An outlook for robotics
(in industry and service)

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International Federation of Robotics IFR

- Represents the global robotics industry
- Turn-over 2015 industrial robotics ~ US$35bn
- >50 members:
  - National robot associations
  - R&D institutes
  - Robot suppliers
  - Integrators
- World (Industrial and Service) robotics Yearbooks; [www.ifr.org](http://www.ifr.org); [www.worldrobotics.org](http://www.worldrobotics.org)
  → Look for downloads. Complete set of data or DB access subject to fee.
Industrial Robotics on the rise in a globalized economy; some basic statistics

Industrial robot shipments worldwide in thousands of units (2016+ estimated)

- Global turnover in industrial robotics ~US$35b (+15.5%); 2015: 253k, 2019: 414k units
- In 2019, estimated 2.6m industrial robots in factories worldwide; 1 million more than in 2015
- Total Industrial Robotics market worldwide estimated US$25bn.
- Strong growth in Asia (China) will impact technology, cost, supply chain of industrial robotics

Industrial robot density worldwide in selected regions (in 2015)

- Germany (7%)
- Japan (10%)
- North America (17%)
- Europe (10% CAGR)
- China (36%)
- Worldwide (16%)

Made in China 2025
+650,000 new Installations for 2016-2020 forecast
→ Robot density: 150

www.worldrobotics.org, September 2016
Industrial Robotics: Almost 70% of systems installed in three main industries

Estimated worldwide operational stock of industrial robots at year-end by main industries 2013 - 2015

- **Automotive**
  - 2015: 623.1 '000 units
  - 2014: 573.1 '000 units
  - 2013: 426.3 '000 units

- **Electrical/electronics**
  - 2015: 328.6 '000 units
  - 2014: 278.1 '000 units
  - 2013: 242.9 '000 units

- **Metal**
  - 2015: 160.9 '000 units
  - 2014: 137.1 '000 units
  - 2013: 118.6 '000 units

- **Chemical and plastics**
  - 2015: 150.9 '000 units
  - 2014: 133.2 '000 units
  - 2013: 111.6 '000 units

- **Food**
  - 2015: 51.2 '000 units
  - 2014: 45.1 '000 units
  - 2013: 37.6 '000 units

- **Others**
  - 2015: 91.6 '000 units
  - 2014: 78.2 '000 units
  - 2013: 68.9 '000 units

- **Not specified by industries**
  - 2015: 225.3 '000 units
  - 2014: 198.6 '000 units
  - 2013: 172.9 '000 units

Source: IFR World Robotics 2016

- Share of robot sales into automotive industries in 2015 → some 40%
- Robots for **electrical/electronics industry** (3C industries incl. medical equipment, precision/optical devices) were up **41% in 2015** to **64,600 units**
Some major technological trends in IR

- Safe human robot collaboration
- Interfacing with production data
- Cost effectiveness
- Sensors
- Cognitive capabilities
- Intuitive instruction (skills), error recovery

- Industrie4.0/Industrial Internet will have strong impact on technological progress
- Still, incremental/evolutionary innovation process in industry
- Role of human operator shifting → knowledge worker on the shopfloor
- Example: SMErobotics in 100 sec; www.smerobotics.org
Industrial Robotics in Industrie4.0-environments

Basic architecture of I4.0 platforms

- **Portal**

- **Platform**

- **Services**

- **Cyber-physical systems**

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ISV: Independent Software Vendor
ERP: Enterprise Resource Planning Software
MES: Manufacturing Execution System
Main application areas of Service Robots

Professional Use
17-23 Field robotics
24-28 Professional cleaning
29-31 Inspection and maintenance systems
32-35 Construction and demolition
36-39 Logistic systems
40-43 Medical robotics
44-46 Rescue & security applications
47-51 Defense applications
52 Underwater systems (civil / general use)
53 Powered Human Exoskeletons
54 Unmanned aerial vehicles (general use)
55 Mobile Platforms in general use
56-60 Underwater systems (civil / general use)
61 Other

Personal/domestic use
1-6 Robots for domestic tasks
7-10 Entertainment robots
11-13 Elderly and handicap assistance
14 Personal transportation (AGV for persons)
15 Home security & surveillance
16 Other Personal / domestic robots
Service robots for professional use. Estimated value of sales 2014 and 2015 and estimated value of forecast 2016 - 2019 (main applications)

Total value of forecast 2016 to 2019: US$ billion 23.1

Source: IFR World Robotics 2016
Service Robotics for personal/domestic use

Service robots for personal/domestic use.
Estimated value of sales 2014 and 2015, forecast 2016-2019
Service Robotics is taking off

2015: US$ 6.8bn global turnover globally (corresponds to ~20% of industrial robotics)
2016-2019: US$ 45bn accumulated sales value
2016 - 2019: US$ 22.4bn turnover of personal/domestic service robots

Source: IFR World Robotics 2016
Number of service robot manufacturers of all types (professional and personal/domestic use) by region of origin

- Europe: 262
- North America: 226
- Asia: 114
- Others: 23
Service Robotics (domestic and professional applications): more than 620 active companies

<table>
<thead>
<tr>
<th>Application Type</th>
<th>Number of Companies</th>
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<tr>
<td>Toy / hobby robots</td>
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<td>Education and research</td>
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<td>Robot-assisted surgery/therapy robots</td>
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<td>Surveillance</td>
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<td>Agriculture</td>
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<td>Multi-media robots</td>
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<td>AGVs, non-manufacturing</td>
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<td>AGV in manufacturing</td>
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<td>Vacuums</td>
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<td>Other inspection and maintenance</td>
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<td>Personal aids</td>
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<td>Other entertainment</td>
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<td>Lawn mowing</td>
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<td>Plants inspection</td>
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<td>Transportation</td>
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<td>Fire and disaster fighting robots</td>
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<td>Other assistance functions</td>
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<td>Other medical robots</td>
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<td>Robot companions</td>
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<td>Nuclear demolition</td>
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<td>Pool cleaning</td>
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<td>Hull cleaning</td>
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Number of service robot manufacturers of main types (professional and personal/domestic use) worldwide

- **Start Ups**
- **Established**
Service Robotics: Opportunities give birth to a new industry worldwide

Number of service robot manufacturers (professional and personal/domestic use) by country of origin.

Applied definition of a start-up:
- Product on the market
- Max age 5 years
Service Robotics: Industrial activity in relation to national GDPs

Number of service robot manufacturers; normalized [per US$1.000bn in GDP]

Service robotics: Some observations

• Service robotics: strong growth and technology burst
• **625 companies** world wide developing/supplying service robots
• Hot field of start-up activities (185/625→**28%**, >US$1bn 2015 in VC investment)
• First eco-systems being formed (networks of end-users, suppliers, technology partners, application modules/packages, services, consulting):
  • Mobile robot platforms
  • Unmanned aerial vehicles/multicopter/drones
• **Strong facilitators for ecosystems:**
  • Mature multi-purpose hardware platforms
  • Open source software-systems → start-ups
• **European potential for further growth:**
  • Logistics, health, domestic/personal, ...
Robotics and jobs: Image of automation

Automation has a **positive net effect** on labour demand [in Europe]:

- Automation reduces production cost
- Reduced product costs reduce prices
- Reduced product prices increase demand for products
- Increased product demand increases employment.

Main challenge for future work → coping with rising inequality, as technological change creates both winners and losers. Policy makers should focus on the qualifications of the workers to ensure that workers’ skills match future skill requirements.