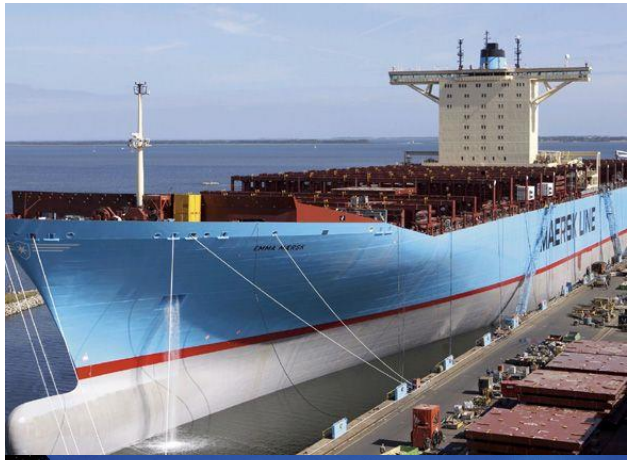
MAERSK MC-KINNEY MOLLER INSTITUTE

Hvorfor investerer SDU mere end 100 millioner i Industry 4.0?

Kasper Hallenborg
06-09-2018

Lindoe shipyard was the breeding ground

- Since mid 1980s the University has collaborated with industry on applied robotics applications and research
  - *Manufacturing as the primary domain from the very beginning, but today also in many other domains*
- 1997: Maersk Mc-Kinney Moller Institute established
- *Research supporting Robotics: Mathematics, software, AI, computer science, electronics, drones, mechanical etc.*
- Intelligent autonomous systems and simplifying the use of robotics

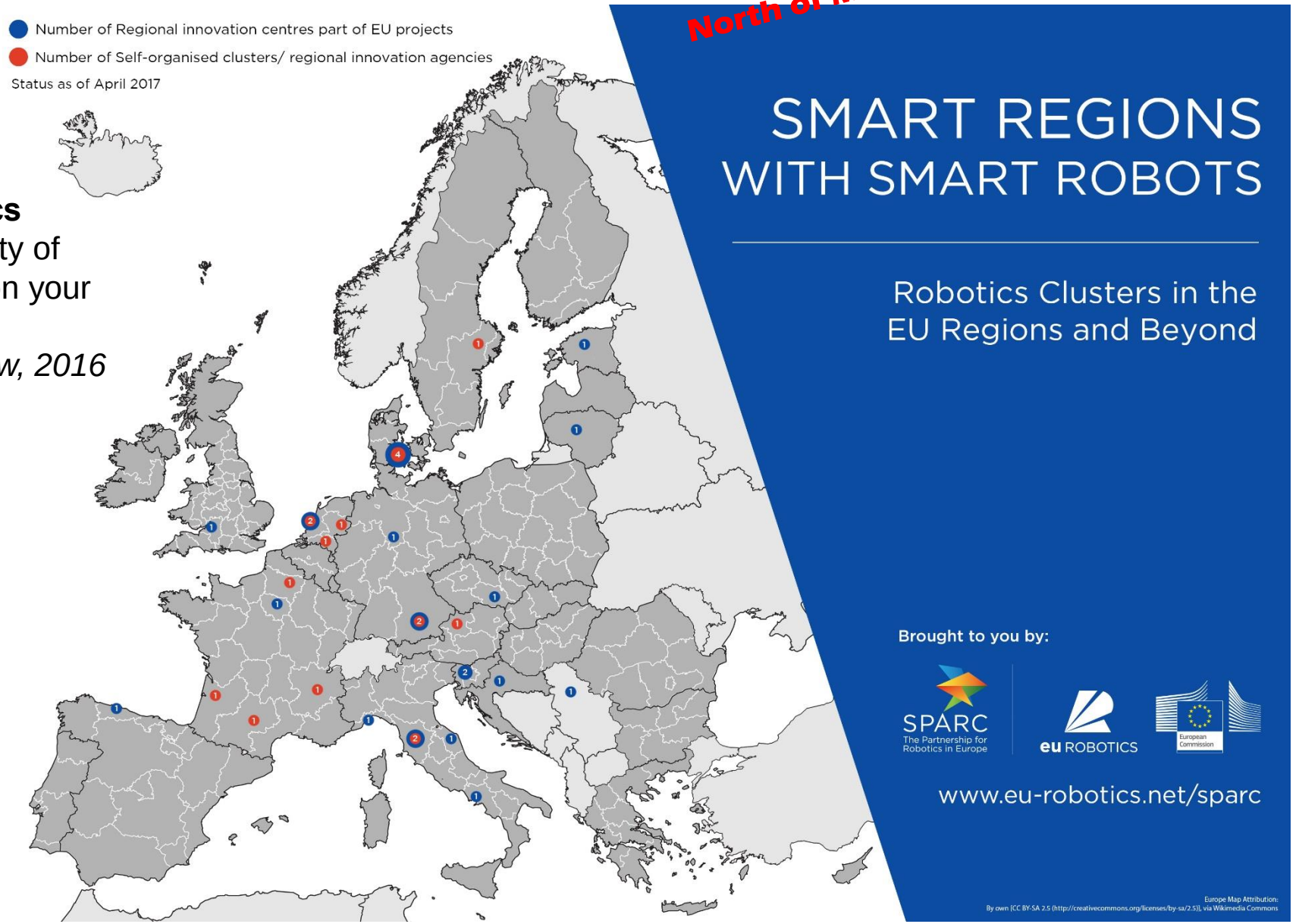


EU’s strongest cluster of robotics

Odense: Europe’s Gateway to Robotics
If you walk in the world of robotics, the city of Odense, Denmark, should definitely be on your itinerary.

Robotics Business Review, 2016

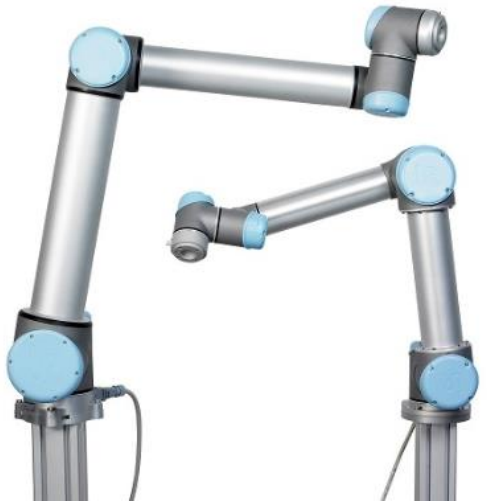
140+ Companies
4,000 jobs in the robotics sector



Innovationsnetværket
ROBOCLUSTER

Spin-outs - examples

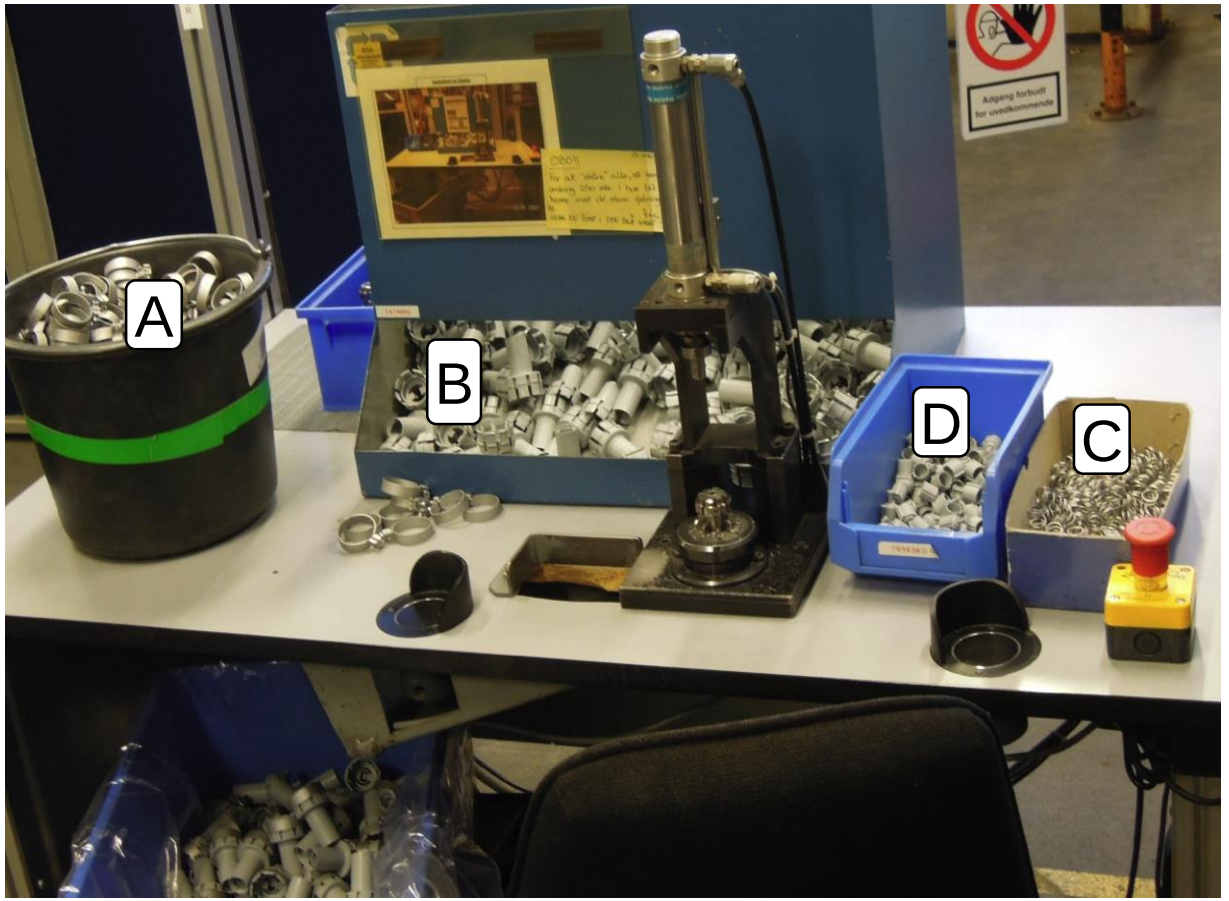
- Scape Technologies A/S (2004)
- Universal Robots (2006)
- MIR (2013)
- Kubo (2015)
- Smooth Robotics (2016)
- Enabled Robotics (2016)



Traditional robot automation complex, but repetitive

Traditional robot automation
Non-repetitive, but simple

Trend in robotic automation
Non-repetitive and (somewhat) complex



Trend in robotic automation
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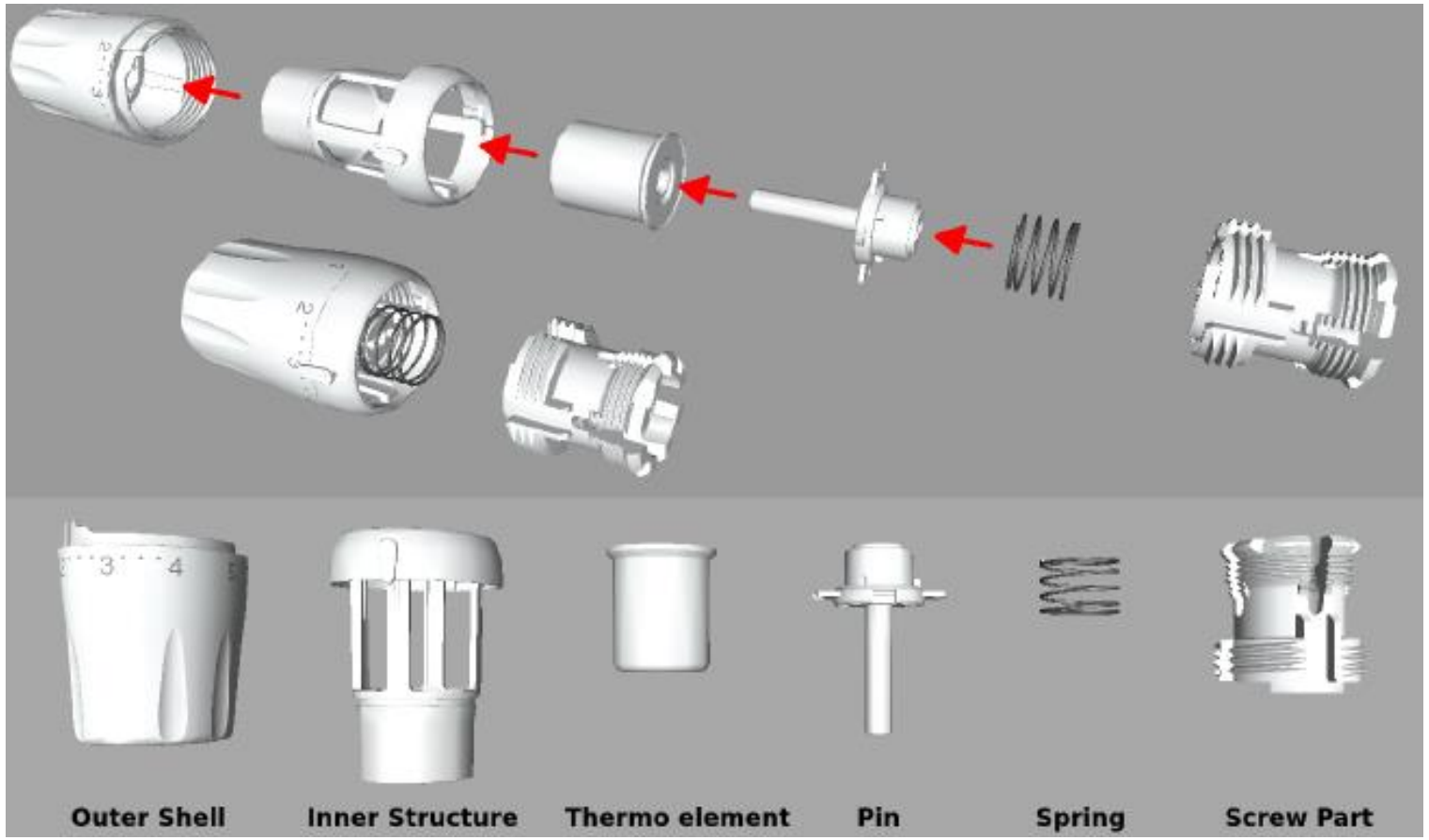
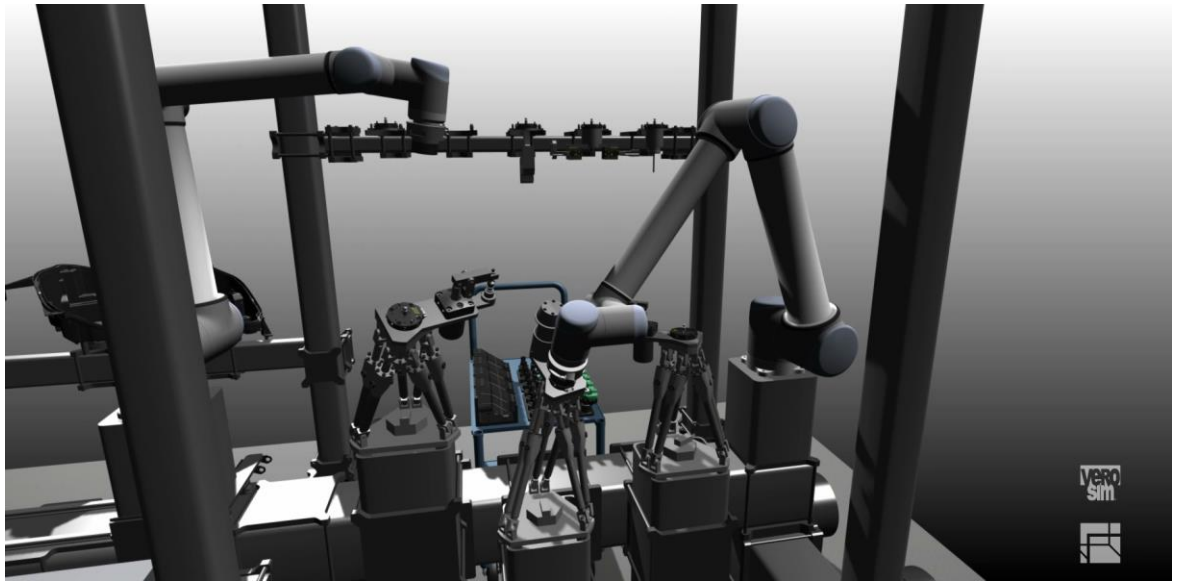
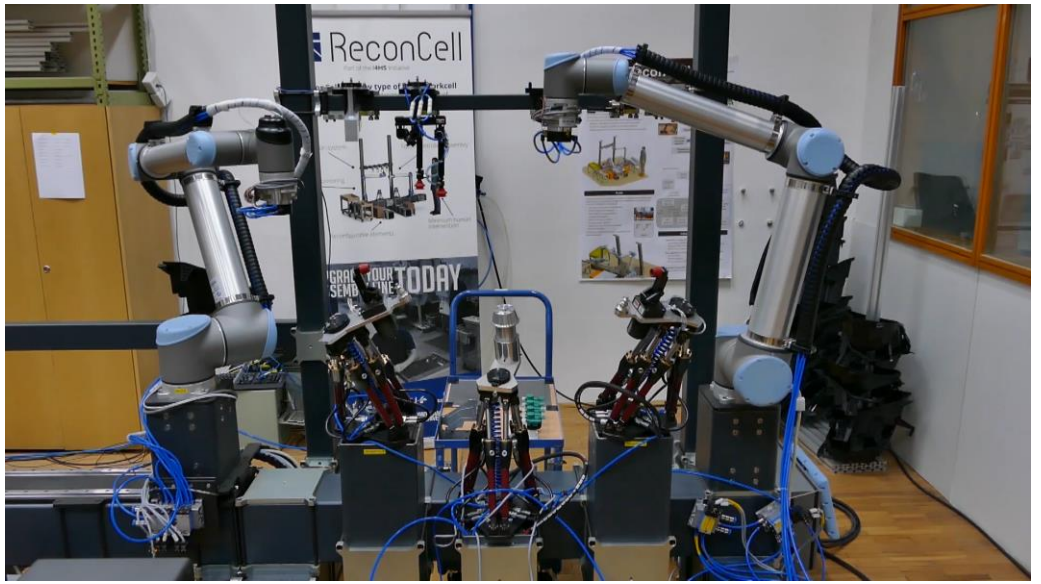


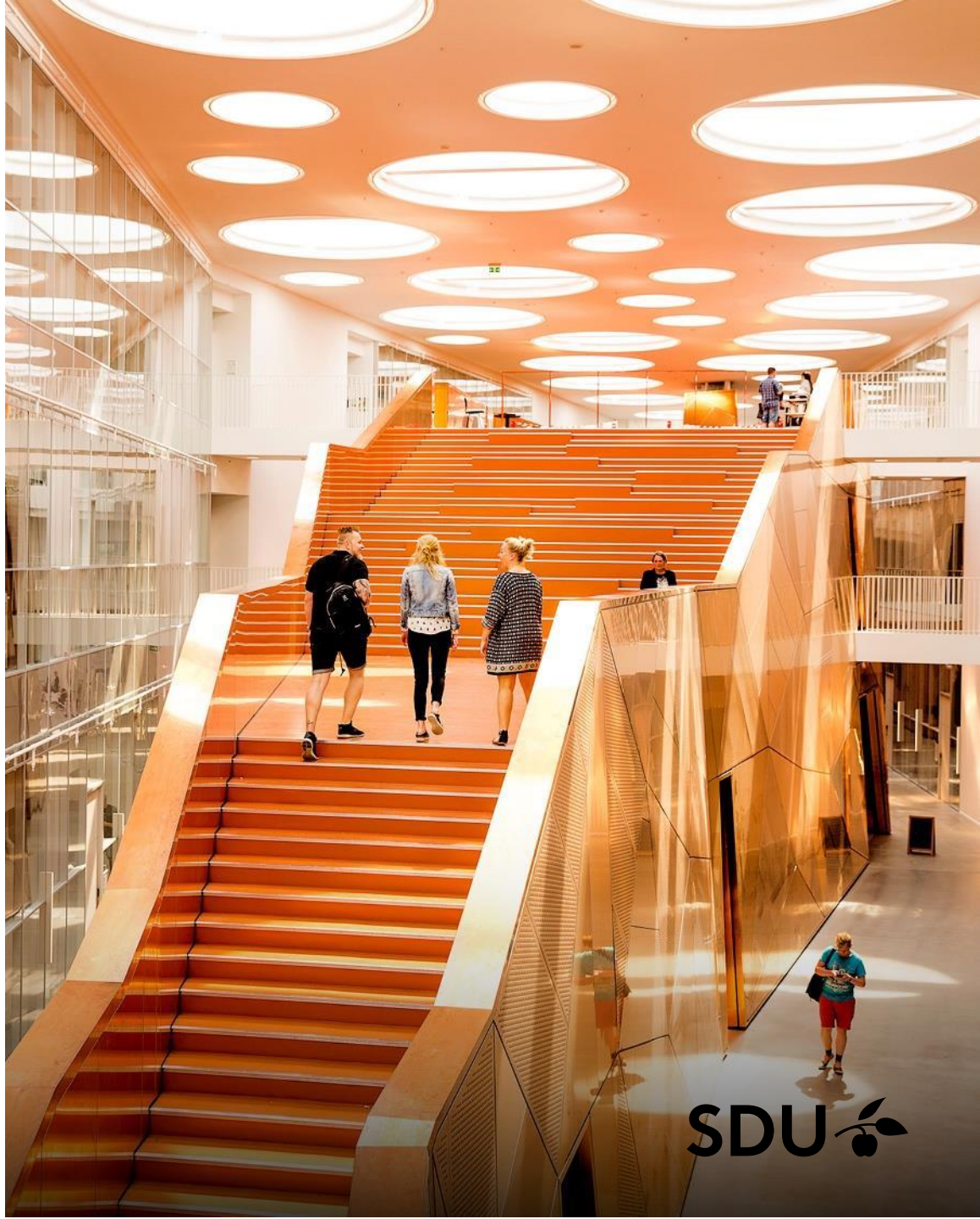
Programming and testing in virtual environments

Example from one European projects:
Headlight assembly for automotive





What’s next?



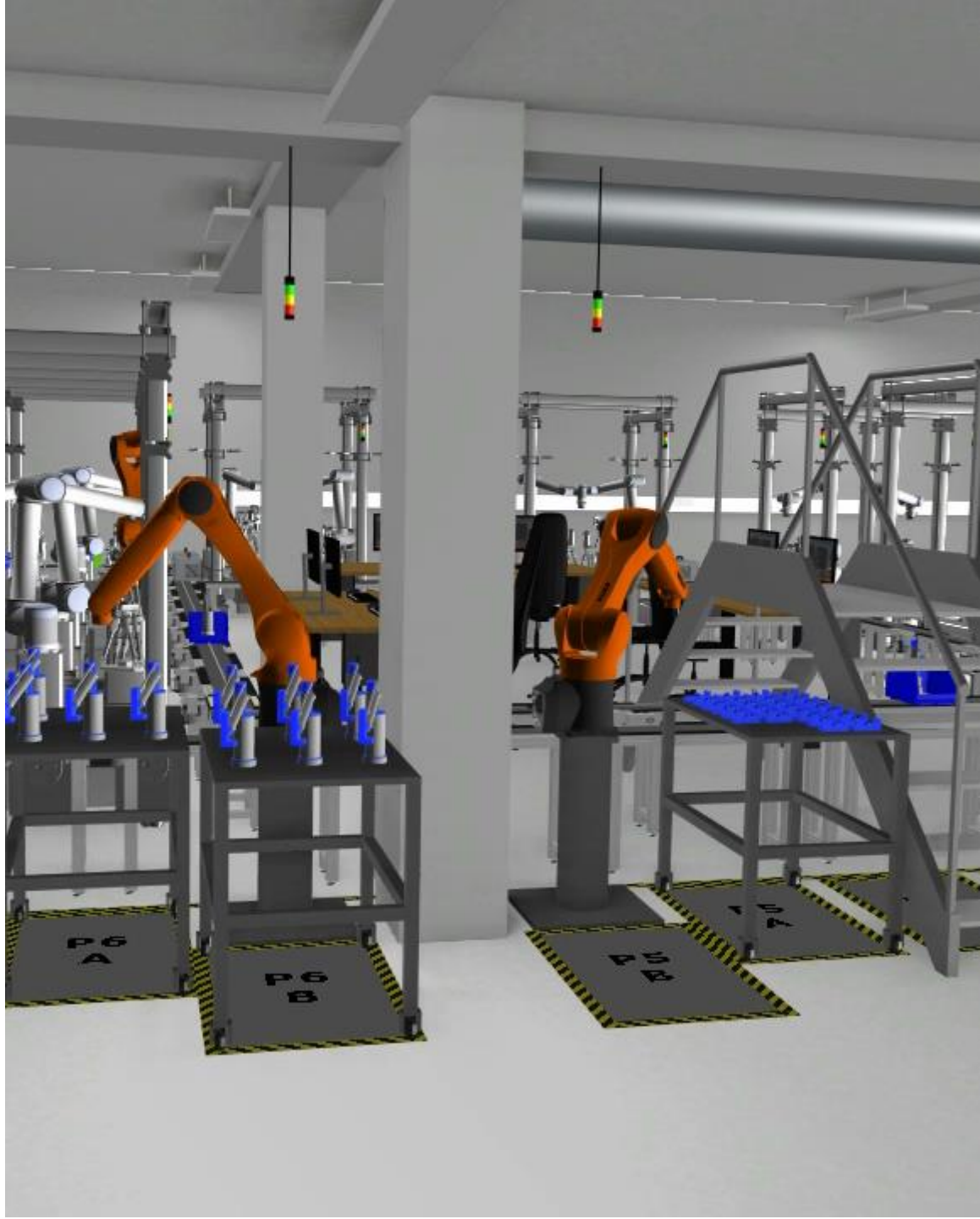
Økosystem analyse fra Region Syd vedr. Robot klyngen

Anbefalinger:

1. Styrket fokus på at sikre tilstrækkelig og kvalificeret arbejdskraft
2. Fokus på at sikre kapital til fortsat vækst i klyngen
3. Øget samarbejde om test og demonstration af robotløsninger
4. Afsøgning af nye anvendelsesmuligheder og -områder
5. Styrkelse af kobling til videnmiljøer inden for robotteknologi
6. Afdækning af muligheder for fremtidig organisering
7. Lobby for national robotstrateg

Industry 4.0 @ SDU

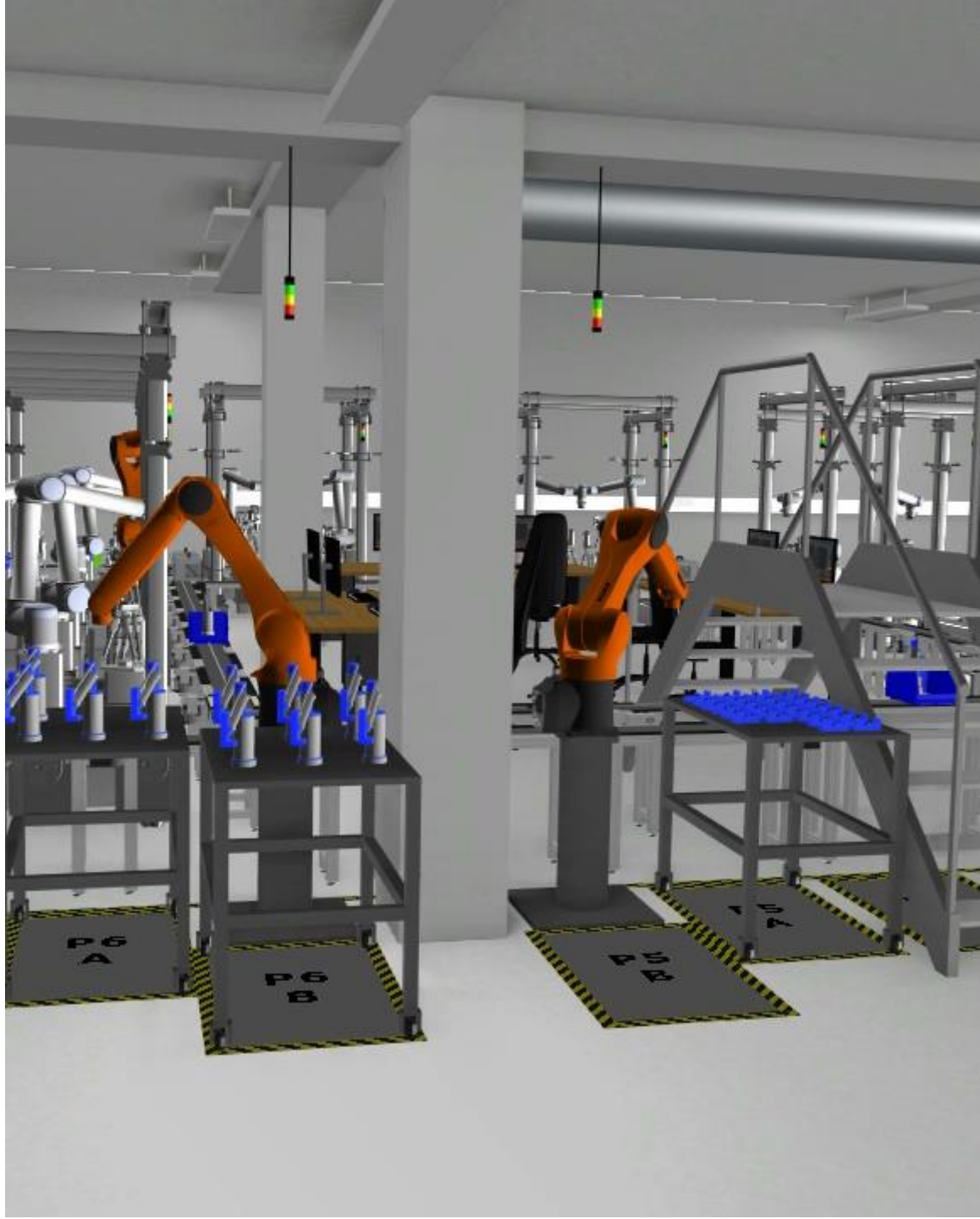
- Robotics and automation companies are growing exponentially
- SDU wants to continue to support companies with access to knowledge, innovation and new staff members
- Support the need of a full scale demonstration centre and world-class research infrastructure
- Building on the core competences of robotics and automation



SDU I4.0 Initiative

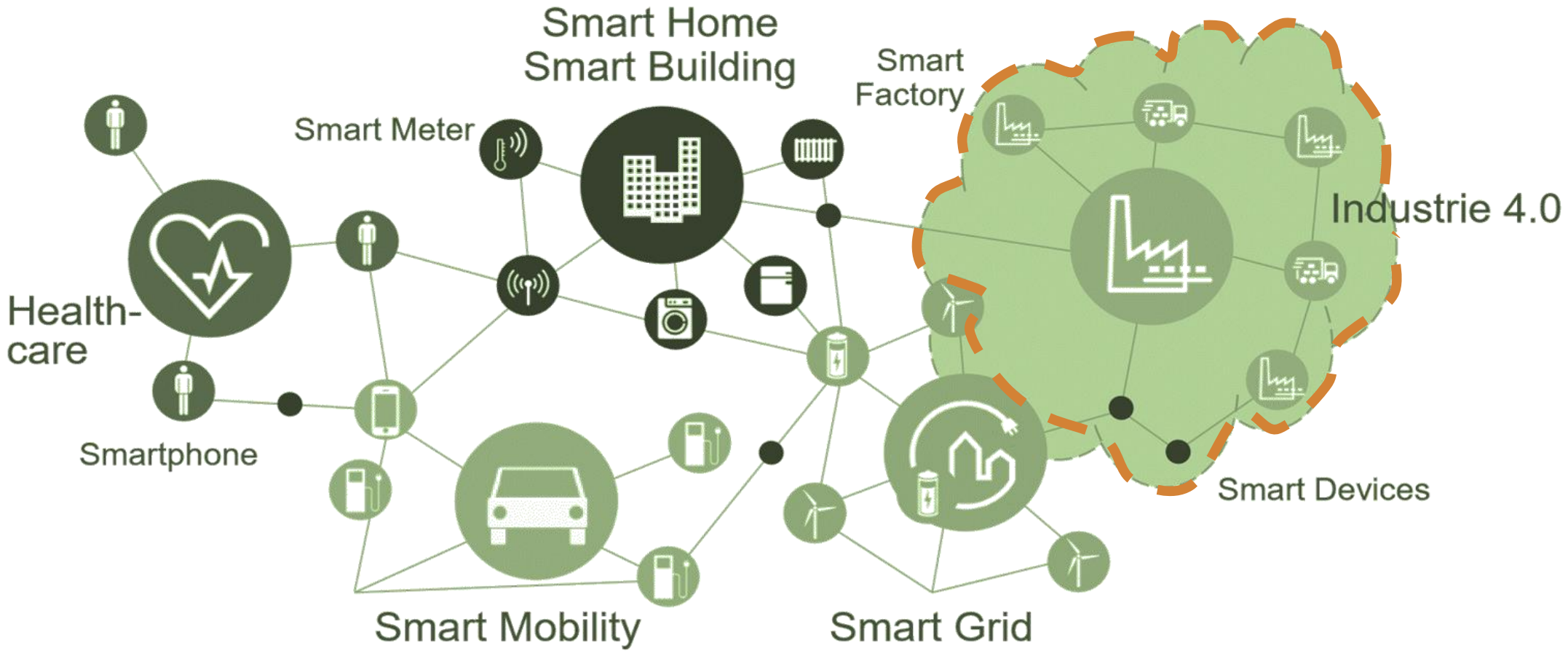
Digital Autonomous Production

- Investing more than 100 million kr (new money)
  - A 800 m^2 basement full of state-of-art technologies
- Students, researcher and industry collaborate to address the challenges of Industry 4.0
  - **End-to-end engineering** - Digitalized co-development of product and production system (Digital Twins)
  - **Personalized production** - Highly customizable production “on-demand”, shorter product cycles
  - **Reconfigurable automation** - Highly modular, highly reconfigurable robotic cell system
  - **Plug & Produce** - Comprehensive control scheme (including simulation and VR/AR)
  - **Flexible logistics** - Flexible material transport between various sections and cells
  - **Horizontal and vertical integration**
  - **From centralized to de-centralized control**



Focus of the I4.0 Lab

Restricting the lab to core topics



Source: Bosch Rexroth 2016

Core topics of the I4.0 Lab

Our definition : Industry 4.0 = Automation + Digitalization

- Smart products and production
- Cyber Physical Systems, IOT (sensors - network - cloud)
- Connectivity/transparency/knowledge sharing/data analytics
- Glocalization (think global – act local)
- VR/AR
- Simulation/digital twins (products and production)
- Operator 4.0 – operator of the future
- Collaborative mobile/industrial robots
- Autonomous Robots – next generations of robots
- Intelligent and integrated control systems

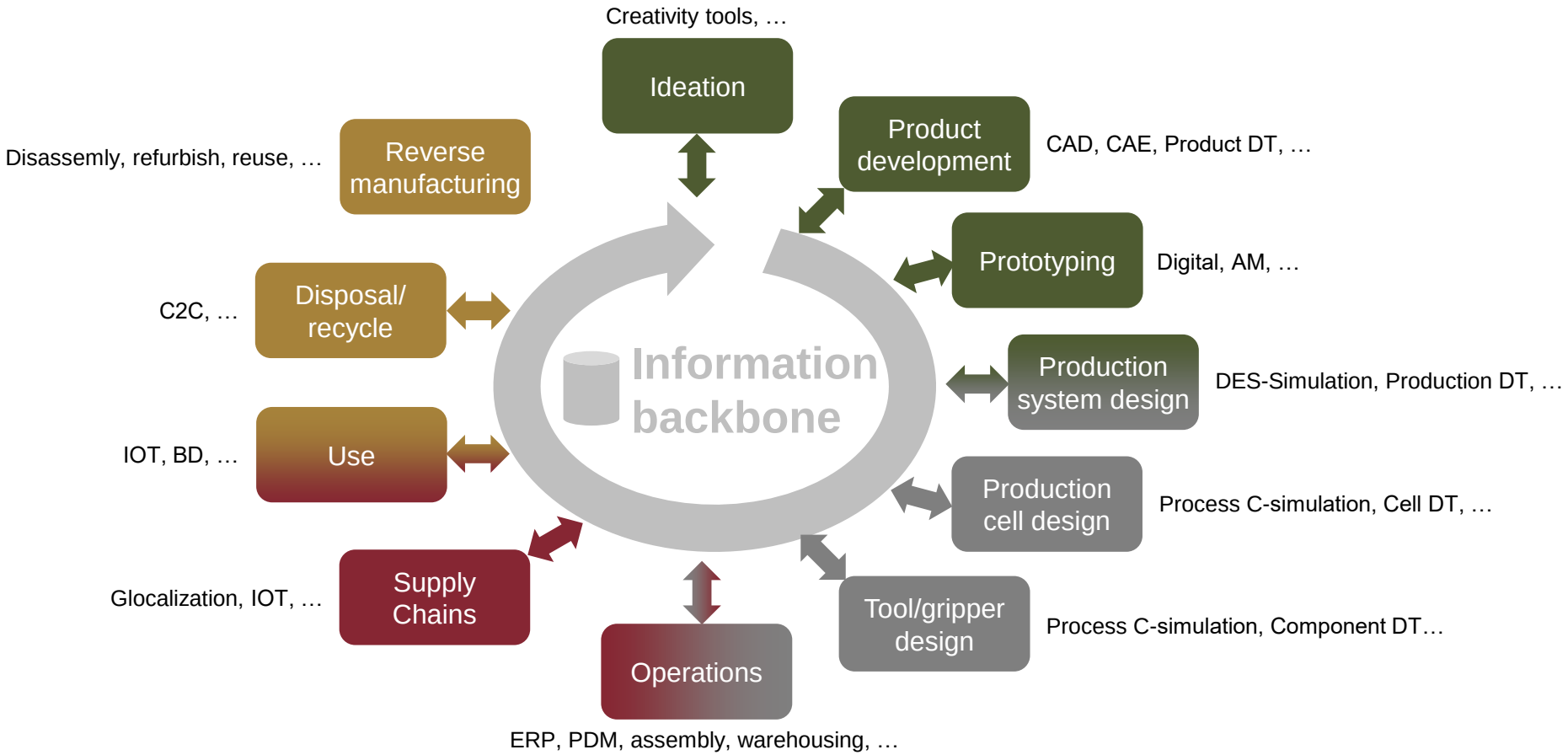
Core technologies in the I4.0 Lab

See I4.0 Lab call

- Flexible robot cells
- Collaborative interaction with robots
- Conveyor system and software for flexible control
- OPC-UA integration architecture
- Cloud integration
- Multi-agent based manufacturing support
- Digital Twins support and components
- Data Science support of production data
- Predictive maintenance support
- AR and VR for training, design and inspection
- ICT security issues
- Data model abstractions

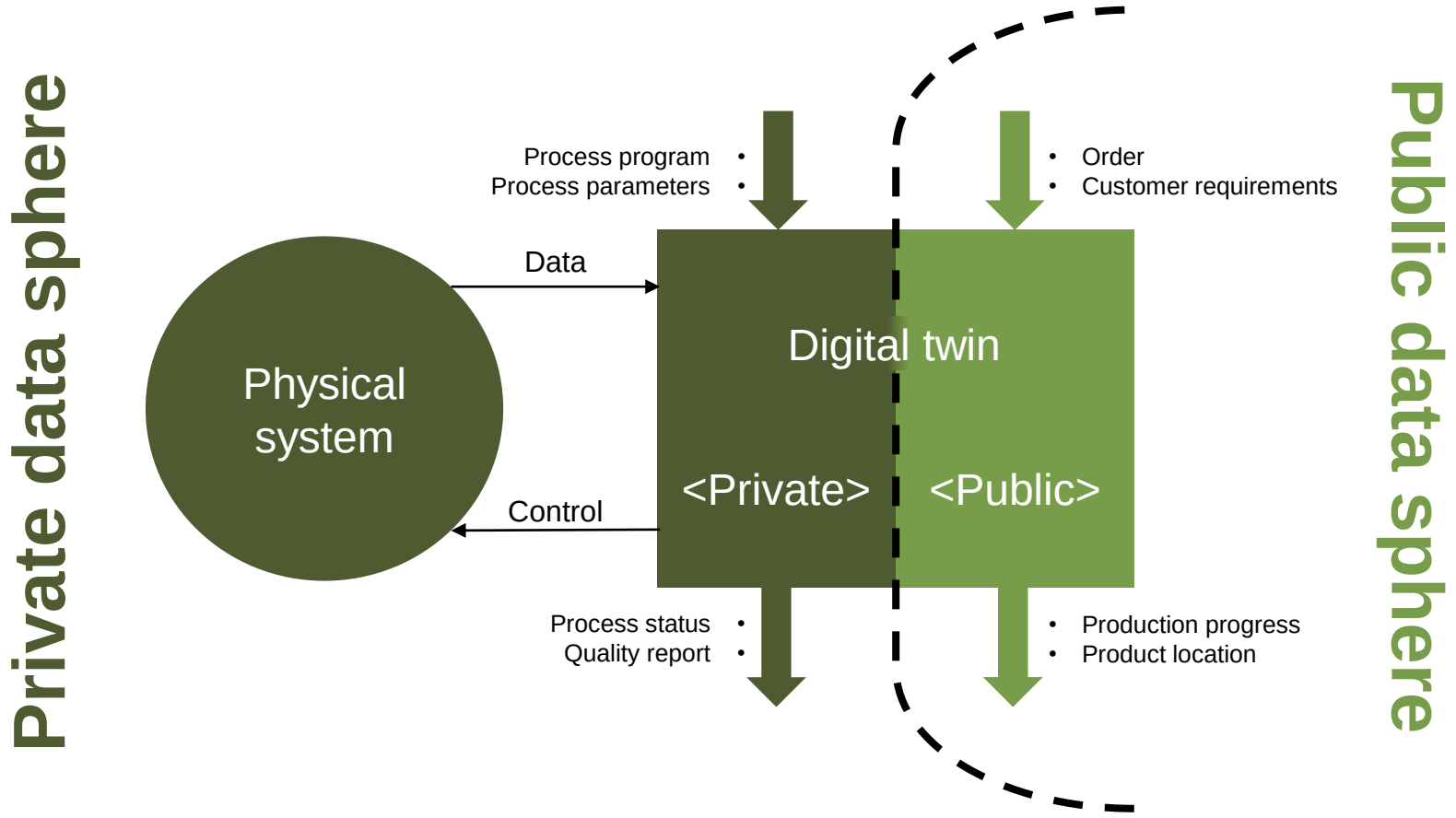
Product/production system lifecycle

Phases of design, implementation and operation in the I4.0 Lab



Digital Twins

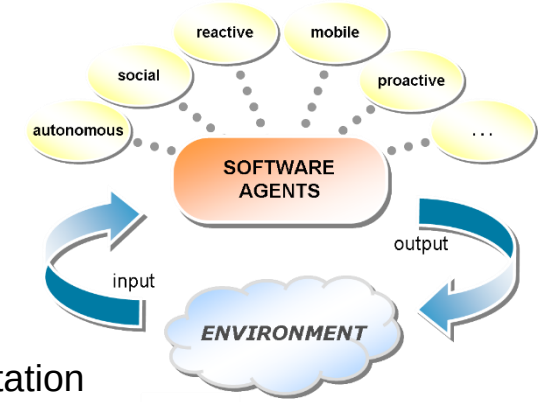
Digital Twins link the physical and virtual world to the information backbone



SDU I4.0 Initiative

Multi-agent based approach

- Originates from research of Distributed Artificial Intelligence
  - What is an agent?
    - An autonomous unit (e.g. robot or software system)
    - Communicative skills for collaboration and negotiation with other agents
    - Reactive and pro-active behaviours to pursue design objectives
  - Pros
    - Handling complexity
    - Flexibility
    - Robustness
    - High-level abstract communication languages (ontologies)
    - Simple behaviour based implementation
  - Cons
    - Indeterminism of the solution
  - A natural approach to model elements of a production system



Digital production and design

- AR and VR technologies
  - Supporting digital design processes
  - Interaction with production and Quality Control
  - Training and maintenance task (paperless)

- Setting up a VR-lab
  - Supporting visualization and interaction between humans and realistic kinematic models

Soft Robotics Center

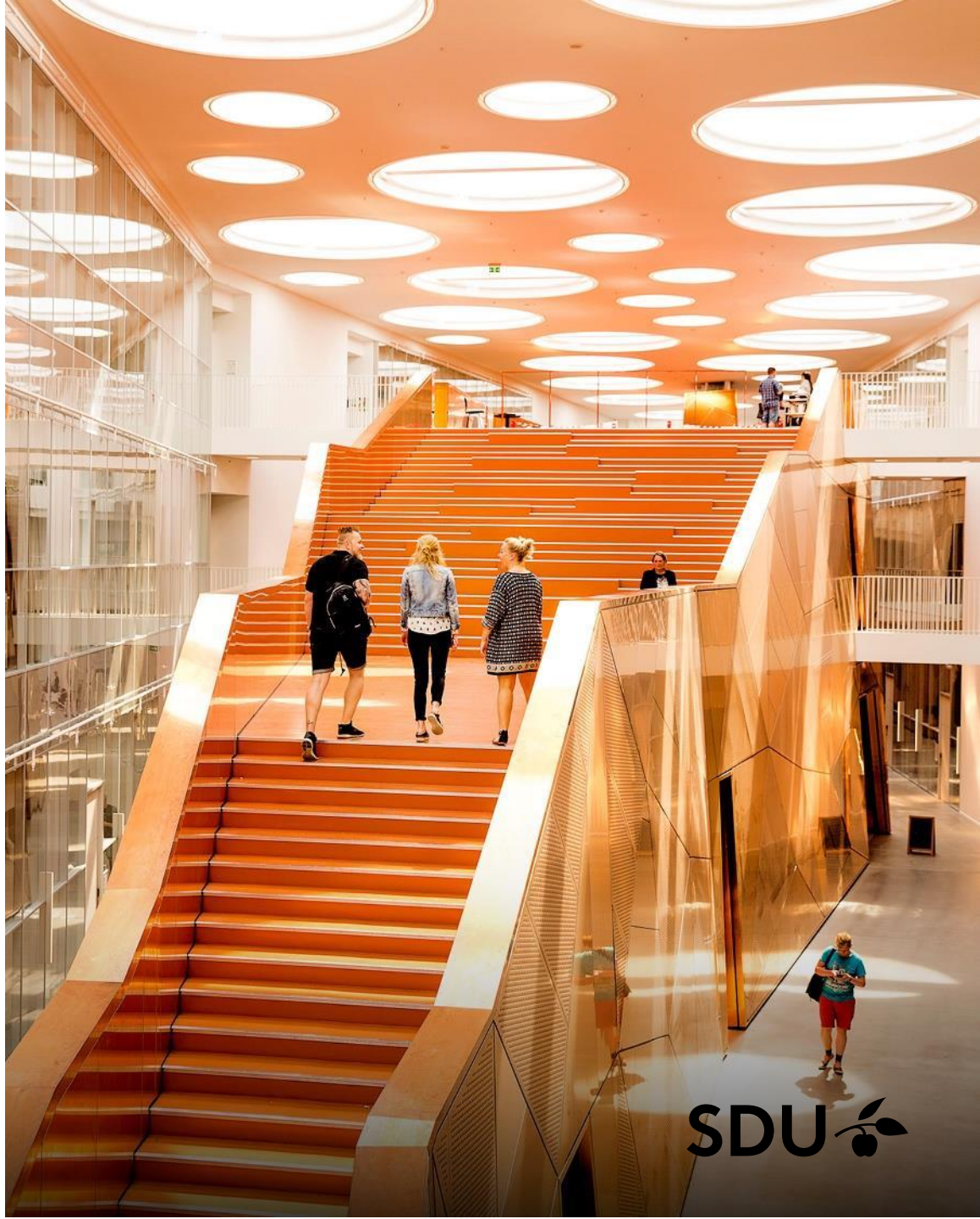
- Usually robots are considering as rigid-body dynamics
  - The classis 6 axis robot arm
- Soft robotics provides
  - new opportunities for robotics applications in HealthCare, personal assistance and collaborative robotics
  - new flexible grasping / handling options for a industry 4.0 environment

- Future robotics
  - Maintain our leading research position with robotics

Collaboration and co-research with industry

- Working closely together with partners and sponsors
  - Student projects
  - Research projects
  - Case studies
  - Consultancy and commercial activities
- **A sandbox for Industry 4.0 activities and prototyping new production facilities**
- **An open infrastructure that invite everybody at SDU to join and explore the opportunities**

Et eksempel fra SDU I4.0 Lab



World Robot Summit 2018

October 17-21, 2018

Tokyo Big Sight

World Robot Expo +

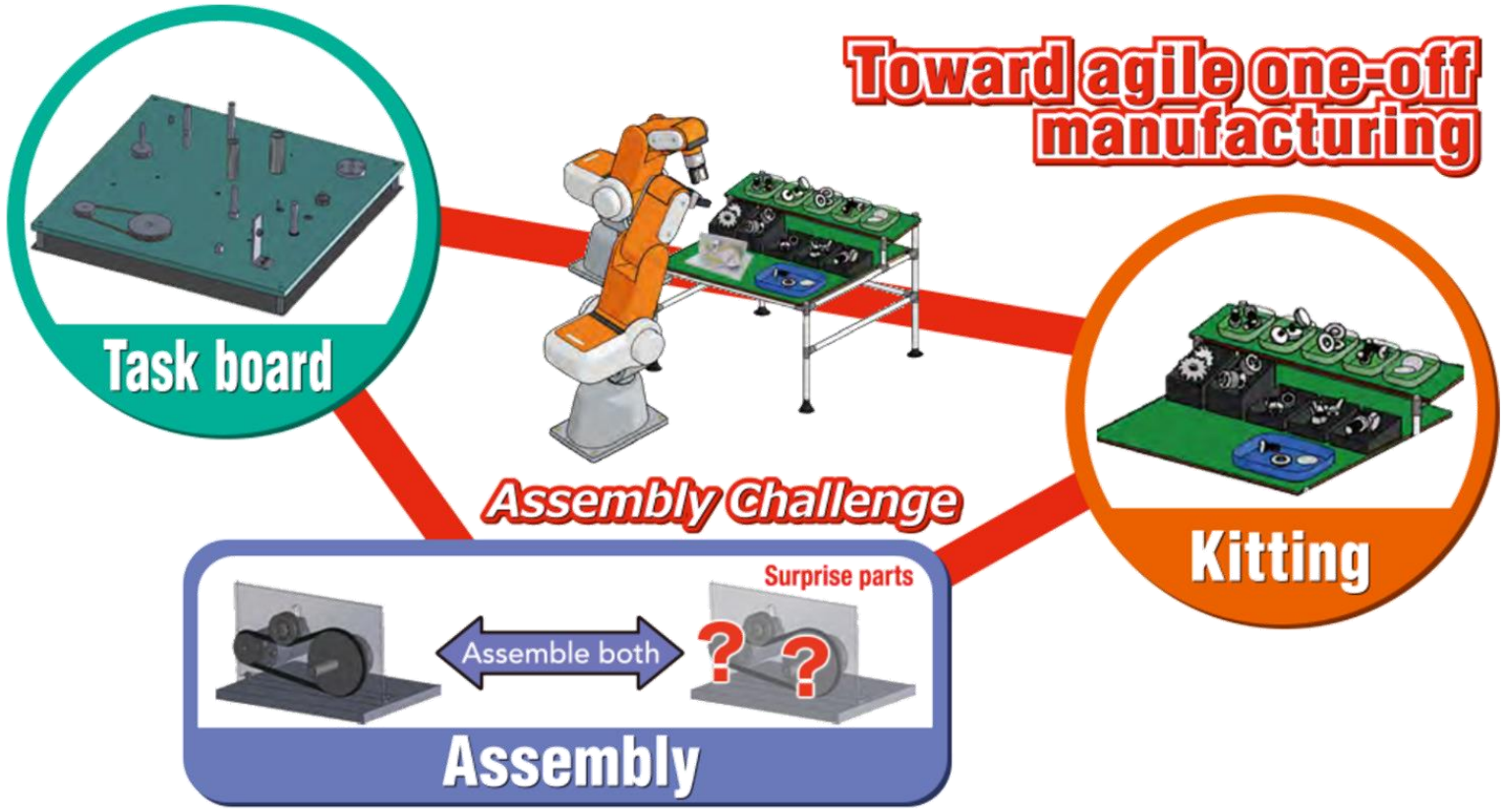
World Robot Challenge:

- Industrial Robotics
- Service Robotics
- Disaster Robotics
- Junior

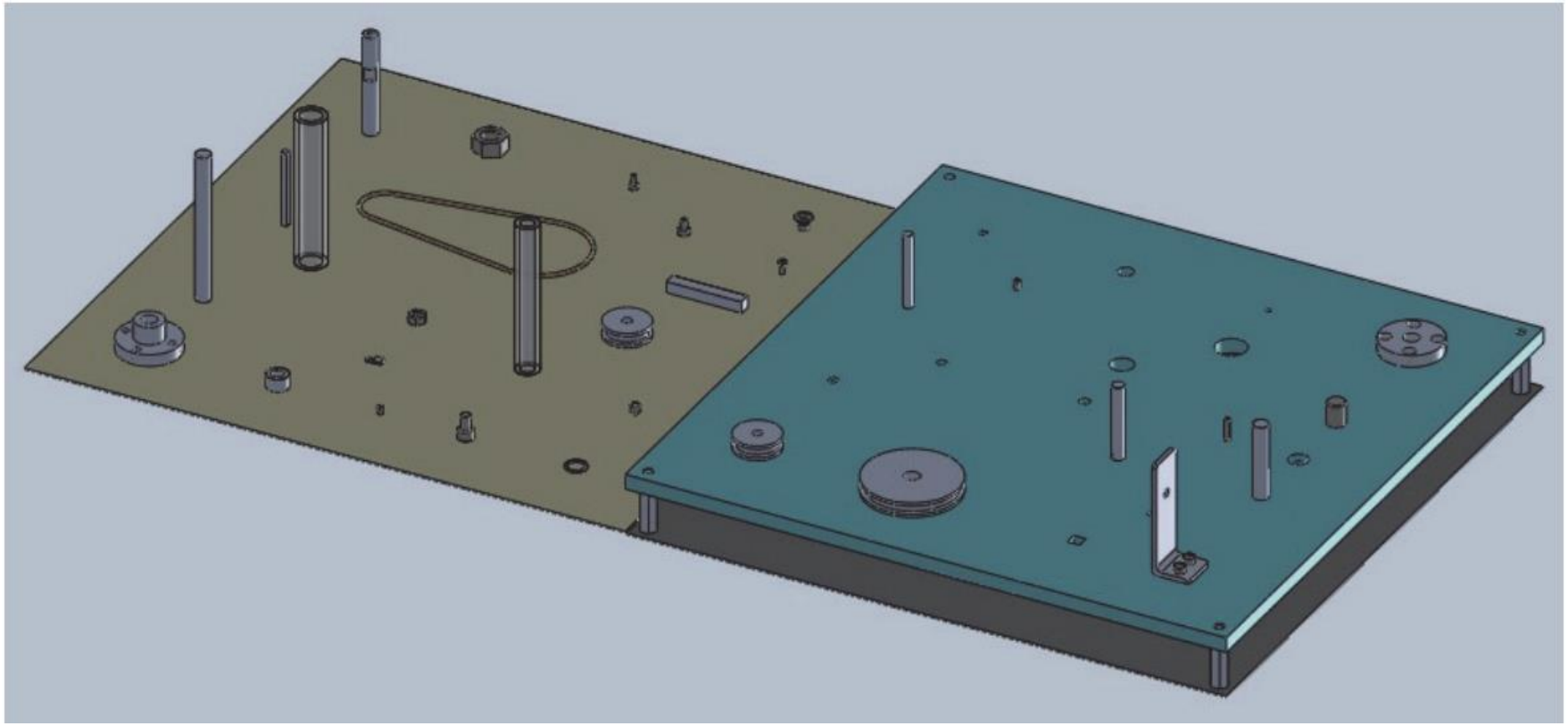
Industrial Assembly Challenge

Four tasks on four days:

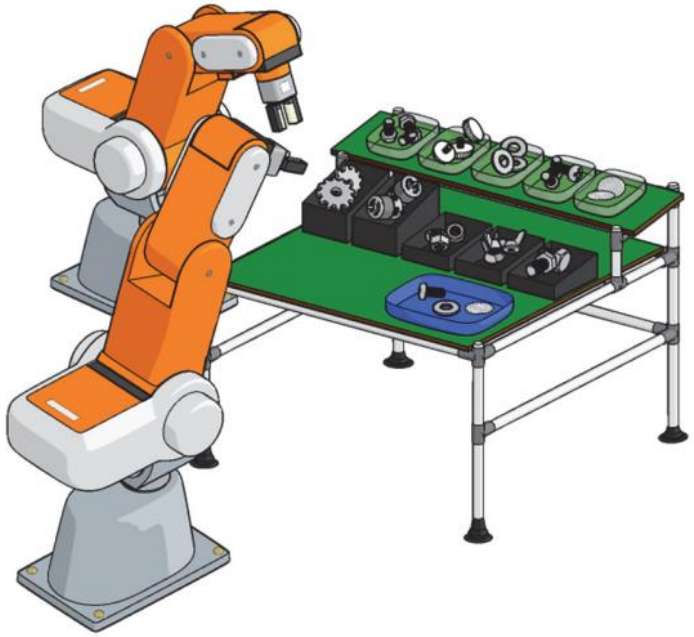
- Taskboard (Robot control)
- Kitting (Computer vision)
- Assembly (both)
- Assembly+ (both)

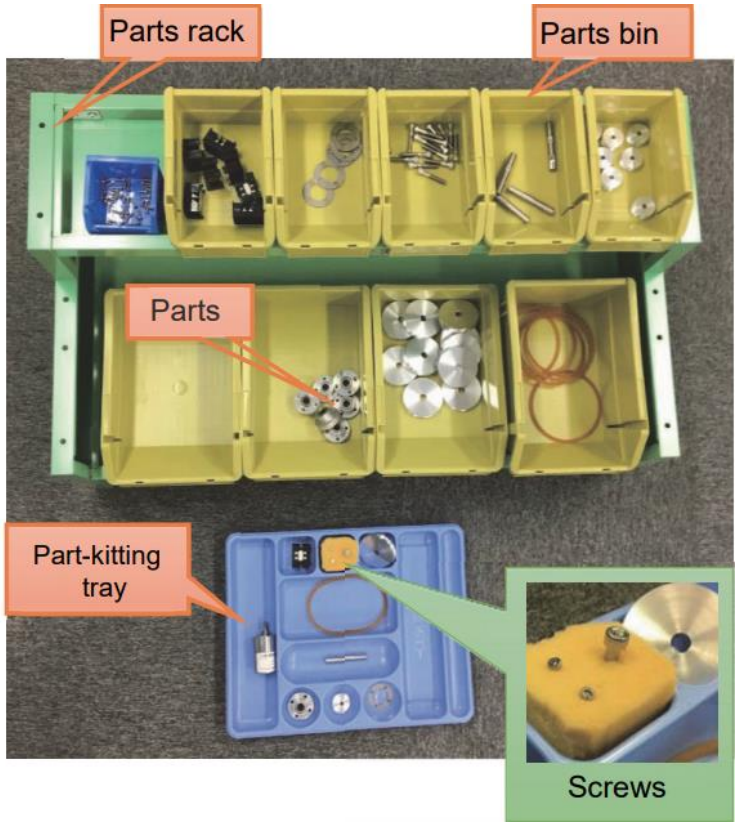


Task 1 - Taskboard

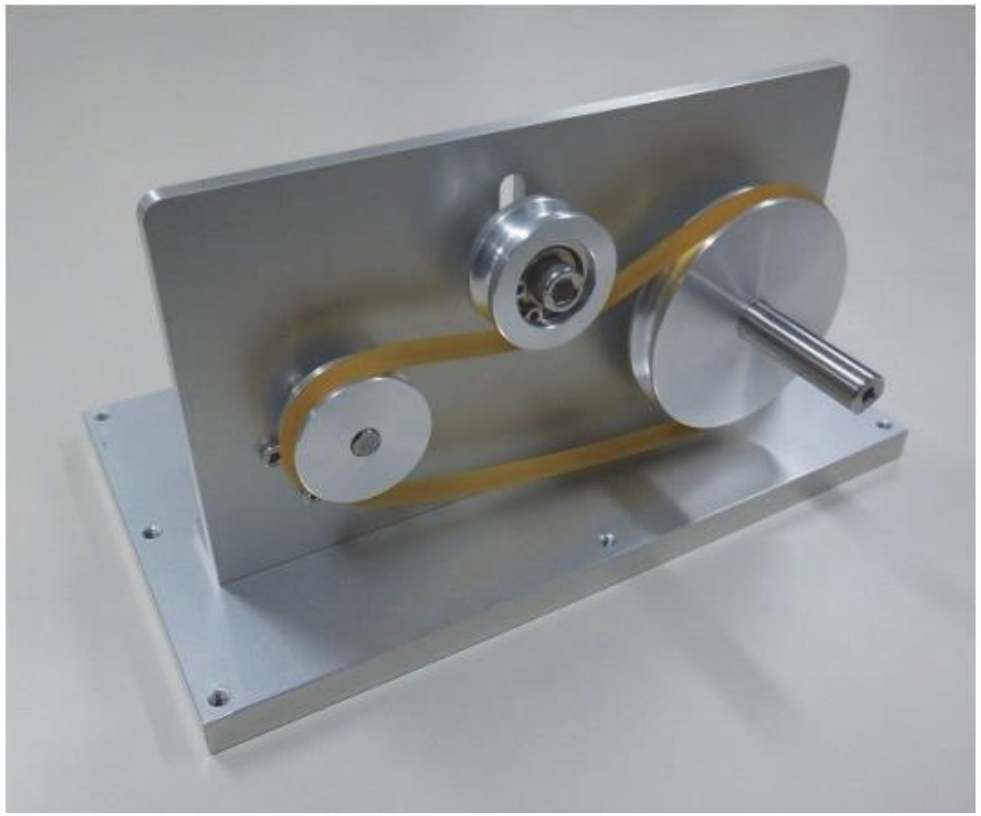


Task 2 - Kitting





Task 3&4 - Assembly

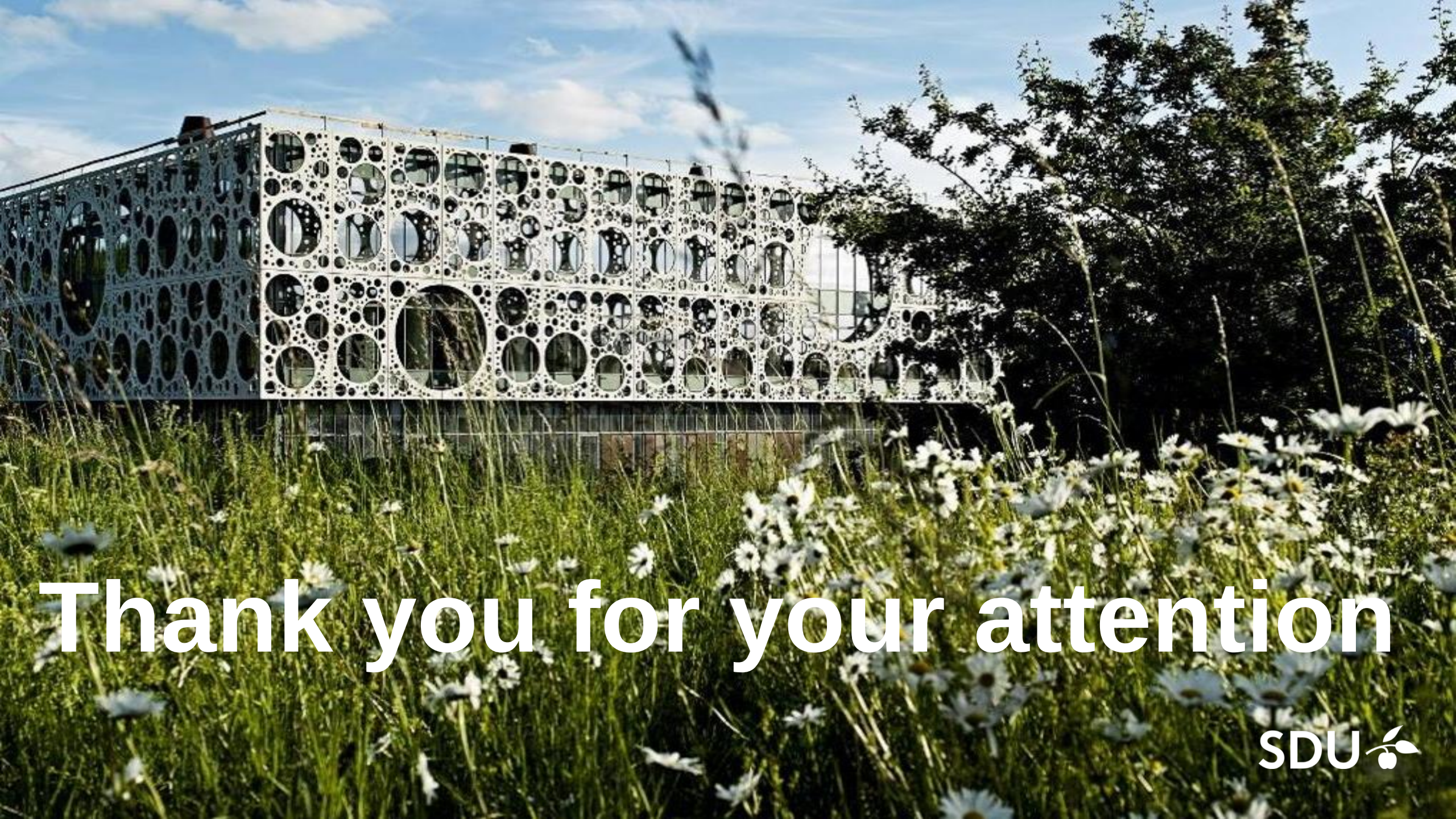


Our system

- 2x Universal Robots UR10e
- 1x Technicon FlexCell
- 2x grippers
- 1x screwdriver with exchangeable bits

- Robot control over URScript
- Component control over OPC-UA
- General control over ROS

- Industrial safety standards


Thank you for your attention