Fraunhofer IFF

Rebuilding Ukraine: new opportunities through digital transformation – Hannover Messe April 23, 2024

# Zero Engineering Robotics in Production

# We Are Fraunhofer IFF, Robotics Systems

## Research Fields

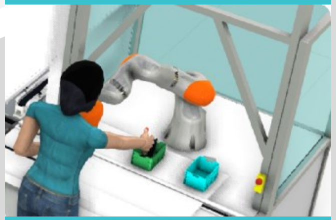
Service Robots for Inspection and Maintenance

Industrial Robot Applications

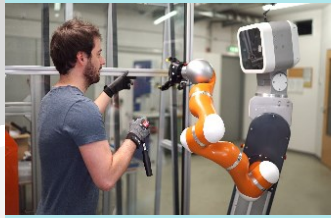
Human-Robot Interaction

Sensors for Safe Human-Robot Collaboration

Intelligent Assembly and Machine Tending



Design and Validation Methods



Autonomous Robot Assistant

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» As technology advances, it reverses the characteristics of every situation again and again. The age of automation is going to be the age of 'do it yourself.'«

**Marshall McLuhan,**
Philosopher

  

# Zero Engineering Robotics in Production

## Automation today – who does the work?- The view from a large company*

**Blue Collar worker - Process Owner**

- Works on the production line
- Has vocational training
- Knows the processes

**Prod. Engineer - Line manager**

- Responsible for set of processes
- Industrial engineer or similar

**Engineering Innovation Team**

- Takes research results and applies them to factory processes

**Safety / Ergonomics Specialist**

- Responsible for a whole factory or even groups of factories

**System Integrator**

- Provides turn-key solution
- Responsible for CE-Mark

* Highly generalized overview of stakeholder roles and engineering processes based on experiences and anecdotes from various industries

 

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## Robotics trends today – „Full digitalization“ versus „In The Wild“

### Full digitalization

Complete digital models of all parts, processes. Programming can take place via simulation / offline programming methods.

Advantages include ability to incorporate AI into workflow for perception tasks

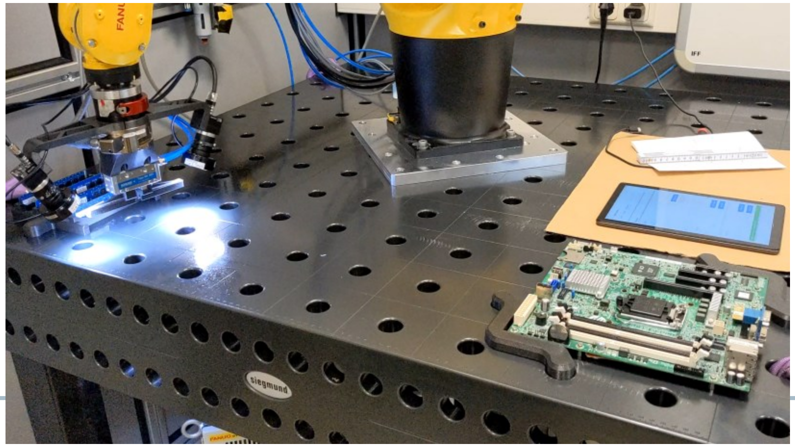
Challenges include fidelity of digital models, computing power and software (skills) necessary to maintain and understand the workflow.

### In The Wild

Using programming by demonstration or teach-in techniques, a worker can quickly implement simple programs.

Advantages include abililty to work with parts without available CAD models

Challenges include safety, scalability and non-ability to leverage AI or other „game changers“ into the workflow.



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## INTAS - Intuitive Assistance Robot for Welding Large Components

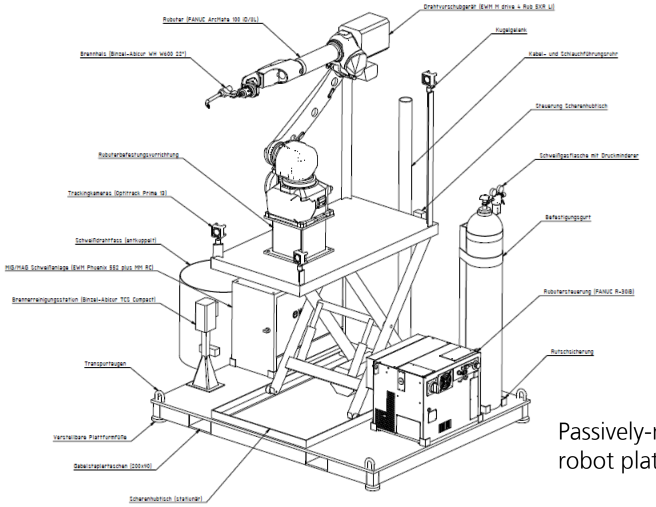
### Motivation

- Welding of large components including forging, presses, machine bed/frame, wind turbines, etc.
- Challenges: costs, ergonomics, personnel-intensive

### Approach

- Automation of multilayer welding with a passively-mobile robot platform
- Simple programming of complex welding paths can be implemented economically and quickly with innovative input device
- Enables use in many other applications in addition to welding: including inspection or sealant application in precast concrete plant

Welding of large components at ATA GmbH (©ATA GmbH)



Passively-mobile robot platform



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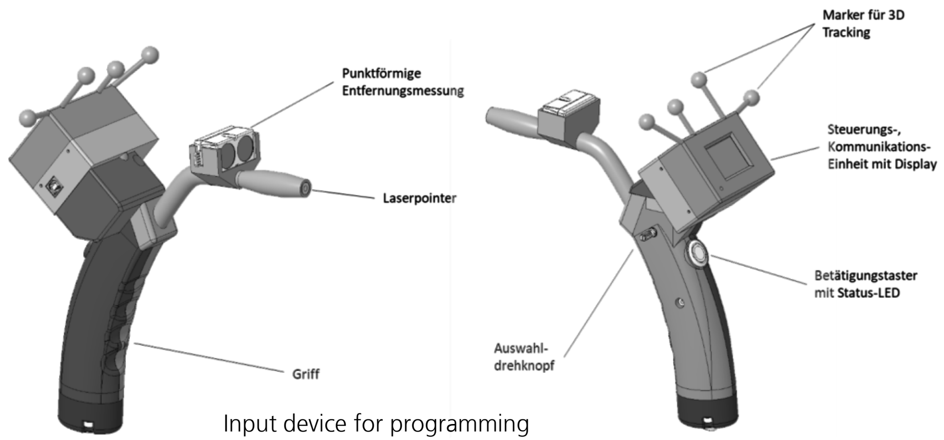
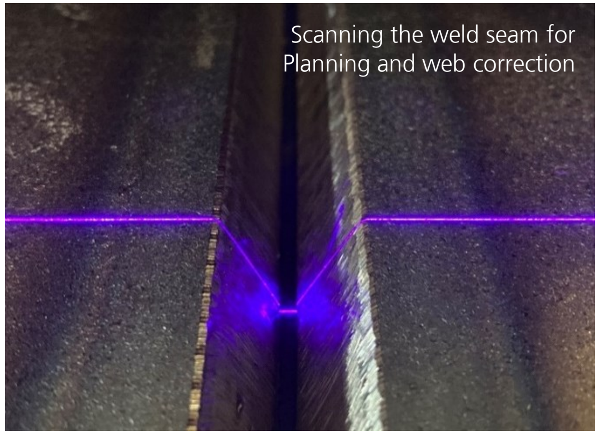
## INTAS – Main set-up

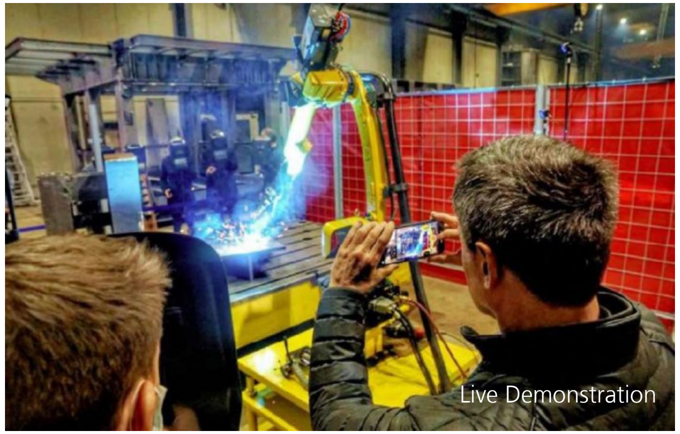
- Input device for interactive web planning
- Localization of the position by external tracking system and transfer to robot coordinates
- Contactless input of distant points due to integrated distance sensor
- Conversion to robot motions with testing for reachability, collision and singularities
- Automatic detection of the weld seam and planning of the welding task
- Automatic path correction through subsequent 3D measurement of the processing point with laser scanner




Input device for programming



Scanning the weld seam for Planning and web correction



Live Demonstration

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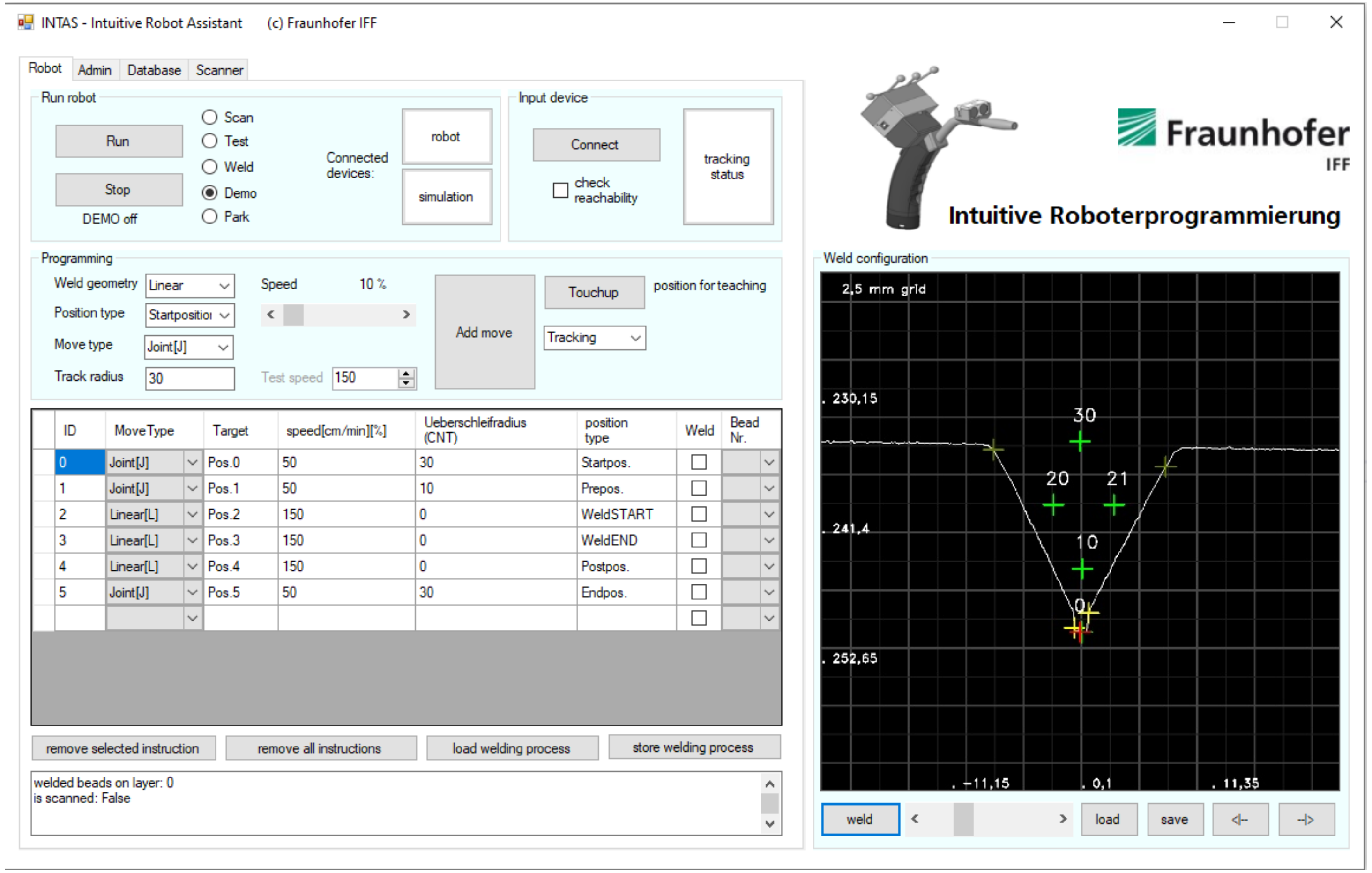
## INTAS - Set-up and Operation

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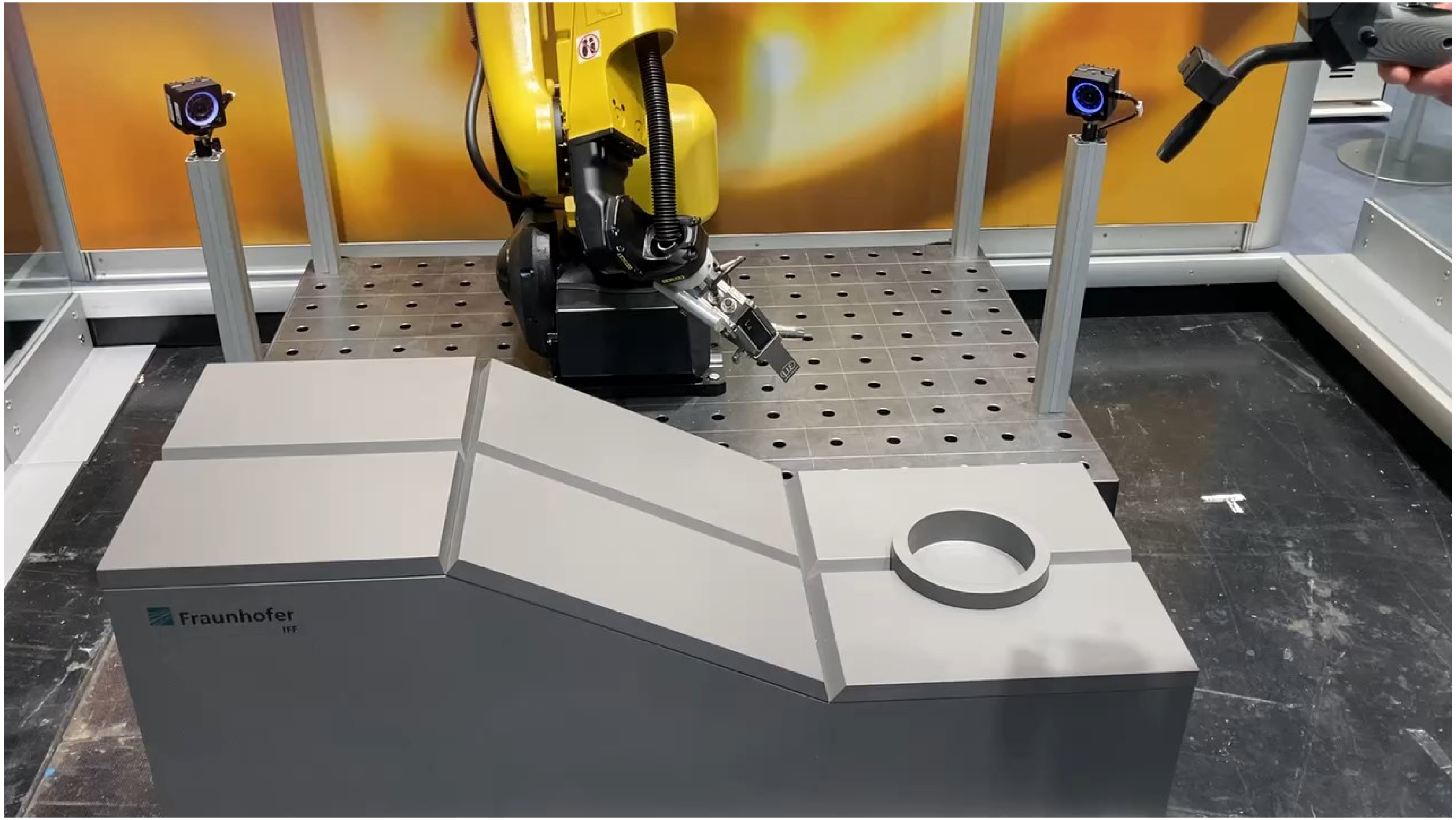
## INTAS- Programming



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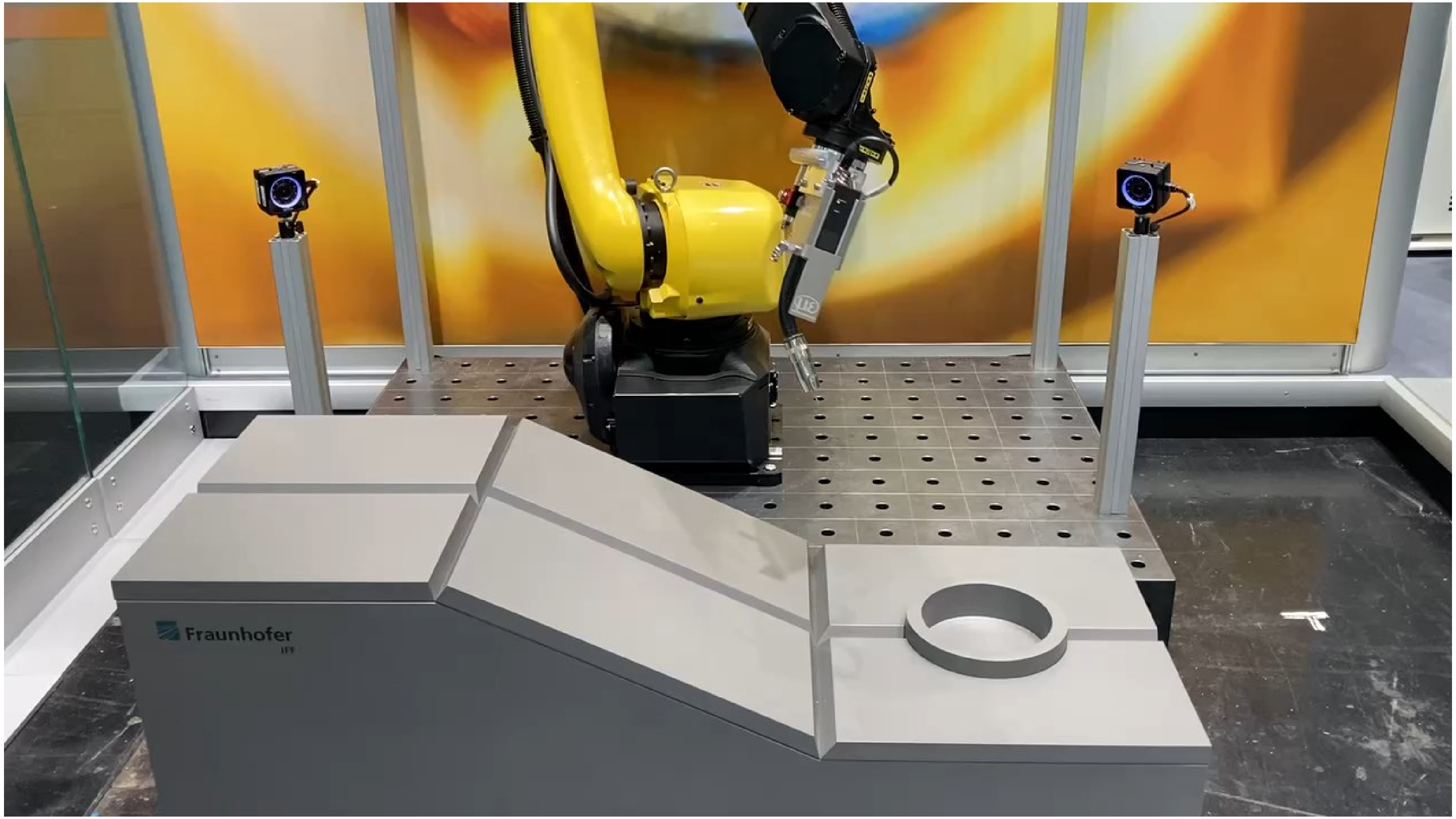
## INTAS- Path correction/planning and multilayer welding



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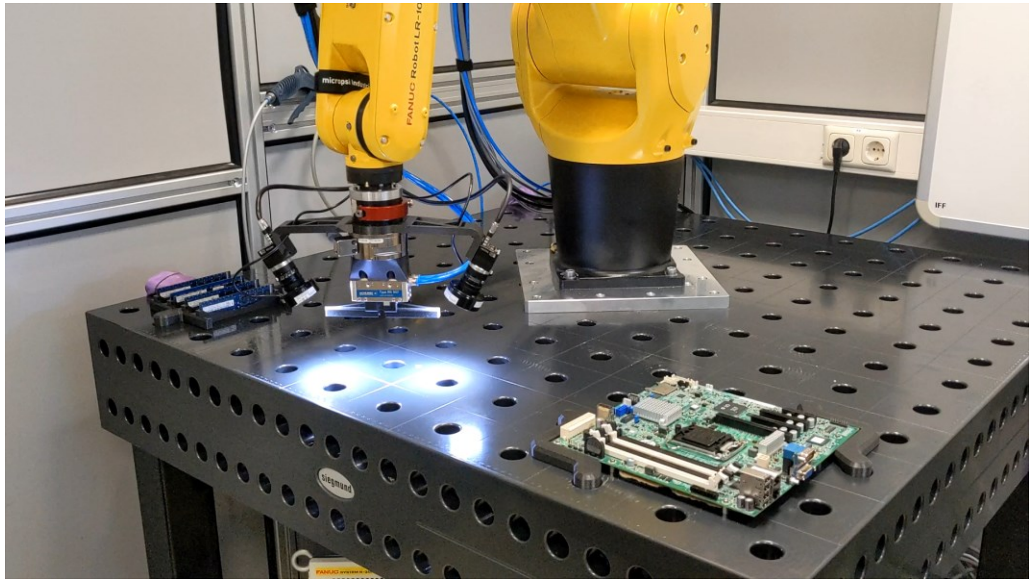
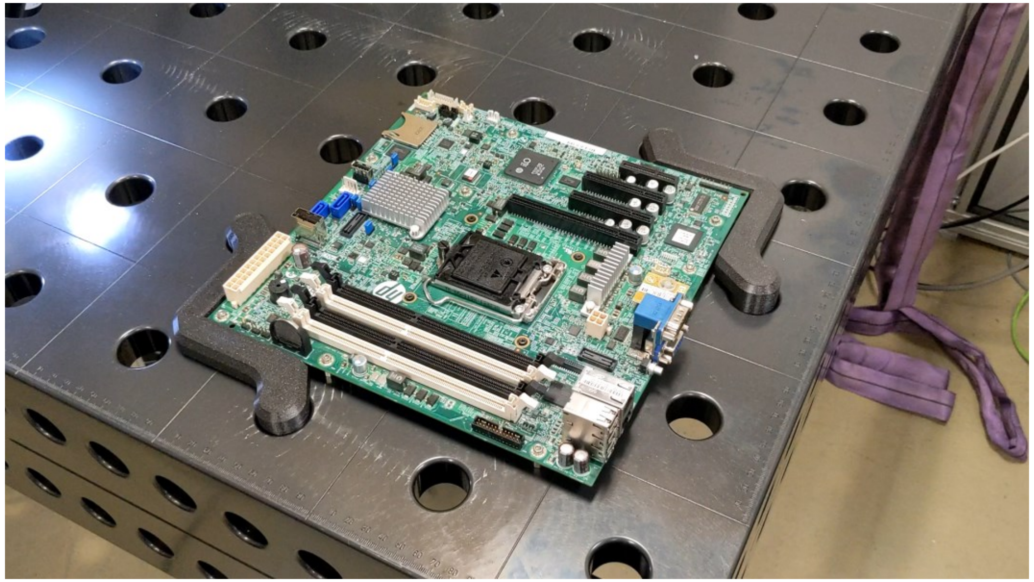
## Micropsi Industries – IFF Use-Case Lab Applications

- Use-Case Lab – joint testing of feasibility for various applications
- Focus on challenging applications with high degree of variance in parts / position
- This case focuses on inserting DIMM (memory) into motherboard without fixtures (motherboard loosely placed with +/- 5 mm positioning accuracy)
- High requirements on positioning accuracy and pressing force
- Focus on ease of integration, ease of use





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## Collision Tests Constitute Economic Risks for the Deployment of Cobot Applications

**Current process from the design of a cobot application to installation and regular operation**


**1) Design of the Application**
- Specification
- Optimization to ensure that the economic objectives will be achieved (e.g., cycle time)
- Align economic objectives to safety requirements is impossible

**2) Installation**
- Purchase of the robot and all other components
- Application set-up

**3) Programming**
- … of the robot according to the processes designed

**4) Risk Assessment**
- Identification of hazards and evaluation of associated risks
- Determine protection measures

**5) Safety validation**
- Test robot against limit (measure contact forces and pressures)

**Productive operation**
- Only possible after validation was successful
- In case of modifications: update the risk assessment and repeat safety validation
- Measurements must be repeated annually

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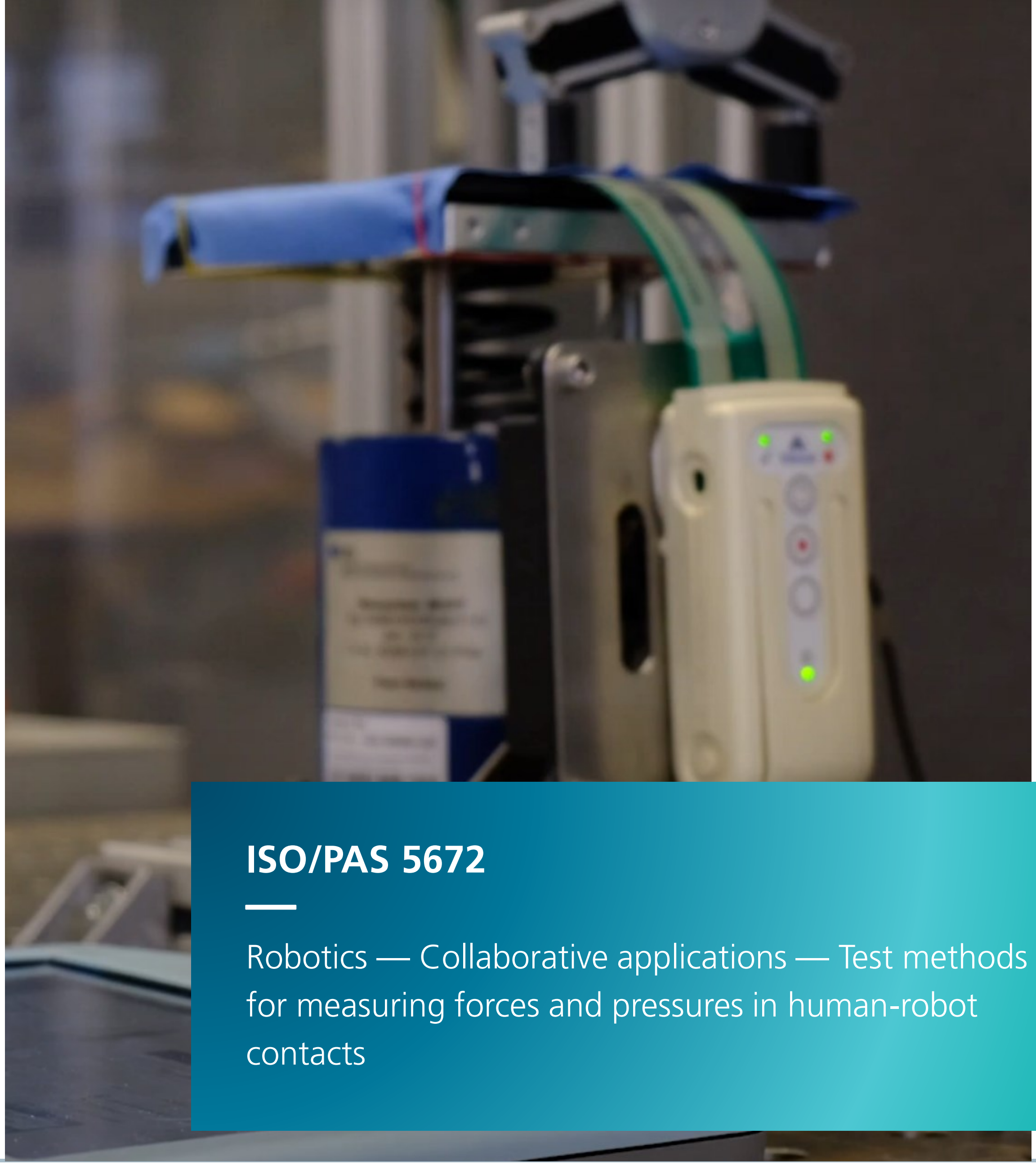
## Testing Cobots Against Limits

### State of the Art

Cobots safeguarded with biomechanical limits have to be tested in simulated collisions against biomechanical limits. A specific measuring instrument is used in the test to replicate the human biomechanics and measure contact forces and pressures. An international standard that specifies the instrument's design and its usage does not exist until today.

**Finished Project**

- Normative ISO deliverable (ISO/PAS) developed in ISO/TC 299 WG8
- WG8: Biomechanical Data and Validation Methods for Physical Human-Robot Interactions
- ISO/PAS was published in November 2023
- Document addresses robot manipulators and mobile platforms deployed in collaborative applications



**ISO/PAS 5672**

Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts

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## Integrating Digital Risk Assessment In a Robot Programming Environment

### Future Risk Assessment Process

STEP 1: Limits of the application and intended use

- Brief (textual) description of the application's intended use (for instance in the program header)
- Automatic documentation of machine data (robot type, serial number, etc.)

STEP 2: Identification of hazards

- Software wizard supports the user to identify hazards while the robot is programmed
- Description of a hazard details based on profiles (type of contact, endangered body parts, location of the contact point, etc.)

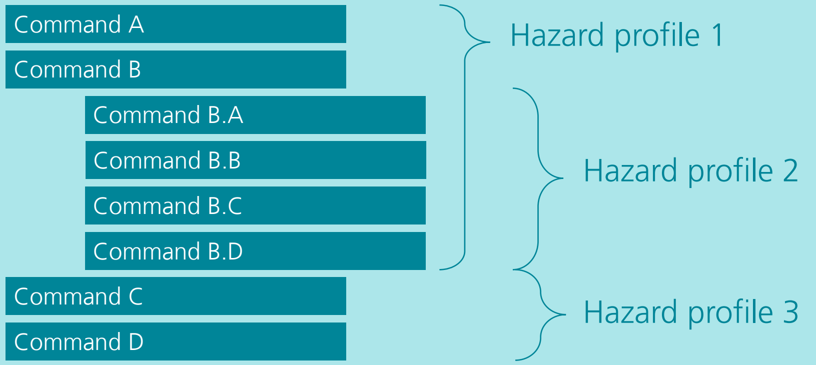
STEP 3: Risk analysis – done automatically

STEP 4: Risk evaluation – in dialog with the robot programmer

STEP 5: Risk reduction – risk reduction measures proposed by the system (e.g., configuration of a velocity limit in the safety properties)

### Assign hazard profiles to program sections

Hazard profiles can be assigned to program code section (robot programming and risk assessment become one)




### Risk reduction measures provided by the system

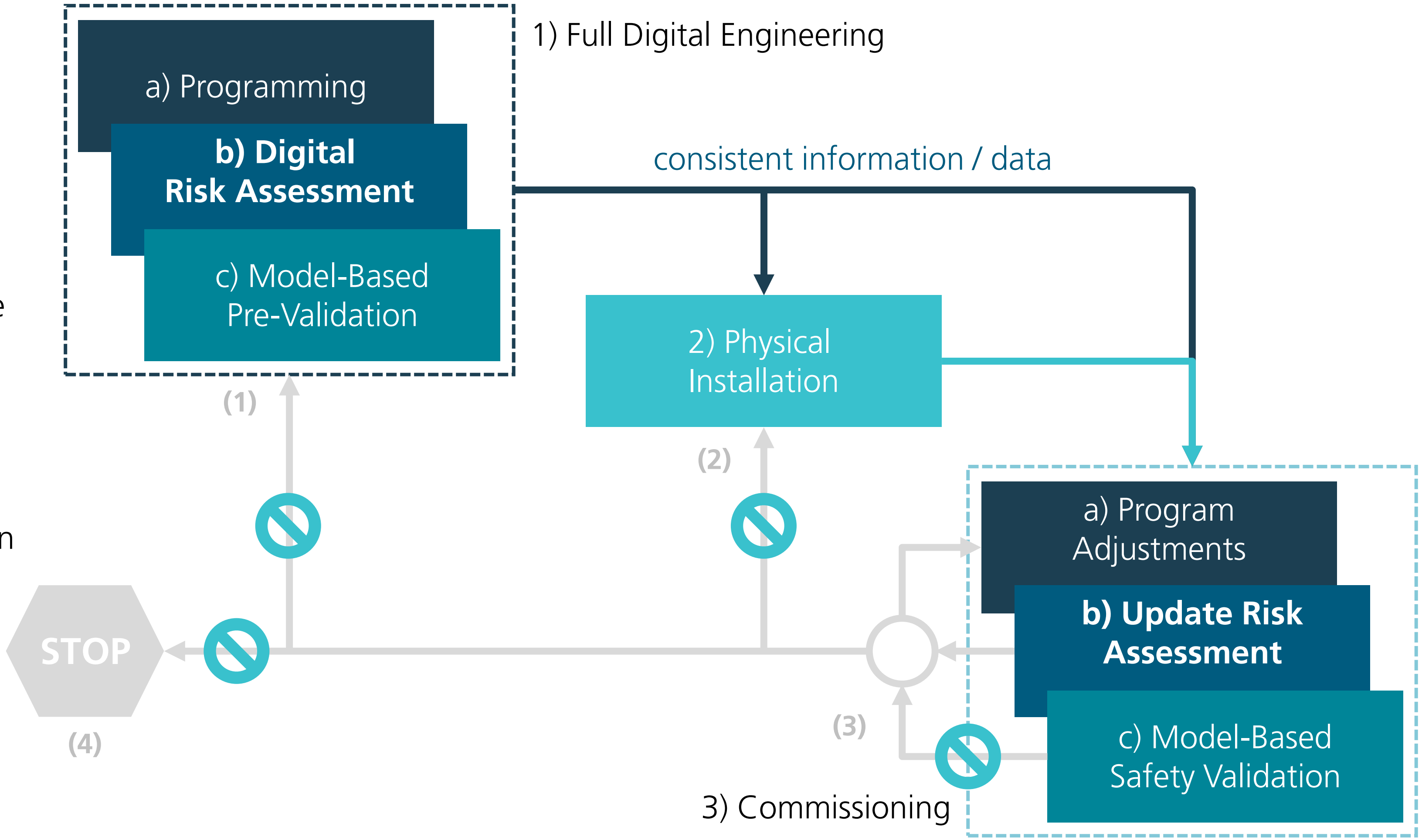
- Low risk: informing the robot operator (directly on the teach-pendant)
- Intermediate risk: robot has to comply with biomechanical limits
- High risk: re-design required (i.e., hazard elimination)

# Zero Engineering Robotics in Production

## Significantly Streamlined Design Process Without Costly Iterations

### Benefits at a glance

- Most parts of the risk assessment will be completed during design time (fully digital)
- Model-based safety validation enables the integrator to determine maximum allowable robot velocities (during design time / not after physical installation)
- Design iterations (and thus the risk of misconceptions) will be completely eliminated (reliable outcome from the design phase)
- Digital Twins ensure full consistency of data relevant for risk assessment



# Zero Engineering Robotics in Production

## Take home message

**We need robots and automation that can be used by the process owner!**

**European Robotics focuses on the human in the loop!**

**Fraunhofer IFF is your partner for „in the wild“ applications.**

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**Blue Collar worker with Fraunhofer IFF Tools**

- Works on the production line
- Has vocational training
- Knows the processes

- Has all tools to safetly create flexible robotic applications

**Flexible robotics in production**

- On-site solutions that work

  

# Contact

**M. Sc. Franz Valdiek**
**Business Unit Robotic Systems**
**Tel. +49 (0) 391 4090-228**
**franz.valdiek@iff.fraunhofer.de**

Fraunhofer-Institut für Fabrikbetrieb und -automatisierung
Sandtorstraße 22
39106 Magdeburg
www.iff.fraunhofer.de

Fraunhofer IFF

# Contact

**Dr. José Saenz**
**Business Unit Robotic Systems**
**Tel. +49 0391 4090-227**
**jose.saenz@iff.fraunhofer.de**

Fraunhofer-Institut für Fabrikbetrieb und -automatisierung
Sandtorstraße 22
39106 Magdeburg
www.iff.fraunhofer.de

# Questions?
# Thanks for your attention!

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