Test Project

Module A

Industry 4.0

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List of documents

NO.	DOCUMENT	DESCRIPTION
1	Central Factory pictures.zip	Archive of pictures of the Central Factory
2	CP-L-MAN_V18.zap18	Siemens TIA project archive

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Introduction

In your company, a new system is implemented step by step to manage relevant product specific data.

With that, the management aims for improved traceability and thereby increased quality delivered to the customers, to allow increased customization and to be prepared for future regulatory requirements.

As part of the system, workpieces will be equipped with an Electronic Label (E-Label).

Today, you are working in a team to analyse existing production data and to build up a prototype station which interacts with the enhanced workpieces.



Description of project and tasks

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

1. A data connection to the Central Factory has been established and relevant production data are visualized on a dashboard.
2. The CP Lab as prototype station has been commissioned and a basic operation mode has been implemented.
3. The Machine Learning Camera has been installed and trained to detect product properties.
4. An algorithm has been developed to identify the barcode on the electronic label and to write data to the label.

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1. Data Visualization of the Central Factory

The ongoing production of your company is represented by the Central Factory. It consists of six production resources as shown in Figure 1.1. In the Central Factory, the conventional product without E-Label is produced.

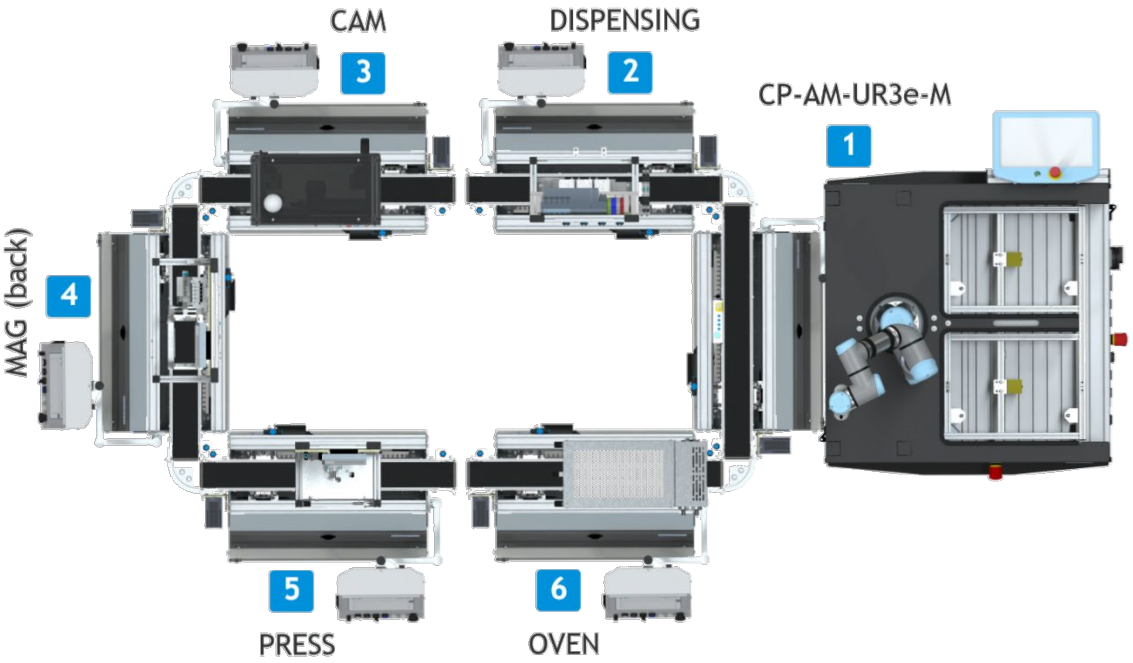


Figure 1.1: Top view on the production resources of the Central Factory.

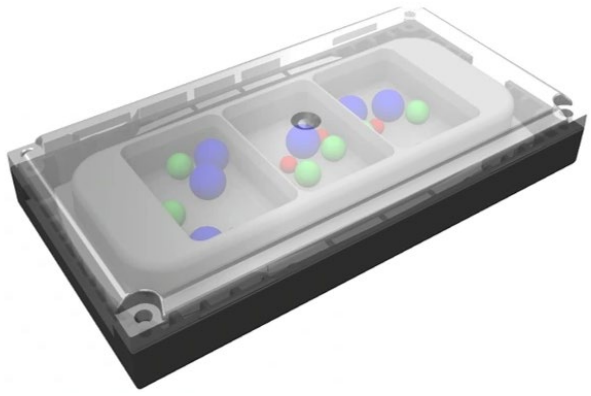


Figure 1.2: Conventional workpiece "pill box" as produced on the Central Factory.

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The products are produced according to the following steps of workplan with WPNo = 4500:

STEP NO.	RESOURCE	OPERATION
1	1 - UR3e-M	Feed from UR
2	2 - DISPENSING	Pill dosing
3	3 - CAM	Count pills
4	4 - MAG (back)	Feed back cover
5	5 - PRESS	Pressing
6	6 - OVEN	Heating
7	1 - UR3e-M	Store by UR

The production is controlled by the MES4 software on a production control PC. You cannot connect to the PC directly, however, the contents of the database tables are published via the following central MQTT broker:

- Broker: 192.168.10.2:1883
- Credentials: see provided letter
- Topics: public/mes/{table name}

with {table name} the MES4 table names

- tblorderpos
- tblfinorderpos

This data is referred to as "MES data" in this Module and must be used as data source for the dashboard specified below.

The dashboard shall meet the following requirements:

NO.	ITEM DESCRIPTION
1.1	A dashboard is created and a link saved as "Solutions\Module_A\1_dashboard".
1.2	The title of the dashboards is "Production Dashboard Central Factory"
1.3	A text "Last data update:" followed by the date and time including seconds, when the last MES data has been received via MQTT, independent of any changes within the data.
1.4	A table lists all order positions of workplan (WPNo) 4500 including both the active and finished order positions. Order positions of other workplans are not shown. The table shows at least the following information in columns: • ONo and OPos in the form {ONo}.{OPos} • Start time and date of the production of the order position • End time and date of the production of the order position • Duration of the production of the order position in "minutes: seconds" If the end time is missing, the order position is considered in progress. Then, the duration must be calculated as: current system time – start time
1.5	The table is sorted by order number, from low number at the top of the table to high number at the bottom. Order positions of same order number are sorted by order position number in the same way.
1.6	The table shall include column headers for all displayed data fields.
1.7	All information refresh as soon as new information is available via the MQTT broker, plus a maximum delay time of 5 seconds, e.g. due to data processing.
1.8	Durations of more than 5 minutes must be highlighted with red text colour and a red warning symbol next to the duration. If the warning symbol is placed in a separate column, it doesn't require a header.
1.9	An image of the Central Factory is added to the dashboard. Images are provided by the design department of your company and stored in "Central Factory pictures.zip".

Files to be delivered:

- Solutions\Module_A\1_dashboard

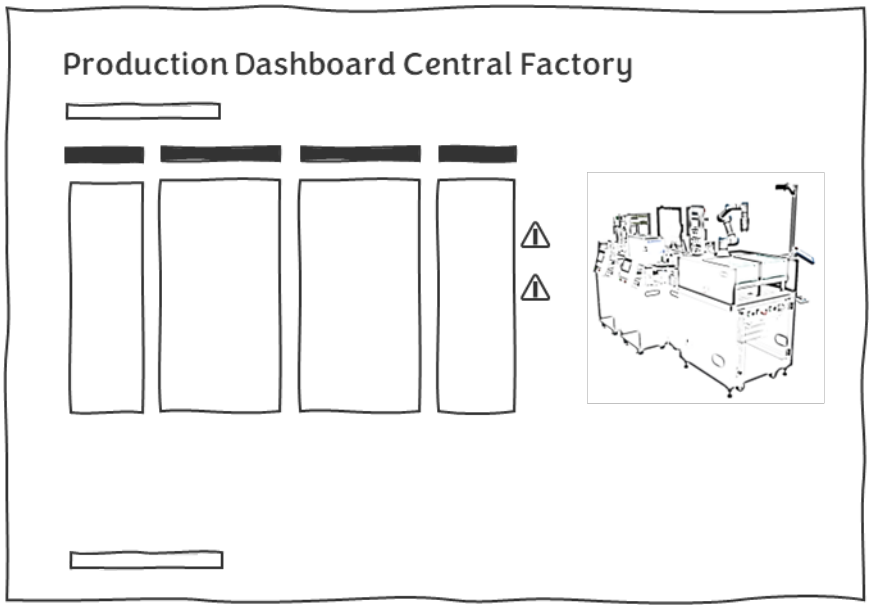


Figure 1.3: Sketch of the Production Dashboard

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2. Commissioning a Prototype Production Station

Your task is now to prepare a prototype production station comprising a CP Lab conveyors system connected to the S7 PLC and HMI all required cables and supply to enable the specified functionality.

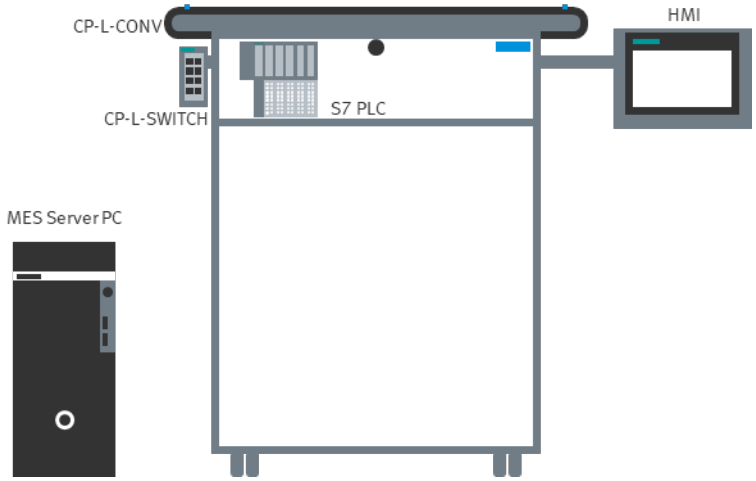


Figure 2.1: Prototype Production Station

The system shall meet the following requirements:

NO.	ITEM DESCRIPTION
2.1	The Siemens TIA project archive CP-L-MAN_V18.zap18 is loaded to the PLC and HMI.
2.2	On the HMI screen “Setup mode”, “Belt”, a button is added with title “To left end”, compare Figure 2.2.
2.3	When in “Setup Mode”, while “To left end” is pressed, the stopper is retracted and the conveyor belt moves to the left, until the sensor BG5 detects a carrier with rising edge of the signal. Then the conveyor belt stops and the stopper is extended.
2.4	When the button “To left end” is released, the conveyor belt immediately stops and the stopper is extended.
2.5	When a carrier is detected at the left end of the conveyor belt, then the button “To left end” is deactivated to indicate that no further movement is possible.
2.6	Analogously to specifications 2.2 to 2.5, a button “To right end” is implemented, allowing to move a carrier to the right end of the conveyor belt while pressed.
2.7	The design of the new buttons is adapted to the existing HMI screen.
2.8	The TIA project is protected with the user “admin” and password “Shanghai4.0”.
2.9	The TIA project is archived as “Solutions\Module_A\2_CP-L-MAN_V18.zap18”.

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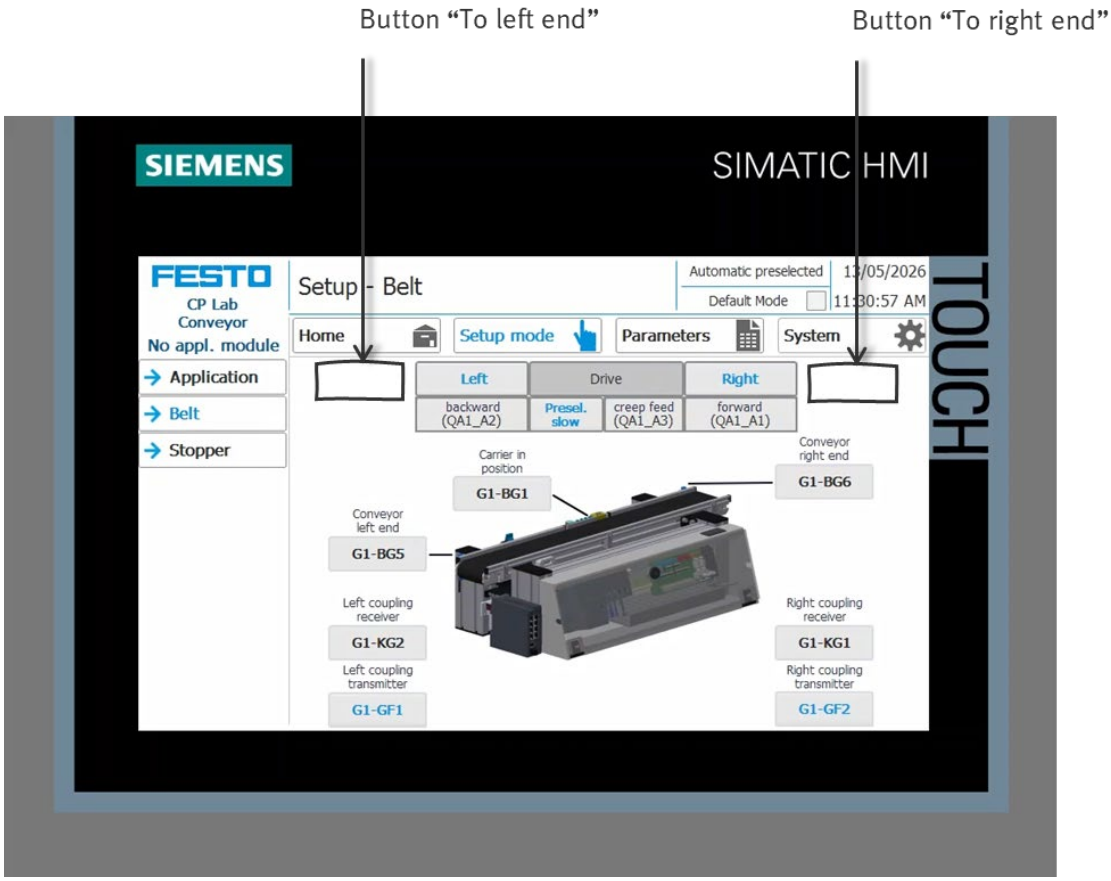


Figure 2.2: HMI screen Setup – Belt with sketched enhancements.

Files to be delivered:

- Solutions\Module_A\2_CP-L-MAN_V18.zap18

3. Integration of a Machine Learning Camera

From the data on the dashboard created in task 1 of this Module, your team noticed that order positions can get delayed or that parts even can get lost.

Therefore, your team now wants to test a system with an electronic label (E-Label) to identify and track each individual workpiece, rather than the carrier only.

The workpiece and its components are depicted in Figure 3.1.

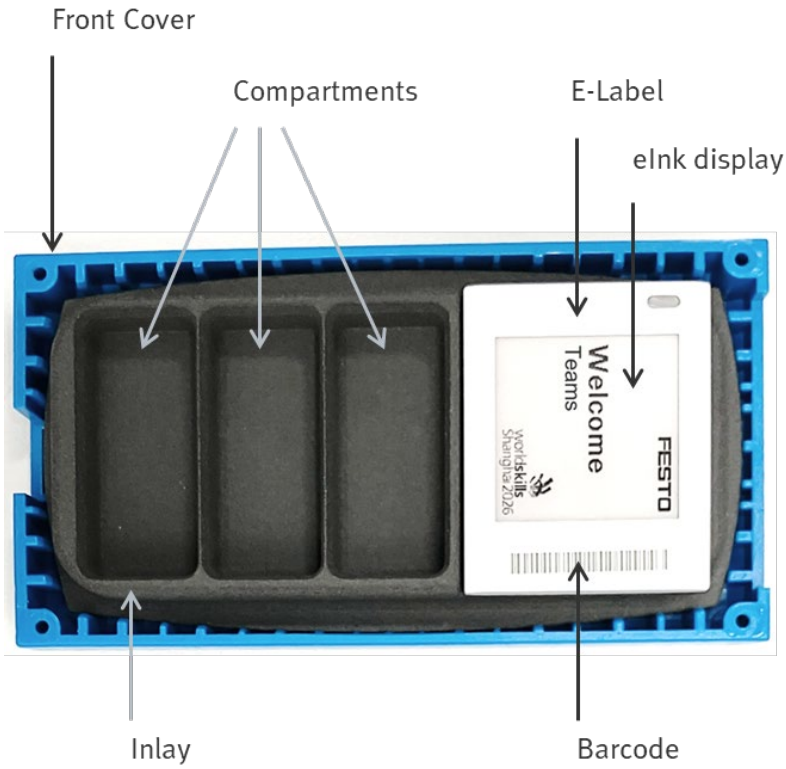


Figure 3.1: New workpiece equipped with the E-Label.

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The workpiece has to be captured by the camera when located on a carrier in the left end position on the conveyor belt, as implemented in 2.3 (HMI button “To left end”).



Figure 3.2: New workpiece on a carrier at the left end of the conveyor belt.

The mounting accessories of the ML CAM shall be used position the camera suitably, compare the sketch in Figure 3.3

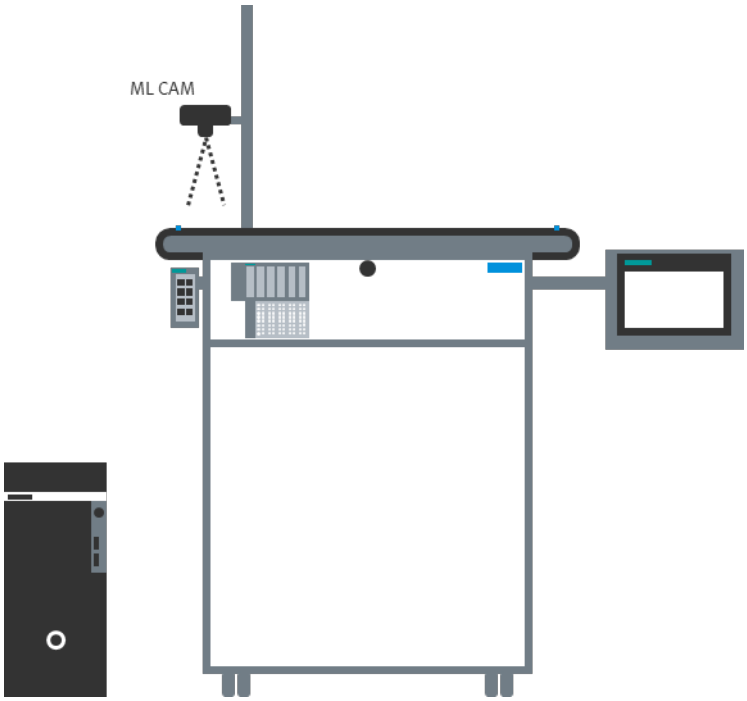


Figure 3.3: Prototype Production Station with Machine Learning Camera.

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The integration shall meet the following requirements:

NO.	ITEM DESCRIPTION
3.1	The ML CAM is mounted on the CP Lab and its web interface is accessible via the MES Server PC on http://172.21.55.46:5000
3.2	The following classes are configured, and the machine learning algorithm is trained to detect the respective condition: • **No Workpiece** If an empty pallet is located on a carrier. • **Blue empty** If a blue front cover with empty compartments is placed on the pallet. • **Grey empty** If a grey front cover with empty compartments is placed on the pallet. • **Blue not empty** If a blue front cover with not empty compartments is placed on the pallet. • **Grey not empty** If a grey front cover with not empty compartments is placed on the pallet. "Not empty" means, that not all compartments are empty. This must be trained for up to 2 blue pills which are located somewhere in the compartments. Your team gets two (2) blue pills plus two (2) additional spare pills. In all cases, all components oriented and positioned correctly according to Figure 3.2 can be assumed. However, the information displayed on the eInk of the E-Label may vary. **Attention: Only the first region of interest (ROI 1) must be used in this task!** The other regions will be used later in this Module and in this Test Project.
3.3	The ML project is downloaded and saved as "Solutions\Module_A\3_classification.zip".

Files to be delivered:

- Solutions\Module_A\3_classification.zip

4. Product Information

Now that the Prototype Station is set up, you want to collect a first set of product data.

The Barcode printed on the E-Label allows to identify each E-Label and thereby the workpiece uniquely.

The ID is encoded using “Code 128”, a high-density linear barcode symbology, which is used extensively worldwide in shipping and packaging. It can encode all 128 characters of ASCII.

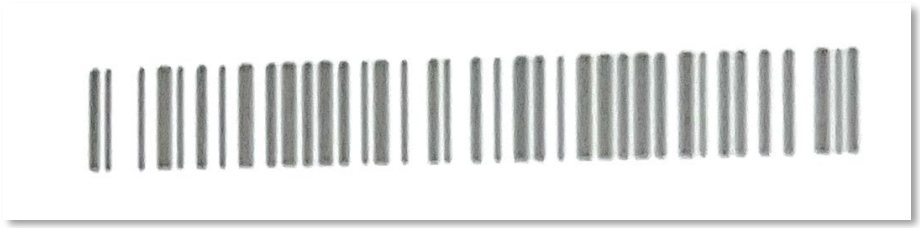


Figure 4.1: Example 1D barcode. The decoded value is “8173E4476”.

For decoding, in Node-RED the “Barcode Decoder” of the Node pallet “node-red-contrib-image-tools” can be used.

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The information presentation shall meet the following requirements:

NO.	ITEM DESCRIPTION
4.1	A dashboard is created and a link saved as "Solutions\Module_A\4_dashboard".
4.2	The title of the dashboards is "Product Information Dashboard".
4.3	The screen layout shall be divided into two vertical sections (compare Figure 4.2): • Left section: "Machine Learning" • Right section: "Product Data" Here, Microsoft Edge browser with maximized window, 100% zoom setting and no "full screen" mode shall be used.
4.4	The section "Machine Learning" shows the live picture of the camera.
4.5	The section "Product Data" lists: • "ID", the last decoded barcode value, but in a masked version showing only the last 3 digits in clear characters. Example: If the ID is "8173E4476", then display ******476 If no barcode can be decoded within 5 seconds, then "N/A" shall be displayed, but trials to decode a barcode keep continuing. Maximum one additional Region of Interest (ROI) can be used for the barcode. • "Colour": The classified colour of the front cover, as text and as coloured rectangle for intuitive perception If no colour is detected, then "N/A" shall be displayed. • "Compartments": The state of the compartment classification , either "Empty" or "Not empty". In case "Not empty", a blinking coloured warning symbol shall be shown.
4.6	The dashboard shall update at intervals of 3 seconds or less.

Files to be delivered:

- Solutions\Module_A\4_dashboard

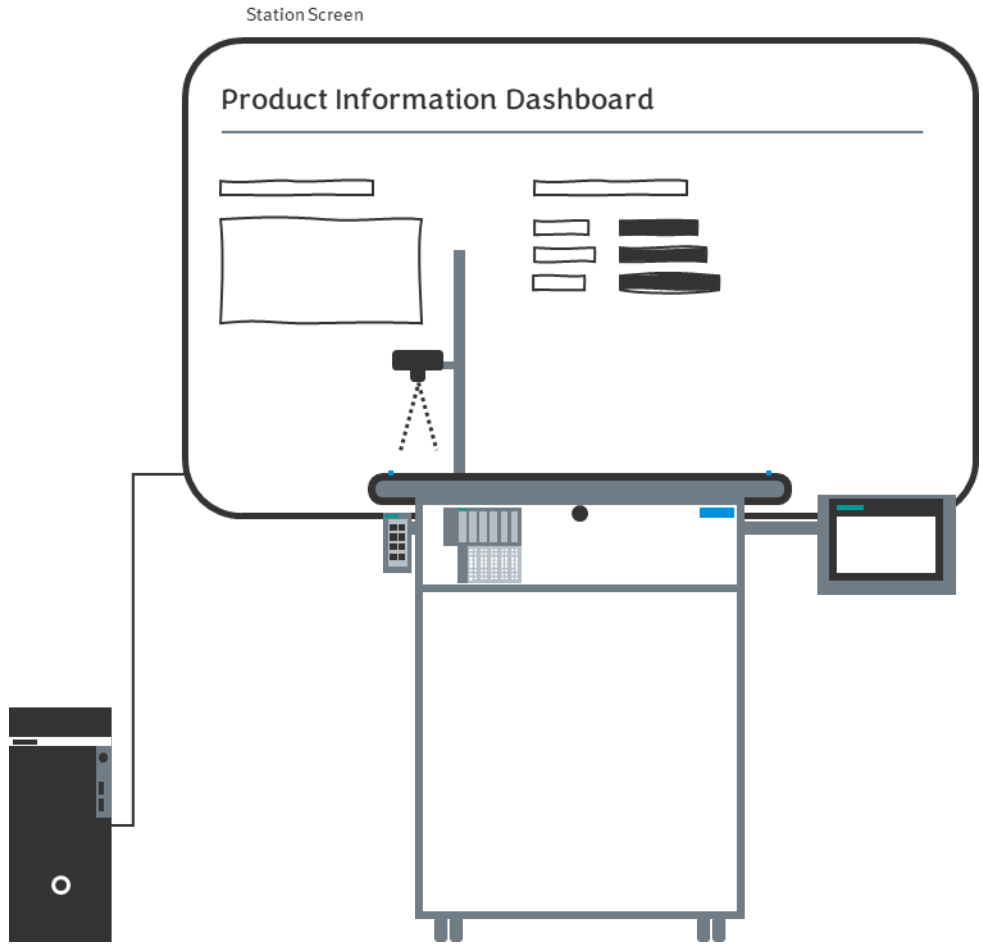


Figure 4.2: Sketch of the Product Information Dashboard on the Station Screen.

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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.

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