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by Taylor Bamford

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HNC Electrical Electronic Engineering
SGEE4006 Electrical Electronic Engineering Project
Final Report

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1 - Introduction and Background Research

Introduction

The primary objective of this project is to develop an air pressure warning system that can be accessed remotely via the internet. The system will utilize an air monitoring sensor to measure air pressure, and the collected data will be transmitted to a programmable logic controller (PLC). The PLC will then analyse the readings and trigger alarms if any potential issues or deviations are detected.

Originally, the project was intended to be implemented within the manufacturing environment of Gestamp, a company operating in the manufacturing and automotive industry. Gestamp specializes in the production of body panels and frames for cars, utilizing two different processes: cold stamping and hot stamping. These processes impart distinct characteristics to the materials used, contributing to the overall quality and performance of the manufactured components. Additionally, the company is involved in the production of sub-assembly parts, which are assembled in dedicated areas using various welding techniques such as TIG, MIG, or spot welding. The air pressure warning system was initially envisioned to be integrated into this manufacturing setting, where it could enhance safety and quality control measures.

However, due to unforeseen circumstances, it was not feasible to complete the project within the Gestamp facility. As a result, the project was transferred to Coleg Sir Gâr. The transition to Coleg Sir Gâr offers a new setting to continue the development and implementation of the air pressure warning system.

A good introduction that identifies the risk element with projects based at the employment industry. You have identified your risk problem and taken action to continue the project through to the solution.

Identifying the problem

The problem was identified several weeks ago. There was a problem with the vacuum system which stopped the line from running and after trying to trouble shoot and come up with ideas on what the root cause of the problem we couldn't identify it, we had to plug in to the system we only have a limited amount of people on site which have the capability to do this because of that it was down for extended period of time and all we needed to solve the problem was to see a live feed of the pressure in the air system.

Grammatical errors

Problem has been clearly identified

The objective and purpose of the project

The primary objective and purpose of this project are two-fold: to prevent downtime in the press shop caused by air pressure faults and to provide a live feed of the air pressure in the system. By achieving these goals, the project aims to enhance operational efficiency, minimize disruptions, and improve overall productivity in the manufacturing process.

Downtime in the press shop can be detrimental to production schedules and output. Air pressure faults or fluctuations can lead to malfunctions or inefficiencies in the equipment and machinery used in the manufacturing process. By implementing the air pressure warning system, potential issues related to air pressure can be promptly detected and addressed before they escalate into significant problems. This proactive approach to maintenance and monitoring can significantly reduce unplanned downtime, saving valuable production time and resources.

Additionally, the project aims to provide a live feed of the air pressure in the system. This live feed will be displayed on large monitors positioned strategically at the end of each production line in the press shop. By making the air pressure information readily available and visible to operators and production personnel, they can monitor and assess the current state of the air system in real-time. This empowers them to take immediate action if any deviations or abnormalities are observed, ensuring prompt response and preventing potential equipment failures or quality issues.

The objective here is clear and related to your industrial requirements. The argument for the project is relevant for the solution requirements, and you have managed to keep the objective directly related to the original industrial problem.

Background Research

How Does a Compressor System Work?

The compressor first pulls air from the surroundings. Air displacement is the process of continuing to cram the molecules into a confined area. The compressor's pump aids in both that endeavour and producing the energy necessary to run the device.

The pressure generates enough force, as was already mentioned, to be released into the receiver tank. When the human operator switches the system on, air enters through the designated channels. Different impulses trigger different valves to open. Once they locate the desired motor or engine, they push them into motion so that the machine may produce parts.

PLCs

Must not use first person terms

As this was though work, I was told to use a specific PLC, the PLC that I will be using is a siemens SIMATIC S7-1200 I will look into the benefits and if there is any drawbacks of the PLC, I will also look to see if there is a better options for the selection of the PLC.

What are the different PLC types?

- LOGO
- SIMATIC S7- 200
- SIMATIC S7-300
- SIMATIC S7-400
- SIMATIC S7-1200
- SIMATIC ET-200SP
- SIMATIC S7-1500

(automationforum.co, 2023)

Advantages of SIMATIC S7-1200

- Scalable and flexible design
 - To best suit my unique machine requirements, the SIMATIC S7-1200 controller family has been developed with maximum flexibility. This enables I'm able to customise my controller system to match my demands and facilitates quick and simple system extensions in the future.
- Industrial communication
 - The SIMATIC S7-1200's built-in PROFINET interface enables seamless communication with third-party devices for advanced integration options, the SIMATIC STEP 7 Basic engineering system for programming, the SIMATIC HMI Basic Panels for visualisation, and additional controllers for PLC-to-PLC communication.
- Integrated technology
 - For many years, the term SIMATIC has served as a dependable icon in the automation industry. We have used our experience to combine our creative and tested technology functionalities into our new controller, spanning from simple process control functionality to counting and measuring, speed, position, and duty cycle control. This extensive range of capability ensures that you will be able to address a wide range of applications using technology that has long been validated in the field.

(corporation triada, 2023)

A good understanding of the PLC technology and purpose

Pressure Sensor

5 different types of Pressure Sensor

- Strain Gauge - Chemical Vapor Deposition Pressure Sensors
 - A technology called Chemical Vapour Deposition (CVD) is used to make strain gauge pressure transducers that are incredibly stable. Whereas so many other inexpensive pressure sensors fall short, the CVD technique offers a trustworthy alternative. An ASIC chip, which provides higher levels of linearity correction, is housed inside each of these transducers. For uses including HVAC, semiconductor processing, and off-highway, CVD pressure sensors are excellent. Additionally, the thicker diaphragm of the CVD pressure transducers allows it to withstand high pulsating pressures.
- Strain Gauge - Sputtered Thin Film Pressure Sensors
 - Sputtered Thin Film Strain Gauges are among the most dependable pressure sensors available because of their long-lasting dependability and precise precision even in the most challenging environments. These sensors can be ordered in ranges from 0-100 to 0-30,000 PSI, depending on their use. In extreme environmental conditions like high temperatures, severe shock and vibration, or significant pressure spikes, the product offers unsurpassed performance. Sputtered Thin Film Sensors are perfect for off-road, fire prevention, refrigeration, and alternative fuel applications.
- Variable Capacitance Pressure Sensors
 - Capacitive transducers are the best option for low pressure measurements when you require a robust, dependable method. To meet a variety of applications, including marine tank level indication, these sensors can be provided in pressure ranges from 0-2 PSI through 0-15 PSI. They boast a robust physical design, wetted parts made of stainless steel and ceramic, and variable capacitor technology. Additionally, capacitive pressure sensors can be employed for high pressure in a variety of applications, including hydraulic systems, process control, and pipelines for natural gas.

- Solid-State Pressure Sensors
 - Solid-State pressure switches are a great option if your application must handle elements of significant shock and vibration. These switches offer highly accurate measurements when stringent system controls are required since they are constructed with a hermetic all-stainless-steel diaphragm. When actuations surpass 50 cycles per minute, they are also superior to electromechanical pressure switches in certain situations. Off-highway, medical gas, compressors, and other demanding general industrial uses for Solid-State Switches.
- MMS Pressure Sensors
 - Low pressures in both absolute and gauge references can be measured extremely economically with micromachined silicon (MMS) strain gauge sensors. The tiny MMS pressure sensors have 316L stainless steel wetted parts and an all-welded design, making them extremely resistant to corrosive substances and conditions. Applications for MMS include medical sterilisers, gas analysis equipment, and refrigerant recovery for air conditioners.
 - These are a few examples of the various pressure sensor types available in the Gems portfolio, which serve a wide range of functions and applications. Whether it's a differential pressure sensor or an air pressure sensor, we can aid you in deciding which one is best for your needs.

(Gems Sensors & Controls, 2021)

*Supporting images could have been included to support content.
Relevant source is included*

Industry 4.0

What is Industry 4.0?

The term "industry 4.0" refers to the fourth industrial revolution, even if it addresses topics like smart cities that aren't typically categorised as industry applications in and of themselves.

Mechanisation, steam power, and waterpower brought in the first industrial revolution.

The second industrial revolution, which focused on mass production and assembly lines that used electricity, came after this.

Electronics, I.T. systems, and automation ushered in the third industrial revolution, which in turn paved the way for the fourth industrial revolution, which is linked to cyber-physical systems.

Industry 4.0 Technologies

Industry 4.0 broadly refers to the manufacturing sector's expanding tendency towards automation and data interchange in technologies and processes, including:



With this automation, industries' machinery are enhanced with wireless connectivity and sensors to monitor the entire production process, visualise it, and make autonomous decisions.

With the entire rollout of 5G, wireless connection and machine augmentation will both develop significantly. Faster response times will result from this, enabling systems to communicate almost instantly.

Advantages of industry 4.0 development is identified with relevant source

(TWI, 2023), (Aura Quantic, 2023)

Good relevant background research has been carried out, with your industrial experience providing examples for industry

2 – Specification

The primary objective and purpose of this project are centred around two key aspects: preventing downtime in the press shop caused by air pressure faults and providing a live feed of the air pressure in the system. Additionally, an alarm system will be implemented to indicate whether the production lines can run or not based on the air pressure conditions. Moreover, the live feed of the pressure will be displayed on large monitors positioned at the end of each line, and the system will allow remote access to the live feed from anywhere in the world.

Clear specification of what the objective will achieve. There should be some information of the technologies and constraints

Time & Budgetary Constraints

The project's time constraints were generously set, allowing for a 35-week period to complete various stages such as research, part sourcing, prototype design, and testing. This ample timeframe provided the opportunity to delve deeply into each aspect and ensured thoroughness in the project's execution.

However, the budgetary constraints posed a challenge, as there was no explicit upper limit specified. Instead, the emphasis was placed on minimizing costs and utilizing readily available parts from stores. The objective was to avoid unnecessary expenses and promote resourcefulness by utilizing existing options whenever possible.

To navigate these budgetary constraints effectively, careful consideration had to be given to the selection of parts and materials. Prioritizing readily available options from the stores was not only cost-effective but also ensured quicker procurement without the need for special orders or potential delays. By leveraging parts that were easily accessible, the project could maintain a steady pace and avoid potential bottlenecks.

A good viable point made

Nonetheless, it was necessary to exercise caution when justifying the need for any additional parts that were not readily available in the stores. A thorough assessment was required to determine if such components were truly essential and if suitable replacements were unavailable in the stores. Justification of these additional expenses was crucial, as it ensured transparency and accountability in budget management.

Good sense of risk of available components

In order to adhere to the budget, it was important to engage in extensive research and price comparison. This allowed for identifying multiple suppliers or stores that offered the required parts at the most cost-effective prices. Through diligent cost analysis and selection, the project could strike a balance between affordability and quality, ensuring the desired outcomes within the allocated budget.

Throughout the project, maintaining a detailed budget log was essential. This log provided an organized record of all expenses, including part costs, materials, tools, and any other necessary resources. By regularly updating and monitoring this log, it became easier to track spending and ensure that the project remained within the set budgetary constraints.

In cases where significant expenses were anticipated that exceeded the initial budget expectations, seeking approval from relevant stakeholders or project managers was vital. This step involved presenting a well-justified case, explaining the necessity of the additional expenses, and highlighting the potential impact on the project's success.

By carefully navigating the budgetary constraints and following these strategies, the project could maintain financial discipline while effectively utilizing available resources to achieve the desired objectives. *This is a realistic modern method of reducing cost and availability risk for the project*

Software & Hardware Breakdown & Cost

- Siemens S7 1200 PLC = £512.40 already on site
- IFM IO Link Master = £316.10
- IFM SD1540 – Air monitoring sensor with IO Link parametrisation = £700.10
- Smart TV with internet browser to interact with PLC. = £221.40
- TIA Portal v17 = £283.00 already on site

Total Cost £2,033

As you can see the total cost of the project was £2,033 if I was to buy very thing new but with the parts which were on site already the total cost was £1,237.70.

Good breakdown of costs

Maintenance & Reliability Requirements

Maintenance

The maintenance requirements for the system have been intentionally designed to be minimal, as the system itself is robust and has built-in safeguards to mitigate potential issues. Consequently, the maintenance plan that has been formulated focuses on regular check-ups to ensure the continued optimal performance of the system.

The central component of the maintenance plan involves conducting a bi-monthly inspection of the IFM SD1540 air monitoring sensor and its associated cables. This sensor is critical to the system's functionality, as it continuously monitors the air quality and provides essential data for analysis and control. By performing routine checks on the sensor, any potential problems or anomalies can be identified in a timely manner, allowing for prompt resolution through repairs or replacements.

During these bi-monthly inspections, special attention is given to examining the sensor and cables for any damage that may have been caused by oils and contaminants. Oils and contaminants can adversely affect the sensor's performance and compromise the accuracy of its readings. By carefully scrutinizing the sensor and cables, any signs of damage, contamination, or degradation can be detected and addressed effectively.

Good argument for reducing maintenance inspections by the availability of the pressure variable

Reliability

The reliability requirements for the system are focused on ensuring its uninterrupted operation over an extended period, specifically targeting a five-year timeframe. The objective is to maintain the system's functionality without any modifications unless expansion or scaling becomes necessary.

To meet these reliability requirements, the system has been designed with robustness and longevity in mind. The components and architecture have been carefully selected and engineered to withstand normal wear and tear, environmental factors, and potential stresses that may arise during operation.

To ensure the system remains operational without any changes, regular maintenance and monitoring activities are crucial. Adhering to the maintenance plan previously outlined, which includes bi-monthly inspections of the air monitoring sensor and cables, helps identify any potential issues early on. By promptly addressing these issues, the system can maintain its reliability and prevent any major failures or disruptions.

3 – Planning

Gantt Chart

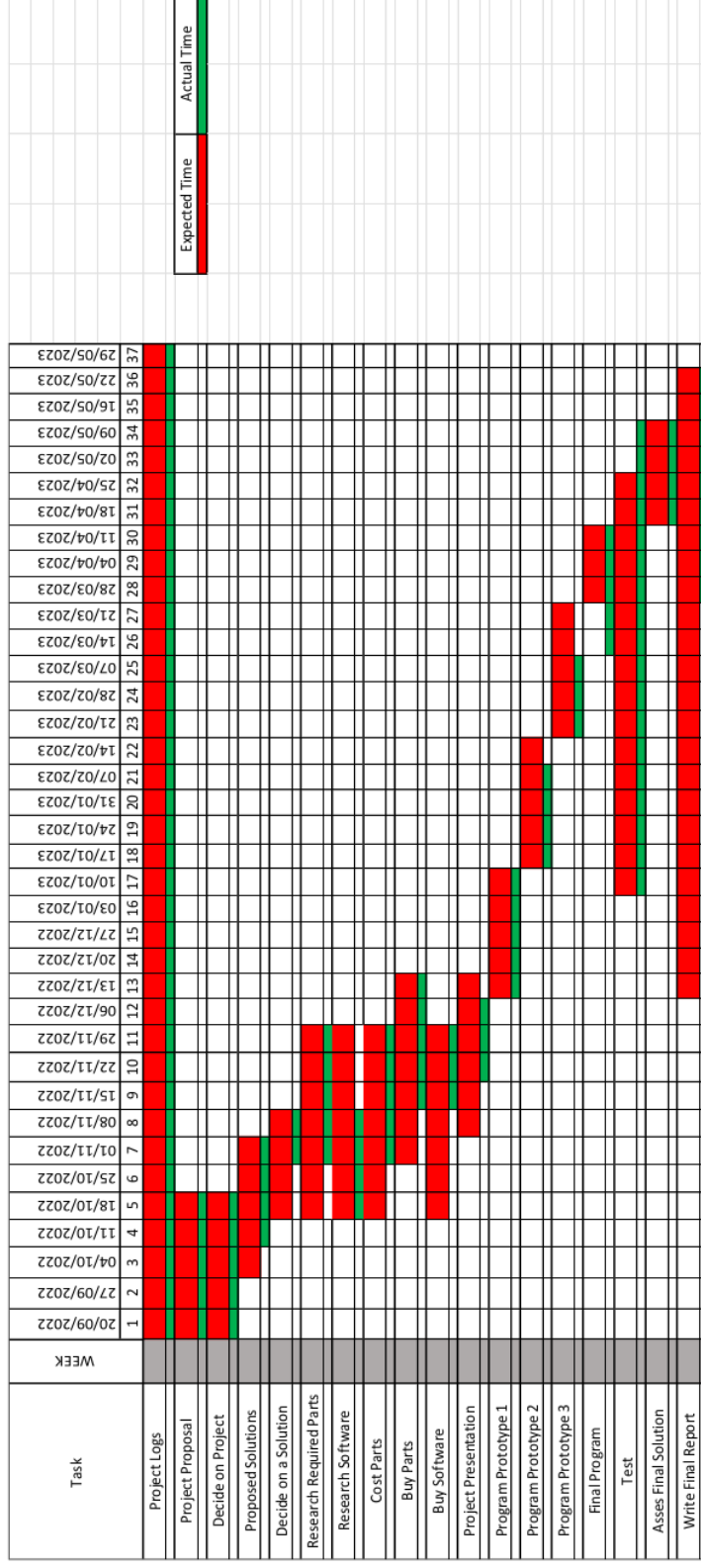


Figure 1 Gantt Chart
A detailed Gantt chart with timeline comparison. There should be a key to the chart included.

Testing Plan

Test Number	Test	Expected Outcome
1	No air in the system	When there is no air in the system all the alams should be red and the pressure should read out 0 Bar
2	1.5 Bar of pressure in the system	When there is only 1.5 bar of pressure in the system line 0 alarm should be green ready to run and the rest of the alams should be red and the pressure should read out 1.5 Bar
3	2.25 Bar of pressure in the system	When there is only 2.25 bar of pressure in the system line 0 and 1 alarm should be green ready to run and the rest of the alams should be red and the pressure should read out 2.25 Bar
4	3 Bar of pressure in the system	When there is only 3 bar of pressure in the system line 0, 1 and 2 alarm should be green ready to run and the rest of the alams should be red and the pressure should read out 3 Bar
5	3.75 Bar of pressure in the system	When there is only 3.75 bar of pressure in the system line 0, 1, 2 and 3 alarm should be green ready to run and the rest of the alams should be red and the pressure should read out 3.75 Bar
6	4.5 Bar of pressure in the system	When there is 4.5 bar of pressure in the system line 0,1, 2, 3 and 4 alarm should be green ready to run and the rest of the alams should be red and the pressure should read out 4.5 Bar
7	5.25 Bar of pressure in the system	When there is 5.25 bar of pressure in the system line 0,1, 2, 3, 4 and 5 alarm should be green ready to run and the rest of the alams should be red and the pressure should read out 5.25 Bar
8	6 Bar of pressure in the system	When there is 6 bar of pressure in the system line 7, 8 and 9 alarm should be red and the rest of the alams should be green ready to run and the pressure should read out 6 Bar
9	6.75 Bar of pressure in the system	When there is 6.75 bar of pressure in the system line 8 and 9 alarm should be red and the rest of the alams should be green ready to run and the pressure should read out 6.75 Bar
10	7.5 Bar of pressure in the system	When there is 7.5 bar of pressure in the system only line 9 alarm should be red and the rest of the alams should be green ready to run and the pressure should read out 7.5 Bar
11	8.25 Bar of pressure in the system	When there is 8.25 bar of pressure in the system all the alams should be green ready to run and the pressure should read out 8.25 Bar
12	Pressure read out on the web page	The pressure should read out whatever the live pressure is

Very detailed test plan table

Figure 2 Testing Table Task 3

In Figure 1, the Gantt chart clearly illustrates some challenges in time management throughout the project. It is evident that several tasks were started late and there were instances of exceeding the allocated time for certain activities. These delays and overruns impacted the overall project timeline and potentially hindered the further development of the program.

Starting tasks later than planned can have a cascading effect on subsequent activities, leading to a compression of time and potential bottlenecks in the project schedule. It is crucial to adhere to the planned start dates to ensure a smoother workflow and avoid unnecessary time pressures later on. By initiating tasks according to the planned schedule, there would have been more flexibility in managing the project's timeline and allocating sufficient time for each task.

Furthermore, exceeding the allocated time for certain activities can have a detrimental impact on the project's overall duration. It is essential to accurately estimate the time required for each task and allocate resources accordingly. By closely monitoring progress and identifying potential delays early on, prompt action can be taken to address any obstacles and mitigate the risk of exceeding planned timeframes.

Completing the project earlier by starting tasks as planned would have provided additional time for the further development of the program. This extra time could have been utilized for refining and enhancing the program's features, conducting additional testing and debugging, or exploring additional functionalities. Early completion of the project allows for more opportunities to fine-tune and expand the program's capabilities, resulting in a more comprehensive and robust final product.

To improve time management and avoid similar challenges in future projects, it is crucial to implement effective project planning and monitoring strategies. This includes creating realistic schedules, setting clear milestones, regularly reviewing progress, and identifying potential issues or bottlenecks in a timely manner. Additionally, incorporating contingency time buffers into the project schedule can help accommodate unforeseen delays or setbacks, ensuring a more resilient timeline.

Figure 2 present the testing tables that outline the various tests to be conducted to ensure that the system meets the requirements specified in the project's specifications. These tests are essential to validate the functionality, performance, and compliance of the system, and they serve as a reference to assess whether the expected outcomes align with the specified requirements.

A good time management evaluation with recommendations

4 – Solutions Considered

Prototype 1

Prototype 1 represents an initial and basic iteration of the final solution. Its primary function is to scale the value obtained from the air pressure sensor, as shown in Figure 3, and display the scaled value on the Human-Machine Interface (HMI) screen depicted in Figure 5.

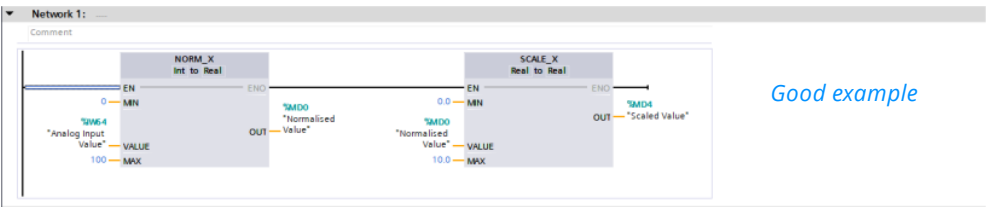
Compared to the final solution, Prototype 1 may appear somewhat simplistic and potentially over-engineered for its specific task of reading out a pressure value. Its purpose, however, lies in establishing a foundation and verifying fundamental functionalities before proceeding to more advanced iterations.

In terms of cost, all the systems, including Prototype 1, require the same hardware and software components. Therefore, the cost remains consistent across the various prototypes. However, as subsequent iterations progress, the efficiency and reliability of the system are expected to improve.

Regarding efficiency, Prototype 1 may not be the most efficient solution, as it may include unnecessary features or functionalities for its basic purpose. It is essential to recognize that further development and optimization are intended in subsequent prototypes to achieve higher levels of efficiency in terms of resource utilization, processing speed, and overall performance.

On the other hand, Prototype 1 demonstrates a high level of reliability. Due to its simplicity and minimal complexity, there are fewer components and potential points of failure within the system. This simplicity contributes to the system's reliability by minimizing the chances of technical issues or malfunctions. The reliability of Prototype 1 serves as a solid starting point for the subsequent iterations, where additional features and functionalities will be incorporated while maintaining an emphasis on reliability.

A good detailed explanation



Good example

Figure 3 Scale Prototype 1

PLC tags									
	Name	Tag table	Data type	Address	Retain	Acces...	Writa...	Visibl...	
1	Analog Input Value	Default tag table	Int	%IW64	☐	☒	☒	☒	
2	Normalised Value	Default tag table	Real	%MD0	☐	☒	☒	☒	
3	Scaled Value	Default tag table	Real	%MD4	☐	☒	☒	☒	

Figure 4 Tag List Prototype 1

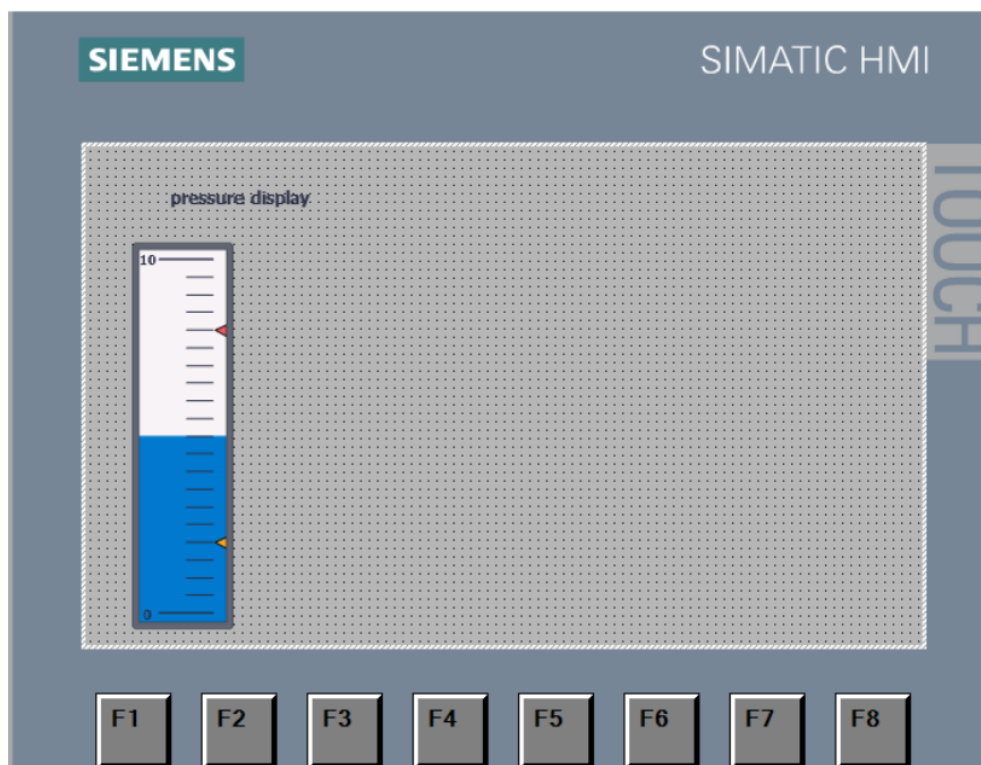


Figure 5 HMI screen Prototype 1

Good evidence of prototype

Prototype 2

Prototype 2 represents a further development and expansion of the initial solution, while still maintaining a basic nature in relation to the final solution. In this iteration, several improvements and additions have been made to enhance functionality and utilization of the hardware and software components.

One notable enhancement in Prototype 2 is the introduction of a new function block to handle the scaled values obtained from the air pressure sensor. By separating this functionality into a dedicated block, it allows for better organization and modularization of the code, making it more maintainable and scalable in the long run.

Additionally, Prototype 2 introduces a PSI scaled value, as shown in Figure 7. This enhancement enables the display of pressure values in PSI units, providing a more familiar and widely used measurement metric. This expansion allows for greater flexibility and compatibility with industry standards and conventions.

Another notable addition in Prototype 2 is the inclusion of a light indicator, as depicted in Figures 8 and 9. This indicator serves as a visual representation to indicate whether the press can run or not based on the monitored air pressure. This feature enhances the usability and user-friendliness of the system, providing clear feedback and status indication at a glance.

The HMI screen, as shown in Figure 10, now incorporates the newly added features, including the PSI scaled value and the light indicator. This improved user interface offers more comprehensive and relevant information, enabling operators to make informed decisions based on the current air pressure conditions.

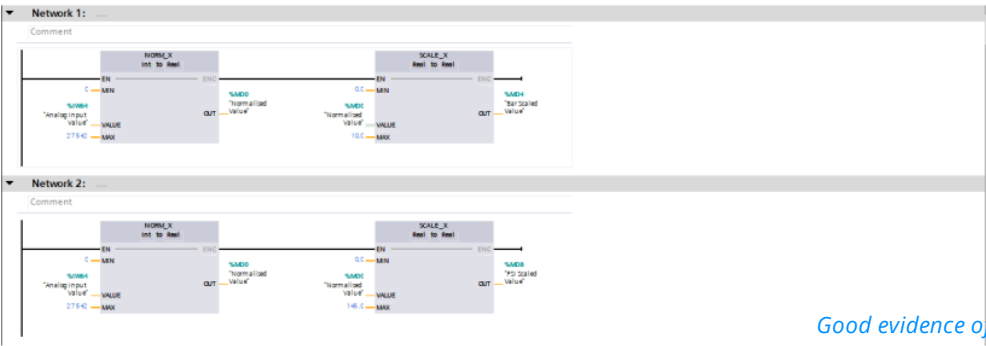
In terms of efficiency, Prototype 2 demonstrates an improvement over Prototype 1. By utilizing more of the capabilities of the hardware and software components, the system achieves greater functionality and efficiency in its operations. The inclusion of additional features and enhancements makes better use of the available resources and expands the overall capabilities of the system.

Despite these enhancements, the reliability of the system remains consistent with Prototype 1. The system retains its basic nature, which inherently reduces the points of failure and potential technical issues. The simplicity of the system design ensures that reliability is maintained throughout the development process.

Good detailed explanation



Figure 6 Main Function Block



Good evidence of program development

Figure 7 Scale Prototype 2

```
1 IF ("Bar Scaled Value" < 9) THEN
2   "Analogue"."Alarm 10" := 1; // IF above 9 bar, All line can run
3 END_IF;
```

Figure 8 Alarm System Prototype 2

	Name	Data type	Start value	Snapshot	Retain	Accessible f...	Write...	Visible in ...	Setpoint	Comment
1	Static									
2	Alarm 10	Bool	false			☒	☒	☒		

Figure 9 Analogue Data Block Prototype 2

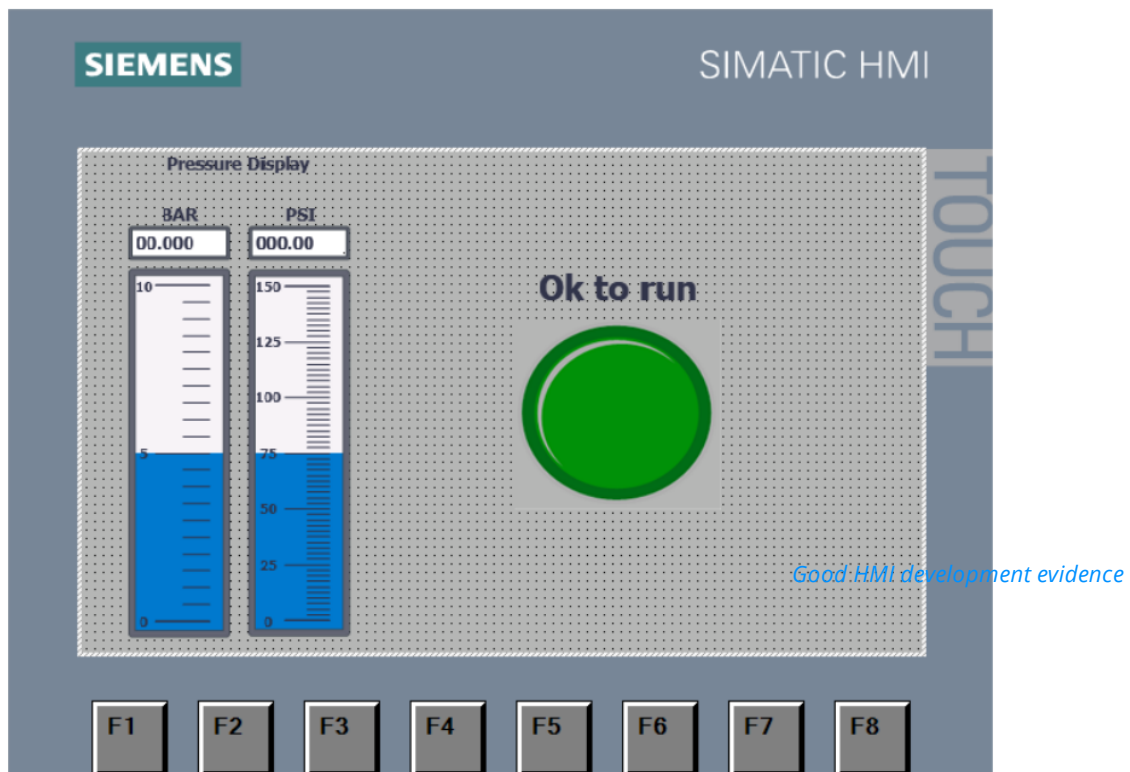


Figure 10 HMI screen Prototype 2

5 - Final Solution and Implementation

In the final solution, significant improvements have been made to the system, leveraging the lessons learned from Prototype 1 and 2. These enhancements further maximize the potential of the hardware and software components, resulting in a more comprehensive and advanced air pressure warning system.

One notable improvement in the final solution is the addition of more indication lights. Each line now has its dedicated indicator, providing clear and specific information on the status of individual lines. This enhancement allows operators to quickly identify which lines can run and which are unable to operate due to air pressure faults. By providing line-specific indications, the system enables efficient monitoring and decision-making, ensuring optimal production workflow and minimizing downtime. *Good arguments for additional conditions*

Another significant addition is the introduction of remote access through the internet using a web server. This feature empowers users to access the live feed of the air pressure values and system status from anywhere in the world, using a web browser or a dedicated application. Remote access enables real-time monitoring, facilitating proactive decision-making, and providing the ability to respond promptly to any issues or abnormalities. This functionality greatly enhances the system's usability, accessibility, and overall efficiency.

The utilization of a web server for remote access ensures a user-friendly interface, allowing operators and authorized personnel to view the air pressure values, line statuses, and any relevant alerts or alarms. By leveraging internet connectivity, the system breaks the barriers of physical presence and enables seamless monitoring and management of the air pressure conditions. *Good argument for condition*

By incorporating these advanced features, the final solution offers an integrated and robust air pressure warning system. It not only ensures efficient monitoring and control of air pressure in the press shop but also provides enhanced user experience, expanded functionalities, and the capability for remote access and data analysis.

Through the iterative development process and the incorporation of these improvements, the final solution achieves a high level of efficiency, reliability, and usability. It represents a comprehensive solution that meets the project's objectives of preventing downtime, providing real-time monitoring, and enabling remote access for efficient management and decision-making.

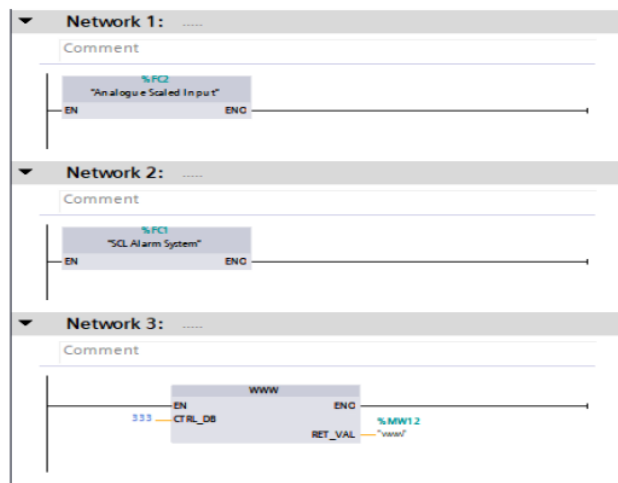
Overall, the final solution builds upon the foundations laid by the earlier prototypes, capitalizing on their successes and incorporating valuable feedback and insights. It represents the culmination of the project, delivering a sophisticated air pressure warning system that leverages the full potential of the hardware and software components, while ensuring the efficiency, reliability, and usability required for seamless operation in the press shop environment.

Must not use first person terms

In my final solution I've introduced further improvement to the system which in my opinion greatly improves the system and utilises the full potential of the hardware and software, with a strong base from prototype 1 and 2 I've been able to add more indication light there is now a light indication for each line this provides more information on what lines can run and what can't, I also introduce the remote access through the internet with the use of a web server.

This section should have a heading for requirements or deliverables

Provide a full explanation of the final project solution including detailed designs and costs. Note that the developmental stages and prototypes will be found in the log book. Photographic evidence must also be provided of the final constructed system or product and installation if appropriate. Explain the operation and maintenance requirements and the steps taken to ensure environmental protection and sustainability.



Good evidence of program development

Figure 11 Main Function Block Final Solution

Figure 11 depicts the main function block of the system, which serves as the central control unit. In the final solution, an important addition can be observed in the form of a new network, Network 3, specifically dedicated to the web server functionality.

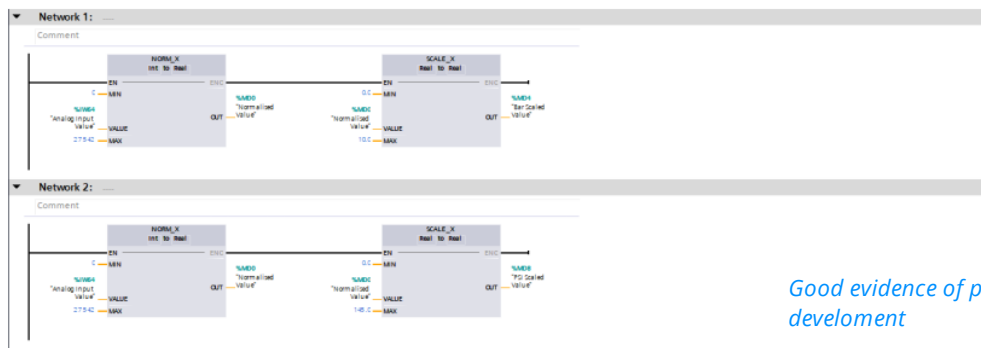
Network 3, as shown in Figure 11, is responsible for handling the communication and data exchange between the system and the web server. It establishes a connection that allows remote access to the system's interface and provides real-time information regarding the air pressure values and system status.

By incorporating Network 3 for the web server, the system gains the capability to interact with external devices, such as computers or mobile devices, via the internet. This network *Good point here* facilitates seamless communication between the system and remote users, enabling them to access the web-based interface from anywhere in the world.

The introduction of Network 3 brings forth a range of benefits and functionalities. Firstly, it enables the establishment of secure and reliable connections between the system and the web server. This ensures that the data transmitted between the two entities remains confidential and is protected against unauthorized access. *This is true and further securities are possible*

Furthermore, Network 3 enables the exchange of real-time data, allowing users to monitor the air pressure values and system status remotely. The web server interface can display the information in a user-friendly format, providing a clear overview of the current conditions and any potential issues that may arise.

The benefits and functionality of the PLC web server are identified



Good evidence of program development

Figure 12 Scale Final Solution

The scaling system for the pressure values has remained unchanged from Prototype 2 in the final solution, primarily due to its seamless functionality and absence of any issues. The decision to retain the same scaling approach is a testament to its effectiveness and reliability in accurately representing the air pressure measurements.

During the development and testing phases, the scaling system implemented in Prototype 2 proved to be robust and dependable. It successfully translated the raw pressure data from the sensor into meaningful and easily interpretable values for display and analysis. As a result, there was no need to modify or adjust the scaling mechanism in the final solution.

The scaling system serves a crucial role in ensuring that the air pressure values are presented in a user-friendly and comprehensible manner. By transforming the raw sensor data into scaled values, operators and users can readily interpret the pressure levels and make informed decisions based on the displayed information.

The decision to maintain the same scaling system also provides consistency and compatibility throughout the project. By adhering to the established scaling methodology, compatibility is ensured between the previous prototypes and the final solution. This continuity simplifies the integration process and minimizes the risk of introducing unnecessary complications or inconsistencies.

Good explanation of the program development

```

1 IF ("Bar Scaled Value" < 1) THEN
2   "Analogue"."Alarm 0" := 0; // If below 0.75 bar no lines can operate all alarms will be on.
3   "Analogue"."Alarm 1" := 0;
4   "Analogue"."Alarm 2" := 0;
5   "Analogue"."Alarm 3" := 0;
6   "Analogue"."Alarm 4" := 0;
7   "Analogue"."Alarm 5" := 0;
8   "Analogue"."Alarm 6" := 0;
9   "Analogue"."Alarm 7" := 0;
10  "Analogue"."Alarm 8" := 0;
11  "Analogue"."Alarm 9" := 0;
12 END_IF;
13
14 IF ("Bar Scaled Value" > 1.5) THEN
15   "Analogue"."Alarm 0" := 1; // If above 1.5 bar but below 2.25 bar, 1 line can run all alarms besides 1 will be on.
16   "Analogue"."Alarm 1" := 0;
17   "Analogue"."Alarm 2" := 0;
18   "Analogue"."Alarm 3" := 0;
19   "Analogue"."Alarm 4" := 0;
20   "Analogue"."Alarm 5" := 0;
21   "Analogue"."Alarm 6" := 0;
22   "Analogue"."Alarm 7" := 0;
23   "Analogue"."Alarm 8" := 0;
24   "Analogue"."Alarm 9" := 0;
25 END_IF;

```

Figure 13 Alarm System 1 Final Solution

```

27 IF ("Bar Scaled Value" > 2.25) THEN
28   "Analogue"."Alarm 0" := 1; // If above 2.25 bar but below 3 bar, 2 line can run all alarms besides 2 will be on.
29   "Analogue"."Alarm 1" := 1;
30   "Analogue"."Alarm 2" := 0;
31   "Analogue"."Alarm 3" := 0;
32   "Analogue"."Alarm 4" := 0;
33   "Analogue"."Alarm 5" := 0;
34   "Analogue"."Alarm 6" := 0;
35   "Analogue"."Alarm 7" := 0;
36   "Analogue"."Alarm 8" := 0;
37   "Analogue"."Alarm 9" := 0;
38 END_IF;
39
40 IF ("Bar Scaled Value" > 3) THEN
41   "Analogue"."Alarm 0" := 1; // If above 3 bar but below 3.75 bar, 3 line can run all alarms besides 3 will be on.
42   "Analogue"."Alarm 1" := 1;
43   "Analogue"."Alarm 2" := 1;
44   "Analogue"."Alarm 3" := 0;
45   "Analogue"."Alarm 4" := 0;
46   "Analogue"."Alarm 5" := 0;
47   "Analogue"."Alarm 6" := 0;
48   "Analogue"."Alarm 7" := 0;
49   "Analogue"."Alarm 8" := 0;
50   "Analogue"."Alarm 9" := 0;
51 END_IF;

```

Figure 14 Alarm System 2 Final Solution

```

53 IF ("Bar Scaled Value" > 3.75) THEN
54   "Analogue"."Alarm 0" := 1; // If above 3.75 bar but below 4.5 bar, 4 line can run all alarms besides 4 will be on.
55   "Analogue"."Alarm 1" := 1;
56   "Analogue"."Alarm 2" := 1;
57   "Analogue"."Alarm 3" := 1;
58   "Analogue"."Alarm 4" := 0;
59   "Analogue"."Alarm 5" := 0;
60   "Analogue"."Alarm 6" := 0;
61   "Analogue"."Alarm 7" := 0;
62   "Analogue"."Alarm 8" := 0;
63   "Analogue"."Alarm 9" := 0;
64 END_IF;
65
66 IF ("Bar Scaled Value" > 4.5) THEN
67   "Analogue"."Alarm 0" := 1; // If above 4.5 bar but below 5.25 bar, 5 line can run half the alarms will be on.
68   "Analogue"."Alarm 1" := 1;
69   "Analogue"."Alarm 2" := 1;
70   "Analogue"."Alarm 3" := 1;
71   "Analogue"."Alarm 4" := 1;
72   "Analogue"."Alarm 5" := 0;
73   "Analogue"."Alarm 6" := 0;
74   "Analogue"."Alarm 7" := 0;
75   "Analogue"."Alarm 8" := 0;
76   "Analogue"."Alarm 9" := 0;
77 END_IF;

```

Figure 15 Alarm System 3 Final Solution

```

79 IF ("Bar Scaled Value" > 5.25) THEN
80     "Analogue"."Alarm 0" := 1; // If above 5.25 bar but below 6 bar, 6 line can run only 4 alarms will be on.
81     "Analogue"."Alarm 1" := 1;
82     "Analogue"."Alarm 2" := 1;
83     "Analogue"."Alarm 3" := 1;
84     "Analogue"."Alarm 4" := 1;
85     "Analogue"."Alarm 5" := 1;
86     "Analogue"."Alarm 6" := 0;
87     "Analogue"."Alarm 7" := 0;
88     "Analogue"."Alarm 8" := 0;
89     "Analogue"."Alarm 9" := 0;
90 END_IF;
91
92 IF ("Bar Scaled Value" > 6) THEN
93     "Analogue"."Alarm 0" := 1; // If above 6 bar but below 6.75 bar, 7 line can run only 3 alarms will be on.
94     "Analogue"."Alarm 1" := 1;
95     "Analogue"."Alarm 2" := 1;
96     "Analogue"."Alarm 3" := 1;
97     "Analogue"."Alarm 4" := 1;
98     "Analogue"."Alarm 5" := 1;
99     "Analogue"."Alarm 6" := 1;
100    "Analogue"."Alarm 7" := 0;
101    "Analogue"."Alarm 8" := 0;
102    "Analogue"."Alarm 9" := 0;
103 END_IF;

```

Figure 16 Alarm System 4 Final Solution

```

105 IF ("Bar Scaled Value" > 6.75) THEN
106     "Analogue"."Alarm 0" := 1; // If above 6.75 bar but below 7.5 bar, 8 line can run only 2 alarms will be on.
107     "Analogue"."Alarm 1" := 1;
108     "Analogue"."Alarm 2" := 1;
109     "Analogue"."Alarm 3" := 1;
110     "Analogue"."Alarm 4" := 1;
111     "Analogue"."Alarm 5" := 1;
112     "Analogue"."Alarm 6" := 1;
113     "Analogue"."Alarm 7" := 1;
114     "Analogue"."Alarm 8" := 0;
115     "Analogue"."Alarm 9" := 0;
116 END_IF;
117
118 IF ("Bar Scaled Value" > 7.5) THEN
119     "Analogue"."Alarm 0" := 1; // If above 7.5 bar but below 9 bar, 9 line can run only 1 alarms will be on.
120     "Analogue"."Alarm 1" := 1;
121     "Analogue"."Alarm 2" := 1;
122     "Analogue"."Alarm 3" := 1;
123     "Analogue"."Alarm 4" := 1;
124     "Analogue"."Alarm 5" := 1;
125     "Analogue"."Alarm 6" := 1;
126     "Analogue"."Alarm 7" := 1;
127     "Analogue"."Alarm 8" := 1;
128     "Analogue"."Alarm 9" := 0;
129 END_IF;
130
131

```

Figure 17 Alarm System 5 Final Solution

```

131 IF ("Bar Scaled Value" > 8.25) THEN
132     "Analogue"."Alarm 0" := 1; // If above 8.25 bar, All line can run no alarms will be on.
133     "Analogue"."Alarm 1" := 1;
134     "Analogue"."Alarm 2" := 1;
135     "Analogue"."Alarm 3" := 1;
136     "Analogue"."Alarm 4" := 1;
137     "Analogue"."Alarm 5" := 1;
138     "Analogue"."Alarm 6" := 1;
139     "Analogue"."Alarm 7" := 1;
140     "Analogue"."Alarm 8" := 1;
141     "Analogue"."Alarm 9" := 1;
142 END_IF;

```

Good detailed evidence of program (SCL) development

Figure 18 Alarm System 6 Final Solution

Figures 13 to 18 depict various components and configurations of the alarm system within the overall solution. Each alarm within the system has specific threshold values that determine when it activates and deactivates, indicating whether a line can run or not based on the measured air pressure.

The alarm system is designed to provide timely and accurate notifications regarding the air pressure conditions, ensuring that operators are promptly alerted to any potential issues that may affect the operation of the lines. By setting specific thresholds for each alarm, the system can differentiate between acceptable and critical pressure levels, enabling appropriate actions to be taken.

Good explanation of program functions

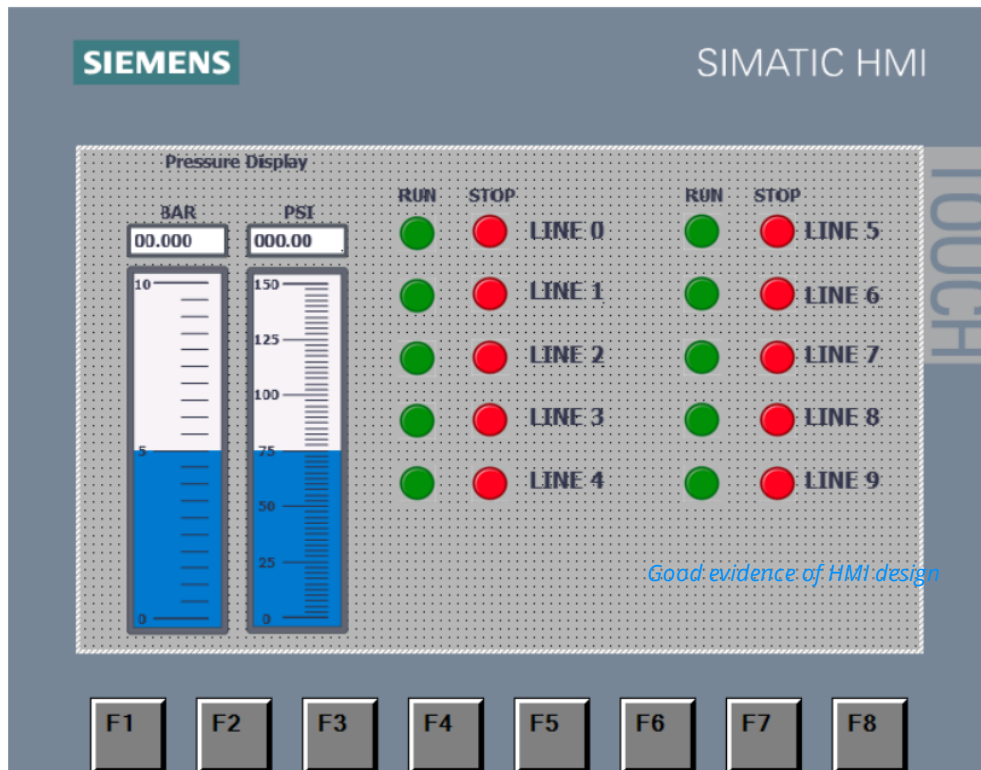


Figure 19 HMI screen for Final Solution

Figure 19 showcases the HMI (Human-Machine Interface) screen of the system, which provides a user-friendly and informative display of the air pressure values. The HMI screen has undergone further improvements and enhancements, incorporating additional features to enhance usability and provide clear indications of line availability.

One notable enhancement is the inclusion of both Bar and PSI units for displaying the pressure values. This allows users to view the air pressure in their preferred units, providing flexibility and convenience. Whether operators are accustomed to working with Bar or PSI measurements, the HMI screen accommodates their preferences, promoting ease of use and improving user experience. *Good explanation and argument for HMI functions*

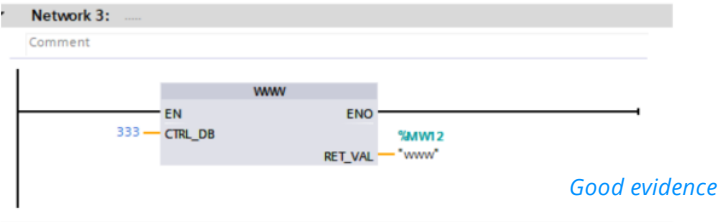
Furthermore, the HMI screen now incorporates run and stop lights for each line, as mentioned. These lights serve as visual indicators to clearly convey the operational status of each line. When a line is able to run, the corresponding run light illuminates, signalling that the line has met the necessary conditions and is ready for operation. Conversely, when a line cannot run due to abnormal pressure conditions or other factors, the stop light indicates that the line should remain idle until the issue is resolved.

The inclusion of run and stop lights on the HMI screen enhances situational awareness for operators, allowing them to determine the status of each line quickly and easily without the need for extensive manual checks or complex data interpretation. This intuitive visual feedback helps streamline decision-making processes, enabling operators to identify operational constraints and take appropriate actions promptly.

Good explanation of HMI conditional indicators

Server Implementation

PLC server configuration with administrative permissions



Good evidence

Figure 20 Web Server Function Block

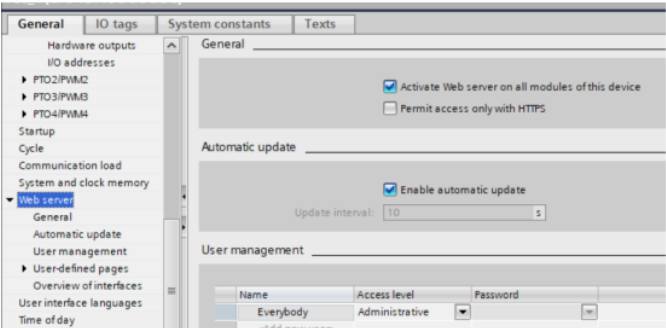
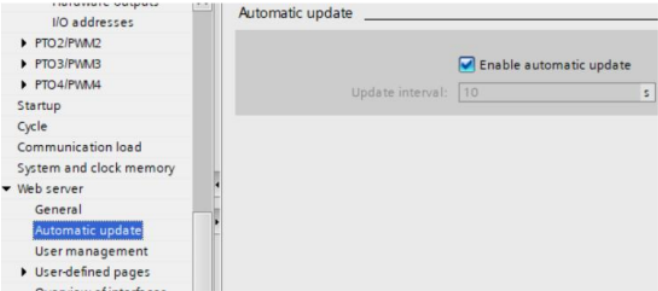


Figure 21 Web Server



Good evidence showing the web server implementation

Figure 22 Automatic Update

Load user defined dynamic web pages to the PLC server.

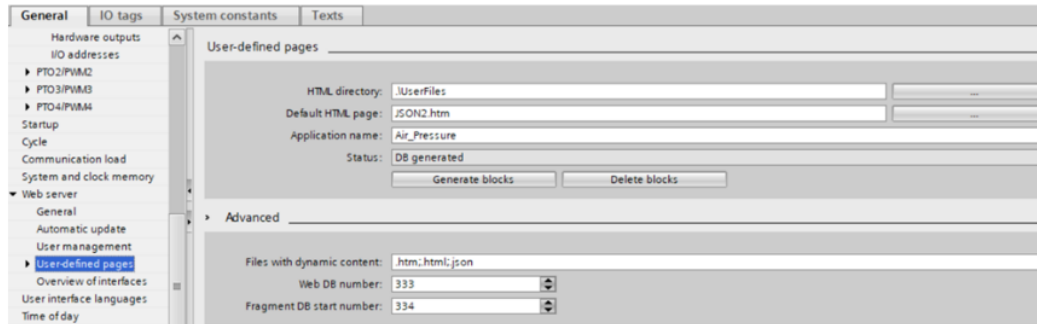


Figure 23 User Defined Page

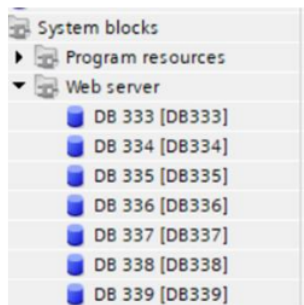
Good evidence of web server page download function

HTML and JavaScript libraries are used to programme dynamic web pages known as user defined web pages. Ajax and JSON are the dynamic function libraries that are used, respectively, for single dynamic variables and many dynamic variables.

The update rate is smooth since dynamic content allows for content updates without updating the entire page.

There are a maximum of 15 web data blocks on the PLC S7 1200, and as programme pages get larger, additional data blocks will be required to store the programme. As seen below, this programme requires 7 of these data blocks.

Dynamic server page functions are identified



Data blocks for web server program storage are created

Figure 24 Web Data Blocks

PLC project files in TIA

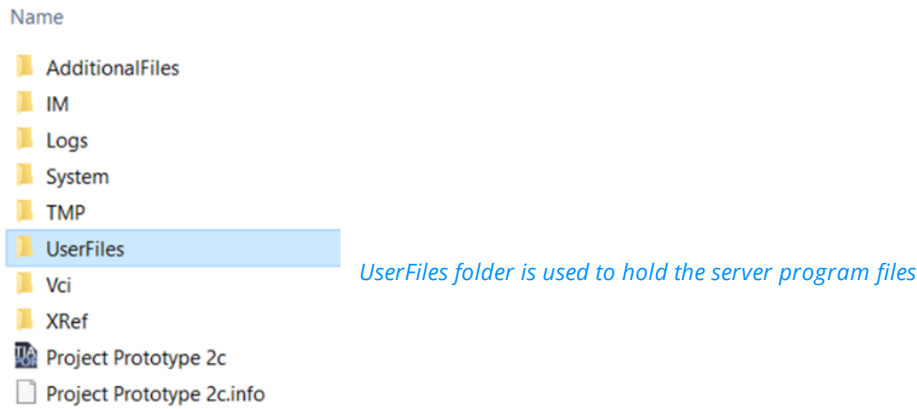


Figure 25 Project Files

The 'UserFiles' subdirectory of the project contains server files (user web pages), which can be posted to the PLC server from there. utilising the TIA software's PLC features.

Server file storage is identified

Programs in the 'UserFiles' folder

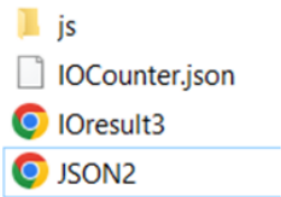


Figure 26 Server Files

JavaScript libraries held in the is folder



Figure 27 JavaScript Libraries

IOCounter.json tag variable

```
{  
  "bar_value" :      "I:=\"Analogue\".bar_value:"  
}
```

Figure 28 IOCounter.json tag variable

Evidence indicated the PLC tag ID for server pages

IOresult3.htm tag variable

```
I:=\"Analogue\".bar_value:
```

Figure 29 IOresult3.htm tag variable

JSON2.htm main program content

```
<!DOCTYPE html>
<html lang="en">
<head>
<meta charset="utf-8">
<title>Pressure Sensor Monitor</title>
<h1>Pressure Sensor Monitor</h1>

<!-- JavaScript library containing Ajax -->
<script src="jquery-3.3.1.min.js"></script>
<script src="js/jquery-2.0.2.min.js"></script>
<script src="js/raphael.2.1.0.min.js"></script>
<script src="js/jstgauge.1.0.1.min.js"></script>

<!-- Aligns the gauge graphic. g1 is the dynamic variable for the gauge. This is contained in a <style> tag-->
<style>
    body {
        text-align: center;
    }

    #g1 {
        width:700px; height:250px;
        display: inline-block;
        margin: 1em;
            title: "Pressure Bar";
    }

    p {
        display: block;
        width: 150px;
        margin: 4em auto;
        text-align: left;
    }
</style>

<!-- Give an id to the g1 dynamic gauge variable contained inside a <div> tag -->
<div style="float: center">
<table>
<tr>
<td><div id="g1"></div></td>
</tr>
</table>
</div>

</head>

<!-- Everything displayed is between the body tags and scripts-->
<body bgcolor="#0080ff">

<-<h1>Air Pressure: <label id="bar_value">:= "Analogue".bar_value:</label>&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&~Bar</h1></br>-->
<div style="float: center">
<table>
<tr>
<td><h1><div> Air Pressure: <label id="bar_value">:= "Analogue".bar_value:</label>&nbsp;&nbsp;&nbsp;&nbsp;&~Bar</h1></div></td>
</tr>
</table>
</div>

</body>

<!-- Script to refresh table content every second -->
<script type="text/javascript">
$(document).ready(function()
{
```

```

$.ajaxSetup({ cache: false });
setInterval(function()
{
$.getJSON("IOCounter.json", function(data)
{

$('#bar_value').text(data.bar_value);
});
},
//Refresh rate in ms.
1000);
});

<!--Initialise the gauge dynamic variables. Only g1, g2 and g3 used. g1 and g3 are dynamic variables form PLC Tags-->
var g1;

var g1 = new JustGage({
  id: "g1",
  value: getRandomInt(0, 10),
  min: 0,
  max: 10,
  title: "Air Pressure",
  label: "Pressure Bar"

});

/////ajax function call for g1 dynamic variable which is linked to Motor_PWM tag in file IOresult3 in PLC directory/////

//call the ajax function. This can easily be converted to JSON if necessary
$.ajaxSetup({ cache: false });
setInterval(function() {
$.get("IOresult3.htm", function(result){

    g1.refresh(parseFloat(result).toFixed(2)); //Parse to change data type and fix at 2 decimal places

});

},1000); // 100ms refresh rate and END OF THIS AJAX FUNCTION      CALL
</script>

</html>

```

*Main server page program is heavily
commentated*

Main components of program

The javascript libraries listed in this section of the programme are required to operate the dynamic variable content, which includes the graph indication.

```

<!-- JavaScript library containing Ajax -->
<script src="jquery-3.3.1.min.js"></script>
<script src="js/jquery-2.0.2.min.js"></script>
<script src="js/raphael.2.1.0.min.js"></script>
<script src="js/justgage.1.0.1.min.js"></script>

```

Libraries are identified

This section of code sets up the dynamic graph instance and is taken as a free sample from the internet where there are many types of graphs that can be implemented.

```

<!-- Aligns the gauge graphic. g1 is the dynamic variable for the gauge. This is contained in a <style> tag-->

```



```

<!-- Script to refresh table content every second -->
<script type="text/javascript">
$(document).ready(function()
{
$.ajaxSetup({ cache: false });
setInterval(function()
{
$.getJSON("IOCounter.json", function(data)
{
$.('#bar_value').text(data.bar_value);
});
},
//Refresh rate in ms.
1000);
});

```

Figure 31 Java Code 2

The example code shows how the dynamic variable g1 was utilised in the graph and how the dynamic function call 'Ajax' was used to call the variable tag from the file 'IOresult3.htm'. Following that, this is parsed as float data type, with a limit of two decimal places.

```

<!--Initialise the gauge dynamic variables. Only g1, g2 and g3 used. g1 and g3 are dynamic variables form PLC Tags->
var g1;

var g1 = new JustGage({
  id: "g1",
  value: getRandomInt(0, 10),
  min: 0,
  max: 10,
  title: "Air Pressure",
  label: "Pressure Bar"
});

//////ajax function call for g1 dynamic variable which is linked to Motor_PWM tag in file IOresult3 in PLC directory/////
//call the ajax function. This can easily be converted to JSON if necessary
$.ajaxSetup({ cache: false });
setInterval(function() {
$.get("IOresult3.htm", function(result){
  g1.refresh(parseFloat(result).toFixed(2)); //Parse to change data type and fix at 2 decimal places
});
},1000); // 100ms refresh ratw and END OF THIS AJAX FUNCTION CALL
</script>
</html>

```

Figure 32 Java Code 3

Server page program code is explained in good detail and implemented successfully

6 - Testing and Results

Test Number	Test	Expected Outcome	Actual Outcome	Figure Number
1	No air in the system	When there is no air in the system all the alarms should be red and the pressure should read out 0 Bar	When there is no air in the system all the alarms should be red and the pressure should read out 0 Bar	
2	1.5 Bar of pressure in the system	When there is only 1.5 bar of pressure in the system line 0 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 1.5 Bar	When there is only 1.5 bar of pressure in the system line 0 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 1.5 Bar	Figure 33
3	2.25 Bar of pressure in the system	When there is only 2.25 bar of pressure in the system line 0 and 1 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 2.25 Bar	When there is only 2.25 bar of pressure in the system line 0 and 1 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 2.25 Bar	Figure 34
4	3 Bar of pressure in the system	When there is only 3 bar of pressure in the system line 0, 1 and 2 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 3 Bar	When there is only 3 bar of pressure in the system line 0, 1 and 2 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 3 Bar	Figure 35
5	3.75 Bar of pressure in the system	When there is only 3.75 bar of pressure in the system line 0, 1, 2 and 3 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 3.75 Bar	When there is only 3.75 bar of pressure in the system line 0, 1, 2 and 3 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 3.75 Bar	Figure 36
6	4.5 Bar of pressure in the system	When there is 4.5 bar of pressure in the system line 0, 1, 2, 3 and 4 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 4.5 Bar	When there is 4.5 bar of pressure in the system line 0, 1, 2, 3 and 4 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 4.5 Bar	Figure 37
7	5.25 Bar of pressure in the system	When there is 5.25 bar of pressure in the system line 0, 1, 2, 3, 4 and 5 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 5.25 Bar	When there is 5.25 bar of pressure in the system line 0, 1, 2, 3, 4 and 5 alarm should be green ready to run and the rest of the alarms should be red and the pressure should read out 5.25 Bar	Figure 38
8	6 Bar of pressure in the system	When there is 6 bar of pressure in the system line 7, 8 and 9 alarm should be red and the rest of the alarms should be green ready to run and the pressure should read out 6 Bar	When there is 6 bar of pressure in the system line 7, 8 and 9 alarm should be red and the rest of the alarms should be green ready to run and the pressure should read out 6 Bar	Figure 39
9	6.75 Bar of pressure in the system	When there is 6.75 bar of pressure in the system line 8 and 9 alarm should be red and the rest of the alarms should be green ready to run and the pressure should read out 6.75 Bar	When there is 6.75 bar of pressure in the system line 8 and 9 alarm should be red and the rest of the alarms should be green ready to run and the pressure should read out 6.75 Bar	Figure 40
10	7.5 Bar of pressure in the system	When there is 7.5 bar of pressure in the system only line 9 alarm should be red and the rest of the alarms should be green ready to run and the pressure should read out 7.5 Bar	When there is 7.5 bar of pressure in the system only line 9 alarm should be red and the rest of the alarms should be green ready to run and the pressure should read out 7.5 Bar	Figure 41
11	8.25 Bar of pressure in the system	When there is 8.25 bar of pressure in the system all the alarms should be green ready to run and the pressure should read out 8.25 Bar	When there is 8.25 bar of pressure in the system all the alarms should be green ready to run and the pressure should read out 8.25 Bar	Figure 42
12	Pressure read out on the web page	The pressure should read out whatever the live pressure is	The pressure should read out whatever the live pressure is	Figure 43

Good use of table for function test results

7 - Discussion, Conclusions and Recommendations

The project has successfully achieved the desired outcomes outlined in the testing table. It has met the specifications by providing a live feed of the air pressure in the system, along with an alarm system indicating whether the production lines can run based on the air pressure conditions. The live feed of the pressure is displayed on large monitors positioned at the end of each line, and the system allows remote access to the live feed from anywhere in the world. These achievements validate the project's overall success in meeting its intended purpose.

Good point identified

Despite challenges in time management, the project was completed within the allocated timeframe, which is a significant accomplishment. It demonstrates effective project planning, resource allocation, and diligent effort in overcoming any delays or setbacks. The ability to deliver the project on time reflects a high level of commitment and perseverance.

Moreover, the project remained within the designated budgetary constraints, indicating successful financial management. The adherence to cost limitations and the careful justification of any additional parts or expenses demonstrate responsible decision-making and efficient utilization of available resources.

As for recommendations, incorporating indication lights and a counter on the web page would be beneficial. By adding indication lights, users accessing the live feed remotely would have visual cues similar to those displayed on the monitors at the end of each line. This would provide a consistent and comprehensive view of the operational status of the lines. Additionally, implementing a counter to track instances when the air pressure drops below the operational value allows for data collection and analysis. This data can be used to identify trends, potential issues, or areas requiring further investigation. It would provide valuable insights into the performance and reliability of the system over time, enabling proactive measures to be taken.

By considering these recommendations, the project can enhance its monitoring capabilities and further leverage data collection for proactive maintenance and troubleshooting. Continuously improving and expanding upon the system's functionalities will contribute to its long-term effectiveness, reliability, and overall performance.

Good conclusion and recommendations

In conclusion, the project successfully achieved its objectives by meeting the specified requirements, delivering a live feed of air pressure, and implementing an alarm system for line operation. Despite time management challenges, the project was completed on time, and the budgetary constraints were successfully managed. The suggested recommendations aim to enhance the system's capabilities and provide valuable insights through data collection, ultimately improving its functionality and performance.

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Good relevant number of sources used

9 – Appendix



Good evidence of implementation and development

Figure 33 HMI screen Test 1



Figure 34 HMI Screen Test 2



Figure 35 HMI Screen Test 3



Figure 36 HMI Screen Test 4

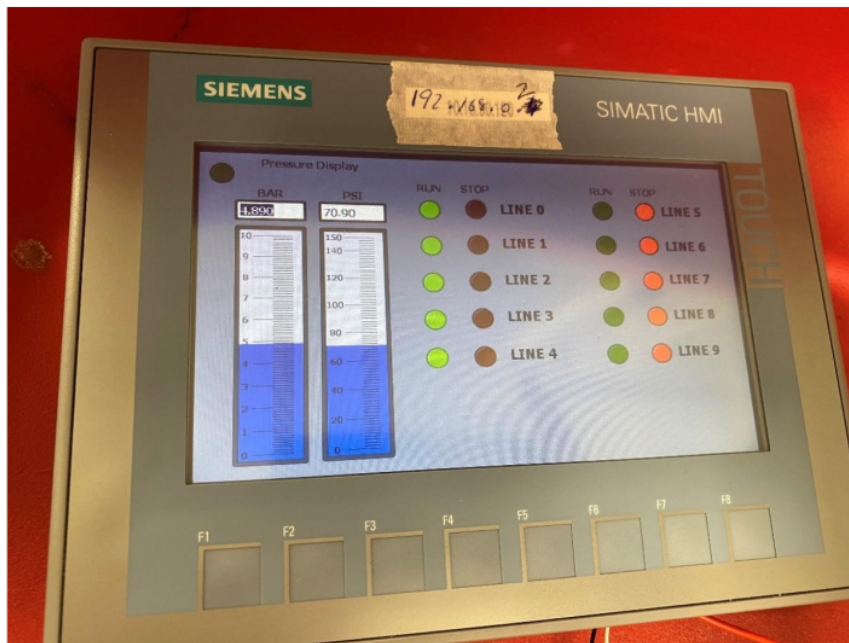


Figure 37 HMI Screen Test 5



Figure 38 HMI Screen Test 6



Figure 39 HMI Screen Test 7

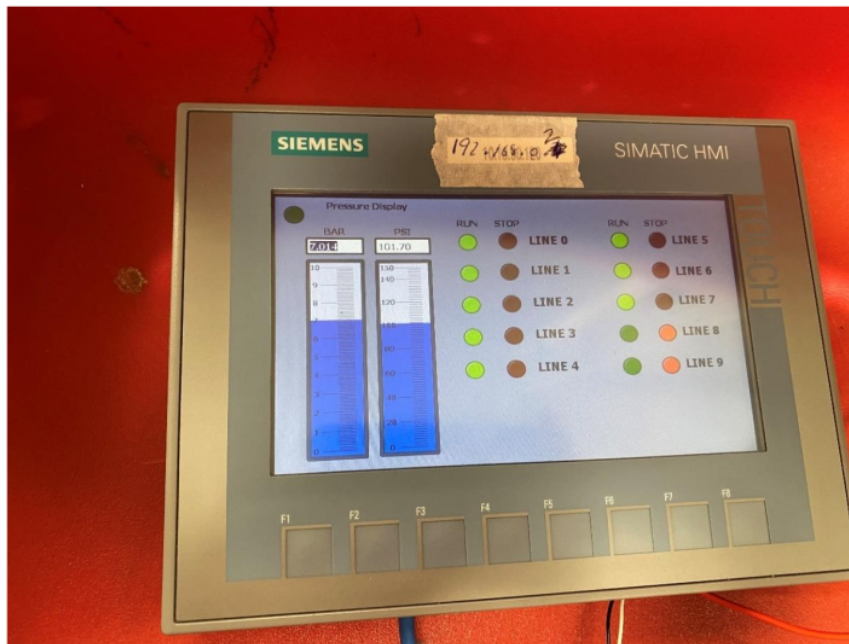


Figure 40 HMI Screen Test 8

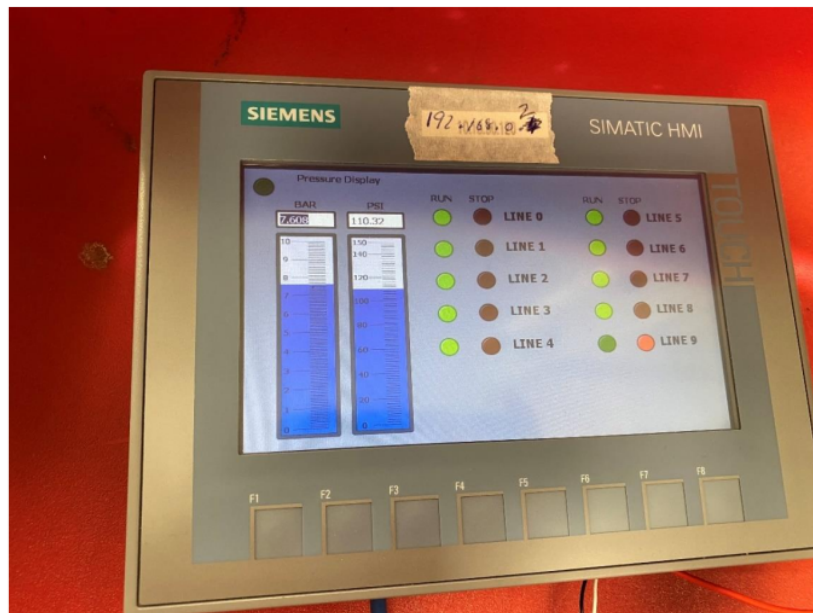
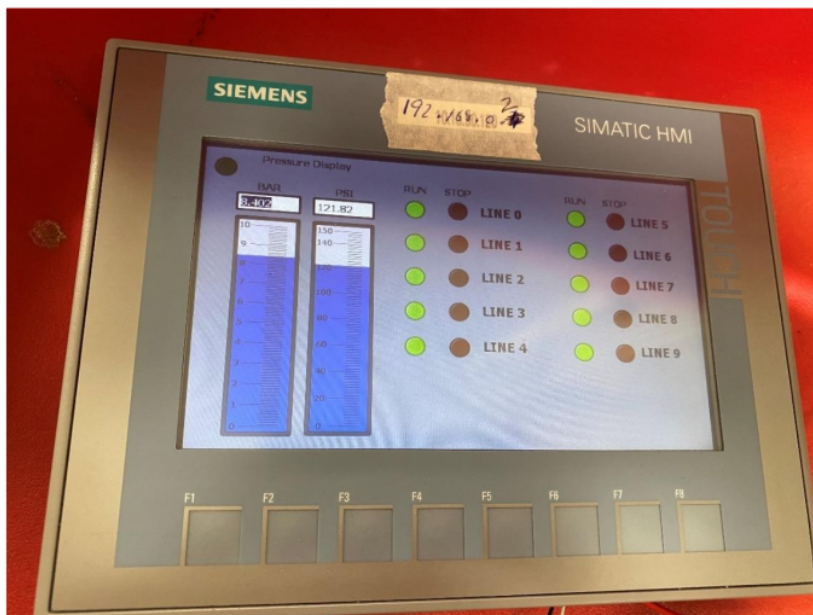


Figure 41 HMI Screen Test 9



Good evidence of testing, with full range of functions tested

Figure 42 HMI Screen Test 10

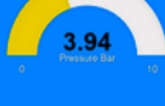
Test No	Web page value	PLC tag value
1	Pressure Sensor Monitor  Air Pressure: 8.339626 Bar	Monitor value 8.333454
2	Pressure Sensor Monitor  Air Pressure: 9.777068 Bar	Monitor value 9.777068
3	Pressure Sensor Monitor  Air Pressure: 1.920703 Bar	Monitor value 1.920703
4	Pressure Sensor Monitor  Air Pressure: 4.993828 Bar	Monitor value 5.0
5	Pressure Sensor Monitor  Air Pressure: 3.941979 Bar	Monitor value 3.95142

Figure 43 Tests for Web Page

Very good evidence of test results

FINAL GRADE

GENERAL COMMENTS

Instructor

63/100

PAGE 1

PAGE 2

PAGE 3

Text Comment. A good table of contents

PAGE 4

PAGE 5

PAGE 6

Text Comment. Comprehensive list of figures

PAGE 7

Text Comment. A good introduction that identifies the risk element with projects based at the employment industry. You have identified your risk problem and taken action to continue the project through to the solution.

Text Comment. Grammatical errors

Text Comment. Problem has been clearly identified

PAGE 8

Text Comment. The objective here is clear and related to your industrial requirements. The argument for the project is relevant for the solution requirements, and you have

manged to keep the objective directy related to the original industrail problem.

PAGE 9

Text Comment. Must not use first person terms

PAGE 10

Text Comment. A good understanding of the PLC technology and purpose

PAGE 11

PAGE 12

Text Comment. Supprting images could have been included to support content.
Relevant source is included

PAGE 13

PAGE 14

Text Comment. Advantages of industry 4.0 development is identified with relevant source

Text Comment. Good relevant background research has been carried out, with your industrial experience providing examples for industry

PAGE 15

Text Comment. Clear specification of what the objective will achieve. There should be some information of the technologies and constraints

Text Comment. A good viable point made

Text Comment. Good sense of risk of available components

PAGE 16

Text Comment. This is a realistic modern method of reducing cost and availability risk for the project

Text Comment. Good breakdown of costs

PAGE 17

Text Comment. Good argument for reducing maintenance inspections by the availability of the pressure variable

PAGE 18

PAGE 19

Text Comment. A detailed Gantt chart with timeline comparison. There should be a key to the chart included.

PAGE 20

Text Comment. Very detailed test plan table

PAGE 21

Text Comment. A good time management evaluation with recommendations

PAGE 22

Text Comment. A good detailed explanation

Text Comment. Good example

PAGE 23

Text Comment. Good evidence of prototype

PAGE 24

PAGE 25

Text Comment. Good detailed explanation

Text Comment. Good evidence of program development

PAGE 26

Text Comment. Good HMI development evidence

PAGE 27

Text Comment. Good arguments for additional conditions

Text Comment. Good argument for condition

Text Comment. Must not use first person terms

Text Comment. This section should have a heading for requirements or deliverables

Text Comment. Good evidence of program development

Text Comment. Good point here

Text Comment. This is true and further securities are possible

Text Comment. The benefits and functionality of the PLC web server are identified

Text Comment. Good evidence of program development

Text Comment. Good explanation of the program development

Text Comment. Good detailed evidence of program (SCL) development

Text Comment. Good explanation of program functions

Text Comment. Good evidence of HMI design

Text Comment. Good explanation and argument for HMI functions

Text Comment. Good explanation of HMI conditional indicators

Text Comment. Good evidence

Text Comment. Good evidence showing the web server implementation

PAGE 37

Text Comment. Good evidence of web server page download function

Text Comment. Dynamic server page functions are identified

Text Comment. Data blocks for web server program storage are created

PAGE 38

Text Comment. UserFiles folder is used to hold the server program files

Text Comment. Server file storage is identified

Text Comment. Significant files are identified

PAGE 39

Text Comment. Evidence indicated the PLC tag ID for server pages

PAGE 40

PAGE 41

Text Comment. Main server page program is heavily commentated

Text Comment. Libraries are identified

PAGE 42

Text Comment. The guage section is recognised and implemented for dynamic data

Text Comment. Good evidence and understanding demonstrated

Text Comment. This is the most significant point for this project and is recognised

PAGE 43

Text Comment. Server page program code is explained in good detail and implemented successfully

PAGE 44

Text Comment. Good use of table for function test results

PAGE 45

Text Comment. Good point identified

Text Comment. Good conclusion and recommendations

PAGE 46

PAGE 47

Text Comment. Good relevant number of sources used

PAGE 48

Text Comment. Good evidence of implementation and development

PAGE 49

PAGE 50

PAGE 51

PAGE 52

Text Comment. Good evidence of testing, with full range of functions tested

PAGE 53

Text Comment. Very good evidence of test results

GRADING FORM: CSG-RUBIC

TAYLOR BAMFORD

0

RESEARCH-INFORMED LITERATURE

-  There could be more ref sources used. Good background research carried out with relevant ref sources used. Good evidence of reading around the subject area for development purposes. Research for alternative solutions is not covered.

11/20

KNOWLEDGE AND UNDERSTANDING

-  Specification is descriptive and the requirements are clear, however, there should be more technical requirements included. 6/10
Solutions considered are the development prototypes for the final solution. There should be different alternatives included.
However, there is a good understanding of requirements using a PLC. 5/10

11/20

ANALYSIS

-  Very good structured test method used with supporting evidence. The testing is extensive and this is evident in the report. 8.5/10
Good conclusion and recommendations. 8.5/10

17/20

PRACTICAL APPLICATION AND DEP.

-  Good planning methods demonstrated using Gantt chart for timeline plan and evaluation, and test plan using tables with ref to evidence in

13/25

appendix. 3/5

Solutions considered are only in the form of prototypes, which are not very good arguments for alternative solutions. 3/10

Implementation methods are demonstrated using prototypes, with supporting evidence and explanations. 7/10

SKILLS FOR PROFESSIONAL PRAC.



Good report and very well structured
There are some grammatical errors

11/15