SEA JAPAN 2016

INDUSTRY 4.0 IN THE MARITIME SECTOR

POTENTIALS AND CHALLENGES

Karl Hribernik
BIBA - Bremer Institut für Produktion und Logistik GmbH
Tokyo, 13th of April 2016

Agenda

Introduction

- Federal state of Bremen
- 660 000 inhabitants in Bremen and Bremerhaven
- Important location for the automotive, electronic, steel and ship building industry as well as the aviation and aerospace industry

Introduction

- Federal State of Bremen
  - 660 000 inhabitants in Bremen and Bremerhaven
  - Automotive, electronic, steel and shipbuilding, aviation and aerospace industries
- University of Bremen
  - Founded in 1971
  - Interdisciplinary and practice orientated studies
  - „University of Excellence“
  - 12 faculties, 137 Bachelor and Master courses
  - 20.000 Students and 290 professorships
- BIBA – Bremer Institut für Produktion und Logistik GmbH
  - Founded in 1981 as the first affiliate institute of the University of Bremen
  - Scientific research institute for engineering in production and logistics
  - Two departments: IPS and IKAP
  - 150 employees

Introduction

- Relevance of maritime industry for Japan
  - Traditional industry of historic importance
  - Today a leading shipbuilding country, 2nd only to Korea
  - Strong competition from the global market

- Current trends in Japanese shipbuilding
(Source. http://www.seatrade-maritime.com/)
  - Less focus on standard ships
  - Technically advanced and specialised ships (e.g. FPSOs, LNG tankers, seismic vessels)
  - Energy-efficient and "clean" ships
  - Strategic move away from mass production of standard bulk carriers towards short-series and "one-of-a-kind"

Source: worldmaritimenews.com / MHI

Source: www.wsj.com

Source: offshoreenergytoday.com/

Introduction

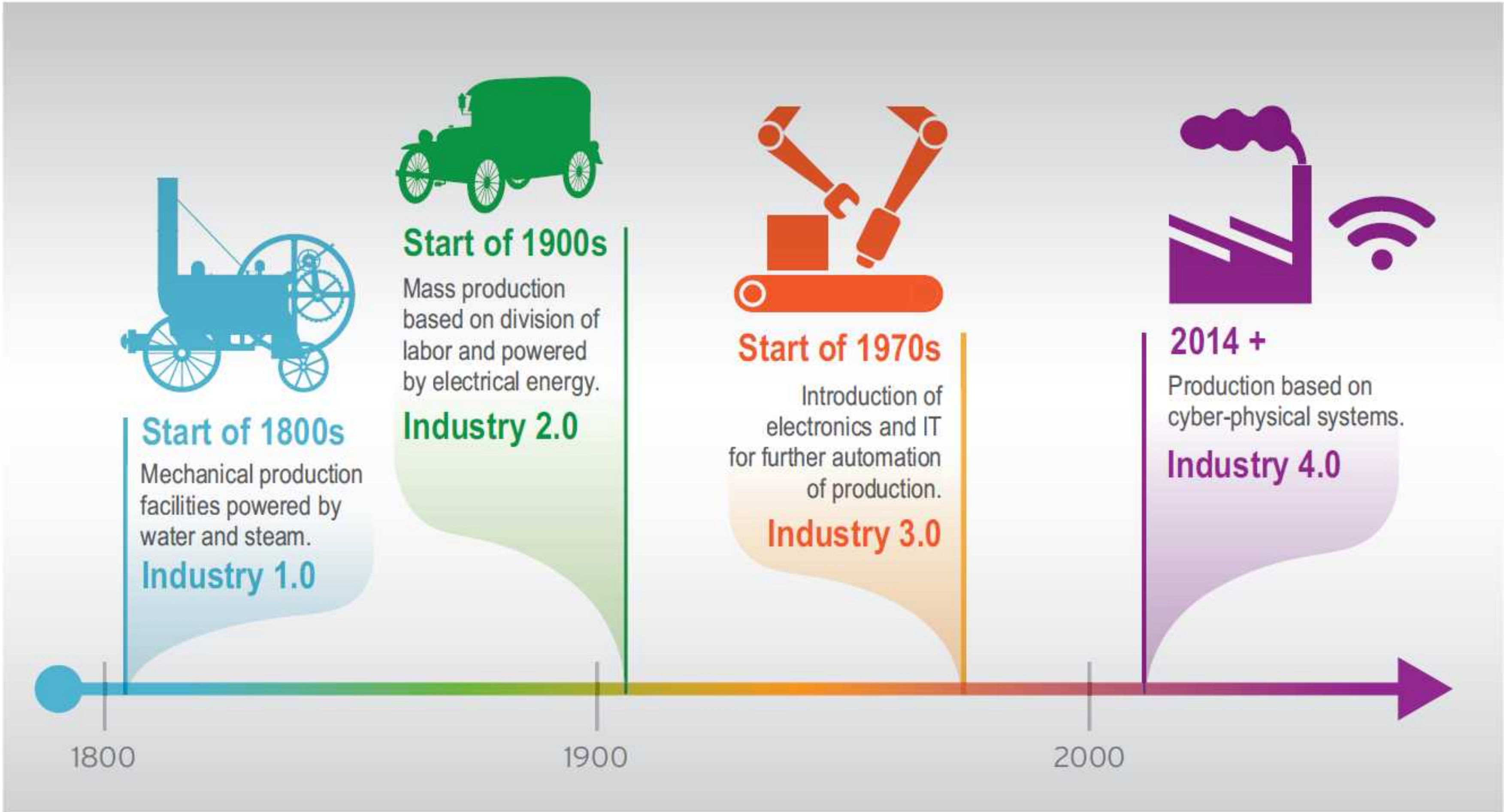
- Relevance of maritime industry for German manufacturing
  - 400.000 employees
  - 54 billion Euro turnover
  - 40% of inland logistics
  - 60% of export logistics
  - Strong competition from the global market
- Current trends in shipbuilding
  - Less standard ships built in the EU
  - Specialised ships (heavy lifting, specialised and chemical transport, research, cruise, etc.)
  - Trend towards “one-of-a-kind”
- ➢ Industrie 4.0
  - German strategy for digitization in the manufacturing sector
  - Prepare German industry *“for tomorrow‘s production“*
  - Goal: *„Keep Germany a manufacturing country”*


Source: Neue Osnabrücker Zeitung


Source: go-maritime.net


Source: ynfpublishers.com

What is this „Industrie 4.0“?



Source: Cognizant, Informed Manufacturing: The Next Industrial Revolution

Integration of IoT and Production

Cyber-physical Systems

Smart Factory

Automation

Human-Robot Interaction

Internet of Services

Business Models/Services

Internet of Things

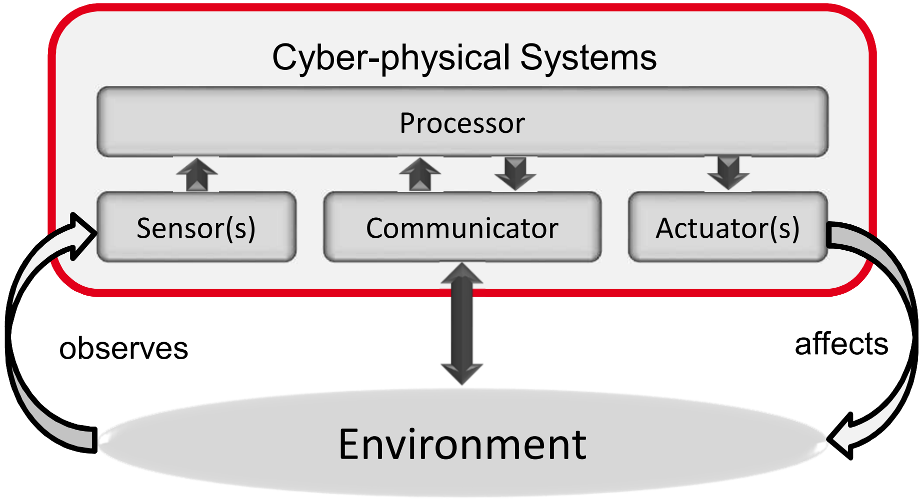
Source: BITKOM

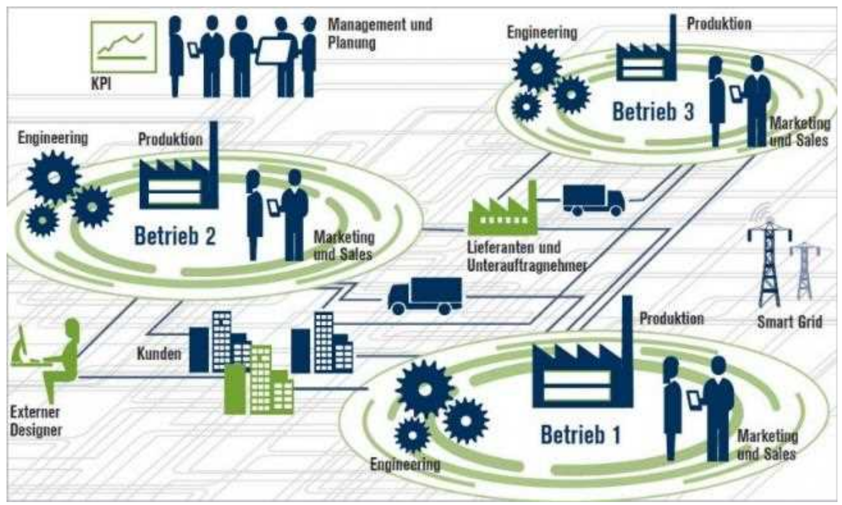
Industry 4.0, CPS and Digitization

- Industry 4.0
  - *„Industrial production will be characterized by strong individualization of products …*
  - *in a highly flexible mass production environment, …*
  - *integrating customers and business partners in value adding processes to a large extent and …*
  - *the integration of production and high level services."*

- Cyber-physical systems
  - Merging of physical and virtual worlds
  - Systems of systems with dynamic borders
  - Context-aware, self-governed, real-time control
  - Collaborative systems, distributed control
  - Human-system interaction

- Digitization in Industry
  - Connected, intelligent products and manufacturing resources
  - New digital business models harnessing collected data for additional value-added services
  - As-a-service products

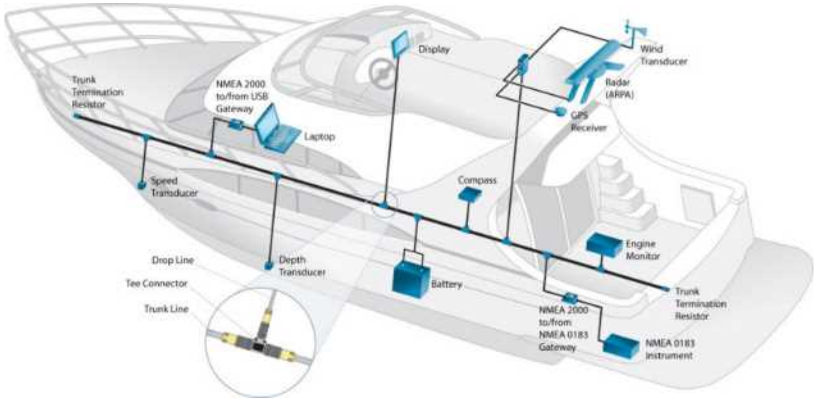


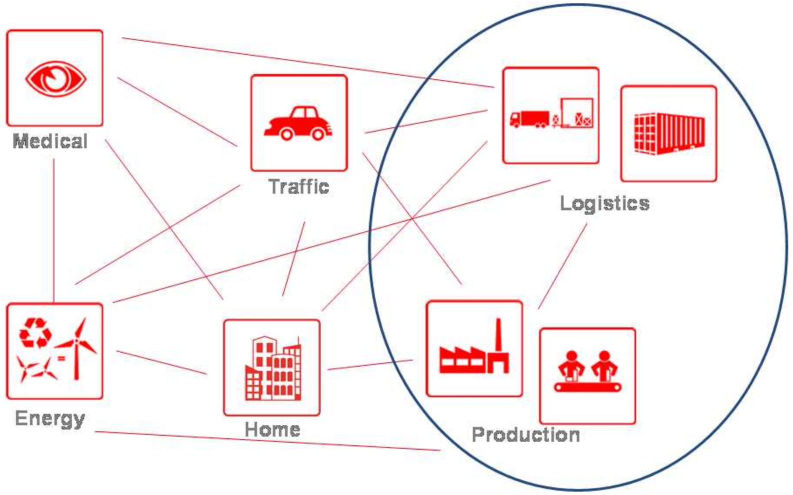


Source: Hewlett-Packard

Industrie 4.0 in the Maritime Sector?

- Comparability to other products
  - Engineering, construction, operation and maintenance only partially comparable
  - Lifecycles and services very different
- IT challenges
  - Media discontinuity between disciplines
  - Parallelisation of processes (simultaneous development, manufacture and assembly)
  - Collaborative value chains
  - Computer support tends to raise, not lower, barriers between disciplines
- ➢ Degree of successful digitization decides a yard's competitiveness (plmportal.org)
- ➢ Applicability of Industry 4.0
  - ✓ Individualised products are core to maritime industry
  - ✓ Shipbuilding relies heavily on cooperative supply networks
  - ? Transfer of concepts from mass production to one-of-a-kind production
  - ? Innovation of concepts for servitization in the maritime industry





CPS in Production Logistics

- Concepts for improving production logistics by CPS
  - Integration of CPS into products, parts and logistics resources
  - Support for demand-oriented production supply (e.g. “Milkrun 4.0”)
  - Holistic synchronisation of material and information flows
  - Automated Kanban approach suitable for mass-production environments – 30% better efficiency
- CPS-based optimization of “high and heavy” logistics processes
  - Tracking and tracing heavy load carriers in harbour environments with Auto-ID and positioning technologies
  - Complimentary inventory strategies
    - ➢ Carrier request time reduction
    - ➢ Optimisation of traffic flow
  - Magnetic traverse for a faster and safer handling of steel-products in seaports
- Potential for the optimisation of one-of-a-kind production logistics in shipyards

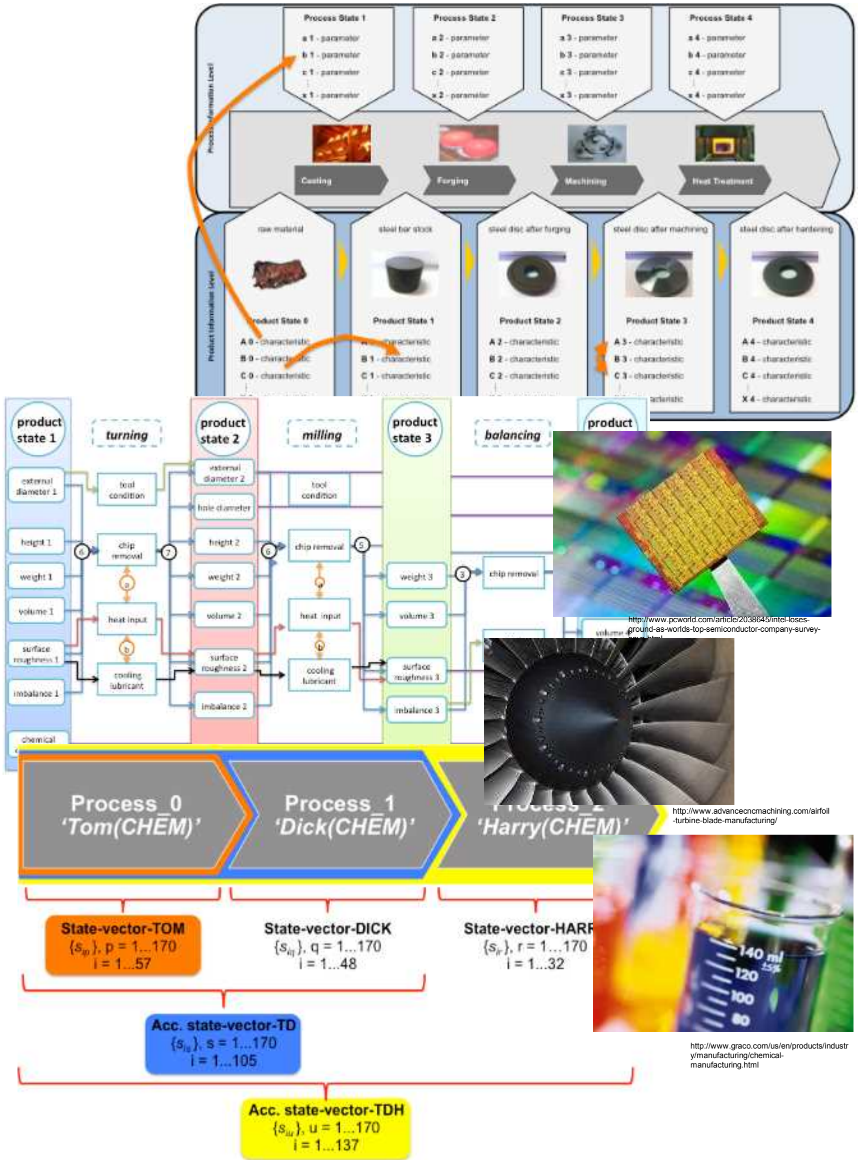
Source: Wittenstein AG

Source: gcaptian.com

Source: worldmaritimenews.com

ML for State Driver Identification in Manufacturing Systems

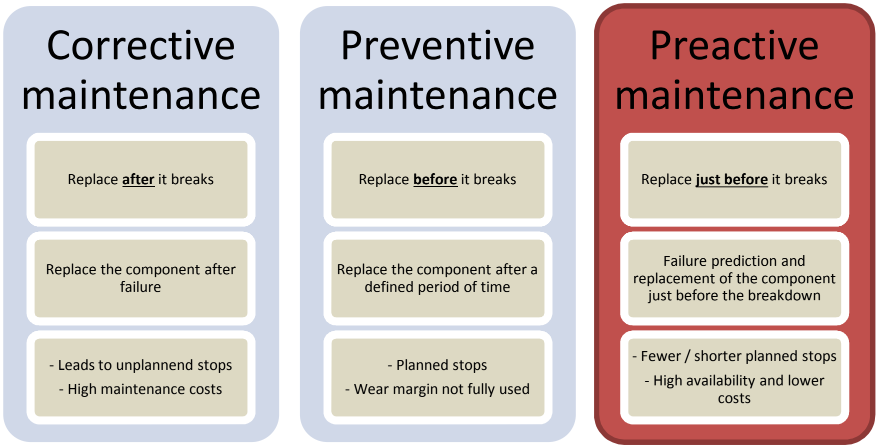
- CPS-enabled machines and real-time KPIs provide monitoring and control of manufacturing processes
  - In complex, dynamic multi-stage manufacturing processes, inter- and intra-relations between states are very important for the quality outcome
  - However, those are often unknown/hard to detect
- Machine learning methods
  - By describing a product’s transformation by a series of ‘product states’ it is possible to create an accumulating state vector
  - Using SVM based feature ranking the main ‘state drivers’ can be identified incorporating also implicit inter- and intra-relations
  - Successfully applied to three manufacturing areas (Aircraft, Chemical and Semiconductor)
- Applicability to other areas
  - Product lifecycle management
  - Maintenance and reliability

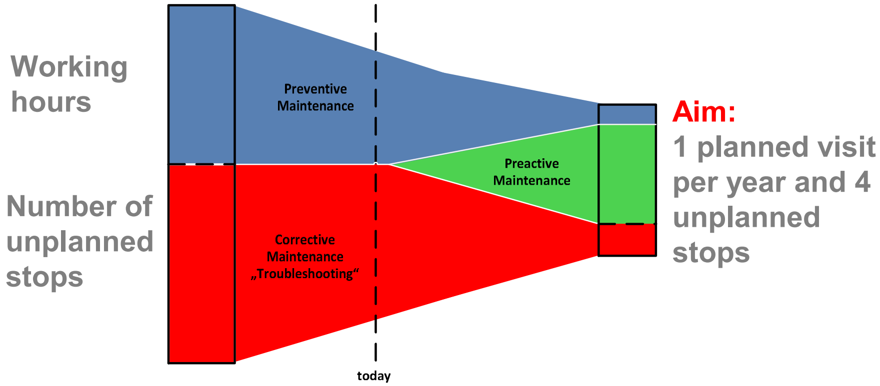


Source: Wuest, T.; BIBA & University of West Virginia

CPS-based Preactive Maintenance

- CPS allow for dynamic adjustment of maintenance process to particular needs under cost-/risk considerations
  - Mining task-relevant information from maintenance-related CPS data
  - Support corrective maintenance tasks by early failure prediction/recognition
  - Components which exhibit a linear wear-out curve should be evaluated by cost-risk and scheduled e.g. together with other tasks
  - Operative executions of tasks by context and based on multi-criteria aspects
  - On mid-term level a continuous improvement of the system will be enabled
- ➢ Increased availability and reliability of production assets and products
- ➢ New business models for maintenance servitization

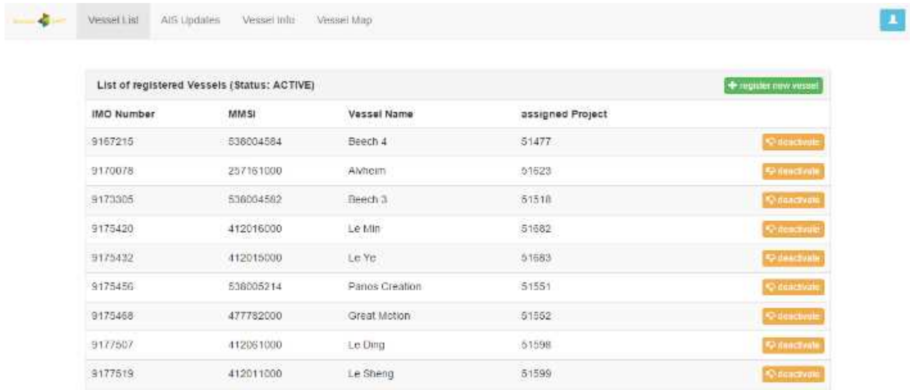




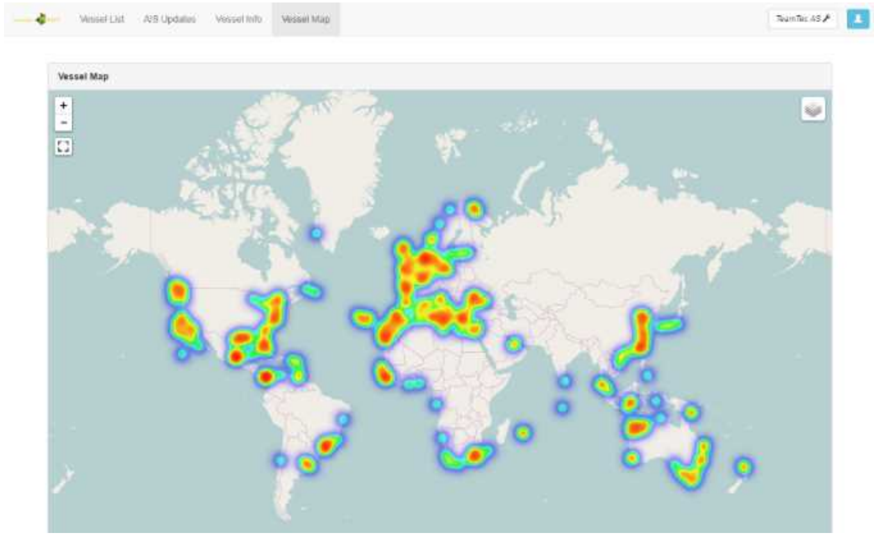
Source: LogDyanmics Lab

Internet Information Services for Servitization

- Parts and servicer suppliers in the maritime industry face challenges in ship operation
  - Logistic challenges of scheduling service personnel visits
    - Spare parts
    - Travel costs
  - High costs of sending personnel for unscheduled maintenance
- Tracking products using information services e.g. Automatic Identification System (AIS)
  - Suppliers can map their install base to ship IMO numbers
  - Products Suppliers can track their installed products via IMO numbers
  - Analysis of ship routes (e.g. via “heat maps”) can be used to identify e.g. most frequent ports of call
  - Analysed data can help plan service strategies



IMO Number	MMSI	Vessel Name	assigned Project	
9167215	538004584	Beech 4	51477	deactivate
9170078	257161000	Alvheim	51523	deactivate
9173305	538004582	Beech 3	51518	deactivate
9175420	412016000	Le Min	51582	deactivate
9175432	412015000	Le Ye	51583	deactivate
9175456	538005214	Panos Creation	51551	deactivate
9175468	477782000	Great Motion	51552	deactivate
9177507	412061000	Le Ding	51598	deactivate
9177519	412011000	Le Sheng	51599	deactivate

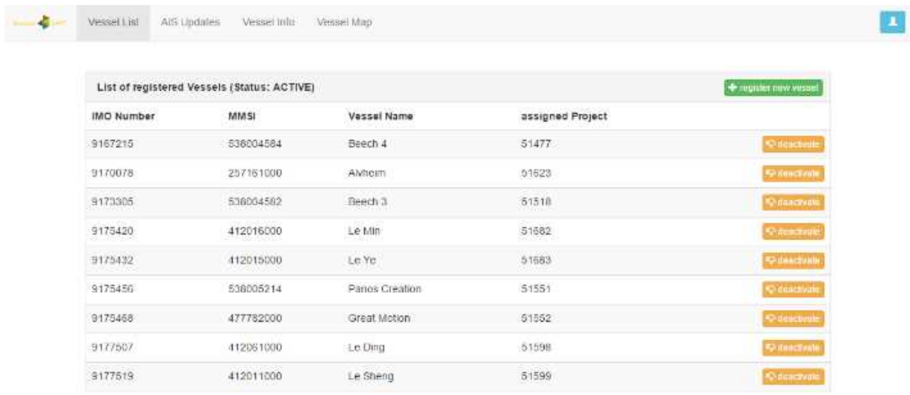


AISHub data sharing center

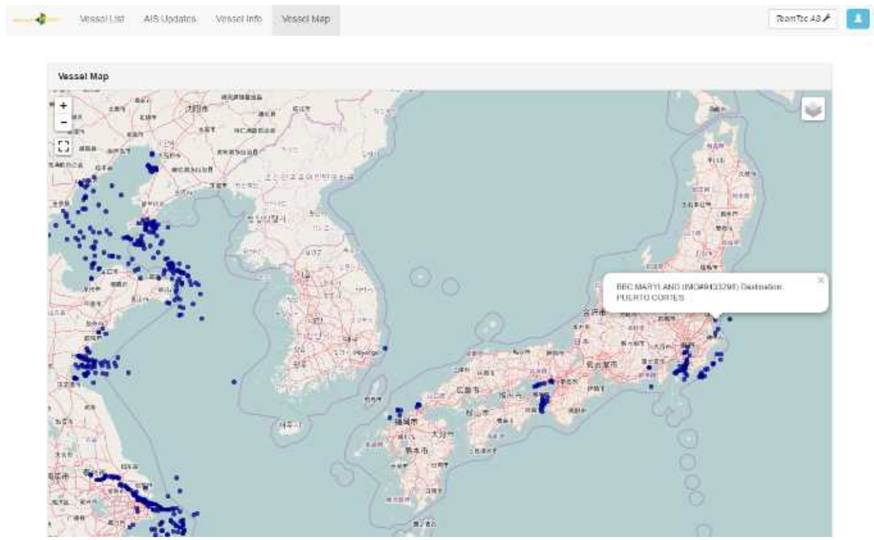
InnovativRAFT

Internet Information Services for Servitization

- Parts and servicer suppliers in the maritime industry face challenges in ship operation
  - Logistic challenges of scheduling service personnel visits
    - Spare parts
    - Travel costs
  - High costs of sending personnel for unscheduled maintenance
- Tracking products using information services e.g. Automatic Identification System (AIS)
  - Suppliers can map their install base to ship IMO numbers
  - Products Suppliers can track their installed products via IMO numbers
  - Analysis of ship routes (e.g. via “heat maps”) can be used to identify e.g. most frequent ports of call
  - Analysed data can help plan service strategies



IMO Number	MMSI	Vessel Name	assigned Project	
9167215	538004584	Beech 4	51477	deactivate
9170078	257161000	Alvheim	51523	deactivate
9173305	538004582	Beech 3	51518	deactivate
9175420	412016000	Le Min	51582	deactivate
9175432	412015000	Le Ye	51583	deactivate
9175456	538005214	Panos Creation	51551	deactivate
9175468	477782000	Great Motion	51552	deactivate
9177507	412061000	Le Ding	51598	deactivate
9177519	412011000	Le Sheng	51599	deactivate

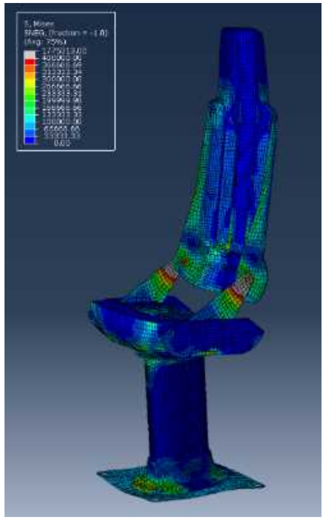


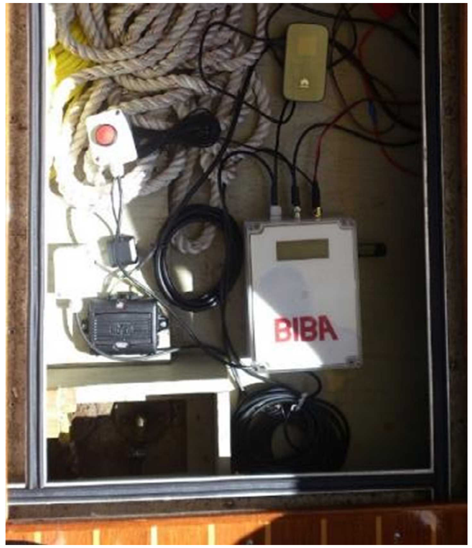
AISHub data sharing center

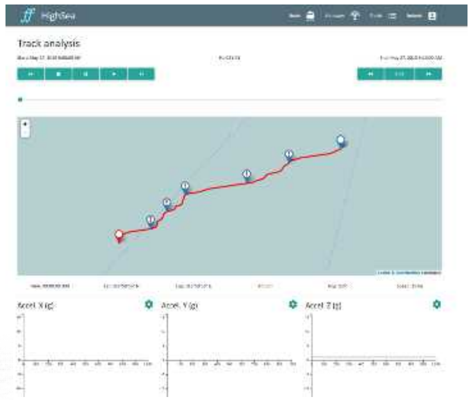
Innovativ RAFT

Sensor Data for Hydrodynamic Simulation

- Boat manufacturers face resource problems dealing with hydrodynamic simulations
  - Fact based boat design is hindered by this
  - High Performance Computing Centres can improve the efficiency of the simulations
- Genuine boat operating data is rarely used in the development phase
  - Design is often based on experience and assumptions, not real data
  - Simulations cannot be validated efficiently
- Fortissimo-HighSea combines high velocity data gathering and HPC based simulations
  - Boat usage can be analysed
  - Simulations can be defined and verified
  - Simulations can be run efficiently and quick



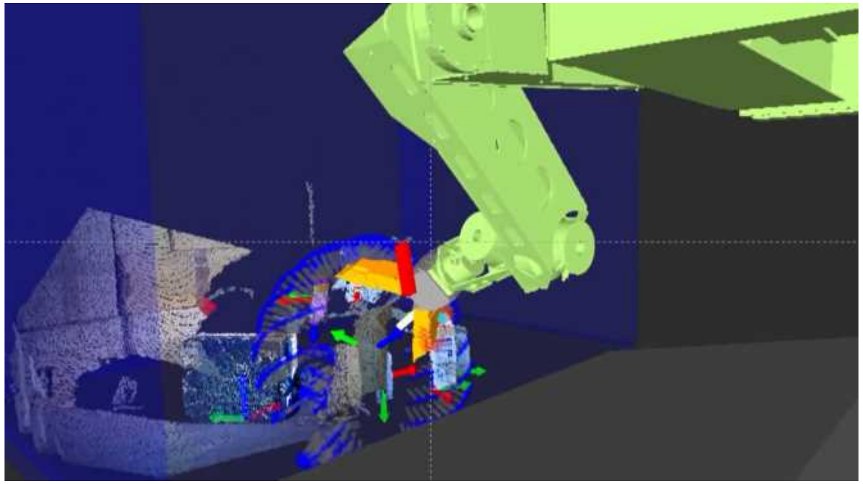


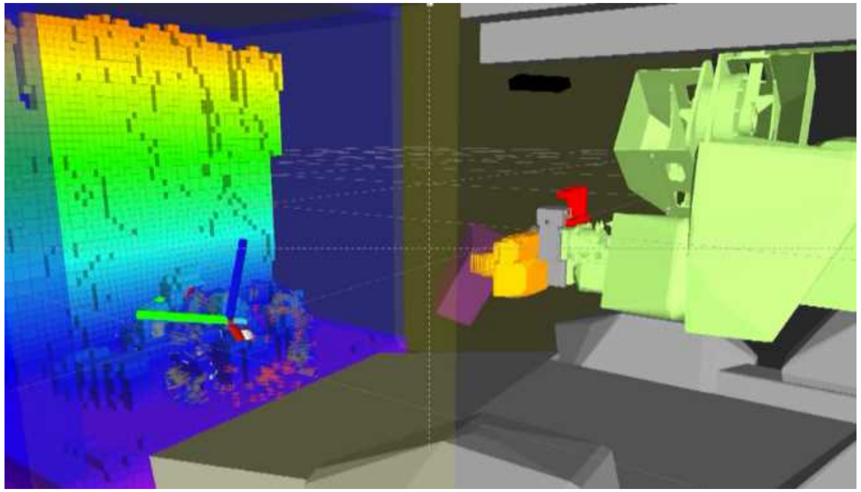


Intelligent, Flexible Robot Control

- The introduction of robotics into shipbuilding processes is hindered by a number of factors
  - Many non-standard parts
  - Heavy parts/complex geometries
  - Non-standard, one-of-a-kind processes and tasks
  - Difficult environments, enclosed spaces
- Requirements for robotics in shipbuilding
  - More intelligent and flexible control
  - Capable of interaction with workers
- Intelligent, flexible robot control
  - Advances in computer vision allow flexible picking and handling of non-standard parts
  - Real-time object-detection algorithms with data e.g. from stereoscopic cameras and laser scanners allow reliable and precise robot control
  - Advanced methods for dynamic camera positioning

➢ Potential applications: Picking, handling, welding, …



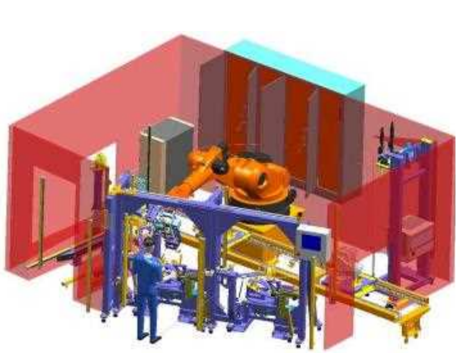


Symbiotic Safe Human-Robot Interaction

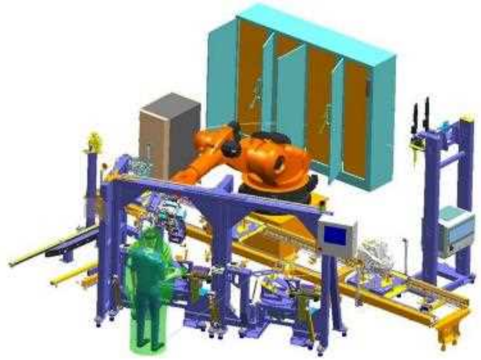
- CPS can increase the potential for the use of robots in shipyards
  - Conventionally, robots helpful for repetitive tasks e.g. on production lines
  - Potential for an increase in productivity by enabling robot to work in close proximity or together with workers
- Solutions for safe human-robot interaction
  - Advanced sensor technology and computer vision provide a first layer of safety
  - CPS integrated into work clothes help monitor and predict body and limb movement
  - Intelligent algorithms connected to robot control
  - Touch-sensitive robots can be guided intuitively by workers for precision control of heavy parts in complex processes
- ➢ Robots will be true partners of the worker in the shipyard
- ➢ More flexible application of robots

Source: kranendonk.com/

Source: Bayreath University



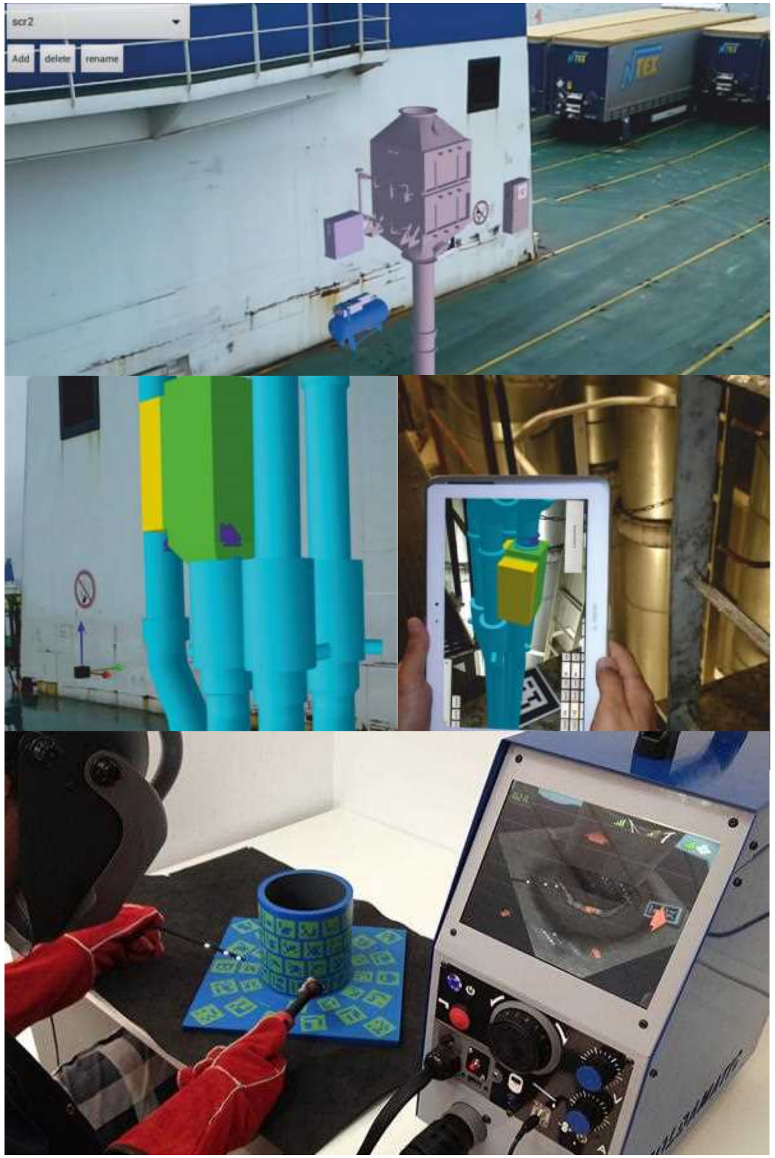
Conventional safety solution



Symbiotic safety solution

Hybrid Worlds – Augmented Reality

- Hybrid worlds in production processes
  - Customers can be directly involved with manufacturers and designers in planning and change processes
  - Assistance for workers in production processes
  - Comparison as-is vs. as-built
- Hybrid worlds for qualification and training
  - AR simulation of difficult, dangerous or costly tasks
  - Faster, more cost effective and realistic training
- Addressing demographic and inter-cultural challenges
  - Intelligent, visual assistance systems are readily understandable by everyone



Source: Titov, F., Friedewald, A., Lödding, H. Augmented Reality zur kundenintegrierten Variantenplanung

Summary and Outlook

- Industry 4.0 has a strong focus on increasing manufacturing flexibility in mass-production sectors
- Despite the unique characteristics of the ship building sector, Industry 4.0 has the potential to transform conventional processes
- It will lead to significant changes for employees, production processes and organizations all areas of manufacturing
- Intelligent assistance systems give employees new scope in the workflow, improve qualification measures and address the future’s demographic and inter-cultural challenges (in contrast to CIM)
- Significant advantages can be identified with regards to process efficiency and flexibility
- New services and business models can be built on the use of CPS in the maritime industry
- However, the application of Industry 4.0 needs to be tailored to the specific demands of the industry and its processes – “there is no silver bullet”

Thank you for your attention!

Contact

Karl Hribernik

Head of Department Intelligent ICT for Cooperative Production

BIBA - Bremer Institut für Produktion und Logistik GmbH
at the University of Bremen

hri@biba.uni-bremen.de

Industry 4.0 at BIBA:

http://www.biba.uni-bremen.de/industrie4.html

BIBA - Bremer Institut für Produktion und Logistik GmbH
an der Universität Bremen

Postanschrift: Postfach P.O.B. 33 05 60 · D-28335 Bremen / Germany
Geschäftssitz: Hochschulring 20 · D-28359 Bremen / Germany
USt-ID: DE814890109 · Amtsgericht Bremen HRB 24505 HB
Tel: +49 (0) 421/218-02 · Fax: +49 (0) 421/218-50031
E-Mail: info@biba.uni-bremen.de Internet: www.biba.uni-bremen.de
Geschäftsführer: Prof. Dr.-Ing. K.-D. Thoben