## For you on the panel

<table>
<thead>
<tr>
<th>Marina Bill</th>
<th>Dr. Christopher Müller</th>
<th>Dr. Werner Kraus</th>
<th>Dr. Susanne Bieller</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFR President</td>
<td>Director Statistical Dpt.</td>
<td>Chair IFR Service Robot Group</td>
<td>General Secretary</td>
</tr>
<tr>
<td>Global Head Marketing &amp; Sales, ABB Robotics</td>
<td>International Federation of Robotics</td>
<td>Head of Dpt. Robot &amp; Assistive Systems, Fraunhofer IPA</td>
<td>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
  - AIA (Advanced Industrial Automation Association)
  - KAR (Korean Association of Robotics)
  - NFEA (North American Foundry Engineering Association)
  - BARA (British Robotics Association)
  - CRIA (Canadian Robotics Industry Association)
  - DIRA (German Robotics Industry Association)
  - SwissRobotics.net
  - Evolis
  - TAIROA
  - VDMA

- Industrial Robot Manufacturers
  - ABB
  - KUKA
  - Nachi
  - Neura Robotics
  - Comal
  - Omron
  - Daewon
  - Durr
  - Ebara
  - Epson
  - Staubli
  - Universal Robots
  - Fanuc
  - Wittmann
  - Fourier
  -Fetch Robotics
  - General Electric
  - Geely Robotics
  - Yuanda Robotics

- Component Suppliers, Integrators, Service Robot Manufacturers
  - 3M
  - Genesis Systems
  - Ambarella
  - HSD Micromotors
  - ATI
  - IBG
  - ILjin Motor & Control Center
  - Mir
  - MIR
  - OK System
  - Inuitive
  - Intel
  - Touché Solutions
  - Standard Robots
  - Robotiq
  - Wepall
  - Geeks+ Geeks++
  - JAKA
  - Schaeffler

- R&D Institutes
  - Fraunhofer IPA
  - NTNU – Twente IHL
  - SwRI
  - SIRI
  - IRIS
  - VDMA
Three pillars of IFR activities

IFR

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

Image: Dürr

Service robots

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

Source: World Robotics 2022
Electronics is major customer of industrial robots

Annual installations of industrial robots by customer industry - World

1,000 units

Electrical/electronics
- 2019: 89
- 2020: 110
- 2021: 137
+24%

Automotive
- 2019: 102
- 2020: 84
- 2021: 119
+42%

Metal and machinery
- 2019: 64
- 2020: 44
- 2021: 102
+45%

Plastic and chemical products
- 2019: 52
- 2020: 24
- 2021: 19
+29%

Food
- 2019: 11
- 2020: 15
- 2021: 12
+18%

All others
- 2019: 30
- 2020: 37
- 2021: 52

Unspecified
- 2019: 87
- 2020: 87
- 2021: 107

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>

'+000 units

*revised

Source: World Robotics 2022
Strong growth in all regions

Annual installations of industrial robots ('000 of units)

<table>
<thead>
<tr>
<th>Year</th>
<th>Asia/Australia</th>
<th>Europe</th>
<th>The Americas</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>284</td>
<td>76</td>
<td>55</td>
</tr>
<tr>
<td>2019</td>
<td>259</td>
<td>74</td>
<td>47</td>
</tr>
<tr>
<td>2020</td>
<td>277</td>
<td>68</td>
<td>39</td>
</tr>
<tr>
<td>2021</td>
<td>381</td>
<td>84</td>
<td>51</td>
</tr>
</tbody>
</table>

Annual percentage growth of installations of industrial robots

- 2020: +7%
- 2021: +38%

Source: International Federation of Robotics
### China increases its lead

#### Annual installations of industrial robots
15 largest markets 2021

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

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)

- **2016**: China 97, Rest of World 207
- **2017**: China 156, Rest of World 243
- **2018**: China 155, Rest of World 268
- **2019**: China 148, Rest of World 243
- **2020**: China 178, Rest of World 216
- **2021**: China 268, Rest of World 249

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

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23</td>
<td>23</td>
<td>37</td>
<td>57</td>
<td>69</td>
<td>97</td>
<td>156</td>
<td>155</td>
<td>148</td>
<td>178</td>
<td>268</td>
</tr>
</tbody>
</table>

Source: World Robotics 2022

+51%
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>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical/electronics</td>
<td>88</td>
<td>42</td>
<td>64</td>
<td>+38%</td>
</tr>
<tr>
<td>Automotive</td>
<td>62</td>
<td>32</td>
<td>31</td>
<td>+97%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>34</td>
<td>22</td>
<td>22</td>
<td>+55%</td>
</tr>
<tr>
<td>Rubber and plastics</td>
<td>22</td>
<td>18</td>
<td>22</td>
<td>+22%</td>
</tr>
<tr>
<td>Food</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>+14%</td>
</tr>
<tr>
<td>Pharma/cosmetics</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-15%</td>
</tr>
<tr>
<td>All others</td>
<td>29</td>
<td>22</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>43</td>
<td>30</td>
<td>31</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
US General Industry driving growth

Annual installations of industrial robots by customer industry - United States

<table>
<thead>
<tr>
<th>Industry</th>
<th>2021</th>
<th>2020</th>
<th>2019</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>9,782</td>
<td>10,494</td>
<td>12,960</td>
<td>-7%</td>
</tr>
<tr>
<td>Metal and machinery</td>
<td>3,814</td>
<td>2,294</td>
<td>3,785</td>
<td>+66%</td>
</tr>
<tr>
<td>Plastic and chemical</td>
<td>3,466</td>
<td>2,661</td>
<td>2,491</td>
<td>+30%</td>
</tr>
<tr>
<td>Plastic and chemical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>products</td>
<td>3,710</td>
<td>2,857</td>
<td>3,460</td>
<td>-23%</td>
</tr>
<tr>
<td>Food</td>
<td>3,402</td>
<td>2,715</td>
<td>2,224</td>
<td>+25%</td>
</tr>
<tr>
<td>Electrical/electronics</td>
<td>4,523</td>
<td>3,710</td>
<td>3,460</td>
<td></td>
</tr>
<tr>
<td>All others</td>
<td>2,618</td>
<td>3,491</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>7,143</td>
<td>6,295</td>
<td>4,967</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>2021</th>
<th>2020</th>
<th>2019</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>1,154</td>
<td>1,053</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>1,593</td>
<td>2,441</td>
<td>2,325</td>
<td></td>
</tr>
<tr>
<td>Unspecified</td>
<td>5,885</td>
<td>6,075</td>
<td>2,816</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
Short-term market determinants

- Macroeconomic headwinds
- Geopolitical tensions leading to uncertainty
- Covid-19 restrictions still hamper business activities
Short-term market determinants

- Full order books
- Scarcity of raw materials and intermediate products
- Continued demand from electronics industry
- Political support
- Labor scarcity in many developed economies
Market trends

- Re- and nearshoring of production
- “Democratizing” robotics
- Ongoing trend to high mix-low volume production
Technological trends

- Sustainable development
- Advancements in adjacent technologies
- Human-robot collaboration steadily developing
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
Labor Shortage beyond the Manufacturing Industry

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

- 24% of global retail sales online by 2026

- Building square footage +39% by 2050 in the US

- Worldwide housing crisis - impacting 1.6 billion people by 2025

- 15 mn health care workers missing worldwide by 2030

- Glyphosat ban worldwide
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%
The United States is home of most service robot suppliers

Service robot manufacturers by country (top 10) all applications

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

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

Number of companies

12% Start-ups
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.