Worker-Robot Interaction in Manufacturing Industry
25. Oktober 2012, Karlsruhe

Human Robot Interaction

Integration of the Employee to increase Flexibility

Dipl.-Ing. Carsten Thomas

Agenda

Human Robot Interaction
Integration of the Employee to increase Flexibility

- Present Status
- Research Approach
- Offline Simulation
- Human Safety
- Status of the Demonstrator
- Summary

IPS

Institute of Production Systems

Heads of the Institute

Prof. Dr.-Ing.
Jochen Deuse

Prof. Dr.-Ing.
Bernd Kuhlenkötter

Employees

89 scientific and technical employees of the disciplines

- Electrical Engineering
- Computer Science
- Physics
- Logistics
- Industrial Engineering

Fields of Work

Time Management

Automation Systems

Digital Factory

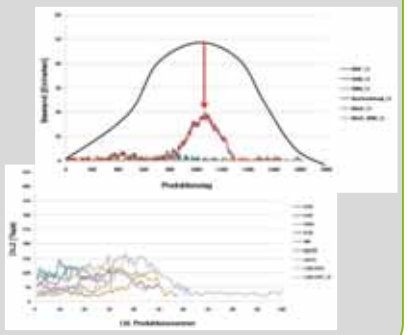
Industrial Assembly

Industrial Robotics and Service Robotics

Human Machine Interaction

Socio-technical Work Systems

Systems Engineering / Factory Physics



Welding in Industrial Production

Welding of Tubular and Framework Constructions

- custom-made assemblies, individual construction
- small batch sizes (< 10 pieces)
- high quality requirements
- heavy-weights

Problems

- labour-intensive tasks with a high amount of manual handling operations
- static body postures of the employees, e. g. when welding overhead or with a bended and twisted back
- working posture during operation is defined by the product geometry

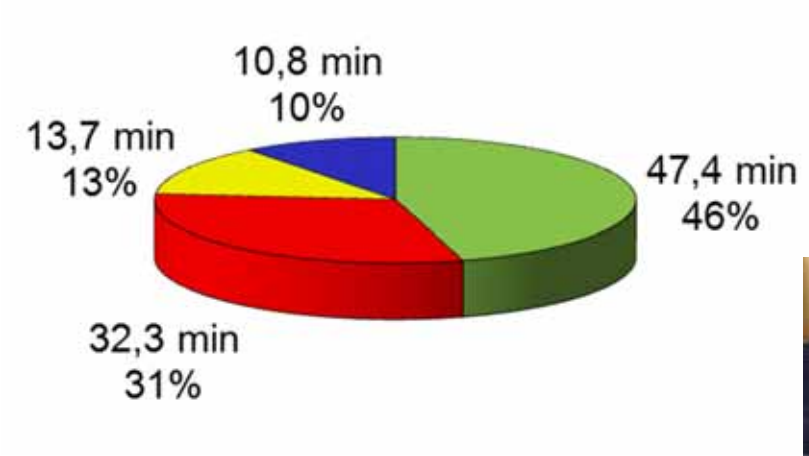
Analysis of the Process Times

Welding

Weld seam finishing

Other secondary time

Handling



Direct Human Robot Interaction

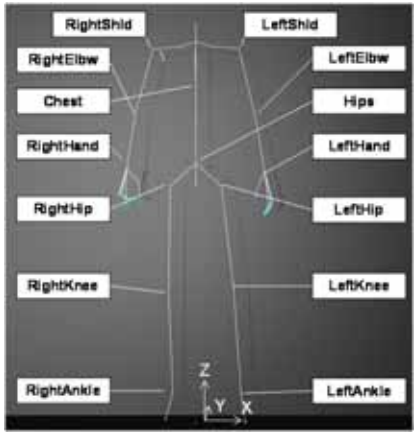
Gefördert durch:
Bundesministerium für Wirtschaft und Technologie
aufgrund eines Beschlusses des Deutschen Bundestages

Development of a multi-robot assistance system with a safe and ergonomic collaboration between humans and robots in an overlapping workspace, to reduce labour intensive manual handling of heavy parts in welding processes.

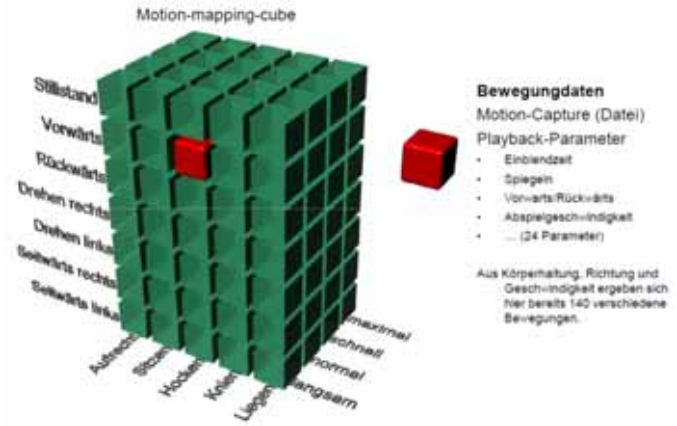
Hybrid systems with direct human-robot interaction require new planning tools with-in the digital factory, especially in offline programming and simulation.

Examples are:

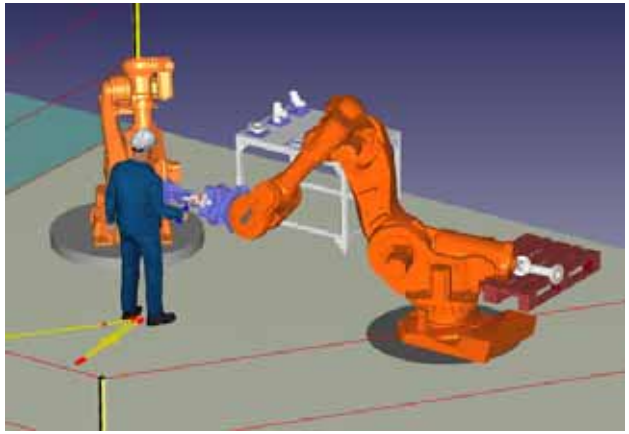
- Integration of digital human models with exact anthropometrics
- Simulation of realistic human motions
- Tools for digitally evaluating human factors
  Ex.: physical stresses, ergonomics, work safety



Digital Skeleton Model



Motion-Mapping-Cube

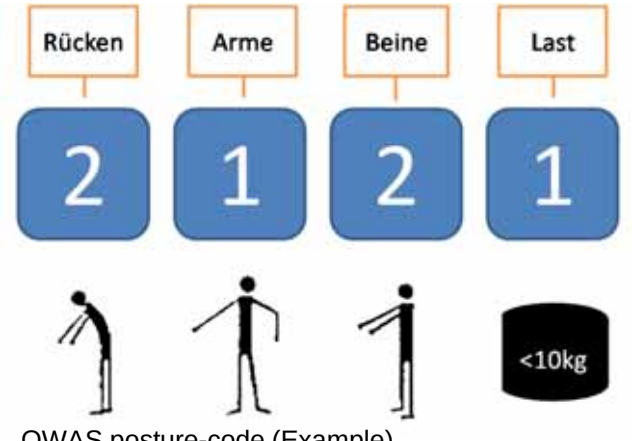

Simulation of a Hybrid Robot Cell

Ergonomics in Human Robot Interaction

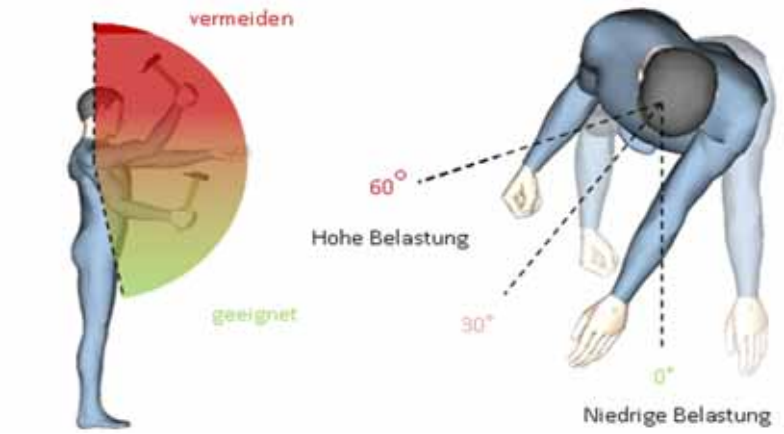
Simulation of human-robot cooperation enables systematic recording and evaluation of body postures and physical stresses

Benefits:

- Ensuring economic and ergonomic optimised motions for human and robot
- Matching the robot path planning with human motions and ergonomics
- Evaluate and adapt system configuration to different body sizes, ages and genders



OWAS posture-code (Example)



Physical load for different human postures

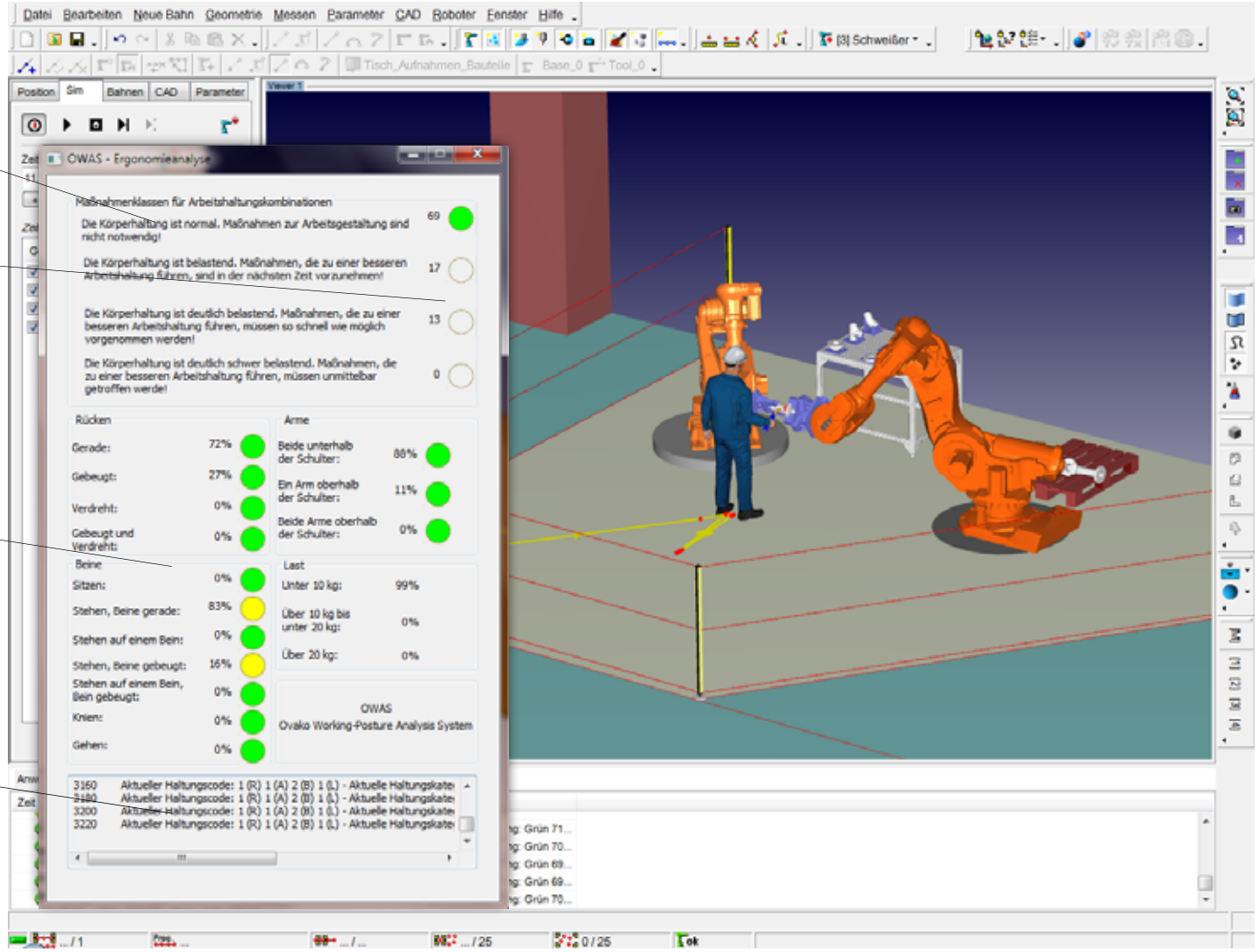
Simulation of the Hybrid Robot System

Description of the OWAS category

Analysis of the current posture combination

Detail analysis for back, arms, legs and weight

Current posture code



Comparison of Manual vs. Robot assisted

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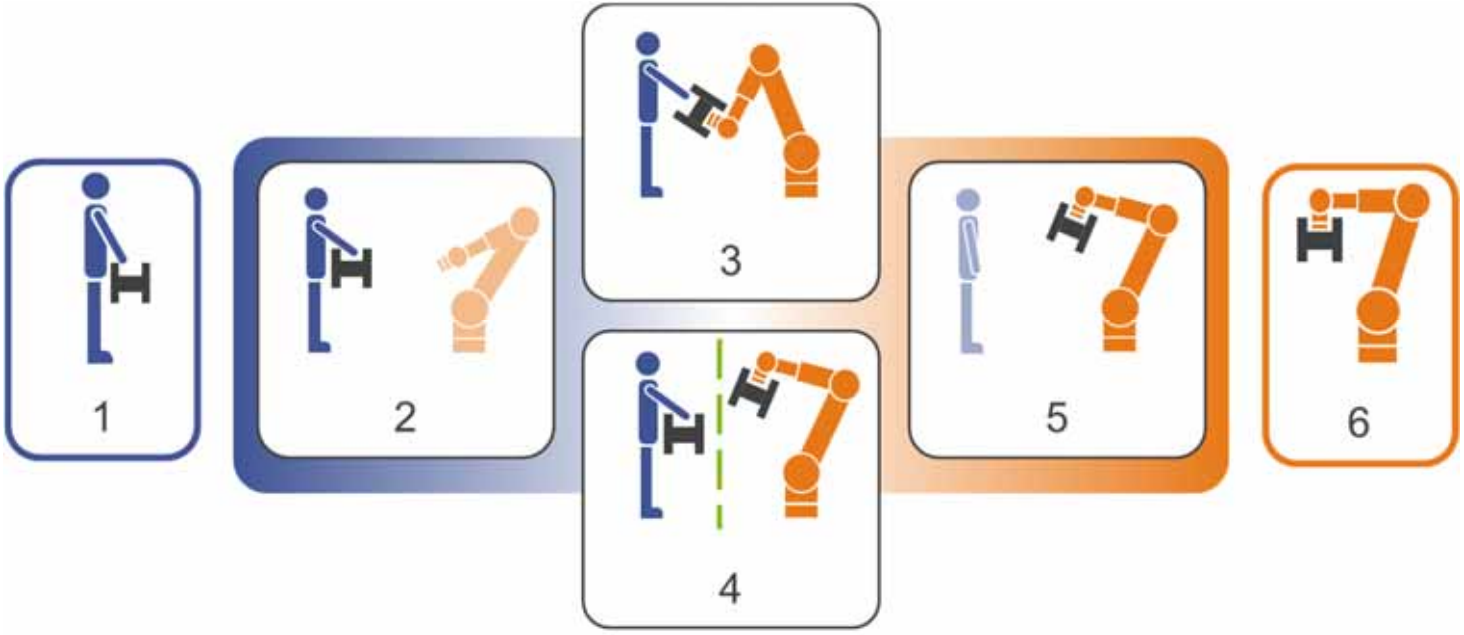
Modes of Human-Robot-Collaboration



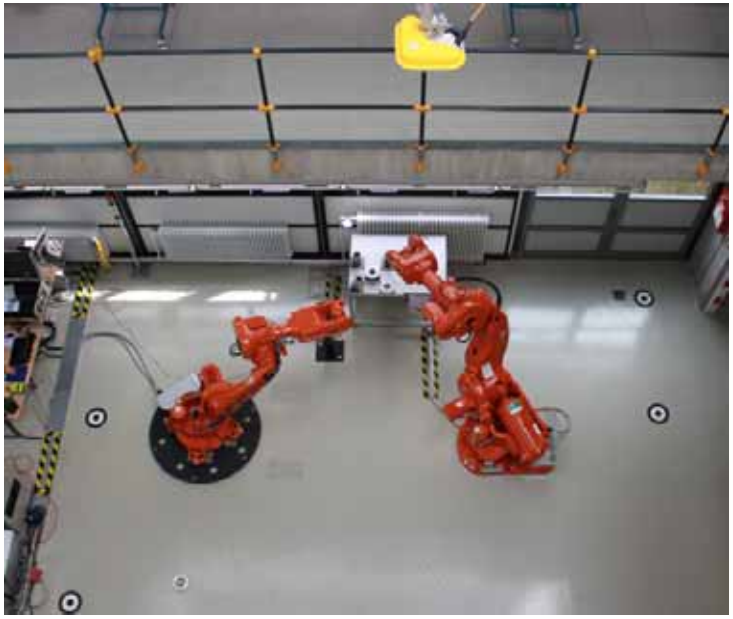
Human	Mode	Robot
manual assembly	1	---
active	2	not active, safe stand still
direct cooperation with robot(s)	3	direct cooperation with human(s)
active, but separate working range	4	active, but separate working range
not active	5	active
---	6	automated assembly

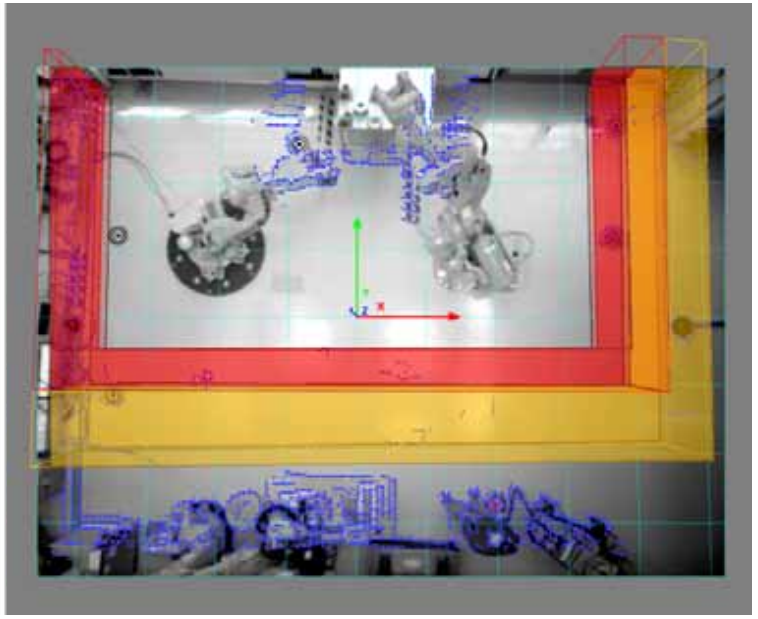
Real Demonstrator and View of the SafetyEye

- Camera-based sensor system
- Safety robot controller

→ Flexible layout of the robot cell

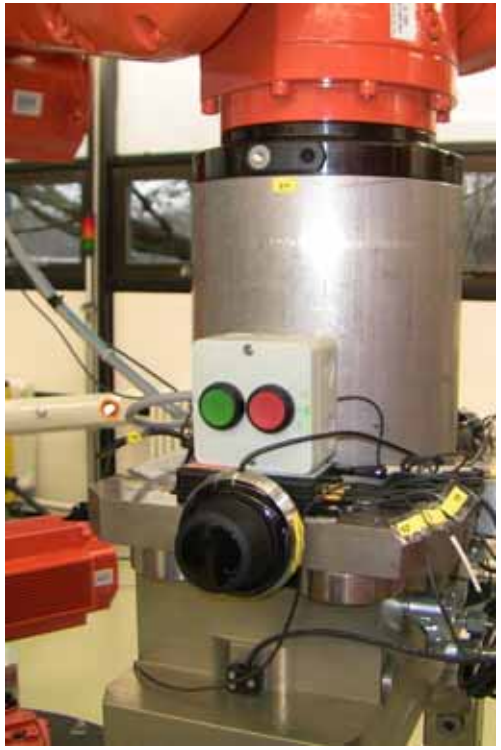
→ Safety configuration adaptable for each mode





Human Robot Interface

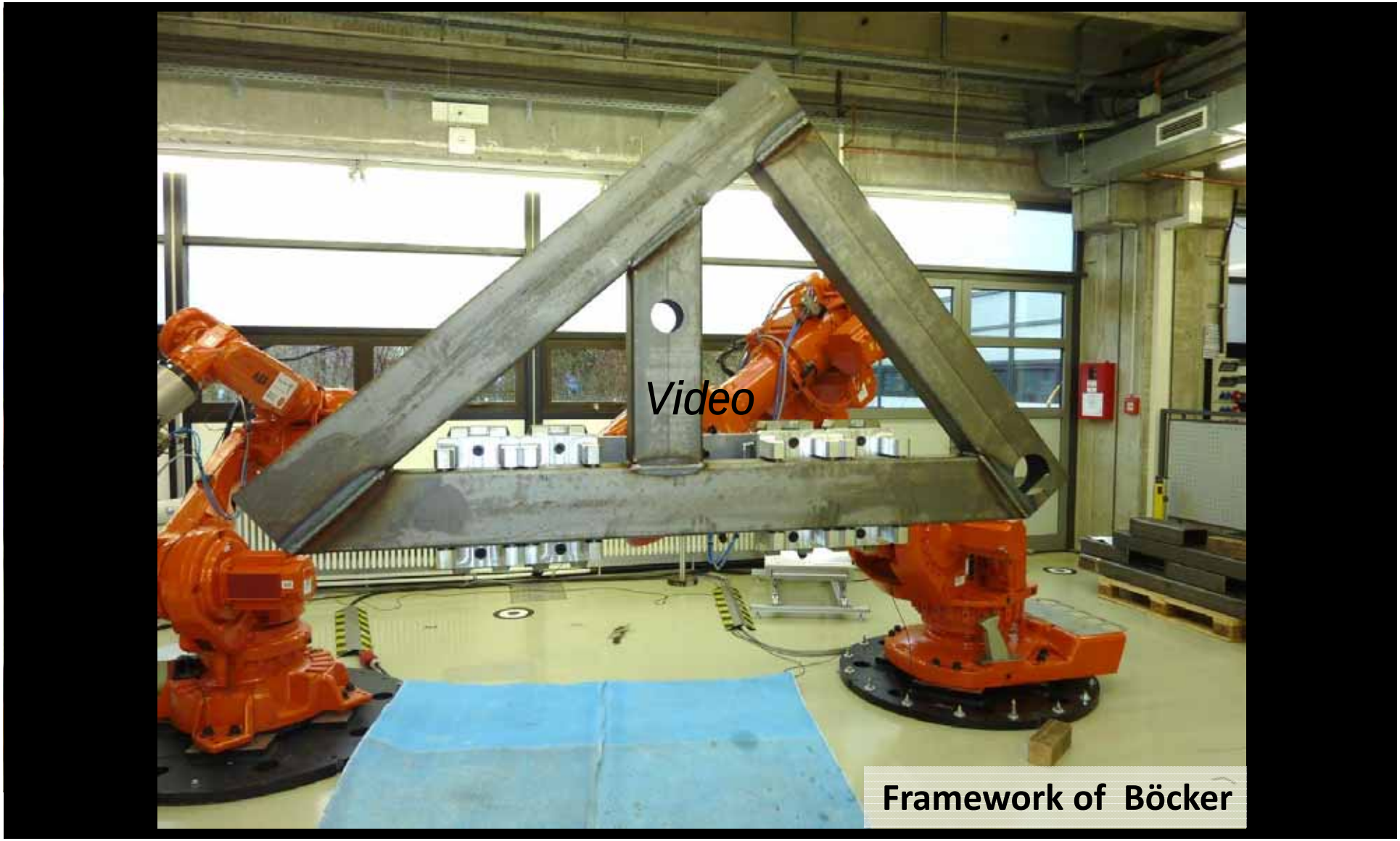
Design of a user-friendly and intuitive human robot interface for collaborative operation of the multi-robot-assistance system.



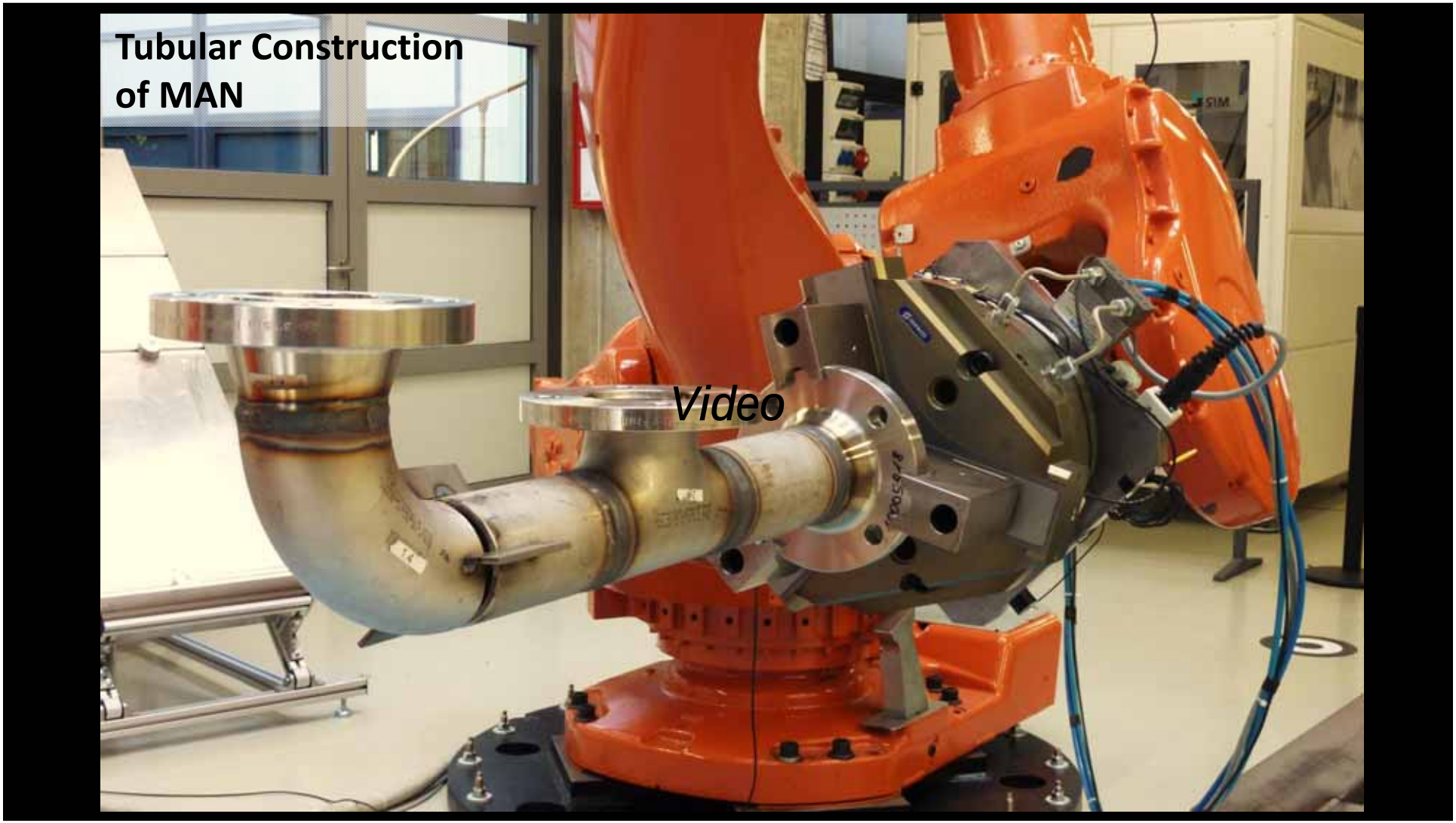
- Influencing the TCP position and orientation by the employee
- Continuous control of the process
- Visualisation of process steps and system errors during the process
- Easy to learn and intuitive to use

In addition to the safety technology ensured by the technical system, the interface must give the feeling of safety in every state of operation to the worker ("Felt security").

Welding in the Robot-Based Assistance System



Schweißen der Rohrbaugruppe



Summary

Human Robot Interaction

Integration of the Employee to increase Flexibility

- Actual working conditions of welding processes in the industry
- Digital Human Model for ergonomic analysis, integrated in a robot simulation to build up hybrid systems
- Technical solutions for safety and worker interface for a direct human robot interaction
- Evaluation with the demonstrator

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