La collaborazione uomo robot nel mondo automotive

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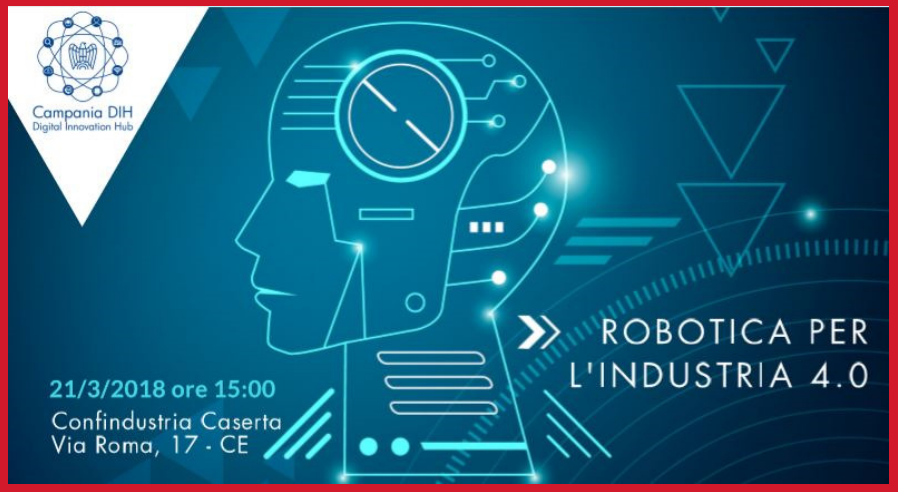
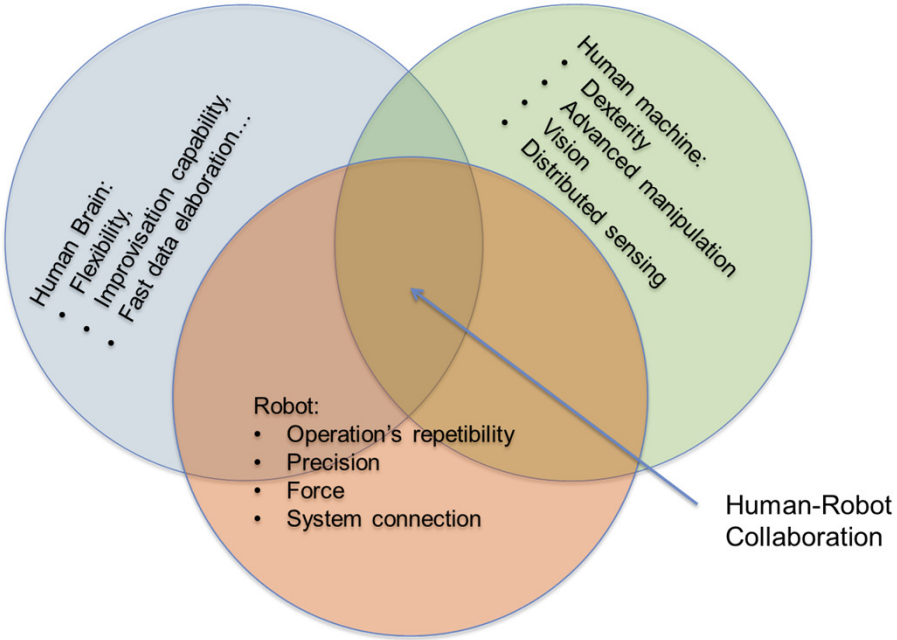


Human Robot Collaboration



The main benefit will be:

- Product quality improvement
- Productivity improvement
- Ergonomic workload reduction
- Investment costs reduction respects conventional robot application

Scenarios of interest considered with concern to H-R collaboration/interaction:

- ✓ *Passive robot used as power actuator:* the Robot it's not "autonomous": it can't execute any job and/or run any motion program in automatic state.
- ✓ *Working areas co-sharing in mutual exclusion*: "passive" HRC where Robot runs with full power in absence of men, and use a gradually reduced power in presence of men.
- ✓ *Human/robot "active" cooperation;* the robot has an active role in the task execution and/or motion program. The Robot is "active" but not "autonomous": "autonomy" requires "intelligence" and "awareness" of the Robot.

Other possible scenarios with collaborative robots but no HRC:

- ✓ *Fenceless workcells:* No Collaboration but safe and less intrusive application..

Human Robot Collaboration/Interaction

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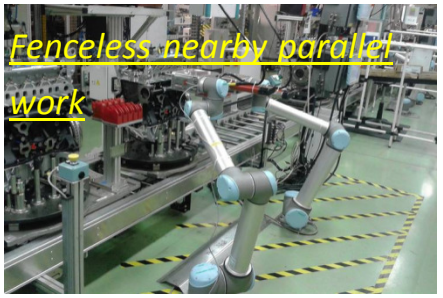
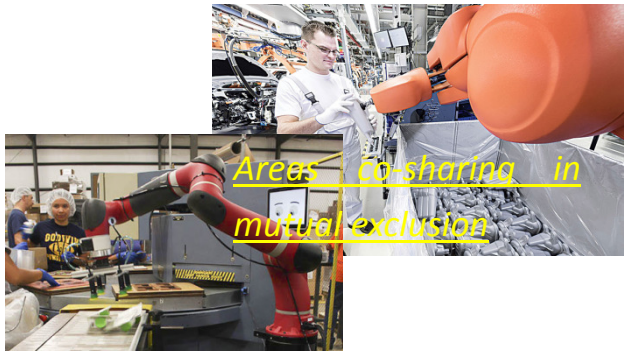
In robotics, the term “collaboration” (lat. con-=“with-”, laborare=“work”) refers to cooperation between humans and robots. This collaboration is limited to a precisely defined collaborative work space.

The objective of collaborative robots is to combine the repetitive performance of robots with the individual skills and ability of people. People have an excellent capability for solving imprecise exercises; robots exhibit precision, power and endurance.

Example Scenarios:





Human Robot Collaboration – Evolution

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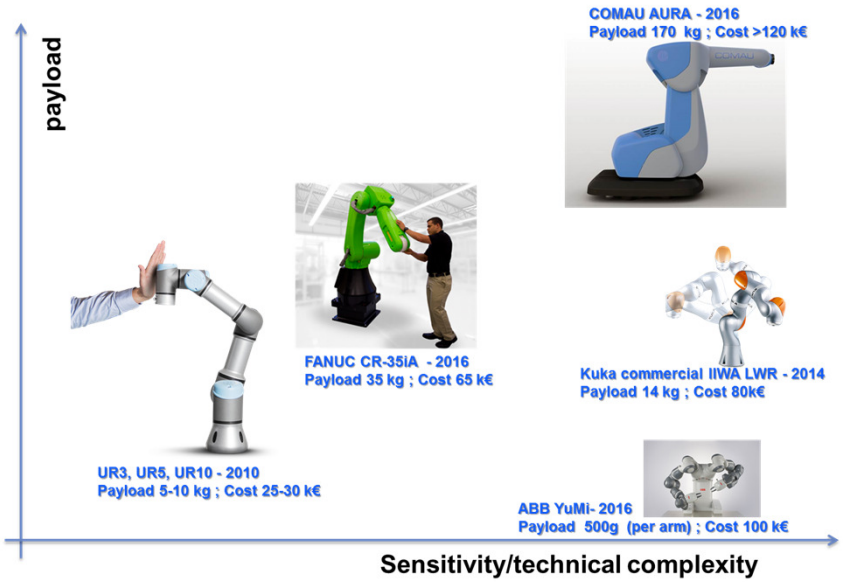
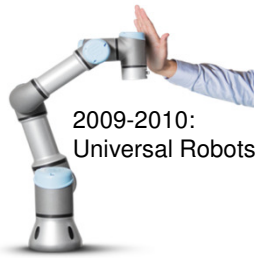


ISO STANDARD for Industrial applications

1995: First DLR Lightweight robot(Light Weight Robot) del DLR
2000: Second DLR robot

2010: ISO 10218 -1 & 2



2009-2010: Universal Robots

2014: Kuka IIWA LWR commercialized

2016:
- COMAU
- FANUC
- KAWASAKY
- YASKAWA
- ABB
- …

2016: ISO/TS 15066

Industrial collaborative robots - Examples

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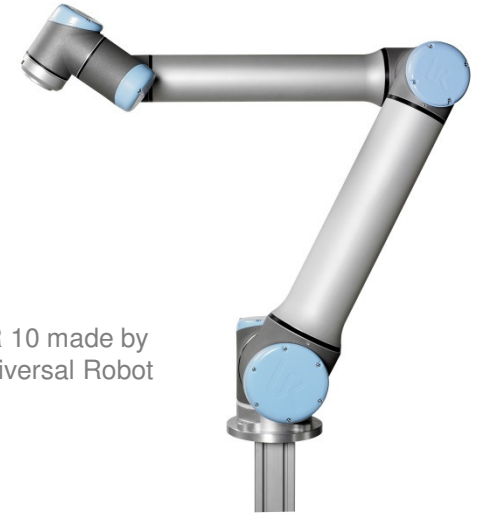
	UR 10	LBR iiwa
N° axis	6	7
Rotational freedom (°)	±360	±170
Velocity	Axis: 120°-180°/s	57°/s -135°/s
Payload (kg)	10	14
Horizontal reach (m)	1.3	0.82
Repeatability (mm)	0.1	0.1
Control system sensor	Current	Force

LBR IIWA made by KUKA

Integrated Safety Stop for collaborative mode according to EN ISO 10218-1:2006

- Kuka: Full functional force sensorization on each joint
- UR: Safety Force sensorization on each joint



UR 10 made by Universal Robot

Principal risks in collaborative operation

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Origin

moving elements

Potential consequences

- crushing
- impact
- shearing

- **RISKS derive not only from robot but from gripper and transported part as well**
- **Safety must take this into account**

Risk Assessment

Free collision

- Dynamic due to high velocities
- Dependent on velocity, mass and shape (of robot, gripper and manipulated object)
- Risks from the end-effector and the transported part
- Collision detection must function reliably and in time (before consequential damage)

Crushing

- No high velocities, virtually static
- Max. force must be parameterizable and not exceeded

Self activation

- External approval for activation required
- Light advices prior to motion

ISO Standards related to HRC

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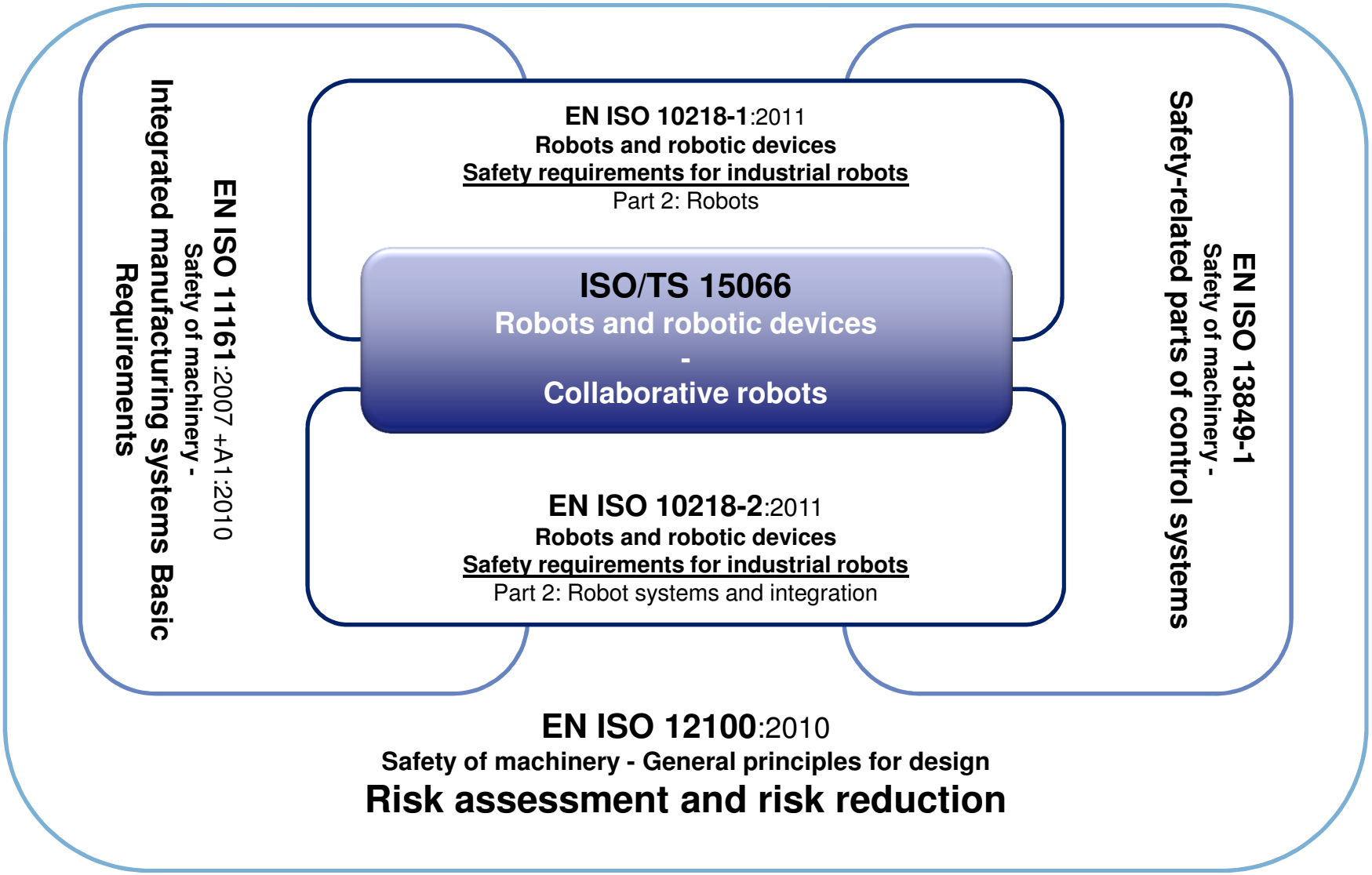

Key points from the main standards

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EN ISO 10218-2:2011:

- Collaboration is only :
  - used for predetermined tasks;
  - possible when all required protective measures are active;
  - possible for robots with features specifically designed for collaborative operation complying with ISO 10218-1.
- A complete risk assessment is required for any application involving collaborative operation specifying collaborative methods, physical parameters (power, force…), ergonomics and so on.
- The whole robot system and application will be included in the risk assessment and certified for safety

EN ISO 10218-1:2011:

- Robot will comply to PL=d and structure category 3 described in ISO 13849-1:2006
- Robots will have a visual indication when in collaborative operation
- Details of control for collaborative methods to take place are defined

ISO/TS 15066:2016

- Supplements and specifies the requirements for collaborative industrial robot operation of ISO 10218-1 and ISO 10218-2.
- Details methods for the proper definition of speed, separation distance, force, energy and so on for all the collaborative methods (SMS, SSM, HG, PFL)

Collaborative operations - operating methods

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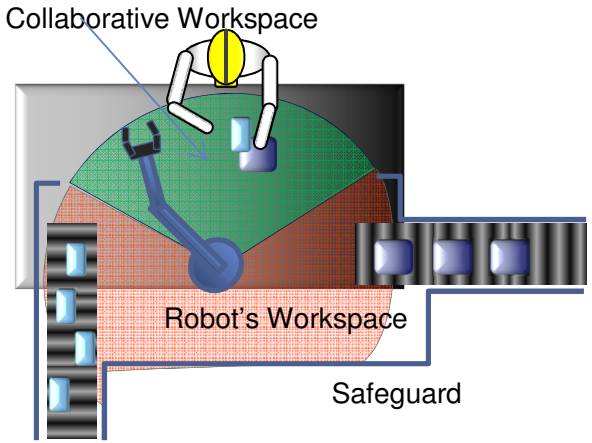
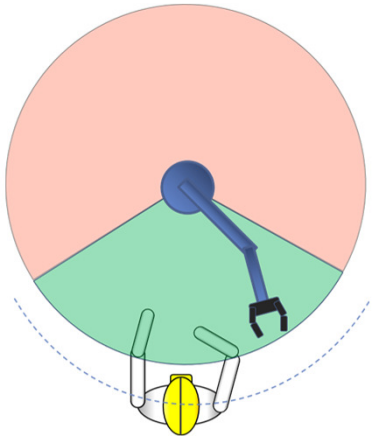
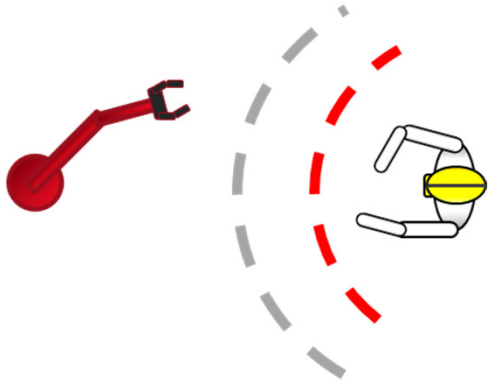
Collaborative operations may include one or more of the following methods:
a) safety-rated monitored stop (SMS);
b) hand guiding (HG);
c) speed and separation monitoring (SSM);
d) power and force limiting (PFL).



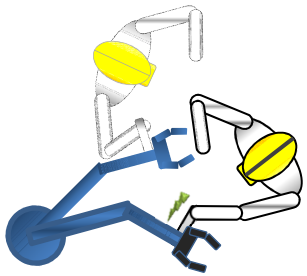
SMS (Safety-rated Monitored Stop)



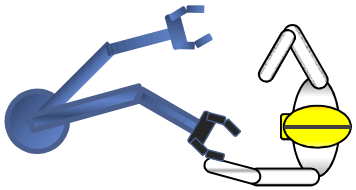
SSM (Speed and Separation Monitoring)



HG (Hand Guiding)



PFL (Power and Force Limiting)



Human Robot Collaboration for Assembly Operations

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Application: Push-pins assembly on aesthetic components for SUV Levante.

BENEFIT / Characteristics

- Takt time with human robot collaboration 5'15"
- Takt time without human robot collaboration 4'
- Human operator dedicated only to load/unload phases
- More available time for Added Value Activities
- Robotic cell certified for human robot collaboration.
- Two functional mode activated (shared space with human and without shared space) .
- Brovind system for automatic supplying of push pins
- LBR IIWA max payload is 14 kg.
- Two laser scanner.

Collaborative Robot Process Phases:

- *Operator:* picks up "codolini" (right side) from the drawer and places it in the clamping system;
- *Robot:* insertion of the push-pins in the respective housing;
- *Operator:* repeats operation for the left side
- *Robot:* insertion of the push-pins in the respective housing (left side)
- *Operator:* places completed parts on the proper output container
- *Operator*: start with new set of "codolini" without stop the robot cycle.