



Smart Production – On The Way To Autonomous Laser Processes

Dr. Rüdiger Brockmann | Industry- / Product Management & Marketing
08.05.2019

Agenda

01 TRUMPF

02 Intelligent Equipment

03 Intelligent Processes

04 Networks

05 Artificial Intelligence

06 Conclusion

Building blocks for
autonomous processing

Intelligent Equipment

Condition Data / Health
Check

Intelligent Processes

Process Data / Assistance
Systems

Networks

Communication

Artificial Intelligence

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TRUMPF Group

FY 2017 / 2018

Sales 2017/18

3,566 in mil. €
+14.6 %

R+D expenditures in mil. €

337

Employees on June 30, 2018

13,420

R+D quota

9.5 %

Business Fields

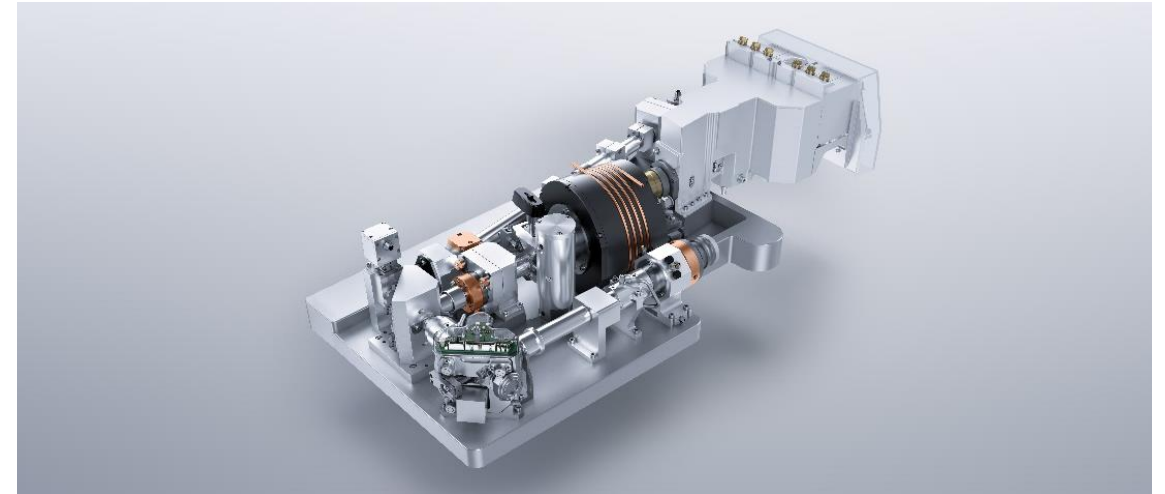
Revenue in FY 2017/18

Machine tools for flexible sheet processing



Revenue 2017/18

3,02 Mrd. €
+11,3%

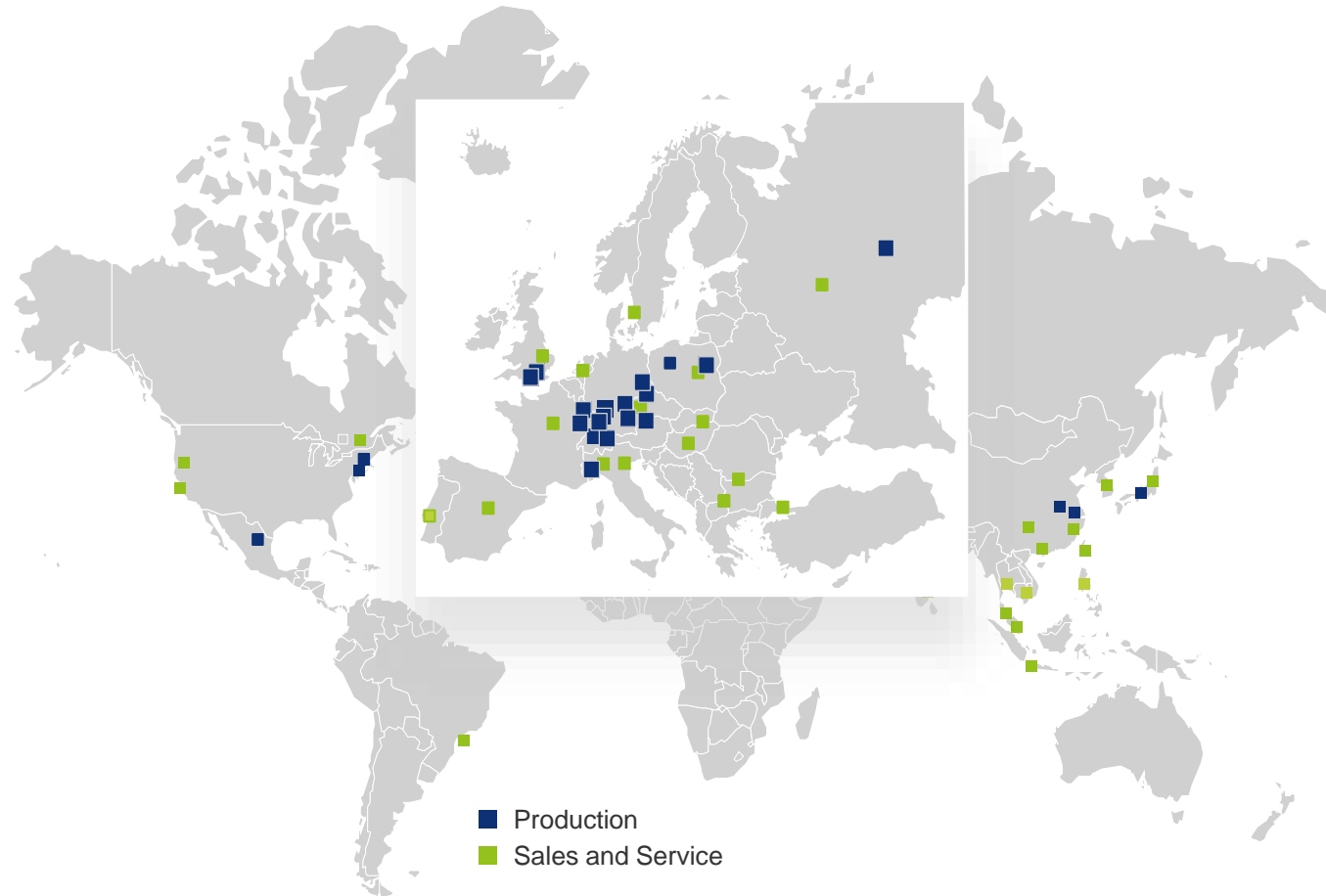


Revenue 2017/2018

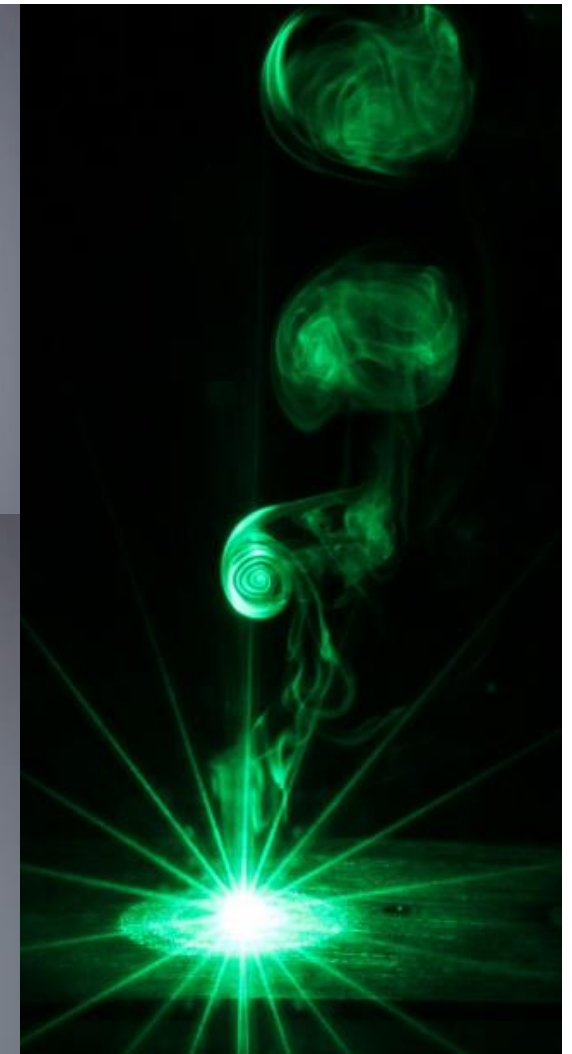
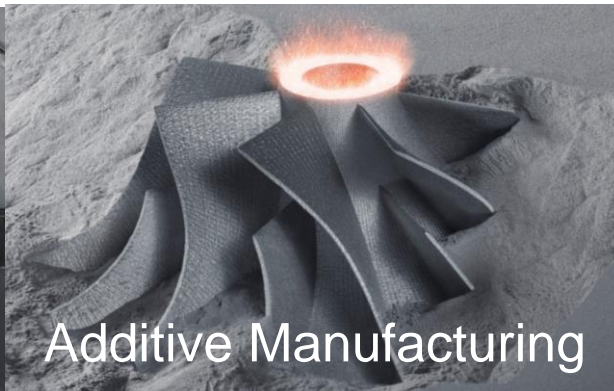
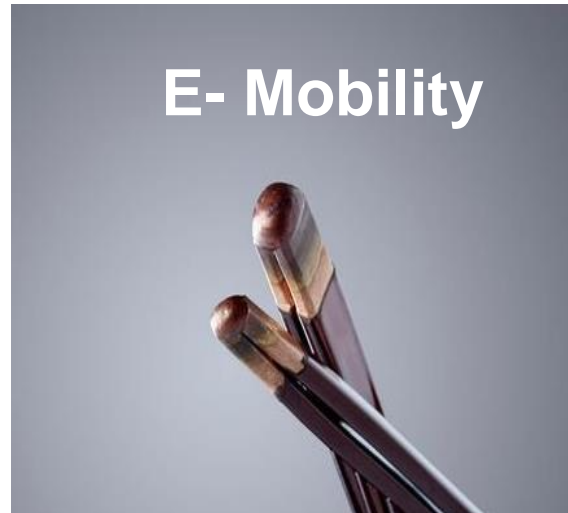
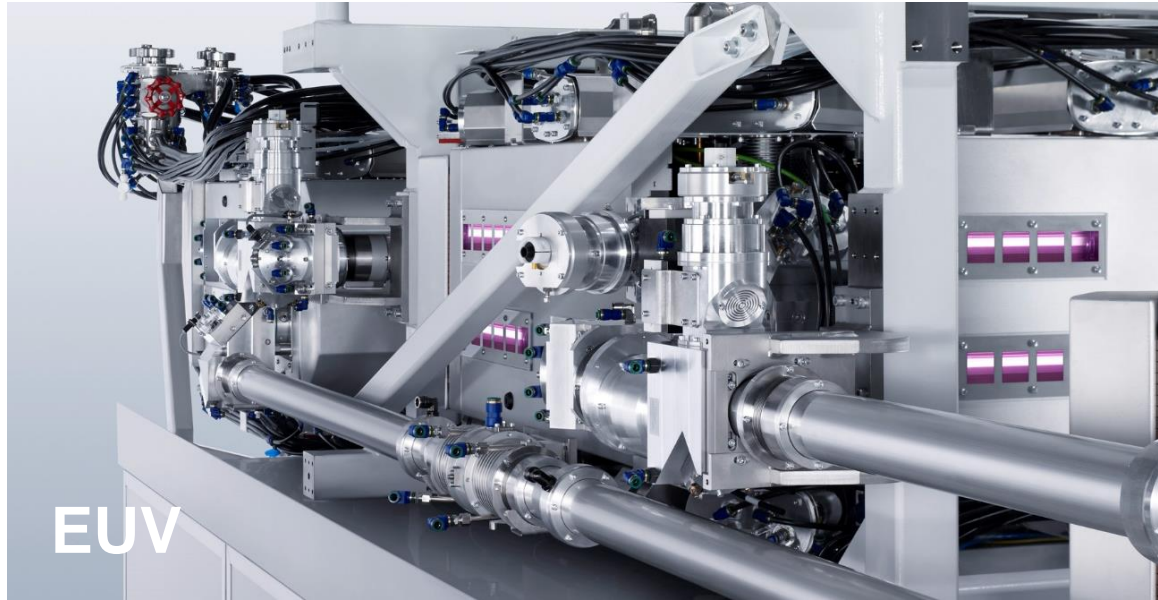
1,50 Mrd. €
+21,5%

Global Presence

Worldwide with our customers at 66 locations

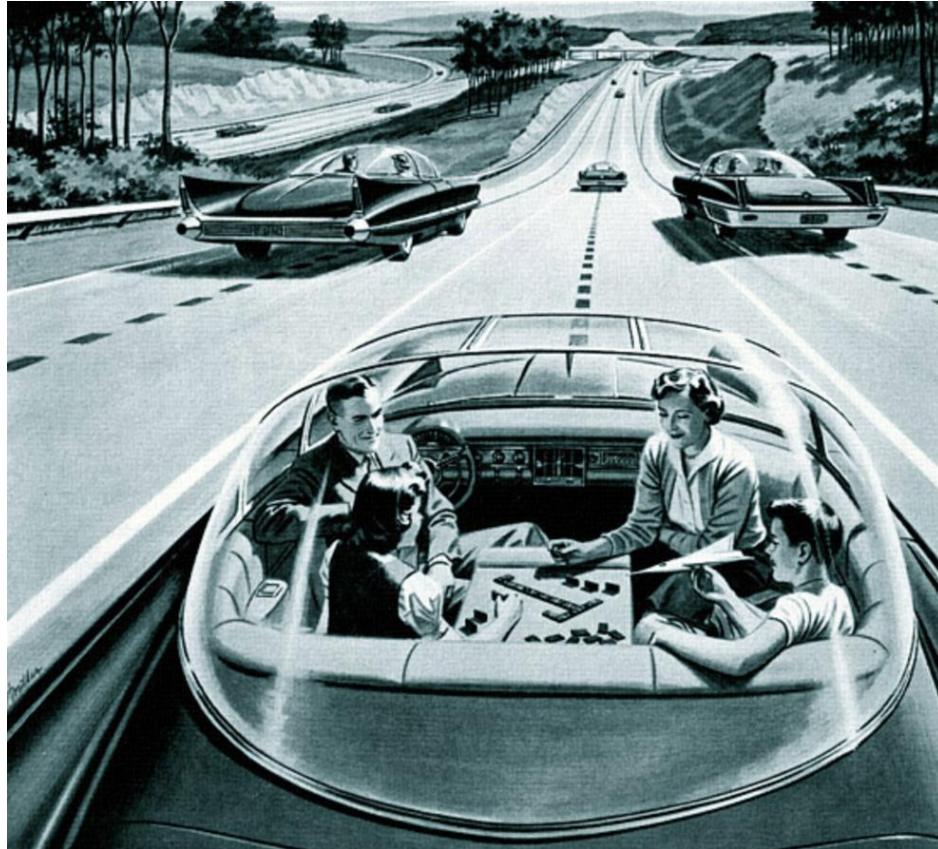


Driven by technology ...



The story of autonomous driving ...

... a parallelity to autonomous laser processes?



*America's Power Companies' advertisement from 1956 depicting a future with autonomous cars. **

* <https://www.engineering.com/DesignerEdge/DesignerEdgeArticles/ArticleID/12665/The-Road-to-Driverless-Cars-1925--2025.aspx>



<https://phys.org/news/2018-06-demystifying-future-autonomous-vehicles.html>



<https://sanfrancisco.cbslocal.com/2018/06/07/ntsb-driver-fatal-tesla-crash/>



<https://medium.com/@DonotInnovate/mind-blowing-driverless-future-fcc5197d509>

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Intelligent Laser systems, optics and sensors provide data

With Condition & Data Based Services we are able to utilize these data



Intelligent laser source



Smart laser light cables



Intelligent scanner optics (PFO)

Overview Laserpool
Maintenance Calendar
Messages & Alarms
Modification of programs
Rule Management

Drill Down of Single Laser

Smart View Services

Dashboards:

- Status of Laser
- Messages / Alarms
- Modifications of programs
- Maintenance Calendar
- Connectivity Status

Condition Monitoring / Predictive Maintenance for higher availability

Smart algorithms and TRUMPF experts monitor your condition data



Condition Monitoring / Predictive Maintenance for higher availability

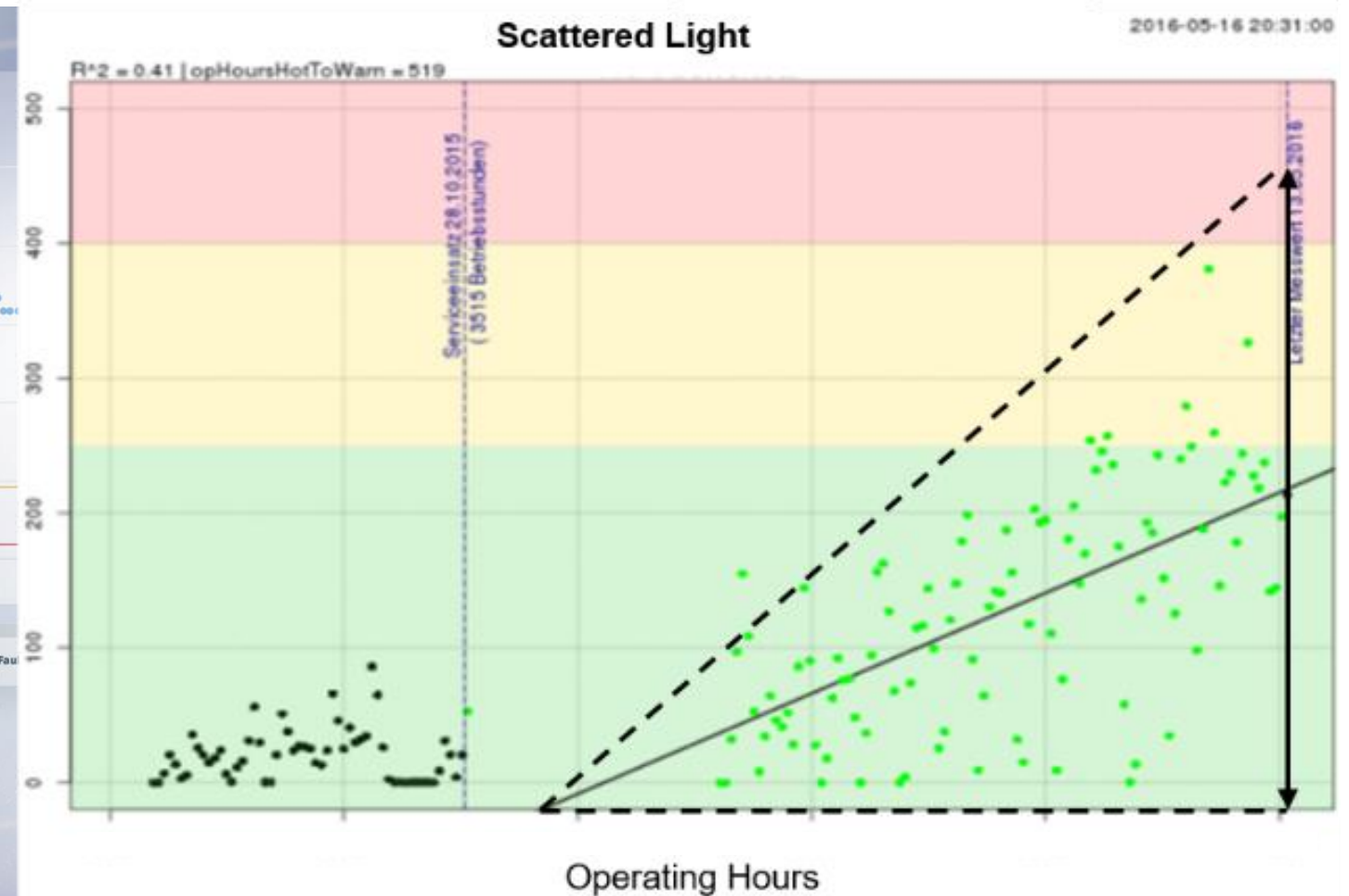
Case Study: Early detection of increasing sensor values

Early detection of production interruptions

- Trend analysis showed increasing values of scattered light
- Service expert contacted customer proactively
- Identification of back reflections caused by welding of aluminum with filler wire
→ Root cause: Operator has changed angle of focusing optic

Benefit

- Based on the analysis and discussion with the service expert a quick solution was found
→ Realignment of focusing optic
- Successful avoidance of downtime
→ Cost savings
→ No production interruption



Condition Monitoring / Predictive Maintenance for higher availability

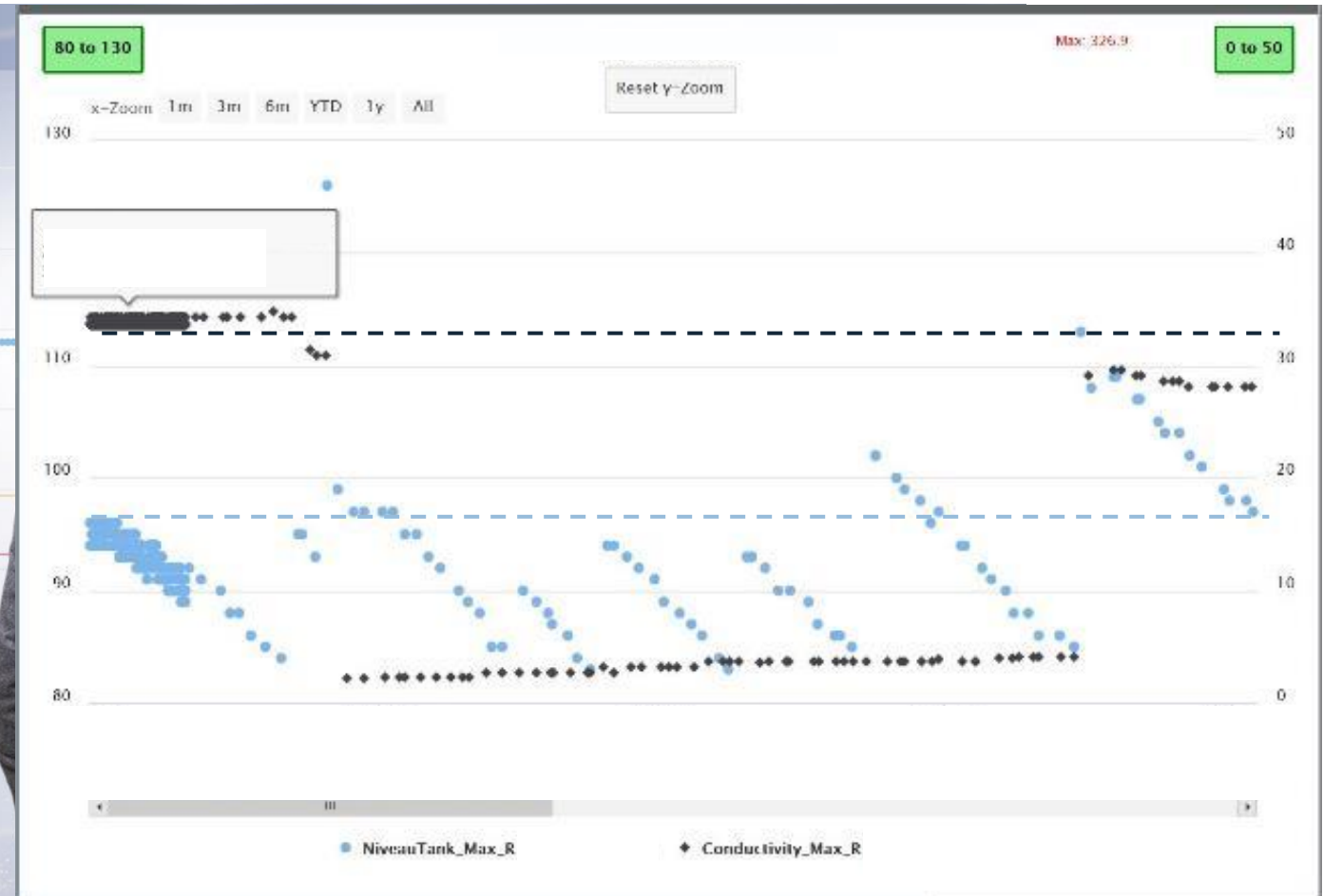
Case Study: Early identification of operating errors and improvement potential

Early detection of production interruptions

- Analysis of data showed low measured values for conductivity → Indicator for missing copper care
- Problem: Customer forgot to add copper care at several refills of cooling water

Benefit

- Avoidance of cost-intensive spare parts & service mission
→ missing copper care might cause corrosion at the cooling fingers
- Identification of necessary training for operators / maintenance



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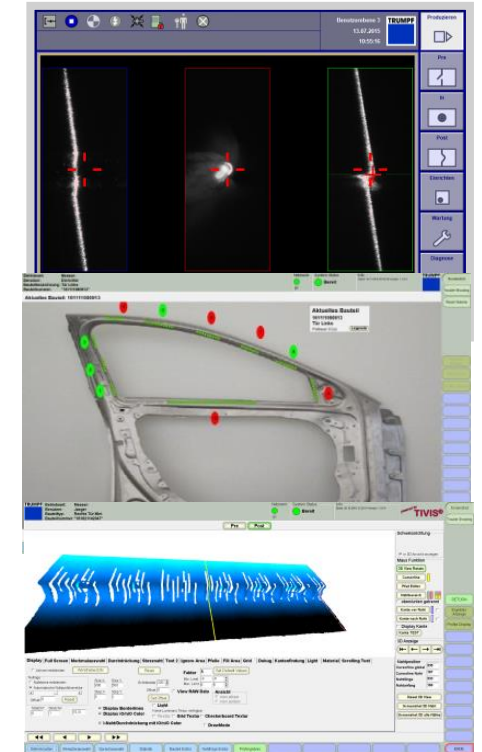
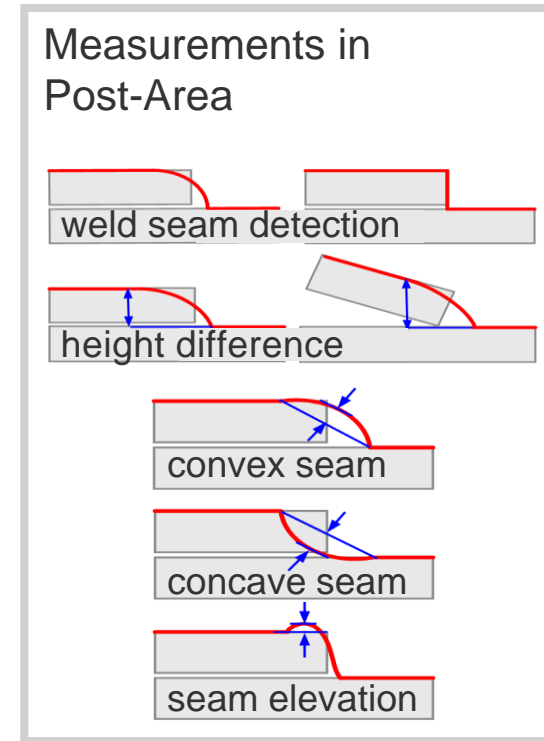
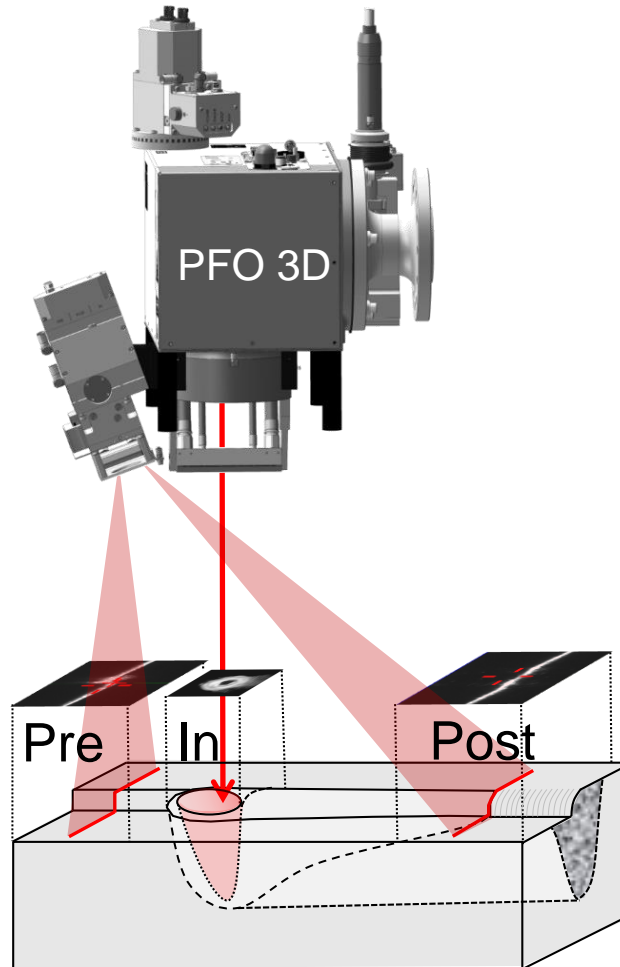
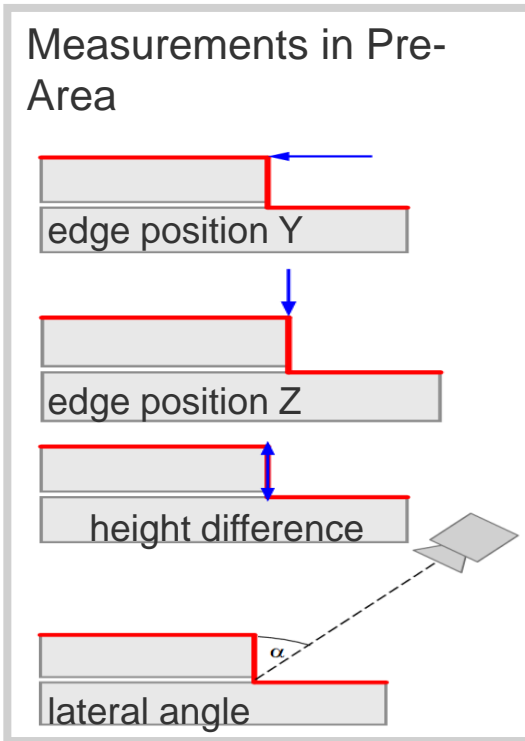
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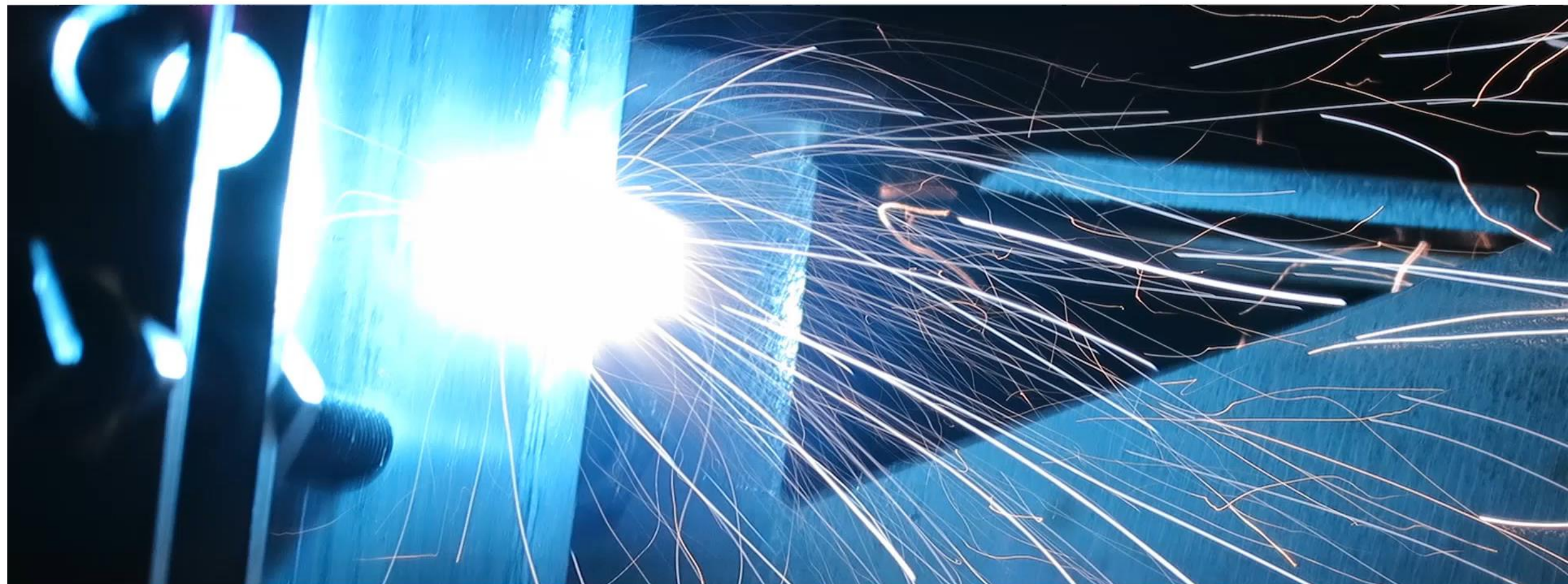


Seam Line Remote

Intelligent Sensor System for Pathfinding



Richtungsunabhängiges Kehlnahtschweißen mit OCT-Nahtlagerregelung

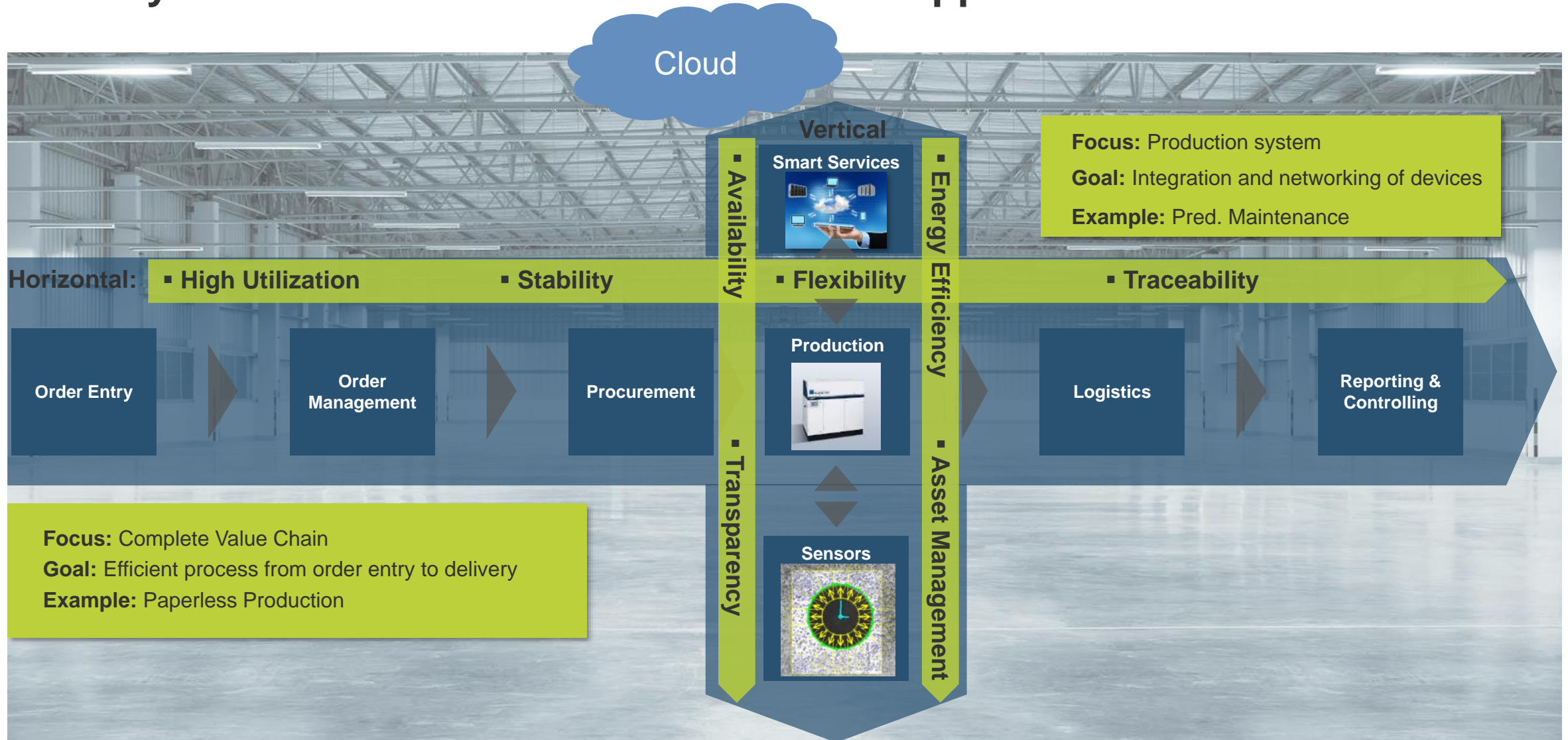


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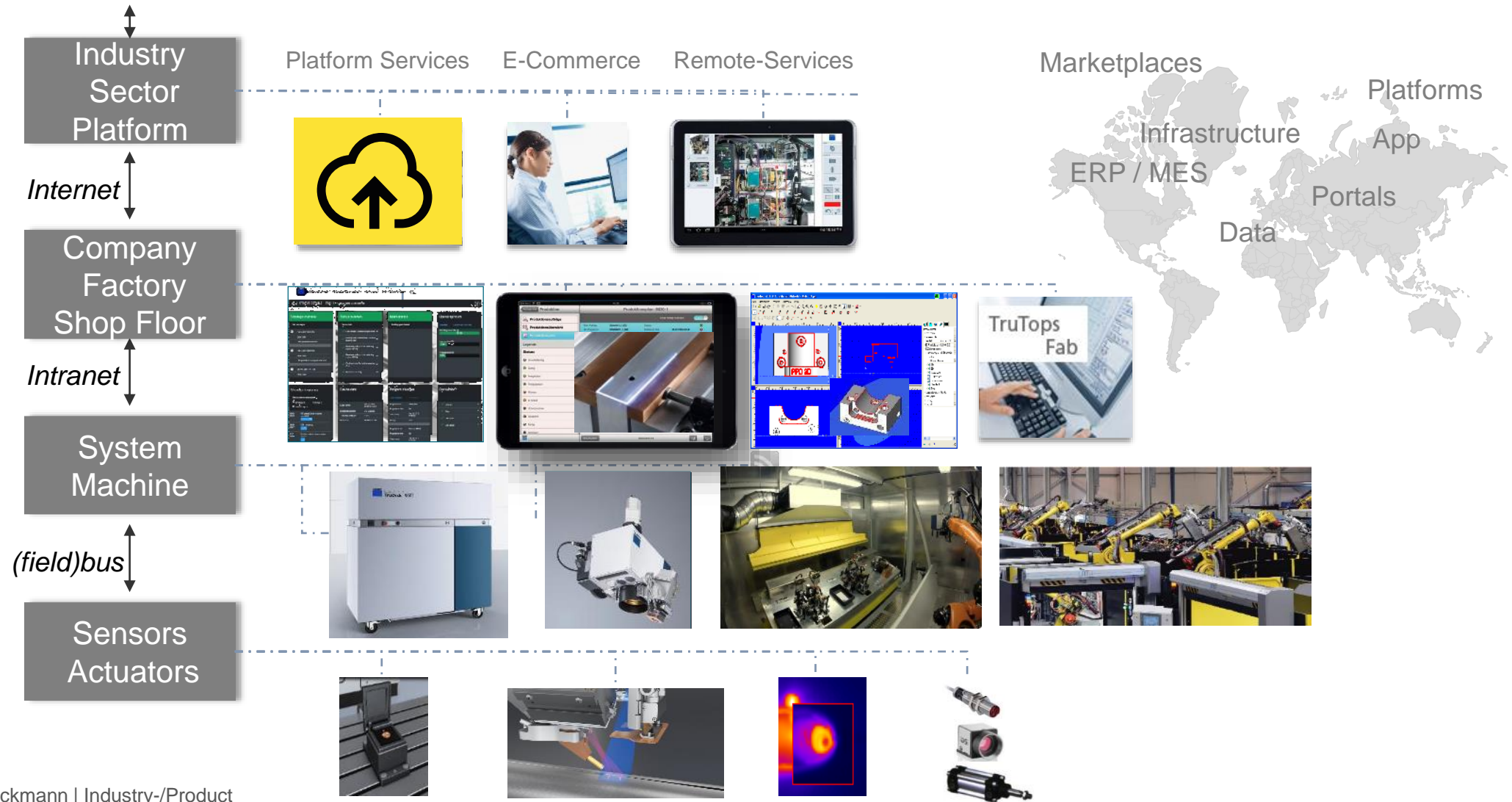
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Industry 4.0: Horizontal and vertical network approach at TRUMPF

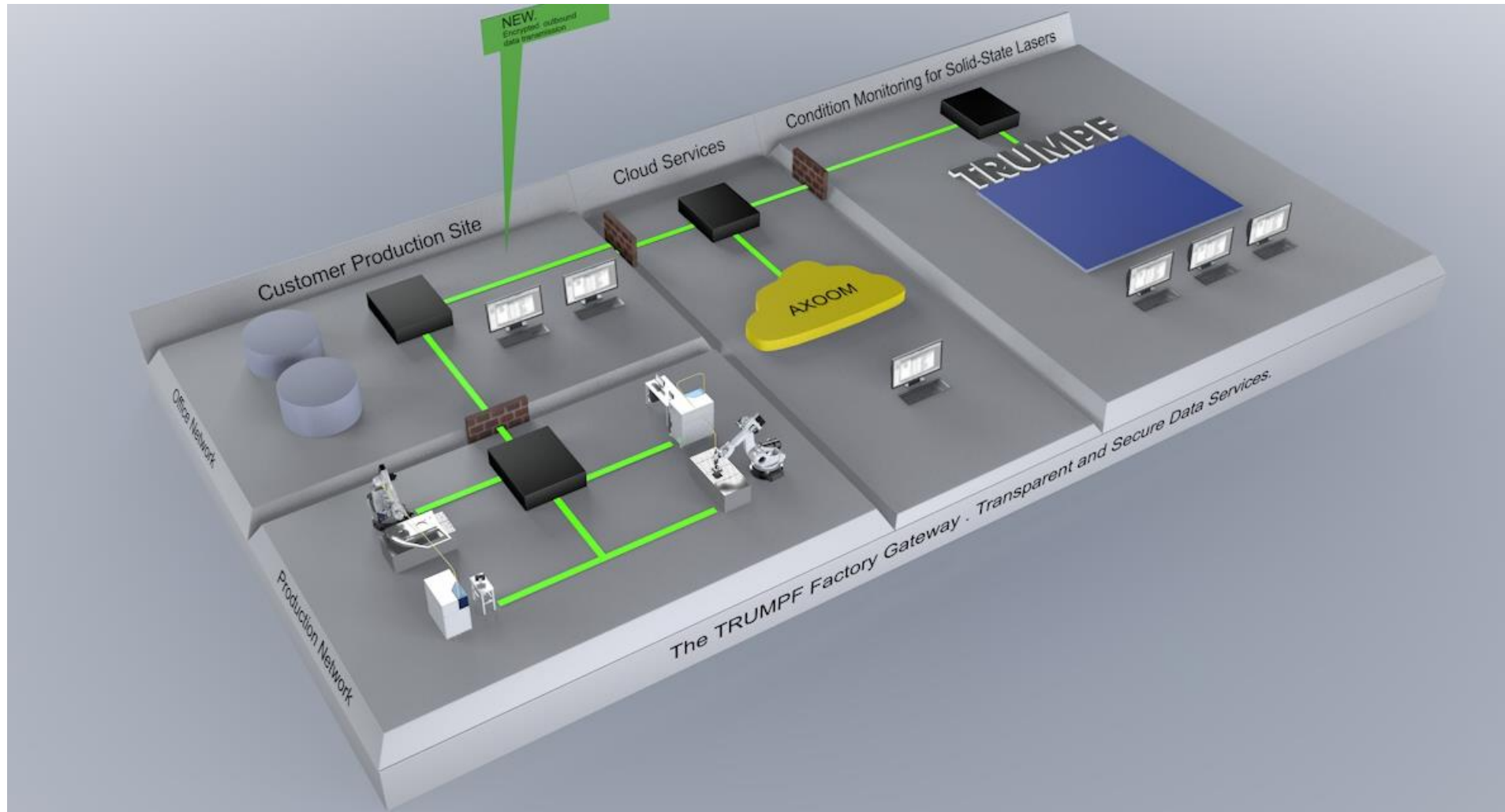


TruConnect: Networks capabilities on different levels – an overview



Take full advantage by using cloud based solutions

Example of IT-Infrastructure for data transfer

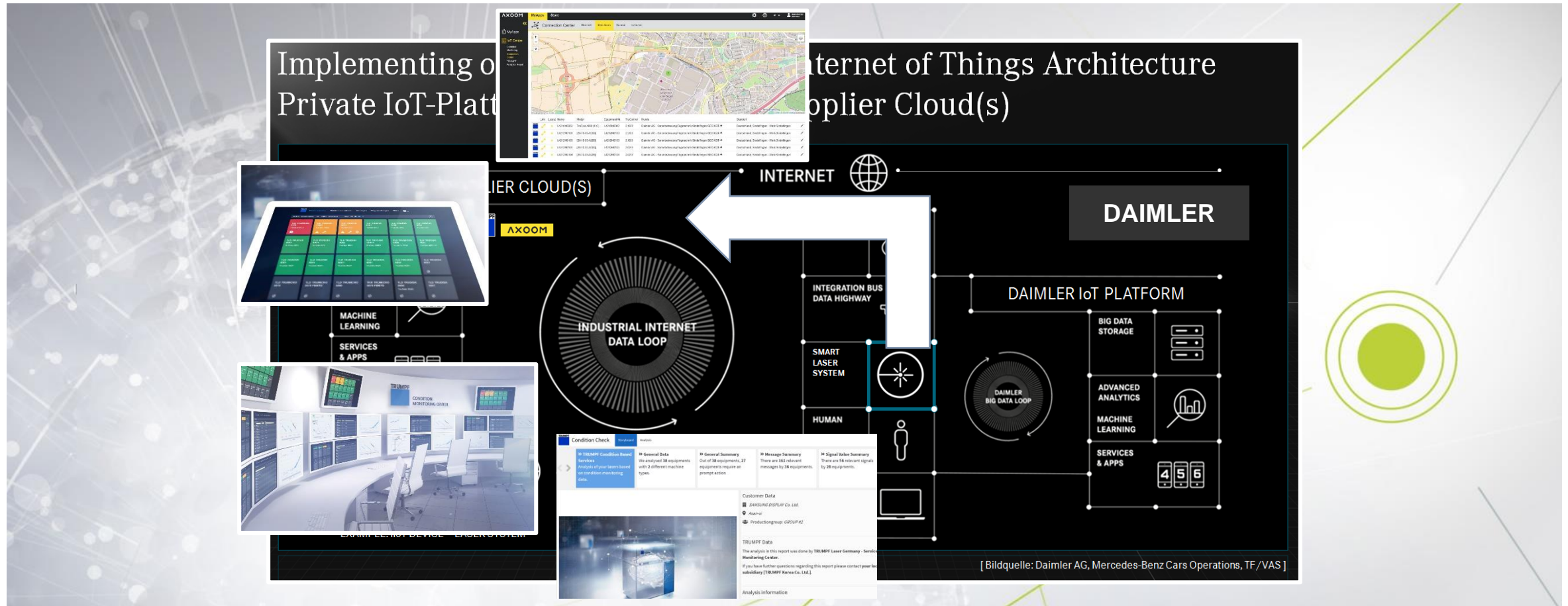


Factory Gate / Cloud Gate powered by C-Labs:



Cooperation is the key factor for success of Industry 4.0

Connectivity as crucial basis for Industry 4.0 benefits



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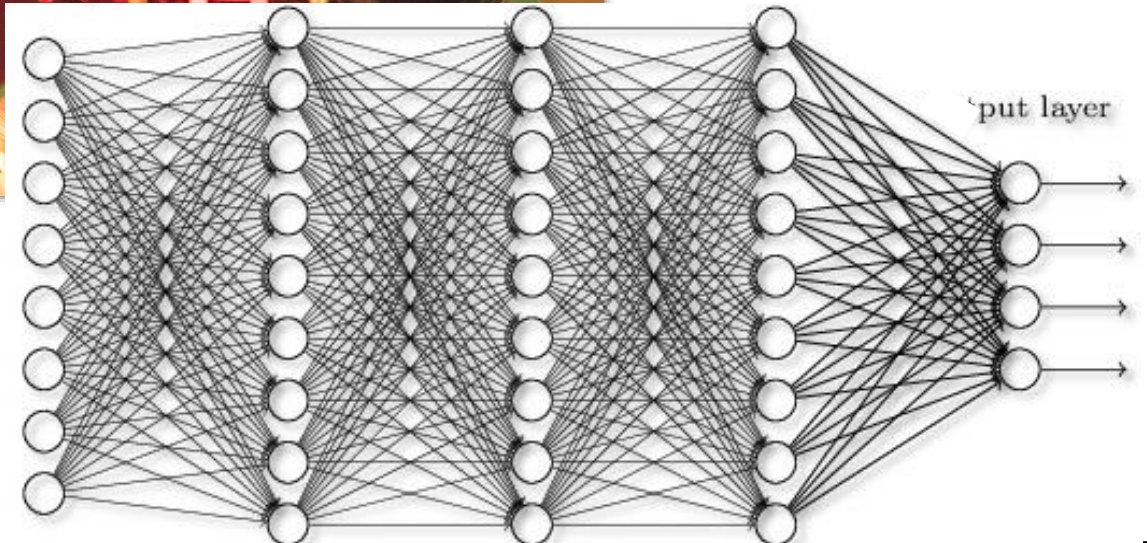
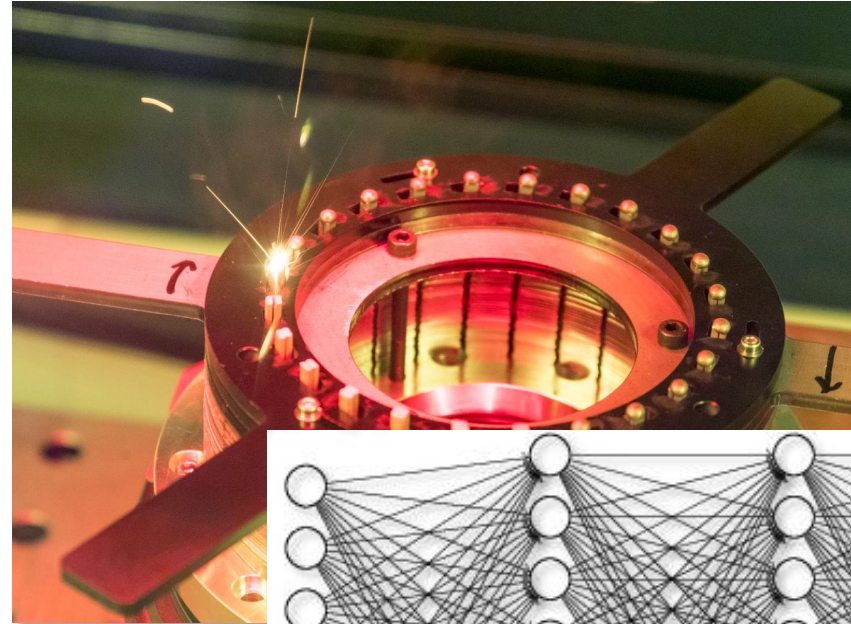
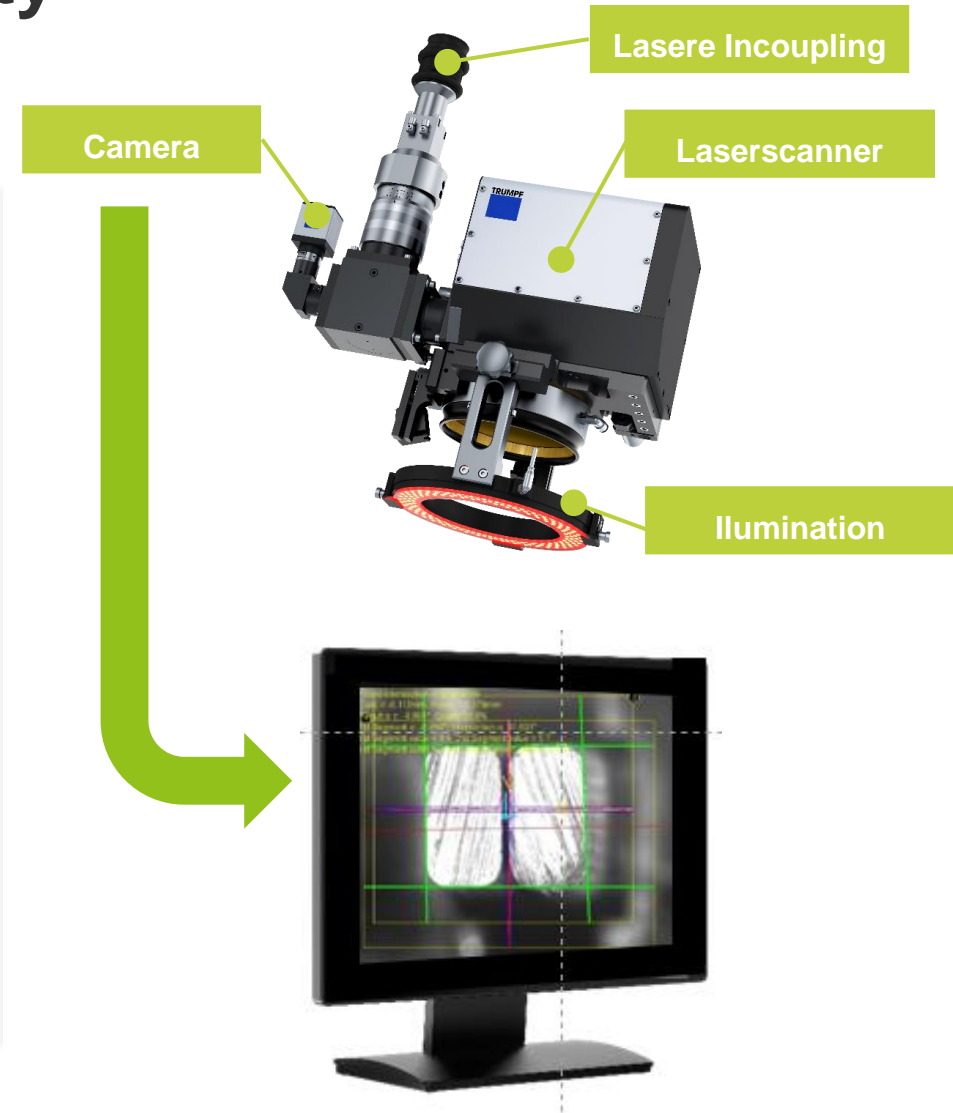
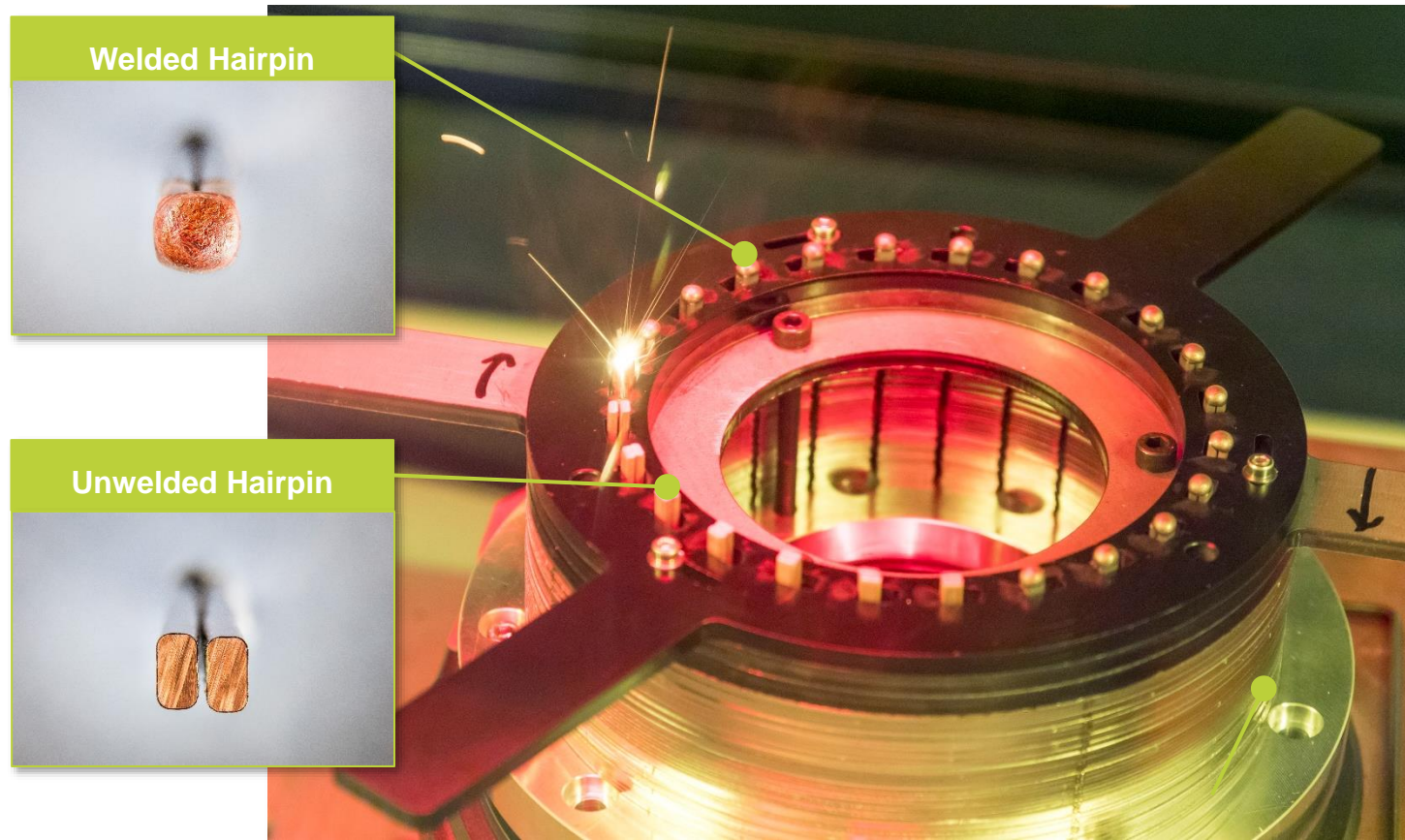


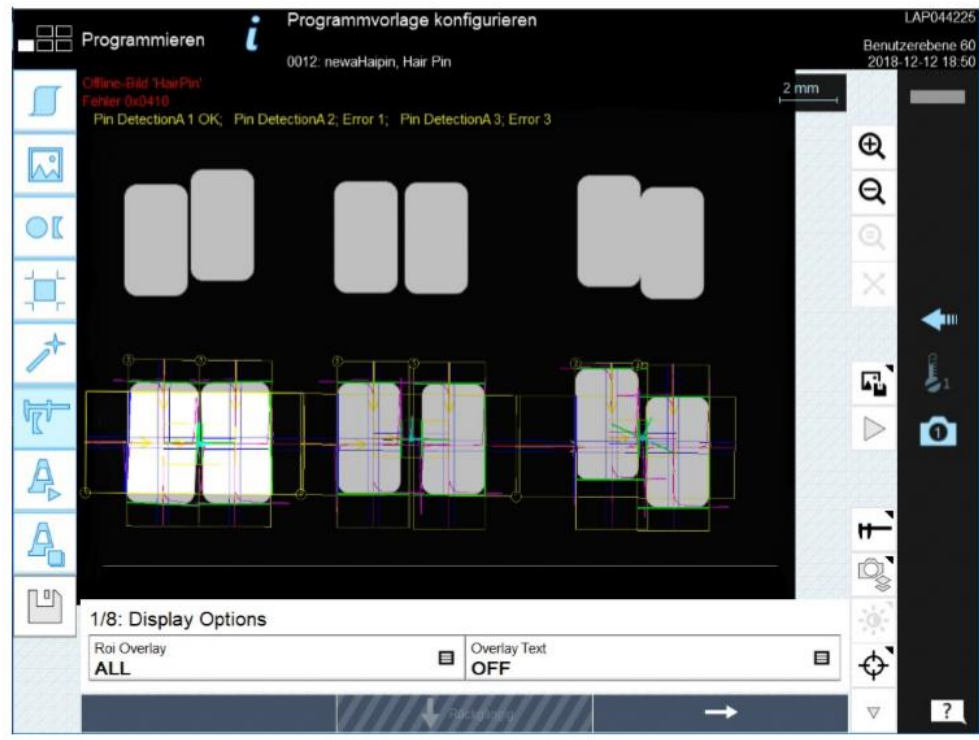
Image:
<https://datawarrior.wordpress.com/2017/10/31/interpretability-of-neural-networks/>

Laser Hairpin Welding for Electro- Mobility



Recognize difficult preconditions / The right welding position

Image processing does recognize gap & shift

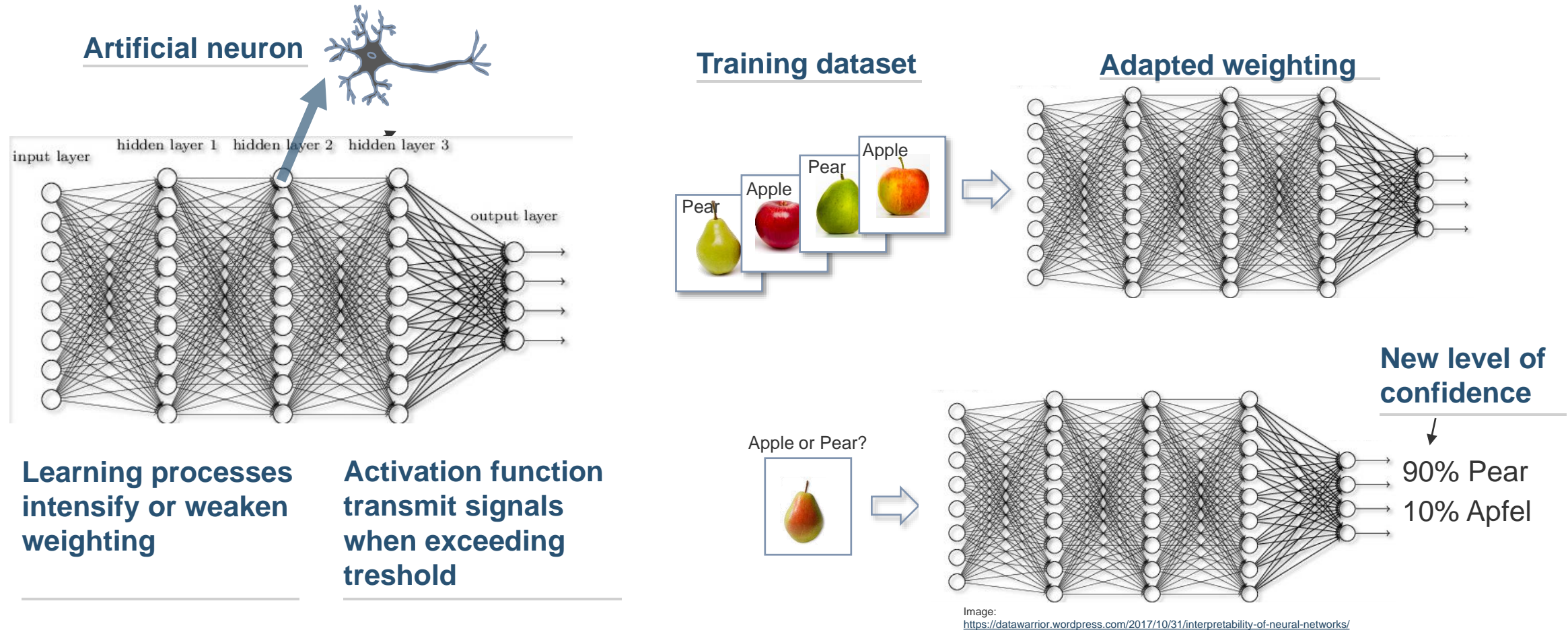


Location data for welding is transferred to scanner head



Artificial Intelligence enables new possibilities

Neural networks have to be trained



Application of deep learning in quality control

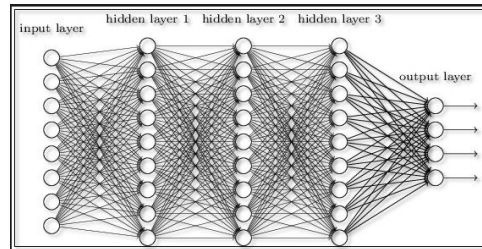
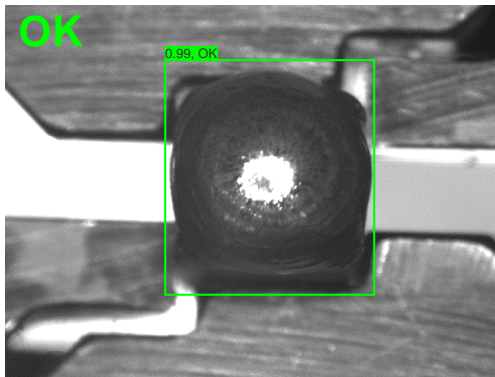
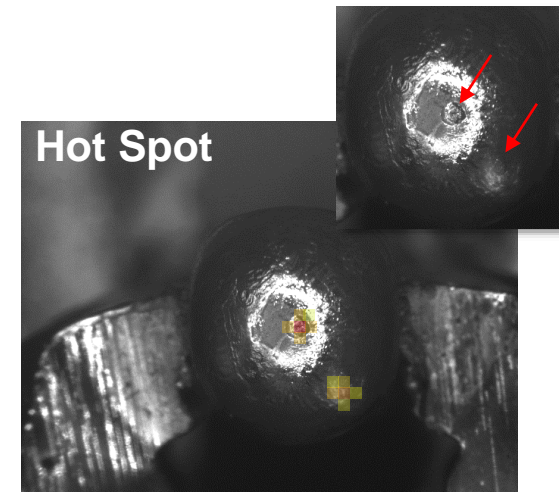
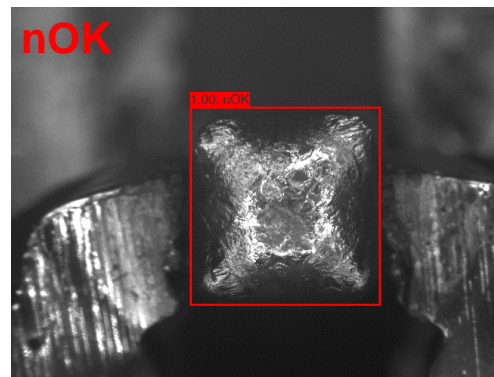


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Images courtesy of Grob-Werke GmbH & Co. KG



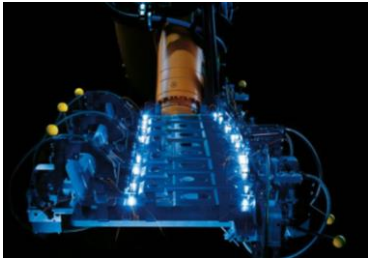
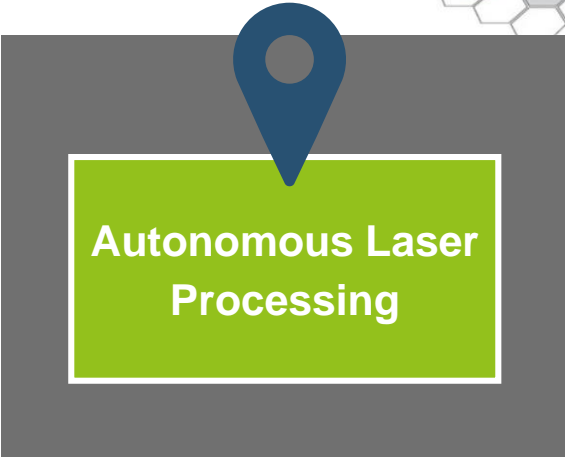
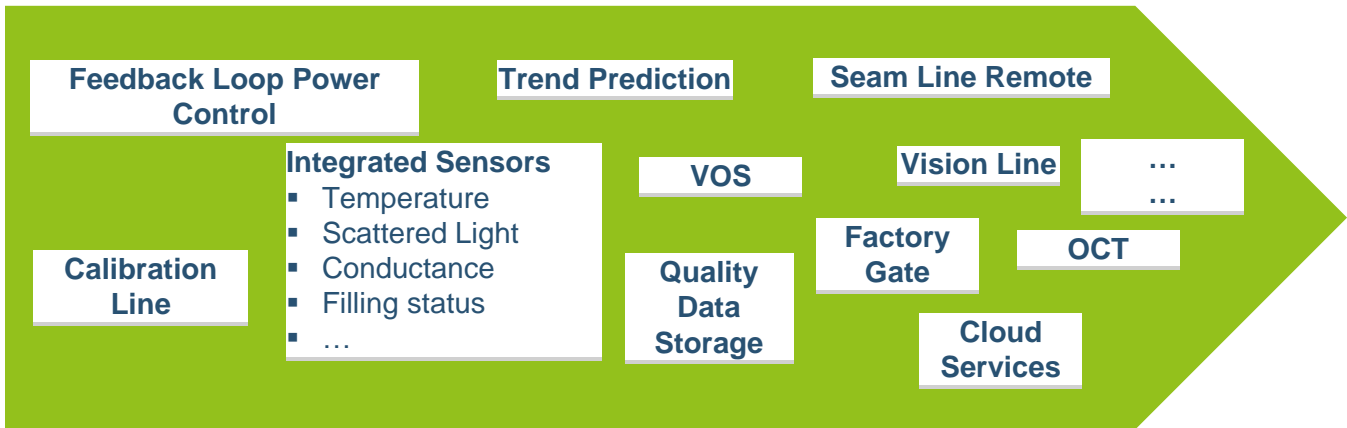
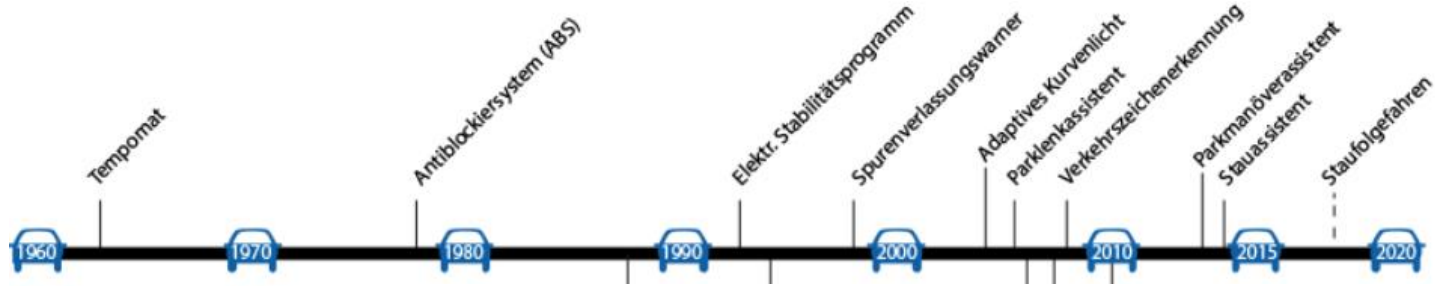
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Vision: Autonomous laser based production

Comparison to autonomous driving





On the way to autonomous laser processing:

Not yet arrived,

but already added value!!!

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