

2117075

by Thomas Woods

MARK OF 67% AGREED



Submission date: 23-May-2023 11:43AM (UTC+0100)

Submission ID: 207304250

File name: 17373_Thomas_Woods_2117075_181809_132962863.pdf (8.05M)

Word count: 2632

Character count: 17329

Course: HNC Electrical and Electronic Engineering
Module: SGEE4006 Electrical Electronic Engineering Project
Name: Thomas Woods
University number: 2117075
Date submitted: 16/05/2023.
Word count: 2542

Contents

1. Introduction	4
2. Specification.....	7
3. Planning.....	8
4. Solutions Considered	11
Solution 1 – PLC	11
Solution 2 – Timers and Relay Modules	12
Solution 3 – Striking Arm	13
5. Final Solution and Implementation	15
Environmental protection & sustainability.....	23
6. Testing and Results	24
7. Discussion, Conclusion and Recommendations	25
8. Bibliography	26
9. Appendix.....	27

Good table of contents

Figure 1 - Timet UK Logo	4
Figure 2 - Timet UK	4
Figure 3 - PLC Ladder example.....	5
Figure 4 - Laser Sensor Example	6
Figure 5 - Project Outcomes	7
Figure 6 - Task 3 Test Plan.....	8
Figure 7 - Task 3 Test Conditions	9
Figure 8 - Project Gantt Chart.....	10
Figure 9 - Sequency Diagram	11
Figure 10 - Solution 2 Timers and Relay Modules	12
Figure 11 - Solution 3 Limit Switch	13
Figure 12 - Solution 3 Block diagram	13
Figure 13 - Installed Panel.....	15
Figure 14 – Mitsubishi PLC Installation.....	16
Figure 15 - PLC wiring Diagram	17
Figure 16 - AC Parker Drive.....	18
Figure 17 - PILZ PNOZ X3 Safety Relay.....	19
Figure 18 - Basic Safety PLC Design.....	20
Figure 19 - E-Stop Wiring.....	21
Figure 20 - Completed E-Stop	22
Figure 21 - Prototype testing motor	23
Figure 22 - Timer Test Plan	24
Figure 23 - Test Condition Plan	24
Figure 24 - Panel after initial installation.....	27
Figure 25 - Installed RCD	28
Figure 26 - Online Data Storage Service.	29

Extensive list of figures

1. Introduction

This heading should also include background research

The problem that was identified within Timet was on one of the annealing machines. It requires the metal to pass through the furnace at a set slow speed. Once the soaking time for the material has been reached the moving conveyor belt is required to eject the material quickly. This will allow for greater efficiency as more material can be loaded into the machine in shorted intervals.

Good intro with problem identified



Figure 1 - Timet UK Logo

The project will be carried out within Timet UK. TIMET has a fully integrated supply chain, dedicated research facilities, and decades of experience which make us the partner of choice when it comes to titanium. Additionally, they operate a fully integrated supply chain from raw material through mill product. Also, they quickly move products using qualified



Figure 2 - Timet UK

raw material and routings that meet stringent customer requirements. (Timet, 2023)

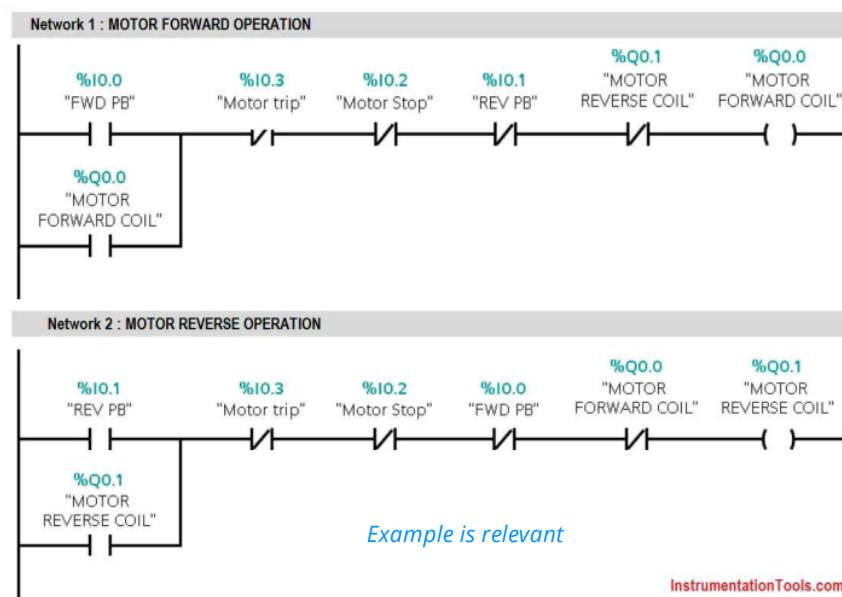
One of the possible components being used within the project is a PLC controller. These controllers are commonly found within industrial environments. As stated by Inductive automation "PLCs come in many different sizes and form factors. Some are small enough to fit in your pocket, while others are large enough to require their own heavy-duty racks to mount. Some PLCs are more modular, with only basic I/O (Inputs and Outputs), but can be customized with additional back planes and functional modules (such as analog I/O,

communications modules, or display modules) to fit different types of industrial applications.” (Inductive Automation, 2023)

*Potential of PLC in industry is realised
Good supporting sources*

Within PLC programming there are various programming languages that can be used. one of the most common programming languages used as stated by SolisPLC “This question is debated among PLC programmers across the world. The consensus is that the most utilized language for PLC programming is ladder logic. This is due to the fact that it's highly flexible, easy to learn and very well understood by electricians who have worked with schematics that model the same architecture.” (SolisPLC, 2023) this can be a large advantage within industry due it allow for easier maintenance to be carried out by less experienced personnel.

Good points made



Example is relevant

Figure 3 - PLC Ladder example

(Inst Tools, 2023)

Another component that can be used within the project would be a Laser detector. A laser detector is an optical component that uses a laser to either determine distances or to detect the motion of an object. They are commonly paired with either a reflector or a receiver. After the laser signal has been detected the unit generates an electronic signal. (Laser Beam Cut , 2023). The output signal generated by a laser detector can be as stated by “Depending on what laser sensor you have, the sensor outputs can be normally open, normally closed, NPN, PNP, or analog. Also depending on the laser sensor, the analog outputs can be zero to ten volts or four to twenty milliamps.” (RealPars, 2023)

Relevant sources used

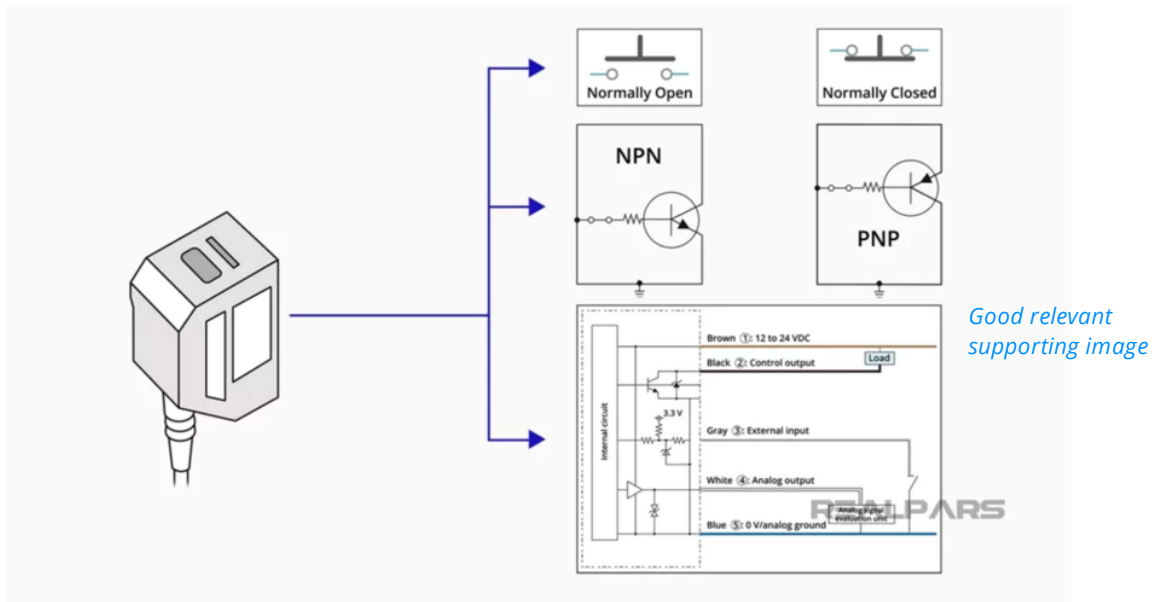


Figure 4 - Laser Sensor Example

2. Specification

For this project to be successful it must efficiently detect the material passing through the furnace while also engaging the fast eject process at a set accurate time consistently. The system will also be required to have a variable timer as different material that is used within the furnace requires various soaking times. The output of the motor will be restricted to 10% of its maximum output. This will allow the material to receive an adequate soak. After the material has passed over the laser detector which is positioned beneath the conveyor. A timer will begin. This time is set by the operator of the machine.

The result for this project will consist of an electrical control panel this will be connected to an AC drive which will monitor and control the output speed of the conveyors AC motor

A good functional description

Project Outcomes	
Where is the project being built	Timet UK Waunarlwydd Plant
How will the reliability of the project be met.	There will be regular meetings with engineering to monitor progress.
Project Budget	The allotted budget for the project was £10000.
Ergonomics and ease of use.	The wiring and the software used will be made simple. This will allow for easier maintenance and fault finding.
Health and Safety Standards	Due to the project being carried out on the Timet site. Their Health and safety procedures will be followed. Additionally the project will adhere to the various health and safety regulations that are present.
Environmental Impact	Within this project. It does not contain any harmful substances or chemicals. However the energy consumption will have an effect on the environment. This will be attempted to be reduced.
Timer Setting	the value of the timer setpoint is determined by the quality department. Through the conduction of various surveys.

Figure 5 - Project Outcomes

Good use of table for constraints

3. Planning

Once the specification has been set a suitable test plan can be determined. As shown in the two figures below. This ensures that the project was a success. These test plans will be revisited again during the tests.

Good use of table for test results

Test Number	Set Value (Seconds)	Expected Value (Seconds)	Actual Value (Seconds)	Error (Seconds)	Pass/Fail
1	30	30			
2	60	60			
3	90	90			
4	120	120			

Figure 6 - Task 3 Test Plan

Test	Predicted Outcome	Actual Outcome	Pass/Fail
The Fast eject timer starts when the laser detects the metal	The timer output should start once the laser has detected the metal.		
The systems fast eject starts when the timer has completed.	The systems fast eject should start once the timer is complete.		
The fast eject within the system stops after a second timer is completed.	The fast eject within the system should stop after the second timer completes.		

Figure 7 - Task 3 Test Conditions

A suitable Gantt can be designed for the project

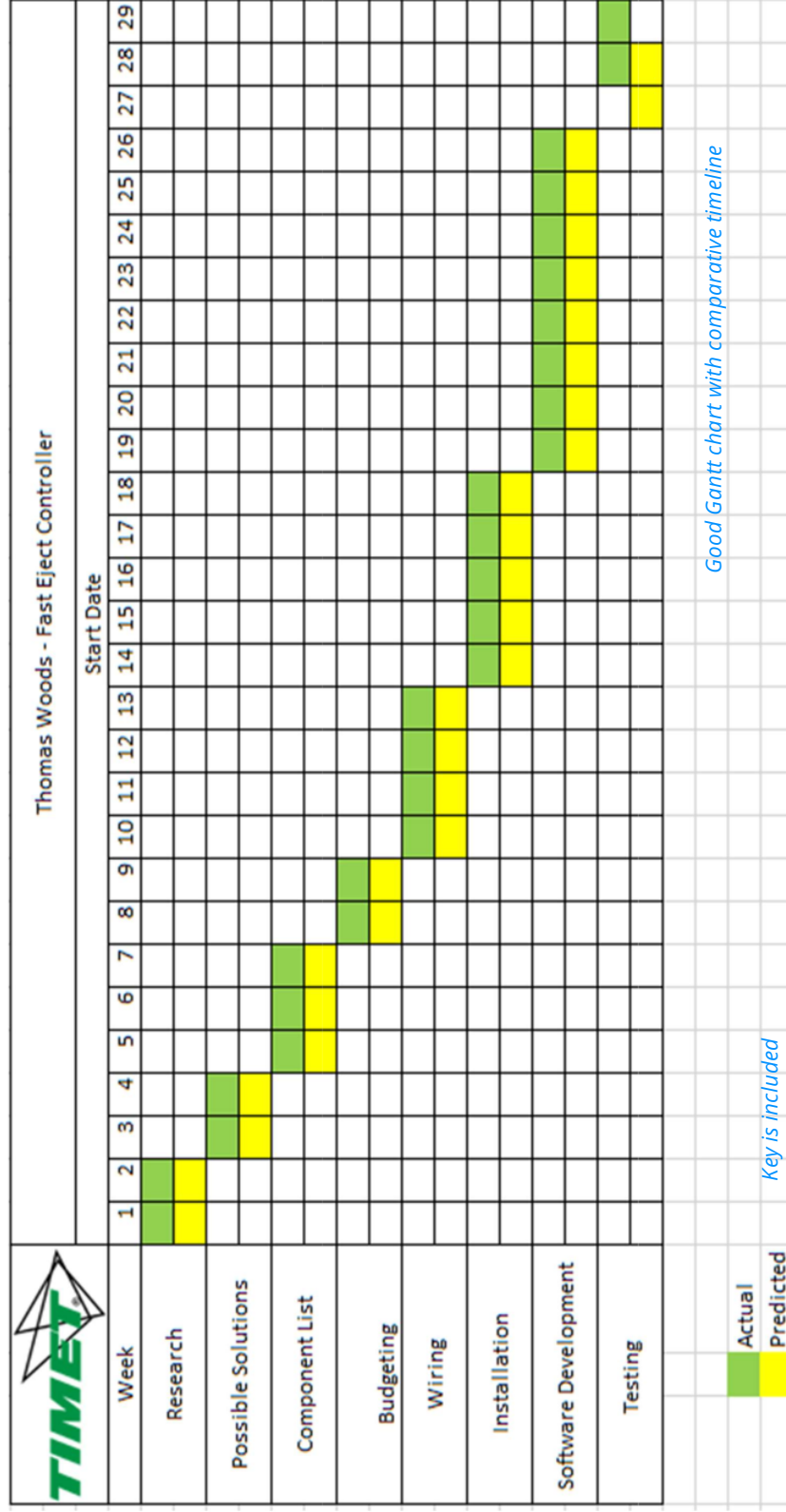


Figure 8 - Project Gantt Chart

4. Solutions Considered

Solution 1 – PLC

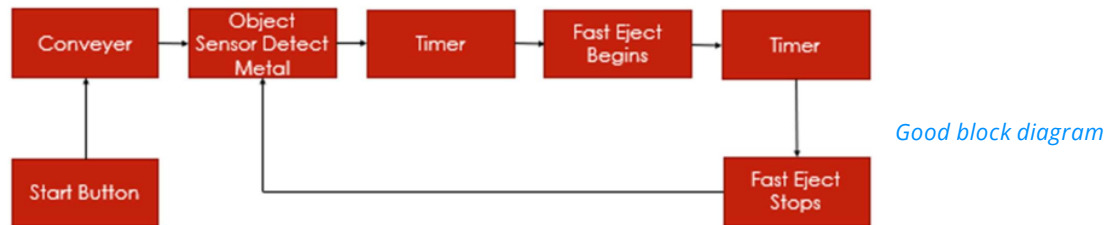


Figure 9 - Sequence Diagram

Solution 1 will implement a PLC to control the sequence of the fast-ejecting process. This works in line with the block diagram shown above. This system allows for the operator to easily monitor the current output speed present within the conveyer. Additionally, allowing them to alter the set time of the timers present for specific material passes. This will allow for the operator to better monitor the process of the machine.

This solution will be expensive in comparison due to the various component costs present. Additionally, programming software licences will be to be purchased prior to the project's conduction.

This should include at least one ref source

Advantages

- Easy for fault finding. As a suitable laptop can be connected to monitor the program code.
- This is a modern solution as it allows for monitoring using Profinet or external monitoring with the implementation of Industry 4.0.
- Future modifications can be made easy by altering the program code and adding additional I/O cards.
- Due to the PLC's compact size it allows for better space management within the panel.

Disadvantages

- The software and hardware required can be expensive.
- Program can become corrupted, so suitable back-ups need to be kept in order and accessible.
- The program code can be difficult to learn.

Good evaluation carried out

Solution 2 – Timers and Relay Modules



Good image

Figure 10 - Solution 2 Timers and Relay Modules

For the second solution it involves a combination of relays and timers. This will also allow for the project to be successful as it will fall in line with the sequence diagram shown previously. The system will be reliable due to the simplicity of the required circuit designs. This solution will be significantly cheaper than the implementation of a PLC. This will allow for easier maintenance as there will be an abundance of spares available. A variable timer contacts will be mounted onto the panel door this will allow for the operator to alter the output time as required for what material is passing through the furnace.

A relevant valid solution. Should include a reference source to support content

Advantages

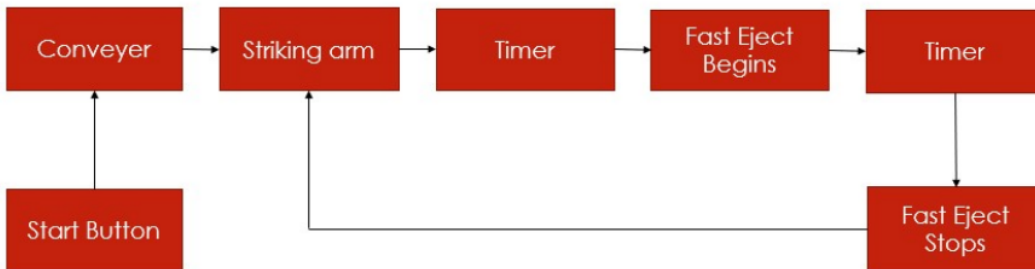
- Cheap component cost.
- Simple circuit design.
- Easy to carry out maintenance.

Disadvantages

- Requires space within the panel.
- Components can be prone to faults, within harsh environments.

Evaluation carried out

Solution 3 – Striking Arm



Block diagram demonstrates how the arm can be implemented into the identical system as an alternative solution

Figure 12 - Solution 3 Block diagram



Good supporting image

Figure 11 - Solution 3 Limit Switch

For the third solution it is to replace the laser detector present within the furnace and implement a striking arm. This will allow for high accuracy as an output signal will be sent back to the control once the material contacts the striking arm.

At least one ref source should be included

Advantages

- Easy to set-up
- Cheap component costs.

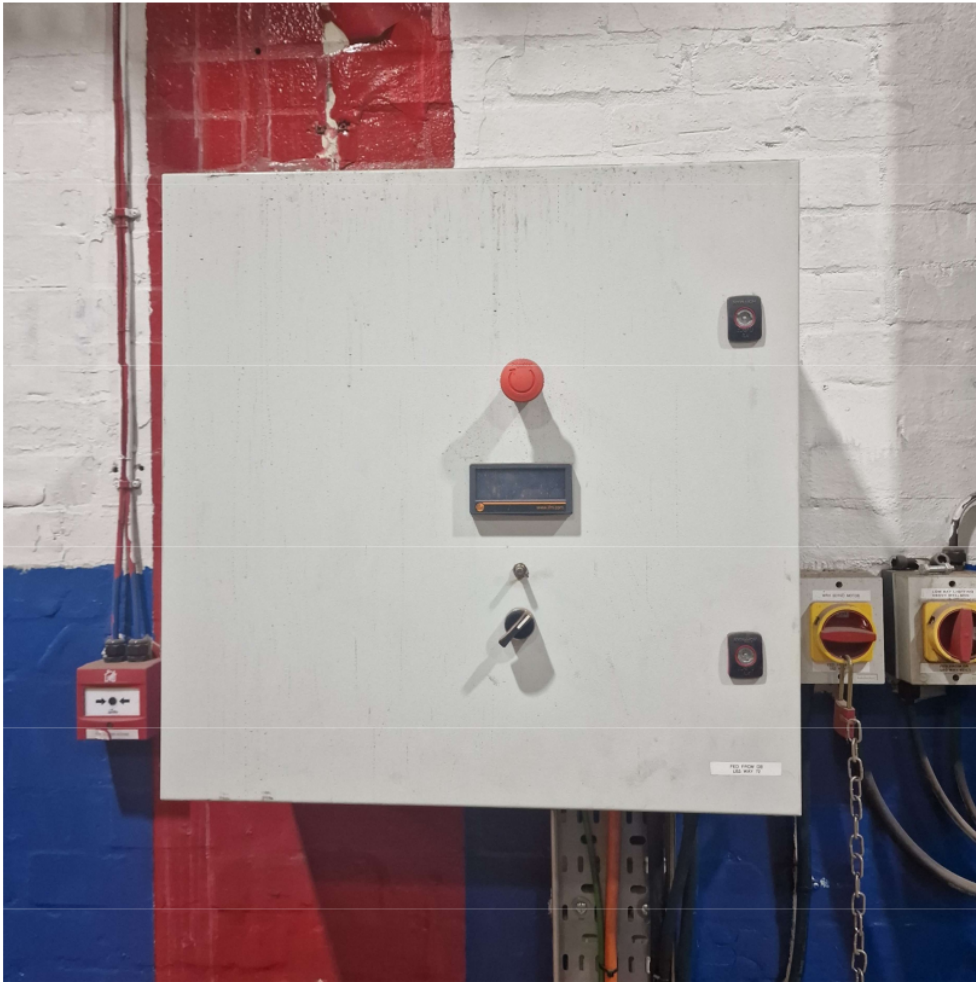
Evaluation points out pro and cons

Disadvantages

- Prone to damage through repetitive use.
- Striking arm would be exposed to high temperatures consistently.

5. Final Solution and Implementation

The final solution that was chosen within the system was to install a suitable PLC controller. This was selected due to the expandability of the module. Additionally, it is beneficial as it allows for modifications to be implemented in the future. With the solution for the project selected. It was then decided to build a separate panel for the controller rather than placing it in the main panel. This was conducted by a contractor company called Fastec.



Good image

Figure 13 - Installed Panel

As shown in the figure above it shows the installed electrical panel that was implemented by a separate contracting firm.

Once the blank panel was mounted onto the wall the various required components were installed. These included an AC drive to control the output speed of the AC motor. The speed of the conveyors motor is monitored by a tachometer. This tachometer works by measuring the rotational speed from the shaft within the motor.

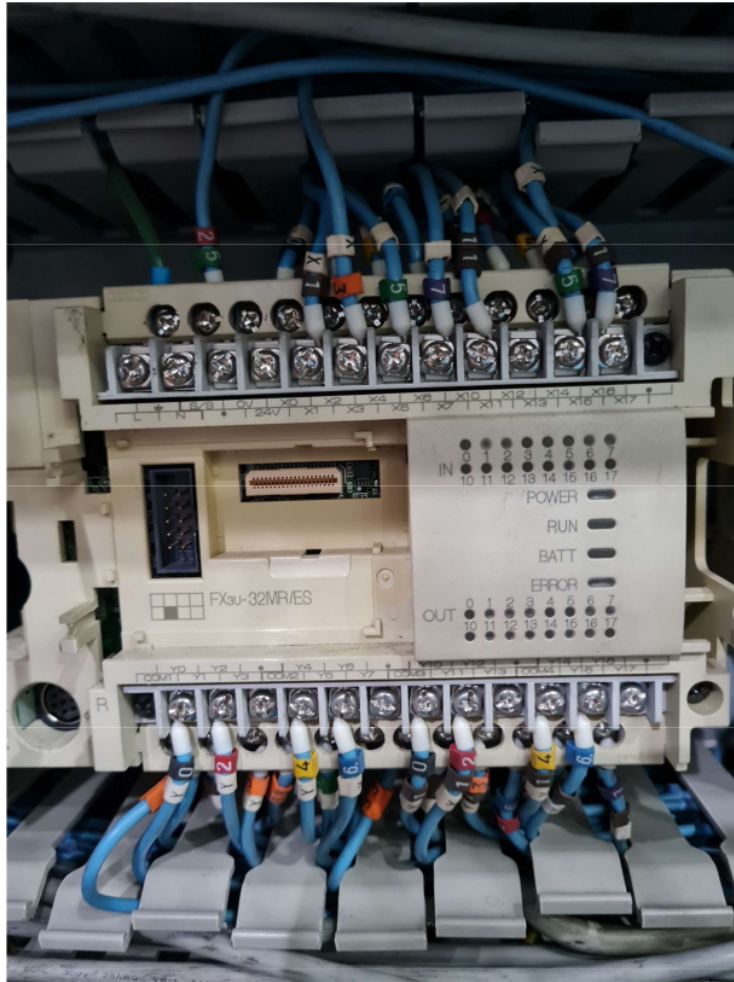


Figure 14 – Mitsubishi PLC Installation

The PLC that was selected to be installed into the panel was a FX3u-32M. The cable wiring used to install the PLC is shown below in figure 12.

Good evidence

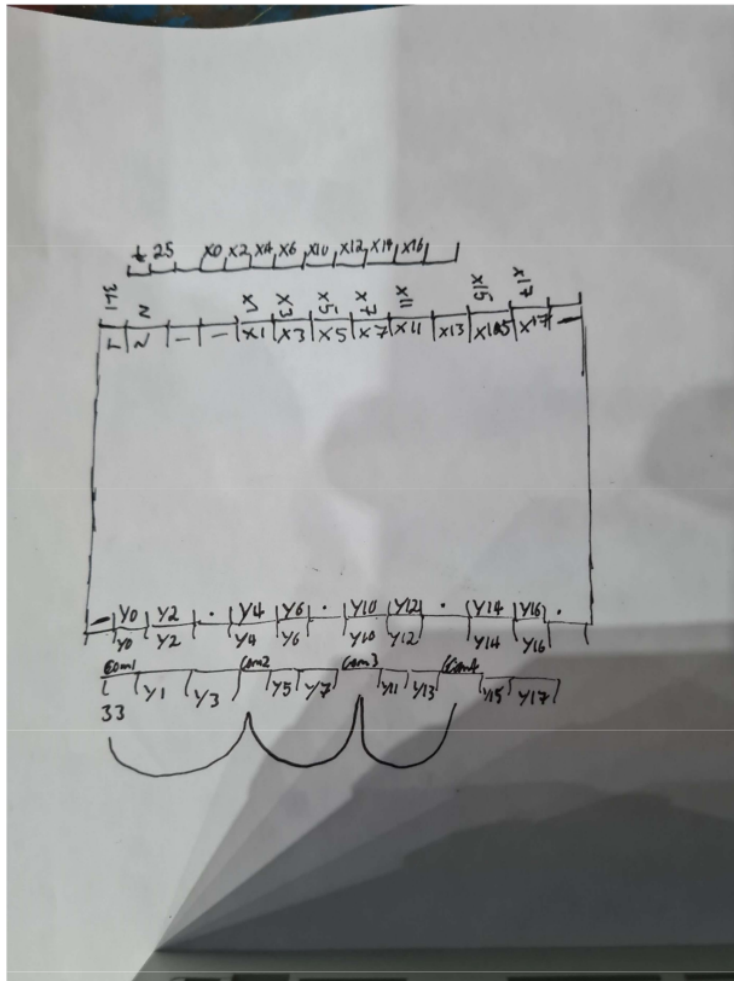


Figure 15 - PLC wiring Diagram

From the figure shown above. It demonstrates the different cable configuration that was required to ensure that the PLC was connected to the correct inputs and outputs. The drawing generated was created with the use of cross-referencing against the pre-existing drawings, for the main control panel. [Good explanation with evidence](#)



Figure 16 - AC Parker Drive

Once the PLC was installed the AC drive could be installed into the panel. This drive is used to control the output speed of the AC motor being used to drive the furnace conveyor. This is done by limiting the output of the drive that feeds the motor. During the standard operation of the furnace the output percentage is limited to 10%. Once the fast eject sequence has started the output percentage is set to 100%.

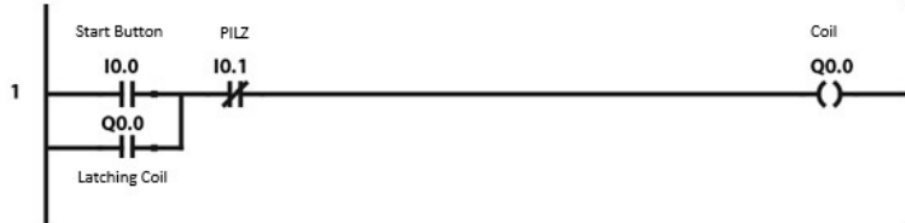
Good significant point made



Good evidence of safety relay

Figure 17 - PILZ PNOZ X3 Safety Relay

This safety relay was implemented into the control circuit. This is to integrate a secure safety system, within the machine. With this installed it allows to control the safety circuit and interlock the machine. Without all of the safety systems being healthy the PILZ unit will restrict the machine from operating.



Good evidence

Figure 18 - Basic Safety PLC Design

Shown in the figure above it demonstrated the basic code used to control the system with the use of safety systems. This is being controlled by a latching coil that can be reset through the use of the disengagement of the safety PILZ relay.

coming from the PILZ relay within the control panel a new 1.5mm 2 Core cable was run under the floor panels to the side of the furnace wall. Once mounted on to the furnace the cables were identified and compared against the normally closed contact that is required for an E-stop circuit.



Good evidence

Figure 19 - E-Stop Wiring



Figure 20 - Completed E-Stop

With the cables identified it can be installed into the normally closed contact within the box. Then the casing lid was mounted and the functionality of the E-stop was tested to ensure that it has been wired correctly and is suitable for the system. *Good explanation with evidence*



Figure 21 - Prototype testing motor

As shown in figure 20 above it shows the motor used during the prototyping of the project. This motor was used to test and ensure that the outputting speeds of the motor is suitable for the system.

Good evidence

Environmental protection & sustainability.

This systems effect on the environment will be kept to a minimum due to the system not containing any harmful chemicals or substances. However, the electrical impact of the system remains consistent as the it continues to operate at a consistent level. With regards to the sustainability of the system it is an easy system to maintain and repair due to the simplicity of the circuit designs. However, due to the vast number of components that can be found within this system. It would be beneficial to conduct suitable spaced maintenance on the overall system to ensure that the functionality of the components doesn't diminish with time.

6. Testing and Results

Good set of results

Test Number	Set Value (Seconds)	Expected Value (Seconds)	Actual Value (Seconds)	Error (Seconds)	Pass/Fail
1	30	30	29.8	0.2	Pass
2	60	60	30.1	0.1	Pass
3	90	90	89.97	0.03	Pass
4	120	120	119.92	0.08	Pass

Figure 22 - Timer Test Plan

Good set of results for conditional testing

Test	Predicted Outcome	Actual Outcome	Pass/Fail
The Fast eject timer starts when the laser detects the metal	The timer output should start once the laser has detected the metal.	The timer output started once the laser had detected the metal.	Pass
The systems fast eject starts when the timer has completed.	The systems fast eject should start once the timer is complete.	The systems fast eject started once the timer completed.	Pass
The fast eject within the system stops after a second timer is completed.	The fast eject within the system should stop after the second timer completes.	The fast eject within the system stopped after the second timer was completed.	Pass

Figure 23 - Test Condition Plan

For the testing that was conducted on this system various tests were carried out. These tests included different timing activities to ensure that the system was accurate to the specification provided. Additionally, observational testing was conducted throughout the overall system this included, ensure that the various functions of the system activated correctly as expected.

7. Discussion, Conclusion and Recommendations

Throughout the course of the project there were various outcomes that were *developed* development and during the course of the implementation of the project these outcomes have been successfully met. These outcomes allow the operator of the machine to safely and efficiently run the system with the use of the fast eject being implemented into the overall machine. Overall the system can be considered an overall success. This is due to the different outcomes and features that have been completed. Additionally, it can be considered a success due to the maintainability of the system and the accessibility of future system upgrades due to the implementation of a PLC. This is a large advantage as it is simple for possible fault finding and expandability. The overall timing constraint for the project was met. This can be shown in the Gantt chart that was generated, the project was conducted with minimal complications and the implementation of the project was conducted around the production personnel and within the time available during regular shift work. Additionally, the budget constraints that were applied to the project were met and the overall project was completed while remaining just under the predicted budget. The project budget was forecast as requiring £10000. However, the overall project only required a total *Good points made about budget issues* £8745. With regards to the environmental and sustainability issues around the project, these were overcome during the designing of the project. This is due to the implementation of energy efficient components and the lack of use of harmful chemicals or substances. During the project high levels of professionalism was conducted. This was shown during the various professional discussion carried out various individuals involved within the project. These included engineers, technicians, and project developers. *This part could be a recommendation*

Conclusion confirms the success of the project and savings due to over predicting costs. The implementation of energy saving components can be a recommendation for the project, and future more energy saving components could replace existing.

8. Bibliography

Inductive Automation, 2023. *What is a PLC?*. [Online]

Available at: <https://www.inductiveautomation.com/resources/article/what-is-a-PLC>

[Accessed 16 05 2023].

Inst Tools, 2023. *3 Phase Motor Control using PLC Ladder Logic*. [Online]

Available at: https://instrumentationtools.com/plc-ladder-logic-for-3-phase-asynchronous-motor-control/?utm_content=cmp-true

[Accessed 16 05 2023].

Laser Beam Cut , 2023. *What are Laser Sensors?*. [Online]

Available at: <https://laserbeamcut.com/how-does-laser-sensor-work/#:~:text=A%20laser%20detector%20is%20an%20optical%20device%20that,use%20the%20signals%20for%20a%20variety%20of%20purposes.>

[Accessed 16 05 2023].

RealPars, 2023. *laser sensor output*. [Online]

Available at: <https://realpars.com/laser-sensor/>

[Accessed 16 05 2023].

SolisPLC, 2023. *Top 5 Most Popular Types of PLC Programming Languages*. [Online]

Available at: <https://www.solisplc.com/blog/plc-programming-languages>

[Accessed 16 05 2023].

Timet, 2023. *Timeline of Milestones*. [Online]

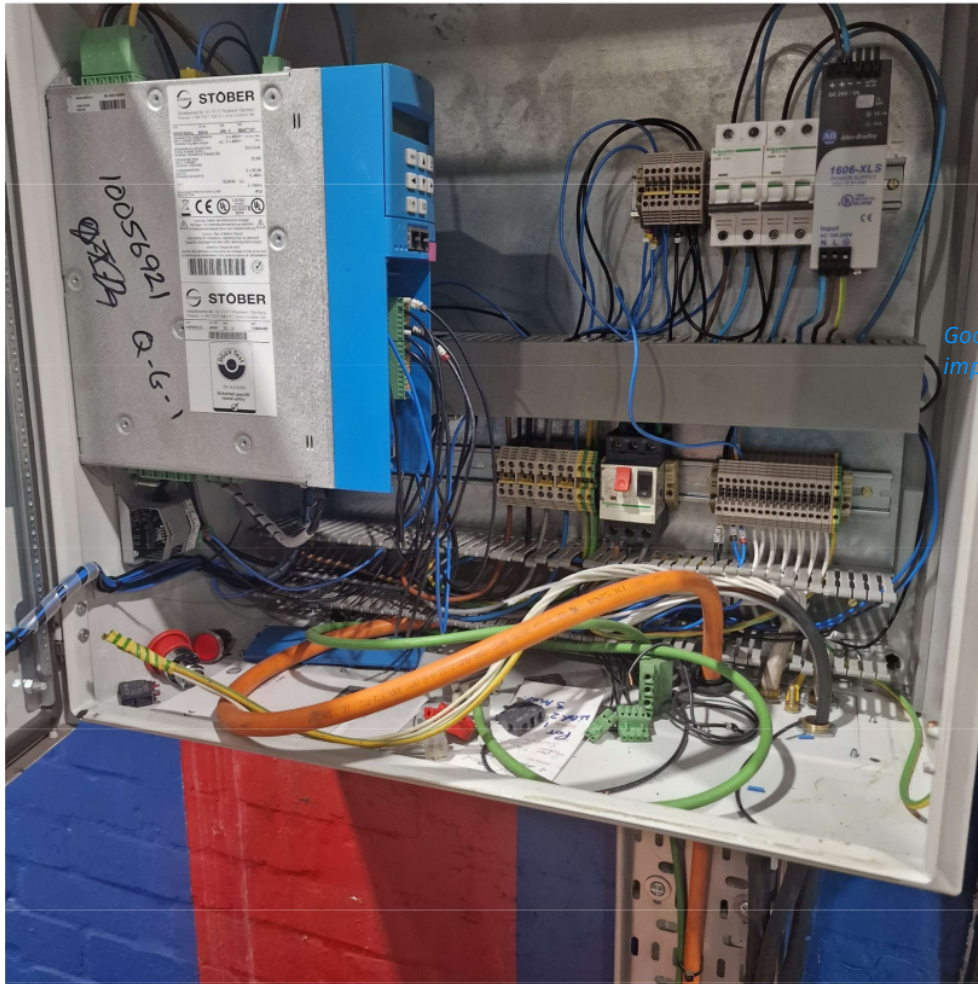
Available at: <https://www.timet.com/about/timeline-of-milestones.html>

[Accessed 16 05 2023].

Acceptable number of sources

9. Appendix

Include schematic drawings, program code printouts, photographs of construction and testing evidence.



Good evidence of implementation

Figure 24 - Panel after initial installation.



Figure 25 - Installed RCD

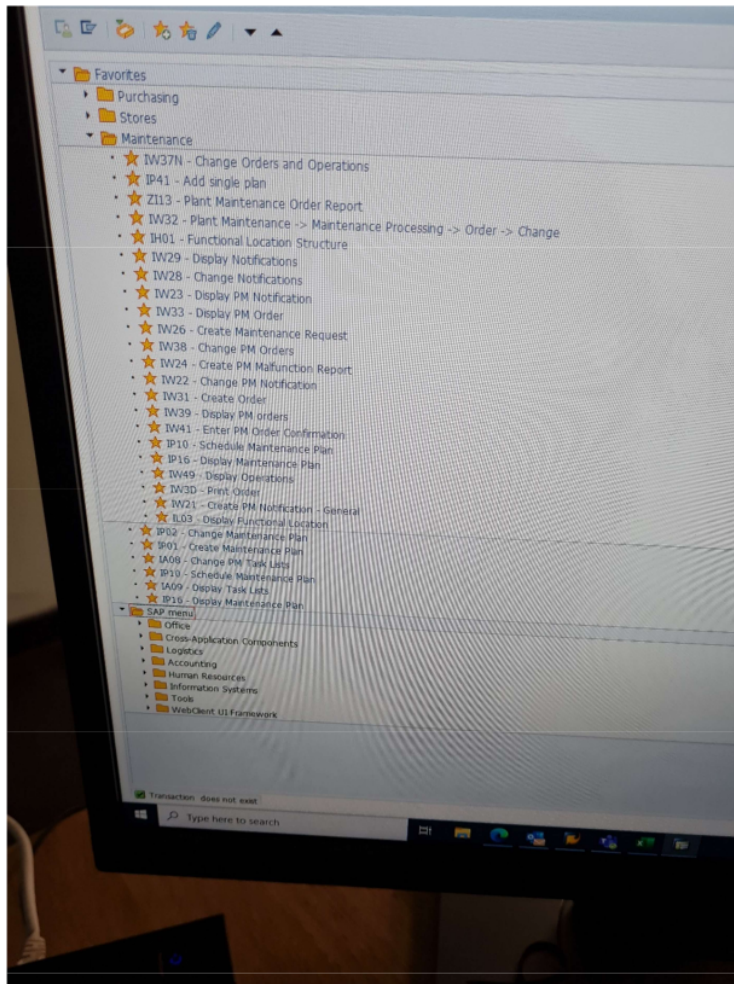


Figure 26 - Online Data Storage Service.

FINAL GRADE

GENERAL COMMENTS

Instructor

67 / 100

PAGE 1

PAGE 2

Text Comment. Good table of contents

PAGE 3

Text Comment. Extensive list of figures

PAGE 4

Text Comment. This heading should also include background research

Text Comment. Good intro with problem identified

PAGE 5

Text Comment. Potential of PLC in industry is realised

Text Comment. Good supporting sources

Text Comment. Good points made

Text Comment. Example is relevant

Text Comment. Relevant sources used

Text Comment. Good relevant supporting image

Text Comment. A good functional description

Text Comment. Good use of table for constraints

Text Comment. Good use of table for test results

Text Comment. Good conditional test plan

Text Comment. Good Gantt chart with comparative timeline

Text Comment. Key is included

Text Comment. Good block diagram

Text Comment. This should include at least one ref source

Text Comment. Good evaluation carried out

Text Comment. Good image

Text Comment. A relevant valid solution. Should include a ref source to support content

Text Comment. Evaluation carried out

Text Comment. Block digram demonstrates how the arm can be implemented into the identical system as an alternative solution

Text Comment. Good supporting image

Text Comment. At least one ref source should be included

PAGE 14

Text Comment. Evaluation points out pro and cons

PAGE 15

Text Comment. Good image

PAGE 16

Text Comment. Good evidence

PAGE 17

Text Comment. Good explanation with evidence

PAGE 18

Text Comment. Good significant point made

PAGE 19

Text Comment. Good evidence of safety relay

PAGE 20

Text Comment. Good evidence

PAGE 21

Text Comment. Good evidence

PAGE 22

Text Comment. Good explanation with evidence

PAGE 23

Text Comment. Good evidence

Text Comment. Environmental and sustainability are covered

PAGE 24

Text Comment. Good set of results

Text Comment. Good set of results for conditional testing

PAGE 25

Text Comment. developed

Text Comment. Good points made about budget issues

Text Comment. This part could be a recommendation

Text Comment. Conclusion confirms the success of the project and savings due to over predicting costs. The implementation of energy saving components cab be a recommendation for the project, and future more energy saving components could replace existing.

PAGE 26

Text Comment. Acceptable number of sources

PAGE 27

Text Comment. Good evidence of implementation

PAGE 28

PAGE 29

PAGE 30

GRADING FORM: CSG-RUBIC

THOMAS WOODS

0

RESEARCH-INFORMED LITERATURE



Background research includes good significant points and supported with ref sources.
The solutions have good arguments, however, are not supported with ref sources.
Acceptable number of sources used.

13/20

KNOWLEDGE AND UNDERSTANDING



Specification is descriptive and requirements are clear.. 6.5/10
Solutions considered are explained and good arguments are presented. The final solution was chosen using evaluations of solutions.
There is a good understanding of requirements using a PLC. 7.5/10

14/20

ANALYSIS



Very good structured test method used with supporting evidence. The testing is successful and explained. This is evident in the report. 7/10
Conclusion is good with many significant points of interest. However, there is a valid recommendation. 6/10

13/20

PRACTICAL APPLICATION AND DEP.



Good planning methods demonstrated using Gantt chart for timeline and comparison timeline plan. Test plan using tables is included. 3.5/5
3 solutions considered are explained and evaluated for purpose. 6/10
Implementation methods are demonstrated and supported with evidence. 6.5/10

16/25

SKILLS FOR PROFESSIONAL PRAC.



Good report with a logical sequence
There are minor grammatical errors

11/15