



INDUSTRIAL PHOTOGRAMMETRY FOR APPLICATIONS IN AUTOMOTIVE AND AEROSPACE INDUSTRY

56th Photogrammetric Week



INDUSTRIAL PHOTOGRAMMETRY FOR APPLICATIONS IN AUTOMOTIVE AND AEROSPACE INDUSTRY

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56th Photogrammetric Week

About AICON

- Founded in 1990 as a spin off from Volkswagen R&D and the Technical University Braunschweig by Dr.-Ing. Carl-Thomas Schneider and Dr.-Ing. Werner Bösemann
- Purchase of Breuckmann GmbH 2012
- Merged 2015
- More than 140 employees
- Since April 1, 2016 part of HEXAGON Manufacturing Intelligence



INDUSTRIAL PHOTOGRAMMETRY FOR APPLICATIONS IN AUTOMOTIVE AND AEROSPACE INDUSTRY

Introduction

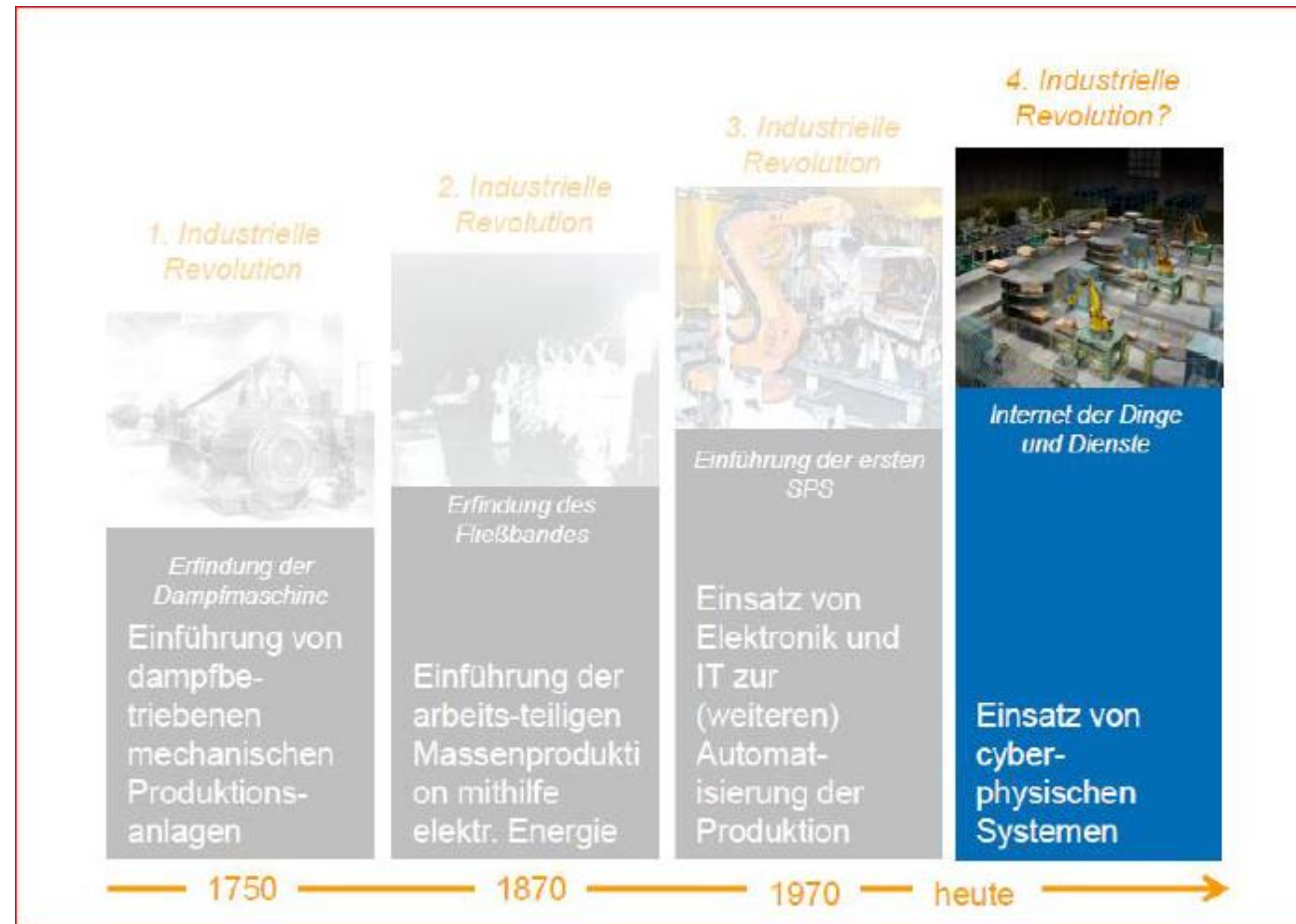
Requirements

Technologies and Systems

Application Examples

Conclusion

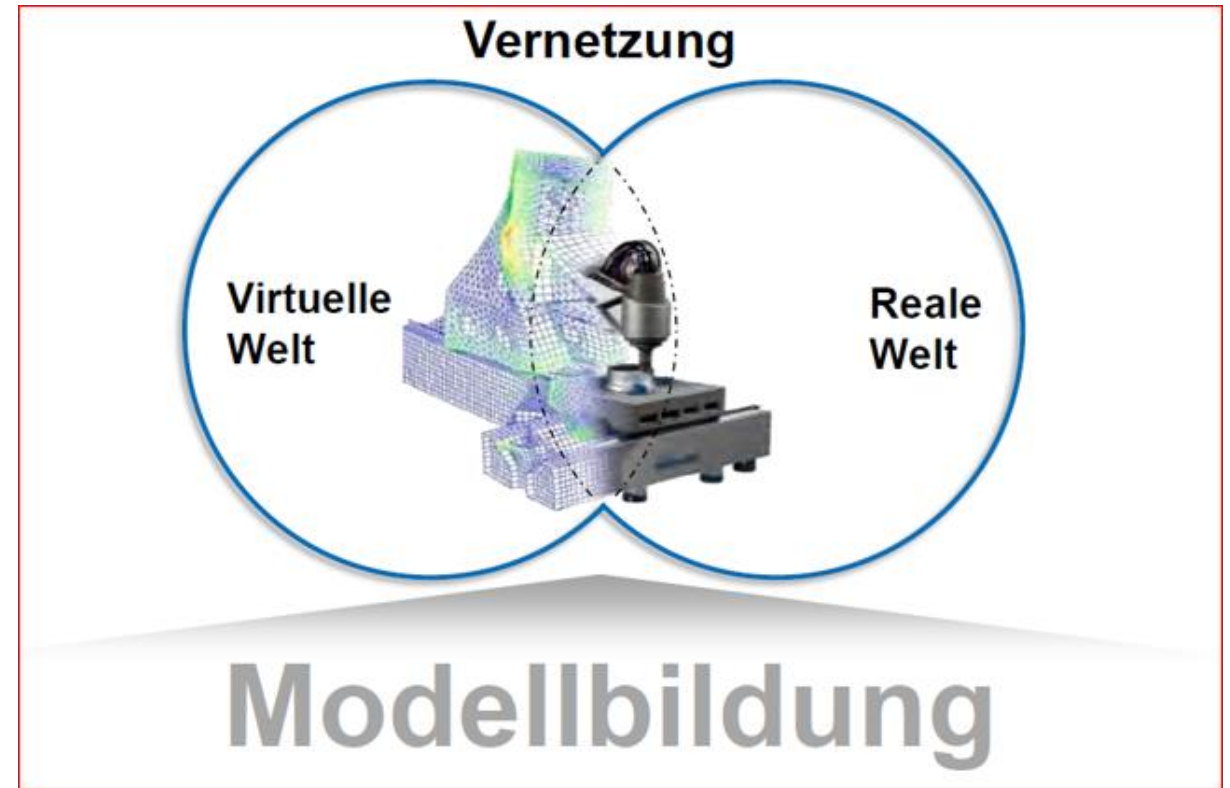
The impact of Industry 4.0 on industrial metrology



Source: WZL Aachen

The impact of Industry 4.0 on industrial metrology

- Individualisation of products
- Flexible Manufacturing
- Combining virtual and real worlds
- Interfacing to production



Source: WZL Aachen

The impact of Industry 4.0 on industrial metrology

Wrap up



- Modelle sind ein wesentlicher Faktor zur Umsetzung der Ideen der Industrie 4.0.
- Es werden zahlreiche verknüpfte, echtzeitfähige und selbstoptimierende Modelle benötigt.
- Messtechnik ist der wesentliche Faktor zur Verknüpfung der realen und virtuellen Welt.
- In Zukunft wird ihre Hauptaufgabe in der aufgabenspezifischen Bereitstellung und Verknüpfung von Daten liegen.

Metrology is the key factor for interfacing real and virtual world

Modellbasierte Messungen gewinnen in diesem Zusammenhang an Bedeutung.

Entwicklung von „Services“
Organisation der Messung durch „coordinates as a service“
Dezentralisierung durch „App“-lisierung

Source: WZL Aachen

The impact of Industry 4.0 on industrial metrology

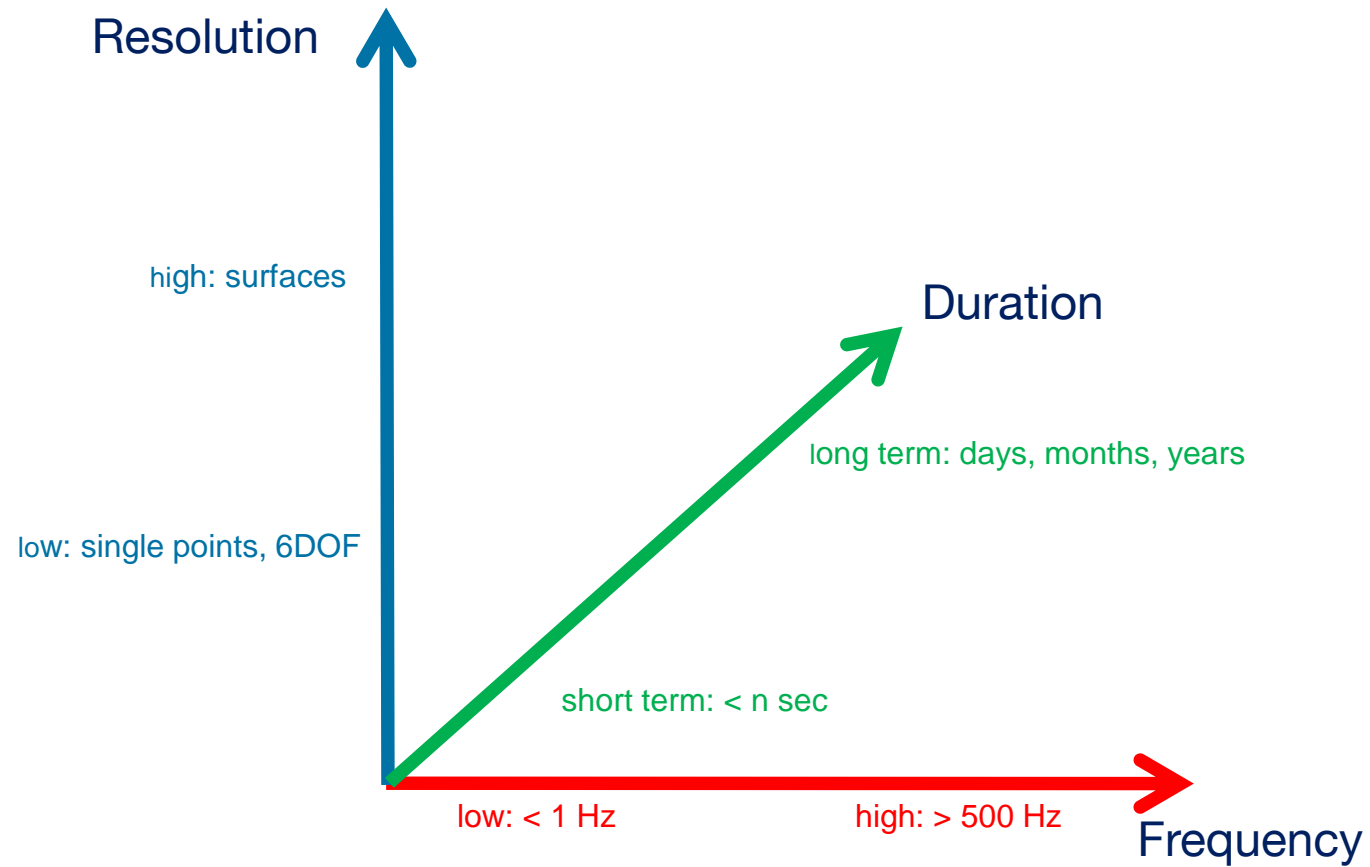
The role of metrology changes:

- Final inspection becomes less important
- Feedback loop to production
- In-, at- and near-line installations growing fast
- MAA (Measurement assisted assembly)

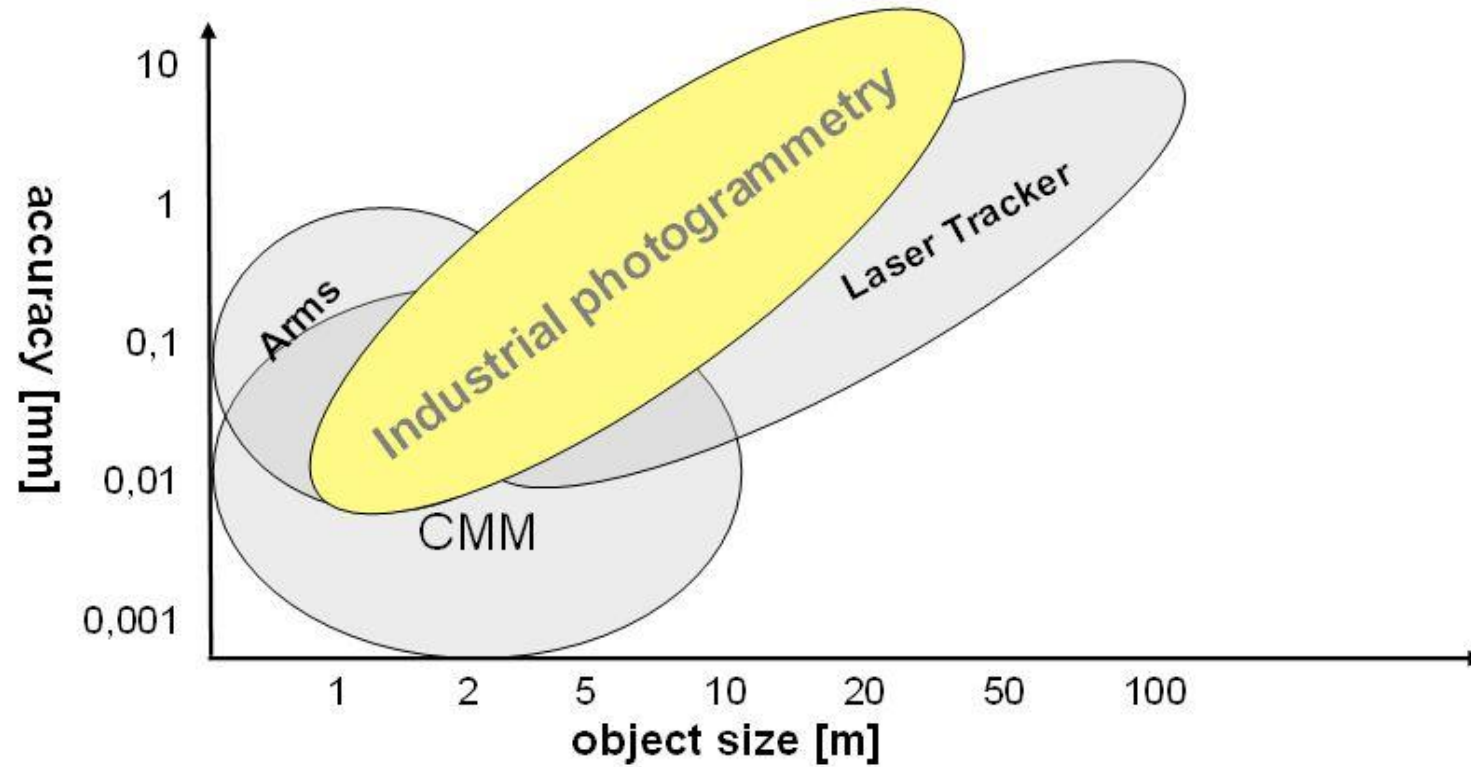
Here photogrammetry offers:

- Scalable and flexible solutions
- Fast and precise multipoint measurements
- Dynamic and real-time output

Photogrammetry: Resolution, Frequency and Duration



Instrument Positioning



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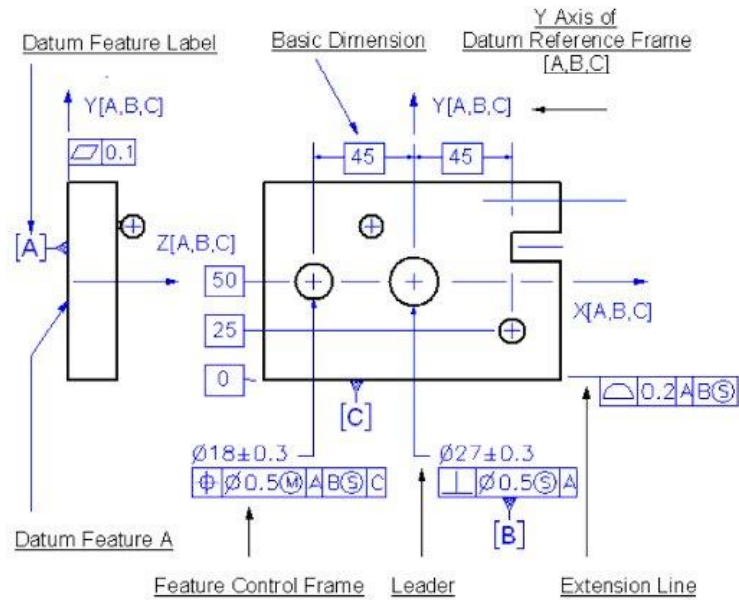
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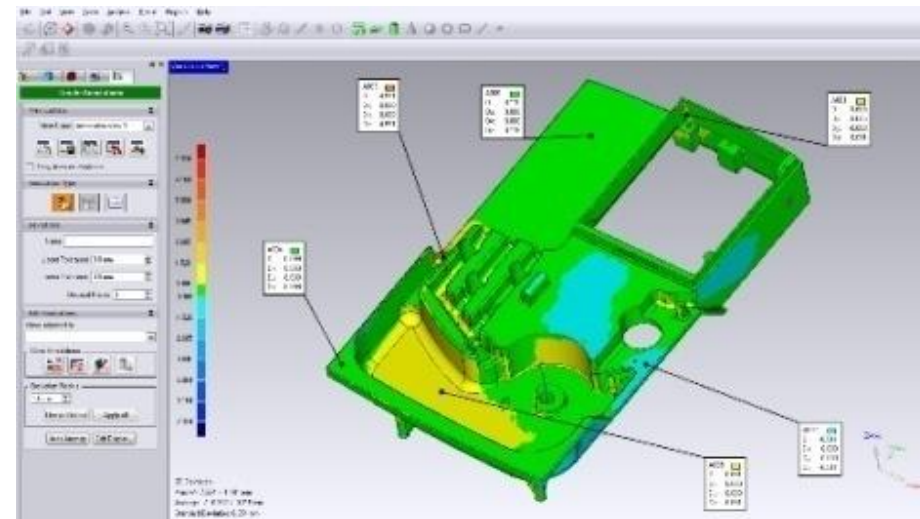
Application Examples

Conclusion

Requirements: Inspection

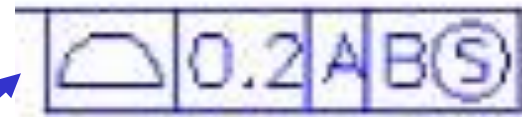
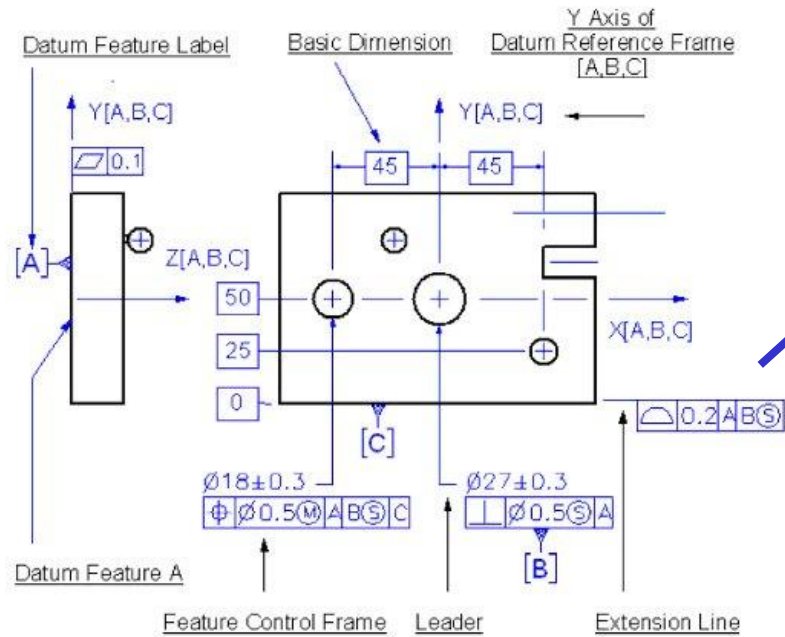


GD&T features of a simple part



CAD comparison

Requirements: Tight part and feature tolerances



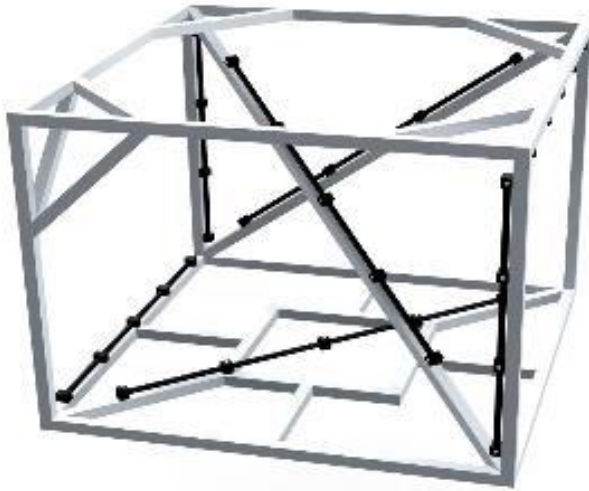
surface tolerance 0.2 mm

10% allowance for measurement

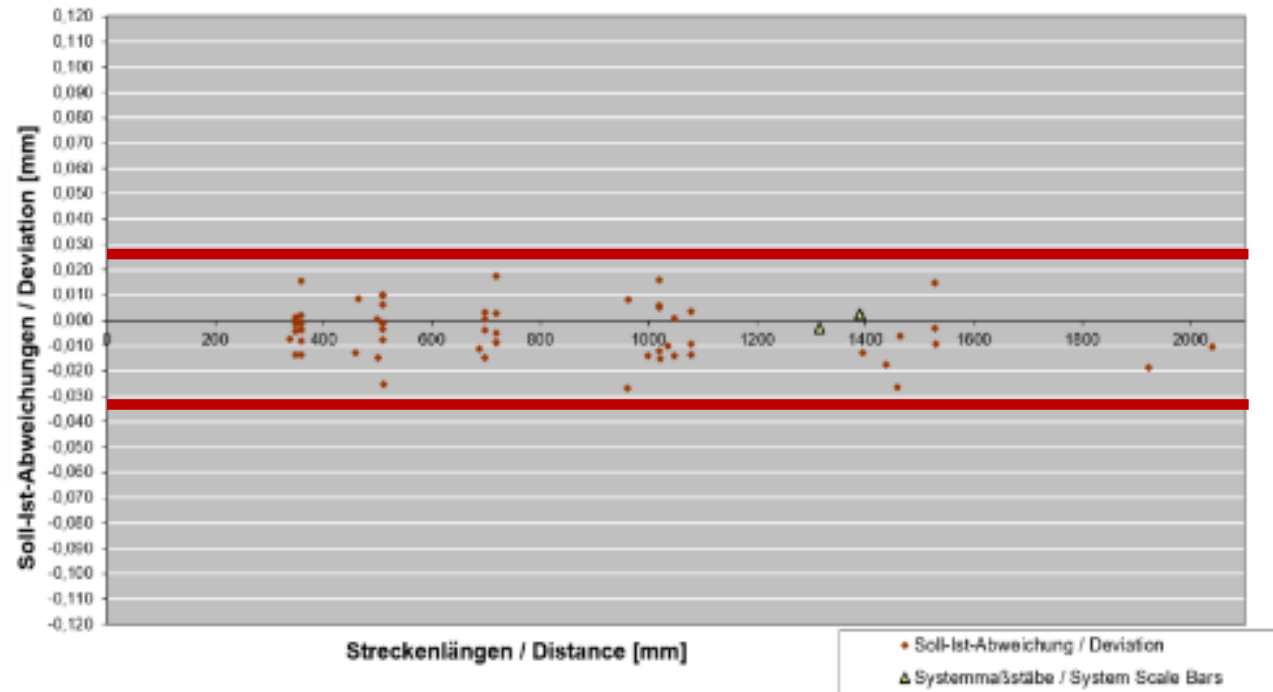
-> 0.02 mm accuracy required

-> +/- 0.01 mm

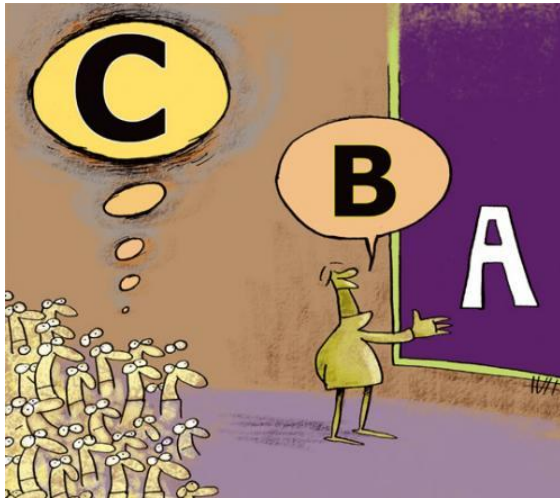
Requirements: Traceability and certification



Längenmessabweichungsdiagramm / Length Measurement Error Diagram



Requirements: Understanding the application



talk and listen to your customer
the customer needs solutions
photogrammetry is just a tool
learn to speak his language

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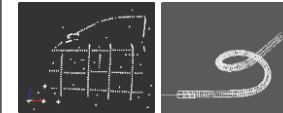
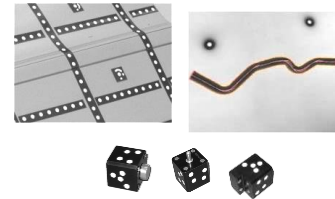
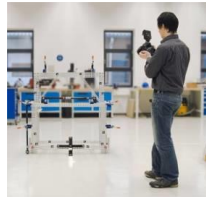
Application Examples

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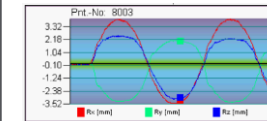
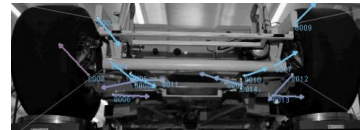
Photogrammetry solutions

Photogrammetry solutions

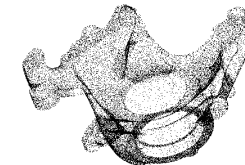
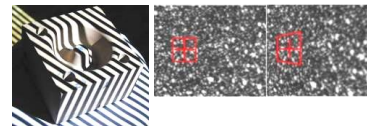
Photogrammetry
(Single points,
Adapter, Features)



Multicamera solutions for
multipoint positioning
and tracked probe


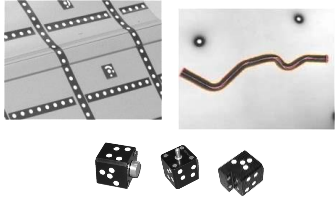

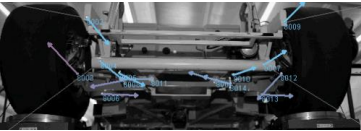

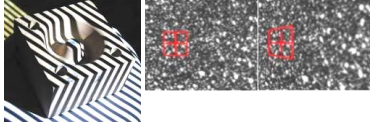


White light scanner
(point clouds)



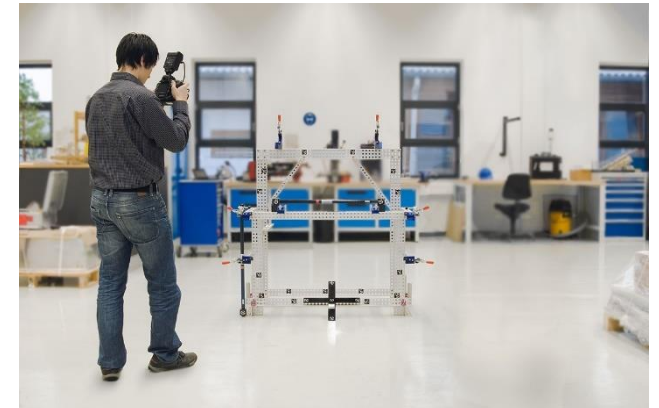
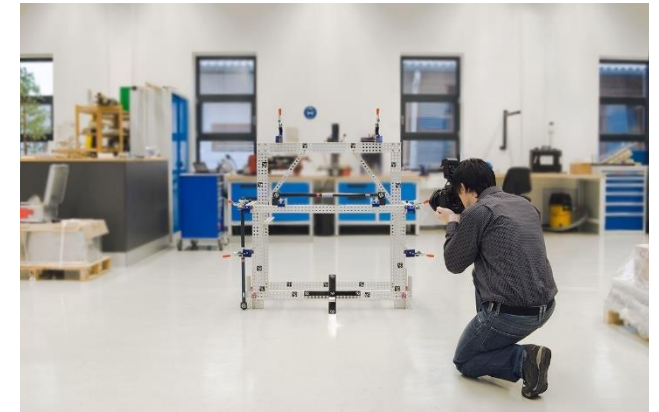
Photogrammetry solutions

Photogrammetry solutions

<p>Photogrammetry (Single points, Adapter, Features)</p>			<p>AICON GSI Gom</p>
<p>Multicamera solutions for multipoint positioning and tracked probe</p>			<p>AICON Creaform GSI Metronor</p>
<p>White light scanner (point clouds)</p>			<p>AICON (Breuckmann) Gom Zeiss (Steinbichler)</p>

Handheld single camera – Targeting

- Customer benefits
 - Extremely mobile
 - Perfect for rough environment
 - Unlimited measuring volume
 - Multi purpose
- Applications
 - Part inspection
 - Deformation analysis
 - Set up of reference meshes
 - CAD comparison



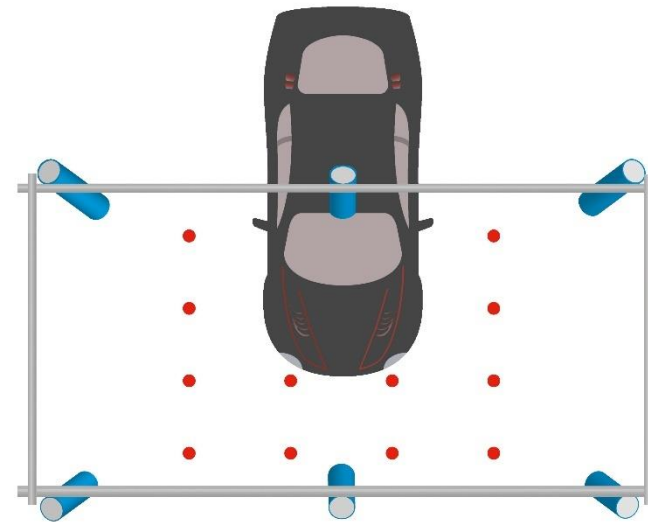
Fixed multi camera solutions

- Probing
- Tracking
- Targetting
- Dynamic referencing
- Easy use



Flexible multi camera solutions

- **MoveInspect** camera-array to cover large measurement volumes
- Tracking / Scanning / Probing in the whole measurement area
- Reference targets for position control of cameras
- No reference targets at object necessary
- Alignment to object coordinate system by adapters or probe measurements



White-Light Scanner (Structured light)

- Very high accuracy (down to some μm)
- Highest resolution
- Scalable for different volumes (mm to several m)
- Automation (turn-tilt or robot)
- Mobile application



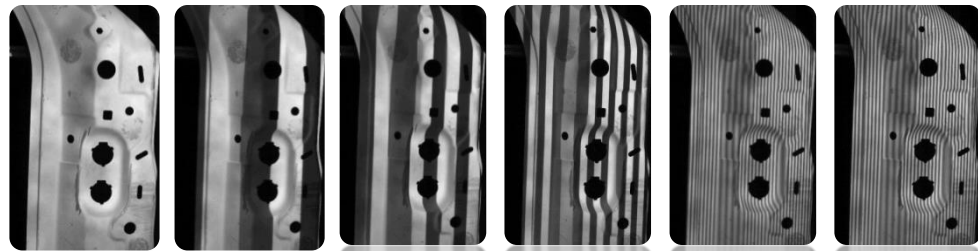
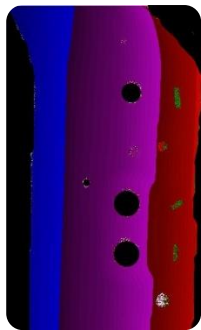
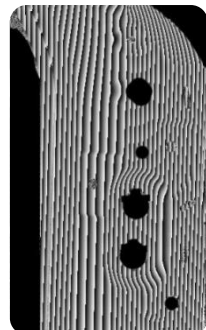


Image acquisition with combined
GrayCode /Phase Shift Technique
(measuring time approx. one second)

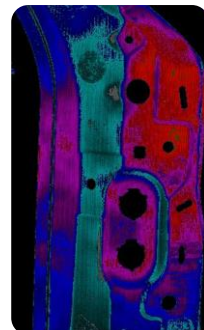
Analysis of Sequence



GrayCode



Phase map

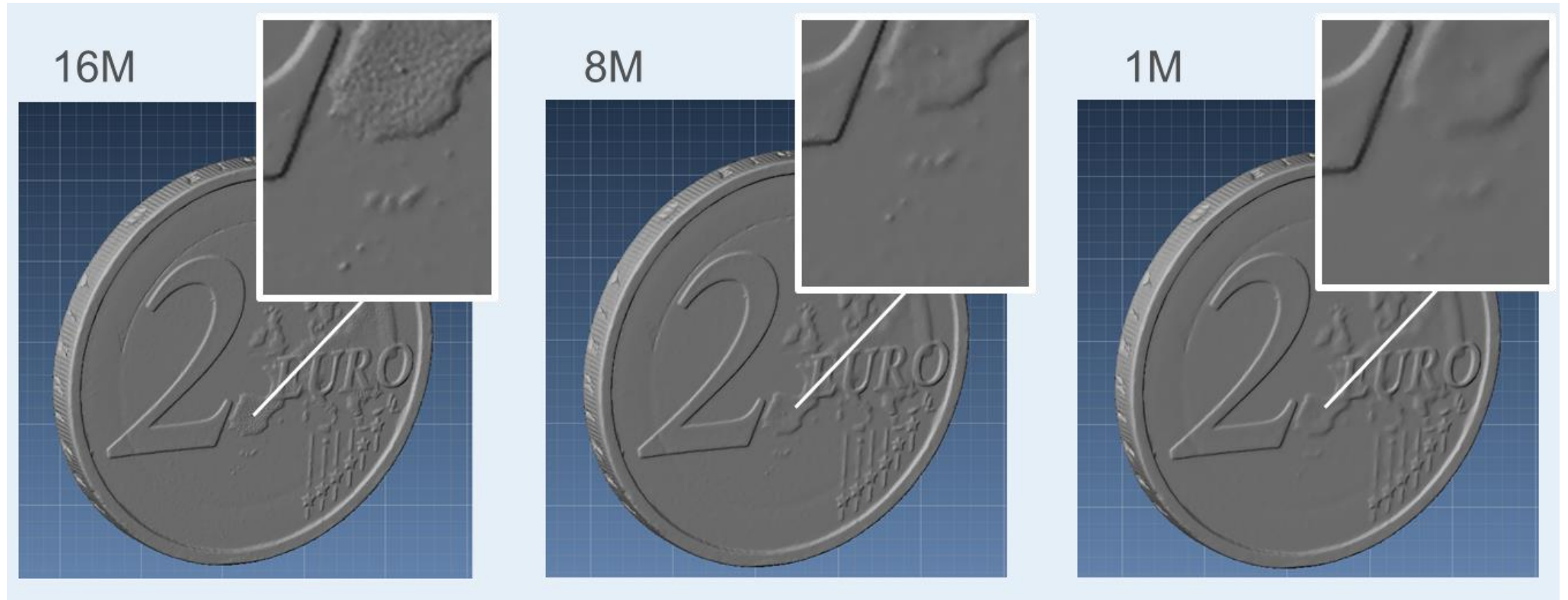


Fringe contrast

Calculation of
3D coordinates



Resolution Impact

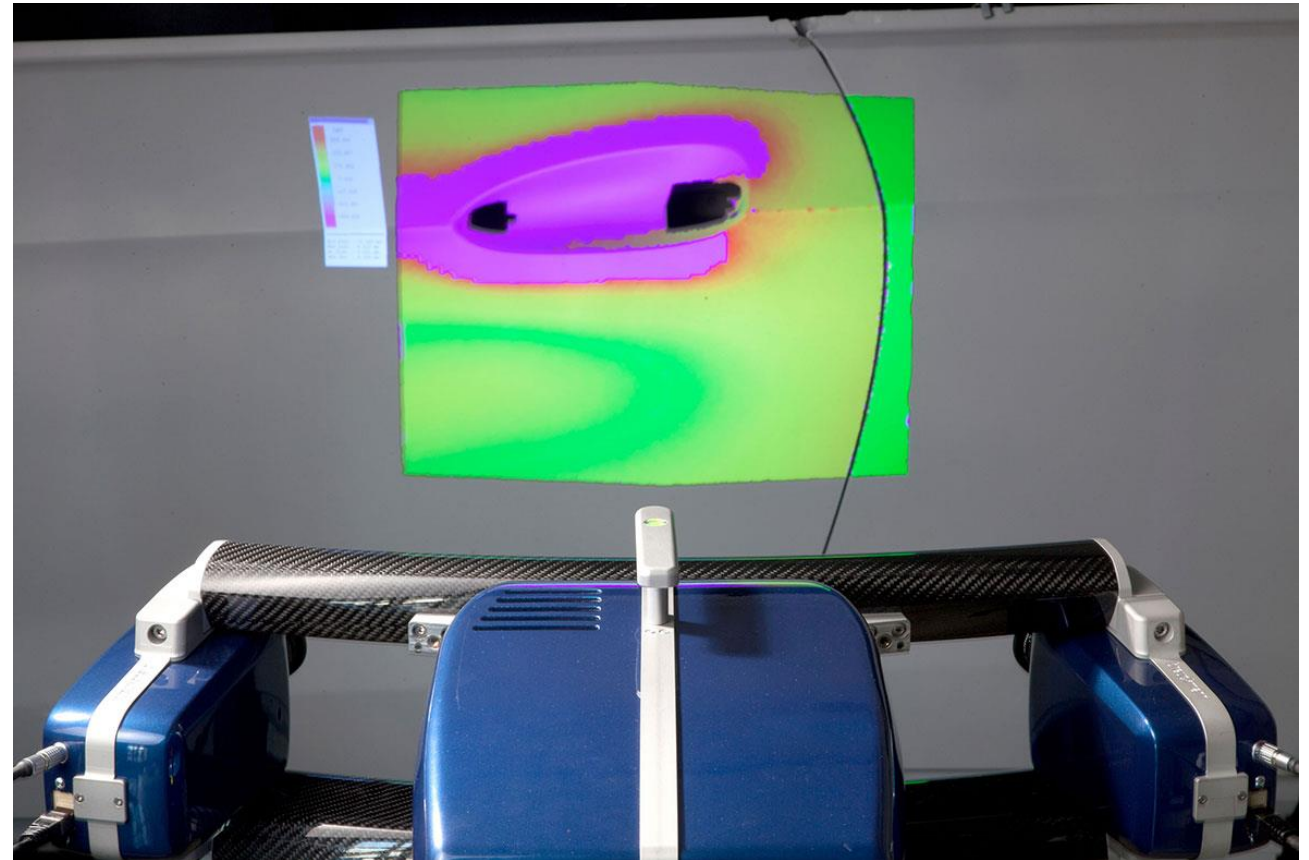


StereoScan neo – multi color projection



StereoScan neo – Back-Projection

- CAD comparison
- Shape defects
- Geometry elements
- Legends
- Marking / Labeling



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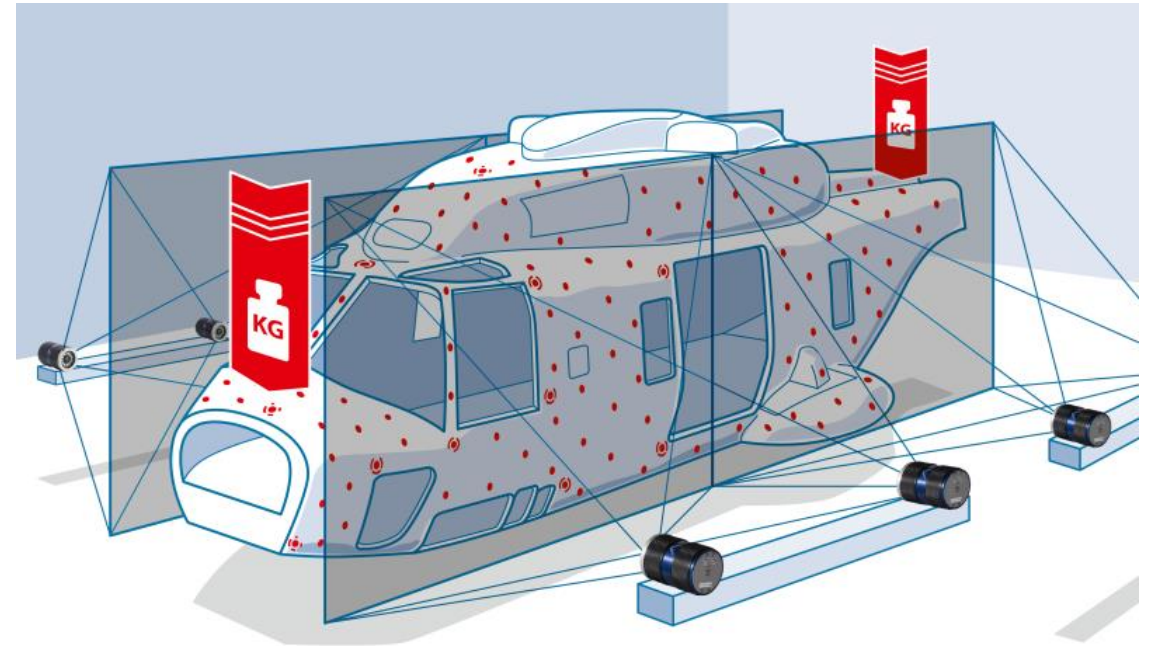
Application Examples

Conclusion

Testing: Deformation and load tests on a helicopter cabin

Task

- 3D deformation measurement of a complete helicopter cabin (L appr. 10m)
- Measurement within a high force actuator test rig (load simulation, hard landing,...)

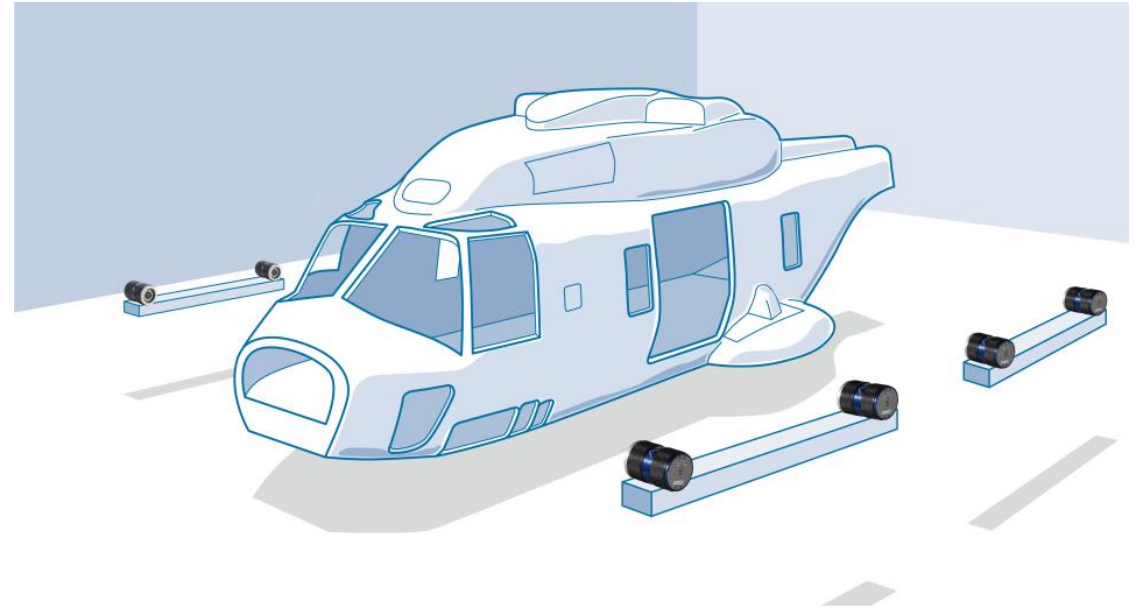


Process Improvements in Aero Applications by Integration of Camera Technology

Deformation and load tests on a helicopter cabin

Challenge

- Reducing setup time
- Providing higher point density than actual string gauges
- Allow large deformation without data loss
- Providing 3D data instead of 1D
- Test until breakage causes risk for measurement system
- Data in one global coordinate reference frame (helicopter system)
- Synchronization with actuator system

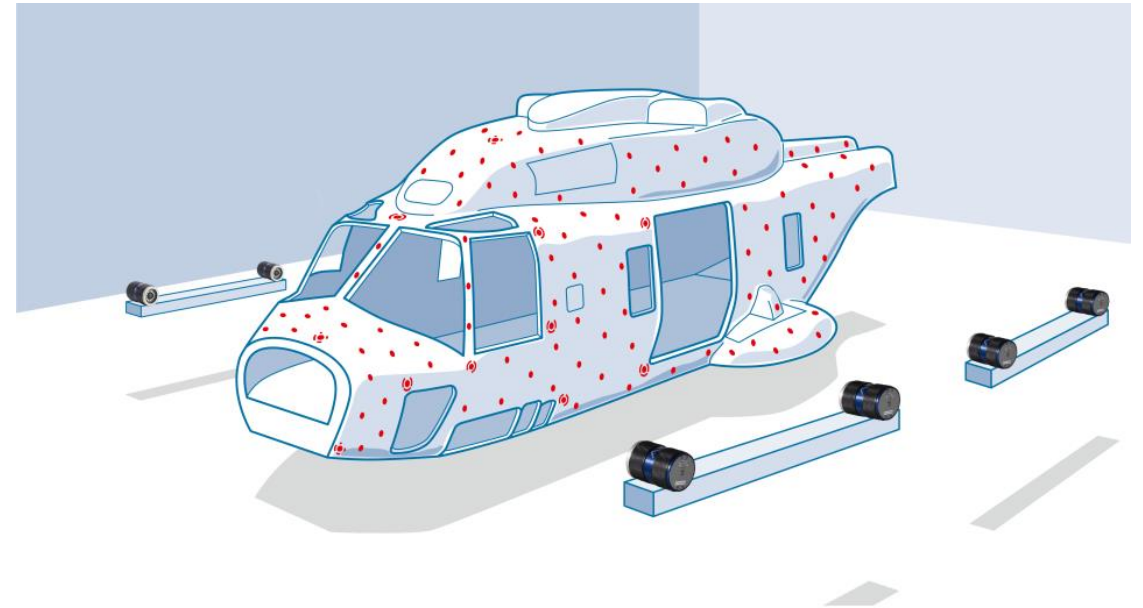


Process Improvements in Aero Applications by Integration of Camera Technology

Deformation and load tests on a helicopter cabin

Solution

- Camera system which allows multiple point online tracking in full 3D
- 4 pairs of online cameras mounted on camera beams
- Reference points taken by offline photogrammetry – global reference frame

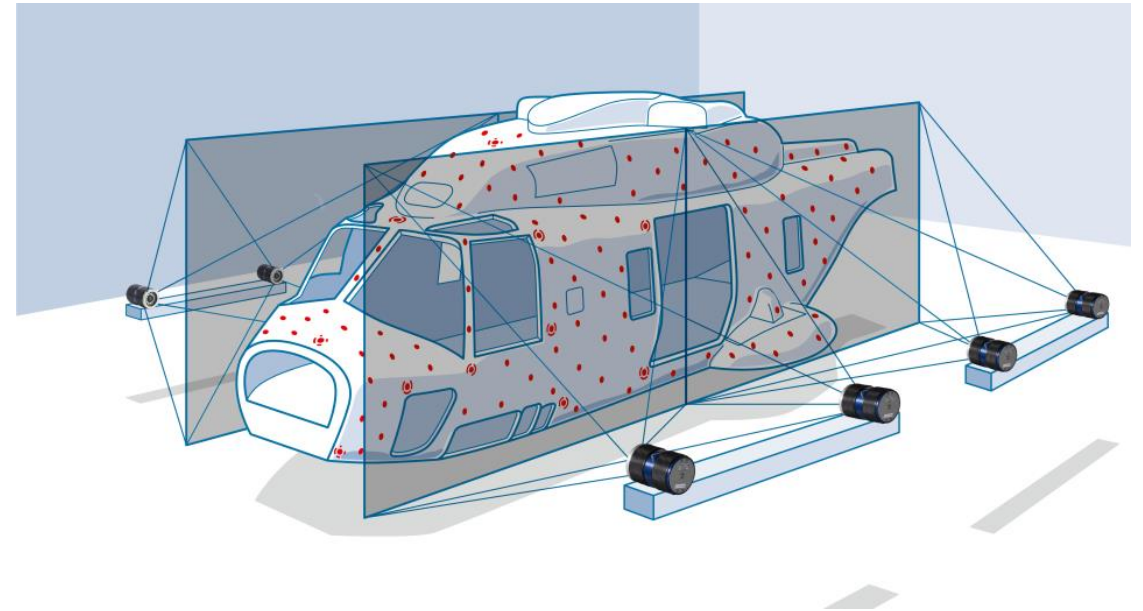


Process Improvements in Aero Applications by Integration of Camera Technology

Deformation and load tests on a helicopter cabin

Solution

- Camera system which allows multiple point online tracking in full 3D
- 4 pairs of online cameras mounted on camera beams
- Reference points taken by offline photogrammetry – global reference frame
- Calibration of all cameras in a single reference frame

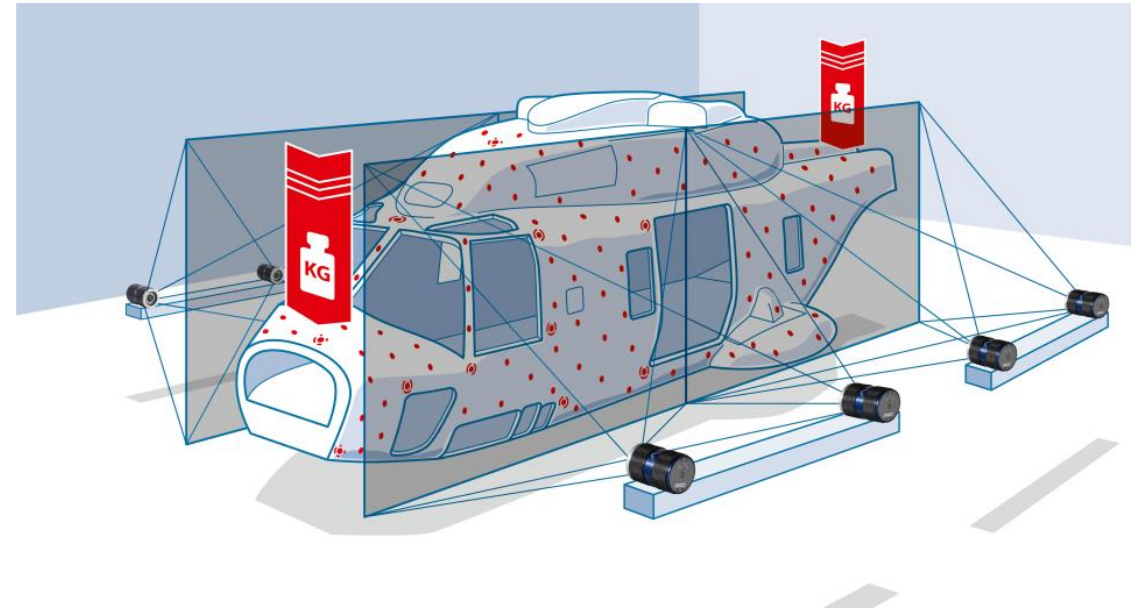


Process Improvements in Aero Applications by Integration of Camera Technology

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Solution

- Camera system which allows multiple point online tracking in full 3D
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- Calibration of all cameras in a single reference frame
- Measurement with 5 Hz while load is applied

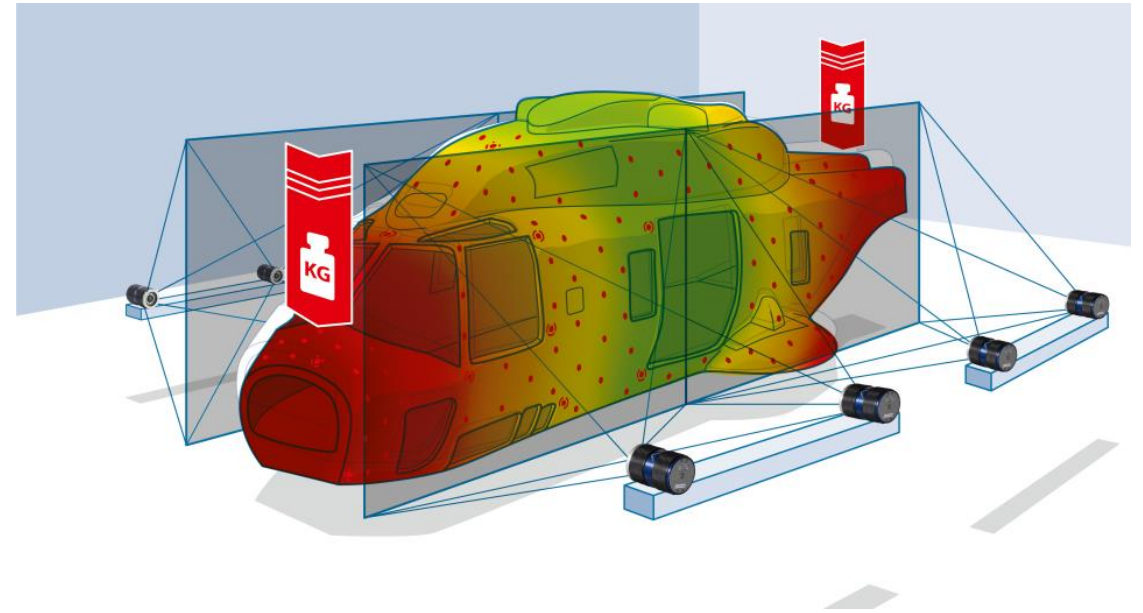


Process Improvements in Aero Applications by Integration of Camera Technology

Deformation and load tests on a helicopter cabin

Solution

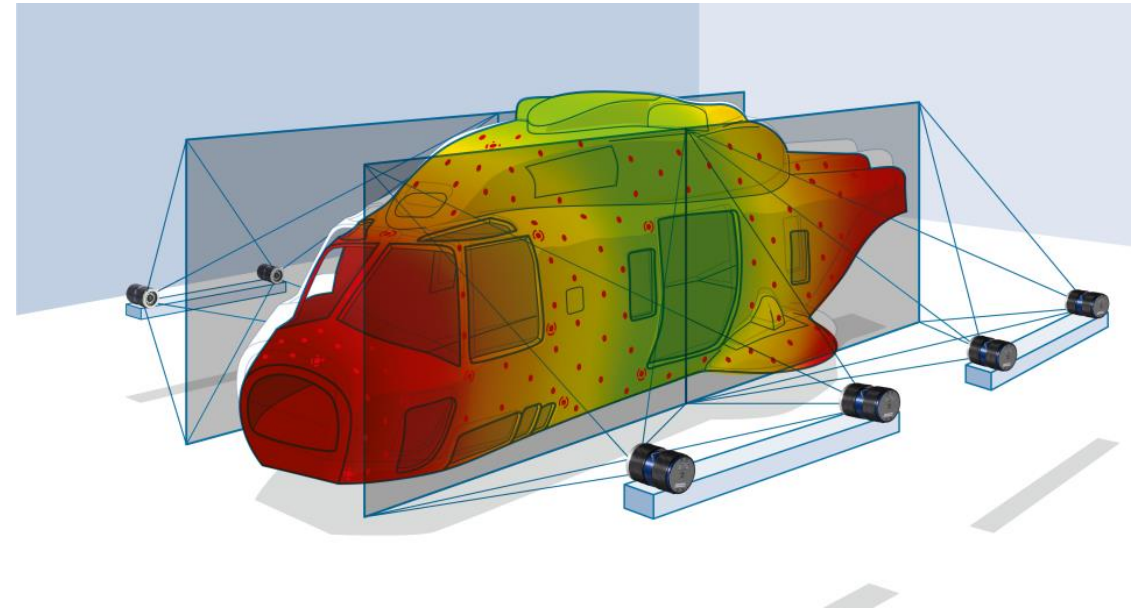
- Camera system which allows multiple point online tracking in full 3D
- 4 pairs of online cameras mounted on camera beams
- Reference points taken by offline photogrammetry – global reference frame
- Calibration of all cameras in a single reference frame
- Measurement with up to 5 Hz while load is applied
- Measurement until breakage



Process Improvements in Aero Applications by Integration of Camera Technology

Deformation and load tests on a helicopter cabin

Configuration	
No. of cameras	8 (4 x 2 camera pairs)
Resolution / Focal length	5 MPixel / 8mm
Volume	ca. 10 x 4m ² per side
Frequency	External trigger and 5Hz
Tests against string gauges showed equal results	

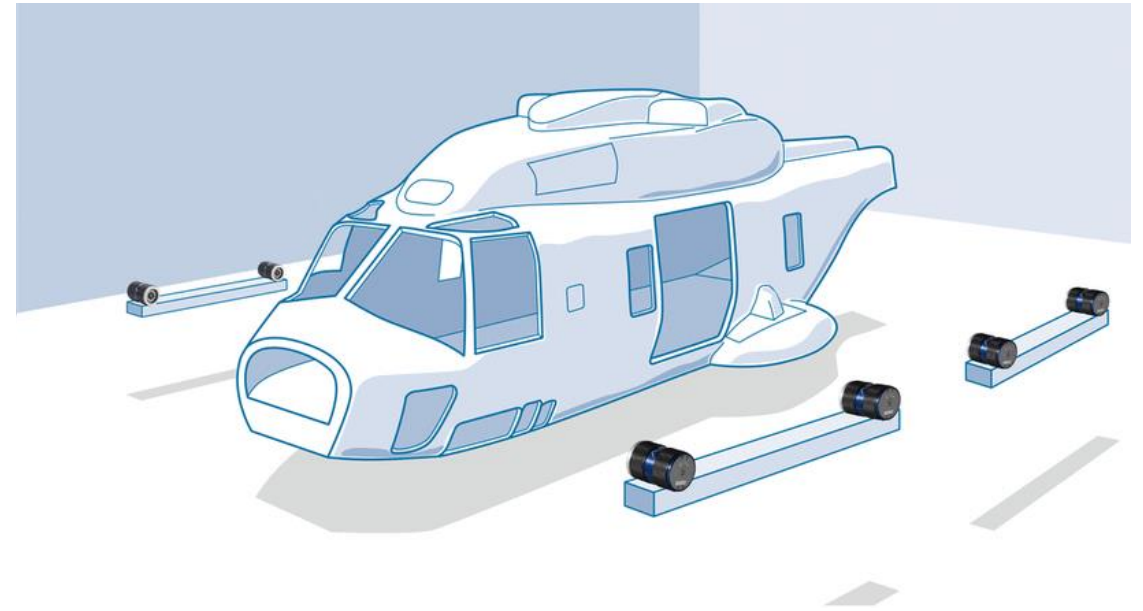


Process Improvements in Aero Applications by Integration of Camera Technology

Deformation and load tests on a helicopter cabin

Advantages

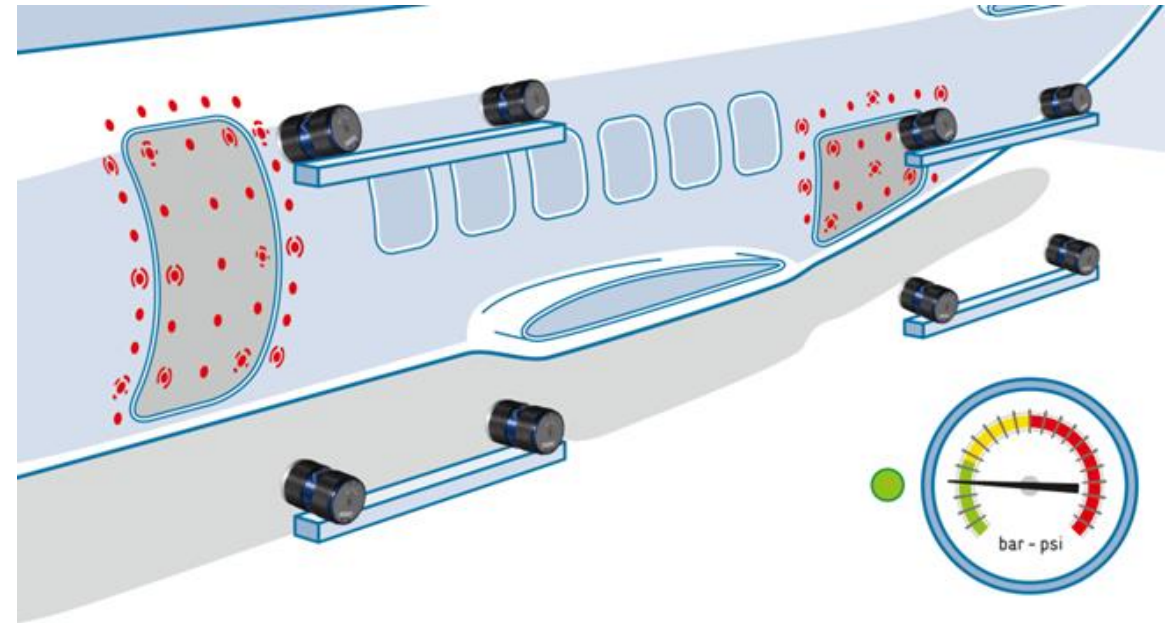
- Reduced setup time from a couple days to a few hours
- No need for huge support structure for string gauges
- Full 3D data (coordinate system consistency)
- Synchronization with other sensors (force, strain)
- Larger deformation without data loss compared to string gauges
- Extendability for more area / details



Testing: Deformation of an aircraft door during change of cabin pressure

Solution

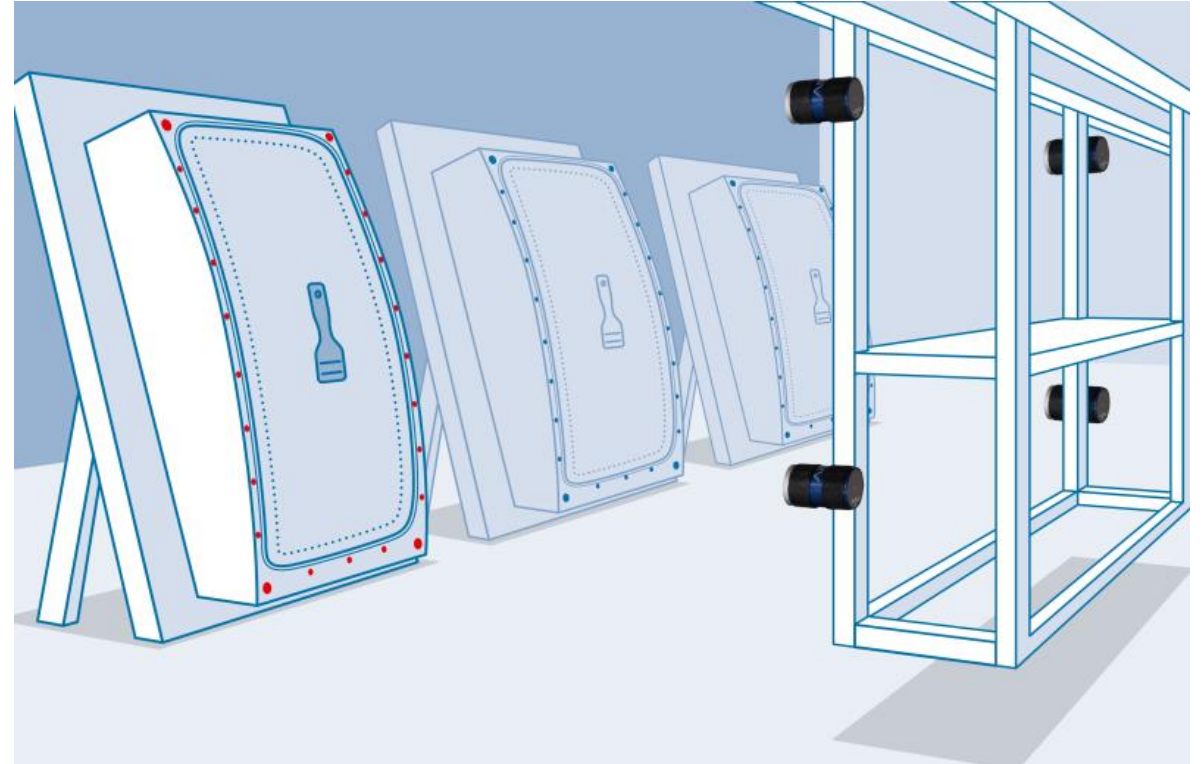
- Camera system which allows multiple point online tracking in full 3D
- Reference points taken by offline photogrammetry – global reference frame
- 4 online cameras are mounted on camera beams
- Image capturing with multiple Hz
- Real time output of the displacement as 3D vectors in a post-processing software (Spatial Analyzer)



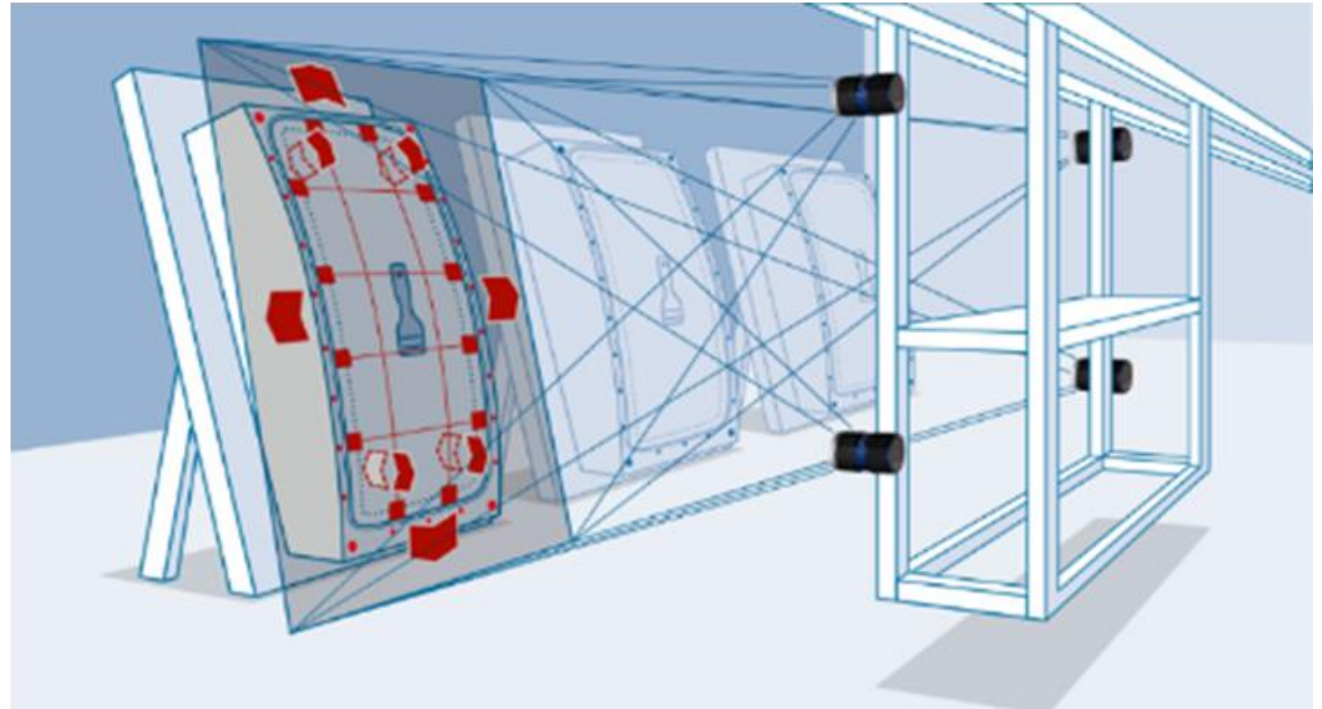
MAA: Adjustment and final inspection of aircraft doors

Task

- Adjustment of passenger door locks in production
- Final inspection of more than 250 features
- Reduction of total time for adjustment and measurement

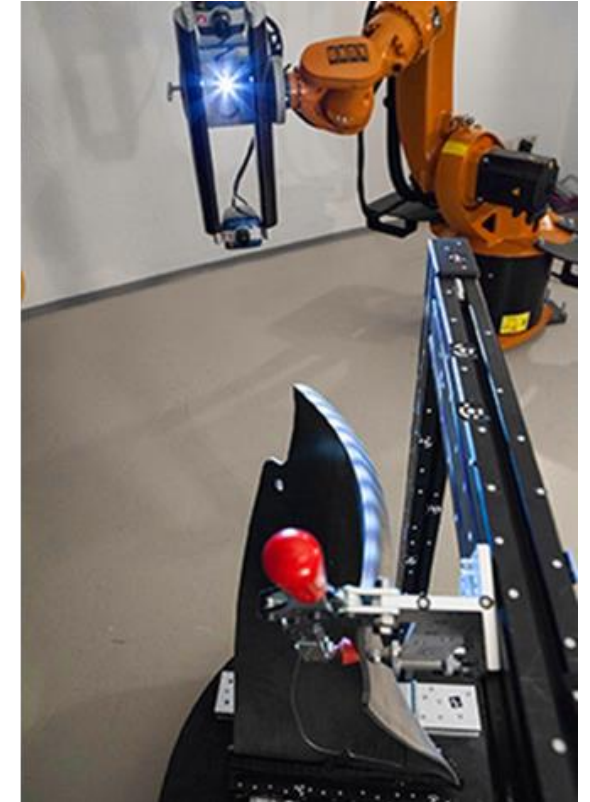


Airbus Helicopters Germany



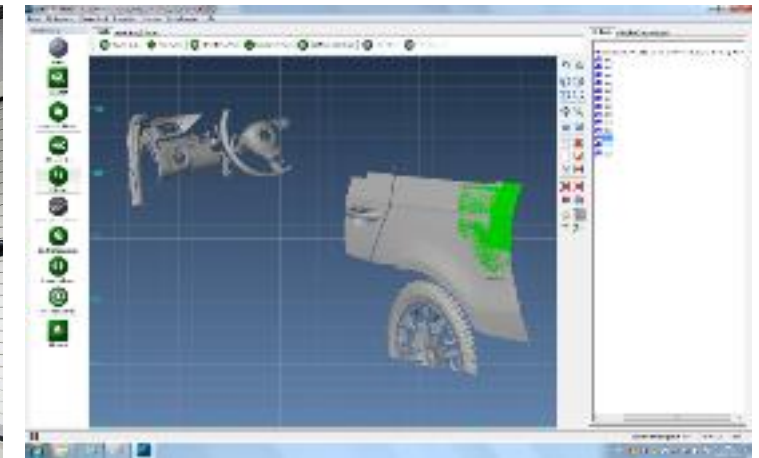
Applications 3D Scanner: Automated inspection of turbine blades

- Robot-based quality control
- System configuration according to individual customer requests

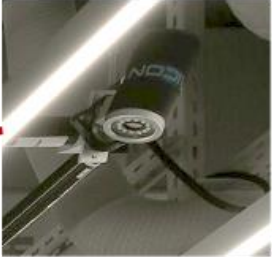
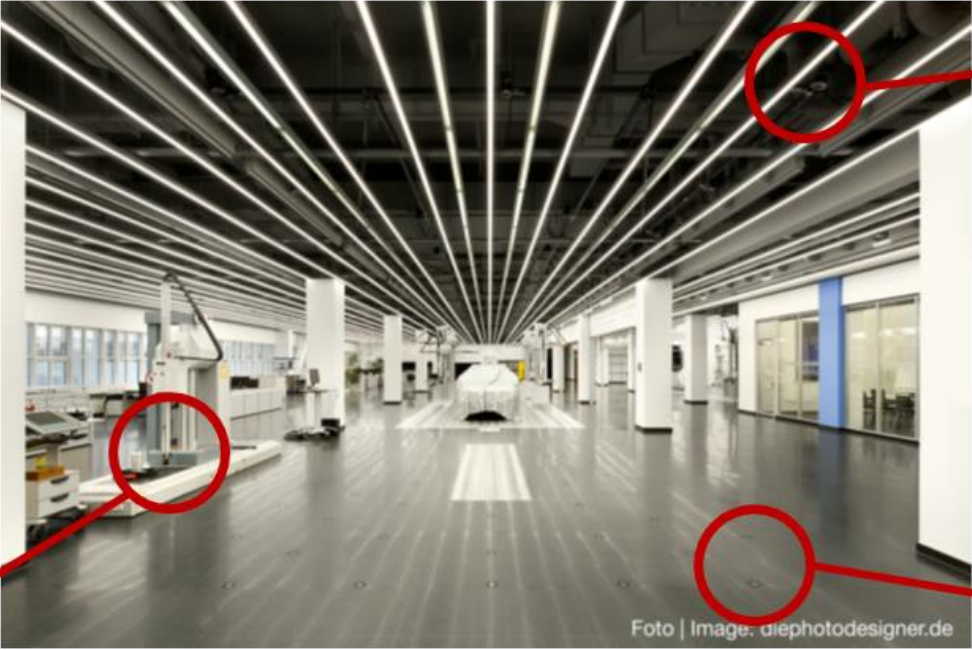


Design Studio Applications

- Tracking / Scanning / Probing in the whole measurement area
- Tracking of measurement systems (e. g. scanners) or tools
- High accuracy (up to 0.2mm)

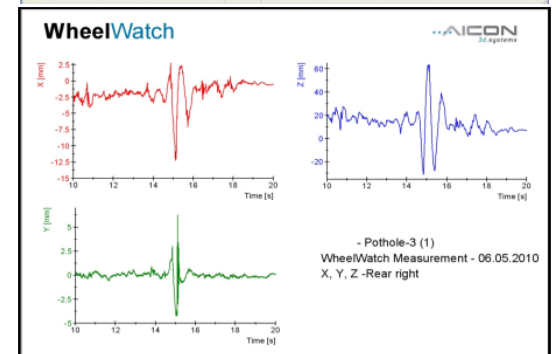
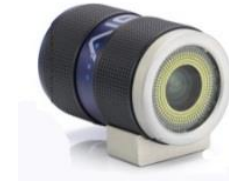


3D Arena in design studios



Dynamic solutions: Motion Analysis

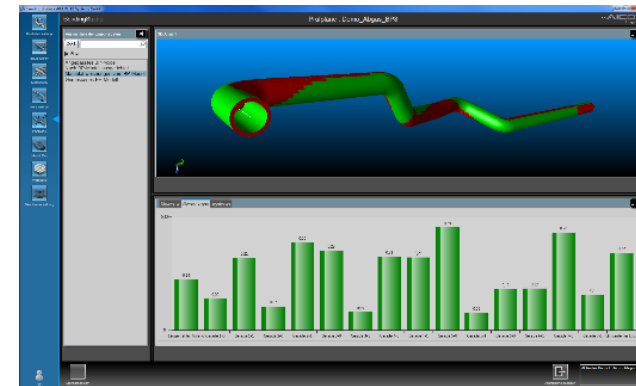
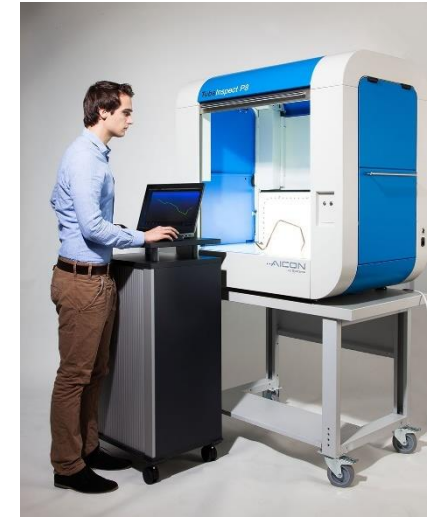
WheelWatch



WheelWatch is a non-contact high speed monitoring systems for wheel motion / engine motion analysis on a moving vehicle or in a test station

TubeInspect: Efficient Quality Assurance for Tube Manufacturing

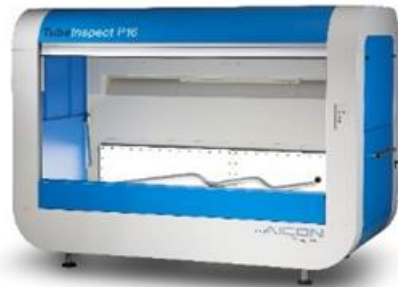
- Optical tube inspection system
- Control loop with bending machines
- Reverse engineering and inspection of sample tubes
- Automatic 100 % inspection in a robot cell
- Total replacement of mechanical gauges



Our approach to Industry 4.0

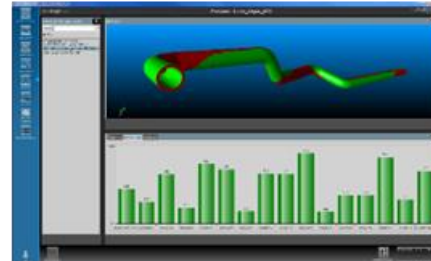
SENSING

Sense physical properties in the real world.



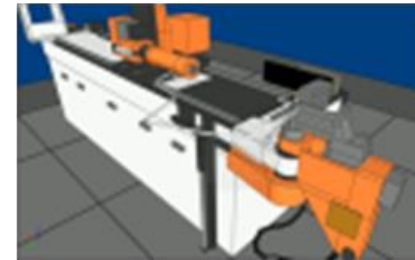
THINKING

Smart platforms to transform data into actionable information.



ACTING

Manufacturing SW Solutions to enhance productivity.



Conclusion

- Industrial photogrammetry is widely used and accepted
- Highest flexibility and mobility
- High accuracy potential
- Fast onsite measurements
- Scanners and fixed camera solutions widely used
- Other applications still rare but accepted



Thank you!

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