

A photograph of four men in a factory setting. Three of the men are wearing blue work coats, while the man in the center is wearing a light blue button-down shirt. They are all smiling and holding various industrial tools. The man on the left holds a metal vise. The man in the center holds a circular metal plate with multiple holes. The man on the right holds a drill bit. The background shows a factory floor with various equipment and structures.

Human-Robot Collaboration Practical Training 2017

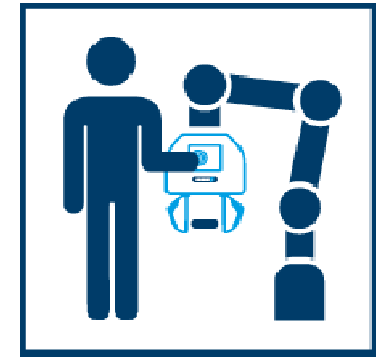
Anna Jung | Product Management Gripping Systems

Superior Clamping and Gripping



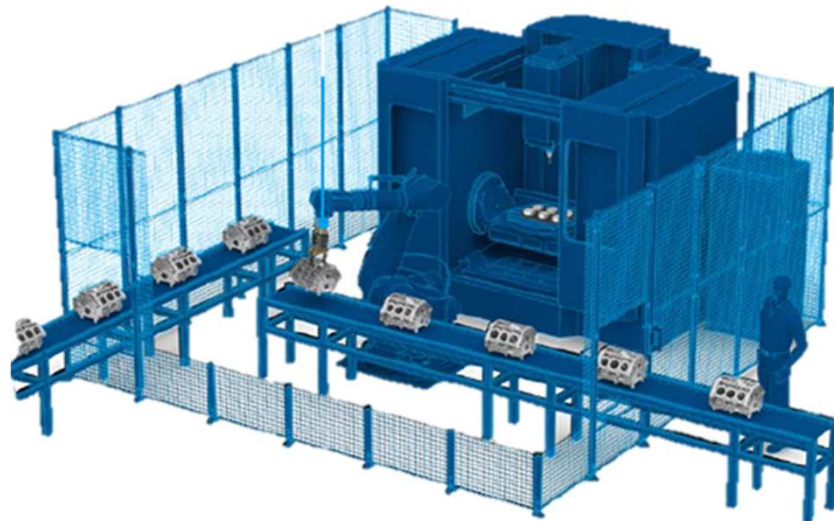
HRC Basics

From full Automation to Human-Robot-Collaboration



Definition

Interaction between an operator [human] and a robot without guards in a shared working space



Advantages

- ✓ Ergonomic benefit for employees
- ✓ Flexibility of work processes
- ✓ Increased efficiency in robot applications
- ✓ Retrofitting and more flexible logistics, loading, assembly and handling

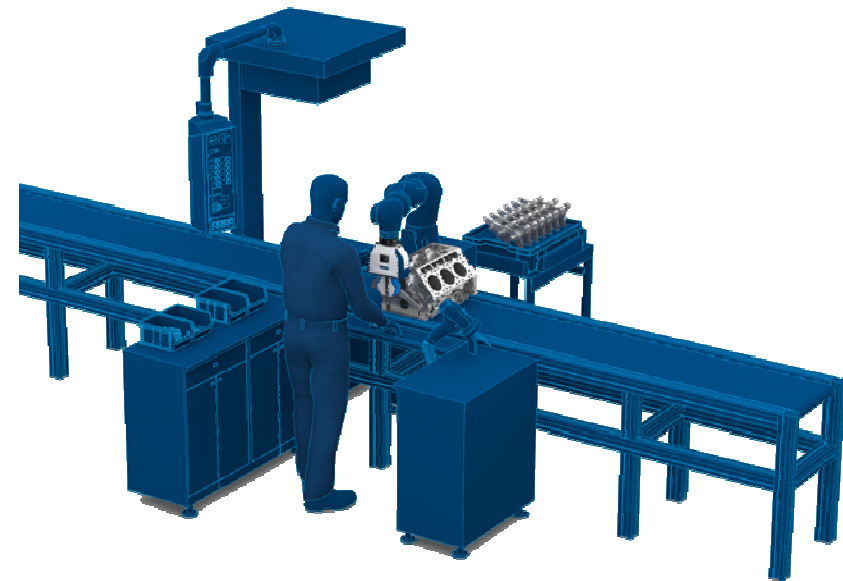
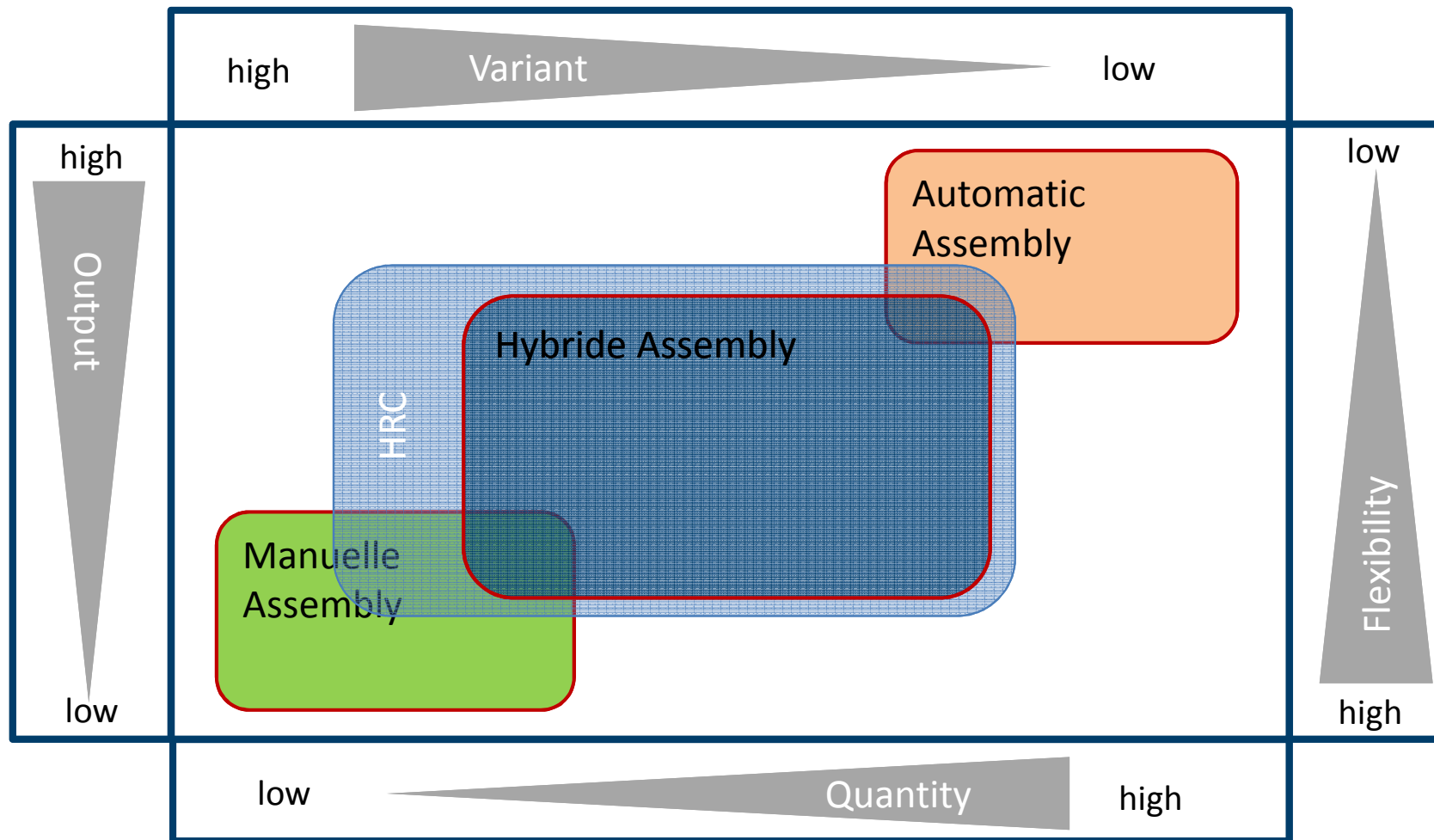


Image Sources: SCHUNK GmbH & Co. KG

Potential in industrial automation



Quelle: Fraunhofer IPA / 2017

Jobs that make sense for using direct interaction between humans and machines

Jobs with quality issues

- Activities with a high demand for reproducibility, e.g. bonding processes
- Activities/jobs with an incidence of errors (e.g. forgotten parts)
- Activities requiring documentation (e.g. screwed connections)

Jobs with ergonomic issues

- Component weights (4 kg to 12 kg) to be moved at a height or a high total load in one shift
Example: 500 g per minute is 240 kg per shift
- Application of joining forces, especially with small surfaces
- Working in ergonomically awkward positions (for example, activities performed over the head, bending over far, stooped postures)

Jobs that make sense for direct interaction between humans and machines

Workplaces with an operator capacity of more than 100%

- Through automation, plant utilization can be reduced to less than 100%, or the operator can operate several machines

But be careful!

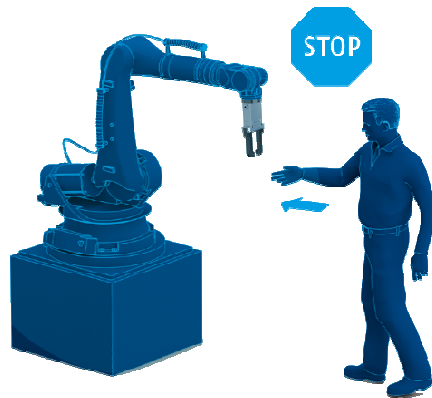
Human-robot collaboration is currently a **trending topic**, a variety of applications are being referred to as “HRC applications”.

These applications are often **easier to realize** using existing standard methods.

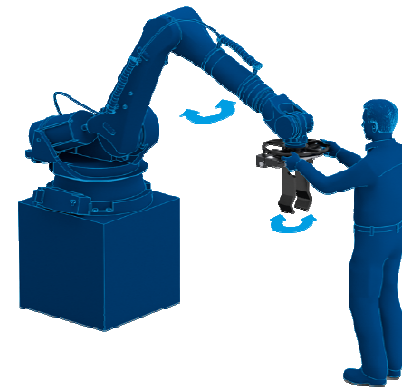
The **topic of cycle time** in particular does not apply well in the field of HRC.

→ **An open review** of “HRC Applications” **including all advantages and disadvantages!**

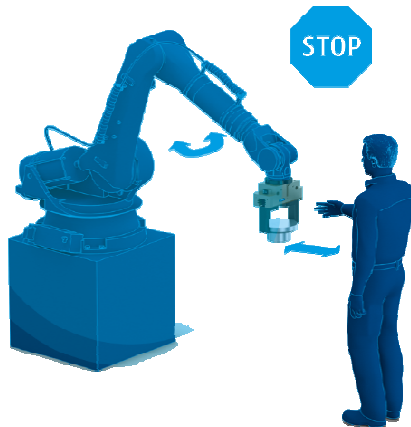
Normative classification of human-robot collaboration



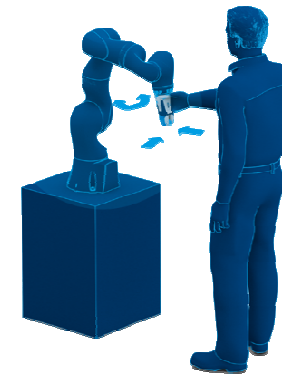
Methode 1 - Safe Hold



Methode 2 – Hand Guiding



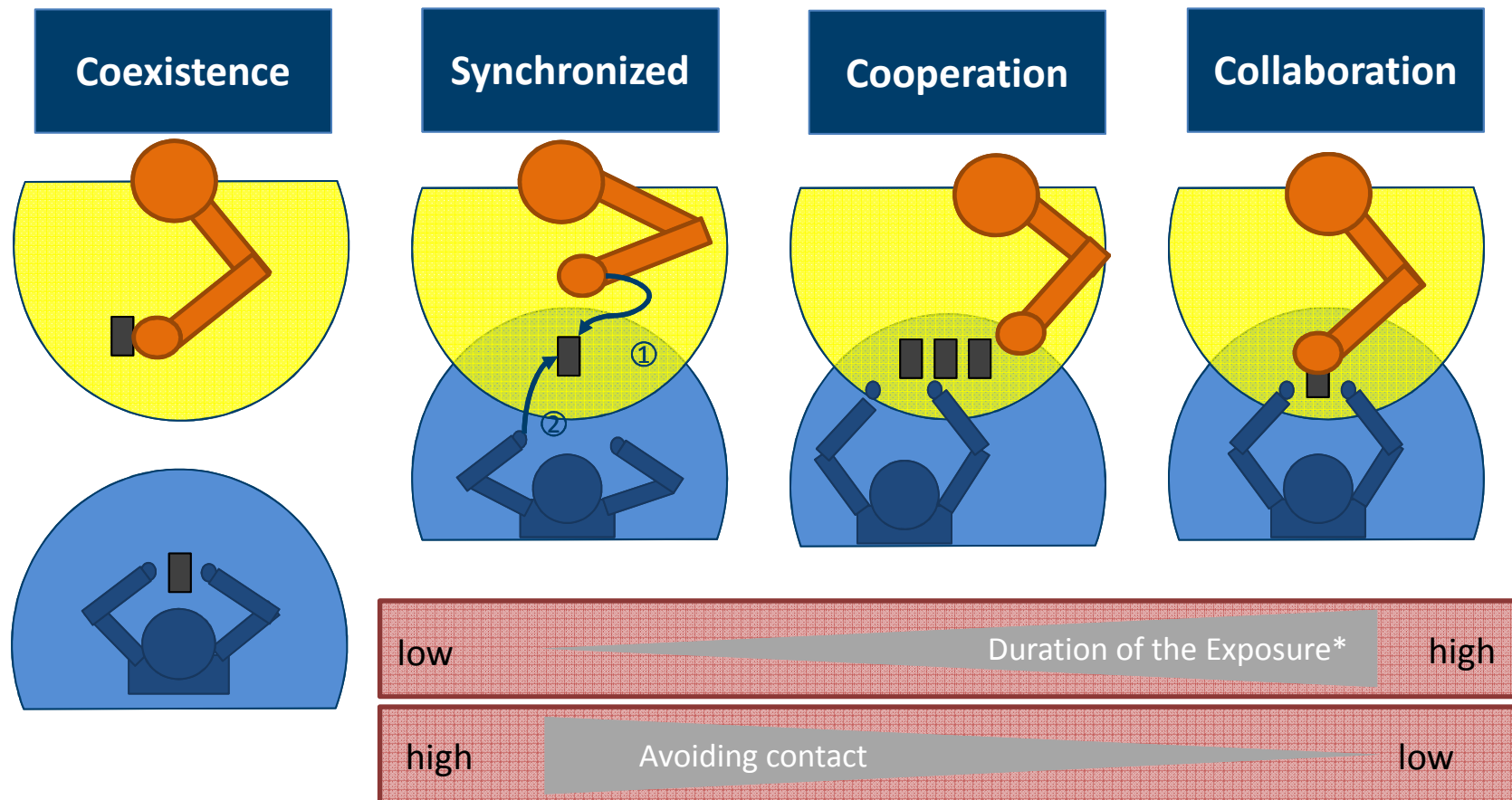
Methode 3 - Speed and Separation Monitoring



Methode 4 – Power and Force Limiting

Source: ISO/TS 15066:2016

Classification in the collaboration between human and robot

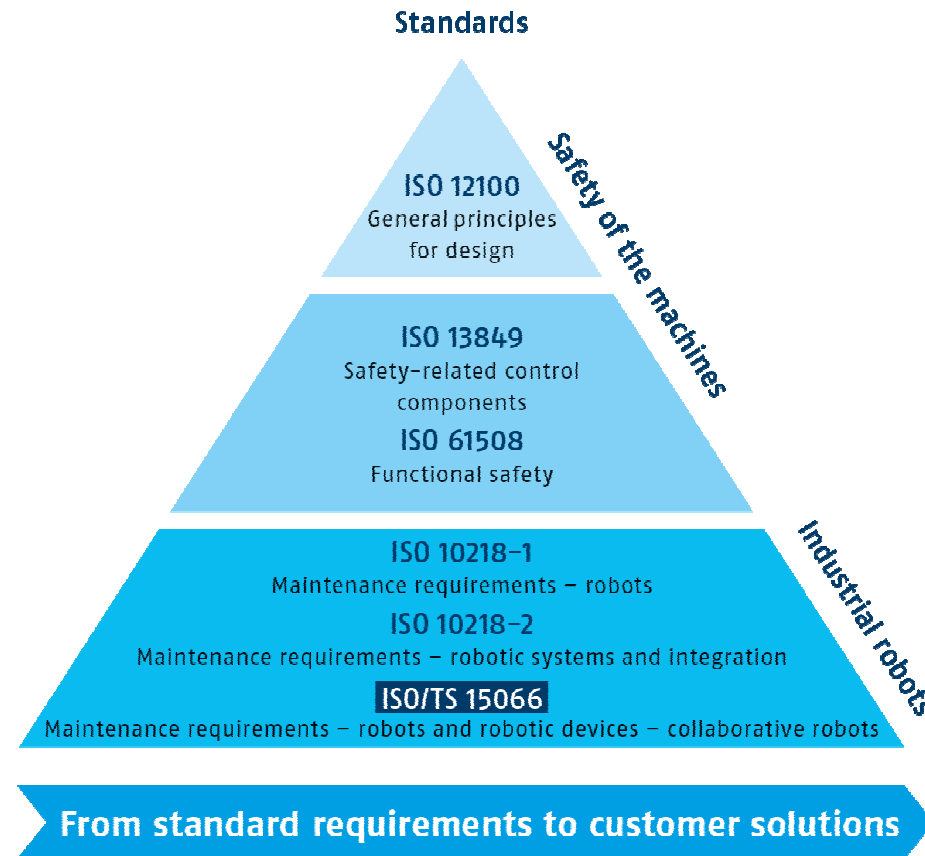


* Def. Duration of the Exposure: Length of time that the human is exposed to a hazard.

Source: Fraunhofer IAO, 2016

Standards and guidelines

In the context of human-robot collaboration



The listed standards and guidelines are not exhaustive. For every application the applicability of further standards or guidelines have to be determined.

Source: SCHUNK GmbH & Co. KG

HRC from SCHUNK point of view

Gripper safety principles for collaborative applications

Derivation of the requirements from the standards:

1. Gripper never loses a workpiece

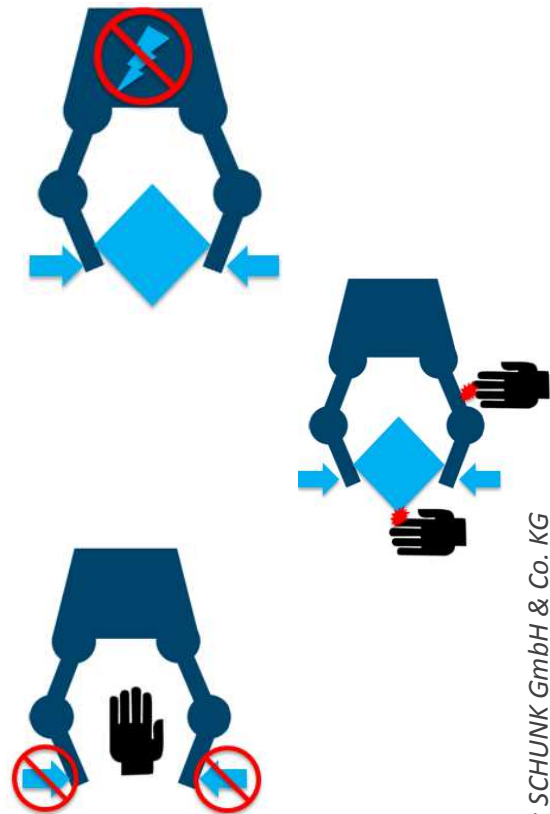
- Gripping force retention even in the case of energy loss or an emergency stop

2. Gripper always detects human contact

- Covering the gripper and gripper fingers, e.g. with capacitive sensors
- Recognition of the workpiece using prior programming

3. Gripper never cause injuries when gripping

- Limitation of the gripping force in the collaborative operation to uncritical value

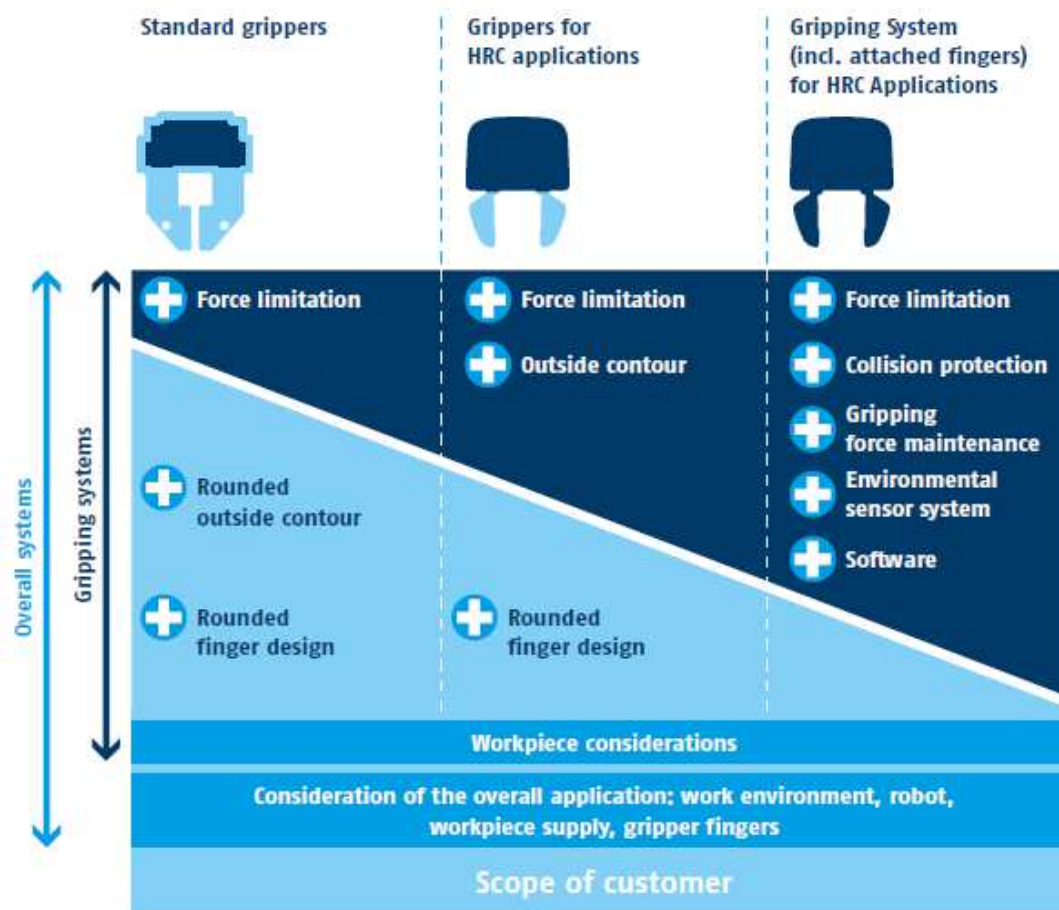


Source: SCHUNK GmbH & Co. KG

NOTE: A gripper for collaborative applications should have these safety functions implemented, but it is not a must.

Gripping technology at HRC applications

View from gripper side



Supported by SCHUNK

HRC application with gripper application



Selection of the right gripper for the application

- Co-act team for the design of the appropriate gripper for your application

Operating instructions with comprehensive information

- SAC (Safety Application Conditions) → Notes on the risk assessment, implementation of the gripper and part of the overall documentation

Support from SCHUNK Service

- Support for the implementation of the product in the robot control and commissioning of the product

Assistance with general **application advice** or with **product acceptance/ safety verification** is carried out by service providers.

Image Source: SCHUNK GmbH & Co. KG

Product selection

Gripper for collaborative applications



Step 1: Task description and feasibility study

→ Are my application/task position and the workpiece suitable for an HRC application?



Step 2: Selection of the robot or cobots

→ Definition of the basic system with mechanical and electrical connection of the peripheral devices.



Step 3: Selection of the gripper

- Selection of the gripper together with the co-act-team:
- Gripping position (at the workpiece and at the receiving and storage location), necessary gripping force, necessary stroke
 - Covering the gripper and the moving parts, avoiding clamping or shearing

Product selection

Gripper for collaborative applications

Delivery status scope of delivery

- Grippers and gripping systems are considered to be incomplete machines according to the Machine Directive
- Construction of the collision protection sleeve is carried out according to BG/BGIA

Indication of the gripping force

- Observe the technical data with regard to max./min. gripping forces
- View of the impulse forces during gripping movements (4 times for approx. 50 ms)
- Gripping forces apply at operating pressure and nominal voltage → safe limitation required!
- Considering workpiece loss through loss of the gripping force in the risk assessment

Actuation

- Ensuring a defined control (valves or grippers)

Product selection

Gripper for collaborative applications



Finger design

- Top jaws must be provided with radii, also in the Z direction
 - Please note the outer contour as well as the contour direction of the workpiece
- The top jaws have a great influence on suitability for HRC!
- The top jaws must also be assessed and observed in the risk assessment and the force/pressure measurement!



Image Source: SCHUNK GmbH & Co. KG

PORTFOLIO

Prototyp

co-act JL1
gripper



Modifications 2017

- Slimer housing
- Bigger display
- Modified tactile Electronic



Touchscreen

Enables communication with the gripper as well as teaching or switching to various operating modes



Capacitive Sensor System

To avoid collision situations due to early detection



Camera

Mounted between the fingers, for detecting the surroundings, differentiating and searching for objects



Parallel and Angular Grips

Two types of grips for gripping any geometries



Optical Feedback

Through the use of LED lights, the Co-act Gripper JL1 provides information to the operator about the status of the gripper and identification of the workpieces



Tactile Sensor System

For in time detection and differentiation of workpieces and humans



Bildquelle: SCHUNK GmbH & Co. KG

Co-act customer-specific gripping solutions

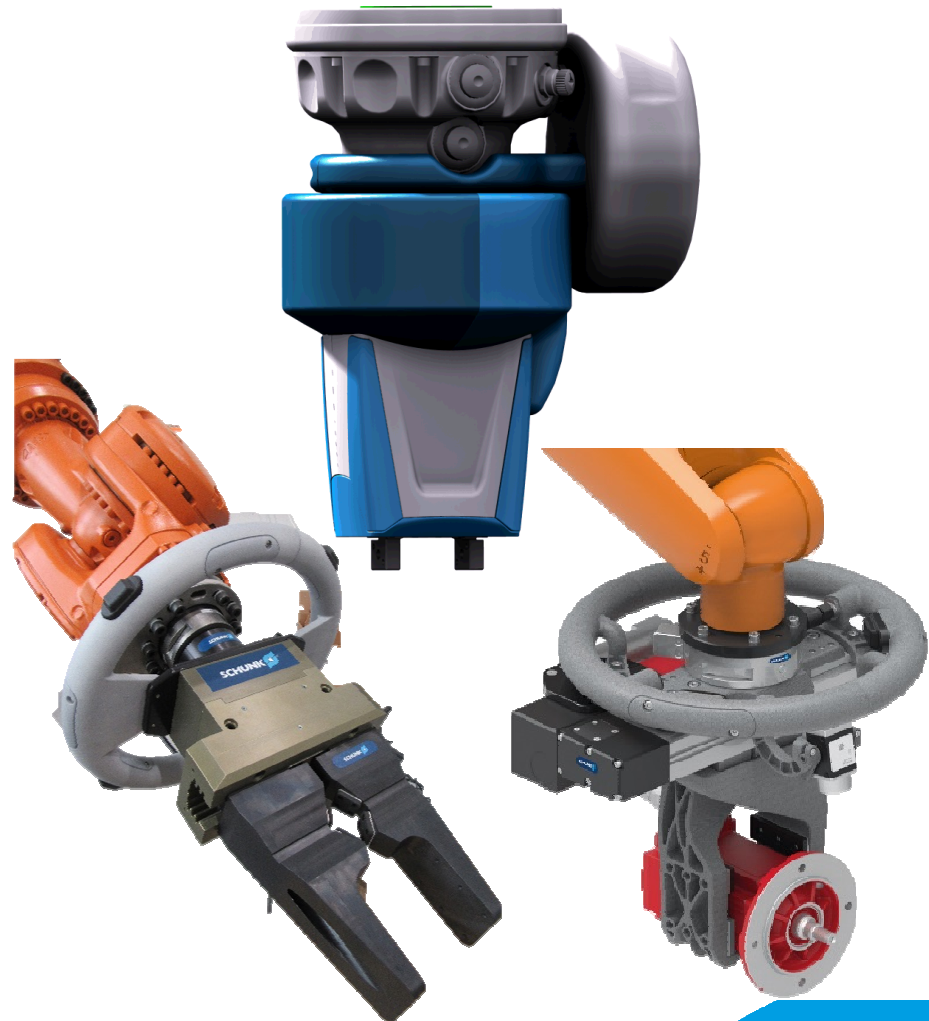
... compatible with your respective type of robot

Various grippers have already been developed for collaborative applications and various robot types

SCHUNK Gripper:

JGP, PGN-plus, EGA, WSG, MPG-plus

... compatible with your respective type of robot!



Picture source: SCHUNK GmbH & Co. KG

Co-act customer-specific Gripper solutions

Task: reaching of welding workpieces



Function – Manual guidance:

Gripping process will only be made after a two hand release of the operator

Objective target:

Ergonomic improvements

Picture source: SCHUNK GmbH & Co. KG

Co-act customer-specific Gripper solutions

Task: assembly / handling

Products in use:

- Electrical, intelligent gripper
- Distance and color sensors

Application:

Gripping of large workpieces with small weight or high variance of parts

Advantages:

Simple mechanical integration at the robot ,
a compact unit of sensor and gripper.



Picture source: SCHUNK GmbH & Co. KG

Co-act customer-specific Gripper solutions

Task: Assembly- Electronics sector

Products in use:

- Pneumatic grippers with integrated microvalves
- Electronic grippers with digital control
- Integrated sensor system

Application:

Gripping of small workpieces

Advantages:

Simple integration at electronical and mechanical interfaces of the robot.



Picture source: SCHUNK GmbH & Co. KG

Co-act EGP-C

Co-act Modular gripping system

Certified Gripper for collaborative operations– in planning

Modular gripping system

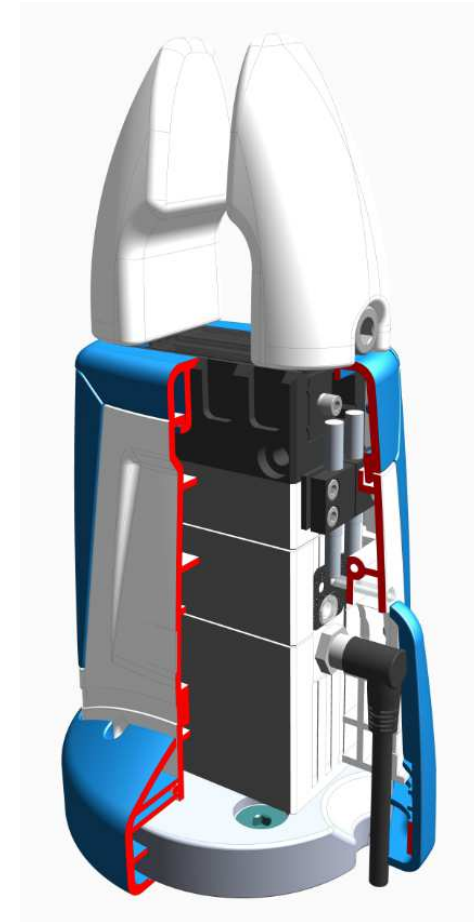
Comprehensive modular system based on three standard grippers (EGP, MPG-plus and KGG) for maximum coverage of applications.

Plug & Play of different Robots

Prepared for direct mechanical and electrical adaption, long term including program modules for simple control

Certified for collaborative operations

Simple evaluation of the risk analysis.



Source: SCHUNK GmbH & Co. KG

Co-act Modular gripping system

Certified Gripper for collaborative operations– in planning



Co-act EGP-C

- **Certified gripping** saves time and effort when carrying out the safety assessment of the overall application
- **Certification by DGUV*** for collaborative
- **Pre-assembled gripping unit with robot interface** for quick and easy integration
- **Plug & Work** with Cobots by KUKA, Fanuc and Universal Robots
- **Integrated lighting** for viewing the application's condition**
- **Service flap in collision protection** built for adjusting the integration into existing systems

				
Size 40	Weight 0.8 kg	Gripping force 140 N	Stroke per jaw 6 mm	Workpiece weight 0.7 kg

Differences of the Co-act Grippers



Special gripper for collabor. applications

- **Not certified** for collaborative operations
Customer have to assess and approve the gripper!
→ high expenditure of time
- **Pre-assembled gripping unit with robot interface**
- **No integrated status indicator**

On request



EGP for UR

- **Not certified** for collaborative operations
Customer have to assess and approve the gripper!
→ high expenditure of time
- **Pre-assembled gripping unit with robot interface**
- **Plug & Work** on Universal Robots
- **No integrated status indicator**

available



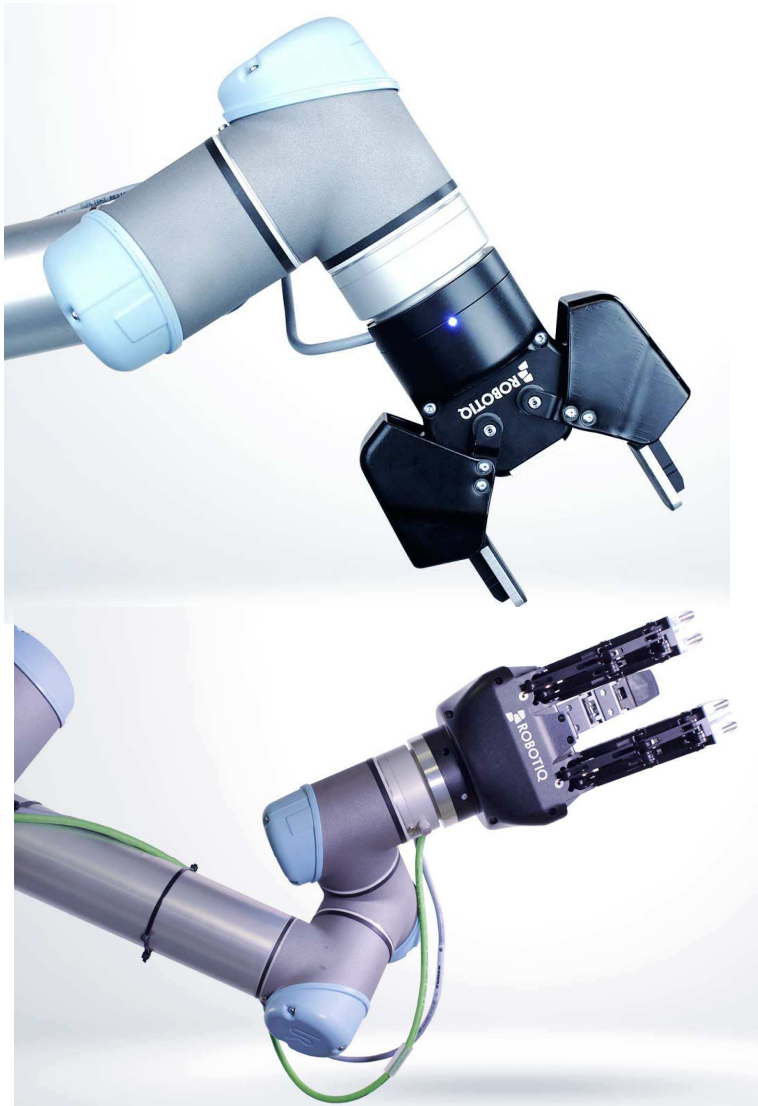
Co-act EGP-C

- **Certified by DGUV** for collaborative operations
- **Pre-assembled gripping unit with robot interface**
- **Plug & Work** on cobots from KUKA, Fanuc und Universal Robots
- **Integrated status indicator** to the visibility of the application state
- **Standard application and safety instructions** in scope of delivery

Q1 2018

COMPETITION

ROBOTIQ



Data

Gripping force	10 - 235 N
Status	available
Load	2,5-5 kg
Stroke	85/140 mm
Robot	UR 3-10
Stroke	
2-Finger	85/140 mm
3-Finger	0-155 mm
Certification	Non

<https://robotiq.com/products/2-finger-adaptive-robot-gripper>

On robot RG2/RG6



Daten

Gripping force	3-120 N
Status	available
Robot	UR
Communication	I/O Link
Stroke	0-160 mm
Load	2 kg
Certification	Non

<http://www.onrobot.com>

ZIMMER HRC-EP 01



Daten

Gripping force	<140 N, bis zu 950 N
Status	Study
Robot	6, 10, 60 mm
Communication	UR5, UR10,
Stroke	I/O Link
Load	Only of the gripping jaws

<http://www.zimmer-group.de/de/mainmenu/megamenu/col1/mrk>

APPLICATIONS

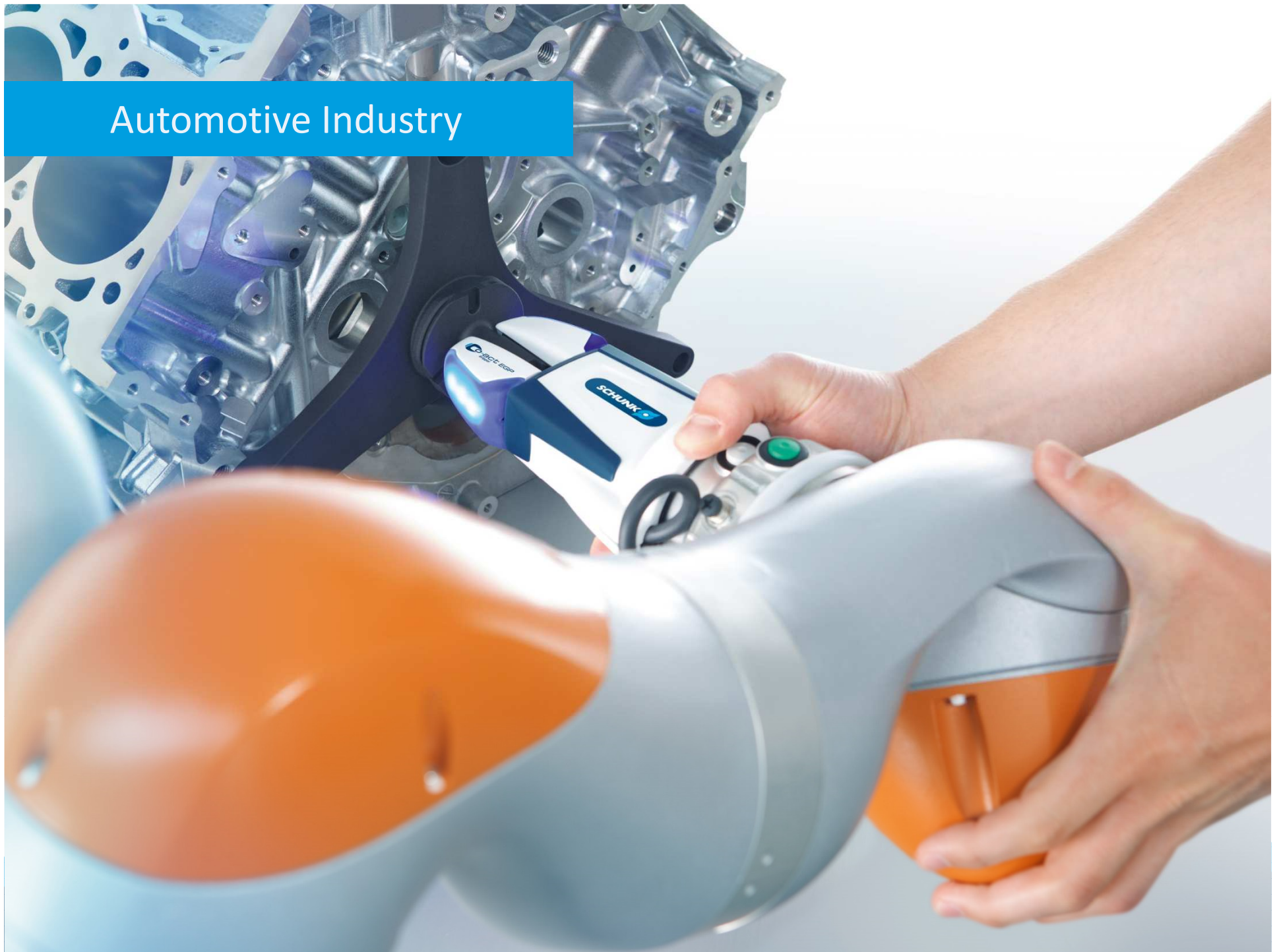
Assembly & Handling



Assembly & Handling



Automotive Industry



Electronic Industry



How to realize a application?

→ Complete the check list

Application				
Field of application of the Co-act Gripper:				
☐ Assembly	☐ Handling	☐ Quality check	☐ Other	
Short description of the application				
☐ Integration into existing system		☐ New workstation	☐ Replaces previous workstation	
Robot type				
☐ Specified by the customer		☐ Suggestion desired		☐ Industrial robot, type
☐ FANUC CR 35iA	☐ KUKA iiwa 7	☐ COMAU Racer5 Collabor	☐ UR 3	☐ Rethink Robotics Sawyer
☐ FANUC CR 7iA	☐ KUKA iiwa 14	☐ COMAU AURA 110	☐ UR 5	☐ BOSCH APAS Assistant
	☐ ABB YuMi	☐ COMAU AURA 60	☐ UR 10	☐ Other
Portable robot version		☐ Yes	☐ No	
HRC type of collaboration				
☐ Safe hold	☐ Hand guiding	☐ Speed and separation monitoring		☐ Force and power limiting

How to realize a application?

→ Complete the check list

Required gripping force			
Note: For collisions with a hand, exact limits of 140 N of applied force and –200 N/cm² pressure are valid; other safety aspects are to be observed for higher forces (e.g. sensor system in gripper fingers, actuation of grippers in a separate area).			
Type of gripping:	☐ Form-fit gripping	☐ Friction	☐ 2 fingers
	☐ Parallel		☐ 3 fingers
Preliminary gripper selection			
☐ Collision protection cover required			
Finger design			
☐ Supplied by the customer	☐ SCHUNK		
Material of the attached fingers	☐ Steel	☐ Alu	☐ Plastic
	☐ Other		
Accuracy at the fingers			
Are interfering contours to be taken into consideration when removing workpieces?	☐ Yes	☐ No	
3D data of point of removal available	☐ Yes	☐ No	

How to realize a application?

→ Complete the check list

Actuation				
Robot via				
☐ PROFIBUS	☐ CAN	☐ PROFINET	☐ Ethernet	☐ Other
Gripper via				
☐ Pneumatics	☐ Digital I/O	☐ PROFINET	☐ Ethernet	☐ Other
Safety				
☐ FT sensor in gripper necessary for collision detection (no redundant FT sensor available)				
☐ Support from SCHUNK desired for safety concept				
Pictures available				
☐ Workpiece	☐ Workpiece deposit and mounting	☐ Existing system		
Drawings available				
☐ Workpiece	☐ Workpiece deposit and mounting	☐ Existing system		
Notes				

Filling in check lists – knowing how

Important points for realizing an HRC Application:

- Advising the customers of HRC possibilities
- Detailed description of existing systems / ideas
- If necessary - pictures of existing systems
- Pictures, dimensions and weight of the workpiece

Filling in check lists – knowing how

! Gripper selected compatible with the HRC Application:

Gripping requirements are partly difficult to implement, grippers with gripping forces over 140 N are not suitable for HRC Applications (Exception: manual guidance)

! View of work pieces:

Sharp-edged work pieces are, no matter what weight, not suitable for a HRC Application (except the handling takes place in a locked area)

! Consideration of cycle times:

An optimization of cycle times is hardly possible with a HRC Application. The robot is operated by limited speed to provide human safety

Using standard text for quotations

Background:

The customer should be informed as soon as possible in which condition the gripper unit will be delivered and which features (e.g. gripping force) can be expected.

Available in STB:

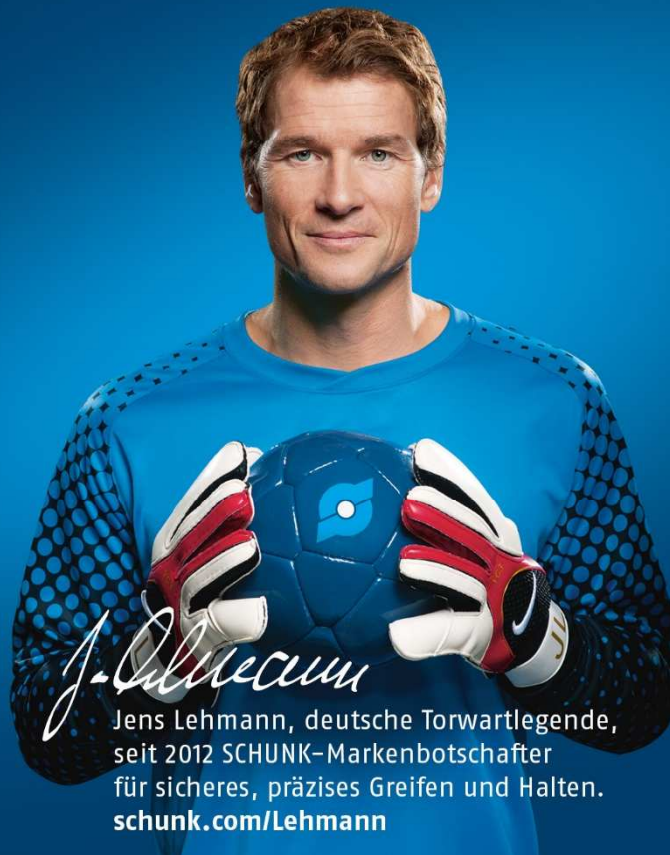


Internal documents

Co-act gripper - standards text for offers



Superior Clamping and Gripping



Jens Lehmann, deutsche Torwartlegende,
seit 2012 SCHUNK-Markenbotschafter
für sicheres, präzises Greifen und Halten.
schunk.com/Lehmann