# AUTOMATION OF A MANUFACTURING PROCESS USING RSLOGIX 5000 AND FACTORY TALK VIEW – AUTOMATIZAREA PROCESULUI DE FABRICATIE FOLOSIND RSLOGIX 5000 SI FACTORY TALK VIEW

**ICĂ Sebastian-Ionuț[1], NICOLESCU Adrian[2]**

Faculty: IIR, Specialization: Robotics, Year of study: Masters II, e-mail: icasebastian@gmail.com,
[2]Professor PhD, Faculty: FIIR, Dept. Robots and Manufacturing Systems
Coordinator: Prof. dr. Ing. **Adrian NICOLESCU**

*Abstract: Will be studied the automation process of a continous manufacturing flow which will integrate various devices created in Factory I/O simulation software. The application will be linked with a virtual programmable logic computer which will run the ladder program for the used devices using Allen-Bradley software such as RSLogix/Studio 5000, Factory Talk View and Factory Talk Linx.*

*Key words: Studio 5000, Factory Talk View, Factory I/O, Allen-Bradley, PackML*

## 1. Introduction

**Industrial automation[1]** is an interdisciplinary domain between mechanical and electrical engineering, as part of engineering science, which is using different methods which are leading to the automation of machines and/or industrial processes for independent work, without human intervention. The complexity and independency of the machines defines their dificulty for automation.

**Allen-Bradley** is a company which is specialized in producing equipments specific for automation, owned today by Rockwell Automation. The company produces industrial components such as programmable logic controllers (PLCs), Human-Machine interfaces (HMIs), sensors and transducers, different safety sistems and components, frequency drives as well as softwares for each individual part.

**Studio 5000 Logix Designer** is the software where the PLC logic is produced. It is used to define industrial logic of different manufacturing processes and is the main link between the PLC and the other devices which are used for automation.

**Studio Logix Emulate** is a PLC emulatior used to validate, test and optimize the control logic without the need of a physical controller.

**FactoryTalk View ME (machine edition)** is a software for creating and commissioning the human machine interface display for Allen-Bradley hardware.

**Factory I/O** is an educational software which creates a virtual industrial control system for industrial programming. You can create different working scenes of different complexities which can be automatized later on using an emulated or real PLC.

## 2. Developing and configuration of a manufacturing process using Factory/IO software.

A manufacturing flow have been created which includes a rejection zone of raw parts, a processing station and a transfer station to a packing line. (which needs additional development)

*Figure 1. The virtual prototype of the manufacturing flow*

**The rejection zone** is integrated in the entrance of the raw materials. The objects are scanned by a Vision camera which will send the result to the programmable logic controller for interpretation. If the objects are considered to be scrap they will be removed from the line by the sorting 3-way roller conveyor.

*Figure 2. The rejection zone of the raw-parts*

**The processing CNC center** is a working station used to manufacture  finished products from the raw materials. The articulated arm robot is waiting for the raw parts in the pick-up area and feed the CNC machine with it. After the milling process is done the robot will take the finished product from the lathe machine and will place it in the exit conveyor.

*Figure 3. Processing centre*

After the finished products are made it is necessary to get them to a packing zone by a transfer station. For this task it is used a cartezian robot with 2 programmable axis, X and Z. The robot will take with the pneumatic end-effector the finished products and will place them in a box which comes from a roller conveyor. After the robot is creating a 3 pieces stack the roller conveyor will take the box away to a packing area.

*Figure 4. Transfer station*

## 2.1 How Factory I/O scenes are configured to create an automation process ready to be programmed.

All the instances which can be created in Factory I/O [2] have attached at least one digital or analogic signal that can be used in the PLC logic. The device signal will appear in the I/O tree. Every signal is configurable so it gives the programmer flexibility. For example a retro-reflexive barrier sensor is standard configured as having a normally open behavior but it's signal can be also transformed into a normally closed one.


*Figure 5. Assembly of the manufacturing line*

Down are summed up the following devices used for the automation process:

1. Roller and belt conveyors ( Equipped later-on with guidance systems for the flow parts )

*Figure 6. Types of conveyors used in project*

They will generate inside the I/O tree 2 BOOL outputs which can be programmed in the PLC logic. (DO – Move forward ; DO – Move reverse)

2. Retro-reflexive barriers

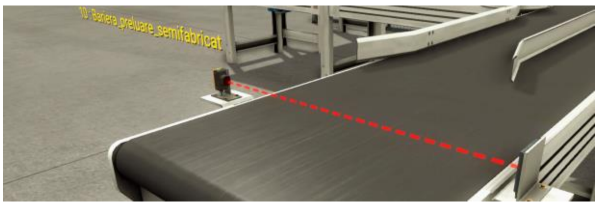


*Figure 7. Barrier type sensor*

It will send only one BOOL signal to the PLC. It is a digital input default defined as a normally opened sensor. (DI – Part is present)

3. Capacitive sensor

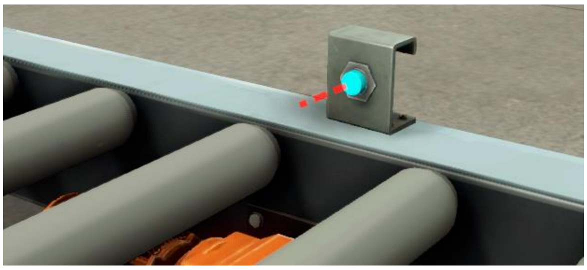

*Figure 8. Capacitive sensor*

Similar to the retro-reflexive barrier but different by functionality. This sensor is not based on the reflector, it will work by sensing different material objects placed within 20cm from it's emitter.

4. Cartezian robot

*Figure 9. Cartezian robot*

The cartezian robot have 6 digital signals from which 3 are inputs and the others are outputs. (DO – Axis Z movement / DI – Axis Z Feedback ; DO – Axis X movement / DI – Axis Z feedback; DO – Vacuum gripper actuate / DI – Vacuum gripper actuated feedback )

5. Visioin camera

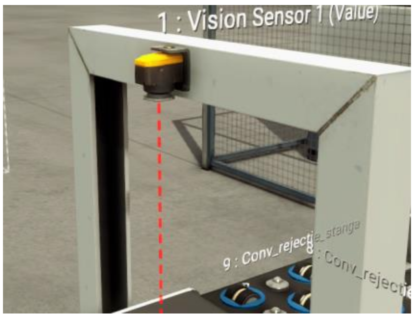


*Figure 10. Vision camera*

The vision camera have been configured to send to the PLC the numerical value of 1 for the scrap parts and 4 for the good parts. (Operating range is 30-200cm)

6. Sorting conveyor (used for rejection)

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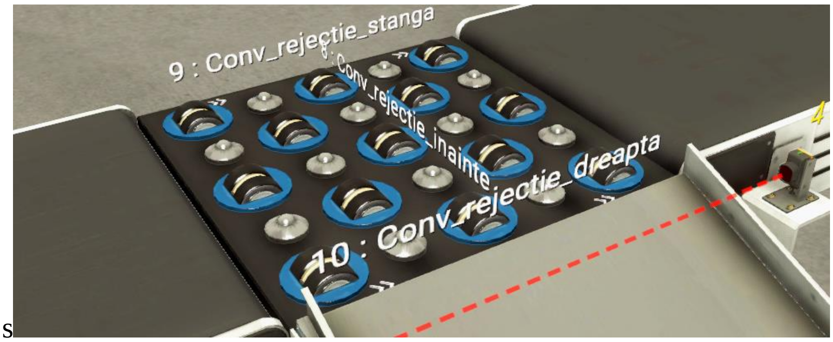


*Figure 11. Sorting conveyor*

The sorting conveyor have 3 digital outputs and it is used to reject the scrap parts out of the manufacturing process. ( 3 x DO – Forward / Left / Right )

7. Processing center

*Figure 12. Lathe machine with industrial robot*

The centre have 3 digital outputs and 3 digital inputs. (3 x DO – Start/Stop/Reset ; 3 x DI – Busy/Error/Opened)

8. InFeeders / OutFeeders

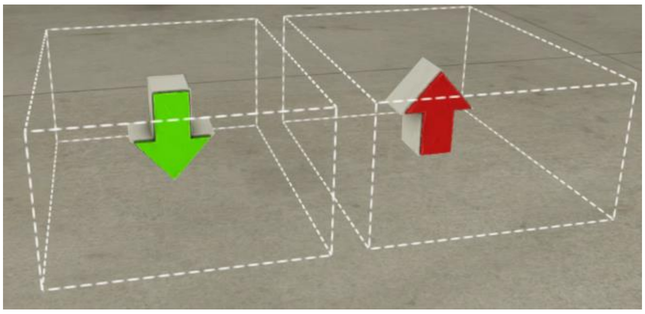

*Figure 13. Infeeder/Outfeeder*

With the configuration of an infeeder (green arrow) we can bring different materials into our flow at a defined amount of time. With the outfeeders (red arrow) we can erase parts out of the processing flow. (For example full pallets or scrap parts)

### 3. Configuring the communication between the used softwares. (Studio 5000 – FactoryTalk View – Factory I/O – Studio Logix Emulate)

The programs[3] need to communicate to each other for a successful simulation between the running ladder program developed in Studio 5000, the HMI created in FactoryTalk View ME as well as making the all the machines move in Factory I/O. To make this possible we will use FactoryTalk Linx, a communication software developed by Rockwell Automation used to link all the programs and to access the virtual PLC created in Logix 5000 emulate.

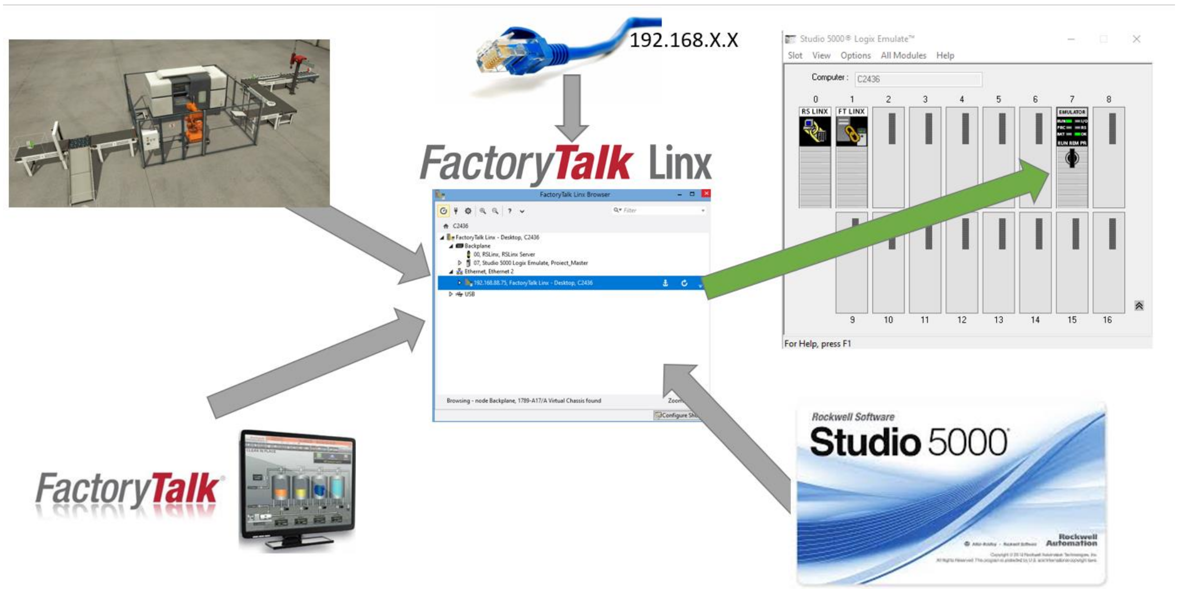


*Figure 14. Communication diagram*

1. Creating the PLC in Studio Logix Emulate on a virtual backplane.

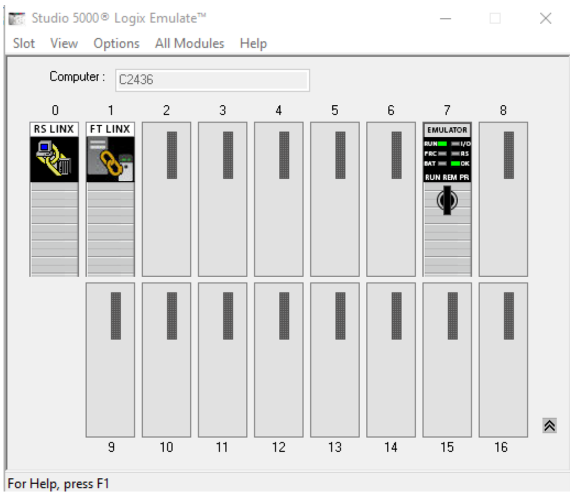


*Figure 15. The virtual PLC on the 7th slot of the rack*

2. Linking the PLC program with the emulated PLC. At this point the program can be downloaded and run online.

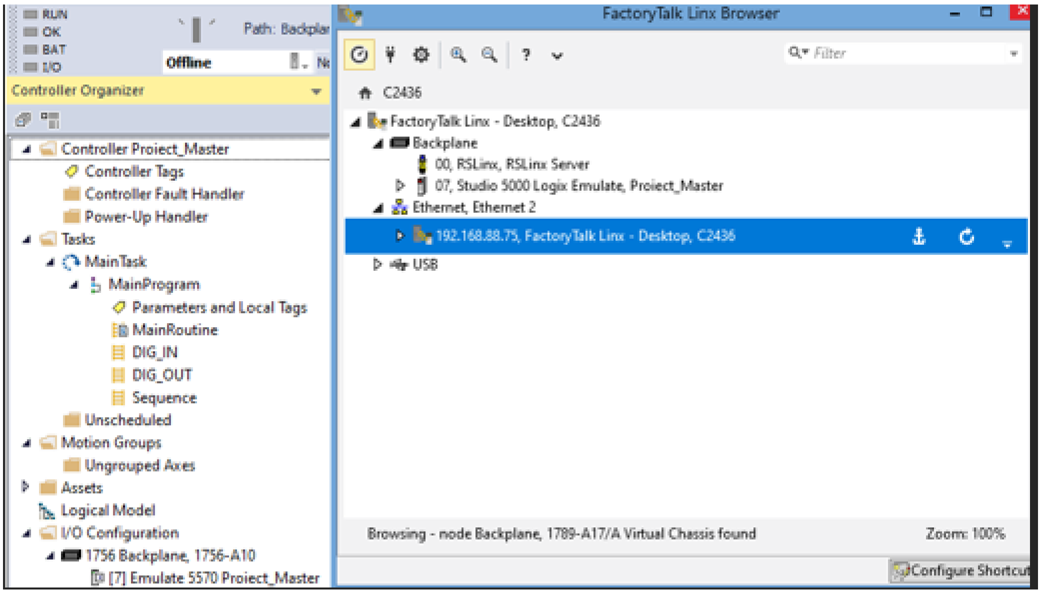

*Figure 16. Establishing communication between Stuudio 5000 and FTLinx*

3. Assigning a topic in FactoryTalk View ME which will be linked to the 7th slow of the previously created virtual backplane. At this point the HMI will communicate with the PLC.

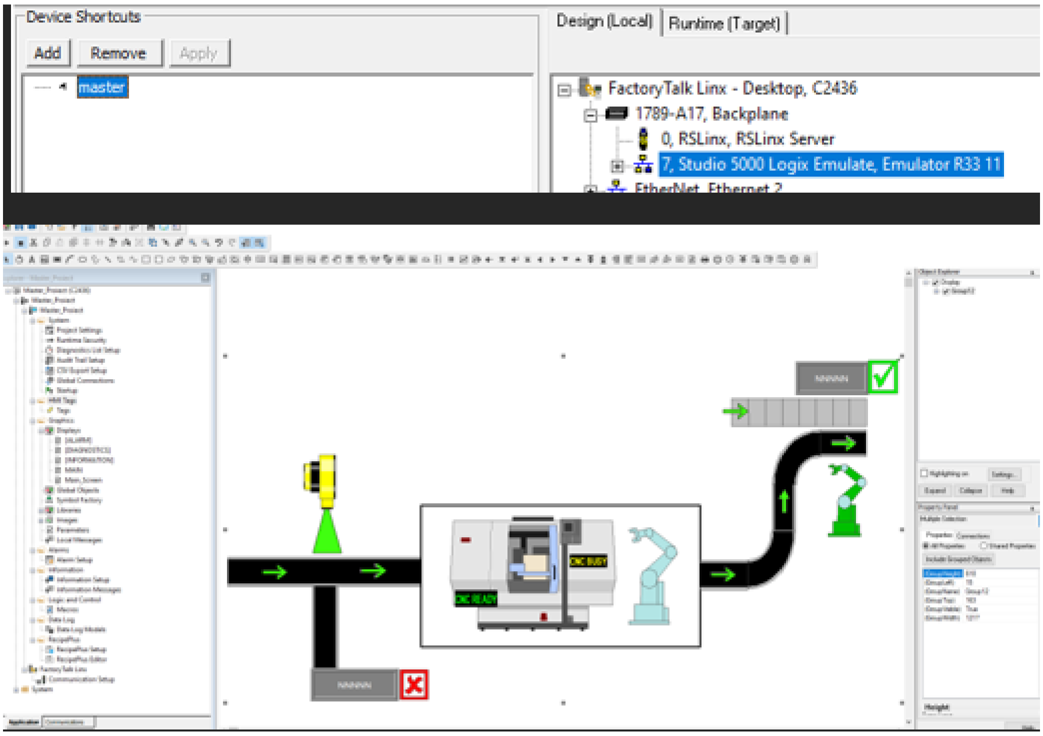

*Figure 17. Communication between Studio 5000 and FactoryTalk View*

4. Configuration of the Logix 5000 module in Factory I/O and assigning tags to the PLC.

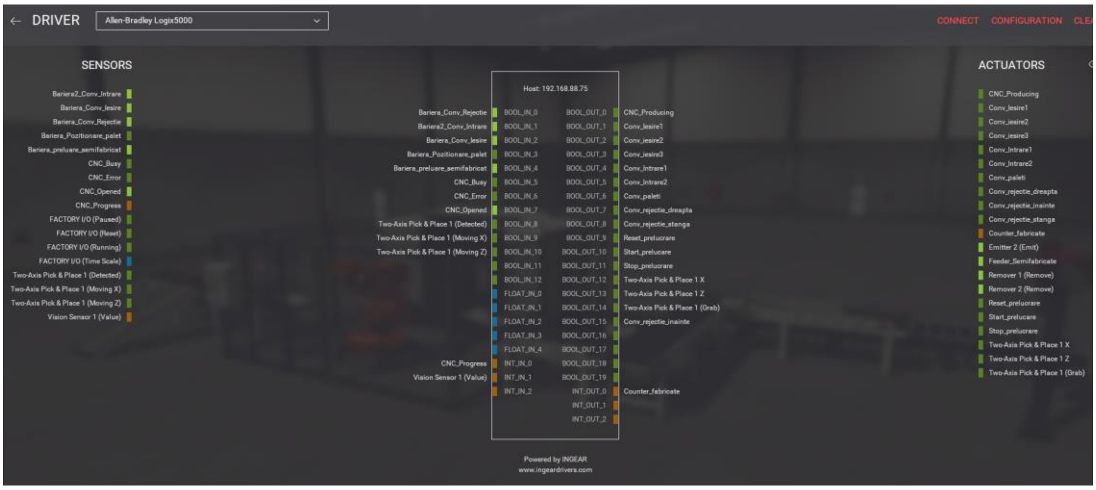


*Figure 18. I/O mapping between Factory I/O and PLC*

## 3.1 Programming approach in ladder language of the manufacturing process in Studio 5000.

A good practice[4] at a start of a project is to structure everything in routines. For the studied project will exist 3 routines: DIG_IN (where digital inputs will be mapped) ; DIG_OUT (where digital outputs will be mapped) ; Sequence (where the process automation logic will execute).

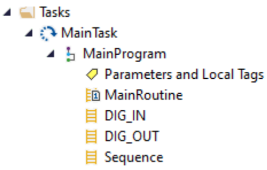


*Figure 19. Routines structure*

Assigning digital inputs to local bits for easy use.

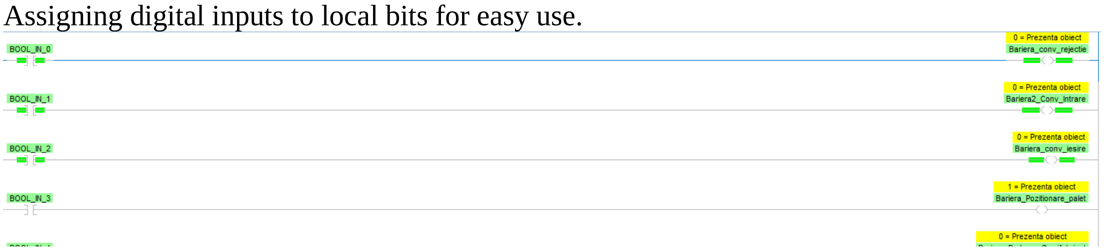


*Figure 20. DIG_IN routine*

Assigning local bits to digital outputs towards Factory I/O.

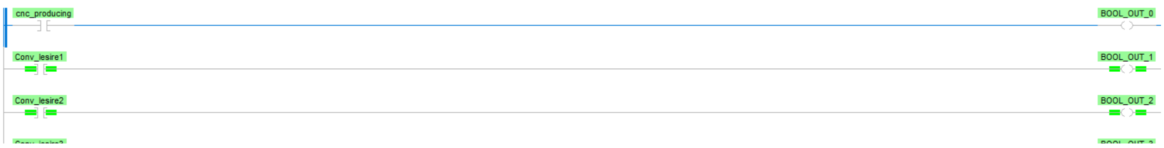


*Figure 21. DIG_Out routine*

Process sequence was created in a single routine named “Seq” in which is running the logic for rejection, manufacturing and transfer.

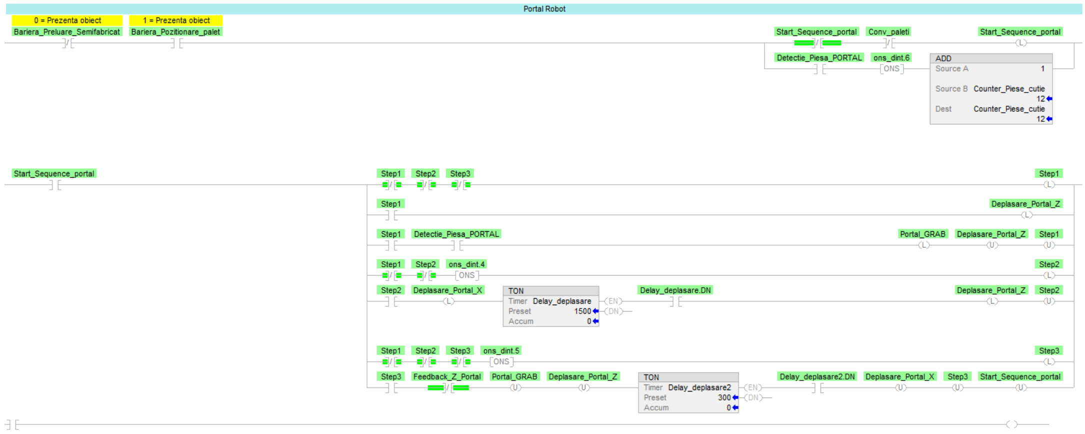

*Figure 22. Logic for the transfer station*

## 3.2 HMI application approach

Symbol Factory was used to create the objects in the HMI application. It is a library incorporated in FactoryTalk Machine edition full of industrial components ready to be linked to an application. Visualization for the following components have been created:

- Identification of a good and a scrap part
- Counter for scrap parts
- Counter complete pallets
- Feedback for the conveyors movements
- Status of the processing center
- Status of the cartezian robot

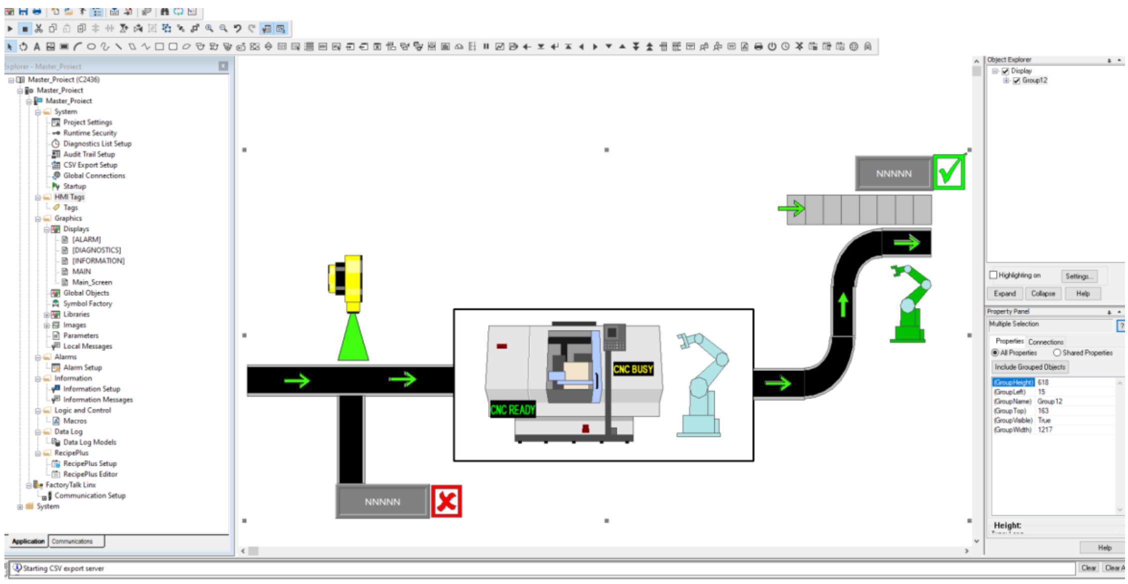


*Figure 23. Application in FactoryTalk View*

### 3.3 Introduction in the PackML , a packing machines software developed by OMAC

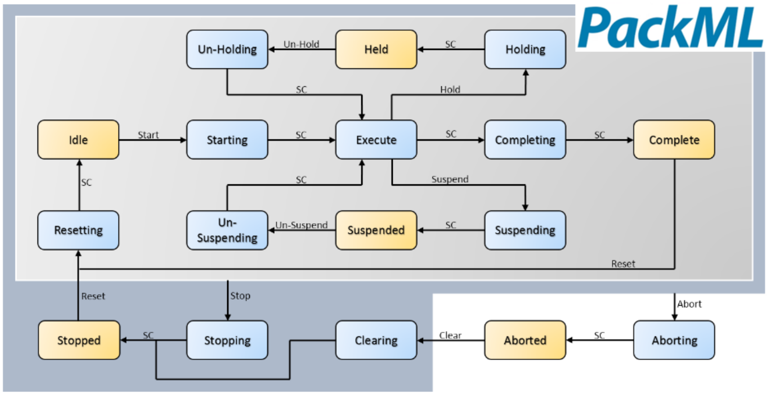


*Figure 24. PackML standard with the symbolic 17 machine states*

PackML (Packaging machine language) is a programming standard developed for machines used in packing lines which includes PLC logic as well as HMI interfaces. It was created by OMAC (Organization for machine automation) in collaboration with strong names from the industry such as Siemens, Rockwell, Omron and Schneider.

The programming of the machine is made by following 17 states which are attributed to the machine's behavior in a complete working cycle. By complexity of the machine we can use all the states provided or we can team up only with 4 main states which are Idle, Execute, Stopped and Aborted.

### 3.3 OEMs and packing lines

An OEM ( Original equipment manufacturer) is a patented machine created by a vendor. Many times this type of machines are complex, unique and mainly programmed in the vendor's local programming standard.

*Figure 25. OEMs*

The integration[5] for such machines can get very difficult because of it's diversity in programming and HMI visualization. By this means an international client will always request from a vendor standardization in a packing/macking software which their company is familiar with.

## 3.4 Developing and programming of cartezian palletizer using PackML

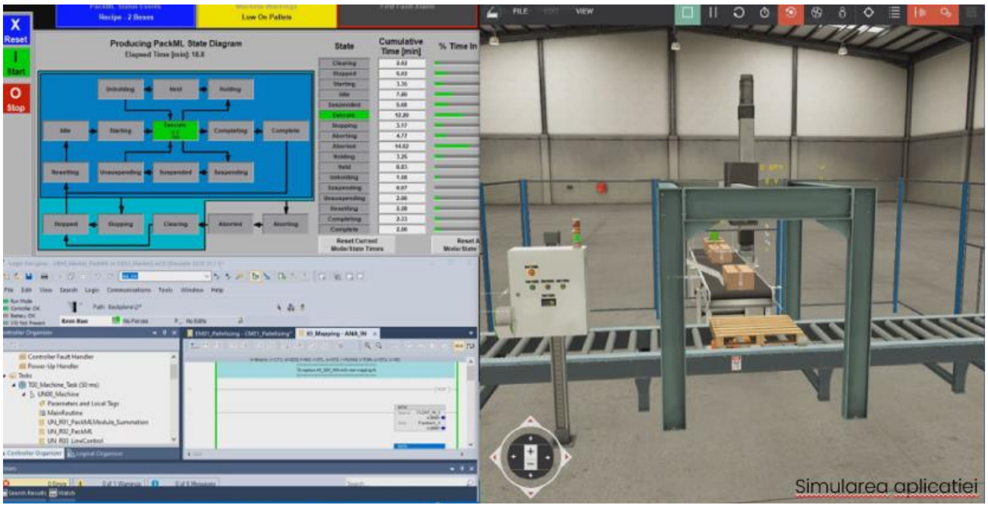


*Figure 26. The palletizer running online with the HMI interface and PLC program*

In order to create an effective and intuitive program we need to answer to the following questions corresponding to each machine state[6]:

- Idle – How can we say that the equipment is ready to run?
- Stopped – What happens when we stop the machine?
- Resetting – How the equipment gets ready to produce?
- Running – What the equipment is doing to produce?
- Holding – How can we pause the production without making scrap?
- Held – How do we know the equipment is paused?
- Restarting – What the equipment needs to do to get back from a temporary stop?
- Complete – How to you know the equipment finished the ordered product?
- Stopping – What happens at a normal stop with the equipment?
- Aborting – What happens at an emergency stop with the equipment?
- Aborted – How do we know if the equipment if safely stopped?

By answering these questions we can create a basic PackML flowchart from which a programmed can start building the ladder program.

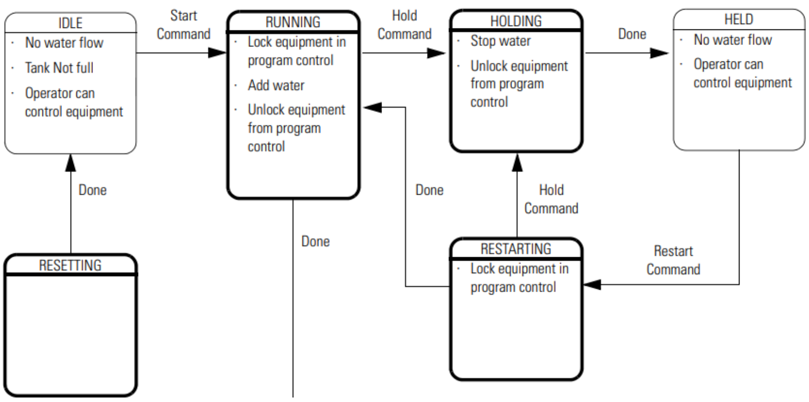


*Figure 27. PackML FlowChart*

## 4. Conclusions and future plans

1. The development and complete simulation of an industrial process using Factory I/O linked with Allen-Bradley/Rockwell software have been successful. A training zone can be created for students with will for automation learning. ( Studio 5000, FactoryTalk ME, Studio Logix Emulate, FactoryTalk Linx)

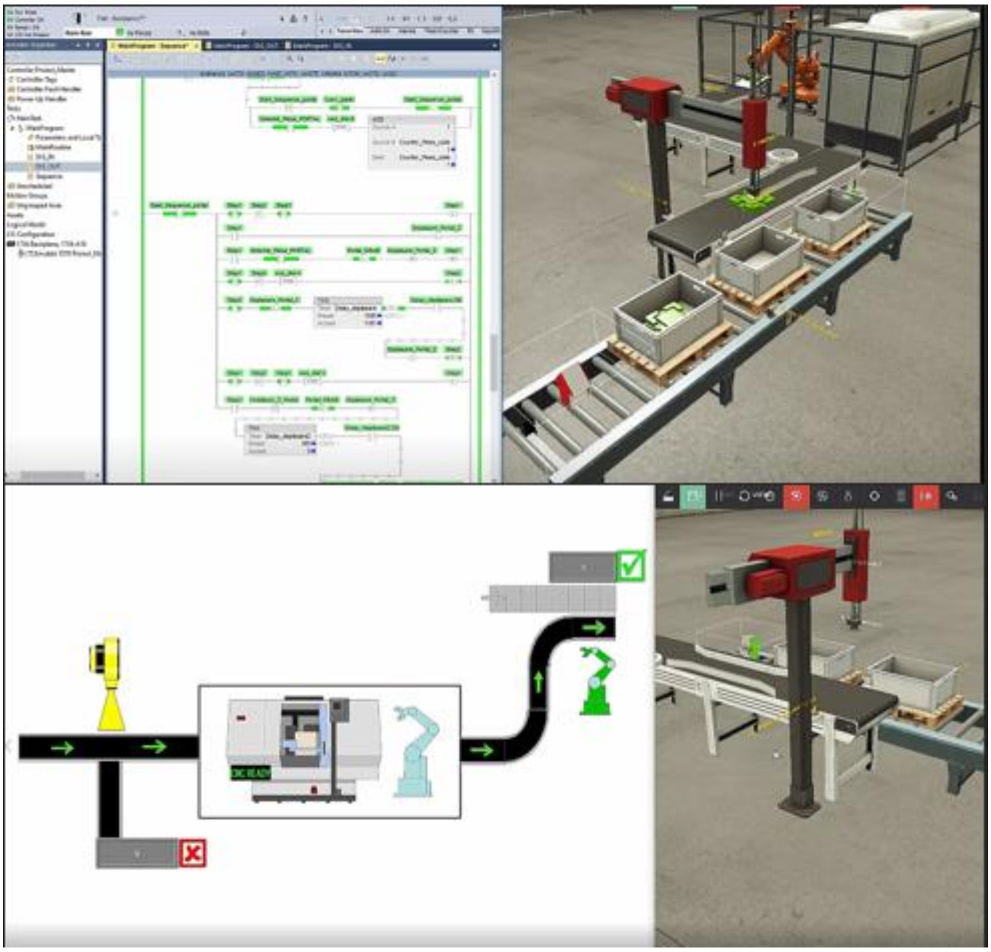

*Figure 28. The complete application running*

2. Factory I/O is an educational software very useful for teaching the automation principles and to create an overview of an automation process.

3. Creating this working scene, HMI application as well as developing a standard program serves as a solid point to further develop the manufacturing process by including a sorting warehouse zone based on RF/ID system.

4. Because there were only Allen-Bradley softwares used into this study it is fair to create an analytical point of view as well as a comparison with it's direct competitor Siemens by using Tia Portal to replicate the manufacturing flow and to point the advantages and disadvantages of both platforms.

5. The implementation of the PackML standard was adopted. A successful packing machine based on a cartezian application have been developed. In the future it is planned to implement PackML on the whole manufacturing line.

## 6. References

[1]*** Robotic process automation. https://en.wikipedia.org/wiki/Robotic_process_automation
[2]*** Sensors and equipment. https://docs.factoryio.com/manual/parts/sensors/
[3]*** ControlLogix Control Systems. https://www.rockwellautomation.com/en-us/products/hardware/allen-bradley/programmable-controllers/large-controllers/controllogix.html
[4]*** IO Buffering best practices forr PLC inputs & outputs. https://class.solisplc.com/courses/460200/lectures/10298223
[5]*** What is PackML?. https://www.omac.org/packml
[6]*** PLC ladder programming http://www.plctalk.net/Ladder