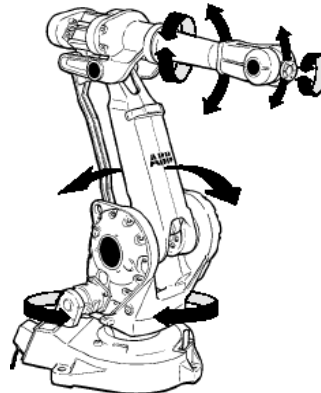


Rovereto, March 13th, 2014

On the Reuse of Robot sub-Tasks in Dual-Arm Manipulation

[Semantics & Modularity]

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www.robot.LTH.se rss.cs.lth.se www.LU.se



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#230902 (Rosetta: RObot control for Skilled ExecuTion of Tasks in natural interaction with humans; based on Autonomy, cumulative knowledge and learning),

#285380 (PRACE: The Productive Robot Apprentice),

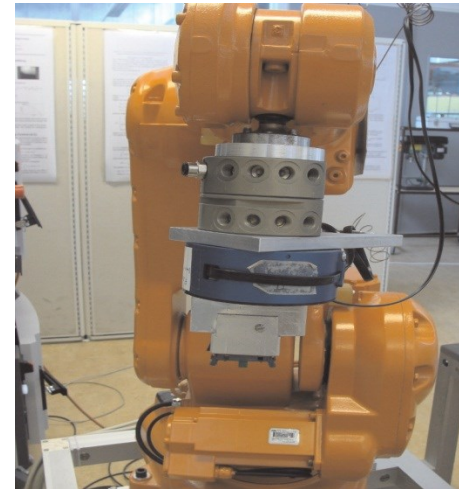
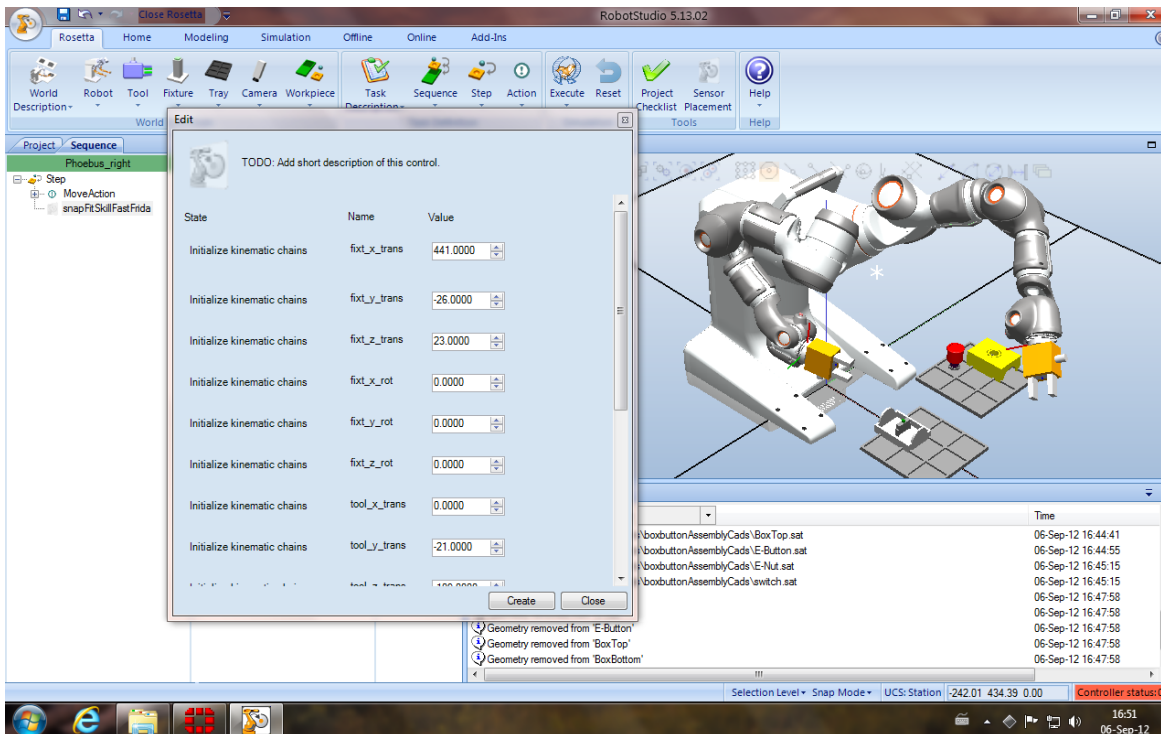
#287787 (SMERobotics: The European Robotics

Initiative for Strengthening the Competitiveness of SMEs in Manufacturing by integrating aspects of cognitive systems).

With additional support from the Swedish foundation for strategic research, in the ENGROSS project: Enabling growing software services

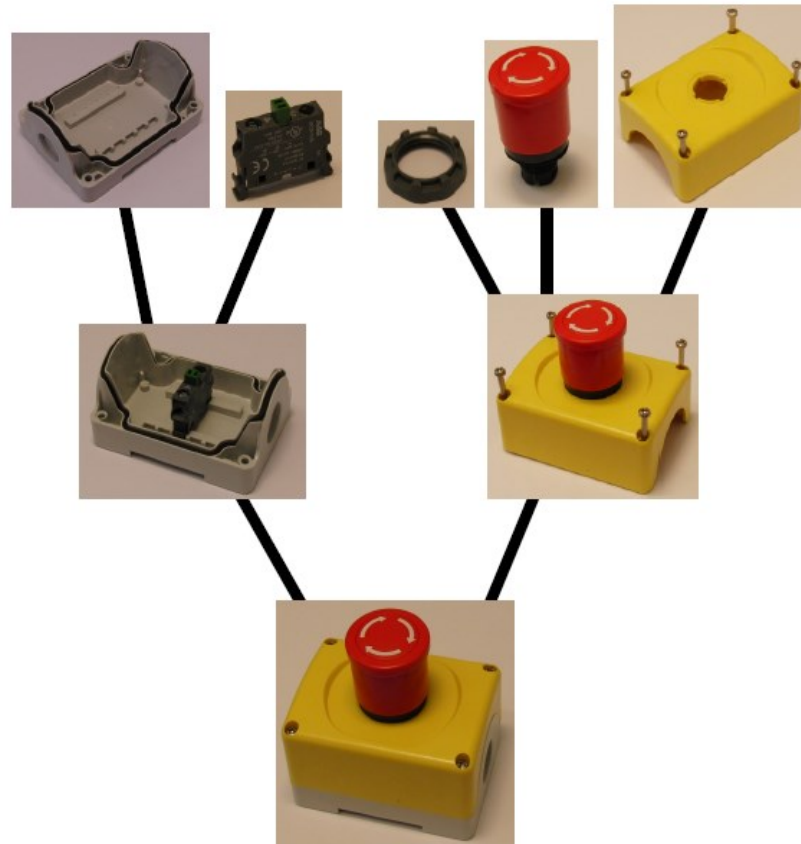
Example: Snap fit Breaker Assembly

Task portability/reuse: The snap fit FSM/SFC was stored in Knowledge-Base, retrieved in the Engineering Station, some parameters were changed (position and speed) and executed on two different robots (FRIDA and Irb140).

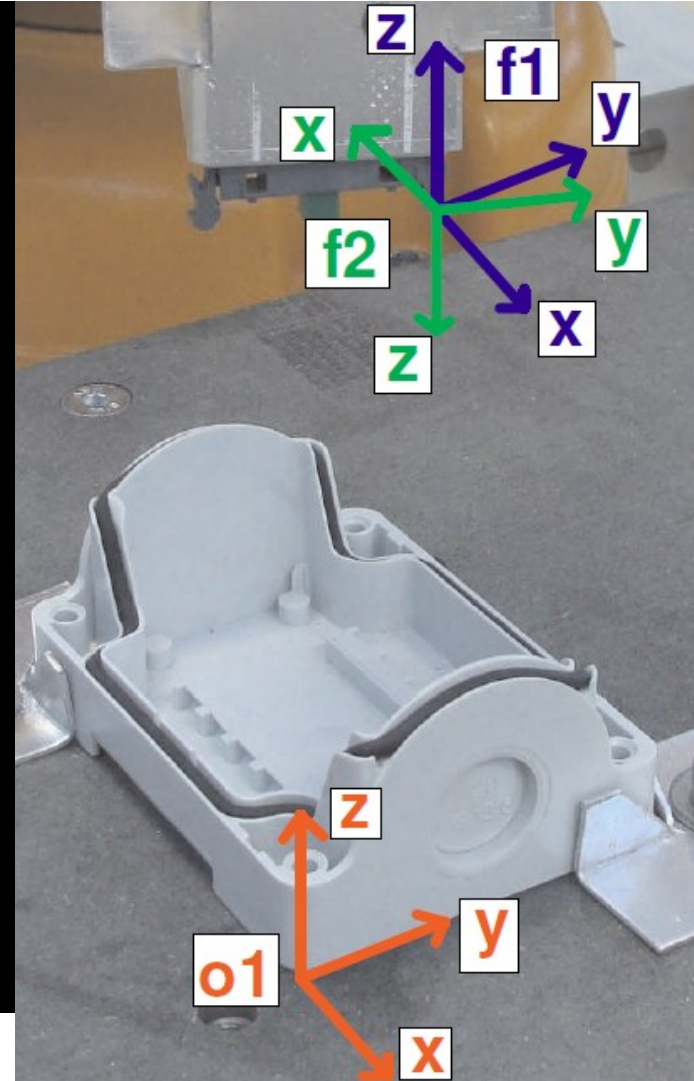
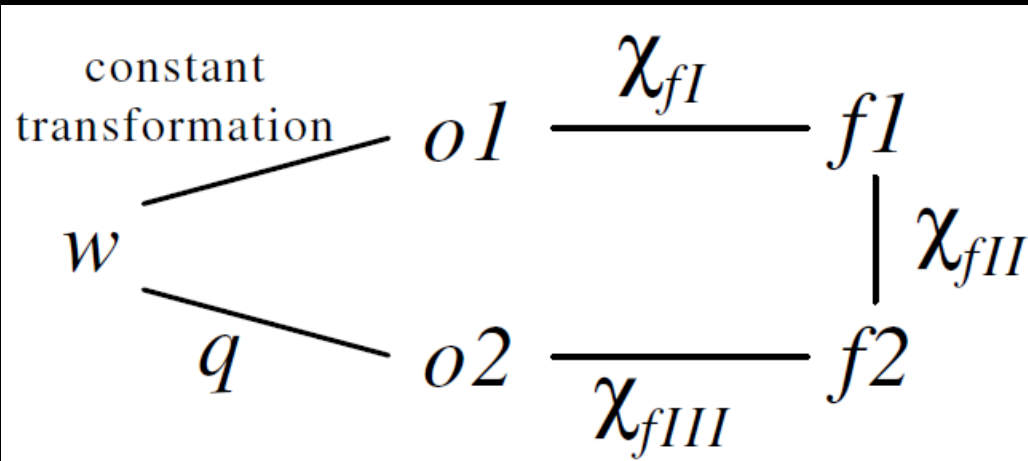


The Assembly Graph

Pick yellow box
Red button, peg in hole
Lift box with two hands
Screw nut
Align box
Put in storage
Pick grey box
Snap fit
Put yellow box on grey box

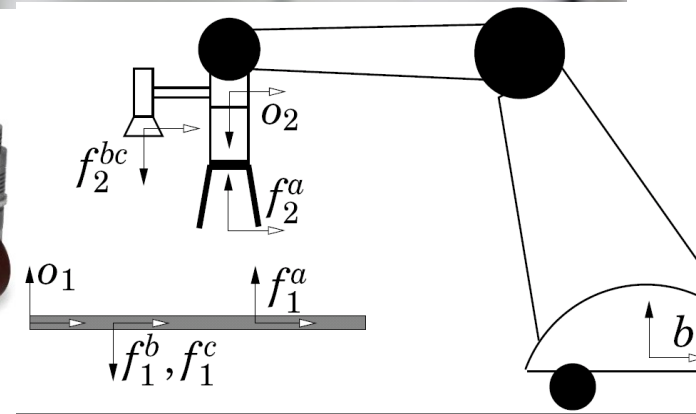
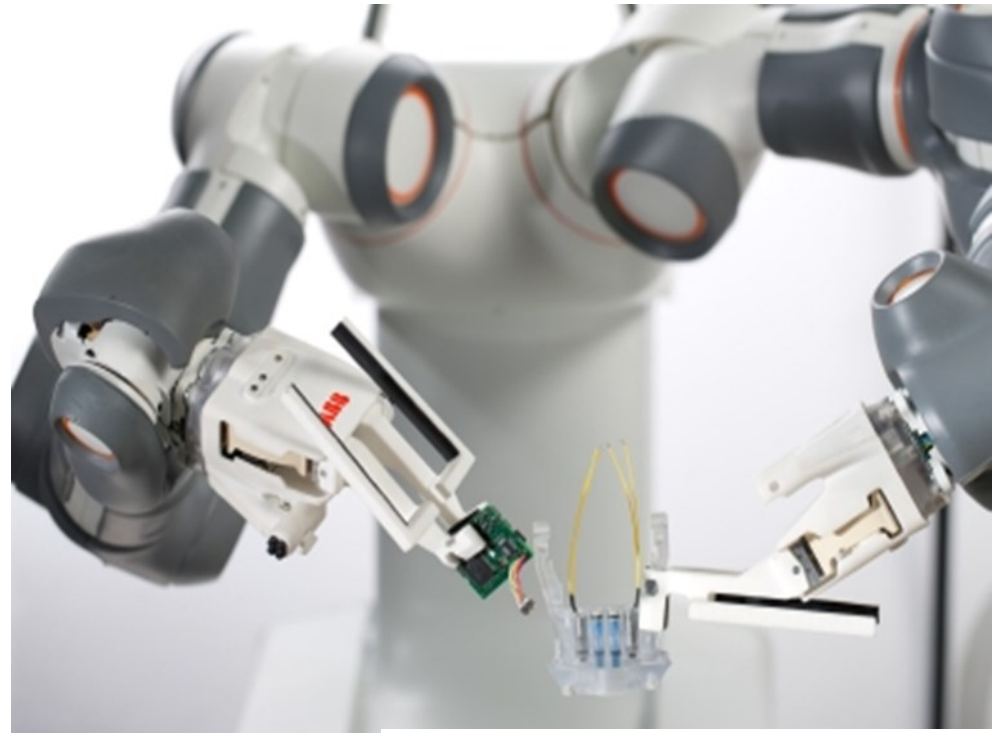
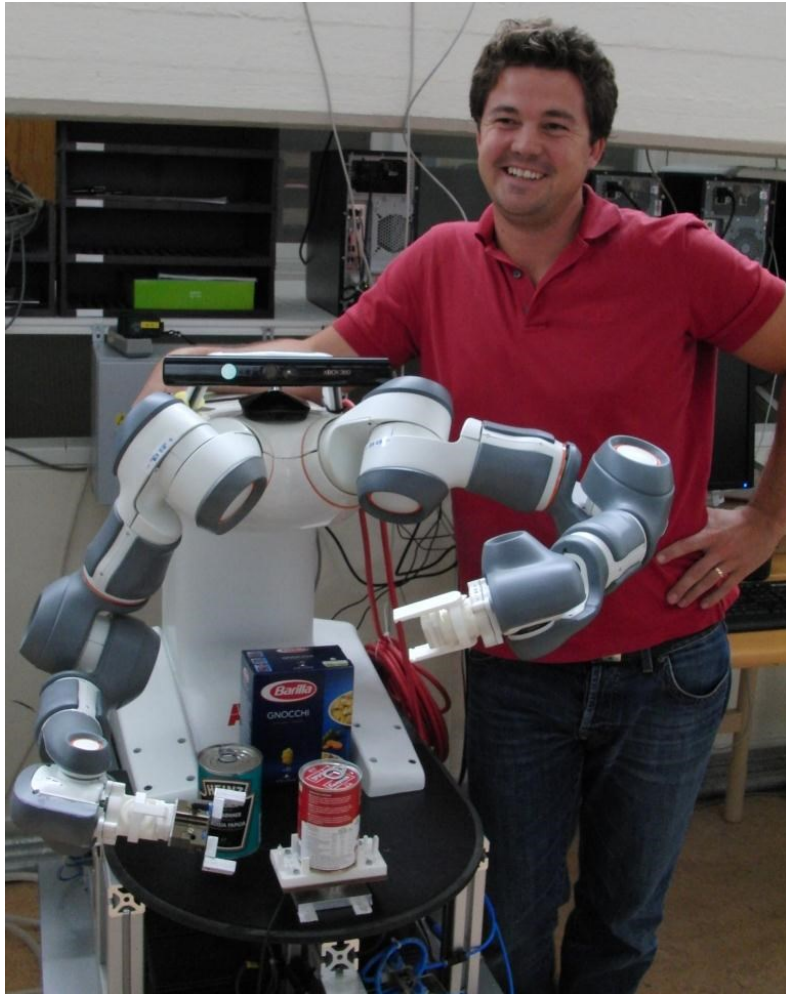


Compositionality of motion descriptions declaratively by the iTaSC formalism



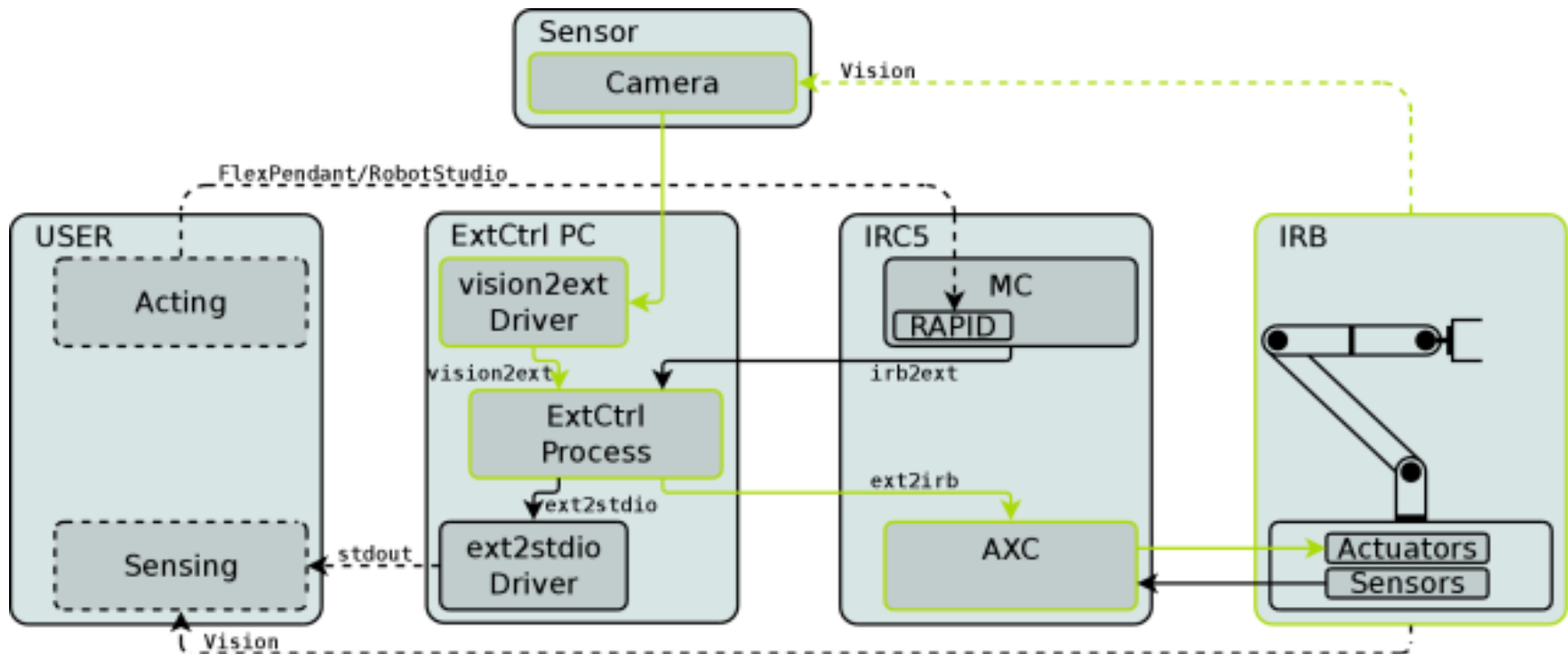
Mobile manipulation

The FRIDA robot in our lab



ABB/LTH ExtCtrl Computing structure

- Robot comes with the ABB Industrial Robot Control 5 (IRC5)
- IRC5 has some 3MLOC closed source code.
- The Embedded IRC5 software protects the users and the robot.



Extended/open ABB controller

Engineering Station;
ABB RobotStudio

Knowledge
Integration
Framework

Tasks, Skills,...
as RDF or
BLOBS

ES

KIF

RAPID code

*FSM/SFC,
e.g. jGC*

State-machine
up/down-load

RAPID socket

jGrafChart
Simulink/RTW
ExtCtrl.ext

IRC5 HW
Added SW:
ExtCtrl.abb

Real-time

[Labcomm]

Rosetta
controller

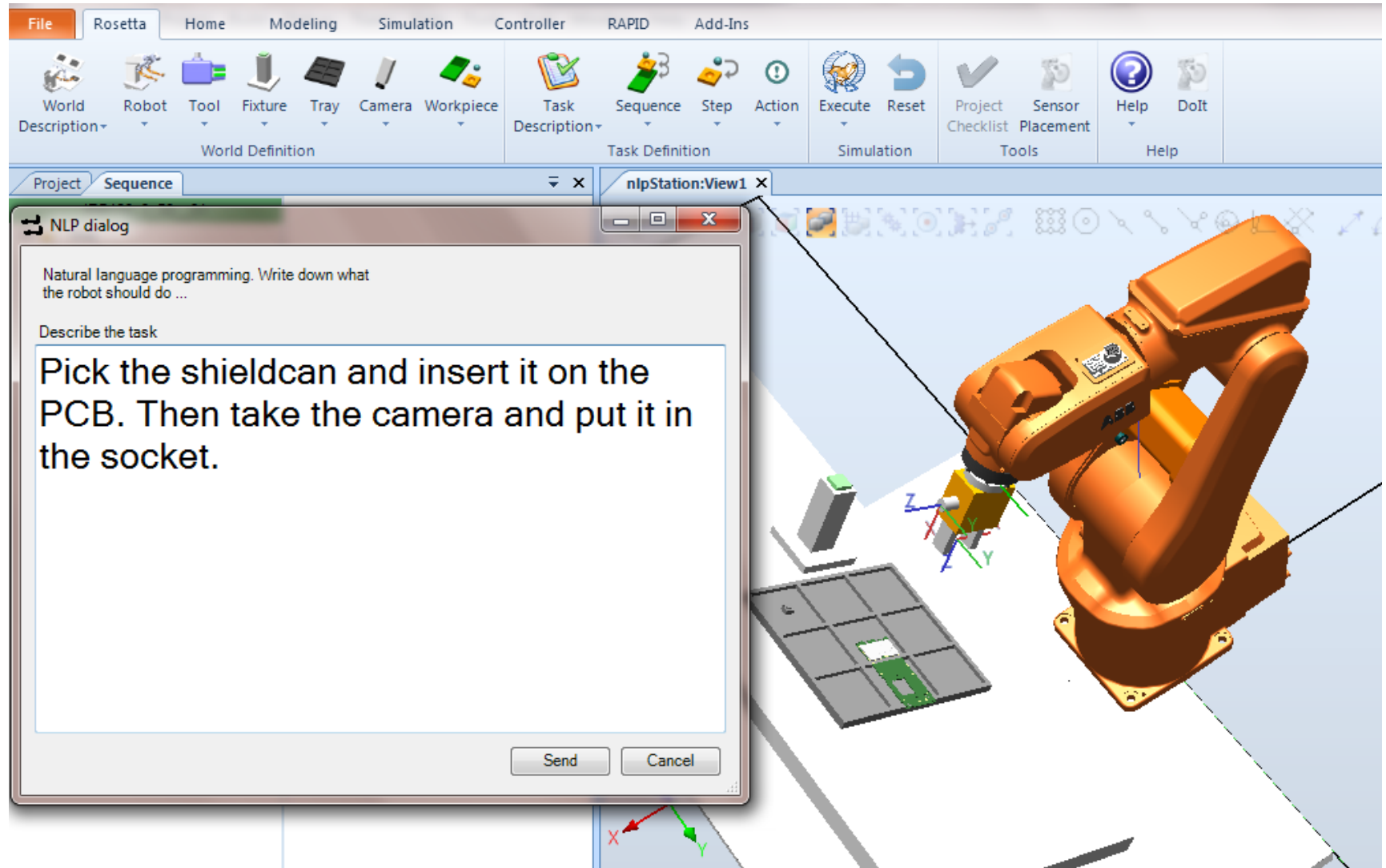
ABB controller

Legend

Research
extension:

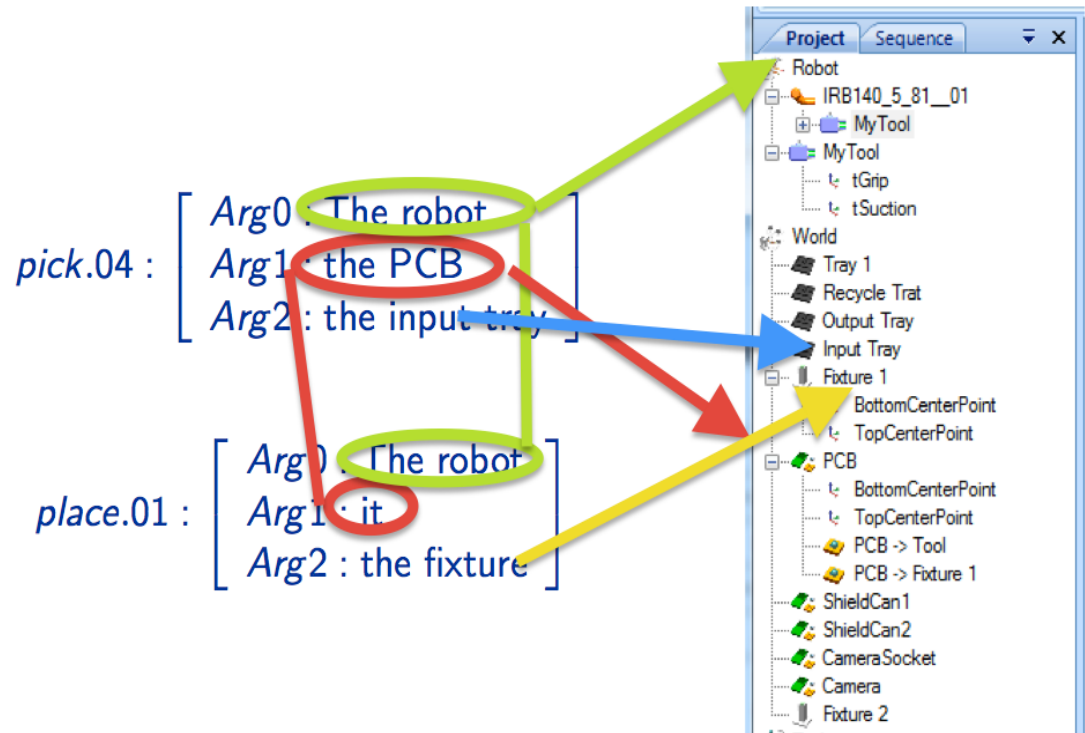
ABB prod.:

Semantic Interpretation of Natural Language



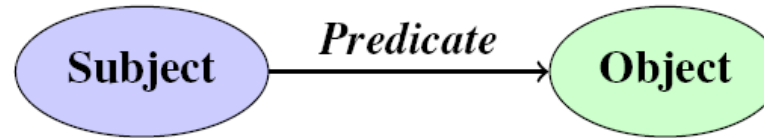
Semantic Interpretation of Natural Language

Dialogue prototype:



The predicate—arguments structures are then mapped onto actions and executed virtually by the engineering station.

The demonstration has been shown successfully to many visitors of the robotics week organized at Lund University.



Predicate(Subject, Object).

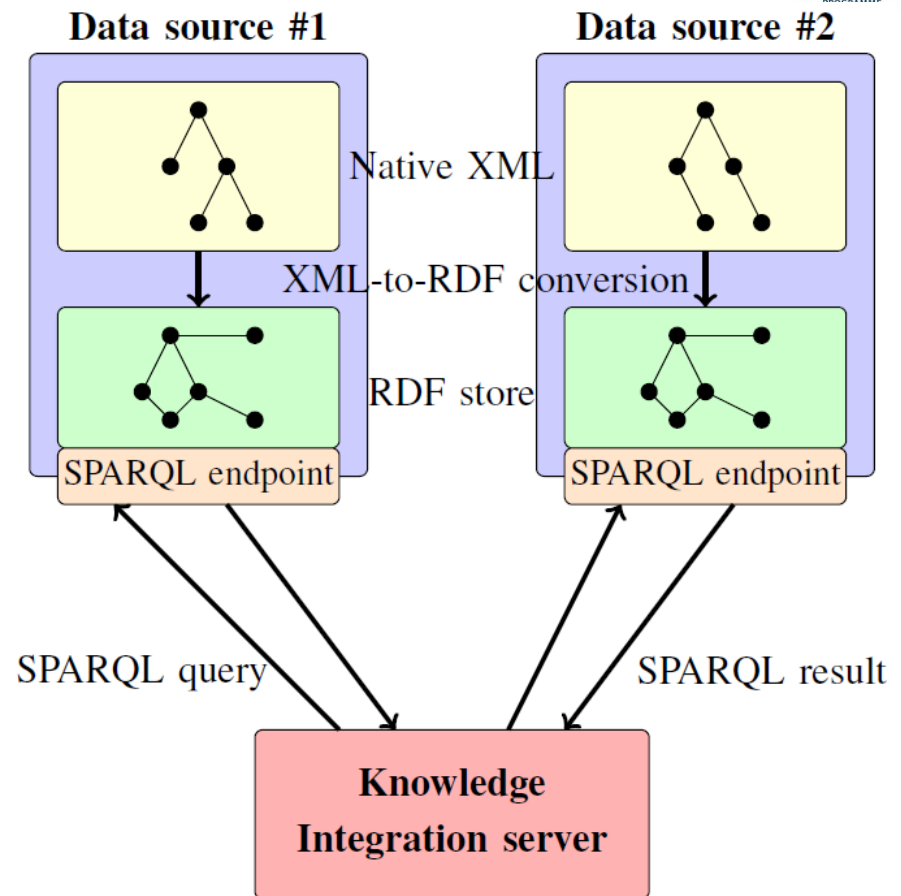
Subject Predicate Object

<demozelle#d1e7> caex-xml:hasName "Linie".

Basis for the open (human, not co-engineered) world;

An open world is one in which we must assume at any time that new information could come to light, and we may draw no conclusions that rely on assuming that the information available at any one point is all the information available.

- Create a semantic *knowledge integration framework* (KIF)
- Architecture and implementation to integrate, distribute, and access data
- Select a set of application cases
- Human/machine interaction: Tie the KIF to semantic representations of language and develop NLP components



Use existing low-level standards to manage without prescribing a high-level standard (that would not work anyway).....



Assembly of entire emergency stop button

Sequence:

Pick yellow box

Red button, peg in hole

Lift box with two hands

Screw nut

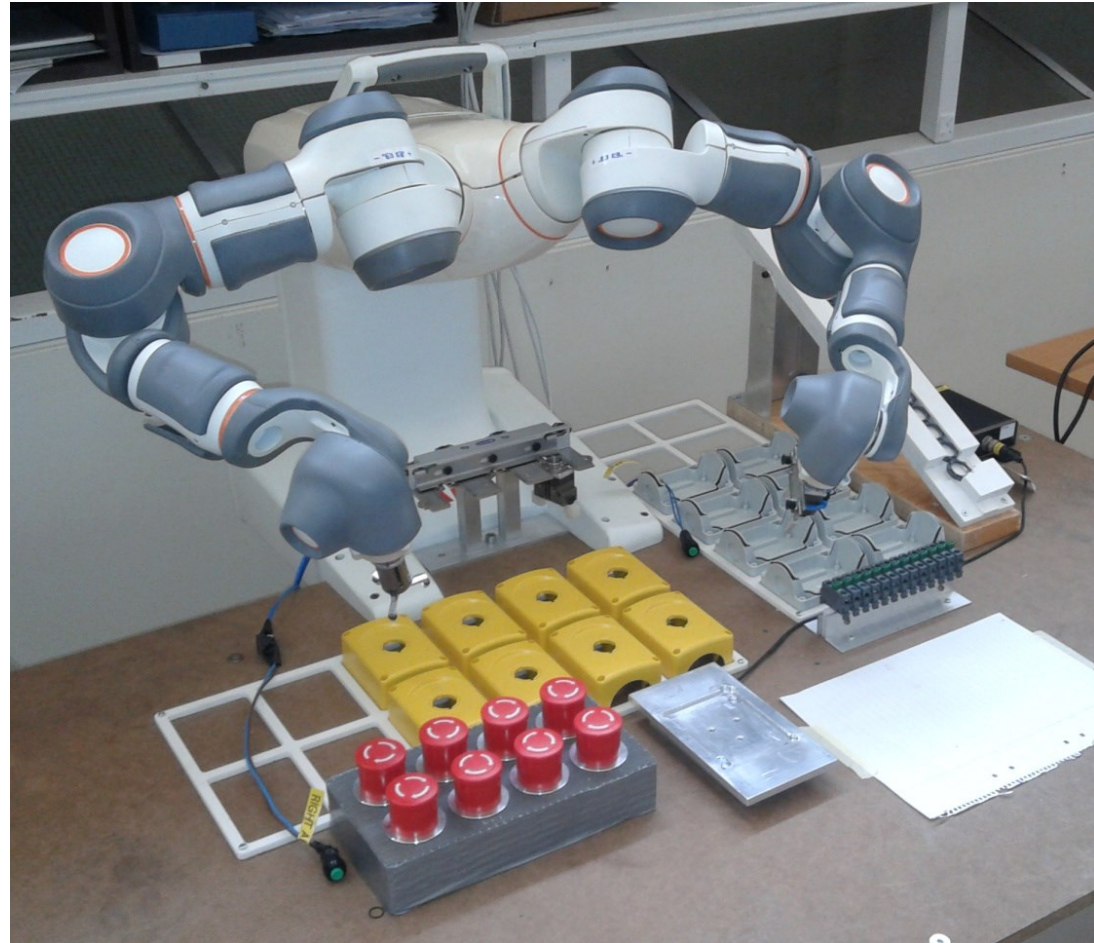
Align box

Put in storage

Pick grey box

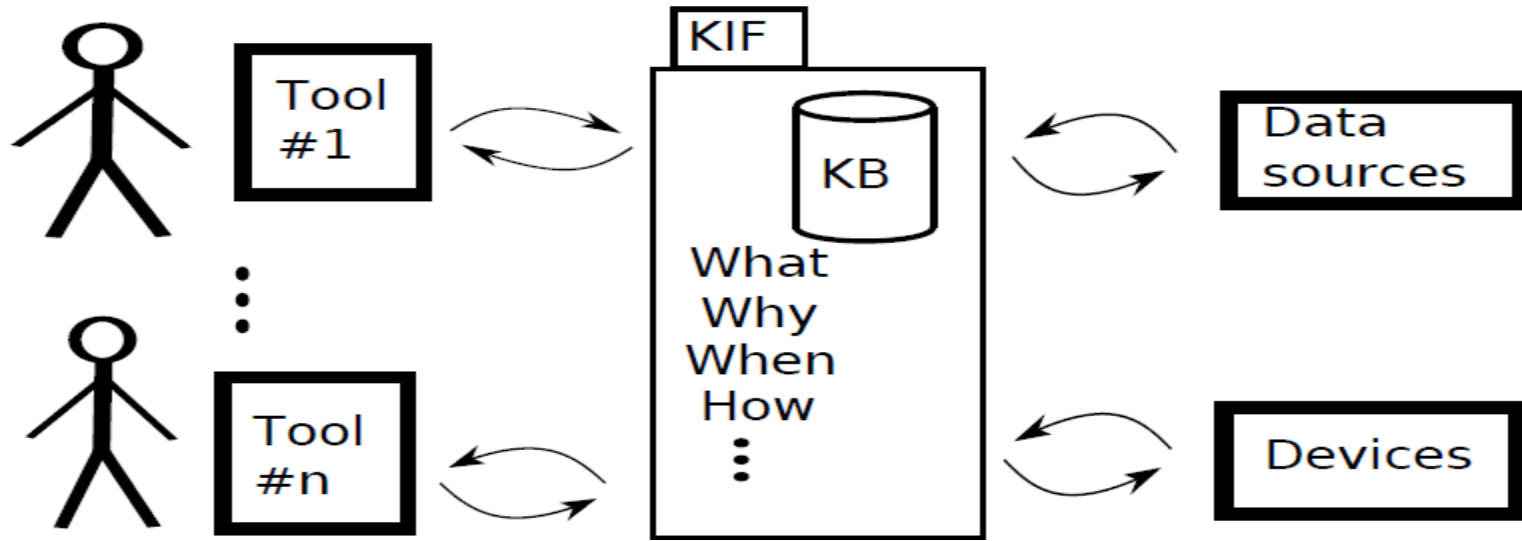
Snap fit

Put yellow box on grey box



Conclusions

- Semantics needed for meaning of operations and cognitive processes, e.g. for operator when things do not work.
- Knowledge gathering, for managing uncertainty and change, to be based on existing tools and manufacturing practices.
- Notions grounded in human natural language.
- Modularity (and SOA) should reflect business values.



Assembly of entire emergency stop button

Pick yellow box

Red button,
peg in hole

Lift box with
two hands

Screw nut

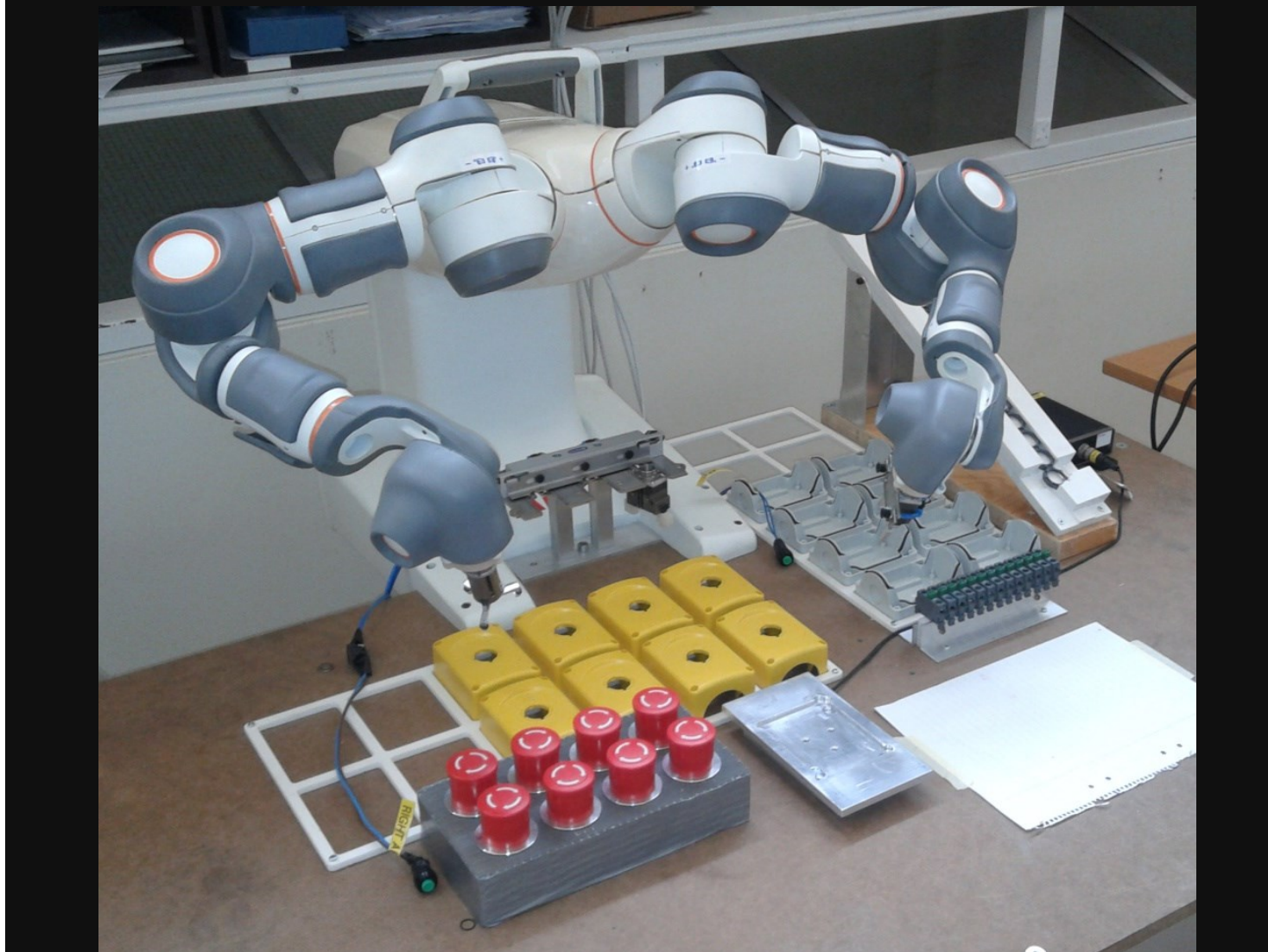
Align box

Put in storage

Pick grey box

Snap fit

Put yellow
box on grey box



QUESTIONS?

THANK YOU FOR YOUR ATTENTION!

The research leading to these results has received funding from the European Community's Seventh Framework Programme.

Please visit our webpages for further information and contact information:

<http://www.fp7rosetta.eu>

<http://www.smerobotics.org>

<http://www.robot.LTH.se>

<http://rss.cs.lth.se>

<http://www.LU.se>

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