ROMER Arm for Tube-Bending Machines
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Dear readers,

the first half of the trade show season is behind us. With the CONTROL show in Stuttgart, the largest such event targeting the metrology market, and a slew of similar shows in France (see pages 8 – 9) and other countries, we at Hexagon Metrology can look at the first half of 2008 and be truly proud.

In February we launched the new Leica Absolute Tracker, arguably the finest laser tracker on the market, bar none. ROMER has introduced Multi Gage, an ingenious new portable CMM that delves well into single-micron accuracies territory. In short, we are not resting on our laurels; instead, we are steadily marching forward and re-asserting our position as a market leader.

In this issue, read about how ROMER arms are used as standard OEM equipment for tube-bending machines. Learn about the dimensional inspection at Snecma, a leading manufacturer of aerospace propulsion systems. The more technically inclined can learn more about how the issue of temperature compensation is addressed in modern laser trackers. And there is a very informative interview with the general director of our French organization, talking about the specifics of the French market and the strategies for the future.

As always, don’t forget to fill out the feedback card in the back and receive a nifty gift as our way of saying “thank you.”

Best regards,

Your measureup Editorial Team
Superiority of Leica T-Probe as ideal solution for accurate general precision industry applications re-confirmed
Following a similar purchase by Caterpillar UK, the company’s Polish subsidiary opted for the new Leica Absolute Tracker AT901 mated to a Leica T-Probe. This portable CMM system proves once again that it has no match when it comes to fulfilling the measurement needs related with to the inspection of large, complex objects. The Leica T-Probe can conduct measurements in a volume of up to 30 meters without having to reposition the laser tracker.

ATEC Spain adds two Absolute Trackers to its array of large-volume measurement systems
The Spanish service company already uses 8 laser trackers from Leica Geosystems for offering measurement services to many industrial segments in its market. To cope with additional demand for their services, ATEC just added an Absolute Tracker 901-LR with a Leica T-Probe, and another one with a Leica T-Scan. This will allow them to expand the portfolio of available services to include applications based on large-volume probing and scanning.

Airbus renews its commitment to laser trackers from Leica Geosystems
Three more Leica Absolute Trackers were added to Airbus’ large arsenal of Leica Geosystems industrial measurement equipment. The plant in Broughton, UK took delivery of its long-range laser tracker, while the one in Méaulte, France received a basic Absolute Tracker and another one capable of conducting 6DOF measurements with the T-products. This acquisition confirms once again the dominant position of Leica Geosystems’ laser trackers in the aerospace market, and the absence of any meaningful competition in the 6DOF segment in particular.

CogniTens provides 3D optical measurement know-how for aerospace industry
CogniTens know-how is sought-after in the aeronautic sector. Learn more about the Hexagon Metrology company’s 3D optical measurement solutions for this sector in the measure up aerospace special issue appearing in September 2008.
Leading Manufacturer of Tube-Bending Machines Incorporates ROMER Arm as Standard OEM Equipment

For more than 150 years the employees of Frederic Steimer’s family-owned company have been laying down the foundation for the present company.

Since 1955 MEWAG has specialized in tube-bending machines. Great value has been directed into the development of new bending methods and modern, easy-to-use controls.

When the Dutch subsidiary of Caterpillar was looking to replace its ageing tube-bending equipment used in manufacturing the hydraulic components for its heavy earth-moving equipment, it invited all global players in the tube-bending industry to submit a bid. In the end the decision was made to award the contract to MEWAG, a family-owned company with some 70 employees.

MEWAG hails from an idyllic village in the Emmenthaler Valley in Switzerland, better known for its world-famous cheeses than engineering prowess. Yet MEWAG got the contract because of its rock-solid reputation going back for more than 50 years, and the fact that it is the world’s only builder of fully electric (i.e. non-hydraulic) tube and profile bending machines that can offer machines that cover tube radii from under 2 to nearly 20 cm.

The advantages of going fully electric are manifold. With hydraulic bending machines, the hydraulic oil needs to be kept within
a specific temperature range, requiring an intricate heat exchange mechanism in need of constant maintenance. A typical bending machine may hold in excess of 300 liters of hydraulic oil, which can leak and also requires periodic changing. And, bringing mechanical parts into exact position hydraulically is difficult because hydraulic pressure is great at delivering concentrated force but is not particularly easy to dose.

The system MEWAG delivered to Caterpillar is a fully integrated, centrally controlled configuration comprising 4 tube bending machines of various capabilities. Importing CAD data, collision avoidance and simulation are fully inter-connected, giving operators full control over all crucial parameters.

Another argument speaking in MEWAG’s favor is its custom-made controller. With up to 15 CNC controlled axes, the controller is crucial in assuring smooth operation. The company’s proprietary MTC-XP controller generation offers an open automation system that integrates into all bending-machine subsystems. Sub-programs can be freely inserted, and the bending commands created can be displayed immediately in a 3D tube graphic. One of the highlights represents the so-called collision feature, which assures that machinery components and the tube itself stay clear of one another, which is paramount when creating programs for complicated tube shapes.

To provide feedback on how the tube machine is performing, a metrology system needs to be implemented, whereby finished tubes are inspected for dimensional integrity. Based on the feedback provided, minute adjustments are made in the bending program to compensate for whatever deviations may have been observed.

The delivery to Caterpillar marked MEWAG’s migration to an OEM metrology solution. MEWAG chose Hexagon Metrology to provide ROMER articulated arms for both the Caterpillar order as well as all future jobs of similar complexity. Andrew Barclay, General Manager, Hexagon Metrology Switzerland: “MEWAG is an important strategic partner for us in the very demanding field of providing complete high-accuracy tube bending solutions. Our solutions gives the customer a solution for both an in-process check and high level metrology data for conformity. The offering of these two top product combinations enhances the respective performance of both and enables us to meet real new challenges together. There is no better way to demonstrate the authority and competence of MEWAG than to provide both the bending and the measuring solution to his customer as a complete solution.”

Contacts

Full version of this case study available upon request using the feedback form in the back.

For further information, please contact your closest Hexagon Metrology Precision Center (see list on page 14).
www.mewag.com
www.portable-cmm.com
ROMER’s all-new, easy-to-handle portable CMM, with its innovative design and ROMER-exclusive features such as easy installation, plug-and-measure probes, and no-nonsense plug-and-play Multi Gage software make it the must-have 3D measurement tool for improving your productivity.

ROMER’s most accurate PCMM to-date: 1.2 m measuring volume with 5 µ accuracies
ROMER Multi Gage is the new industry-leading metrology tool for the dimensional control and inspection of features and geometrical shapes, providing the functionality of a 3D height gage with extremely high accuracies.

New plug-and-measure probes
Using Swiss-made multi-wire connectors from TESA, the same type used on the TESASTAR-M motorized probe head, ROMER’s longstanding automatic probe recognition feature is now coupled with a highly proven, robust kinematic joint connection. The probes are automatically recognized and identified by the software – just like on a large CMM – with no re-calibration of probes required when changing from probe to probe.

New innovative counterweight
Innovative counterweight design eliminates operator fatigue and assures the same high accuracy over the full range of measurements.

New wrist design
Ergonomic wrist with intuitive and easy-to-reach buttons provides superb comfort of use and increases productivity.

Easy installation and automatic report generation
No special installation required on-site; mount the Multi Gage directly on your machine and inspect parts without disassembly. No previous metrology knowledge is required, and measurement reports are generated automatically.

Internal battery
Measure whenever, wherever: the Multi Gage’s internal battery grants you full autonomy of operation. Enjoy the same functionality on the shop floor as in the metrology lab – with no need for an external power supply.
Number-One Priority: Staying Close to Customers

*measureup* interviewed Daniel Jullien, General Manager Hexagon Metrology SAS at the INDUSTRIE show in Paris in April 2008.

*measureup* We are at the Hexagon Metrology stand at the INDUSTRIE Paris show, the most important industrial metrology trade show in France. Looking at the booth, it looks different from all previous booth designs. Rather than obtaining one large booth space, the company chose to get four corner booths located at the intersection of two major pedestrian walkways. What was the reasoning behind altering the existing booth concept?

**Daniel Jullien:** We came up with a rather simple idea about how to maximize foot traffic at our booth. By bringing the booth to the intersection of two major foot traffic arteries connecting two main visitor halls, we have made the booth much more accessible and at the same time more attractive for our visitors. Rather than having to locate our stand on the exhibition map, our customers will find us simply by going down the isles from one hall to the other. The booth becomes a focal point, and many visitors who would otherwise not see our booth have a very natural way of reaching us. Instead of bringing the customers to us, we have come to them. The amount of foot traffic we are able to generate is bigger than anything we have had in the past. Even if visitors haphazardly comes to our booth, they will inevitably look around because the booth space is very large. Plus, we are profiting from the nice side-effect that the two major pathways that form the intersection at which our four corners are located also become an integral part of the booth, thus increasing the effective amount of space allocated to our product exhibits. There is less overcrowding of products, and the flow of people is more natural.

As you can see, we have made a shift away from focusing on products and are instead focusing on applications. One corner is devoted to automotive applications and features a cross-section from several different brands that tackle the automotive market. Another corner deals with aerospace applications. In the third corner we have high-precision applications that delve into the single-digit micron accuracies, and in the last corner we have the unique exhibition of products from our Tesa brand. By bringing products together according to application and not brand name, we are broadening the horizons for our customers, who might otherwise be side-tracked into thinking that their particular application can only be dealt with using only one type of metrology equipment. For example, a customer who in the past might have been using a large stationary CMM might be interested in migrating to a laser tracker,
which also offers a large measurement volume and can also be brought directly to the measurement object.

If this new booth layout proves to be a success, we will continue using it in the future. We will perform a thorough evaluation after the show and decide how we want to proceed in the future.

**measureup** As mentioned earlier, this is the single most important metrology trade show in France. What have been some of the recent market developments in your home market?

**Daniel Jullien:** The direct result of the brand name consolidation that has been happening under the Hexagon Metrology umbrella is that we are the number-one provider of metrology solutions in France, bar none. We are not only the largest supplier, we also have the strongest support network around. In France, we have two main types of customers — automotive and aerospace. With the general trend toward more accurate manufacturing with extremely tight tolerances, we have been pushed to the forefront of being incorporated into all important manufacturing processes. What was a “nice-to-have” feature just a decade ago is a “must-have” feature now, and with industrial metrology gone mainstream, our customers need absolutely dependable equipment with superbly reliable support structure to back it up. We are in the process of consolidating our sales and support network, strongly focusing on key accounts who need to be given king treatment at all times. We are avoiding having too many different people going to one and the same customer; our customers expect to have one, central point of contact who will answer to all of their needs, be it for new equipment acquisitions or in providing support for the existing products.

Many of our key customers have operations in several countries, not only in the EU but also beyond European borders. For example, Renault has expanded to Romania, Russia and India, and their manufacturing processes are very closely related, mandating the use of metrology equipment that does not vary from location to location. As a result, the Renault plant in Romania can count on the same support team that our French locations do, because the physical location of the customer’s plant is irrelevant — what counts is providing the same kind of quality throughout. Besides, in today’s world, everything is inter-connected, and we needed to show very strong leadership in this field.

The most important thing is to establish personal, long-lasting relationships with our customers. Such relationships take a long time to nurture but in the long run, the effort pays off: if customers grow to expect nothing but excellence from us, they will have no reason to shop around, and customer loyalty is the best recognition of success we could ask for.

**measureup** The French government has removed some bureaucratic hurdles associated with starting new businesses or securing government-backed financing. What kind of impact have these changes had on your business?

**Daniel Jullien:** Earlier I spoke about the importance of automotive and aerospace customers to Hexagon Metrology, but we have also not lost sight of small- and medium-sized companies. With better government regulations and more readily available financing, more jobs are staying in France and are not being shipped overseas. These smaller companies are also extremely important to our business, and making sure that their needs are met is paramount. We have more sales engineers visiting prospective customers and performing product demonstrations, which helps us establish a great reputation on the market. Many of these fresh start-ups need state-of-the-art metrology solutions, and we are absolutely able to deliver in that respect. Even though the classical stationary CMM market is approaching maturation, the newly expanded product portfolio that includes some cutting-edge technologies is helping us secure an important chunk of this emerging market in France. With the right sales people aboard, we are putting this new technology out in the field.
Case Study

Automated large-scale serial inspection

Snecma Propulsion Solide designs, produces and markets rocket engines and composite materials for the defense, aviation and aerospace industries and other related fields. Within the French national defense programs M45 and M51 as well as the European space programs such as Ariane 5 and Vega, Snecma is a first-choice business partner.

With the armament and aerospace industries, manufacturing precision and the assembly of parts are hugely important. Damien Darriet is in charge of service methods and non-destructive dimensional control at Snecma. His department tackles the development of the solutions for the dimensional and material inspection, while at the same time focusing on modifying the existing equipment in order to keep the processes as simple as possible for the equipment users. Darriet explains: “How we perform dimensional inspection at Snecma is often determined by very unusual factors. The pyrotechnical regulations are extremely tight. For example, no more than 5 people are allowed to work on a single piece of equipment at any one time. The accuracy requirements are just as stringent. The internal rules mandate that the measurement uncertainty of the measurement equipment (standard deviation) is 16 times better than the assembly accuracy. Besides, the sheer size of our equipment – up to 12 m in height and 50 tons of weight – limit the kind of measurement equipment we are able to use.”

As Snecma started this strategic activity, only theodolites were capable of meeting the requirements resulting from the size of the equipment that was being measured. The first theodolites installed were made by Kern, and were mounted onto the constructions with which the coordinates of points found on the equipment could be assigned to spatial segments in the room. This way, the metrology technicians inspected the jets found on the Ariane 5 rocket. After Kern was acquired by Leica Geosystems, the theodolites from the TM5100A series were deployed, and were used to inspect the different stages of the M51 rocket. Darriet expands: “The Leica TM5100A was exactly what we needed to inspect spatial sections with large dimensions – but the preparations and the actual measurements took too long. We had to take aim at the large measurement objects and then deploy three theodolites and a PC. The theodolites were located on heavy-duty industrial tripods at a height of one to three meters. We needed to use a hoisting platform for our personnel. At least four people were needed to inspect a single measurement object. Simply put, it took over a week to measure a single stage of the M51 rocket.”

During a theodolite training session Snecma started looking for a more automated measurement solution that would substantially reduce inspection times while staying within the accuracy requirements. A solution relying on a laser tracker seemed to be the most appropriate. The four companies that answered the bid invitation had to offer a long-term solution that would run for at least 15 years and was easy to use. Darriet remembers the solution proposals submitted by two other laser tracker manufacturers and a company that offered a solution based on photogrammetry: “The first solution required the acquisition of an articulated..."
The laser tracker system fully automatically calculates all parameters and creates measurement reports in Excel in order to visualize the individual points and to facilitate easy data manipulation with simple mathematical methods. Using a laser tracker lets Snecma conduct accurate and dependable measurements of aerospace parts. Darriet explains: “According to their definition, aerospace parts require a direct inspection relative to a digital model. Measuring individual points and fine-adjusting the object surface allow for immediate comparisons to digital models. During the manufacturing process, newly assembled parts have to be thermally treated in a special oven, whereby the temperature plays a pivotal role. The temperature and the pressure change the geometric form of an object. After being put through the oven, a part needs to be inspected again. With certain sheeting parts, as little as 500 g of pressure are enough to deform it. The dimensional inspection has to be conducted briefly before the part enters the oven, and then shortly thereafter. Only a contactless measurement system located next to the part can solve this challenge. The Leica Geosystems laser tracker, matched to the hand-held, large-volume Leica T-Scan scanner, was the perfect solution. The first measurement objects were inspected through Leica Geosystems directly, and additional parts were entrusted to a service company. It quickly became apparent that the extra costs resulting from having to re-manufacture those parts that were not inspected and do not correspond to the CAD data are several times higher than an investment in an entire measurement system! Snecma is considering ordering a Leica T-Scan system.

Damien Darriet sums up: “In our business, contactless, high-accuracy inspection is the future of metrology. Not only the departments engaged in product development are aware of this, but also the colleagues who research the behavior of different materials in various production cycles under high temperatures and pressures or inspect them for material deposits or stability. Today, Leica Geosystems is the only manufacturer that can deliver metrology equipment that corresponds to our requirements in both the accuracy and the measurement volume.”
A laser tracker is a self-contained measurement instrument that needs to deliver reliable measurements regardless of the instrument or ambient temperatures or how quickly they change. The instrument may be brought in from storage into a cold shop floor environment, or the surrounding temperature might change substantially over the course of a day. The laser tracker’s internal components generate heat, and the environment also heats up the laser tracker as a whole. Either way, the laser tracker is not a monolithic design; rather, it consists of internal parts made of different materials that react differently to changing temperatures. Different metals have varying expansion coefficients, not to mention glass prisms and other components. The Leica Absolute Tracker tackles these phenomena in many different ways, deploying both mechanical and mathematical methods to compensate for temperature variations both within the laser tracker and in its working environment, thus staying well ahead of the competition and delivering rock-solid performance in all operating conditions.

The first front on which the Absolute Tracker performs temperature compensation is in tackling the effects of different expansion coefficients of metals and glass. Namely, the optical axis where the ADM (absolute distance meter) beam is combined with the IFM (interferometer) beam needs to stay aligned despite the variations induced by changing temperatures.
The heat generated by the internal components, combined with the variations in the ambient temperature, changes the dimensions of the prism unit. This unit is made of aluminum and glass, which have different expansion coefficients. The aluminum casing elongates under the influence of heat, creating a change in length $\Delta_1$. The glass prism changes its length in the amount of $\Delta_2$. The engineers have accounted for this discrepancy by resorting to a well thought-out, clever location of binding points between the aluminum and the glass prism. The different expansion coefficients are thus accounted for, resulting in the exit beam that remains true to its desired position and parallelism in the entire operating temperature range.

The second way the Absolute Tracker confronts the effects of heat on beam stability is by making sure that the so-called ADM point of origin is always the same. When the mechanical ADM assembly elongates, it sets the point of origin off. The distance between this imaginary point and the axis of rotation of the mirror at the beam’s exit point is crucial. By continually keeping track of the inside temperature, a mathematical algorithm keeps the offset distance at the same value.

Last but not least, the Absolute Tracker boasts an industry-leading warm-up phase of a mere 5 minutes. This time refers to the time required between powering up the laser tracker and it being able to deliver consistent measurement results. The previous LTD series needed 20 minutes, while competitive products require even longer. The Absolute Tracker uses a patented solution to reducing the warm-up phase to only 5 minutes. The basic principle is as follows: when the Helium-Neon laser is first fired up, the laser modes within the gain profile are changing because the laser is in the process of reaching a stable temperature. Only when the inside temperature is in an equilibrium with the ambient temperature does the modes value maintain a constant value. As long as the resonator inside the laser is expanding, the modes are changing. The previous generations of laser trackers used to measure the internal temperature and then waited until the resonator passively reached a temperature equilibrium with the surroundings. In contrast, the new Leica Absolute Tracker measures the resonator’s starting temperature, measures the ambient temperature, and then calculates the number of lasing modes that have to pass through. Differently put: the temperature difference between the present resonator temperature and the ambient temperature corresponds to a specific number of modes. Knowing this number of modes, the laser tracker lets the Peltier element (a thermoelectric cooler, TEC) “burn” at full power until these modes have passed through, and then shuts the heating down to an optimal lower power which allows for cooling or heating the system depending on the ambient temperature. Knowing the exact time needed to heat up the laser until the operating temperature is reached instead of waiting for this to happen on its own accord substantially reduces the warm-up time. This process is supported by an active temperature regulation system which suctions ambient air inside the housing. Special care was taken to avoid water condensation on the optics by appropriately packaging the internal components.
The large-volume, hand-held Leica T-Scan made Italian artist Roberto Cuoghi's work easier. For the creation of a monumental sculpture, Leica T-Scan delivered the digital basis by scanning an original statuette of Pazuzu, the king of the wind demons in the Assyrian and Babylonian mythology. The almost 6-meter tall Pazuzu sculpture could be seen at the Castello di Rivoli Contemporary Art Museum near Torino, Italy in July 2008.
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