Robotica collaborativa:

il punto di vista dell’industria

Ing. Alessio Cocchi – Sales Development Manager Italy
History of Robotics

- **The Cosmic Engine, Clock Tower**
  - Su Song
  - 1092

- **First mentioning of term robot**
  - Karel Capek
  - 1921

- **Robot capable of assembling wooden blocks**
  - Freddy II
  - 1974

- **First real collaborative robot in industry**
  - Universal Robots
  - 2008

- **3rd Cent. BC**
  - Philo of Byzantium
  - Washstand Automaton

- **1495**
  - Da Vinci’s Humanoid robot

- **1954**
  - George Devol
  - First digitally operated & programmable robot – Unimate. Installed at GM in 1960

- **1983**
  - Kuka
  - World’s first industrial robot with 6 axes - Famulus
1995

M. A. Peshkin and J. E. Colgate launch a spinoff for producing IADs

“Cobotics” is born

..coworker

Courtesy of Professor Antonio Bicchi - UNIPI & IIT
2006

First Robotic Crash Tests Worldwide

Courtesy of Professor Antonio Bicchi - UNIPI & IIT
TODAY COBOTS..

Power and Force limiting by inherent design and control
..and COBOTS

Skin, sensors..
Next future
Collaborative Workspace: the space within the operating space where the robot system and a human can perform tasks concurrently.

Collaborative Operation: purposely designed robot system and operator work within a collaborative workspace.

Four different types of collaborative operation:

5.5 Collaborative operations

5.5.1 General

Collaborative operations may include one or more of the following methods:

a) safety-rated monitored stop;
b) hand guiding;
c) speed and separation monitoring;
d) power and force limiting.
Che cosa è un robot collaborativo?

Applicazioni collaborative
Che cosa è un robot collaborativo?

Applicazioni collaborative
Che cosa è un robot collaborativo?

Applicazioni collaborative
Supervisione operatore
Installazione in linee di produzione esistenti
Economia e semplicità attrezzature asservimento
Nessun cambio di layout di impianto
• **A - All / risk assessment**
  • ISO 12100

• **B - Group of machines**
  • ISO 13849-1
  • ISO 13850

• **C - Specific**
  • ISO 10218-1
  • ISO 10218-2

• **Normal/non-harmonized**
  • ISO/TS 15066 (Technical Specification)
  • ISO 9409 Tool
  • ISO 9946 Characteristics
  • ISO 9283 Performance and test methods

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**2016 Current Safety Standards**

Global Industrial Robots Safety Standard:
ISO 10218-1: Manufacturer of robots.
ISO 13849-1: Provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software.

The European Machinery Directive 2006/42/EC is the machinery law relevant for all installations in Europe. It can be found on the European Commission's official homepage.
Who made ISO/TS 15066?

- ISO/TS 15066 is developed under the technical committee ISO/TC 299 (Former ISO/TC 184/SC 2)
- All the large industrial robot manufacturers are represented in this committee, including those who produce collaborative robots:
  - Universal Robots (UR3, UR5 & UR10)
  - ABB (YuMi)
  - Rethink robotics (Baxter & Sawyer)
  - KUKA (IIWA)
  - Fanuc (CR-35iA)
- The ISO/TS 15066 is consensus guidelines agreed upon by all cobot manufacturers.
  - All cobots listed above can be installed in compliance with ISO/TS 15066
Two different types of contacts

3.4 **quasi-static contact**
contact between an operator and part of a robot system, where the operator body part can be clamped between a moving part of a robot system and another fixed or moving part of the robot cell

3.5 **transient contact**
contact between an operator and part of a robot system, where the operator body part is not clamped and can recoil or retract from the moving part of the robot system
Pain pressure values

Research studies on threshold limits are presented

The table is based on:

- Pressure
- Force
- Multipliers/factor

- Pressure depends on tool shape
- Pressure depends on workpiece shape

<table>
<thead>
<tr>
<th>Body region</th>
<th>Specific body area</th>
<th>Quasi-static contact</th>
<th>Transient contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skull and forehead</td>
<td>Middle of forehead</td>
<td>100</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Temple</td>
<td>120</td>
<td>not applicable</td>
</tr>
<tr>
<td>Face</td>
<td>Masticatory muscle</td>
<td>100</td>
<td>65</td>
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<tr>
<td></td>
<td>not applicable</td>
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<td></td>
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<tr>
<td>Neck</td>
<td>Neck muscle</td>
<td>150</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Seventh neck muscle</td>
<td>210</td>
<td>2</td>
</tr>
<tr>
<td>Back and shoulders</td>
<td>Shoulder joint</td>
<td>160</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Chest</td>
<td>Sternum</td>
<td>120</td>
<td>2</td>
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<tr>
<td></td>
<td>Pectoral muscle</td>
<td>170</td>
<td>2</td>
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<tr>
<td>Abdomen</td>
<td>Abdominal muscle</td>
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<tr>
<td>Pelvis</td>
<td>Pelvic bone</td>
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<tr>
<td></td>
<td>Upper arm and elbow joints</td>
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<td></td>
<td>Deltoid muscle</td>
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<td>150</td>
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<td></td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Humerus</td>
<td>220</td>
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<tr>
<td></td>
<td>Lower arm and wrist joints</td>
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</tr>
<tr>
<td></td>
<td>Forearm muscle</td>
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<td>2</td>
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<tr>
<td></td>
<td>Arm nerve</td>
<td>100</td>
<td>2</td>
</tr>
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<td></td>
<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Hands and fingers</td>
<td>Forefinger pad D</td>
<td>300</td>
<td></td>
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<td></td>
<td>Forefinger pad ND</td>
<td>270</td>
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<td>Forefinger end joint D</td>
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<td></td>
<td>Forefinger end joint ND</td>
<td>220</td>
<td>2</td>
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<td></td>
<td>Thumet eminence</td>
<td>200</td>
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<td></td>
<td>Palm D</td>
<td>260</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Palm ND</td>
<td>260</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Back of the hand D</td>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Back of the hand ND</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Thighs and knees</td>
<td>Thigh muscle</td>
<td>250</td>
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<td>Kneecap</td>
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<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower legs</td>
<td>Middle of shin</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calf muscle</td>
<td>210</td>
<td>2</td>
</tr>
</tbody>
</table>

What is ISO/TS 15066? – Annex A
Pain pressure measurements

What is ISO/TS 15066? – Annex A
UR features vs. traditional features

Safety-related software features:
Traditional robot:
• Safe axis limiting
• Safe speed

UR Cobot:
• Safe axis limiting
• Safe speed
• Safe force
• Safe momentum
• Safe mechanical power
• Safe tool orientation
• Safe boundaries

Advanced collaborative safety features + Low weight minimizes impact forces
Future standards, documents and republications

Brilliant! What’s coming next in the ISO world?

• ISO/TR 20218-1 for collaborative end-effectors (~ 2017)
• ISO/TR 20218-2 for manual load stations (~ 2017)
• ISO XX for all kinds of man-machine contacts (~ 2018)
• ISO 10218-1 and -2 review and update (~ June 2020). Expect to roll TS15066 (plus improvements) into the revisions.
Examples of accepted clamping hazards

- Remember... many places have acceptable clamping conditions. Even places our children go!

What is ISO/TS 15066?
Industrial Robotics – Growth Perspectives

- Robotics for Automotive
- Robots for General Industry and Professional Services: Entertainment, Medical, Food, Logistics
- Robots Multipurpose tools for manufacturing SMEs: In sourcing, Increase Quality & Flexibility
- Mobility Robots
- Robots for Domestic Services
- Robots For? - THE FUTURE INDUSTRIE OF ROBOTICS
INDUSTRIAL ROBOTS

Estimated worldwide annual shipments of industrial robots in ’000 of units
2008 – 2016 and forecast 2017* - 2020*

+ 15% on average per year

Source: IFR World Robotics 2017
*Forecast

UNIVERSAL ROBOTS
GLOBAL COLLABORATIVE INDUSTRIAL ROBOTS MARKET
by Volume (Units) 2015-2021, Forecast years (2016-2021)

CAGR +71.42%

Source: Bis Research Analysis, Global Collaborative Industrial Robot Market, 2016-2021
GLOBAL COLLABORATIVE
INDUSTRIAL ROBOTS MARKET
by Value ($Million) 2015-2021, Forecast years (2016-2021)

Source: Bis Research Analysis, Global Collaborative Industrial Robot Market, 2016-2021
GLOBAL COLLABORATIVE INDUSTRIAL ROBOTS MARKET

by Industry 2015-2021 (% of participation) Forecast years (2016-2021)

Source: Big Research Analysis, Global Collaborative Industrial Robot Market, 2016-2021
GLOBAL COLLABORATIVE INDUSTRIAL ROBOTS MARKET

by Application 2015-2021 (% of participation) Forecast years (2016-2021)

Source: Big Research Analysis, Global Collaborative Industrial Robot Market, 2014-2023
2015 MARKET

of global collaborative industrial robots by sold units

- In 2015, collaborative industrial robots constituted around 2% of the total industrial robot market.
- Total volume sales of collaborative industrial robots stood around 5,000 units in 2015.
- Total volume of collaborative industrial robots sales is set to reach around 126,000 units by 2021 at a CAGR 2015-2021 of 71.43%, driven by the increasing adoption of low cost automation by small and medium enterprises in the Asia Pacific and the European region.

Source: Big Research Analysis. Global Collaborative industrial Robot Market, 2016-2021
Opportunità concrete per il Manifatturiero Italiano

70% dei cobots sono implementati in nuove applicazioni non coperte dalla robotica tradizionale.

Nuovi scenari, anche in nuovi settori.

Fonte: Robotics Update
85% delle Aziende Manifatturiere ritiene che, entro il 2020, sarà naturale abbinare lavoro degli operatori ai cobot

Fonte: Accenture Consulting
INDUSTRIAL ROBOTS

- Difficult set-up
- High programming expertise needed
- Fixed installations
- Extensive space requirements
- Need a safety fence
- Numerous additional costs

COLLABORATIVE ROBOTS

- Fast set-up
- Anyone can program
- Flexible deployment
- Limited space requirements
- Collaborate side-by-side with humans
- Cost effective with fast payback
1. Installing the robot
HISTORY OF INDUSTRIAL REVOLUTIONS

1st industrial revolution
End of XVIII
Merchanization, water and steam powered

2nd industrial revolution
End of XIX
Mass production assembly line, electricity

3rd industrial revolution
1970
Robotics, automation computers

4th industrial revolution
Today
Cloud & Services
Automation using cost-effective, advanced robotics technologies is helping the reshoring shift by enabling companies of all sizes remain cost-competitive while keeping their manufacturing operations at home.
Sfide per le Aziende

- Domanda fluttuante e variabile
- Incremento della diversità e costi dei prodotti
- Riduzione del Time to market
- Migliore Qualità del Prodotto/processo

Lightweight cobot come soluzione flessibile, economica ai processi di manufacturing
Cobot come Cyber Phisical System (CPS)

- Cobot
- Sensori e attuatori
- Intelligenza
- Comunicazione
Perché questa è Industria 4.0?

- Flessibilità e reattività al cambio di produzione
- Adattività come reazione alla variabilità
- Intelligenza -> A.I. and smart devices
- Generazione ed analisi del dato
About the Company

+400 Employees
+35 Nationalities
+400 Partners
26 International Awards
65 Patents
17 offices in 12 Countries
+18,500 cobots installed worldwide
UR: Robotica collaborativa a 360°
Facile Programmazione

- Autoapprendimento (Freedrive)
- Interfaccia intuitiva su tablet
- Wizard guidati
Rapido Set-up

- Robot leggeri
- Facile e rapido da installare
- “Plug and play”. Alimentazione a 230V
- Riduzione tempi di “commissioning”
Utilizzo Flessibile

- Robot leggeri e facilmente trasportabili
- Facili da riutilizzare su diversi task/macchine
- Utilizzo in layout esistenti
- Possibilità di lavoro in spazi compatti
- Facilità di automatizzare processi manuali
Collaborativo e Sicuro

- Condivisione di spazi di lavoro
- Aiuta gli operatori in task pericolosi, ripetitivi e senza valore aggiunto
- Migliora ergonomia -> salute operatori
- 15 funzioni di SAFETY completamente programmabili e certificate TÜV
Rapido ritorno dell’investimento

- Tempo medio ritorno: 195 gg
- Tutti I vantaggi di una robotica avanzata, senza costi aggiuntivi per opzioni
- Riduzione costi hardware accessorio
- Tempi rapidi di messa in funzione
- Riduzione costi di programmazione
- Adatto per alto mix prodotti, piccolo lotti
Cobot UR come TOOL intelligenti e flessibili, utilizzabili facilmente per migliorare i processi produttivi
UNIVERSAL ROBOTS+

- Customize your UR robot with cutting-edge products
Plug&Play
WE WISH TO EMPOWER OUR CUSTOMERS, BY BRINGING BACK THE HUMAN TOUCH TO PRODUCTION
Grazie!

Ing. Alessio Cocchi  
Sales Development Manager  
Universal Robots  
Via Lugaro 15  
10126 Torino  
Italy  

Cell: +39 33 48 80 31 71  
aco@universal-robots.com  
www.universal-robots.com