Automation – Major Task – MTC 313

TEAM 8

18P8506	**Ahmed Ossama El-Sayed**
18P4188	Haidy Emad Samir Abouelnasr
18P5892	Tasneem Mohamed Mansour
1805479	Arwa Ashraf Mahmoud Farag
18P8983	Mahmoud Magdy El-Asmar

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INTRODUCTION

A production line is a series of sequential operations set up in a factory where components are assembled to make a finished product. Usually, a production line includes feeding, sorting, assembly, and storing stations. A production line is designed to increase efficiency by minimizing the movement of parts and people to the greatest extent feasible.

The production line consists of multiple components:

1) Sensors: (vision sensor -IR sensors-limit switches)
2) Actuators: (pick & place robots -conveyors- CNC machines)
3) Manual control panels (start -stop -emergency stop)
4) PLC (siemens S7 314c pn/dp)

This production line is simulated using FACTORY I/O connected to Siemens TIA Portal, Programmed with Ladder diagram.

An HMI -device is (TP_700)- is presented to allow tracking the activity of the station, the amount of products assembled

PRODUCTION LINE ON FACTORY I/O

➢ Feeding Unit

This unit can be considered as the beginning of the production line, where it generates the random raw materials, one emitter for each color. It also incorporates a pick & place robot which can be used to place the fed part to the beginning of your line.

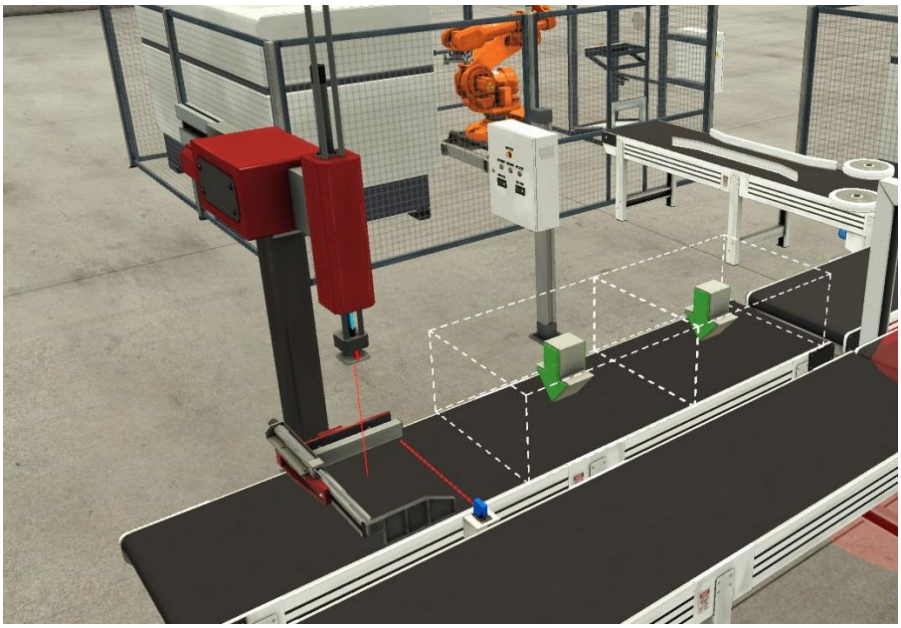


Figure 1: feeding Station, one emitter for each color

➢ Sorting Unit

Sortation is the process where the raw materials are identified on the conveyor and separated based on their color in order to get prepared for their next stations. The sorting is done with vision sensor configured to detect green raw materials. When a green material is detected, the clamp after it raises to allow the product to get to the machining center of green products. If the product is blue, the clamp will stay in place and hold on product, then the pick and place machine will transport it to its conveyors.

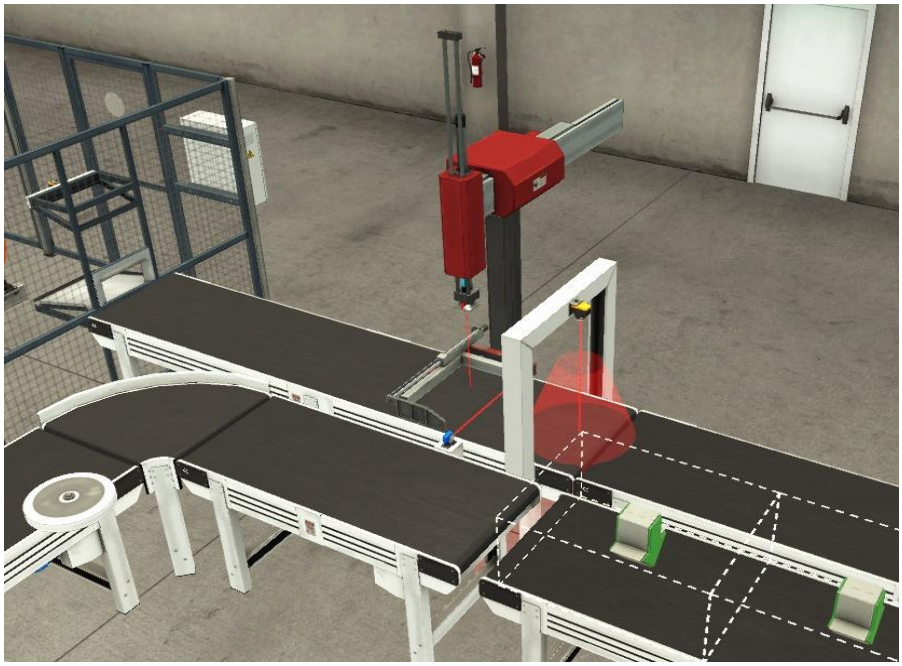


Figure 2: Sorting Station

➢ Machine Centre

The Machining Center is a station used to manufacture lids and bases from raw materials. First, the articulated robot waits for raw material to be placed at the entry bay. When new material is detected, it is loaded into the CNC machine which will start manufacturing an item. Each item type takes a different interval of time to be produced (lids: 6 seconds; bases: 3 seconds). Once the operation is complete, the robot places the item on the exit bay.

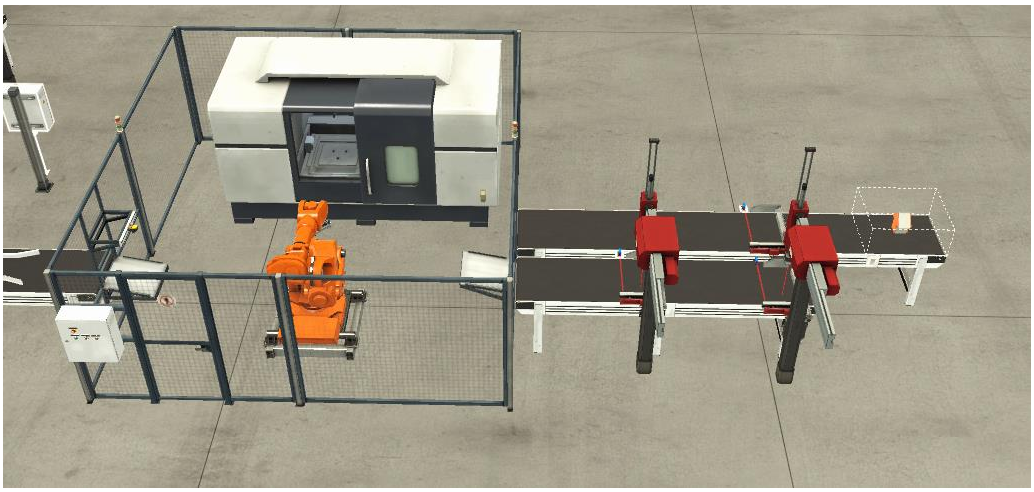
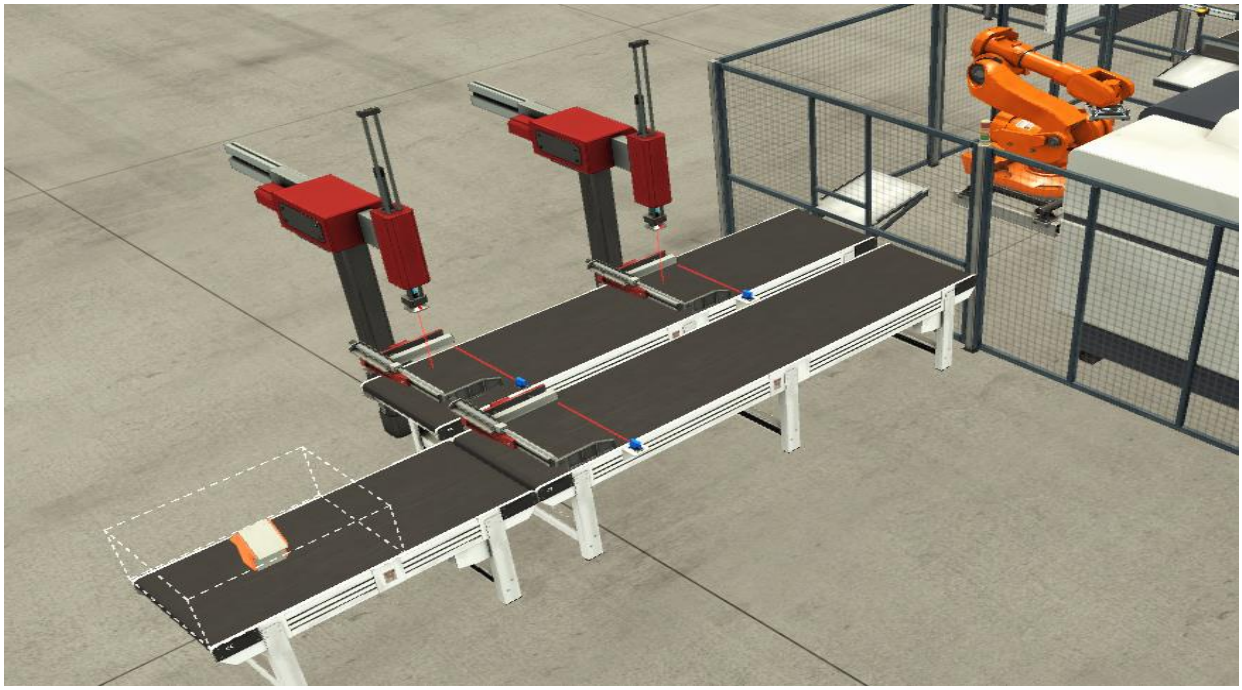


Figure 3:Machine center

➢ Assembly Unit

- The Assembly station is where the items are picked and placed from one place to another. Bases and lids are properly aligned by positioning bars to guarantee a correct fit. It has two pick an place machines and three clamps. The pick and place machine transfers the base of the product to the next conveyor where it held with the positioner waiting for the lid to be assembled with it. The second pick and place is responsible for the assembly of the lid over the base. After assembly is done, the positioner holding the assembled products will raise so they can be moved from the production line.



Driver:

The scene is connected to Siemens S7-PLCSIM driver. The addresses of the inputs and outputs were adjusted from the “configuration” tab to match the addresses in TIA-Portal

Figure 5: Factory io driver

FULL LADDER DIAGRAM ON TIA PORTAL

- PLC Tags

p		

4Production_line_project / PLC_1 [CPU 314C-2 PN/DP]

PLC tags

	Name	Data type	Address	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Supervision	Comment
	Start	Bool	%I0.0		True	True	True		
	Stop_LED	Bool	%Q4.2		True	True	True		
	Stop	Bool	%I0.1		True	True	True		
	Start_LED	Bool	%Q4.1		True	True	True		
	Feeding_conv1	Bool	%Q4.3		True	True	False		
	Feeding_ir_sensor	Bool	%I0.2		True	True	True		
	Feeding_clamp_state	Bool	%I0.3		True	True	True		
	Feeding_gripper_z	Bool	%Q4.4		True	True	True		
	Feeding_gripper_x	Bool	%Q4.5		True	True	True		
	Feeding_gripper_suction	Bool	%Q4.6		True	True	True		
	Feeding_gripper_suction_state	Bool	%I0.4		True	True	True		
	Feeding_gripper_Zmoving	Bool	%I0.5		True	True	True		
	Feeding_gripper_Xmoving	Bool	%I0.6		True	True	True		
	Emergency	Bool	%I0.7		True	True	True		
	Feeding_clamp	Bool	%Q4.7		True	True	True		
	try	Int	%IW288		True	True	True		

M_Feeding_ir_sensor	Bool	%M0.0		True	True	True		
M_feeding_zmoving	Bool	%M0.2		True	True	True		
Clamp_time_elapsed	Time	%MD2		True	True	True		
Feeding_Clamp_Timer	Timer	%T0		True	True	True		
M_feeding_zmoving2	Bool	%M0.3		True	True	True		
M_feeding_zmoving3	Bool	%M0.4		True	True	True		
M_feeding_zmoving4	Bool	%M0.5		True	True	True		
M_feeding_xmoving	Bool	%M0.1		True	True	True		
Feeding_conv2	Bool	%Q5.0		True	True	True		
F_started	Bool	%M0.6		True	True	True		
F_ended	Bool	%M0.7		True	True	True		
Feeding_conv3	Bool	%Q5.1		True	True	True		
Feeding_conv4	Bool	%Q5.2		True	True	True		
Feeding_conv5	Bool	%Q5.3		True	True	True		
Feeding_conv6	Bool	%Q5.4		True	True	True		
Color_sensor	Bool	%I1.0		True	True	True		
Sorting_clamp_raise	Bool	%Q5.5		True	True	True		
Sorting_clamp	Bool	%Q5.6		True	True	True		

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Totally Integrated Automation Portal

Name	Data type	Address	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Supervision	Comment
Sorting_clamp_state	Bool	%I1.1		True	True	True		
Sorting_suction_state	Bool	%I1.2		True	True	True		
Sorting_gripper_Zmoving	Bool	%I1.3		True	True	True		
Sorting_gripper_Xmoving	Bool	%I1.4		True	True	True		
Sorting_suction	Bool	%Q5.7		True	True	True		

	Sorting_gripper_Z	Bool	%Q6.0		True	True	True		
	Sorting_gripper_X	Bool	%Q6.1		True	True	True		
	Sorting_ir_sensor	Bool	%I1.5		True	True	True		
	M_sorting_ir_sensor	Bool	%M1.0		True	True	True		
	Sorting_gripper_start	Bool	%M1.1		True	True	True		
	Sorting_gripper_end	Bool	%M1.2		True	True	True		
	Mc_centre_green_start	Bool	%Q6.2		True	True	True		
	Mc_centre_blue_start	Bool	%Q6.3		True	True	True		
	Green_conv_1	Bool	%Q6.4		True	True	True		
	Green_conv_2	Bool	%Q6.5		True	True	True		
	Green_conv_3	Bool	%Q6.6		True	True	True		
	Blue_conv_1	Bool	%Q6.7		True	True	True		
	Blue_conv_2	Bool	%Q7.0		True	True	True		
	Blue_conv_3	Bool	%Q7.1		True	True	True		
	GreenLid_ir_sensor	Bool	%I1.6		True	True	True		
	GreenBody_ir_sensor	Bool	%I1.7		True	True	True		
	GreenAsm_ir_sensor	Bool	%I2.0		True	True	True		
	GreenLid_Z	Bool	%Q7.2		True	True	True		
	GreenLid_X	Bool	%Q7.3		True	True	True		
	GreenLid_Suction	Bool	%Q7.4		True	True	True		
	GreenLid_clamp	Bool	%Q7.5		True	True	True		
	Green-Lid_clamp_raise	Bool	%Q7.6		True	True	True		
	GreenLid_Zmoving	Bool	%I2.1		True	True	True		
	GreenLid_Xmoving	Bool	%I2.2		True	True	True		
	Green-Lid_clamp_state	Bool	%I2.3		True	True	True		
	GreenLid_suction_state	Bool	%I2.4		True	True	True		
	M_greenLid_ir_sensor	Bool	%M1.3		True	True	True		
	GreenLid_started	Bool	%M1.4		True	True	True		
	GreenLid_ended	Bool	%M1.5		True	True	True		
	Mc_green_opened	Bool	%M1.6		True	True	True		
	Mc_centre_green_opened	Bool	%I2.5		True	True	True		

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	Name	Data type	Address	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Supervision	Comment
	Mc_centre_blue_opened	Bool	%I2.6		True	True	True		
	Mc_green_produceLids	Bool	%Q7.7		True	True	True		
	Mc_blue_produceLids	Bool	%Q8.0		True	True	True		
	M_green_toggle	Bool	%M1.7		True	True	True		
	GreenBody_suction_state	Bool	%I3.0		True	True	True		
	GreenBody_Zmoving	Bool	%I3.1		True	True	True		
	GreenBody_Xmoving	Bool	%I3.2		True	True	True		
	Green-Body_clamp_state	Bool	%I2.7		True	True	True		
	GreenBody_gripper_Z	Bool	%Q8.1		True	True	True		
	GreenBody_gripper_X	Bool	%Q8.2		True	True	True		
	GreenBody_clamp	Bool	%Q8.3		True	True	True		
	GreenBody_suction	Bool	%Q8.4		True	True	True		
	M_greenBody_ir_sensor	Bool	%M6.0		True	True	True		
	GreenBody_started	Bool	%M6.1		True	True	True		
	GreenBody_ended	Bool	%M6.2		True	True	True		
	M_greenAsm_ir_sensor	Bool	%M6.3		True	True	True		
	GreenAsm_clamp	Bool	%Q8.5		True	True	True		
	GreenAsm_raise	Bool	%Q8.6		True	True	True		
	M_greenbodyEnded	Bool	%M6.4		True	True	True		
	Mc_blue_opened	Bool	%M6.5		True	True	True		
	M_blue_toggle	Bool	%M6.6		True	True	True		
	BlueLid_clamp_raise	Bool	%Q9.6		True	True	True		
	BlueLid_ir_sensor	Bool	%I3.3		True	True	True		
	M_BlueLid_ir_sensor	Bool	%M6.7		True	True	True		
	BlueLid_clamp	Bool	%Q9.5		True	True	True		

BlueLid_ended	Bool	%M7.0		True	True	True		
BlueLid_started	Bool	%M7.1		True	True	True		
BlueLid_clamp_state	Bool	%I3.4		True	True	True		
BlueLid_suction_state	Bool	%I3.5		True	True	True		
BlueLid_Xmoving	Bool	%I3.6		True	True	True		
BlueLid_Zmoving	Bool	%I3.7		True	True	True		
BlueLid_Suction	Bool	%Q9.4		True	True	True		
BlueLid_Z	Bool	%Q9.2		True	True	True		
BlueLid_X	Bool	%Q9.3		True	True	True		
BlueLid_ir_sensor(1)	Bool	%Q8.7		True	True	True		
BlueBody_ir_sensor	Bool	%I4.4		True	True	True		
BlueAsm_ir_sensor	Bool	%I4.5		True	True	True		

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Totally Integrated Automation Portal

Name	Data type	Address	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Supervision	Comment
M_blueBody_ir_sensor	Bool	%M7.2		True	True	True		
BlueBody_clamp	Bool	%Q10.3		True	True	True		
BlueBody_started	Bool	%M7.3		True	True	True		
Blue-Body_clamp_state	Bool	%I4.0		True	True	True		
BlueBody_ended	Bool	%M7.4		True	True	True		
BlueBody_suction_state	Bool	%I4.1		True	True	True		
BlueBody_Zmoving	Bool	%I4.2		True	True	True		
BlueBody_Xmoving	Bool	%I4.3		True	True	True		
BlueBody_suction	Bool	%Q10.4		True	True	True		
BlueBody_gripper_Z	Bool	%Q10.1		True	True	True		
BlueBody_gripper_X	Bool	%Q10.2		True	True	True		
M_BlueAsm_ir_sensor	Bool	%M7.5		True	True	True		

	BlueAsm_clamp	Bool	%Q10.5		True	True	True		
	M_bluebodyEnded	Bool	%M7.6		True	True	True		
	BlueAsm_raise	Bool	%Q10.6		True	True	True		
	Blue_timer_memory	Bool	%M7.7		True	True	True		
	Green_timer_memo-ry	Bool	%M8.0		True	True	True		
	Feeding_Station_On	Bool	%M8.1		True	True	True		
	Sorting_Station_On	Bool	%M8.2		True	True	True		
	MC_Blue_On	Bool	%M8.3		True	True	True		
	MC_Green_On	Bool	%M8.4		True	True	True		
	Asm_Station_Blue_On	Bool	%M8.5		True	True	True		
	Asm_Station_Green_On	Bool	%M8.6		True	True	True		
	Green_Product_Finished	Bool	%M8.7		True	True	True		
	Blue_Product_Finished	Bool	%M9.0		True	True	True		
	Result_Blue	Int	%MW12		True	True	True		
	Result_Green	Int	%MW14		True	True	True		
	Current_Value_Blue	Int	%MW20		True	True	True		
	Blue_Counter_On	Bool	%M9.1		True	True	True		
	Green_Counter_On	Bool	%M9.2		True	True	True		
	Current_Value_Green	Int	%MW9		True	True	True		
	Result_Blue1	Int	%MW16		True	True	True		
	Result_Green1	Int	%MW18		True	True	True		
	M_MC_On	Bool	%M11.0		True	True	True		
	M_MC_On_Reset	Bool	%M11.1		True	True	True		
	Green_Count	Int	%QW100		True	True	True		

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Totally Integrated Automation Portal		

	Name	Data type	Address	Retain	Accessible from HMI/OPC UA/Web API	Writable from HMI/OPC UA/Web API	Visible in HMI engineering	Supervision	Comment
	MC_Green_Busy	Bool	%I4.6		True	True	True		
	MC_Blue_Busy	Bool	%I4.7		True	True	True		
	Blue_Count	Int	%QW102		True	True	True		
	M_bluebodyEnded2	Bool	%M11.2		True	True	True		
	M_sorting_end	Bool	%M11.3		True	True	True		
	Emit_Green	Bool	%Q4.0		True	True	True		
	M_emitGreen_toggle	Bool	%M11.4		True	True	True		
	Emit_Blue	Bool	%Q9.0		True	True	True		

HMI

➢ HMI Tags:

Name	Path	Connection	PLC tag	DataType	Length	Coding	Access Method	Address
Sorting_on	Default tag table	HMI_Connection_2	Sorting_Station_On	Bool	1	Binary	Absolute access	%M8.2
Feeding_on	Default tag table	HMI_Connection_2	Feeding_Station_On	Bool	1	Binary	Absolute access	%M8.1
MC_Blue_on	Default tag table	HMI_Connection_2	MC_Blue_Busy	Bool	1	Binary	Absolute access	%I4.7
MC_Green_on	Default tag table	HMI_Connection_2	MC_Green_Busy	Bool	1	Binary	Absolute access	%I4.6
Assembly_Blue_on	Default tag table	HMI_Connection_2	Asm_Station_Blue_On	Bool	1	Binary	Absolute access	%M8.5
Assembly_Green_on	Default tag table	HMI_Connection_2	Asm_Station_Green_On	Bool	1	Binary	Absolute access	%M8.6
Blue_Count	Default tag table	HMI_Connection_2	Blue_Count	Int	2	Binary	Absolute access	%QW102
Green_Count	Default tag table	HMI_Connection_2	Green_Count	Int	2	Binary	Absolute access	%QW100

- HMI :

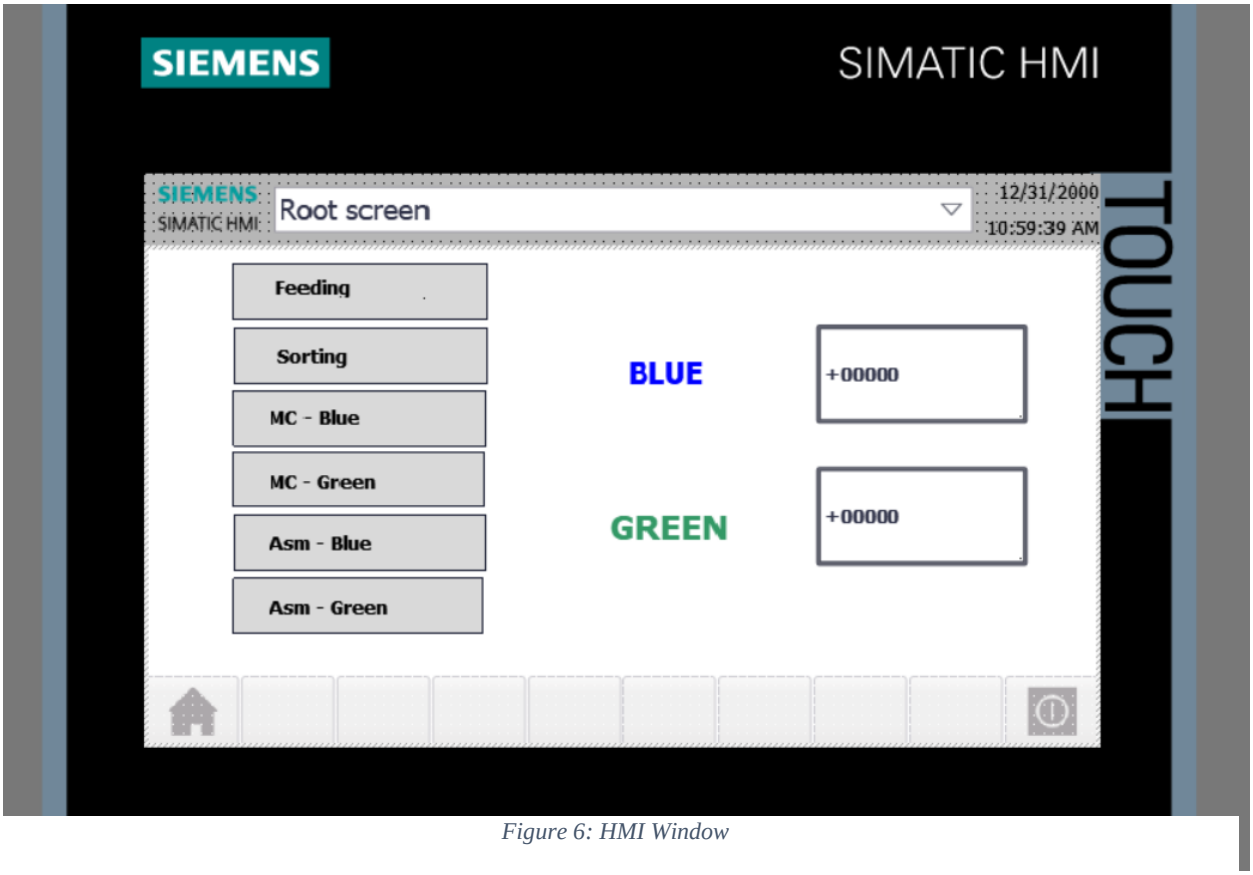


Figure 6: HMI Window

OUTPUT VIDEOS

https://drive.google.com/file/d/1vqAex74G33eqgLzMgFKmmiMdureY11x2/view?usp=sharing

CONCLUSION AND RESULT ANALYSIS

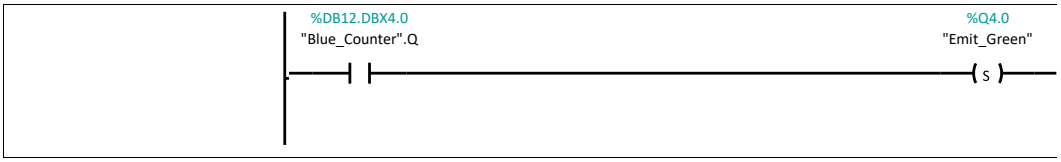
-The existence of such simulation tools makes the design process much easier and less risks are taken,

Costs are cut because less probability of failure in testing and prototyping.

-Similar outputs could be reached by different logic diagrams but sometimes one is more optimized.

-We found that the response on Factory I/O was different for each run of the simulation even though no changes were made.

-To fix a problem that happened in Factory I/O where the green emitter is stopped when the blue counter is reached its required number of parts, so, we made sure that the green emitter is set when the blue counter is elapsed.



CONTRIBUTION

Members	Contribution %
Ahmed Ossama El-Sayed	**- Making production line in factory io** **- helped with programming**
Haidy Emad Samir Abouelnasr	- **HMI** - **Helped program assembly and machining of blue product**
Tasneem Mohamed Mansour	**-Helped program assembly and machining of blue product** **-HMI**
Arwa Ashraf Mahmoud Farag	**-programmed feeding and sorting** **-machining and assembly of green product** **-HMI**
Mahmoud Magdy El-Asmar	**-helped with programming in blue product** **-HMI**