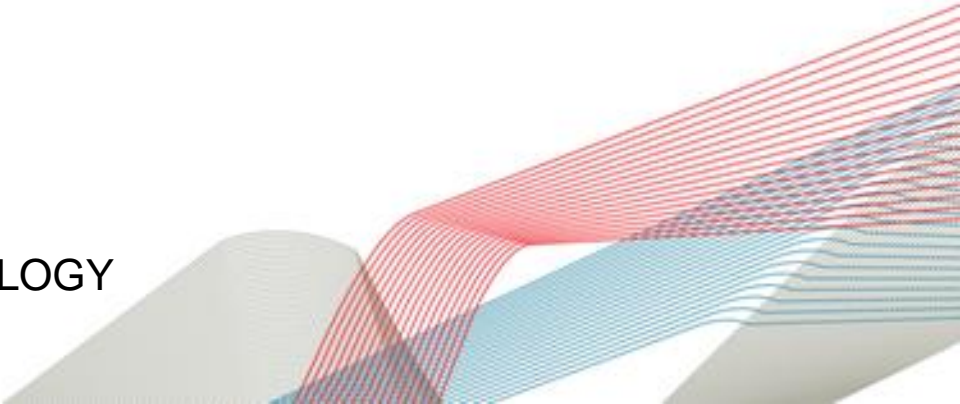
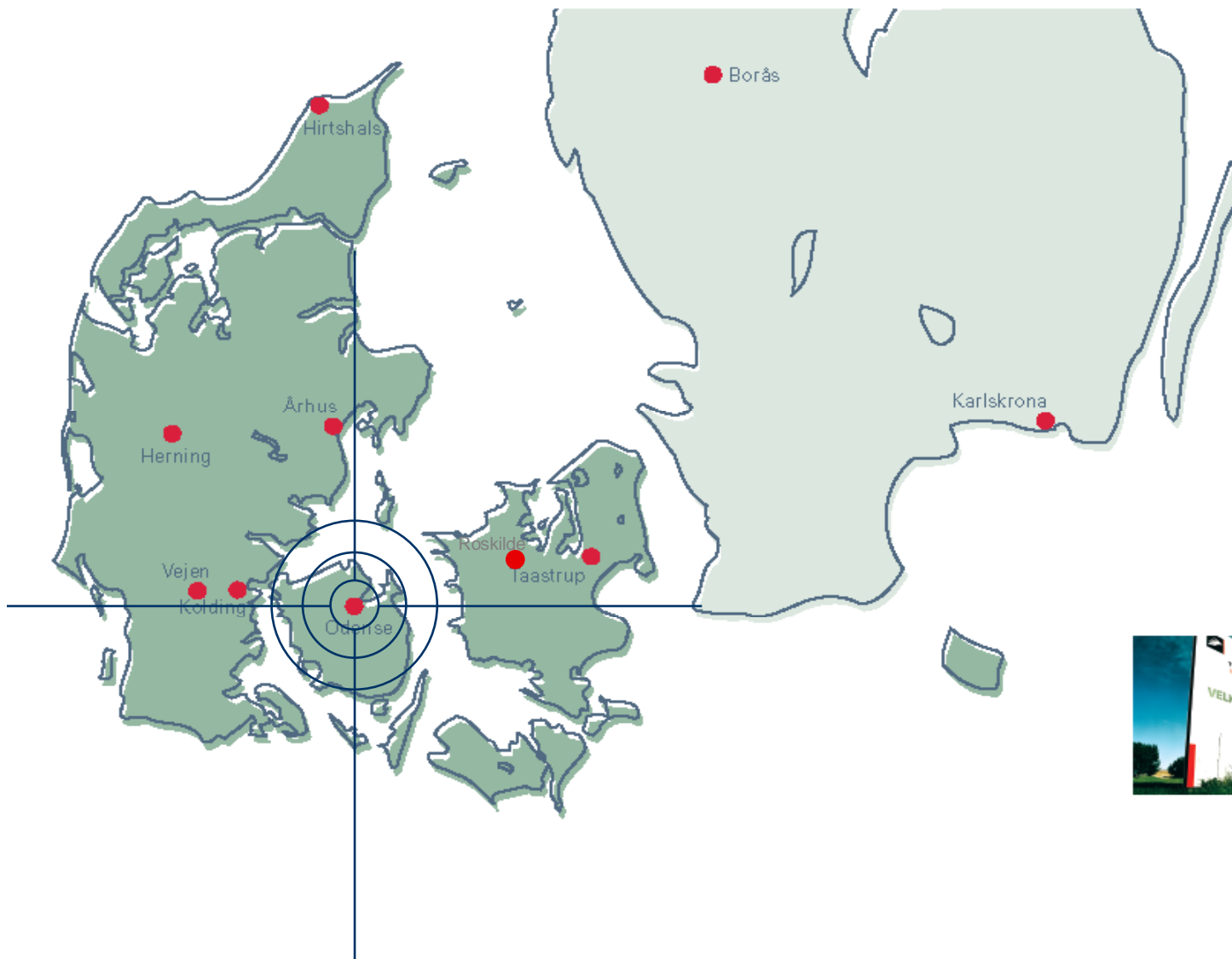


ROBOT TECHNOLOGY DRIVEN INNOVATION

- EXAMPLES AND TRENDS

CLAUS RISAGER, PH.D.
HEAD OF CENTRE FOR ROBOT TECHNOLOGY
DANISH TECHNOLOGICAL INSTITUTE





Danish Technological Institute • 33 Centres • 9 Divisions • 1.000 Employees • 10 Locations
Knowledge Development • Knowledge Application • Knowledge Transfer
Counselling/Consultancy • Courses/Conferences/Educations • Laboratories/Tests
SMV Focused • 40.000 Trainees • 20.000 Customer projects • 1.000 mio. DKK. in turnover

DIVISIONS AND CENTRES

BUILDING TECHNOLOGY

Concrete
Building Processes
Indoor Climate and Humidity
Masonry and Building
Components
New Industrialisation
Swimming Pool Technology
Timber and Textiles

MATERIALS AND PRODUCTION

Materials Testing
Microtechnology and Surface
Analysis
Metrology and Quality
Plastics Technology
Product Development
Tribology

ENERGY AND CLIMATE

Energy Efficiency and
Ventilation
FEM-Secretariat
Installation and Calibration
Refrigeration and Heat
Pump Technology
Pipe Centre
Renewable Energy and
Transport

PRODUCTIVITY AND PRODUCTION

Automobile Technology
Packaging and Transport
Production
Productivity
Robot Technology

LIFE SCIENCE

Food Technology
IT Development
Chemistry and Water
Technology

BUSINESS DEVELOPMENT

Policy and Business
Development
Human Resources Development
Creativity and Growth
Technology Partnership

TRAINING

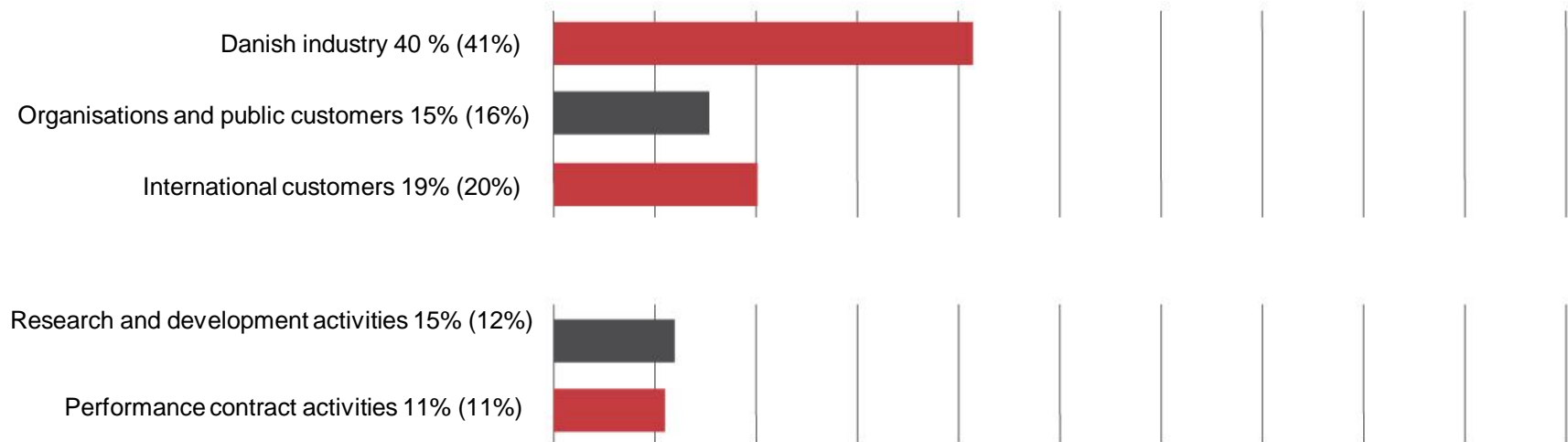
IT Training
Conferences
Leadership and Management
Training

INTERNATIONAL CENTRE

TURNOVER

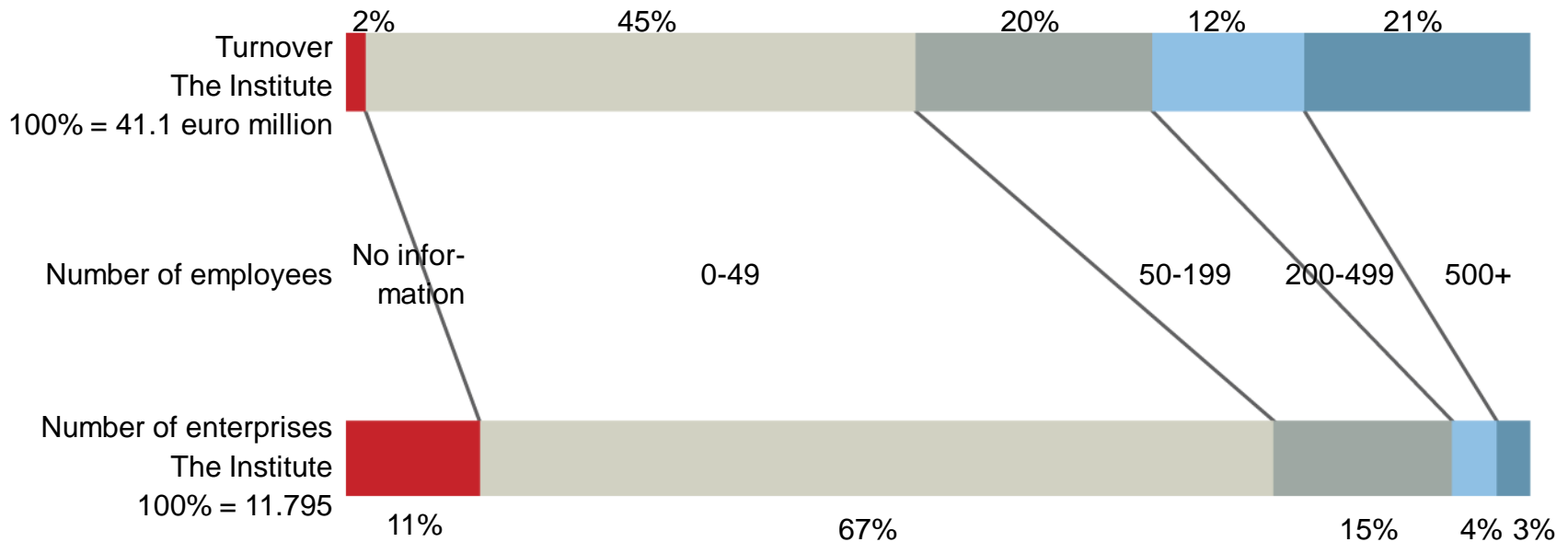
100% = 102.9 EUR. MILLION (2007: 100.7) 0%

100%



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THE INSTITUTE COVERS A SIGNIFICANT NUMBER OF SMALL AND MEDIUM SIZED ENTERPRISES (SME)



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Centre for Robot Technology

40+ Robot experts • 25+ R&D&I-projects • 50+ Customer projects

Innovation • Applied Robot Technology focus

Laboratories (1.000 m² in Sept. 2010) • 12-14.000 users per year • 100-120 installations

Test facilities • Work shops • Innovation & Training facilities

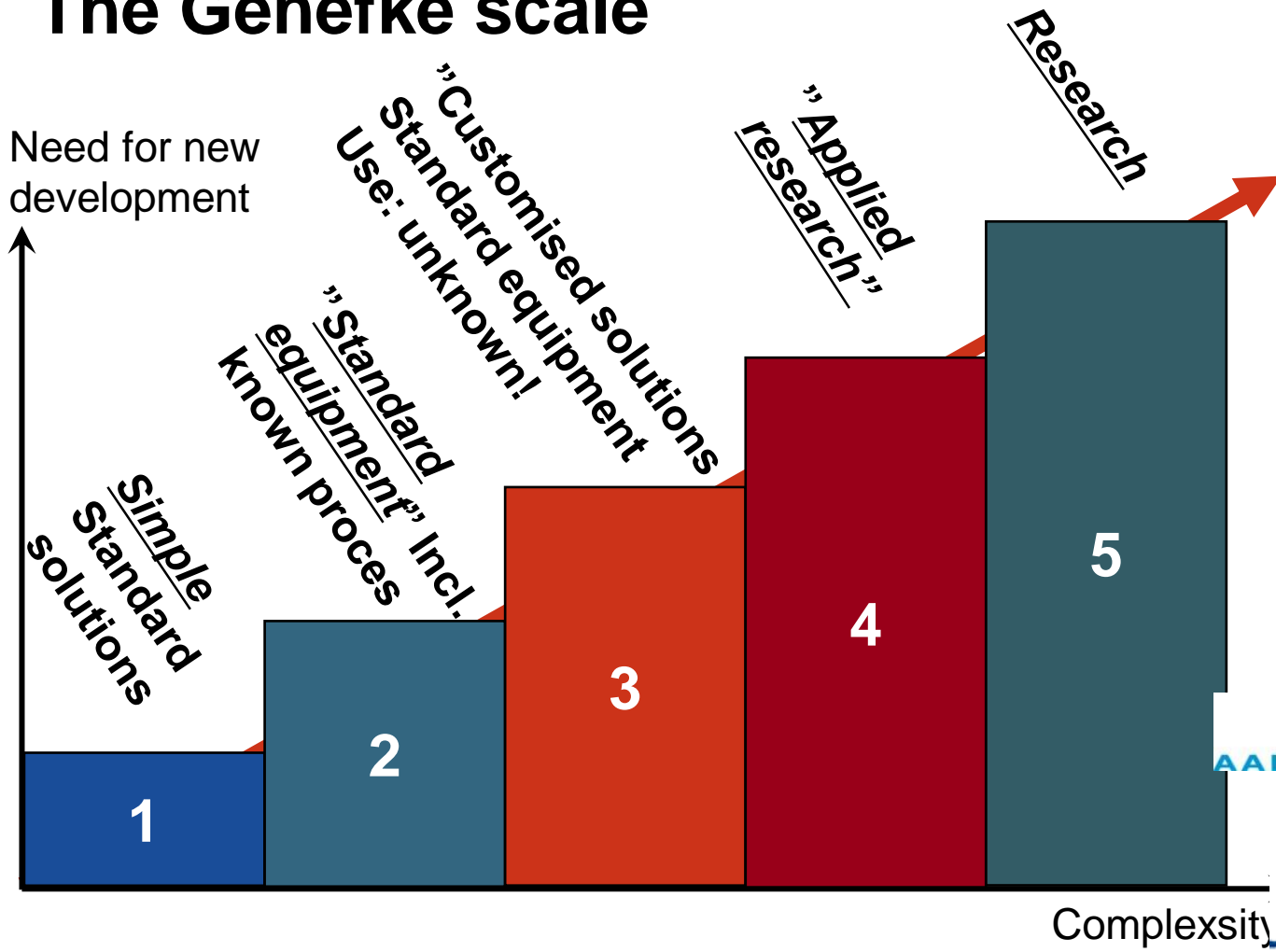
Manufacturing & Food Industry • Health Care & Welfare • Green Robots •

Buildings & Urban Spaces • Edutainment & Event • Climate & Environment

Classification of Robotic Innovation Processes

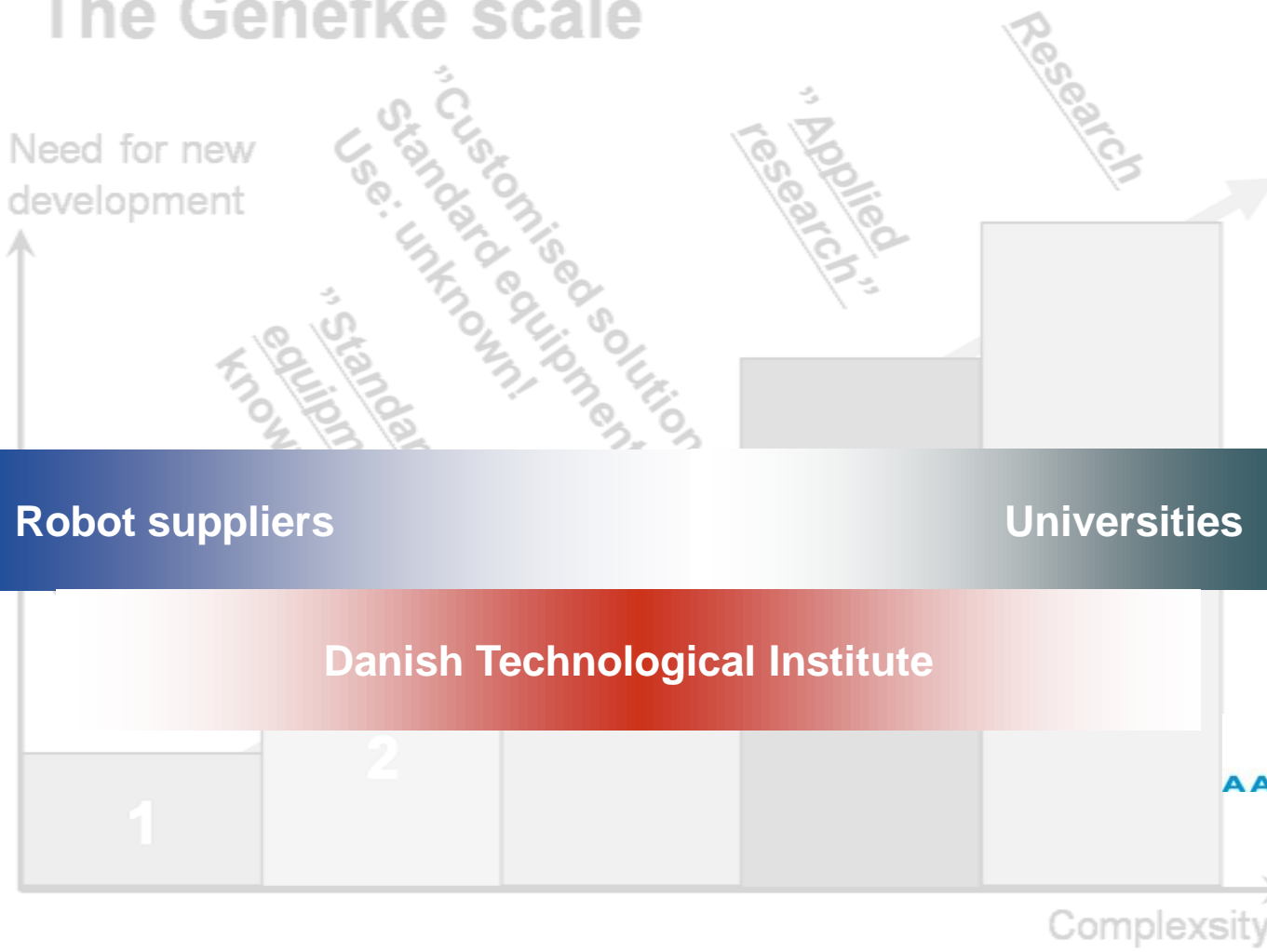


The Genefke scale



A.I.M. – Avanced Automation Investment Model
 The Industry Foundation • 2010-2013 • 12 mill. DKK
 The Genefke scale • Strategic, knowledge based, cross-organisational automation
 Avanced economic model of calculation for category 2-4
 50 key companies • 450+ knowledge transfer and test companies
 DTI • Eltronic A/S • Copenhagen Business School • Aalborg University •
 University of Southern Denmark

The Genefke scale



Eltronic

Centre for Robot Technology



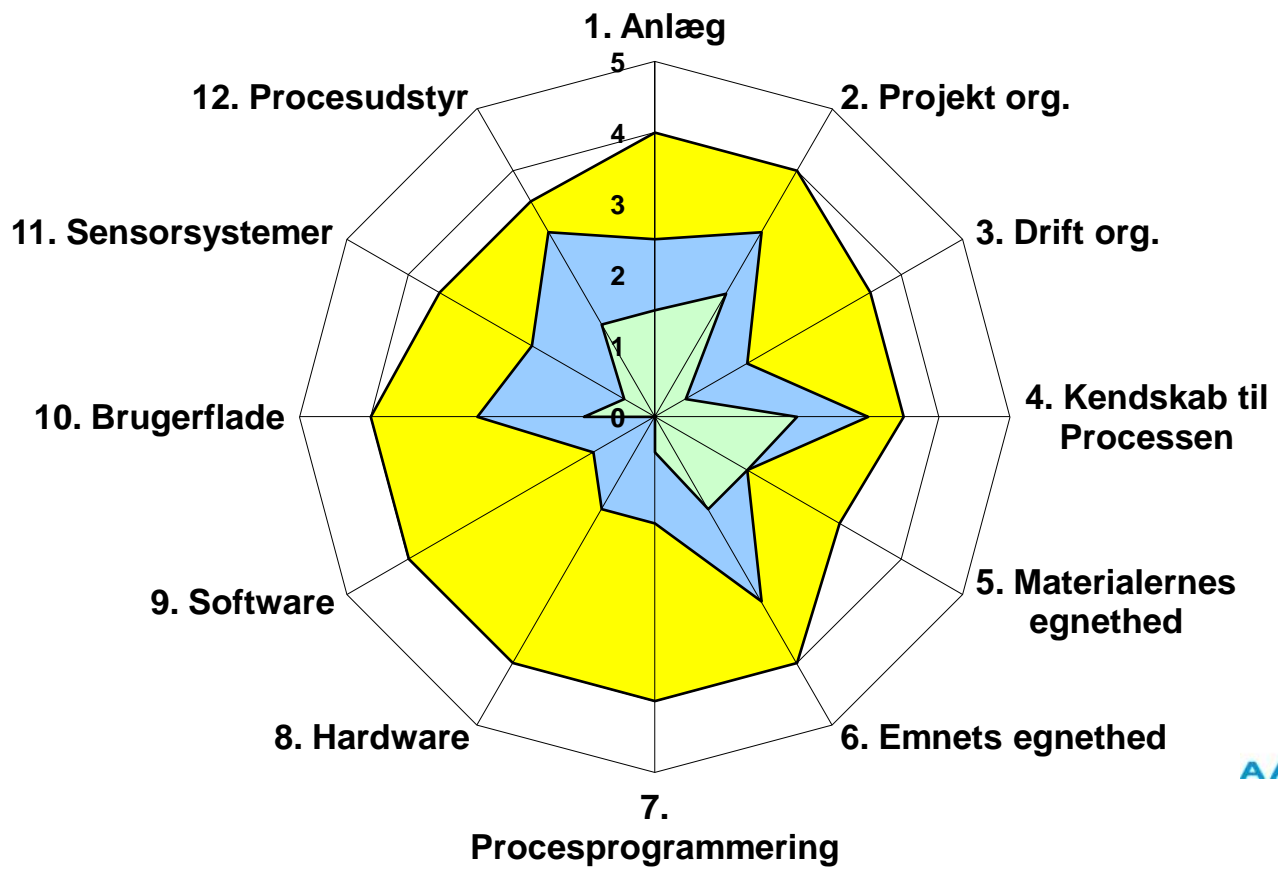
Copenhagen Business School
HANDELSSHJOLEN



SYDDANSK UNIVERSITET

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 The Industry Foundation • 2010-2013 • 12 mill. DKK
 The Genefke scale • Strategic, knowledge based, cross-organisational automation
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 University of Southern Denmark

Yellow = danger? or challenge!



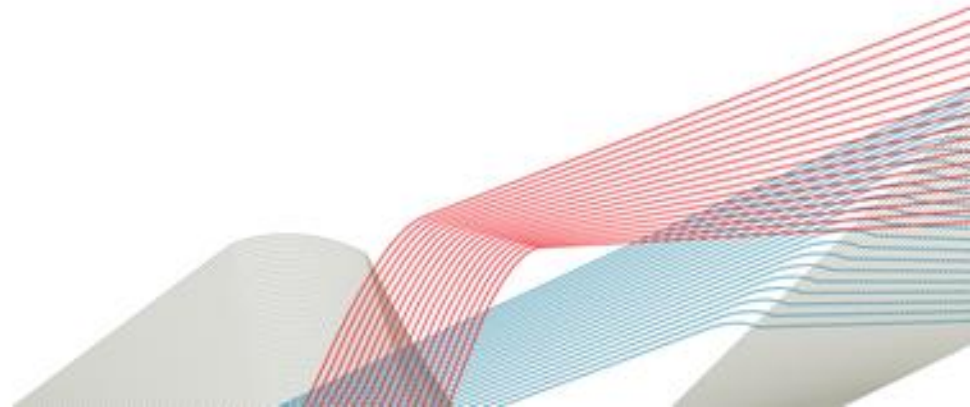
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University of Southern Denmark

In perspective...

- Yellow is where a company can distance itself from its competitors!
- A product solution above category 2½ cannot be transferred to the competitors without internal knowledge transfer!

A.I.M. – Advanced Automation Investment Model
The Industry Foundation • 2010-2013 • 12 mill. DKK
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University of Southern Denmark

Object Manipulating Robotics





Eltronic



5



400.000 – 700.000 kr.

3 4



50.000 kr.-75.000 kr.

2



30.000 kr.

1



10.000 kr.

HybridGriber

High technology foundation • 2009-2012 • 9 mill DKK.

Flexibel • Robust • Cheap • Customer adapted • Robot hand for industry, food and Service
Casted rubber material • Micro-hydraulics • Tactile Sensors • Management •

Movement management

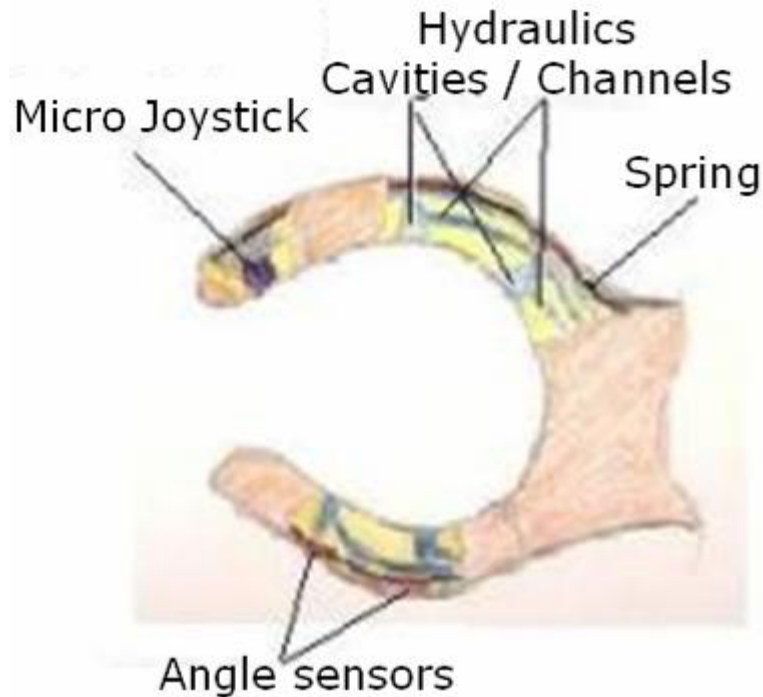
Prototype development • New Danish Company - HybridGriber A/S •

Research environment in world-class

DTI • Eltronic A/S • Kaj Verner Madsen • Schunk Intec Danmark A/S •

University of Southern Denmark





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Scape
technologies



KUKA


AALBORG UNIVERSITET


SYDDANSK UNIVERSITET

Centre for Robot Technology

Bin-Picker

The world's first off-the-shelf robot handling item

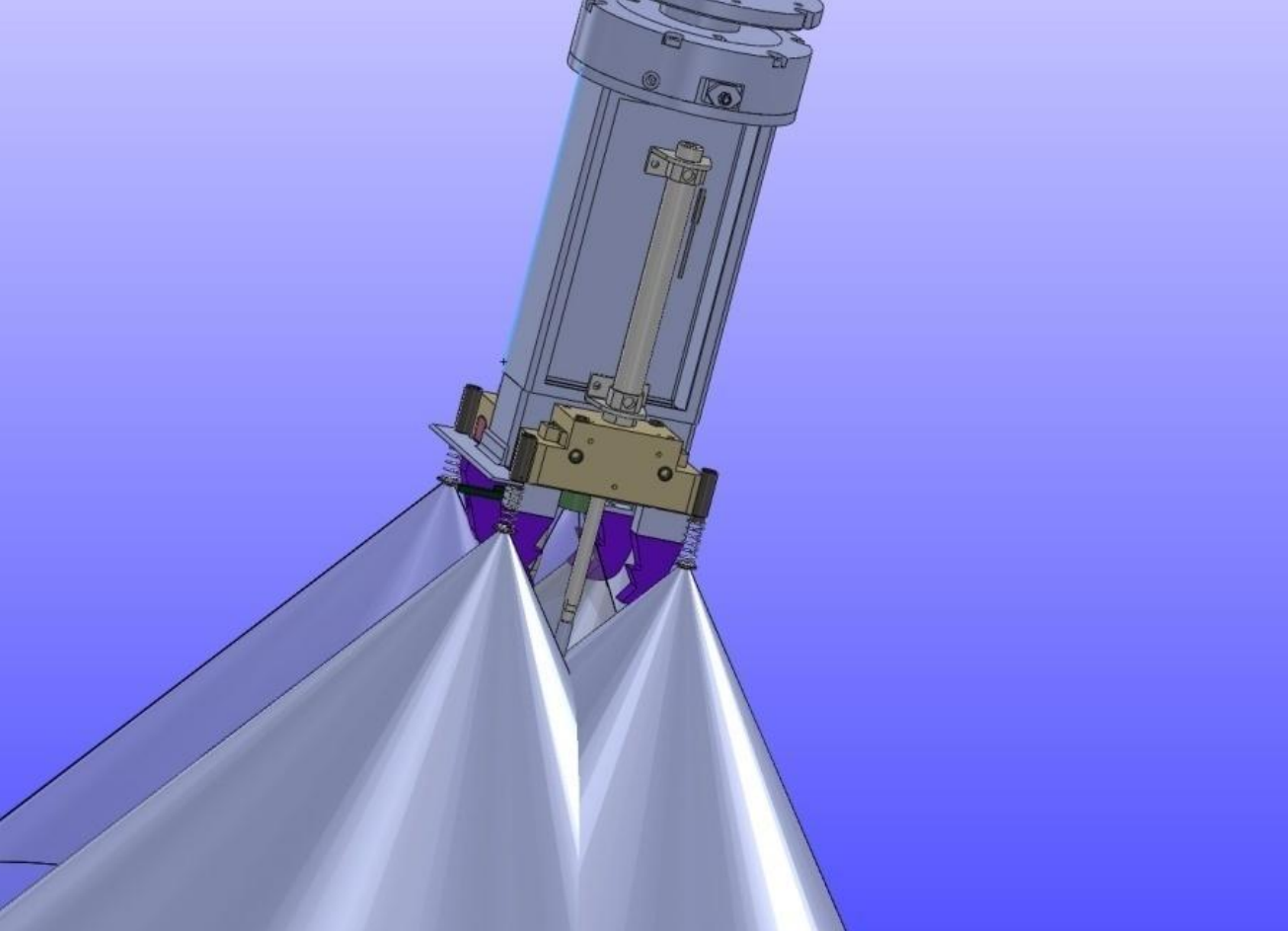
High Technology Foundation • 2009-2012 • 23,7 mill. DKK

Picks up 3+ kg cylindrical items for metal working machine

Cost-competitive prize level • Simple installation • Easy and fast set up

Scape Technologies A/S • DFT – Dansk Flydepresse Teknologi A/S • KUKA • DTI •

Aalborg University • University of Southern Denmark



Centre for Robot Technology

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KUKA


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The apple picking robot

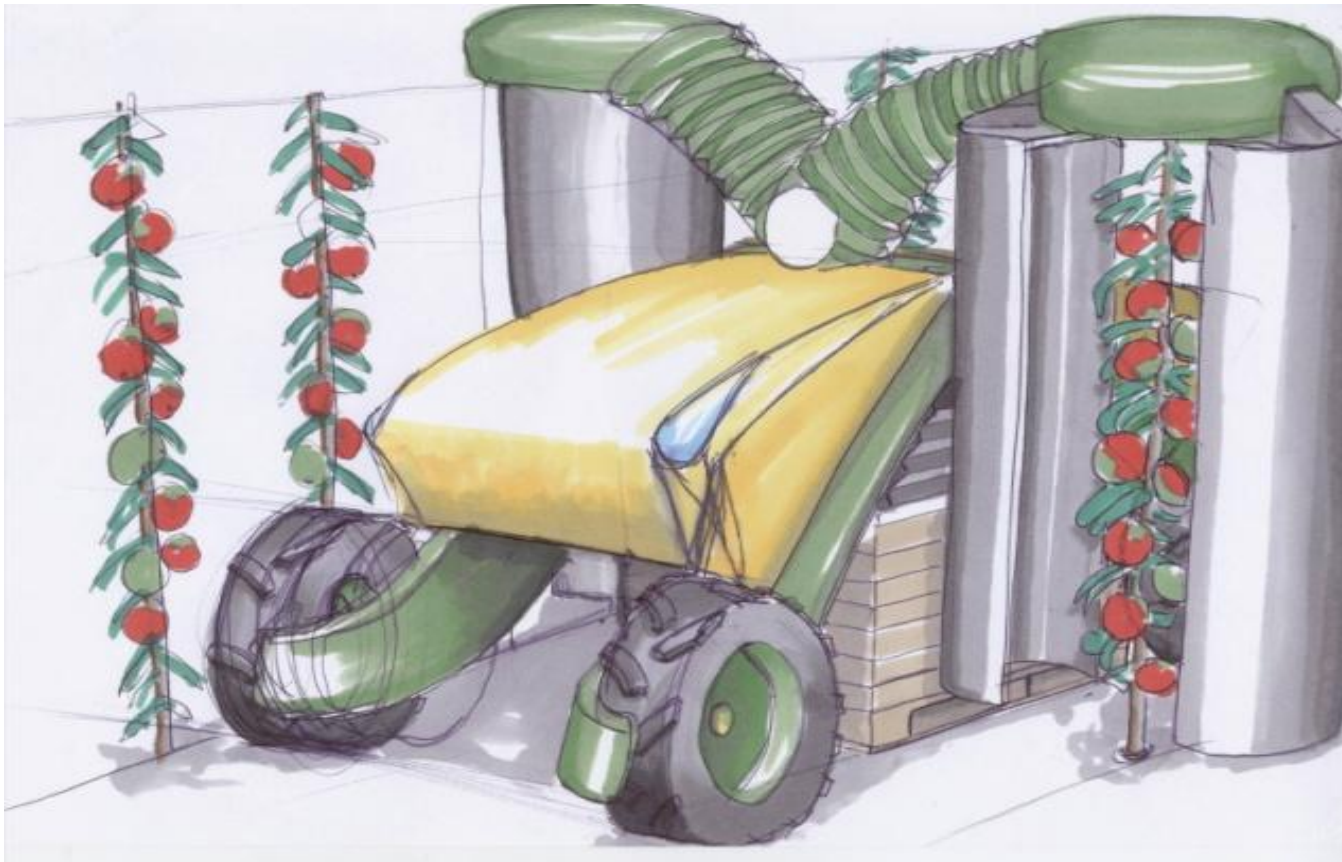
Innovation law • 2007-2009 • 3 mio. DKK

Automatic, gentle, effective apple pick and other fruit trees

Better working environment • Higher quality • Increased harvest capacity •
retreating season workforce

Ground-breaking new growing and harvest concepts • New machines or companies

RoboCluster • Technological Institute • BSBioSystems • Kærsko Frugtplantager



The apple picking robot

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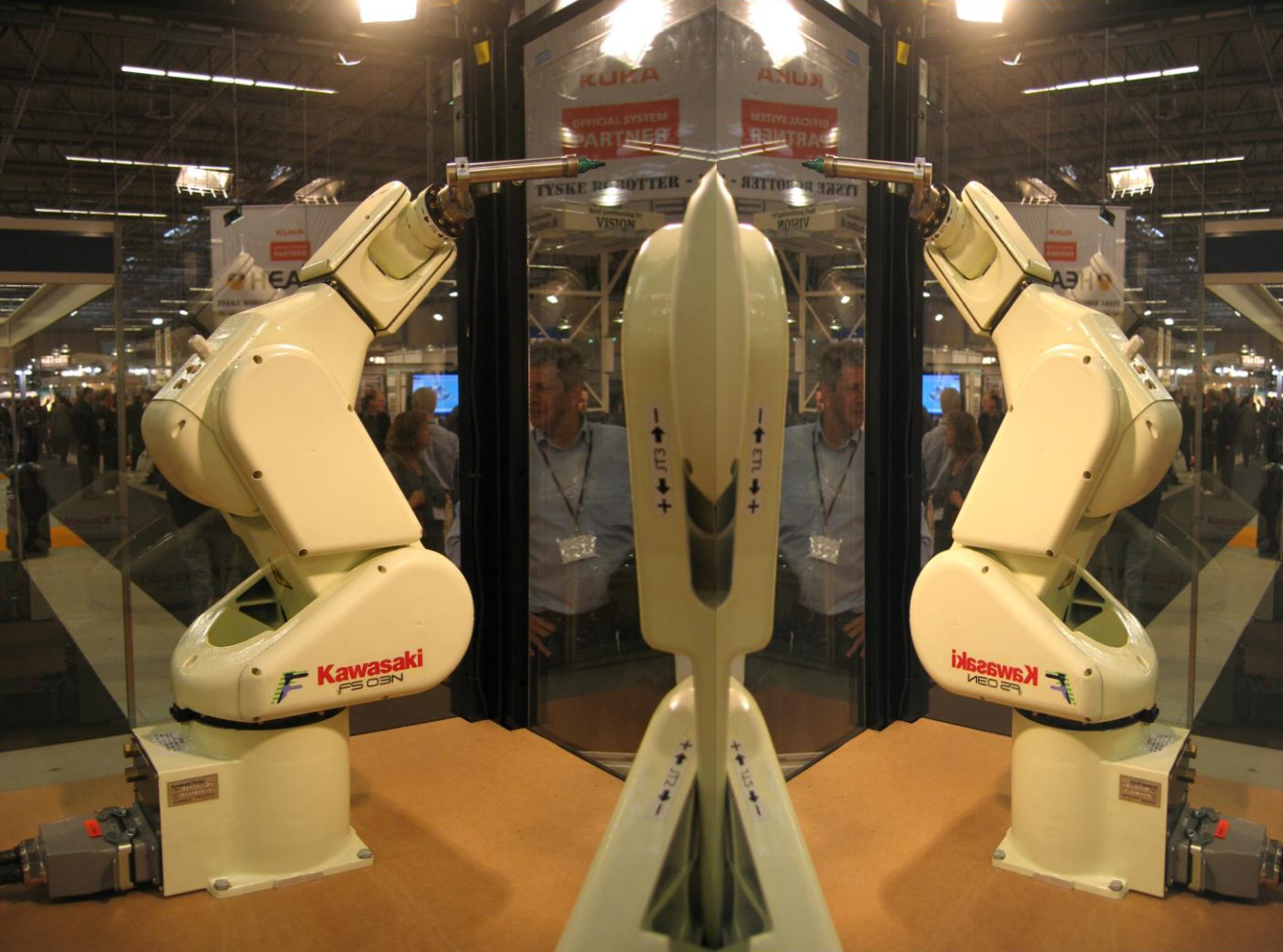
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TriVision
Intelligent Vision Solutions

Unisensor


**UNIVERSAL
ROBOTS**


Scape
technologies

GRUNDFOS 

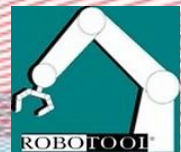
 **ideal-line** 


UNIVERSITY OF
SOUTHERN DENMARK



TENDER

T&O STELECTRIC



Centre for **Robot Technology**

MoveBots

Danish Board of Research and Innovation • 2006-2010 • 31 mill. DKK
 Development of the world's most advanced gripper robot • Danish and international knowledge •
 Use in service and manufacturing • Flexible material handling •
 Network and knowledge spreading among partners •
 DTI • AMROSE Robotics • BILA • Grundfos • Ideal-Line • University of Southern Denmark •
 RoboTool • Scape • Tender Trolleys • TriVision • T&O Stelectric • Unisensor •
 Universal Robots



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MoveBots Tactile Sensors



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TriVision
Intelligent Vision Solutions


GIBOTECH™
moving technology


DANISH CROWN

 SYDDANSK UNIVERSITET

**DANISH
AGRICULTURE
AND FOOD
COUNCIL**

Centre for Robot Technology

Robo-Packman

Innovation law • 2007-2011 • 16,5 mill DKK

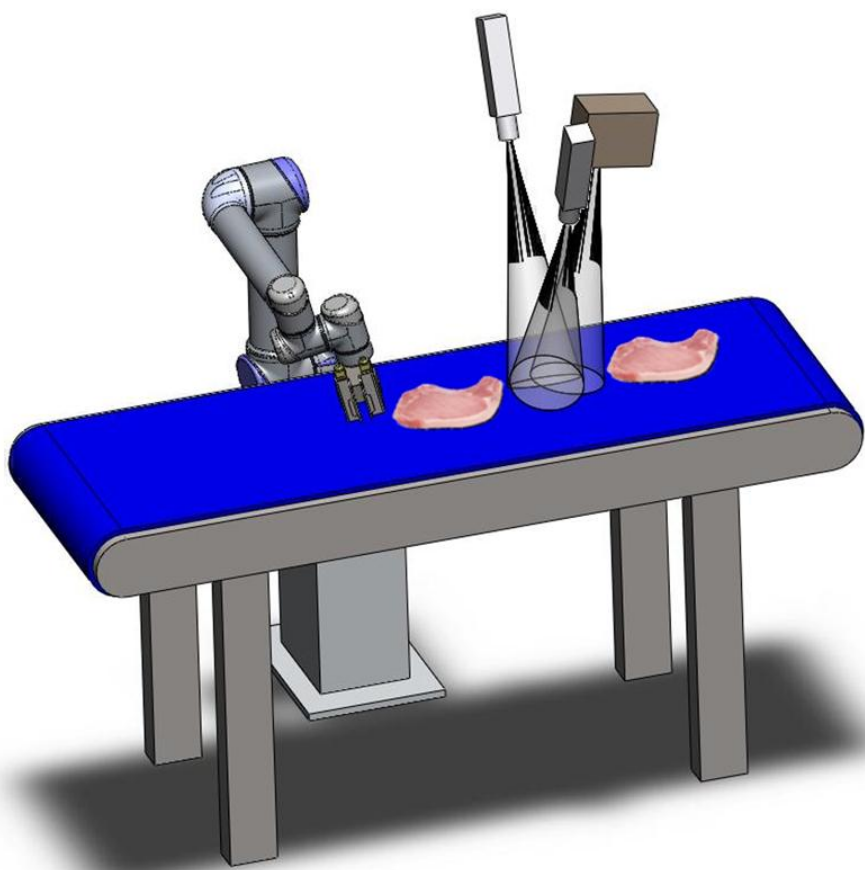
Intelligent and Flexible Robots in Food packaging • Handling of Meat products

Working environment • Competitive position • Cognitive Robots with sense of touch and vision

Unique research in Flexible Catch robots • Unique Robot solutions for slaughterhouses

Technological Institute • Danish Crown Amba • Gibotech A/S • TriVision A/S •

Danish Agriculture and Food Council • University of Southern Denmark



Intelligent Robots for Handling of Flexible Objects (IFRO)

EU Regional Development Fund, Interreg IVa • 2009-2012 • BELØB •

Identification and handling of flexible objects • Minimizing work-related injuries •

Robot learning abilities • Vision and tactile sensing • Mathematical data modelling •

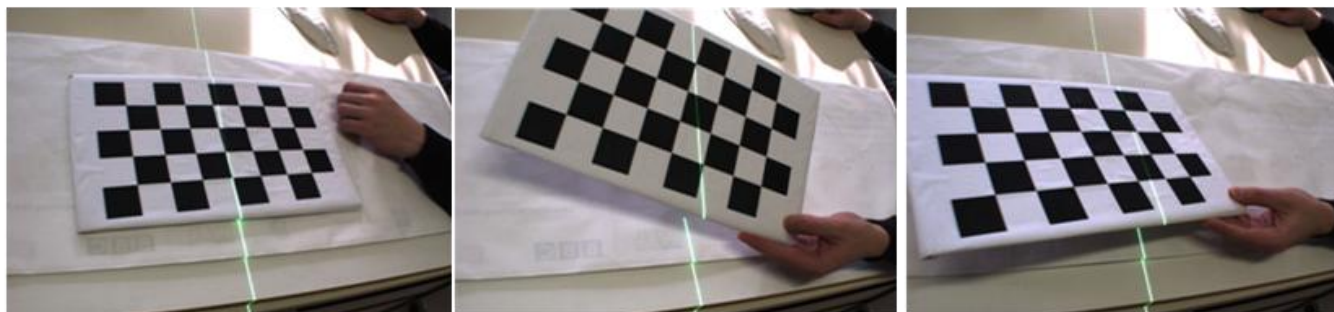
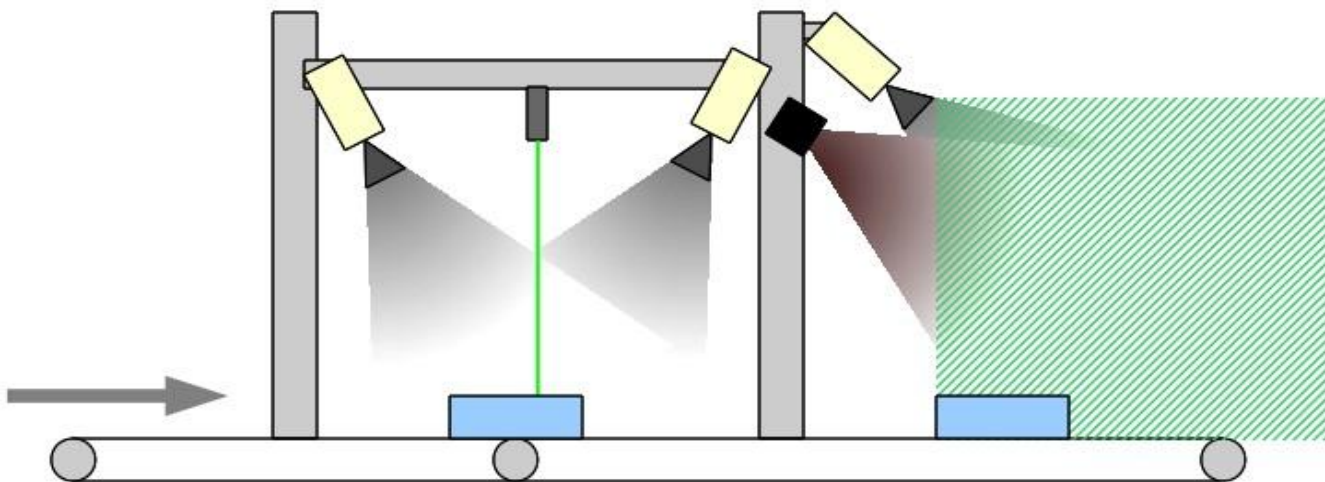
Basic demonstrator to transfer technology in to the robot industry •

Innovation: Combining ToF-cameras, stereo vision, tactile sensing in the gripper and
mathematic modelling

University of Southern Denmark – Maersk McKinney Moller Institute and Mads Clausen
Institute • CAU – Christian-Albrechts-Universität zu Kiel • DTI

Laser stage

ToF stage



Calibration method for the laser stage

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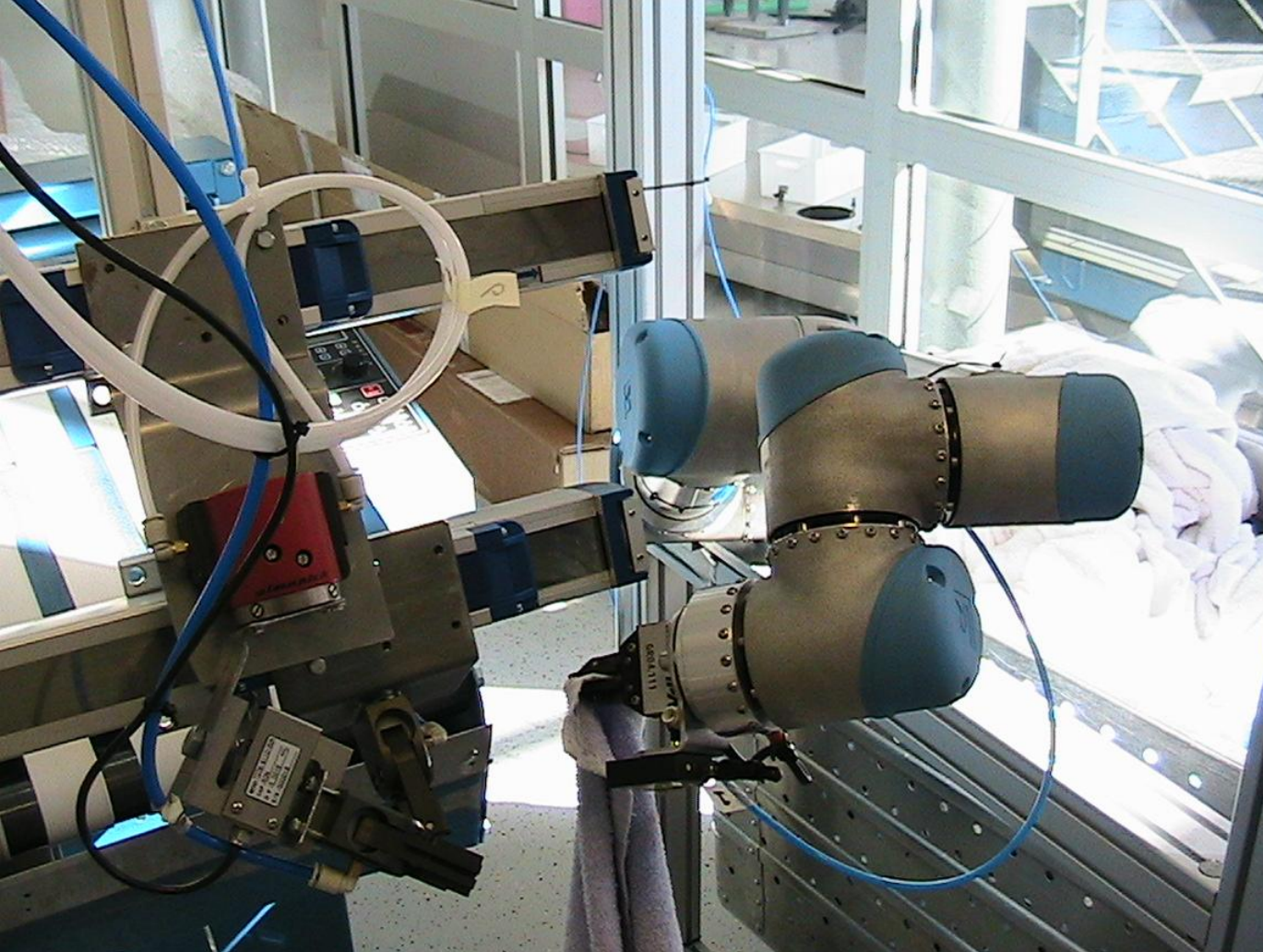
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 **fcons**

Unisensor

 **BERENDSEN**

TriVision
Intelligent Vision Solutions



**UNIVERSAL
ROBOTS**

Centre for Robot Technology

Laundry Robots

The Prevention Fund • 2009-2010 • 1,3 mio. Dkr.

Picking towels etc. • Folding machine • Work environment • Productivity
Vision/Laser • Light weight robot • Grippers • Mechanical supporting systems
Cooperation on Product-/Service development • Unique Robot solutions for laundries
fcons ApS • Unisensor A/S • Berendsen A/S • TriVision •
Universal Robots • Danish Techlogical Institute

Concrete Manufacturing Robotics





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Centre for Robot Technology

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Danish National Advanced Technology Foundation • 2007-2009 • 12,7 mill. DKK.

Unique concrete constructions casted by advanced robots

Architecture • Self compacting concrete • Robot technology •

Technology transfer to concrete branch

Technological Institute • Mærsk Mc-Kinney Møller Institute, SDU • Gibotech A/S • Aarhus

School of Architecture • Unicon A/S • Spæncom A/S • MT Højgaard A/S

TaylorCrete (continuation) • 10 mill. EUR • 2009-2013 • EU, NMP



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MTHøjgaard



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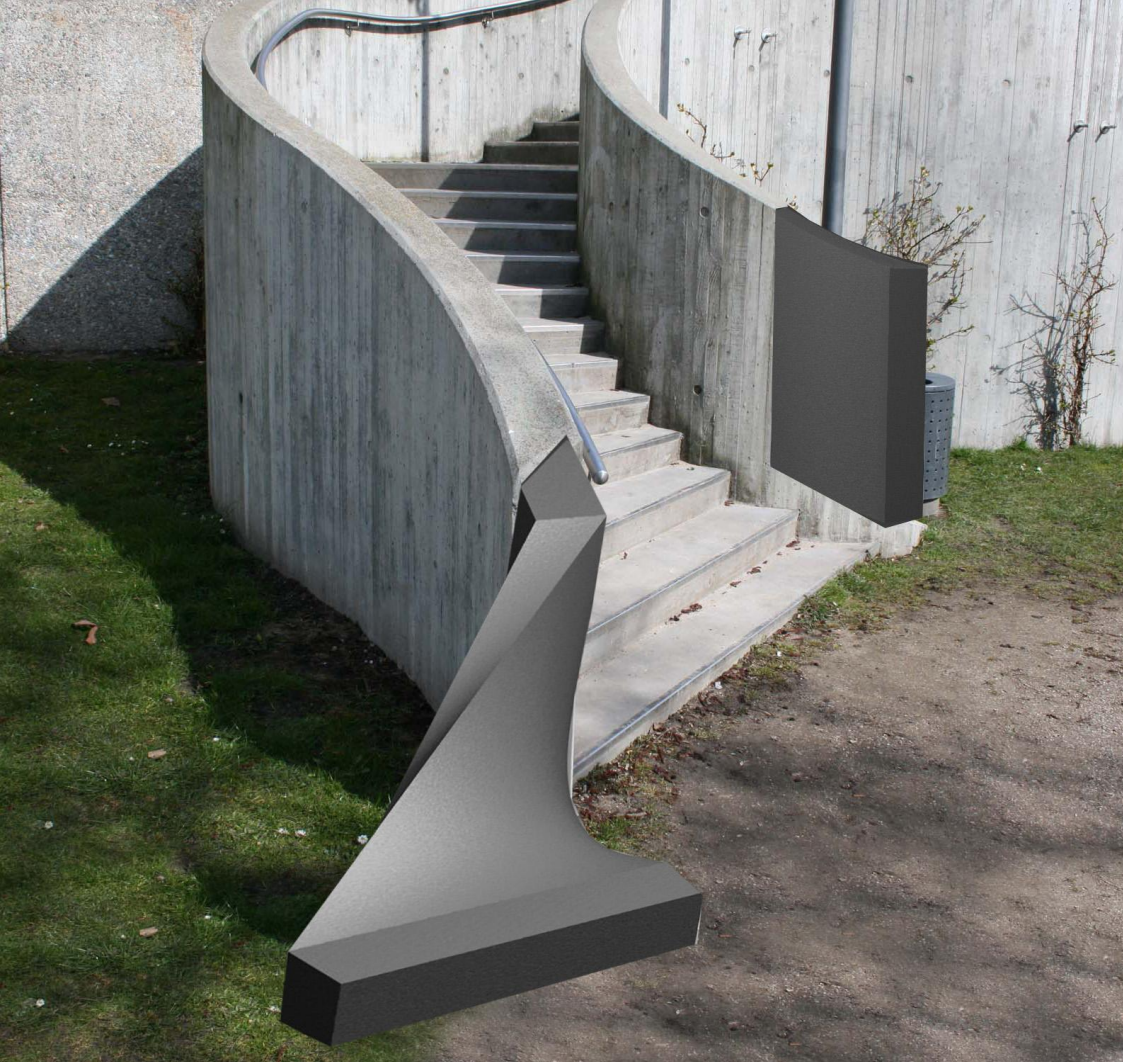
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nuevas tecnologías, s.a.

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DRAGADOS

 **CHALMERS**

 **BEKAERT**

better together

GRACE
Construction Products



ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

UNICON ///

D+P
DESIGN TO PRODUCTION



TailorCrete

Continuation of UnikaBeton • 2009-2013 • 10 mill. EUR • EU, NMP

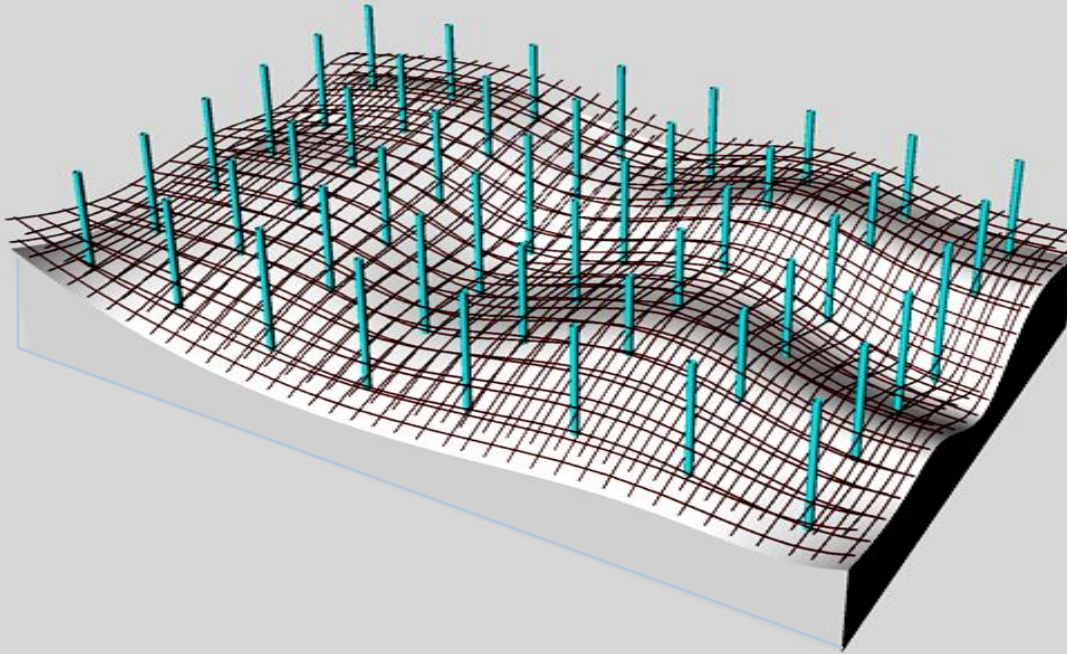
Development of new flexible reinforcement methods for concret construction

Reinforcement production • Milling • Spraying • Casting • Use of standadized robots

DTI, Robot Technology and Concrete • Chalmers • ETH Zürich • University of Southern

Denmark • Czech Technical University • El Caley Nuevas Tecnologías • Paschal Danmark

• Superpool • Gibotech • DesignToProduction • Dragados • Unicon a/s • Bekaert • Grace



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DRAGADOS



CHALMERS

BEKAERT

better together

GRACE
Construction Products



ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

UNICON

D+P
DESIGN TO PRODUCTION



TailorCrete

Continuation of UnikaBeton • 2009-2013 • 10 mill. EUR • EU, NMP

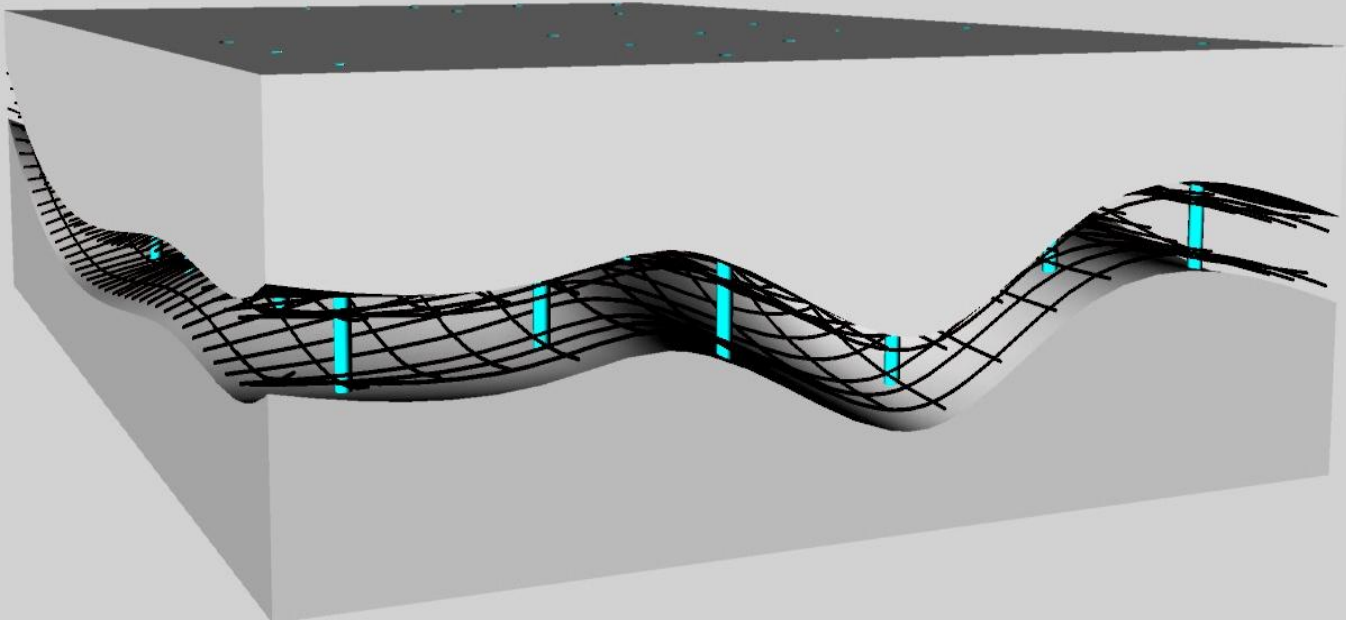
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TailorCrete

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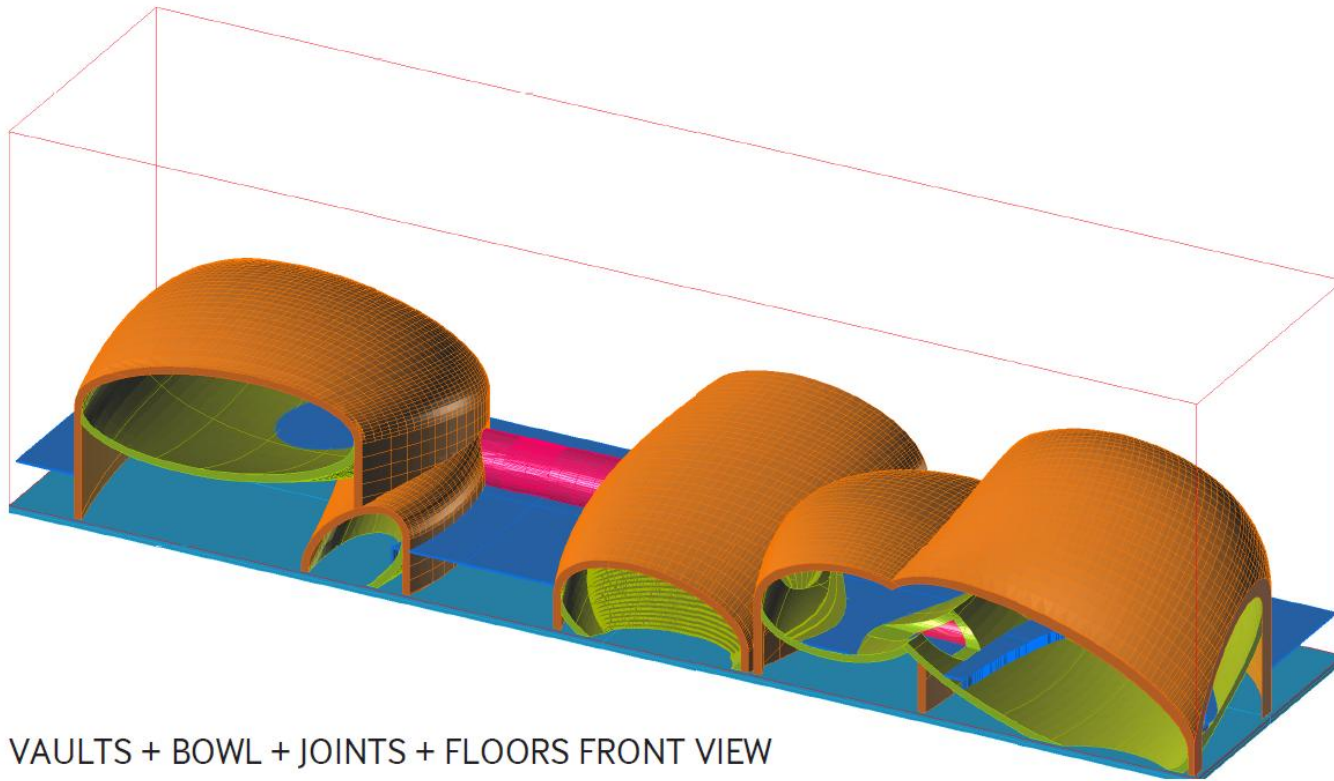
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DTI, Robot Technology and Concrete • Chalmers • ETH Zürich • University of Southern

Denmark • Czech Technical University • El Caley Nuevas Tecnologías • Paschal Danmark

• Superpool • Gibotech • DesignToProduction • Dragados • Unicon a/s • Bekaert • Grace





VAULTS + BOWL + JOINTS + FLOORS FRONT VIEW



Centre for Robot Technology



Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



Construction Products

TailorCrete

Continuation of UnikaBeton • 10 mill. EUR • 2009-2013 • EU, FP7, NMP

Development of new flexible reinforcement methods for concrete construction

Reinforcement production • Milling • Spraying • Casting • Use of standardized robots

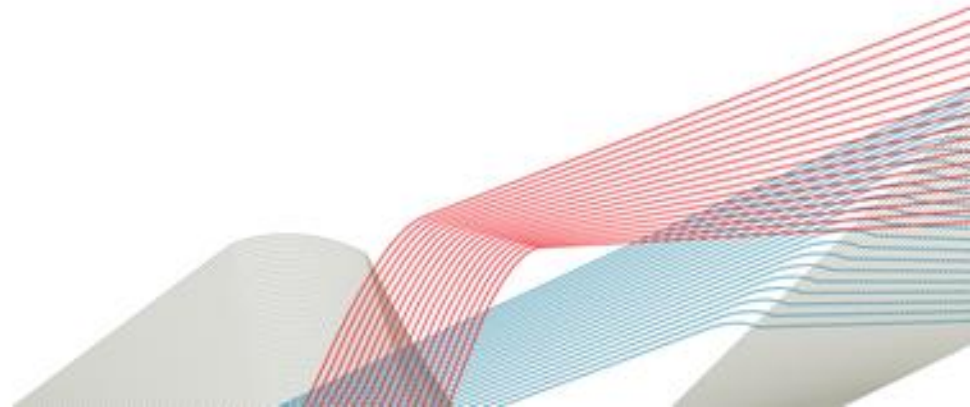
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Service Robotics





PV-Servitor

EU SME program • 2009-2011 • 1,5 mio. €

Cleaning of large Solar cell systems • Robot Technology • Intelligent Swarms

Energy efficiency +5% • Cost reduction • Sustainable

Cooperation on SME Product-/Service development

Unique Robot solutions for Solar cell systems

Manu Systems AG, Germany • Robotnik Automation SSL, Spain • The Shadow Robot Company Ltd. GB • DTI • Hochschule Regensburg, Germany • Profactor GmbH, Austria • Berner Fachhochschule, Switzerland • IBC Solar AG, Germany • Conergy Services GmbH, Germany • SOLON AG, Germany • ILIOTEC Solar GmbH, Germany • juwi solar GmbH, Germany • Solarparc AG, Germany



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**DANISH
TECHNOLOGICAL
INSTITUTE**

SOLOON *Don't leave the planet
to the stupid*

solarparc
Aktiengesellschaft

Robotnik

PROFACTOR

MANU SYSTEMS

ILIOTEC

juwi
Energie wird fähiger

HOCHSCHULE
REGENSBURG
UNIVERSITY
OF APPLIED
SCIENCES

IBC
SOLAR

Shadow
ROBOT COMPANY

CONERGY

Berner Fachhochschule

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Centre for Robot Technology





StaldTek

Innovation Syndicate • 2009-2013 • 34,4 mill .DDK

Work Environment • Animal Welfare • Environmental influence • Future Pig production

Sensor- & Robot technology • Buildings • Inventory • Equipment •

Digital Simulator model • Physical prototypes & Mock-ups

Co-operation on competence building • Unique solutions for pig production

DTI • Agro Products A/S • Danish Farm Design A/S • Danish Pig production • EGATEC A/S •

EURISCO ApS • Novotek Planning Systems A/S • Samson Agro A/S • University of

Aarhus • University of Southern Denmark • Technological University of Denmark



Dansk Svineproduktion



SKIOLD



A A R H U S U N I V E R S I T E T



Ørsted-DTU
Danmarks Tekniske Universitet



Centre for Robot Technology

StaldTek



A A R H U S U N I V E R S I T E T



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GULDBORGSUND



HØRSSENS KOMMUNE



INGENIØRHØJSKOLEN I ÅRHUS



Guldmann™

CareNet

Member financed • 2007- • 60+ members

Development, Application & Utilization • Robot- & Welfare Technology • Care Municipalities • Care businesses • Technological businesses • Scientists • Innovation • Relations • Knowledge • Inspiration • Meeting point • Idea development • DTI • Municipality of Århus • Pressalit Care A/S • RoboCluster • The Danish Centre for Assistive Technology • Danish Rehabilitation Group

Centre for Robot Technology



Paro

Therapeutic seal robot for demented and others • The Nordic countries & Europe
User financed participation • 2008- • 90+ robots in Denmark
Improvement of working environment • Safety care • Aggression calming • Demand of care
Only professional care environments •
Obligatory course certificate and experience gathering and sharing
Home bringing, distribution and utilisation • Japanese technology in Danish welfare sector
DTI • Psychological Institute, KU • National Institute of Advanced Industrial Science and
Technology (AIST), Japan • Intelligent Systems Corporation (ISC), Japan



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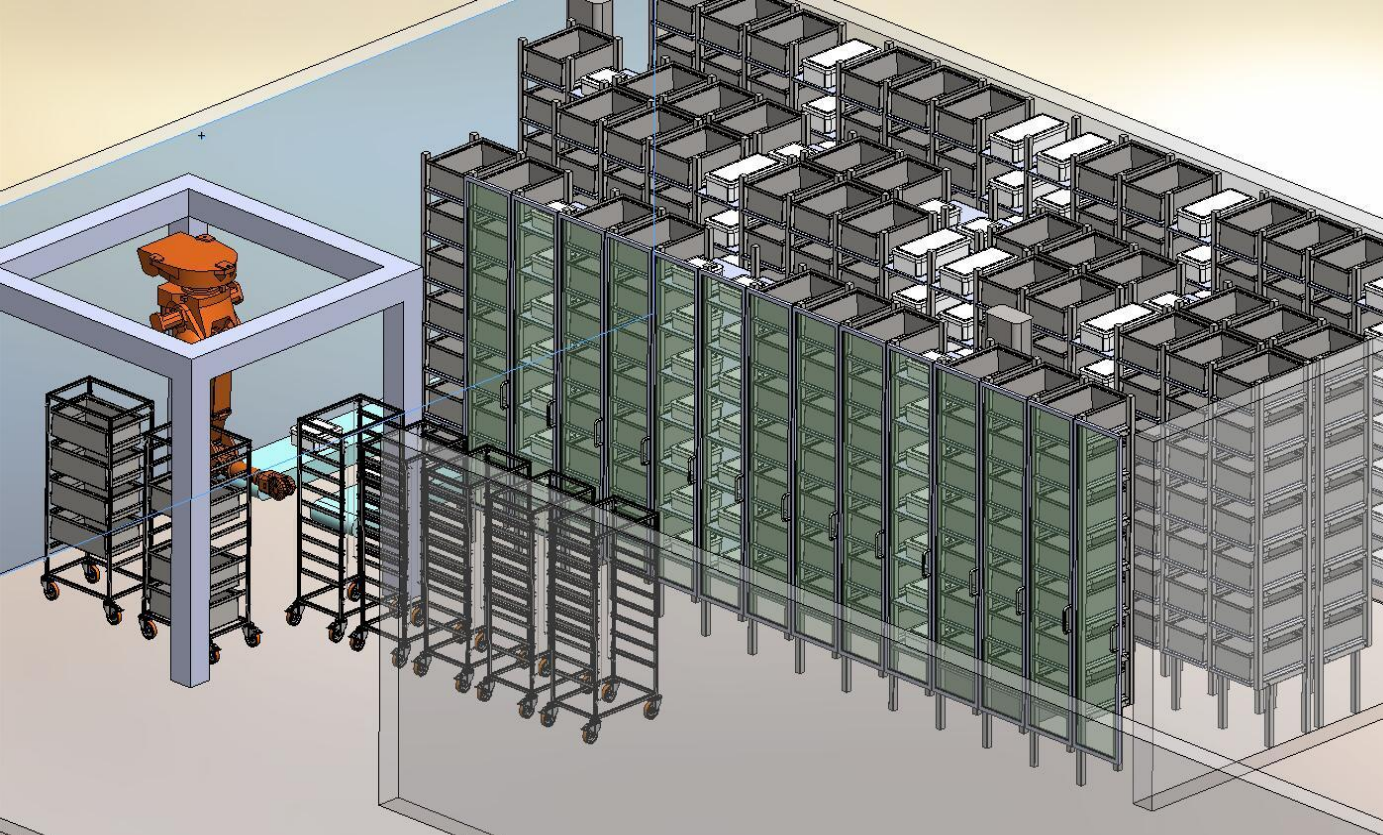
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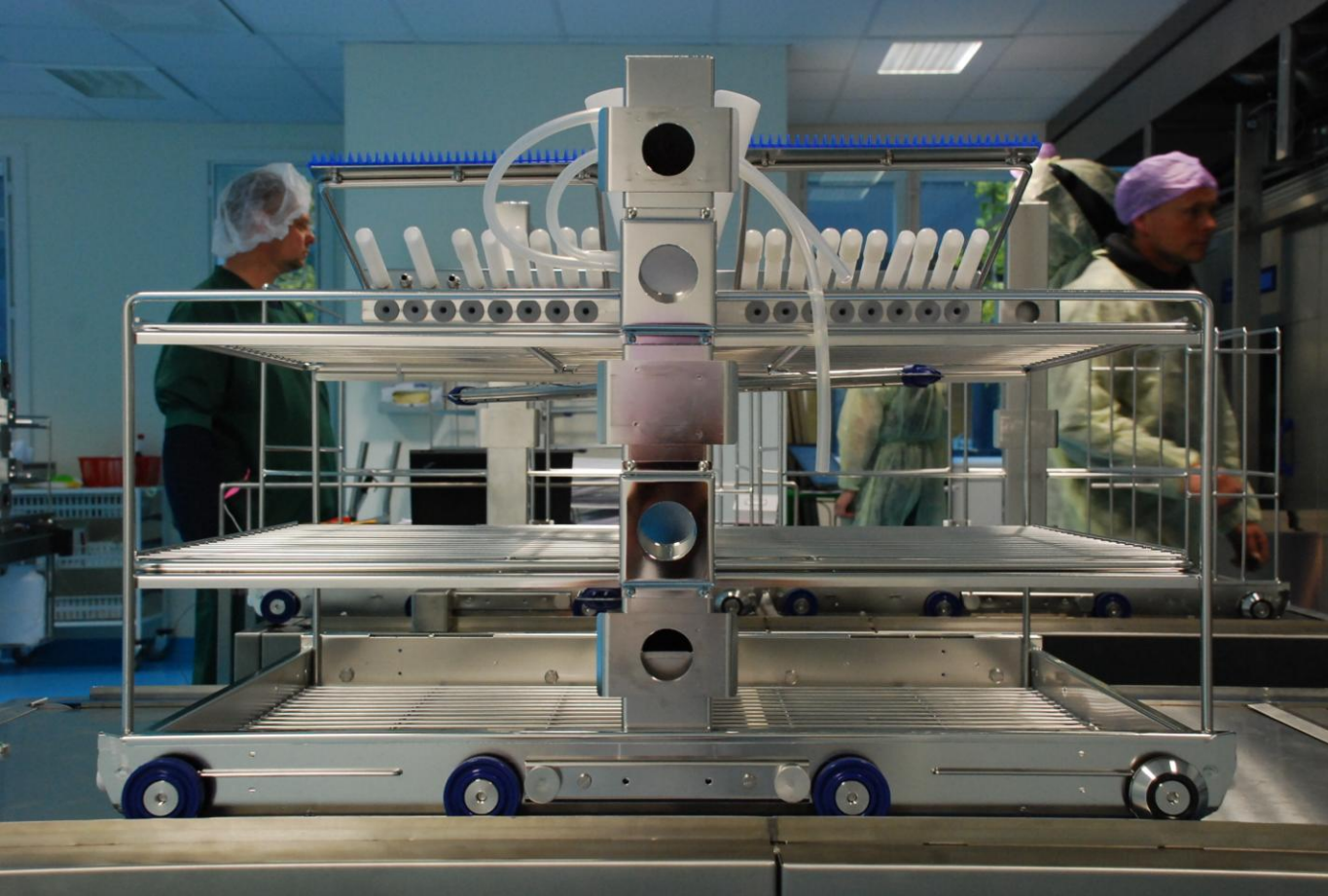
Central Sterile Processing Department

The Danish PWT Foundation – Investments in Public Welfare Technology • Gentofte Hospital
• 2009-2010 (2011) • 13,5 mill. DDK

Controlled storage instruments and articles for operations • Automatic production and packing
of case carts for operation rooms • minimization of heavy lifts • keep track of articles and
instruments in stock

Efficiency improvements • reduction of staff • reliable surveillance of instruments
DTI • Gentofte Hospital • The Capital Region of Denmark





**Gentofte
Hospital**



**Region
Hovedstaden**

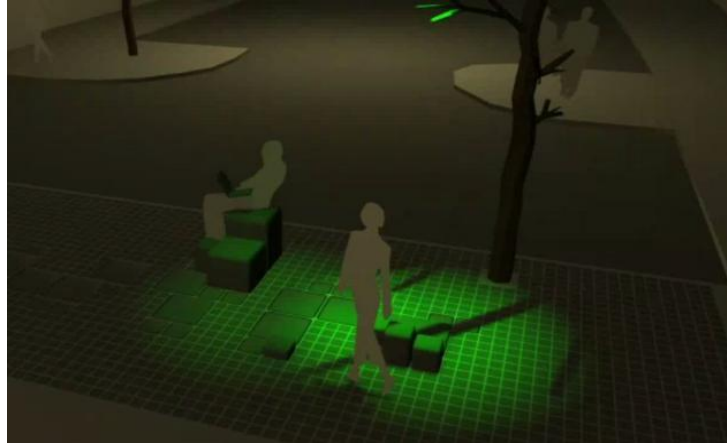
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MOVETEC

VEKSØ



ODENSE KOMMUNE

Centre for **Robot** Technology

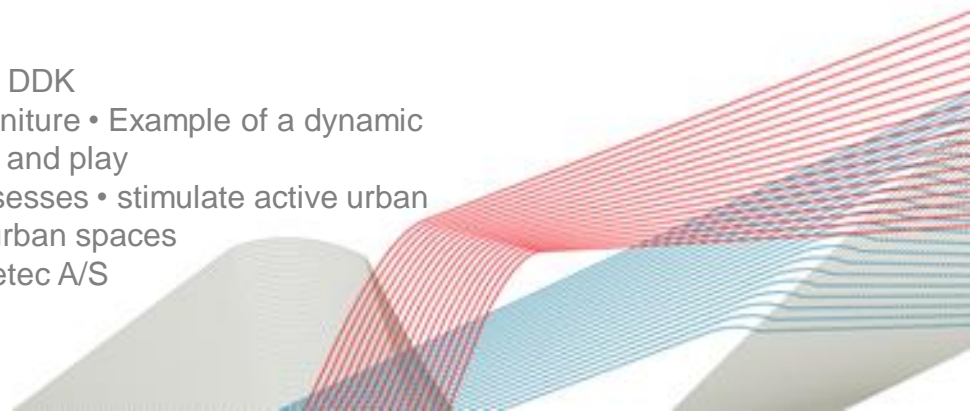
Performative Urban Plaza

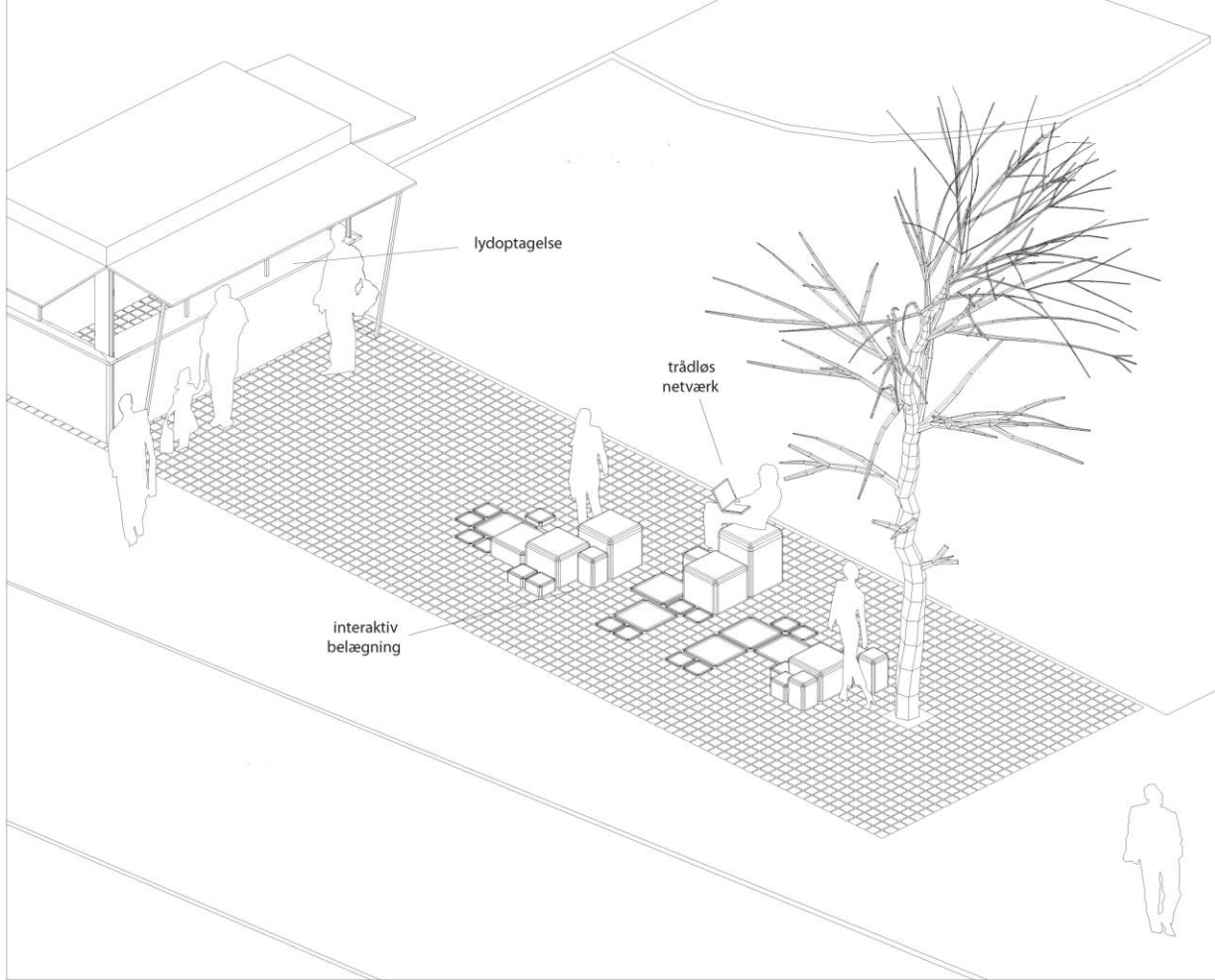
Odense Municipality • 2010 • 115.000 DDK

Creation of a performative plaza • Vertically movable urban furniture • Example of a dynamic plaza as a social platform • Creativity and play

Promote use of new technology for culturelle and urban purposes • stimulate active urban life • social interaction • multi functional urban spaces

Odense Municipality • Veksø A/S • Movetec A/S





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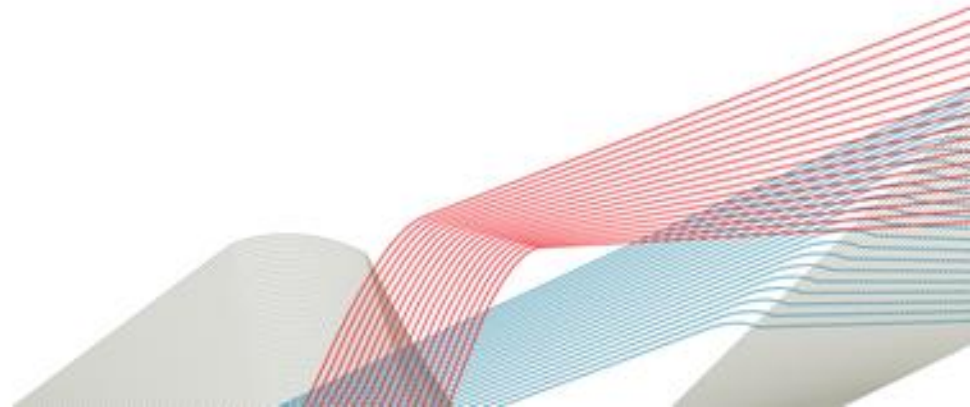


Innovatarium for Robot & Welfare Technology

- NAO

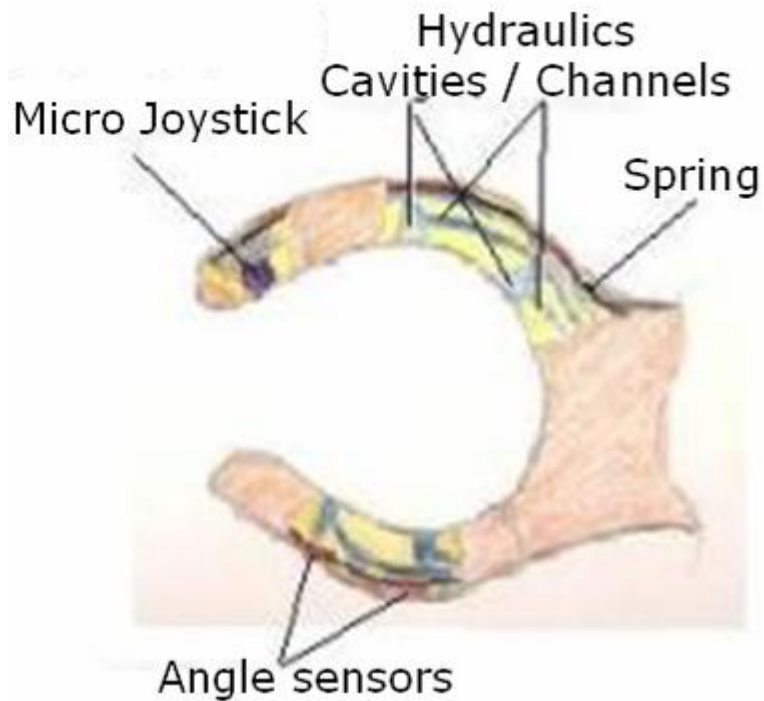
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Innovation driven Experimental Laboratory • Expose, explore and test on your own body
500 square km in Forskerparken • 2-3.000 guests /year • 30-40 installations
Technological Institute • Research Associates • Company associates • Other Research,
development and innovation projects meeting point

Trends in Robotics-driven Innovation



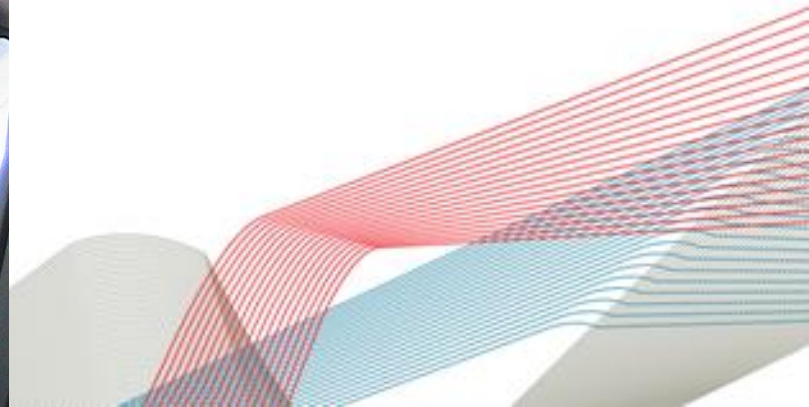
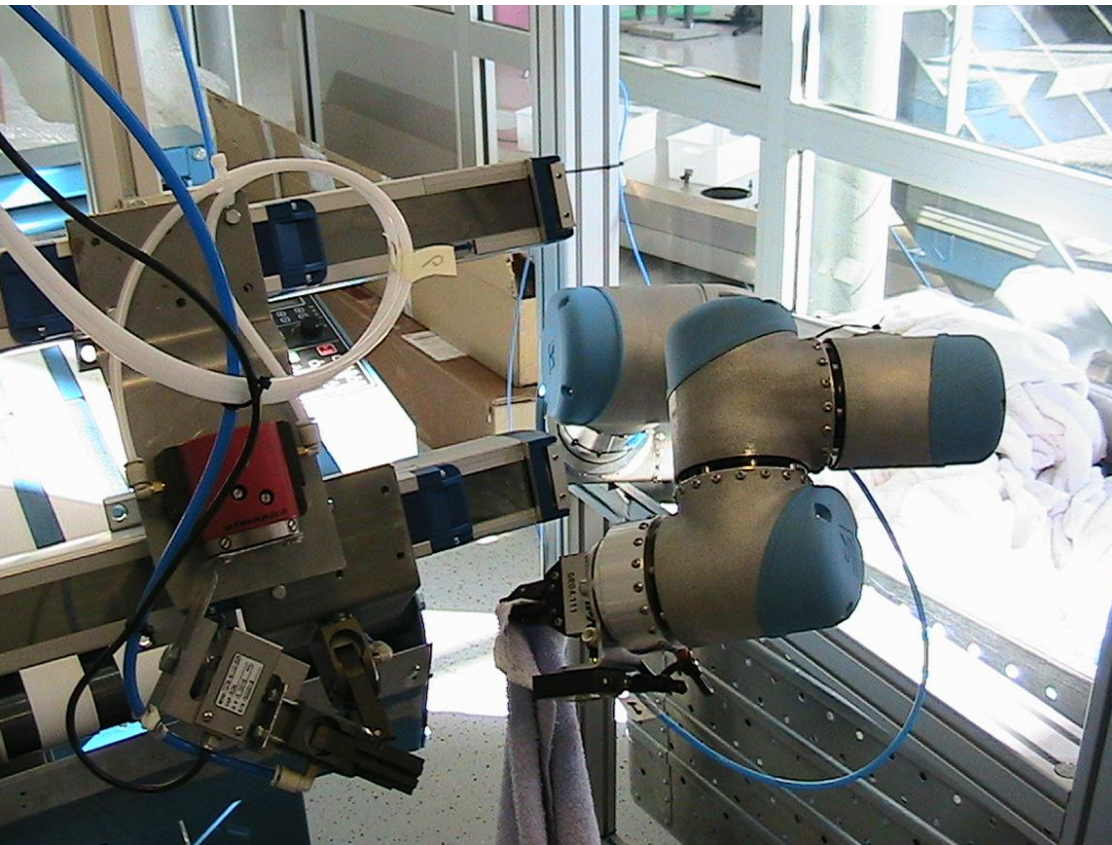
Robotics-driven Innovation, Trend no. 1

- Smart mechanics is often crucial and seems to be the single most important factor in development of robotic applications



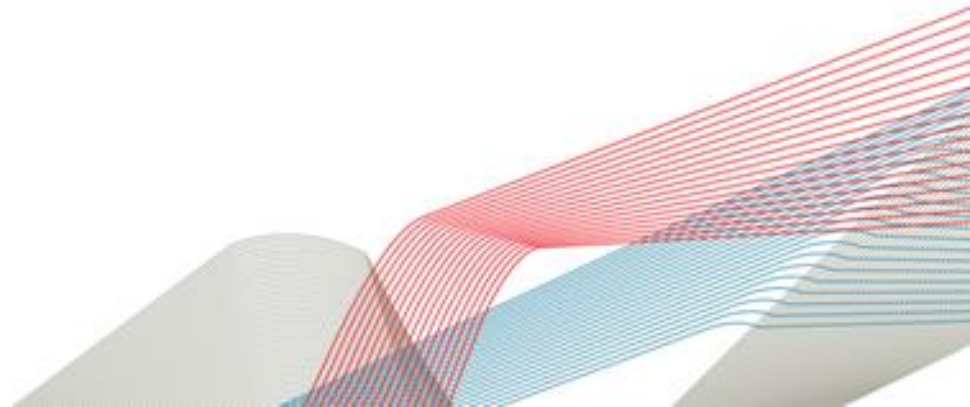
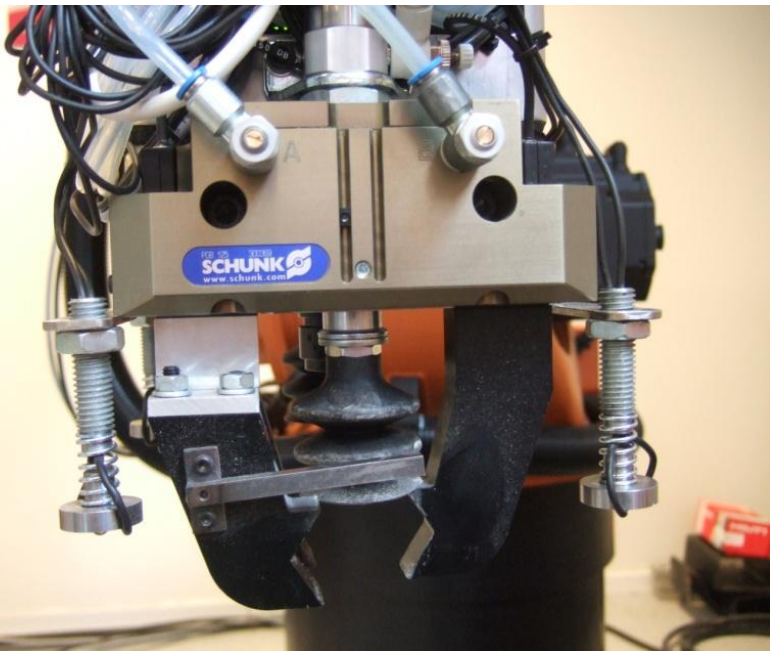
Robotics-driven Innovation, Trend no. 2

- Vision and laser technologies have become standard components and has raised the cognitive level of modern robotic systems to a higher level in both industry and service



Robotics-driven Innovation, Trend no. 3

- Cognitive technologies besides vision and lasers seems to be in a research and development phase for a longer period of time than most expects
 - Tactile sensing: a lack of really good applications
 - Multi-modal human-robot interaction: seems to be too complex for practical use at the moment
 - Manipulator tools (grippers): Generically applicable robust low-cost end-effector manipulators are really not available for use



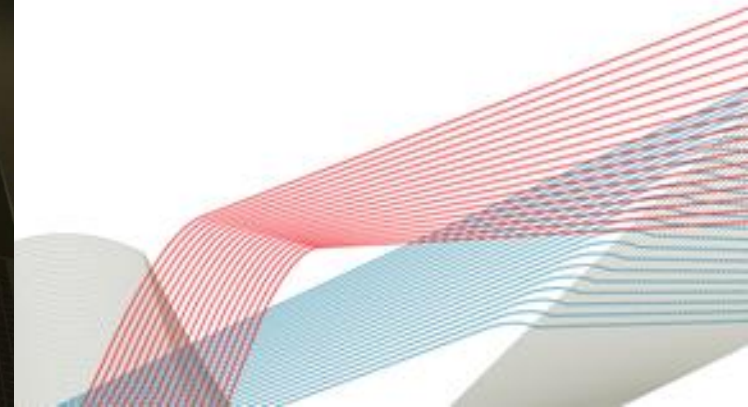
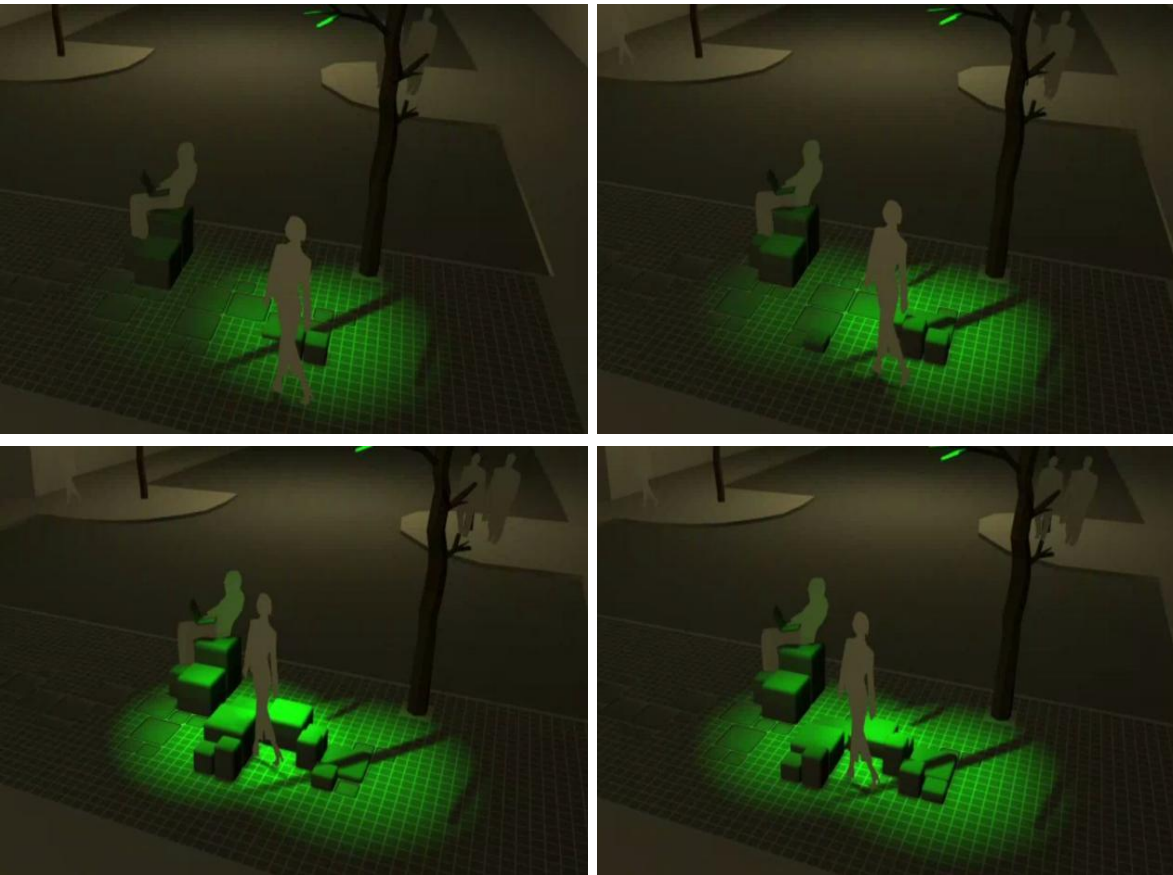
Robotics-driven Innovation, Trend no. 4

- In innovation, NEVER underestimate a thorough understanding of and listening to users, and NEVER exclude training, coaching and supporting as well as close and day-to-day dialogues with users



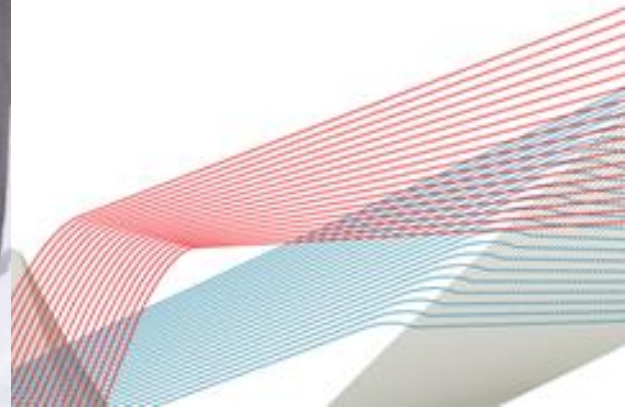
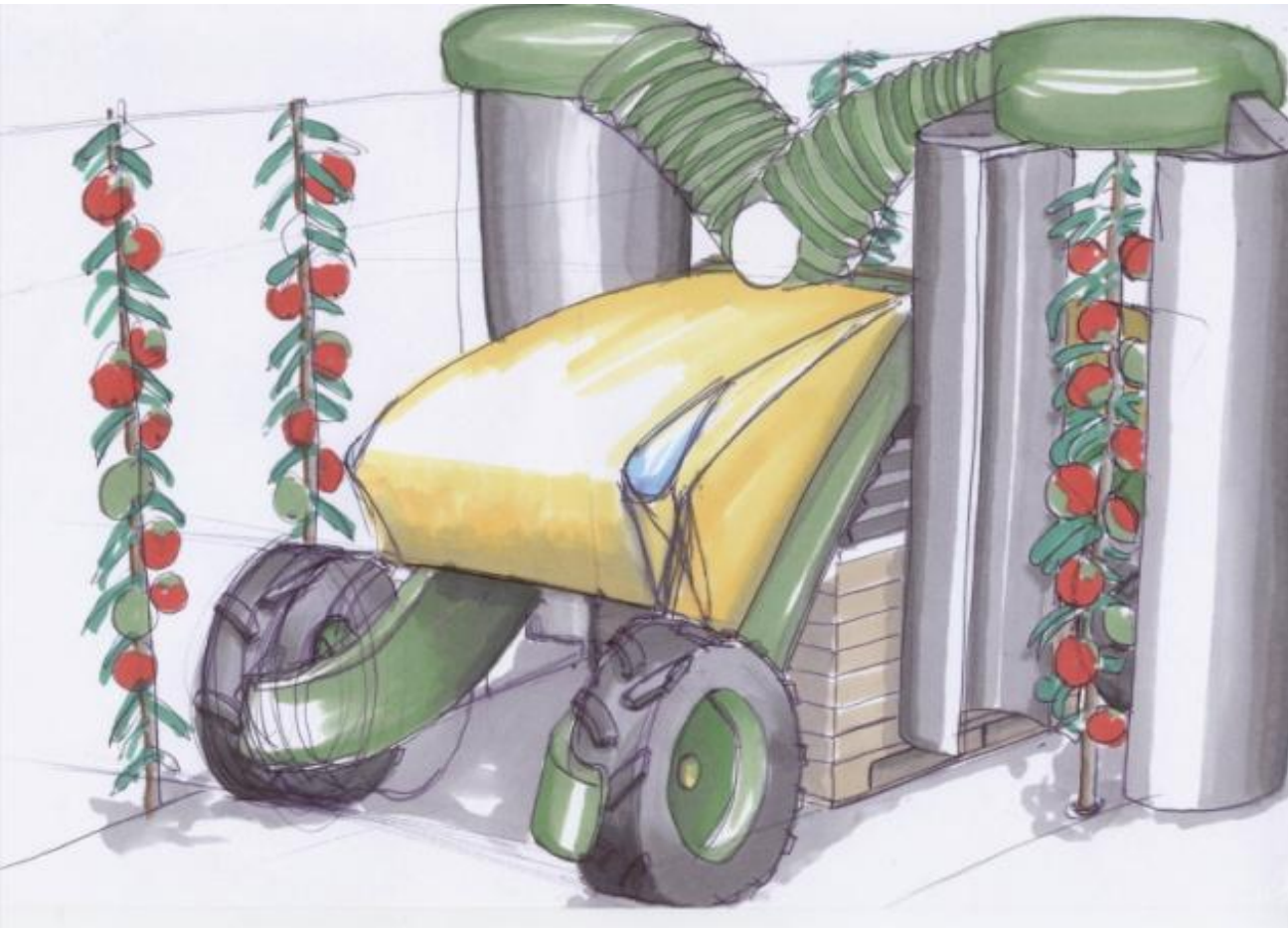
Robotics-driven Innovation, Trend no. 5

- Many successful innovations are embedded in larger systems and does not look-and-feel as robots to people



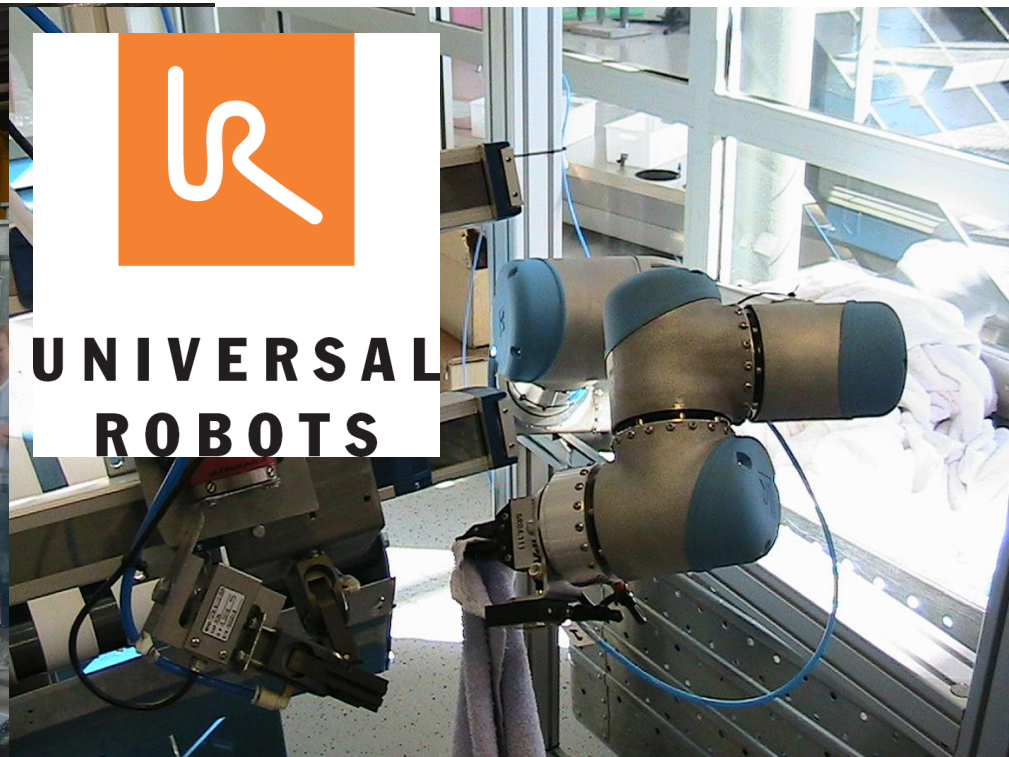
Robotics-driven Innovation, Trend no. 6

- Networking, facilitating cross fertilisation of ideas and mixing skills often makes more successful innovations



Robotics-driven Innovation, Trend no. 7

- In general 80-85 % of all industrial manufacturing processes in Europe are not automated – so there is plenty of opportunities for cognitive robotics pioneers to do
 - Look at branches with a low degree of automation

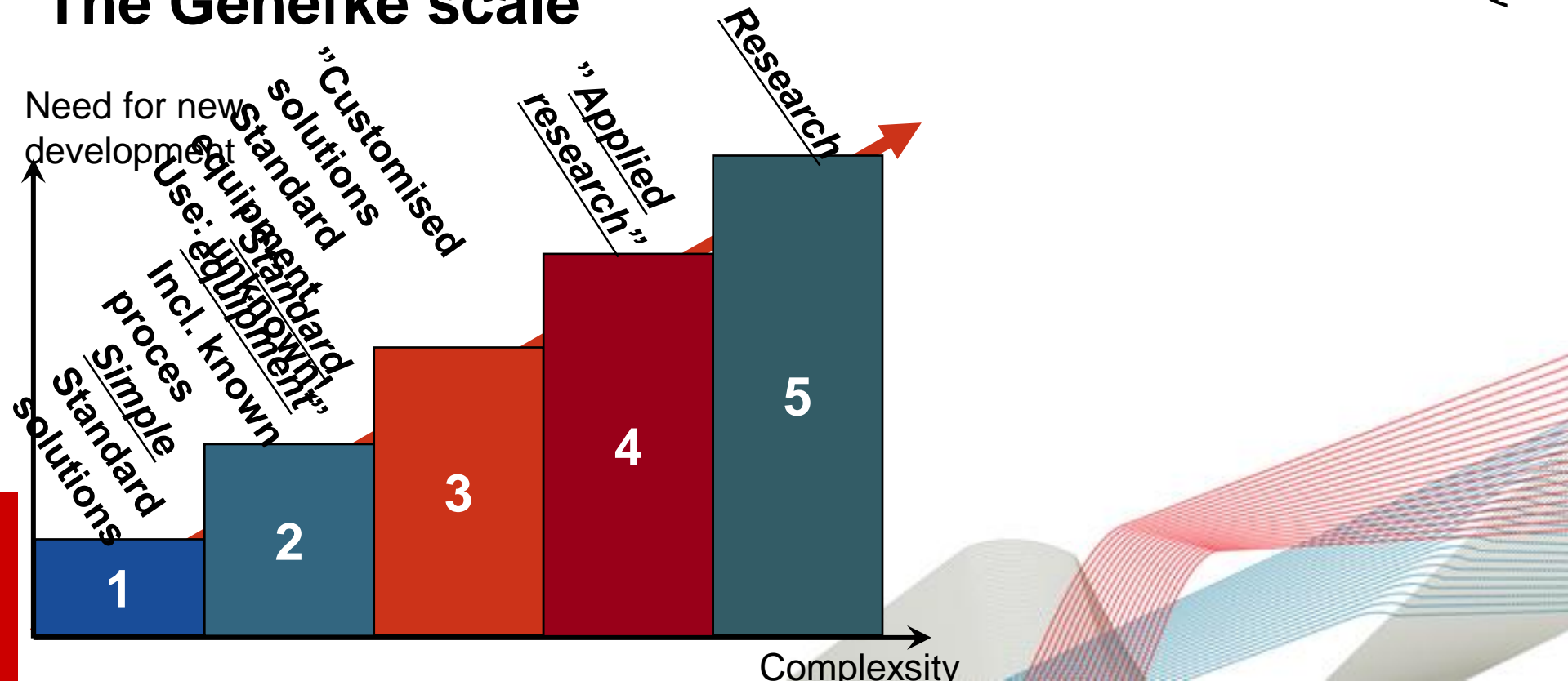


**UNIVERSAL
ROBOTS**

Robotics-driven Innovation, Trend no. 8

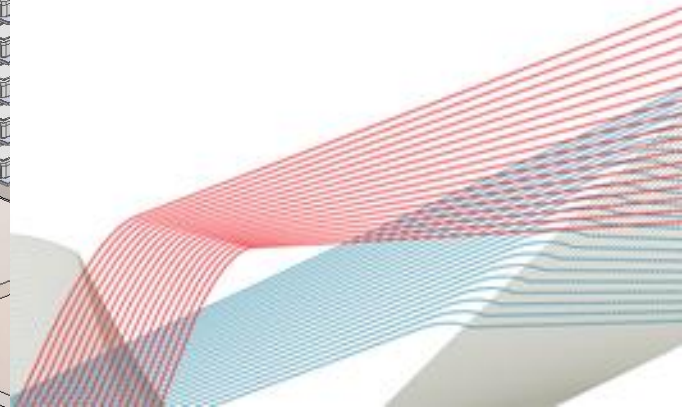
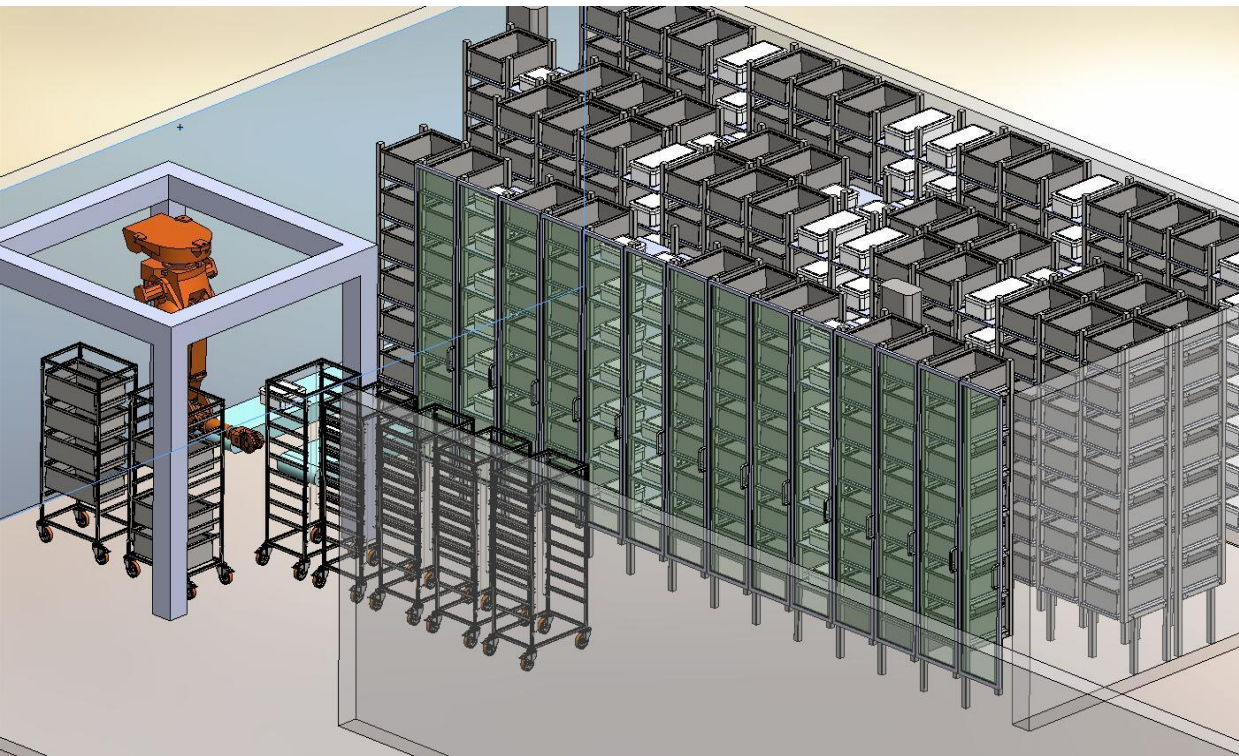
- Western countries with relatively high hour rates and highly skilled work force must focus on strategic automation based on knowledge, competences and cross-boundaries collaborations (cat. 2.5-4 on the Genefke scale)

The Genefke scale



Robotics-driven Innovation, Trend no. 9

- Significant yearly growth in number of non-industrial robotic applications
 - Shortage of labour, frequent working accidents or hygiene problems are often good drivers for successful innovations
 - Hospitals are full of industrial technology transferable processes



Robotics-driven Innovation, Trend no. 10

- Innovation = technology + usability/training + price/value + service + supply





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