

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

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HERA Director



METALS NEW ZEALAND INDUSTRY CONFERENCE 2015



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



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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



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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



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.

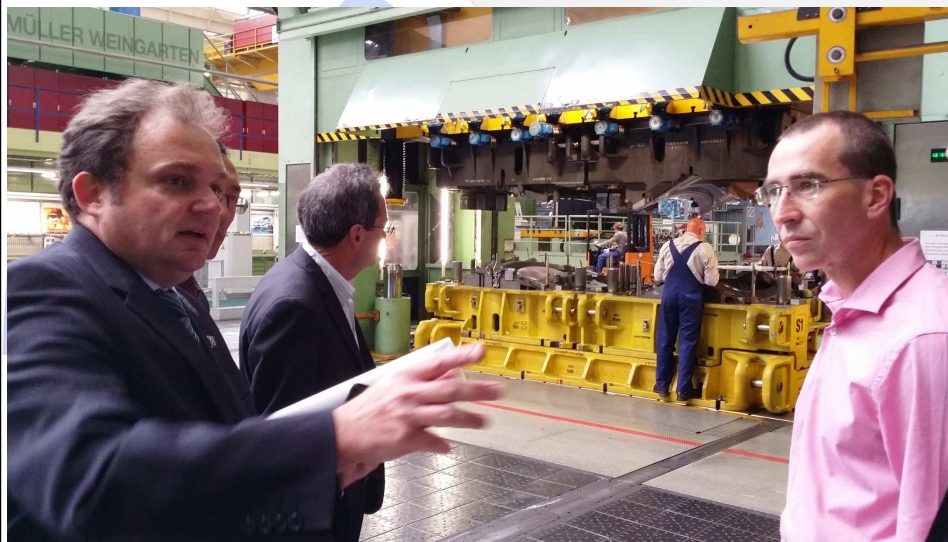
Source: German Ministry for Education and Research



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First Hand Explanations



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Body Assembly Line



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Shift in Services Provision

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



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QA using IT capability



What a choice?



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FHG IPA – STUTTGART-VAIHINGEN



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



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



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



ORC Technology @ Achema



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



Siemens Hydrolyzer @ Achema



Proton Exchange Membrane (PEM) Hydrolyser



Process Equipment Manufacture 4.0

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



Förmer: **ANLAGENBAU 4.0** unterstützt die Verfahrenindustrie, um flexibler, kostengünstiger und sicherer zu produzieren.



Wir schaffen Produktivität



“Self-improving processing plant is no more Utopia”

Andreas Poerner



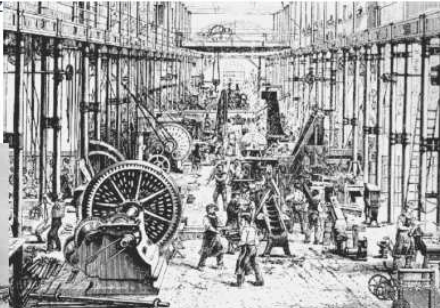
Saxony – Cradle of Mechanical Engineering in Germany

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



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



Saxony – Automotive Engineering Today



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



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



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



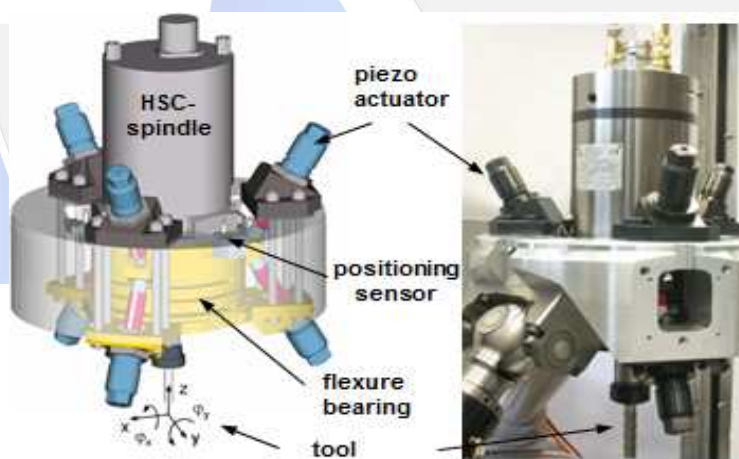
Fraunhofer IWU Departments



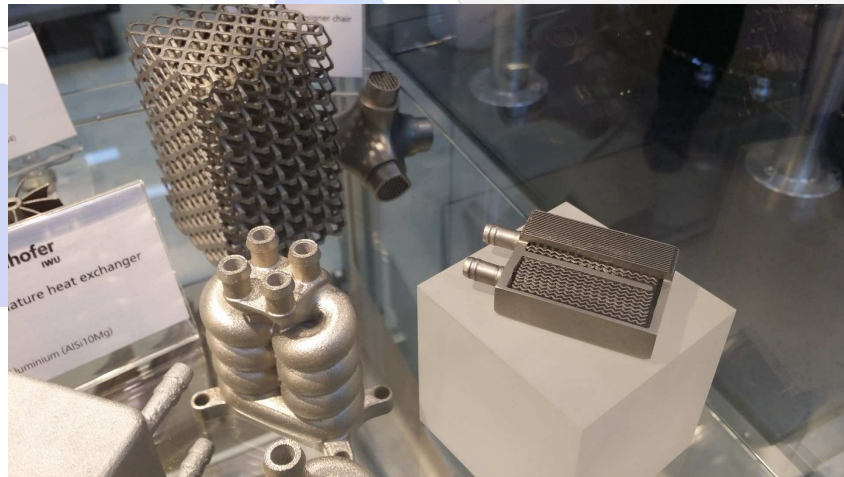
FRIENZ Delegation at FhG IWU



Adaptive Spindle Control based on Piezo Actuators



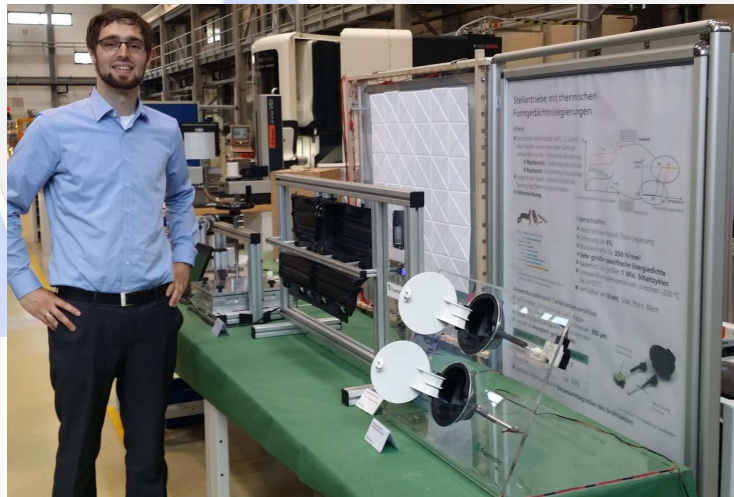
Additive Manufacturing



Laser sintered heat exchanger examples



Smart Materials Research – PCM's



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



Water Jet Cutting – Exploring the 3rd dimension



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Metal Foam and Light Weight Design



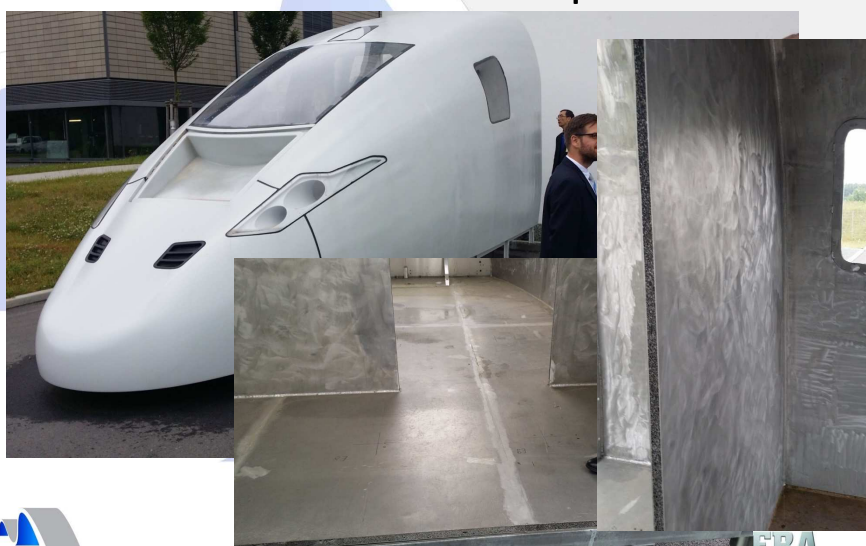
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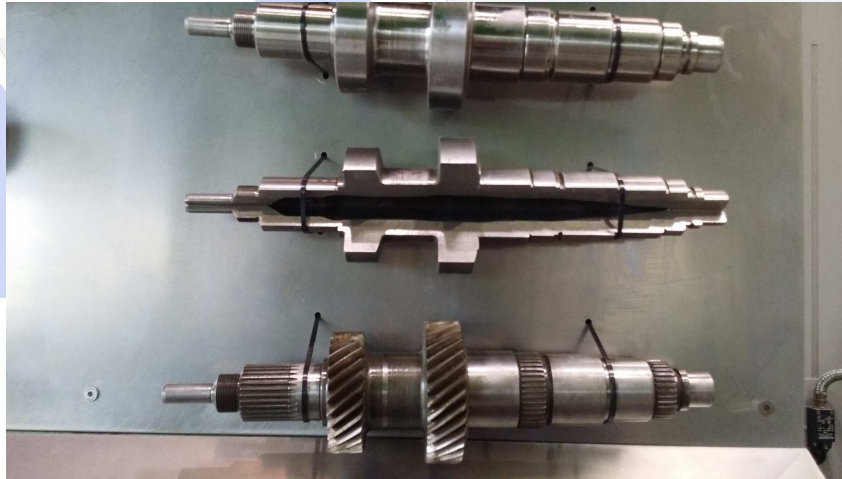
Metal Foam Examples



ICE Train Cabin from Metal - foamed components



Metal Forming Technologies for Hollow Shaft Geometries



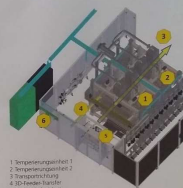
Process-modified Metal-forming

Kontaktwärmungsanlage

Seriennahe Temperierungsanlage für die Blechwärmumformung.
Schnell und kompakt.

Kenndaten

- 2 Erwärmungseinheiten mit je 12 Kontaktplatten (Ober-/Unterseite: je 6 Stück)
- Separat geregelter Gasbrenner je Kontaktplatte
- Temperaturbereich: 100 bis 1000 °C
- Schnellerwärmung:
≈ 10 s auf 900 °C bei $s_0 = 1,0 \text{ mm}$
- Max. Platinengröße: 500 x 800 mm²
- Erwärmung und Zwischenkühlung möglich für reduzierte Werkzeug-Einlegetemperatur (z. B. für direktes Preshärten von verzinkten Blechen)



Temperierungsanlage auf dem Prinzip der Kontaktwärmung mit automatisiertem 3D-Transfer

Zielsetzung

- Bewertung des Potentials geeigneter Blechwerkstoffe und -beschichtungen
- Prozessangepasste Werkstoffe, Beschichtungen und Geometrien für Kontaktplatten
- Intelligentes Temperaturmanagement in der Prozesskette



Lokal unterschiedlich erwärmtes Blech zur Herstellung von Hochgeschwindigkeitsbauteilen durch Pressen




KIT Hydrogen Campus Bus



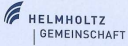
KIT Hydrogen Fuel Station




Research ORC System MoNiKA



KIT
Karlsruher Institut für Technologie



HELMHOLTZ
GEMEINSCHAFT

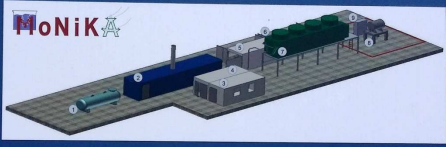


Bundesministerium
für Bildung
und Forschung

Hier entsteht:
MoNiKa – Modularer und mobiler Niedertemperaturkreis Karlsruhe

Komponenten:

- Öltank
- Heizzentrale
- Container Schaltzentrale
- Container Leittechnik
- Kraftwerkscontainer
- Werkstattcontainer
- Kondensator
- Propan Tank
- Gasflaschenschrank



Technische Daten:

- Betreiber: Institut für Kern- und Energietechnik (IKET), Arbeitsgruppe Energie- und Verfahrenstechnik (EVT)
- Ansprechpartner: Dr. Kuhn, Tel. 23483
- Leistung: 1 MW_{therm}; ca. 140 kW_{el}
- Frischdampfparameter: 55 bar, 117 °C, 2,9 kg/s
- Thermalwassertemperatur: ~150 °C
- Kondensationstemperatur: 30 °C
- Arbeitsfluid: Propan
- Baubeginn: Herbst 2013

Zur Stromerzeugung aus geothermischer Energie oder aus Restwärme werden spezielle Kraftwerkskonzepte basierend auf dem Clausius-Rankine-Kreisprozess verwendet. Anstelle von Wasser werden Kältemittel oder Kohlenwasserstoffe als Arbeitsfluid eingesetzt. Zur Weiterentwicklung und Optimierung dieser Technologie wird hier ein Kraftwerkstechnikum aufgebaut und betrieben. Das Kraftwerkstechnikum entspricht in verkleinertem Maßstab einer Verstromungsanlage wie sie an Geothermiestandorten der Tiefen Geothermie betrieben werden. Die geothermische Energiequelle wird hier jedoch durch das heiße Wasser einer Heizzentrale simuliert. Das Versuchskraftwerk erlaubt Untersuchungen zu Lastwechseln, transientem Verhalten, leistungsoptimierter Fahrweise, optimierter Kraft-Wärme-Kopplung sowie der Entwicklung und Optimierung von Komponenten. Durch die Installation des Systems in Containern kann die Anlage zukünftig auch an realen Standorten getestet werden.

KIT – Universität des Landes Baden-Württemberg und
nationales Forschungszentrum in der Helmholtz-Gemeinschaft

www.kit.edu

Monika Under Construction



University of Konstanz fish farm netting research



Pilot tests in 8 locations across the world

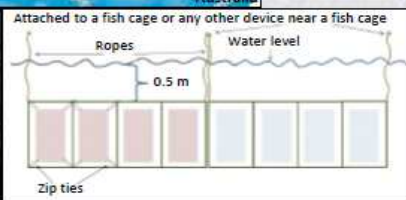
3. Tests and Results

2. Stainless Steel

→ Corrosion resistance: seawater-proof and cost-effective stainless steel

→ Laboratory and immersion tests regarding

Immersion time
6 to 12 months



SS Netting Solutions

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

- Collecting center 8'500 m²
- Collaboration with partners
 - design
 - pre-assembly
 - installation
 - fish farmer
- Result:
 - minor improvements were required
 - proof of concept
 - new orders



Steel Construction Institute at the TU Aachen

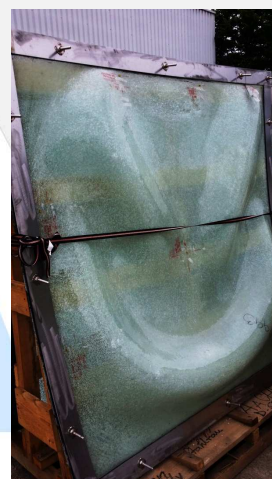




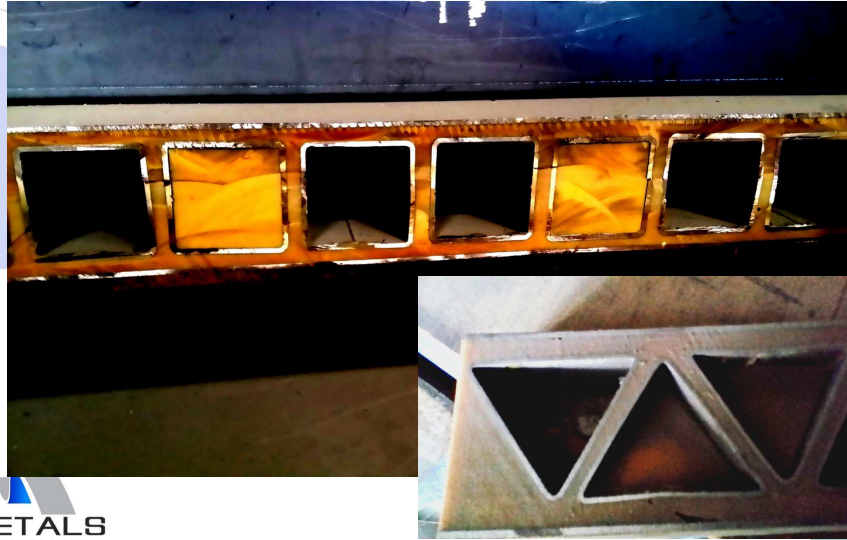
Composite Steel/Glass Construction



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



Composite Steel/Polymer Foam Sandwich Construction



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Adhesive Bonded Steel Composites



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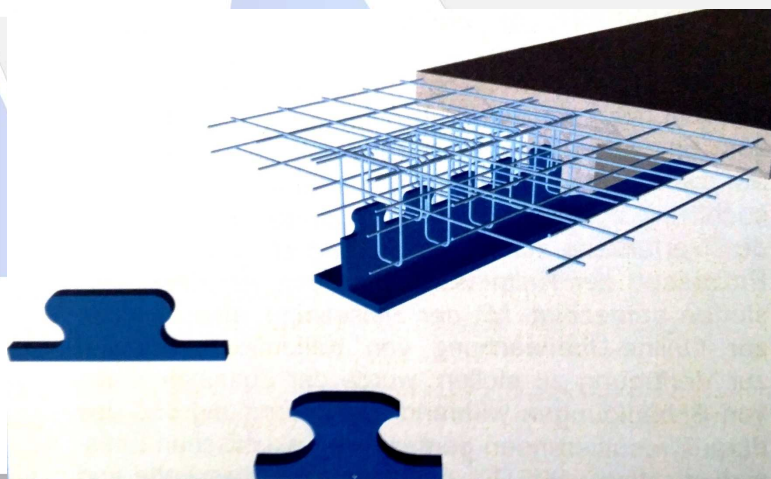
Innovative Shear Connectors used in composite bridge girders



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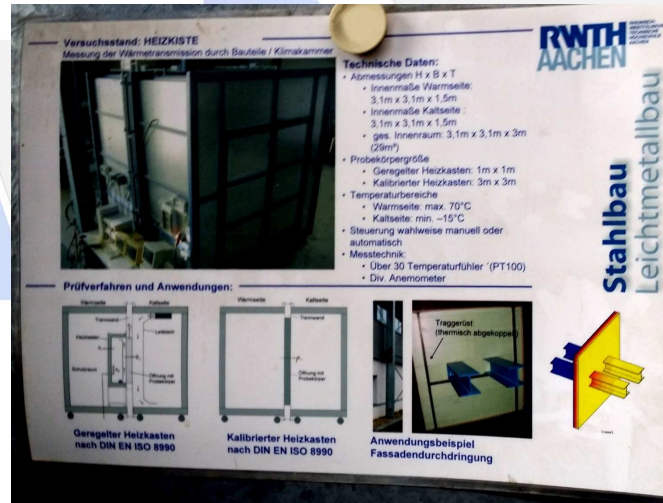
Innovative Shear Connector Concept for Composite Deck



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Thermal Testing Chamber



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 \(MPIE\)](#)



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



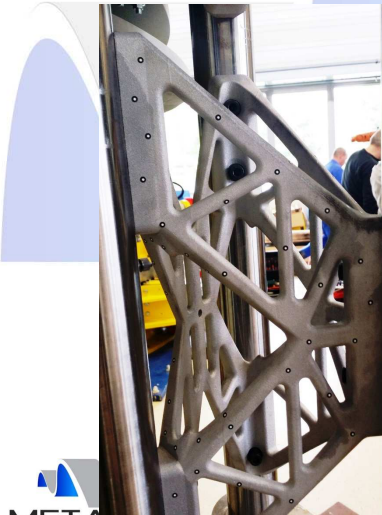
FhG Institute for Large Structures University of Rostock



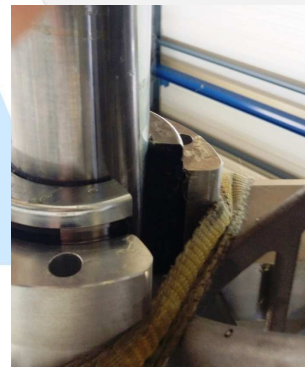
Institute Director, Prof Martin-Christoph Wanner, in front of the largest robot built to date - 6m high – 4 tons



Largest Robot – Superlatives



**Largest additive manufactured part
seen by author incorporating novel
bearing concepts**



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Largest Robot – Superlatives

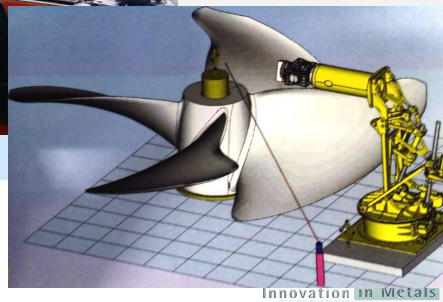
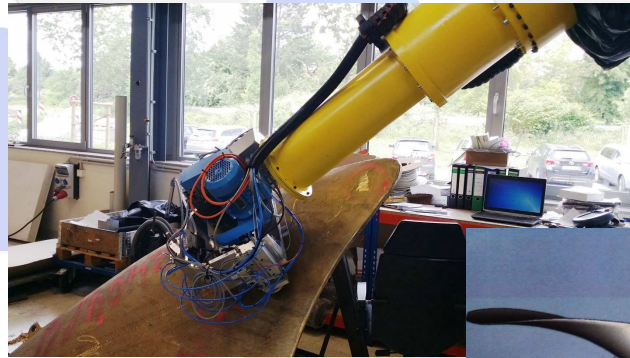


**Novel kinematics
and drives**



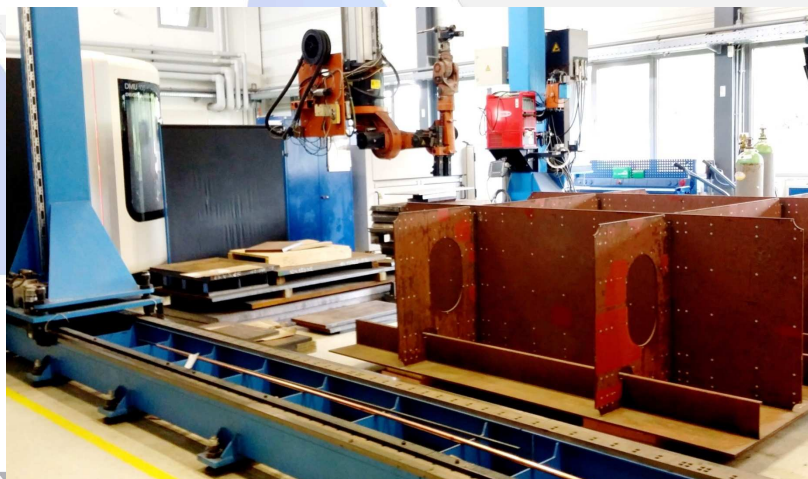
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Largest Robot – Application Research Optimising Ship Propeller Shapes



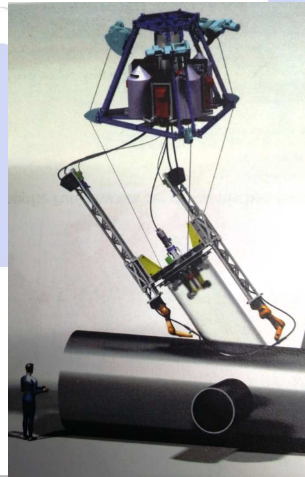
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Gantry Ship Hull Welding Station



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Welding System for Large Pipe Intersections



The plan

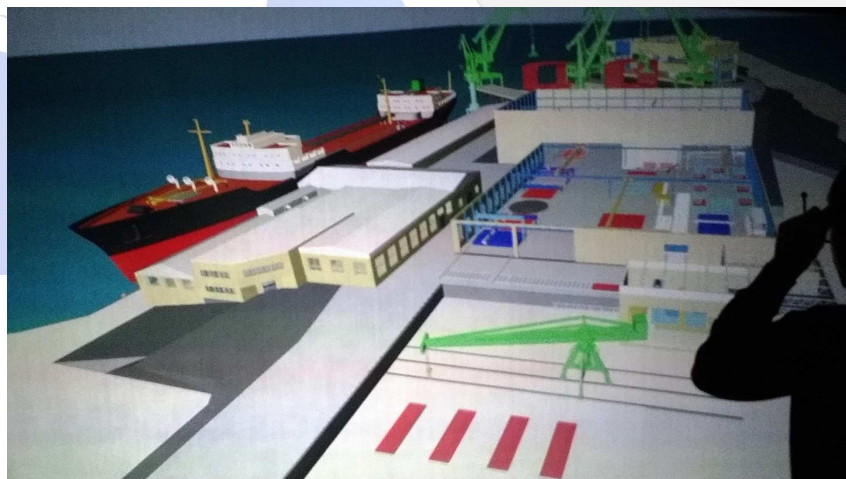


The execution

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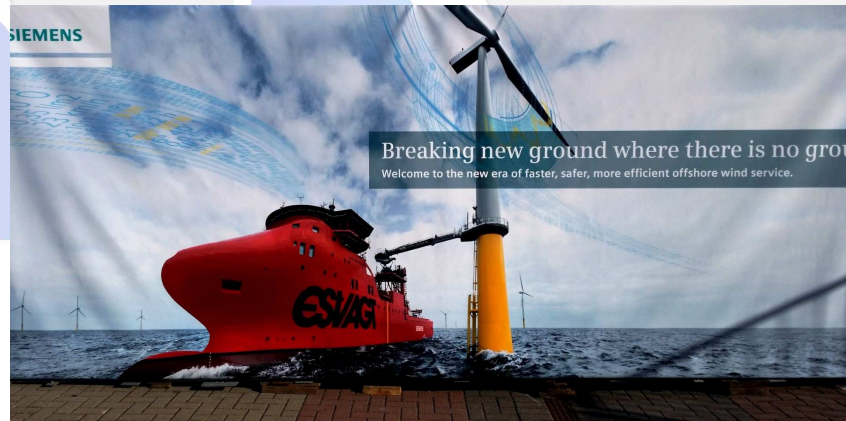
Virtual Reality Ship Building Planning



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Wind Energy Offshore Structures ("Energiewende" Projects Support)



Research – as long as it is for heavy structures



**Heavy section
welding
processes**

**Connections
research for bolts
in offshore
applications**



At EEW Group - Structural Pipes in Rostock Germany



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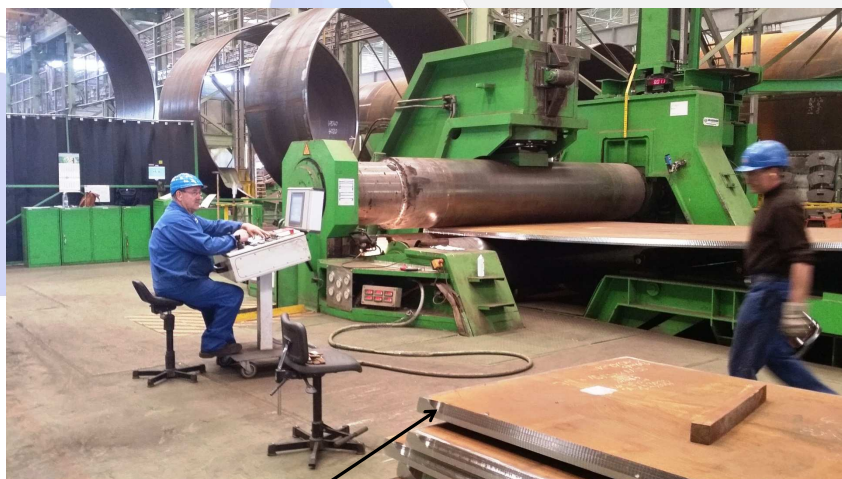
Weld Preparation OAW Cutting



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Plate Rolling Expertise



Note machined weld edge preparation



Toughness Requirement 50J @ - 60 °C

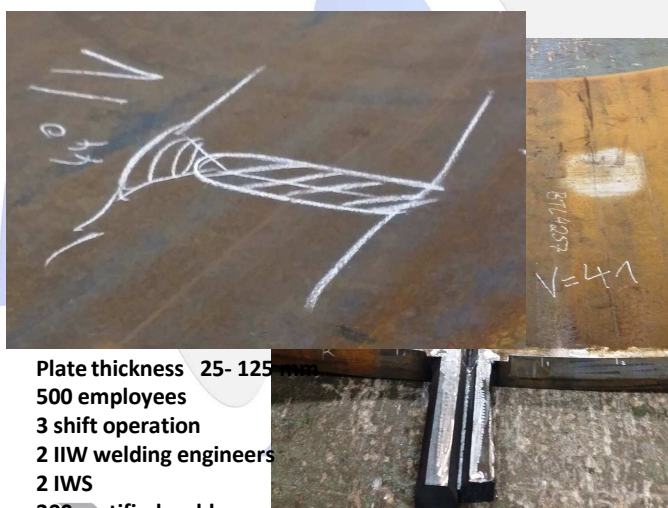
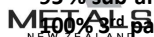


Plate thickness 25- 125 mm
500 employees
3 shift operation
2 IIW welding engineers
2 IWS
300 certified welders
95 % sub-arc welding
100 % 3rd party NDT



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



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Technical Monopile Data



B2J7 – Das schwerste Monopile der Welt
(the heaviest monopile in the world)

Maßstab (scale)	1:50
Gewicht (weight)	930 to
Durchmesser (diameter)	6,5 m
Länge (length)	73,5 m
Wassertiefe (water depth)	35,5 m
Rammtiefe (penetration depth)	37 m

Ausgeliefert im Oktober 2013
(delivered in October 2013)

EnBW
Windpark Baltic 2

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Endless rows of Monopiles ready to be shipped



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EWE Structural Pipes Rostock



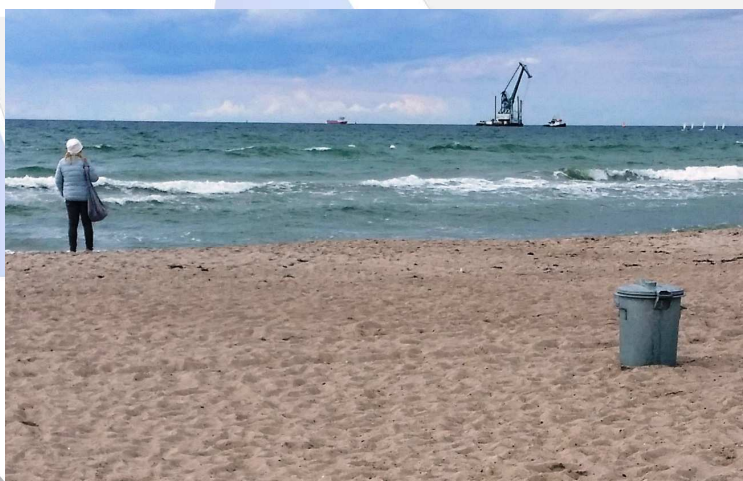
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Monopiles In Transport to their Windfarm Location in the Baltic Sea



Piling Crane in Transit



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-operation

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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)



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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



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Thank you

Full report available shortly from HERA website
as HERA Report



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