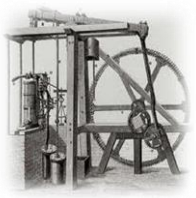


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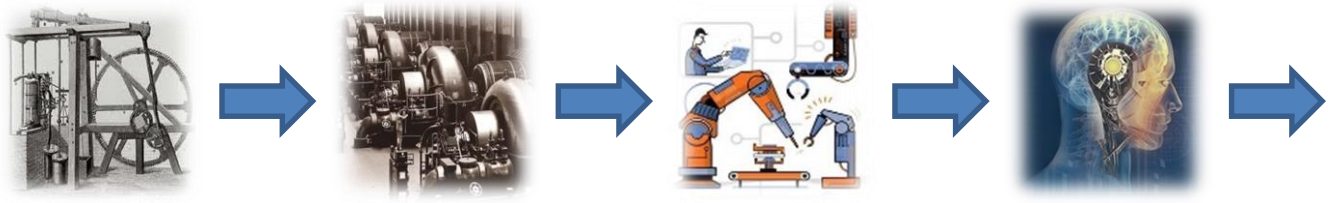
Synergetic dexterity and skills in physical human-robot interaction

Dragoljub Surdilovic
Fraunhofer IPK Berlin
Laboratory for Robot Supported Cooperative Work



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WorkShop Work Flow

Robots 4.0

Adaptive Grippers

Dexterous Manipulators and Human Manipulation

Multi-Modal/Arms Cooperation

Manufacturing 4.0

Human Robot Collaboration

Cognitive Manufacturing

Cooperative Manufacturing

Flexibility 4.0

Service Oriented Approach in Flexible Manufacturing

Task Planning in Flexible Manufacturing

Open Dynamic Manufacturing Operating System in Flexible Manufacturing

Not Flexible Robots

Lose jobs in Assembly Lines

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Bloomberg News : February 25, 2016 — 6:00 AM CET Updated on February 25, 2016 — 5:07 PM CET

Mercedes Boots Robots From the Production Line

“With customization key to wooing modern consumers, the flexibility and dexterity of human workers is reclaiming space on Mercedes’s assembly lines…….”

Ambitious, nevertheless logical demand

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Dextereous Manipulation and Flexibile Automation for Manufacturing Applications

- **Dextereous Manipulation : Area of robotics in which multiple manipulators or fingers cooperate to grasp and manipulate objects;**
- **Flexible Automation : Ability for a robot or system to be quickly and easily re-tasked to change product design for both low and high mix manufacturing (capacity-volume and product variants flexibility)**

- Robots are currently incapable of competing with human to perform dexterous tasks (contact tasks) in a flexible manner!
- Role of compliance (dexterity ↔ flexibility)?

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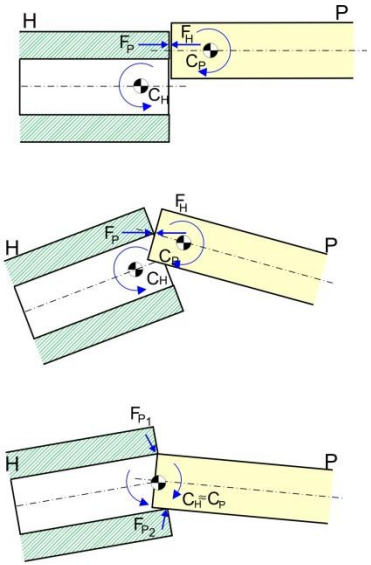
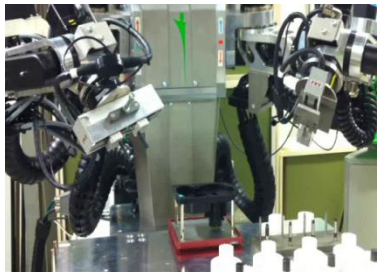
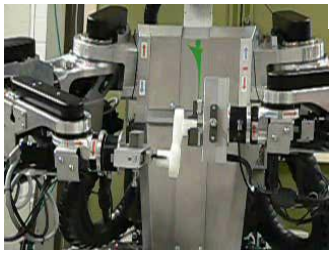
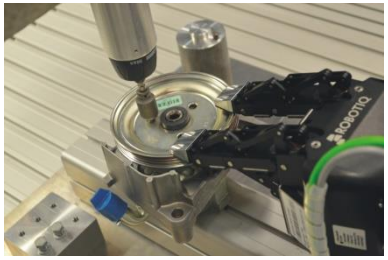
a) Increase robot skills

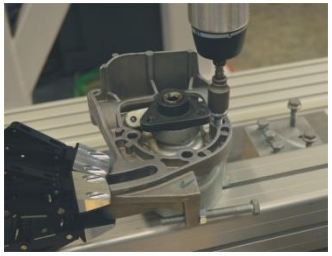
Compliance control, vision control











Bi-manual skills (Tasks: Bi-Install, spec. -Bi-Install-HOLD-Adjust etc.; Actions: Bi-APPROACH, Bi-INSERT,Bi-RETRACT etc.), articulated hands

“Killer” Applications: Gears Meshing, Screwing

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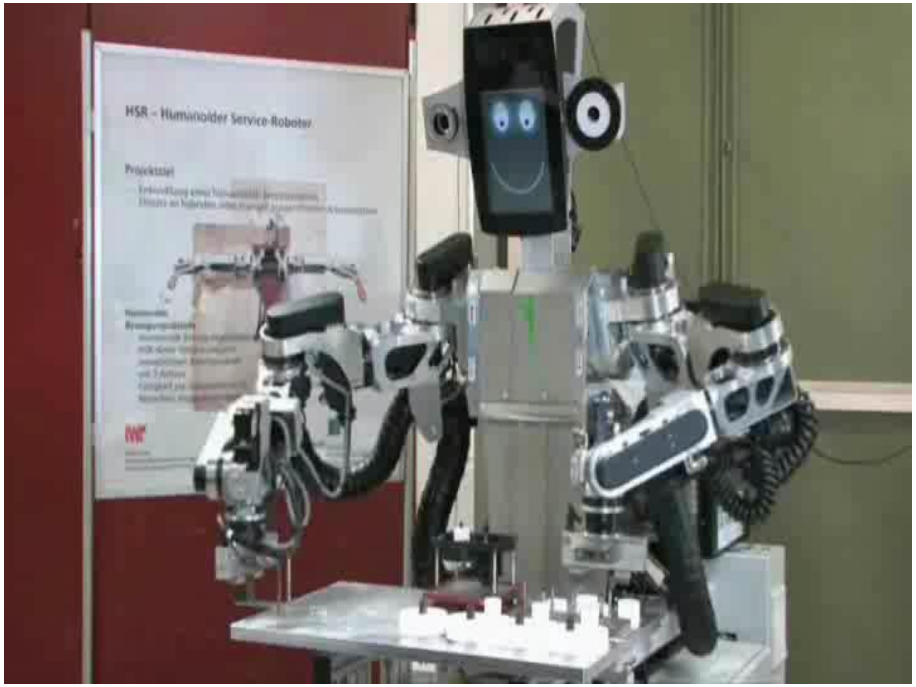

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Process Automation and Robotics department

b) Increase synergetic skills -
Collaborate and cooperate with

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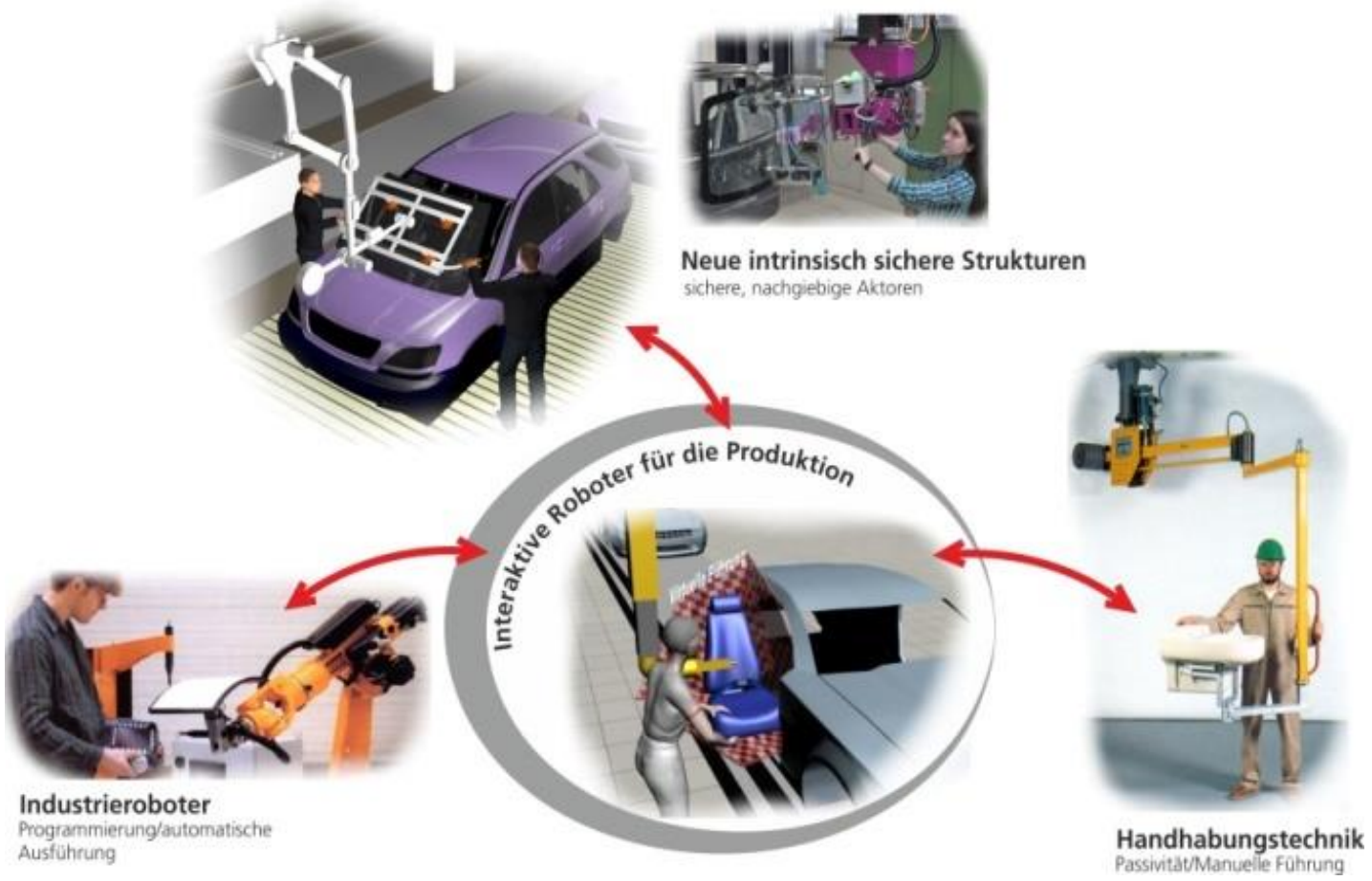

Cooperative robots developments directions at IPK (“Together we are unbeatable”)

Human robot cooperation

Synergetic pHRI

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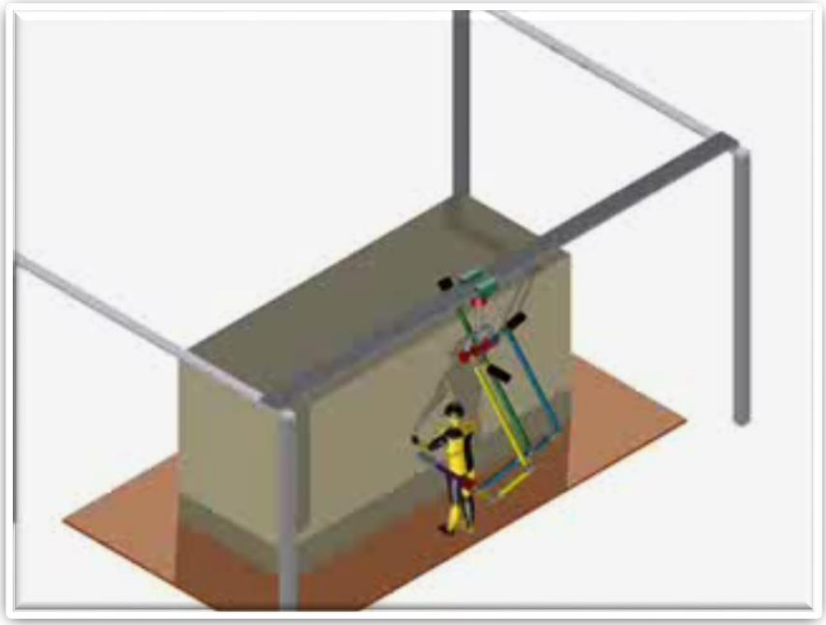
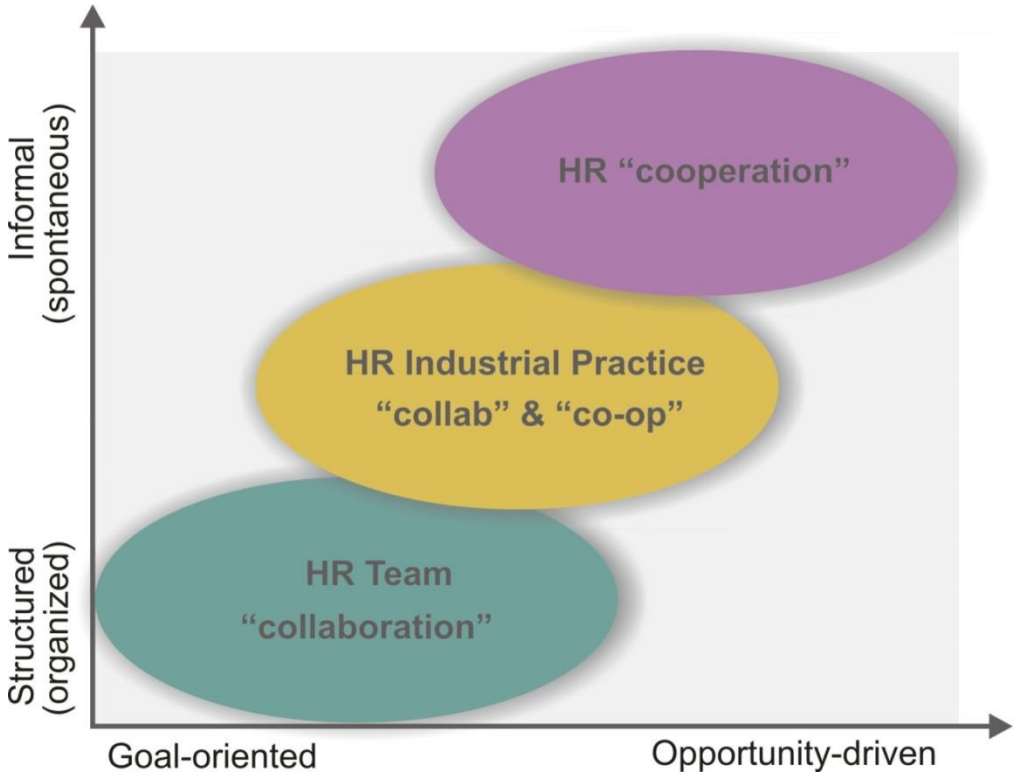
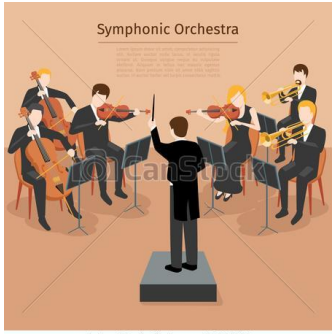


C3: Collaboration, cooperation, coexistence



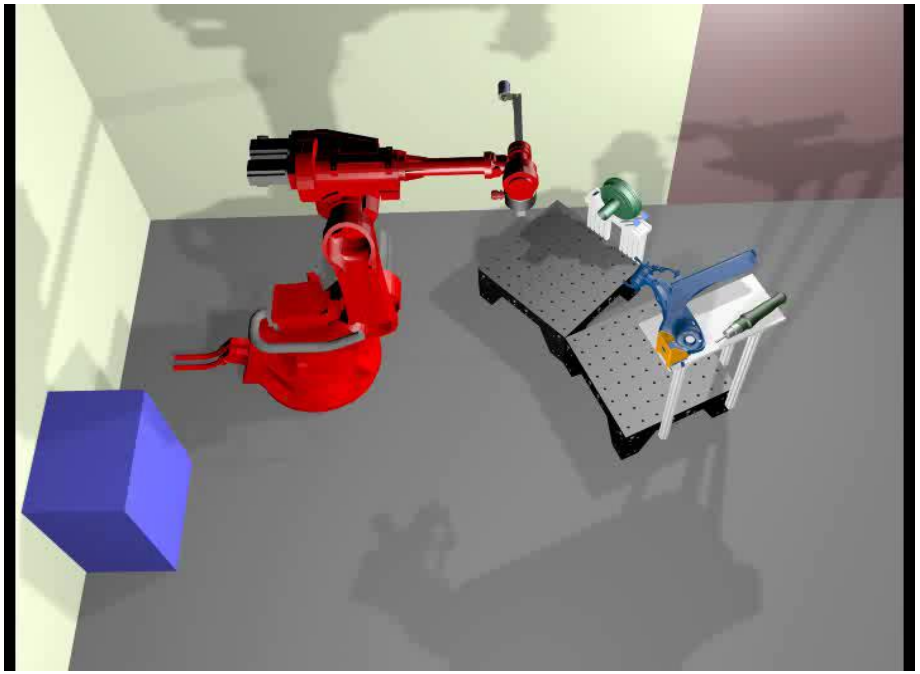
Cooperation (connective, group value… new skills!)

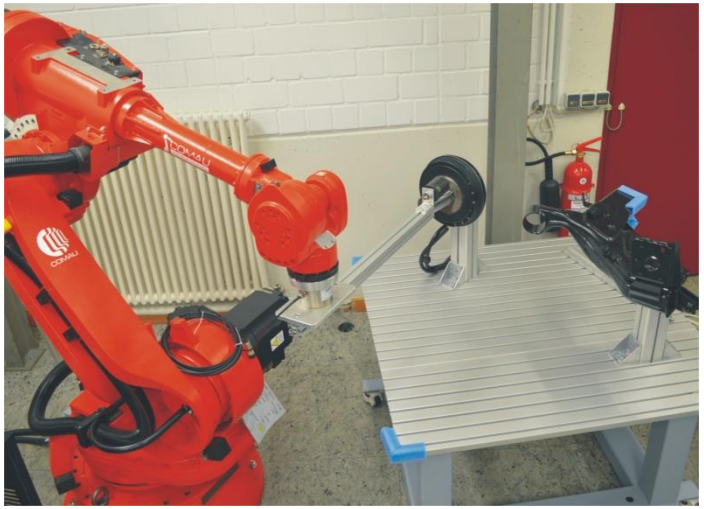


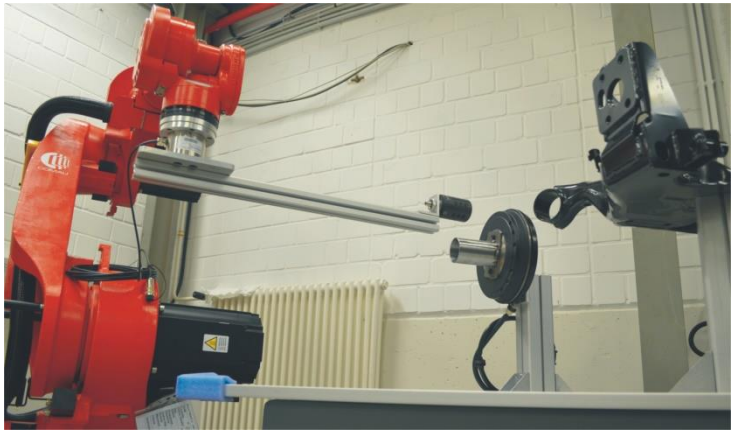
Collaboration (collective, individual value….)

Hybrid C2 - industrial application
"hands on control"

C2 - industrial application
“hands on payload” manual guiding







c) Improve communication
I3 – instructive, intuitive and interactive programming

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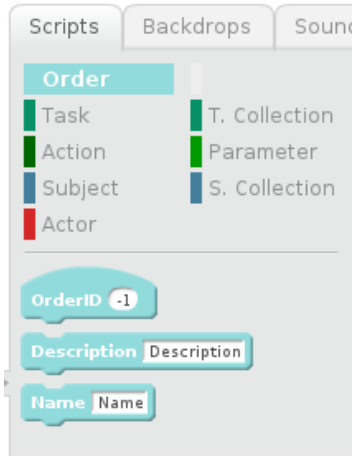
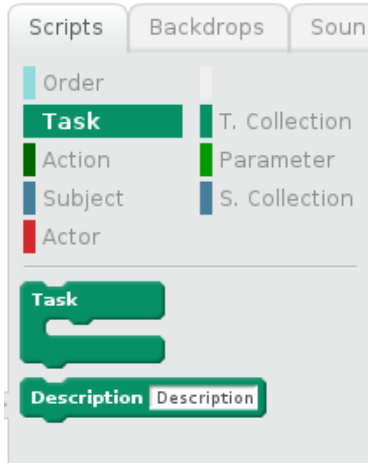
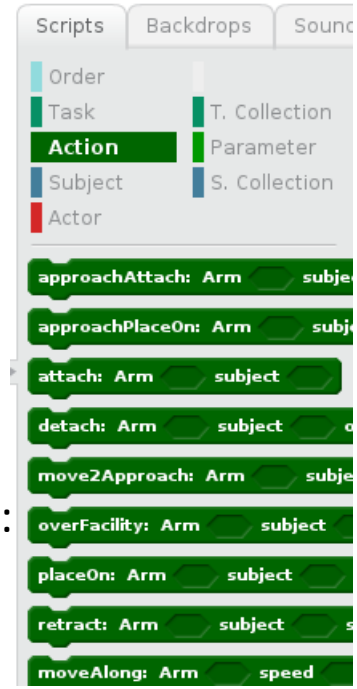
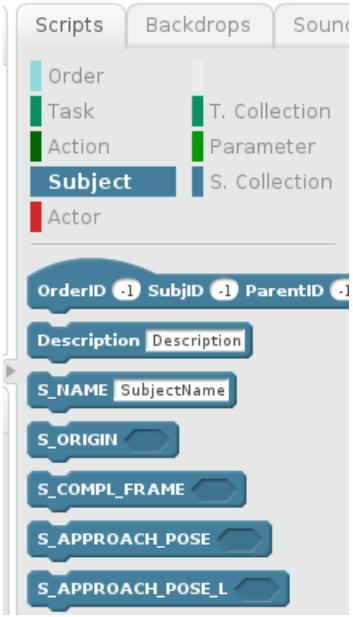
- Standard multi-chanels communication and SW libraries (voice, vision, gesture devices etc.) and task-oriented programming (INSTALL, APPROACH, ATTACH)
- Icon based programming – Scratch and SNAP! (visual programming, education, MITLab/Berkley development, open source, Adobe ActionScript + 0MQ binding)









Background: **ROS** packages (open source):

CURL++

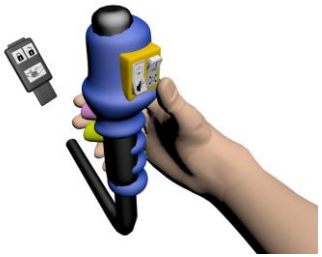
TOP – MongoDB

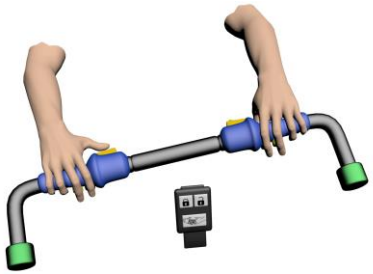
TOP- Mock

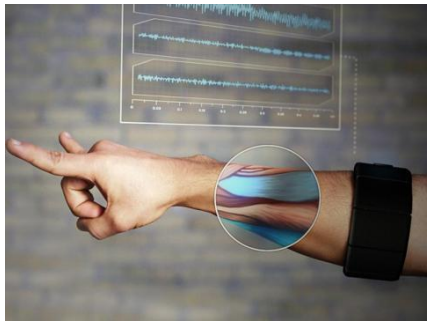
c) Improve communication

Design of sensor integration for fast teaching and program adaptation through physical interaction

- Common sensing technologies (WP2)
- Various novel gesture devices, speech recognition…
- HRI interface package (HW and SW) for manual-guiding (programming)







Human, Robots and Flexible Processes

Synergetic pHRI

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Process Automation and Robotics department




INSTEAD OF CONCLUSION : COMPLIANCE ROBOT ARMS CONTROL (PHRI) + I3 PROGRAMMING KEY TECHNOLOGIES TOWARDS ENHANCED DEXTERITY AND FLEXIBILITY