Rebuilding Ukraine: new opportunities through digital transformation –
Hannover Messe January 23, 2025

# Zero Engineering Robotics in Production

# We Are Fraunhofer IFF, Robotics Systems

## Research Fields

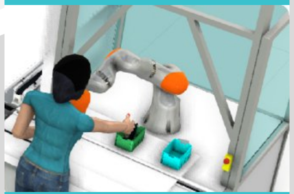
**Service Robots for Inspection and Maintenance**

**Industrial Robot Applications**

**Human-Robot Interaction**

**Sensors for Safe Human-Robot Collaboration**

**Intelligent Assembly and Machine Tending**



**Design and Validation Methods**

**Autonomous Robot Assistant**

# 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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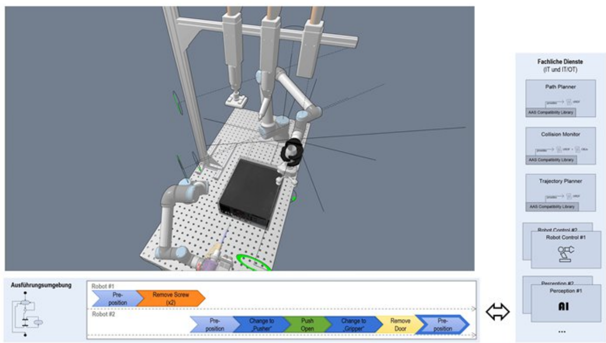
## Robotics trends today – „Skills-based Programs“ and „AI Foundational Models“

### Skills-based programs

Sensors for environmental and part detection, combined with high-level task description can replace classical “X-Y-Z programming” paradigms

Works well for simple actions with high degree of certainty (e.g. pick and place, simple tool usage like using a screwdriver)

Challenges include creating library of software (skills), maintaining these for various robot  hardware configurations.

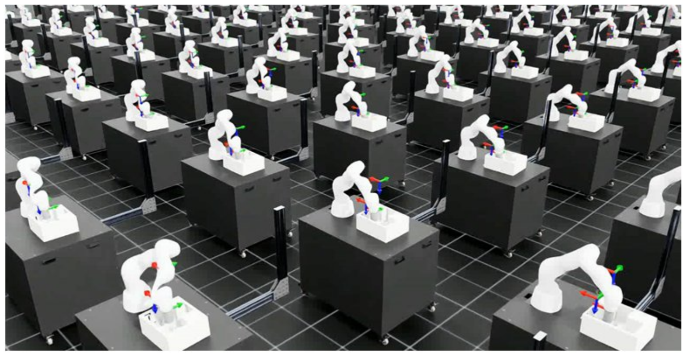



### AI Foundational Models

Usage of foundational models to allow for robot to deal by itself with unknown situations.

Advantages include ability to react to variance (in part, color, etc.), offline training possibilities.

Challenges include safety, scalability and transfer to real robot systems.



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## INTAS - Intuitive Assistance Robot for Welding Large Components

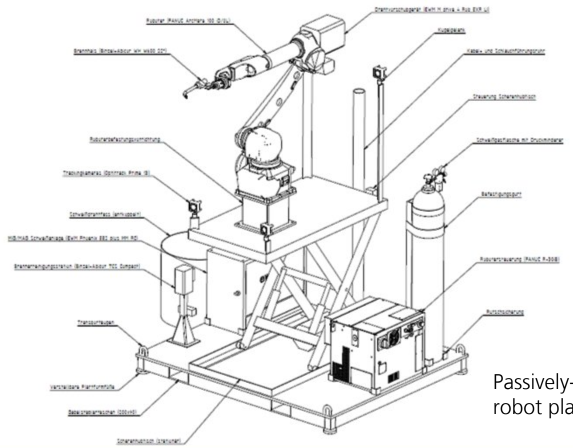
### Motivation

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

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

### 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



Passively-mobile robot platform

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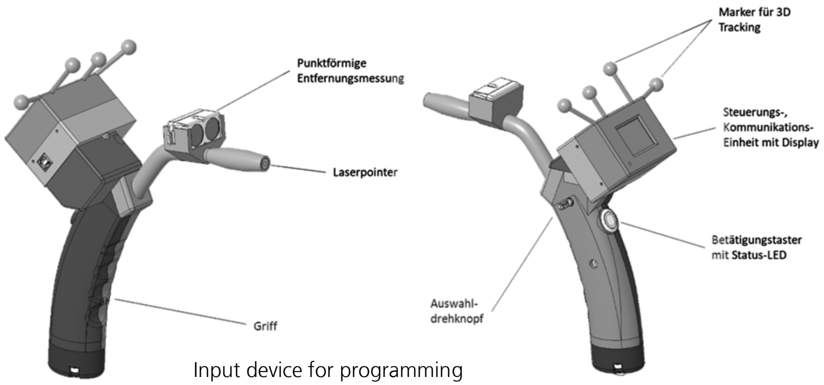
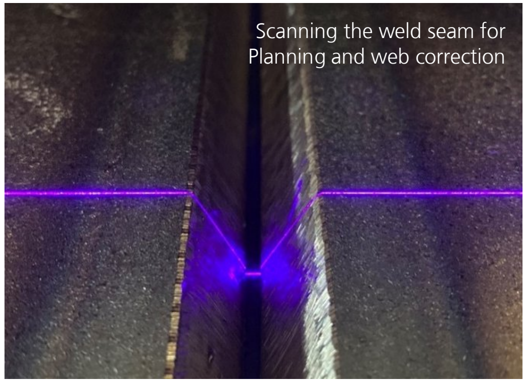
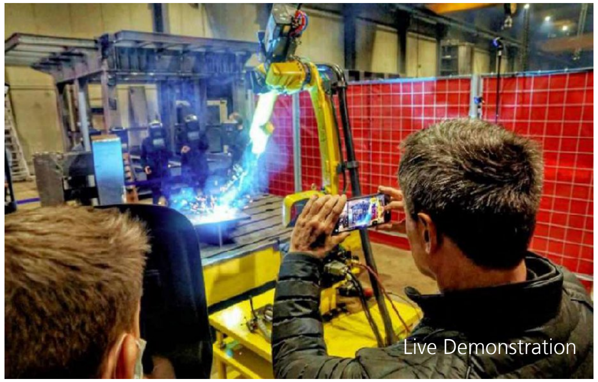
## INTAS – Main set-up

- 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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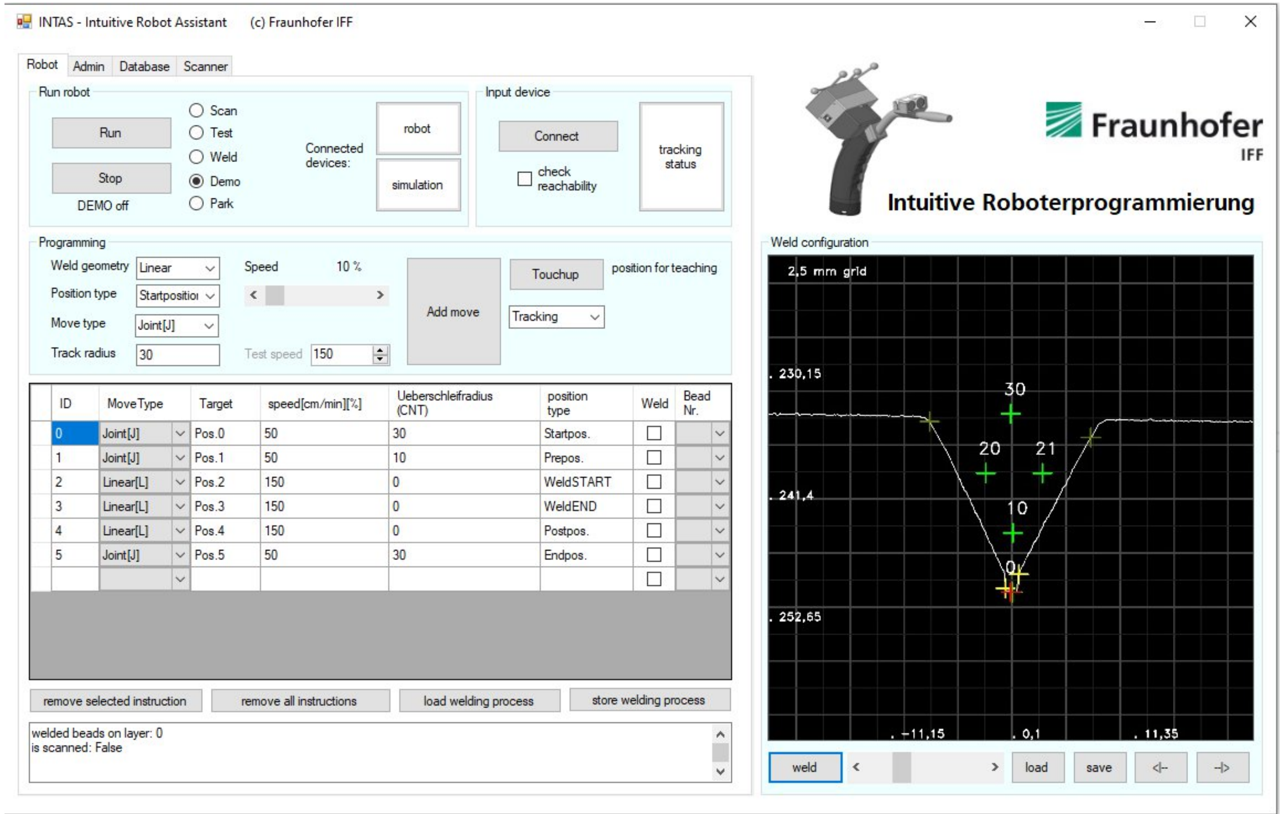
## INTAS - Set-up and Operation

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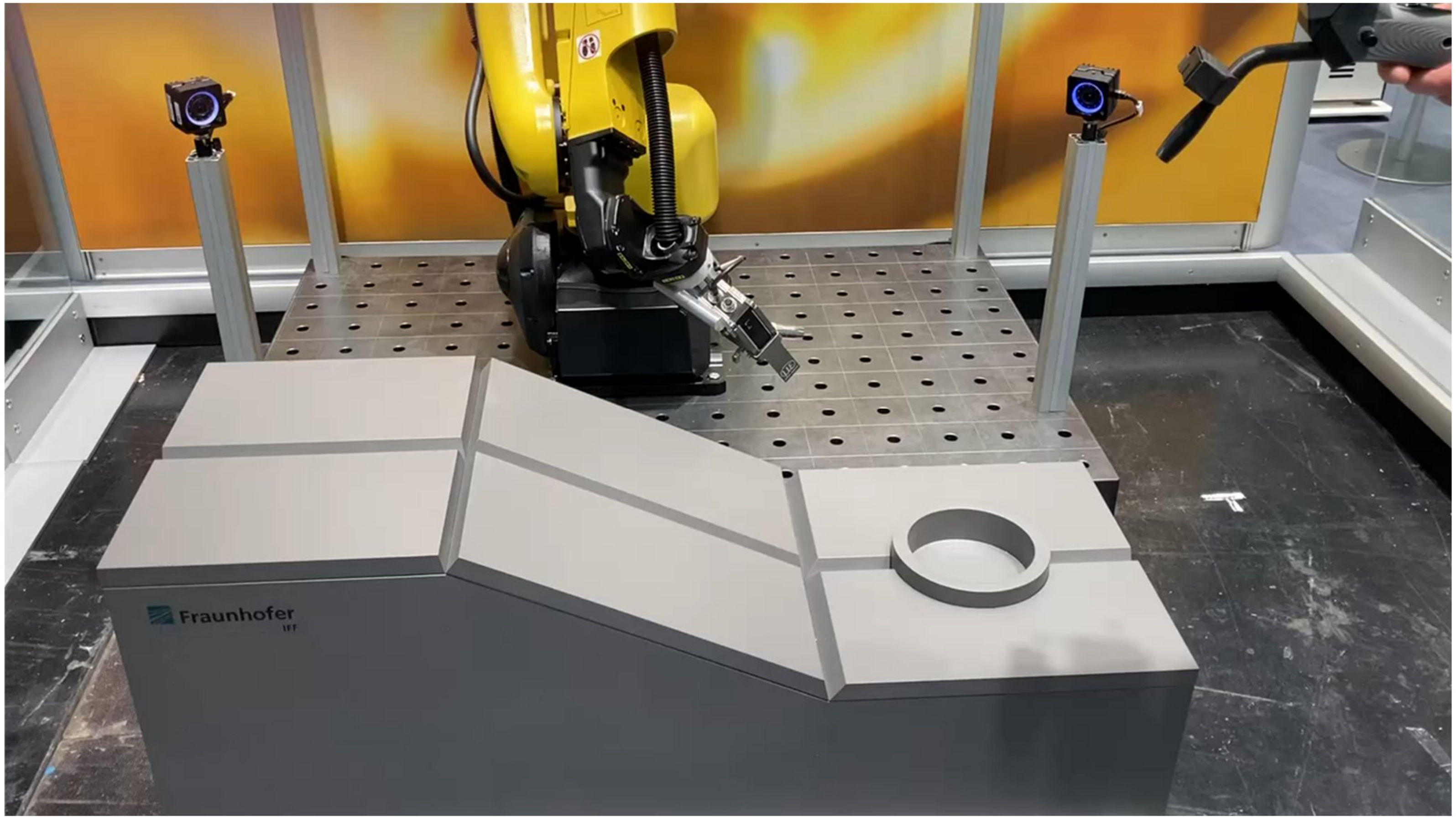
## INTAS- Programming



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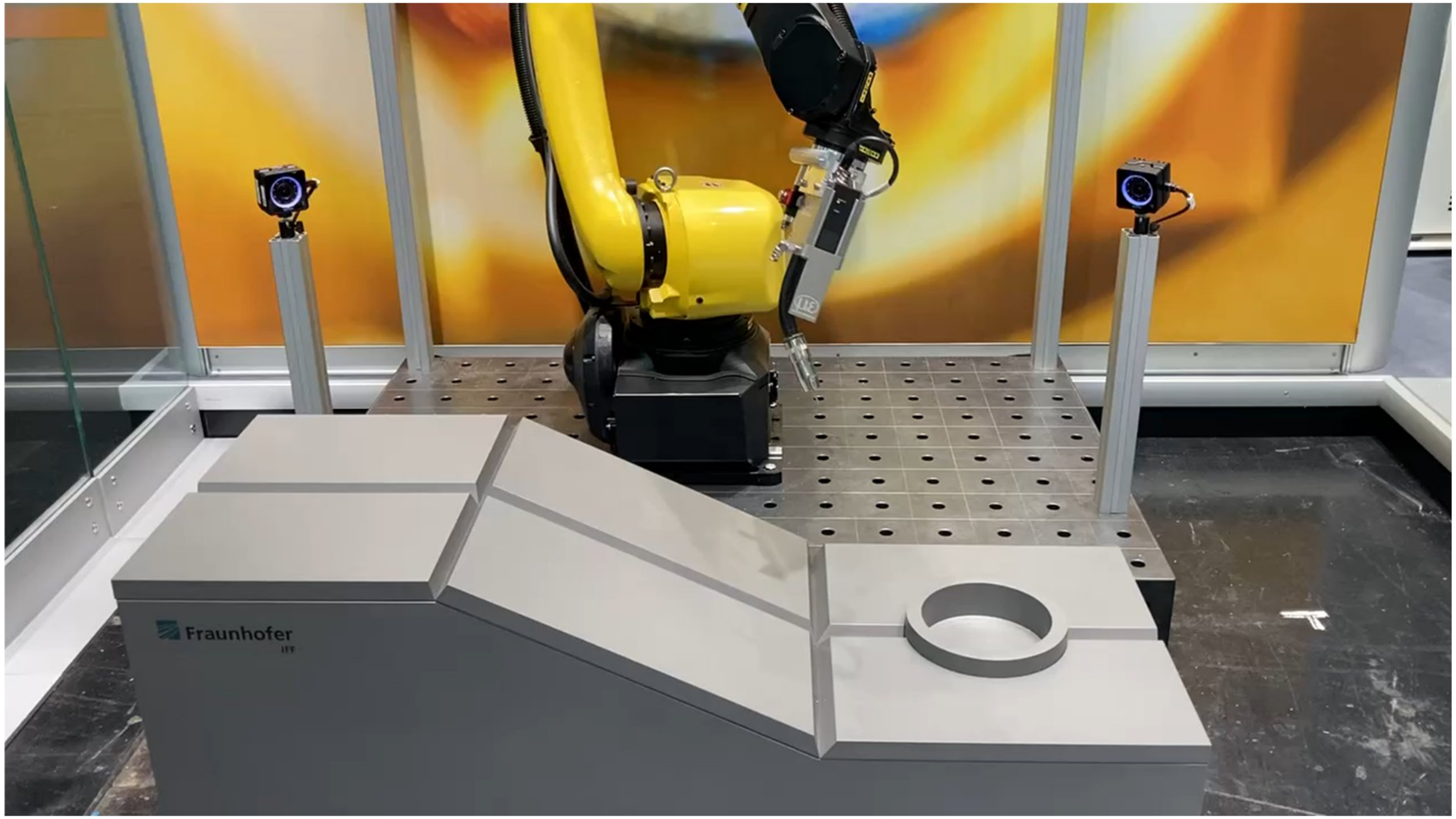
## INTAS- Path correction/planning and multilayer welding



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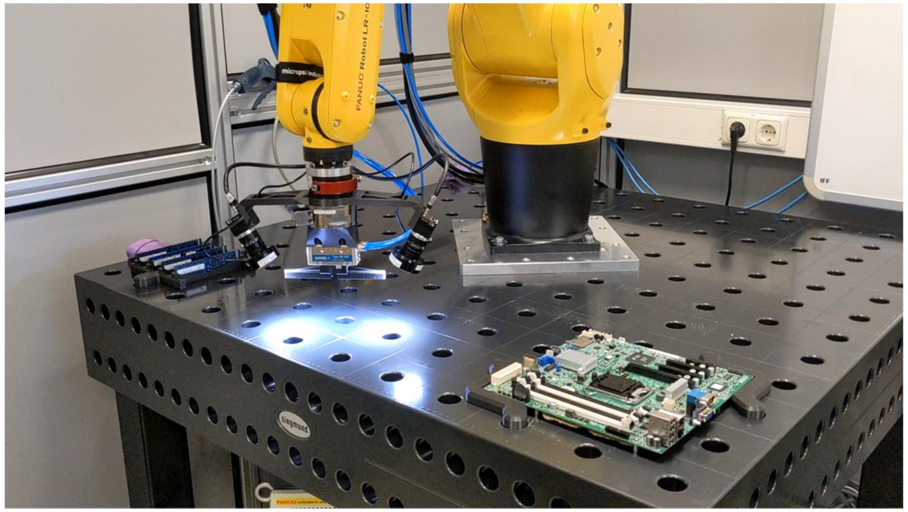
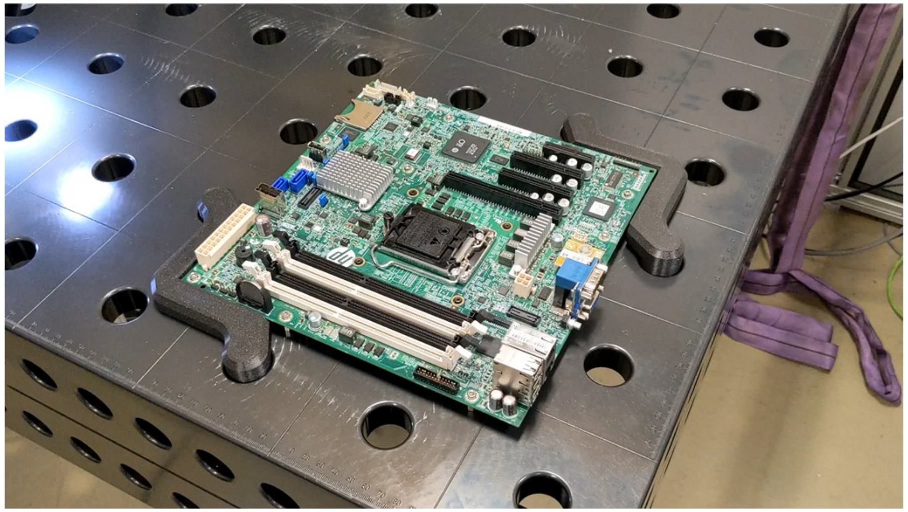
## Micropsi Industries – IFF Use-Case Lab Applications

- 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

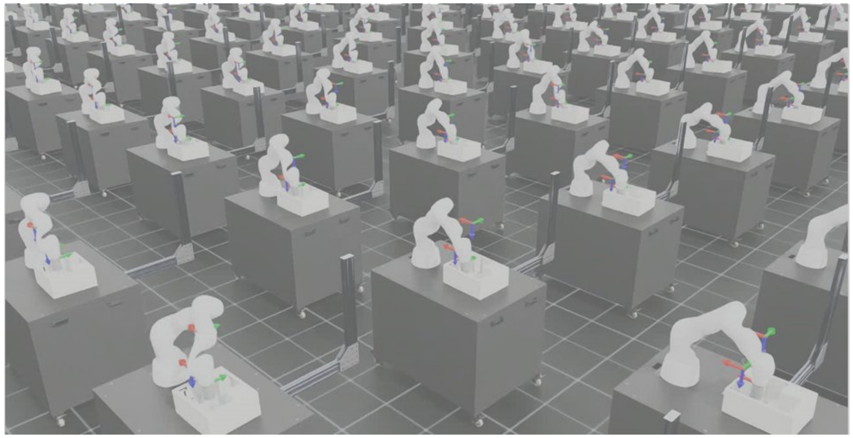


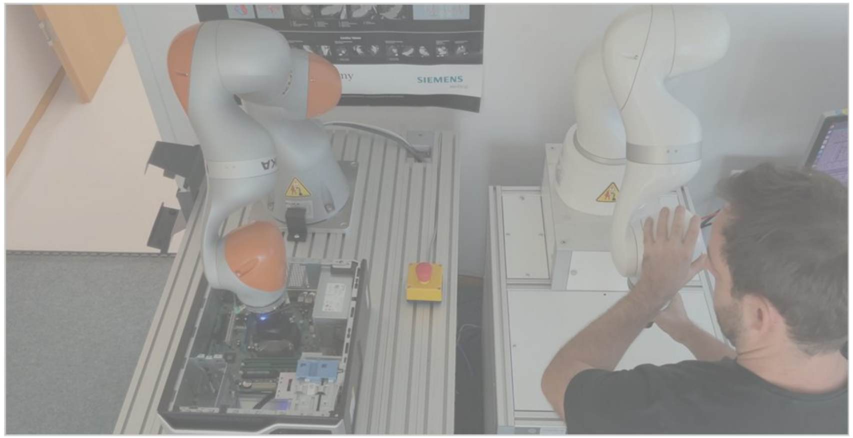


# AI-based Robot Actions

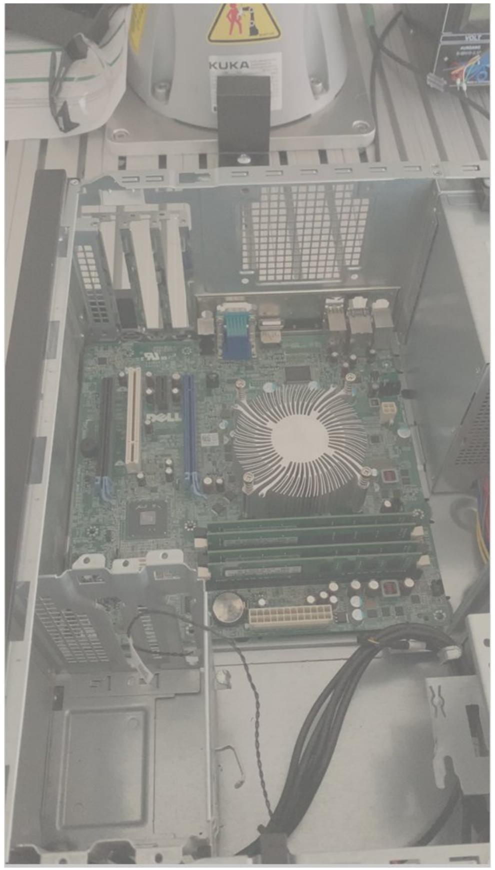
## Mainboard Demontage

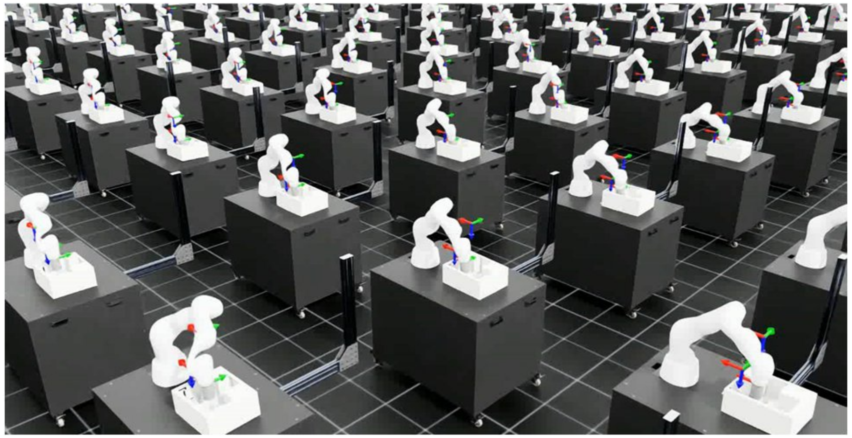



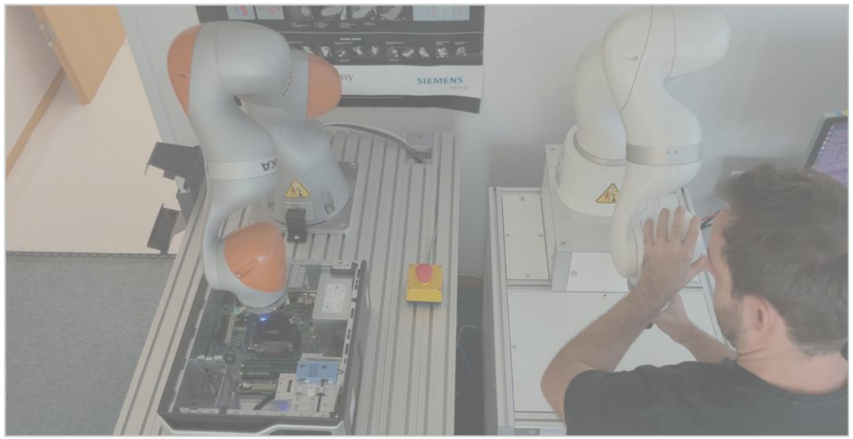



# AI-based Robot Actions

## Mainboard Demontage – Reinforcement Learning

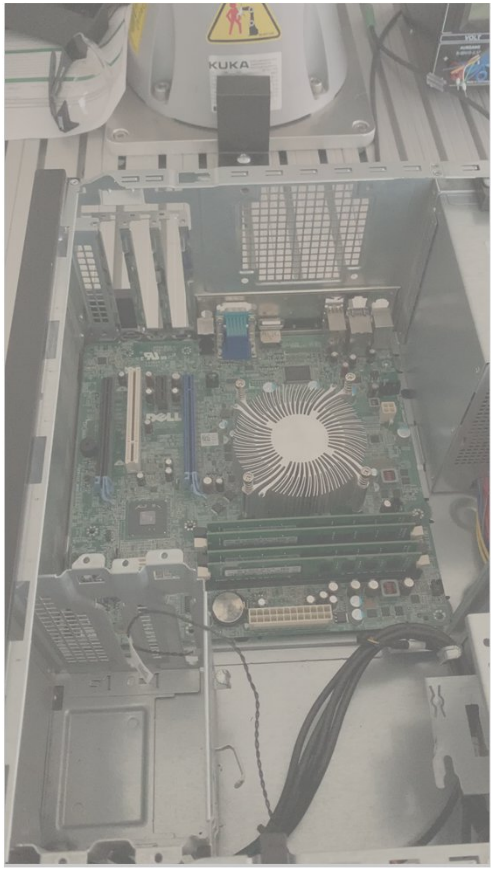


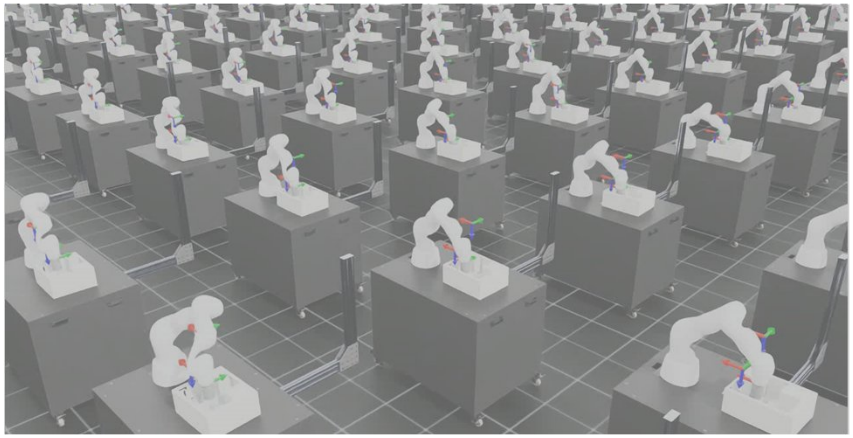






# AI-based Robot Actions

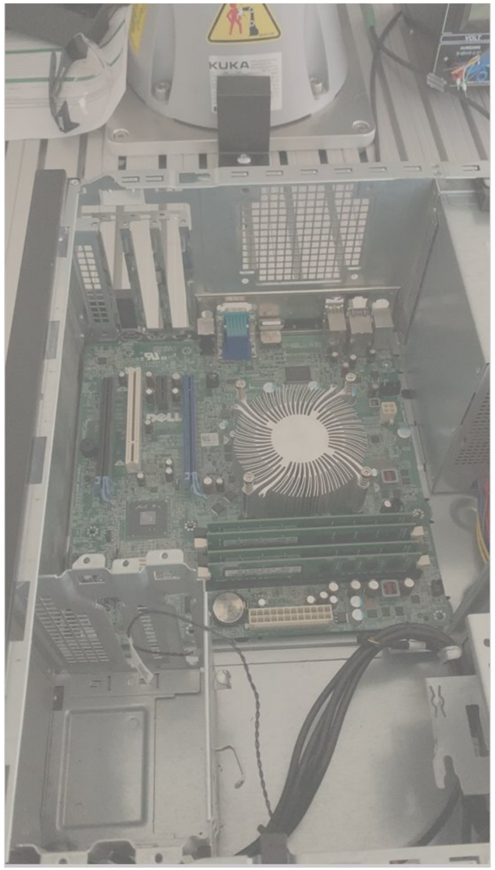
## Mainboard Demontage – Imitation Learning

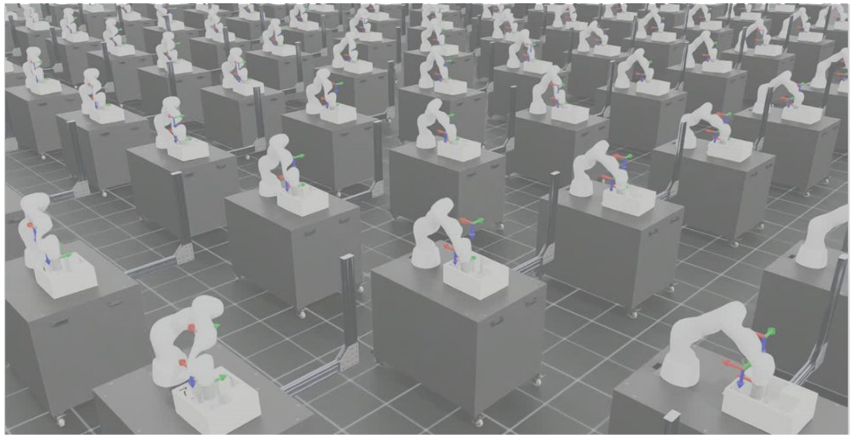


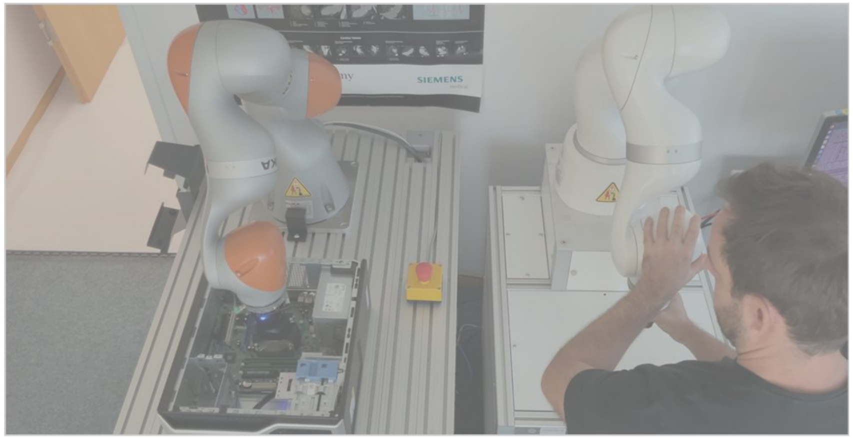




# AI-based Robot Actions

## Mainboard Demontage






# Zero Engineering Robotics in Production

## 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

# Zero Engineering Robotics in Production

## 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.)

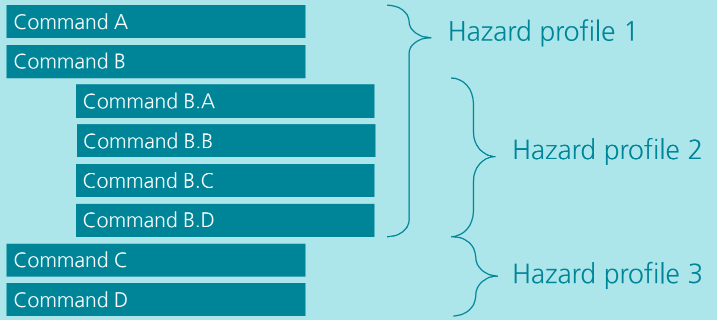
STEP 3: Risk analysis – done automatically

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

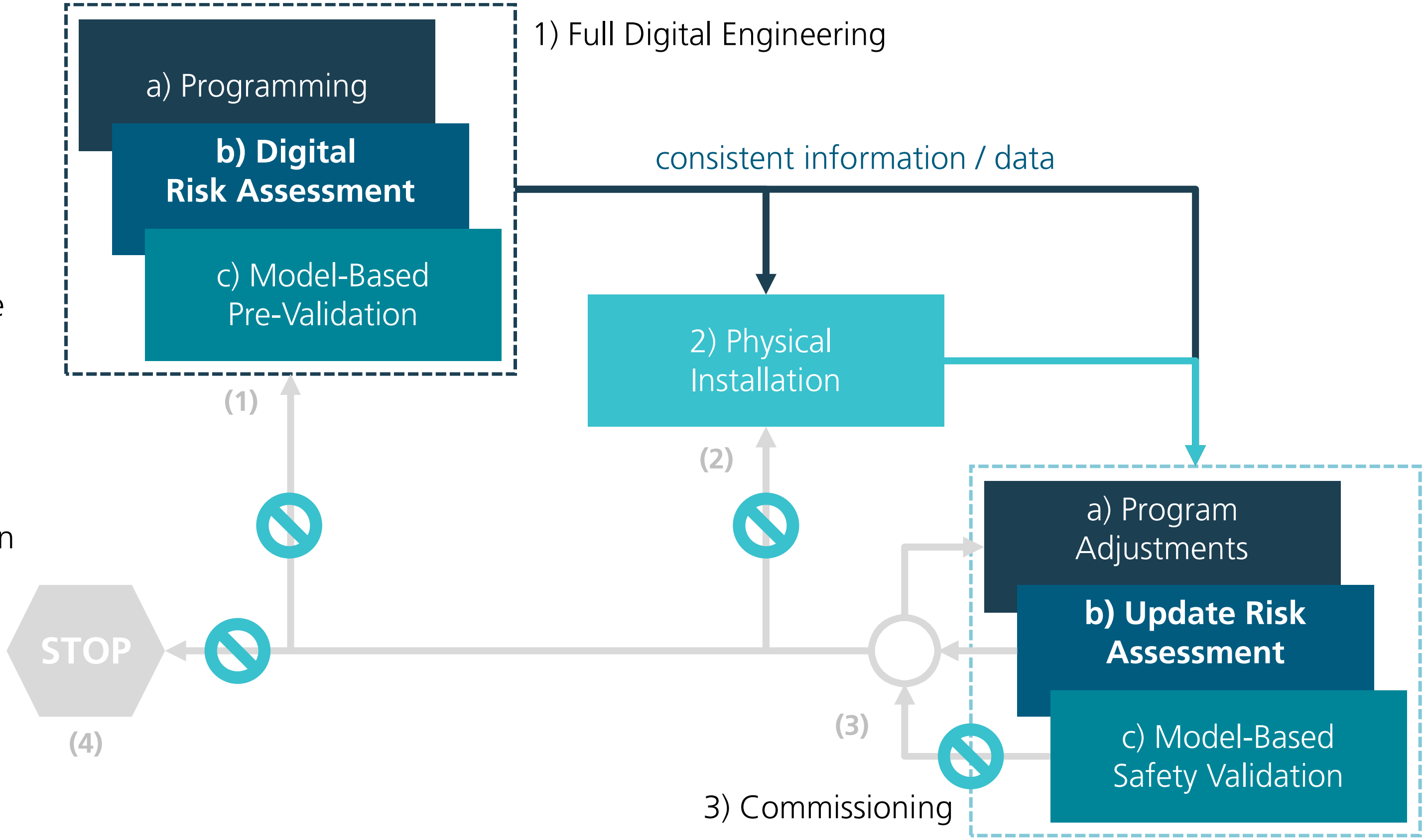
- Low risk: informing the robot operator (directly on the teach-pendant)
- Intermediate risk: robot has to comply with biomechanical limits
- High risk: re-design required (i.e., hazard elimination)

# 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 challenging applications that no one else can solve.**

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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 safely create flexible robotic applications

**Flexible robotics in production**

- On-site solutions that work

- Leverages AI technologies for variety of tasks (identification, robotic actions, environmental understanding)

 

# Contact

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# Questions?
# Thanks for your attention!