Collaborative 2D Unscrambling & Assembly Robot
Omron TM5 collaborative robot on mobile chassis with conveyor and worktop

ErmaSmart #1

Description of the technological support

The **2D Unscrambling & Screwing Robot** system is a **robotic system for unscrambling** jars/vials and **screwing** lids onto the Ermasmart line of gearboxes. It integrates an **OMRON 6-axis industrial collaborative robot**. The functions and components are derived from real industrial components used in the food, pharmaceutical or cosmetics industry (jars/vials) or the assembly industry (boxes/pallets).

This **collaborative 2D Unwinding & Screw Assembly Robot** system, designed in the spirit of **the Industry of the Future** (Industry 4.0), meets the main requirements on intelligence and the evolution of production methods:

✓ **Flexibility & Customisation** with the possibility of producing customised objects to the customer's order
✓ **Collaborative robotics** with the OMRON robot
✓ **IoT & Communications** with RFID tag reading/writing for identification and tracking of customer order packages.

This **automated** system can be **used as a stand-alone system** with jars/flasks or cans/pallets, but can also be **integrated into the flexible ErmaSmart production line (see pages 3 and 4)**.

The main functions of the 2D Unscrambling & Screwing Robot are :
✓ Convey jars/flasks or boxes/pallets from the entrance to the exit
✓ In **"Packaging" configuration**: Unscramble pots (different sizes) - Place the pot on the product conveyor
✓ In **"Assembly" configuration**: Unscrew gearbox covers (different colours) - Remove the cover from the gearbox - Screw in the cover screws

And optionally: Monitor the presence of operators in the area to allow the robot speed to be decreased/increased.

This training system is mainly intended for **activities in driving, system control, industrial maintenance, robotics & automation**.

This product is accompanied by a technical and educational file in digital format.

CAP CIP - Bac PRO PLP / MELEC / MSPC
BTS CRSA / Electrical engineering / MS
IUT - Universities - Engineering schools

Main themes
Industrial Maintenance
Production Control
Multi-technology Systems Design
Industrial Automation and Robotics

Themes "Industry 4.0" addressed

ON10: "Collaborative 2D Unscrambler & Screwdriver" in Ermasmart Assembly configuration

Themes "Industry 4.0" addressed
Scalability & Flexibility
Personalization
Simplified programming
Digital twin
Mobile Robotics
Collaborative Robotics
Efficient Actuators
CAPM & CMMS
Digital instructions & MES
Quality control "online".
Vision & Smart Sensors
IOT & Communications
Big Data, AI & Predictive Maintenance
Augmented reality
Virtual reality
Additive manufacturing for tooling...

Highlights of the 2D Unscrambler & Screwdriver Collaborative Robot

✓ Real industrial system with modern technologies (collaborative robotics, 2D vision, IO-Link, RIFD ...)
✓ **Simplicity of programming of collaborative robots**
✓ **Production flexibility** (Use in "Packaging" configuration with jars/vials or in "Assembly" configuration with boxes/pallets)
✓ **Traceability of the customer's order** with the writing of RFID tags
✓ System usable in the fields of **electrical engineering**, **industrial maintenance**, and the **operation and control of automated systems**
✓ Includes TIA Portal programming software for programming the PLC and the dialogue terminal
✓ Omron TM robots are widely used in the industry
✓ **IO-Link technology** with IO-Link Profinet master (IFM brand) and software for supervision/parameterisation of Monéo Configure sensors and IO Link intelligent sensors (RFID, vacuum generator, photoelectric sensor)
✓ Possible extensions to the ErmaSmart flexible production line

⊘ **IO**-Link

6-axis collaborative robot sub-assembly (In ON10)

It consists mainly of:
- ✓ A 6-axis industrial collaborative robot with a 900mm radius of action and a maximum load of 4kg (Omron TM5)
- ✓ A 5MPix colour camera integrated at the end of the robot arm
- ✓ A robot controller
- ✓ A robot control box
- ✓ A set of software for controlling and programming the robot
- ✓ Various accessories (USB restoration key, etc.)

OMRON

Chassis, Conveyor and Work Platform sub-assembly (In ON10)

It consists mainly of :
- ✓ A painted steel frame
- ✓ Belt conveyor driven by Siemens induction motor and variable speed drive
- ✓ An evolving worktop for the robot
- ✓ A lighted beacon
- ✓ A pneumatic circuit with a suction cup, a vacuum generator with vacuum switch (NFC, IO-Link), the air handling unit (FRL)...
- ✓ An electrical cabinet with **Siemens S7-1500 PLC** and space for other electrotechnical components depending on the project
- ✓ A Siemens SIMATIC HMI HMI MTP700 Unified (colour touch screen Human Machine Interface
- ✓ An IO-Link Profinet master (IFM brand) and Moneo Configure sensor visualization and settings software

The following can be added to this frame
- ✓ Two laser scanners for safe management of travel speeds (Ref: UR11)
- ✓ *Pack "Screwing" for 2D Unscrambling & Screwing-Assembly collaborative robot in "Assembly" configuration (Ref: ON11)*

Option UR21: Set of two laser scanners for safe multi-zone management of travel speeds for Ermasmart

This option can be used to implement a laser scanner safety system. This safety system automatically slows down the robot if an operator gets too close to the machine.

It is a solution that is widely used in collaborative robotics, as it combines operator safety with speed of movement. A tutorial on the safety of collaborative robotic cells is provided.

IO-Link Master and Moneo Configure visualization and settings software

Programmable Logic Controller Industrial S7-1500

Human Machine Interface Siemens HMI MTP700 Unified

Option ON17: OnRobot RG2 Collaborative Electric Gripper for Omron TM Cobot Station

The RG2 gripper is an end-of-arm collaborative tool designed for seamless integration with the leading brands of collaborative robotic arms.
Some technical features and benefits:
- ✓ No external cables
- ✓ Adjustable gripping force from 3 to 40N
- ✓ Adjustable gripping distance from 0 to 110mm
- ✓ Absolute reading of the width in mm, without initialisation
- ✓ Grip status indications
- ✓ Automatic depth compensation
- ✓ Automatic calculation of payload and tool centre point (PCO)
- ✓ Multi-position mounting bracket
- ✓ Customisable fingertips

Options ON18 Suction cup gripper and Schmalz on-board autonomous vacuum generator for Omron TM Cobot Station

This sub-assembly allows the gripping of parts (jars, cans, prisms...) on the work tray and allows the deposit of these parts in vertical mini-stores or on the conveyor belt for evacuation... It consists of several suction cups and an autonomous OnRobot vacuum generator.

Collaborative 2D Unscrambling & Assembly Robot
Station 1 of the ErmaSmart flexible production line "Packaging

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ErmaSmart Station 1 "Packaging

In the **ErmaSmart "Packaging"** context, the 2D Unscrambling & Screw Assembly Collaborative Robot (ON10) is used for 2D unscrambling of jars and their placement on a conveyor.

Downstream of the "2D Unscrambling & Assembly Screwdriving Robot", there are:
- Item 2: The **Dosaxe**, automatic linear axis filling system (ref DX10 and associated codes)
- Station 3: The **Collaborative Capping & Assembly Robot**, capping system, custom over-capping and control (ref **MI00 and associated codes**)
- Item 4: The **XYZ Cartesian Pick&Place** (ref **XY10 and associated codes**)
- Item 5: The **Dynamic Vertical Store** (ref **VL10 and associated codes**)
- Station 6: The **manual order picking, packing and palletising station with RFID tracking** (ref **PM91**).

ErmaSmart Configuration "Conditioning"

In the ErmaSmart "Packaging" configuration, the 2D Unscrambler & Screw-Assembler uses its 2D vision to locate the jars used for packaging the granules on a tray.
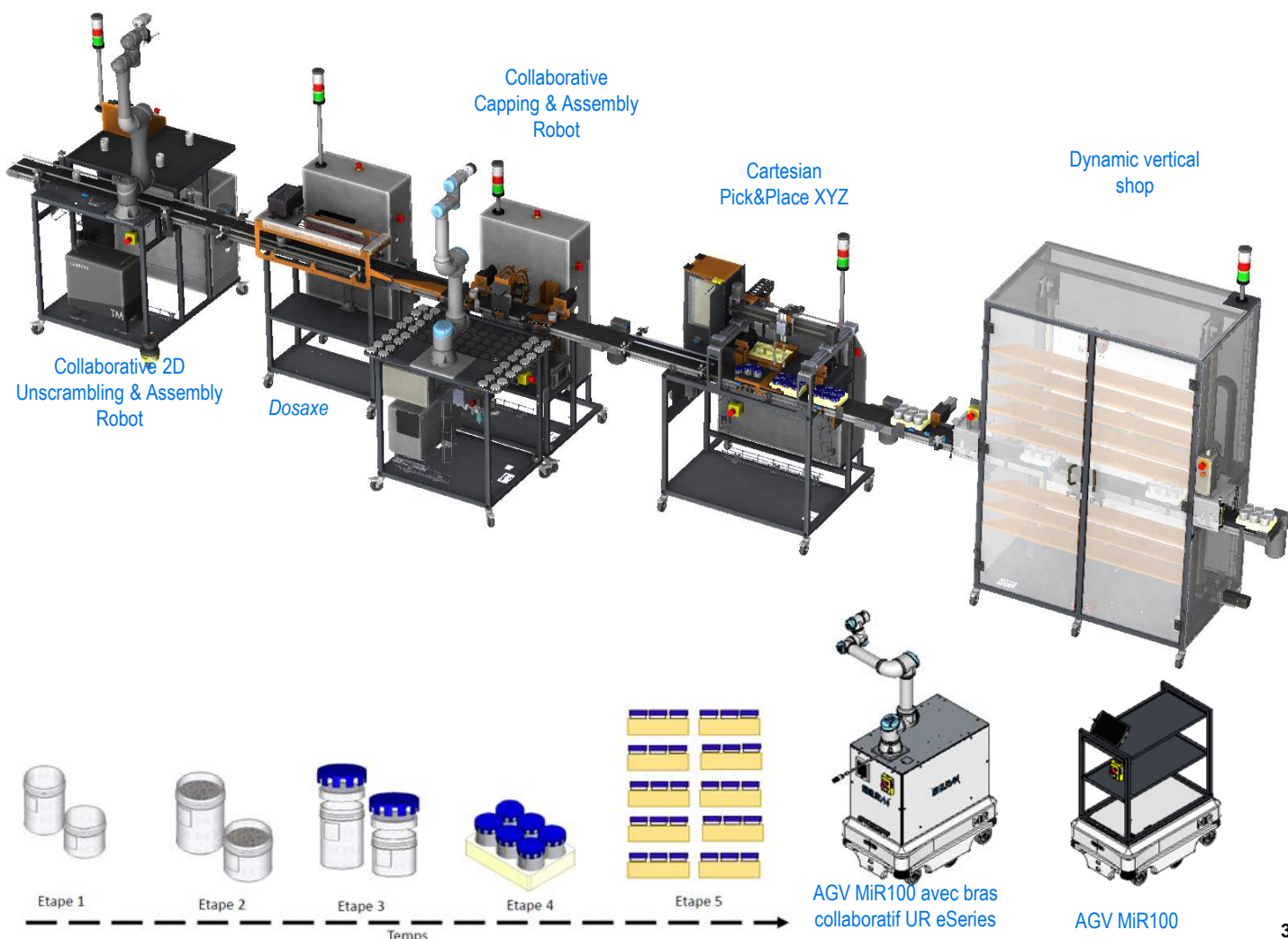
These pots are positioned in bulk by the operator on the work tray.

After locating the pot, the Cobot Station picks it up with its gripper and places it on the conveyor belt to the next station.

This configuration requires the codes:
- **ON10**: The collaborative 2D Unscrambler & Screwdriver
- Optionally: **UR21**: Set of two laser scanners for safe multi-zone management of travel speeds for Ermasmart

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the 2D Unscrambling & Screw Assembly Collaborative Robot in the ErmaSmart "Packaging"
Industry 4.0 Factory

Collaborative Capping & Assembly Robot

Cartesian Pick&Place XYZ

Dynamic vertical shop

Collaborative 2D Unscrambling & Assembly Robot

Dosaxe

Etape 1 Etape 2 Etape 3 Etape 4 Etape 5

Temps

AGV MiR100 avec bras collaboratif UR eSeries

AGV MiR100

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Collaborative 2D Unscrambling & Assembly Robot
Station 3 of the ErmaSmart flexible production line "Assembly

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ErmaSmart Station 3 "Assembly

In the **ErmaSmart "Assembly"** context, the collaborative 2D Unscrewing & Assembly Screwdriving Robot is used to assemble the top cover of the planetary gearbox and screw the 4 screws into the base inserts to complete the assembly.

Upstream of the "Collaborative 2D Unscrambling & Screwing Robot", there are:
  • Item 1: The **XYZ Cartesian Pick&Place** (ref **XY10 and associated codes**)
  • Item 2: The **Collaborative Capping & Assembly Robot**, customised assembly system and control (ref **MI00 and associated codes**)
Downstream of the "2D Unscrambling & Assembly Screwdriving Robot", there are:
  • Item 4: The **Dynamic Vertical Store** (ref **VL10 and associated codes**)
  • Station 5: The **manual order picking, packing and palletising station with RFID tracking** (ref **PM91**).

ErmaSmart Configuration "Assembly

In the ErmaSmart "Assembly" configuration, the 2D Unscrambler & Screwdriver collaborative robot performs the following operations
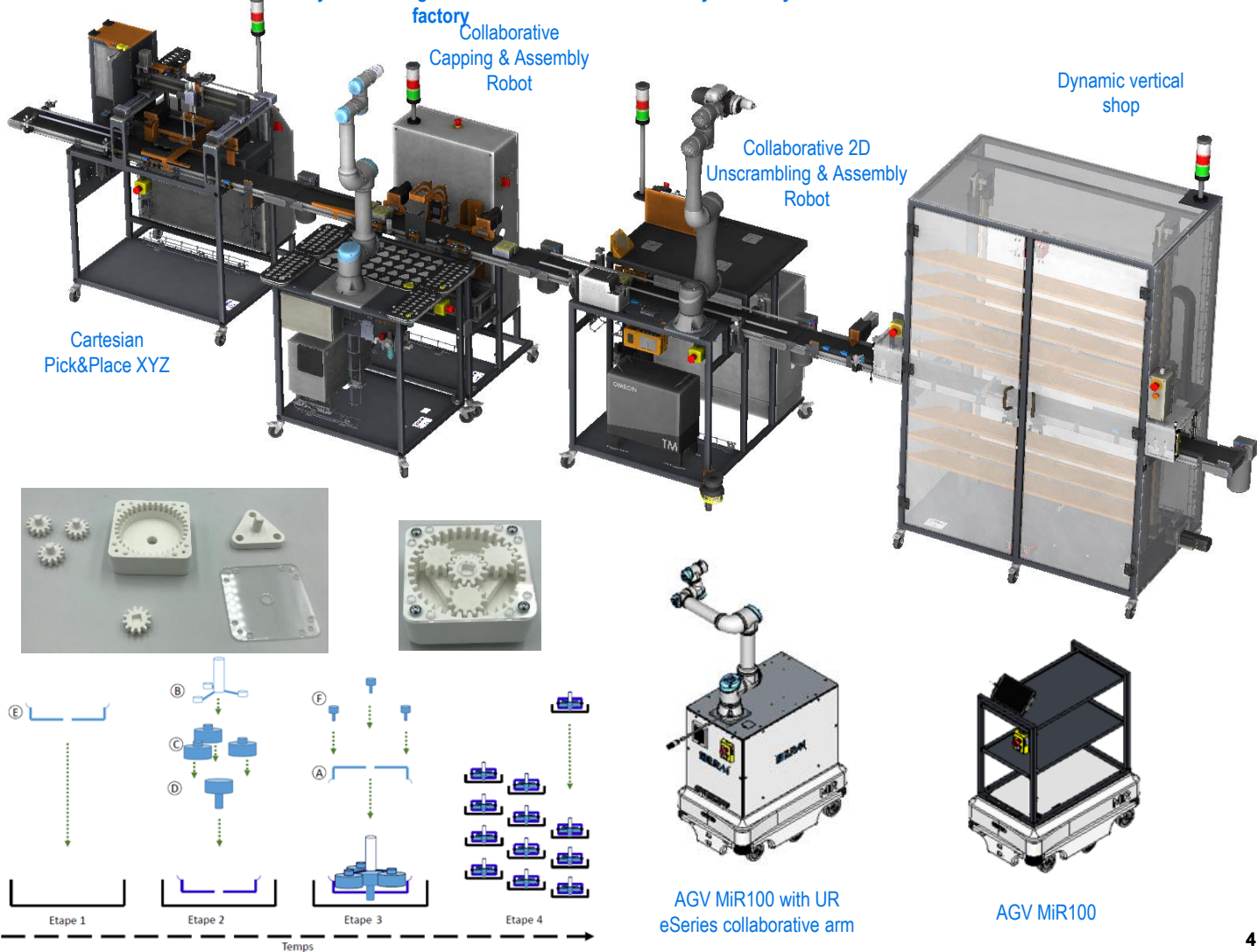 • A suction pad ensures that the cover (Bulk 2D) is picked up from the cover tray and assembled on the gearbox
  • The robot moves to the automatic screw dispenser to suck a screw onto the screwdriver head tip
  • The camera on the end of the arm ensures that the position of the inserts is identified for screwing.
  • The screwdriver at the end of the arm tightens the screw to the required torque.

In this configuration, the end of the arm is then equipped with a robot camera, a suction cup and a torque screwing head.

This configuration requires the codes:
  • **ON10**: The collaborative 2D Unscrambler & Screwdriver
  • **ON11**: "Robotic Screwdriving" Pack for the 2D Unscrewing & Assembly Collaborative Robot (See next page)
  • Optionally: **UR21**: Set of two laser scanners for safe multi-zone management of travel speeds for Ermasmart

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the 2D Unscrambler & Assembly Robot integrated in the ErmaSmart "Assembly" Industry 4.0 factory

Collaborative Capping & Assembly Robot

Dynamic vertical shop

Collaborative 2D Unscrambling & Assembly Robot

Cartesian Pick&Place XYZ

Etape 1   Etape 2   Etape 3   Etape 4
Temps

AGV MiR100 with UR eSeries collaborative arm

AGV MiR100

Didactique | Robotique | Fab&Test | Energies

Robotic Screwdriving Pack for the 2D Unscrewing & Assembly Robot

It consists mainly of :
- ✓ **Collaborative electric torque screwdriver** (OnRobot brand) at the end of the robot arm with **torque control**, simple screwdriving programming cycle to be carried out with the students
- ✓ **Screw dispenser** (OnRobot)

Torque screwdriver with vacuum

Screw distributor

Educational activities

The 2D Unscrambling & Screw-Assembly collaborative robot system allows the following **educational activities to be carried out:**

- ✓ **Electrical engineering**
  - • **Discovery and handling of the system (**functional analysis and study of system technologies)
  - • **Control of the system's electrical quantities** (network, power supply, drive, PLC, human machine interface and control circuit).
  - • **Commissioning and validation of the** system **operation** (of the different production modes)
  - • **Adjustment and parameterisation** of the installation components (three-phase asynchronous motor and its frequency converter)
  - • **Wiring of** new sensors and actuators in an **eco-responsible** way (improvement and/or replacement of an electrical component of the installation)
  - • **Programming of** new cycles of the PLC and the Human Machine Interface (Tia Portal software supplied).
  - • **Diagnosis of one or more malfunctions**
  - • **Use of digital tools and communication**
- ✓ **Automation & Robotics**
  - • **Functional** and **structural analysis** of the system
  - • **Robot programming with the intuitive dedicated software**
  - • **Programming of production cycles** (Tia Portal software delivered with the system)
  - • Programming of associated additional peripherals (vision, etc.)
  - • Implementation of IO-Link sensors (Reassignment of inputs/outputs...) and IO-Link vacuum generator

- • **Programming** of **the human machine interface** (TIA Portal software delivered with the system)
- ✓ **Production control**
  - • **Production control** with choice of "assembled objects" or "capping, control and customisation" operating mode
  - • **Change of** production **format** with integration of new magazines, new fitting,
  - • **Production control with vision tunnel**
  - • **Development of operator support procedures**
  - • **Optimising production with digital 4.0 tools**
- ✓ **Industrial maintenance**
  - • **Preventive maintenance** (conveyors, suction, etc.)
  - • **Corrective maintenance** (fault diagnosis using the TIA PORTAL basic software delivered with the cell, rapid manufacture of 3D printing tools, etc.)
  - • **Improved maintenance** (addition of sensors on the conveyor, scrap management, control with vision,...)
- ✓ **Mechanics**
  - • Study of a robotic workstation, ergonomics, robot and actuator sizing...
 - • Design of 3D printed parts

Solutions didactiques et technologiques
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Installation features

✓ ON10: Dimensions (WxDxH): 1450x1000x1750 mm
✓ Weight: 140kg
✓ Power supply: 230 V single phase (P + N + T)
✓ Pneumatic supply: 6 to 7 bar

Software tools

The 2D Uncoiling & Screwdriving Collaborative Robot is supplied with the **Omron TMFlow software suite** required to implement the robot and the application programs. TMFlow offers graphical or scripted programming modes in robot connection or offline
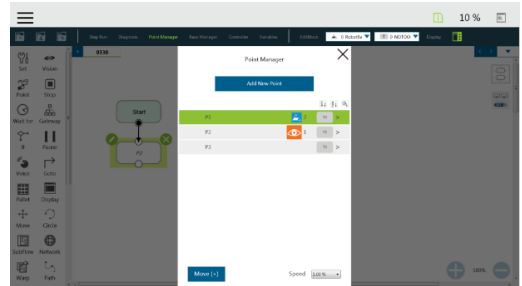
References

✓ **ON10:** Collaborative 2D Unscrambler & Screwdriver
✓ **ON11:** "Robotic Screwing" Pack for the 2D Unscrewing & Screwing Assembly Collaborative Robot
✓ **UR21:** Set of two laser scanners for safe multi-zone management of travel speeds, for Ermasmart
✓ **ON17:** OnRobot RG2 Collaborative Electric Clamp Option for Omron TM Cobot Station
✓ **ON18:** Option: OnRobot suction cup gripper and autonomous on-board vacuum generator for Omron TM5 Cobot Station
✓ **RK11:** Parts option for robotic clip and glue simulation projects
✓ **RK12:** Parts option for 2D and pick-and-place projects
✓ **UC90:** Option: Fault box for electrical cabinet, remotely configurable on a tablet (Not supplied)
✓ **UC50:** MES Tulip, Visual Instructions & Production Indicator Monitoring, for the Line Manager
✓ **UC52:** Visual Instruction option on the Tulip open application environment and touch tablet, for a production operator or maintenance technician (with Tulip Standard in the free Academic Version)
✓ **UC41:** Siemens Remote Desk Option on iPad (Included)
✓ **IO00:** Electrical (Modbus-TCP) and pneumatic (IO-Link) measurement sensor package

MES Tulip, Visual Instructions & Production Indicator Monitoring, for the Line Manager (Ref: UC51)

Electrical and pneumatic measurement sensors (IO-Link) for monitoring the power, flow and electrical and pneumatic consumption of a machine equipped with an IO-Link master (Ref: IO01)

Diota" Augmented Reality Scenario available

From the CAD/PLM tool (Solidworks Composer) to the industrial maintenance RA scenario job card
DF10: Industrial augmented reality solution DIOTA Tablet