

# Robotics Training Day 3

*Talent Journey training*

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# Definition of a robot and classification of robots

## *Service robots*

- a programmable device with at least two degrees of freedom
- moves in its environment and performs the tasks assigned to it
- from partial autonomy to full autonomy
- performs useful tasks for humans or equipment excluding industrial automation applications
- a personal service robot performs non-commercial service tasks.
- a professional service robot is used by a trained person and performs commercial service tasks with it.
- <http://www.ifr.org/service-robots/>



## *Industrial robots*

- automatically controlled
- reprogrammable multipurpose manipulator
- programmable in three or more axes
- ISO 8373:2012



# Collaborative Robots

# Collaborative Robots

Definitely the most talked reform in the world of industrial robots and smart manufacturing at the moment!



Picture: ABB

<http://blog.robotiq.com/what-does-collaborative-robot-mean>

# Philosophy behind the collaborative robotics

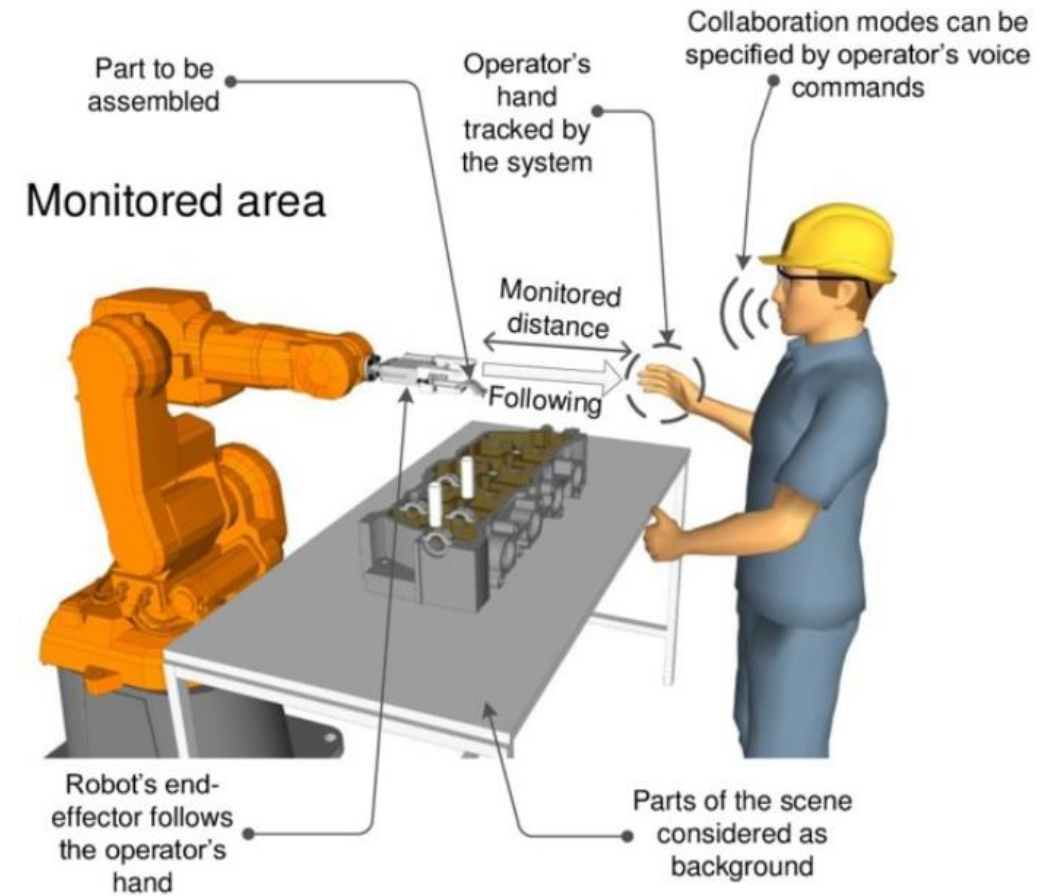
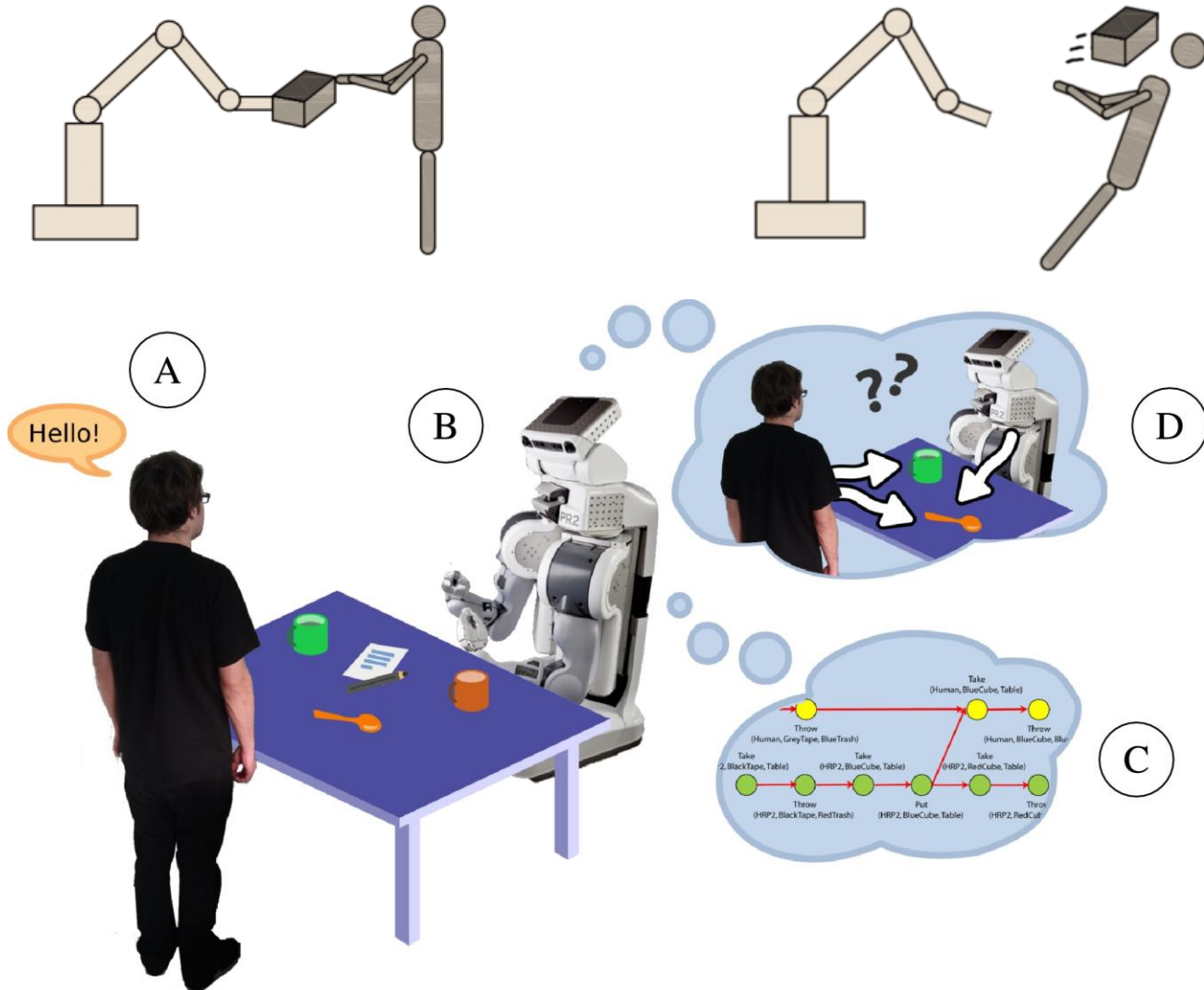
- *"Why a robot and a human could not work closely together if it is safe for a human?"*
- *"If a hit to a robot feels the same as a hit to a stationary robot feels?"*
- *"Will a touch that doesn't feel anything once or twice become painful at some point if the touch is repeated often?"*





# Human-robot collaboration (HRC)

What has it been? – What is it now? – What could it be?



# Drivers for Human Machine Collaboration

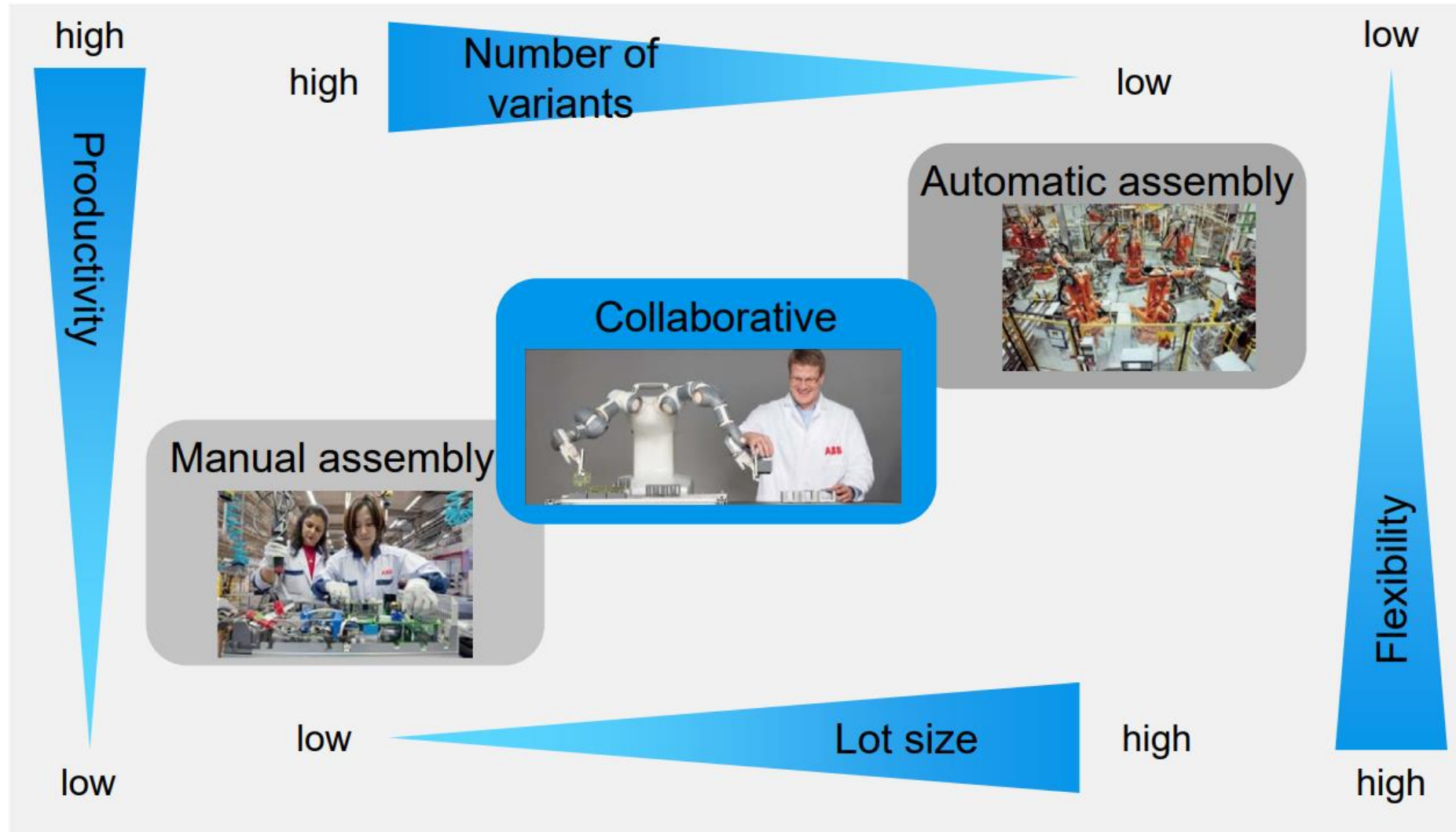
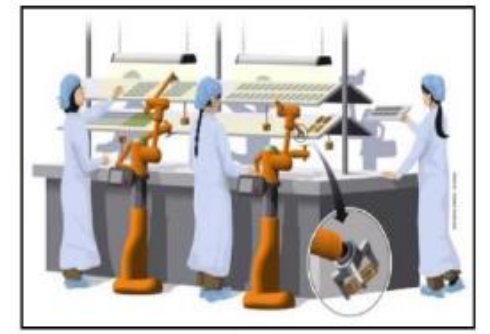
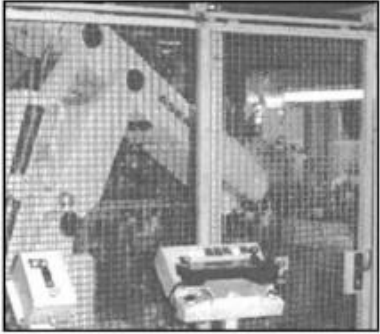


Figure from:  
Nicolas De  
Keijser, ABB  
Robotics

# HRC: Development of the safety equipment and systems



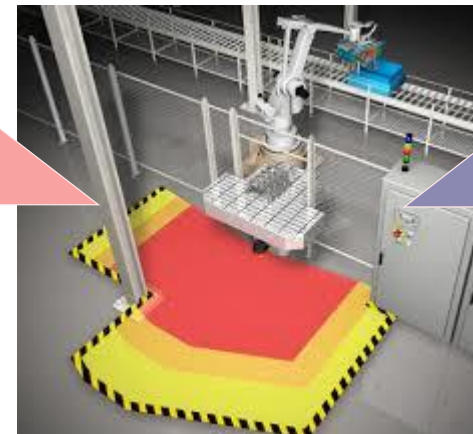
The robot is separated from the human by a safety system → no collaboration

Safety controls  
→ Limited collaboration

Harmless/safe robots  
→ Real collaboration

Applications

Technology





# Human-robot collaboration

Human, together with the robot, decides how to act at any given moment.

The purpose is to help a human do the work instead of replacing it with a robot.



## HUMAN

- Adaptable
- Creative
- Deft

## ROBOT

- Uniform
- Tireless
- Strong



# What are collaborative robots??

- Collaborative robots refer to robots that can share the same workstation with a human
- In general, a collaborative robot is an application rather than a single or a specific brand of robot
- It is also especially important to consider a tool at the end of the robot's arm that interacts with its environment on an equal footing with the robot application
- Collaborative robot = Cobot



# Collaborative robotics

- Collaborative literally means an activity where you **work together with someone for the purpose of making or creating something**
- Usually, when talking about collaborative robots, only the ways in which the robots are used in different locations are discussed, but the starting point for defining a collaborative robot is how the robot works
- Without safety fences, working among people does not make a robot a collaboration robot !!!
- There are different types of collaborative robots, but only one type can be genuinely used among humans without any external security arrangements
- Basically, there are four different techniques for implementing collaborative robotics

# Definition of collaboration

- Force and speed monitoring are the defining abilities of collaborative robots
- According to the standards defining collaborative robots, collaboration is considered:
  - Safety Monitored Stop: The robot stops if a person enters the robot's workspace and resumes automatically when the person leaves the room
  - Hand Guiding: The robot is controlled by a human
  - Speed & Separation Monitoring: The robot prevents a collision with various sensors and other safety devices
  - Power & Force Limiting with inherently safe design or control: The power and force of the robot is technically limited so small that the robot does not hurt a person when it hits a human.

Want to read more about the standards and risk assessment of collaborative robots:

<https://blog.robotiq.com/which-iso-standards-are-made-for-collaborative-robots>



# Safety factors of collaborative robots

- Enabling technologies:
  - Force feedback
  - Low-inertia servomotors
  - Elastic actuators
  - Collision detection
- More compact compared to traditional industrial robots
- Safety increasing features:
  - Lightweight frames with soft, rounded edges
  - Minimized pinch points



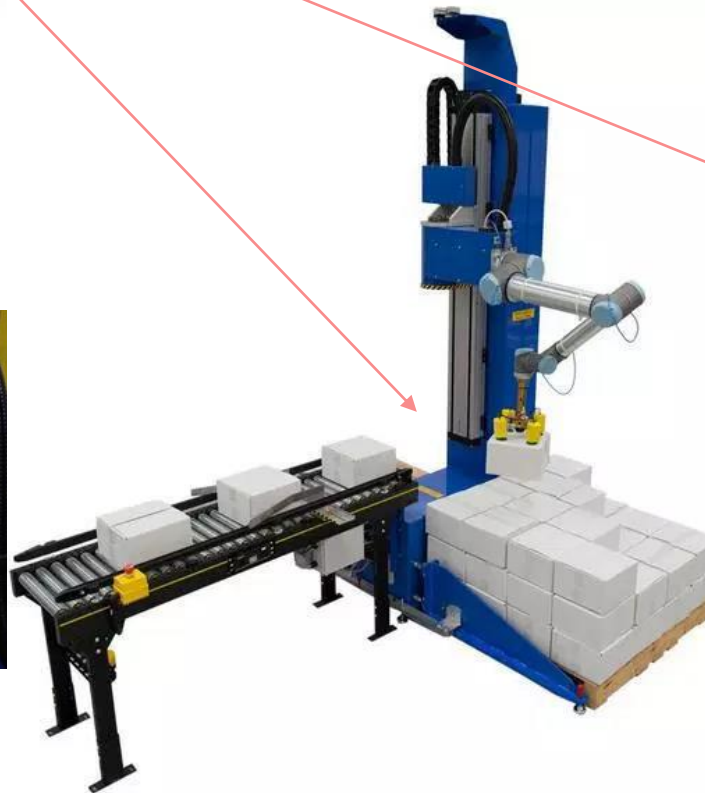
# The benefits of collaborative robots

- Flexible
- Easy to use
- Light weight
- Inexpensive compared to traditional industrial robots
- Easy to set up and move
- Fits in a small space
- Make HRC safer
- Do not require any special programming skills
- Tireless extra hands that are easy to deploy



# Tasks suitable for collaborative robots

- Packaging
- Loading boxes on pallets
- Machine service / Filling machines
- Pick-and-place applications
- Installation work
- Quality control work





# Implementation of collaboration

The best way to implement collaboration is determined:

- Based on the process
- Based on the size of the robot
- Based on the size of the parts
- Based on the risk assessment

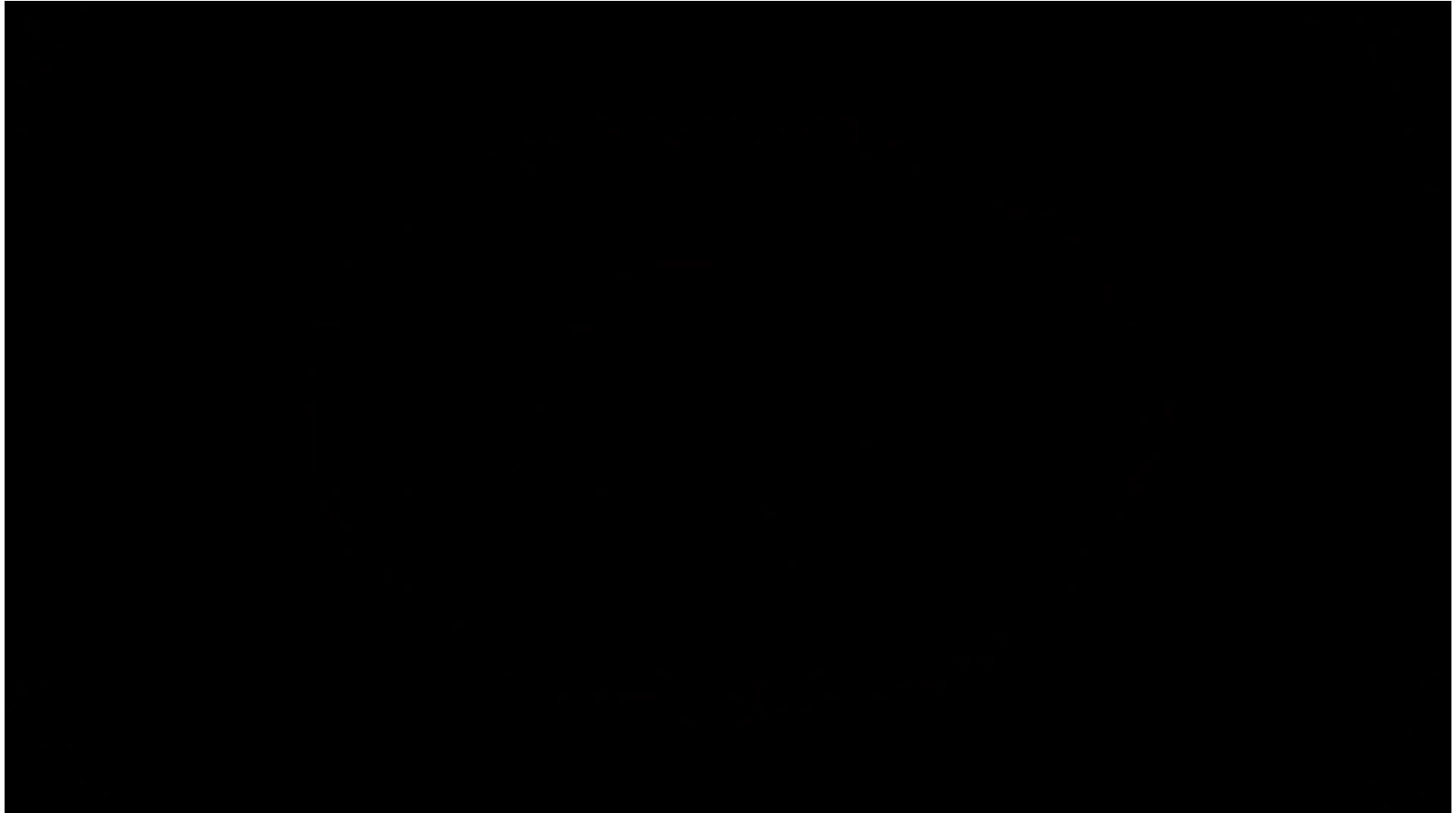


A collaborative robot telling about its job:

<https://youtu.be/UvUpWvR1svs>



# Examples of collaborative robots in use



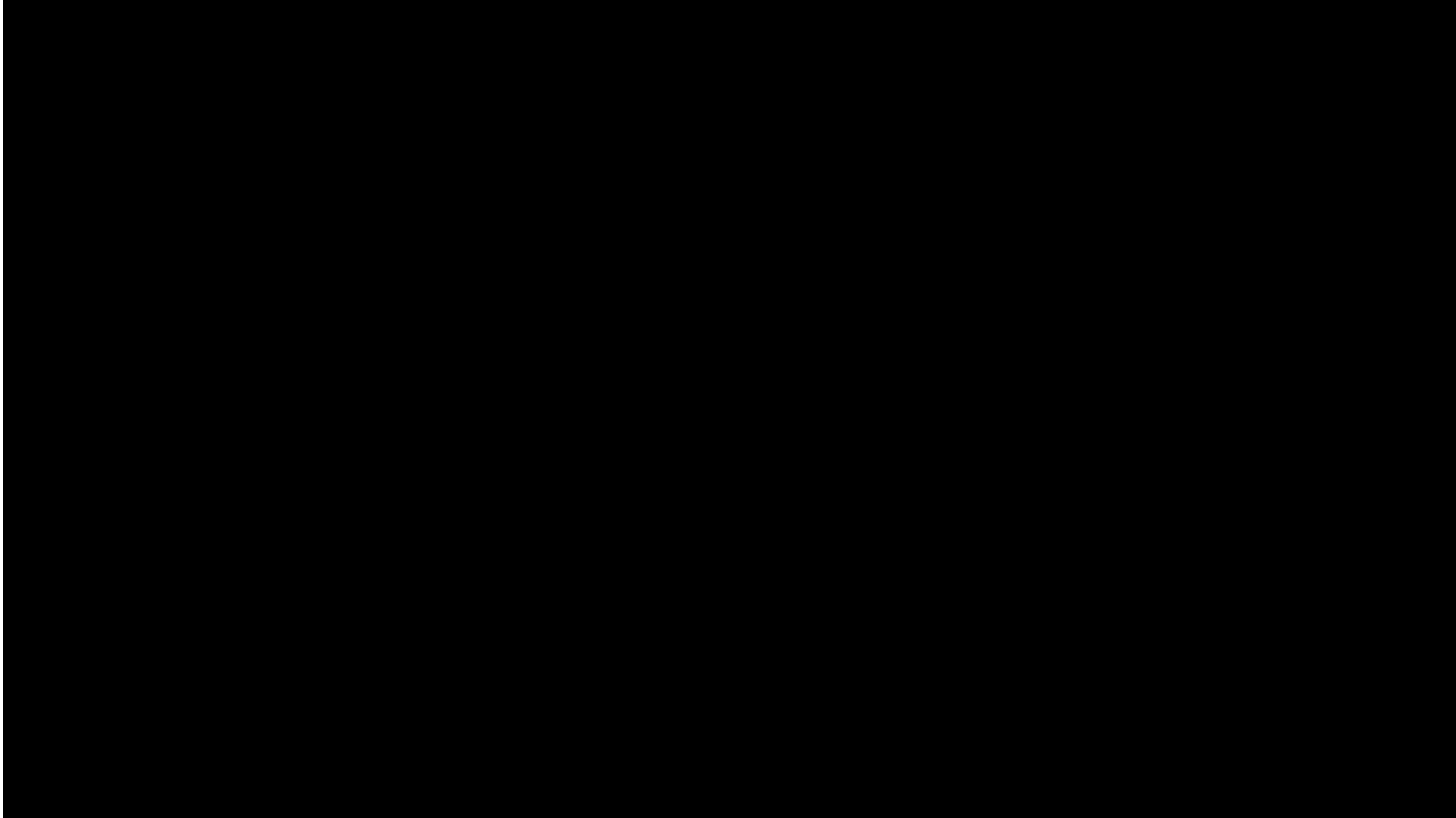
# Remote-recognition

- Capacitive “skin” on a padded arm
- Detects a person even before a collision
- Prevents co-compression and shearing



Picture: Bosch Apas

# Capacitive skin example



# Human-robot collaboration possibilities

- Requires a collaborative robot as well as safe accessories and process
- Enables natural collaboration
- Gestures and movements instead of the user interface
- Force control enables new processes





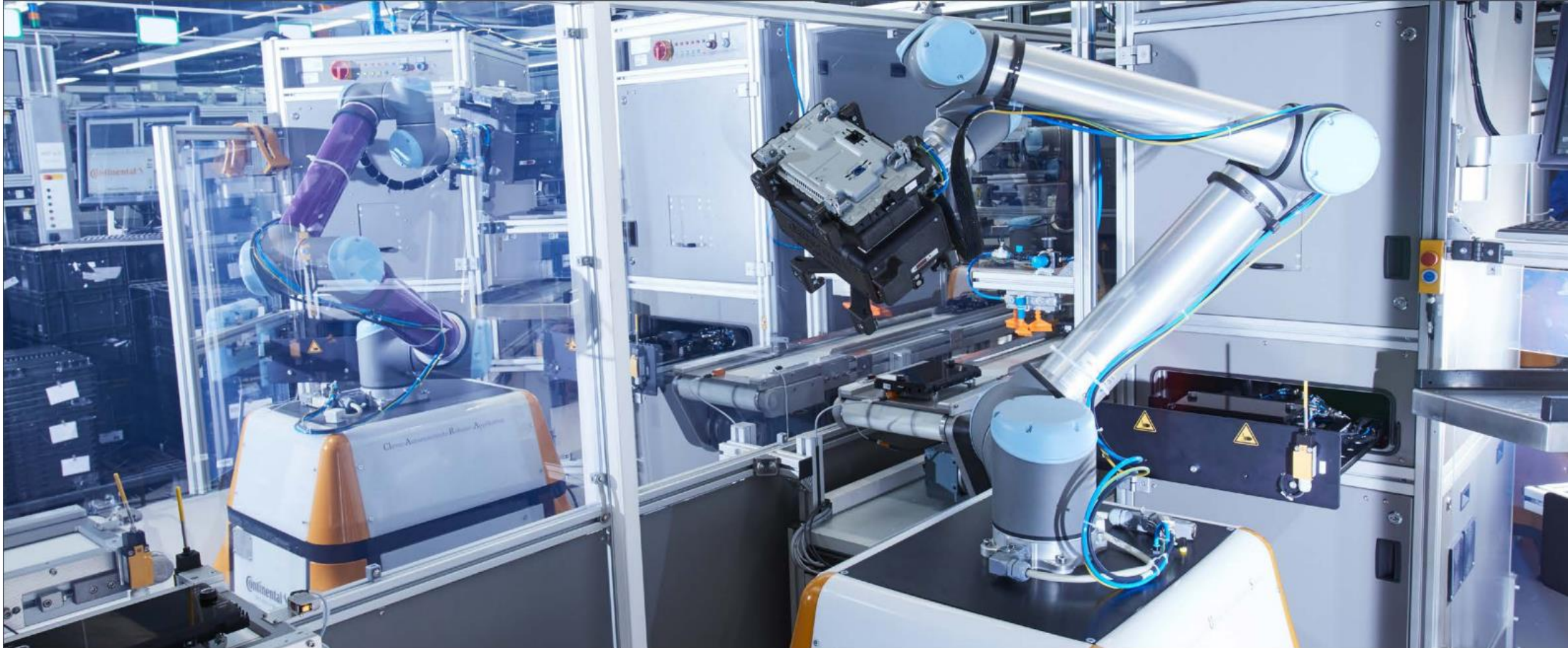
# Hazardous situations with collaborative robots

- A robot suitable for cooperation is only a part of the machine
- In principle, the robot does not even need the CE safety mark
- No safety devices are required from the robot's point of view
- However, a ready-made application always requires a risk assessment!



<https://youtu.be/7spX-PC51Ts?t=329>

# Mobile cobots Claus and Clara

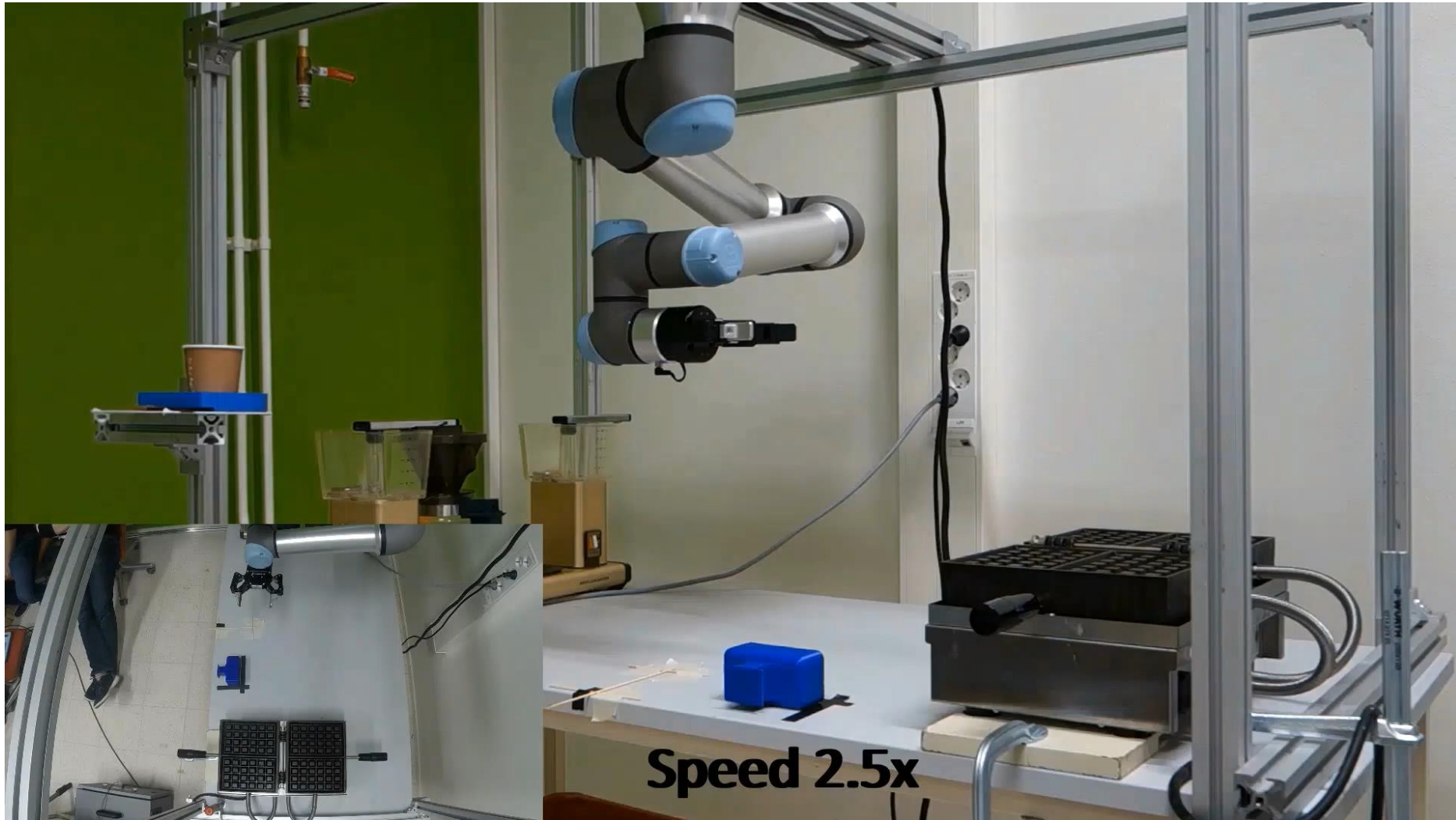


Claus and Clara act as test robots at the required workstations at Continental's automotive component plant. Claus and Clara go from one test point to another and put the parts to be tested on the test machine and take them out to the next conveyor belt. They have different safety modes that vary based on where the cameras see people going.

Source: Sick customer magazine 3/2018



# UR5 collaborative robot as a cafe worker



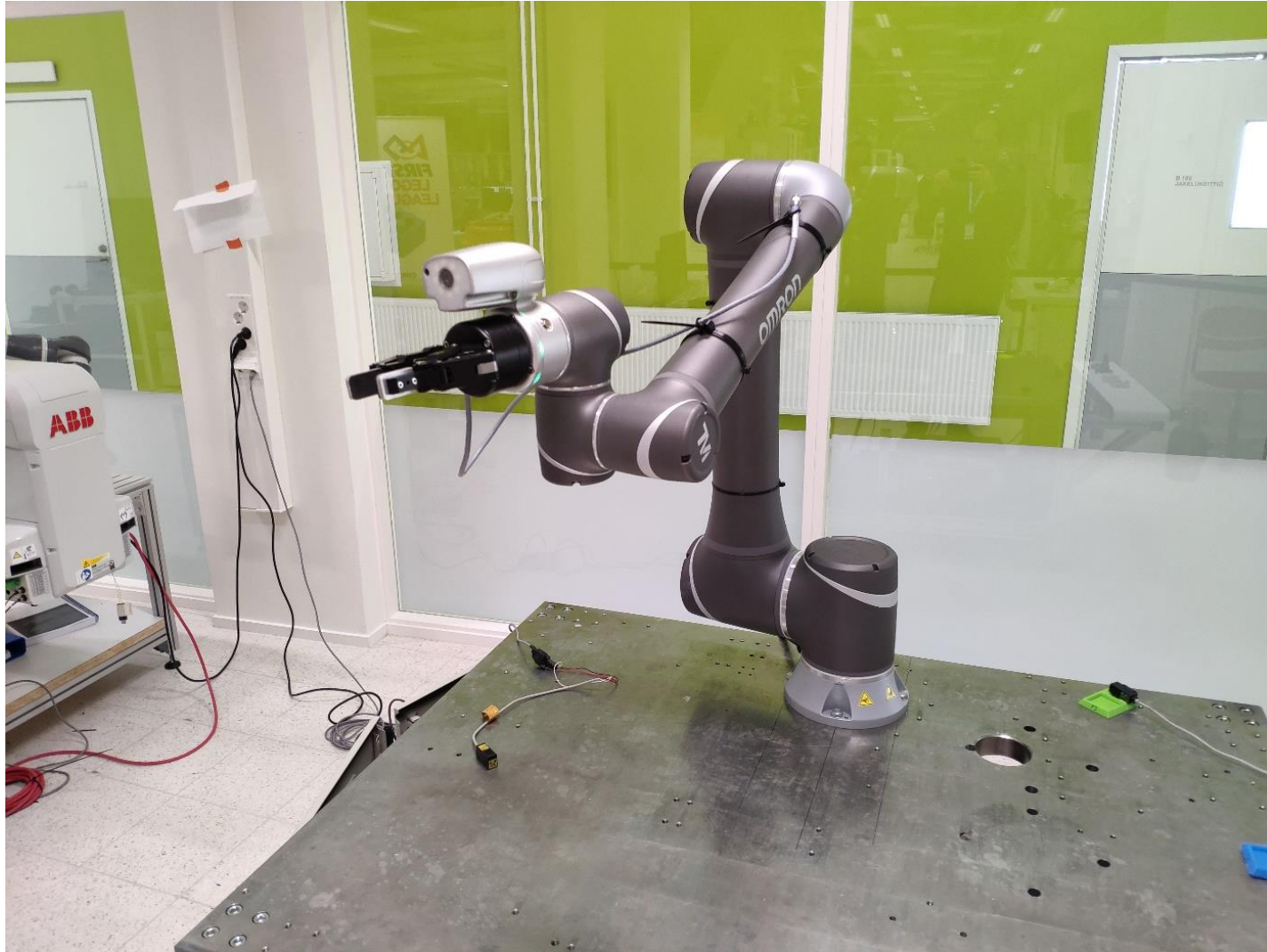
# Collaborative robots as realizers of individual orders



<https://youtu.be/RlwgEY53WbY>



# How to program a collaborative robot?



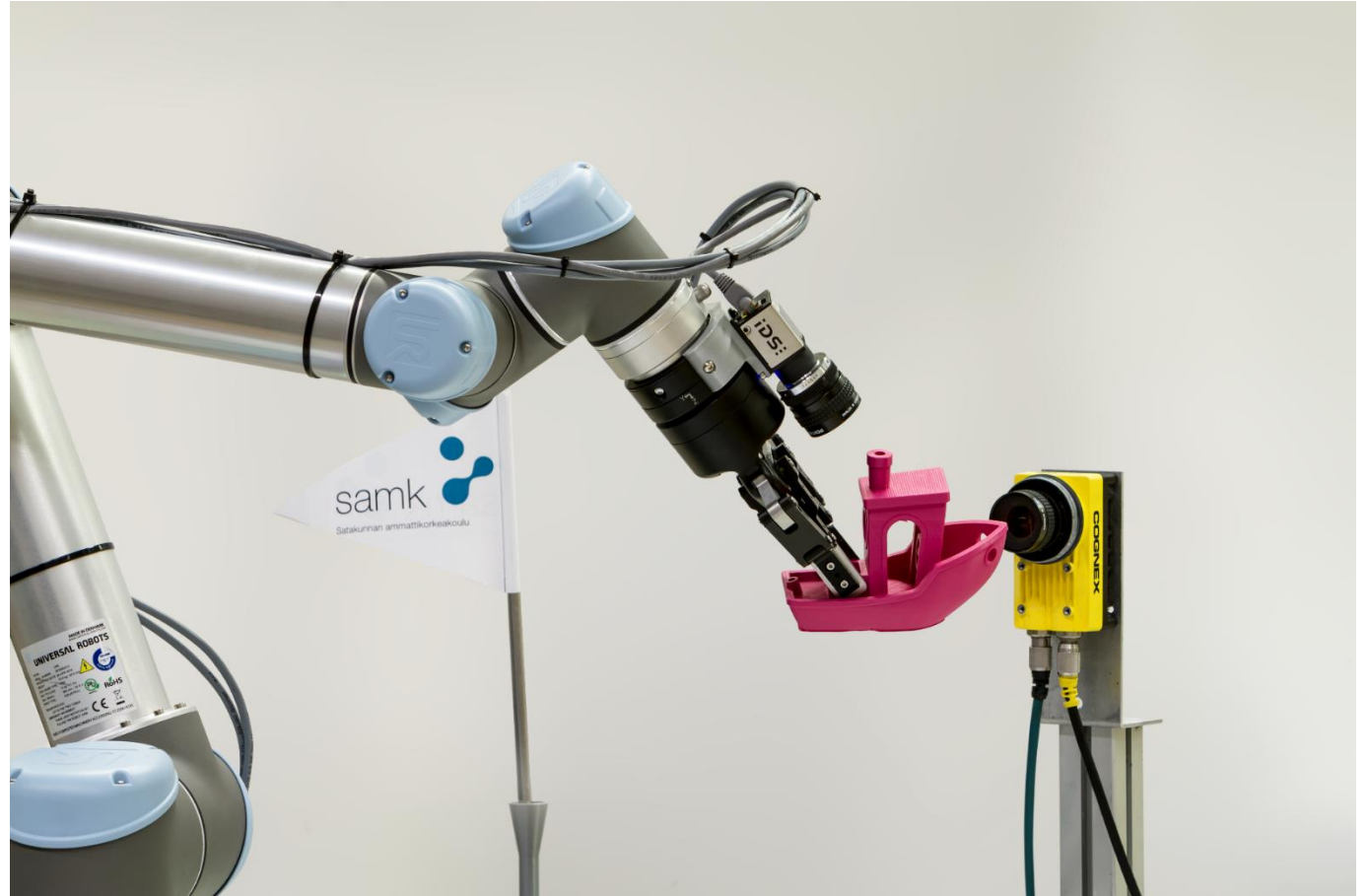
# More examples

Collaborative robot in Opel manufacturing:

<https://youtu.be/uARkiAGON9k>

Collaborative robot and machine vision in collaboration:

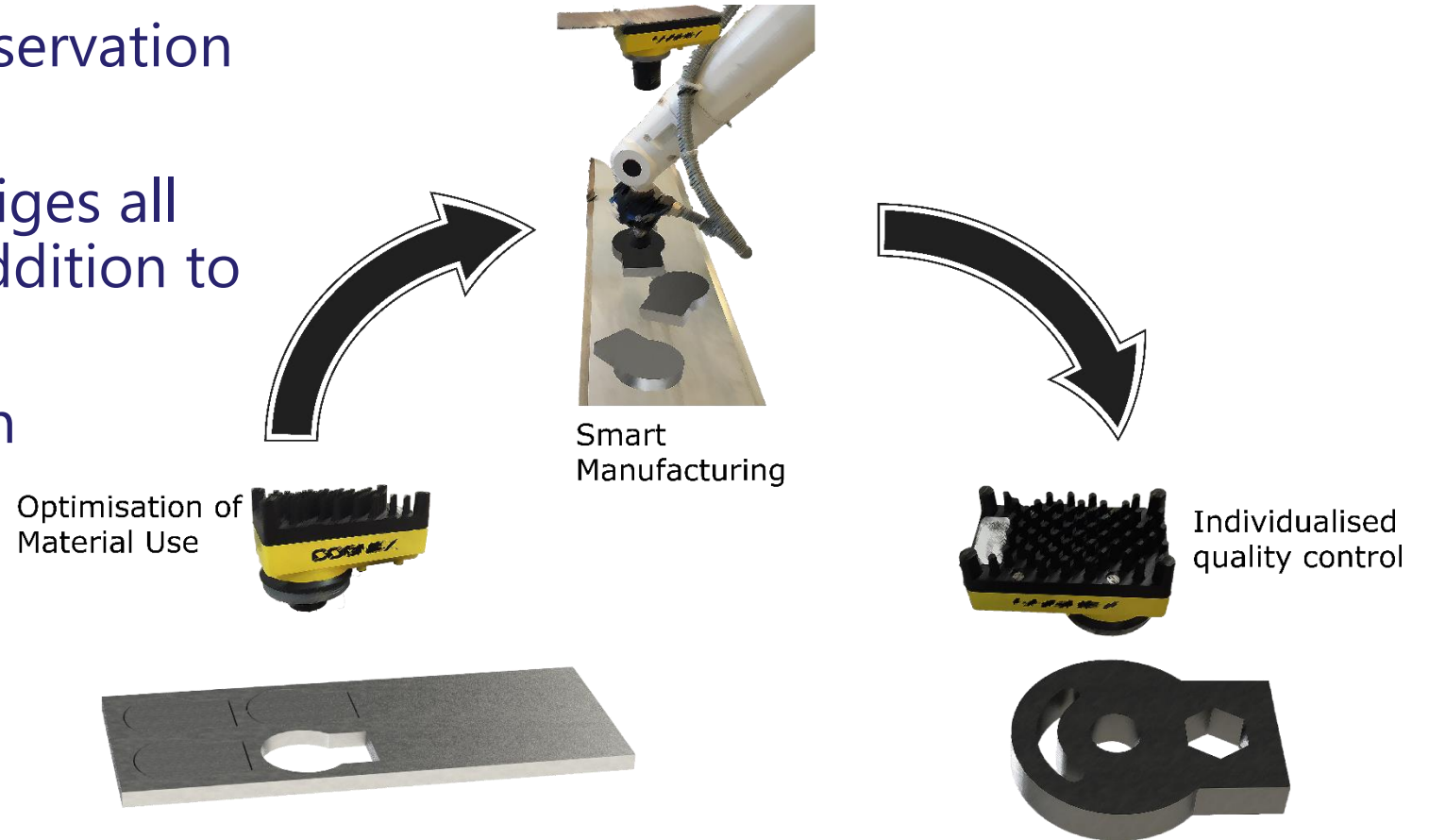
<https://youtu.be/A9gZvifS7JM>



# QA oriented robots

# Quality assurance as part of manufacturing

1. Boring and monotonous observation work
2. Quality control task that obliges all manufacturing workers in addition to their own work
3. Quality monitoring based on scheduled samples





# Quality assurance by robots

- Quality control is just the right extra job for intelligent robots
- Can repeat their tasks with the same high accuracy just as many times as needed
- Can inspect even the smallest parts
- Are able to measure even with microscopic accuracy
- Are capable of uniformity that the human eye cannot match



# Lecture assignment - List five...

- Write in the chat the five things you remember about this lecture!
- Most common topics:
  - Collaboration with humans
  - Max speed 250 mm/s in collaboration mode
  - Easy programming
  - Small size
  - Decisions always done by humans
  - Difference between service and industrial robots
  - Collaborative robot = cobot
  - Collaborative robot + mobile robot = mobile cobot
  - Sensitive skins
  - Safety mat

# Sources of information

International Federation of Robotics: <https://ifr.org/>

- IFR presents World Robotics Report 2020: <https://ifr.org/ifr-press-releases/news/record-2.7-million-robots-work-in-factories-around-the-globe>

Universal Robots: <https://www.universal-robots.com/>

- Cobots offer game changing benefits: <https://www.universal-robots.com/products/collaborative-robots-cobots-benefits/>

Manufacturing tomorrow: <https://www.manufacturingtomorrow.com/>

- 5 Ways robotics are being used in smart manufacturing: <https://www.manufacturingtomorrow.com/article/2018/05/5-ways-robotics-are-being-used-in-smart-manufacturing/11568>

# Assignment 2 for the day 4

- Prepare a **MindMap** of collaborative robots
- Write collaborative robots in the center of the image or paper
  - Think about the key features, enabling technologies, benefits, and uses of collaborative robots, and write a separate title for each of them, combined with a line of collaborative robots
  - Think again about all the things that fall under these headings again
  - Assemble at least three different levels in the mindmap
  - Return the MindMap with a brief introduction as an attachment in email to Mirka ([mirka.leino@samk.fi](mailto:mirka.leino@samk.fi)) and Mirka will share them in chat.
- Deadline: Next training session on Fri 29th January



# Example of a MindMap

