Digitalisering og robotter på fremtidens arbejdsplads

Hvordan fremtidens arbejdsmarked ser ud i en digitaliseret og robotiseret verden

Herning, November 21st 2018

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University of Southern Denmark
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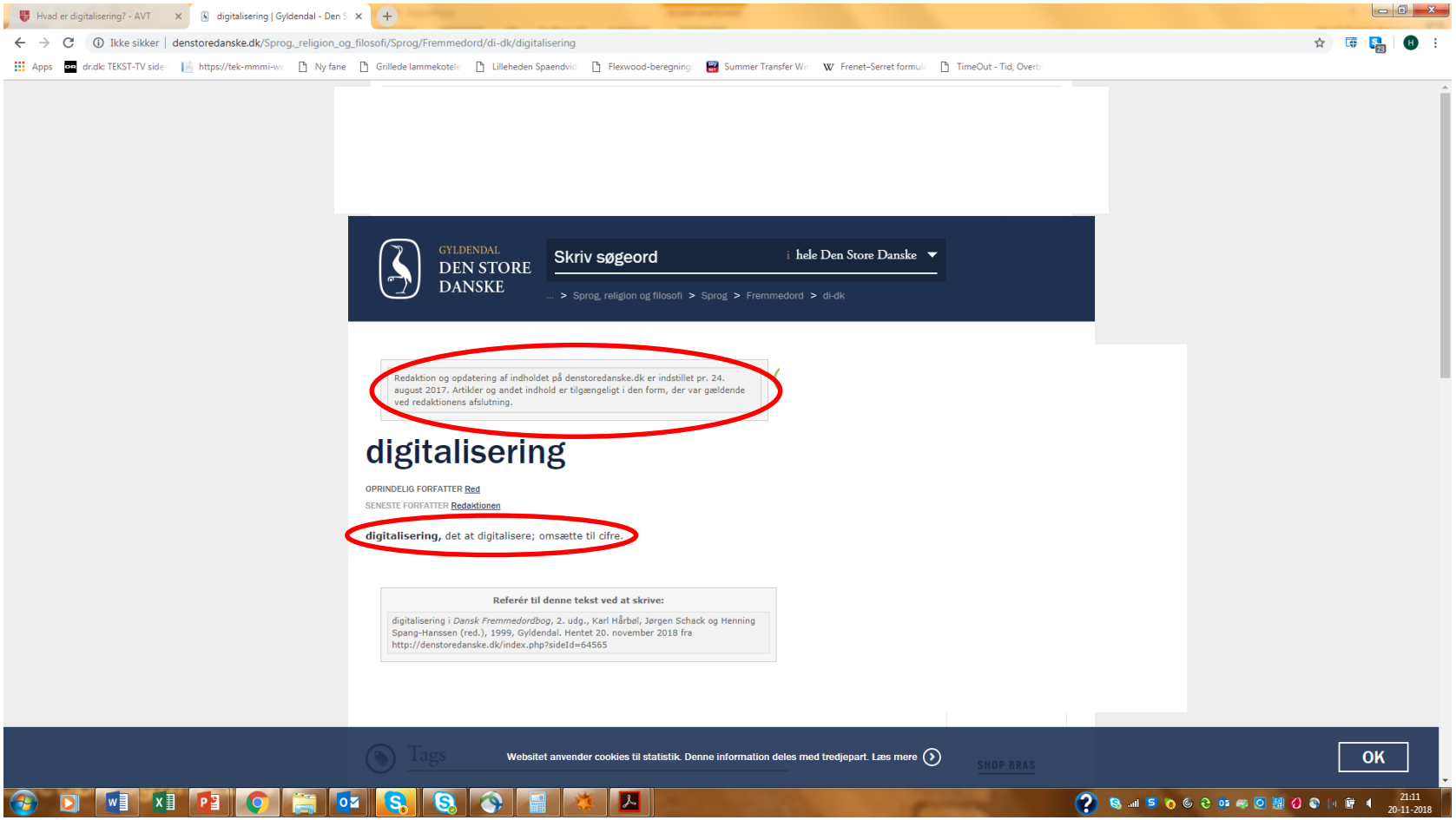
URL: robotics.sdu.dk

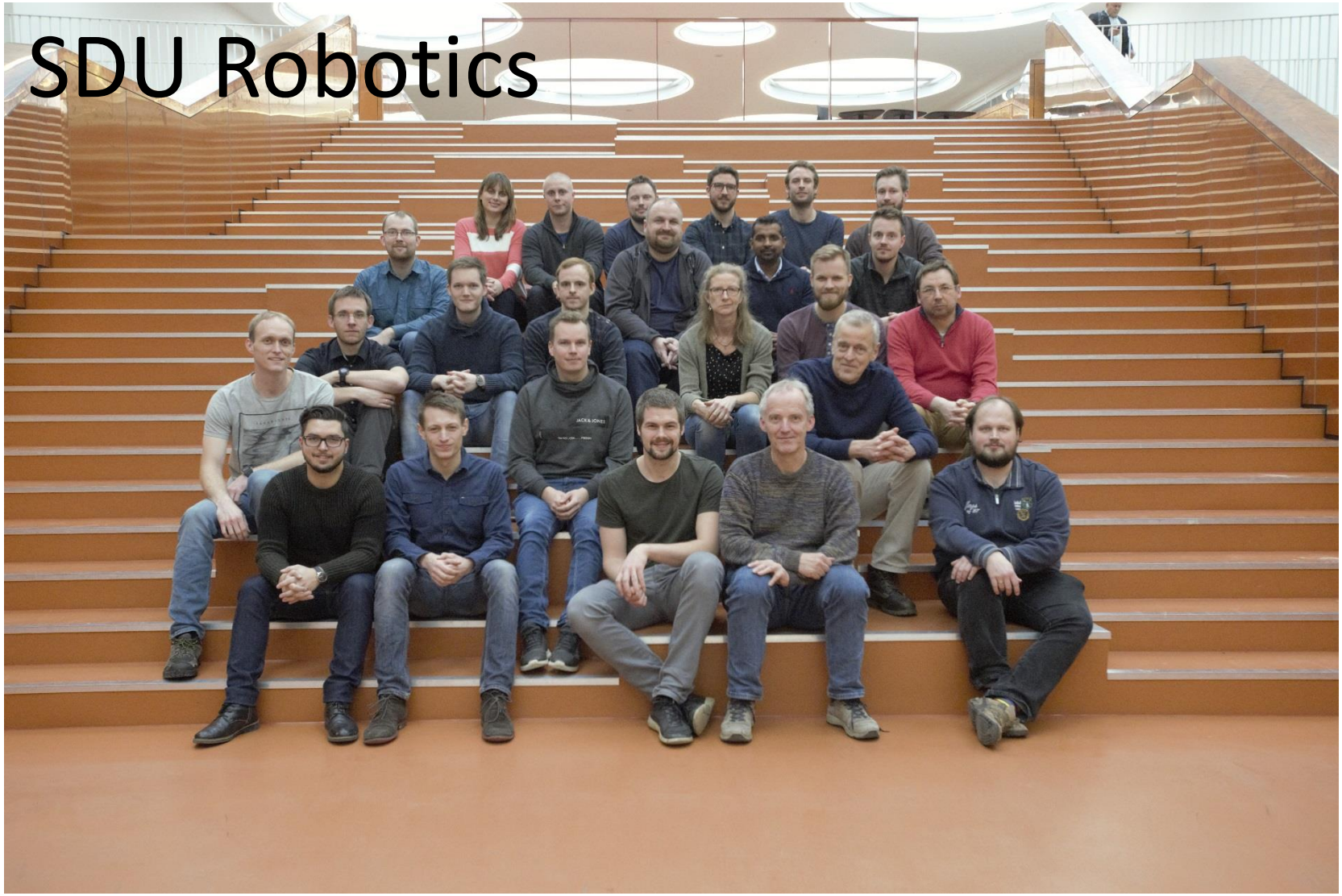
Hvad er digitalisering ?



Hvad er digitalisering ?

- Indførelse af digitale teknologier i virksomheders processer
- Generering af digital information (databaser) i virksomhederne om processer, produkter, etc.
- Benyttelse af digitale redskaber i stedet for papir til instruktion af medarbejdere
- Indførelse af robotter/automatisering kan udfoldes langt bredere. Dette er en konsekvens af digitalisering og IKKE en del af definitionen
- Vi forsker i *teknologier til at muliggøre denne udfoldning af robotter*. Nu følger en præsentation af vores forskningsområde med eksempler som for det meste desværre er udenfor mejeribranchen. Slides er ovenikøbet for det meste på engelsk…

SDU Robotics



Research

Mathematical modeling

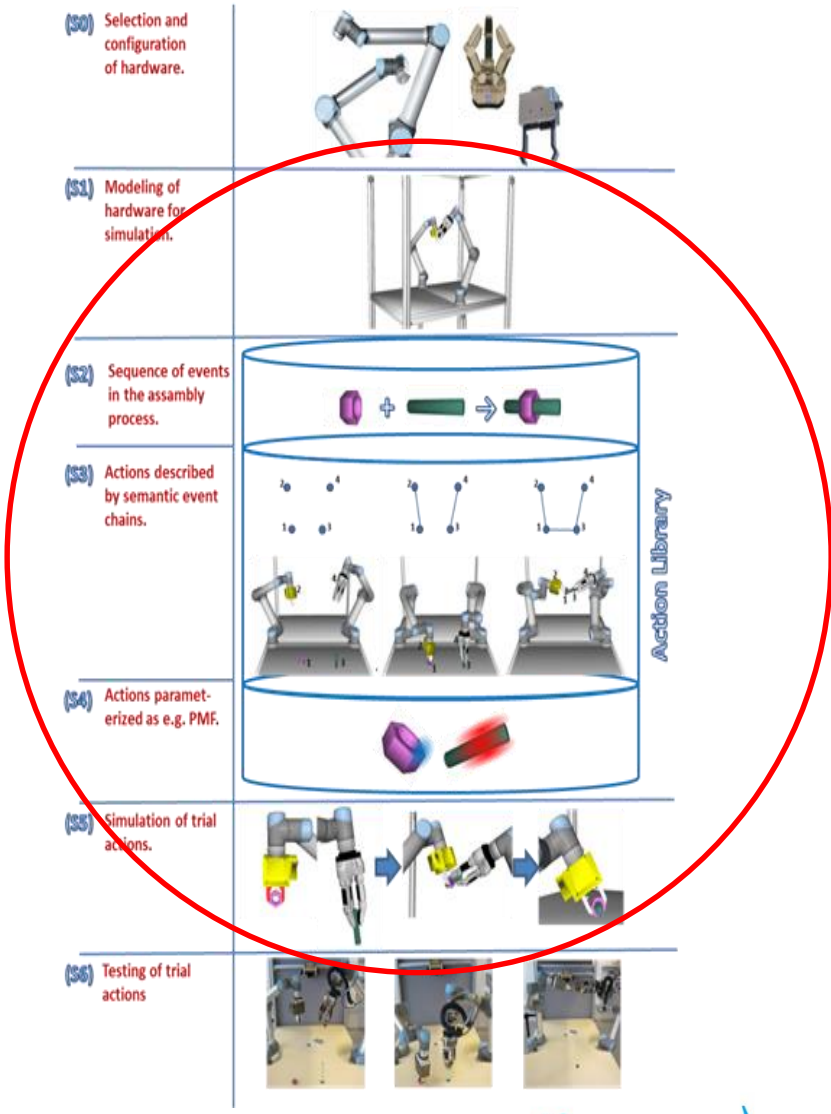
We model robotic systems and robotic processes. These models are the basis for accurate simulations and the learning of robotic solutions.

Planning optimal robot trajectories

When planning the trajectories for executing a task, the optimal trajectory must be efficient and robust to uncertainties in the used models.

Object recognition and pose estimation

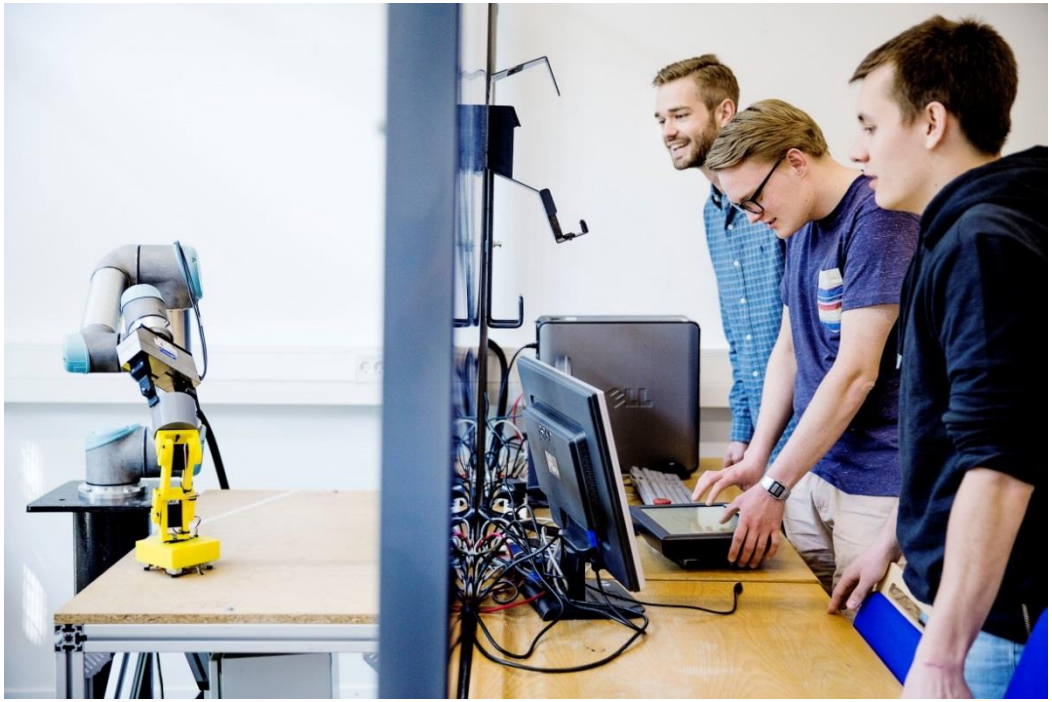
Our research involves a set of new approaches aiming at decreasing the manual involvement and thereby reducing setup time to a minimum



Education

Robot systems Engineering
M.Sc. (2 years)
(Intake 2018: 80 students)
BSc (MSc) (3 (5) years)
(Intake 2018: 72 students)
B.Eng.
(Intake 2018: 76 students)
Around 225 new students !!

Welfare Technology
M.Sc., B.Sc.
(Intake: around 30 students)




COMPANIES
ABB
AK Automation
ANNELO
ARM-TEC DIVISION
AutomationLab
Automation Modules
B&R
bam transtech as
BEKIDAN
BERGER neurorobotics
BILA
BiLFINGER
Bionic Systems Solutions
BIPA A/S
BLUE OCEAN ROBOTICS
BLUE UNIT
Boelbjerg Maskinværksted
Bygkontrol
Cabinplant
ceetec
CORE DYNAMICS
CP ROBOTICS
CT ELTEKNIK
DANA
Danish Aerospace
DAN ROBOTICS
DANISH TECHNOLOGICAL INSTITUTE
EFFIMAT
Ega Matic ApS
EGATEC PACKAGING INT.
EGATEC A/S
eltraco automation
ENABLED ROBOTICS
FANUC
FOM
FRONTMATEC
GEA
GIBOTECH
HOW
HYDAC
ideal-line
inrotech
intego
INVENTAR ASSEMBLY
Inwatec
JM Engineering A/S
JORGENSEN
KEN HYGIENE SYSTEMS
Kjærgaard
KK-Tech
KUBO
Laptics Ivs
Lead Robotics ApS
Leica Geosystems
LWT
LYNGHOLM ELECTRIC
Martiny Automation
MASKINSIKKERHED
MEL COO
micro technic
MiR
mmr
MRN
MRR Produktion A/S
Multi Tower
MURR ELEKTRONIK
NEW ICON
NEWTEC
Nidec -All for dreams
NORD MODULES
NORDBO
ODICO
on robot
PFCON ApS
PJD
Polund
Produktionsteknik
PURPLE ROBOTICS
QRS
QuadSAT
robeman
ROBOT AT WORK
ROBOT NORDIC
RobotDrengene
ROBOTIC SPORT SOLUTIONS
RobotSort ApS
RV
SANOVO
Scan Convert A/S
Scancomp Sensor and Automation
ScanStore
scanvaegt systems
Scape technologies
Life is On Schneider Electric
SCHUNK
senmatic
sensohive
SG-TECH
SICK Sensor Intelligence.
SKAKO
Smooth Robotics
Stable-Gear
TAKE ON ROBOTICS
tendo
TRIVISION Machine Vision - Made Easy
UNIVERSAL ROBOTS
UV-DR Company Ivs
Valcon
valk welding
Viggo Hansen A/S
VIKING
VIKING SOFTWARE
WallMo
WAMATECH
Ztove
CLUSTERS AND PARTNERS
CARENET
DANSK METAL
DIRA
IDA
ODENSE HEALTH INNOVATION & BUSINESS
RoboCluster
SYDDANSK FORSKERMARKER
URS DENMARK
WelfareTech
WORK IN DENMARK
SOUTH DENMARK EUROPEAN OFFICE
PUBLIC SECTOR AND BUSINESS SUPPORT PROVIDERS
ASSENS KOMMUNE
Developing Fyn
FAABORG-MIDTFYN KOMMUNE
INVEST IN ODENSE
Nyborg KOMMUNE
ODENSE KOMMUNE
Region of Southern Denmark
Svendborg Kommune
VÆKSTHUS
ODENSE ROBOTICS
FRONTIER FOR ROBOTIC TECHNOLOGIES
POWERED BY DEVELOPING FYN
FINANCING
SCIENCEVENTURES
SYDDANSK INNOVATION
VÆKSTFONDEN
BOREAN Innovation
ODENSE SEED AND VENTURE
Public Funding
Family Offices
Venture Funding
Crowd Investors
Business Angels (100+)
Loan and Bank Financing
110+ mill. Euros invested in 2016/2017
EDUCATION
SDU UNIVERSITY OF SOUTHERN DENMARK
BEng
Electrical Power Engineering
Electronics and Computer Engineering
Global Management and Manufacturing
Integrated Design
Manufacturing Engineering and Management
Mechanical Engineering
Mechatronics
Robot Systems
Software Technology
MSc
Applied mathematics
Computer science
Electronics
Energy Technology
Engineering Robot Systems (Advanced Robotics Technology and Drone Technology)
Information Technology - Product Design
Learning and Experience Technology
Mathematics
Mechanical
Mechatronics
Operations Management
Physics and Technology
Product Development and Innovation
Software Engineering
Welfare Technology
LILLEBÆLT ACADEMY
Academy Profession AP
Automation Technology
Computer Science
IT Technology
Multimedia Design and Communication
Production Engineer
Bachelor BA
E-Concept Development
PBA Software Development
Product Development and Technology Integration
Web Development
Continuing Education
Academic Education
Diploma
SYDDANSK ERHVERVSSKOLE
Electricity Automation and IT
Automatics Electrician
Data Technician (+EUX)
Electrician (+EUX)
Metal, Industry and Technology
Automation Technician (+EUX)
Industrial Operator
Industrial Technician (+EUX)
Sheet Metal Worker (+EUX)
Technical Designer
SIMAC
Bachelor
Marine Engineer
OTHERS
UNIVERSITY COLLEGE Lillebælt
ODENSE TEKNISKE GYMNASIUM
RESEARCH, DEVELOPMENT AND INNOVATION
DANISH TECHNOLOGICAL INSTITUTE
Disciplines
Advanced robots
Co-working robots
Sensors and robots
Mobile robots
Drones (UAS)
Personal care robots
Industry 4.0 and data
Augmented reality
Artificial intelligence
Safety
Activities
Implementation of solutions
Dissemination, training and education
Analysis and consultancy
SDU UNIVERSITY OF SOUTHERN DENMARK
Faculty of Engineering
TEK Innovation
The Mads Clausen Institute
SDU Mechatronics
SDU Innovation and Design Engineering
The Maersk Mc-Kinny Møller Institute
SDU Robotics
SDU UAS Centre
SDU Software Engineering
SDU Electrical Engineering
SDU Embodied Systems for Robotics and Learning
SDU Health Informatics and Technology
SDU Energy Informatics
Department of Technology and Innovation
SDU Mechanical Engineering
SDU Engineering Operations Management
Faculty of Science
Department of Mathematics and Computer Science (IMADA)
Faculty of Health Sciences
Department of Sports Science and Clinical Biomechanics
Department of Clinical Research
Department of Public Health
SDU Research & Innovation Organisation (RIO)
LILLEBÆLT ACADEMY
Knowledge Center for Automation and Robotic Technology
Knowledge Center for Health and Welfare Technology
SYDDANSK ERHVERVSSKOLE
Knowledge Center for Automation and Robotic Technology
OUH Odense University Hospital
Updated: 15.01.2018
GOLD Cluster Management Excellence
COMPANIES ARE SELECTED BASED ON AN ASSESSMENT OF THE FOLLOWING PARAMETERS:
Share of turnover in the robotic and automation industry
Strategic focus
Activity in cluster cooperation
Dedicated technology

Traditional robot solutions
a) Complex, but repetitive

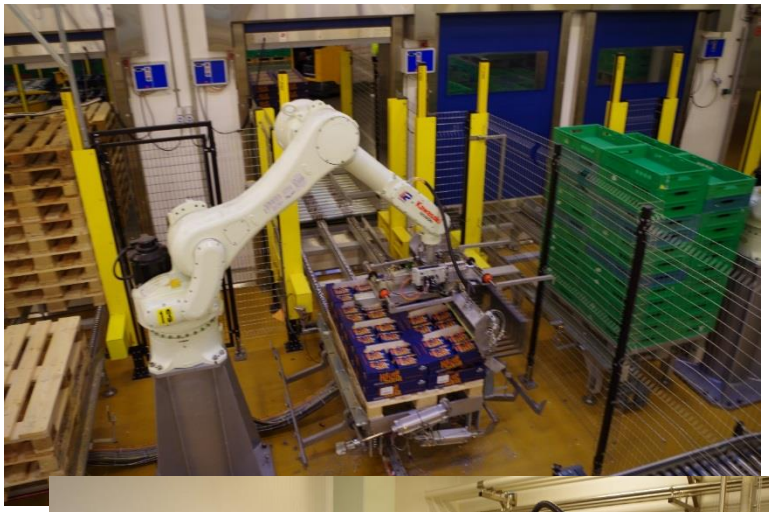
Fixed part locations

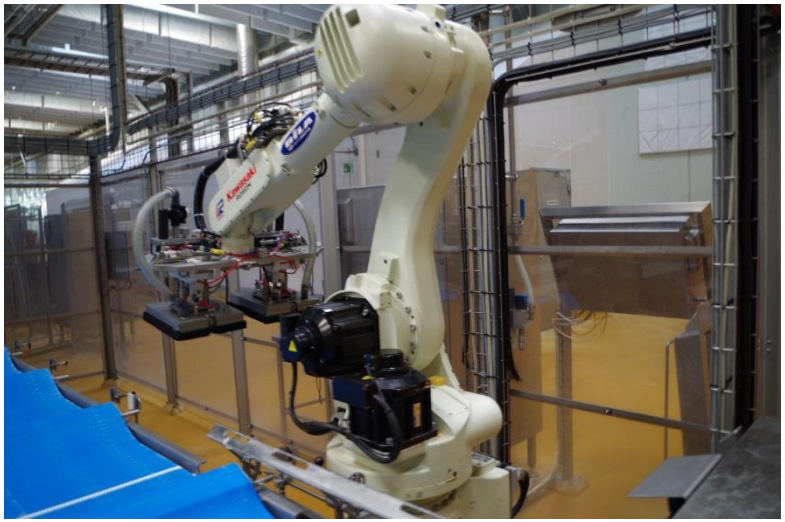
Repetitive robot movements

Robots are fenced off

Potentially complex processes

Lignende robotter på Taulov Mejeri





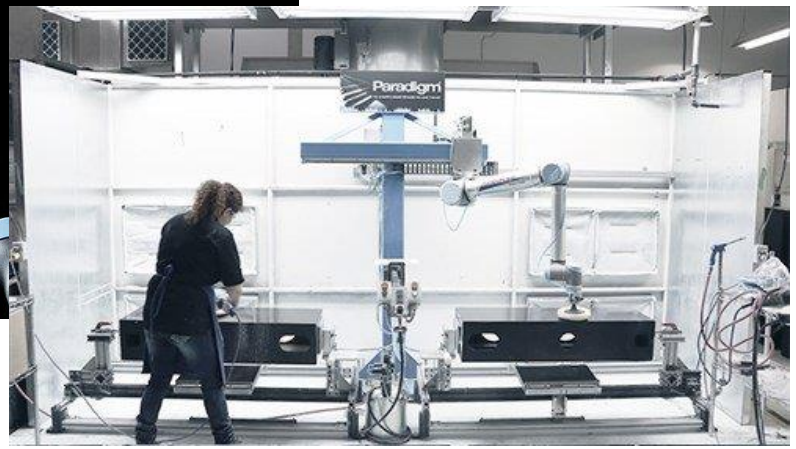
Traditional robot solutions
b) Non-repetitive, but simple

Random part locations

Detection with vision (simple)

Robots are fenced off

Simple processes



"Collaborative robots is a new technology that allows us to have a human and a robot working in the same workspace.

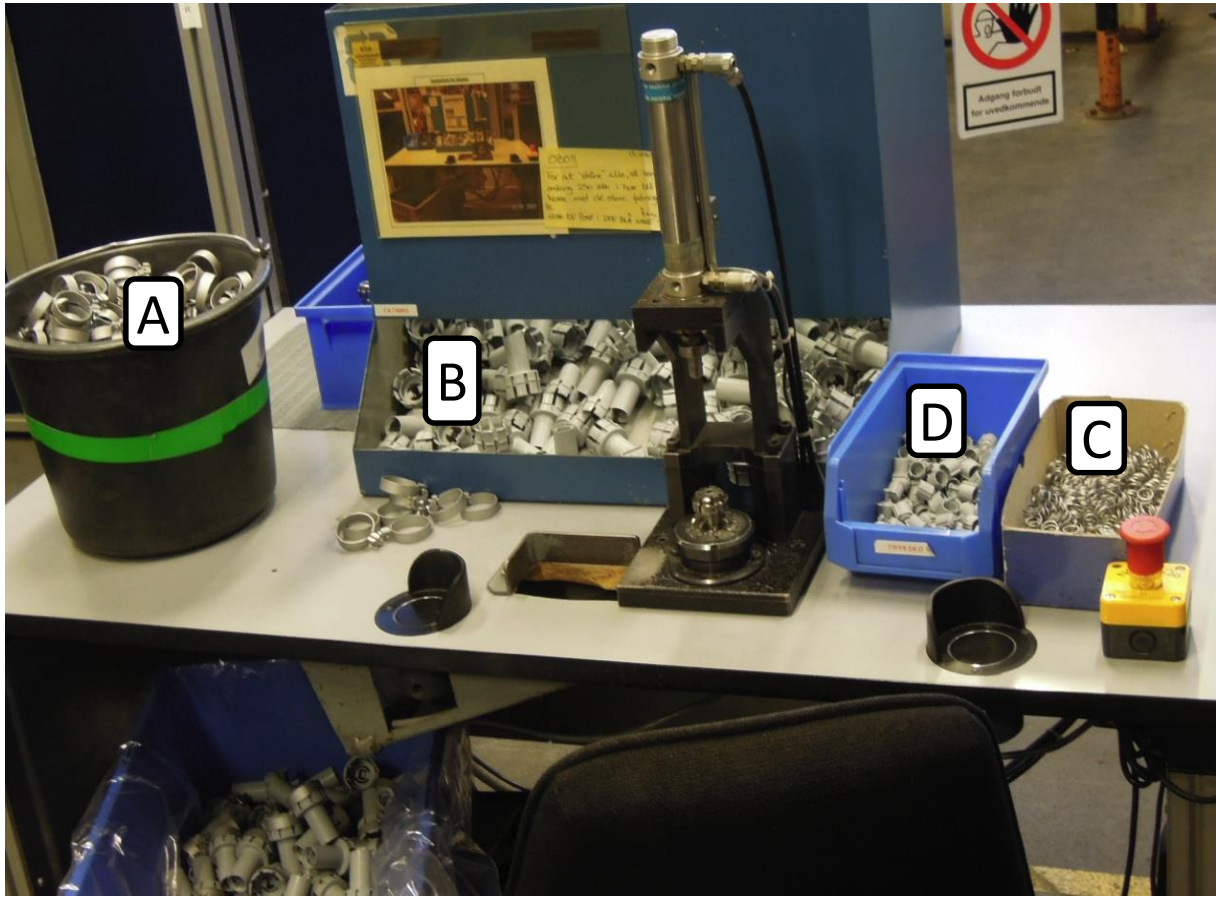
Of course, this means that collaborative robots need to have certain characteristics: They need to be flexible, easily programmable and safe. Only if these preconditions are met, a true collaboration of human and robot can take place and thrive"

Kollaborative robotter her ?

Our (SDU Robotics) main topic: Collaborative robot assembly

- Very relevant for Danish companies
- Automation of assembly currently almost only for mass production (parts at fixed locations as in the car assembly example)
- Challenging (no standard solutions)

Human assembly
Non-repetitive and more complex



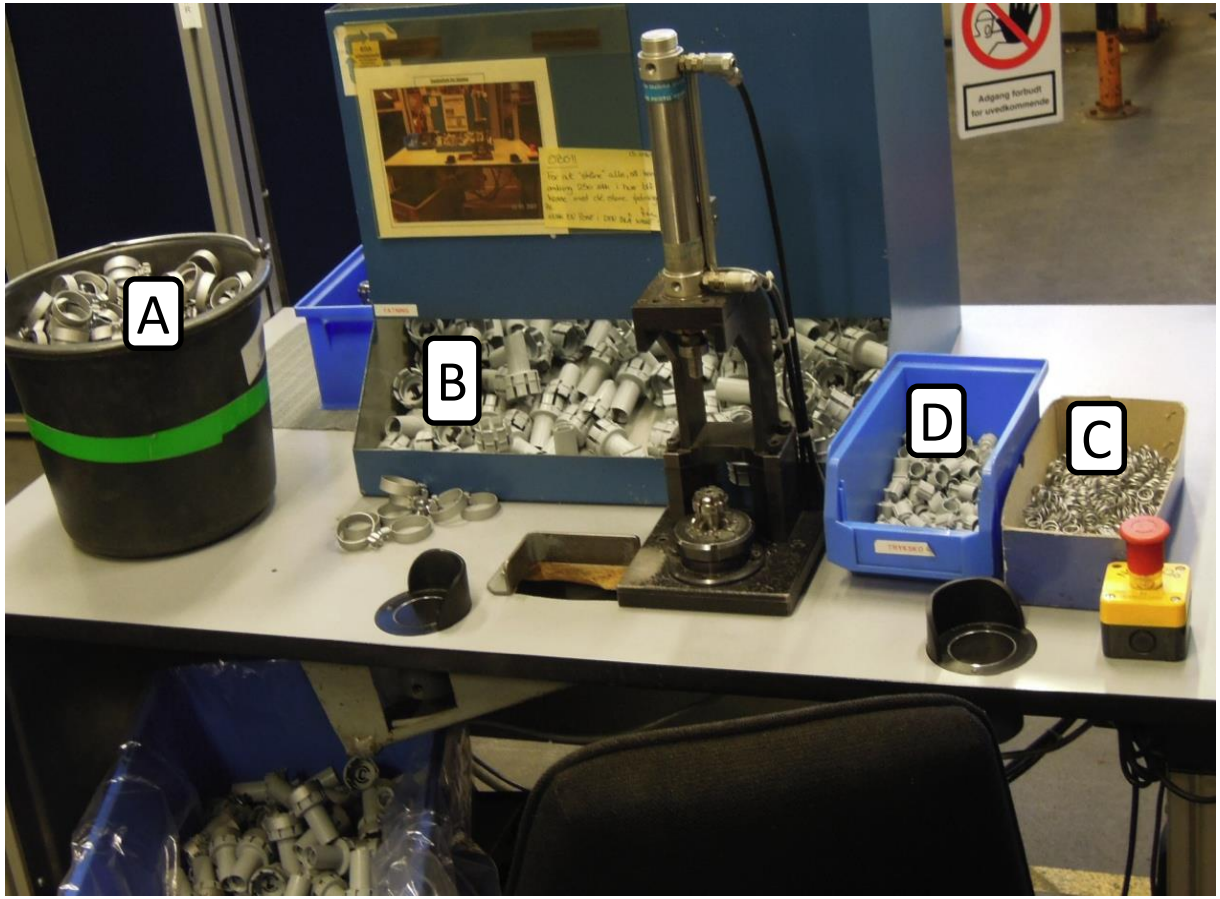
Randomly located parts

Accurate placements

Humans are not fenced off

Maybe only e.g. for 2 hours

Collaborative robot (cobot) assembly Some challenges



Randomly located parts

Feeding techniques

Accurate placements

Force/Vision/AI based control

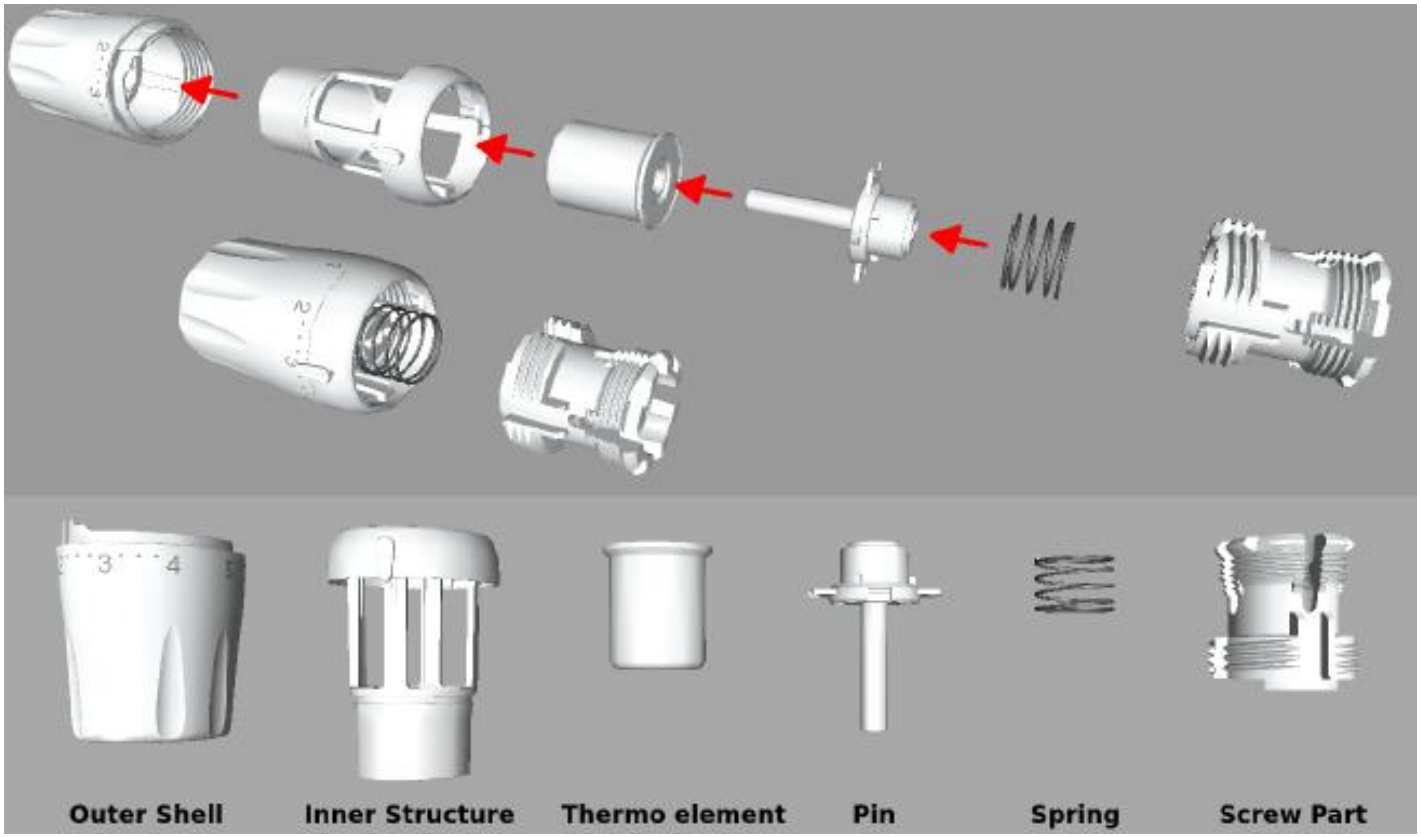
Robots and Humans

Safety, easy programming

Maybe only e.g. for 2 hours

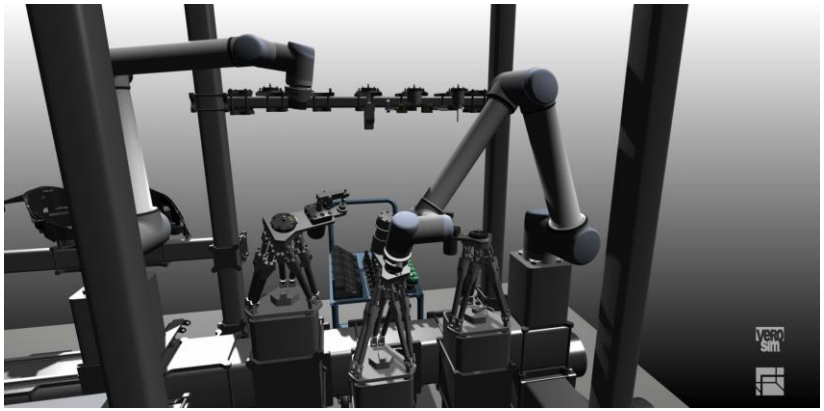
Movable and easily reconfigurable robot cells

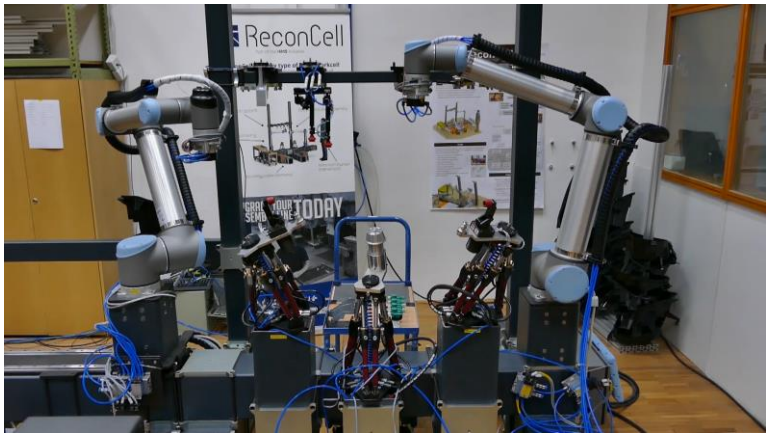
Important:
Digital models of parts and sequences



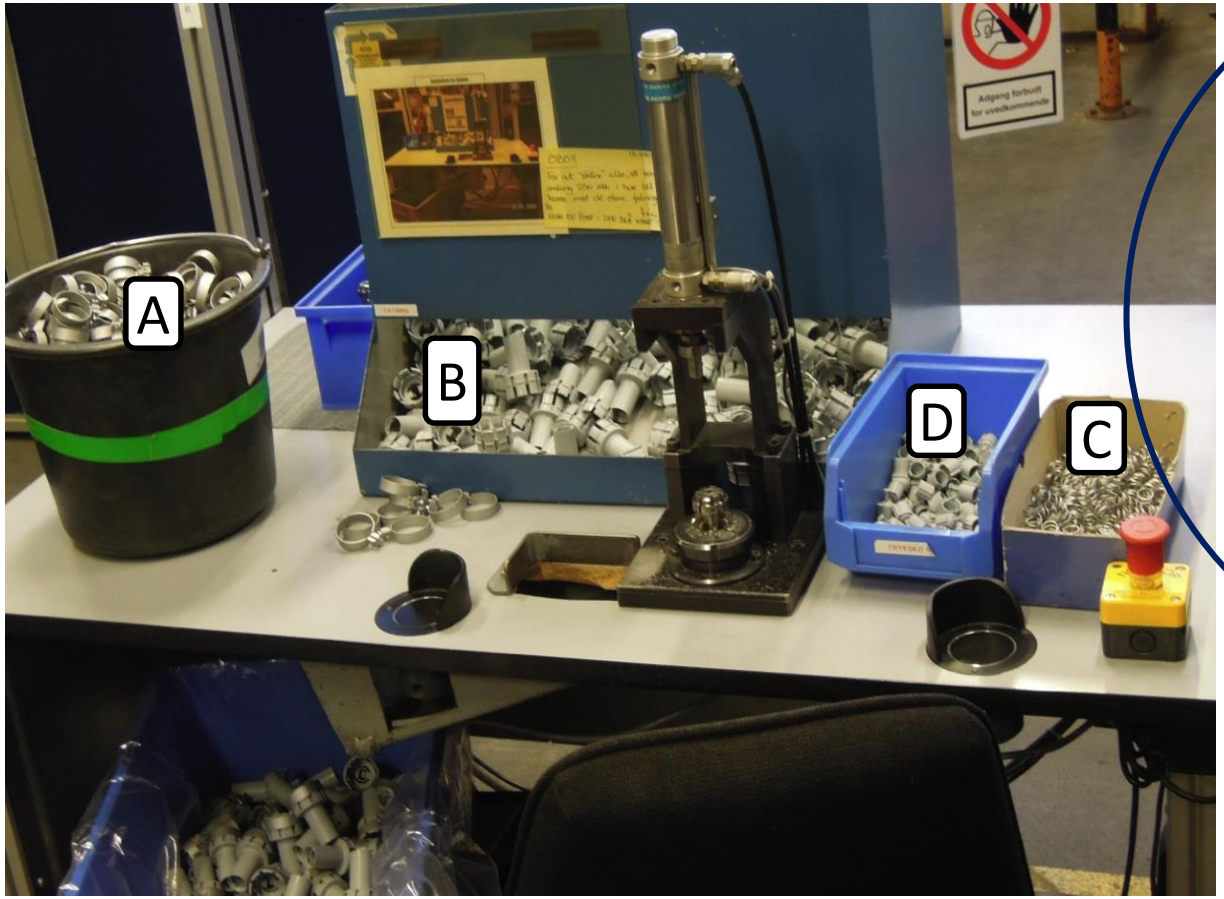
Programming and testing in virtual environments

Example from one of our European projects:
Headlight assembly for automotive





Cobot assembly
Some challenges



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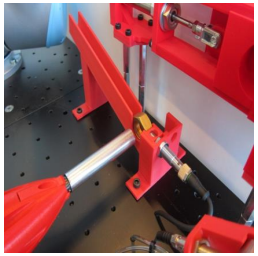
Examples of using digital modeling and simulation for cobot assembly

Feeding techniques

Precise dynamic simulations of vibrational feeders for virtual design and optimization of traps and trap sequences

Accurate placements

Optimizing the control with respect to robustness to deviations in part location relative to robot end effector (gripper)



Robots and Humans

Simulation of functionality of overall system.
AR/VR simulations for training of shop floor workers

Easy programming using building blocks

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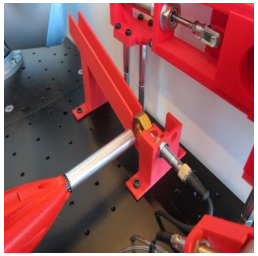

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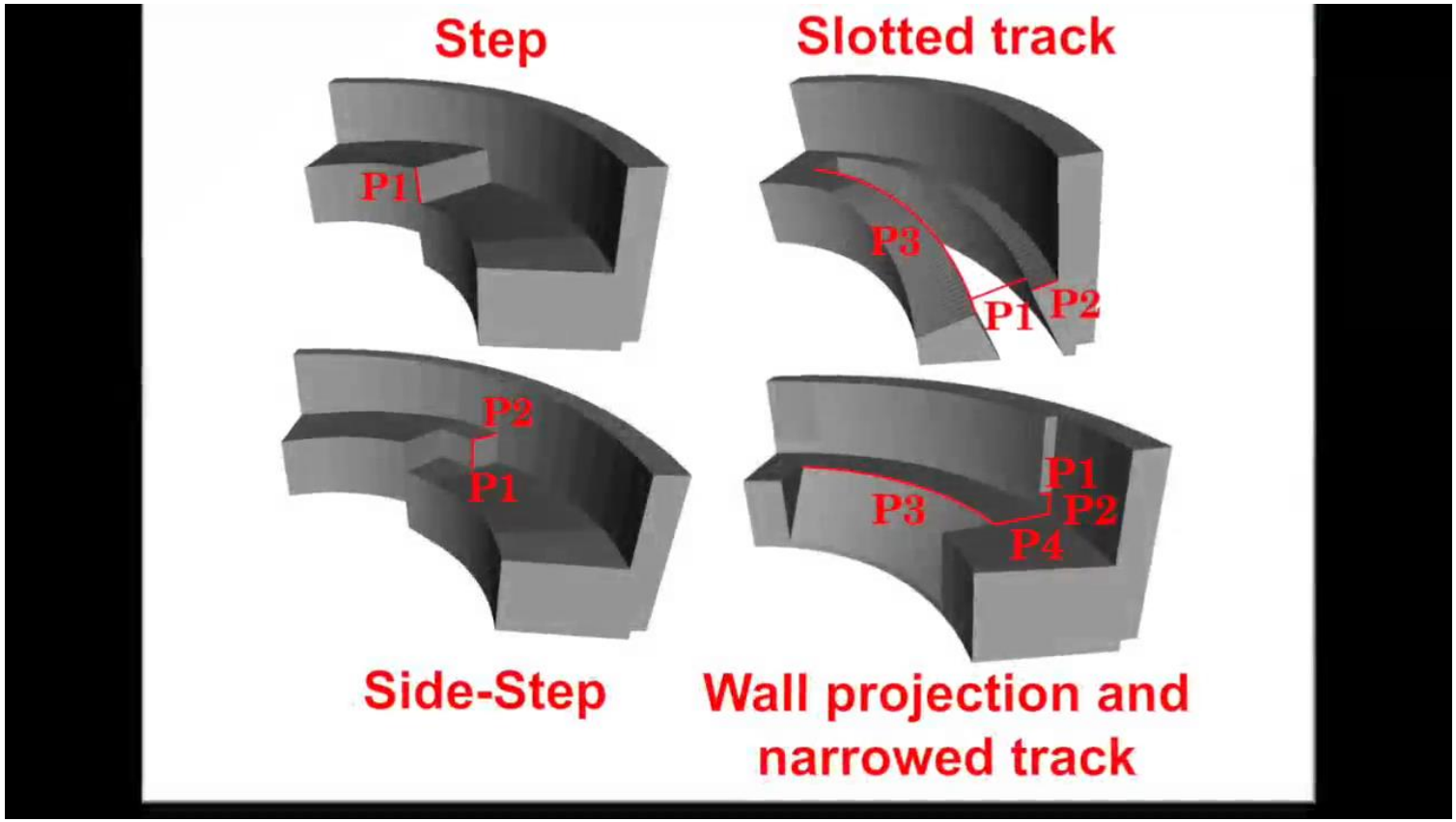

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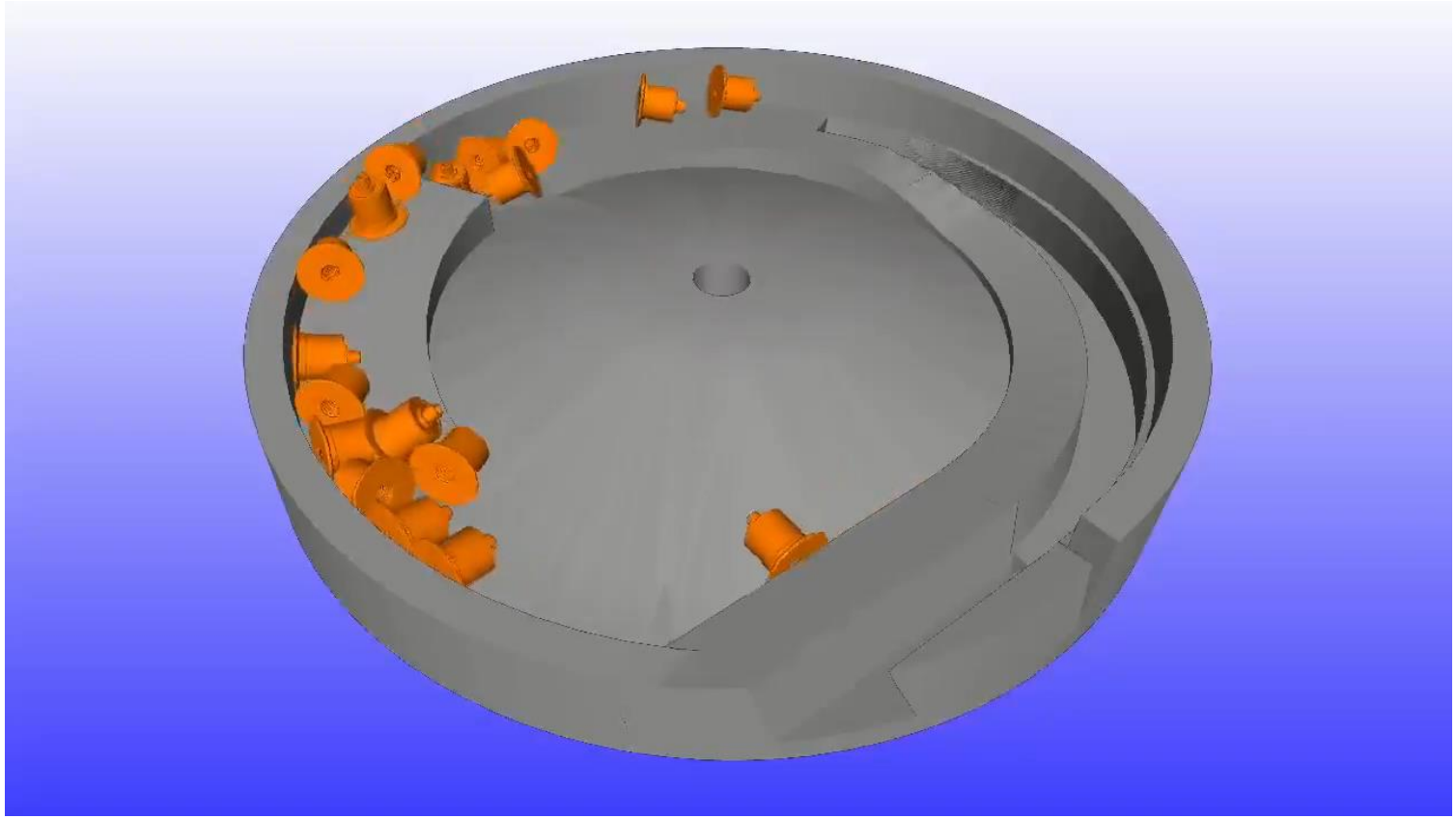

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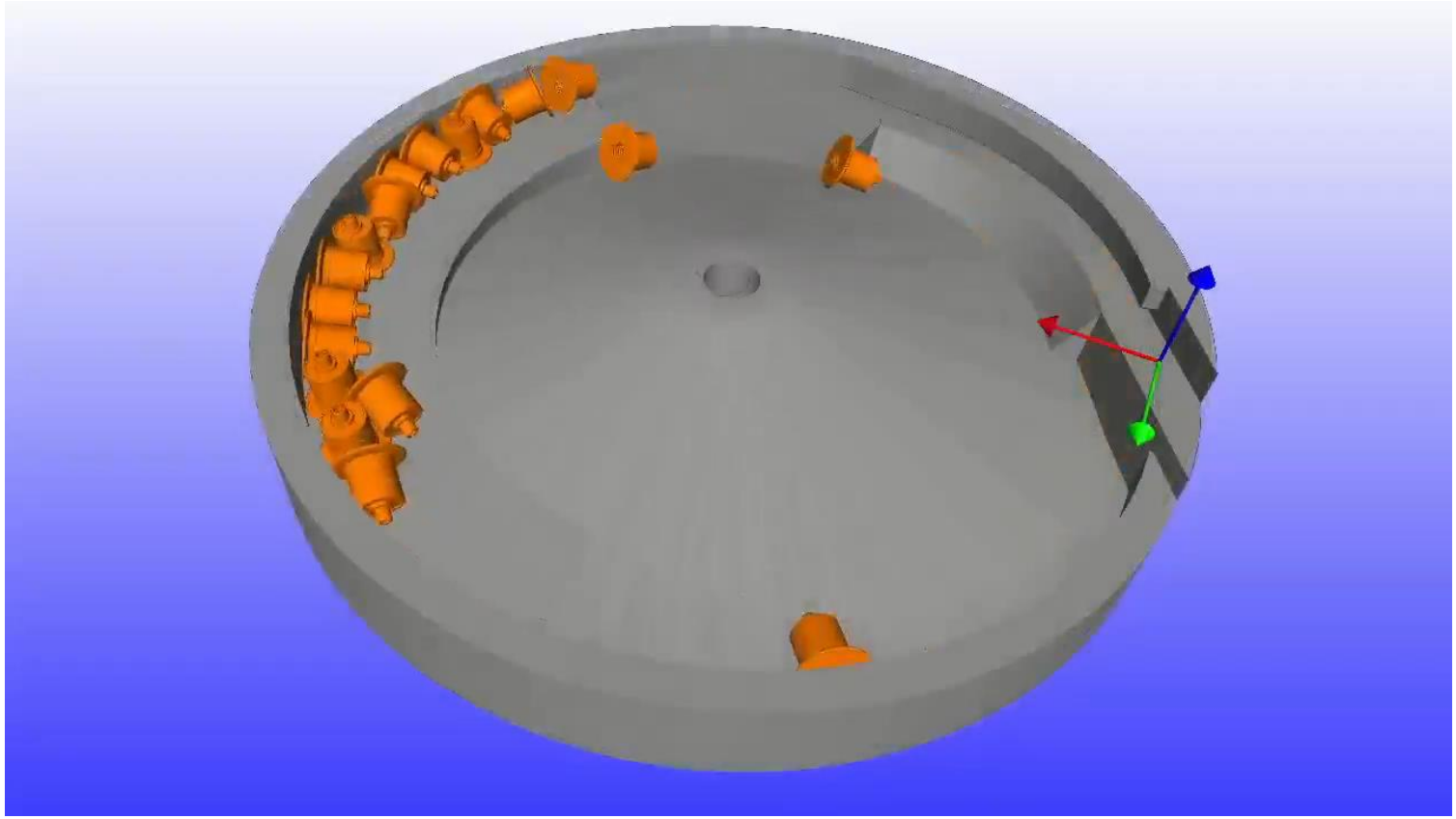

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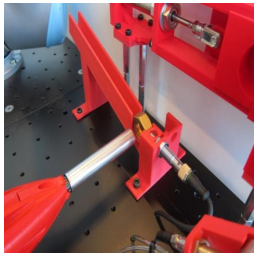

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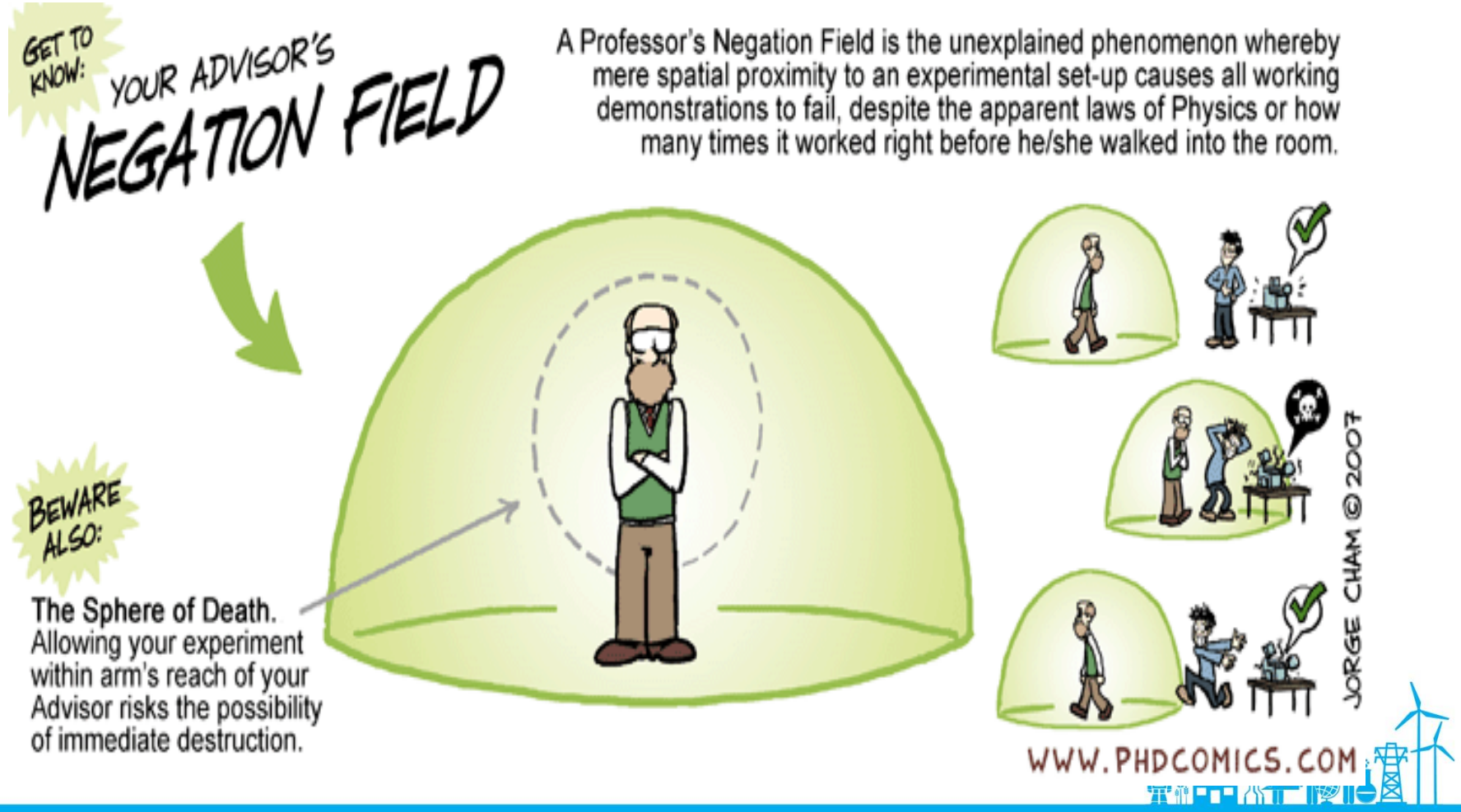
The infamous Professors Negation field



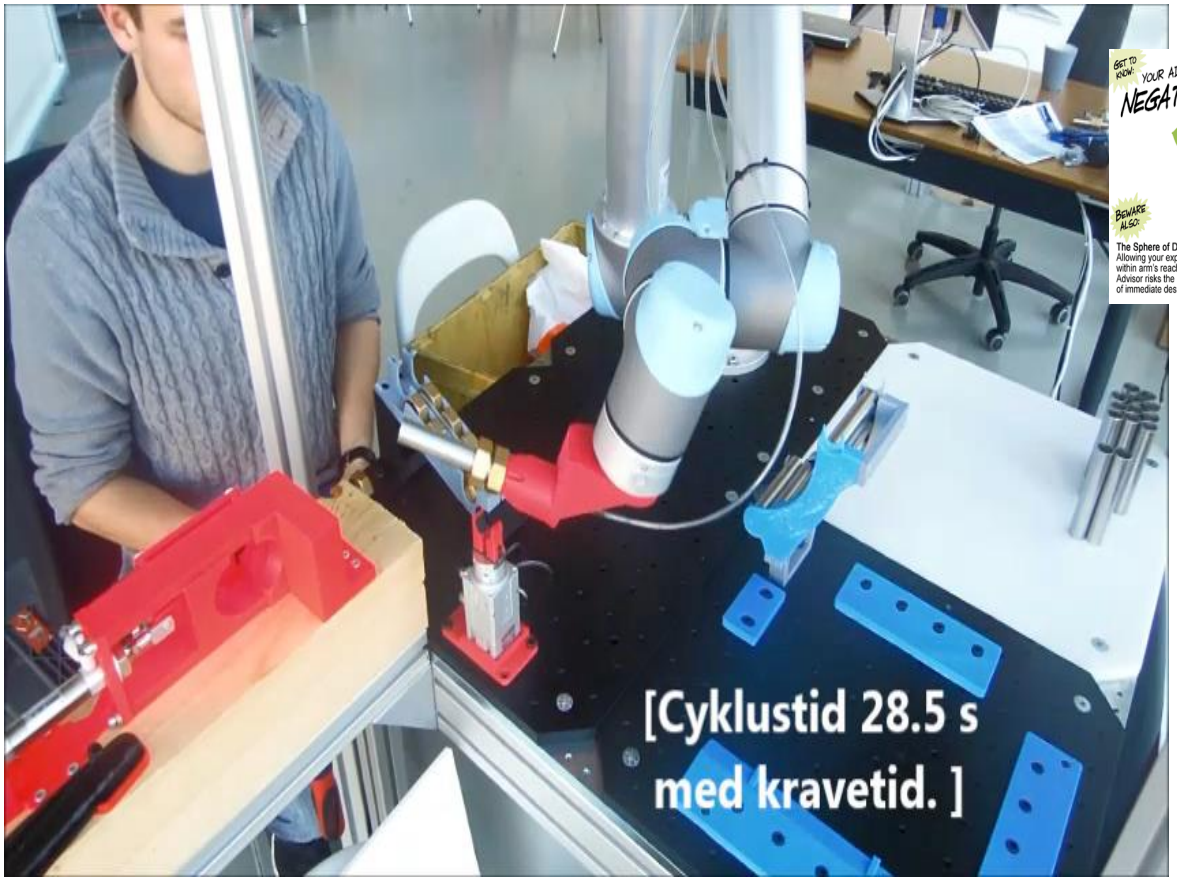
Accurate placements

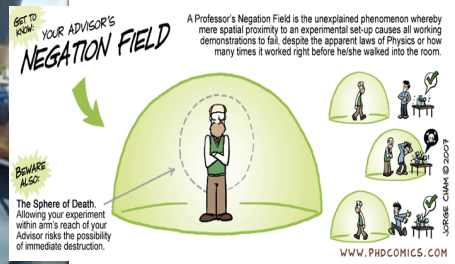
Optimizing the control with respect to robustness to deviations in part location relative to robot end effector (gripper)

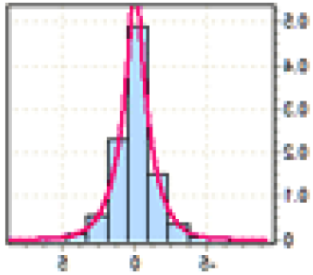
- From an industrial application at a local Danish company
- Task: Place the two union nuts on the pipe as shown
- Several steps in the task, but main objective here is getting the nuts onto the pipe
- Simple pipe and nut feeders used

Accurate placements

Optimizing the control with respect to robustness to deviations in part location relative to robot end effector (gripper)







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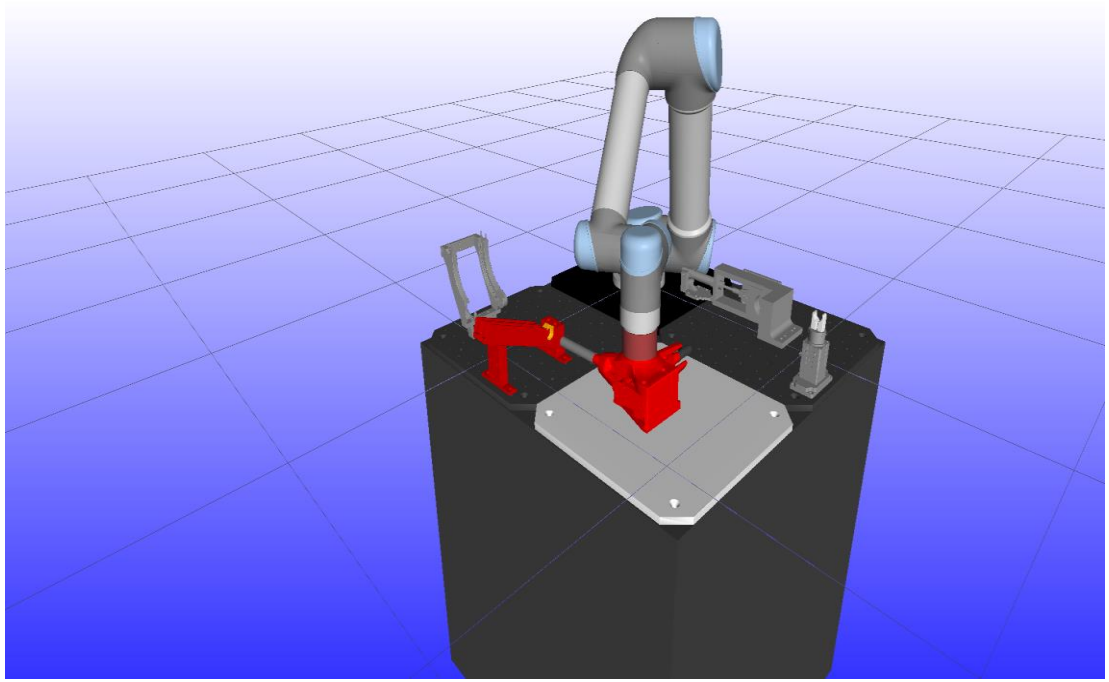

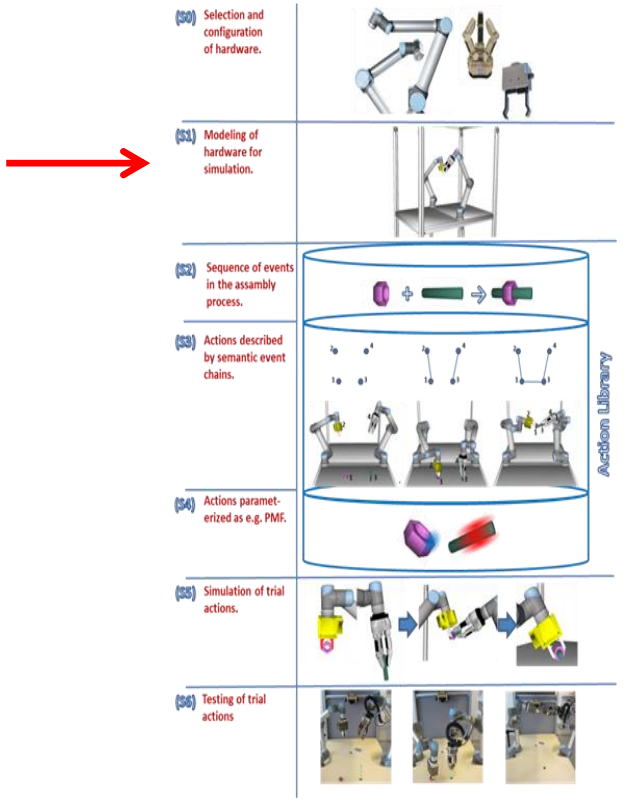

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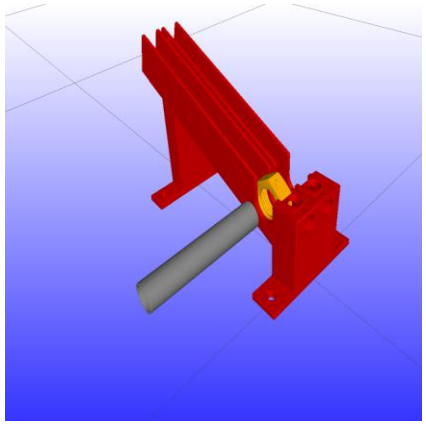

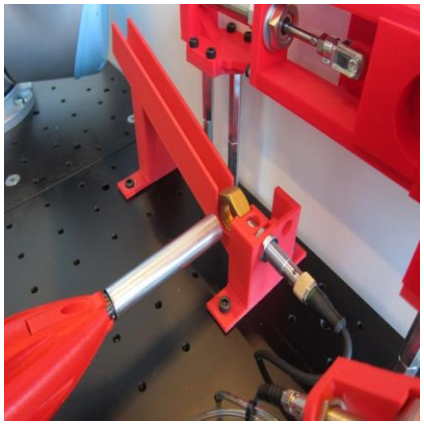

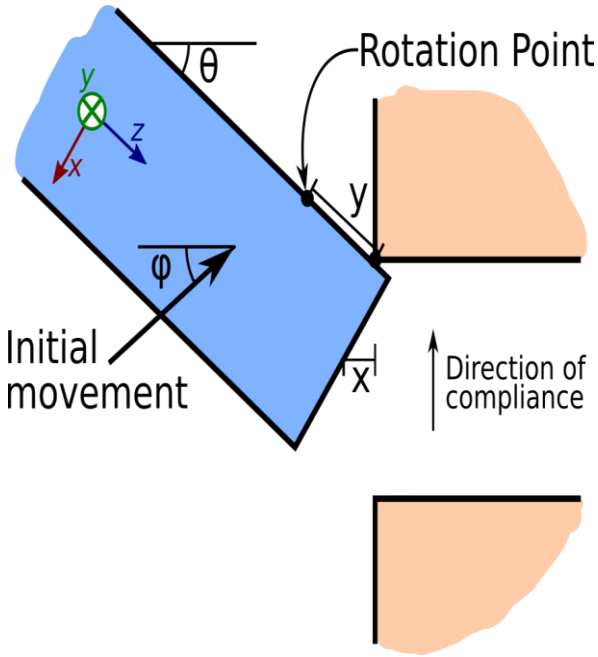

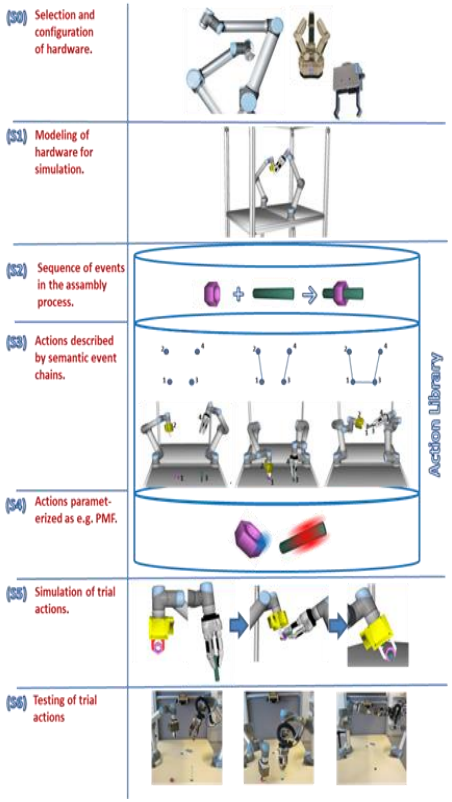

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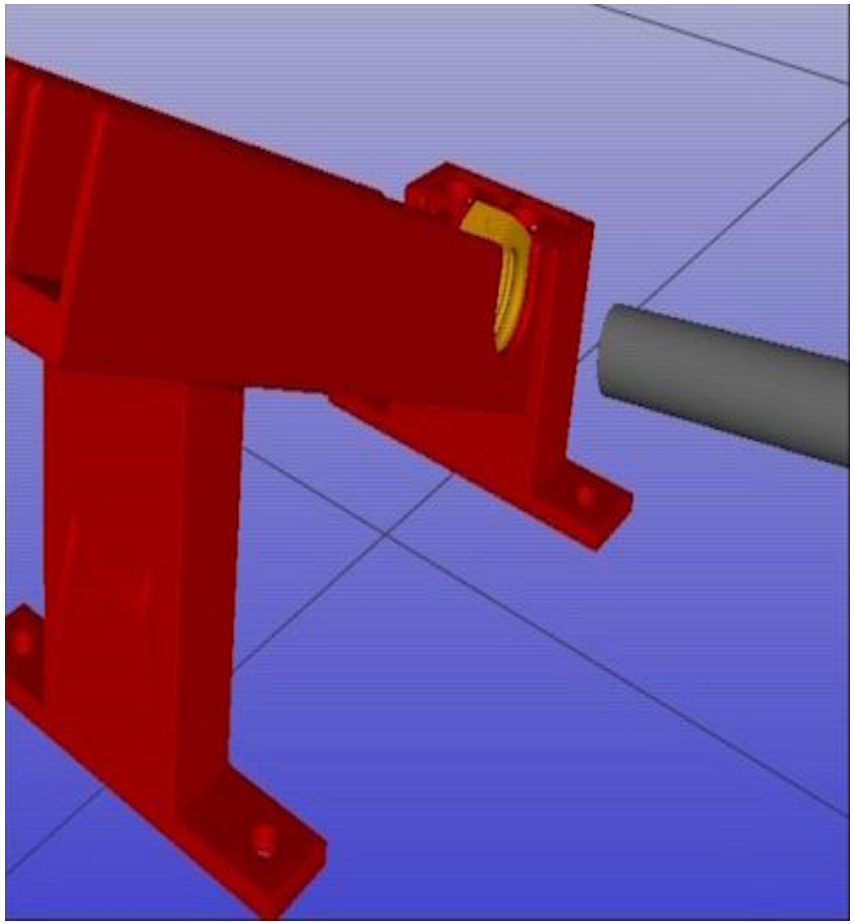

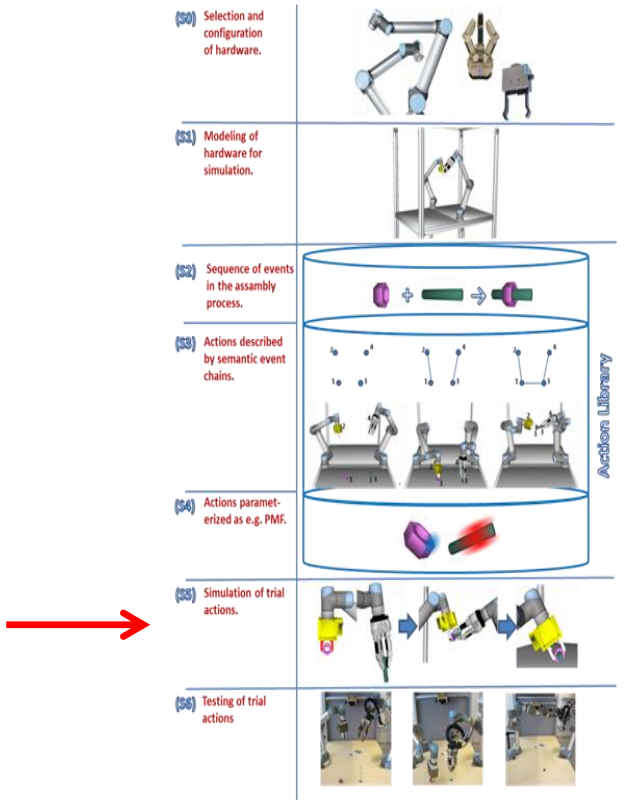

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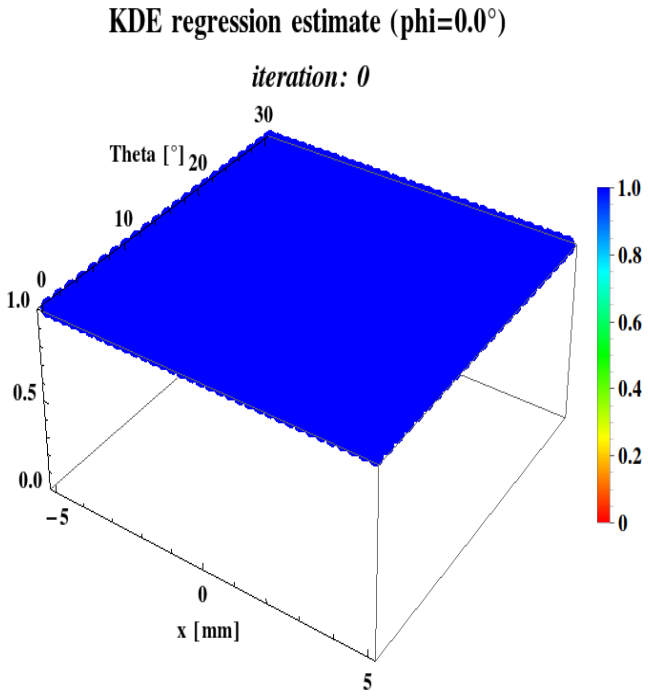

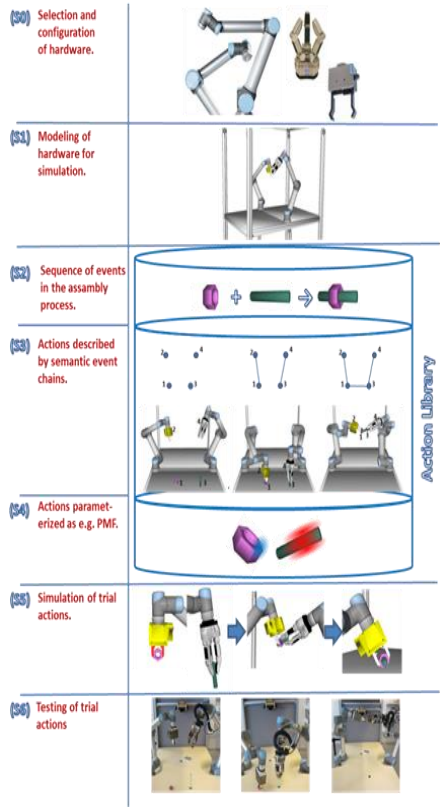

$$\hat{\mu}_H(x) = \frac{\hat{p}_O(x,s)}{\hat{p}_X(x)} = \frac{n^{-1}\sum_{i=1}^{n} K_{H,x_i}(x) O_i}{n^{-1}\sum_{j=1}^{n} K_{H,x_j}(x)}$$

$$CI_{kde} = z \cdot \sqrt{\frac{||K||_2^2 \, \hat{\sigma}_H^2(x)}{n\,|H|\,\hat{f}_H(x)}}$$

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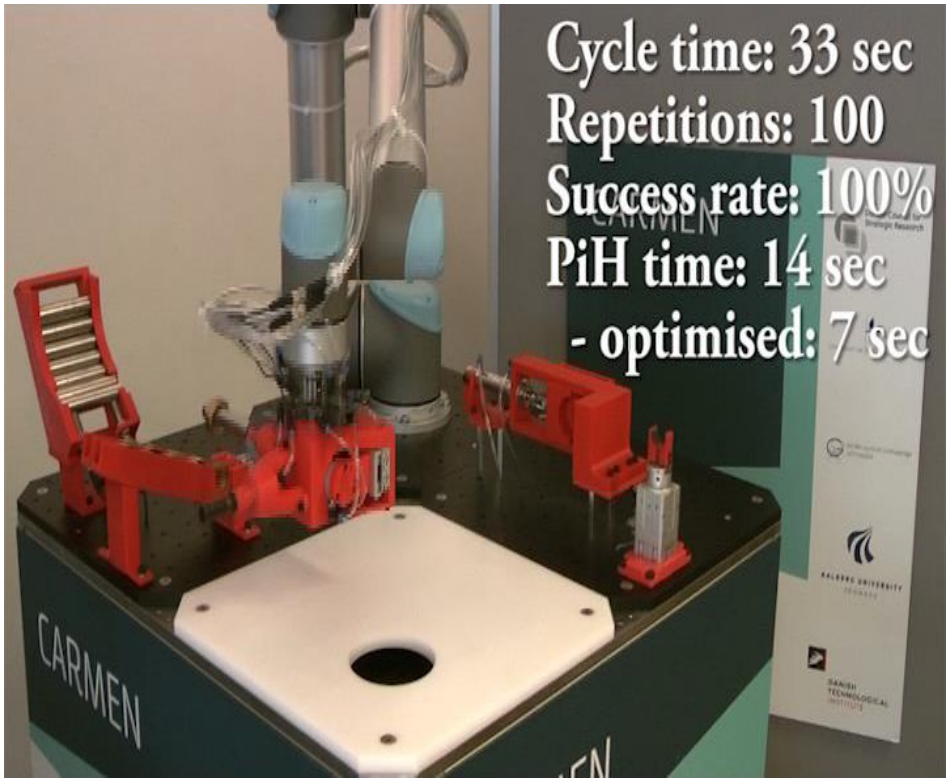
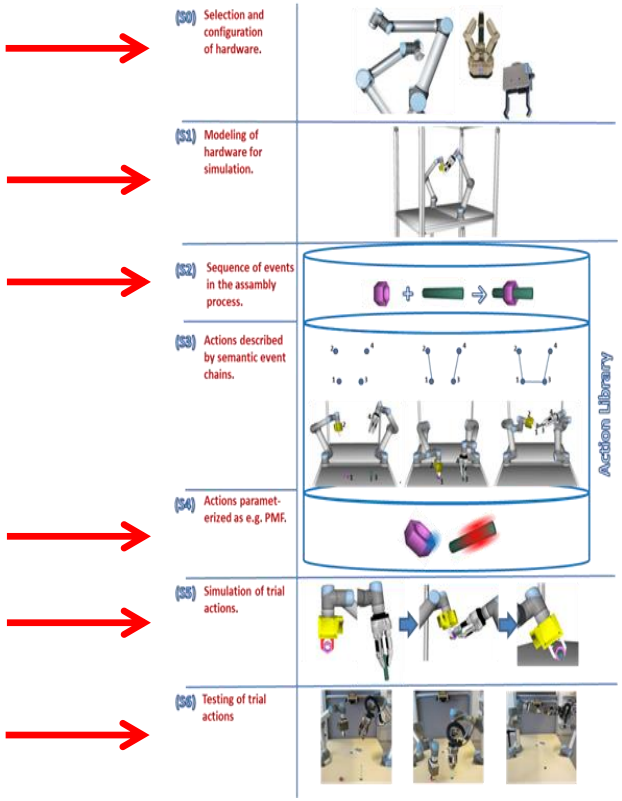
Optimizing the control with respect to robustness to deviations in part location relative to robot end effector (gripper)





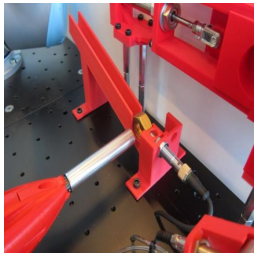
Examples of using digital modeling and simulation for cobot assembly

Feeding techniques

Precise dynamic simulations of vibrational feeders for virtual design and optimization of traps and trap sequences

Accurate placements

Optimizing the control with respect to robustness to deviations in part location relative to robot end effector (gripper)



Robots and Humans

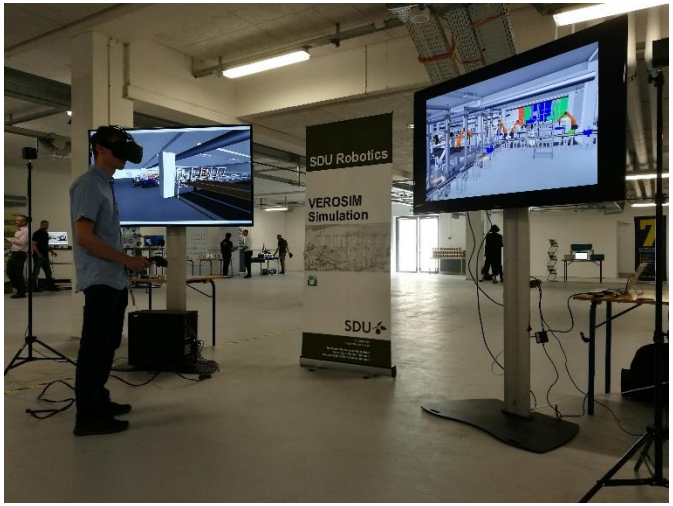
Simulation of functionality of overall system.
AR/VR simulations for training of shop floor workers

Easy programming using building blocks

Humans work as robots
(and safety/working condition is treated rather liberally)

Robots and Humans

Simulation of functionality of overall system.
AR/VR simulations for training of shop floor workers



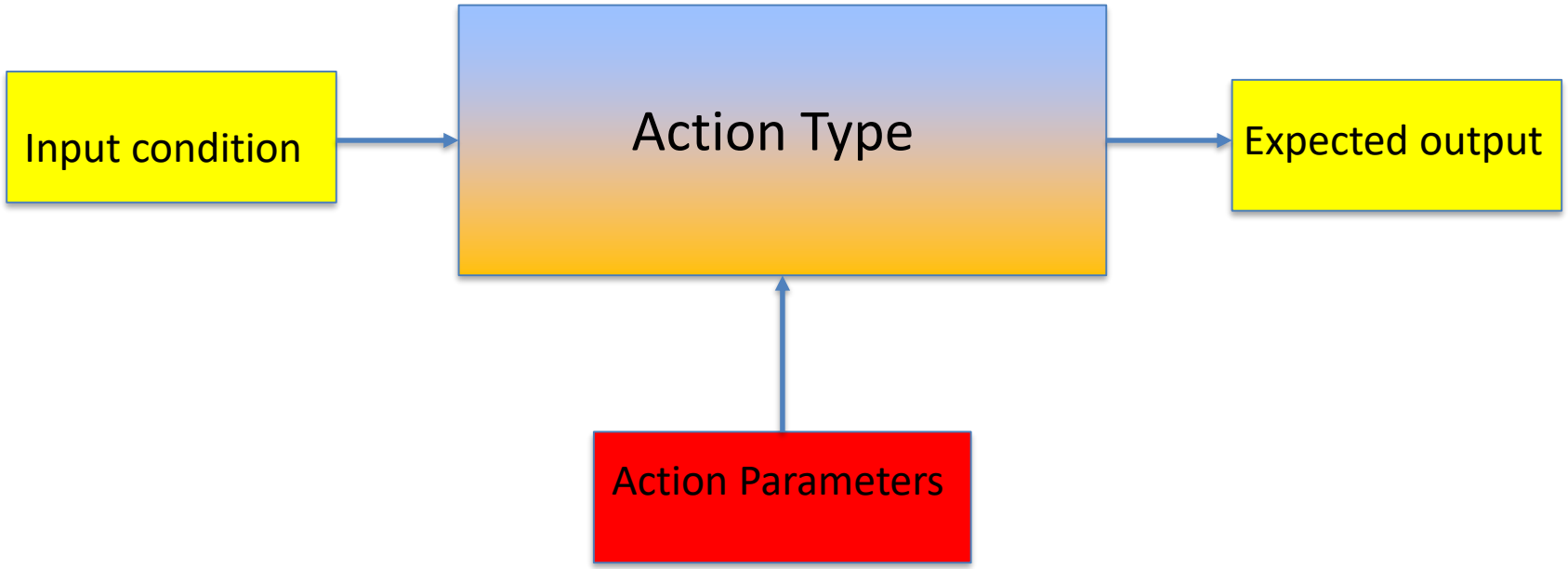
Test facilities: Production realistic laboratory at SDU

Simulation from overall system to detailed processes

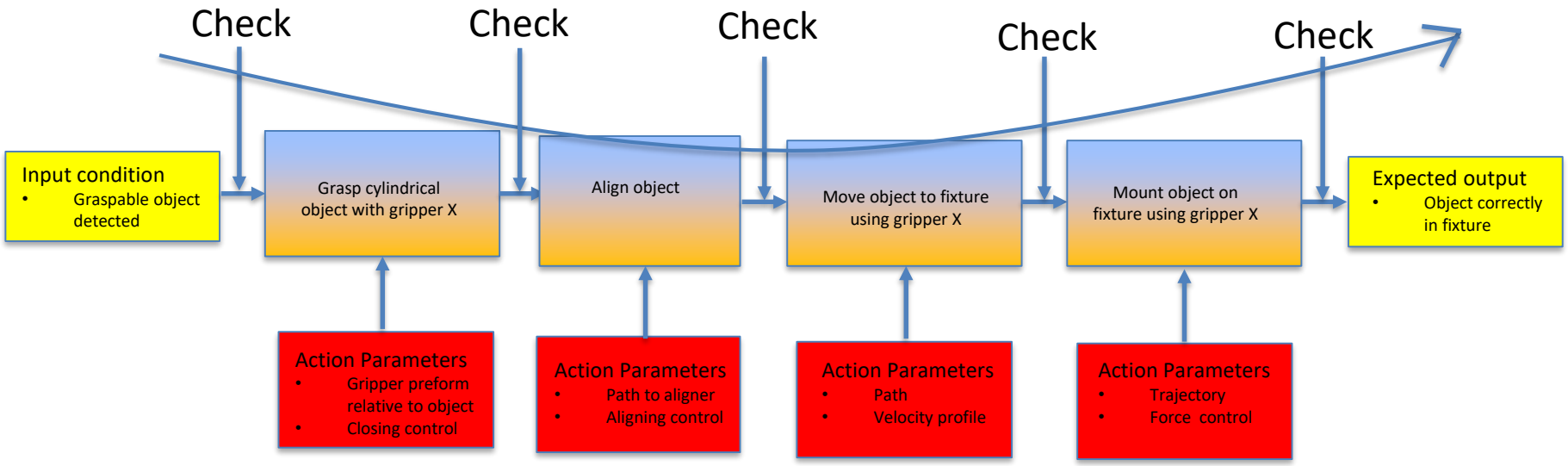
Simulation support for AR/VR to test UI and human-robot environment

Robots and Humans

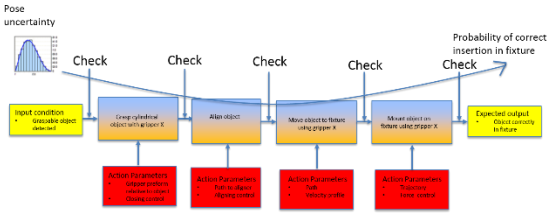
Easy programming using building blocks



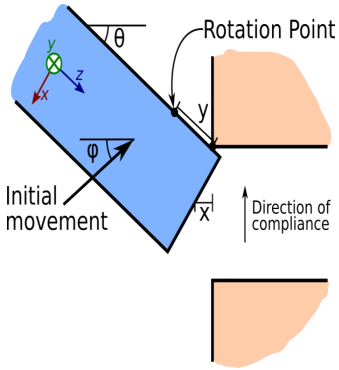
Programming with building blocks



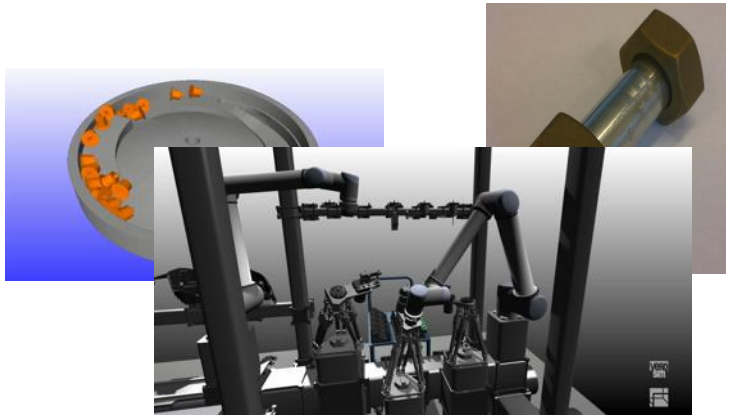
Summary: Tools for Cobot Assembly



Smart building blocks



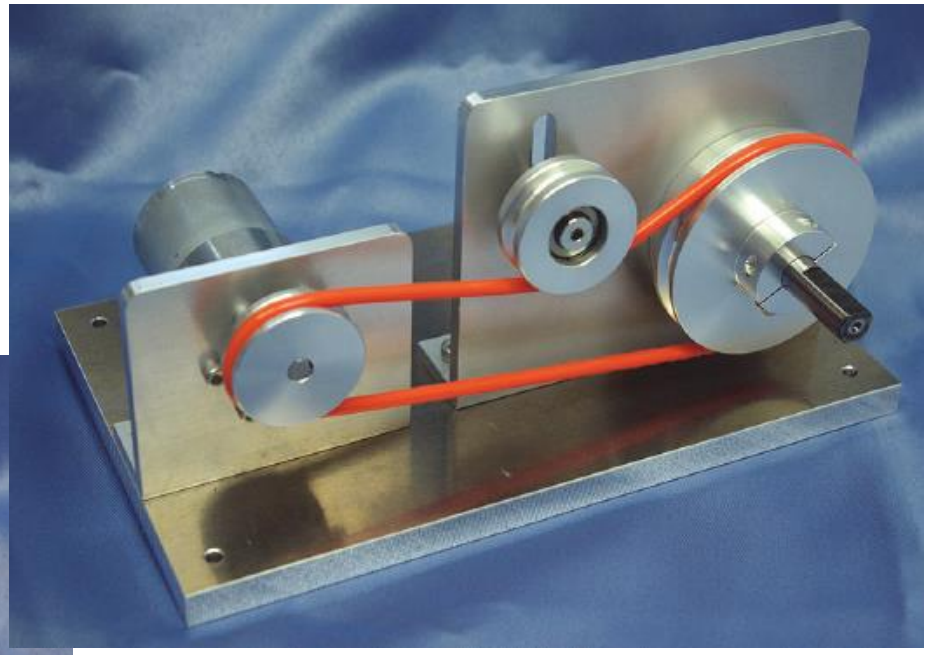
Building block parametrization (intuitive for the user)

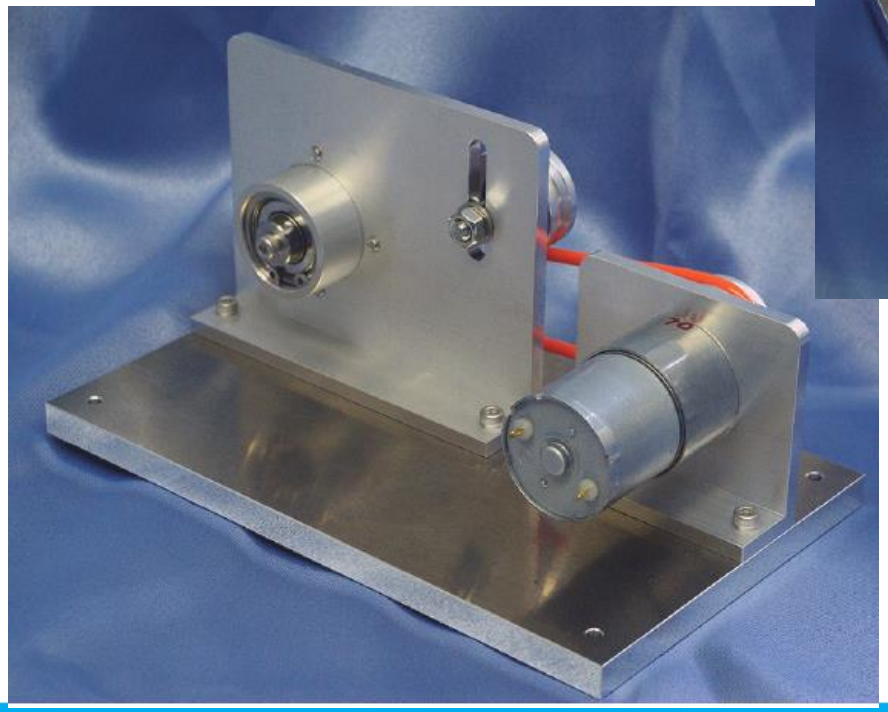


Simulation of assembly lines, Cells, processes incl. AR/VR

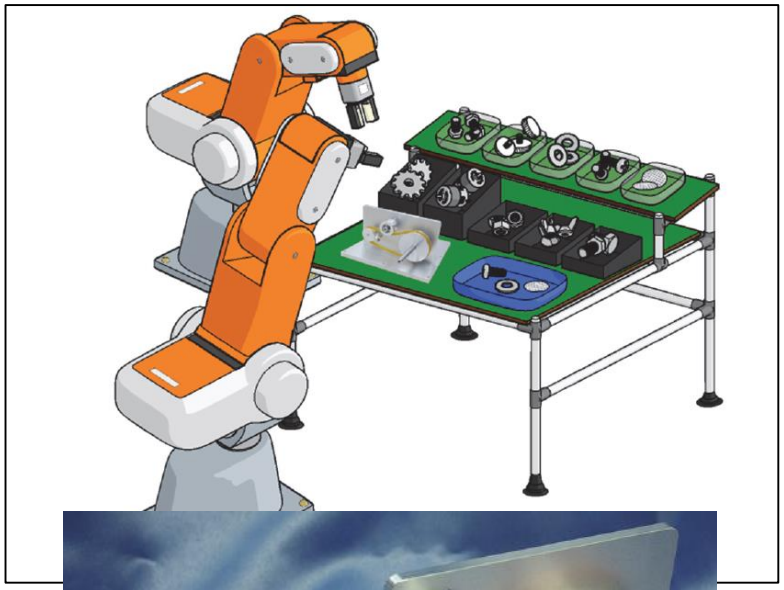
- Hvad det er for redskaber og kompetencer, der skal til for at løse de opgaver, som udviklingen kræver?
- Hvilken betydning det får for arbejdsmarkedet, når arbejdsstyrkens aldersspredning øges med den stadigt stigende tilbagetrækningsalder?

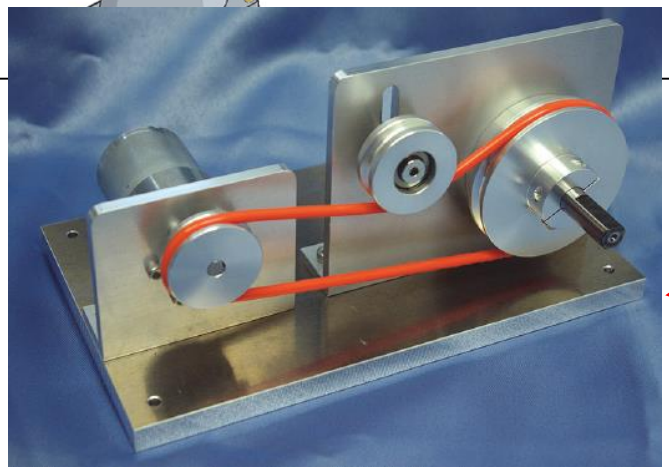
World Robot Summit (Tokyo, Oct. 2018) Industrial Assembly Challenge



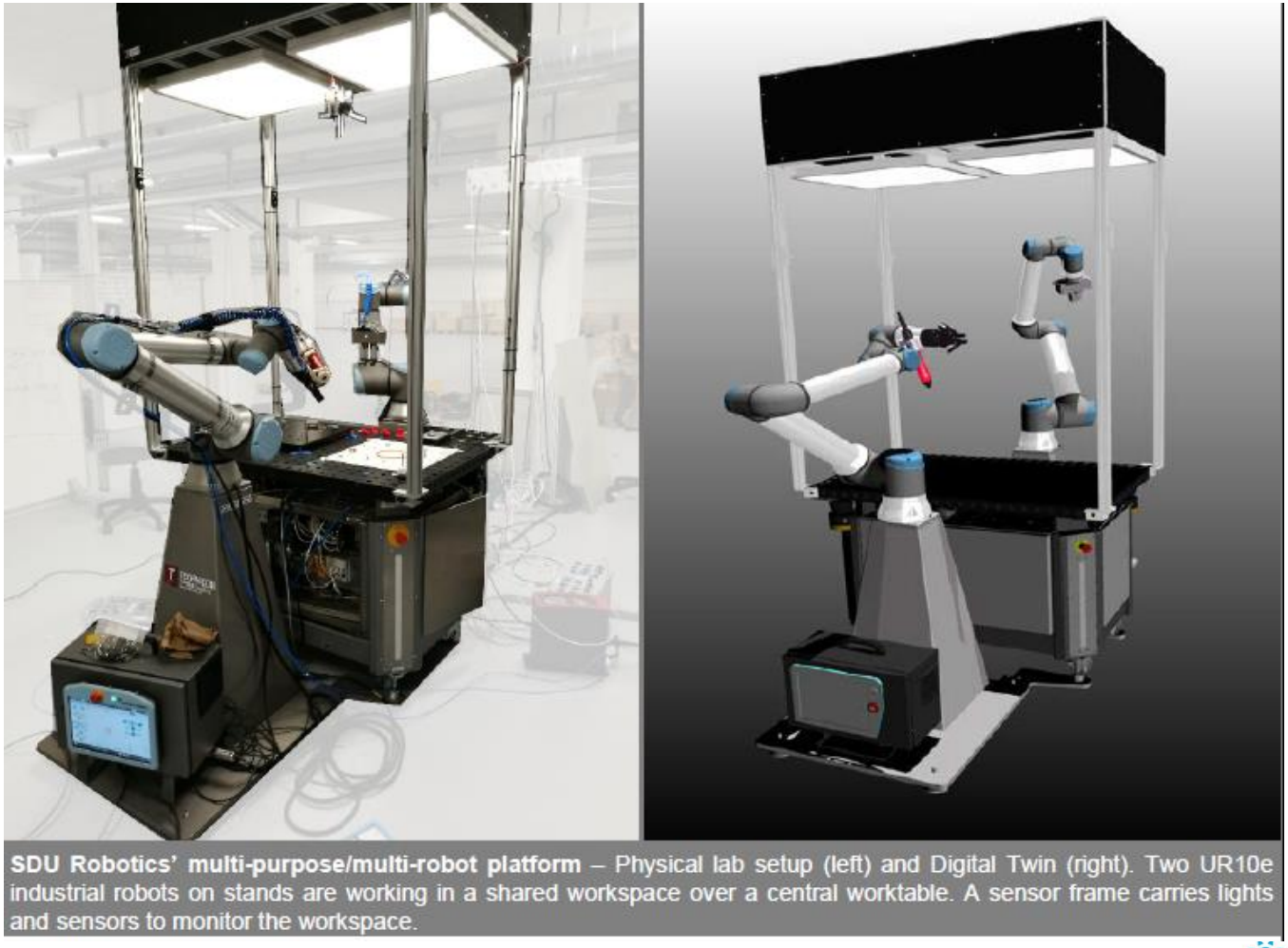


Outline of challenge in pictures





Our robot cell



SDU Robotics' multi-purpose/multi-robot platform – Physical lab setup (left) and Digital Twin (right). Two UR10e industrial robots on stands are working in a shared workspace over a central worktable. A sensor frame carries lights and sensors to monitor the workspace.

250 applied to compete of which 16 were selected. Among them SDU Robotics (us).

チーム名	国籍・地域	所属
Cambridge Robotics	United Kingdom	University of Cambridge
CMIT Robotics	Thailand	Kasetsart University
JAKS	Japan	Kanazawa UNIV.
Robotic Materials	U.S.A.	Robotic Materials Inc.
BerlinAUTs	Germany	TU Berlin UNIV.
Team SAGAMIHARA	Japan	MEMO Technos Corp.
O2AS	Japan	Osaka UNIV.
Team. ALGoZa	Japan	Chitose Robotics Inc.
3up technology	Japan	3up technology
YH-CASIA	China	Institute of Automation, Chinese Academy of Sciences UNIV.
FA.COM Robotics	Japan	office FA.com Co.,Ltd.
Team The Robot System Integrators	Japan	-
ARTC	Singapore	-
CPF Robotics	Thailand	CPF
hippopoTaMUs	Japan	Tokyo Metropolitan UNIV.
SDU Robotics	Denmark	University of Southern Denmark

C	France	Denmark
D	Croatia	Argentina
E	Brazil	Switzerland
F	Sweden	Mexico
G	Belgium	England
H	Colombia	Japan

Bracket [edit]

Round of 16

30 June – Sochi
- Uruguay 2
- Portugal 1

30 June – Kazan
- France 4
- Argentina 3

2 July – Samara
- Brazil 2
- Mexico 0

2 July – Rostov-on-Don
- Belgium 3
- Japan 2

1 July – Moscow (Luzhniki)
- Spain 1 (3)
- Russia (p) 1 (4)

1 July – Nizhny Novgorod
- Croatia (p) 1 (3)
- Denmark 1 (2)

3 July – Saint Petersburg
- Sweden 1
- Switzerland 0

3 July – Moscow (Otkritie)
- Colombia 1 (3)
- England (p) 1 (4)

Quarter-finals

6 July – Nizhny Novgorod
- Uruguay 0
- France 2

6 July – Kazan
- Brazil 1
- Belgium 2

7 July – Sochi
- Russia 2 (3)
- Croatia (p) 2 (4)

7 July – Samara
- Sweden 0
- England 2

Semi-finals

10 July – Saint Petersburg
- France 1
- Belgium 0

11 July – Moscow (Luzhniki)
- Croatia (a.e.t.) 2
- England 1

Third place play-off

14 July – Saint Petersburg
- Belgium 2
- England 0

Final

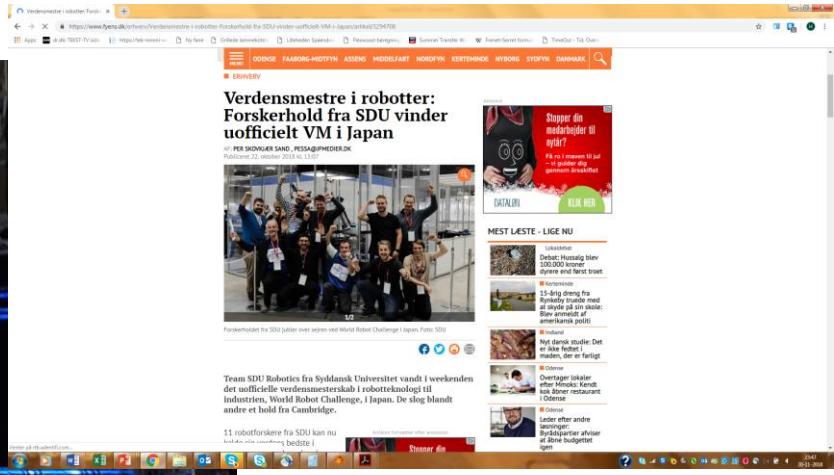
15 July – Moscow (Luzhniki)
- France 4
- Croatia 2

Round of 16 [edit]

France vs Argentina [edit]

The teams had faced each other in 11 previous matches, including two World Cup group stage matches, both won by Argentina (1–0 in 1930, and 2–1 in 1978).[5]

Vi er bedre til robotter… ☺



Thank you for your attention !