

FOR FESR EMILIA-ROMAGNA 2014/2020

REGIONE EMILIA-ROMAGNA

ASTER FABBRICHE REGGIO

METAGEAR OR.4: ROBOTIC ASSEMBLY

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InterMech Mo.Re. MechLav Bonfiglioli Forever Forward SIR ROBOTICS DEMOCENTER



INTERMECH MO.RE.

- Emilia Romagna High Technology Network
- University Industry Joint research lab on:
 - Digital Manufacturing
 - Industrial Robotics and automation
 - Industry 4.0

UNIMORE



XILAB
X-IN-THE-LOOP SIMULATION



InterMech

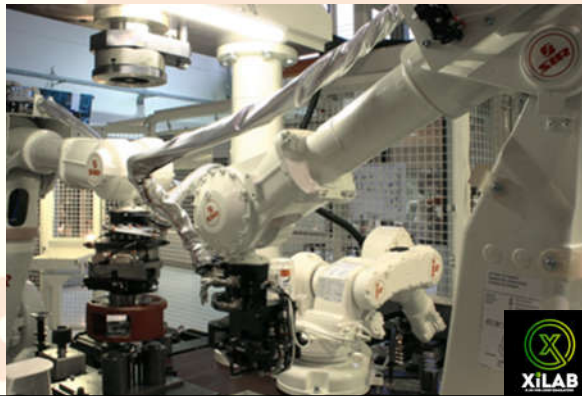


SIR AREUS
fabbrica intelligente
Cat Robot

BACKGROUND AND MOTIVATIONS



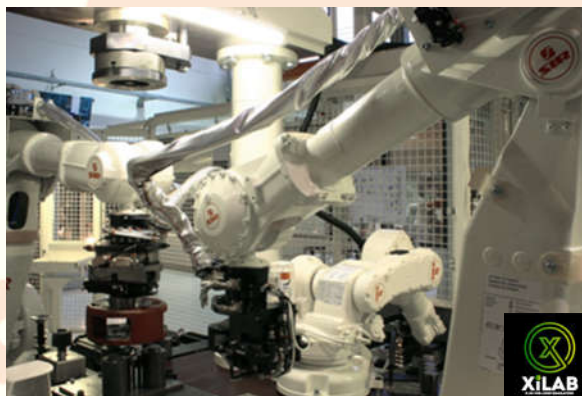
- Increase the final **manufacturing quality** to better exploit the engineering design innovations
- **MASS CUSTOMIZED, ZERO-DEFECT, INDUSTRY 4.0 DIGITALLY CONNECTED PRODUCTION**
- Improve **sustainability** with energy-efficient robotic processes
- Reduce **costs and delivery time**



MAIN OBJECTIVES




- **Superior accuracy**, energy-efficient force feedback robotic assembly
- **SINGULARLY OPTIMIZED, ONE-PIECE-FLOW PRODUCTION**
- IoT-based **product quality tracking**
- Novel generation of **modular and reconfigurable robotic assembly cells**




DEMO-CELLS & CASE STUDY

- Application-driven research: experimental validation
- TRL-6 Demonstration on 2 demo cells

Demo-cell @ UNIMORE



Demo-cell @ SIR



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SR
ROBOTICS

DEMO-CELLS & CASE STUDY

- Application-driven research: experimental validation
- Demonstration: wormgear case-study



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Bonfiglioli
Forever Forward

DEMO-CELLS & CASE STUDY

Semi-automated production line

Manual workstation Automatic Operations

14 stations

Full Robotic assembly

Challenges:

- 1-piece flow: reconfigurable flexible manufacturing system
- Zero-defect
- Micro-Factory

Self-optimization of process sequences

*Manual workstations: only humans can manage the **product mix and configurations***

DEMO-CELLS & CASE STUDY

Wormgear reducer

W 63 L1 - - 24

> 640 configurations

ratio

Torque limiter	
W /WR	L1, L2

Size

W /WR	63, 75, 86, 110
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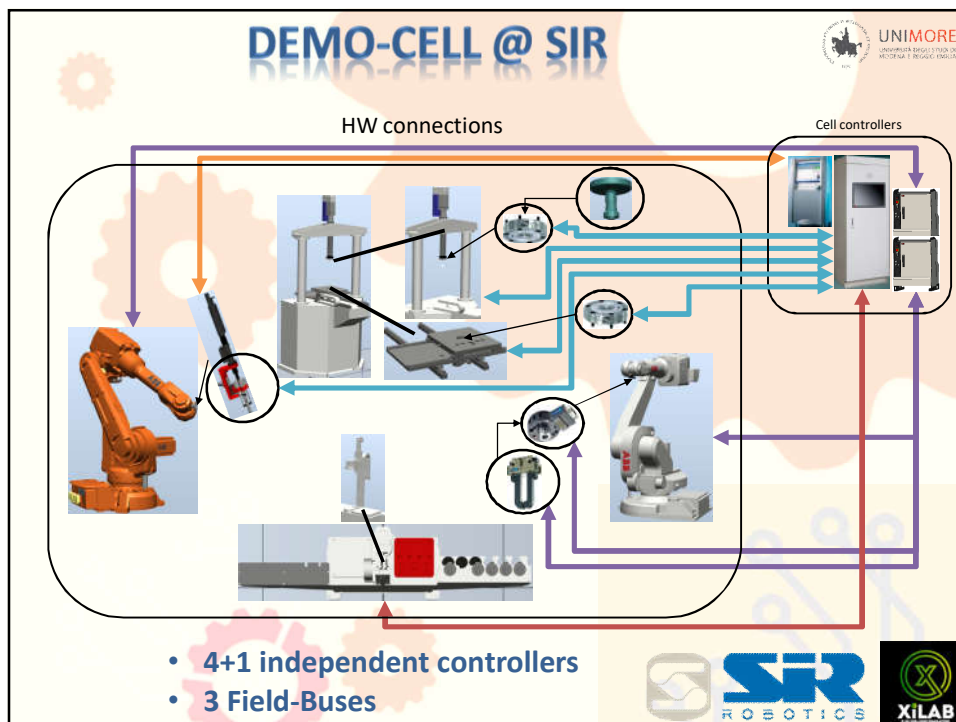
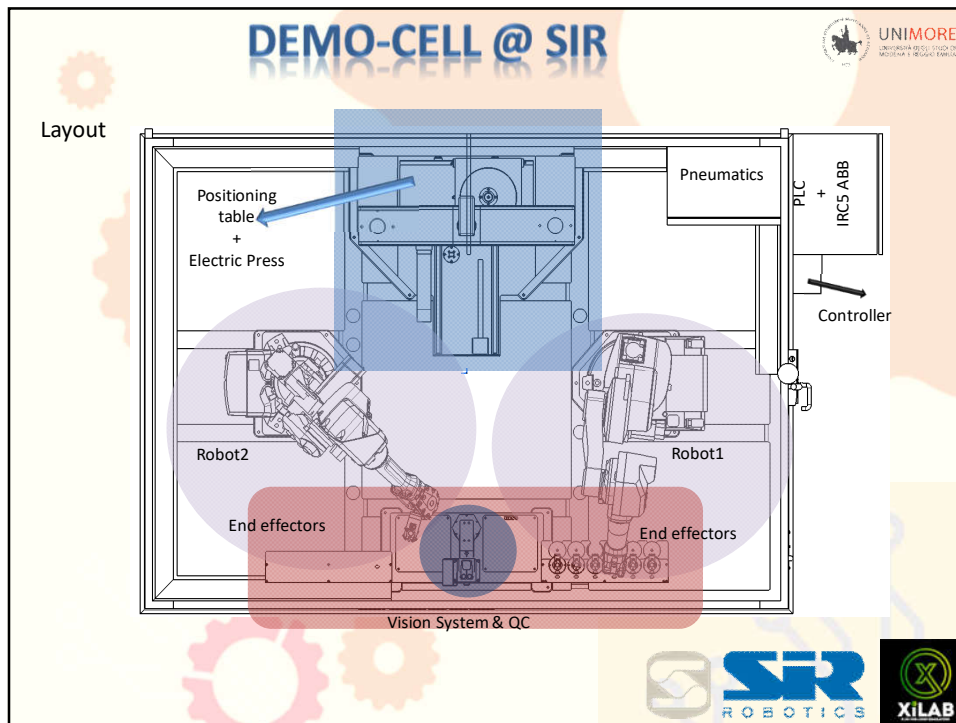
Reducer type

W, WR


1-piece-flow, high product mix:
Full reconfiguration in real time

Only Industry 4.0 (I4.0) approaches can provide robots the intelligence to autonomously plan and self-optimize process and sequences

Forever Forward

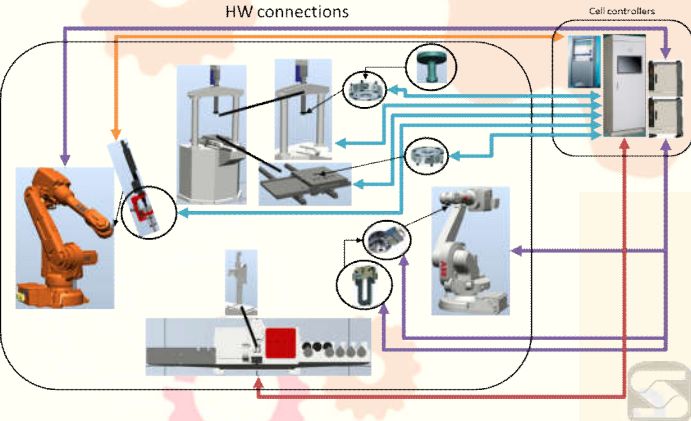


DEMO-CELL @ SIR



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With state of the art industrial controllers and SW architectures each operation **must be fully programmed and validated in advance:**
Fully optimized production sequences (i.e.: 1-piece-flow, zero defect) are not feasible!


I4.0 DIGITAL TWIN APPROACHES CAN SOLVE THE PROBLEM!

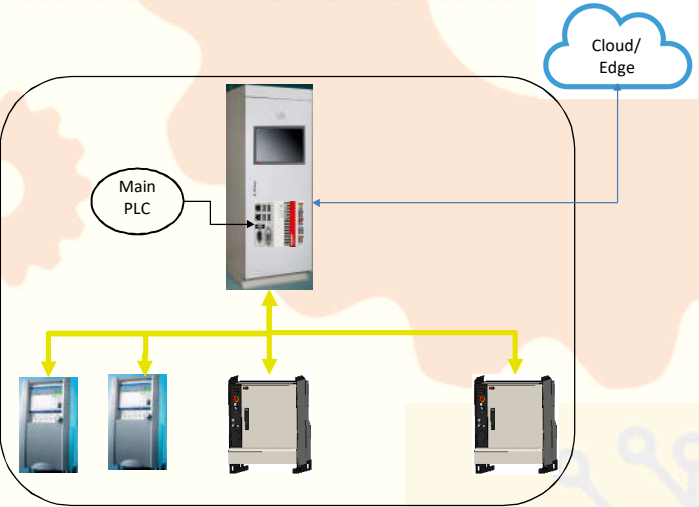


The diagram illustrates the hardware connections in a demo cell. On the left, a collection of industrial equipment including a robotic arm, a lathe, a mill, and a work cell are shown. On the right, a rack of 'Cell controllers' is depicted. Multiple colored lines (blue, orange, purple, red) represent the data and control connections between the various machines and the central cell controllers. The background features faint gear icons.



 

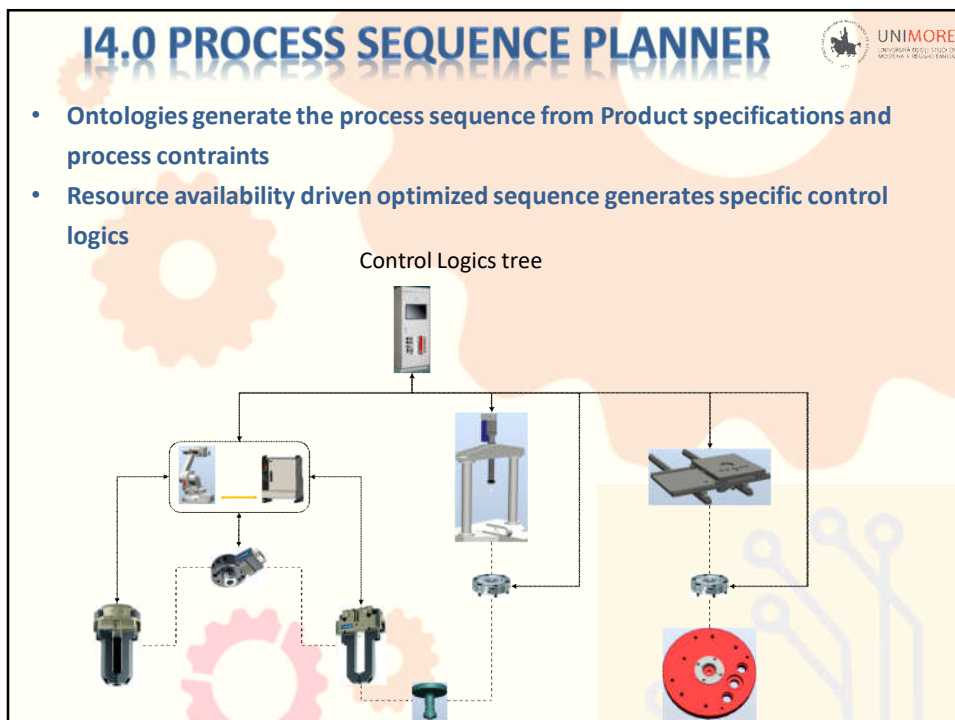
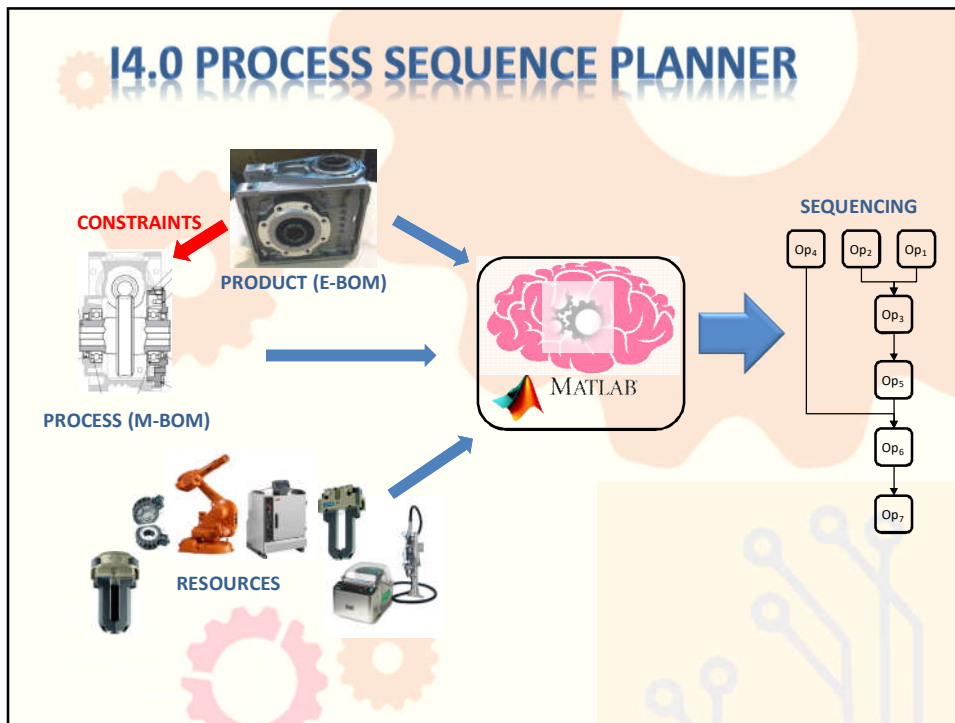
DISTRIBUTED O.O. CONTROL

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The diagram shows a distributed O.O. control architecture. A central 'Main PLC' is connected to a 'Cloud/Edge' cloud icon. Below the Main PLC, four 'Cell controllers' are shown, connected to the Main PLC via yellow lines. The background features faint gear icons.

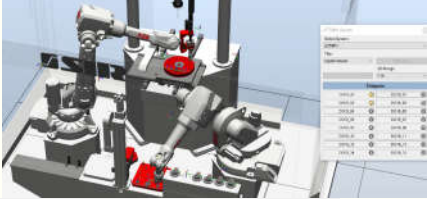
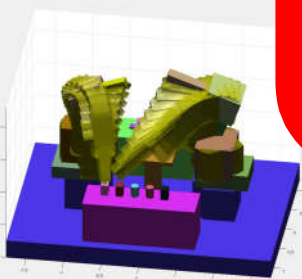




14.0 PROCESS SEQUENCE PLANNER




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- Collision free trajectories verified on a Digital Twin
- Received the ERP production order, the tool automatically optimizes the productivity and **generates optimized Robot programs in real-time**

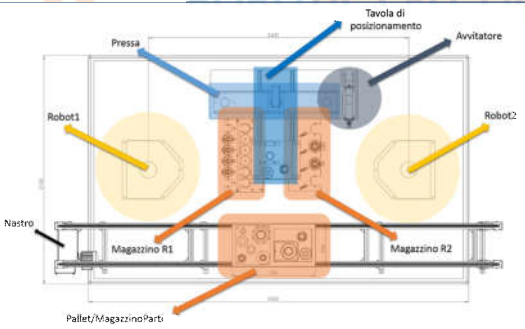








**AUTOMATIC GENERATION OF
OPTIMIZED ROBOT PROGRAMS
AND SEQUENCES IN REAL-TIME**

ROBOTIC CELL LAYOUT



Pressa

Tavola di posizionamento

Avvitatore

Robot1

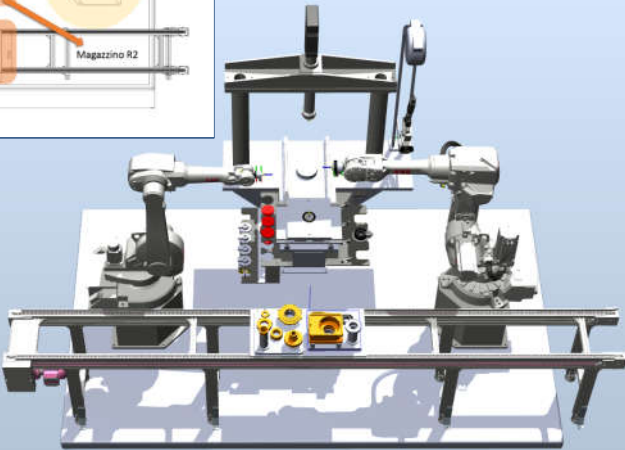
Robot2


Nastro

Magazzino R1

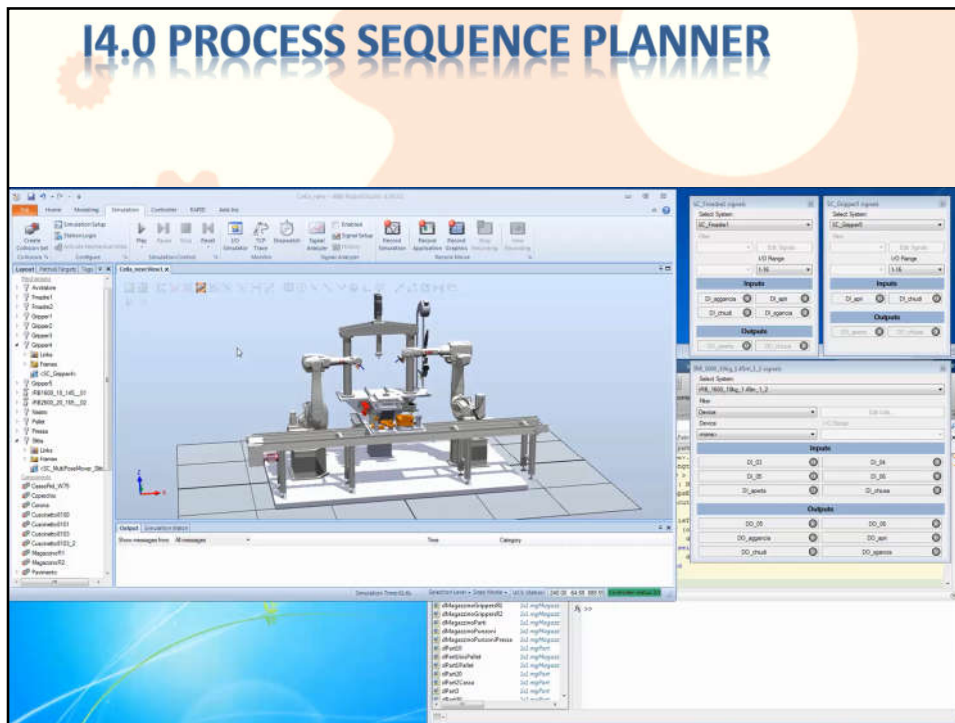
Magazzino R2

Pallet/Magazzino Parti





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X-OF-THE-LOOP SIMULATION



THANK YOU! QUESTIONS?

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