I4.0LAB @ SOM
**The teaching factory lab for the new manufacturing**

Politecnico di Milano – School of Management – Manufacturing Group

Agenda

- **I4.0Lab @ SOM: what, why and people working around**

- **The plant structure**

- **I4.0Lab @ SOM in the knowledge value chain of SOM-MFG Group**

- **Research Activities**

- **Plant Video**

- **Conclusions and Future developments**

INDUSTRY4.0 lab

I4.0Lab @ SOM is promoted and developed by Manufacturing Group of the School of Management of Politecnico di Milano

It is implementing a **tangible physical entity** where the research activity in the innovative manufacturing management and planning approaches can be carried out in conjunction with a **practical implementation in a "real-like" environment**

INDUSTRY4.0 lab
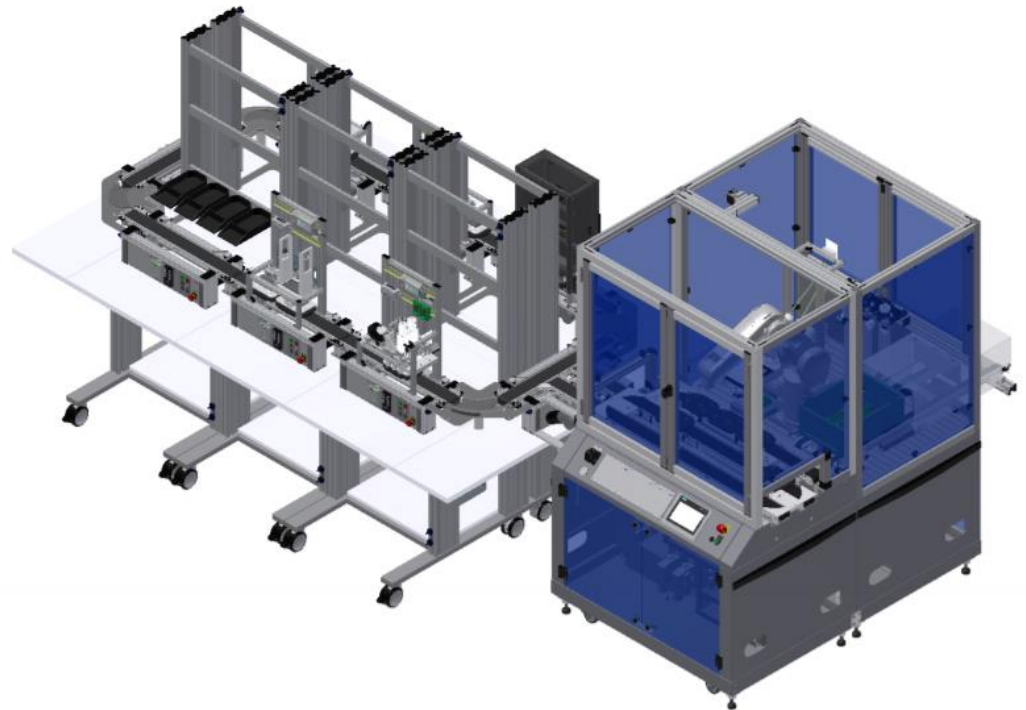
The Manufacturing EcoSystem where **I4.0Lab @ SOM** is positioned includes 3 major dimensions to consider: the **human factor**, the **product**, the **process/plant**

The Stakeholders

The Product

Manufacturing Ecosystem
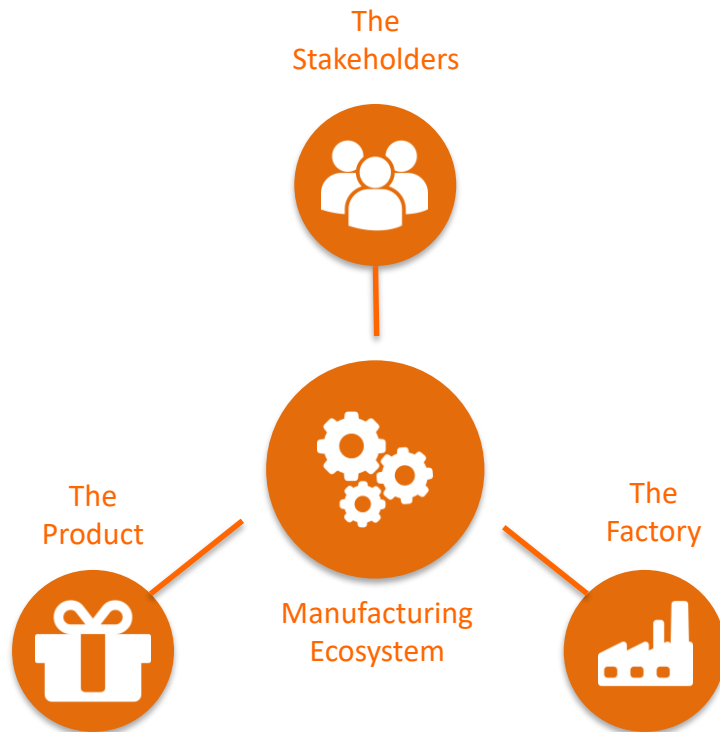
The Factory

The product and the factory are two main pillars to consider both in term of **management**, **control** and **monitoring**, but also in terms of **complete Life Cycle** to centralize the human factor within the Manufacturing EcoSystem

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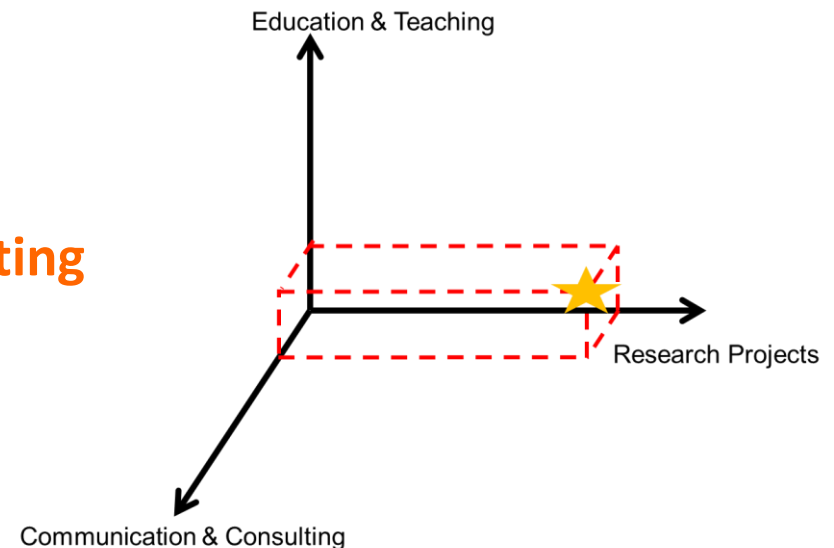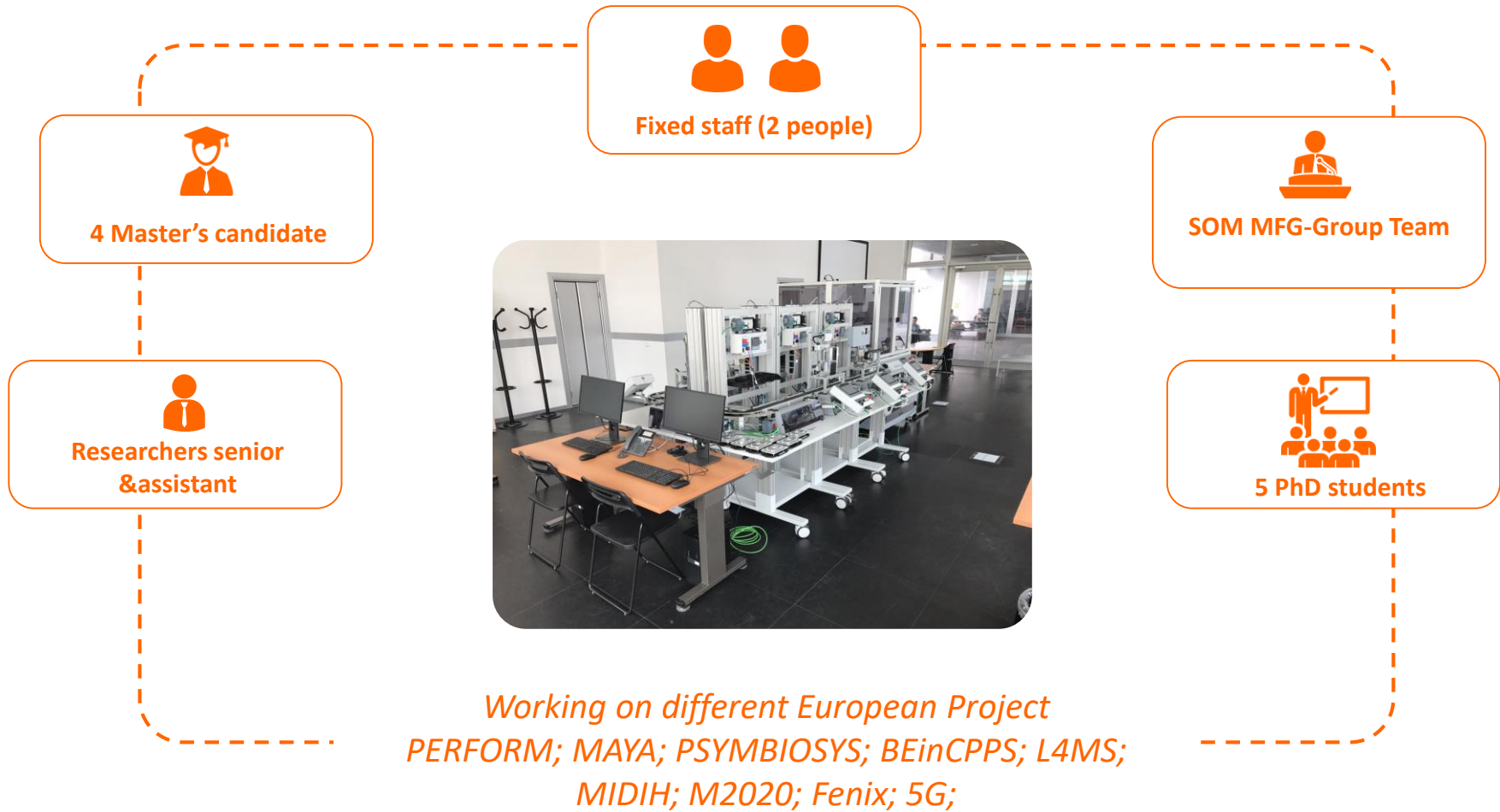For the exploitation perspective we expect I4.0Lab @ SOM addresses **3 main purposes**:

Education & Training

Communication and Consulting

Research Projects related activities

Education & Teaching

Research Projects

Communication & Consulting

People working around I4.0Lab @ SOM

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Fixed staff (2 people)

4 Master's candidate

Researchers senior &assistant

SOM MFG-Group Team

5 PhD students

Working on different European Project
PERFORM; MAYA; PSYMBIOSYS; BEinCPPS; L4MS;
MIDIH; M2020; Fenix; 5G;

Collaborations and external connections

Enterprises
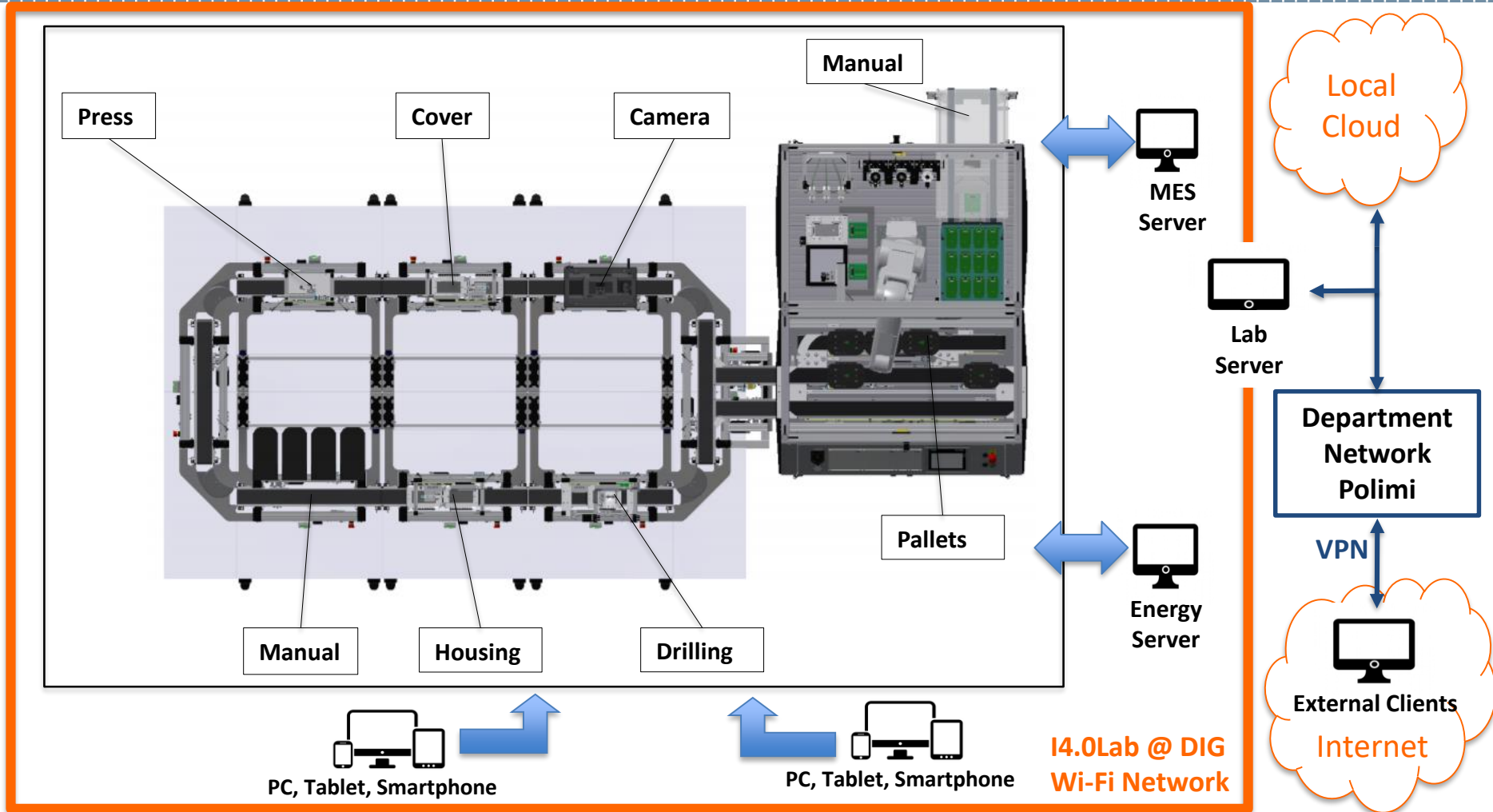
Competence Centres
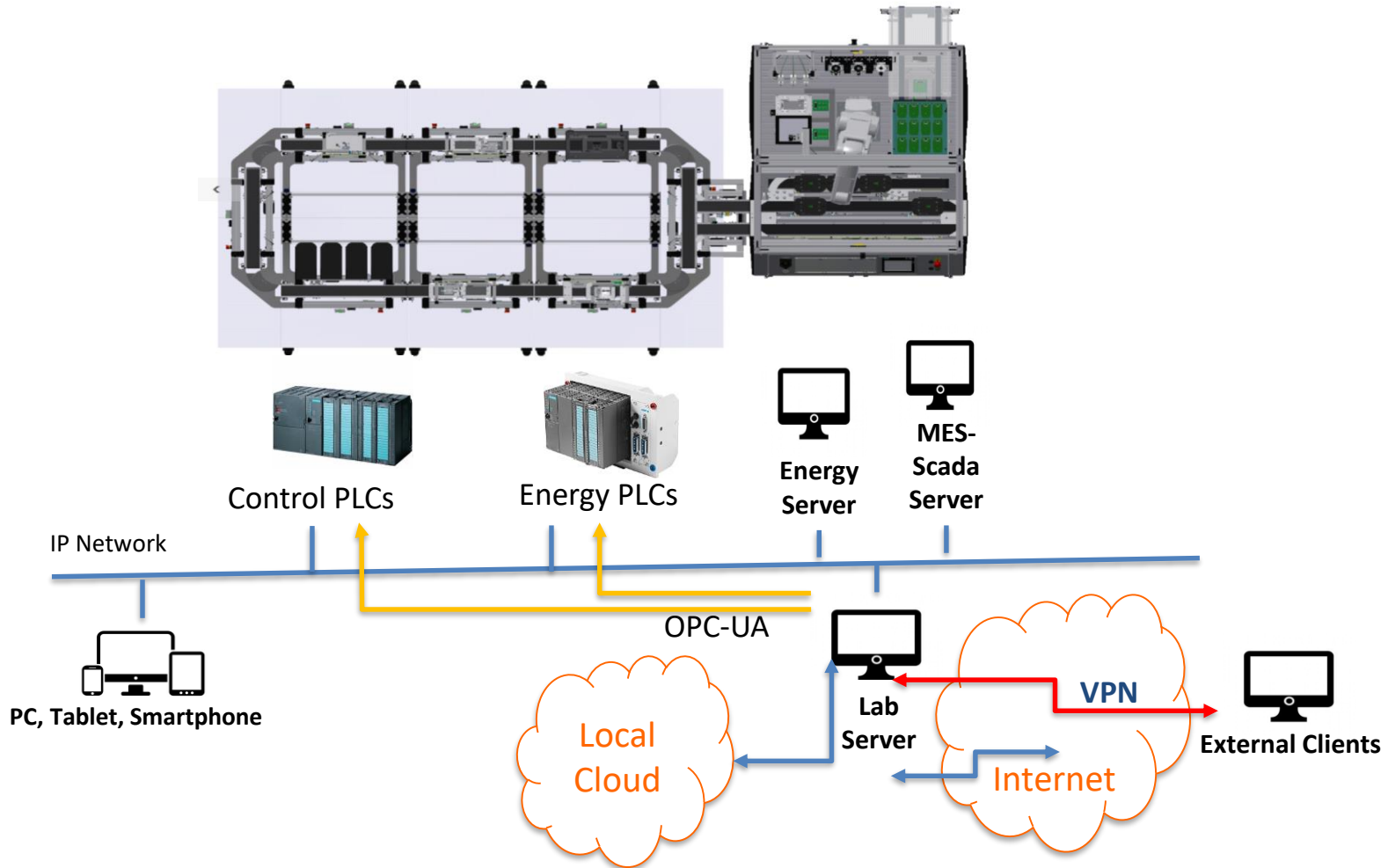
Other Universities

**Other Polimi Departments**

FoFLab Structure: Equipment Layout

FoFLab Structure: Architecture

- Embedded sensors and monitoring systems (RFID, QRCODE and Power consumption)

- OPC-UA interface

- SW suite for modeling, simulation and control application set

- Seamless interfaces of single hardware module to enable transparent plag&play of new modules or reconfiguration of the production system

- Open architecture for integrating 3rd parties software and devices (e.g. robots or machineries)

I4.0Lab @ SOM Structure:
Main processes implemented
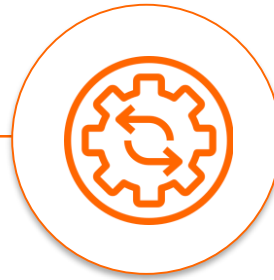
- Flow control (bar-code, RFId, Visual) of individual products and assembled
- Processing operations emulation or real
- Final product assembly using robot
- Quality control using optical camera
- Intelligent handling system

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- Warehouse management input raw products (input materials) / outgoing finished products

- Finished / assembled (product output) or flow control of individual products as the assembled or operations processing of the raw products, which is executed by real CNC machine or operation of assembly and final finishing of the product via anthropomorphic robot

- Quality control with optical method by camera

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- Control flows of individual products and monitoring via RFID and barcode
- Intelligent handling of parts made by motorized conveyors and pallets
- Possibility to measure the energy consumption of the various constituent parts of the system
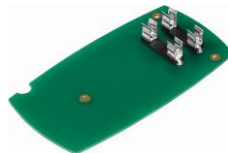
Product:

the main task is to produce a symbolic product of Smartphone or remote control. The symbolic product consists of 4 parts:

Housing   **Platine**   **Fuses**   **Cover**

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Process:

The system is designed for transporting workpieces on carriers, which are equipped with RFID-tag. The production process coming from MES is saved on the RFID-tag.

The system will be delivered with the following standard process:

1. Distributing of housing
2. Drilling of housing (simulated)
3. Assembly of Platine and fuses by the robot assembly station
4. Camera inspection if workpiece is right
5. Distribution of covers
6. Press the cover
7. Manual workplace (packing/disassembly of finished parts)

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Robot Assembly Cell:

- 6 axis robot
- Two parallel conveyors
- The action on the robot cell takes place thanks to the RFID chip mounted on the workpiece carrier, where the parametrers are stored
- With the help of the patented, passive redirection at the ends of the conveyors, the linear transfer module can be changed within some seconds to a closed loop material flow.
- Magazines and fixtures for assembly process, gripper for robot
- Control panel consisting of Siemens Touchpanel
- Robot gripper exchanger 3
- Camera system - Colour camera Resolution 752x480
- Sensorless collision detection
- Payload 4 kg

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**Application module Drilling CPS**

- Two drilling spindels can be moved in z-direction, as well as in x-direction
- Controller with web functionality for Cyber Physical System operation: self diagnosis inside of the application, web visualization

INDUSTRY4.0 *lab*

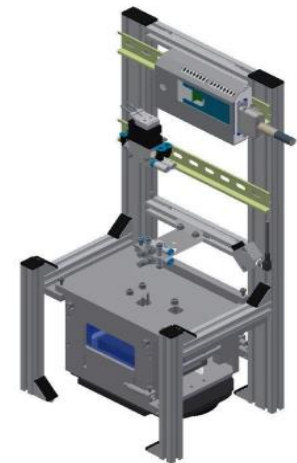## Application Module Camera Inspection

- A powerful industrial vision inspection system checks the workpieces with an optical check:
  open system to Image&Visual Management through the camera
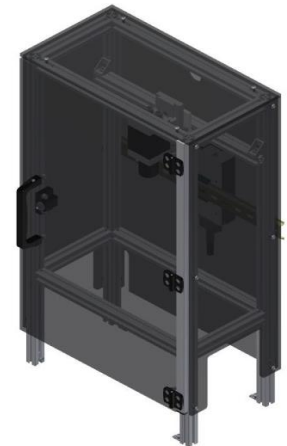
Application Module Press

- The two covers arriving on the carrier on the conveyor are assembled with the help of a pneumatic press

CP Pallet transfer system and Touch Panel TP700

- Ready for Industry 4.0
- Pallet identification with BCD (Bar Code) and RFID
- Bi-directional + slow-speed
- 6 x The touch panel TP700 Comfort is a 7" touch panel and comes from the Siemens HMI series for advanced applications

Manual station

- With control panel for process synchronization

Power consuption measuraments

- Energy monitoring on all stations

Set of workpieces

- 16 x Pallet
- 6 x Workpiece carrier
- 10 x printed circuit board + housing: cover; housing: base plate
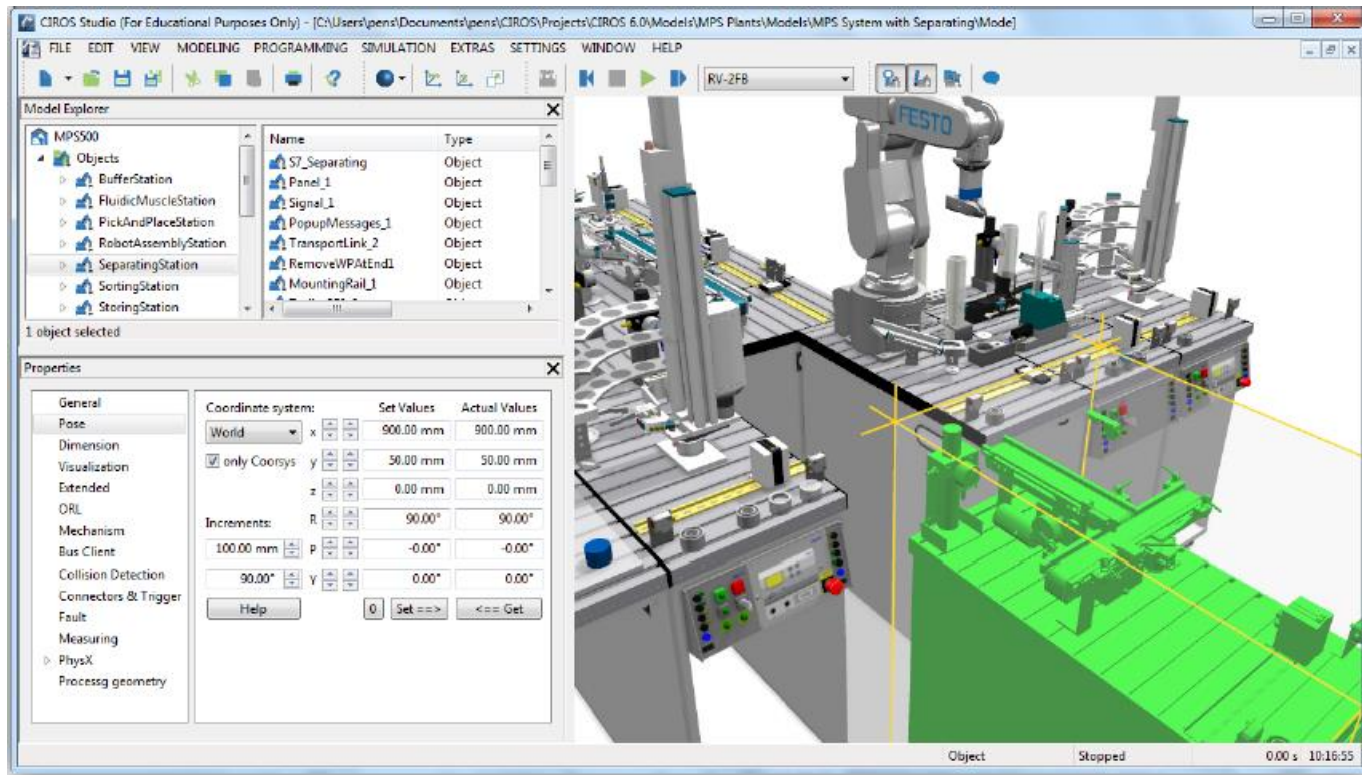- Fuses

INDUSTRY4.0 lab

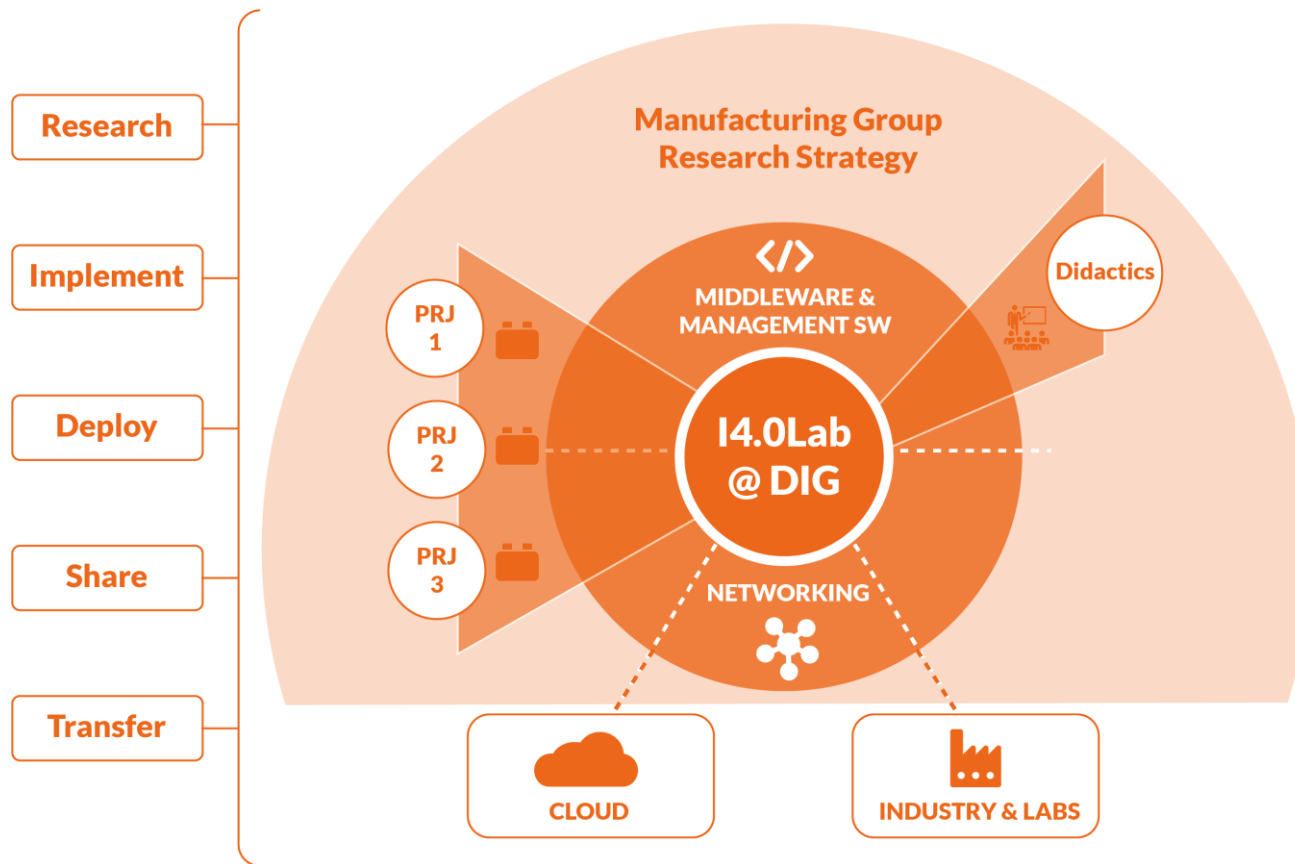## Design, Modelling and Simulation

- 3D real-time simulation and modelling

- Import filters for STEP, IGES, STL, VRML

- Export filters for DXF, STEP, IGES, STL, ...

- Plug-in for Autodesk Inventor and Autodesk

- Robot programming in the programming
languages: - Industrial Robot Language (IRL)
- Mitsubishi Movemaster Command Language (MRL) - Mitsubishi MELFA BASIC III, IV and
V - Kuka Robot Language (KRL) - ABB Rapid - V+ (for Adept and Stäubli)

- Communication via OPC client/server

- Virtual human with 30 independent degrees of freedom

- Online connection to Mitsubishi robot control systems for upload and download of robot
programs and position lists
It is the program version for the trainer who creates new models, tests the virtual
learning environments and releases programs for the connected robots and transfers
them to the robot control system

I4.0Lab @ SOM Structure: Software features

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Research

Implement

Deploy

Share

Transfer

**Manufacturing Group
Research Strategy**

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**MIDDLEWARE &
MANAGEMENT SW**

Didactics

PRJ 1

PRJ 2

PRJ 3

**I4.0Lab
@ DIG**

NETWORKING

CLOUD

INDUSTRY & LABS

- Components for the implementation of applications oriented to flexible robotics and monitoring of energy efficiency in the 'scope of the PERFORM project "Production Harmonized Reconfiguration of Flexible Robots and Machinery" Grant Agreement n. 680435

- Environment for the simulation of the operations associated with the manufacturing process in the 'scope of the MAYA project "Multi-disciplinary integrated simulation and forecasting tools, empowered by digital continuity and continuous real-world synchronization, towards reduced time to production and optimization" Grant Agreement n. 678556

- Study oriented paradigms to CPS (Cyber Physical Systems) to support the complete life cycle of the product within the PSYMBIOSYS project "Product-Service Symbiotic SYStems" Grant Agreement n. 636804

- Environment for the validation of the human operator interaction in a robotic context and automated within the project BEinCPPS "Business Experiments in Cyber Physical Production Systems" Grant Agreement n. 680633

- Environment for the study of applications for the optimization of production and logistics flows of a robotic automated production environment as part of the Smart Manufacturing 2020 research project, ID CTN01_00163_216744

- Support to the training of engineers with expertise on design, respectively, modeling, simulation and implementation of automated and robotic flexible production environments draft Smart Manufacturing 2020 education, ID CTN01_00163_216744

Conclusions and Future Developments

I4.0 Lab @ SOM is the new **tangible physical entity** of the School of Management Manufacturing Group and allows to carry out research activity in the innovative manufacturing management and planning approaches in conjunction with a **practical implementation in a "real-like" Industry 4.0 environment**.

Future Developments

Physical system extension

Software system extension

Enterprise consulting

New Research activities