Standards & Regulations

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Selected Standards

- **ISO 10218-1:2011 Part 1**

Safety requirements for industrial robots -- Part 1: Robots

- **ISO/TS 15066:2016**

Collaborative robots


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HOUSTON... WE HAVE A PROBLEM.
I TAUT I TAW A PUDDY TAT.
CURIOSITY

Industrial Robots

- An **industrial robot** is a manipulator designed to move materials, parts and tools, and perform a variety of programmed tasks in manufacturing and production settings

- How many Axes? **3** or more

- The device must be reprogrammable to be considered an industrial robot
- Mechanical changes to effect changes in operation, such as adjusting hard-stops or strokes, are excluded

What is ISO 10-218 Part 1 about?

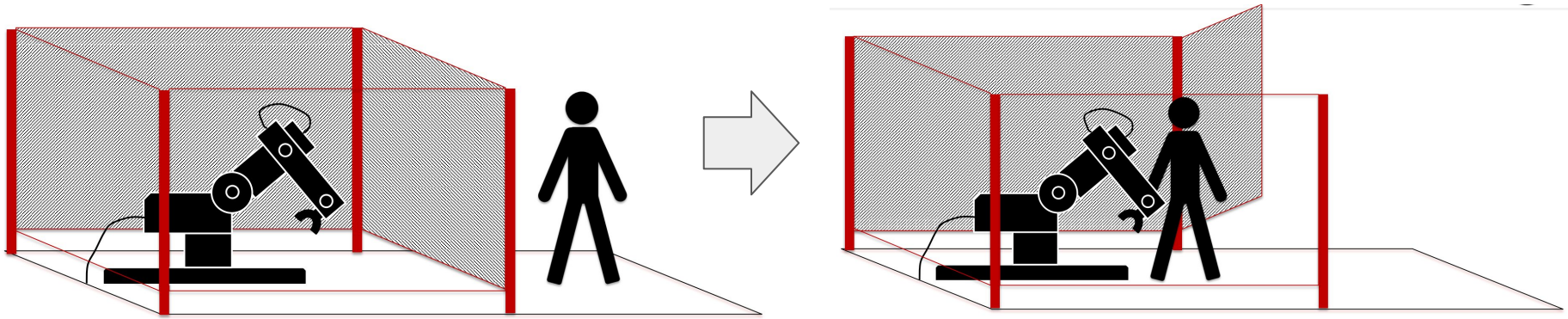
Standard structure for 10-218

- **Part 1:** Robot (that which comes from robot manufacturers)

- **Part 2:** Integration-Requirements placed on the integrator
  (can also be the User when the User is acting as the integrator)

What is ISO/TS 15066

- Build on the requirements in ISO 10-218-part1 and ISO 10-218-part2
- Focusing on collaborative robot



ISO 10218-1:2011 Part 1

Safety requirements for industrial robots -- Part 1: Robots

ISO 10-218 Part 1

- Deals only with industrial robots-Doesn’t cover applications like undersea,military,prosthetics, etc
- Deals exclusively with the robot itself-Robotic systems, integration and installation are covered in Part 2
- Applies to new and rebuilt robots
- Does not speak to the application safety requirements-additional hazards created by welding,cutting, etc

Hazard identification and risk assessment

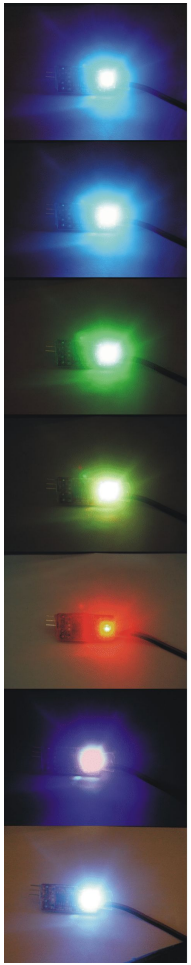
- Mechanical
  - Intended and unintended motion
  - Ejection of end-effector or tools
  - Loose clothing or long hair
  - Collisions with people and environment
- Electrical
  - Contact with live parts or connections
  - High Voltage end-effectors
- Thermal
  - Extreme hot or cold surfaces associated with end-effector function
- Noise, Vibration, Radiation, Hazardous Substances (lubrication, cooling, hydraulic), Ergonomic, Environmental

Design requirements and protective measures

- The robot shall be designed in accordance with the principles of ISO 12100 for relevant hazards. Significant hazards such as sharp edges are not dealt with by this standard
- General Requirements
  - Power Transmission Components
  - Power loss or change
  - Component malfunction
  - Sources of energy
  - Stored energy
  - Electromagnetic compatibility (EMC) - avoid hazard caused by EMI
  - Electrical equipment

Actuating controls

- Protection from unintended operation
- Status indication
  - Power on, fault detected and automatic operation
- Labelling
- Single point of control



BLUE = FULLY CHARGED

CYAN = VERY GOOD

GREEN = GOOD

YELLOW = LOW WARNING

RED = LOW BATTERY

MAGENTA = OVERLOAD

WHITE = OVERLOAD

Robot stopping functions

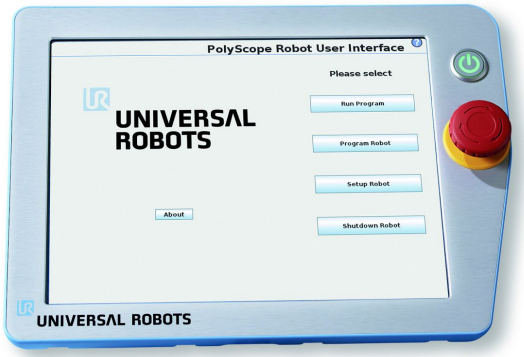
- Every robot shall have a protective stop function and an independent emergency stop function
- Protective stop
  - Manual or automatic
  - For safeguard or risk reduction
- Emergency stop
  - Manual only
  - For emergency only

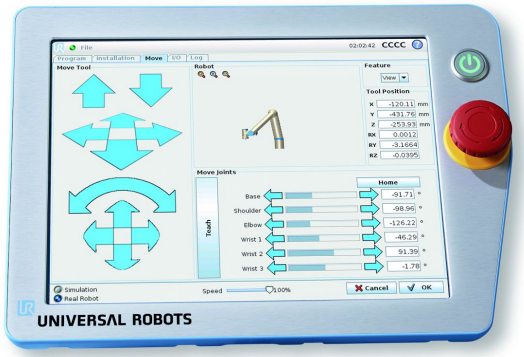
Speed Control

- The speed of robot end effector shall be controllable at selectable speeds
- Reduced speed control operation
- Safety-rated reduced speed control
  - When fault occurs, speed should lower than 250mm/s
- Safety-rated monitored speed control
  - Activate protective stop if the speed exceed limit

Pendant controls

- A pendant controller has the capability to control the robot from the safeguarded space
- Pendant emergency stop function
- Initiating automatic operation
- Cableless or detachable teach controls
  - Loss of communication shall result in a protective stop



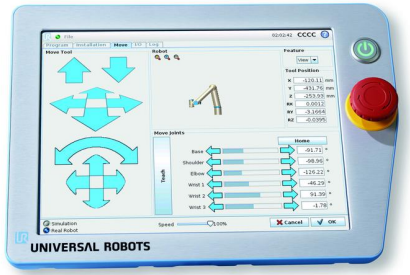


Verification and Validation of Safety Requirements and Protective Measures

- A.Visual inspection
- B.Practical tests
- C.Measurement
- D.Observation during operation
- E.Review of application-specific schematics, circuit diagrams and design material
- F.Review of task-based risk assessment
- G.Review of specifications and information for use

How does it apply to the team's project?

- The UR10 is an industrial robot
- The UR10 recognizes the mechanical (collisions,loose clothing), electrical (high voltage for control box) hazards
- UR10 control box supports status andon
- UR10 provides speed control modes
- UR10 provides Pendant Control
- UR10 provides a robot stopping functions for Emergency and Protective stops that is overloaded by our system E-Stop



ISO/TS 15066:2016

Collaborative robots

What is it about?

- Key idea:
  - if contact between robots and humans is allowed, and incidental contact does occur, then that contact shall not result in pain or injury
- Collaborative robot:
  - Purposely designed robots work in direct cooperation with a human within a defined workspace
- Collaborative Workspace:
  - The space within the operating space where the robot system and a human can perform tasks concurrently

To which products/markets does it apply?

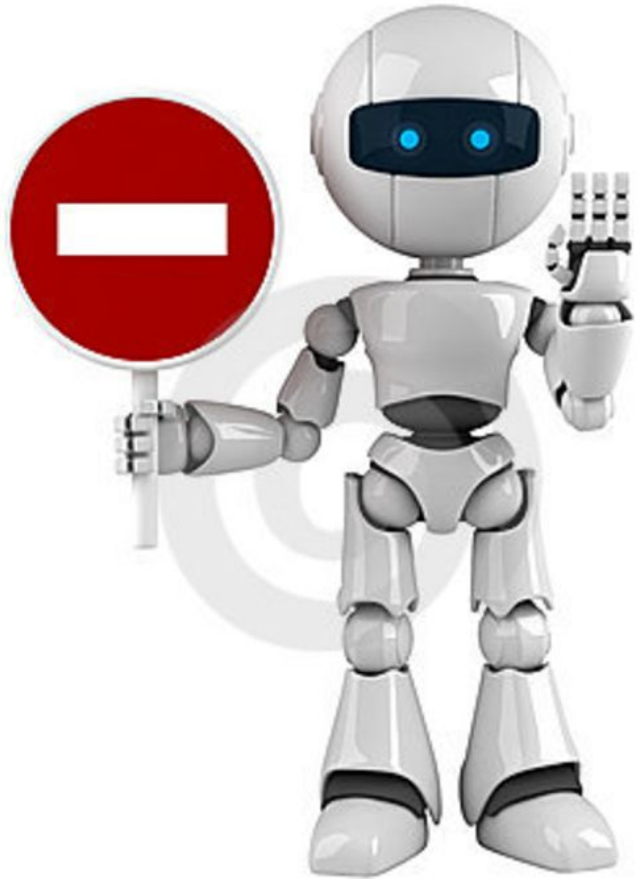
- Any Product where humans and robots interact
  - **Warehouse/Factory robots**, robot assistants, autonomous vehicles, etc

Prescriptions

- Safety-rated monitored stop
- Hand-guiding operation
- Speed and separation monitoring
- Power and force limiting

Safety-rated monitored stop

- Stopping the robot if a human enters its collaborative workspace
- It is often made using one or more sensors to detect human presence
- Infrequent human interface with robot

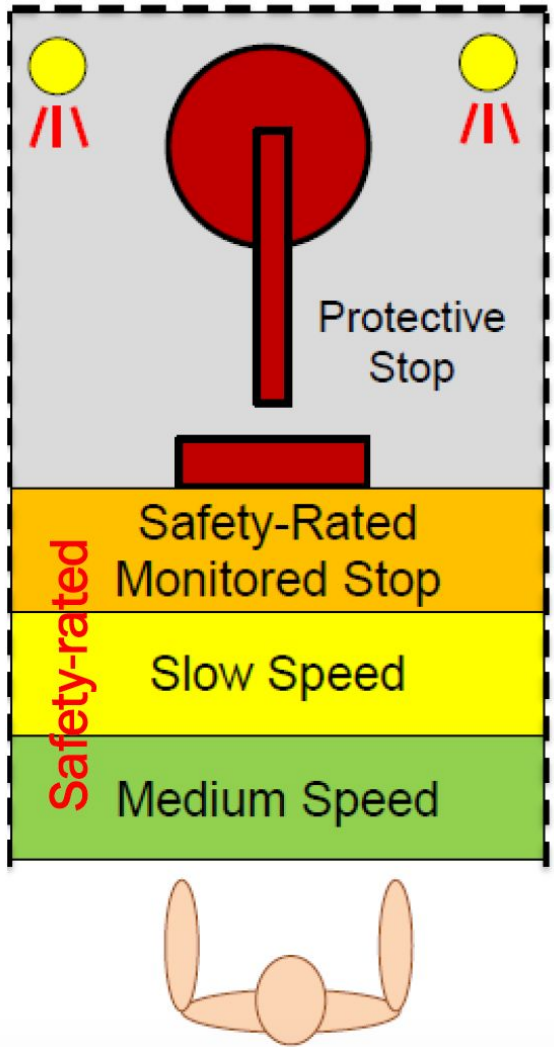


Hand-guiding operation

- Move under someone’s control
- Workers are still protected, since the robots movements are under control

Speed and separation monitoring

- Robot system will slow upon approach
- Minimum protective separation distance
- Real time monitoring to avoid any collision
- Frequent human interface with robot



Power and force limiting

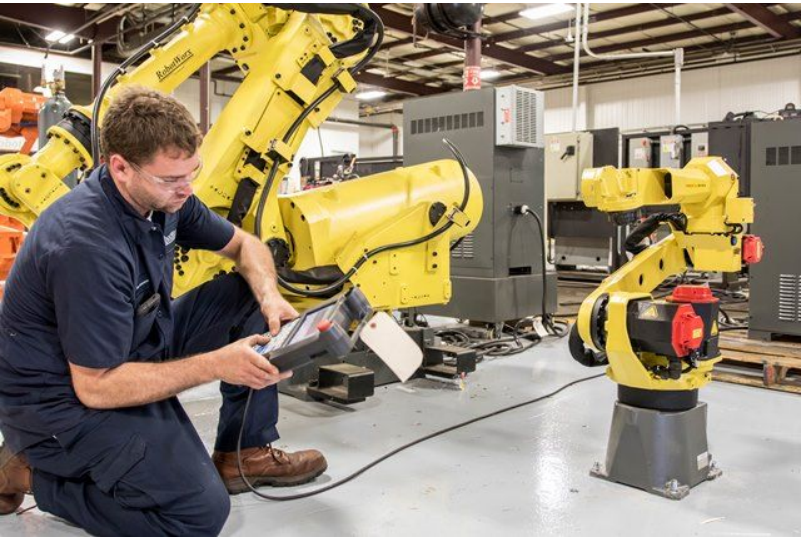
- No sharp corners, exposed motors, or pinch points
- Sensitive force monitoring devices
  - current monitoring
  - force-torque sensors
  - compliant joints
  - low-power actuators
- Most collaborative of the types

How does it apply to the team's project?

- Human operators will supply and remove totes near our robot (virtually verbatim scenario from guidelines)
- Power and Force Limiting

Further Relevance

- Integration into other workspaces
- Power and Force Limiting prevents damaging
  - Items
  - The Robot Itself



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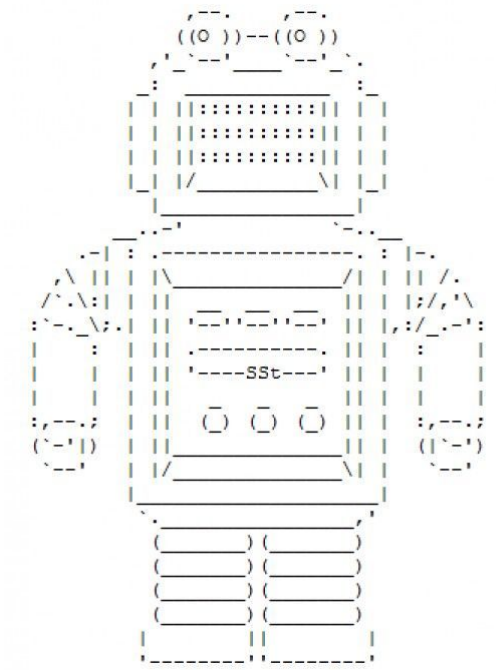
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Reference

http://me.umn.edu/courses/me5286/robotlab/Resources/12-TR15066Overview-SafetyforCollaborativeApplications-RobertaNelsonShea.pdf

http://www.robotics.org/userAssets/riaUploads/file/6-Pat.pdf

http://pattiengineering.com/blog/4-types-collaborative-robots/

http://robotiq.com/wp-content/uploads/2016/05/ebook-ISOTS15066-Explained.pdf

https://industrial.omron.us/en/media/Collaborative_Robot_RatedStop_Part4_r2_tcm849-112291.pdf

http://blog.robotiq.com/bid/66790/Safety-Standards-for-Collaborative-Robots