Factories of the Future – Impression from a Study Tour to Germany

Dr Wolfgang Scholz
HERA Director

Objective of Talk

- To report on what has been seen
- Are impressions only - but should deliver food for thought
- Probably far too many slides and need to constrain what I can cover in talk
- Definitely want to cover conclusion/recommendations
- Extensive tour report which can be downloaded shortly from HERA website as HERA Report

METALS NEW ZEALAND INDUSTRY CONFERENCE 2015

Objective of Study Tour

- Part of FRIENZ Project
  (Facilitating Research and Innovation cooperation between Europe and New Zealand)
- Promote opportunities for research collaboration between Germany and NZ
- Visit organisations relevant to our industry heavy engineering interests
- Get a personal insight what will shape the factory of the future

Visits to

- 13 German technical research institutions being part of
  - German technical universities and /or
  - Fraunhofer Society
- Achema fair in Frankfurt
- 3 Metals-based Manufacturing companies

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Mercedes Benz
Stuttgart Sindelfingen

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Mercedes Benz Technology Centre

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Project of the Future: Industry 4.0

Industry is on the threshold of the fourth industrial revolution. Driven by the Internet, the real and virtual worlds are growing closer and closer together to form the Internet of Things. Industrial production of the future will be characterized by the strong individualization of products under the conditions of highly flexible (large series) production, the extensive integration of customers and business partners in business and value-added processes, and the linking of production and high-quality services leading to so-called hybrid products. German industry now has the opportunity to actively shape the fourth industrial revolution. We want to support this process with the "Industry 4.0" forward-looking project.

Source: German Ministry for Education and Research

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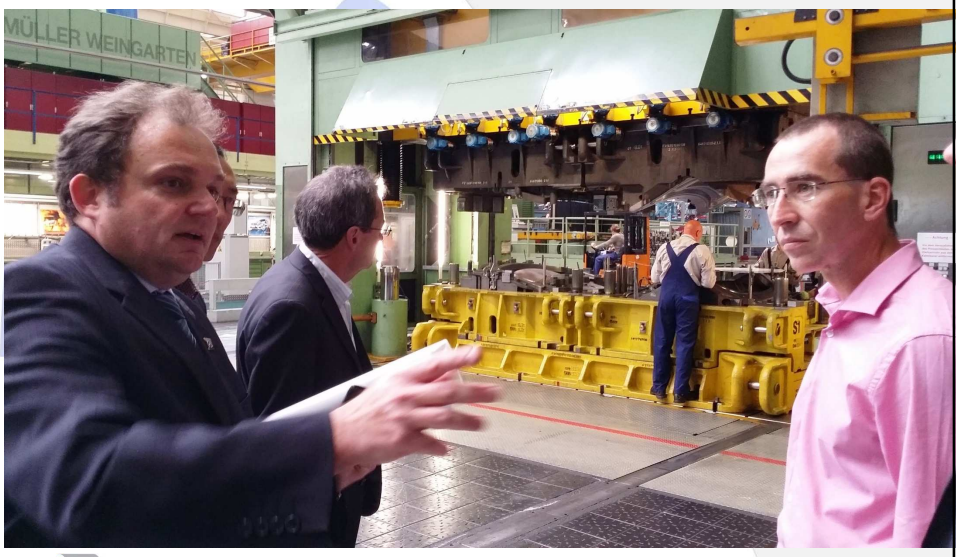
First Hand Explanations



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Body Assembly Line

Shift in Services Provision

- E.g. consumable supply will become a comprehensive service
- Remote controlled storage shelves

QA using IT capability

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What a choice?

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FHG IPA – STUTTGART-VAIHINGEN

- One of the largest institutes of the German Fraunhofer Society (FHG)
- Around 1000 employess

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Industry 4.0 - ARENA 2036

- "Mass Sustainability"
- "Mass Personalization"
- Aim " **to manufacture products with the lot size of one at the cost of mass produced components**"

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FhG IPA – UoA Links

- The FhG IPA entered into a formal 3 year Co-operation with the University of Auckland in the area of Bio-mechatronic Systems. The contract was signed by German Chancellor Angela Merkel, MBIE Minister Stephen Joyce and then IPA Head Professor Alexander Verl
- University of Auckland Ass. Prof Leo K. Cheng received the Fraunhofer-Bessel Research award for his outstanding work in bioengineering and is for 9 months guest at IPA

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Achema Fair in Frankfurt

- Largest processing engineering fair
- Held every three years
- 2015: 166,444 visitors, 3,813 exhibitors
- Cuddon Engineering from Blenheim exhibited with success

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ORC Technology @ Achema

- **INTEC GMK - radial inflow turbine assembly (www.intec-energy.com)**
- **Several other ORC exhibitor such as Duerr (www.durr.com)**

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Siemens Hydrolyzer @ Achema

Proton Exchange Membrane (PEM) Hydrolyser

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Process Equipment Manufacture 4.0

- IT driven, holistic , with focus areas
  - product quality
  - optimised plant operation
  - energy efficiency
  - human/equipment interface
  - environmental considerations

"Self-improving processing plant is no more Utopia"
Andreas Poerner

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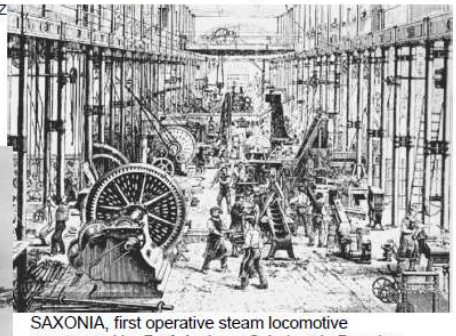
Saxony – Cradle of Mechanical Engineering in Germany

1846 232 mechanical engineering companies in Saxony (1st position in Germany)
source: G. Spur „Vom Wandel der Industriellen Welt durch Werkzeugmaschinen"

1848 First machine tools construction with process suitable for series production in Germany by Johann Zimmermann, Chemnitz

1891 Foundation of German Machine Tool Builders` Association (VDW) in Leipzig



SAXONIA, first operative steam locomotive constructed by Prof. Andreas Schubert in Dresden
1st ride Nürnberg – Fürth, 7th December 1835

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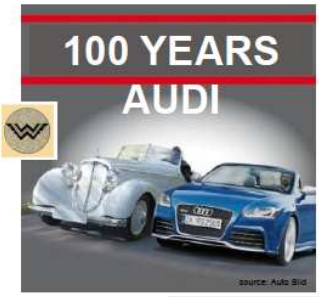
Saxony – Cradle of German Automotive Engineering

1904 **Horch Werke, Zwickau**
(aluminium casting for engines and gearbox cases;
cardan shaft as power transmission element)

1909 **Audi Werke in Zwickau**
(steering wheel on the left-hand side, centred gear stick)

1932 Horch and Audi Werke merge with
Wanderer Chemnitz and DKW Zschopau
to **Auto Union AG** (four rings)

1948-1990 car factory **"Sachsenring"**, Zwickau



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Saxony – Automotive Engineering Today

VW Sachsen GmbH
locations in Mosel,
Chemnitz and Dresden

PORSCHE

Porsche
and
BMW
in Leipzig

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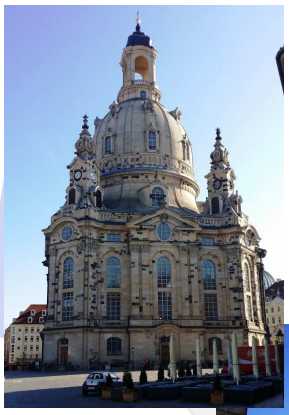
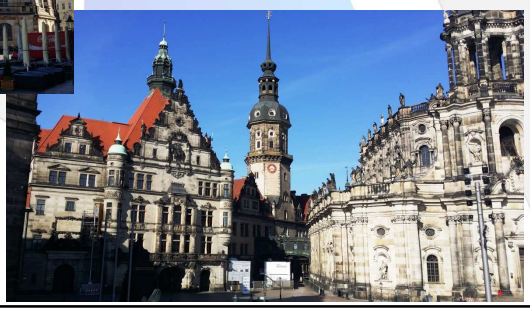
Technical University of Dresden



- **Founded in 1828**
- **Named Technical University in 1961**
- **Part of Germany's 11 "excellence" universities**
- **37,000 students**
- **45% in Engineering Sciences**



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Technical University of Chemnitz

1836	Foundation with the Royal Mercantile College
1900	Royal Technical Academy
1929	State Academy of Technology
1953	College for Mechanical Engineering
1969	Technical College
1986	University of Technology

8 Faculties with 27 Institutes

Natural Sciences
Mathematics
Mechanical Engineering (1.732 Students)
Electrical Engineering / Information Technology
Computer Science
Economics and Business Administration
Humanities
Behavioural and Social Sciences

Total students 2014: 11,650 of which 20% international

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Fraunhofer IWU

Institut fuer Werkzeugmaschinen und Umformtechnik

- Established on July 1, 1991
- about 590 employees
- 37.6 million euros annual budget
- Locations: **Chemnitz**, Dresden, Zittau, Augsburg

Research with the guiding focus on »Ressource Efficient Production«

Academic Areas

- Mechatronics and Lightweight Design
- Machine Tools and Production Systems
- Forming Technology and Joining
- Cutting Technology

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Fraunhofer IWU Departments

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FRIENZ Delegation at FhG IWU

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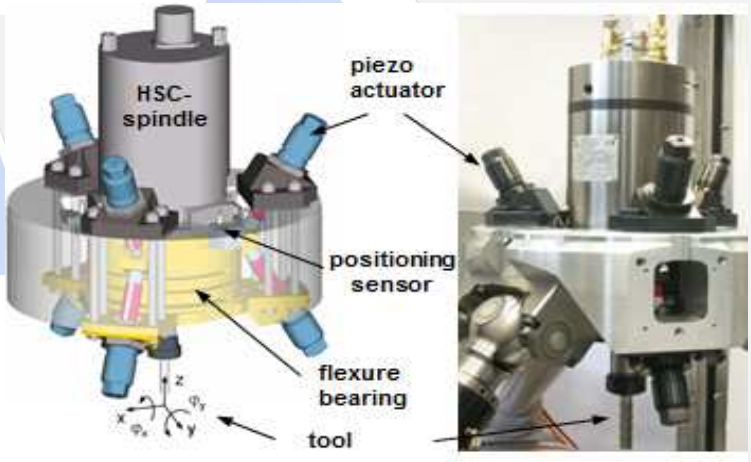
Adaptive Spindle Control based on Piezo Actuators



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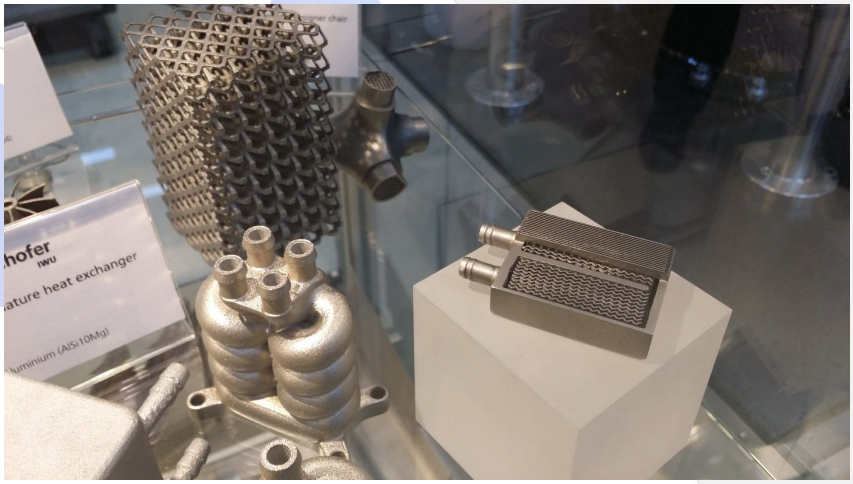
Additive Manufacturing



Laser sintered heat exchanger examples

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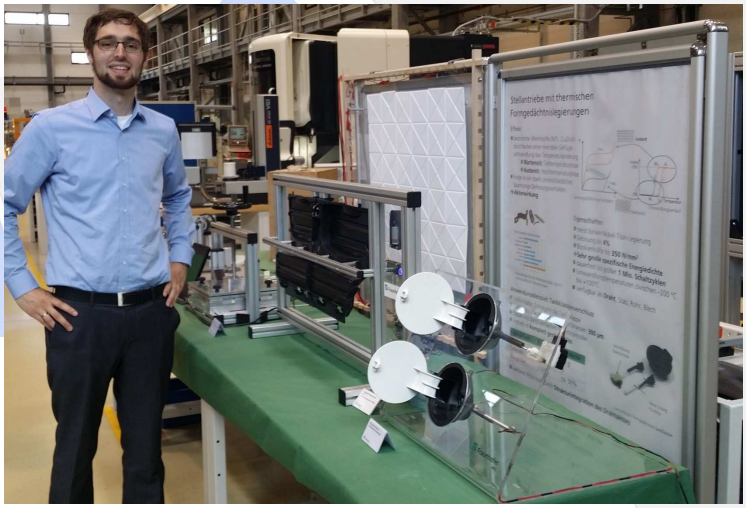
Smart Materials Research – PCM's



Example: Opening mechanism for car tank lid using Phase Changing Metals

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Water Jet Cutting – Exploring the 3rd dimension

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Metal Foam and Light Weight Design

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Metal Foam Examples

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ICE Train Cabin from Metal - foamed components

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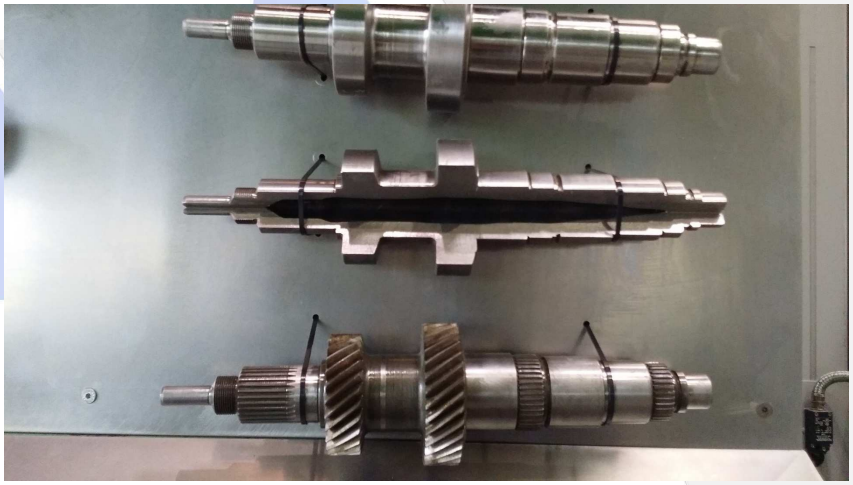
Metal Forming Technologies for Hollow Shaft Geometries



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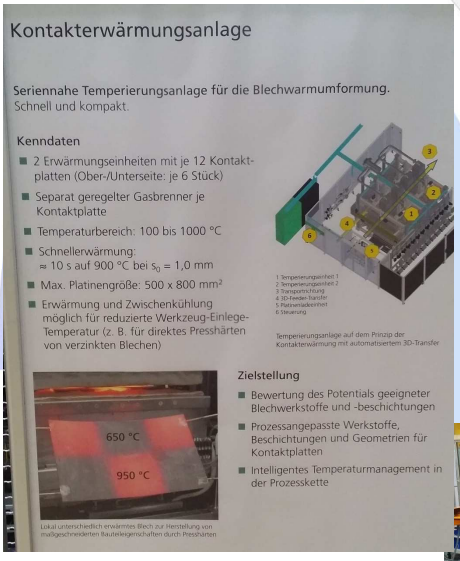
Process-modified Metal-forming



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KIT Hydrogen Campus Bus

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KIT Hydrogen Fuel Station

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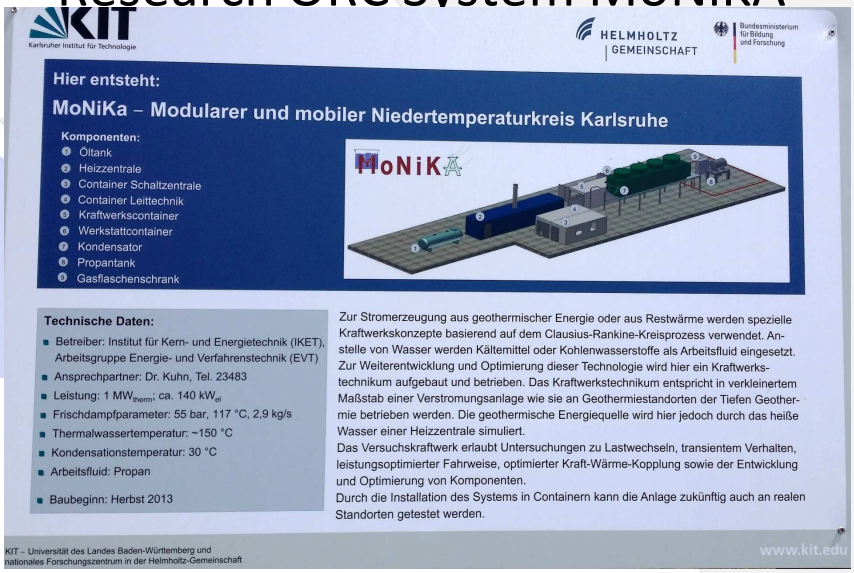
Research ORC System MoNiKA



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Monika Under Construction

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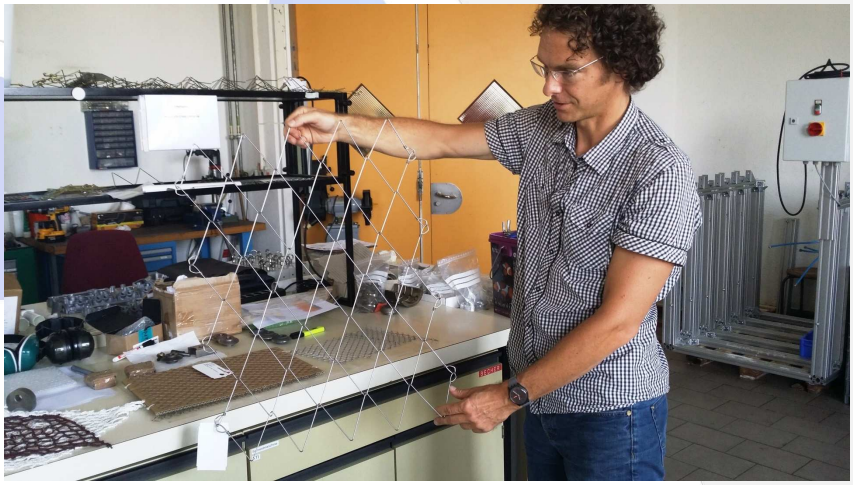
University of Konstanz
fish farm netting research



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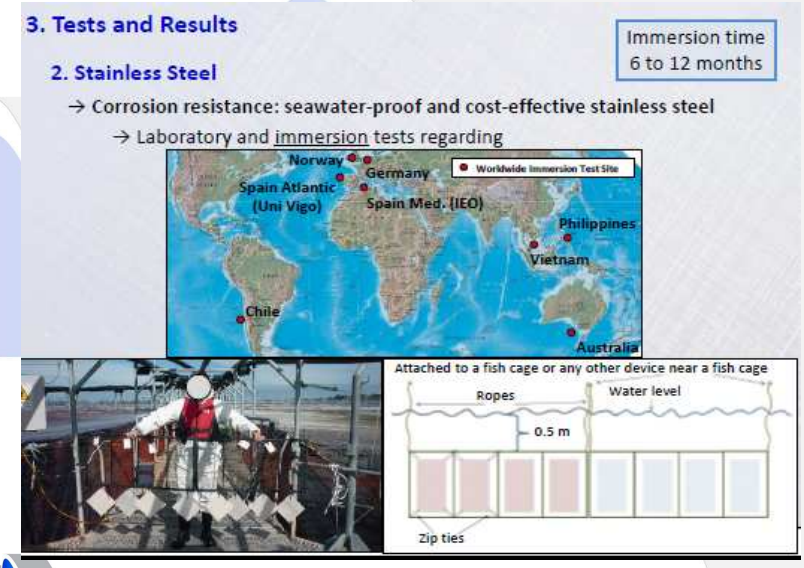
Pilot tests in 8 locations across the world



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SS Netting Solutions

1:1 FIELD INSTALLATION IN CHILE (OCT. 2014)

- Collecting center 8'500 m^2
- Collaboration with partners
  - design
  - pre-assembly
  - installation
  - fish farmer
- Result:
  - minor improvements were required
  - proof of concept
  - new orders

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Steel Construction Institute at the TU Aachen

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Composite Steel/Glass Construction

Steel-glass composite elements before and after testing at TU Aachen

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Composite Steel/Polymer Foam Sandwitch Construction

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Adhesive Bonded Steel Composites

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Innovative Shear Connectors used in composite bridge girders

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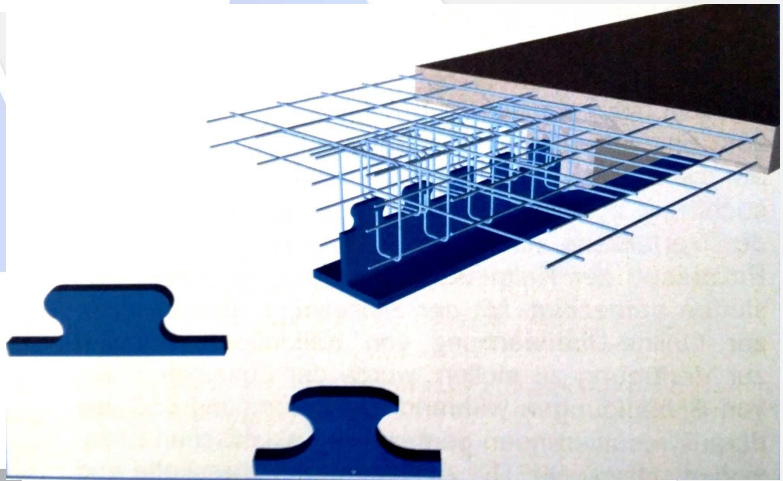
Innovative Shear Connector Concept for Composite Deck



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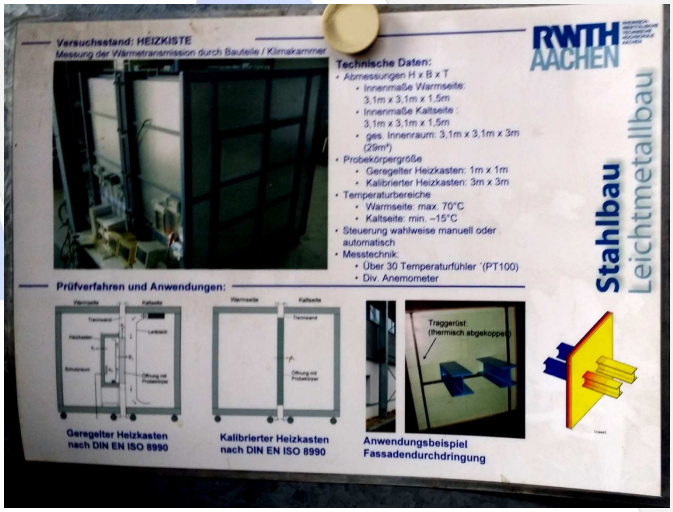
Thermal Testing Chamber



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German Stahl Zentrum

- **Organisations of the Steel Center**
- The German Steel Federation
- Steel Institute VDEh
- Steel Information Centre (S-I-Z)
- Research Association for Steel Application
- The Special Steel Association
- Information Center Stainless Steel (ISER)
- Stahleisen Publishing House
- VDEh-Institute for Applied Research GmbH (BFI)
- Max-Planck-Institut für Eisenforschung GmbH (MPIE)

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Hot-dip Galvanising Research For Bridge Construction

New FOSTA co-ordinated research paves the way for the use of hot-dip galvanising in German bridge construction

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FhG Institute for Large Structures University of Rostock

Institute Director, Prof Martin-Christoph Wanner, in front of the largest robot built to date - 6m high – 4 tons

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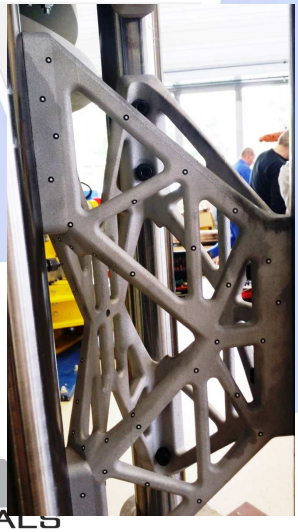
Largest Robot – Superlatives



Largest additive manufactured part seen by author incorporating novel bearing concepts

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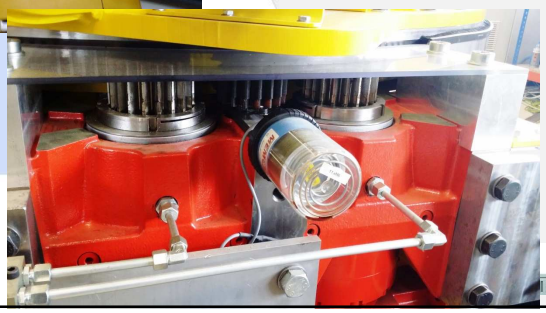
Largest Robot – Superlatives

Novel kinematics and drives



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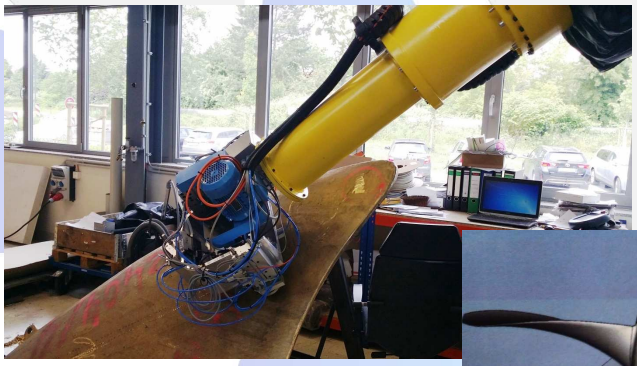
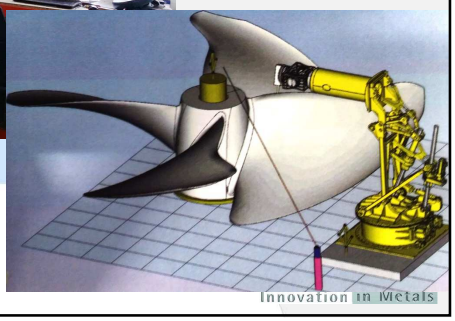
Largest Robot – Application Research Optimising Ship Propeller Shapes





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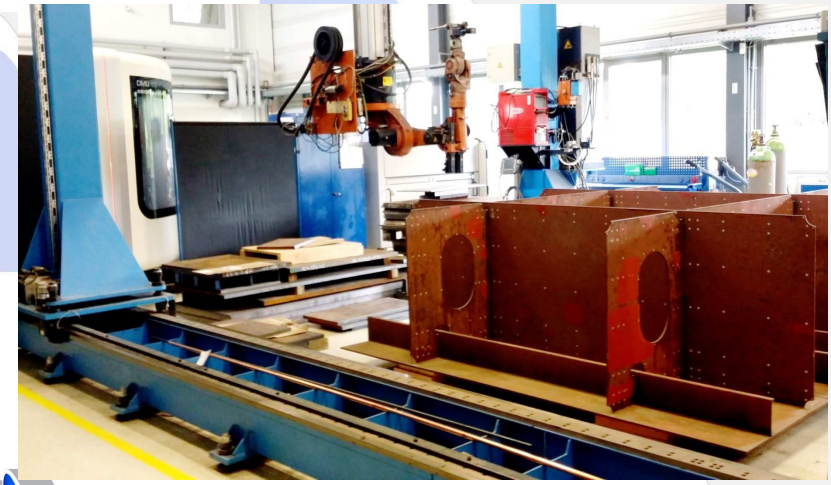
Gantry Ship Hull Welding Station



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Welding System for Large Pipe Intersections

The plan

The execution

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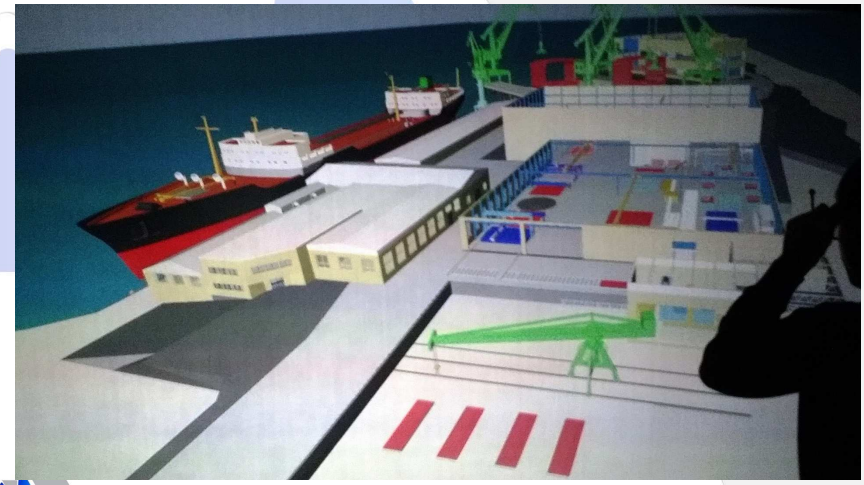
Virtual Reality Ship Building Planning



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Wind Energy Offshore Structures ("Energiewende" Projects Support)

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Research – as long as it is for heavy structures

Heavy section welding processes

Connections research for bolts in offshore applications

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At EEW Group - Structural Pipes in Rostock Germany

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Weld Preparation OAW Cutting

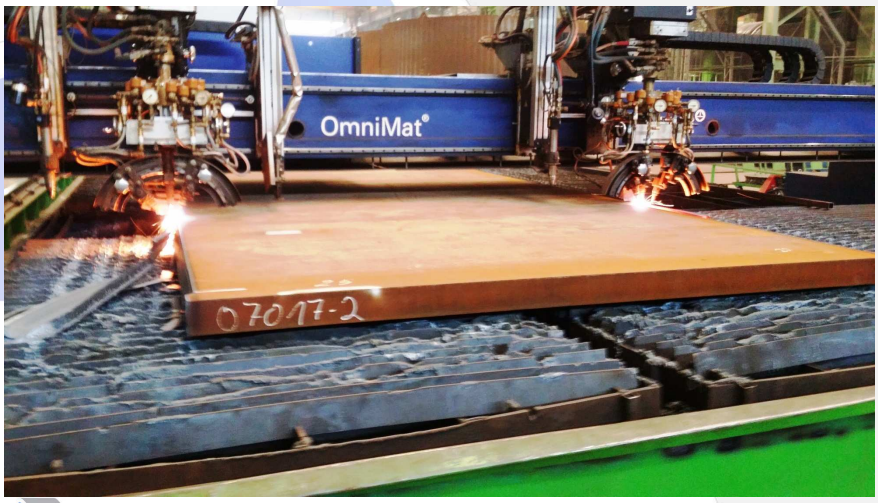

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Plate Rolling Expertise

Note machined weld edge preparation

Toughness Requirement 50J @ - 60 ºC

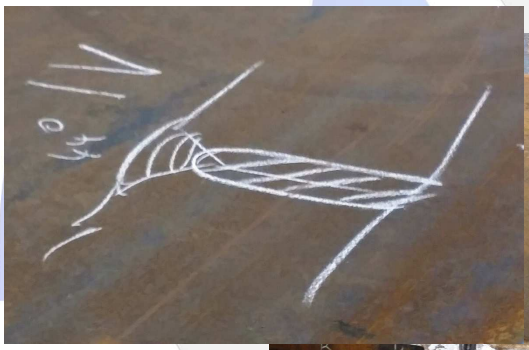

Plate thickness 25- 125 mm
500 employees
3 shift operation
2 IIW welding engineers
2 IWS
300 certified welders
95 % sub-arc welding
100% 3rd party NDT

Up to 12m Diameter, up to 80 m long Monopiles, weighing up to 1500 tonnes

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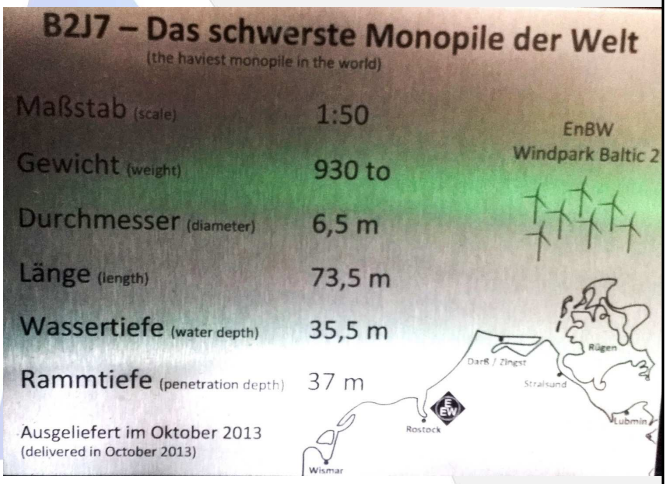
Technical Monopile Data



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Endless rows of Monopiles ready to be shipped

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EWE Structural Pipes Rostock

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Monopiles In Transport to their Windfarm Location in the Baltic Sea

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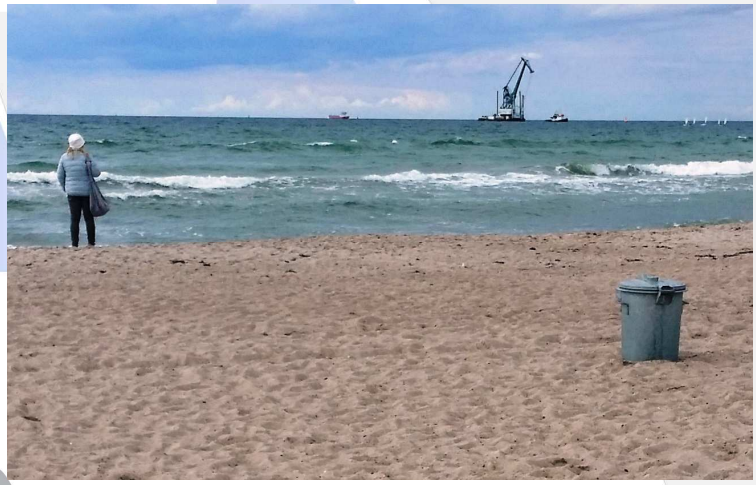
Piling Crane in Transit



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Specialist Offshore Windfarm Maintenance Ship

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Conclusions/Recommendations

IT Driven Metals Engineering Technologies

- Take notice of IT based 4th Industrial revolution
- Advocate that IT applied in conjunction with HVM products has likely higher return than IT based software development on its own
- Create NZ Industry 4.0?
- HERA research focus on IT integration in our product offerings
- HERA pick-up identified business opportunities and research co-opeoration

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Conclusions/Recommendations Steel Construction Research

- Intensify research co-operation in
  - Seismic research e.g. reliability of welded joints
  - Leverage IT opportunities in the QA area including around SFC scheme (e.g. weld quality monitoring)
  - Steel bridge life extension (e.g. bonded steel deck options)
- Develop steel composite material research road maps (e.g. steel glass, steel/engineered timber)

Conclusions/Recommendations Hydrogen Based Technologies

- New look at NZ business case for hydrogen economy
- HERA (and others) to performs research supporting the development of an NZ-Inc. business case

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Summary Conclusion

- Plenty of innovation in metallic materials , manufacturing and associated IT
- Will keep product sector competitive
- Should give confidence for sustainable industry future
- But forward plan your business and R&D activities around proposed themes

Thank you

Full report available shortly from HERA website as HERA Report

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