HEXAGON
MANUFACTURING INTELLIGENCE

SOLUTIONS BROCHURE

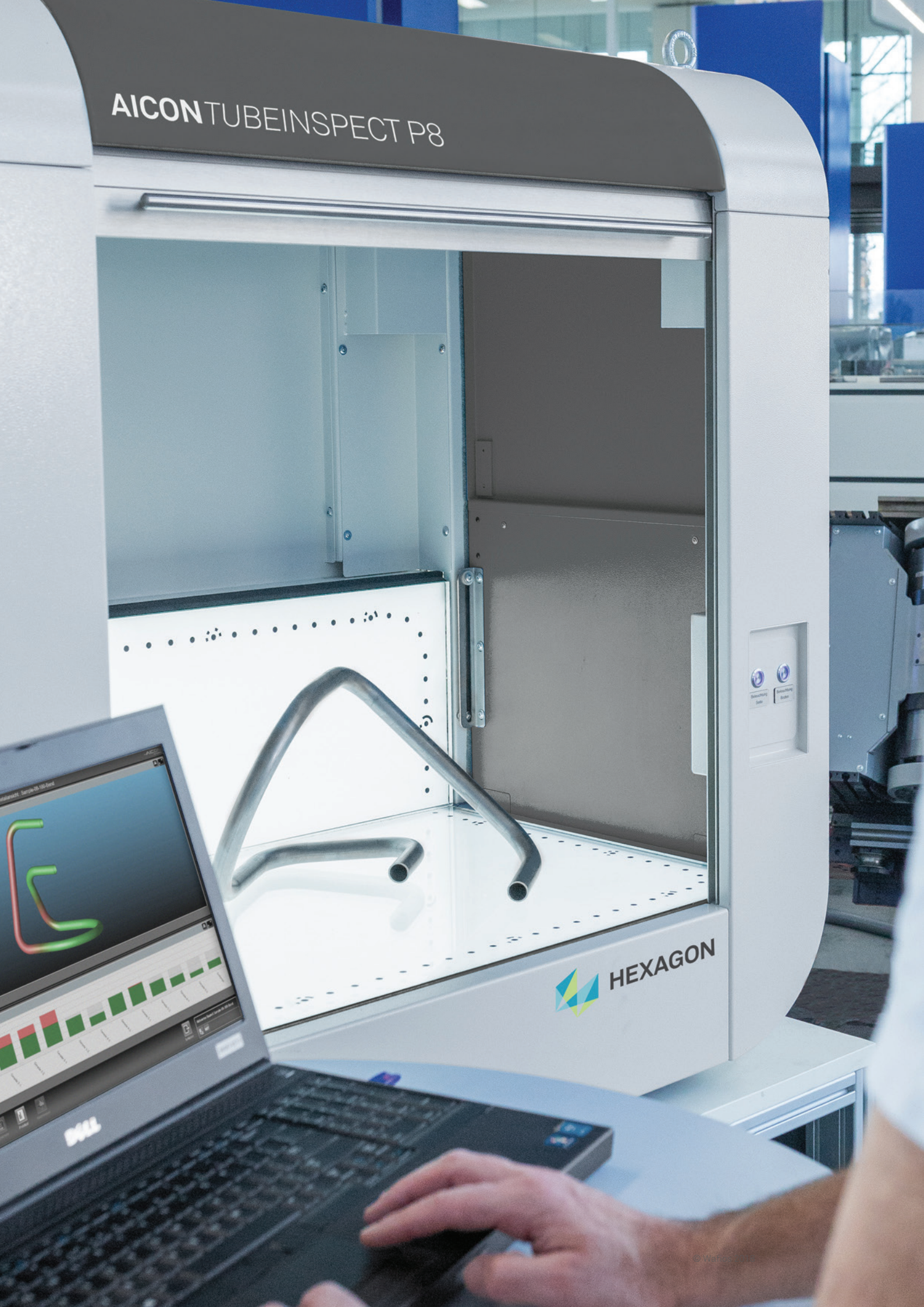
TUBE AND WIRE INSPECTION SOLUTIONS

METROLOGY FOR THE TUBE AND WIRE PRODUCTION INDUSTRY

TUBE AND WIRE MEASUREMENT
ANY SHAPE, ANY SIZE, ANYWHERE

Bent tubes and wires are everywhere. Often invisible to the casual observer, they're simply indispensable for the function of much of the equipment of both day-to-day life and industrial production. Brake and fuel lines, exhaust systems, air conditioner lines or seat structures in automotive engineering; hydraulic pipes in aircraft ship or machine construction; tubes in the production of furniture and housewares – innumerable pipes and tubes of all sizes, diameters and forms are bent and processed every day for a wide variety of purposes.

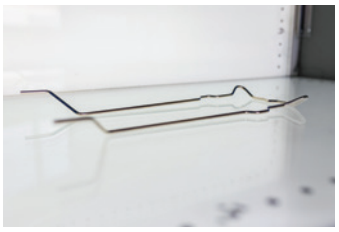
The comprehensive range of tube and wire measurement systems from Hexagon Manufacturing Intelligence delivers solutions tailored to a variety of applications. Designed to fully meet the demands of inspection, manufacturing, gauging and reverse engineering processes, they combine high-precision hardware engineering with innovative and intuitive software platforms. The result is a product portfolio tailored to support cost-effective production and meet the challenges of every application in the tube and wire manufacturing sector.


AICON TUBEINSPECT P8
HEXAGON
DELL

BENDINGSTUDIO WITH TUBEINSPECT

The high-accuracy standard in non-contact tube measurement, the AICON TubeInspect range represents the height of what's possible with optical scanning in the tube and wire production industry. Powered by the dedicated BendingStudio software platform and available in both an industrial-sized TubeInspect P16 version and a smaller TubeInspect P8 variant, high-quality analysis of tubular parts has never been so simple.

Thanks to state-of-the-art technology, TubeInspect exceeds even the highest requirements for accuracy and speed in tube and wire assessment. The integrated long-life and low-maintenance LED illumination technology guarantees a particularly smooth illumination of the measuring field. High-resolution cameras with GigE technology ensure synchronic capture of the measuring object within milliseconds, while the innovative three-dimensional glass reference surface is highly precise and offers long-term stability.




> TubeInspect is another step towards providing the right quality to our customers. Our production becomes even more cost-effective, which also benefits our customers."

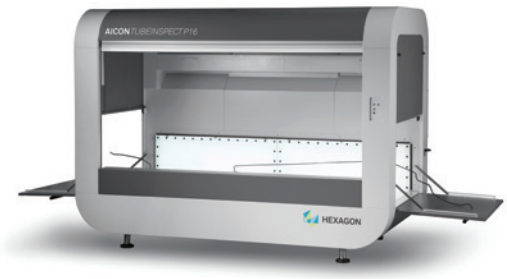
Roger Olofsson
Proton Engineering AB, Sweden

NEAR-INSTANT HIGH-END MEASUREMENT

TubeInspect is a high-end metrology solution built on a platform of innovative technology and designed to make fast tube and wire measurement an easy part of the manufacturing process.

- Suitable for rough production environments.
- Measurement within seconds after placing tube into the measurement system.
- Highly reproducible user-independent results.
- Applicable either for serial inspection of high-volume batches or for reverse engineering and prototyping.
- Measures also flexible, malleable or freeform bent tubes.
- Can entirely replace expensive mechanical gauges.
- Calculates sheath deviation as well as bending points and bending data.
- Efficient sending of corrections direct to the CNC bending machine.
- Long-term investment based on high build-quality.
- Quick return on investment due to less waste and higher machine availability.

SPECIFICATIONS



TUBEINSPECT P-SERIES	P8	P16
Measurement area	1000 mm x 580 mm x 400 mm	2600 mm x 1250 mm x 700 mm
Measurement speed	3 sec. for one measurement	3 sec. for one measurement
Sensor	8 high-resolution digital cameras with GigE technology	16 high-resolution digital cameras with GigE technology
Reference field	Three-dimensional glass reference	Three-dimensional glass reference
Dimensions (W x D x H)	1140 mm x 746 mm x 1140 mm	2980 mm x 1640 mm x 2300 mm
Weight	240 kg	1200 kg
Power requirement	100-240 V AC 400 VA	100-240 V AC 1300 VA
Working temperature	+5° to +40° C	+5° to +40° C
Relative humidity	10% - 90% not condensing	10% - 90% not condensing
CE Conformity	yes	yes

SOLUTION	P8	P16
Tube diameter	1.00 mm to 125 mm	3.00 mm to 200 mm
Max. tube length	Unlimited, with repositioning	Unlimited, with repositioning
Bending angle	1° to 340°	1° to 340°
Min. push between two bends	Bend in bend and freeform possible	Bend in bend and freeform possible
Software	BendingStudio	BendingStudio
Measurement accuracy for tubes and wires	0.035 mm sheath deviation (1σ)	0.085 mm sheath deviation (1σ)


ABSOLUTE ARM
85

BENDINGSTUDIO WITH ABSOLUTE ARM

Combining the established laser scanning technology of the Absolute Arm range with the leading tube and wire analysis capabilities of AICON BendingStudio, the BendingStudio with Absolute Arm system is the perfect portable complement to the AICON TubeInspect series.

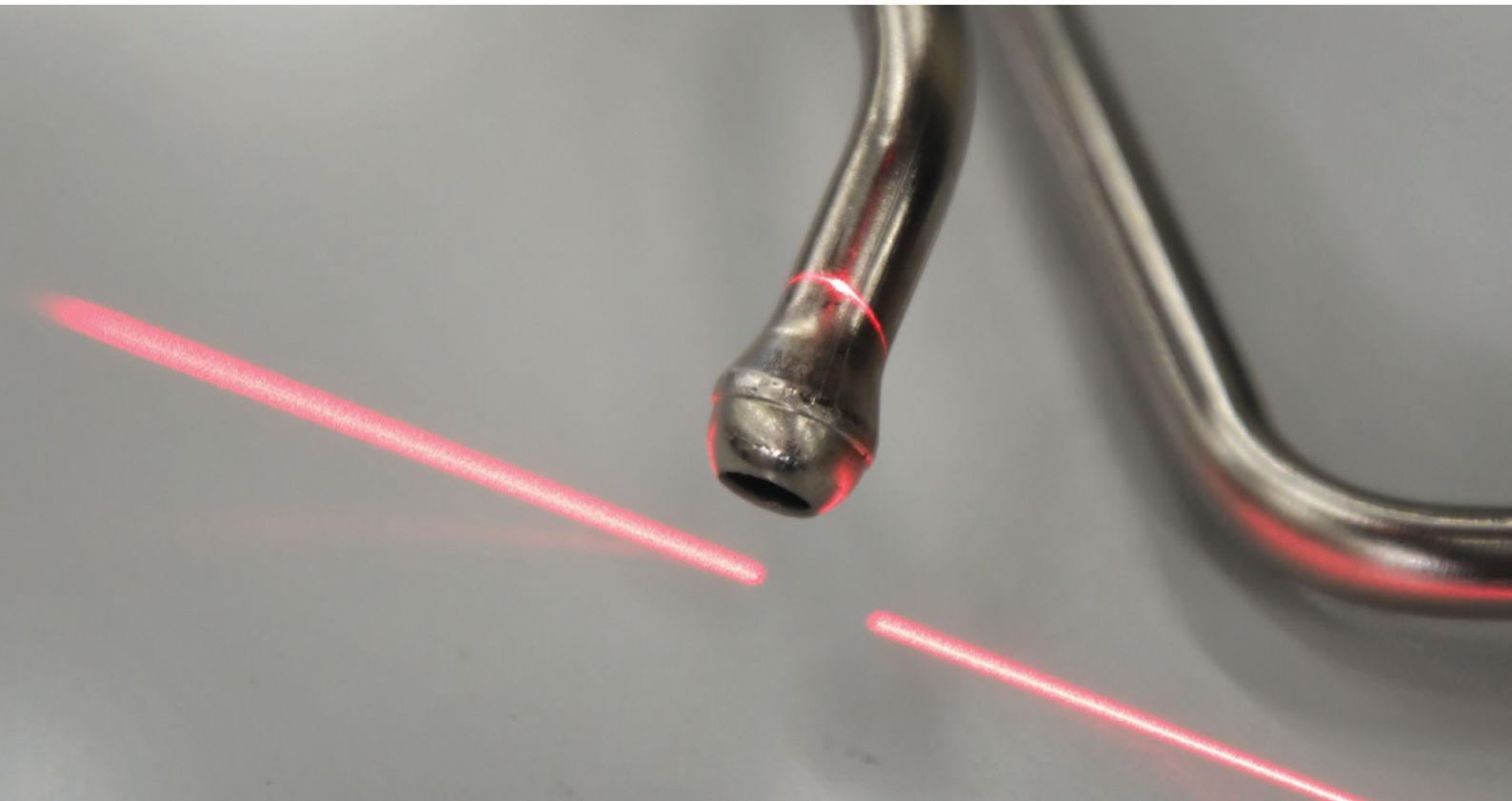
Working from the same innovative software platform as TubeInspect, BendingStudio with Absolute Arm allows for the manual collection of high-accuracy scan data of any tube or wire. Leveraging the leading measurement technology of the RS5 Laser Scanner, full non-contact measurement and geometry definition is quickly achievable with no need for special clamping or alignment procedures.

Flexible or rigid, freeform or angular, at the bending machine or in the centre of the production process, BendingStudio with Absolute Arm is a highly adaptable solution for high-quality tube and wire measurement.




AN UNRIVALLED SOLUTION FOR TUBE AND WIRE ANALYSIS

- Collect accurate tube and wire geometry data without scanning the entire tube surface.
- Functional as an optical tube gauge for flexible, malleable tubes of any length and of diameter up to 300 millimetres.
- Accurate scanning on tubes of a wide variety of materials, colours and surfaces.
- Go beyond bending points and bending data to more accurate measures of sheath deviation.
- Communicate corrections directly to the CNC bending machine
- Automatic correction of self-weight deformation effects in thin or elastic workpieces.
- Highly portable system suitable for tube and wire measurement in any place needed.
- Repeatable, user-independent measurement results.
- High-definition scanning delivers incredibly fast determination of full tube and wire geometries.
- Easy measurement of in situ parts in hard to reach areas.
- Modular wrist allows total control during measurement.



SPECIFICATIONS

SOLUTION SPECIFICATIONS

Measurement range (Ø)	6 different sizes available, up to 4.5 m
Weight	8.8 kg to 10.5 kg
Measurable tube diameter	3.0 mm to 300 mm
Max. tube length	Unlimited, with repositioning for leap frog relocation
Bending angle	1° to 340°
Geometries	Standard angular, bend-in-bend or freeform
Measurement accuracy for tubes and wires	0.05 mm sheath deviation (1σ)
Certification	ISO 10360-8 Annex D

RS5 LASER SCANNER SPECIFICATIONS

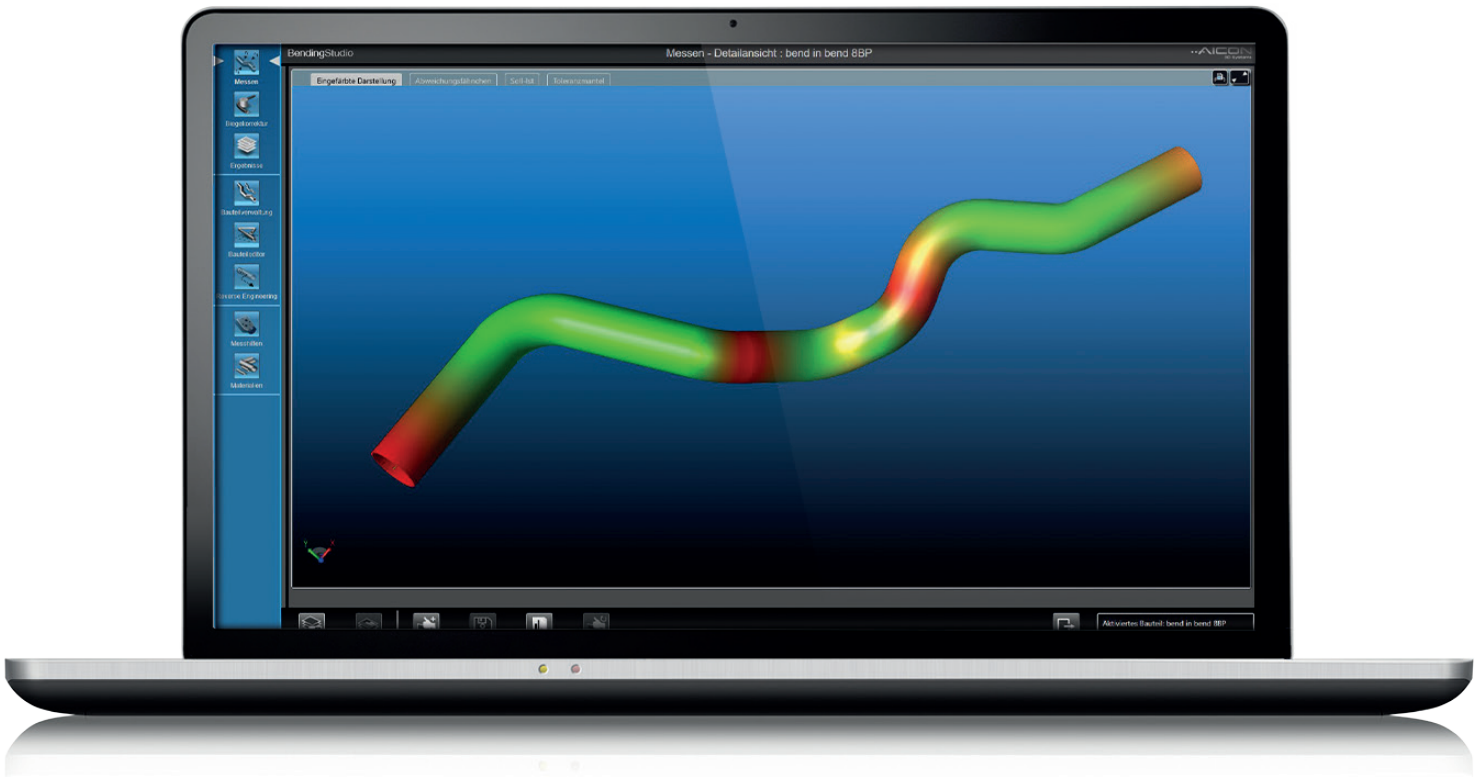
Point acquisition rate	752 000 points/s
Line rate	Max. 100 Hz
Line width (mid range)	115 mm
Stand off	165 ± 50 mm
Accuracy	0.028 mm (2σ)
Minimum point spacing	0.011mm (line)

BENDINGSTUDIO

The BendingStudio software platform links all data and process around the production of bent parts – from design and process planning to manufacturing and quality control. BendingStudio is the only tool to meet and combine these requirements with an emphasis on metrological processes.

With clear actual-nominal value comparison allowing for fast evaluation, the implementation of multiple inspection plans with individual measurement criteria for each part, and the presentation of results remaining the same no matter the origin of the data, BendingStudio is the complete package for complex analysis and management of tube and wire production.

With the capacity to work with measurement input from both AICON TubeInspect and Absolute Arm systems, as well as the Leica Absolute Scanner LAS, BendingStudio is a key part of any tube and wire manufacturing toolkit.



INNOVATIVE BENEFITS

CONNECTIVITY - OPTIMISED DATA HANDLING

Working places, across production, quality control and design offices, are connected and data is shared and can be edited from authorised persons. Communication between human, machine and product – BendingStudio links all together.

SIMPLY USABLE

BendingStudio works with a simple and clearly structured handling concept and provides measurement results within seconds. Many small tools ease daily work in all areas of bent part manufacturing.

USER-FOCUSED SOLUTIONS

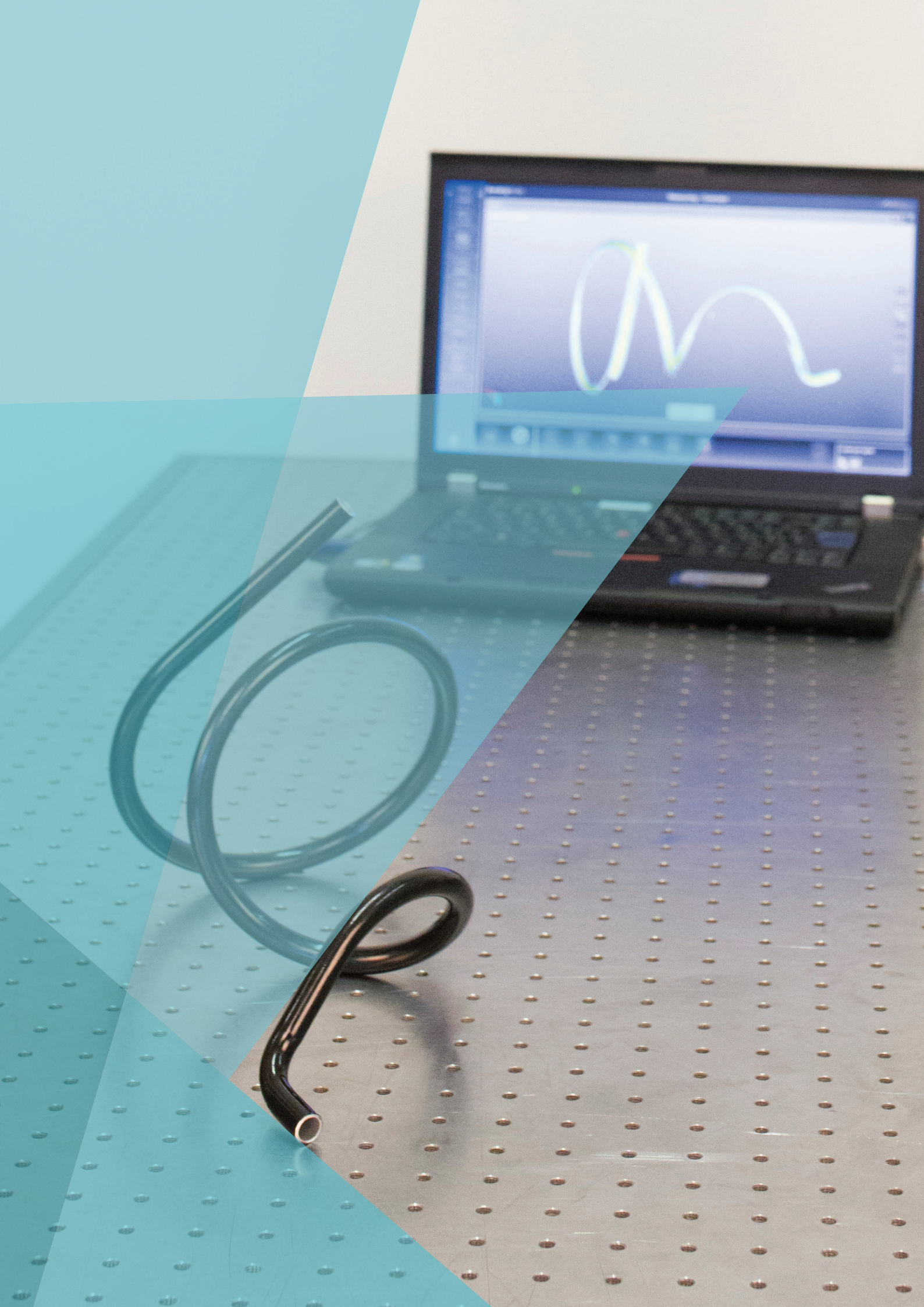
Users in various process steps can have quite different requirements. BendingStudio provides one-click functionality for measurement results, data import and export, and interfaces for statistical process control such as qs-STAT or printed reports in multiple languages.

BEST FUNCTIONS

BendingStudio closes the gaps between the different evaluation methods for bent parts by allowing for different measurement plans to be assigned to a part. That means the requirements of the drawing as well as certain mounting conditions can be displayed from the same measurement.

FUTURE FIT

BendingStudio is built on a data concept that is fully prepared for the demands of future applications, making it a secure investment not matter how business needs change in the years ahead. Whether involving connection to bending machines, different measurement systems, integration with new manufacturing technologies or the demands of new applications, BendingStudio will be ready.



BENDINGSTUDIO PACKAGES

FUNCTIONALITIES

		EFFICIENT	TUBE	WIRE	PRO
MEASUREMENT SYSTEMS	Compatible to Absolute Arm with Scanner (RDS) and TubeInspect (TubeInspect Controller)	●	●	●	●
DATA BASE	Part data base, material data base, im- and export of part data, support of many file formats, user management	●	●	●	●
OPTICAL GAUGE	Virtual gauge inspection with sheath tolerance for centerline (also applicable for free-formed tubes) and bending points, comparison NOMINAL to ACTUAL	●	●	●	●
BEND DATA	Calculation of bending data (LRA/PBR, XYZ) for parts with fixed bending radius, comparison NOMINAL to ACTUAL	●	●	●	●
BENDER INTERFACE STANDARD	Open bender interface, calculation of bending corrections with fixed radii, virtual gauge simulation to make effects of bending correction visible, file-based export of correction data, all major standard bender formats included NOTE: bender must be enabled to load up correction data	●	●	●	●
REVERSE ENGINEERING	Reverse engineering to acquire tube geometry data from parts, applicable also for free-formed tubes	●	●	●	●
STATISTIC	Export of measurement results in DFQ file format (qs-Stat®) and ASCII format (text file)	●	●	●	●
REPORT	Viewer, report generation in multiple languages Customization of report templates	●	●	●	●
FUNCTIONAL DIMENSIONS	Inspection criteria for functional dimensions (e.g. point to point, point to plane, etc.), dimension types: distance, angle, length)		●	●	●
DEFLECTION COMPENSATION	Automatic correction of self-weight deformations in thin or elastic work pieces (e.g. long thin or rubber tubes), not appllicable for free-formed tubes)		●	●	●
FORMED ENDS DIAMETER CHANGES ADAPTERS	Measurement of tube ends with rotationally symmetric formed ends, measurement of positions of diameter changes, tube end-point measurement with straight-on and elbow adapters ONLY WITH TUBEINSPECT: Measurement with TubeInspect 7-point adapters to determine position and direction of fixings, flanges and attachments		●		●
BENDER INTERFACE FREEFORM	Open bender interface, calculation of bending corrections including correction values for bending radii, file-based export of correction data, NOTE: bender must be enabled to load up correction data			●	●
BRANCHED TUBES	Measurement of branched tubes with multiple classically bended components				●
HOSES	Straightening of hose components				●

OPTIONAL MODULES

		EFFICIENT	TUBE	WIRE	PRO
CAD-WIZARD	Import and export of IGES and STEP files, import by automatic or interactive selection of bending data, export of tube geometry in IGES and STEP format				
OFFLINE	Off-line license with same modules as main licenses but without interface to measurement system				
OFFLINE NETWORK	Off-line license with same modules as main licenses but without interface to measurement system, network license for one user				
NETWORK SERVICE	Data storage and service on external server				

BendingStudio Packages include 12 months' SMA

● functionality included

TUBESHAPER WITH ABSOLUTE ARM

The TubeShaper with Absolute Arm system is a completely integrated hardware and software solution for the measurement of tubes, pipes, wires and hoses. Combining the non-contact measurement capabilities of the Absolute Arm portable coordinate measuring machine and the purpose-built tube measurement software TubeShaper, the system offers total measurement versatility.

Tubes can be checked throughout the entire manufacturing process in one simple package, from supplying correctional data to a CNC tube bender to checking the position of welded accessories like flanges, brackets or hangers. The system makes it easier than ever to spot problems on the shop floor, saving time and reducing waste.

Available as a turnkey hardware and software package or as an upgrade to existing portable measuring arms, TubeShaper with Absolute Arm is a certified portable measuring solution designed for engineers, quality managers and shop-floor operators alike.

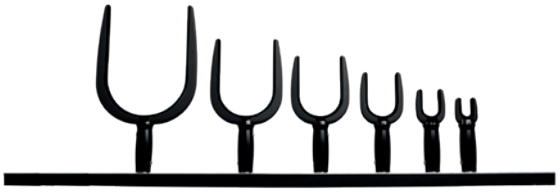



PROVEN ABSOLUTE HARDWARE

- Six non-contact tube probes available for tube diameters from 4 mm to 130 mm, while the supplied touch probe can be used for larger tubes.
- Automatic probe recognition and repeatable mounting mean probes can be swapped without recalibration, ideal for measuring geometric features like flanges, brackets and hangers or certifying Go/No-Go fixtures.
- Non-contact tube probes enable the inspection of almost any tube material, including malleable surfaces.
- Portable 6-axis or 7-axis arms available in seven sizes, ranging from 1.2 m to 4.5 m measurement volumes.
- Two dedicated special 'T' Models of the Absolute Arm, with a stronger counterbalance for improved ergonomics, faster measurements and zero operator fatigue when performing high-volume measurements.
- Easy-to-use arm requires no warm up or encoder referencing – simply switch on and it's ready to measure.
- Acoustic, haptic and visual feedback helps minimise user error, while a Wi-Fi connection is also optionally available.
- Full range of accessories includes additional probes, tube clamps, measurement tables and raisers to suit the working environment.
- Every Absolute Arm is delivered fully certified to the ISO 10360-12 standard for probing. This is an extremely demanding internationally recognised standard for defining the probing accuracy of portable measuring arms.

SPECIFICATIONS

Measurement volume	1.2 m to 4.5 m
Tube diameter	4 mm to 130 mm
Working temperature	+5° to +40° C
Storage temperature	-30° C to +70° C
Relative humidity	10% to 90% non-condensing
CE conformity	yes
Power requirement	universal worldwide voltage 110V - 240V



TUBE PROBE RANGE AND TUBESHAPER WITH ABSOLUTE ARM ACCURACY

Tube Probe Size 1	Tube Probe Size 2	Tube Probe Size 3	Tube Probe Size 4	Tube Probe Size 5	Tube Probe Size 6
Tube diameters of 4 - 13 mm	Tube diameters of 6 - 20 mm	Tube diameters of 10 - 40 mm	Tube diameters of 12 - 65 mm	Tube diameters of 20 - 85 mm	Tube diameters of 30 - 130 mm

System accuracy (Absolute Arm + Tube Probe) = E_{UNI} value + 0.1 mm

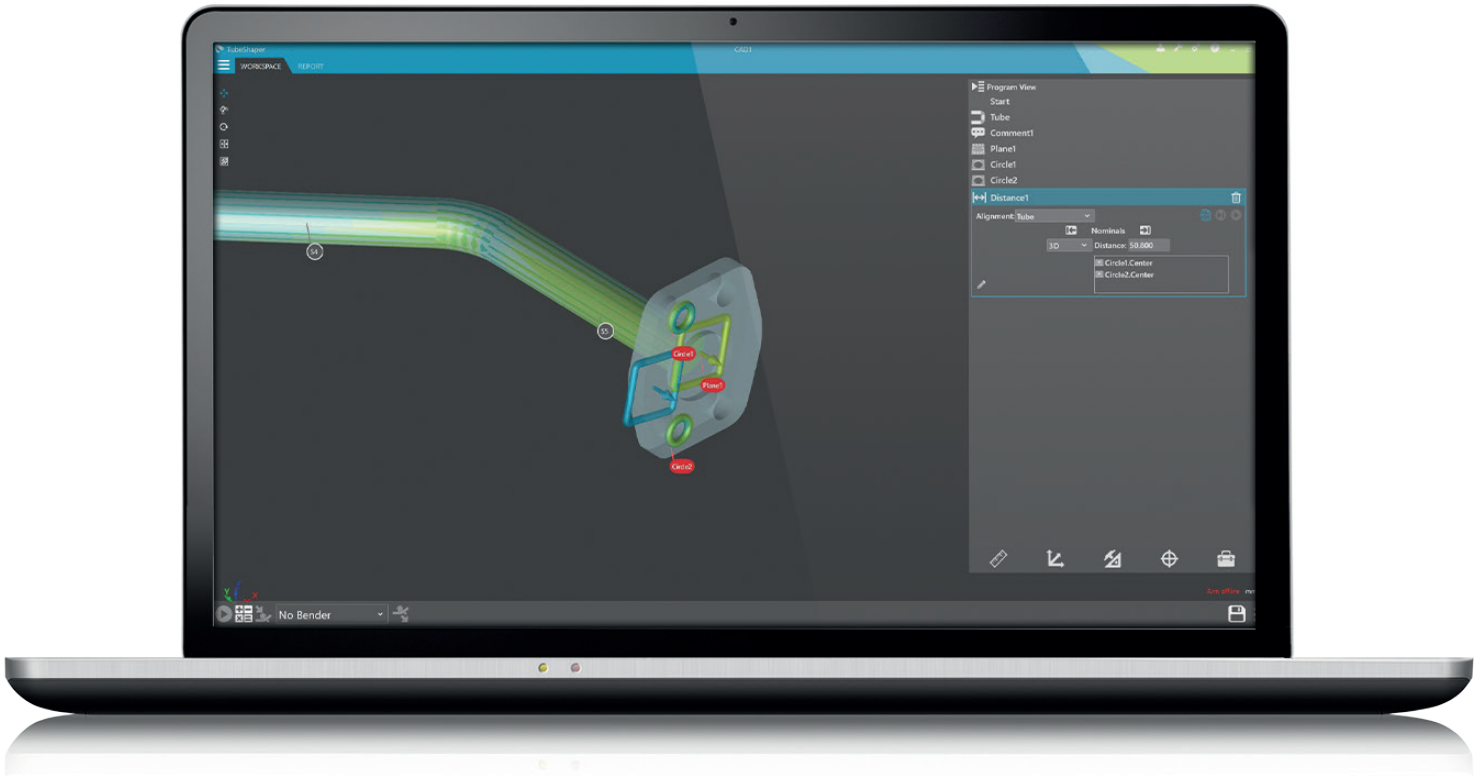
Model	E_{UNI} [1]	P_{SIZE} [2]	L_{DIA} [3]	P_{FORM} [4]	Weight[5]	Max. reach
8325T	0.058mm	0.025 mm	0.066 mm	0.048 mm	8.1 kg	2.73 m
8330T	0.084 mm	0.036 mm	0.089 mm	0.068 mm	8.4 kg	3.23 m

[1] E_{UNI} Maximum permissible longitudinal error of measurement – according to ISO 10360-12:2016
[2] P_{SIZE} Maximum permissible probe deviation, size – according to ISO 10360-12:2016
[3] P_{FORM} Maximum permissible probe deviation, shape – according to ISO 10360-12:2016
[4] L_{DIA} Maximum permissible probe deviation, position – according to ISO 10360-12:2016
[5] Weight Weight without probe

TUBESHAPER PURE VERSATILITY

TubeShaper combines the best cutting-edge technology to create a highly advanced yet totally intuitive software proposition. Designed to maximise efficiency and reduce waste, TubeShaper can connect directly to CNC tube bending machines, automatically create measurement plans and import CAD models, all within a user-friendly package.

With a state-of-the-art user interface designed to fully harness the measurement potential of the Absolute Arm for all tube inspection applications, TubeShaper comes replete with a wide range of valuable functions that make tube and wire inspection easier and faster than ever before, guaranteeing time and cost savings right there on the shop floor from within a single simple package.

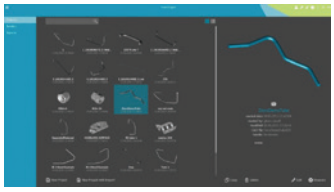


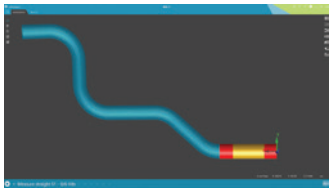
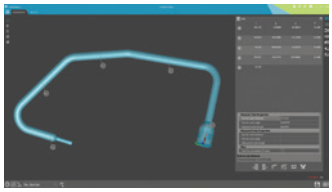
INNOVATIVE BENEFITS

- Supports touch-probe measurement as standard, for measuring welded brackets and flanges.
- Real-time CNC bending machine connection allows measurement corrections to be implemented easily, minimising waste and increasing process efficiency.
- Easy creation of spring-back and elongation library, to be stored and applied to any tube later. Tube geometry (LRA / YBD data) is automatically extracted from any imported CAD model.
- Automatic report creation makes tracking bender performance over time much simpler. Springback libraries can be updated and shared in a network, so different seats of TubeShaper can always update and access the most recent data.
- Dual-profile graphical user interface with touchscreen compatibility streamlines training as users learn only what they need.
- Sketch function for creating a first tube, by simply picking up hard points with the touch probe.
- Barcode scanner compatibility makes finding and loading the right tube data faster.
- Measurement plans can be created automatically at first-part inspection or set up offline to minimise downtime and support high-speed batch measurement.
- Supports in-bend measurement.
- Tube definition by keying in LRA (YBD) or xyz values, CAD model import, reverse engineering, SKETCH function.
- One seat of TubeShaper can connect to multiple tube benders (of the same type).

SPECIFICATIONS

CAD model import formats	IGES, STEP, VDA, PAR, PRT, CAT, DXF, X_T, CAD, ASM and IAM
CAD export formats	Tubes and features can be exported as IGES
Data import	SV, GTT (G-Tube), ds (DOCS)
Data export	IGES, SV
Measurement report export	PDF, CSV
Available languages	English, French, Spanish, Italian, German, Simplified Chinese, Korean, Polish, Japanese, Dutch, Russian, Turkish, Portuguese.



SOLUTIONS OVERVIEW
TECHNICAL COMPARISION

	TubeInspect	BendingStudio with Absolute Arm	TubeShaper with Absolute Arm
Range of sizes	2 possible sizes	6 possible sizes	6 possible sizes
CNC Bender Compatibility	yes	yes	yes
One installation can be connected to multiple benders	yes	yes	yes (if same interface)
Measurement type	optical	laser scanner	infra-red tube probe and/ or touch probe
Evaluation method	3D model with straights and bends	3D model with straights and bends	intersection of straights
Freeform tube measurement	yes	yes	no
CAD import	yes	yes	yes
Reverse engineering of tubes (with CAD export)	yes	yes	yes
Measurement reporting	yes	yes	yes
Measurement of jigs and fixtures	no	no	yes (with touch probe)
Measurement time per tube	3 sec approx.	1-2 min depending on tube length	ca. 2-3 min depending on tube length

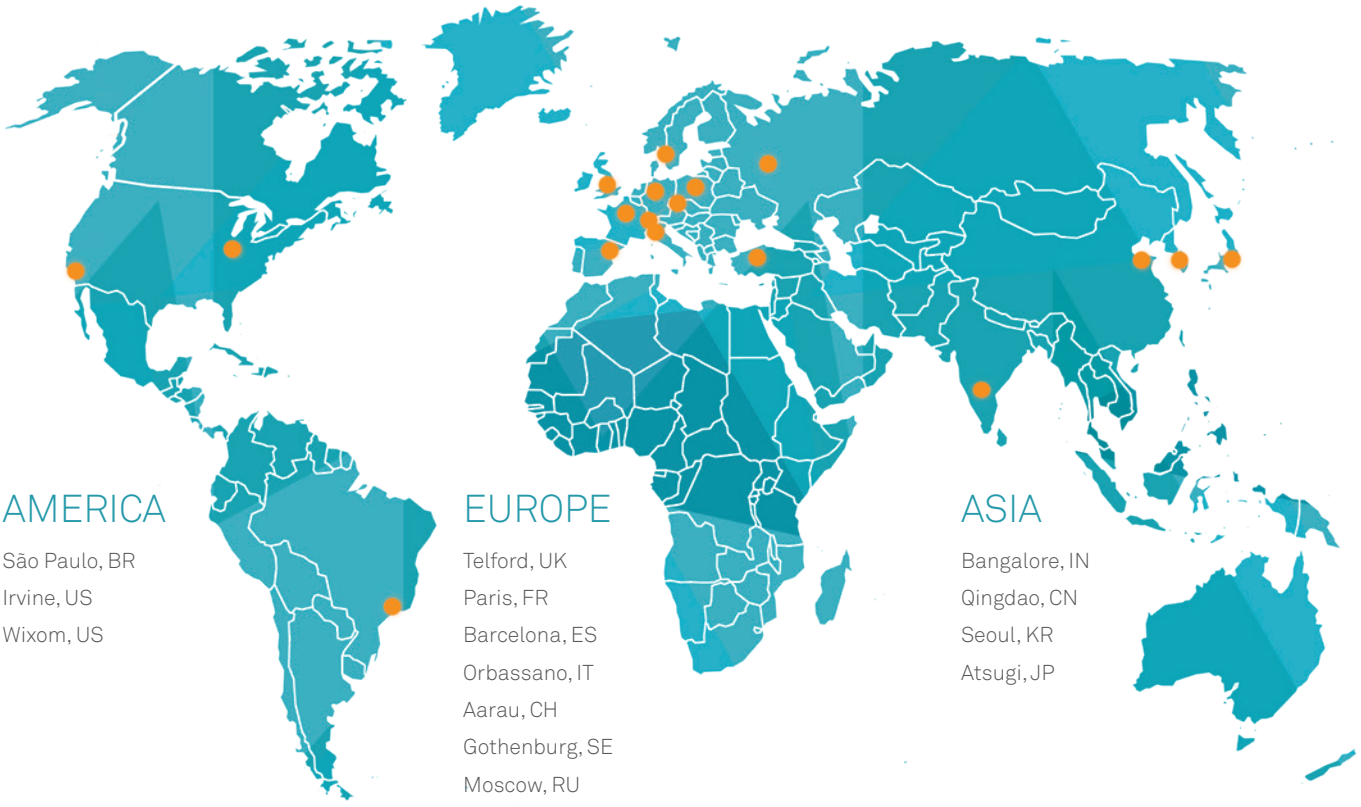
QUALITY ACROSS THE GLOBE
LEADING TOOLS WITH LEADING SUPPORT

Drawing on decades of research and development experience, tube and wire inspection technology from Hexagon Manufacturing Intelligence is built on a long history of outperforming technological innovation. Deriving quality from experience to drive productivity is what keeps Hexagon in front and able to deliver first-class solutions for industries around the world.

The international presence of Hexagon guarantees comprehensive aftersales support and services across the globe. With the largest dedicated service team of any metrology equipment manufacturer and an emphasis on locally delivered solutions, Hexagon is unmatched from service, repair, certification and calibration through operator training and software maintenance and upgrades.

Along with the assurance of ten years of serviceability, owners of Hexagon tube and wire inspection solutions benefit from a minimum of 12-month factory warranty – our guarantee that our technology will always meet the needs of our users.

Hexagon Manufacturing Intelligence Service Centres



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Hexagon Manufacturing Intelligence helps industrial manufacturers develop the disruptive technologies of today and the life-changing products of tomorrow. As a leading metrology and manufacturing solution specialist, our expertise in sensing, thinking and acting – the collection, analysis and active use of measurement data – gives our customers the confidence to increase production speed and accelerate productivity while enhancing product quality.

Through a network of local service centres, production facilities and commercial operations across five continents, we are shaping smart change in manufacturing to build a world where quality drives productivity. For more information, visit **HexagonMI.com**.

Hexagon Manufacturing Intelligence is part of Hexagon (Nasdaq Stockholm: HEXA B; **hexagon.com**), a leading global provider of information technologies that drive quality and productivity across geospatial and industrial enterprise applications.

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MANUFACTURING INTELLIGENCE

IMS center
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Authorized service, training, technical and methodological support of portable coordinate measuring machines

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