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Presented by:

Berkane Lahcene Walid & Bendiba Nadhir

Study and Realization of Systems Supervision of a Pasta Production Line.

Submitted by: Dr. khalal (USDB 1) & Mr. Ameur Abdelatif (SIM)

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Dedication

First of all, I humbly extend my deepest gratitude to Allah, the Almighty, for granting me the strength, patience, and determination to embark on and complete this significant journey. This achievement stands as a testament to the collective efforts of many individuals over an extended period.

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To my beloved family, particularly my parents, I owe an immeasurable debt of gratitude. Their boundless patience, unwavering support, continuous encouragement, and steadfast belief in my abilities have been a source of strength and inspiration throughout my life. my brothers, Ayoub and Nour El Houda .Without their enduring love and guidance, I would not have reached this significant milestone.

This work is dedicated to you, my cherished family, bendiba and hassib whose sacrifices and unwavering faith have propelled me forward in pursuit of my dreams. May this achievement bring you immense joy and pride, for it is as much yours as it is mine.

Special thanks to H.belkacem and his And his beautiful family who supported me throughout my studies

Dedication

To my dear friends, M. Amina, E. Widad, D. Sidali, and my binome, B. Lahcene Walid, I extend my heartfelt appreciation for your companionship, camaraderie, and unwavering support. Your friendship has been a source of comfort and encouragement, enriching my university experience beyond measure. May our bond continue to thrive, transcending borders and time.

Lastly, I extend my heartfelt thanks to all those who have placed their trust in me, whether through encouragement, support, or belief in my capabilities. Your confidence in my abilities has been a driving force behind my success, and for that, I am eternally grateful.

NADHIR BENDIBA

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We begin by expressing our sincere gratitude to Allah, the Almighty, for providing us with the strength, patience, and determination needed to undertake and complete this important journey.

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BERKANE LAHCENE WALID

ملخص

تتناول هذه الدراسة خط إنتاج المعكرونة الخاصة، وتستكشف مشكلات الإشراف الناتجة عن نظام العرض 'ASEM' الحالي. الحل المقترح هو برنامج إشراف جديد يعتمد على WINCC ومتكامل مع واجهة إنسان-آلة منSIEMENS ، باستخدام وحدة التحكم المنطقية القابلة للبرمجة Siemens S7-1200. الهدف من هذا الحل هو تعزيز دقة وموثوقية عملية الإشراف، مما يسمح بمراقبة وتحكم أفضل في خط الإنتاج

الكلمات الدالة : ASEM, WINCC, SIEMENS, HMI, PLC, S7-1200,TIA Portal

Abstract

This study focuses on the Special Pasta production line, exploring supervision issues caused by the existing 'ASEM' display system. The proposed solution is a new WINCC supervision program integrated with a SIEMENS HMI, using a Siemens S7-1200 PLC. The goal is to enhance the accuracy and reliability of the supervision process, allowing for better monitoring and control of the production line.

Keywords: ASEM, WINCC, SIEMENS, HMI,PLC, S7-1200, TIA Portal.

Résumé

Cette étude porte sur la ligne de production des pâtes spéciales et explore les problèmes de supervision causés par le système d'affichage existant 'ASEM'. La solution proposée est un nouveau programme de supervision WINCC intégré à une interface Homme-Machine SIEMENS, utilisant un automate programmable Siemens S7-1200. L'objectif est d'améliorer la précision et la fiabilité du processus de supervision, permettant une meilleure surveillance et un meilleur contrôle de la ligne de production.

Mots clés: ASEM, WINCC, SIEMENS, HMI,PLC, S7-1200, TIA Portal.

Contents

List of Figures

List of Tables

list of abbreviations

SIM Semoulerie Industrielle de la Mitidja.

PDR Product Defect Reports.

HMI Human-Machine Interface.

S.p.A société pâte alimentaire.

PLC programmable logic controller.

TIA Portal Totally Integrated Automation Portal.

(I/O) inputs and outputs.

SCADA Supervisory Control And Data Acquisition.

CPU Central processing unit.

WinCC Windows Control Center.

AC alternative courant.

DC direct courant.

GUI Graphical User Interfaces .

V16 version 16.

RAM Randoom Access Memory.

General introduction

The "SIM SPA" factory specializes in the industrial production of pasta, which encompasses four distinct categories: short pasta, long pasta, couscous, and special pasta. This variety imposes unique demands on each stage of manufacturing, from processing to transportation and packaging. It also requires close coordination among various stakeholders who rely on different monitoring and supervisory systems.

Our research aims to streamline the supervision of the Special Pasta production line, covering the entire process from the semolina's arrival to the moment the pasta carts leave for the drying cells. Currently, supervision is conducted using an 'ASEM' display, which has led to several challenges, including maintenance issues, diagnostic complications, and managing Product Defect Reports (PDRs).

To resolve these issues, we propose implementing a new supervision system using a WINCC program integrated into a SIEMENS Human-Machine Interface (HMI). This approach is expected to standardize the supervision process within the company. The Siemens S7-1200 programmable logic controller will serve as the backbone of this new system, providing enhanced performance and memory management.

The proposed restructuring will be detailed in three key sections:

- Chapter 1: Generalities

This chapter will offer a comprehensive introduction to SIM company, providing an overview of the manufacturing process and delineating the various types of pasta manufactured at the factory.

- Chapter 2: Short Pasta Production Line and Programming Tools

Here, we will delve into the specifics of the short pasta production process and outline the software and hardware tools used to manage the line.

- Chapter 3: Supervision and simulation

This chapter will focus on the steps involved in developing and integrating the new WINCC supervision system with the Siemens S7-1200 controller. It will also cover the anticipated benefits and expected improvements in maintenance, diagnostics, and production efficiency.

By implementing this new supervision system, "SIM SPA" aims to improve reliability, streamline maintenance, and enhance overall productivity in its Special Pasta production line.

Chapter 1

Generalities

1.1 Introduction

Pasta and related grain-based products form a substantial part of the global food manufacturing industry. This chapter provides an overview of the SIM Group, a leading Algerian company with a pioneering role in flour milling and pasta production, and Storci S.p.A., an Italian manufacturer of pasta processing equipment known for its innovative technologies. And their manufacturing relationship with each other.

1.2 Presentation General of the SIM Group

The Company was founded in 1990 by Mr. TAIEB EZZRAIMI Abdelkader as a small family company in the field of flour-milling and semolina where it acted as a pioneer in its quality as the first private company in this branch of activity in Algeria.

1.2.1 Presentation of the SIM company

This group, known by the acronym "SIM" which stands for "Semoulerie Industrielle de la Mitidja", has firmly established its reputation. Its activities extend far beyond the borders of the country and have seen prestigious development. After establishing itself as a leader in the agro-food sector, its leaders decided to invest in several other areas. To achieve this, the group has five subsidiaries. Investments have been made in the healthcare, real estate development, energy, and agro-food sectors, in addition to acquiring two public companies, BEN HAROUN and MOUZAIA mineral water. The agro-food subsidiary's assets include:

Figure 1 : Logo SIM company

- semolina mills
- 8 couscous units
- 3 flour mills
- 4 long pasta units
- 5 short pasta units
- 1 production line for special pasta (Lasagna).
- 1 string bread production line.

The entire complex, sprawling over an area of 90,000 m2, boasts impressive overall capacities:

- Semolina (durum wheat): 1500 Tones/Day.
- Flour milling (soft wheat): 1000 Tons/Day.
- Pasta and couscous: 1000 Tons/Day.

Our end-of-studies project was implemented within the SIM company. It is located near the east-west highway A1, in the "Ain Romana" commune of Mouzaia in the Blida province.

Figure 2: location of SIM company

1.3 Company Storci Pasta Machinery

Storci S.p.A. is an Italian pasta processing equipment manufacturer. The company is based in Collecchio, Parma, Italy.

Storci manufactures equipment and machinery which produces different types of pasta such as dry pasta, fresh pasta, ready meals, gluten-free pasta, and special pasta. The company works in partnership with Fava S.p.A, based in Cento, Italy, and manufactures industrial lines for the production of dry pasta and couscous. It has a market share of around forty percent worldwide. According to another estimate, more than a thousand Storci plants are in use worldwide with a market share of forty-five percent (1).

Figure 3: Storci company

1.3.1 THE LINES

Storci's philosophy is to get back to the Italian tradition of manufacturing pasta, applying it to the most modern technologies of production and monitoring. It is vital for the Company that the same care, used in the past by master pasta makers, be kept along with the slow manufacturing, and the long drying. There are always researches and continuous tests to be carried out, in order to guarantee a very high-quality service to our Customers (2).

- Dry pasta lines
- Fresh pasta lines
- Couscous line
- Ready meals lines
- Dry gluten-free pasta lines
- Fresh gluten-free pasta lines
- Instant pasta lines

1.3.1.1 Dry pasta lines

Our pasta production lines are currently used for spaghetti production as well as penne, paccheri, long tubular fusilli, conchiglioni, ziti, macaroni production and many other shapes. We recapture the culture of the tradition and adopt it using advanced technologies to maintain the original philosophy of slow processing and long drying times, so that to combine tradition with the most high-tech equipment in the world and modern, reliable control systems. Our pasta line can be completely automatic up to trolley filling, for both short- and long-cut pasta, while leaving to traditional drying in the static chamber the task of completing shaping. However, nothing is left to chance and a personal computer controls all drying phases in order to obtain a constant quality. All this leads to a reduced need of manpower and to a final product as tradition dictates. Best pasta processing, best pasta plants (3).

Figure 4: Dry Pasta

1.3.1.2 Fresh pasta lines

The production of fresh pasta is a process that many pasta equipment manufacturers consider fully-developed a long time ago. Storci Spa disagrees and is ready to accept new challenges offered by the market: fresh pasta is just one of them. Our fresh pasta production machines prove the point. A market that is constantly growing ad increasingly demanding expertise and knowledge in the plant engineering sector. Pasta manufacturers require, for theirs pasta plants, a technology that can guarantee the excellent quality of the product but, most importantly, its safety for the consumers (3).

Figure 5:Fresh pasta

1.3.1.3 Couscous lines

Couscous is a natural product connected with an ancient tradition. Its preparation and cooking require care and skill, following specific rules which make it a healthy and enjoyable food. For this reason we have dedicated all our experience to the creation of a couscous line and equipment capable of obtaining the very best at each stage of the processing. The various machines making up the couscous line are built with the most valuable and resilient materials now available on the market. We have transferred all our technical know-how into this sector. The technology adopted strictly and scientifically adheres to the rules of the couscous tradition (3).

Figure 6:Couscous

1.3.1.4 Ready meals lines

Storci S.p.A. has further expanded the range of products offered such as engineering, technologies and pasta production lines, positioning itself as a partner for the customers who want to start or expand the production of pasta-based convenience food. Thanks to the Storci/BS Network pasta processing, we can offer, with our pasta plants, for the production of lasagna and cannelloni, the opportunity to choose between semiautomatic or automatic lines with different production capacities (all lines offer user-friendly control, top level automatisms, easy cleaning and servicing, vacuum technology): from 600 trays/hour, up to approximately 4,500 kg/h. On the other hand, for those interested in ready meals made of filled, short- and long-cut pasta, the multiproduct line is the answer, offering a large selection of pasta shapes as spaghetti, space-saving cooking and production capacity, maximum simplicity in terms of use and cleaning. The multiproduct line has a production capacity ranging from 600 to 5,000 trays/hour and, when necessary, products such as dry pasta, meat, rice, fish and vegetables can also be cooked (3).

Figure 7:Ready meals

1.3.1.5 Instant pasta lines

New markets? New technologies? Waste no time... Storci presents its new lines for instant pasta production, designed to competitively and successfully meet the very latest food trends. Versatile and customizable, they can make different types of instant pasta, creating a valid and quality alternative to instant Asian noodles. Ease of cleaning, flexibility.... discover all the benefits these pasta plants offer. A handy and versatile ready meal option with excellent profit margins (3).

Figure 8:Instant pasta

1.3.1.6 Dry gluten free pasta lines

Is it possible to make good dry pasta without durum wheat semolina? Sure! The consumer dedicates much more time in choosing these products than in choosing traditional pasta, so top quality is the indispensable key to success. Why producing this kind of pasta production lines? To guarantee growing market shares. Traditional systems produce dough mixes that are not very uniform and not of excellent quality. Additionally, they are complex and hence difficult to clean as well as being energy consuming. The difference? The Storci No-Glut pasta production lines are a concentration of experience and innovation with long-lasting guaranteed quality. Thanks to the new dough gelatinization system, it is possible to produce appetizing, high quality products for consumers requiring gluten-free pasta or for those who periodically like to choose alternative and healthy products. Advantages? Homogeneity in the pasta processing, high energy efficiency, control of the gelatinization level, easy cleaning. Choose the best pasta manufacturing, choose Storci pasta plants (3).

Figure 9: Dry gluten

1.3.1.7 Fresh gluten free pasta lines

Tortellini, ravioli, tagliatelle, orecchiette fresh and gluten-free? Why deprive gluten intolerant consumers of our traditional pasta dishes? Storci No-Glut pasta production lines responds to the requirements of customers who wish to produce high quality fresh pasta, making them happy and enthusiast to serve delicious pasta dishes. We guarantee, with our pasta machinery and pasta plants, the maximum quality of the dough mixes thanks to the patented gelatinization system for flour and starch varieties without gluten, such as for example maize, rice, potato flour and various starches (3).

Figure 10:Fresh gluten

1.4 Conclusion

SIM Group is an Algerian company that produces flour, semolina, and pasta. They have a huge facility and use equipment from Storci S.p.A., an Italian company known for its high-tech pasta production machinery. Storci is all about blending traditional Italian pasta-making techniques with modern technology.

The partnership between SIM Group and Storci shows how local companies can benefit from advanced technology to boost production and maintain high quality. Storci's equipment is designed to meet different market demands. This collaboration demonstrates that it's possible to mix tradition with innovation and succeed, offering a useful example for others in the food manufacturing industry.

Chapter 2

Short Pasta Line And Used Programming Tools

2.1 Introduction

In this chapter we talk about the Short-cut Pasta Line, revealing the sophisticated technology that powers this versatile production system. From the technical specifications of the pasta production machine to the complex electrical components, we examine the essential elements that make this line efficient and reliable. We explore the programmable logic controllers (PLCs) that control the system, the cutting-edge Human-Machine Interfaces (HMIs) that facilitate user interaction, and the software tools like TIA Portal and Premium HMI that drive automation. and we discuss how PROFINET ensures seamless communication within the production process.

2.2 Short-cut Pasta Line

With the short pasta line, you can produce standard short pasta such as penne or special pasta such as paccheri or also cut pasta such as farfalle. Production ranges from 100 to 1200 kg/h. Equipped with our lasagna production machine NEST, it enables a total automatic production of nests and lasagna (4).

2.2.1 Production Capacity

Production Capacity for Short-cut Pasta Line (5):

Models	Standard short pasta
Short 150	from 90 to 130 Kg/h
Short 250	from 180 to 220 Kg/h
Short 300	from 340 to 380 Kg/h
Short 600	from 550 to 650 Kg/h
Short 1000	from 900 to 1000 Kg/h
Short 1200	from 1100 to 1200 Kg/h

Table 1:Production Capacity ''Short-cut Pasta Line''

2.3 Short 250-cut Pasta Line

Presenting the Short 250-cut Pasta Line, now available for company-level production.

Figure 11: Short 250-cut Pasta Line

2.3.1 Machine Specification Short 250-cut Pasta Line

The Short 250-cut Pasta Line is a semi-automatic machine for efficient pasta production. Below are the key specifications:

Machine Type	Semi-Automatic
Capacity	220Kg/Hour
Usage	Pasta Making
Power Consumption	35kw
Phase	Three Phase
Voltage	380V
Power Source	Electric

Table 2: Specification Short 250-cut Pasta Line

2.3.2 Presentation of the Production Process

Presentation of the Production Process for Short 250-cut Pasta Line (6):

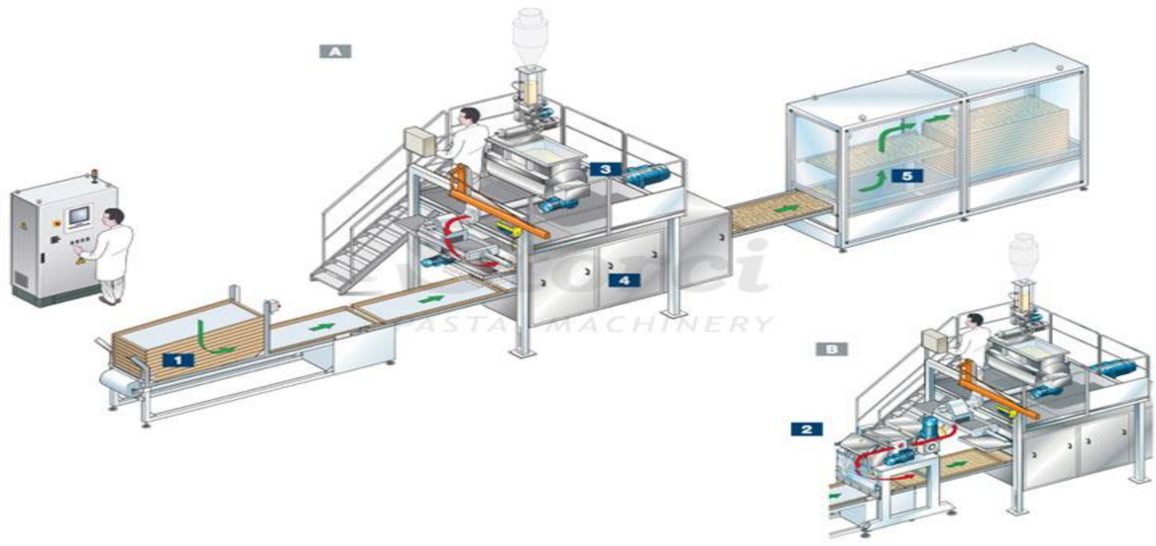

Figure 12:Presentation of the Production Process

Specification

1 -Trays feeder AT-12.60

2 -Nests and lasagna machine NEST-540/L

3 - Press with a circular head

4 -Short pasta pre-drying shaker with trays inside passage

5 -Trays automatic stacking machine ROBO-T 12.60

A -Short pasta production

B -Nests and lasagna production

2.3.3 Representation of the electrical part

To achieve effective control over this machine, we employed a dual-PLC setup, utilizing two Siemens Programmable Logic Controllers (PLCs), and integrated two Human-Machine Interfaces (HMIs) to enhance operational oversight and precision. In addition, various sensors and actuators were installed.to ensure responsive and adaptable machine control, allowing for a more seamless and efficient management process.

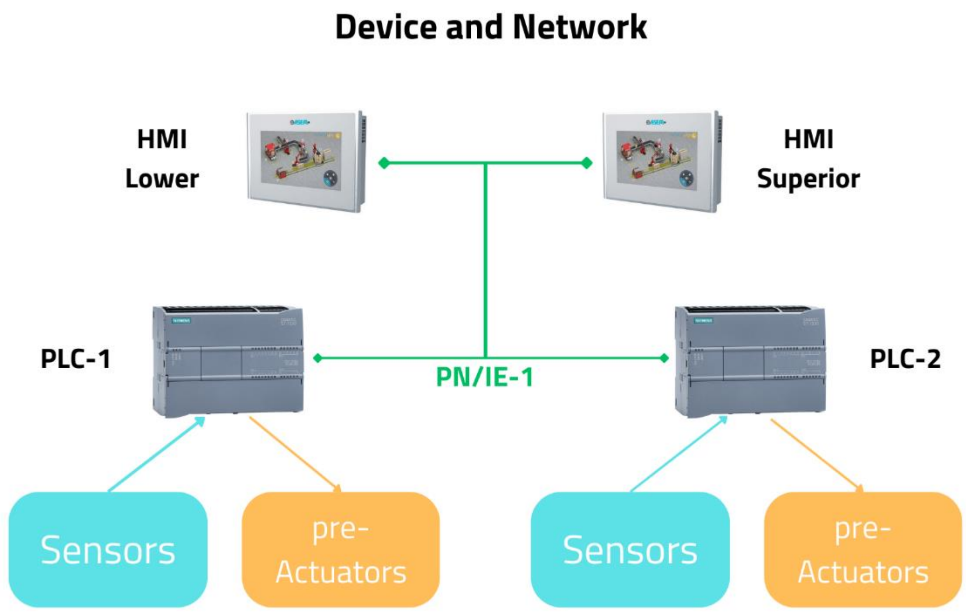

Figure 13: Electrical part

2.4 Programmable logic controller

A programmable logic controller (PLC) or programmable controller is an industrial computer that has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, machines, robotic devices, or any activity that requires high reliability, ease of programming, and process fault diagnosis.

PLCs can range from small modular devices with tens of inputs and outputs (I/O), in a housing integral with the processor, to large rack-mounted modular devices with thousands of I/O, and which are often networked to other PLC and SCADA systems. They can be designed for many arrangements of digital and analog I/O, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

PLCs were first developed in the automobile manufacturing industry to provide flexible, rugged and easily programmable controllers to replace hard-wired relay logic systems. Dick Morley, who invented the first PLC, the Modicon 084, for General Motors in 1968, is considered the father of PLC.

A PLC is an example of a hard real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation may result. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory (7).

Figure 14: different types of Programmable logic controller

2.4.1 Historic

The PLC originated in the late 1960s in the automotive industry in the US and was designed to replace relay logic systems. Before, control logic for manufacturing was mainly composed of relays, cam timers, drum sequencers, and dedicated closed-loop controllers.

The hard-wired nature of these components made it difficult for design engineers to alter the automation process. Changes would require rewiring and careful updating of the documentation and troubleshooting was a tedious process. When general-purpose computers became available, they were soon applied to control logic in industrial processes. These early computers were unreliable and required specialist programmers and strict control of working conditions, such as temperature, cleanliness, and power quality (8).

PLCs are used across all industrial sectors for controlling machines (conveying, packaging, etc.), production lines (automotive, food processing, etc.), or for regulating process functions (metallurgy, chemistry, etc.). They are increasingly utilized in the building sector (commercial and industrial) for controlling heating, lighting, security, or alarms.

2.4.2 Internal architecture of an PLC

- A PLC is an industrial microprocessor-based controller with programmable memory used to store program instructions and various functions. It consists of:
- A processor unit (CPU) which interprets inputs, executes the control program stored in memory and sends output signals,
- A power supply unit which converts AC voltage to DC,
- A memory unit storing data from inputs and program to be executed by the processor,
- An input and output interface, where the controller receives and sends data from/to external devices,
- A communications interface to receive and transmit data on communication networks from/to remote PLCs (9).

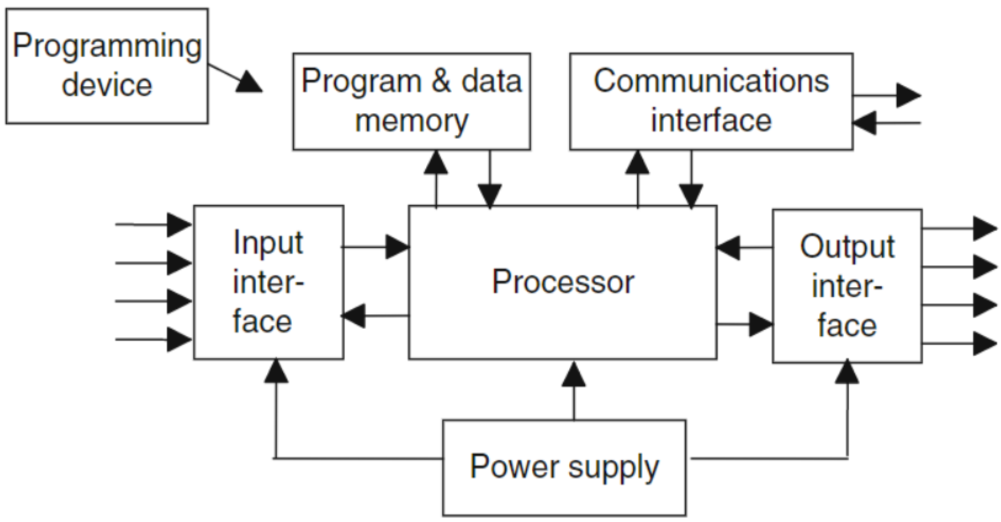

Figure 15: architecture of an PLC

2.4.3 PLC S7 1215C DC/DC/DC

The SIMATIC S7-1200 CPU 1215C is a compact central processing unit designed for industrial automation applications. This model features a DC/DC/DC power configuration with two PROFINET ports for network communication, allowing seamless integration with other systems and devices. Key specifications for this unit include:

- **Onboard I/O:** It has 14 digital inputs operating at 24 V DC and 10 digital relay outputs with a capacity of 2 A. Additionally, it offers 2 analog inputs ranging from 0 to 10 V, and 2 analog outputs programmable between 0 and 20 mA, providing flexibility in controlling various processes.
- **Power Supply:** The CPU is designed to work with a 24 V DC power supply, which is commonly used in industrial settings.
- **Memory:** With 125 kB of program and data memory, this CPU can accommodate complex automation logic and data storage needs.

Figure 16: PLC S7 1215C DC/DC/DC

2.5 Supervisor Controller

2.5.1 SCADA (Supervisory Control And Data Acquisition)

Technically, SCADA is an advanced industrial measurement and control system that comprises a central host or master, operating in data acquisition and control units in one or more fields, or consists of a collection of standard and custom software used for remote monitoring and control of devices and data elements. In this sense, SCADA software primarily performs monitoring, control, data collection, data recording and storage functions. The term SCADA stands for Supervisory Control And Data Acquisition, which highlights its focus on the supervisory level rather than being a comprehensive control system.

In this context, SCADA systems can be described as an automation system used for monitoring and controlling industrial processes. SCADA systems are used for real-time data collection, process control and process optimization. The systems manage and process data exchange between distributed hardware and software components through a central computer. These components carry out control and monitoring functions, thus ensuring the processes operate healthily and efficiently (10).

2.5.1.1 Advantages of SCADA Systems for the Automation Industry

SCADA systems are pivotal in the automation industry, facilitating the monitoring, control, and management of processes and systems. Here are some key advantages provided by SCADA systems:

- Real-Time Data Collection and Monitoring
- Remote Control and Management
- Alarm & Event Notification
- Data Analysis & Reporting
- Energy & Resource Usage Optimization
- support protocol integration

2.5.2 Human-Machine Interfaces (HMI)

A Human-Machine Interface (HMI) is a user interface or dashboard that connects a person to a machine, system, or device. While the term can technically be applied to any screen that allows a user to interact with a device, HMI is most commonly used in the context of an industrial process.
HMIs are similar in some ways to Graphical User Interfaces (GUI) but they are not synonymous GUIs are often leveraged within HMIs for visualization capabilities.
In industrial settings, HMIs can be used to:

- Visually display data
- Track production time, trends, and tags
- Oversee KPIs
- Monitor machine inputs and outputs

Basic HMI examples include built-in screens on machines, computer monitors, and tablets, but regardless of their format or which term you use to refer to them, their purpose is to provide insight into mechanical performance and progress (11).

Figure 17: Human-Machine Interfaces

2.5.3 ASEM HMI

ASEM is operating in the markets of Industrial Automation, Test, and Measurement with a complete range of industrial PCs and monitors and a complete range of HMI, control (PAC - Programmable Automation Controller), remote assistance, and Industrial IoT gateways, based on x86 (PC) and ARM hardware platforms and FT OptixTM, Premium HMI, UBIQUITY, SoftPLC and SOFTMOTION software platforms.

ASEM is characterized by its own hardware, firmware, software, mechanical, and system design capability, and by the ability to manage all the phases of the production process on its own, including the assembly and soldering of the electronic boards. The complete domain of hardware and software technologies allows ASEM the maximum flexibility in realizing also products and systems customized for specific customer needs (12).

Figure 18:LOGO ASEM Company

2.5.4 HMI 30-TF "ASEM"

We will proceed to unravel the basic functions of the HMI 30 (13):

Figure 19:HMI 30-TF "ASEM"

		30-TF
HMI SOFTWARE		**Premium HMI Basic** **Premium HMI Advance**
REMOTE ASSISTANCE SW		**UBIQUITY runtime PRO**
O.S.		**Windows Embedded Compact 7 Pro with Data light Reliance Nitro system**
LED backlight TFT LCD		**7” W - 800x480** **12.1” - 800x600** **12.1” - 1024x768** **12.1” W- 1280x800** **15” - 1024x768** **15.6” W - 1366x768**
CUT-OUT		**A/B**
TOUCHSCREEN		**Resistive 4 / 5 wires**
FRONT PANEL	**Material**	**True Flat Aluminum**
	ASEM Logo	**Silk screen printed**
PROTECTION GRADE IP	**IP rating**	**IP65 - frontal**
	NEMA rating	**UL type 1, 4x (indoor only) and 12**
CASE	**Installation**	**Panel mounting**
	Material	**Zinc-coated skin pass steel**
PROCESSOR (soldered on-board)		**NXP® i.MX535 ARM Cortex® A8 1GHz • integrated GPU**
SYSTEM MEMORY RAM		**1GB (DDR3 module)**

MASS STORAGE		**256MB NAND-FLASH** **4GB eMMC pseudo-SLC** **1x SD/SDHC slot on board with external access**
INTERFACES	**LAN**	**2x Fast Ethernet (RJ45)**
	USB	**2x USB 2.0 rear (Type-A)**
	SERIAL	**1x RS232/422/485 (DB15M)**
POWER SUPPLY INPUT		**24VDC (18 ÷ 36VDC) isolated**
OPERATING TEMPERATURE		**0° ÷ 50°C**
STORAGE TEMPERATURE		**-20° ÷ 60°C**
OPERATING/STORAGE RELATIVE HUMIDITY		**20% ÷ 90% RH (non-condensing)**
APPROVALS		**CE** **RoHS** **UKCA** **cULus Listed** **ATEX zone 2/22**

Table 3: HMI Spécifications

2.6 Pre-Actuators

Pre-actuators are devices designed to channel various external energy sources to the actuators. They function by receiving electrical signals from the control system, then distributing energy to the appropriate actuators as specified by the operating instructions. Essentially, they bridge the gap between the control system and the actuators, ensuring the latter receive the correct energy source to perform their function.

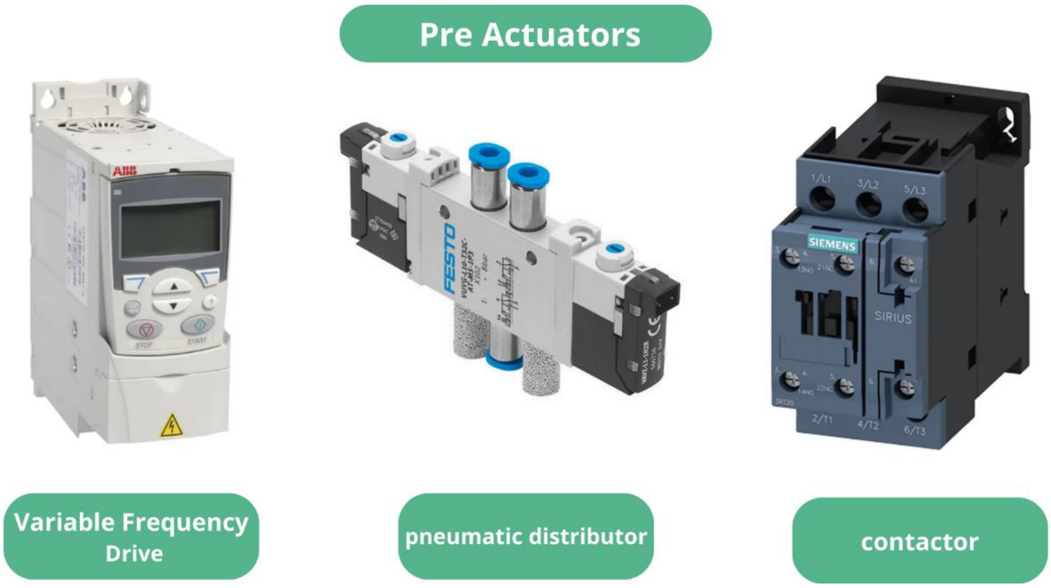

Figure 20: Pre-actuators

2.7 Sensors

Sensors can be thought of as the "eyes and ears" of a control system. They are sensitive components that detect changes in physical properties and convert this information into electrical signals that the control system can understand. Sensors play a crucial role in instrumentation by providing real-time feedback on various physical, thermal, magnetic, and chemical characteristics.

In general, sensors fall into two broad categories:

Digital Sensors: These sensors output binary signals, typically used for detecting conditions that have only two states, such as on/off or true/false.

Analog Sensors: These sensors produce a range of values, allowing them to capture variable data from physical phenomena and convert it into electrical signals that the control system can process.

Sensors are responsible not only for detecting changes but also for providing crucial feedback to the control system about the status and progress of the system. This feedback loop helps maintain proper system operation and enables continuous monitoring and adjustment as needed.

Figure 21: Sensors

2.8 Software Description and Tools

2.8.1 TIA PORTAL Platform

TIA Portal = Totally Integrated Automation is a Siemens engineering platform that offers a package of complete automation solutions for an optimized solution in engineering processes and machine manufacturing.

Surely if you are starting out in the world of PLC programming you will start to hear about the TIA Portal, if you are already a veteran of programming you already have it very clear. Siemens is one of the main brands that you will find in any factory in the world and that is why it is highly recommended to know their equipment and their programming software.

In general, in an industrial automation project we will have to work and therefore program several components: Automata (PLC), HMI screens, Variable Speed Drives, Servos…

Until not long ago, each device had its own programming software which was a bit of a hassle. What platforms like Siemens TIA Portal have done is bring together in a single software everything that is needed to program a complete machine.

TIA Portal in addition to installing the basic software (STEP 7, WinCC, SINAMICS Startdrive, SIMOCODE ES and SIMOTION SCOUT TIA), also installs new functionalities such as multi-user and power management in a single interface.

With TIA Portal we can program the new series of PLCs S7-1200 and S7-1500. Besides the old range S7-300 and S7-400, this can also be programmed with STEP7 (The predecessor software for programming Siemens PLCs) (14).

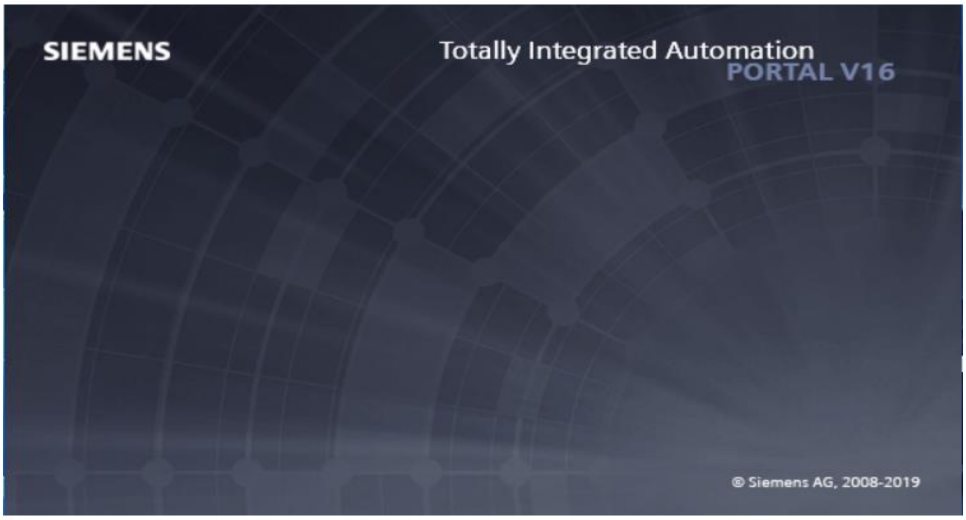

Figure 22: TIA PORTAL

2.8.1.1 Portal view

The portal view provides an overview of all project configuration steps and task-oriented access to our automation tasks. The different portals clearly and systematically display all the work steps needed to perform an automation task. This allows for quick decision-making regarding what we want to do and which tool we need to call upon.

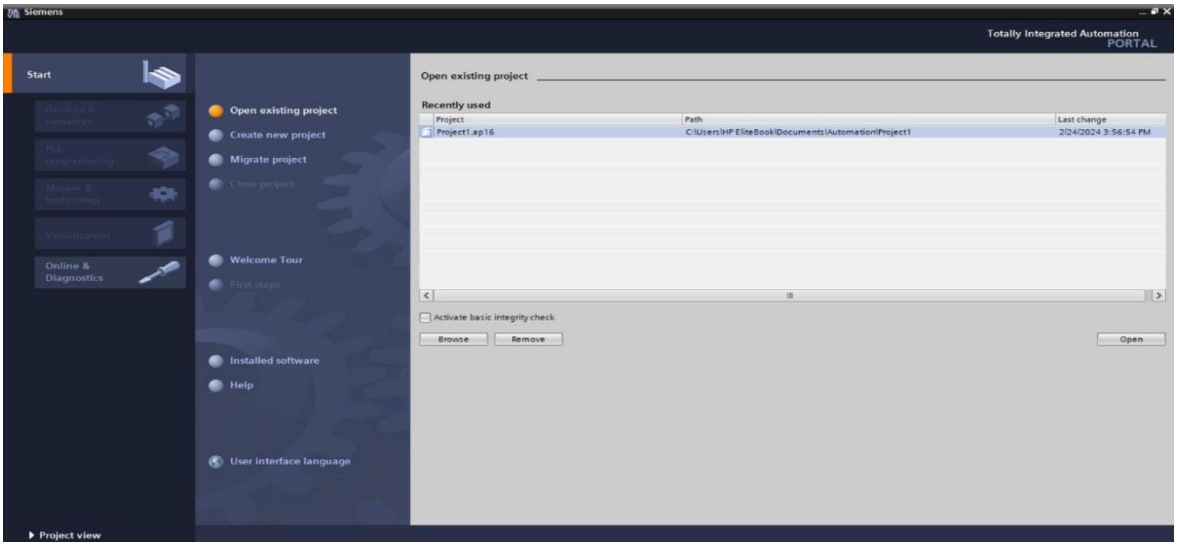

Figure 23: Portal view

2.8.1.2 Project view

The project view acts like a structured roadmap for all the bits and pieces of our project. It's like a directory that lets us quickly find and dive into any project element, its workspace, and the tools we need to work on it. With the editing tools at our fingertips, we can easily craft and tweak project components.

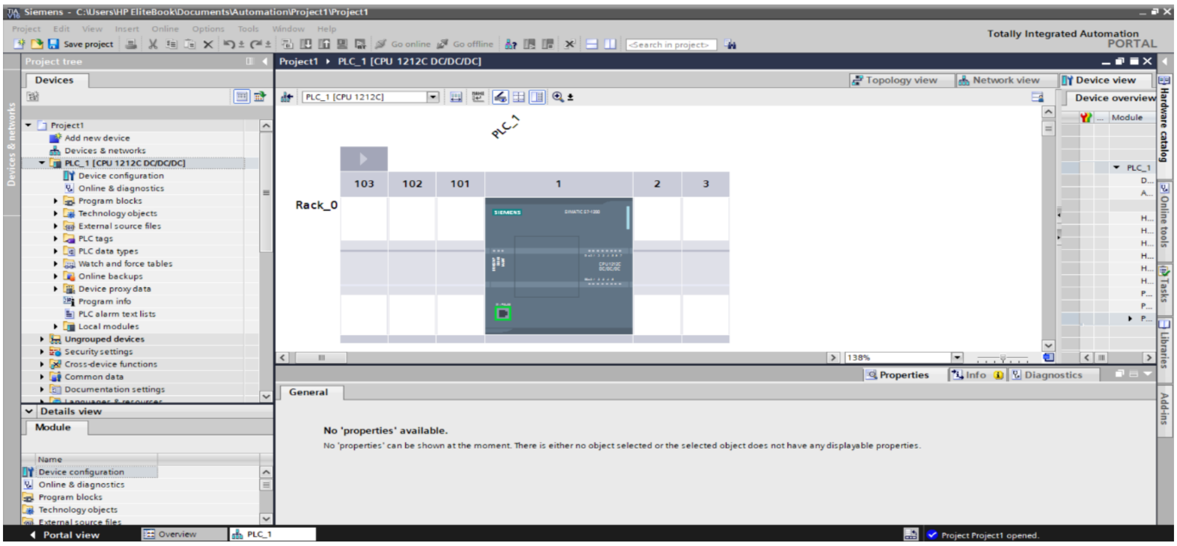

Figure 24: Project view

2.8.1.3 WinCC

SIMATIC WinCC is a supervisory control and data acquisition (SCADA) and human-machine interface (HMI) system from Siemens. SCADA systems are used to monitor and control physical processes involved in industry and infrastructure on a large scale and over long distances. SIMATIC WinCC can be used in combination with Siemens controllers. WinCC is written for the Microsoft Windows operating system. It uses Microsoft SQL Server for logging and comes with a VBScript and ANSI C application programming interface.

In 2010, WinCC and PCS 7 were the first known SCADA systems to be specifically targeted by malware. The Stuxnet worm can spy on and even reprogram infected systems (15).

2.8.2 Premium HMI

Premium HMI® is a SCADA/HMI visualization software which permits you to transform your PC, your TouchPanel, your Workstation or your mobile device into a data acquisition, processing and process control station, or to create Human-machine interfacing solutions.

Premium HMI allows you to generate and run any application within the industrial automation or supervision.

By means of the Premium HMI Drivers you can communicate with the process which Premium HMI has to interact with. The process managing devices, being PLC, Termoregulators, Intelligent cards, PC, etc, can be connected to the system where Premium HMI is installed (also in multitasking) through serial lines, modem, communication networks or other.

A Premium HMI project has the job of supervising production processes through animated video pages called Screen windows, or consents setting commands or set-points to the process through video pages called dialog windows, in addition to this there is a countless variety of functions to render process management complete and functional in the most easiest and safest way possible (16).

Figure 25: Software Premium HMI ASEM

2.8.3 Canva

Canva is a website that allows you to create and customize designs for any type of project, in a simple and intuitive way. It is very useful, especially for those who do not have particular graphics skills. The main feature of Canva is that it allows you to freely use already ready-made templates of good quality, and to both modify and conform them to your own taste or requirements. Which makes it a tool that guarantees a qualitatively high result, flexible, and adapted to all circumstances.

Through this short guide, we will try to explain how Canva works, in what situations it can help you, and how, from the project carried out using this instrument, it is possible to start printing the document just as easily and quickly (17).

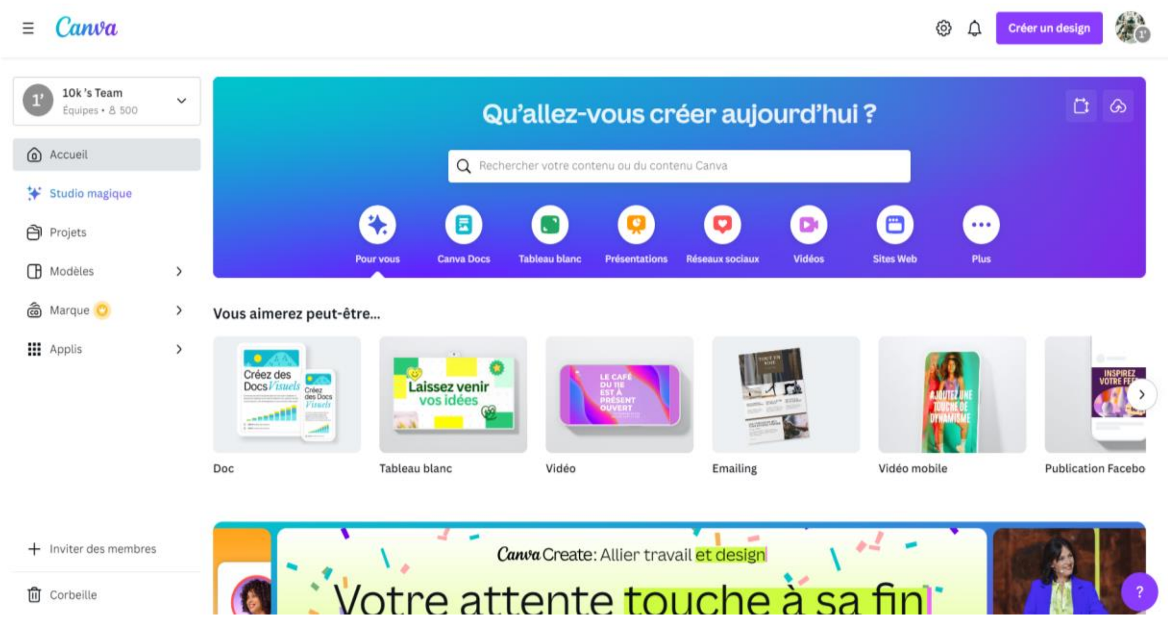

Figure 26: CANVA Interface

2.8.4 PROFINET RJ45 cable

ProfNet cables are industrial Ethernet cables, also known as "Ethernet Cat. 5" or simply "Cat 5" cables, used for wiring industrial fieldbus systems according to the globally accepted TCP/IP protocol. They are suitable for fixed, dynamic, or flexible industrial automation applications. As required by the ProfNet system and Cat5e specifications, ProfNet cables are designed to be anti-interference cables, providing strong active and passive protection against unwanted signals.

Figure 27: PROFINET Cable

2.4 Conclusion

The Short-cut Pasta Line exemplifies the seamless integration of technology and efficiency in pasta production. With programmable logic controllers (PLCs), Human-Machine Interfaces (HMIs), and the versatility of tools like TIA Portal for the supervision and Canva for the design, this system delivers precision and adaptability. Through the use of PROFINET for connectivity the line ensures a reliable and efficient workflow.

This chapter highlights how these sophisticated components work together to create a robust and flexible system, paving the way for pasta manufacturing.

Chapter 3

Realization Supervision

3.1 Introduction

After presenting the software and tools used to develop our project, this chapter will delve into a step-by-step demonstration of our process.

We will detail how to create supervision with WinCC Professional and how we utilized the software and tools described in our project.

3.1.1 technical specifications

Problematic

The Special Pasta Production line is supervised using an 'ASEM' display, which generates numerous maintenance and diagnostic problems (and PDR management).

We propose for this system: the creation of a WINCC supervision program which will be introduced into a SIEMENS HMI, which will be part of the standard adopted in our company.

Work Plan:

- Backup and Migration of Existing Programs from PLC and HMI Systems
- Integrating WinCC RT Professional and Network Configuration
- Screen Development and Organization in TIA Portal

3.2 Backup and Migration of Existing Programs from PLC and HMI Systems

3.2.1 Backing Up the HMI Asem 30 Program

To back up the HMI Asem 30 program, we started by connecting our PC to the HMI Asem 30 using a USB cable. We then launched the Premium HMI software on our PC and configured it to recognize the HMI via USB. Using Project Manager, we downloaded the project from the HMI. After the download was complete, we saved the project file on our PC and verified its completeness.

Upon opening the project, we discovered numerous functions and screens, including alarms, trends, and scripts, totaling over 160 screens.

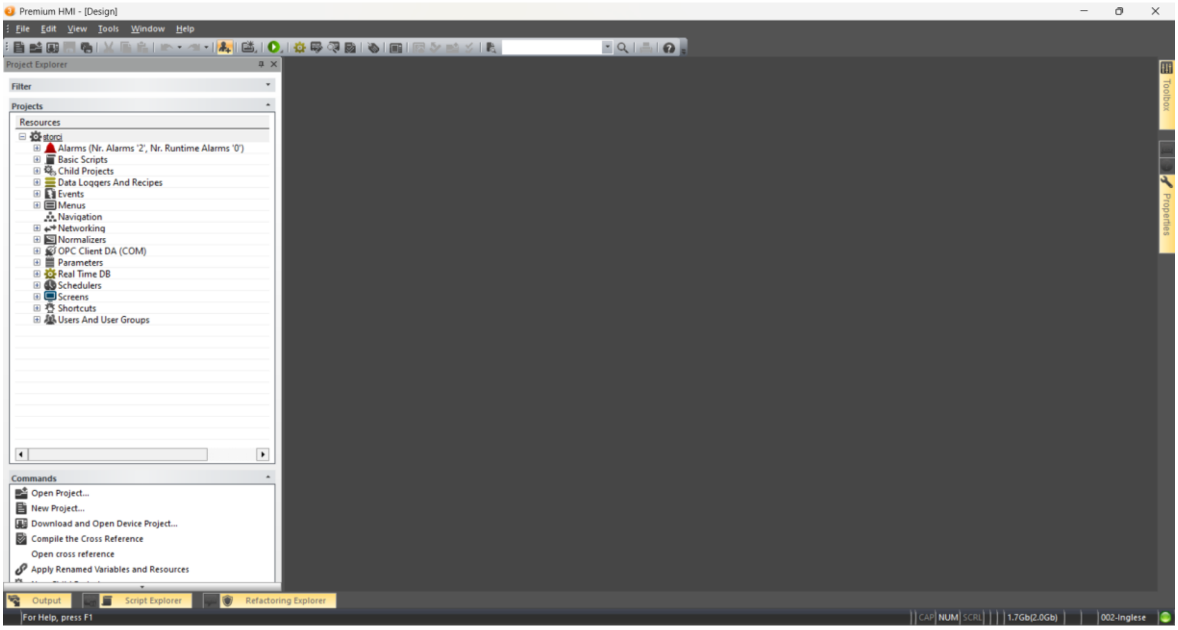

Figure 28: Program Existing in the HMI Asem 30

3.2.2 Backing Up the Program from Siemens S7-1215C PLC

We begin by connecting to PLCs using an Ethernet cable and adjusting our computer's IP address to match the PLCs' subnet. Then, we open the TIA Portal software and create a new project. Then we take the following steps:

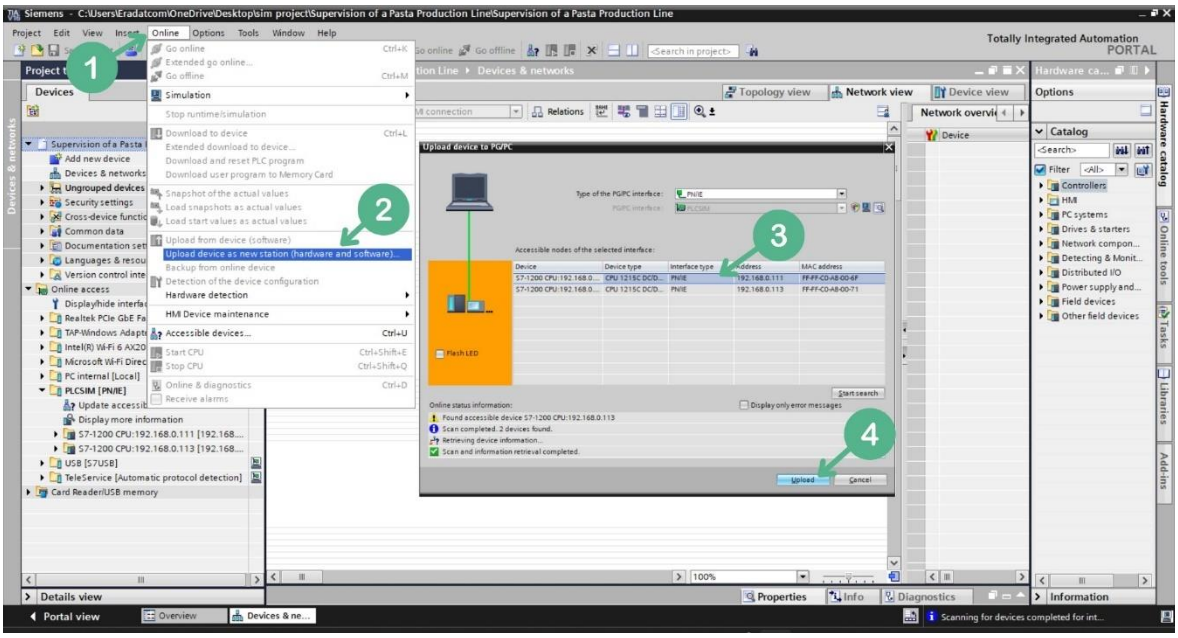

Figure 29: Backing Up the Program from PLC

1. **Select online**
   - In the toolbar we select Online.
2. **Upload device**
   - From the list of options we selected the upload device as a new station (hardware and software).
3. **Select device**
   - After selecting the network, we select the device that is on the same network.
4. **Upload**
   - Download the chosen device in our project.
   - we follow the same steps for the second PLC S7-1215C.

3.2.3 Migrating Program from TIA Portal V13 to V16

we will show you how to migrate PLC programs from TIA Portal V13 to V16, a process essential for ensuring compatibility with new features, improving performance, and maintaining and upgrading automation systems.

To begin, we select "Open Project," and navigate to the project file created in V13. When prompted to migrate the project, we follow the on-screen instructions to complete the migration.

After the migration, we review the project for any compatibility issues or necessary updates, and finally, we save the project in the new V16 format.

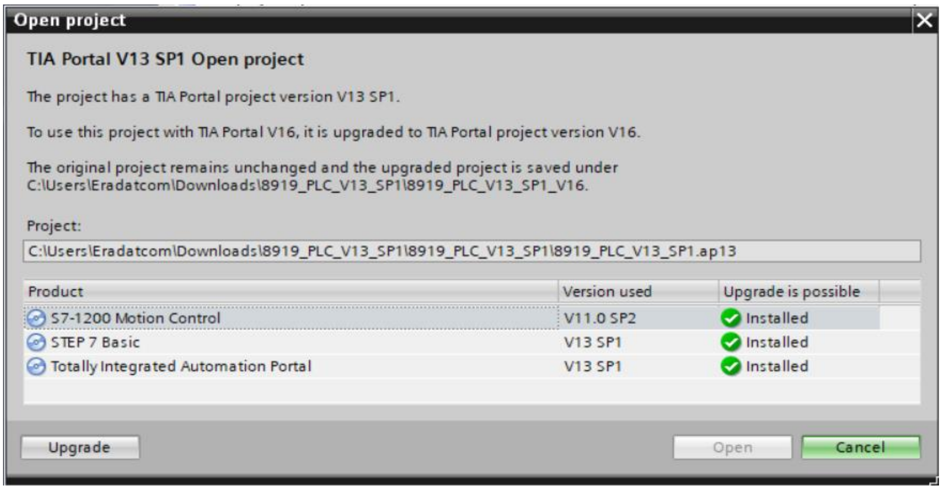

Figure 30: Migrating Program from TIA Portal V13 to V16

After we opened the obtained program, we discovered several functions and data blocks originating from the two PLCs interconnected via Profinet.

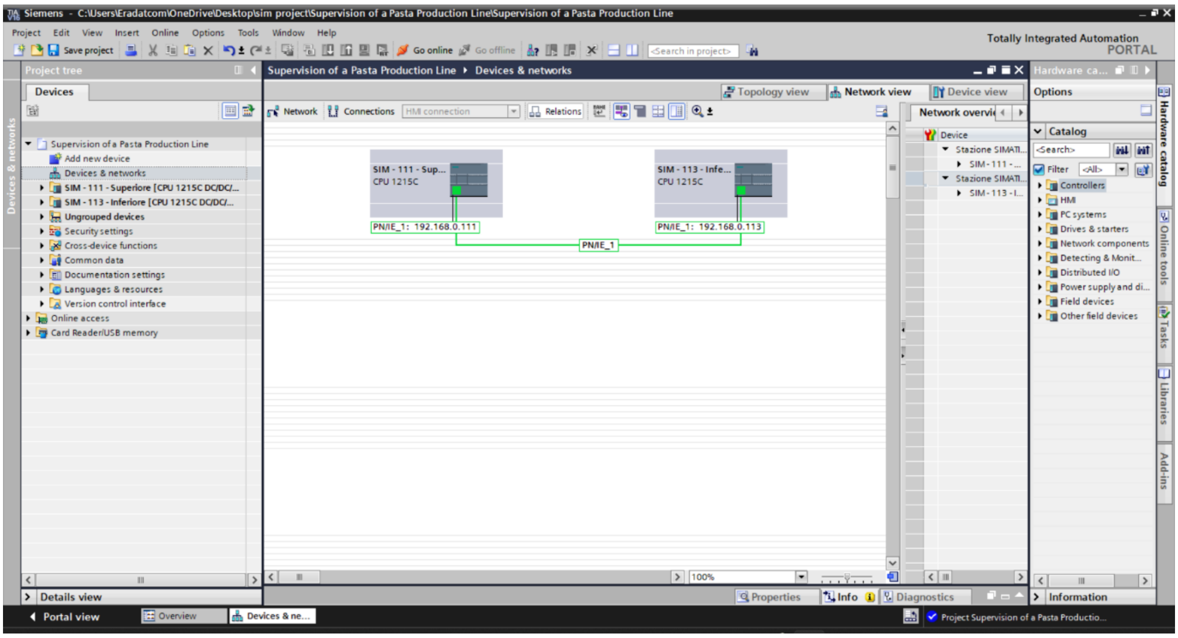

Figure 31: Existing device and network

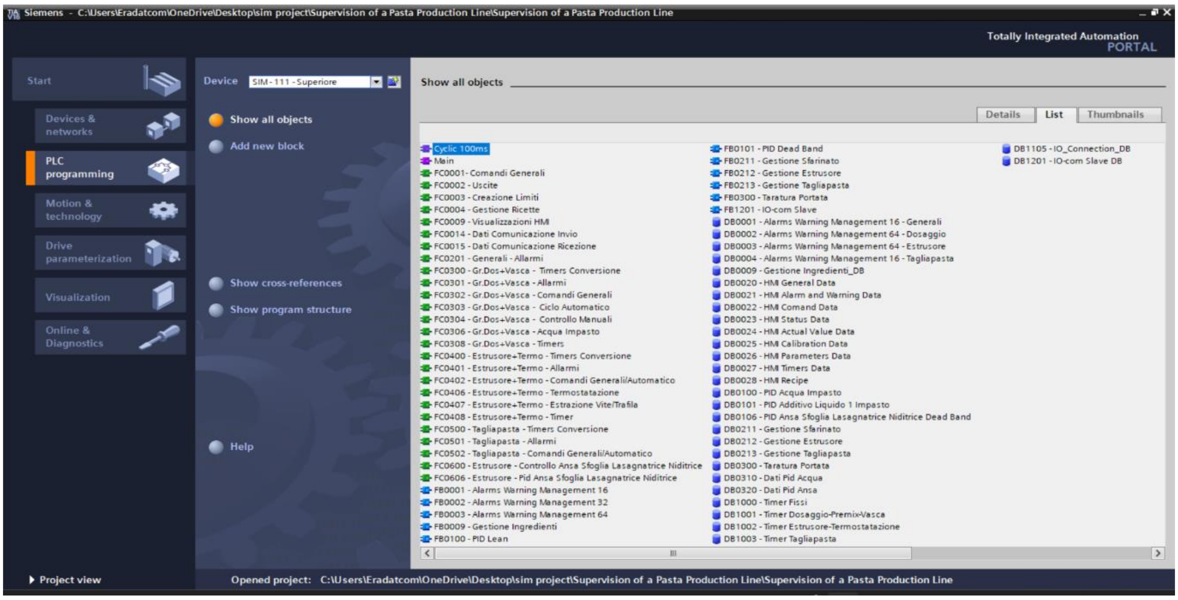

Figure 32: Objects from PLC 1"sim_111_Superiore"

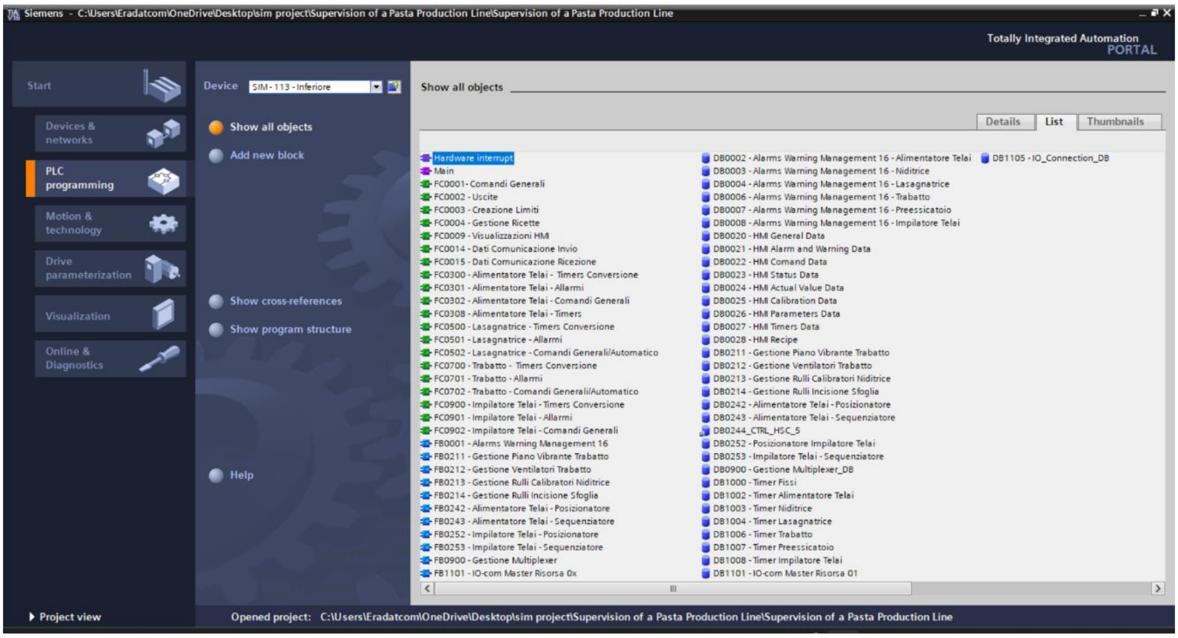

Figure 33: Objects from PLC 2"sim_113_Inferiore"

3.3 Integrating WinCC RT Professional and Network Configuration

3.3.1 Integrating WinCC RT Professional

We will integrate PC systems using "WinCC RT Professional" in our project. Initially, the project will be opened, followed by subsequent steps.

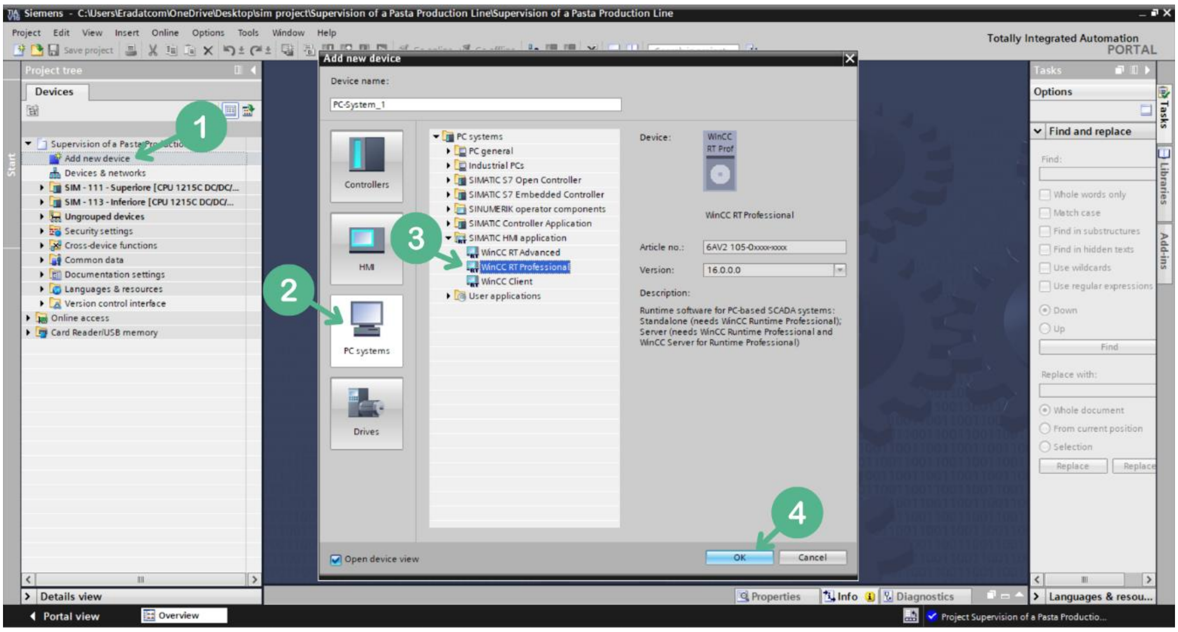

Figure 34: Integration Steps for WinCC RT Professional Station

1. **add new device**
   - We select “Add a new device” from the list of devices and double-click on it.
2. **select PC systems**
   - After displaying the various devices that can be added, we select and add the desired device.
3. **Select WinCC RT Professional**
   - We select "WinCC RT Professional" from the folder level.
4. **Confirm the device**
   - After selecting the device, we click "OK" to confirm the selection.

3.3.2 Network Configuration

In the network view, we drag the PC station onto the network and connect it to the same Profinet network as the PLCs. This is what (Figure 35) shows.

we selected different names for each device and assigned appropriate IP addresses within the same subnet. Names and addresses are shown in (Tab4),

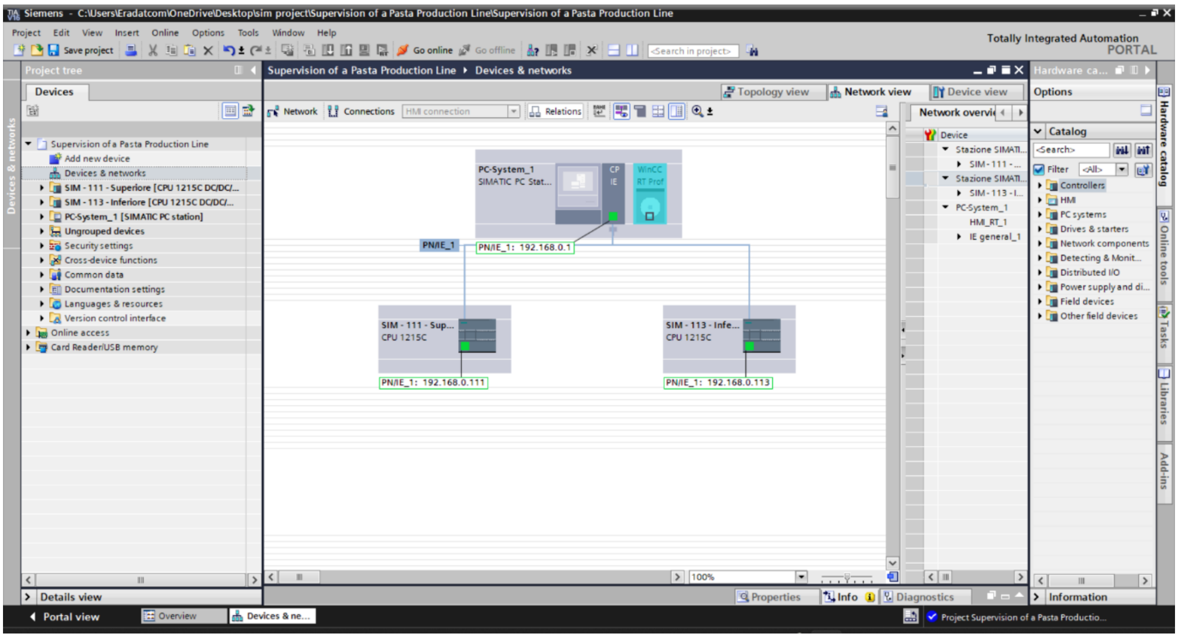

Figure 35: Connecting PC Station to Profinet Network

Device Name	IP Address
SIM_111_Superiore	192.168.0.111
SIM_113_Inferiore	192.168.0.113
PC System_1	192.168.0.1

Table 4: Device Names and IP Addresses

3.4 Screen Development and Organization in TIA Portal

3.4.1 Creating Screens

We've crafted approximately 130 screens, each bearing its own distinctive name yet upholding uniform properties: a resolution of 1920 x 1080, a scale of 250 ms, and a harmonious aesthetic. Our focal point, the primary screen, is marked as '0001_main', We will show a selection of these screens to demonstrate our exact work.

Figure 36: Main Screen (0001_main) in ASEM HMI Interface

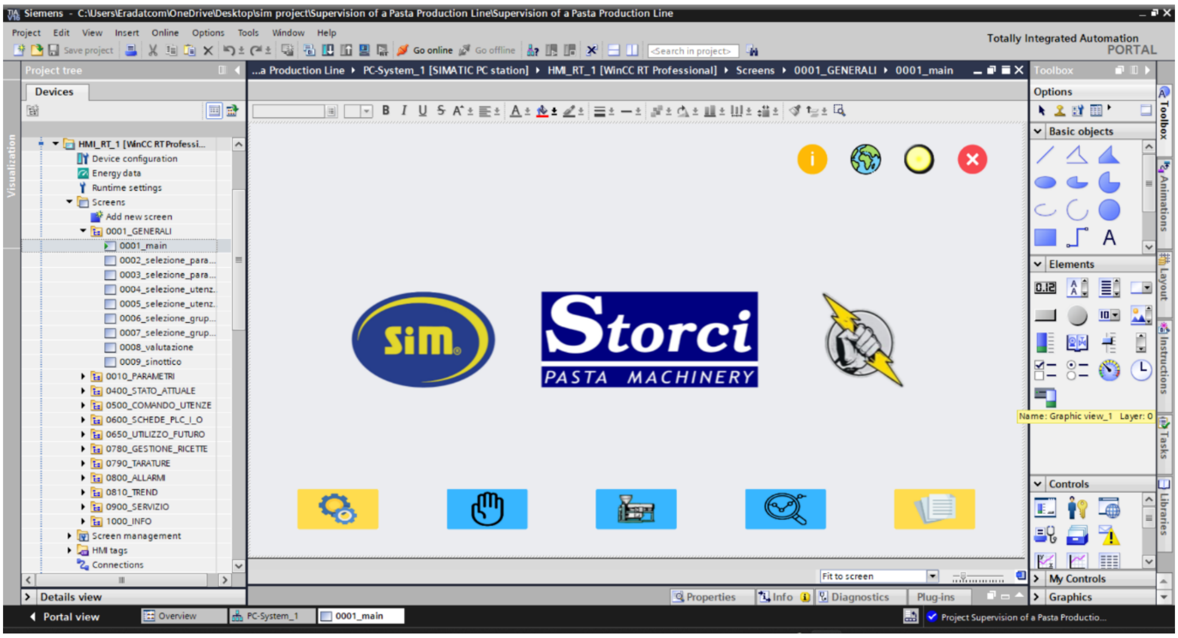

Figure 37: Main Screen (0001_main) in WinCC Interface

Figure 38: Lower Parameter Selection Screen (0003_selezione_parametri_inferiore) in ASEM HMI Interface

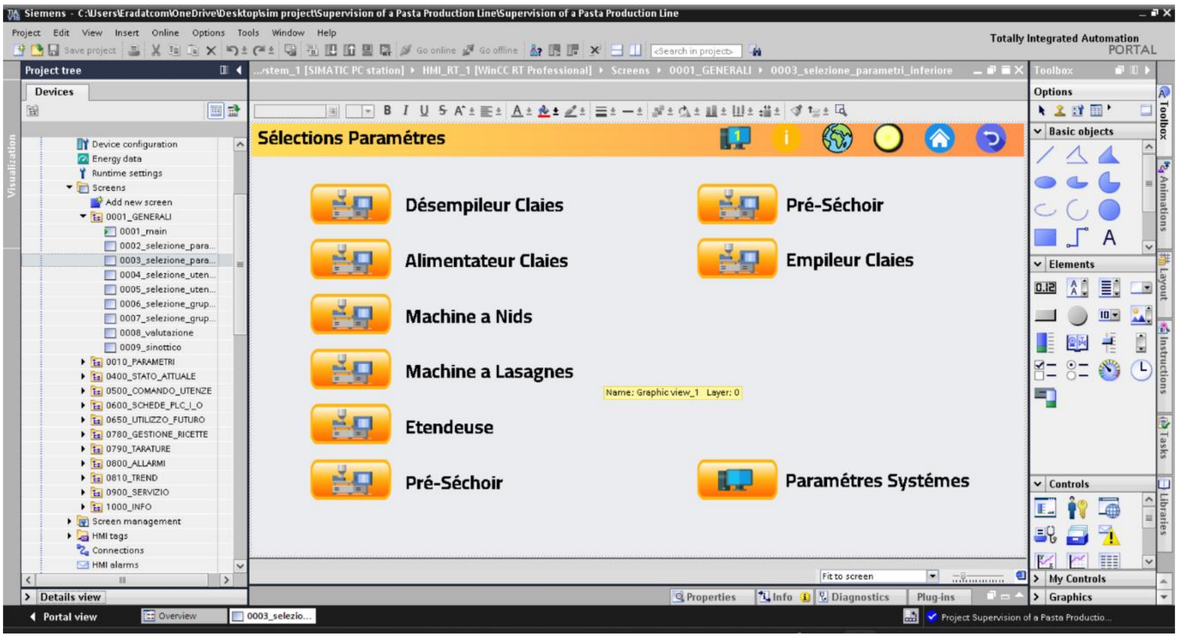

Figure 39: Lower Parameter Selection Screen (0003_selezione_parametri_inferiore) in WinCC Interface

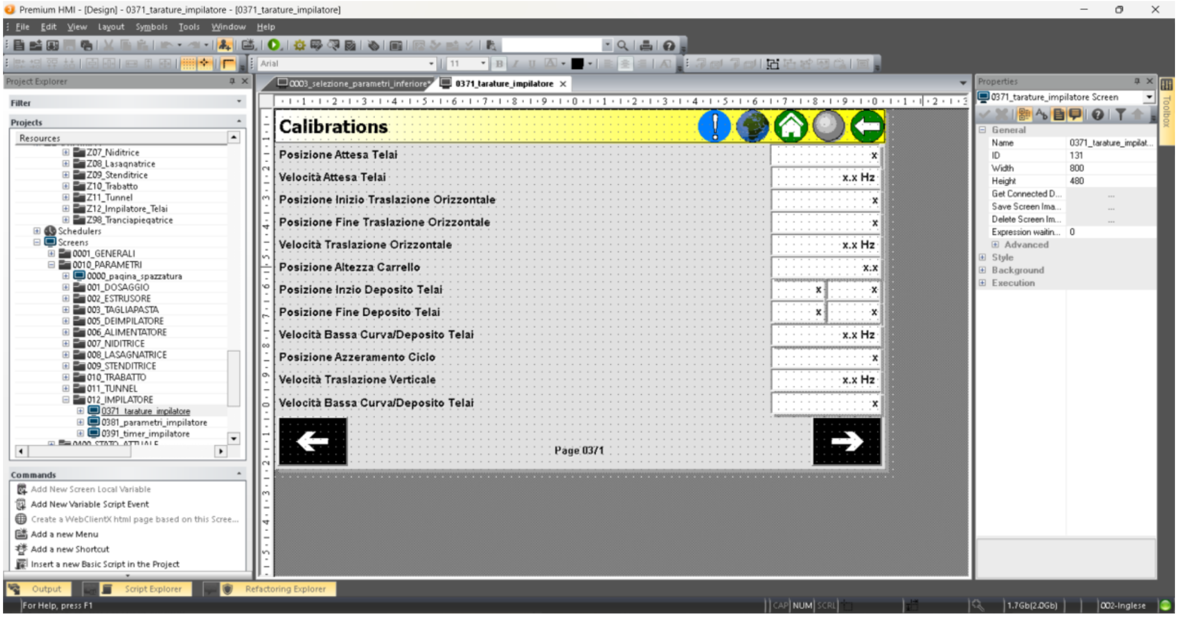

Figure 40: Calibrator Settings Screen (0371_tarature_impilatore) in ASEM HMI Interface

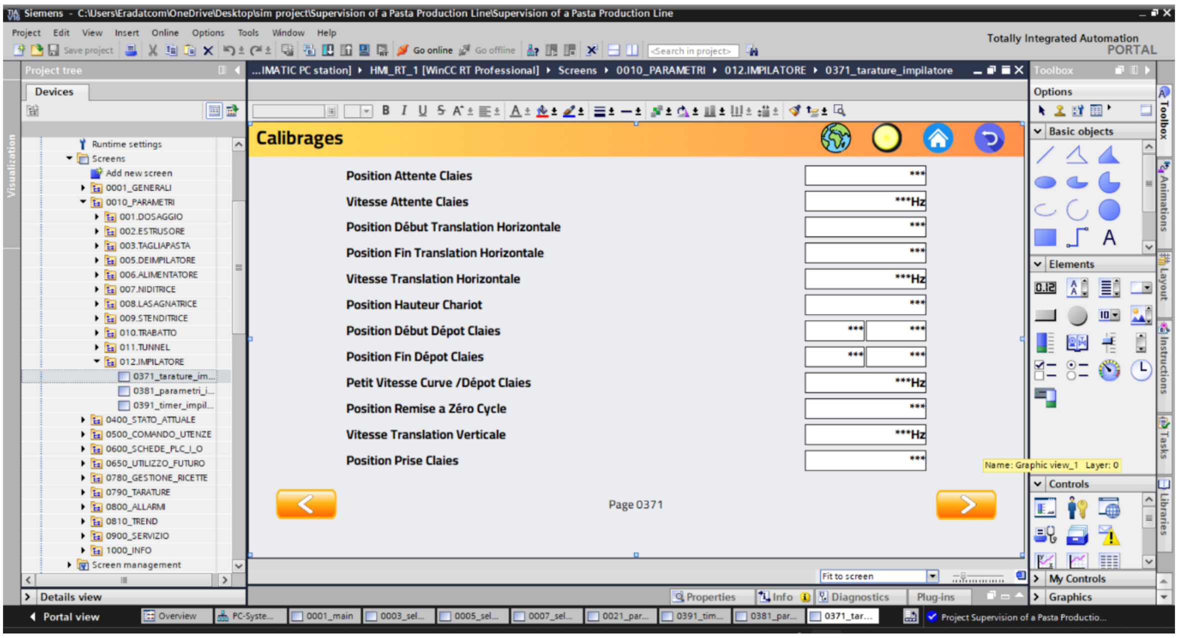

Figure 41: Calibrator Settings Screen (0371_tarature_impilatore) in WinCC Interface

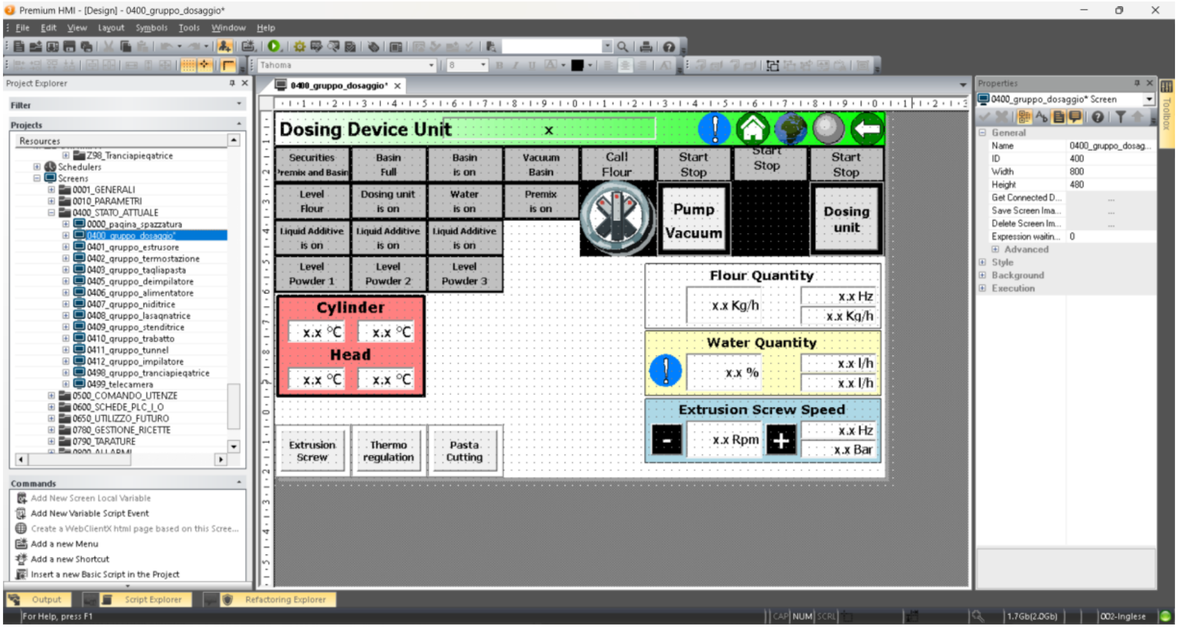

Figure 42: Dosing Group Screen (0400_gruppo_dosaggio) in ASEM HMI Interface

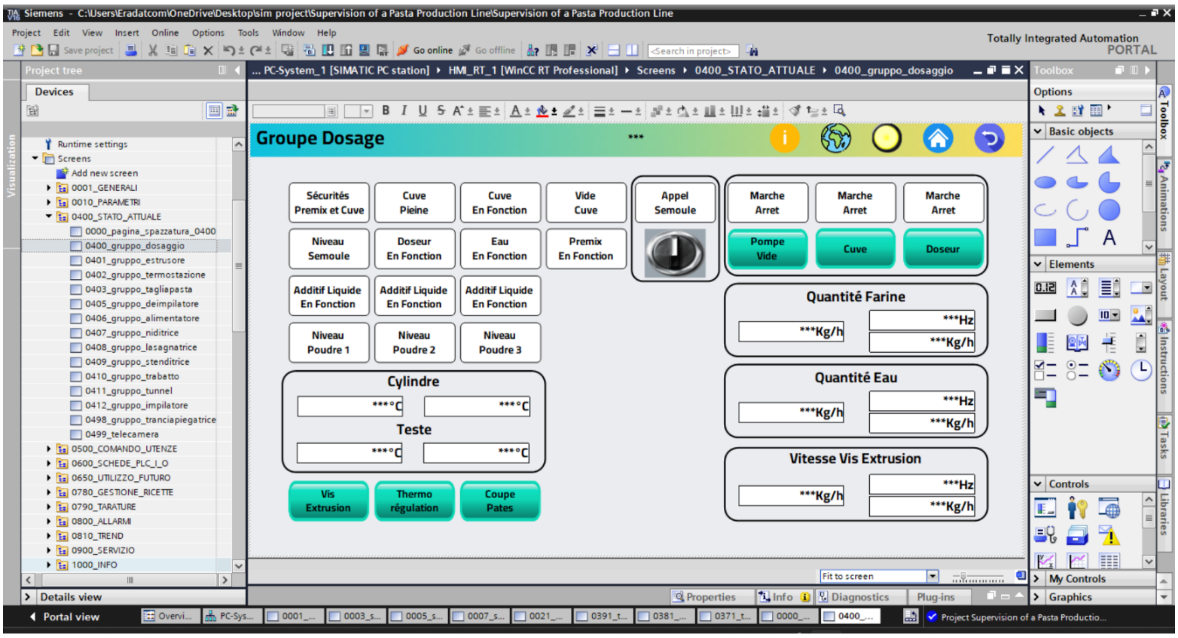

Figure 43: Dosing Group Screen (0400_gruppo_dosaggio) in WinCC Interface

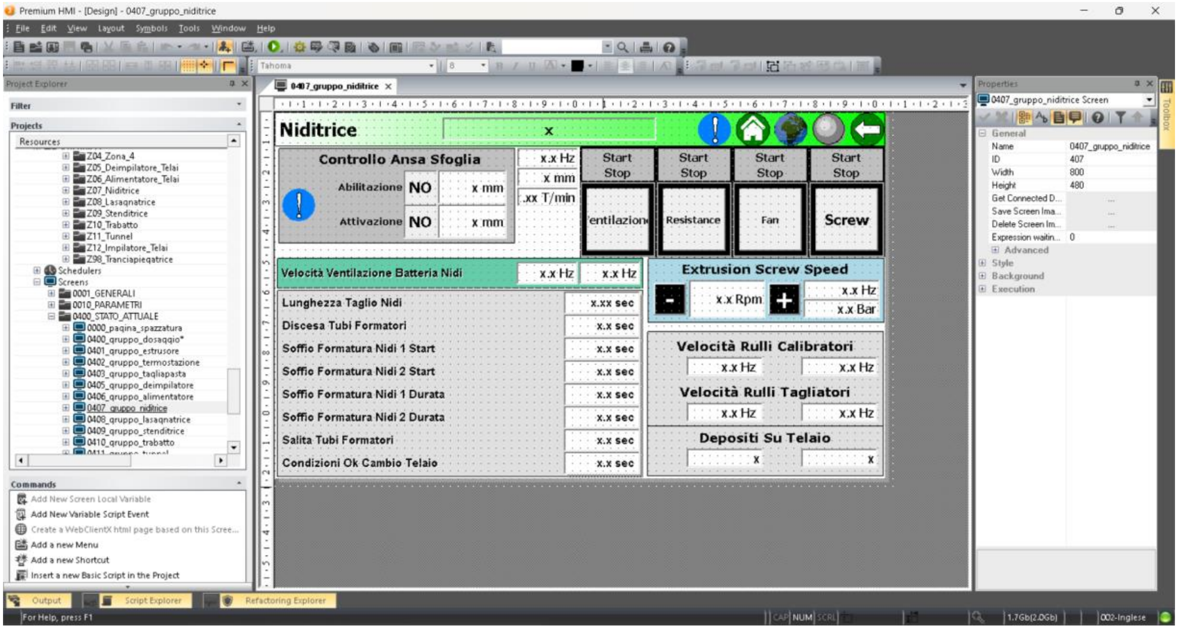

Figure 44: Nesting Group Screen (0407_gruppo_niditrice) in ASEM HMI Interface

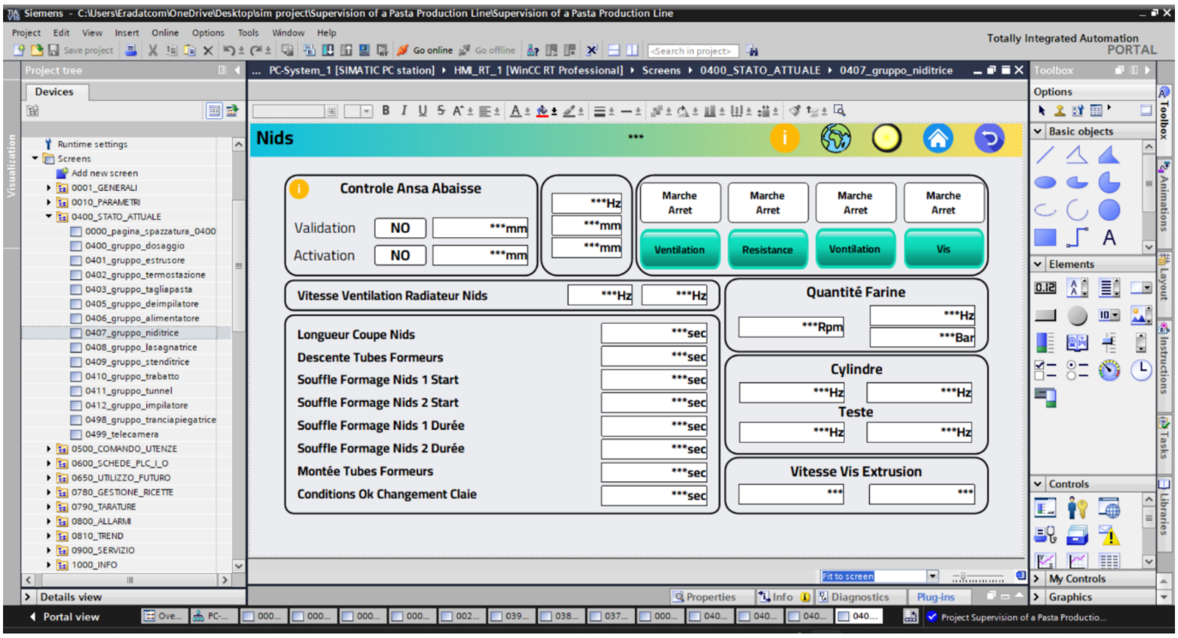

Figure 45: Nesting Group Screen (0407_gruppo_niditrice) in WinCC Interface

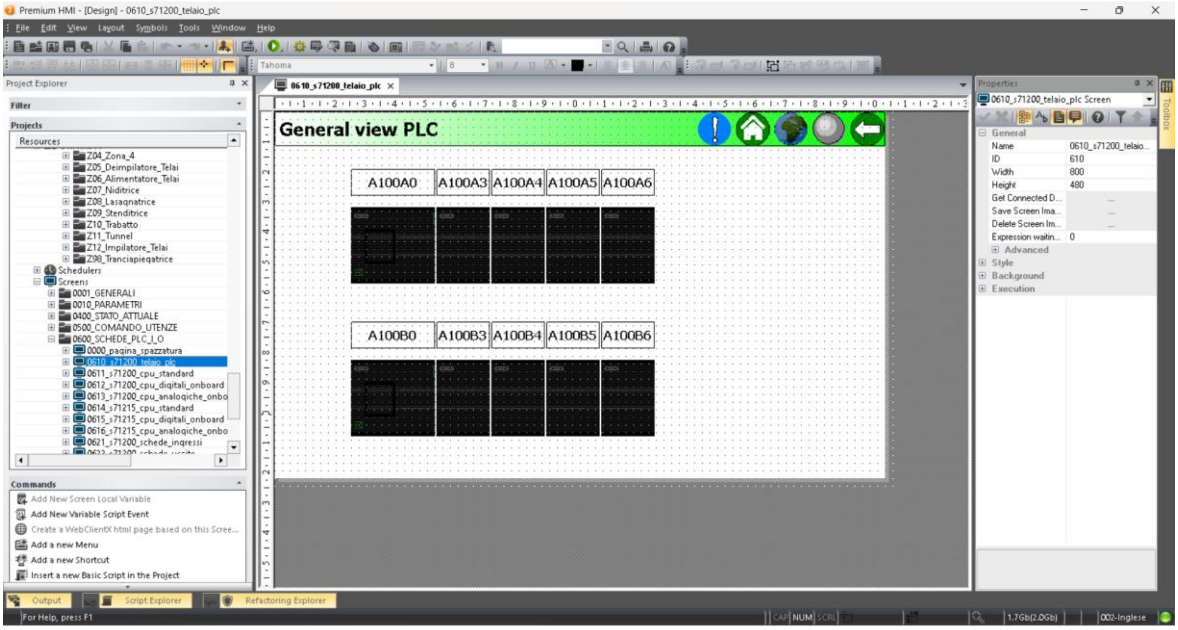

Figure 46: S7-1200 PLC Frame Screen (0610_s71200_telaio_plc) in ASEM HMI Interface

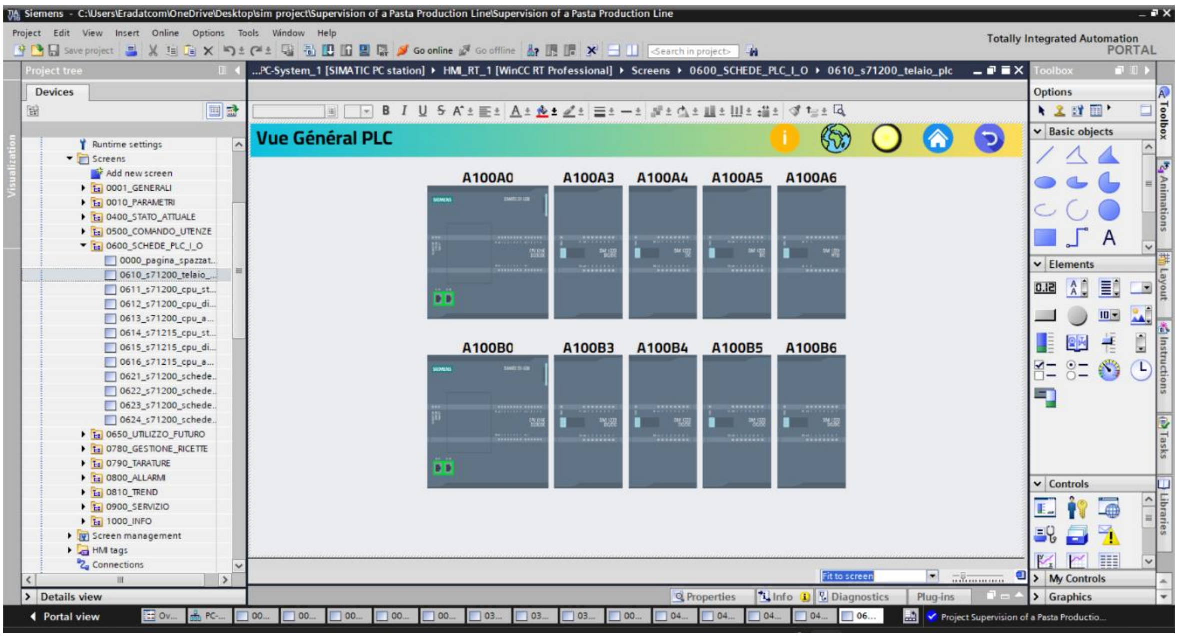

Figure 47: S7-1200 PLC Frame Screen (0610_s71200_telaio_plc) in WinCC Interface

We utilize Canva to meticulously design backgrounds, buttons, and logos. By leveraging Canva's advanced design tools, we ensure that each element is both aesthetically pleasing and intuitively crafted, contributing to a cohesive and professional user interface.

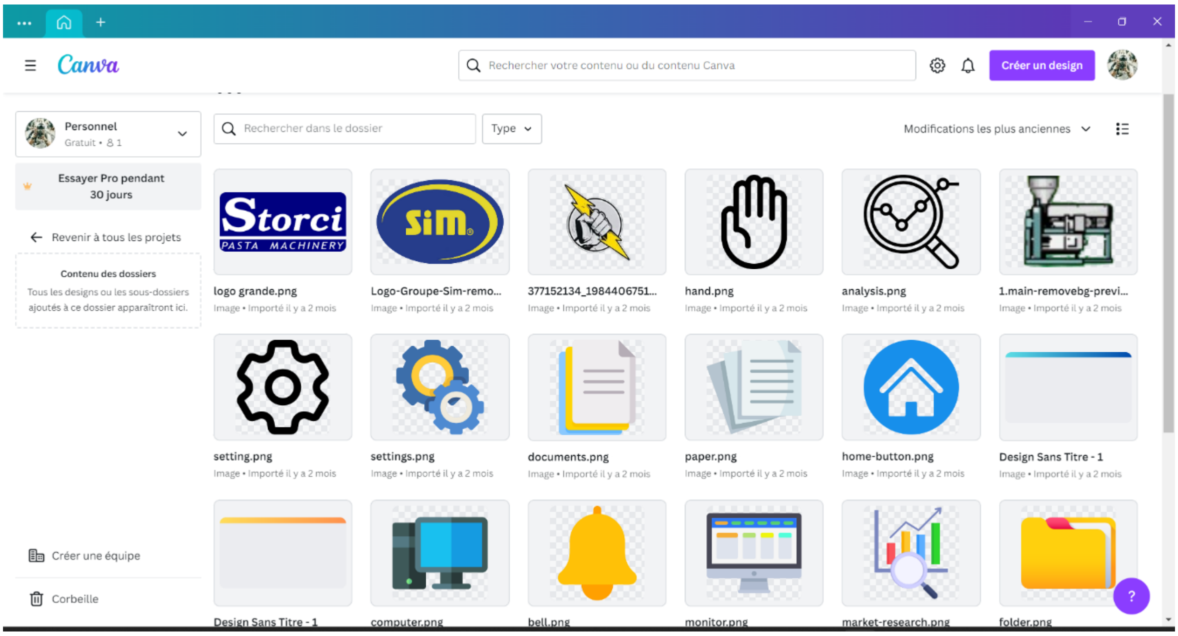

Figure 48: Some logos and interfaces designed with Canva

3.4.2 Transferring Functions from HMI Premium to TIA Portal

In this section, we will explore the process of transferring various functions from HMI Premium to TIA Portal so that the transfer maintains the same characteristics to ensure consistency. The different events we will cover include:

- **Screens (Active Screens)**
- **Edit bits (Invertbit)**
- **I/O field (Display Value)**
- **I/O field (Display Text)**
- **Animation (Appearance)**
- **Trends**
- **Alarms**
- **Users**

3.4.2.1 Screens (Active Screens)

We will explain how to we copied a button event "active screens" in Premium HMI to the TIA Portal.

In Premium HMI

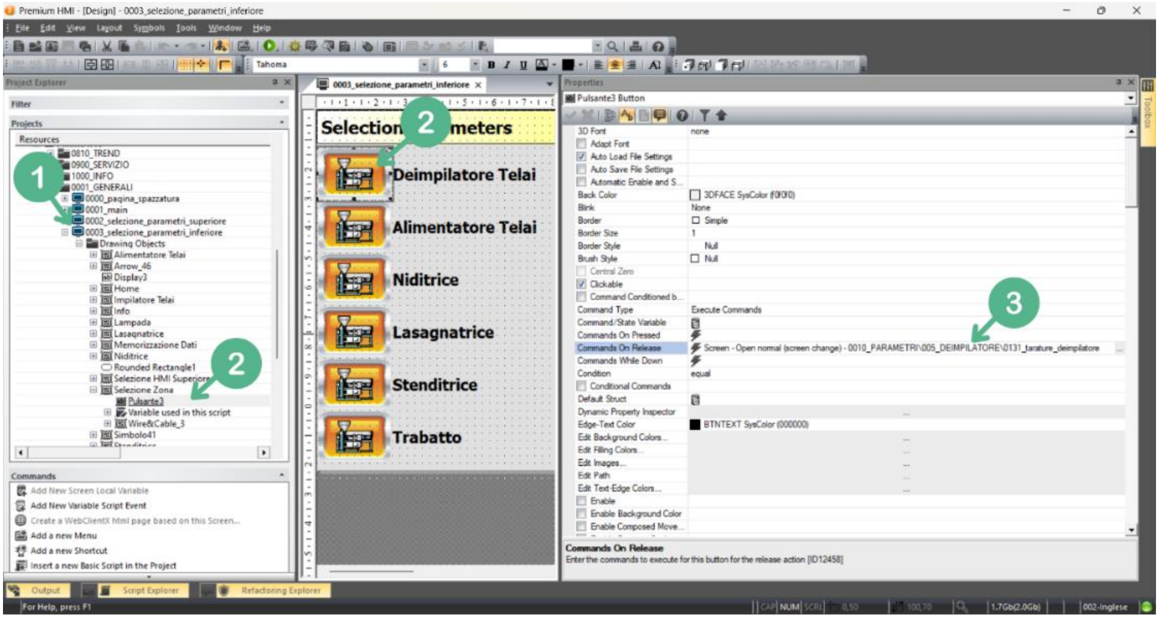

Figure 49: Select and Note Down Button Event in Premium HMI

1. Select the Screen

- We navigate to the "Screens" folder in the Project Explorer.
- We select the desired screen, such as (e.g., 0003_selezione_parametri_inferiore).

2. Select the Button

- In the screen editor, we click the button we want to copy, like (e.g., Pulsante 3).

3. Note the Command on release Variable

- In the properties window, we find and note down the command on release associated with the button, for example, (screen-open normal (screen change) 0010_PARAMETRI\005_ DEMPILATORE \0131_tarature deimpilatore).

In TIA Portal

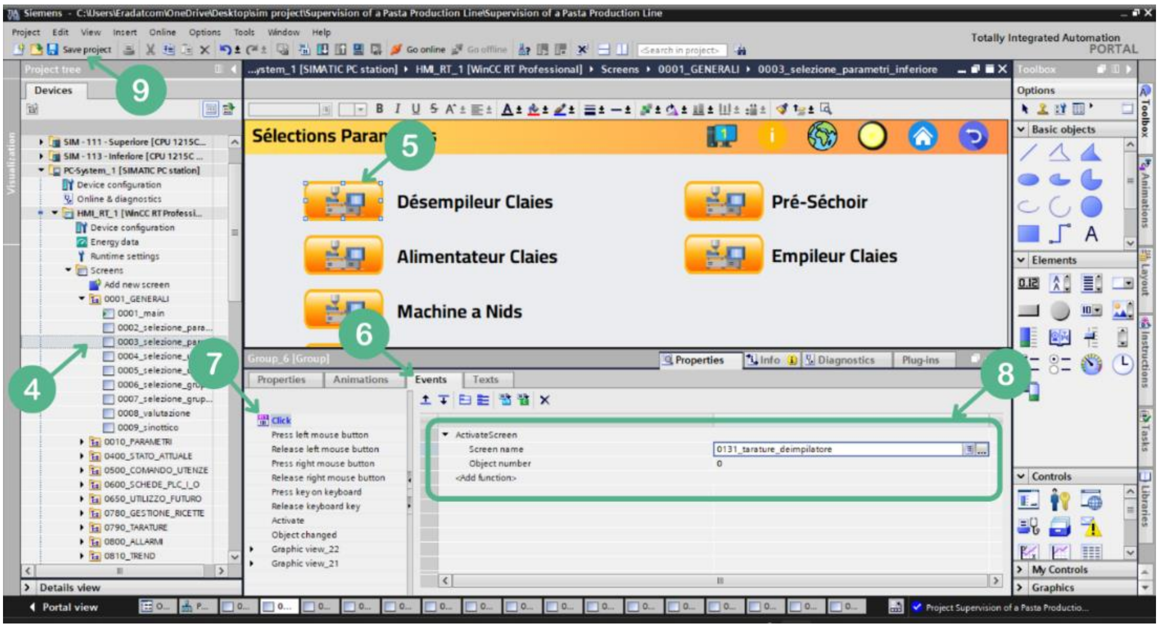

Figure 50 : Configure Button Event in TIA Portal

4. Select the Screen

- We navigated to the “Screens” folder in the project tree and selected the screen (0003_selezione_parametri_inferiore) where we wanted to configure the button event.

5. Select the Button

- In the screen editor, we clicked on the button we wanted to configure. This highlighted the button and displayed its properties and events in the lower part of the window.

6. Open the Events Tab

- With the button selected, we went to the "Events" tab in the properties panel at the bottom.

7. Configure the Event

- In the "Events" tab, we added a new event. We selected "Click" as the type of event for the button.

8. Select Action

- In the “Action” section, we chose “ActivateScreen” from the dropdown menu.
- We then specified the target screen name by setting the “Screen name” to (0131_tarature_deimpilatore.)

9. Save the Configuration

- Finally, we saved the project to ensure all changes were stored.

3.4.2.2 Edit bits (Invertbit)

we will explain how we copied a button event “ Invertbit” from Premium HMI to TIA Portal.

In Premium HMI

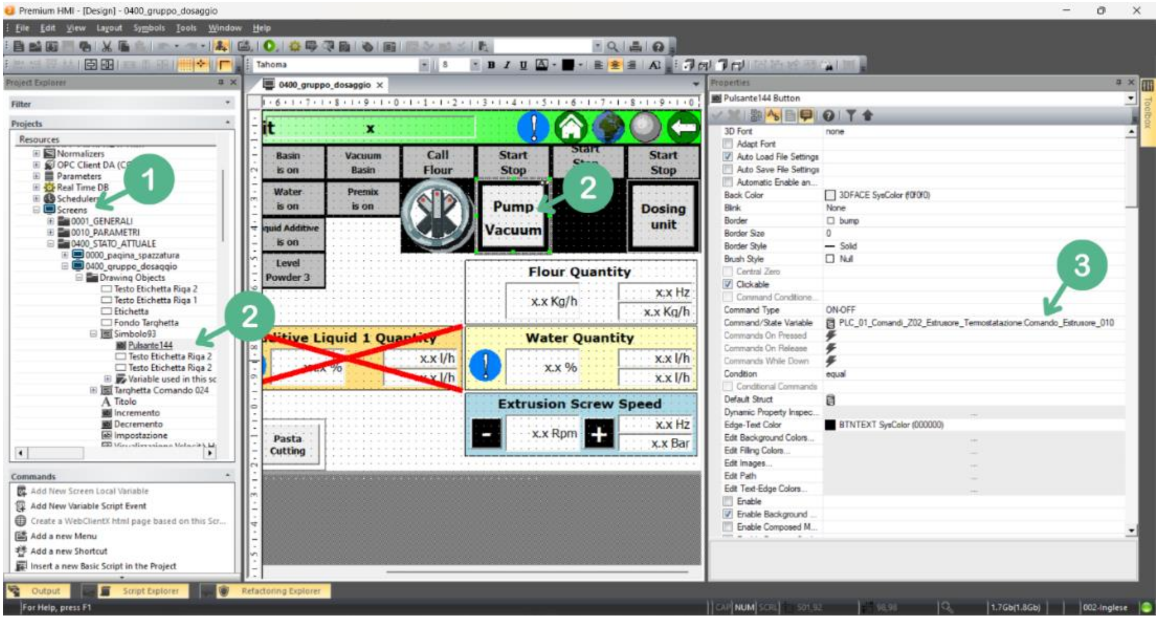

Figure 51 : Select and Note Down Command/State Variable in Premium HMI

1. **Select the Screen**
   - We navigate to the "Screens" folder in the Project Explorer.
   - We select the desired screen, such as (e.g., 0400_gruppo_dosaggio).
2. **Select the Button**
   - In the screen editor, we click the button we want to copy, like (e.g., Pulsante144).
3. **Note the Command/State Variable**
   - In the properties window, we find and note down the command on release associated with the button, (PLC_01_Comandi_202_Estrusore_ Termostatizzazione: Comando_ Estrusore_010).

In TIA Portal

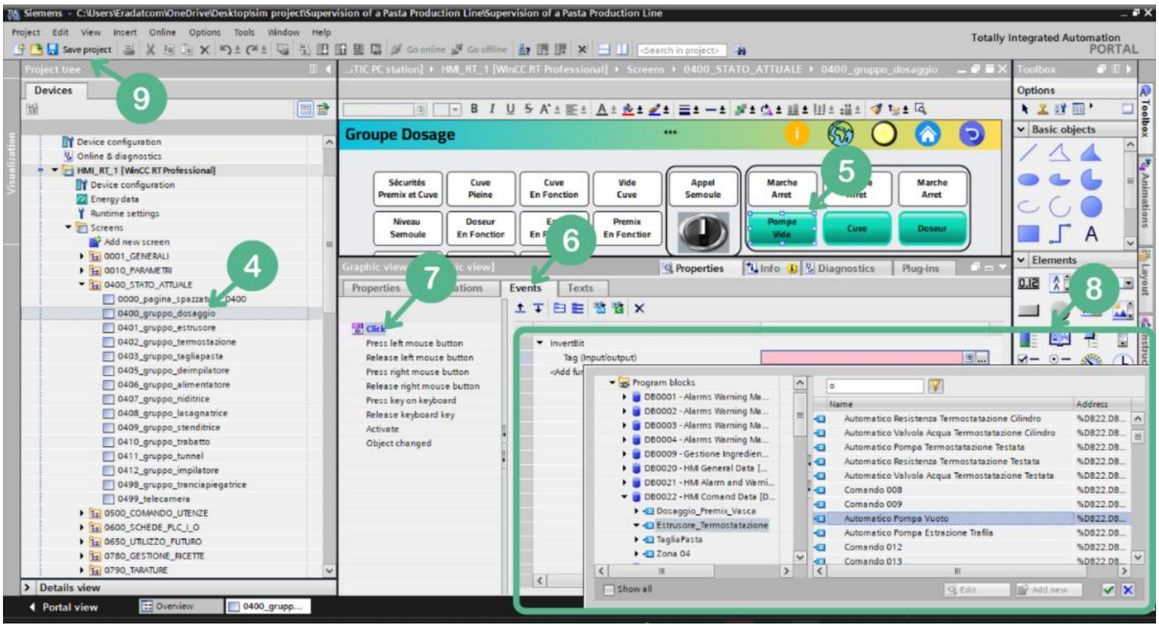

Figure 52 : Configure Invert Bit Event in TIA Portal

4. **Select the Screen**
   - We navigated to the “Screens” folder in the project tree.
   - We Select the corresponding screen (0400_gruppo_dosaggio).
5. **Select the Button**
   - In the screen editor, we clicked on the button where we want to apply the event (Pompe Vide).
6. **Open the Events Tab**
   - With the button selected, we went to the "Events" tab in the properties panel.
7. **Configure the Event**
   - We selected "Click" as the type of event for the button.
8. **Assign the Command/State Variable**
   - In the "Action" section, we choose "InvertBit" from the dropdown menu.
   - In the "Tag" field, we entered the command/state variable noted from Premium HMI (Automatico Pompa Vuoto).
9. **Save the Project**
   - Than we Clicked the "Save project" button to ensure all changes are stored.

3.4.2.3 I/O field (Display Value)

we will explain how we copied an I/O field “Display the Value” from Premium HMI to TIA Portal.

In Premium HMI

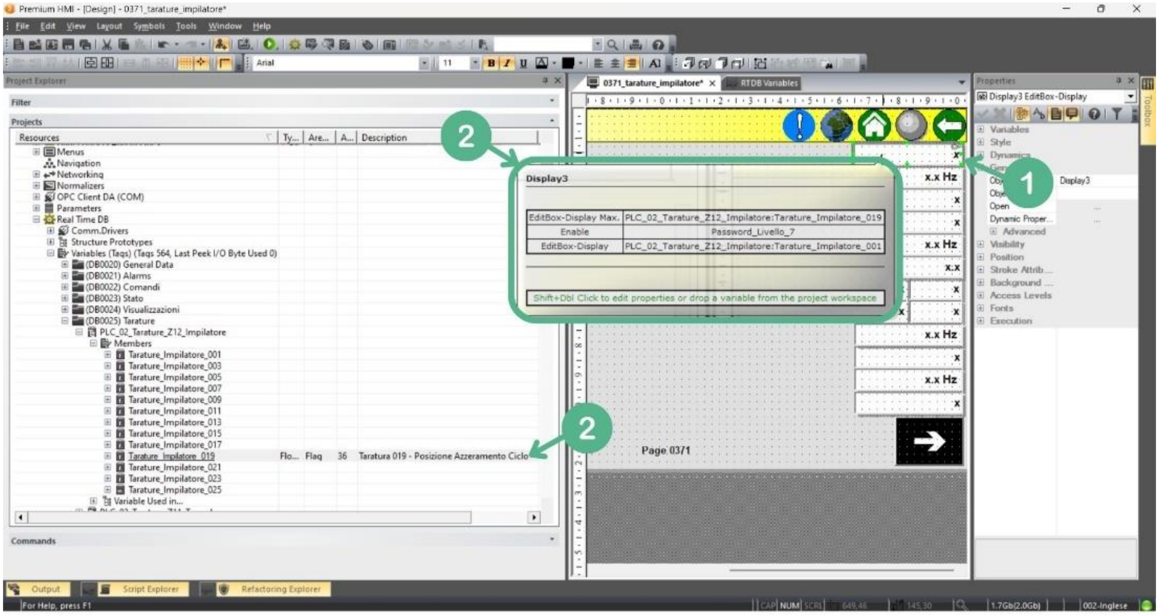

Figure 53 **:** Select and Specify Input and Output Space in Premium HMI

1. **Select the Scree**
   - We navigate to the "Screens" folder in the Project Explorer.
   - We select the desired screen, (e.g.,Display3).
2. **Specify the Input and Output Space**
   - In the screen editor, we clicked on the input and output space.
   - Than we Note the tags associated with the space, such as the maximum limit, minimum limit, and whether it is an output unit or an input unit (e.g.,PLC_02_Tarature_ Z12_ Impilatore, PLC_02_Tarature_Z12_Impilatore).

In TIA Portal

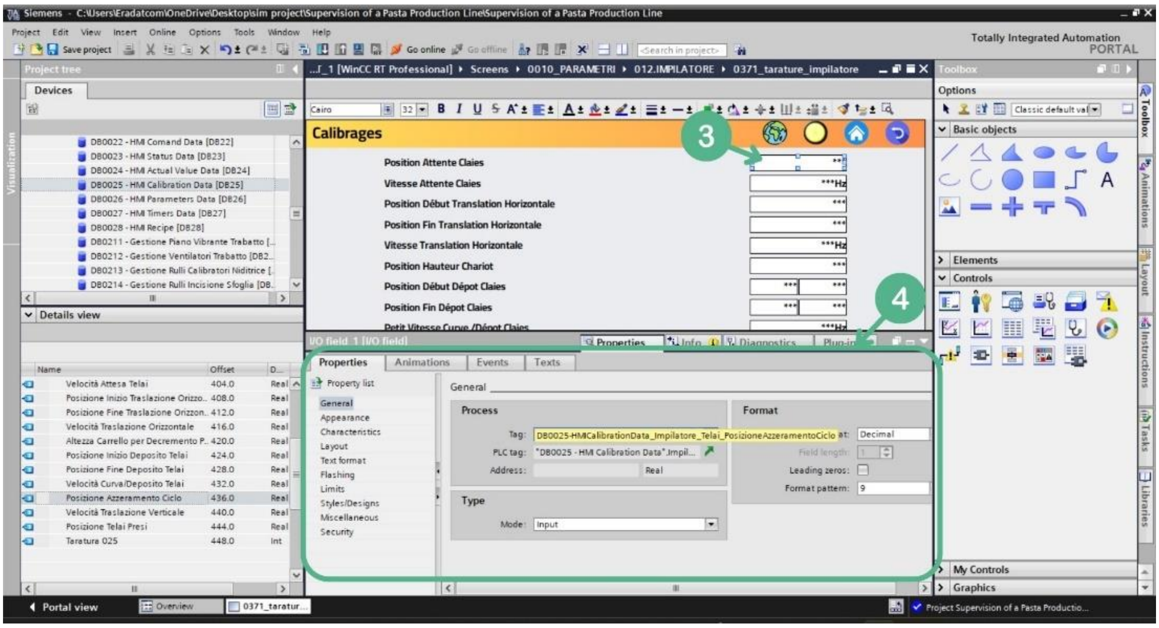

Figure 54: Configure I/O Field in TIA Portal

3. **Select I/O Space**
   - We selected the input and output filed on which we enter information
4. **Enter Process Type and Format**
   - In the properties window, we entered the tag obtained from the previous step.
   - Than we specify the Process Type and Format.

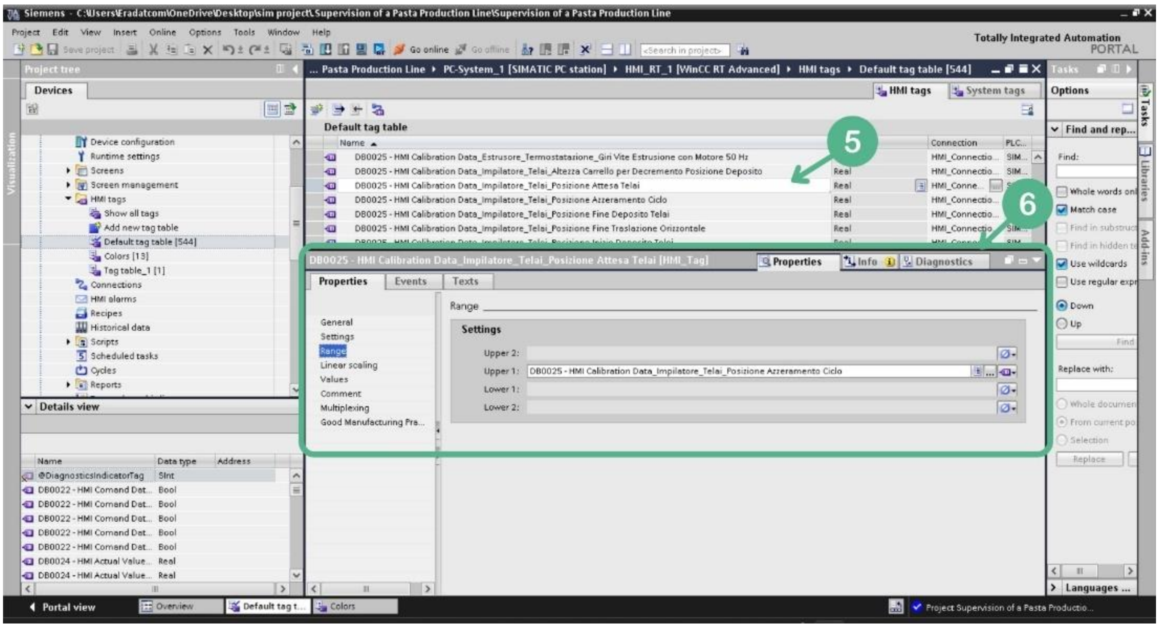

Figure 55: Specify Tag Range in TIA Portal

5. **Select the Tag**
   - We navigate the "Tags" folder in the Project Explorer.
   - We Selected the relevant tag for configuration.
6. **Specify the Range**
   - We open the Properties window and we want to the Range property.
   - We Specify the tag's upper and lower limits (e.g., PLC_02_Tarature_Z12_ Impilatore).

3.4.2.4 I/O field (Display Text)

we will explain how we copied an I/O field “Display the Text” from Premium HMI to TIA Portal.

In Premium HMI

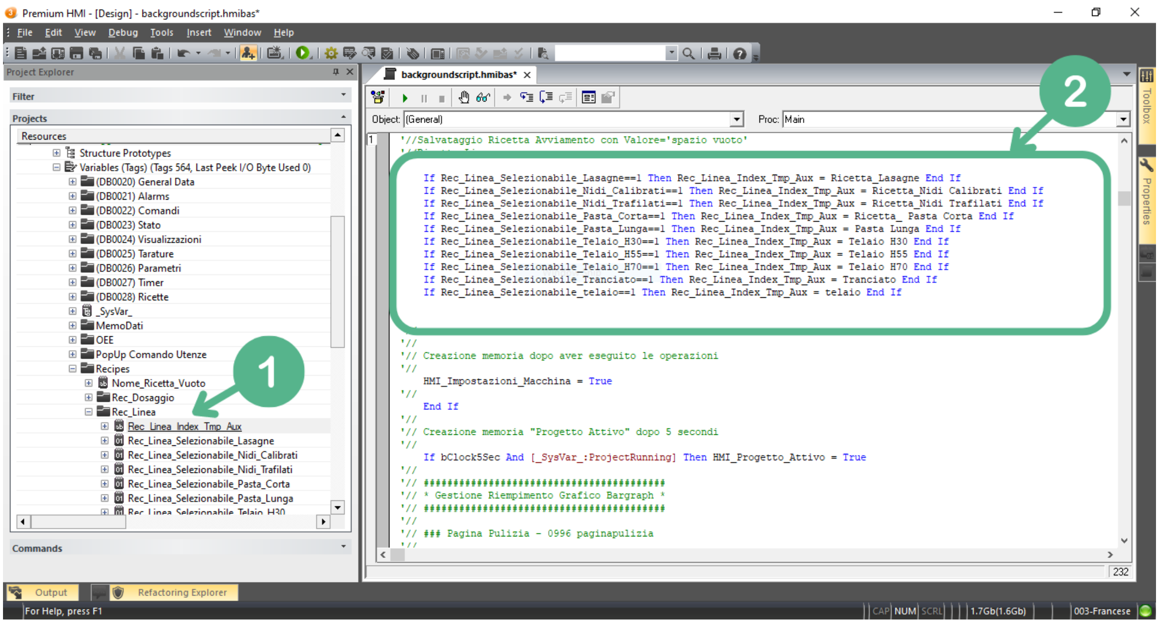

Figure 56: Locate and Understand Pasta Recipes in Premium HMI

1. **Select the Folder**
   - We navigated the folder that contains the pasta recipes.
2. **Locate the Pasta Recipes**
   - Than we Identified the location of the pasta recipes in the program developed in the C language.
   - We Understand this part of the program to obtain the necessary information.

In TIA Portal:

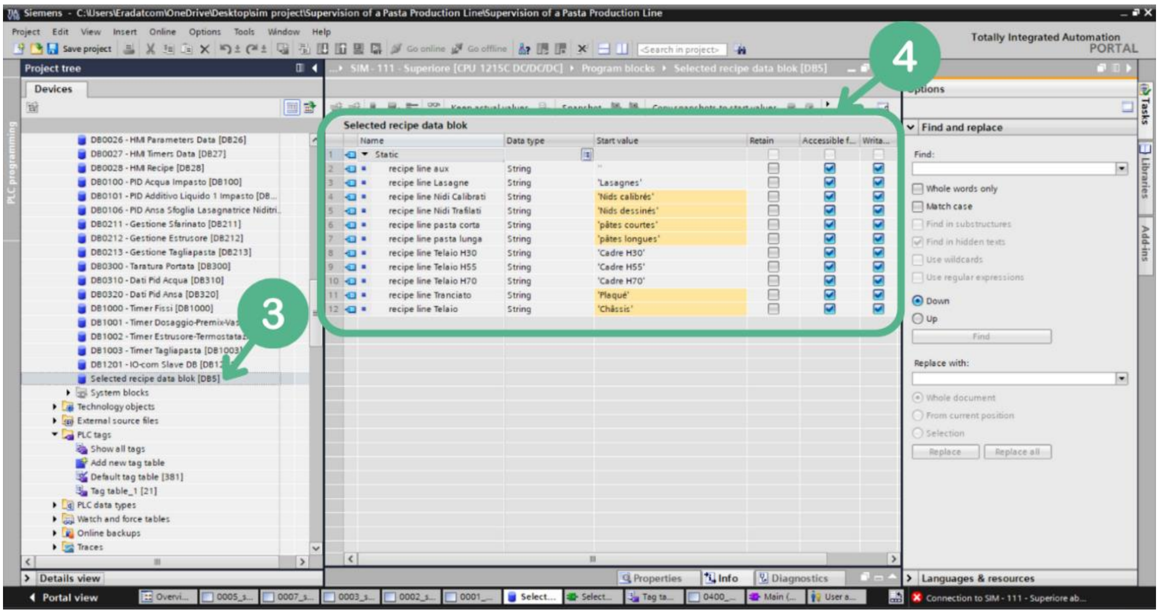

Figure 57: Create Data Block and Variables in TIA Portal

3. Create a Data Block

- We developed a data block where the variables will be entered.

4. Create Variables

- We define the variables of type "string" and we assign each variable an initial value representing the name of the recipe (e.g., lasagna).

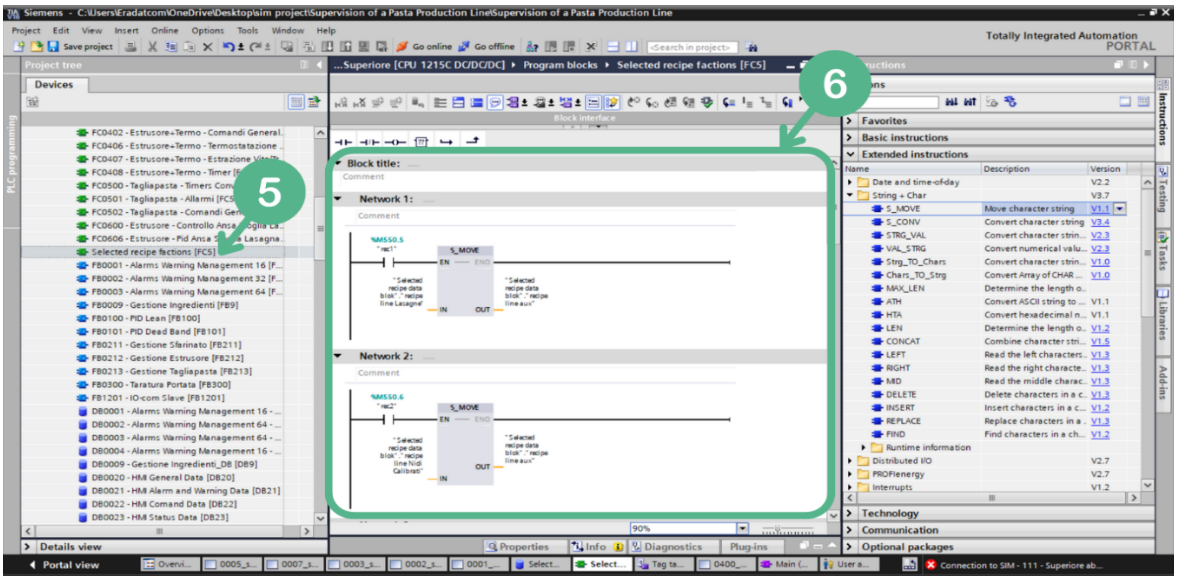

Figure 58: Develop Functional Block and Program in TIA Portal

5. **Create a Functional Block**
   - We develop a functional block that will contain the new program.
6. **Develop the Program**
   - We Create a program consisting of 10 Networks.
   - Than we Utilize the S_MOVE function, which transfers data from 'in' to 'out' if the condition at the 'En' input is met.

3.4.2.5 Animation (Appearance)

we will explain how we copied an Animation “Appearance” from Premium HMI to TIA Portal.

In Premium HMI

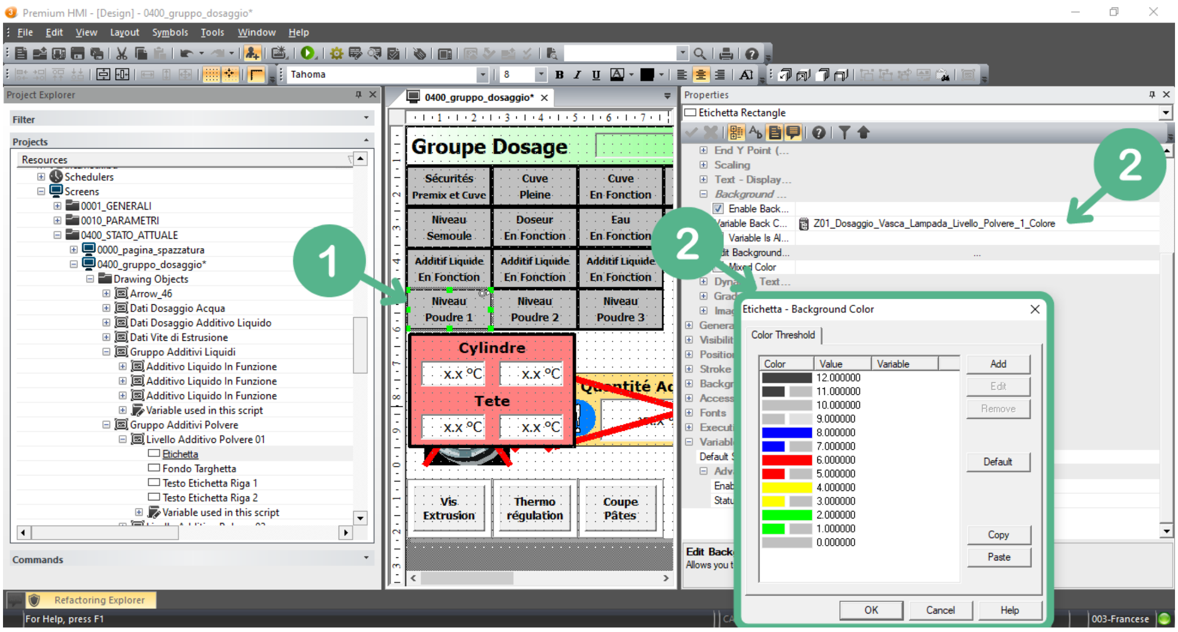

Figure 59: Select Display Space and Record Variables in Premium HMI

1. **Select Display Space**
   - After opening the screen, we selected the display space from
2. **Record Variable Tag and Range**
   - After the information appears, we note down the variable tag and the range for each color.

In TIA Portal

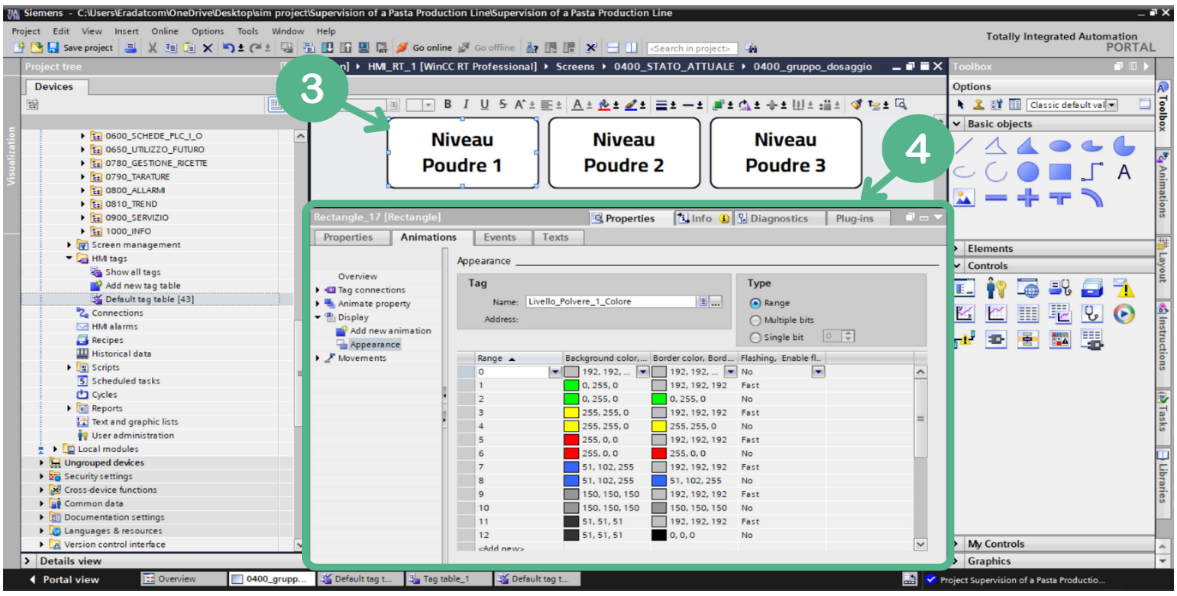

Figure 60: Enter Variable Tag and Range in TIA Portal

3. Select Display Space

- We select display space.

4. Enter Information:

- We enter the obtained information, including the variable tag and the range for each color.

3.4.2.6 Alarms

we will explain how to copy Alarms from Premium HMI to TIA Portal.

In Premium HMI

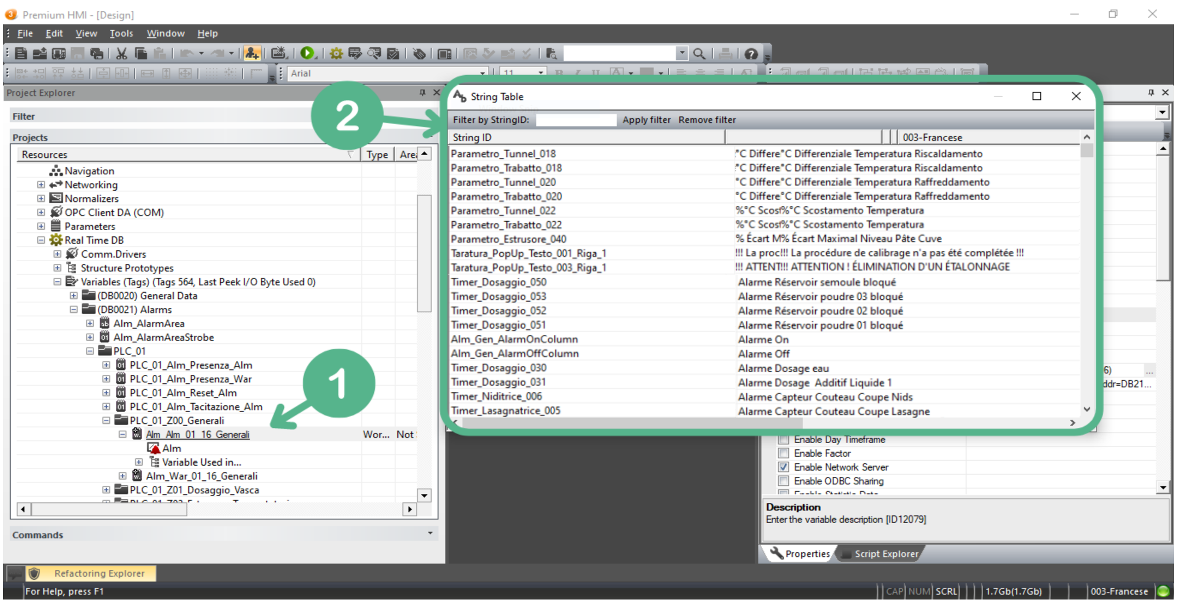

Figure 61 : Opening the Alarms Folder and Recording Variables

1. Open the Alarms Folder

- We navigate to the "Alarms" folder and open it.

2. Record Variables and Alarm Messages

- Than we Identified and note down the variables and alarm messages.

In TIA Portal

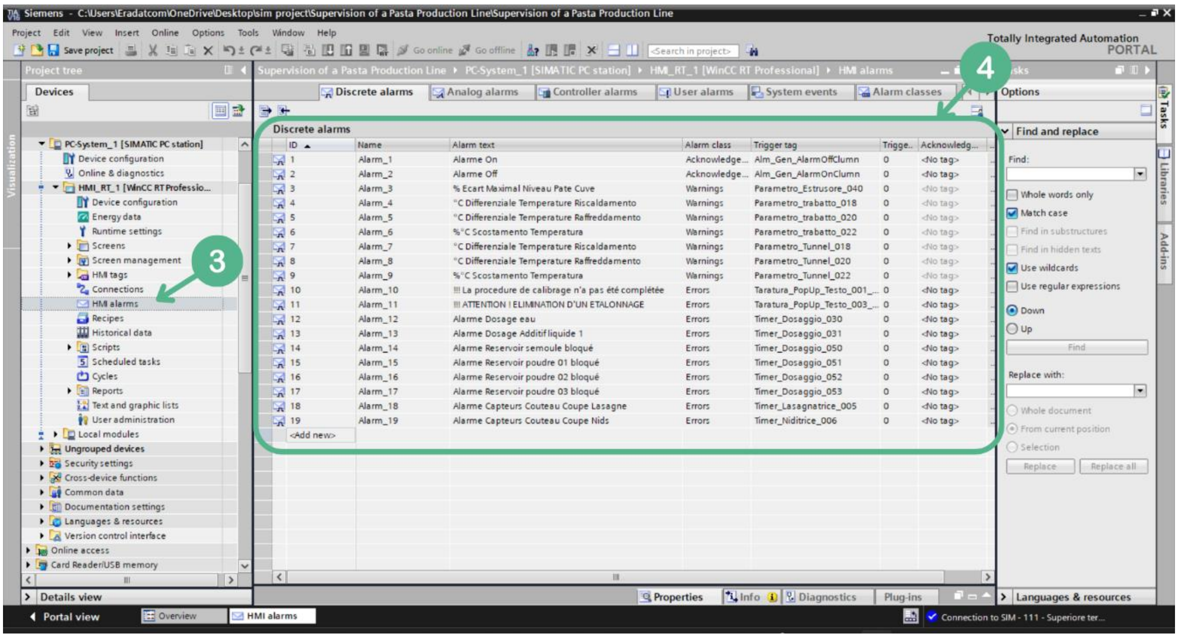

Figure 62: Configuring HMI Alarms in TIA Portal

3. Open HMI Alarms

- We navigate to the HMI alarms configuration section in TIA Portal.

4. Enter Variables and Alarm Messages

- We Input the recorded variables and alarm messages, specifying the type of alarm.

3.4.2.7 Trends

we will explain how we copied Trends from Premium HMI to TIA Portal.

In Premium HMI

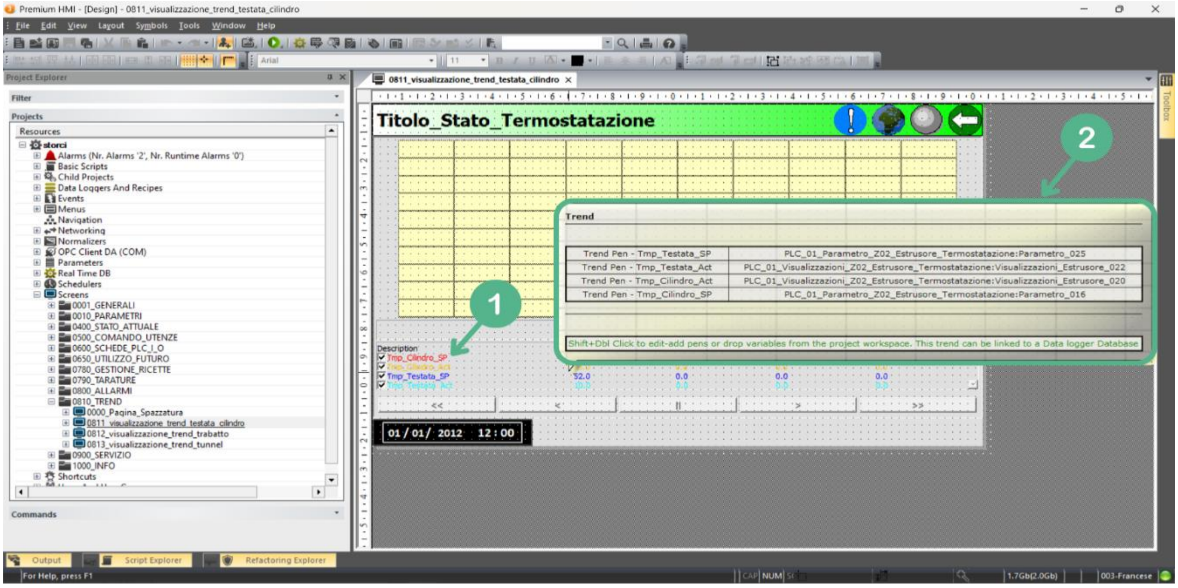

Figure 63: Opening and Defining Variables for Curved Screen in Premium HMI

1. **Open the Curved Screen**
   - We opened the screen that displays the curves.
   - We defined the variables associated with the curves.
2. **Record the Variables**
   - Than we note the identified variables.

In TIA Portal

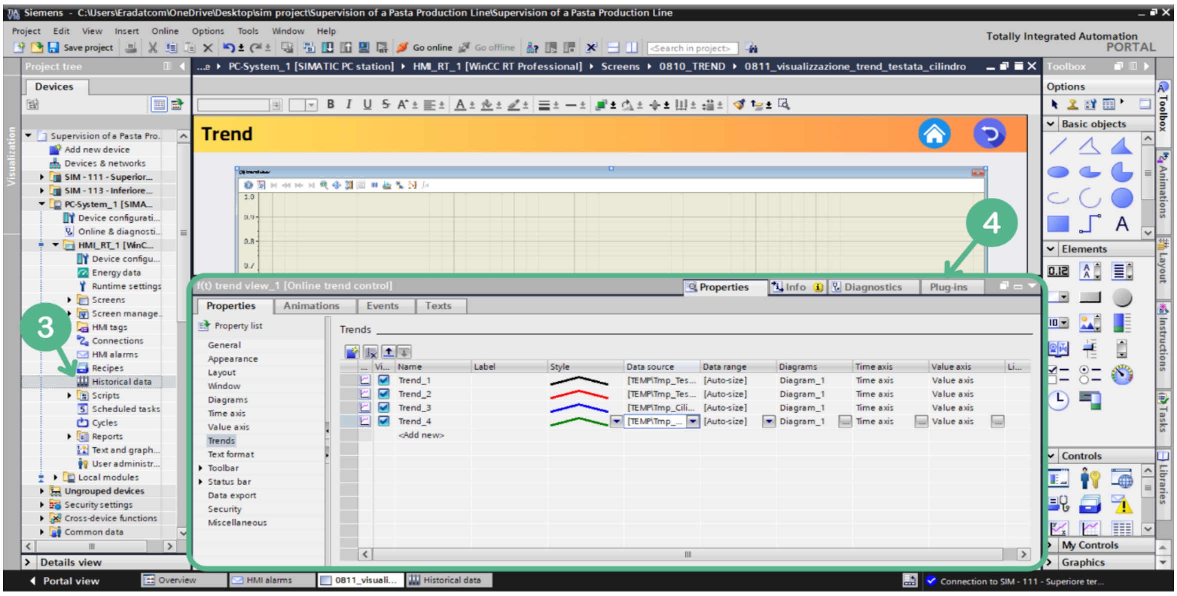

Figure 64: Entering Variables and Configuring Curve Display in TIA Portal

3. **Enter Variables into Historical Data**
   - We navigate to the Historical Data section.
   - We Inputted the recorded variables.
4. **Configure Curve Display**
   - We Opened the screen that will display the variables.
   - We want to the settings menu, we entered the variables, we specified line colors for each curve, we Assign names to each curves.

3.4.2.8 Users

we will explain how we copied Users from Premium HMI to TIA Portal.

In Premium HMI

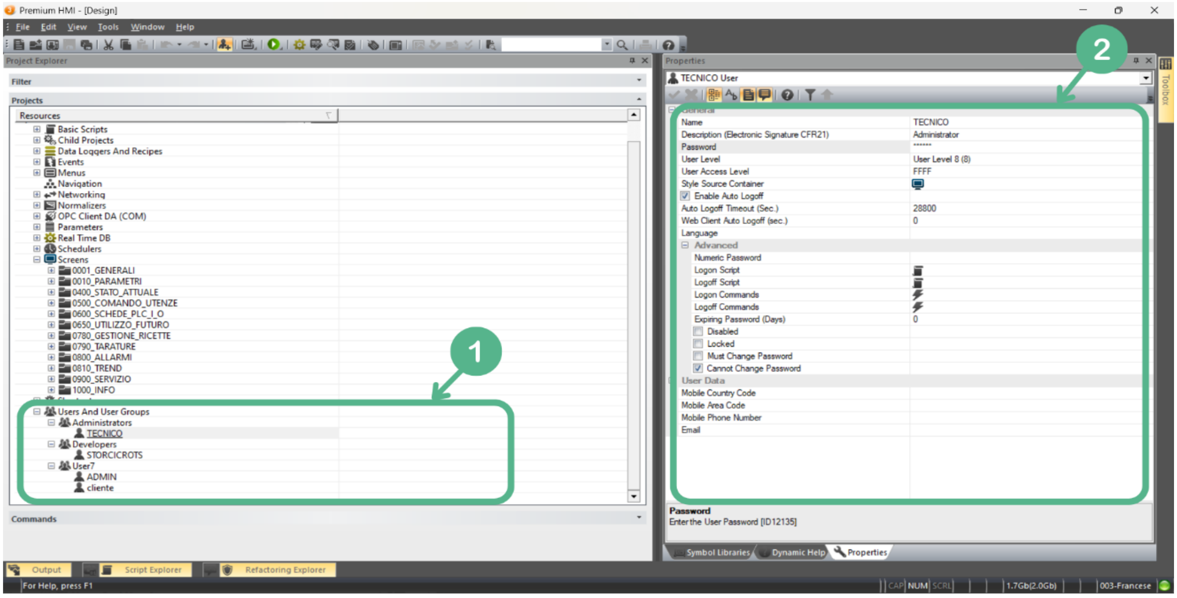

Figure 65: Accessing and Recording User Information in Premium HMI

1. **Open the Users and User Groups Folder**
   - We navigated the "Users and User Groups" folder.
   - Than we open the folder to access the user information.
2. **Record Name and Password Information**
   - We Identified and noted down the name and password information for each user.

In TIA Portal

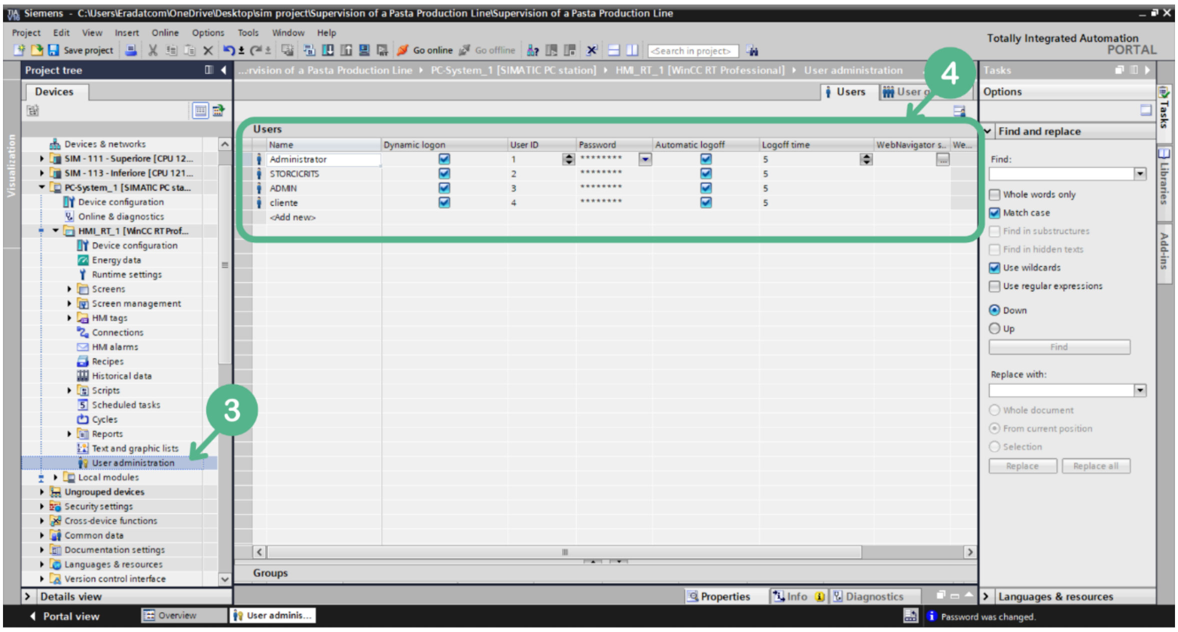

Figure 66: Entering User Information in TIA Portal

3. Open User Administration in TIA Portal

- We navigated to the user administration section in TIA Portal.
- We Opened the user administration interface.

4. Enter Name and Password Information

- We inputted the recorded name and password information into the user administration.
- We Ensured that all details are correctly entered.

3.4.3 Organizing Screens in TIA Portal as Structured in HMI ASEM

Initially, our project was structured into folders aligned with the program specifications obtained from HMI ASEM. These folders were categorized into groups such as "general," "parametri," and "stato_attuale." The organization of these folders in our project will be illustrated in (Figure 36).

In the figure, number one represents the folders present in the program at the HMI ASEM level, while number two represents the folders created within our project.

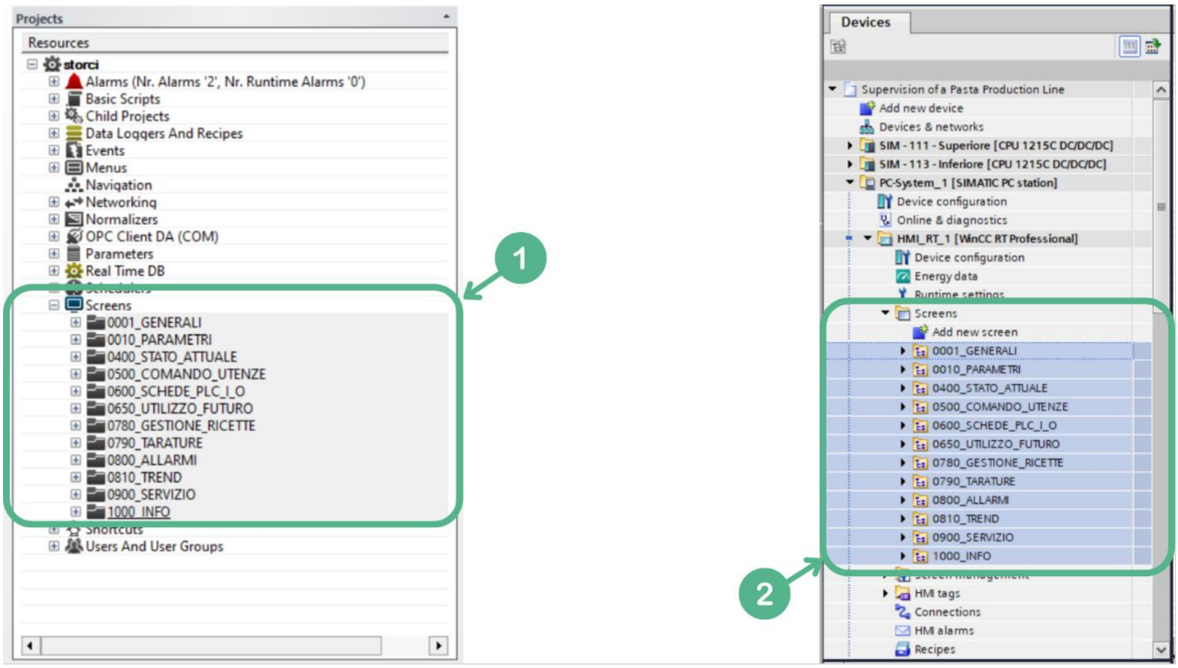

Figure 67: Comparison of Folder Structure between the HMI ASEM Program and Tia Portal

3.5 conclusion

In conclusion, our project involved backing up and migrating programs, integrating WinCC RT Professional and meticulously developing screens in TIA Portal. Through thorough execution, we've optimized automation processes, ensuring system robustness and user satisfactio

General conclusion

This project aimed to enhance the supervision of the pasta production line at SIM SPA by addressing the limitations of the existing ASEM display system. By implementing a new WINCC supervision system integrated with a Siemens S7-1200 PLC and HMI, the project significantly improved the accuracy and reliability of the production process.

The transition from the old system to the new one involved comprehensive steps, including program backup and migration, integration of WinCC RT Professional, and the development of user-friendly screens in TIA Portal. These steps were critical in ensuring seamless operation and improved functionality.

The new supervision system has optimized automation processes, leading to increased system robustness and user satisfaction. It has also enhanced monitoring and control capabilities, facilitating better maintenance and diagnostics. This project not only resolved the immediate challenges but also established a scalable and efficient framework for future improvements.

Overall, the implementation of the new WINCC supervision system has markedly improved the operational efficiency and reliability of the pasta production line at SIM SPA, ensuring better perfrmance and scalability for the future

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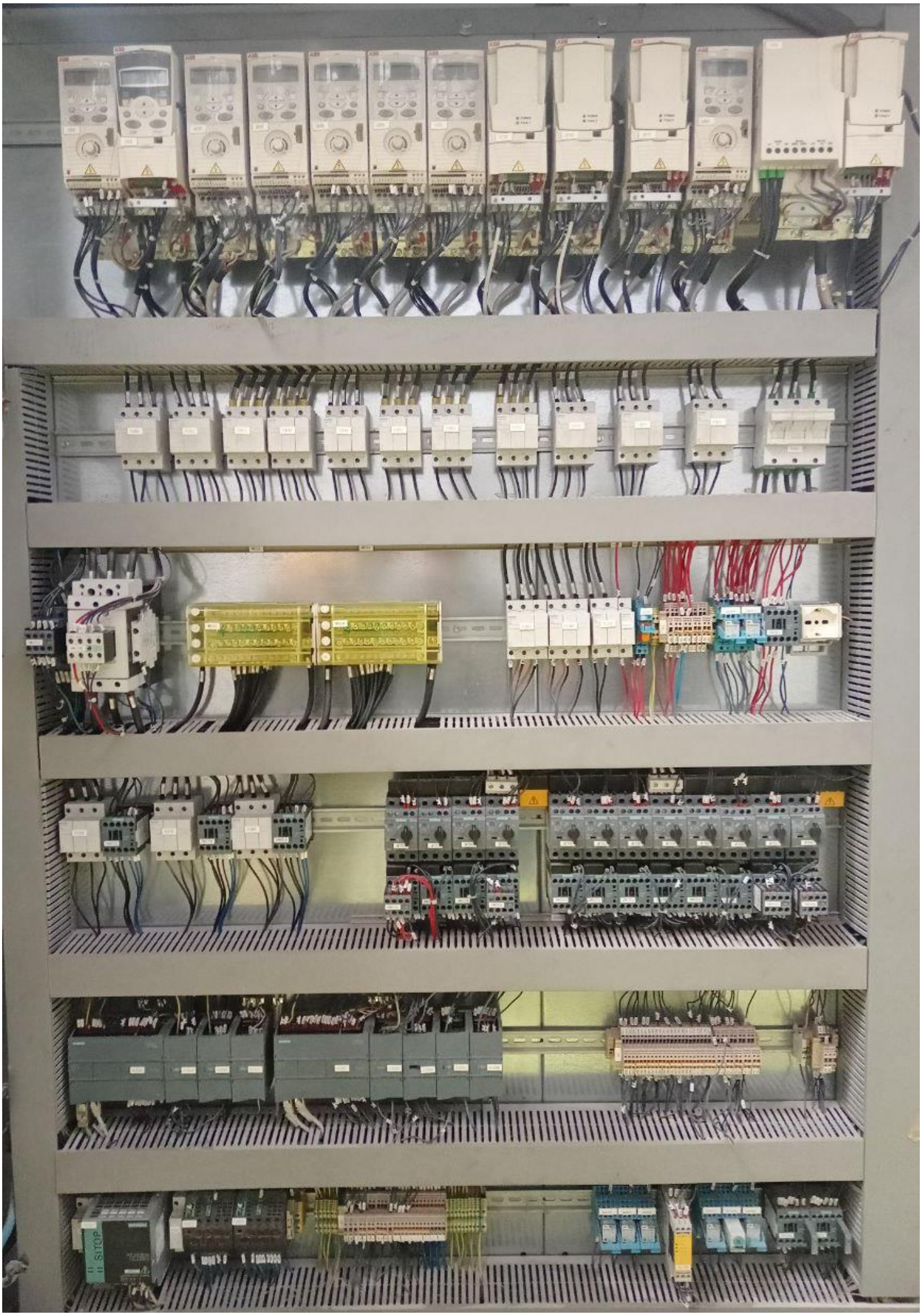


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