

# Pre-competition Activity

Skill Industry 4.0



**PLC Programming  
HMI Programming  
SCADA (Node-RED)  
MES4**

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## Introduction

Your task will be to program the given CP-Lab station to fit process required by customer.

The customer has specified for conveyor system to be added to an already existing production line. Despite all necessary hardware being delivered, a program for PLC controller and HMI display has to be implemented. In order to reach this goal, your task will be to update delivered workplace with automated process.

For testing purposes, before the final product is delivered to customer, your next task is to develop a dashboard, hosted on the technician's (yours) computer, where data of the material flow and the process is observable via a web browser.

In the meantime, customer is in a process of introducing a digital shadow to their already existing system. Your task is to configure an MES4 system according to production line's specification, connect it to digital model and observe results.

Finally, all work and updates what has been carried out must be properly documented.

## Description of project and tasks

This pre-competition activity is divided into 3 subsections, or three individual tasks. Each one has a different time limit and marking sheet:

- |                                      |               |
|--------------------------------------|---------------|
| <b>Task A: PLC / HMI Programming</b> | <b>(2h)</b>   |
| <b>Task B: SCADA</b>                 | <b>(1.5h)</b> |
| <b>Task C: MES4</b>                  | <b>(1h)</b>   |

## Equipment, machinery, installations, and materials required

ITEM	TASK	QUANTITY	DESCRIPTION	NOTES
CP Lab (any application)	1,2	1	Festo Didactic CP Lab station with conveyor system, HMI display and a carrier	Older variants should also comply.
Siemens S7-ET200SP PLC	1,2	1	Siemens PLC controller	Supplied with CP Lab system
Siemens 7" TP700 Comfort Panel	1	1	Siemens HMI Panel	Supplied with CP Lab system
STEP 7 Professional V15.1 or greater	1,2	1	Software licence for programming advanced Siemens PLC controllers	Supplied with CP Lab system
WinCC Advanced V15.1 or greater	1	1	Software licence for programming Siemens HMI comfort panels	Supplied with CP Lab system
TIA Portal V15.1 or greater	1,2	1	Software for programming Siemens PLCs and HMIs	Supplied with CP Lab system
MES4 V1.2	3	1	Software for managing production of CP System	Supplied with CP Lab system
Node-RED	2	1	Used for creating online dashboard	Free software; requires node.js. Pallets used: opcua, dashboard
UA Expert	2	1	Software used as OPC UA client browser	Free software;
CIROS Studio V6.4	3	1	Used for simulation; able to simulate CP Lab system to act as digital shadow	Optional; used in last task to work with MES4 configuration.

# TASK A



**PLC Programming  
HMI Programming**

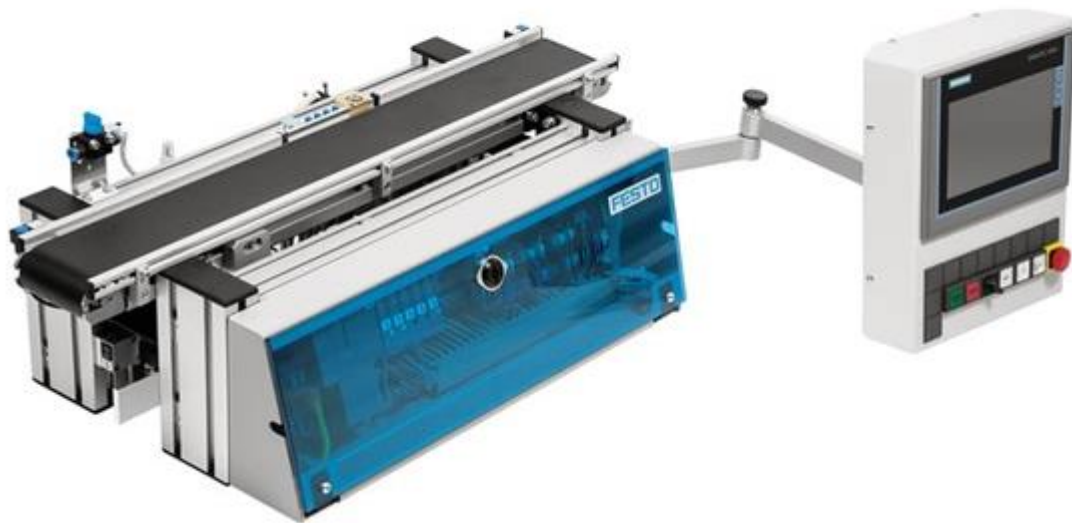
## List of documents

No	Item description	Link
1	User manual of the CP-Lab base module	<a href="#">Download link</a>
2	Manual of the PLC of the CP-Lab Conveyor	<a href="#">Download link</a>
3	Datasheets of building blocks of the CP-Lab base module	<a href="#">Download link</a>
4	TIA Portal: Tag Table for Conveyor Control	<a href="#">Download link</a>
5	TIA Portal: Tag Table for Control Panel	<a href="#">Download link</a>
6	TIA Portal: Main sequence	<a href="#">Download link</a>
7	TIA Portal: Resetting sequence	<a href="#">Download link</a>

## Description of a task

Your task will be to detect current hardware configuration of PLC used at the station and to program it to control a conveyor and stopper module.

Next, a new program is meant to be added to an HMI screen, following hardware configuration and requirements listed in the specification.



*Figure 1 CP Lab base module*

Your task will be completed when:

1. Device configuration for PLC is set according to Specification 1.
2. System follows a sequence listed in Specification 2.
3. Stop / Emergency stop function is implemented together with resetting sequence, according to Specification 3.
4. HMI Panel is added to the project and configured according to Specification 4.
5. HMI screen is set to display information listed in Specification 5.

## Specification 1 – Device configuration

First, your task is to set up a TIA Project with a device that matches controller available at CP Lab base station. Next, make sure to set parameters listed below.

### ET200SP CPU

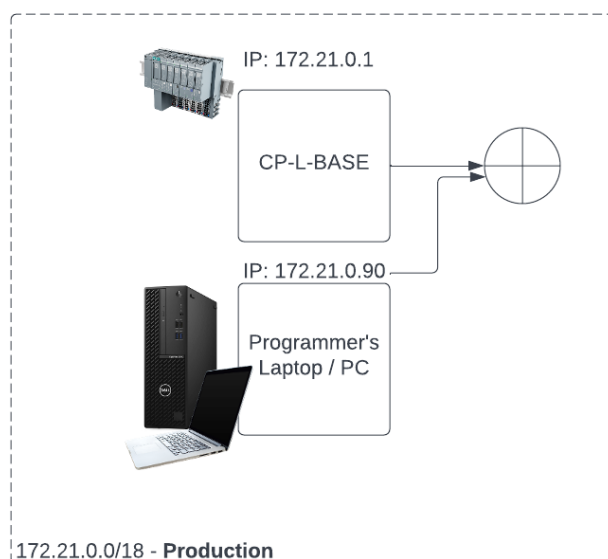
No	Item description	Value
1.1	Ethernet Address: IP Address	172.21.0.1
1.2	Ethernet Address: Subnet mask	255.255.192.0
1.3	Clock memory bits: Enable the use of clock memory byte	True
1.4	Clock memory bits: Address of clock memory byte (MBx)	10
1.5	Protection & Security: Access Level	Full access inc. fail-safe (no protection)

Initial setting of IO-Link module has to be carried out in order to avoid problems later on.

### CM 4xIO-Link\_1

No	Item description	Value
1.6	I/O Addresses: Input/output type – input/output	64/64
1.7	Input addresses: start address	10
1.8	Output addresses: start address	10

Network should be defined as follows:





PLC Tag tables are supplied with this task. Make sure to download them from list of documents and add to your project.

### PLC Tag tables: Conveyor\_Control & Control\_Panel

No	Item description	Value
1.9	PLC Tags: Add new tag table	Conveyor_Control
1.10	PLC Tags: Add new tag table	Control_Panel

### Specification 2 – Sequence

Station should be programmed in a programming language of your choice. A main sequence is defined in a form of a flow chart - included in list of documents.

#### Main sequence

No	Item description	Value
2.1	Sequence to be completed	Flow chart in list of documents
2.2	Start button light blinking	Frequency = 1Hz
2.3	Delay time in stopper position	2 seconds (static)
2.4	Once sequence finishes, it can be restarted by placing carrier at the beginning of conveyor and pressing Start button	Continuous cycle

### Specification 3 – Resetting sequence

With main function in place, next step is to implement a stop/emergency stop function that will force your program to stop all moving parts (conveyor) and force resetting sequence before being able to run again.

**Please note** stop function should be able to stop the system at any moment, especially during main sequence!

#### Stop/Emergency stop function

No	Item description	Value
3.1	Once stop button is pressed	Flow chart in list of documents
3.2	Once emergency stop button is pressed and released	Flow chart in list of documents

#### Resetting sequence

No	Item description	Value
3.3	Resetting sequence to be completed	Flow chart in list of documents
3.4	Condition for starting resetting sequence	Stop button OR Emergency Stop button
3.5	Reset button light blinking	Frequency = 1Hz

### Specification 4 – HMI Panel

Next, add an HMI Panel to the project. Make sure to set parameters as listed.

#### TP700 Comfort Panel

No	Item description	Value
4.1	Model	TP700 Comfort (6AV2 124-0GC01-0AX0)
4.2	Version	(match panel's version no)
4.3	Ethernet Address: IP Address	172.21.0.10
4.4	Ethernet Address: Subnet mask	255.255.192.0
4.5	PLC Connection	To 172.21.0.1

## Specification 5 – HMI Design

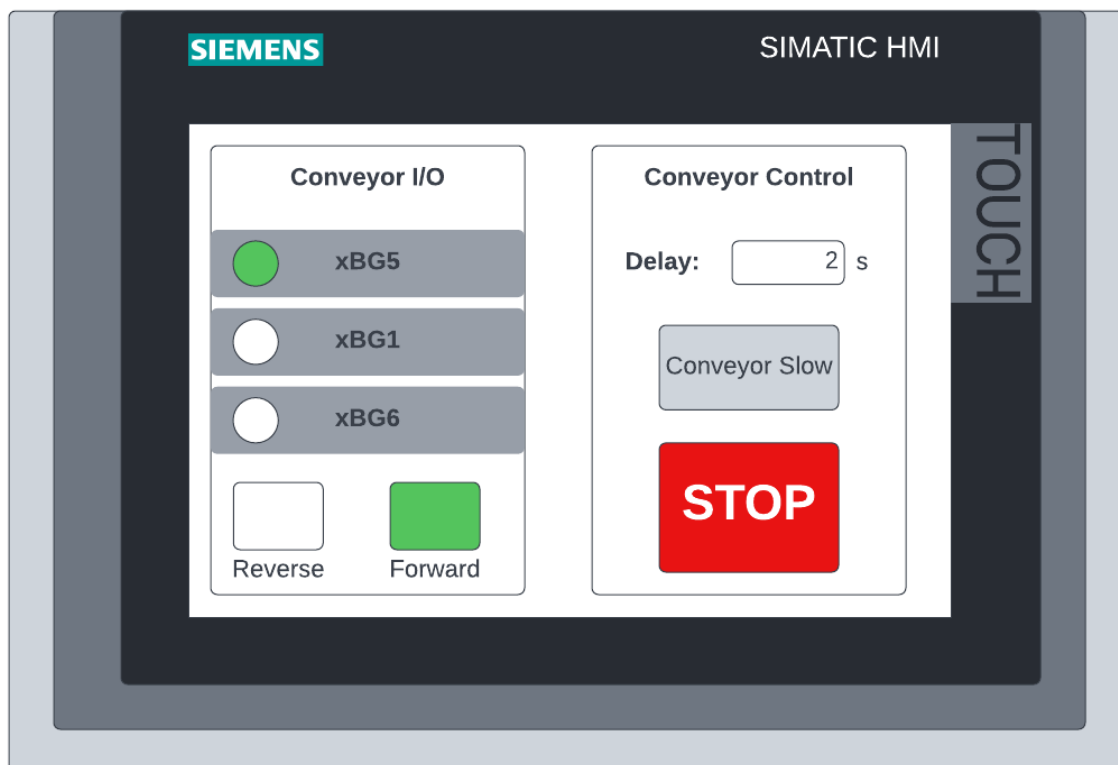


Figure 2 Example of HMI screen final solution

HMI screen must contain 2 separate blocks: Conveyor I/O and Conveyor Control.

Conveyor I/O block must include indicators for:

Inputs:

- sensor xBG5
- sensor xBG6
- sensor xBG1

Outputs:

- signal for conveyor forward
- signal for conveyor backward

**Please note** these are meant to be only indicators, meaning they change their appearance according to state of these I/O, but without overwriting their values.

Conveyor Control block must include:

- I/O field for selecting number of seconds – this number will be then passed on to delay timer to delay carrier in stopper position.
- Button for stopping a sequence. Its action is equal to one's of stop button or emergency stop button.
- Button for changing the speed of conveyor. It shouldn't be required to hold the button to make conveyor run slower; just a single press will change between speed modes.



# TASK B



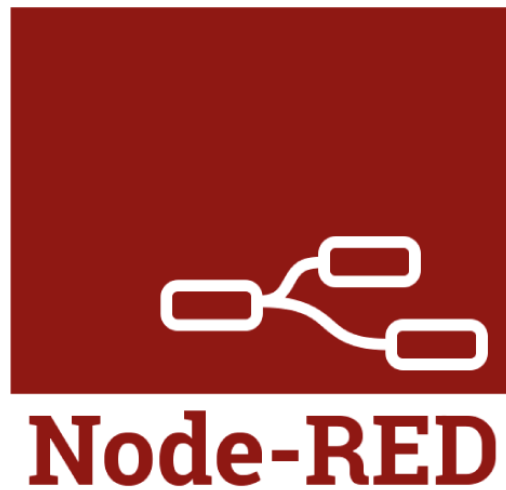
# SCADA

## List of documents

No	Item description	Link
1	User manual of the CP-Lab base module	<a href="#">Download link</a>
2	Manual of the PLC of the CP-Lab Conveyor	<a href="#">Download link</a>
3	Documentation template	<a href="#">Download link</a>

## Description of a task

Your task will be to develop an online dashboard using Node-RED to support an already programmed CP Lab application.



Your task will be completed when:

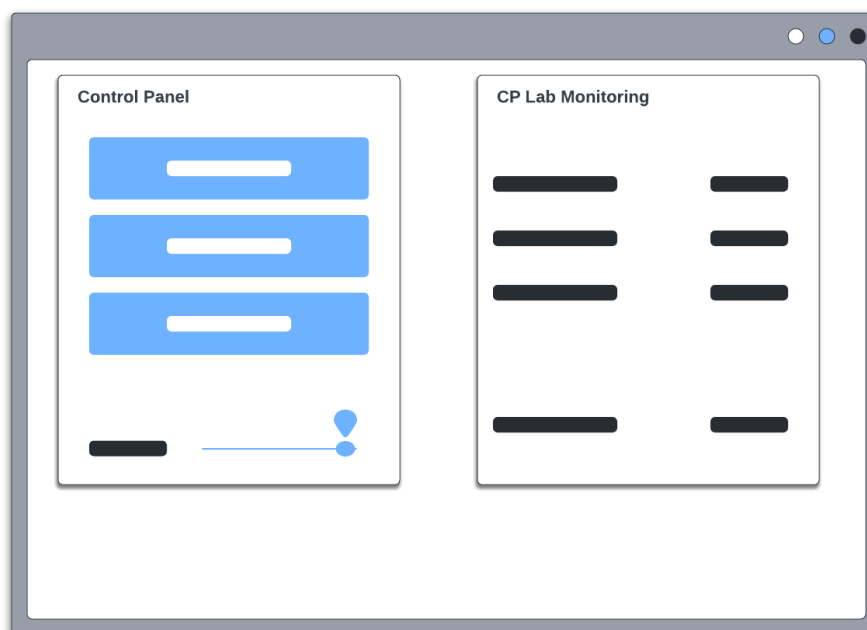
1. OPC UA server is enabled on Siemens PLC according to Specification 1.
2. Node-RED dashboard is set up according to Specification 2.
3. Documentation is provided according to Specification 3.

## Specification 1 – OPC UA server

First, your task is to use an existing program from Task A and enable OPC UA server for ET200SP PLC, with an application name listed below:

No	Item description	Value
1.1	Application name	"WorldSkills OPCUA_Server_CPLab_Base"

## Specification 2 – Node-RED dashboard



One block of the dashboard must contain the 3 main control buttons of the CP-Lab, with the same functionality as physical buttons of HMI screen, from top to down as:

- Start            must start the application of CP Lab base module
- Reset            must move the carrier to initial position
- Stop             must end the sequence in either normal or resetting mode

The text on the buttons must be identical with the description given above. Additionally, a time for delay timer can be selected in a form of a slider, with value between 1 and 5 seconds (inclusively). Slider should display the number of seconds that is currently selected.

The second block of the dashboard must contain the following data of the system:

- xBG5             carrier at the beginning of conveyor
- xBG1             carrier at stopper position
- xBG6             carrier at the end of conveyor
- Carrier counter    how many carriers have been processed since last reset



### **Specification 3 – Documentation**

A documentation in a form of a word or pdf document must be provided, explaining all steps that were taken during this task. Screenshots together with brief explanations must be added, to act as a manual for other technicians who will be undertaking similar tasks in a future.

Documentation template is provided in list of documents.

# TASK C



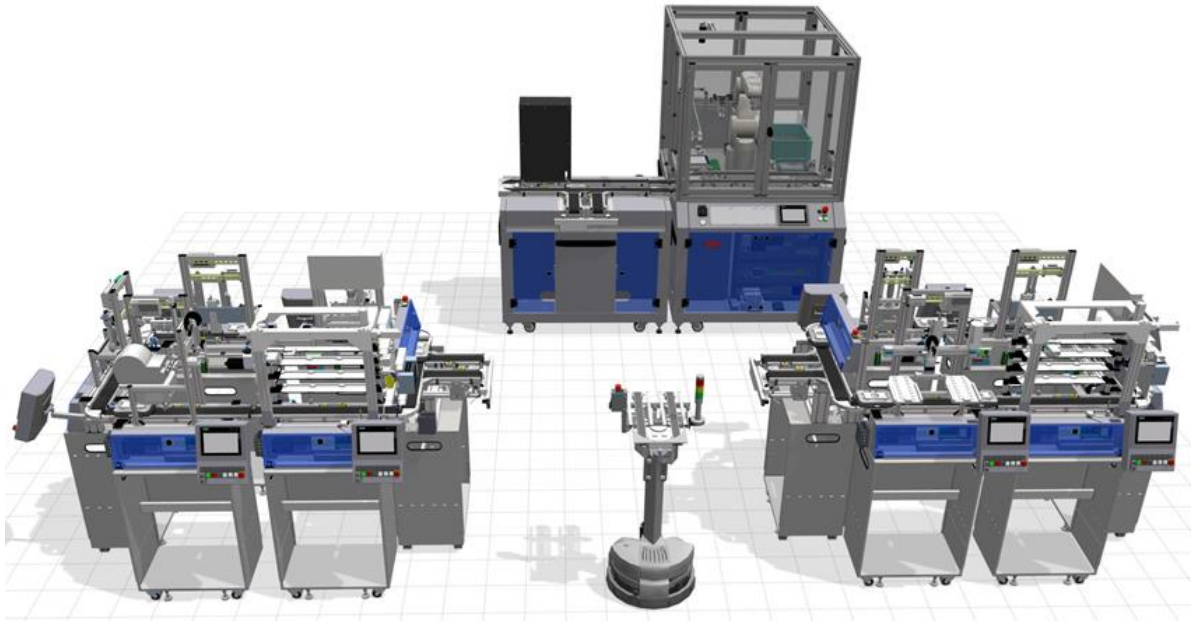
## MES4

## List of documents

No	Item description	Link
1	MES4 user manual	<a href="#">Download link</a>
2	Additional MES4 manual	<a href="#">Download link</a>
3	CIROS manual	<a href="#">Download link</a>
4	CIROS 6.4 model	*To be provided*

## Description of a task

Customer is in a process of introducing a digital shadow to their already existing system. Your task is to configure an MES4 system according to production line's specification, connect it to digital model and observe results.



Your task will be completed when:

1. MES4 resources are configured according to Specification 1.
2. Production orders are set up according to Specification 2.
3. Customer order is set up according to Specification 3.

## Specification 1 - MES4 configuration



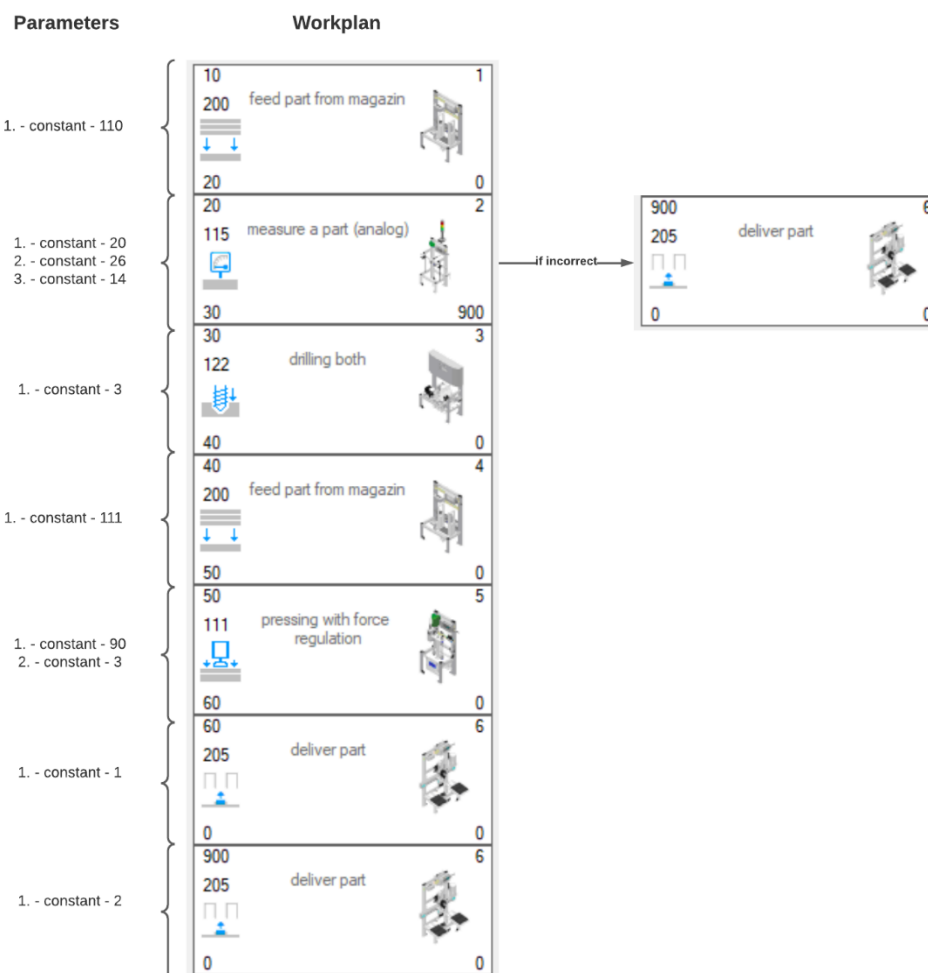
Resources must be configured according to the table below:

No.	Resource ID	Resource	IP Address
1.1	1	CP-AM-MAG-FRONT (BLACK)	12.7.0.0.1
1.2	2	CP- AM -MEAS	12.7.0.0.1
1.3	3	CP- AM -iDRILL	12.7.0.0.1
1.4	4	CP-AM-MAG-BACK (BLACK)	12.7.0.0.1
1.5	5	CP- AM -MPRESS	12.7.0.0.1
1.6	6	CP- AM -OUT	12.7.0.0.1

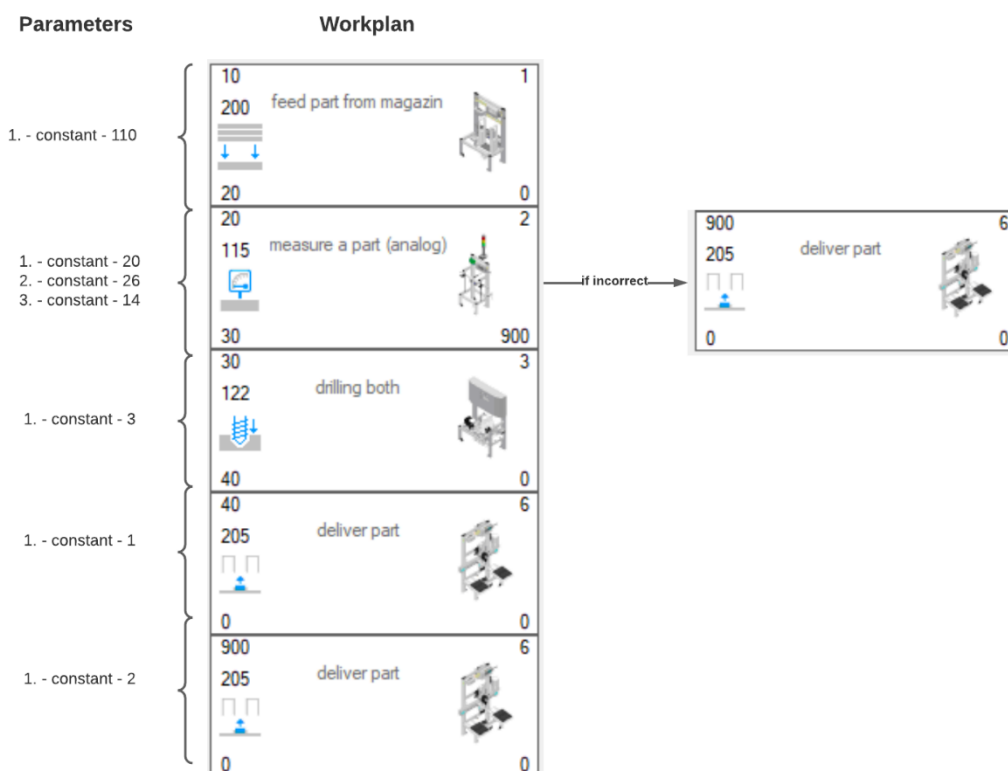
## Specification 2 – Production orders

Create 2 parts and their workplans for production order according to specification below. Provide parts with most accurate pictures from standard library of MES4 provided.

No.	Item description	Value / Type
2.1	Workplan and part number	2020
2.2	Name	Black complete
2.3	Type	production
2.4	Resources included in the workplan	1,2,3,4,5,(6)
2.5	Workplan order	*Refer to flow chart below
2.6	Error step included?	Yes



No.	Item description	Value / Type
2.7	Workplan and part number	2021
2.8	Name	Black front cover drilled
2.9	Type	production
2.10	Resources included in the workplan	1,2,3,(6)
2.11	Workplan order	*Refer to flow chart below
2.12	Error step included?	Yes



### Specification 3 – Customer order

Create part and its workplan for customer order according to specification below. Provide part with most accurate picture from standard library of MES4 provided.

**Note:** Even that bottom cover at step 40 is left on changeable, only option for part 111 should appear in final order creation window.

No.	Item description	Value / Type
3.1	Workplan and part number	3020
3.2	Name	Custom complete
3.3	Type	customer
3.4	Resources included in the workplan	1,2,3,4,(6)
3.5	Workplan order	*Refer to flow chart below
3.6	Error step included?	Yes

