BURO VOOR FYSIEKE ARBEID TNO Ministerie van Sociale Zaken en Werkgelegenheid duurzameinzetbaarheid

Workshop 4

Robotisering en de gevolgen voor fysieke belasting

Door: Michiel de Looze en Reinier Könemann (TNO) en Marcel Grooten (TOM Projects & Interim)

Bijeenkomst duurzaam fysiek werk

Leren en innoveren

op weg naar duurzame**inzetbaarheid**

Brabantse Ontwikkelings Maatschappij

BOM

Support, Assistance & Collaborate

Tools & Toys

Jobs & Joys

Brabantse Ontwikkelings Maatschappij

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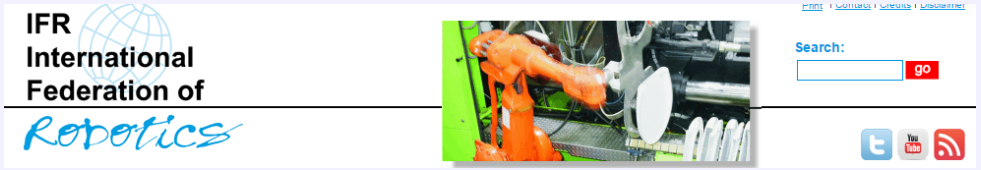
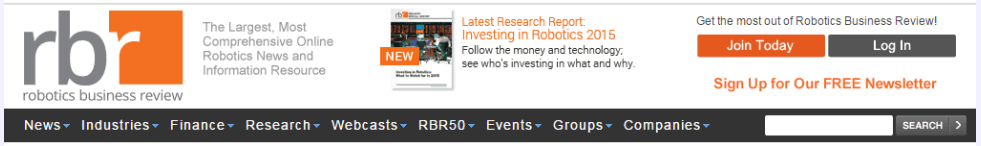
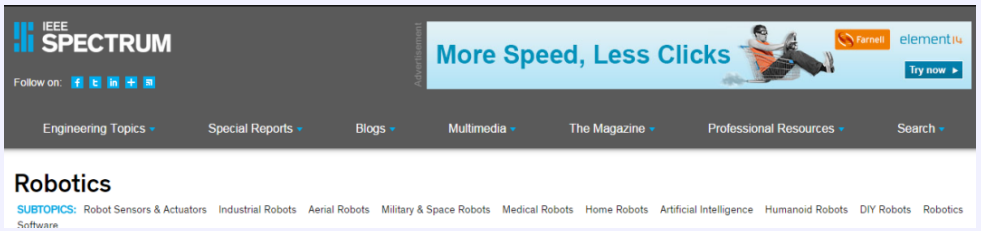
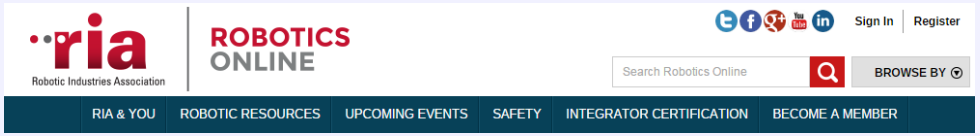
Platforms & Sites

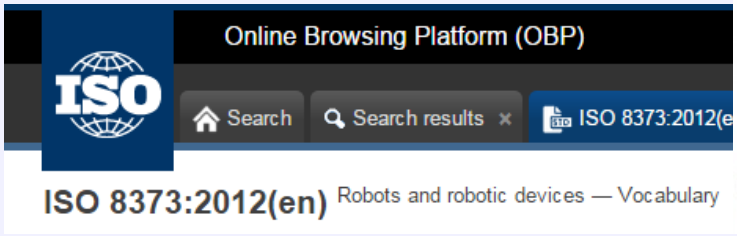
World Wide



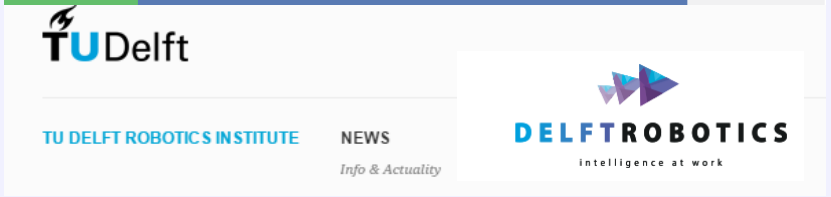


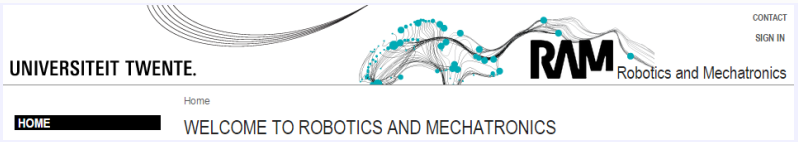


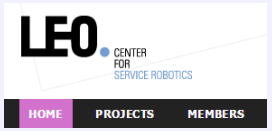


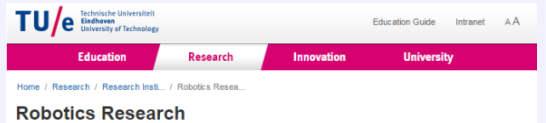


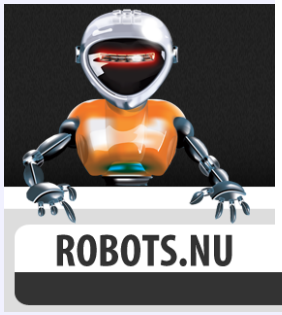
The Netherlands

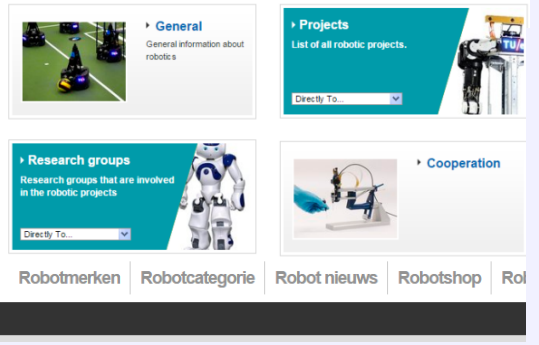












Brabantse Ontwikkelings Maatschappij

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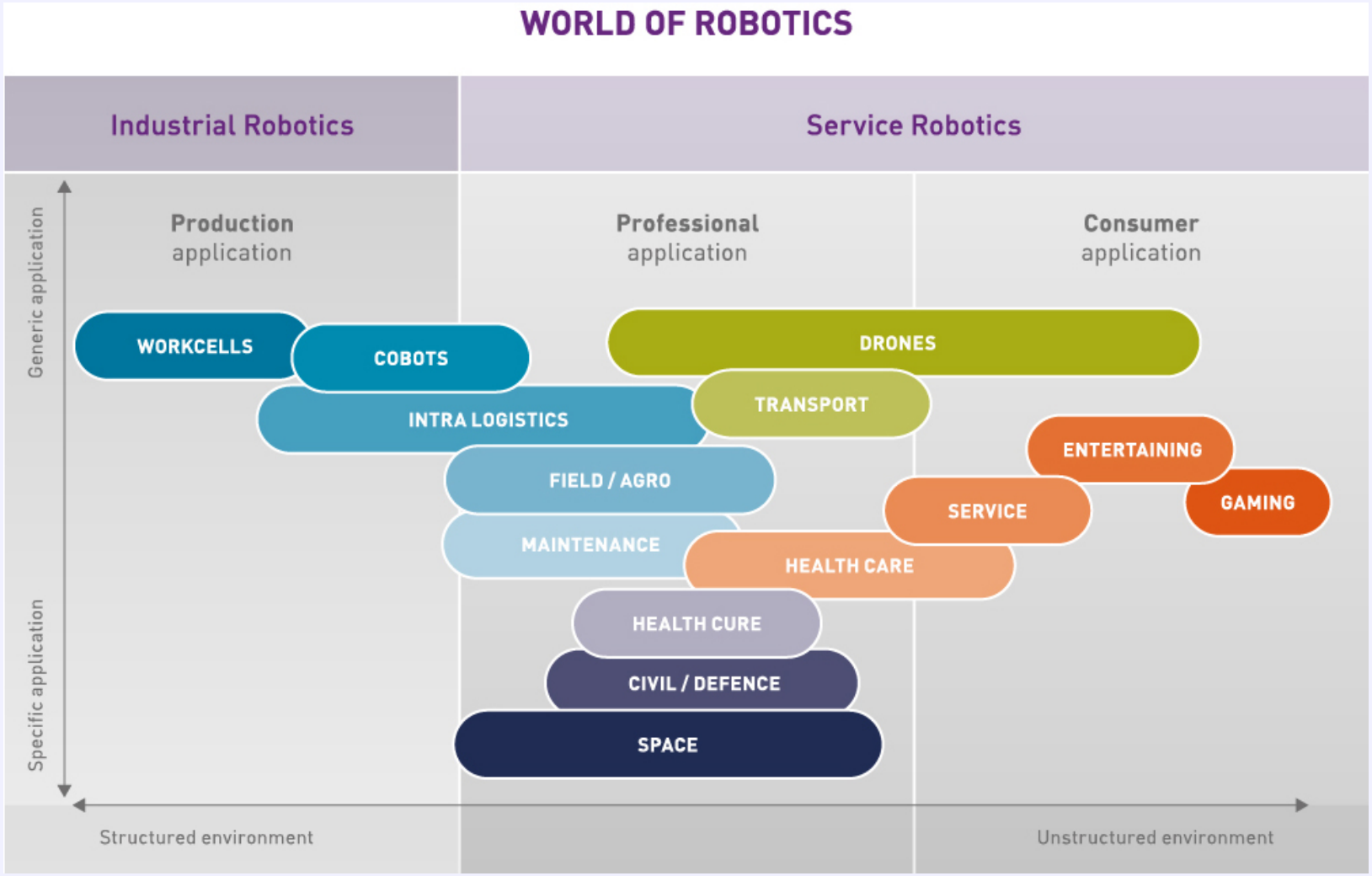
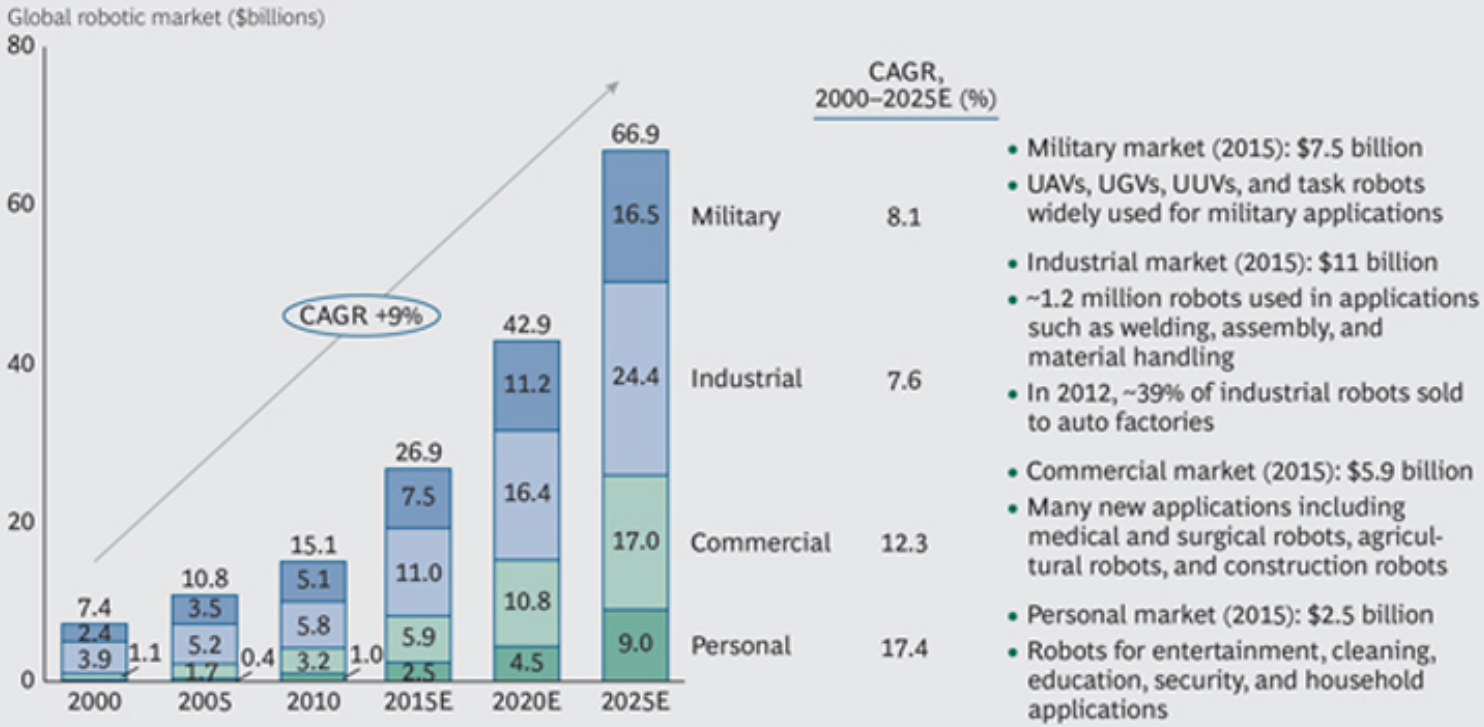
World of Robotics



World Market Growth

EXHIBIT 1 | Worldwide Spending on Robotics Is Expected to Reach $67 Billion by 2025



Sources: International Federation of Robotics, Japan Robot Association; Japan Ministry of Economy, Trade & Industry; euRobotics; company filings; BCG analysis.
Note: UAV = unmanned aerial vehicle; UGV = unmanned ground vehicle; UUV = unmanned underwater vehicle. Estimates do not include the cost of engineering, maintenance, training, or peripherals.

Source: Boston Consulting Group 2014

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Industrial Robotics

Characteristics

○ Around for over	40 years
○ Types & sizes	6DOF / SCARA / DELTA
○ 75% of the market	Big 4 (AFKY)
e.g. Yaskawa	*24.000 units/yr*
○ Average price HW	$ 50K/unit
○ Minimum pricing	$ 20K (SCARA)
○ Robot density NL low	93 robots/10K FTE
○ Market Benelux	1900 units/yr;
○ NL about	800 units/yr

Data irf.org

Trends

- Focus on **TCO** and **Productivity**
  Payload, Accuracy, Speed and Reliability
- Enhanced SW and control
- Random Order Picking
- Mobile robots on AGV
- Automated warehouse & logistics
- Automated work cells

ABB

FANUC

KUKA

YASKAWA MOTOMAN

And many others whereas:

Adept, Cloos, Comau, Epson, Denso, Hyundai, Kawasaki, Mitshubishi, Nachi, Electric, Panasonic, Reis, Schunk, Staubli, Toshiba, Yamaha,

Foremost Japanese and German Billion dollar companies….

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Color Branding

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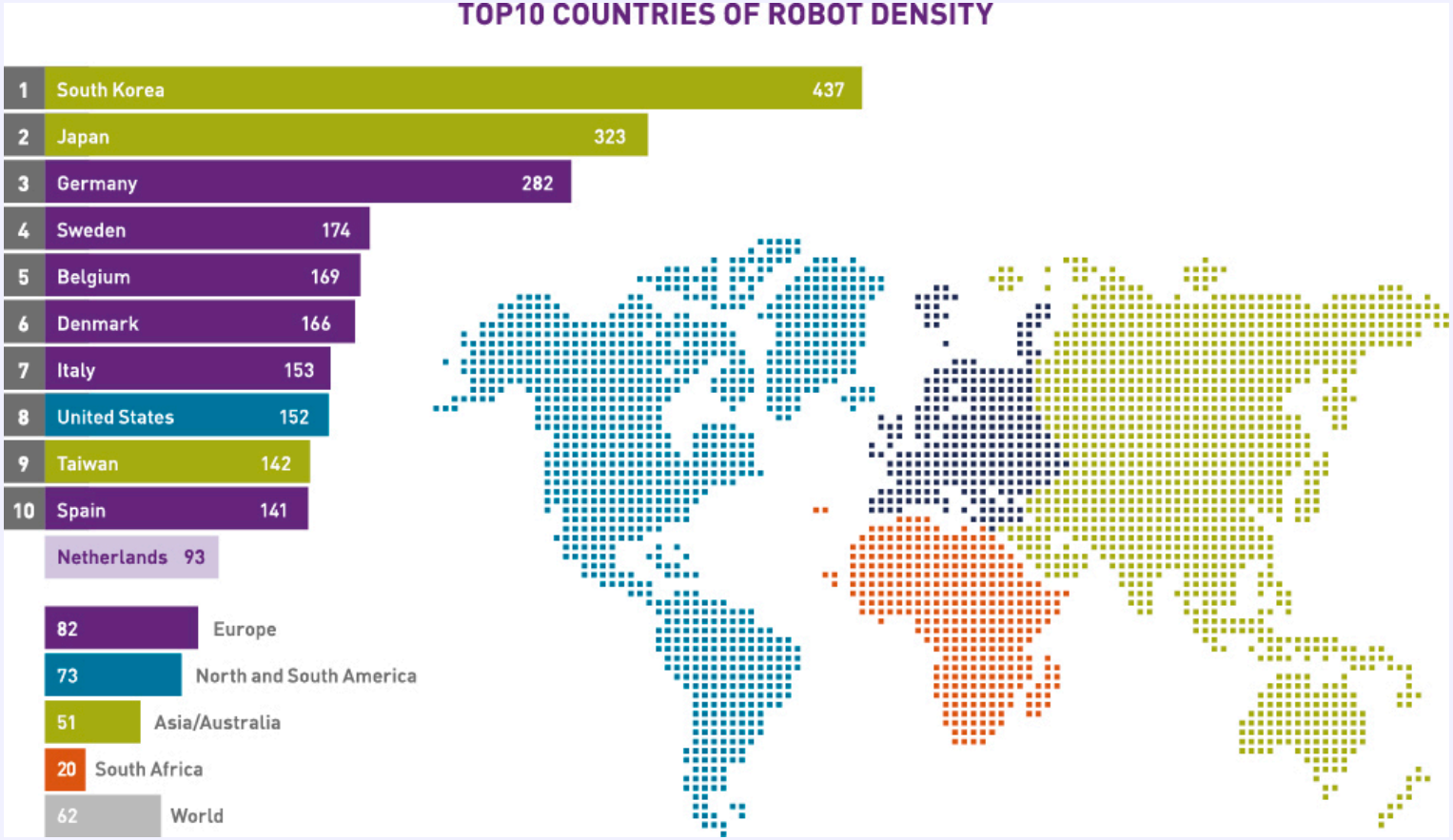
Robot Density



Source: IFR World Robotics 2014; Robot density per 10.000 operators in production

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Industrial Robotics

Drivers

- Automate **D**ull, **D**irty, **D**angerous applications
- Industry 4.0 / Smart Industry
- Human – Machine Collaboration
- Flexibility due to decline Product Life Cycle
- New and affordable HW/SW technology & materials

China/Asia growing 40%

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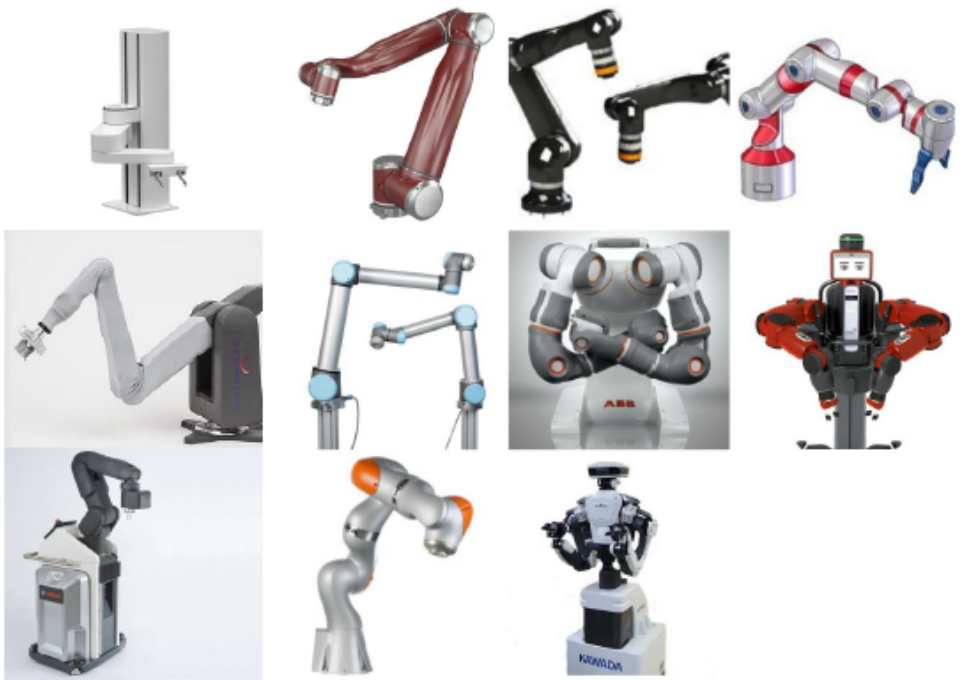
Collaborative Robotics

PRob – ROBERTA – SPEEDY-10 – BAXTER
ABB YUMI – KUKA IIWA – UNIVERSAL ROBOTS
PF 400 – NEXTAGE – APAS – BIOROB



New in industry, especially for SME:

- Low cost
- Easy and fast programmable
- Safe operation

PART4You Audi

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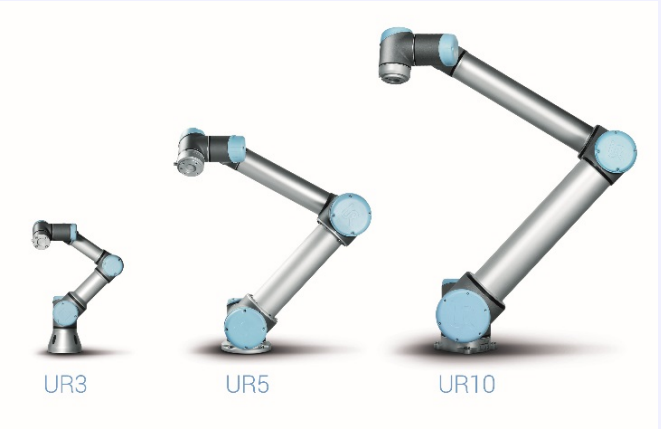
Collaborative Robotics

Universal Robotics, Denmark

- 2005 Started company
- 2009 Product on the market
- 2014 Sold 4.000 units total,
  Revenue $100M
- 2015 new UR3
- Target sales 4.000 pc
- 2017 Target Revenue $200M



Rethink Robotics, USA

- Baxter
- Sawyer (new 2015)
- Strong investments and marketing

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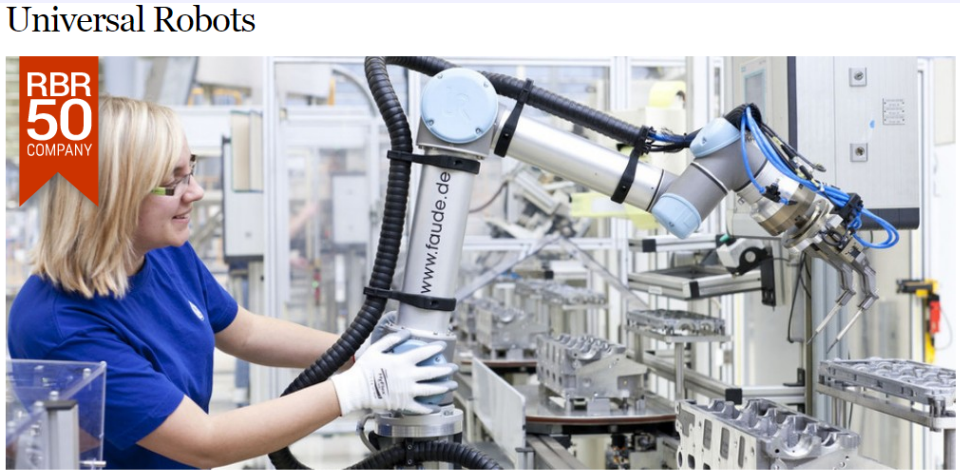
Collaborative Robotics



Basic Principles

- Move Robot to work location, not work to robot cell
- Small footprint. Fit within existing shop-floor layout
- Programming/teaching by operator

Brabantse Ontwikkelings Maatschappij

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Health Cure

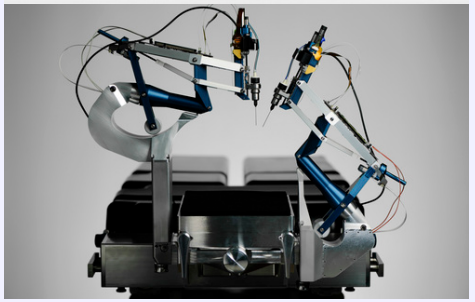
- Tele-operation
- Micro surgery
- Minimal invasive
- Endoscopy

DEMCON

Advanced Endoscopy

Medical Robotic Technologies

PRECEYES
Medical Robotics



microsure

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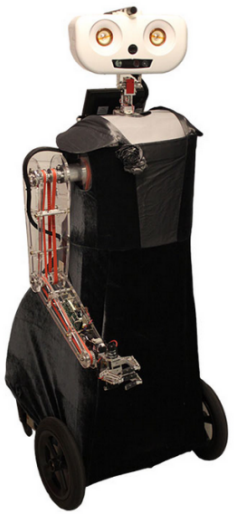
Health Care

- Service Robots
- Telepresence
- Exoskeleton
- Rehabilitation



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Field Robotics

Brabantse Ontwikkelings Maatschappij

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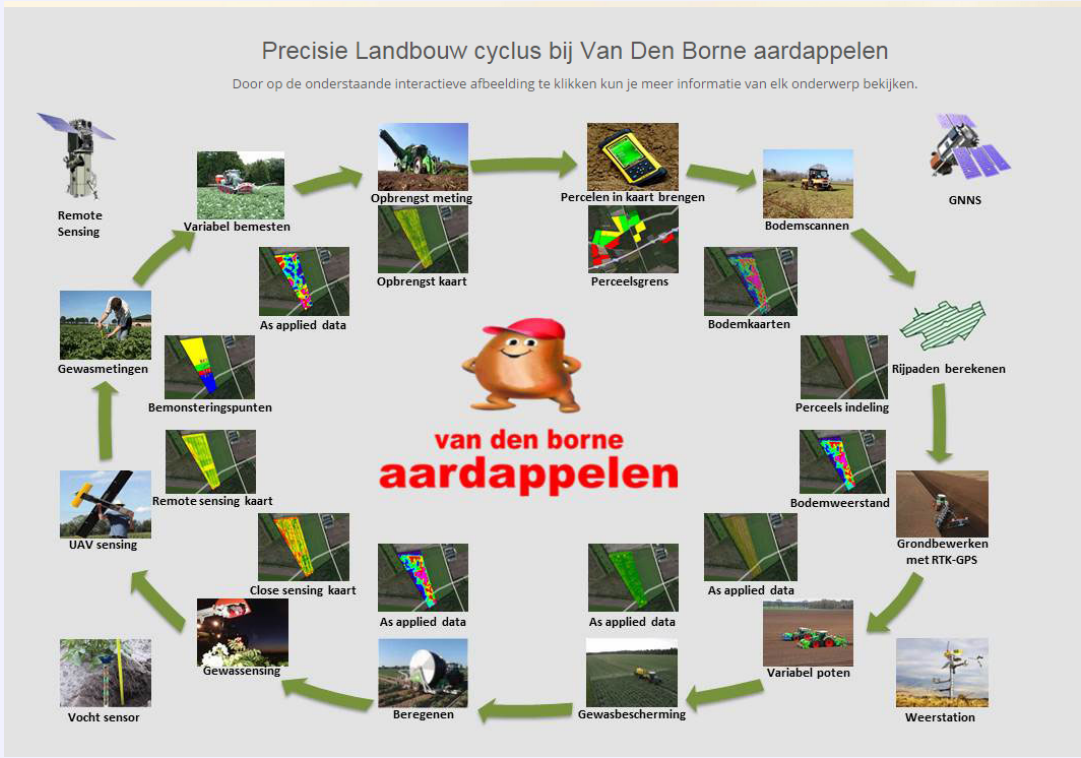
Field Drones



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Agri, Horti Culture & Food

Productivity driven

- Harvesting
- Milking
- Packing
- Processing
- Picking
- Handling

Supporting and assisting in harsh labor and unstructured environment

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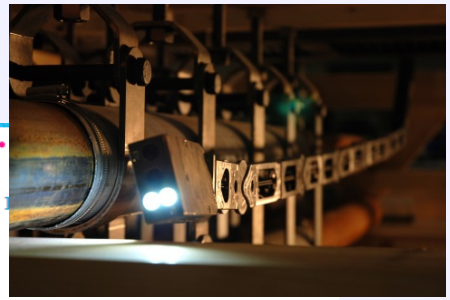
Maintenance & Service

ALSTOM Inspection Robotics

petrobot

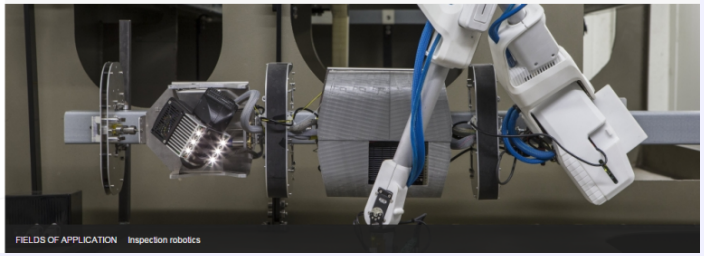
NATIONAL ROBOTICS NREC ENGINEERING CENTER

Sensabot
Mobile robotic sensor system



ROBOSHIP

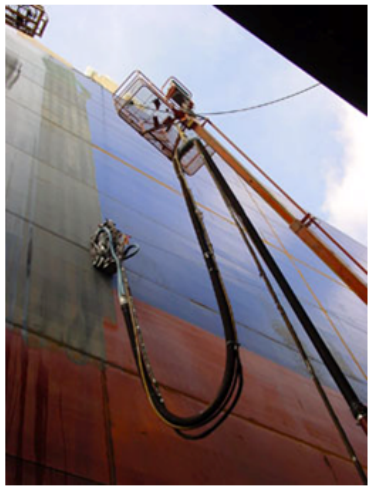
PARTICIPATING MEMBER(S) LEO *IMOTEC / Universiteit Twente, Robotics and Mechatronics*
START DATE 1-1-2012 BUDGET € 1.700.000 TYPE OF FUNDING INTERREG IVa



Welkom ⋰ Nieuws ⋰ MVP ⋰ Ki< ⋰

[Kennis- en Innovatie Centrum ::

Ontwikkelen coating robot



Het ontwikkelen van een coating robot door een automatisch systeem te creëren dat een aanmerkelijke bijdrage zal leveren aan veilig en doelmatig reinigen van grote oppervlaktes.

Voor meer informatie bekijk de

Projectposter Coating Robot

PIRATE

PARTICIPATING MEMBER(S) LEO *Universiteit Twente, Robotics and Mechatronics*
START DATE 1-1-2006 TYPE OF FUNDING FP7

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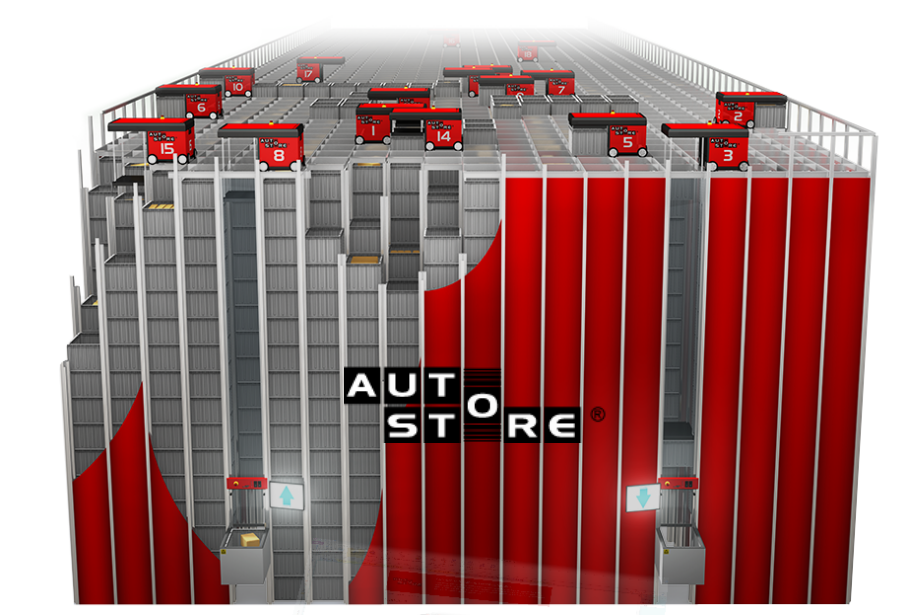
Intra Logistics



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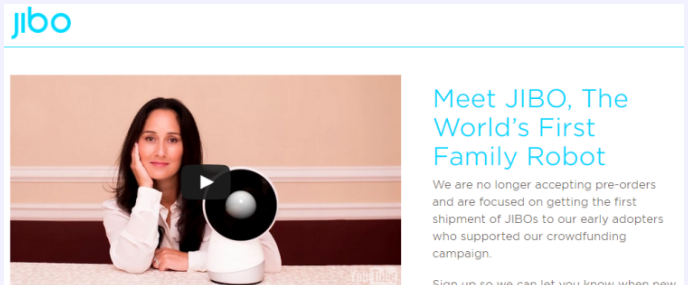
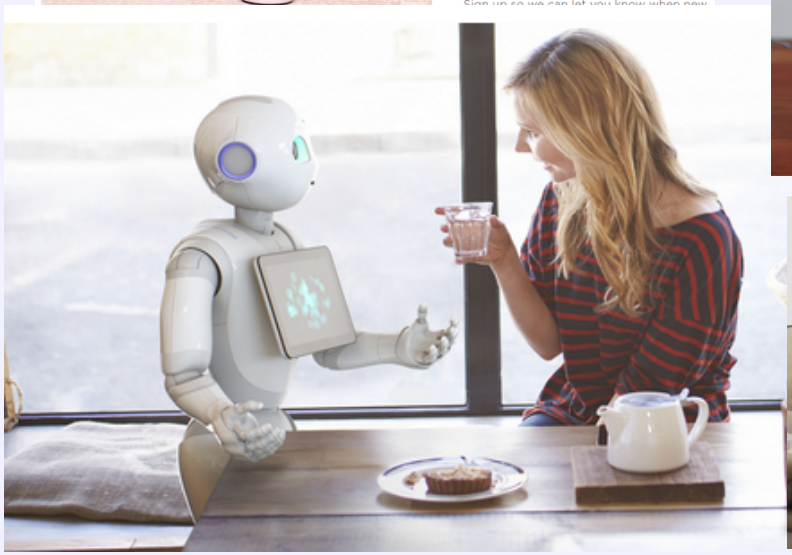
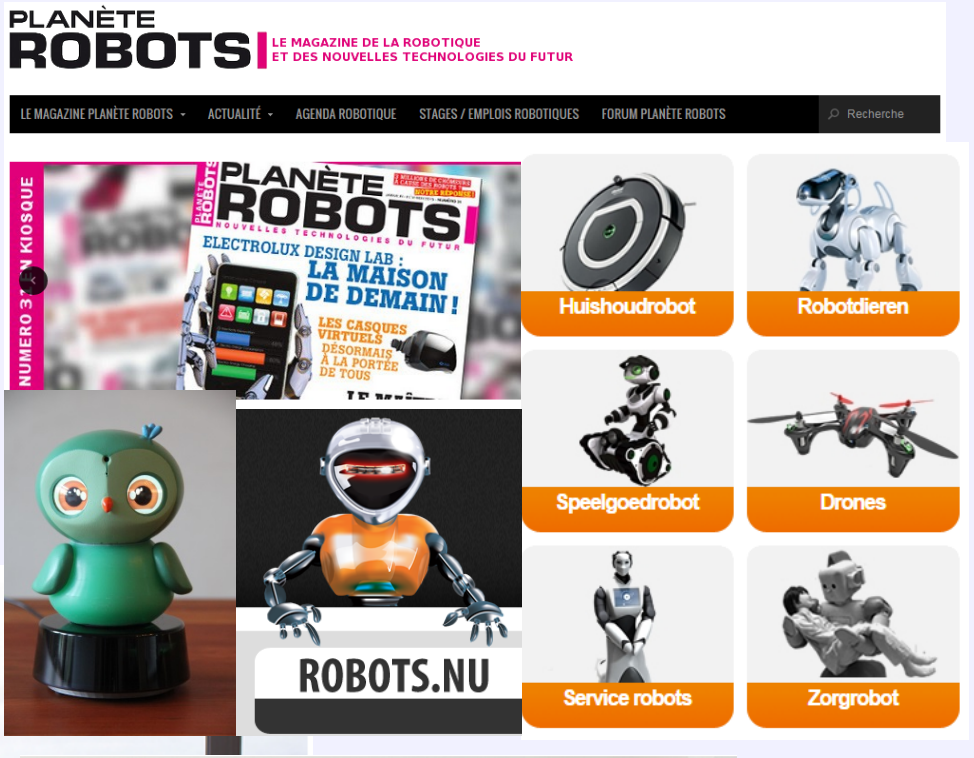
BOM

Consumer & Entertainment

- Drones
- Paro
- Nao and Pepper
- Jibo







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Consumer & Entertainment

Vacuum and Cleaning mass consumer market

- More then 15 brands world wide *(iRobot, Philips, Samsung, Siemens, etc.)*
- More then tens of millions sold

Brabantse Ontwikkelings Maatschappij

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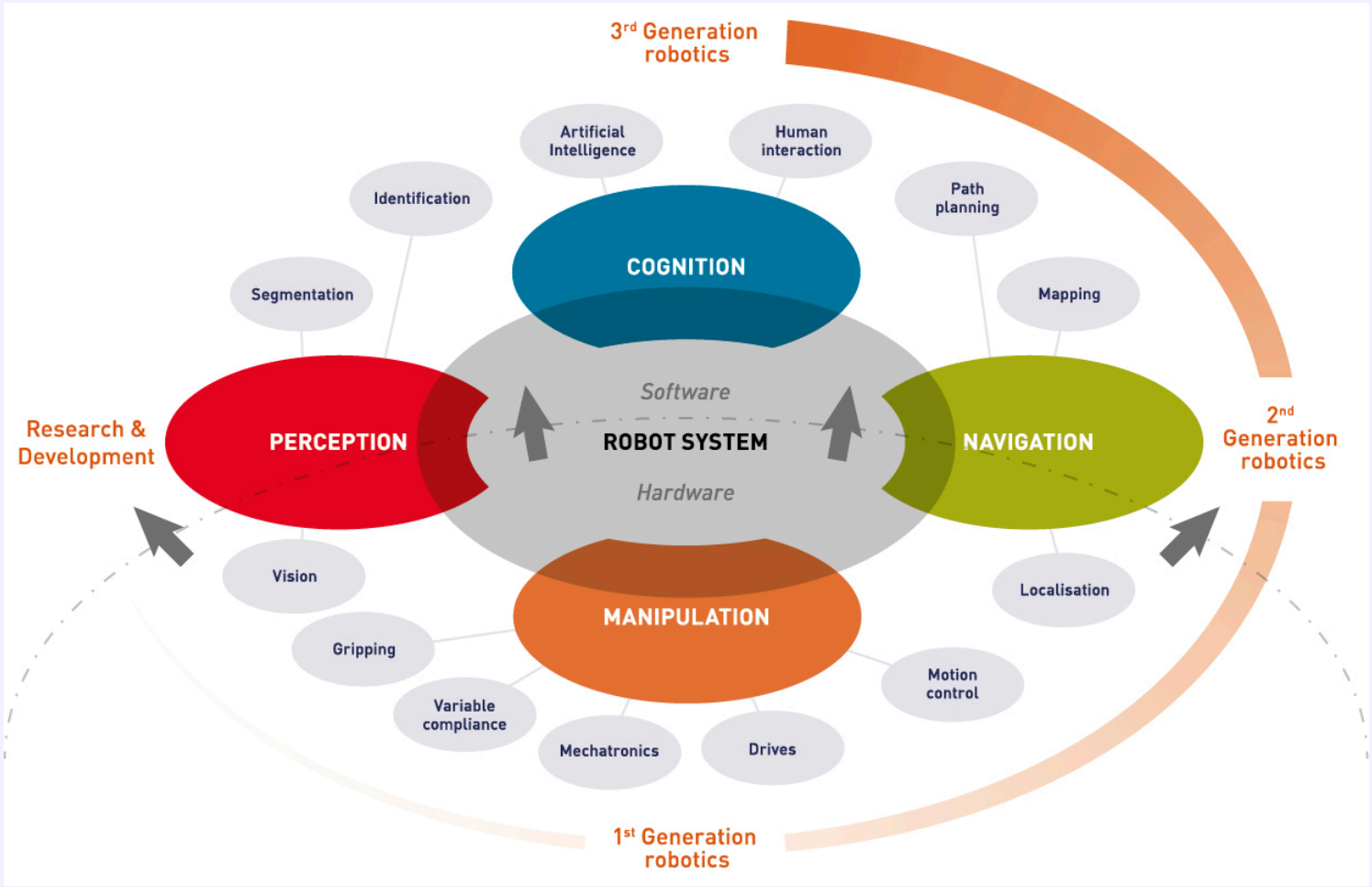
Systems & Technology



Brabantse Ontwikkelings Maatschappij

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Systems & Technology

Trends

- Affordable 3D vision and sensing technology available from gaming industry
- Open software platform ROS increased potential
- Affordable HW solutions

Challenges

- Perception, Navigation and Cognition
- System integration
- SW & HW limitations
- Fully **addressing application** needs:
  simplicity, costs, reliability, productivity, flexibility, acceptance, safety, TCO

Darpa Challenge

https://www.youtube.com/watch?v=fQ6b5Wm5Glw

https://www.youtube.com/watch?v=M8YjvHYbZ9w

CO-BOTS GEVEN MEDEWERKERS UITDAGENDER EN MEER GEVARIEERD WERK.

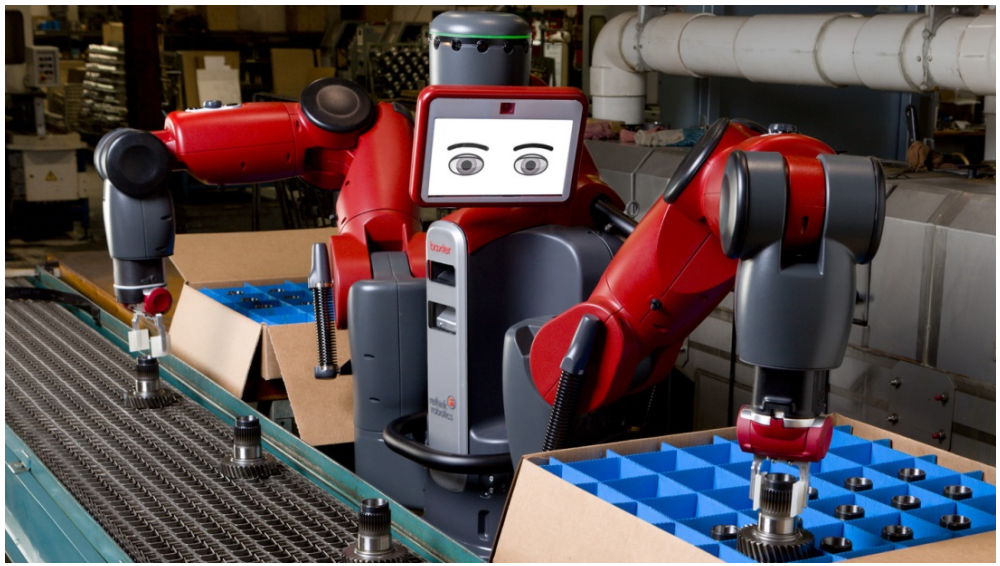
- OMDAT MEDEWERKERS CO-BOTS TAKEN KUNNEN LEREN (INTERACTIE)

- CO-BOTS REPETITIEVE TAKEN UIT HANDEN NEMEN

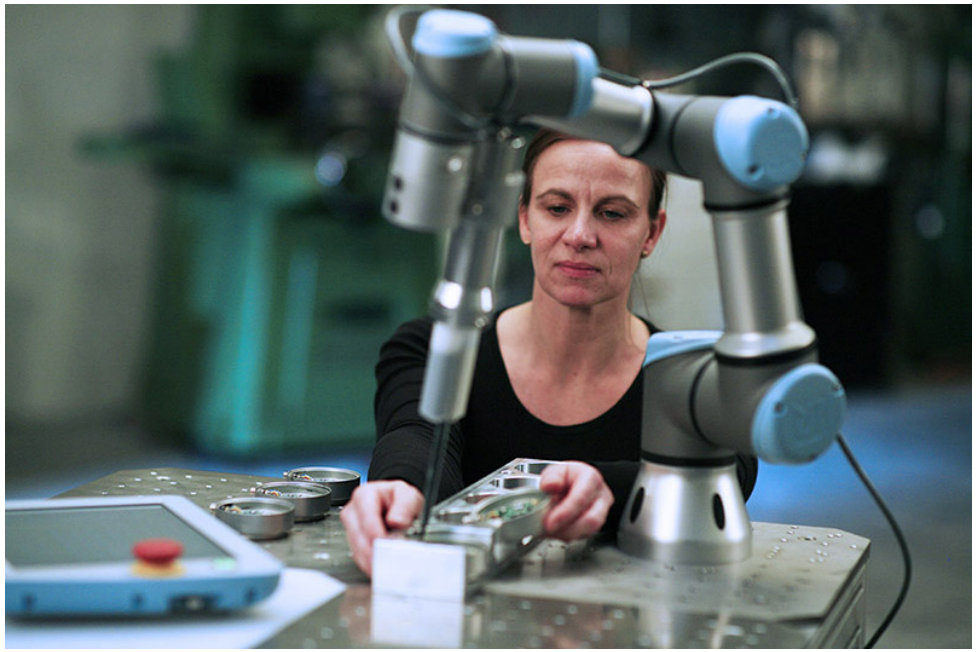
ER ZIJN GEEN NADELEN VAN CO-BOTS VOOR DE FYSIEKE BELASTING VAN MEDEWERKER EN ERGONOMIE VAN DE WERKPLEK.

CO-BOTS KUNNEN ALLEEN VEILIG NAAST MENSEN WERKEN ALS ZE LANGZAMER BEWEGEN DAN MENSEN EN DUS ZIJN ZE NIET PRODUCTIEF GENOEG IN DE SAMENWERKING MET MENSEN.

→ KIES MENSEN IPV CO-BOTS



SOCIALE WERKPLAATSEN KUNNEN INGEWIKKELDERE PRODUCTIE AAN DOOR DE SAMEN WERKING VAN CO-BOTS MET MENSEN MET EEN HANDICAP.



EXOSKELETONS

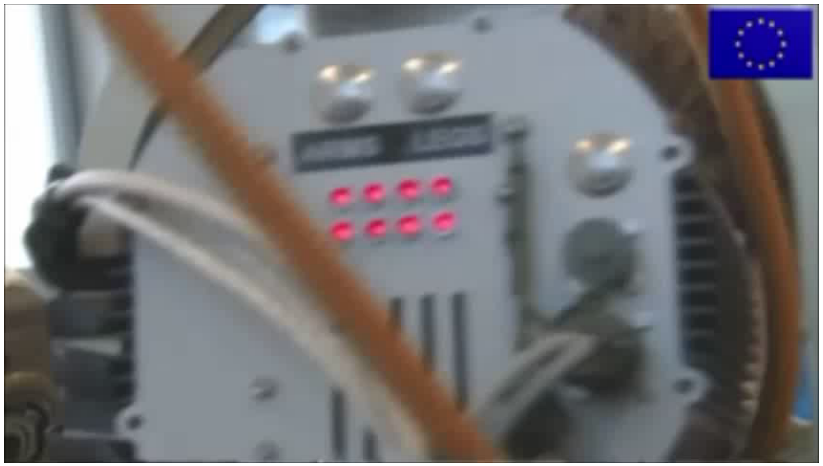
What is an exoskeleton?

- Mechanical structure
- External to the body
- Wearable
- Enhance power of a person
- Human is in charge…

Variations in..

- Power supply: passive or active
- Size: full body, lower body, upper body

EXAMPLES



POTENTIAL BENEFIT

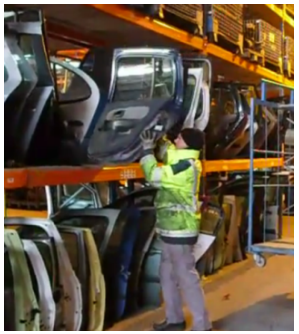
large variation in activities and/or products to be handled is large

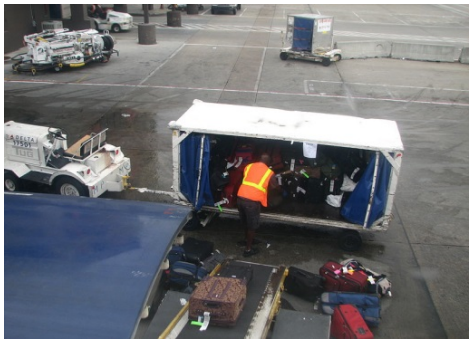
human tasks are too difficult or too expensive to automate

exoskeletons, augmenting power to the human body while keeping human flexibility may increase business performance (flexibility, productivity) and promote health

worker is mobile and has to handle loads on many different locations

cranes or balancers are not feasible or effective





CHALLENGES

- Benefits are unclear (from health and productivity perspective)
- Risk of non-acceptance is high
  - Usability
  - Discomfort (anthropometry fit, pressure points, climate)
  - Safety
- Technical issues
  - Hindrance of fast and smooth movements
  - Weight / power source for complete work shifts
  - Size of device
- Missing standards for exoskeletons in industry
  - ISO 13482 on personal care robot safety (not about industry…) (TC 184)
  - ISO 10218-1 en -2 on industrial robot safety (not about exo-skeletons…)

RUNNING PROJECT: EU ROBO-MATE

Intelligent exoskeleton based on human robot interaction for manipulation of heavy goods in Europe - Large-scale Integrating EU project (GA 608979)

ZHAW
CENTRO RICERCHE FIAT
INDRA SAS
IIT
TNO
UNIVERSITY LIMERICK
MRK
FRAUNHOFER IAO
COMPA
ROPARDO
ACCELOPMENT

JOINT INNOVATION CENTER
INTERACTION ROBOTS

TU Twente & TNO

- Samenbrengen van kennis
- Versnellen van innovatieve robotica applicaties
- Creëren van partnerships
- Strategic and operational continuity
- Aanbieden hele waarde keten

WEARABLE ROBOTS STELLINGEN

STELLINGEN:

- Een wearable robot helpt de mens om het maximale uit zich zelf te halen. Optimale belasting van deelsystemen.
- Een wearable robot stelt meer mensen in staat zwaar werk uit te voeren.
- Wearable robot is een persoonlijk beschermingsmiddel (Mag alleen worden toegepast als alle andere maatregelen niet mogelijk zijn)
- Er moet een grens gesteld worden aan de gebruiksduur van een wearable robot om afname van getraindheid te voorkomen.

- User intension is niet door sensoren te detecteren.
- Een wearble robot mag enig discomfort geven.
- Extra gewicht (>5kg) van een wearable robot moet naar de grond worden afgesteund.
- Extra activiteit van andere sterke spiergroepen (bv in de benen) bij het gebruik van een wearable robot is een optimalisatie van de mens.