Test Project

Module B

Industry 4.0

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List of documents

NO.	DOCUMENT	DESCRIPTION
1	IODD for UC-F77-EP-IO.zip	IODD file of the ultrasonic distance sensor
2	TURCK-GSDML.zip	GSDML file of the IO Link master
3	Logo_WS_Shanghai2026_Black_RGB_1000.png	WorldSkills Shanghai logo

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Introduction

In this Module, your team has to modify the prototype production station to achieve a mixed reality operation of the real system and a simulation. With that, the new production process and further use of the E-Label will be tested.

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Description of project and tasks

This Module will be completed when the following tasks are executed:

1. A distance sensor is integrated to determine the exact position of the carrier on the belt.
2. The MES is configured to control the dispensing process.
3. The Webshop is configured with the new product.
4. A Mixed Reality mode is implemented to demonstrate the process.

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1. Smart Sensor Integration

To prepare your prototype station for the mixed reality operation, you are asked to implement a position tracking system for the carrier on the conveyor belt.

For that, the IO-Link ultrasonic sensor shall be mounted on the CP Lab as sketched in Figure 1.1 and 1.2 to measure the distance to the actual position of the carrier.

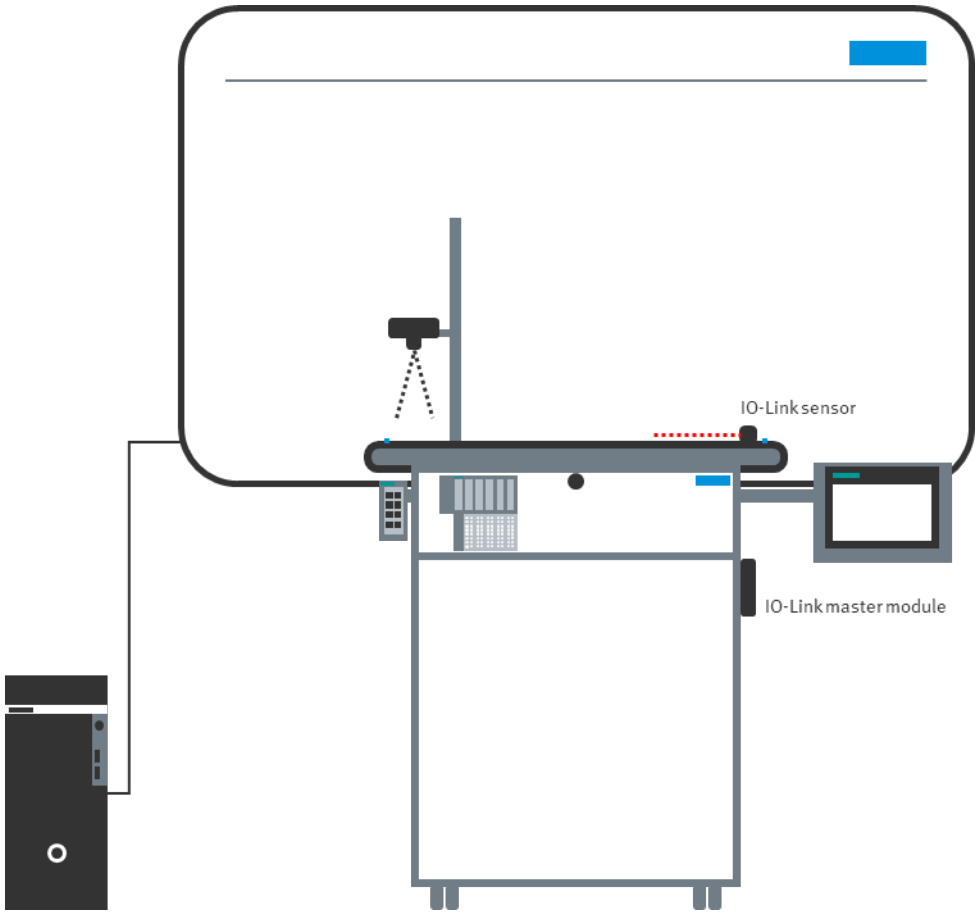


Figure 1.1: Prototype station with IO-Link system added.

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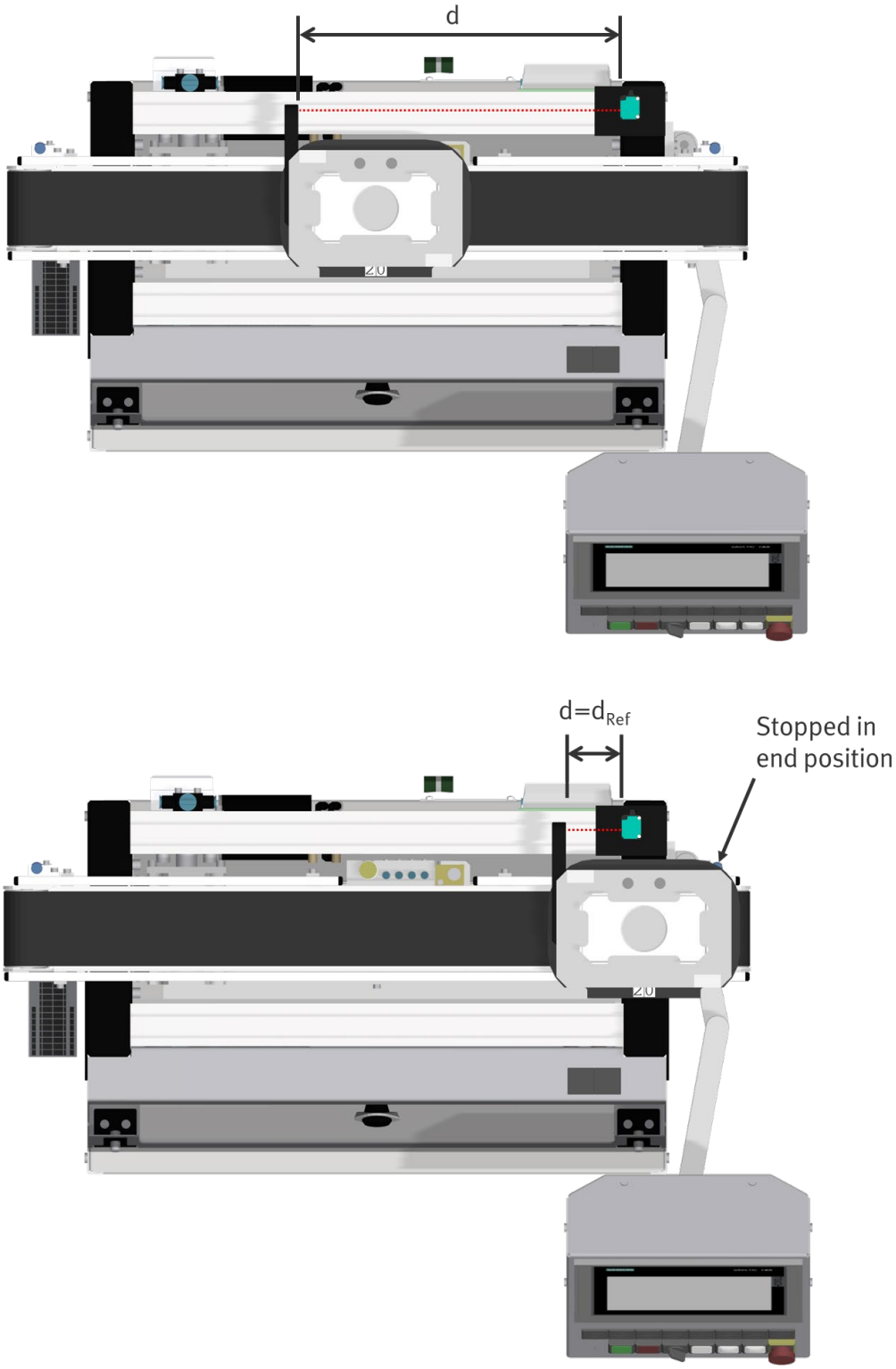


Figure 1.2: Ultrasonic distance sensor measuring the distance d to the reflector attached to the pallet.
Top: Carrier in stopper position (= maximum valid measured distance).
Bottom: Carrier in right end position on the conveyor (= reference position).

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To enable the sensor to measure a distance to the carrier position, a reflector has to be attached to the pallet as shown in Figure 1.3.

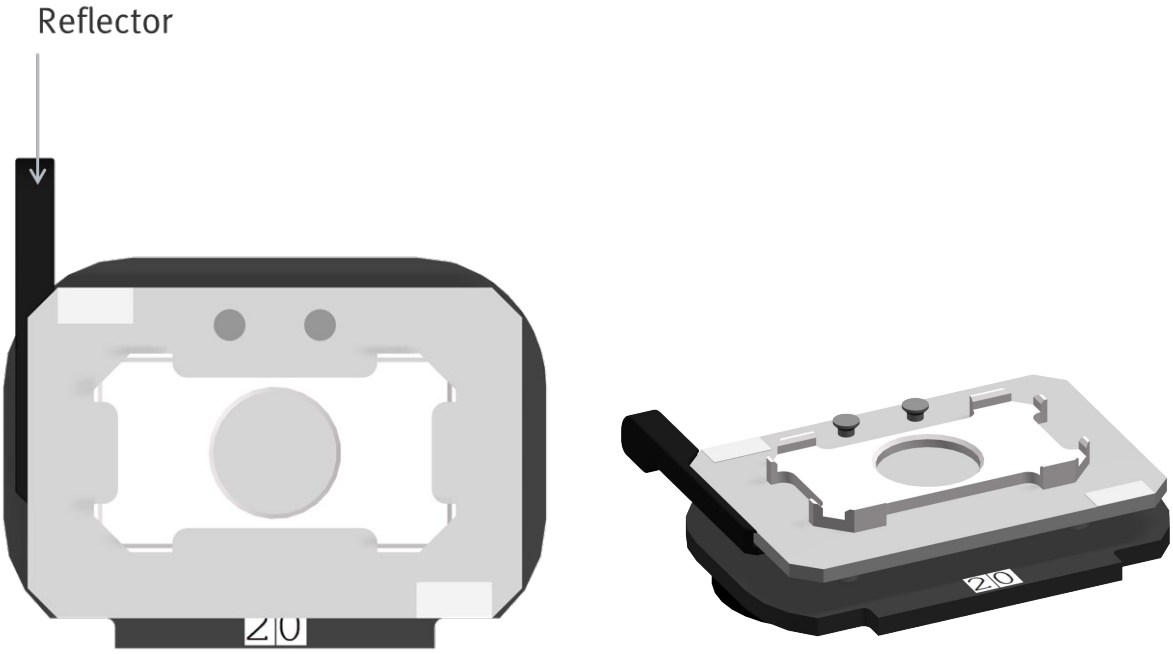


Figure 1.3: Reflector attached to the pallet on the carrier.

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The position tracking system shall meet the following requirements:

NO.	ITEM DESCRIPTION
1.1	The reflector is mounted to the pallet. The carrier with the pallet can still move from left to right end of the conveyor belt without blocking due to the new reflector.
1.2	The IO-Link ultrasonic sensor is mounted on the CP Lab. The ultrasonic sensor distance measurement shall be aligned parallel to the conveyor belt.
1.3	The TURCK IO-Link master module is mounted on the trolley and connected to the ultrasonic sensor and to the network of the CP Lab.
1.4	The integrated webserver of the TURCK IO-Link master module is accessible from the MES PC, and the URL is saved as "Solutions\Module_B\1_IO-Link". The password to login to the webserver is changed to "Shanghai4.0".
1.5	Distance information is added to the HMI screen "Home" – "Overview", showing the measured distance d between the sensor and the reflector in mm, labelled "Sensor distance".
1.6	Additional distance information is added to the HMI screen "Home" – "Overview", showing the distance of the carrier from the end of the conveyor belt in mm, labelled "Carrier distance to right end". It is calculated by "Carrier distance to right end" = $d - d_{Ref}$ "0" means, the carrier has stopped at the right end of the belt (reference position) as shown in Figure 1.2 bottom.
1.7	Valid distance information is available for the carrier being in the range between the stopper position and the right end of the conveyor. If the carrier is farther away from the stopper position, or no carrier is detected, then the measurement is considered invalid and the display shall show "–"for both distance values.

For measured distances, a tolerance of ± 5 mm is acceptable.

Files to be delivered:

- Solutions\Module_B\1_IO-Link

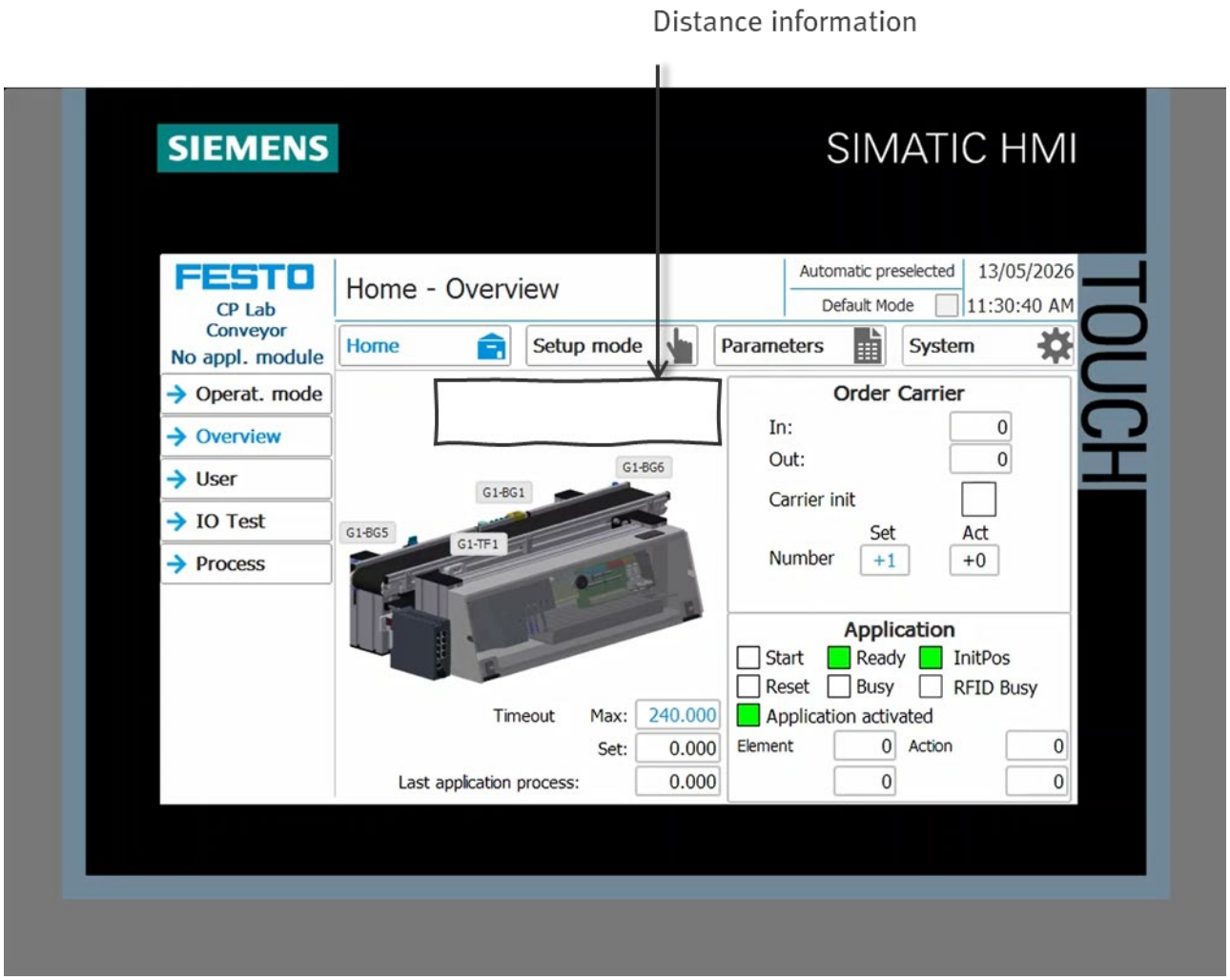


Figure 1.4: HMI screen "Home" – "Overview" with added enhancement.

2. MES Configuration of the Dispensing Process

The new workpiece shall be configured in the MES software.

The workpiece comprises three compartments. Each compartment is permanently assigned to one capsule type as shown in Figure 2.1.

The MES shall prevent assignment of capsule types to incorrect compartments in MES orders created on the MES GUI, e.g. is must not be possible to order Omega-3 capsules in compartment 2.

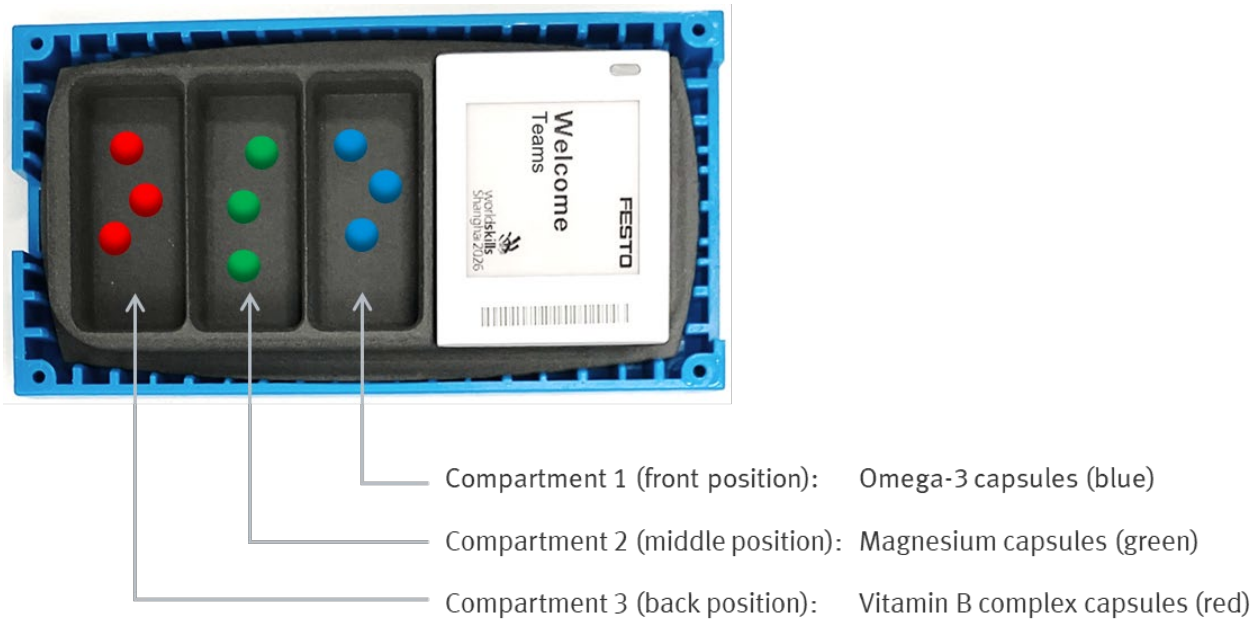


Figure 2.1: Workpiece with compartments and content.

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The MES configuration shall meet the following requirements:

NO.	ITEM DESCRIPTION
2.1	A system is configured comprising a CP-L-LINEAR-C11-M0 station with DISPENSING application module, resource ID 1 and IP address 127.0.0.1
2.2	A product is configured with name “WorldSkills Capsules Box”.
2.3	The product has the part number 4503.
2.4	The product has a picture configured showing the new workpiece with compartments and E-Label.
2.5	A workplan is configured for the product with operation “117 pill dosing” as workplan step.
2.6	An order for the product can be placed in the MES with exactly three (3) changeable numeric parameters in the range of [0..3] representing the number of compartment-specific capsules.

Files to be delivered:

- None.

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3. Webshop Configuration

The webshop has to be configured to allow the representation and ordering of the new product.

The price of the optional capsules shall be changeable in two modes:

1. Manually from a dashboard
2. Automatically via data from the Cloud PC

To change the product options in the webshop programmatically, direct connection to the database "opencart" with user "root" and password "Festo4.0" can be used.

The webshop configuration shall meet the following requirements:

NO.	ITEM DESCRIPTION
3.1	The shop logo shown in the header of the Webshop is changed to the provided file "Logo_WS_Shanghai2026_Black_RGB_1000.png".
3.2	A new product "WorldSkills Capsules Box" is visible in the Webshop frontend.
3.3	The product is available in the new category "WorldSkills Products".
3.4	The product has three required options in the following order: • Capsules Omega-3 • Capsules Magnesium • Capsules Vitamin B complex
3.5	Only values in the range 0 to 3 can be selected per capsule option.
3.6	The product has a description of at least four lines, naming at least the three capsule types.
3.7	The product has a picture showing the workpiece with compartments and E-Label.
3.8	The product has three additional pictures, one per capsule type showing at least a capsule of that type.
3.9	Prices are configured and shown in Chinese Yuan with symbol "¥" (currency code: CNY) in the Webshop, e.g. "¥10".
3.10	The base price of the product with no capsules is ¥10.
3.11	When customers configure the product, prices per capsule must be added to the basic price of the product, so that the total price is calculated as follows: Total price = base price + Σ {quantity_i × price_i} with i the three types of capsules. Example: If a customer configures a WorldSkills Capsules Box with no Omega-3 capsule, 2 Magnesium capsules and 1 Vitamin B complex capsule, then the product price calculates as:

	Basic price (¥10) + 2 x price per Magnesium capsule + 1 x price per Vitamin B complex capsule.
3.12	To control the prices of the capsules, a dashboard must be implemented with title "Product Management Dashboard" and the URL is stored as "Solutions\Module_B\3_dashboard".
3.13	On the dashboard, a switch element allows to activate or deactivate the dynamic pricing mode.
3.14	On the dashboard, a "Manual price per capsule" for the three types can be set. When dynamic mode is deactivated, after a manual change, the prices of the respective webshop option values change immediately.
3.15	Dynamic prices via MQTT can be accessed in the following way: • Broker: 192.168.10.2:1883 • Credentials: see provided letter • Topic: public/webshop/prices • Structure: {"omega3":4.1,"magnesium":3.7,"vitaminb":2.3} in ¥ per respective capsule type. On the dashboard, the three dynamic prices received via MQTT are shown and labelled with "Dynamic price per capsule" for the three types.
3.16	When dynamic mode is activated, the dynamic prices have to change your product options in the webshop immediately after MQTT updates and are visible for the customer after a browser refresh of the product page in the webshop frontend.

Files to be delivered:

- Solutions\Module_B\3_dashboard

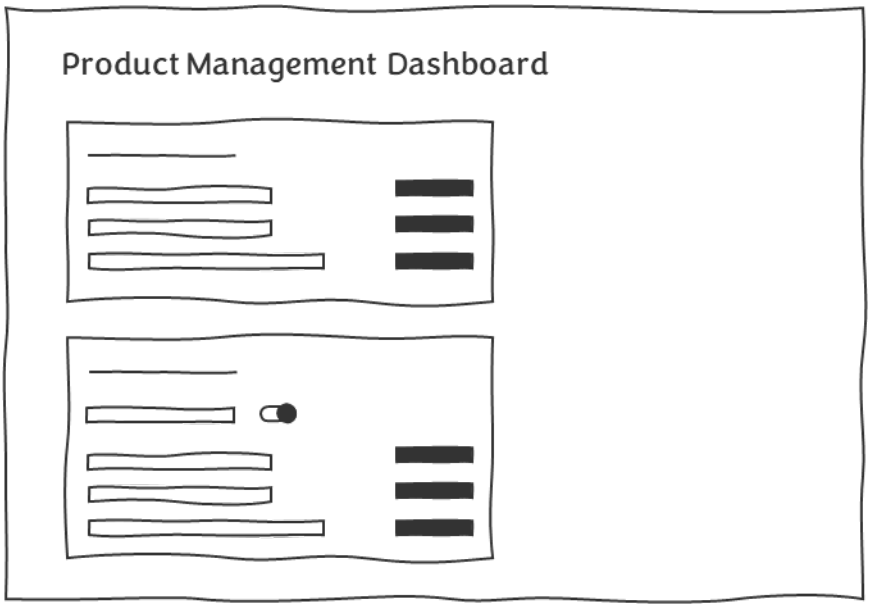


Figure 3.1: Sketch of a Product Management dashboard.

4. Mixed Reality Mode

The production of the new workpiece shall be tested in a Mixed Reality mode, comprising the real prototype CP Lab system and a virtual system simulation in CIROS.

While on the real system, the real new product is transported, stopped and detected by sensors, the virtual system enhances the simulation of the dispensing process.

The scenario will be assessed by the stakeholders of your project and is divided into a preparation phase and the mixed reality production phase.

The **preparation** comprises the following steps:

1. The CP Lab is switched to "Default Mode", which means it will operate based on the Transitions table.
2. In "Parameters", "Transitions" the following is configured for No 1:

- Start condition: 1
- Application execute: Checked
- Parameters: all 0
- End condition: OK: 1, NOK: 0

3. On the RFID of the carrier, the Default Mode State Code 1 is set.
   With that, No 1 of the Transition table will be executed when the carrier arrives at the stopper.
4. In "Parameters", "Application"
   - "Mode" is set to "Simulate application"
   - "Acknowledge end of process" is activated
   - "Return value of application" is set to 0
   - "Time for application processing (s)" is set to 0
5. An order of the product "WorldSkills Capsules Box" is created in MES4.

The CIROS simulation configuration shall meet the following requirements:

NO.	ITEM DESCRIPTION
4.1	A new CIROS simulation model is saved as "4_CIROS\mixed_reality.modx".
4.2	The model includes a model of the CP-L-CONVEYOR with Application Module DISPENSE, with no carrier on the belt.
4.3	The belt is not running at the beginning of the simulation.
4.4	The start view is set so that the application module enhances the real CP Lab system, compare Figure 4.1. The dimensions fit to the real dimensions of the hardware, given CIROS is maximized (but "Full screen" not activated).
4.5	The object "_Panel_Halter" (the HMI of the CP-L-CONVEYOR) is hidden (= not visible). The horizontal front aluminium profile of the Application Module DISPENSE is hidden to allow watching the dispensing process.
4.6	Part 320 (grey front cover with inlay on a pallet on a carrier) must appear in the simulation, once a carrier is present on the left end of the real conveyor. The belt is still stopped.

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	Alternative: A CP-L-SOURCE can be triggered manually to continue, but the requirement is not met.

The following table specifies the required behaviour in the **mixed reality production** phase:

NO.	ACTION	BEHAVIOUR REAL SYSTEM (PROTOTYPE CP LAB STATION)	BEHAVIOUR VIRTUAL SYSTEM (CIROS SIMULATION)
4.7	The CP Lab is switched to "Automatic" mode.	The conveyor moves the carrier to the stopper position, the carrier stops.	The conveyor moves the carrier to the stopper position, the carrier stops.
4.8		On the HMI the pop up "Simulation of application" is shown.	Capsules are dispensed according to the MES order.
4.9		Once the dispensing process in the simulation is finished, the pop up disappears, the real carrier is released, and the conveyor belt moves it to the right.	Once the dispensing process in the simulation is finished, the simulated carrier position shall follow the real carrier with a maximum deviation of ±30 mm E.g. if the real carrier is blocked even though the belt is running, the simulated carrier also stops at the same position.
4.10	The carrier is removed from the right end of the real belt (sensor BG6).		The virtual carrier with pallet and workpiece disappears.

Information: Like in reality, also in the simulation capsules being dispensed might "jump" into neighbouring compartments accidentally. This behaviour is not relevant within this Test Project.

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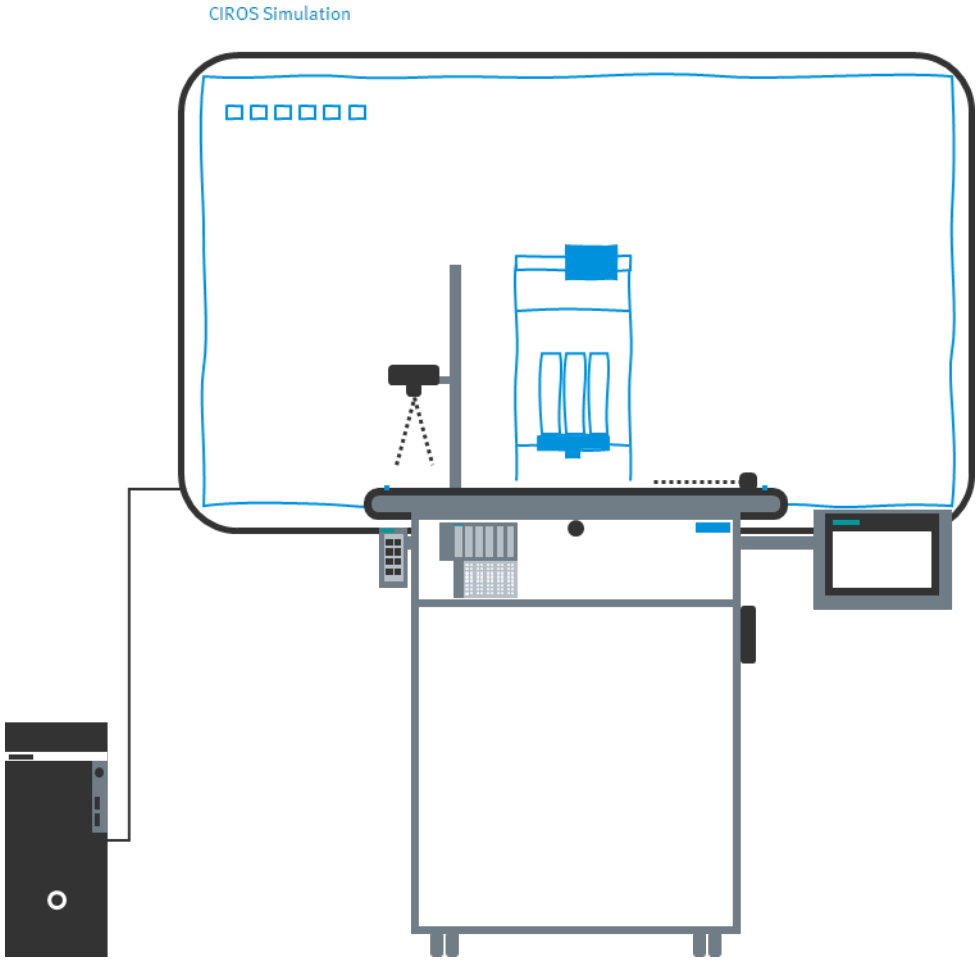


Figure 4.1: Prototype station with CIROS Simulation in Mixed Reality configuration.

Files to be delivered:

- Solutions\Module_B\4_CIROS\mixed_reality.modx (and required project files)

Instructions to the Competitor

The Test Project and related documents will be provided digitally.

Competitors may use personal computers during development. Final solutions must be deployed and executed on the provided MES Server PC and on the Station Screen. It is allowed to connect monitors, a keyboard, and mouse to the MES Server PC or to access it via Remote Desktop Connection**.**

Whenever a shared network infrastructure is used, any attempt to gain unauthorized access to network devices including servers, switches, routers or devices and systems of other teams, or to disturb data traffic, is prohibited, regardless of success.

Make sure to save and backup your work before leaving the workplace.

Files to be delivered are to be stored on the Desktop of the MES Server PC in the given directories.

Unless otherwise specified, all interfaces and signals may be implemented using appropriate engineering judgment, provided that the required system behaviour is achieved.

During the marking, only solutions running or saved on the competition system are evaluated, unless requested differently.

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