<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marina Bill</td>
<td>IFR President</td>
</tr>
<tr>
<td></td>
<td>Global Head Marketing &amp; Sales, ABB Robotics</td>
</tr>
<tr>
<td>Dr. Christopher Müller</td>
<td>Director Statistical Dpt. International Federation of Robotics</td>
</tr>
<tr>
<td>Dr. Werner Kraus</td>
<td>Chair IFR Service Robot Group Head of Dpt. Robot &amp; Assistive Systems,</td>
</tr>
<tr>
<td></td>
<td>Fraunhofer IPA</td>
</tr>
<tr>
<td>Dr. Susanne Bieller</td>
<td>General Secretary International Federation of Robotics</td>
</tr>
</tbody>
</table>
International Federation of Robotics
Who we are

- Professional non-profit organization
- Established in 1987
- Communication and networking platform
- About 90 members
  - National robotics associations, R&D institutes, robot suppliers, integrators
- Over 2000 organizations represented indirectly
Our members

**NATIONAL ASSOCIATIONS**

**INDUSTRIAL ROBOT MANUFACTURERS**

**COMPONENT SUPPLIERS, INTEGRATORS, SERVICE ROBOT MANUFACTURERS**

**R&D INSTITUTES**
Three pillars of IFR activities

- **Robotics Industry Statistics**: world authority on robotics industry statistics
- **Voice of Robotics Industry**: worldwide promotion of robotics
- **Policy Support**: worldwide, national and local policies supporting the adoption of robotics
What is a robot – and what is not?

- “Robot” defined by International Standards Organization (ISO)

- No robots:
  - software ("bots", AI, Robotic Process Automation - RPA)
  - remote-controlled drones, UAV, UGV, UUV
  - voice assistants
  - autonomous cars
  - ATMs, smart washing machines, etc.
Two types of robots

Industrial robots

Service robots

Image: Dürr

Image: Fourier Intelligence
Presentation of World Robotics 2022
Industrial robots - top findings

2021: Robot installations hit new record level
“The automation booster ignited”
Strong recovery from the pandemic year

New robots
- 517,000 units (+31%)
- highest number in history
- CAGR 2016-2021: +11%

Robot stock
- 3.5 million units (+15%)
- CAGR 2016-2021: +14%
Half a million limit broken in 2021

Annual installations of industrial robots - World

1,000 units

Source: World Robotics 2022
3 million industrial robots operating in factories around the world

Operational stock of industrial robots - World

1,000 units

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1,153</td>
</tr>
<tr>
<td>2012</td>
<td>1,235</td>
</tr>
<tr>
<td>2013</td>
<td>1,332</td>
</tr>
<tr>
<td>2014</td>
<td>1,472</td>
</tr>
<tr>
<td>2015</td>
<td>1,632</td>
</tr>
<tr>
<td>2016</td>
<td>1,838</td>
</tr>
<tr>
<td>2017</td>
<td>2,125</td>
</tr>
<tr>
<td>2018</td>
<td>2,441</td>
</tr>
<tr>
<td>2019</td>
<td>2,740</td>
</tr>
<tr>
<td>2020</td>
<td>3,035</td>
</tr>
<tr>
<td>2021</td>
<td>3,477</td>
</tr>
</tbody>
</table>

Source: World Robotics 2022

+15% increase from 2020 to 2021.
Electronics is a major customer of industrial robots.

### Annual installations of industrial robots by customer industry - World

<table>
<thead>
<tr>
<th>Industry</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical/electronics</td>
<td>89</td>
<td>110</td>
<td>137</td>
<td>+24%</td>
</tr>
<tr>
<td>Automotive</td>
<td>64</td>
<td>84</td>
<td>119</td>
<td>+42%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>44</td>
<td>52</td>
<td>102</td>
<td>+45%</td>
</tr>
<tr>
<td>Plastic and chemical products</td>
<td>19</td>
<td>24</td>
<td>52</td>
<td>+29%</td>
</tr>
<tr>
<td>Food</td>
<td>11</td>
<td>15</td>
<td>12</td>
<td>+18%</td>
</tr>
<tr>
<td>All others</td>
<td>30</td>
<td>37</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>87</td>
<td>87</td>
<td>87</td>
<td></td>
</tr>
</tbody>
</table>

Source: World Robotics 2022
Handling is most important application with 44% share

Annual installations of industrial robots by application - World
1,000 units

- Handling: 230 units (2021), 169 units (2020), 177 units (2019), +36%
- Welding: 96 units (2021), 70 units (2020), 74 units (2019), +38%
- Assembling: 62 units (2021), 40 units (2020), 50 units (2019), +24%
- Cleanroom: 32 units (2021), 32 units (2020), 26 units (2019), +1%
- Dispensing: 11 units (2021), 8 units (2020), 12 units (2019), +28%
- Processing: 7 units (2021), 5 units (2020), 7 units (2019), +37%

Source: World Robotics 2022
Collaborative robots steadily growing their market share

Collaborative and traditional industrial robots

<table>
<thead>
<tr>
<th>Year</th>
<th>Traditional Industrial Robots</th>
<th>Collaborative Robots</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>389</td>
<td>11</td>
</tr>
<tr>
<td>2018</td>
<td>405</td>
<td>19</td>
</tr>
<tr>
<td>2019</td>
<td>370</td>
<td>21</td>
</tr>
<tr>
<td>2020*</td>
<td>368</td>
<td>26</td>
</tr>
<tr>
<td>2021</td>
<td>478</td>
<td>39</td>
</tr>
</tbody>
</table>

Source: World Robotics 2022

*revised
Strong growth in all regions

Annual installations of industrial robots
('000 of units)

<table>
<thead>
<tr>
<th>Region</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia/Australia</td>
<td>284</td>
<td>259</td>
<td>277</td>
<td>381</td>
</tr>
<tr>
<td>Europe</td>
<td>76</td>
<td>74</td>
<td>47</td>
<td>68</td>
</tr>
<tr>
<td>The Americas</td>
<td>55</td>
<td>47</td>
<td>39</td>
<td>51</td>
</tr>
</tbody>
</table>

Annual percentage growth of installations of industrial robots

<table>
<thead>
<tr>
<th>Year</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>+7%</td>
</tr>
<tr>
<td>2021</td>
<td>+31%</td>
</tr>
</tbody>
</table>

Source: International Federation of Robotics
China increases its lead

Annual installations of industrial robots
15 largest markets 2021

- China: 268.2 '000 of units (+51%)
- Japan: 47.2 '000 of units (+22%)
- United States: 35.0 '000 of units (+14%)
- Rep. of Korea: 31.1 '000 of units (+2%)
- Germany: 23.8 '000 of units (+6%)
- Italy: 14.1 '000 of units (+65%)
- Chinese Taipei: 9.6 '000 of units (+31%)
- France: 5.9 '000 of units (+11%)
- Mexico: 5.4 '000 of units (+61%)
- India: 4.9 '000 of units (+54%)
- Canada: 4.3 '000 of units (+66%)
- Thailand: 3.9 '000 of units (+36%)
- Singapore: 3.5 '000 of units (-35%)
- Spain: 3.4 '000 of units (+1%)
- Poland: 3.3 '000 of units (+56%)

Source: World Robotics 2022
China now installs more industrial robots per year than the rest of the world taken together.

Annual installations of industrial robots ('000 of units)

<table>
<thead>
<tr>
<th>Year</th>
<th>China</th>
<th>Rest of World</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>97</td>
<td>207</td>
</tr>
<tr>
<td>2017</td>
<td>156</td>
<td>243</td>
</tr>
<tr>
<td>2018</td>
<td>155</td>
<td>268</td>
</tr>
<tr>
<td>2019</td>
<td>148</td>
<td>243</td>
</tr>
<tr>
<td>2020</td>
<td>178</td>
<td>216</td>
</tr>
<tr>
<td>2021</td>
<td>268</td>
<td>249</td>
</tr>
</tbody>
</table>

Source: International Federation of Robotics
China multiplied its annual installations by more than factor 11 in a decade

Annual installations of industrial robots - China

1,000 units

Source: World Robotics 2022
China’s electronics industry is the main customer

Annual installations of industrial robots by customer industry - China

1,000 units

<table>
<thead>
<tr>
<th>Industry</th>
<th>2021</th>
<th>2020</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical/electronics</td>
<td>88</td>
<td>62</td>
<td>-15%</td>
</tr>
<tr>
<td>Automotive</td>
<td>64</td>
<td>42</td>
<td>+38%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>31</td>
<td>34</td>
<td>+97%</td>
</tr>
<tr>
<td>Rubber and plastics</td>
<td>32</td>
<td>34</td>
<td>+55%</td>
</tr>
<tr>
<td>Food</td>
<td>22</td>
<td>22</td>
<td>+22%</td>
</tr>
<tr>
<td>Pharma/cosmetics</td>
<td>6</td>
<td>3</td>
<td>+14%</td>
</tr>
<tr>
<td>All others</td>
<td>12</td>
<td>21</td>
<td>-15%</td>
</tr>
<tr>
<td>Unspecified</td>
<td>30</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

Source: World Robotics 2022
Japan recovers strongly – third highest installation count ever recorded

Annual installations of industrial robots - Japan

1,000 units

Source: World Robotics 2022
Japan's electronics and automotive industry demand high quantities

Annual installations of industrial robots by customer industry - Japan
1,000 units

<table>
<thead>
<tr>
<th>Industry</th>
<th>2021</th>
<th>2020</th>
<th>2019</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical/electronics</td>
<td>16</td>
<td>16</td>
<td>13</td>
<td>+21%</td>
</tr>
<tr>
<td>Automotive parts</td>
<td>12</td>
<td>9</td>
<td>7</td>
<td>+20%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>+15%</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>-16%</td>
</tr>
<tr>
<td>Rubber and plastics</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>+101%</td>
</tr>
<tr>
<td>Food</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-9%</td>
</tr>
<tr>
<td>All others</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Source: World Robotics 2022
Second highest level ever recorded in the United States

Annual installations of industrial robots - United States

1,000 units

Source: World Robotics 2022
Annual installations of industrial robots by customer industry - United States

<table>
<thead>
<tr>
<th>Industry</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>12,960</td>
<td>10,494</td>
<td>9,782</td>
<td>-7%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>12,960</td>
<td>3,814</td>
<td>2,294</td>
<td>+66%</td>
</tr>
<tr>
<td>Plastic and chemical</td>
<td>12,960</td>
<td>3,466</td>
<td>2,661</td>
<td>+30%</td>
</tr>
<tr>
<td>products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>12,960</td>
<td>3,402</td>
<td>2,715</td>
<td>+25%</td>
</tr>
<tr>
<td>Electrical/electronics</td>
<td>12,960</td>
<td>3,710</td>
<td>2,857</td>
<td>-23%</td>
</tr>
<tr>
<td>All others</td>
<td>12,960</td>
<td>4,523</td>
<td>2,618</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>12,960</td>
<td>6,295</td>
<td>4,967</td>
<td></td>
</tr>
</tbody>
</table>

Source: World Robotics 2022
Robot demand in Korea moving sideways

Annual installations of industrial robots - Rep. of Korea

1,000 units

Source: World Robotics 2022
Robot demand from the Korean electronics industry down by 10%

Annual installations of industrial robots by customer industry - Rep. of Korea

<table>
<thead>
<tr>
<th>Industry</th>
<th>Units 2021</th>
<th>Units 2020</th>
<th>Units 2019</th>
<th>Change 2020-2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semiconductors, LCD, LED</td>
<td>7,191</td>
<td>7,968</td>
<td>12,901</td>
<td>-10%</td>
</tr>
<tr>
<td>Other electrical/electronics</td>
<td>6,861</td>
<td>7,610</td>
<td></td>
<td>-10%</td>
</tr>
<tr>
<td>Automotive</td>
<td>5,631</td>
<td>5,386</td>
<td></td>
<td>+5%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>1,005</td>
<td>1,882</td>
<td>2,405</td>
<td>-47%</td>
</tr>
<tr>
<td>Food</td>
<td>623</td>
<td>366</td>
<td>373</td>
<td>+70%</td>
</tr>
<tr>
<td>All others</td>
<td>633</td>
<td>1,275</td>
<td></td>
<td>-9%</td>
</tr>
<tr>
<td>Unspecified</td>
<td>8,497</td>
<td>6,661</td>
<td>6,629</td>
<td></td>
</tr>
</tbody>
</table>

Source: World Robotics 2022
Demand for industrial robots in Germany growing slowly

Annual installations of industrial robots - Germany

1,000 units

Source: World Robotics 2022
Automotive is still the major customer in Germany

Annual installations of industrial robots by customer industry - Germany

<table>
<thead>
<tr>
<th>Industry</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicles</td>
<td>6,206</td>
<td>6,672</td>
<td>6,507</td>
<td>-7%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>3,376</td>
<td>2,538</td>
<td>3,683</td>
<td>+33%</td>
</tr>
<tr>
<td>Automotive parts</td>
<td>2,740</td>
<td>2,998</td>
<td>3,719</td>
<td>-9%</td>
</tr>
<tr>
<td>Rubber and plastics</td>
<td>1,490</td>
<td>997</td>
<td>1,548</td>
<td>+49%</td>
</tr>
<tr>
<td>Electrical/electronics</td>
<td>1,053</td>
<td>1,154</td>
<td>1,250</td>
<td>+10%</td>
</tr>
<tr>
<td>Pharma/cosmetics</td>
<td>485</td>
<td>422</td>
<td>450</td>
<td>+15%</td>
</tr>
<tr>
<td>All others</td>
<td>1,599</td>
<td>2,325</td>
<td>2,441</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: World Robotics 2022
Trends and Forecast
Excellent growth prospects for 2022

Annual installations of industrial robots 2016-2021 and 2022*-2025*

*forecast

Source: World Robotics 2022
Annual installations of industrial robots 2020-2021 and 2022*-2025*

*forecast

Source: World Robotics 2022
Short-term market determinants

- Macroeconomic headwinds
  - High inflation in the Americas and Europe
  - Tightening of monetary policy
  - Slowdown of Chinese economy

- Geopolitical tensions leading to uncertainty

- Covid-19 restrictions still hamper business activities
  - Travel restrictions / quarantine requirements
  - Local outbreaks interrupt supply chains
Short-term market determinants

- Full order books
  - Strong order intake in 2022
- **Scarcity of raw materials** and intermediate products
  - Transportation challenge
  - Longer lead times
  - Growing order backlog
- Continued demand from electronics industry

- Political support
  - Ongoing government incentives (e.g., “NextGenerationEU”)
  - Ambitious targets force automotive industry to invest
    - 100% electric vehicles in EU by 2035
    - 50% New Energy Vehicles in China by 2035
- Labor scarcity in many developed economies
Market trends

- Re- and nearshoring of production
  - Securing supply chains
  - Increasing resilience and flexibility (logistics, politics)

- “Democratizing” robotics
  - Low-cost robotics opens up new customer segments
  - Easy setup and installation (out-of-the-box solutions)
  - New distribution channels

- Ongoing trend to high mix-low volume production
  - Growing demand for highly customized products
  - Fully digitalized production from order intake to delivery.
Technological trends

- **Sustainable development**
  - Reducing the carbon footprint of production
  - Responsible industrialization
  - Contributing to the accessibility/availability of renewable energies

- **Advancements in adjacent technologies**
  - Vision and spacial awareness technologies
  - New software and end effectors for a diversified range of tasks
  - AI offering new applications

- **Human-robot collaboration** steadily developing
  - Expanding product range with higher payloads and longer reach
  - Business ecosystems & one-stop shops ease the deployment
  - Ease of use is a driver for the use of cobots
Long-term Growth Driver: Demographic change

- Low birth rates (< 2.1 children per woman) and babyboom generation going to retire
- Growing need for elderly care
- Situation similar in major economies

➢ Massive labor shortage to be expected

Source: United Nations

Germany  
2020

Japan

2050

China

Source: United Nations
Labor Shortage beyond the Manufacturing Industry

- Intralogistics
  - in factories and e-commerce
- Professional Cleaning
- Inspection and Maintenance
- Hospitality
- Agriculture

Source: Energy Robotics, PAL Robotics
Source: FarmDroid, DeLaval
Megatrends

24% of global retail sales online by 2026
Statista

Building square footage +39% by 2050 in the US
Health Care Weekly

Worldwide housing crisis - impacting 1.6 billion people by 2025
Worldbank

15 mn health care workers missing worldwide by 2030
WHO

Glyphosat ban worldwide
WHO

What's next?
Service robots – top findings

2021: Continuous growth

New professional service robots*
- 121,000 units (+37%)

New consumer service robots
- 19 million units (+9%)

*All numbers based on a sample of 229 companies and 2 association reports
Top 6 application areas for professional service robots

- **Hospitality**: 20.0k units, +85%
- **Medical/Healthcare**: 14.8k units, +23%
- **Professional Cleaning**: 12.6k units, +31%
- **Agriculture**: 8.0k units, +6%
- **Transportation & Logistics**: 49.5k units, +45%
- **Maintenance and inspection**: 5.5k units, +21%
Transportation & Logistics

State of the art

Future trend

49.5k units, +45%
Hospitality

State of the art

Future trend

20.0k units, +85%
Medical/Healthcare

State of the art

Future trend

14.8k units, +23%
Professional Cleaning

State of the art

Future trend

12.6k units, +31%
Agriculture

State of the art

Future trend

8.0k units, +6%
Maintenance and inspection

State of the art

Future trend

5.5k units, +21%
Service robots for professional use. Top 5 applications
Unit sales 2020 and 2021
'000 of units

Transportation and logistics AP5
Hospitality AP8
Medical robotics AP6
Professional cleaning AP2
Agriculture AP1

Source: World Robotics 2022
The United States is home of most service robot suppliers

Service robot manufacturers by country (top 10) all applications

- United States: 194 (2 Incumbents, 29 Start-ups)
- China: 94 (1 Incumbents, 9 Start-ups)
- Germany: 79 (12 Incumbents, 0 Start-ups)
- Japan: 61 (5 Incumbents, 5 Start-ups)
- France: 49 (5 Incumbents, 5 Start-ups)
- Russian Federation: 44 (3 Incumbents, 3 Start-ups)
- South Korea: 44 (3 Incumbents, 3 Start-ups)
- Switzerland: 34 (4 Incumbents, 4 Start-ups)
- Canada: 35 (4 Incumbents, 4 Start-ups)

Source: World Robotics 2022
2013-2016: baby boom years for service robotics

Number of companies

12% Start-ups
More than 1,000 service robot suppliers worldwide – start-ups becoming mature

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Suppliers</th>
<th>Incumbents</th>
<th>Start-ups</th>
<th>Unknown founding year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>342</td>
<td>54</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>America</td>
<td>0</td>
<td>186</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asia</td>
<td>1</td>
<td>185</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Australia/Africa</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Suppliers</th>
<th>Incumbents</th>
<th>Start-ups</th>
<th>Unknown founding year</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Australia/Africa</td>
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</tbody>
</table>

Source: World Robotics 2022
80% of service robot supplier are small-medium sized enterprises (SME with <=500 employees)

Number of service robot manufacturers by business size (number of employees)

Source: World Robotics 2022
Outlook

- Lack of skilled staff/
  Demographic change

- New business models:
  Robots-as-a-Service

- Technology advances and AI are opening up new use
  cases and improves performance in existing ones
Thank you for your attention.