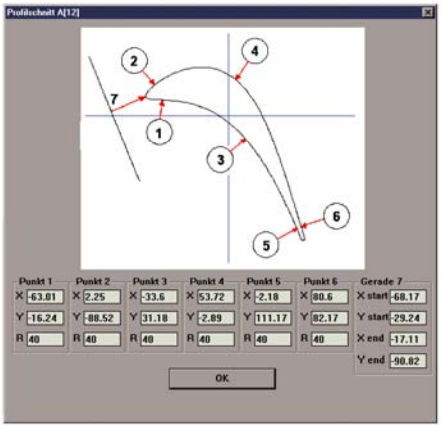
Influence of the cone beam angle

The Werth TomoScope® uses very small cone angles. This means that this effect is normally very small. For applications with high radiation absorption, it can make sense to reduce the distance from the detector to the X-ray source, in order to obtain sufficiently short measurement times. This unavoidably leads to greater cone angles, which can be eliminated by using the Helix CT.



Helix tomography: In order to perform Helix CT, the component is "threaded" through the center plane of the measurement volume through one full revolution. This results in a highly accurate measurement point cloud.

ScopeCheck V 200 in an application for an automotive supplier



User oriented interface for measuring a cross section

VideoCheck® UA

Measuring in the sub-micron range

The new VideoCheck® UA (Ultra Accuracy) is tracking the trend toward miniaturization and greater component tolerance requirements. The machine uses cutting edge air bearing technology, vibration isolators, and glass ceramic scale systems with 0.001 µm resolution. A special method for connecting the drives to the axes minimizes stress effects to the precision of movement.

The measurement volume of 400 mm x 400 mm x 250 mm is unique for its class. This expands the area of application from microcomponent measurements to the measurement of microfeatures on large components, as well as the calibration of larger standards.

Depending on the application, the VideoCheck® UA can be equipped with any of the sensors in the Werth Multisensor tool kit. This includes, for example, the new, patented 3D WFP Werth Fiber Probe, or high precision distance sensors such as the Werth CFP Chromatic Focus Probe or the WIP Werth Interferometer Probe.

The 3D maximum permissible error of this machine series is MPE E = (0.25 + L/600) µm.

Fast Calibration

Magnetic mount for reproducible sphere position

In order to more quickly and easily calibrate sensors, there is now a new mounting method available for the calibration sphere. The lower part of the holder is securely fastened to the measuring table (outside of the measurement region) and makes it possible to install the calibration sphere at the identical position every time, quickly and easily, by means of a magnetic mount.

The position of the calibration sphere is saved in the measurement software, and the calibration procedure can be started at the push of a button, no cumbersome alignment required. This option is available for all Werth coordinate measuring machines.

The New Werth QuickInspect

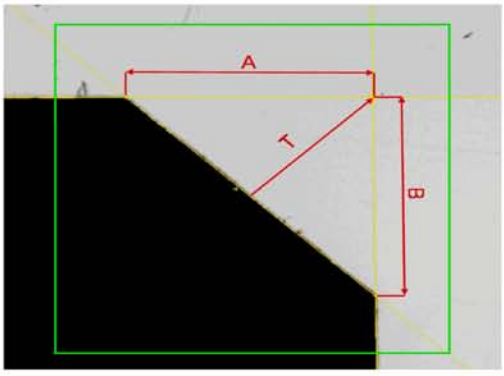
Everything in view

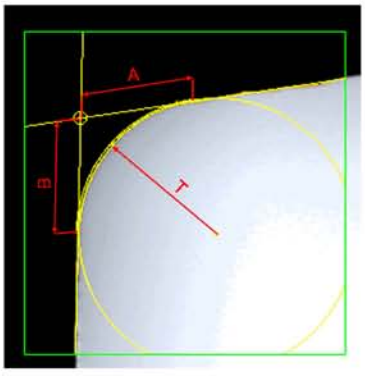
The new generation of the QuickInspect has a high resolution image processing unit, in order to guarantee appropriately small length measurement deviations even in large fields of view. Low distortion, telecentric precision optics allows measurement ranges from 8 mm x 6 mm up to 225 mm x 168 mm, depending on the precision and workpiece size.
Of course, the machine is specified comparable to ISO 10360 and VDI/VDE 2617, and its factory calibration makes it traceable to the PTB length standard. With the right configuration, its maximum permissible error is less than one micrometer.

The QuickInspect can be used as a separate production measurement station, or directly integrated into the production machine. Its modular and solid construction allows coordinate measuring tables (CNC or manual) to be retrofitted. This increases flexibility, and the measurement range can be expanded if needed.

Automatic Measurement of Undercuts and Chamfers

The measurement of undercuts and chamfers has always been a technically difficult problem. In order to address this problem, the "edge break feature" has been integrated in the WinWerth measurement software as a measurement element, similar to distance, angle, or diameter. When the edge break element is selected, there are two strategies available, depending on the feature's chamfer and radius.





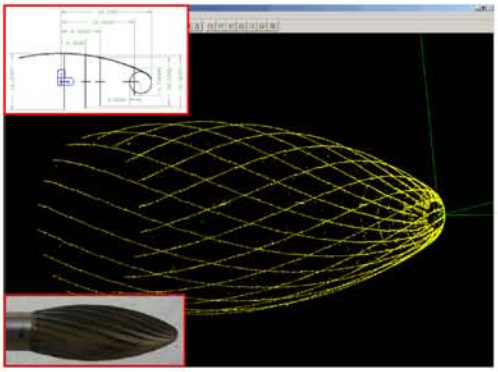
The geometry and size of the feature are automatically detected in the measurement window and corresponding dimensions are output. Tolerances are then applied and can be displayed graphically as well. The function is also available in CNC operation.

what's new

Measuring the Active Contour

Metrological simulation of tool shapes

Form cutters are used to generate a contour on the workpiece that matches their form. Test cuts are often performed in order to assure the quality of the cutter as part of quality assurance. Because this process is relatively difficult and time consuming, however, the image processing function of maximum outscribed contour scanning was developed. This function allows complete metrological 3D capture of all cutting edges in space, and mathematically simulates the cutting result when all cutters are used.



Example of "metrologically captured" parameters from the overall contour

All parameters, such as diameter, runouts, profile form deviations, and other typical tool features can be determined for the entire captured contour. This analysis takes the wobbling motion of the tool into consideration, and is thus largely independent of chucking.

Werth Interferometer Probe WIP

High-precision measurement using interference

The WIP is a non-contact fiber optic distance measuring system for high precision measurement of geometry, form, and roughness. It is based on the principle of short-coherence interferometry, and is particularly well suited for capturing geometric features in small or deep boreholes (injector nozzles, turbine blades, etc.). The WIP can be used to measure the form and roughness of optical components, lithographic structures on glass, or structures on wafers without a problem.

The components are "measured" by a very thin glass fiber probe that is first positioned at a defined working distance from the component.

Pivot Joint for Measuring Holes with the Werth Fiber Probe

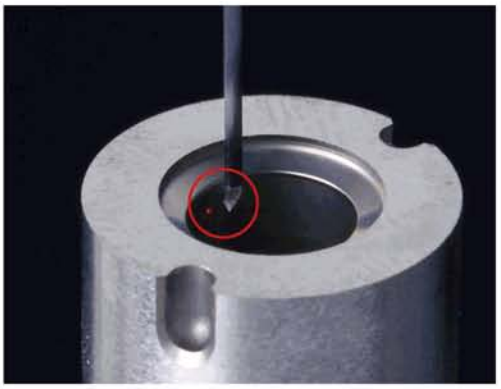
A difficult task has been solved by combining the patented sensor principle and a new development. The task was to capture the diameter and spatial position of microbores at different angles to a depth of 80 mm in a rotationally symmetrical component. The solution had to be a pivoting microprobe with an extremely long probe pin.

Because no such system was available on the market, a continuously variable servo pivot joint was developed for the IP 110 T sensor head. The IP 110 T has a working distance of 110 mm. This means that it can be used with a WFP Werth Fiber Probe with a 100 mm long fiber to measure the microbores at the base of the bores as well.

The combination of mounting the part on a rotary table and using an infinite position pivoting sensor means that nearly any hole, at any spatial orientation, can now be measured. The IP 110 T and the Werth Pivot Joint are completely integrated in the Werth multisensor concept and are available as an option on all Werth coordinate measuring machines.

The reflected signal is then superimposed on a reference signal. This produces an interference pattern, from which the distance to the workpiece can be calculated.

Depending on the angle to the surface of the component, appropriate probes are required. These can, however, be manufactured as desired and interchanged later very easily in the measurement head.



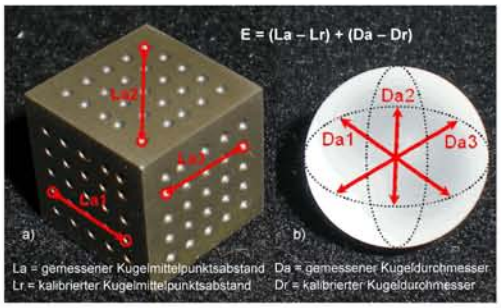
Hole measurement using the ***WIP Werth Interferometer Probe***

The working distance is in the range of a few millimeters, but can be adjusted due to the material of the fibers used. Composite materials, or a special metal alloy, are used as the carrier material for the fibers. The probe inserts typically have a diameter of 0.1 to 1 mm, and lengths between 5 mm and 50 mm. If desired, however, special inserts can be manufactured.

New Directives for Coordinate Measuring Machines

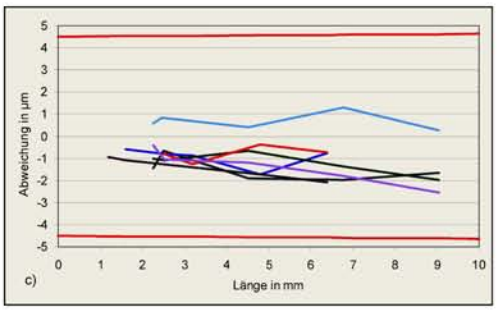
The new VDI directive 2617 Page 13, for acceptance testing and monitoring of coordinate measuring machines with X-ray tomography, which was mentioned in the Multisensor 2010 edition, has since been sent for white printing. The corresponding processes have also been put into practice at Werth, and are now being used for testing the measuring machines.

The illustration shows the implementation of the guideline by measuring a calibration cube.



Calibration cube with semispherical reference features (3 x 25) and standard sphere

The sphere spacing (a) is determined using the calibration cube with semispherical reference features and measuring an additional two point diameter on a standard sphere (b). The analysis provides a result for the maximum permissible error.



Example of a result of length measurement deviation. The values are well within the specification (red lines).

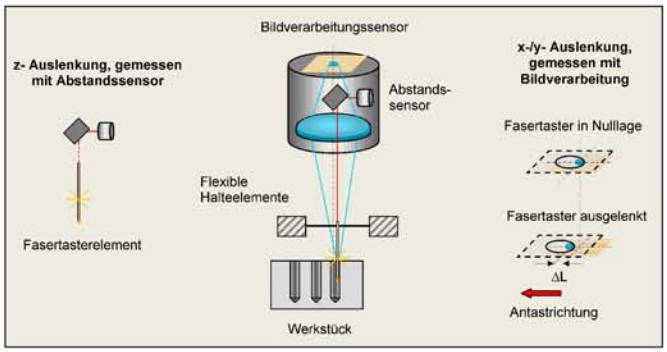
ISO Directive 10360 has a new page 7 for acceptance testing and monitoring of coordinate measuring machines with image processing sensors. It will also be available in printed form in the coming months. It implements worldwide the method that has already been included in VDI for years (Directive 2617 Page 6.1).

Werth 3D Fiber Probe

High precision three dimensional measurement

With the new 3D fiber probe, the range of applications of the proven Werth Fiber Probe technology has expanded, particularly for 3D measurement tasks. The advantage of the most successful microprobe technology in the world is based in the patented basic principle. The probe sphere deflection is determined by optical sensors. In the new 3D WFP, this concept has been expanded to include the measurement of probe deflection in the direction of the probe pin. An integrated optical distance sensor is used for this purpose.

Because the probe pin is not used for transmitting the signal, the Werth Fiber Probe has a series of advantages compared to microprobes that use the typical mechanical - electrical principle. It is significantly less susceptible to breakage, has smaller probe spheres, and has probing forces that are lower by an order of magnitude. For example, very small probe spheres, with a diameter of 20 micrometers, can be implemented. The low probe forces, less than a thousandth of a Newton, make the 3D WFP suitable for the (nearly non-contact) measurement of sensitive components, such as optical surfaces or elastic components made of rubber or plastic. Measurement deviations due to the flexing of the probe pin are minimized.



The 3D fiber probe can be used for measuring both in single point and in scanning mode. This also makes it possible to use the fiber probe to capture profile curves on workpiece surfaces. In combination with appropriately precise coordinate measuring machines, such as the Werth VideoCheck UA, the 3D WFP has a maximum permissible error of only a few tenths of micrometers. The new Werth 3D-WFP is particularly well suited for tactile measurement of three dimensional microstructures. Typical applications are measuring tools, optical components, watches, microgears, fuel injection parts, and micromechanical components from all branches of industry. The fiber probe can also be used for calibrating optical measurements. The 3D Fiber Probe is completely integrated in the Werth Multisensor concept.

Werth IP 40 T and IP 110 T

Measuring in any position

The IP 40 T and IP 110 T sensor heads allow flexible measurement with image processing on large coordinate measuring machines combined with rotating/pivoting joints. The IP 40 T and the IP 110 T are compact sensor heads with telecentric optics and an integrated zoom function.

The IP 40 T is available with magnification of 4x or 1.5x, with a working distance of 40 mm for each. Due to its compact design, it provides brilliant image quality at a very shallow angle of incidence when using darkfield incident light. It is thus very well suited for measuring low contrast technical plastic parts. Its short length means that very little of the measurement range is lost in the pivoted or parked state. The IP 110 T has a magnification of 1.5x at 110 mm working distance. This property makes it suitable for measuring lower lying features, with no risk of collision.

Both measurement heads can be mounted on the Renishaw PH10M rotating / pivoting joint, or on the Werth servo pivot joint directly on the ram of the coordinate measuring machine. They are interchangeable with other measuring probe systems. A powerful brightfield incident lighting system is integrated in the beam path. The darkfield incident light illumination, implemented in an 8-segment circuit, allows the best possible contrast to be set.

Left: Werth IP 40 T on the Renishaw rotating-pivoting joint
Right: Werth IP 110 T on the infinite position Werth pivot joint

The non-contact principle of the sensor heads is based on powerful Werth contour image processing, with high-precision autofocus. This allows both measurement of standard geometric elements and scanning of contours. The incident light ring can be exchanged for a transmitted light fixture, or the Werth Fiber Probe, using an interchange kinematic system (patent pending). The result is a rotating / pivoting measurement head with a microprobe that allows contact measurements of extremely small geometries, with very small contact forces, at high precision. The area of application of coordinate measuring machines is significantly expanded.

application

Lifesaving Precision

Multisensor technology from Werth Messtechnik ensures reliable stents and other implants.

High quality and precision are very important at Admedes Schüssler GmbH. The manufacturer of medical implants has to ensure that only one hundred percent correct products are shipped from its facilities. Admedes uses various measuring machines from Werth Messtechnik for final inspection. They are flexible and work at a high precision level, so that the user can reliably measure finer tolerances than has previously been possible.

The products from Admedes Schüssler GmbH save lives, because the Pforzheim company specializes in the manufacture of vascular micro implants. Their core business is stents, made of a special alloy of Nitinol, which Admedes produces using machines that were largely developed in house.

The manufacture of such a Nitinol implant is a difficult process, consisting of up to 15 steps. Precision and maximum quality play a decisive role in the end product. Such stents are introduced into the bloodstream via a catheter, where they must fulfill their function reliably at the damaged location for the long term. This function is to support the blood vessel wall and prevent it from collapsing again.

A significant part of the production process is laser cutting the implant. A mostly tubular raw part made of Nitinol must be given a reticulated structure. Laser machining of Nitinol was the specialty of Dr. Andreas Schüssler even while at the Karlsruhe research center. He recognized the potential of this machining during the course of his scientific work and ultimately founded Admedes Schüssler GmbH in 1996. For the first two years, Dr. Schüssler and his Admedes team primarily addressed the continued development of the entire process chain of producing stents made of Nitinol and the establishment of appropriate capacities. This is because the market expects finish machined, tested, and packaged products from a supplier.

The fine laser cut structures on stents and other implants are subject to high requirements for precision and quality (a segment of a heart valve cage is shown).

Brief explanation of technical terms:

*A **Stent** is a support for a blood vessel, that is, a medical implant that is inserted into hollow organs to hold them open. They are generally mesh structures in a tubular form, made of metal or plastic. Stents are used, for example, in blood vessels such as the femoral, biliary, and carotid arteries (primarily self-expanding Nitinol stents) or especially the coronary vessels and renal arteries (primarily balloon expanding stents), in order to prevent renewed collapse after they are expanded (PTCA).*

***Nitinol** is a nickel-titanium alloy, and the most well known representative of shape memory alloys. This description derives from the phenomenon that the material can apparently "remember" its previous shape, despite very severe deformation.*

***Vascular** is the medical term for "having to do with blood vessels."*

Image: Admedes Schüssler GmbH

Multisensor Technology Provides Highly Flexible Measurement

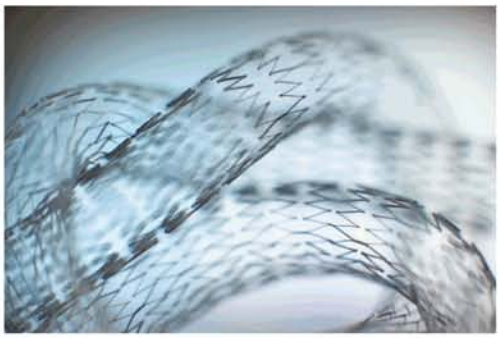
Admedes and Werth Messtechnik have been working together since 2003. While searching for optimal measurement methods and machines, the technical manager at the time realized that the Werth products were fundamentally well suited for measuring implants due to their multisensor capabilities and machine construction. He was convinced that the Werth machines had better efficiency and greater flexibility than previously available measurement systems. He was right. The measuring machines did have to be modified slightly to mount and light the stents, but the expertise of both partners and extensive experimentation were used to optimize the systems for this measurement task.

Dirk Heining evaluated the cooperation with Werth as very good: "*Joint development work produces a connection. Our companies are also structurally very similar. We have very innovative managers who make an effort to drive new development. The technical expertise at Werth is also impressive.*" The cooperation was successful for both companies. Werth was able to expand the range of applications of its coordinate measuring machines, with the support of Admedes, to include the measurement of stents. Admedes now uses three models of Werth coordinate measuring machines, primarily for final inspection: VideoCheck and ScopeCheck machines, and a FlatScope 2D measurement system - a total of 18 measuring machines.

The Essential Processes: Laser Cutting, Forming, and Surface Treatment

After laser cutting, the product is cleaned and then brought into its final form by means of heat treatment. Because Nitinol is a shape memory alloy, the product always takes on this exact final form again. This happens despite the deformation and compression that are required in order to insert it through a catheter. To ensure that the surface is compatible with the body, it is electropolished to generate a titanium dioxide coating. This ensures excellent biocompatibility and outstanding corrosion resistance of the material.

In addition to these three most critical processes, many other processes take place, until the final product is packaged and ready to ship and can be delivered to the OEM customer. Dirk Heining, member of the management board and responsible for all production, explains: *From the procurement of the raw materials, to the shipment of the parts, the quality of the products and processes is our focus. We do not allow any compromises. This is why quality assurance gets so much attention. From the first to the last process step, we have installed in-process checks that continuously inspect process specific aspects and requirements. A critical part of quality assurance is also the 100 percent inspection of finished products with respect to dimensions, function, and surface finish. In Werth Messtechnik, we have found a partner that is an optimal match in terms of innovation and capabilities.*"



Nitinol stents are the core business of Admedes Schüssler GmbH. Image: Admedes Schüssler GmbH

Reliably measuring the finest dimensions

VideoCheck and ScopeCheck machines are used for measuring dimensions such as the web width, angle, and wall thickness of the implants. Dirk Heining appreciates their capabilities, because he remembers another time: "*Previously, the parts were manually placed under a light microscope, an image was captured, and dimensions were taken from the photos. The captured values were transferred to an Excel file and checked. The effort required for this method, for the many thousands or hundreds of thousands of implants each year was enormous.*"

The VideoCheck and ScopeCheck machines in use at Admedes are equipped with an image processing system that is specially tuned for the requirements of coordinate measuring technology, as well as with a tactile probe system. The image processing is used, for example, for measuring structural widths and determining the position of various features, such as mesh intersections. A video camera records an image, from which the measurement software derives the required data. These are then available for further analysis. The tactile measurement system is then used to measure the wall thickness. Admedes can thus determine all the measured values for a component in a single setup.

The Werth FlatScope is used for the functional test that every implant must pass. Here again, the measuring machine had to be equipped with a special device for bringing the component under test to body temperature prior to measurement. Only then are the diameter and length of the stent measured.

Werth VideoCheck-IP 400 x 200 x 200 3D-CNC multisensor coordinate measuring machine.
Image: Werth Messtechnik GmbH

Pioneering Work in Implant Technology

Admedes Schüssler GmbH was founded by Dr. Andreas Schüssler in 1996 as a spinoff of the Karlsruhe research center. The company, based in Pforzheim, employs about 420 people at its main location.

It produces vascular micro implants for OEMs, primarily stents made of the special alloy Nitinol. In this area, Admedes is the global market leader. Over 80 percent of its products are exported, the majority to the USA, where a fully owned subsidiary is located.

Admedes considers itself a leader in innovation in implant manufacture and is currently driving process expertise and existing production technology forward, in two directions: first, in the direction of larger structures for artificial heart valve frames, and second, in the direction of smaller and finer structures, such as are needed for implants in the neuro and coronary areas.

Admedes has also expanded its vertical integration, in that rivets can be applied to stents and components in order to make the parts more visible in X-ray images.

Admedes has also expanded its process technology, in that implants, especially stents, can also be made from formed or woven wire. About 90 percent of Admedes products are made of Nitinol. Other materials, such as stainless steel or the cobalt-chromium alloy L605, as well as other metal materials and alloys, are also processed.

Admedes thus ensures that the size of the implant is correct, even for medical intervention, and that it will fit precisely in the location where it is to be used.

Economical and technical process advantages

The use of Werth measuring machines has brought many advantages. Without them, the labor requirement for the "fine dimensional check" would be significantly greater. The measurement process using the Werth VideoCheck and ScopeCheck is also much faster and more flexible.

Thanks to multisensor technology, Admedes can measure a wide range of features on a single component using such a measuring machine, whereas several different machines were required in the past. Dirk Heining emphasizes one function: "*The autofocus point available in the VideoCheck and ScopeCheck, which works very well, is of particular interest to us. It enables us to make optical, non-contacting measurements in the Z direction in various planes, and to complete measurements on non-cylindrical objects as well, without any problems.*"

In order to measure the fine structures of stents, they are drawn onto special mandrels.
Image: Werth Messtechnik GmbH

Precision and reliability are other advantages. According to Dirk Heining, the Werth measuring machine are highly precise, which clearly differentiates them from other measuring machines. He indicates that the progress with respect to the produced precision of stents and other implants make it necessary to have measurement systems that can keep up. "*Werth is definitely far ahead in this respect. In our area of application, in my opinion, Werth Messtechnik is the technological market leader. I don't know of any measuring machines that are as precise, and so demonstrably reliable, even for the finest of dimensions.*"

news

New Partner in Brazil - IPT

With convincing technical solutions in the area of multisensor coordinate measurement technology, Werth Messtechnik GmbH has established a partnership with IPT (Instituto de Pesquisas Tecnologicas), located in Sao Paolo. IPT does research and development in the area of dimensional metrology and also provides services for industrial partners in Brazil. In the next few weeks, an ultra-modern building will be ordered, in which the various Werth measuring machines will be installed.

IPT has, at this time, the most modern set of measuring machines in South America. This includes a coordinate measuring machine with computer tomography, the TomoScope HV-Compact, and several multisensor coordinate measuring machines. The high precision VideoCheck UA, with 3D WFP, is available for calibrating standards and measuring microstructures. A ScopeCheck MB 1000 for larger components and a VideoCheck 400 x 200 for standard multisensor measurement tasks round out the machine palette. The machines are also available for service measurements of geometry, shape, and roughness, as well as for machine demonstrations in the South American market.

Advancing Internationally - Expanding Market Presence

In order to provide first class consultation and support, even in distant countries, additional Werth offices for service and sales were opened in China, Brazil, England, and Hungary. A representative office was founded in China, under the management of Dr. Zhichao Li.

Dr. Li lived in Germany for several years and obtained a PhD at the Technical University in Aachen. He has been using Werth coordinate measuring machines for years. Dr. Li supports the dealers located there, but is also active in direct consultation, as the Werth representative.

COMMENT

Multisensor says …

The crisis is barely over, and the complaints start again. The euphoria over impressive growth rates is slightly tainted by new problems. Some companies apparently took savings too far, and undermined their own businesses. Here and there, material and employees can hardly be found to cover the normal levels of production that have returned once again. Fortunately, the laws of the market economy promote the most suitable alternative solutions. I am certain that my company will not be held back by these problems.

Gratifying growth is evident in the use of X-ray tomography. Many producers want to get to know their components and assemblies quickly and completely, to analyze whether everything fits and functions properly.

This means that it is high time to make the cumulative technical knowledge of Werth available to a wider public. With this motivation, nights and weekends have been spent in the creation of a book for end users, with knowledge of the function and use of X-ray tomography in industrial metrology. This technology is presented for the first time with an emphasis on metrology.

This book, from the series "The Library of Technology," builds on the volume that appeared a few years ago, "Multisensor Coordinate Measuring Technology."

We hope that these two books from Werth find an interested audience, and lead to knowledgeable decisions.

Best wishes,

The Multisensor

Werth Shanghai

Werth Magyarorszag Kft. was founded in Hungary, under the direction of Mr. Tamas Csontos. Mr. Csontos has been able to collect many years of experience in the use of Werth multisensor measuring machines, as the Werth product manager at the Werth representative in Hungary. He is an expert contact for any technical questions about Werth coordinate measuring machines.

Managing Director Tamas Csontos

New activities have also begun in England and in Brazil. Here again, employees with many years of experience in 3D metrology have been hired to comprehensively advise our customers about "High Tech - Made in Germany".

Paul Nash, Managing Director, Werth UK

Nelson Rigon, Managing Director, Werth do Brasil

Credits

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