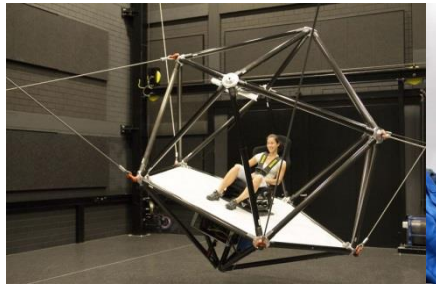
Robotics impacts Industry and Society: What are the Numbers and Trends?

ROS-Industrial Conference 2019; Stuttgart, 10-12 December 2019





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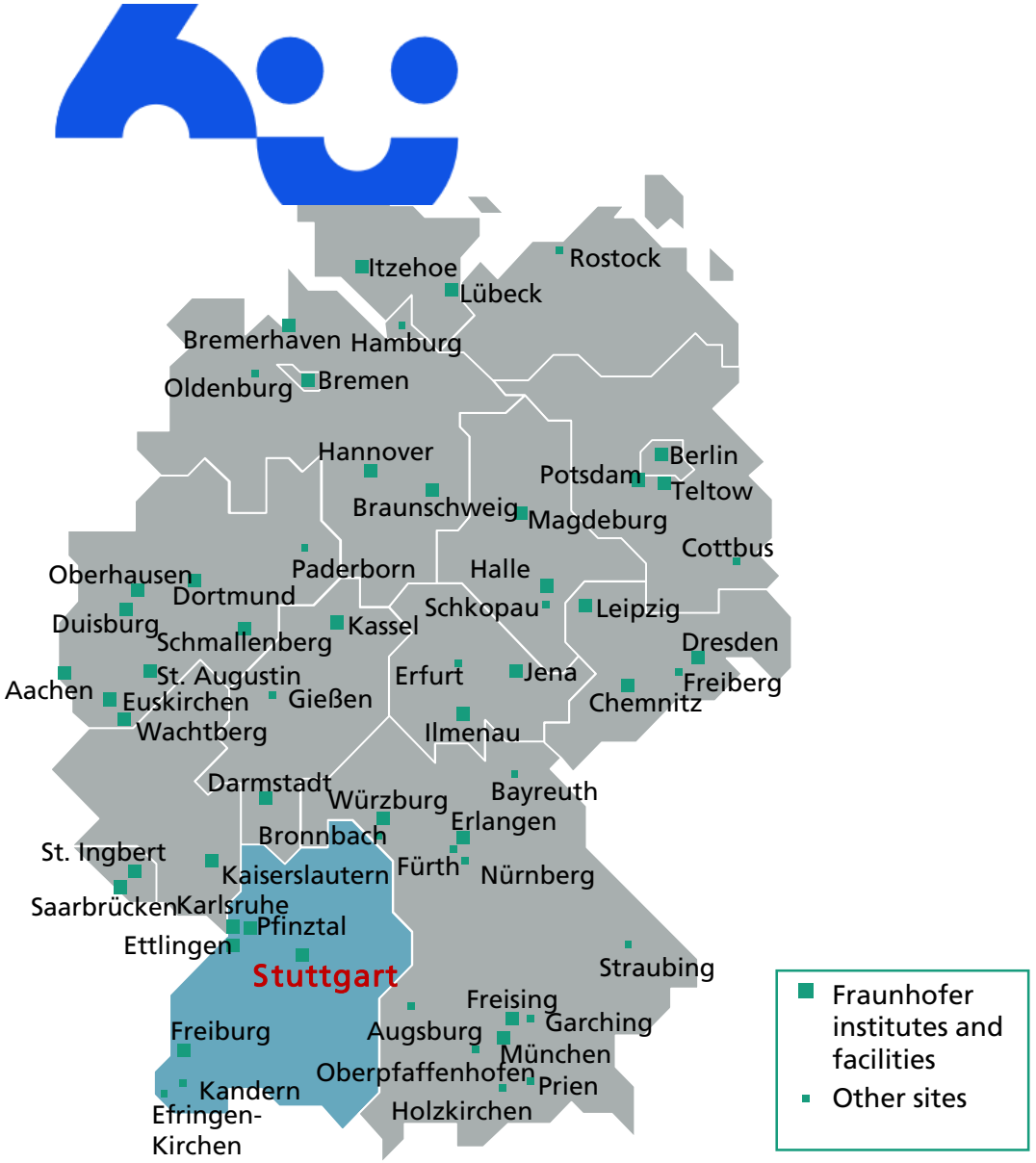
as part of the Fraunhofer-Gesellschaft

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

- One of the largest institutes of the Fraunhofer-Gesellschaft
- IPA located in Stuttgart, the capital of federal state of Baden-Württemberg
- IPA: More than 1,000 employees
- 60 years of experience implementing innovations for the industry
- Main customers are equipment/ machinery and automotive industry
- 74 M€ Budget in 2018, 28 M€ industrial revenues



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Diversity of Research Missions

Main Pillars

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Application oriented Research

Application

Universities

Research and Education

HELMHOLTZ GEMEINSCHAFT

Pursues the long-term research goals of state and society

Leibniz-Gemeinschaft

Knowledge-driven and applied basic research

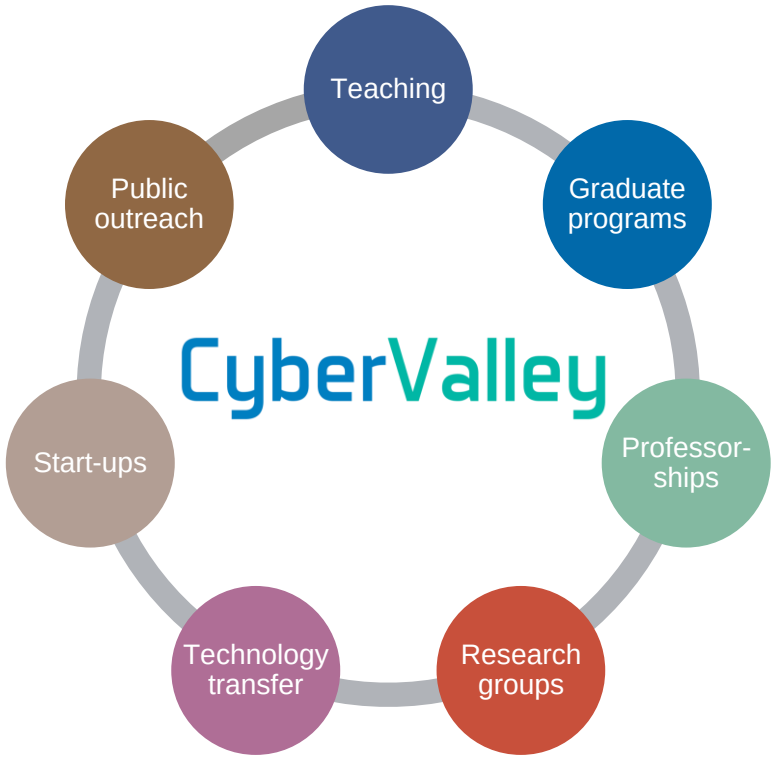
MAX-PLANCK-GESELLSCHAFT

Basic research – curiosity driven

Basics

CyberValley — A cluster for artificial intelligence and robotics

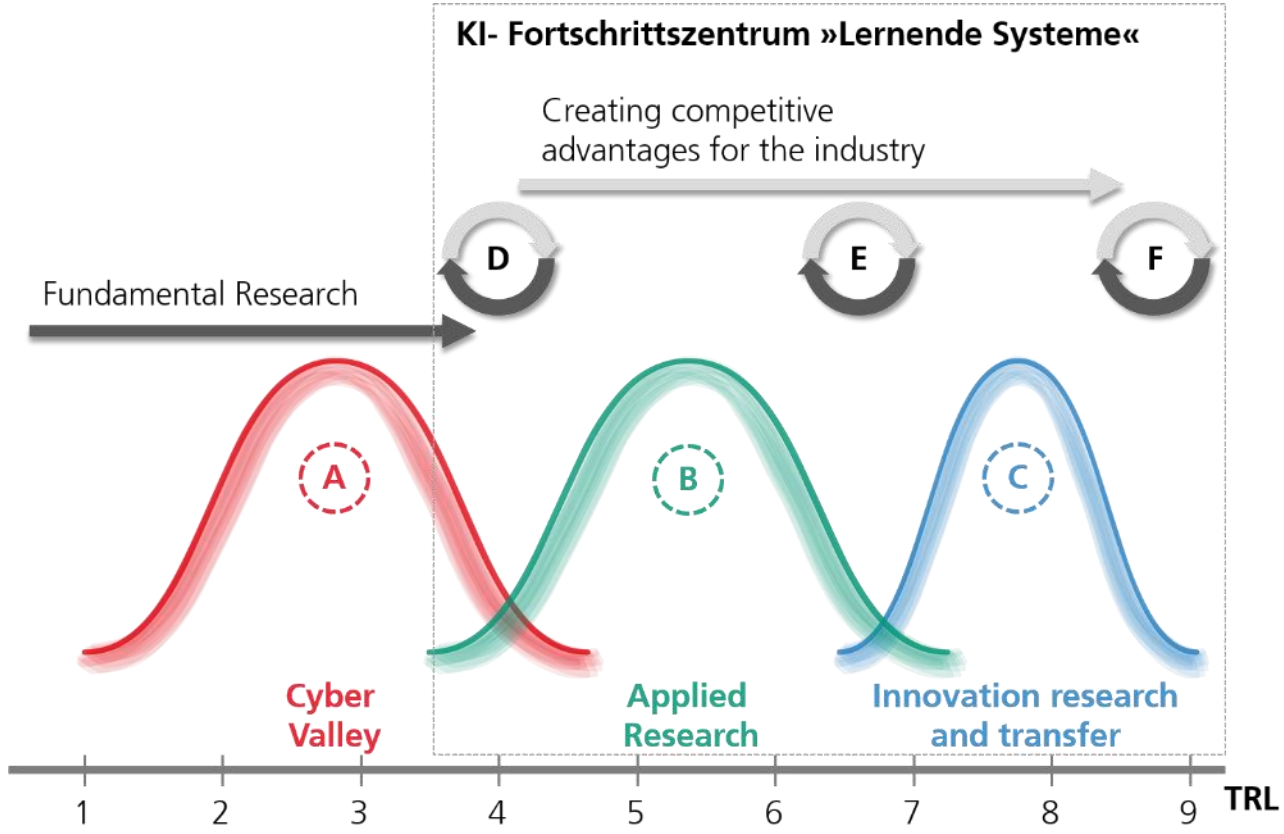
- **Europe's largest research consortium** for artificial intelligence
- Partners from **academia, business, and society**
- Attracts researchers from **around the world**
- Offers a European perspective



Spokesperson:
Dr. Michael J. Black
MPI for intelligent systems

Baden-Württemberg
MAX PLANCK GESELLSCHAFT
Universität Stuttgart
EBERHARD KARLS UNIVERSITÄT TÜBINGEN
Fraunhofer
amazon
BMW
BOSCH Technik fürs Leben
DAIMLER
automotive iav
PORSCHE
ZF

AI innovation center Learning Systems
Overview



Example from Max-Planck Institute for Intelligent Systems: Learning control

Technical equipment and laboratories

In tune with the times


Application Center Industrie 4.0


Motion laboratory


Machine vision laboratories


Biomanufacturing laboratory


Factory planning and production laboratory


Future Work Lab


Electroplating laboratory


Intervention room


Labs for additive manufacturing


Labs for cutting, joining and sawing


Coating technology center


nICLAS Laboratory automation


Cleanrooms & cleanliness rooms


Robotics experimentation area


Model factory for functional coatings


Virtual Orthopedic Lab

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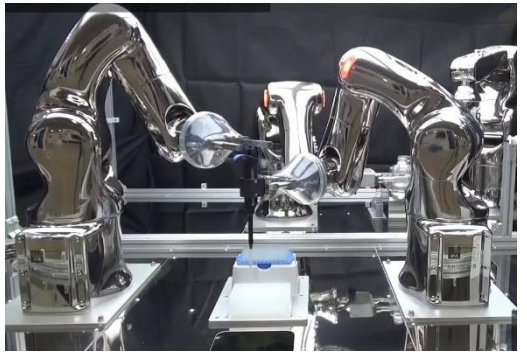
Worldwide shipments of industrial robotics in 2018

Most relevant industrial application areas and processes

Handling (42%)



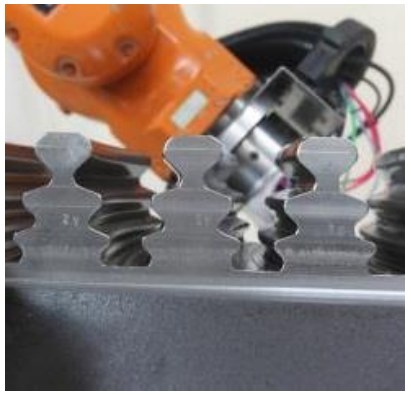
Clean Room (10%)



Welding (21%)

Assembly (11%)


Machining (1%)



Dispensing (3%)

World Robotics Report; www.worldrobotics.org, Sept. 2019

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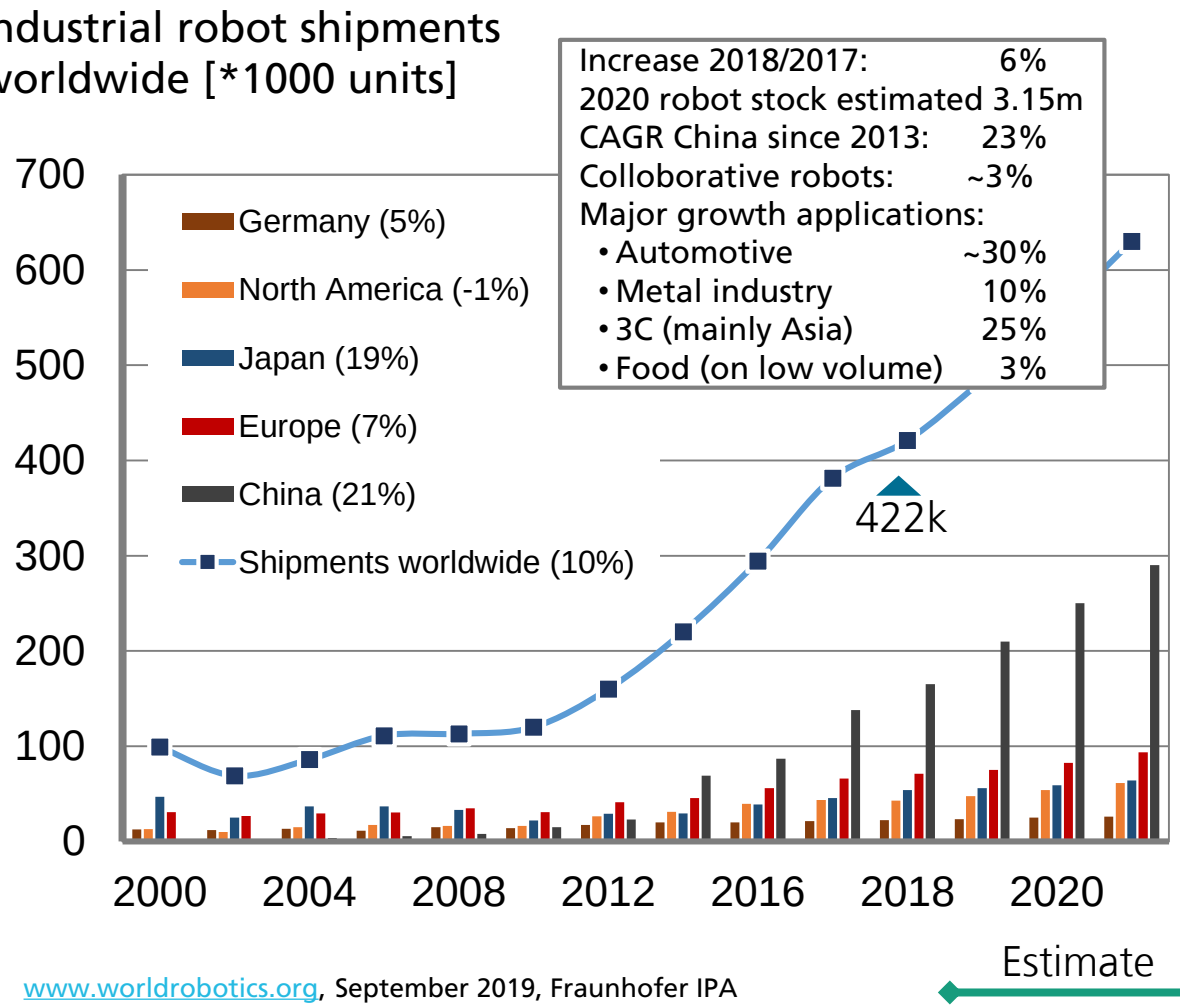
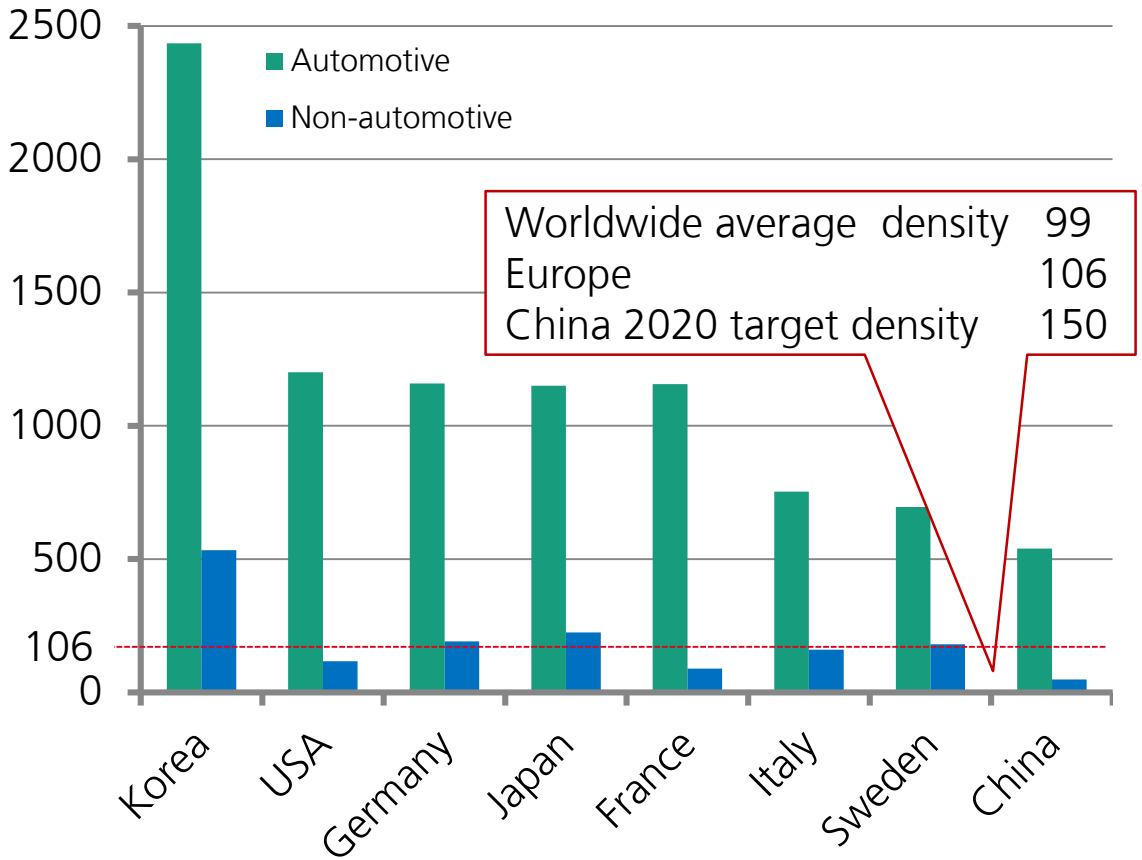
Industrial robot shipments (new installations)
All time high in 2018 and positive prospects

Industrial robot shipments worldwide [*1000 units]



Robot density 2018: Number [units] of installed industrial robots per 10,000 employees in the respective domains



www.worldrobotics.org, September 2019, Fraunhofer IPA

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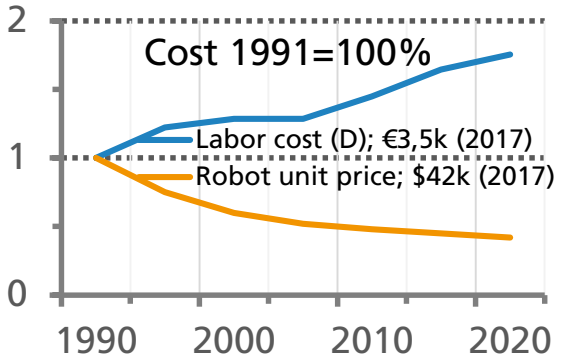
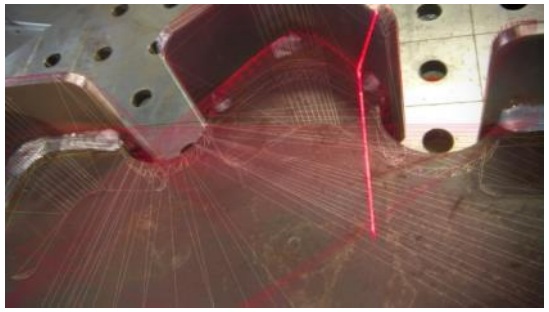
Technology Trends in Industrial Robotics

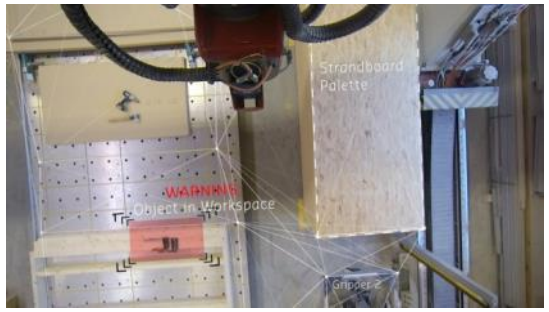
Cost effectiveness





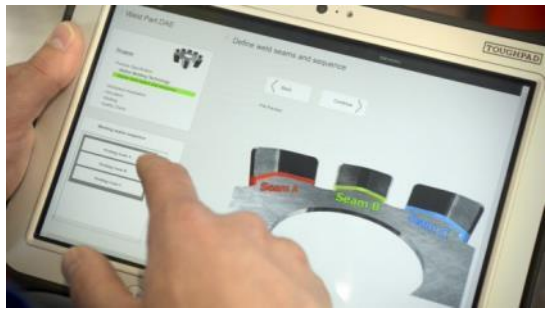
Sensors

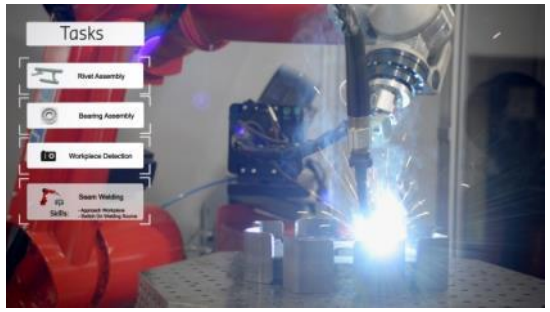
Human-Robot Collaboration



Cognitive capabilities

Networked → Industrie4.0





Skill-based, intuitive robot instruction

Robot Optimization by AI/Machine Learning

1 Processes, tasks
- Physical interaction
- Learning control
- Strategies, skills

2 Program generation
- Planning
- HMI
- Behavior explanation

3 Robot performance
- Accuracy
- Dynamics
- Durability etc.

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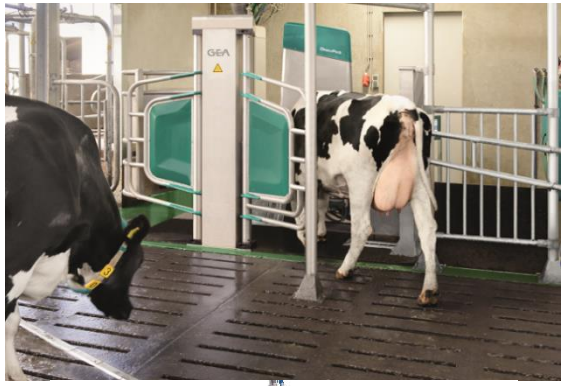
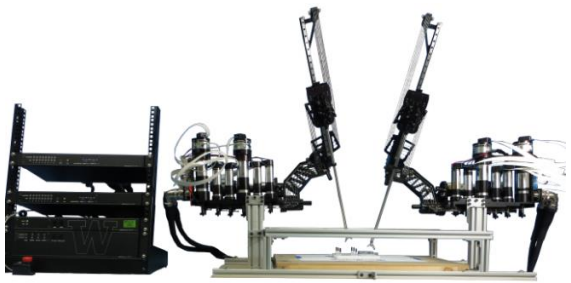
Service Robots for Professional Use I





Source: Deepfield Robotics, GEA, Vitirover, Lely, Applied Dexterity, Medroborics, Hocoma, Blue Ocean Robotics, Adlatus, EFFIDENCE/Deutsche Post, Navya, Robot Drilling Systems

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Service Robots for Professional Use II







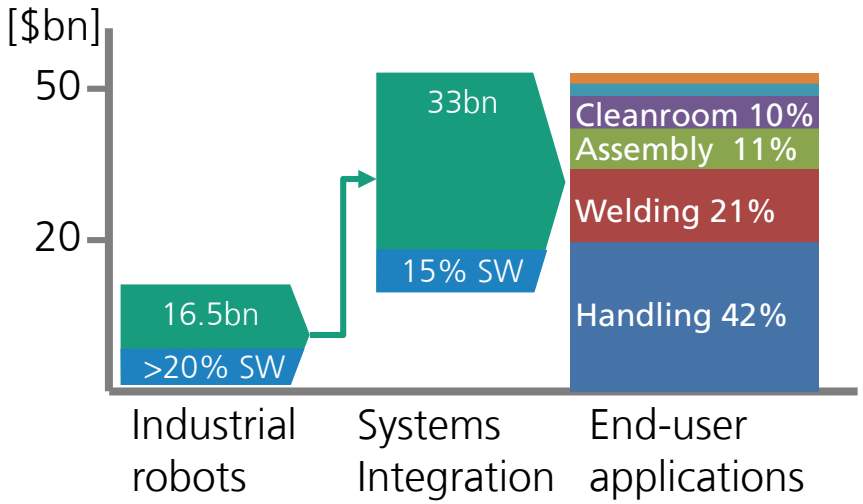




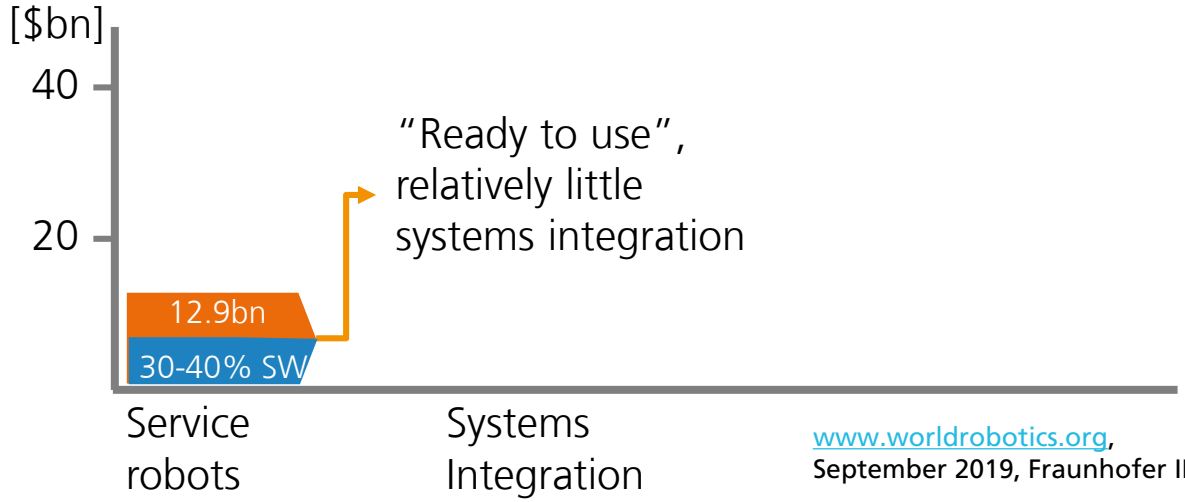
Source: Motorika, TWIICE, TBC France, Cobalt Robotics, metralabs, Roboteam, Lockheed Martin, Marathon Targets, ISE, Simbe Robotics, Kampai Robotics, Mojin Robotics, Aerotain

Industrial and service robotics supply industries

Industrial Robotics annual turn-over



Service Robotics annual turn-over



www.worldrobotics.org,
September 2019, Fraunhofer IPA

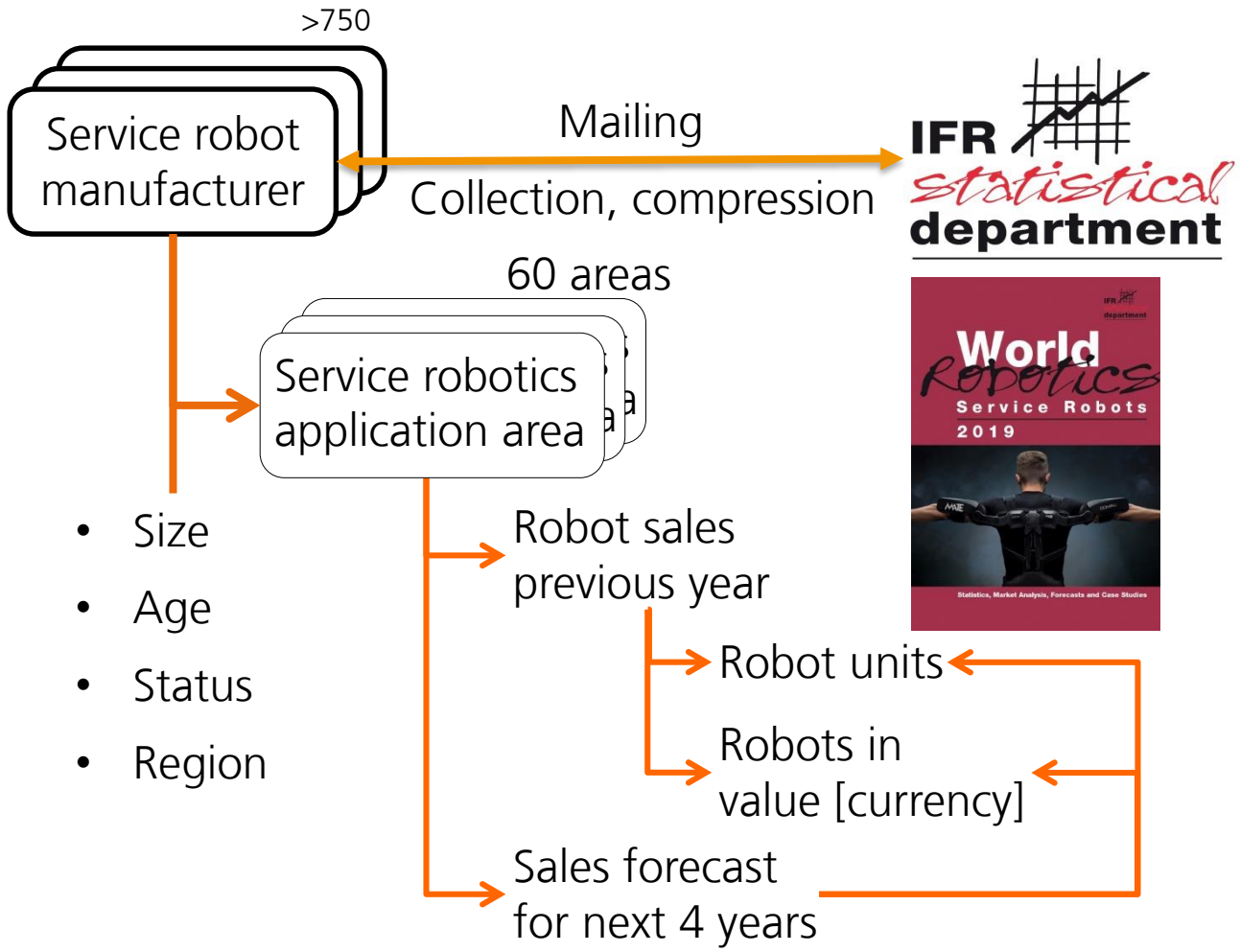
Key figures Industrial Robotics IR (est.)

- US$16.5bn turn-over Industrial Robots (IR)
- 55 IR manufacturers worldwide
- 1k systems integrators
- $50-55bn total turnover IR industries
- 15% CAGR until 2020+ (estimated)
- Average unit price US$53k (2012) → 42k (2017)

Key figures Service Robotics SR

- >$12.9bn turn-over (US$9.2bn professional service robotics, 3.7bn in "domestic/personal"
- >750 suppliers/manufacturers of SR, ~25% start-ups (max. 5 years)
- 70% use ROS in one form or the other (estimated)
- 41% CAGR (estimation until 2022) for professional SR
- 46% CAGR (estimation until 2022) for domestic/personal SR

Statistics Scheme and Classification of Service Robots by Application Areas



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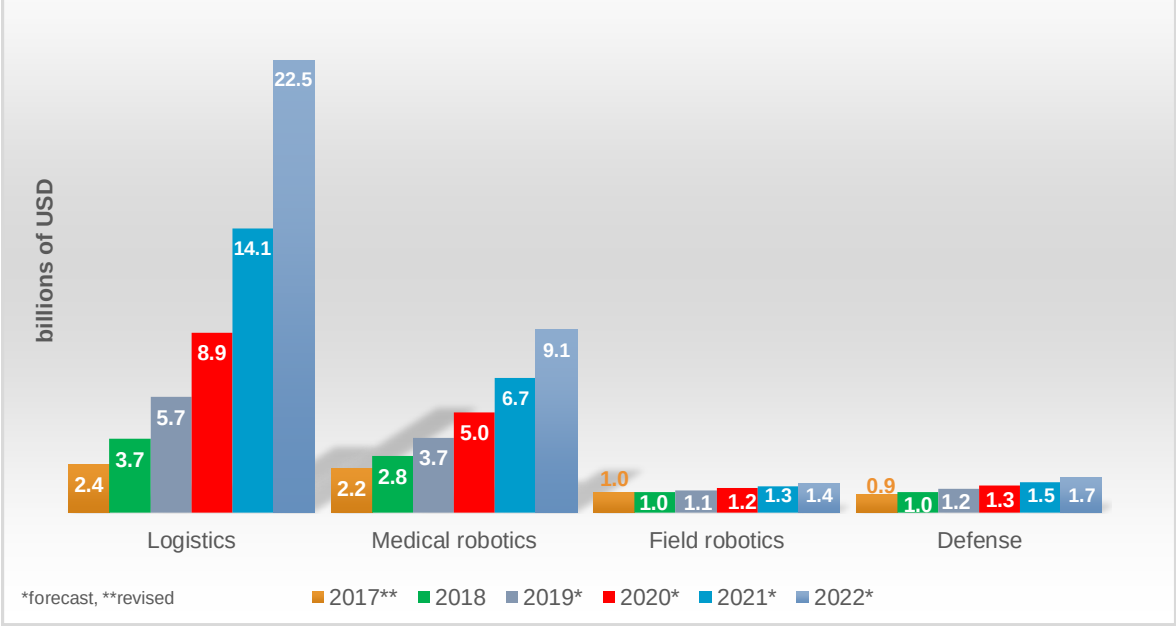
Professional use

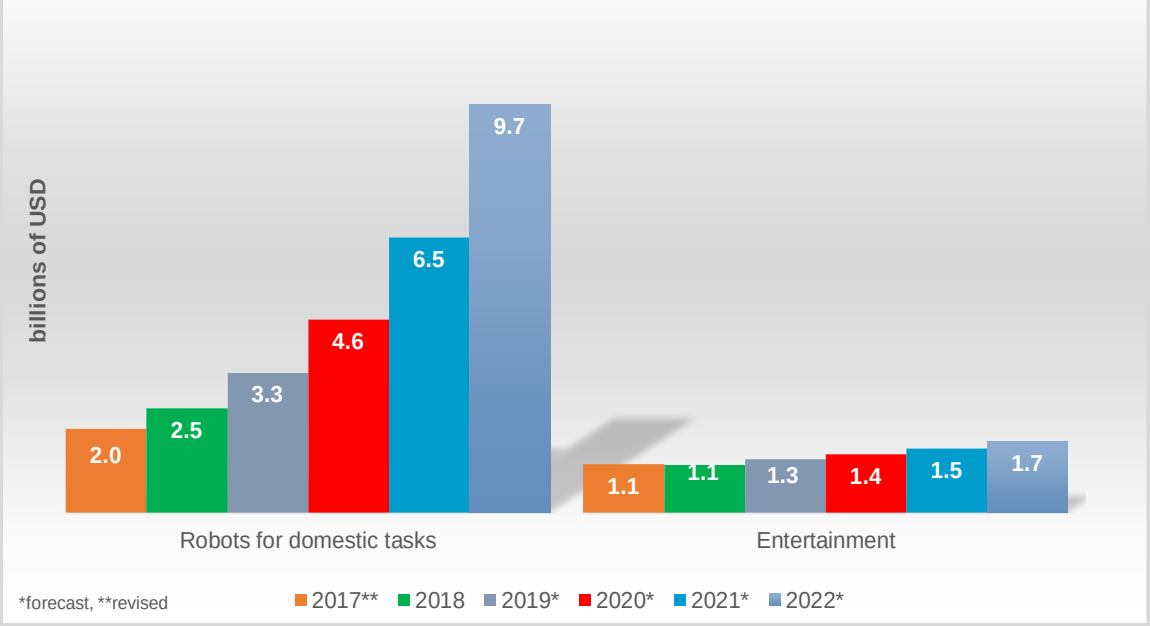
16-21	Field robotics
22-26	Professional cleaning
27-29	Inspection, maintenance systems
30-33	Construction and demolition
34-38	Logistic systems
39-42	Medical robotics
43-45	Rescue & security applications
46-50	Defense applications
51	Underwater systems (civil/general use)
52	Powered Human Exoskeletons
53	Mobile Platforms in general use
54-58	Underwater systems (civil/general use)
59	Other

Service Robots for Professional and Domestic Use (Main Applications) Estimated Values 2017 and 2018; forecasts(*) 2019 - 2022

Professional Applications



Domestic Applications



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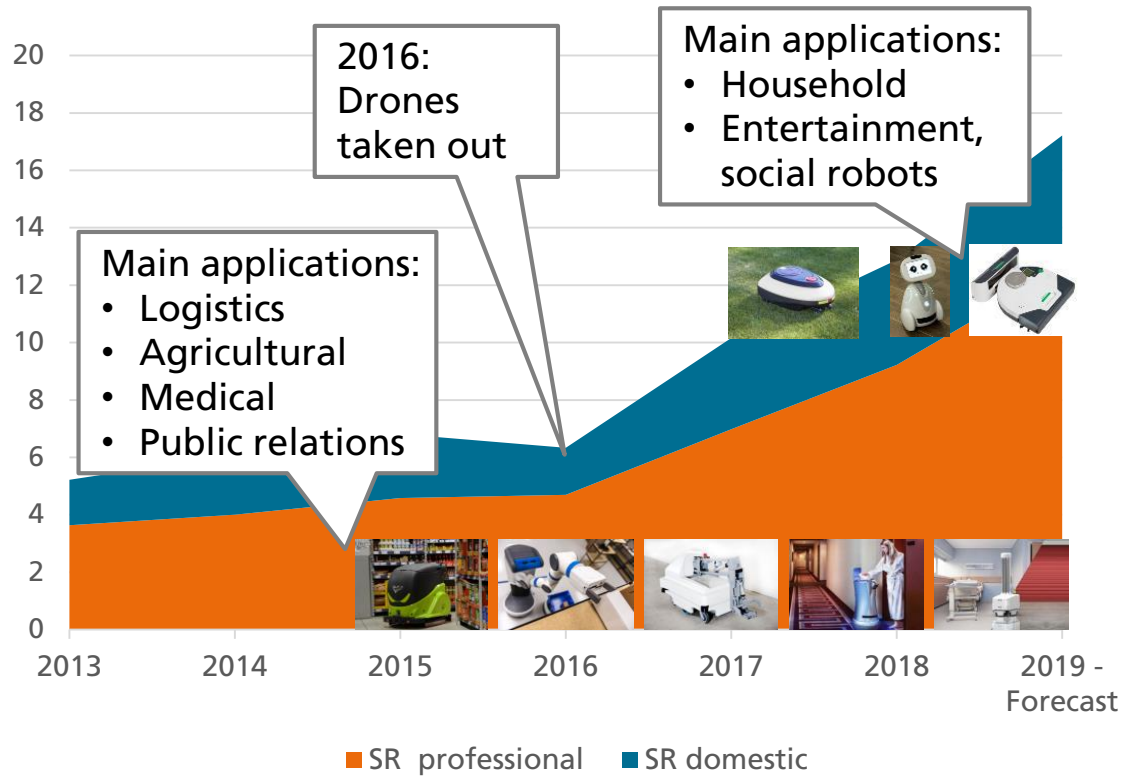
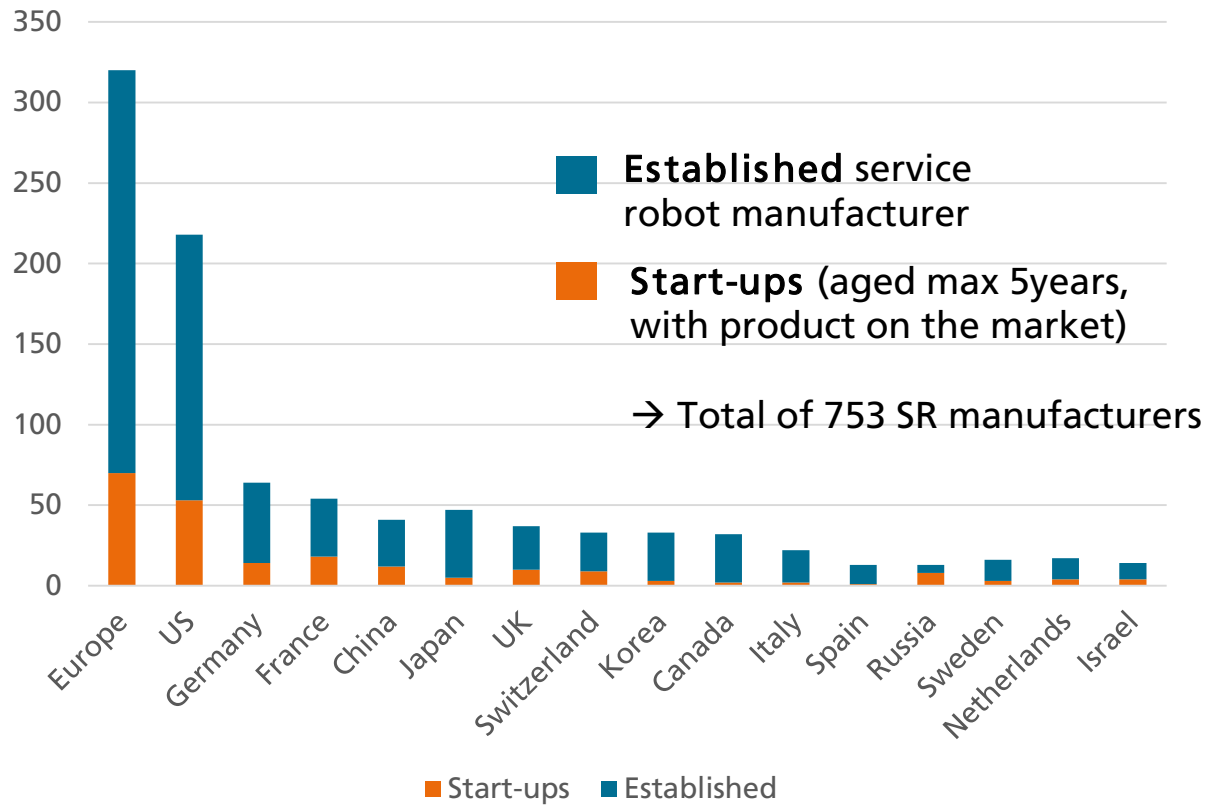
Robotics Outside the Manufacturing Scenario

Service robot (SR) annual sales worldwide for professional, domestic applications in [bnUS$]



Number of service robot manufacturers (professional and domestic use) by country of origin (2019, excerpt)



Source: World Robotics 2019; www.worldrobotics.org , Fraunhofer IPA

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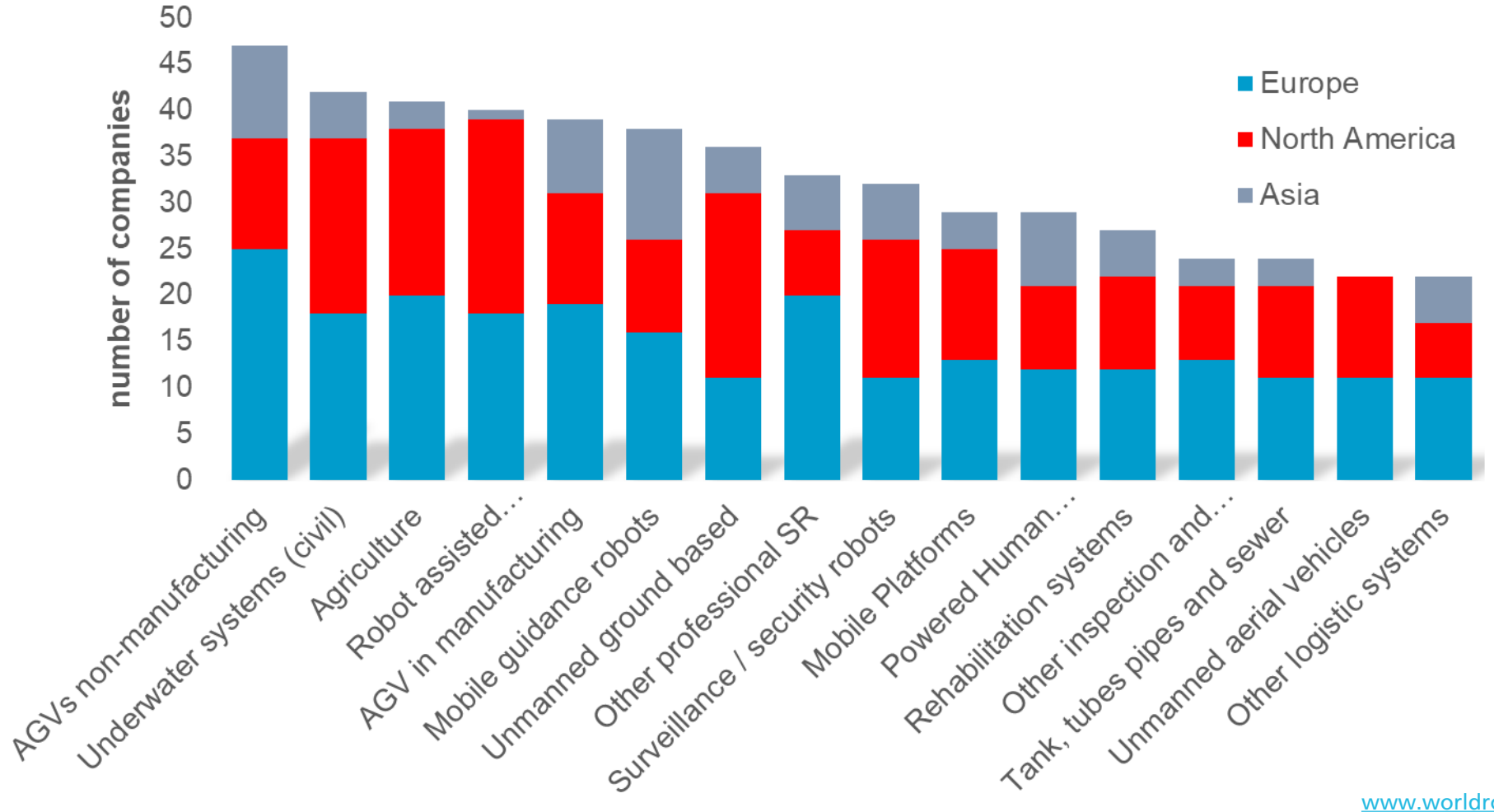
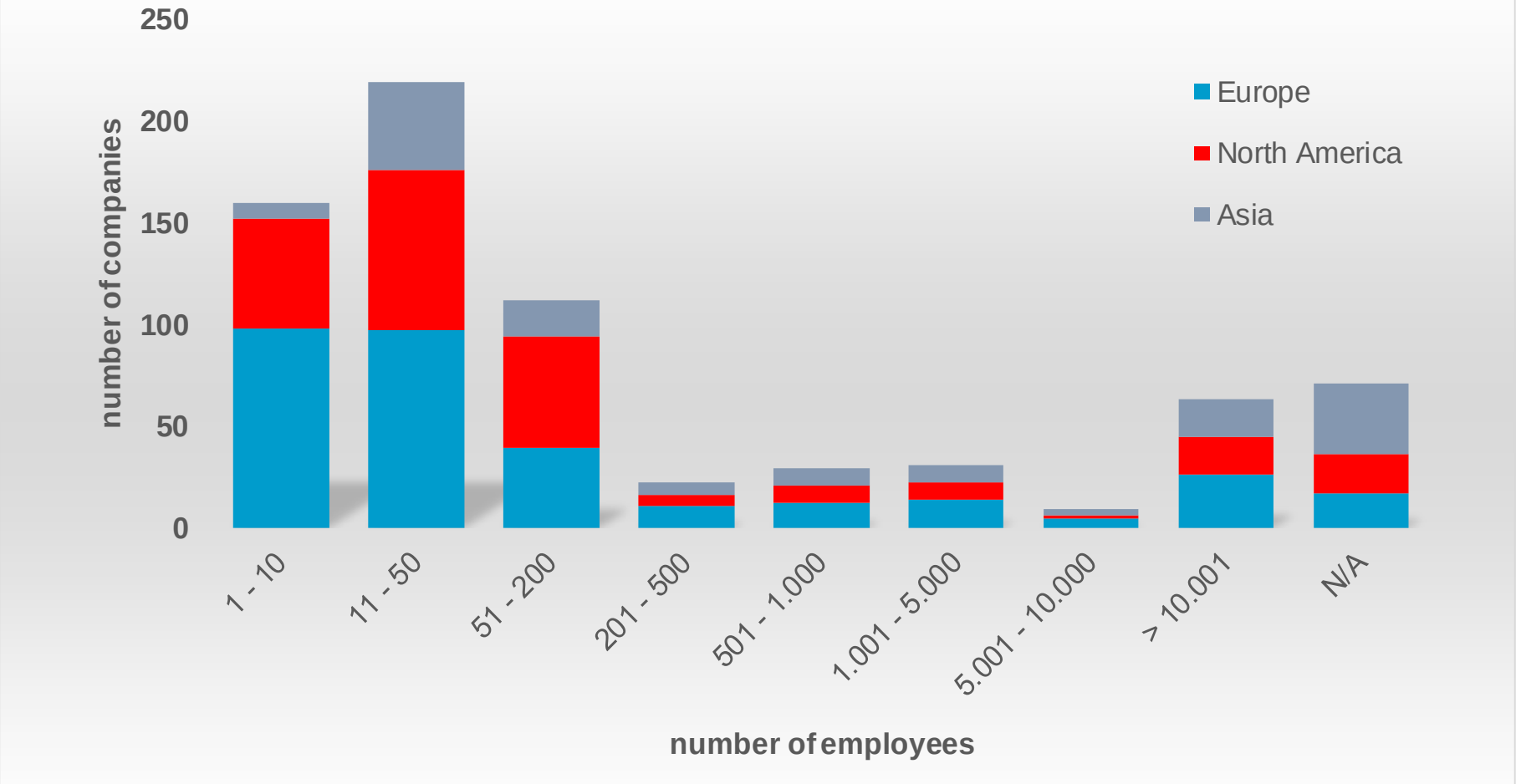
Number of service robot manufacturers by main types (professional use) and by region of origin, status 2018 (selection)



www.worldrobotics.org, Oktober 2019, Fraunhofer IPA

Business sizes of service robots of all types in numbers of employees (by region of origin, 2018)



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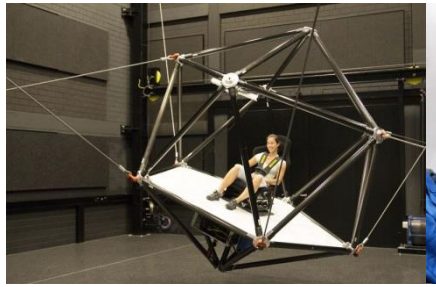



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