Production Technology Center Berlin

Your Partner for Research,
Development, Realization

R+D Offers
for Mining Industry in Chile

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Topics and Offers for Mining Industry

1. Maintenance Repair and Overhaul Technologies

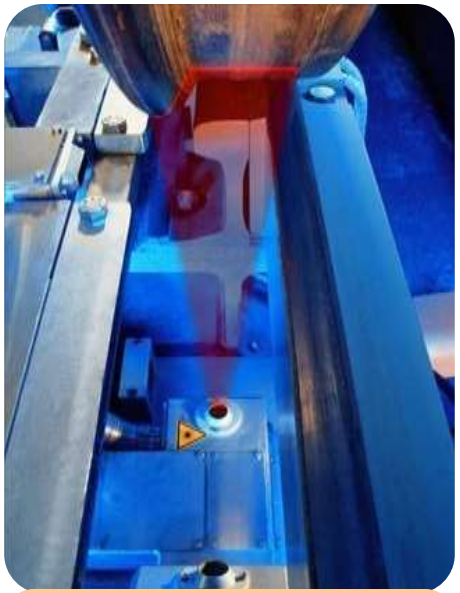
- Condition Monitoring for Preventive Maintenance
- Repair Technologies
- Cleaning Technologies

2. Automation and Robotization

- Automation Solutions
- Cooperative Robots

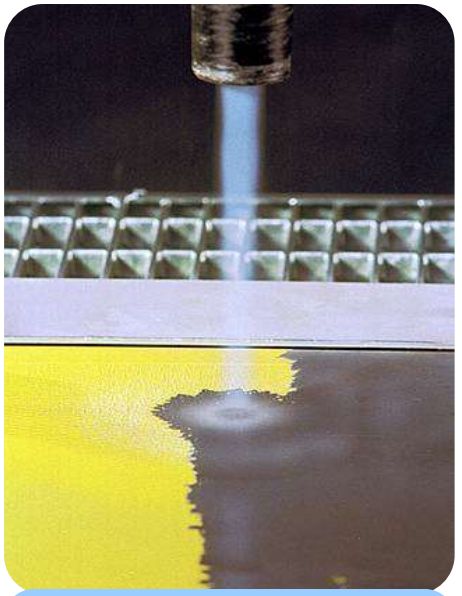
Maintenance Repair and Overhaul Technologies

Fields of Innovation in Innovation Cluster with regional industry “MRO IN ENERGY AND TRANSPORT“

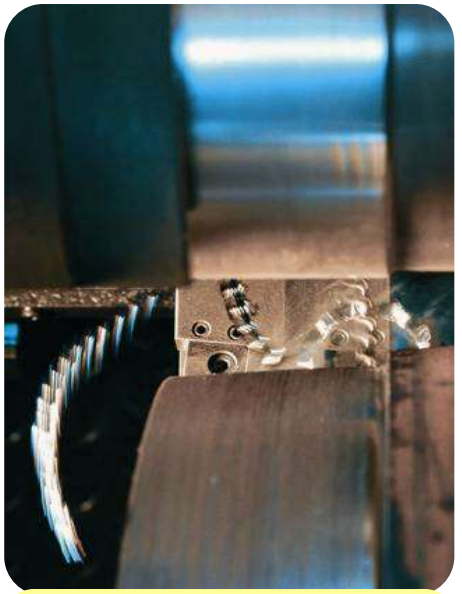


Condition monitoring and diagnostics

MRO-Planning and digital assistance



Industrial cleaning



Repair technologies

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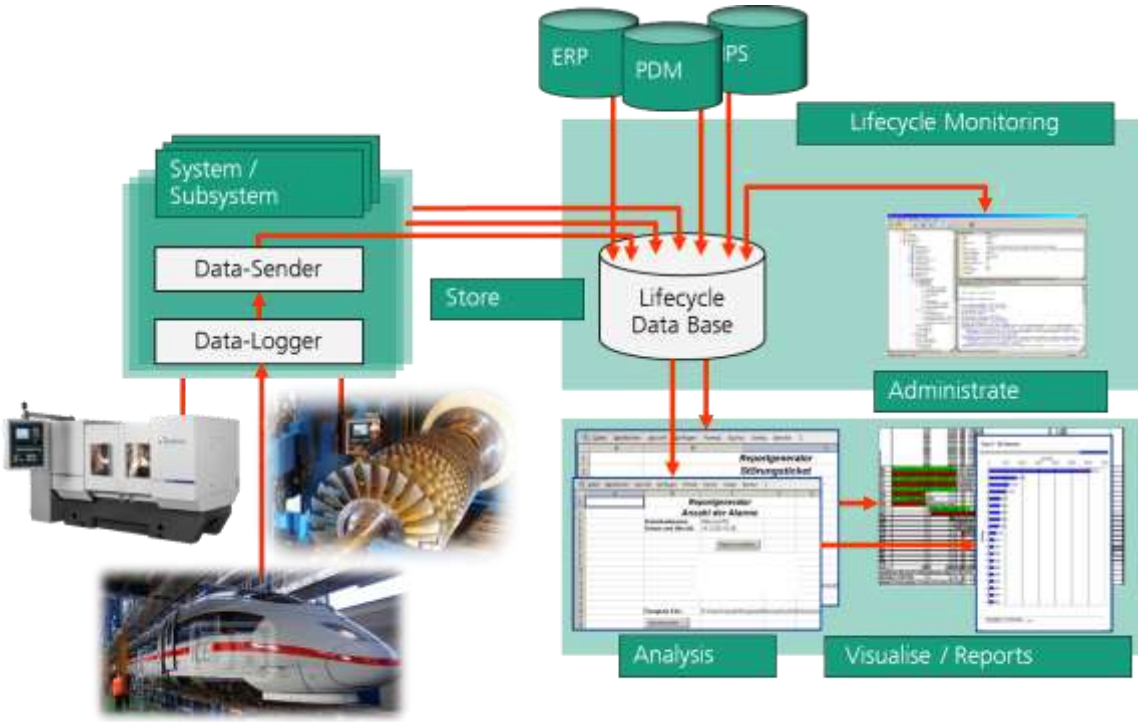
Condition Monitoring for Preventive Maintenance

Life Cycle Monitoring System

Previous projects with industry

- Remote sensing and control
- Monitoring of machine tools
- Diagnosis for high speed trains
- Data logging in system
- Life cycle data base for monitoring
- Algorithms for condition analysis
- Visualization and reporting
- Interfaces for maintenance staff



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Condition Monitoring for Preventive Maintenance

Life Cycle Monitoring System

Motivation and Objective

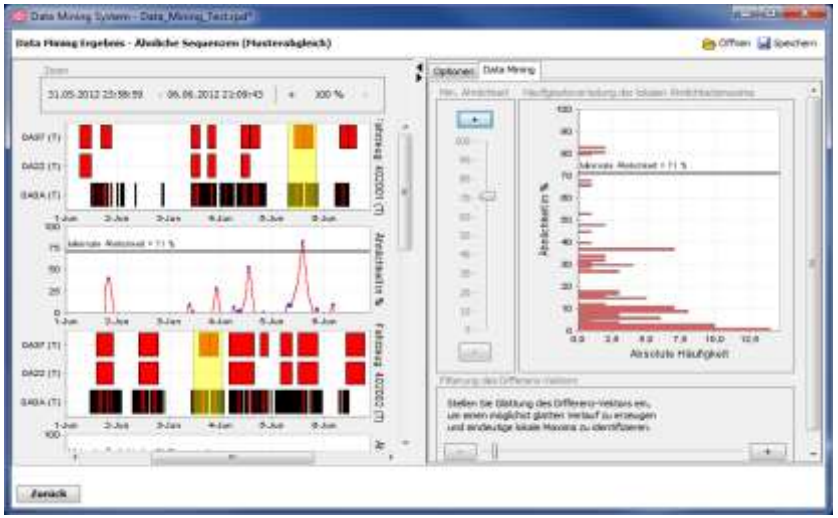
- Use of diagnostic data of existing on-board diagnosis system
- Event logs, Alarms
- Plausibility check
- Data model (entity relationship model)
- Data mining algorithms for interval data
- Modular software application with GUI for administration, analysis and reporting

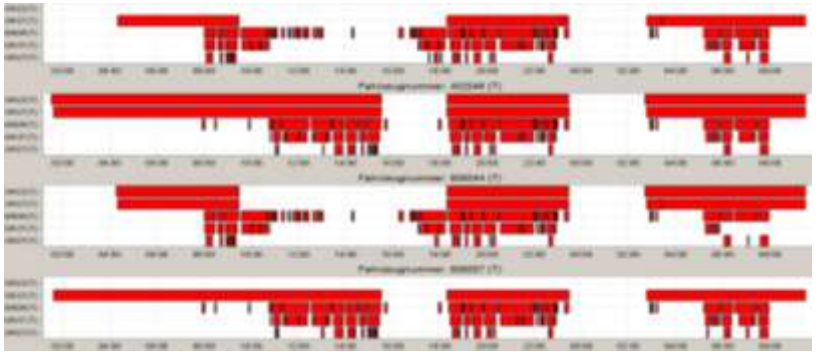
Condition Monitoring for Preventive Maintenance

Life Cycle Monitoring System

Big data management and Data Mining example

- Search for similar patterns by describing a template pattern quantitative search
- Inspired by image processing algorithms
- Matching algorithm calculates distance between search and template image
- Candidates for matching results derived from local maxima





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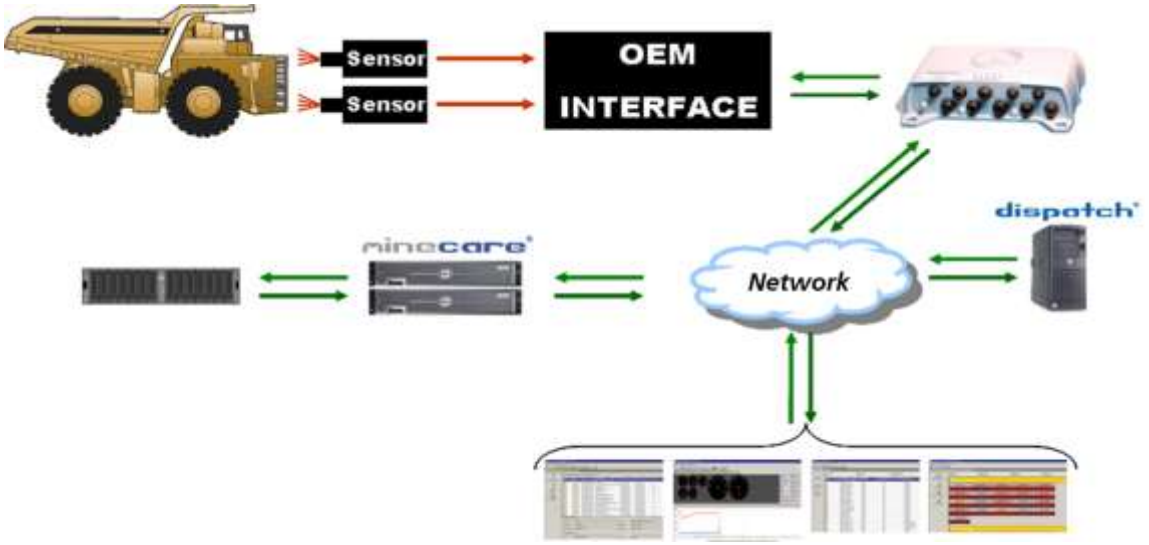
Condition Monitoring for Preventive Maintenance

Improve Operation of Mining Trucks
(Opportunities 9 & 10)

Concept and approach

- Continuous monitoring of trucks in operation
- Data logging and documentation
- Data analysis in maintenance and diagnostic center
- Adjust schedule for operation and maintenance of trucks
- Improve availability of trucks
- Optimize maintenance and repair services
- Reduce maintenance costs



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Repair Technologies

Challenges

› Strategies for increasing the level of automation

› Flexibility of repair processes

› Concepts for rapid manufacturing of spare parts

› Increasing the useful life of structural components
by using more-wear-resistant materials and protective layers

Trend

› Still Retrofit

› On-site repair

Highlights

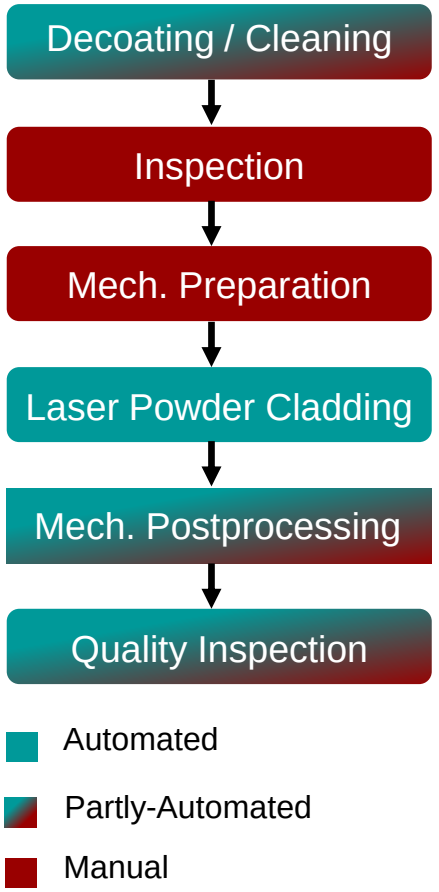
› Flexible repair solutions

Repair Technologies

Flexible Repair Solution

Motivation and Objective

- Repair offers a considerable saving of costs as opposed to replacement
- High proportion of manual processes
- Low process reliability of individual stages of repair
- Low reproducibility of results
- Improvement of reproducibility and increase of automation
- Analysis of mechanisms of action and correlations between manufacturing technologies
- Concentration on repair technologies in one multiflexible prototypical robot cell



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Repair Technologies

Flexible Repair Solution

Reference parts of LoI partners

Separation of defect parts: Milling, Grinding

Laser Powder Cladding

Manufacturing of desired contour and surface: Milling, Grinding

Damage analysis

Component dataset

Manufacturing of peripheral zone properties

Cleaning / Decoating

Quality Inspection

MRO demonstrator component

Material flow

Process step

Information flow

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Repair Technologies

Flexible Repair Solution with Robots

Summary of Results and Fields of Application

- Prototypical demonstrator cell for the repair of turbine blades
  - Continuous, partly-automated process chain developed
  - Suitability of individual processes attested and partial links established
  - Further development of active resilience and force regulation as an effective, highly-flexible and economic approach for the mechanical processing with industrial robots

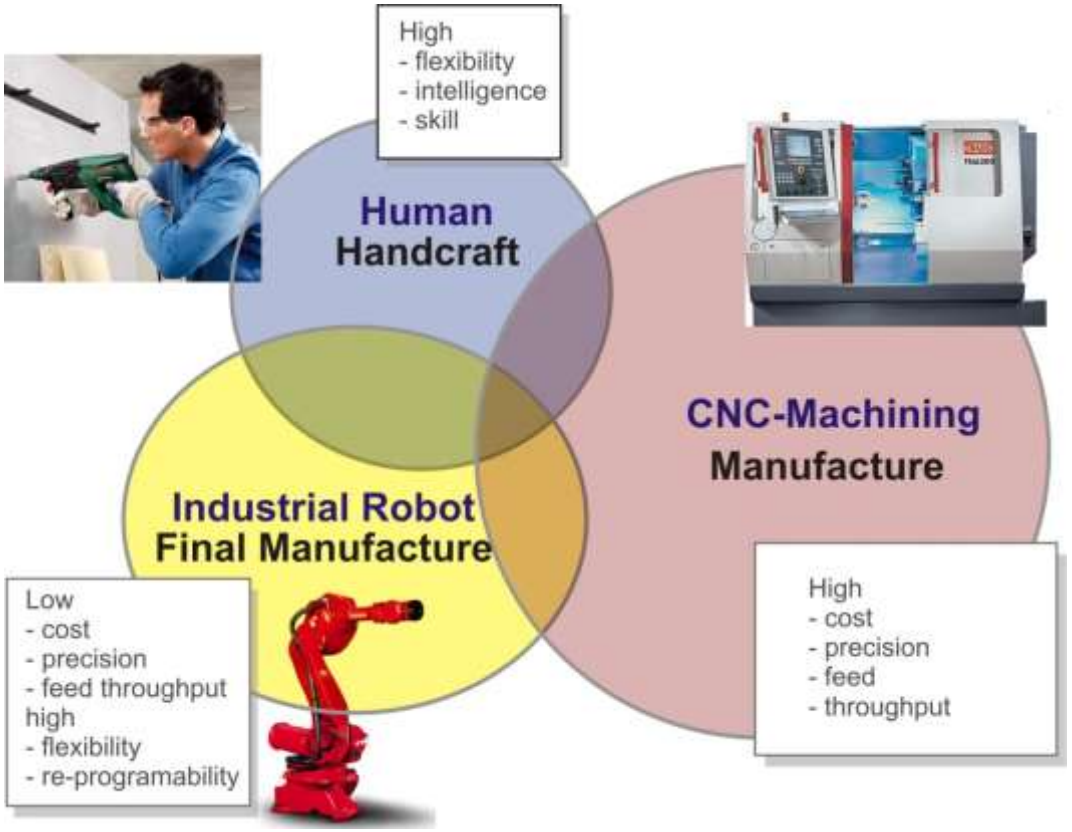
- Transferability to different (hard) materials and component contours is given
  - Nickel-based alloys ←→Titanium alloys
  - Blades ←→ Blisks

Turbine components repair cell

Beltgrinder for robot applications

Machining with industrial robots - feasibility and limits

- Benefits: Scalable workspace and considerably price reduction (1/5-1/3)
- Use conventional robots and open robot control systems
- Perform contact tasks without additional passive/active impedance devices
- Advanced position based impedance and force control
- Adapt process parameters to specific robot features
- Development of robot friendly machining processes and process chains



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Experimental set-ups at Fraunhofer IPK
Robotic cells for milling, grinding and polishing

Applied Comau robots with C4GOPEN Controllers:

- NH3-220 (left)
- NJ-370 (upper-right)
- SMART-SIX (down-right)

Repair Technologies

Mobile repair solutions

Challenge

- Reduction of down time during maintenance and repair
- Reproducible always constant repair quality required
- High-precision parts with small tolerances

Solution

- On-site repair avoids transportation and reduces downtime
- Automated methods offer high reproducibility
- Laser technology with low energy input for little delay

Approach

- Implementation of a CAD-CAM chain for laser welding repairs
- Integration of metal cutting and laser cladding in mobile system concept

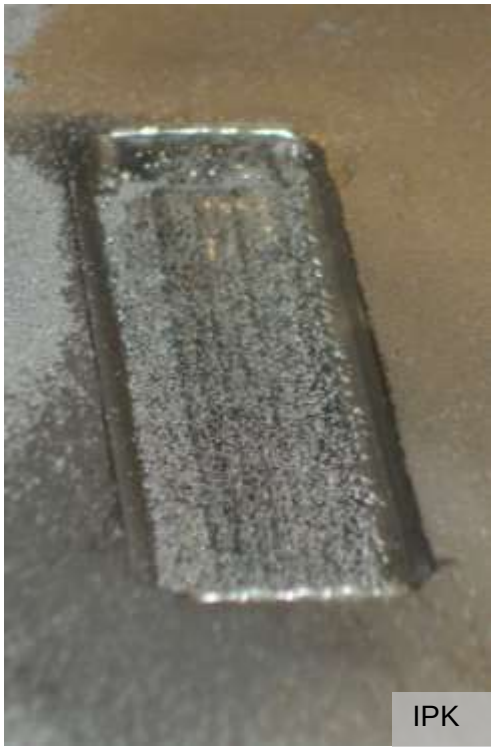
Repair Technologies

Rebuilding of grooves

Process chain for crack repair:

- Cleaning
- Milling of damaged area
- Material deposition
- Refilling of the groove with multiple layer deposition

Refilling milled grooves



Multi layer build up

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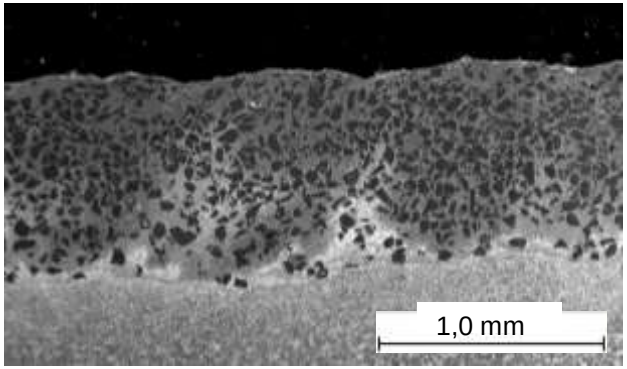
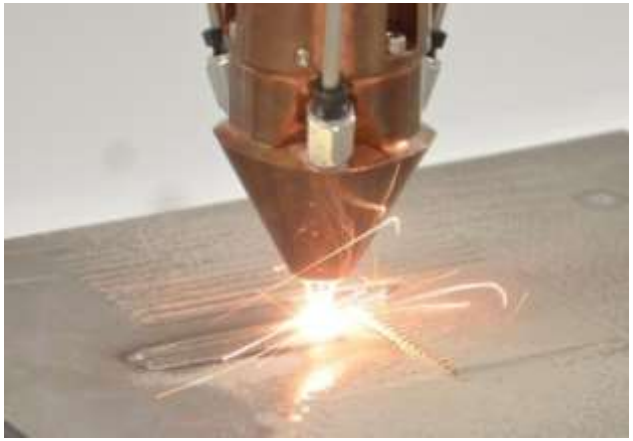
Repair Technologies

Wear protection layers with laser metal deposition





Hard-facing coating for wear protection

Opportunities

- **No. 25:** Improve designs and materials to increase the operating time of buckets shovels
- **No. 50:** Coatings, special materials, corrosion and abrasion resistant materials, etc

Possible project contents

- Cladding of bucket shovels with wear resistant material
- Optimization of cladding material for the specific wear conditions in order to increase corrosion and abrasion resistance
- Analysis of different carbide types (titanium or tungsten carbide) and matrix materials regarding their wear resistance
- Economic analysis of cladding process and tool life enhancement
- Comparison of different cladding technologies

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Cleaning Technologies

Development of ecological efficient technologies for cleaning

- Research and development for blasting technologies using stable abrasive materials and CO_2
- Development of individual cleaning tools
- Optimization of machines
- Exploration in new industrial fields of application for innovative cleaning technologies
- Initialization and management of the Fraunhofer-Alliance Cleaning Technologies

Cleaning Technologies

Project example – On-Site Cleaning tool

Motivation

- Areas to clean are difficult to reach within a system
- Disassembly and reassembly longer than cleaning operation
- Lack of on-side and on-platform tools and solutions for cleaning

Cut through CAD-Model

Solution

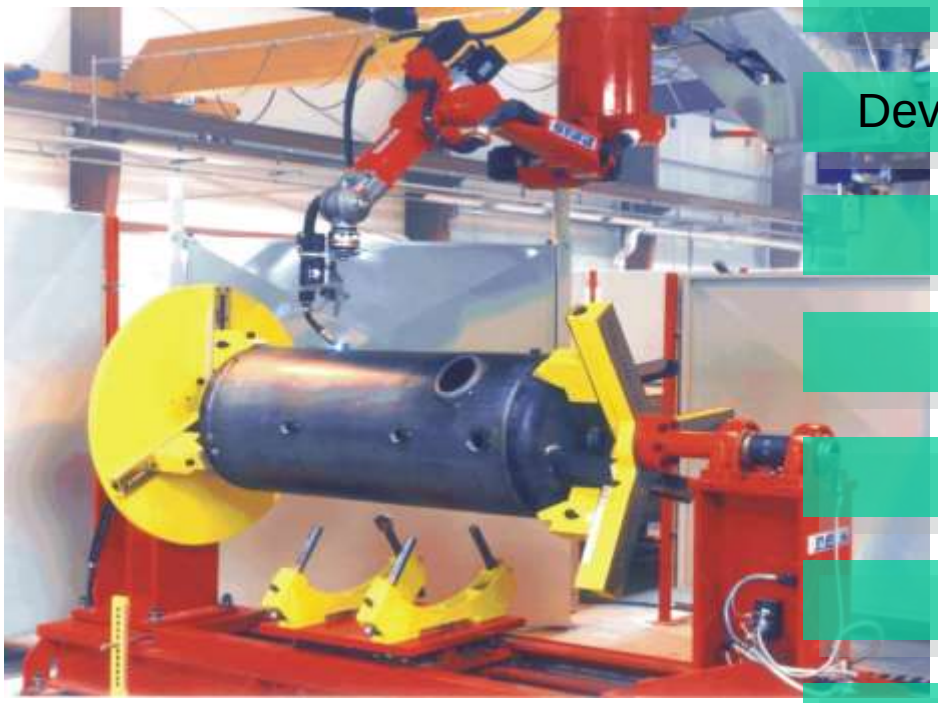
- Development of miniaturized and application orientated cleaning tools
- Use of dry ice or water for cleaning tasks

Deflection nozzle for cleaning of areas difficult to reach

Results

- Prototype of a deflection nozzle system for the cleaning of pipes and areas difficult to reach
- Prototype of a on-side cleaning tool for turbomachines (details confidential)

Support on Development and Introduction of Automation Solutions



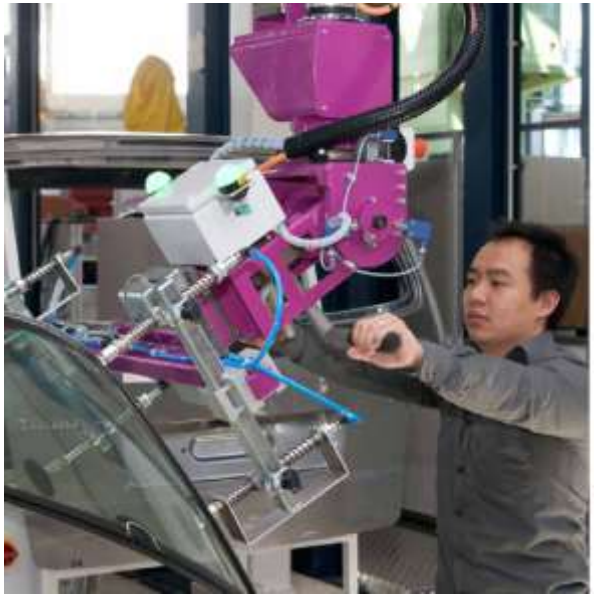
- Analysis and Requirement Spec.
- Development of Automation Concepts
- Elaboration of Tenders
- Assessment of Offers
- Acceptance Procedures
- Support of start-up
- Support of initial operation

Cobots/Kobots – A New Class of Systems that Combine Features of Robots and Passive Hand-driven Manipulators

Human centered semi-automatic part handling and assembly with cooperative robots (Cobot)

COBOT - Approach

- Power assist system supporting the worker in part handling tasks
- Manual motion controlled by force input of the worker
- Intelligent additional functions
  - Path guidance / virtual walls
  - Teach-in function for positioning in automatic mode
  - Collision avoidance

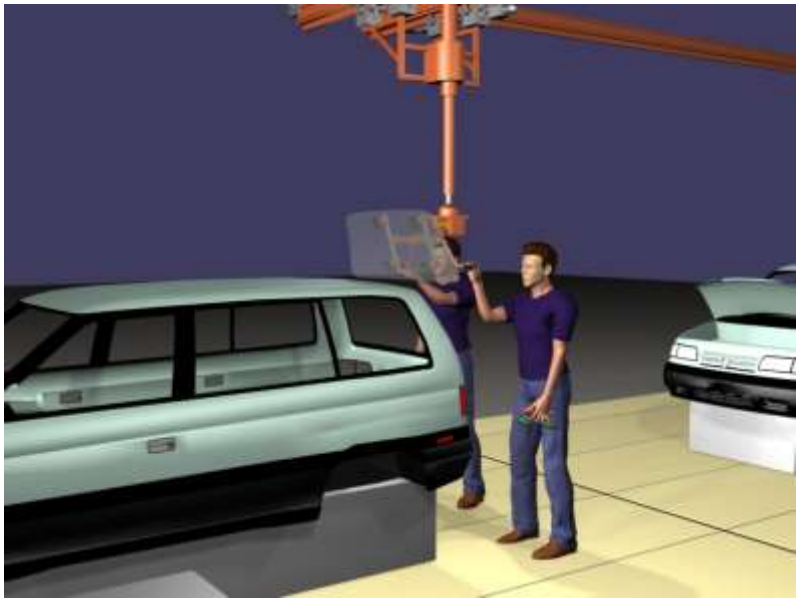


Source: Fraunhofer IPK

Human centered semi-automatic part handling and assembly with cooperative robots (Cobot)

COBOT - Advantage

- High flexibility by direct human integration
- Intuitive (force based) interaction
- Configurable system behavior adapted to manual assembly processes
- Automatic functions for screen feeding and return to home / storage position
- Cost-efficient overall system solution
- Improvement of work conditions



=> Proposed usage in mining: Robotization of handling tasks in Electrowinning

Source: Fraunhofer IPK

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