NEW APPROACHES TO IMPROVE THE DESIGN OF HRC ROBOT APPLICATIONS (COMPUTER-AIDED SAFETY)

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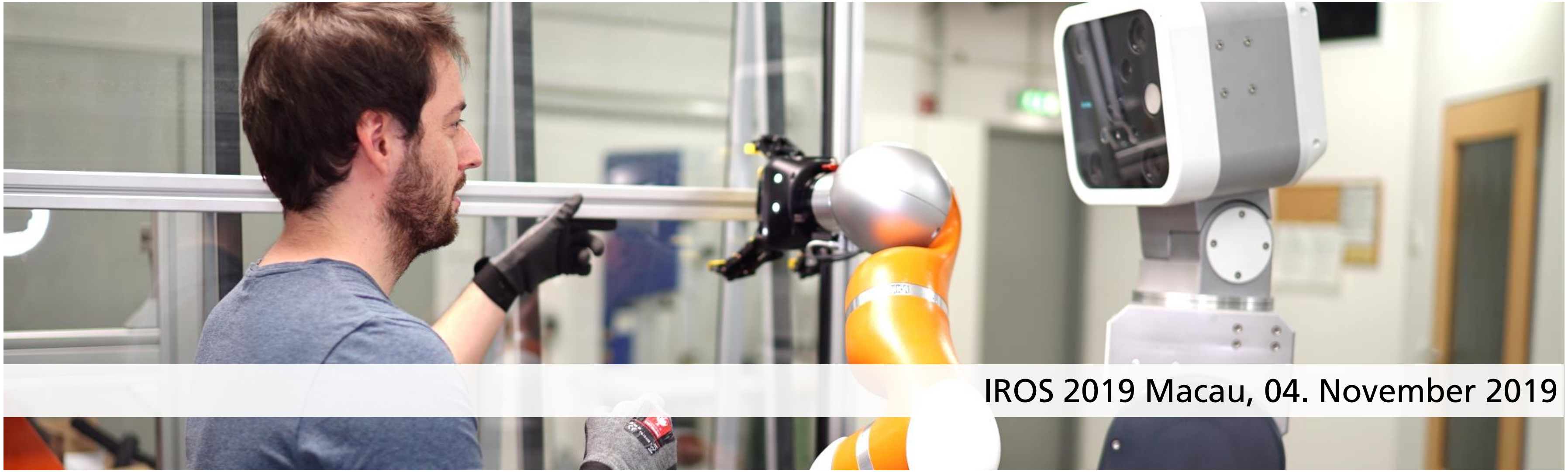

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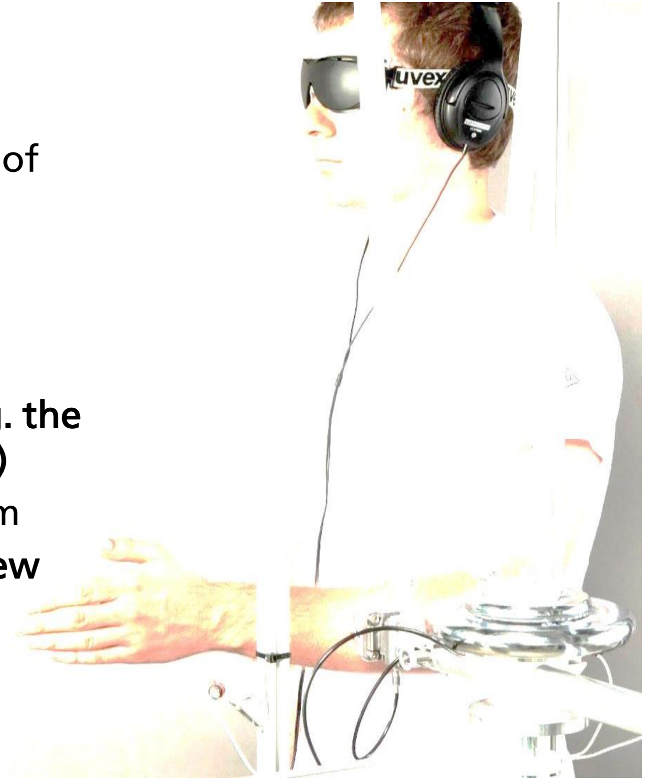
Safe Human Robot Collaboration

Today's standards regarding HRC and safety



General information on HRC standards/safety

- A Robot cannot achieve CE marking, but only a declaration of incorporation, since it is an incomplete machine

=>

- An extensive risk assessment is mandatory
- **The entire cell has to be considered, not only the robot (e.g. the processes, grippers, workpieces, sensors, system layout, etc.)**
- There not “the“ safe robot und not “the“ safe sensor system
- **Changes in application, layout, tool, workpiece require a new risk assessment**

Safe Human Robot Collaboration

Overview of safety methods as defined by ISO/TS 15066 and EN ISO 10218

Speed and Separation Monitoring

Robot stops in case a human exceed a certain safety distance (physical contact to the moving robot is not possible)

Power and Force Limiting

Physical contact between human and robot is allowed (risk reduction due to biomechanical limit values)

Not in the focus today

Safety-rated monitored stop

Robot stops in the moment a person steps into the collaborative space and stay in this condition after the person leaves

Hand-guiding

Robot follow the motion commands of its operator given by a hand-guiding device (which is usually mounted close to the robot tool)

Simplifying the Realization of Safe HRC Applications

Experiences in implementing Human-robot-collaboration (HRC) applications

- high engineering effort for planning and installation (including CE process)
- high safety requirements (also considering the foreseeable misuse by the worker)
- Risk assessment validation with the robot application very extensive (use of biofidelic measuring device for collision tests with the robot in case of power and force limiting)
- Repetition/adaptation of the risk assessment in case of changes at the robot application (program, workpiece etc.)
- Autonomous robots: consideration/test/measurement of all eventualities not possible
- Challenge: risk assessment/CE-certification for autonomous/ intelligent (not deterministic behavior) robots

→ Approach Fraunhofer IFF

- Determination of biomechanical load limits (volunteer studies) and from that creating precisely body models for collision simulation
- Digital planning and simulation tools tailored to HRC (Computer-Aided-Safety)
- Automated safety approval (Smart Safety)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Simplifying the Realization of Safe HRC Applications

Computer-Aided-Safety: novel planning tools for HRC-applications

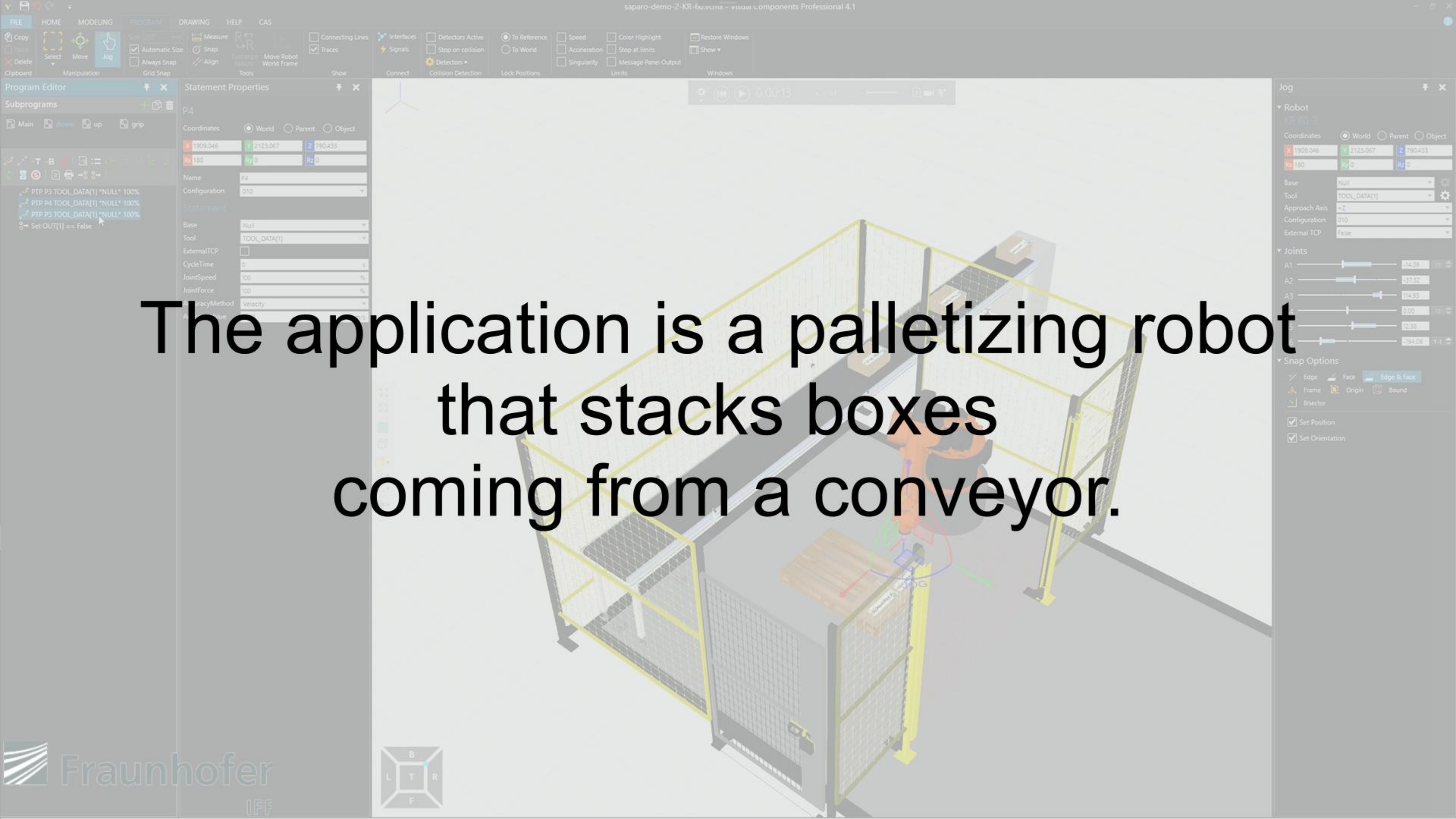
„Computer-Aided-Safety“: efficient tools for planning and developing safe Human-Robot-Collaboration

- Significant reduction of engineering effort for planning, design and installation of safe HRC applications (Computer-Aided Safety)
- Simulation of robot AND safety sensors AND plant layout, inclusion of safety standards and guidelines
  - early evaluation of key-performance indicators (cycle time, required space and investment)
  - Optimization of applications feat. HRC during the entire design phase
  - Using models and simulation data for virtual and on-site commissioning of the entire application
  - Preliminary validation of safety requirements and support of the CE certification process on-site
  - Plug-Ins for commercially available design and simulation tools

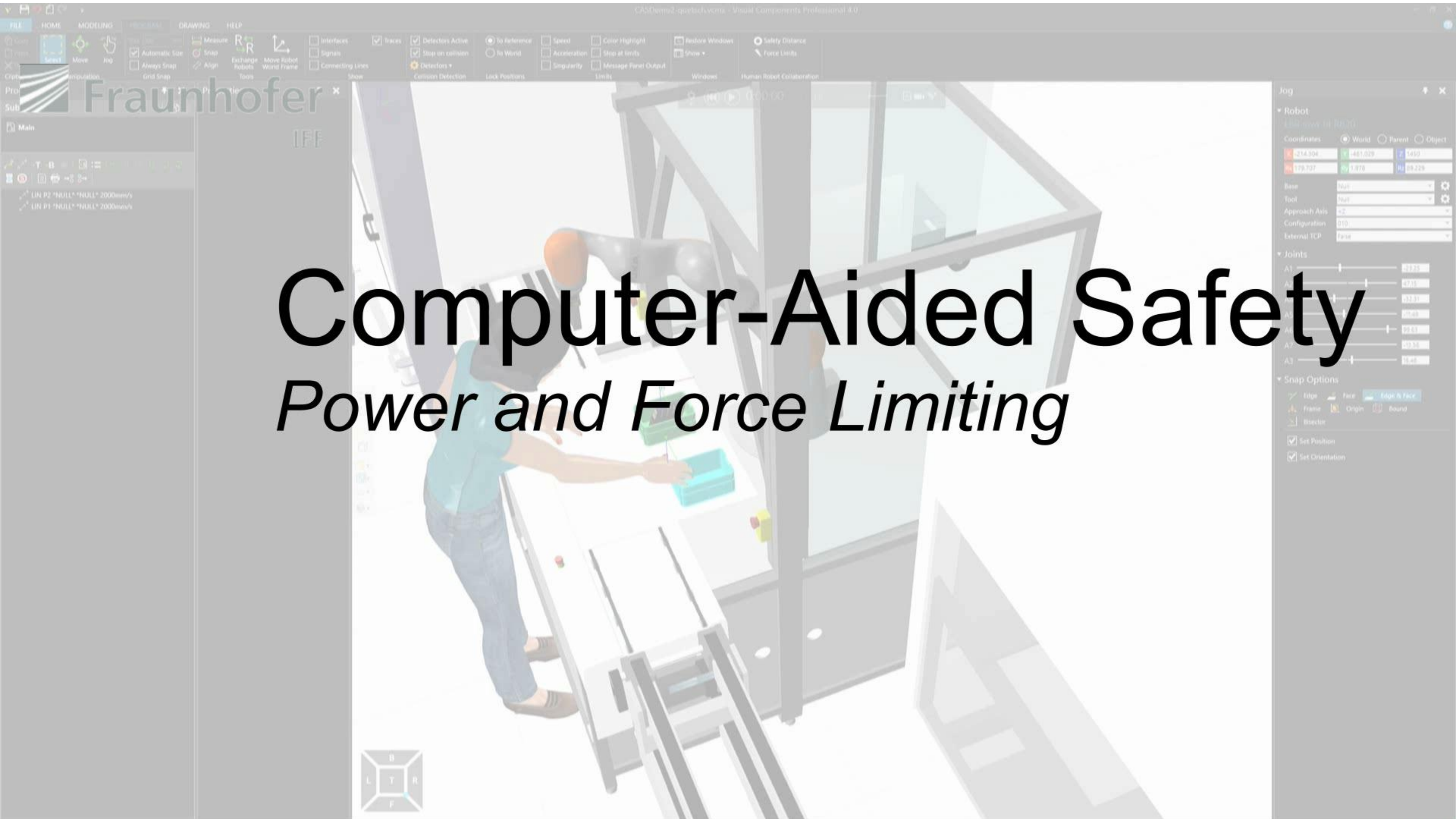
alignment of safety requirements from standards (ISO/TS 15066)

→ Approach of Fraunhofer IFF

- Providing cloud-based services for supporting the design of HRC applications
- Integrating the services into usual design tools as plug-ins



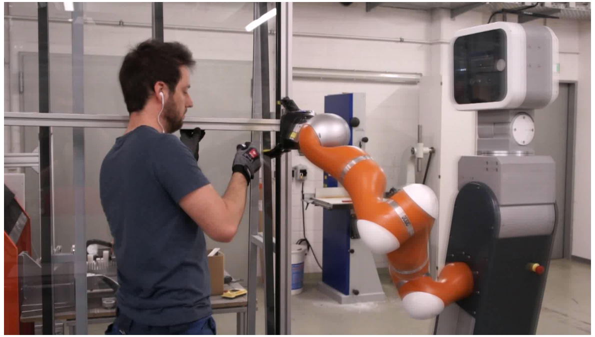
The application is a palletizing robot that stacks boxes coming from a conveyor.

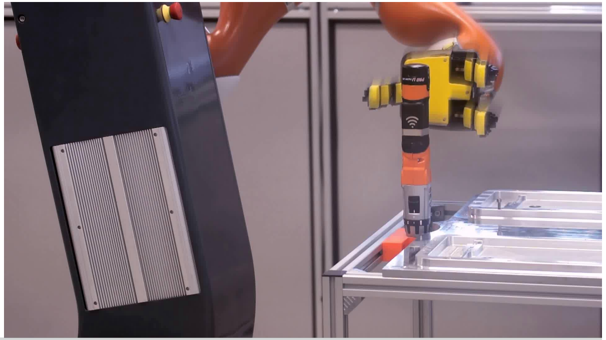


Computer-Aided Safety

Power and Force Limiting

Autonomous Robots and Human Robot Collaboration
Today's safety requirements ??



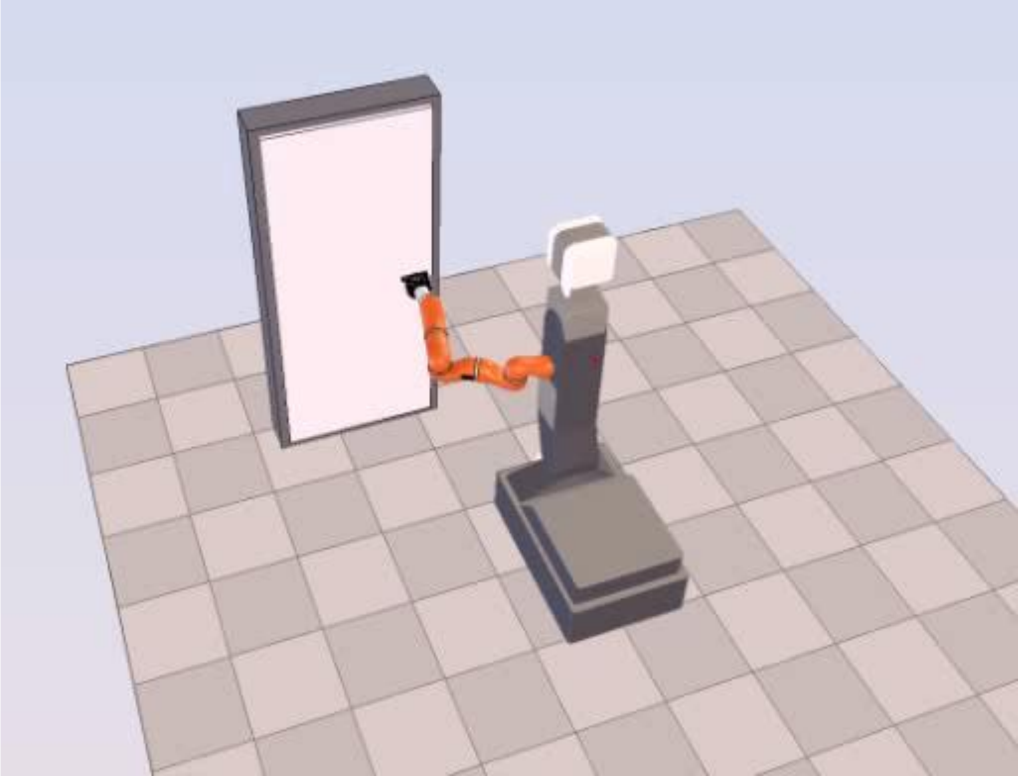


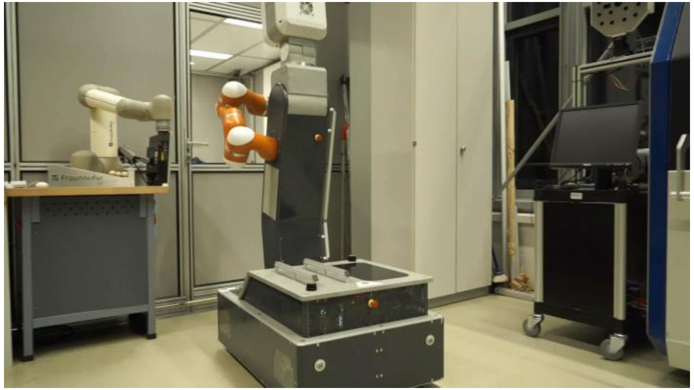
- Challenge: safety vs. autonomous robotics !!
- Autonomy:
  - ➢ Sensory perception of the environment, intelligence in perception
  - ➢ independent task planning and motion execution by the robot
  - ➢ Integration of machine learning and artificial intelligence methods/technologies
  - ➢ fault tolerant behavior / action of the autonomous robot

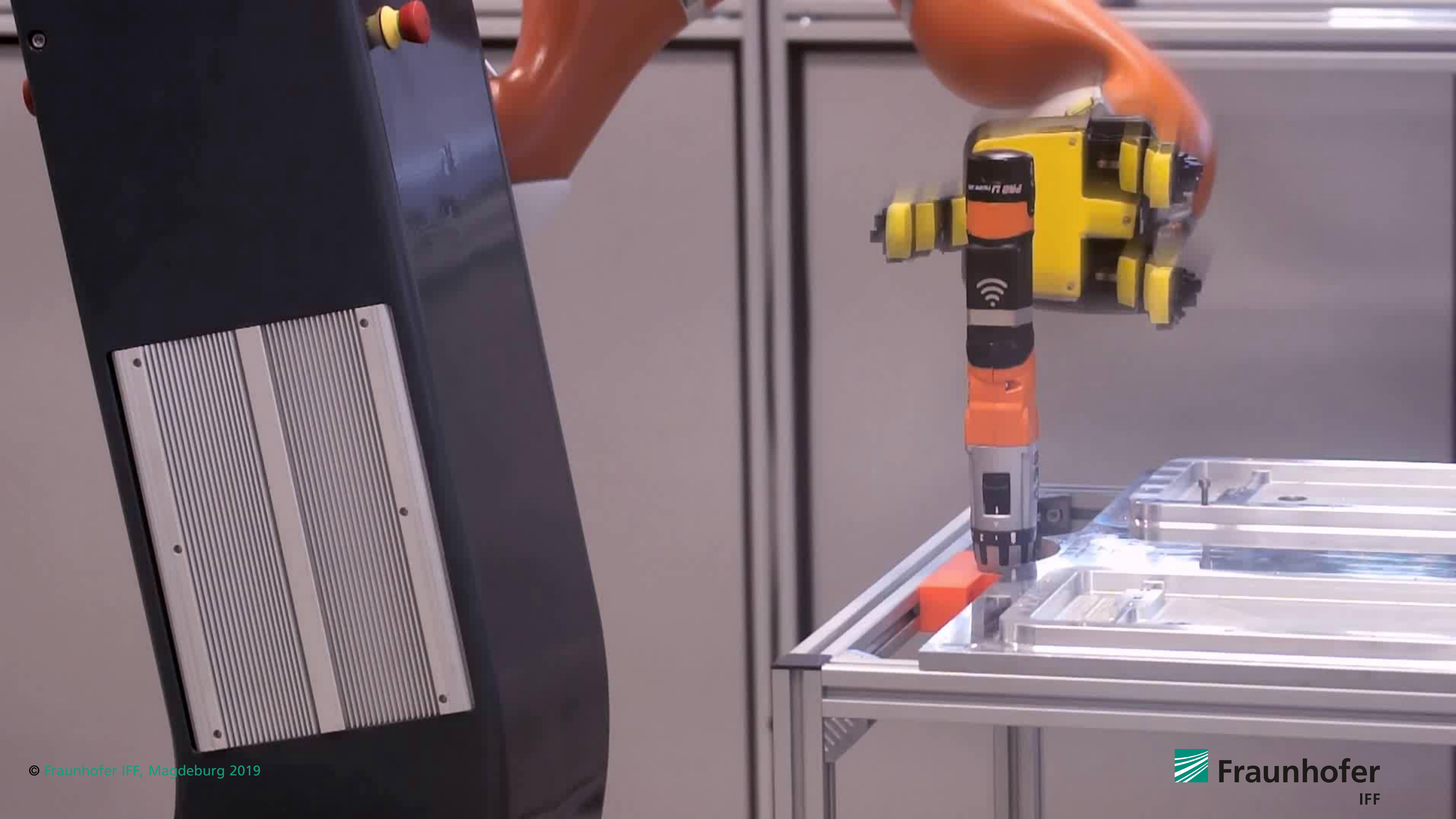
=> today’s safety approach (risk analysis, certification of robot system) usable?

Autonomous Robots and Human Robot Collaboration

Example “robot autonomy”: opening a hatch with unknown trajectory or doors







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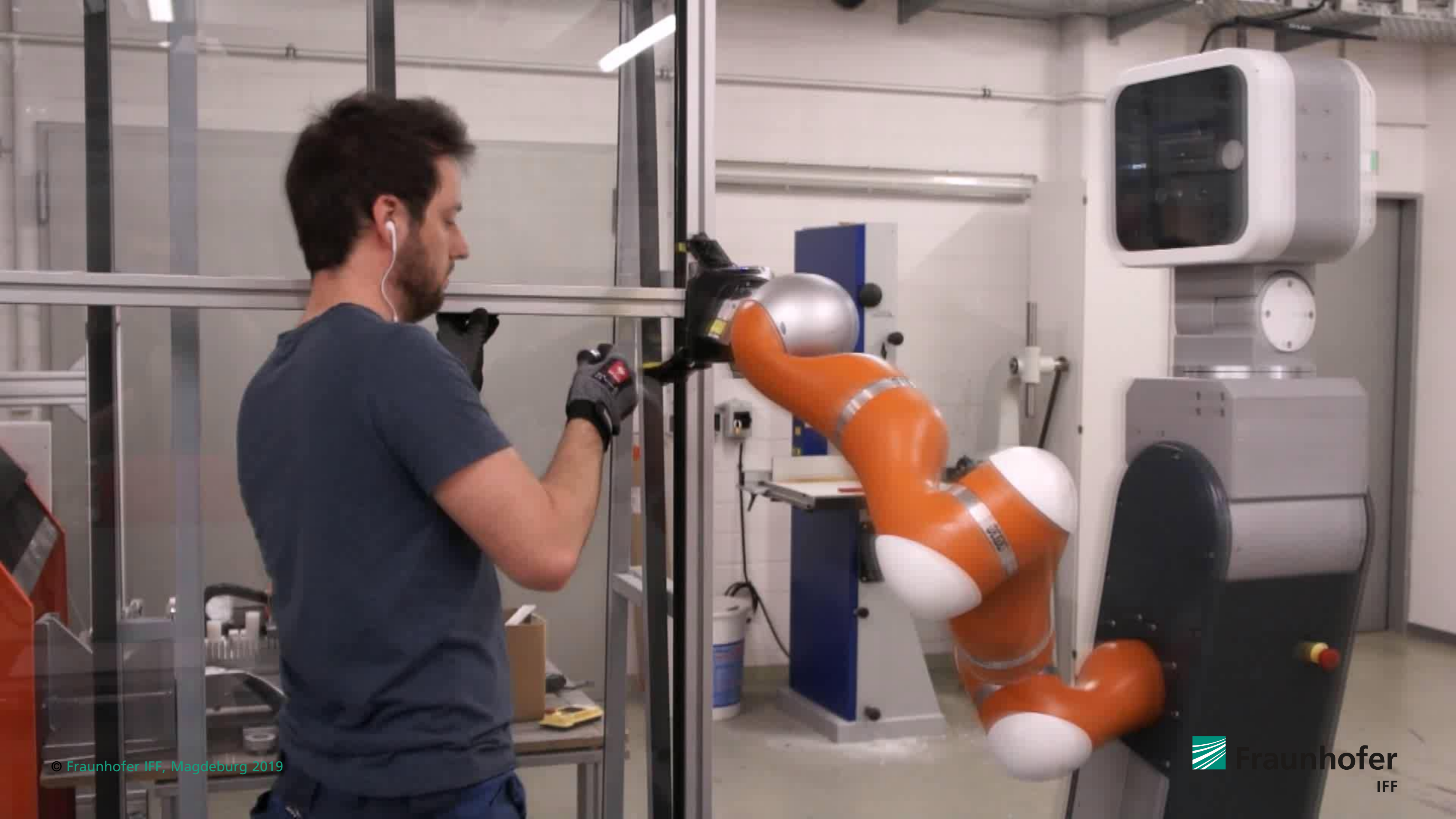
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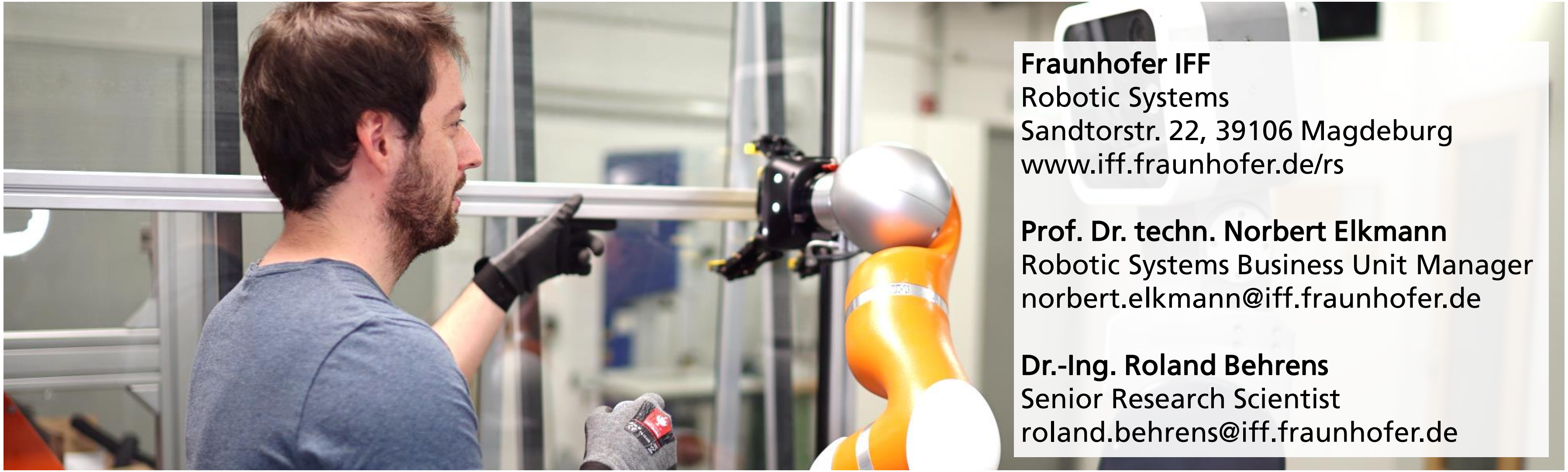

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