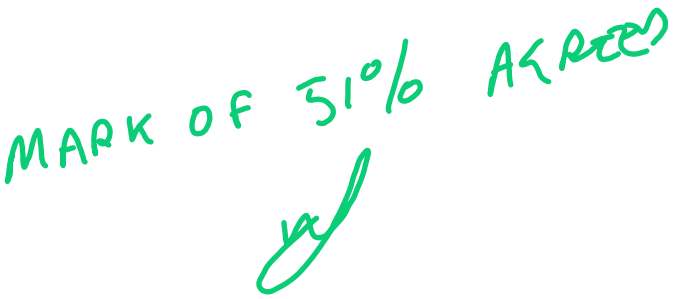
# 2119237

*by* Joshua Thomas




**Submission date:** 23-May-2023 09:01PM (UTC+0100)
**Submission ID:** 207377215
**File name:** 17375_Joshua_Thomas_2119237_181809_1893887070.pdf (9.61M)
**Word count:** 2579
**Character count:** 18539

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|---|---|
| **Course:** | HNC Electrical and Electronic Engineering |
| **Module:** | SGEE4006 HNC Electrical and Electronic Engineering Project |
| **Assignment**: | Final Report |
| **Name:** | Joshua Thomas |
| **University number:** | 2119237 |
| **Date submitted:** | 23/05/23 |
| **Word count:** | 2360 |

# Contents



*Table of contenets could be more detailed*

*Comprehensive list of figures*

## 1. Introduction and background research

The Project at hand will be situated within the Coleg Sir Gar Graig campus in room G23. The project is part of a three-piece process station and the section being worked on is the final station which uses a swing arm with a suction cup that picks up the mechanical part from the centre station. The mechanical part is then deposited in front of the main cylinder which will extend the mechanical part to the hydraulic press. The hydraulic press will then process the machinal part and will return it to the position in front of the main cylinder. A secondary cylinder then will extend to push the mechanical part to the output ramp.

The problem to solve is to upgrade the hydraulic/pneumatic robot system in G23 from the old Mitsubushi PLC to the new Siemens S7 1200 PLC. The current system requires for the communication to be hardwired; this will get updated to be connected using PROFINET communication using IP addresses. Also, currently there is no HMI indication or feedback that exists, and this will be improved using the Siemens HMI touchscreen. The system has no manual control at the moment and the new system will have a selectable manual and auto function.

*Good introduction that identifies requirements*
*There are no ref sources to support the research element of this section*

## 2. Specification

*Good use of table*

| | |
|---|---|
| Where is the project based? | This project will take place at Coleg Sir Gar Graig campus in room G23 |
| How will the project be monitored | The project will be monitored by using a Gannt Chart which shows when tasks should be completed by to allow to keep everything on track. |
| Time Limit? | The project began at the beginning of the college year and the deadline is 25/4/23 |
| Project budget | The budget was set at £1500 |
| User needs | The user needs for this project is to create a fully functioning sequence for the PLC Controlled Hydraulic Station. |
| Expected operation | The system should operate in both a manual and automatic mode. |
| Maintenance and Reliability Requirements | For maintenance purposes, a manual mode is created. Pilot lights are also shown on the HMI screen so when carrying out maintenance work it is easy to see at a glance if everything is working. Also, before it gets put to use, many tests will be carried out to ensure it is safe and ready. |
| Health and safety requirements | As the project is carried out in the College, the health and safety protocols and procedures they have in place will be followed |
| What are the risks and how are they reduced? | At the beginning, a risk assessment is carried out on the system to identify all possible hazards. There are interlocks in place and the system is guarded off. |
| Environmental protection | This project will not require the use of any harmful chemicals or materials, so it is quite environmentally friendly. |
| Sustainability issues | When carrying out this project any components needed will be reused where it is possible to do so. Also, as the PLC just needs to be changed to allow the system to communicate via PROFINET, all the old wiring for the I/O will be taken out the old PLC and put into the new one. |

*The spec should include more functional requirements*

*Budget should be included*

## 3. Planning

As there were many aspects to the overall Project, a Gannt Chart was put in place to be able to keep track of all the tasks and to ensure that everything was done in time so there was no falling behind.

The tasks range from the research at the beginning to the report which is at the very end. Each task has a planned outcome of how long it should take to complete the task, it also has an actual column to show if everything was on track or not and should be filled out when the tasks have been completed. The columns are also divided into weeks as work on the project is monitored on a weekly basis.

*Good overview of the Gantt chart and its purpose*

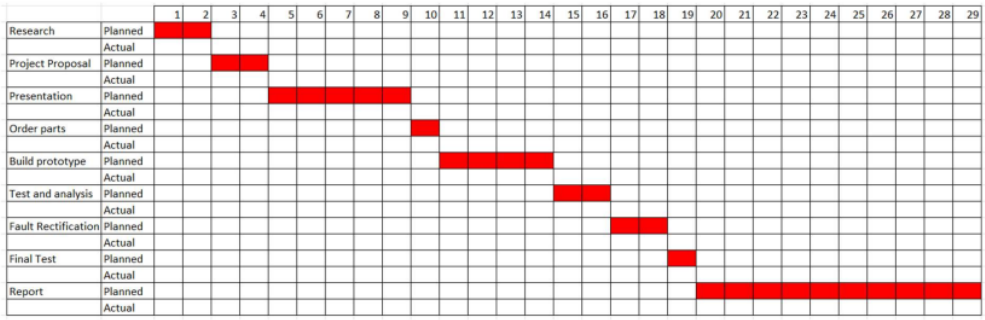



*Figure 1*

*The chart has a comparison timeline, hwever, the actual timeline has no plots*

The red on the Gannt Chart indicates the number of weeks it should take to carry out the set tasks. The last week is the deadline in which the final report and logbooks should be handed in.

*The actual timeline should be present so that an evaluation can be carried out!*

## 4. Solutions considered

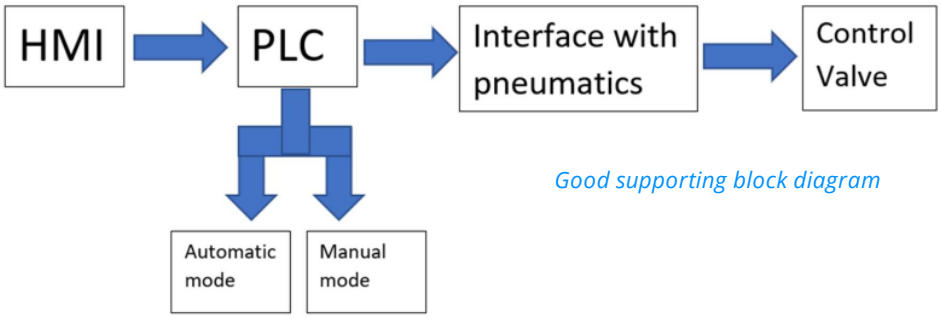
Mitsubishi Melsec PLC

*There are significant points highlighted here, however, there should be at least one ref source and a supporting image.*

The first solution to be considered is the current PLC in place, the Mitsubishi Melsec. Whereas this PLC may do the job, it is very outdated. It uses PROFIBUS, which means hardwiring is needed for communication. Also, there is no HMI available for the Mitsubishi Melsec, therefore no visual feed is available to show quick and easy information.

Siemens S7 1200 PLC

The second solution to be considered is the Siemens S7 1200 PLC. By updating to this PLC, it would bring the system up to date by being able to use PROFINET. This allows for wireless communication which makes connecting to the PLCs and working on them much easier. Also, with the Siemens PLC, HMIs are available that can be customized using TIA Portal which can show a range of information that is required.




*Good supporting block diagram*

*Figure 2*

TIA Portal is the program software used to be able to control the PLCs. It is extremely user friendly and has many useful uses. The program languages in TIA Portal are Ladder, SCL, STL and FBD. These all play a massive role in writing the program needed. Especially SCL as it is very good for creating automatic sequencing.

As most of the PLCs within the college are already Siemens, and TIA Portal is widely used, it would make changing the current system to Siemens very easy as the resources are already within the college.

The only downside to Siemens PLCs is that they can be quite expensive especially if the HMI and other miscellaneous accessories are needed.

*This should include at least one ref source*

Comparisons of solutions

After looking at the solutions, the Siemens S7 1200 PLC will be the best fit for the system. It is far more up to date than the Mitsubishi Melsec as it offers PROFINET rather than PROFIBUS. Also, TIA Portal is a huge factor too, it makes developing the program much easier. It has many great features such as simulation, and everything is easy to use. TIA Portal has also been used previously so background knowledge was used to further speed up the design process and therefore able to achieve the deadline quicker.

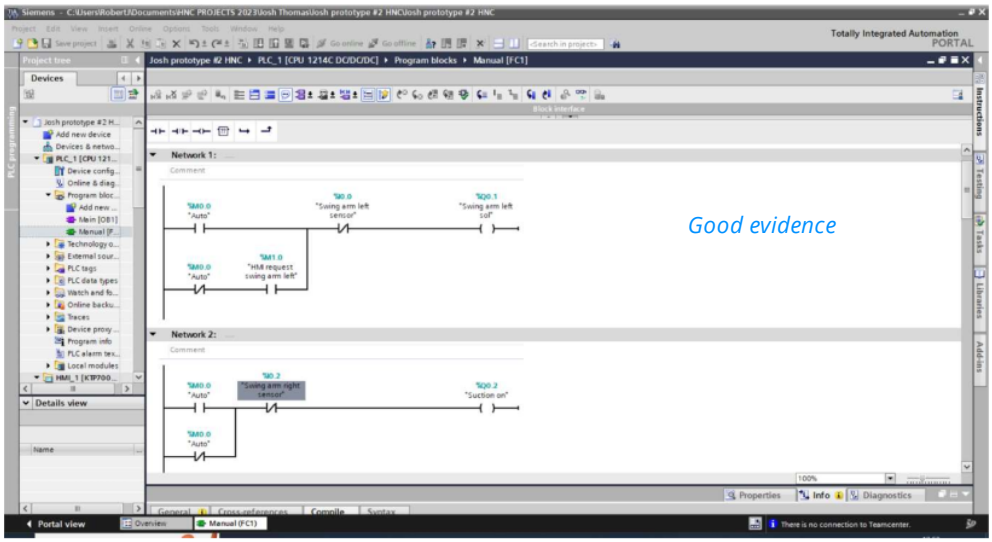
*There is an argument here, the main being that Siemens uses Profinet. This would be more effective and better presented in a table with pros and cons for the evaluation.*

## 5. Final solution design and implementation

The final solution which was chosen was the Siemens S7 1200 PLC. Along with the PLC an HMI was also needed. The necessary parts needed were ordered as soon as possible to ensure that the parts would arrive on time and all testing could be carried out.

Prototype #1

*Good use of prototype method to devlope the system*




*Good evidence*

*Figure 3*

The screenshot above is a snippet of the Ladder Program. The rest of the Ladder program can be seen in the appendix. This specific part of the code relates to the swing arm moving left and turning the suction on to allow the swing arm to pick up the object from the central station. By using Normally Open and Normally Closed contacts, this allows for only one of the modes, manual or automatic, to be used at a time. Prototype #1 was mainly used to make a start with the Ladder programming by initially creating a semi-functioning manual mode. An HMI screen was also created with pilot lights to show when the sensors were activated.

*Good explanation*

Prototype #2

*develope*

This prototype was used to further developing the Ladder program to ensure that it could be fully functional in the manual mode test and to make a start at prepping for the automatic mode. When each button was pressed on the HMI, the system moved accordingly and switched on the relevant pilot lights when the sensor was triggered. A new HMI screen was created for the auto control, and a Start and Stop button was added to it, a step counter was also put in the screen to display which point the sequence is at. A few contacts were also added into the Ladder program to help with the auto mode, however the SCL code hadn't been started, they were just in place ready. A picture of the developed Ladder program can be seen below.

*The HMI should be included here, since it is covered in the explanation*

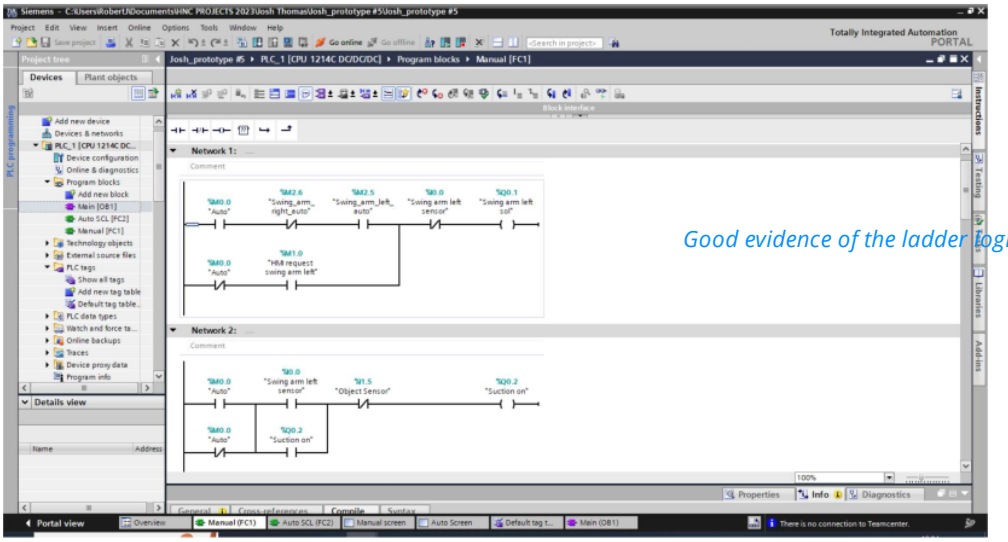



*Figure 4*

## Prototype #3

The third protype worked mainly on making a start at the SCL code and adding pilot lights to the HMI to display the sensors coming on. A snippet of the SCL code can be seen in the image below. It shows what the initial conditions need to be before the automatic sequence can comense. Step 0 to 3 was also coded in this prototype and each step was tested along the way to ensure it works. Not much else changed within the rest of the program, the main concern was starting the SCL coding.

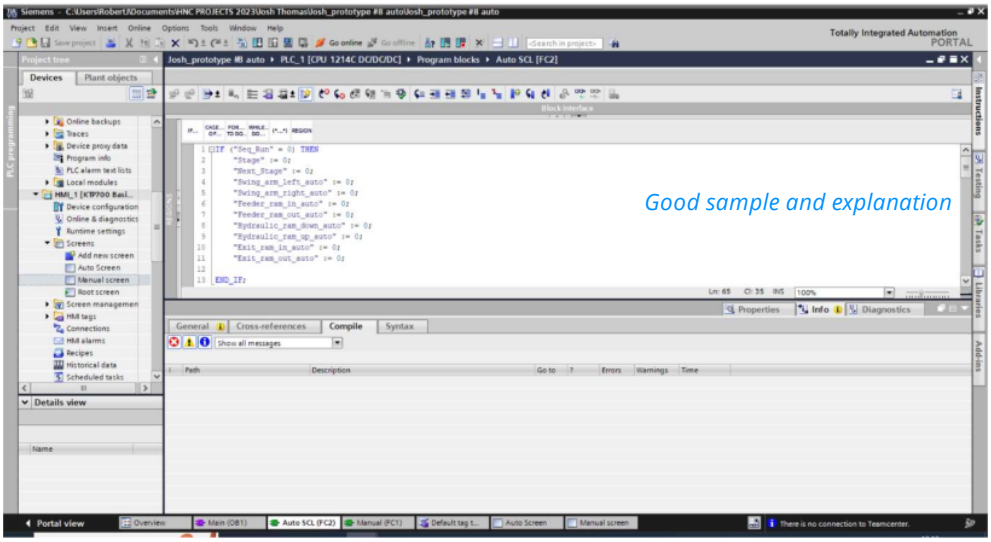
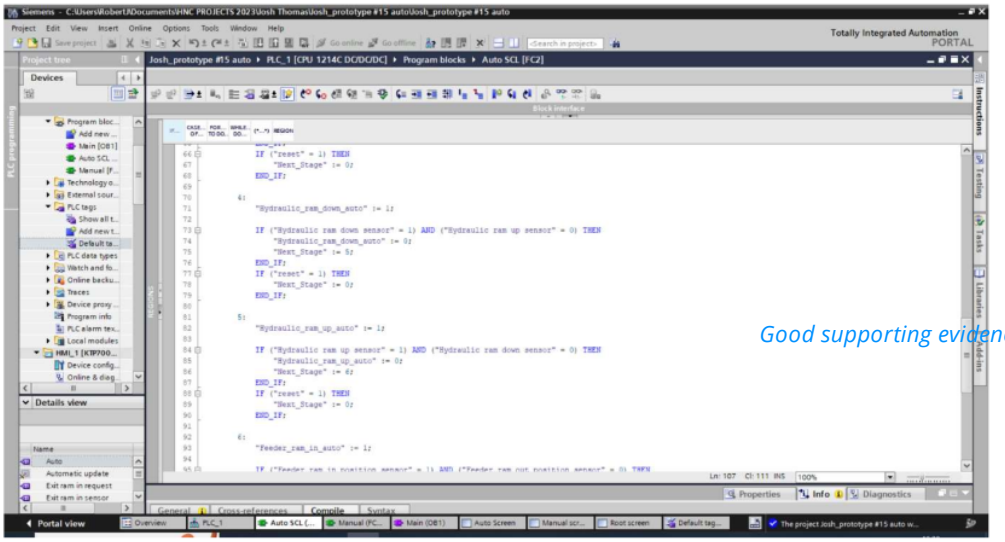



*Figure 5*

Prototype #4

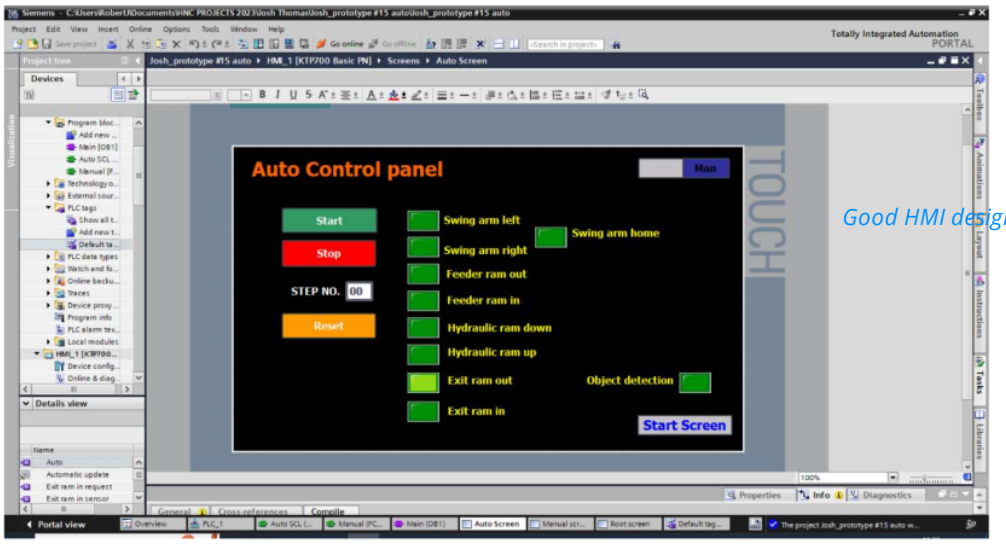
The fourth and final prototype was in place to finalise everything. The SCL code had been completed and fully tested, therefore it is in fully working order and the auto mode is finished. The auto SCL code has also been added to the main block and all finishing touches have been done to the HMIs. In total, there are 3 HMIs, the Root Screen, the Manual Mode Screen, and the Auto Mode Screen, all with the correct tags, buttons, pilot lights and so on. The HMIs can be seen in the Appendix along with the full SCL code, Ladder Diagrams and PLC Tags.

*Explanation is too brief, there are many parts to the system that could be explained.*



*Good supporting evidence*

*Figure 6*




*Good HMI design*

*Figure 7*

*The manual function screen is included in the appendix*

## I/O Mapping

The I/O Mapping for the system can be seen in the tables below.

| | |
|---|---|
| Y0 | Q0.0 |
| Y1 | Q0.1 |
| Y2 | Q0.2 |
| Y3 | Q0.3 |
| Y4 | Q0.4 |
| Y5 | Q0.5 |
| Y6 | Q0.6 |
| Y7 | Q0.7 |
| Y10 | Q1.0 |
| Y11 | Q1.1 |

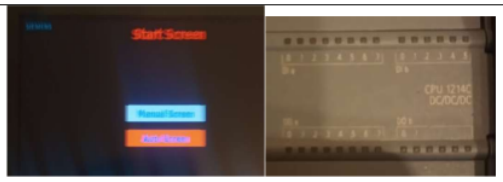
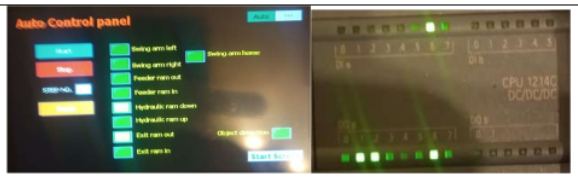
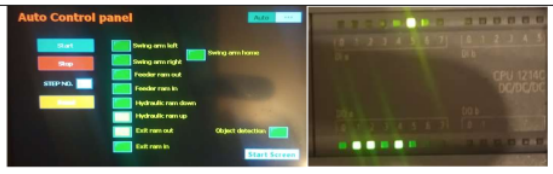
*Good use of table for output mapping to new system*

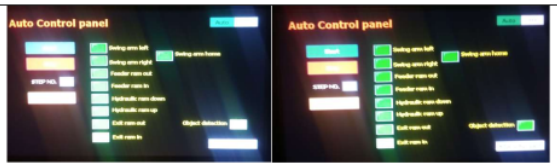
| | |
|---|---|
| X0 | I0.0 |
| X1 | I0.1 |
| X2 | I0.2 |
| X3 | I0.3 |
| X4 | I0.4 |
| X5 | I0.5 |
| X6 | I0.6 |
| X7 | I0.7 |
| X10 | I1.0 |
| X11 | I1.1 |
| X12 | I1.2 |
| X15 | I1.3 |
| X16 | I1.4 |
| X17 | 1.5 |

*Good use of table for input mapping to new system*

## 6. Testing and results

Test and analysis of hydraulic press system
Table of results for auto test mode

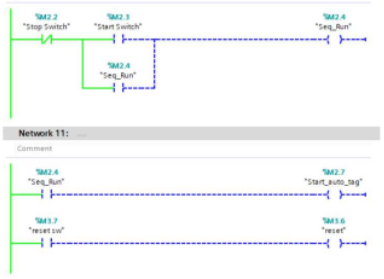
| Test No | Stage | Expected results | Actual results | Pass / Fail |
|---|---|---|---|---|
| 1 | 0 | Initial conditions<br>All outputs off<br>Root screen |  | P |
| 2 | 1 | Swing arm left<br>%Q0.1 %I0.0 |  | P |
| 3 | 2 | Swing arm right<br>%Q0.2 %I0.2 |  | P |
| 4 | 3 | Feeder ram out<br>%Q0.3 %I0.4 |  | P |
| 5 | 4 | Hydraulic ram down<br>%Q0.5 %I0.6 |  | P |
| 6 | 5 | Hydraulic ram up<br>%Q0.6 %I0.5 |  | P |

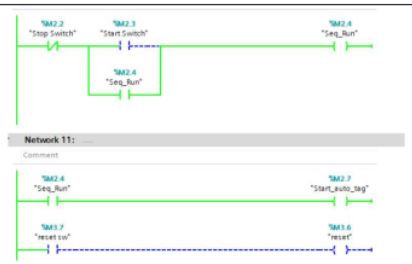
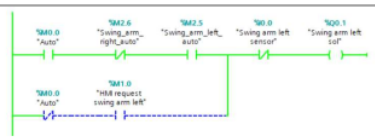
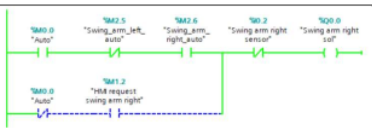
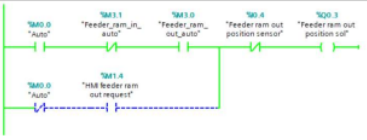
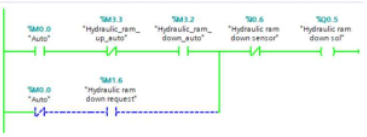
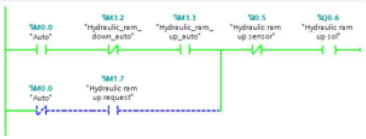
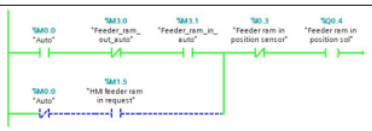
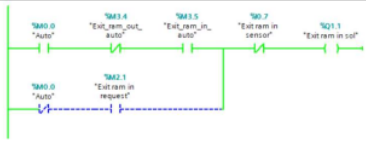
| | | | | |
|---|---|---|---|---|
| 7 | 6 | Feeder ram in<br>%Q0.4 %I0.3 |  | P |
| 8 | 7 | Exit ram out<br>%Q0.7 %I0.7 |  | P |
| 9 | 8 | Object detection<br>%I1.5 |  | P |

*Very good detailed test evidence*

Results were taken in a simulated mode using switches to simulate the sensors. This proved the operation of the system and enabled the test images to be taken by controlling the speed of each step in the auto mode process.

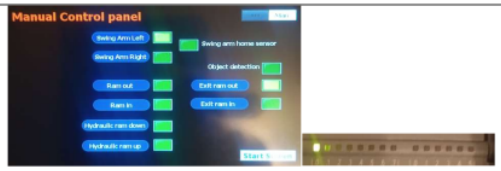
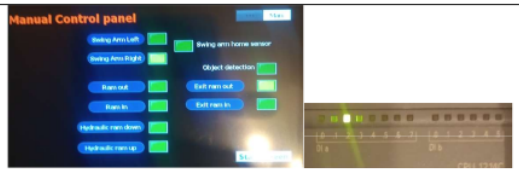
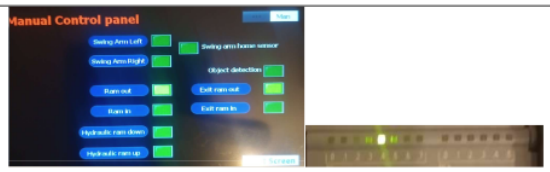
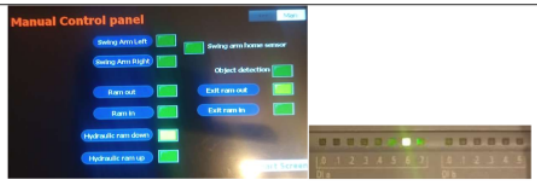
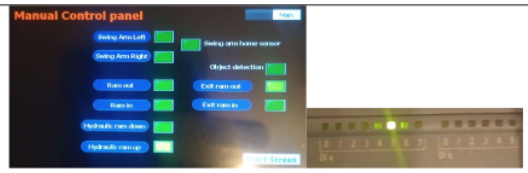
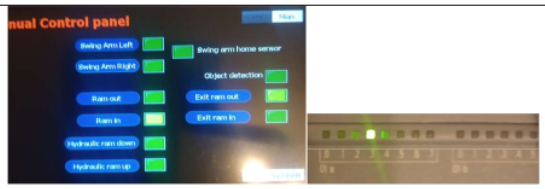
**Auto functional test online with PLC**

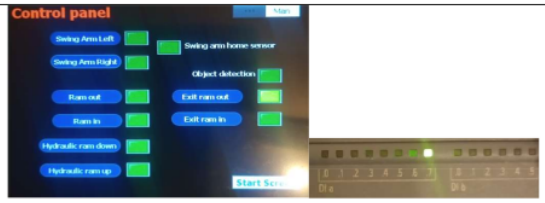
| Test No | State | Actual logic state | Pass / Fail |
|---|---|---|---|
| 1 | 1<br>All stop |  | P |

| | | | |
|---|---|---|---|
| 2 | 1<br>Start sequence |  | P |
| 3 | 1<br>Swing arm left |  | P |
| 4 | 2<br>Swing arm right |  | P |
| 5 | 3<br>Feeder ram out |  | P |
| 6 | 4<br>Hydraulic ram down |  | P |
| 7 | 5<br>Hydraulic ram up |  | P |
| 8 | 6<br>Feeder ram in |  | P |
| 9 | 7<br>Exit ram out |  | P |

*Good functional test evidence form PLC*

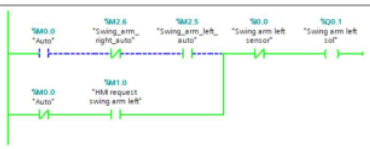
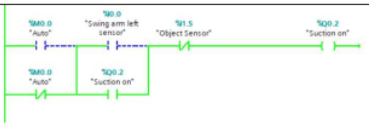
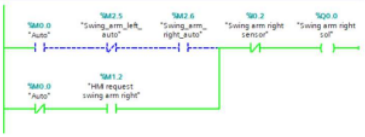
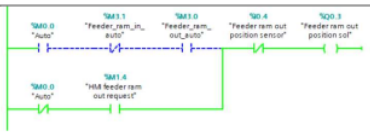
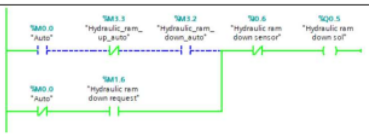
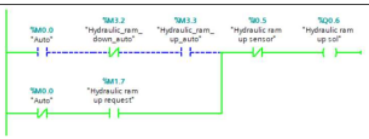
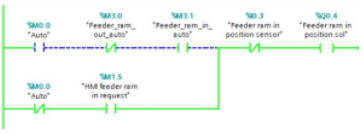
**Table of results for manual test mode**

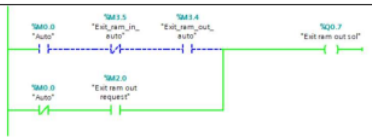
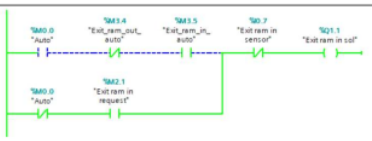
| Test No | Expected results | Actual results | Pass / Fail |
|---|---|---|---|
| 1 | Initial conditions |  | P |
| 2 | Swing arm left<br>%Q0.1 %I0.0 |  | P |
| 3 | Swing arm right<br>%Q0.0 %I0.2 |  | P |
| 4 | Feeder ram out<br>%Q0.3 %I0.4 |  | P |
| 5 | Hydraulic ram down<br>%Q0.5 %I0.6 |  | P |
| 6 | Hydraulic ram up<br>%Q0.6 %I0.5 |  | P |
| 7 | Feeder ram in<br>%Q0.4 %I0.3 |  | P |

| | | | |
|---|---|---|---|
| 8 | Exit ram out<br>%Q0.7 %I0.7 |  | P |

*Very good detailed test results*

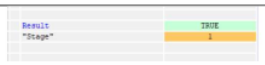
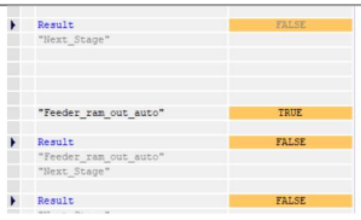
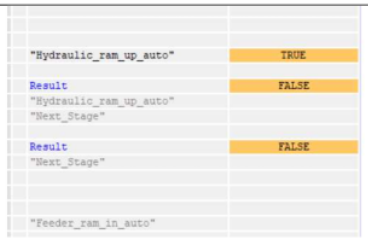
**Manual functional test online with PLC**

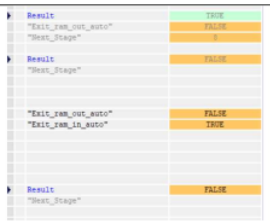
| Test No | State | Actual logic state | Pass / Fail |
|---|---|---|---|
| 1 | Swing arm left |  | P |
| 2 | Suction on |  | P |
| 3 | Swing arm right |  | P |
| 4 | Feeder ram out |  | P |
| 5 | Hydraulic ram down |  | P |
| 6 | Hydraulic ram up |  | P |
| 7 | Feeder ram in |  | P |

| | | | |
|---|---|---|---|
| 8 | Exit ram out |  | P |
| 9 | Exit ram in |  | P |

*Good functional test results from PLC*

**Auto test logic sequence**

| Test No | Stage | Actual logic states | Pass / Fail |
|---|---|---|---|
| 1 | 1 |  | P |
| 2 | 2 |  | P |
| 3 | 3 |  | P |
| 4 | 4 |  | P |
| 5 | 5 |  | P |

| | | | |
|---|---|---|---|
| 6 | 6 |  | P |
| 7 | 7 and 8 |  *Good evidence of live auto test* | P |

## 7. Discussion, Conclusions and Recommendations

To conclude all of the project outcomes in place have been met and the project overall has been successful. The projects purpose was to upgrade the hydraulic station so that it is up to date and meets all the correct standards and this was met by upgrading the old Mitsubishi Melsec to a Siemens S7 1200.

*beginning*

With ordering the components at the begging of the year it ensured that everything able to arrive on time. Also, many parts were reused from the colleges as they already had them so this helped to keep the budget lower.

Overall, this project was very successful at doing what it needed to do, and met all the requirements that were set.

A recommendation for this project would be to add a proximity sensor by the exit chute. This should be done so that when the exit ram pushes the object out, the sensor will detect the object going past and the exit ram can go back in, and the process will be able to start over again by itself. Currently the auto sequence is unable to restart on its own and has to be restarted manually.

*Good conclusion with a very relevant recommendation*

# 8. Appendix

Prototype #1

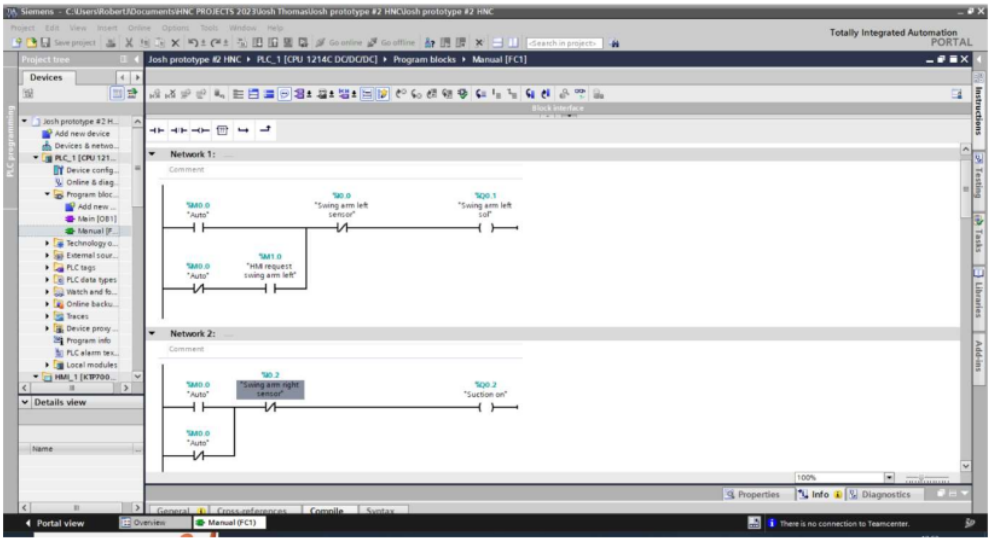



*Figure 9*

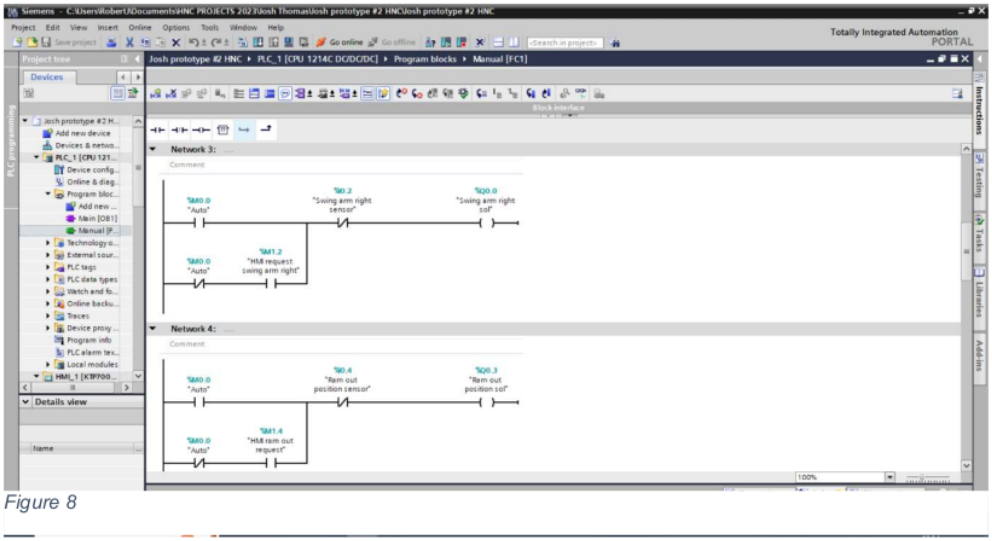



*Figure 8*

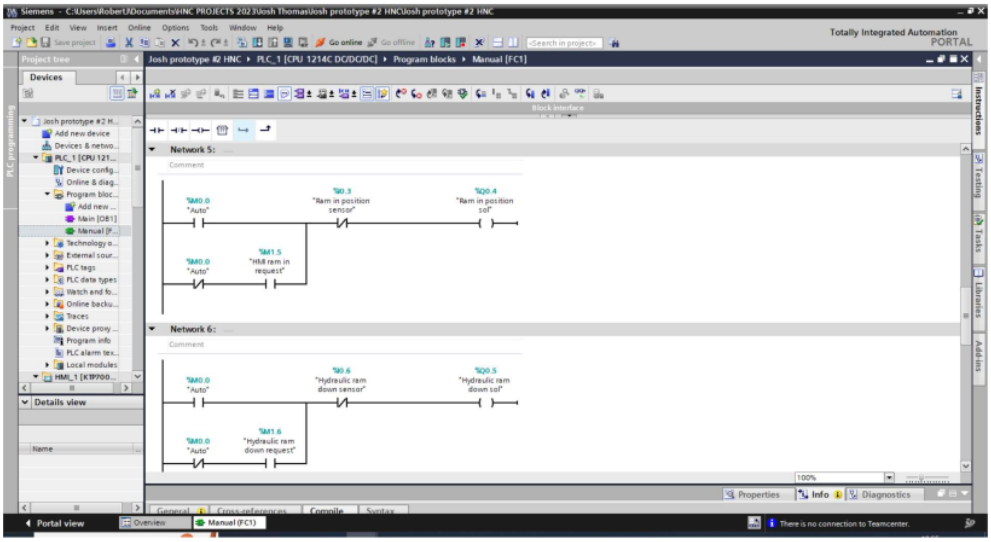



*Figure 10*

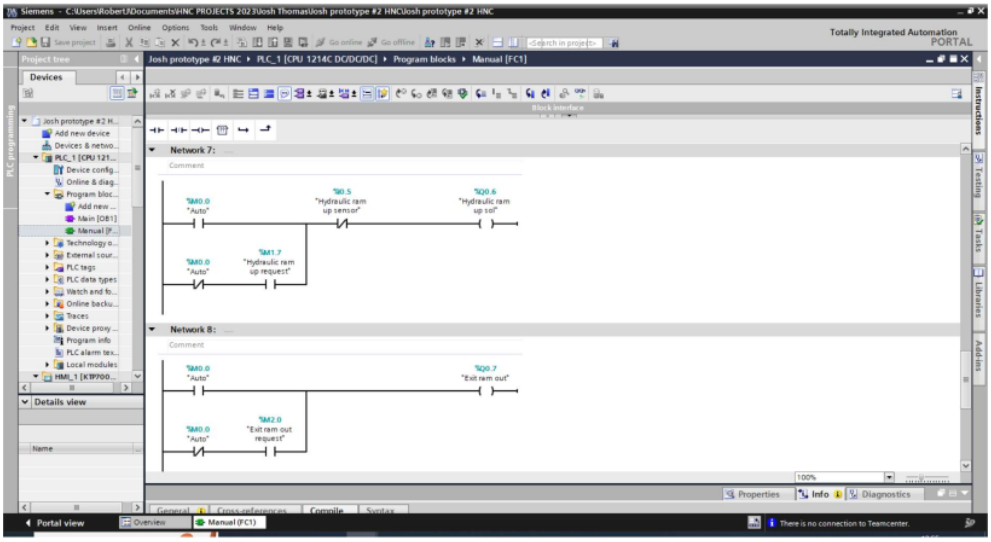



*Figure 11*

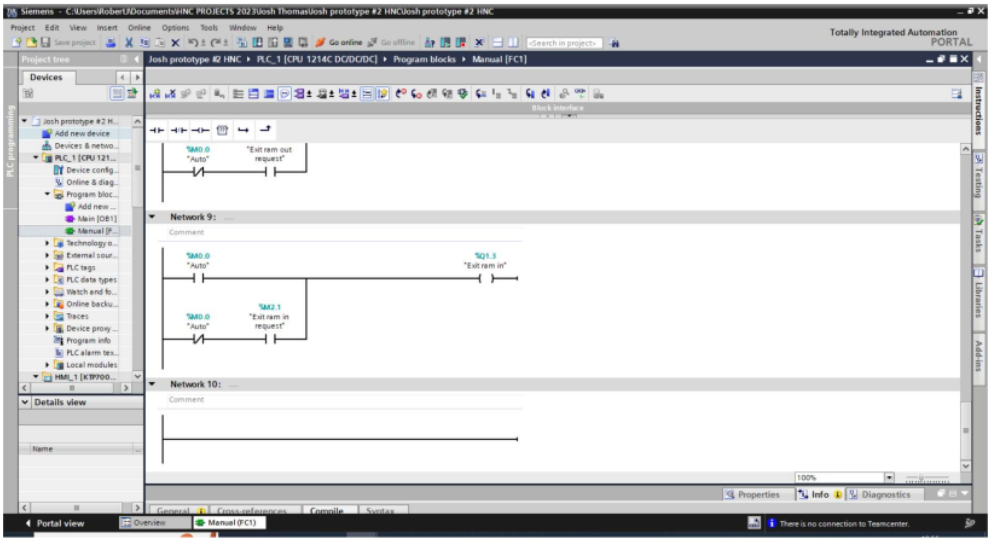



*Figure 12*

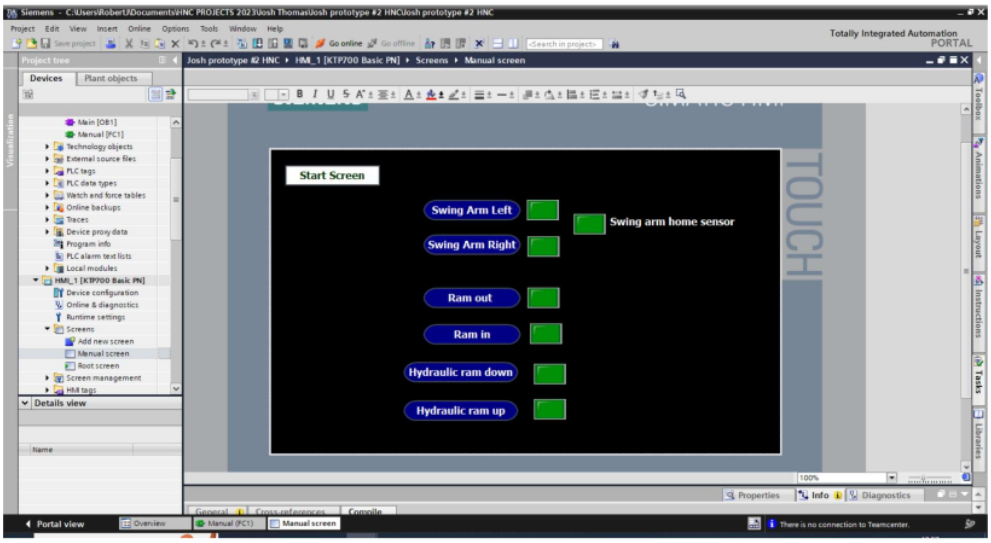



*Figure 13*

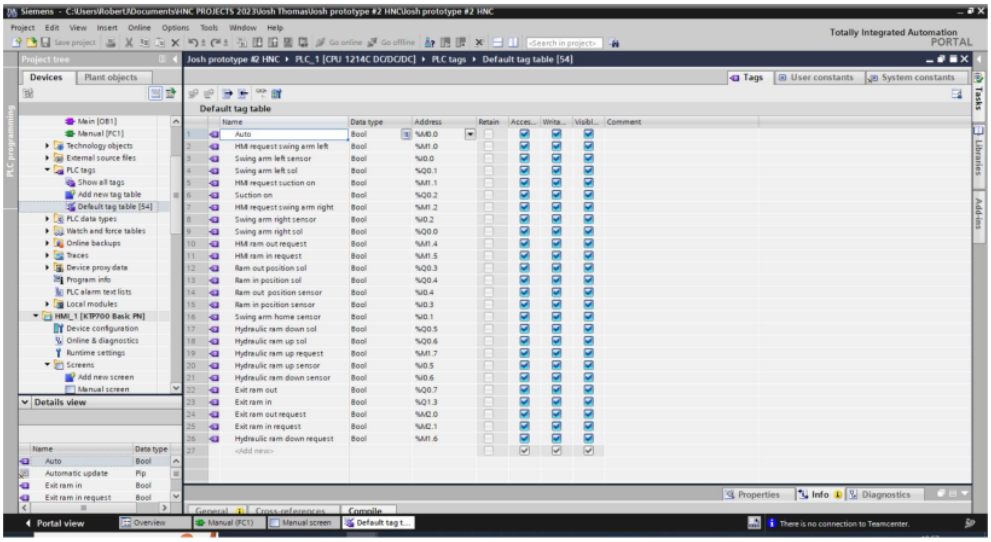


*Figure 14*

*Good evidence of prototype #1*

## Prototype #2

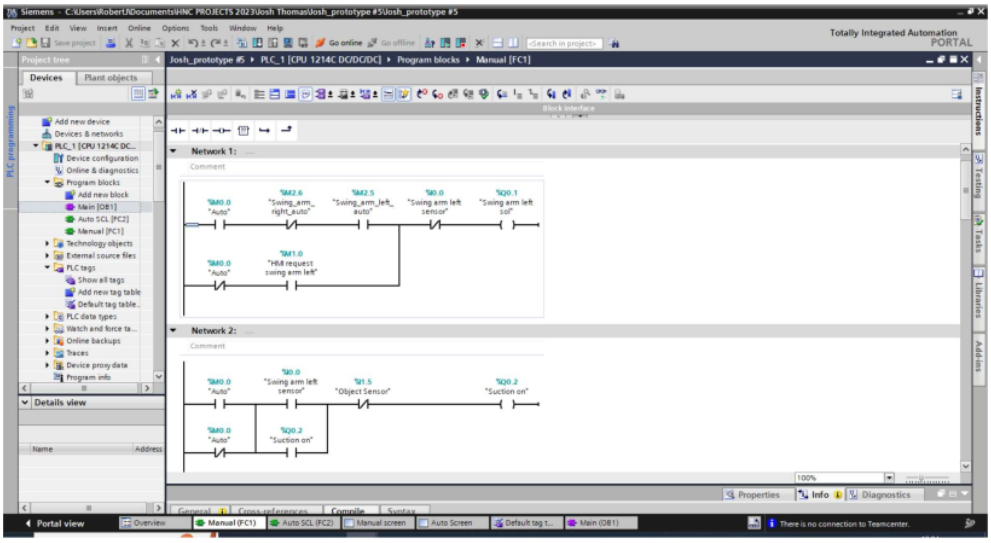


*Figure 15*

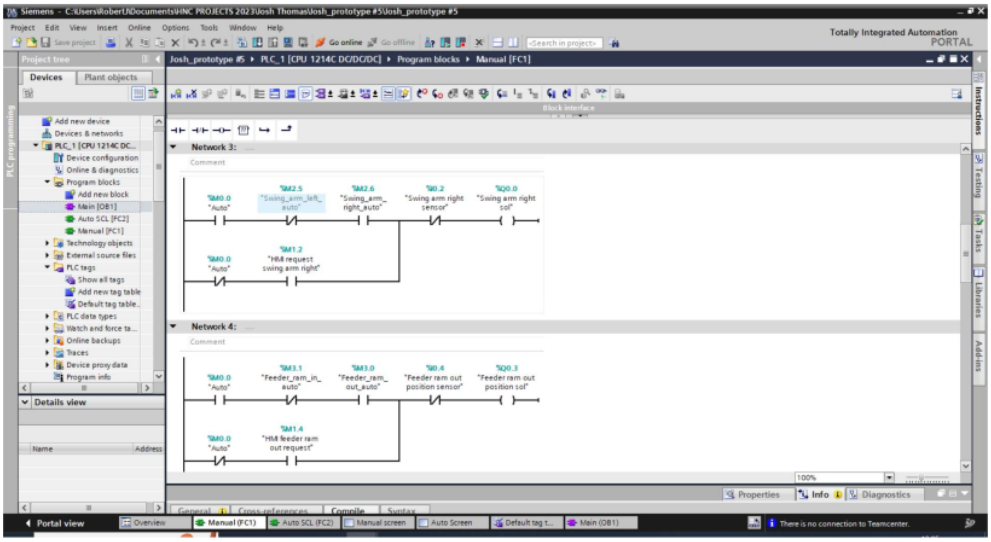

Siemens - C:\Users\Robert\Documents\VHC PROJECTS 2023\Josh Thomas\Josh_prototype #5\Josh_prototype #5
Totally Integrated Automation
PORTAL
Josh_prototype #5 ▸ PLC_1 [CPU 1214C DC/DC/DC] ▸ Program blocks ▸ Manual [FC1]
Project tree
Devices
Plant objects
Add new device
Devices & networks
PLC_1 [CPU 1214C DC...
Device configuration
Online & diagnostics
Program blocks
Add new block
Main [OB1]
Auto SCL [FC2]
Manual [FC1]
Technology objects
External source files
PLC tags
Show all tags
Add new tag table
Default tag table...
PLC data types
Watch and force ta...
Online backups
Traces
Device proxy data
Program info
Details view
Name
Address
Network 3:
Comment
%M0.0
"Auto"
%M2.5
"Swing_arm_left_auto"
%M2.6
"Swing_arm_right_auto"
%I0.2
"Swing arm right sensor"
%Q0.0
"Swing arm right sol"
%M1.2
"HMI request swing arm right"
Network 4:
Comment
%M3.1
"Feeder_ram_in_auto"
%M3.0
"Feeder_ram_out_auto"
%I0.4
"Feeder ram out position sensor"
%Q0.3
"Feeder ram out position sol"
%M1.4
"HMI feeder ram out request"
Properties
Info
Diagnostics
Portal view
Overview
Manual (FC1)
Auto SCL (FC2)
Manual screen
Auto Screen
Main (OB1)
There is no connection to Teamcenter.

*Figure 16*

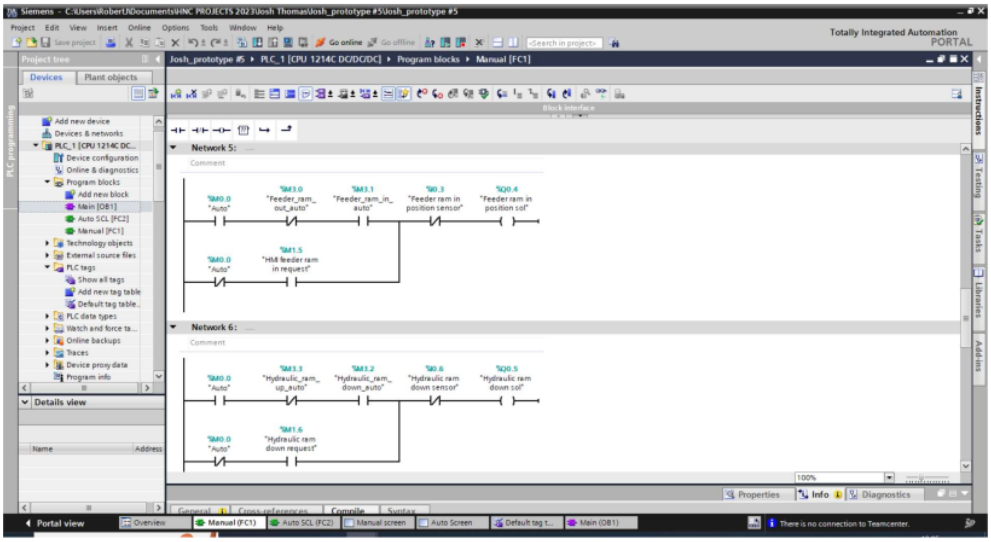



*Figure 17*

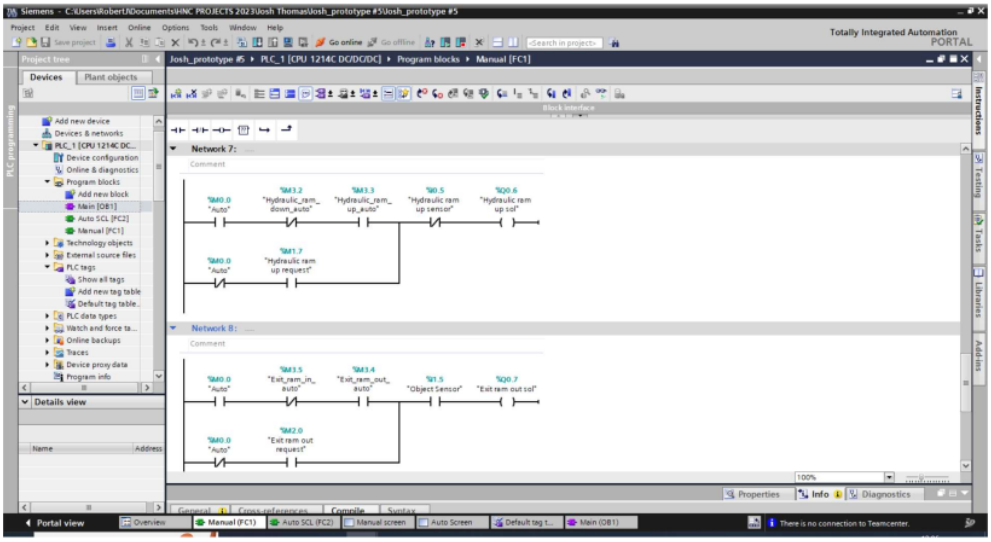



*Figure 18*

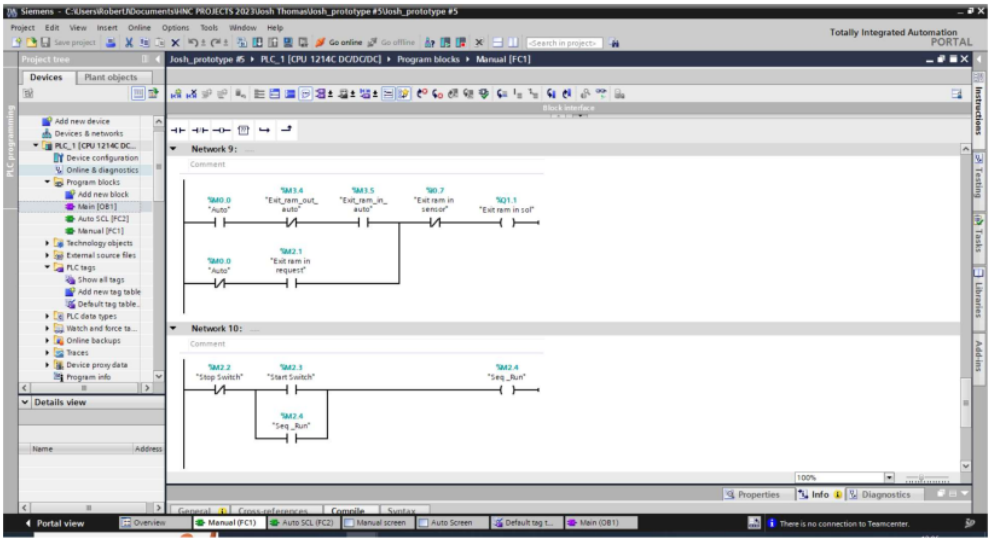



*Figure 19*

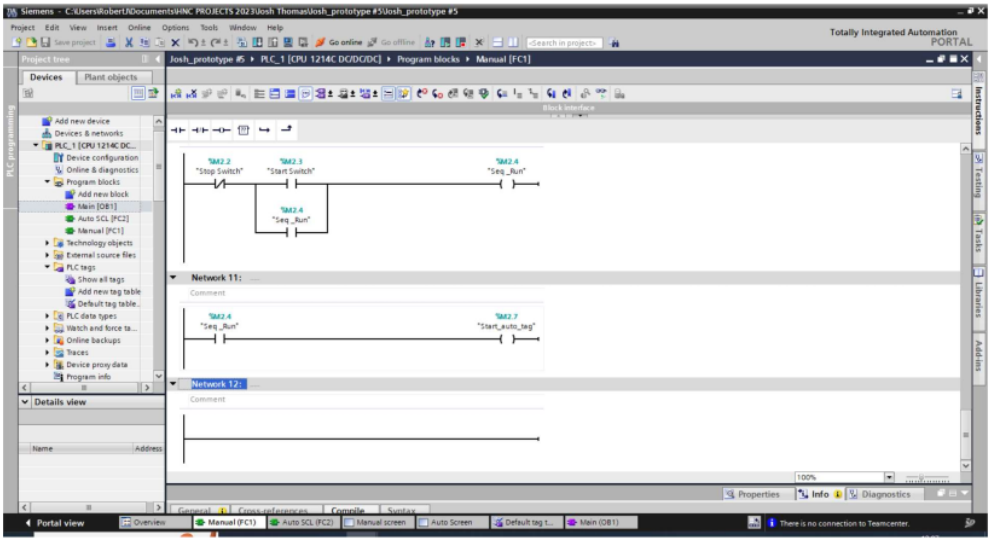



*Figure 20*

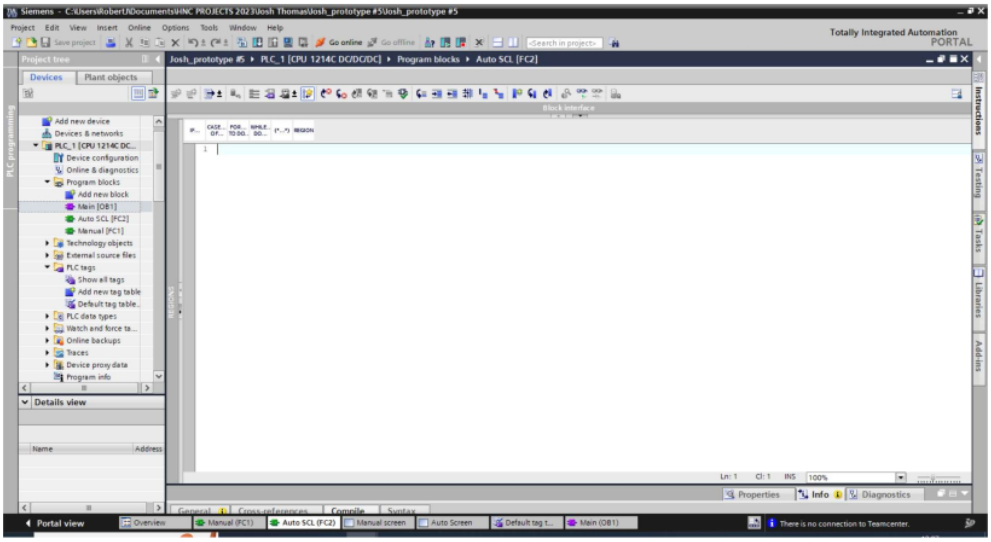


*Figure 21*

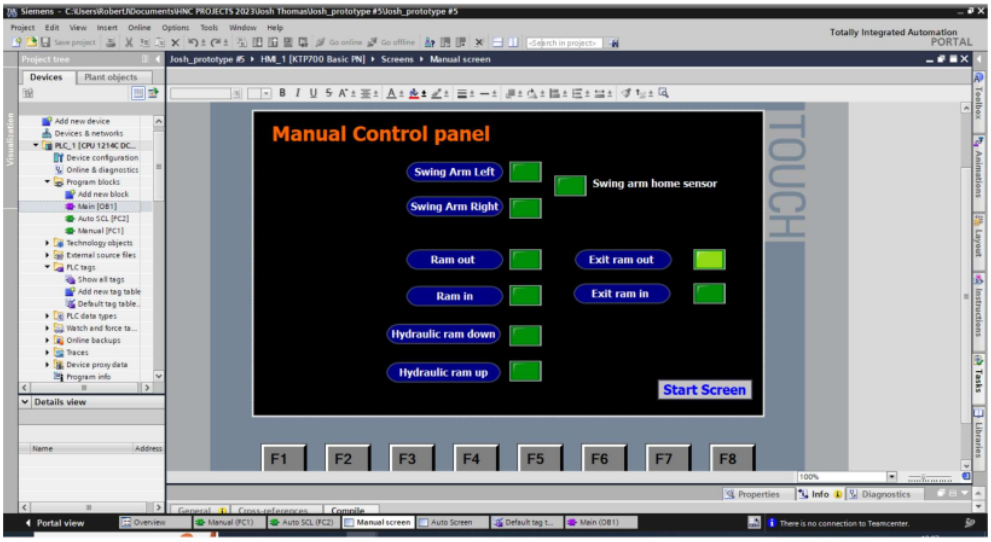



*Figure 22*

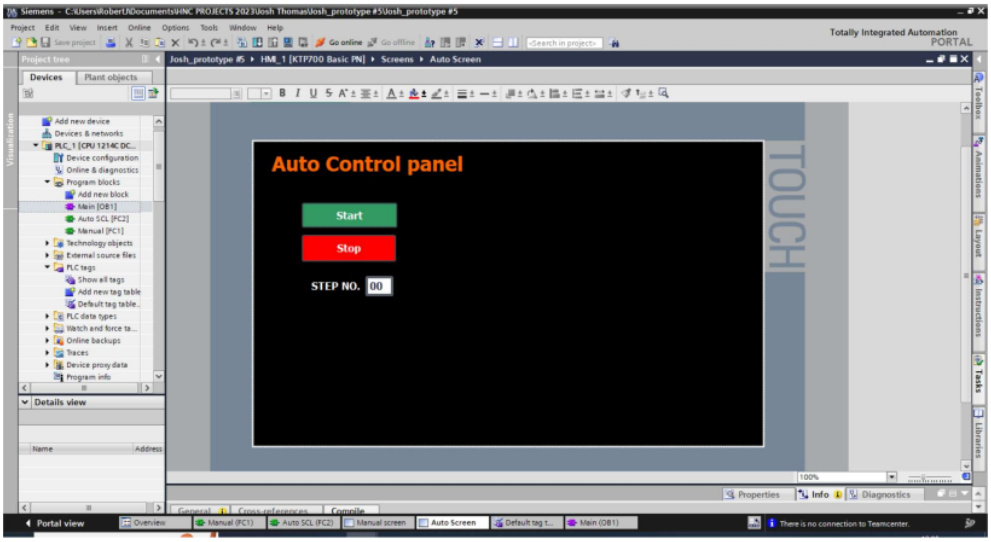



*Figure 23*

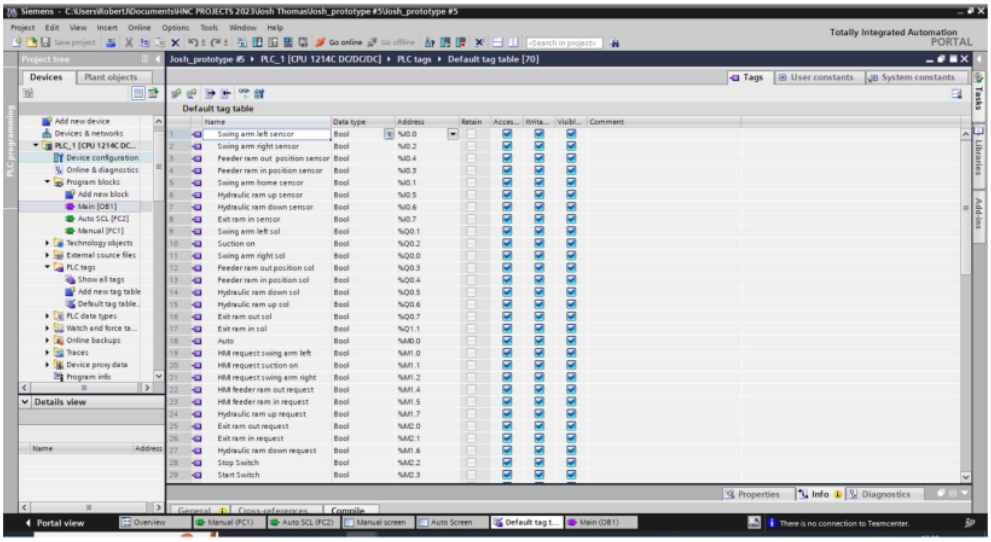


*Figure 24*

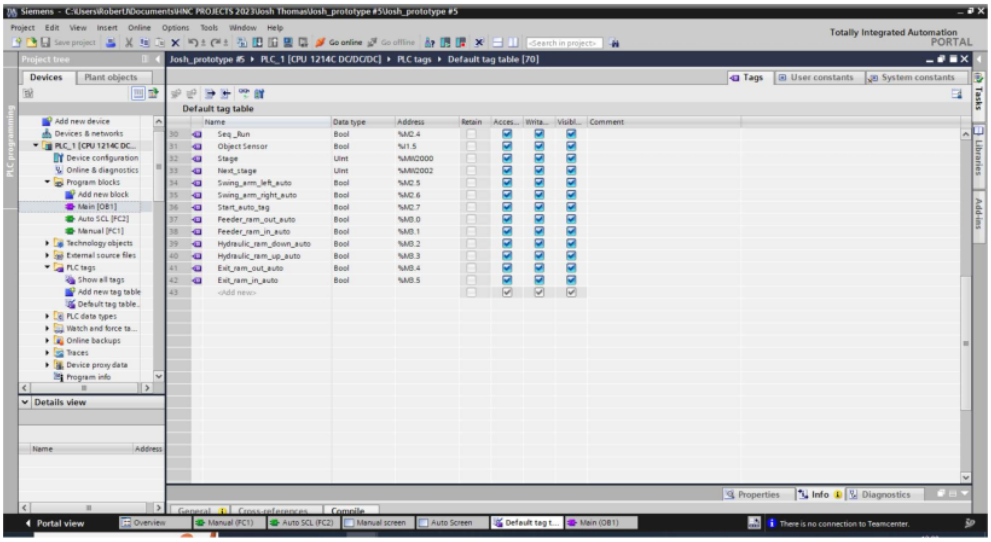



*Figure 25*

*Good evidence of prototype #2*

Prototype #3

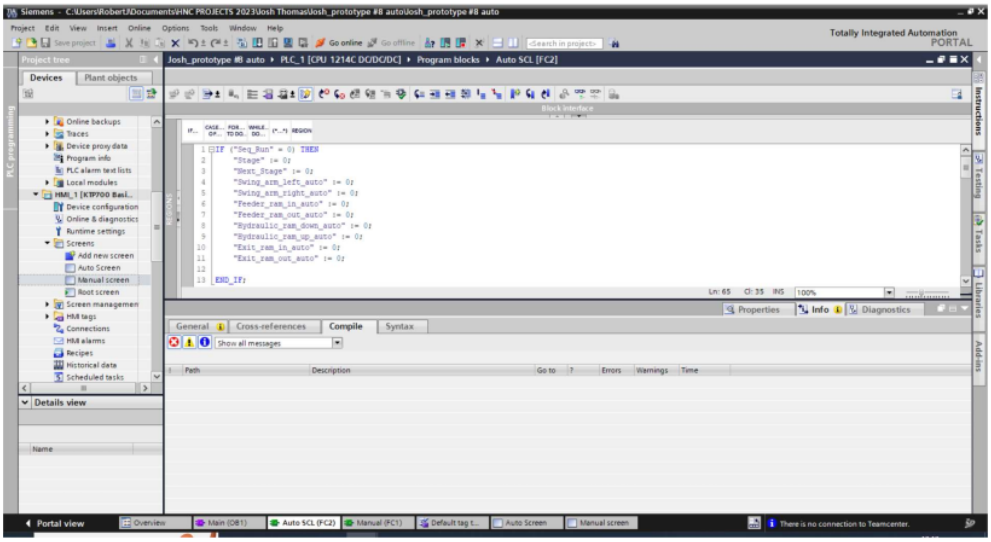



*Figure 26*

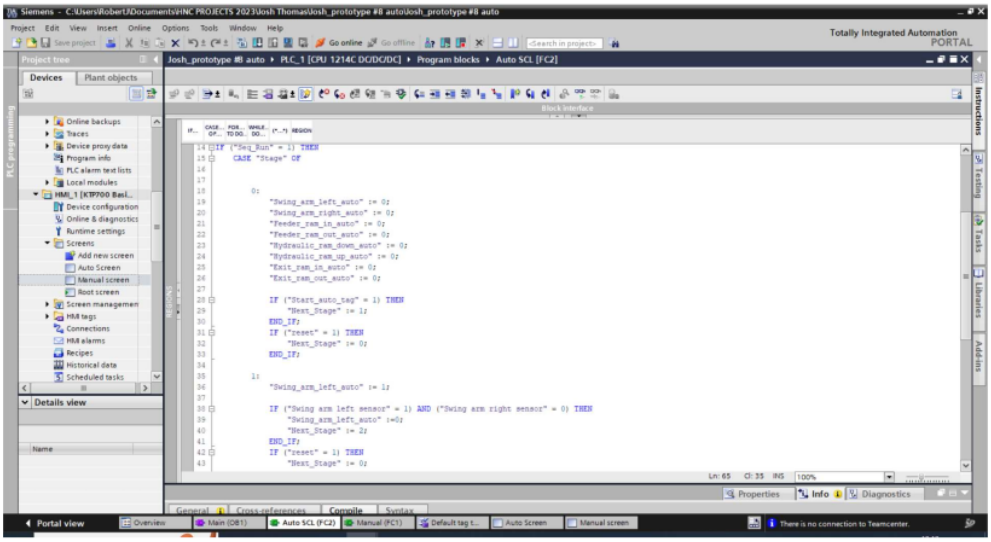



*Figure 27*

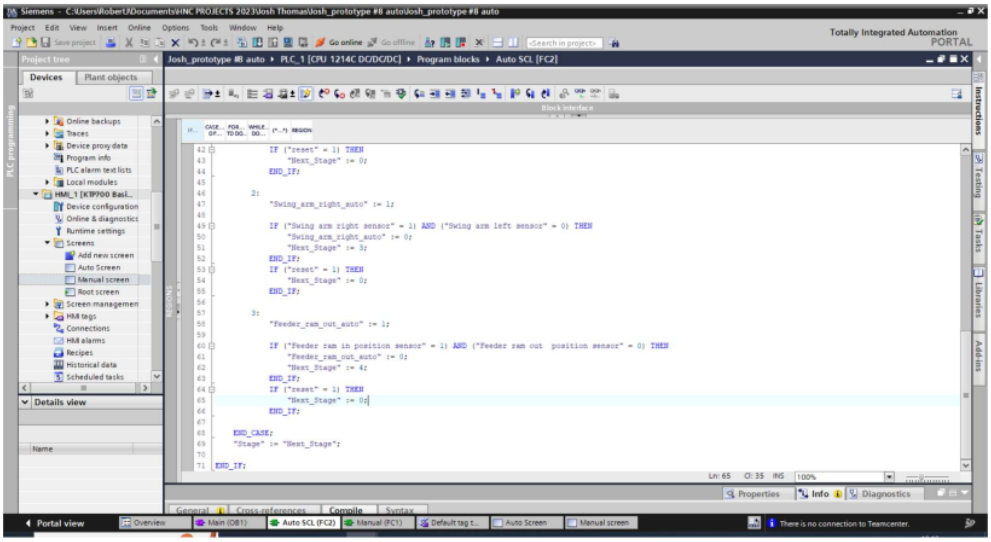



*Figure 28*

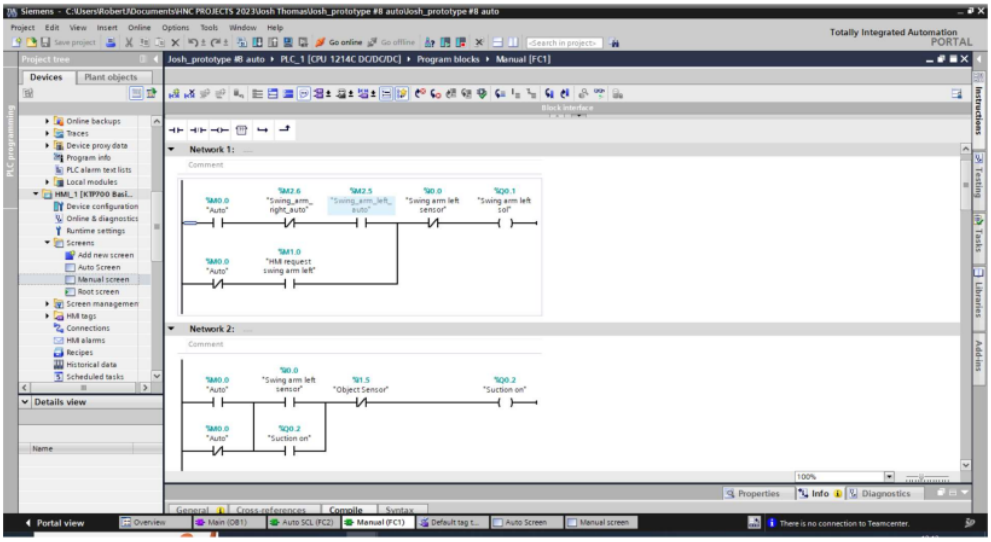



*Figure 29*

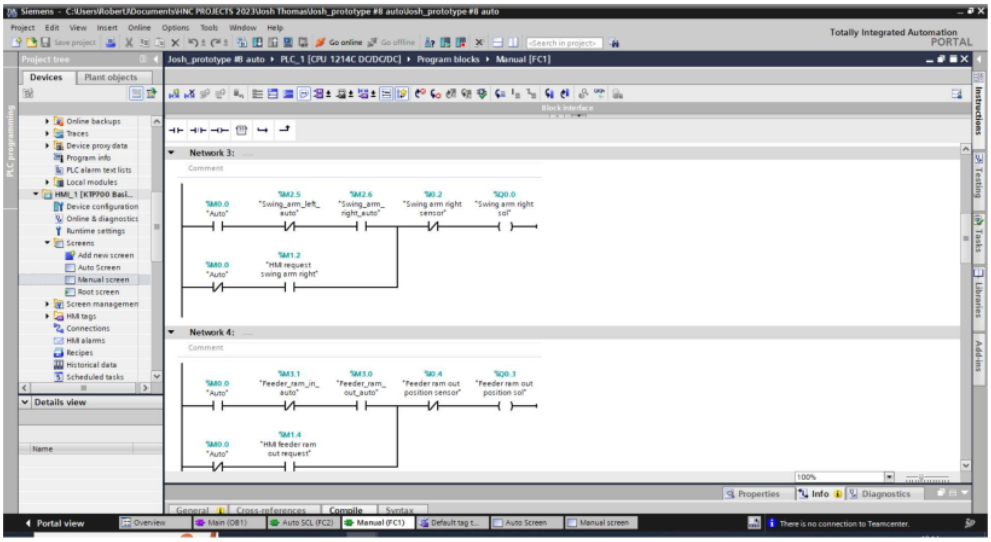



*Figure 30*

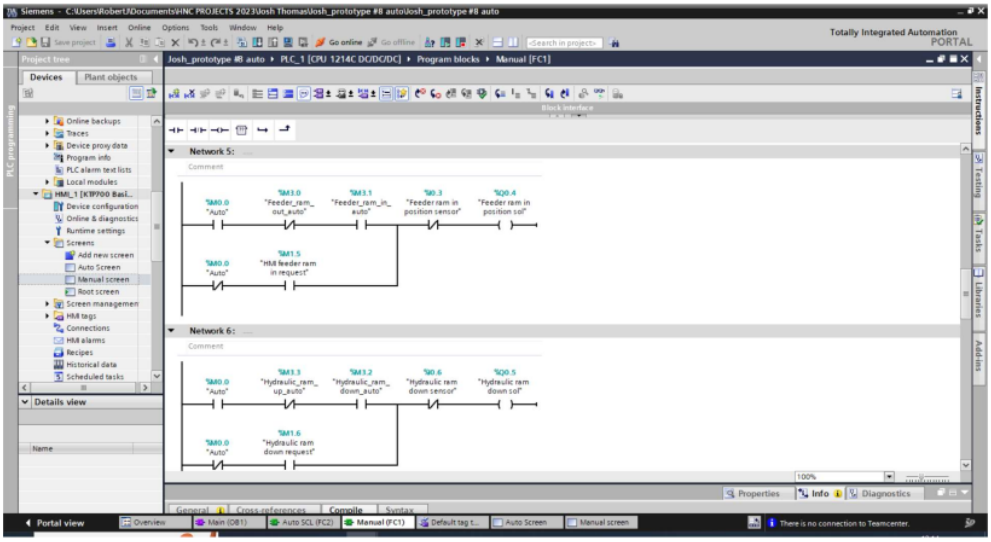



*Figure 31*

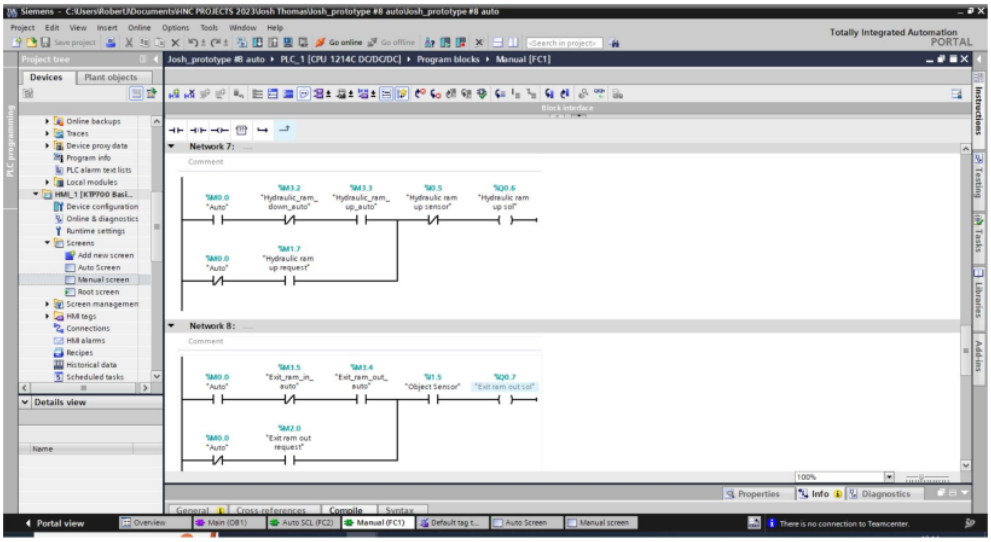



*Figure 32*

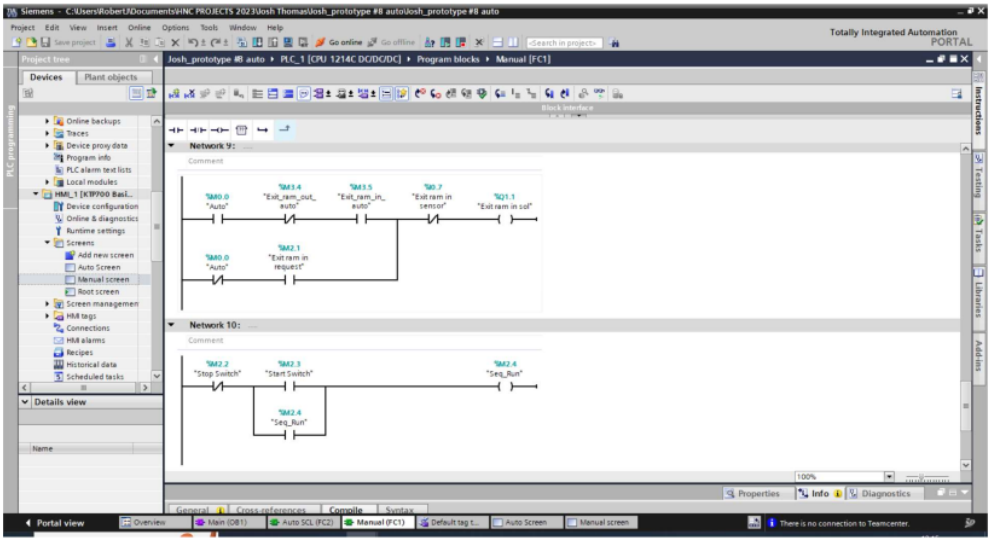



*Figure 33*

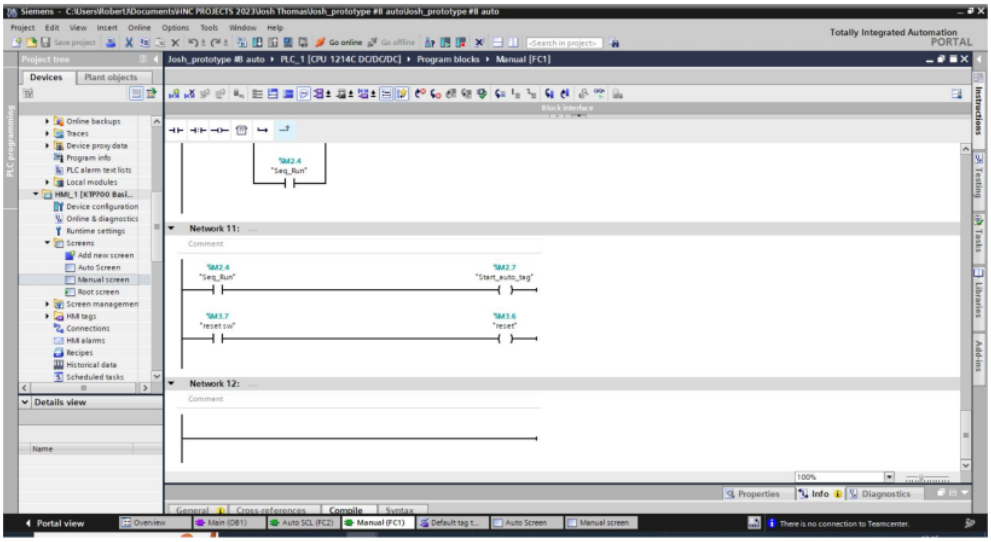



*Figure 34*

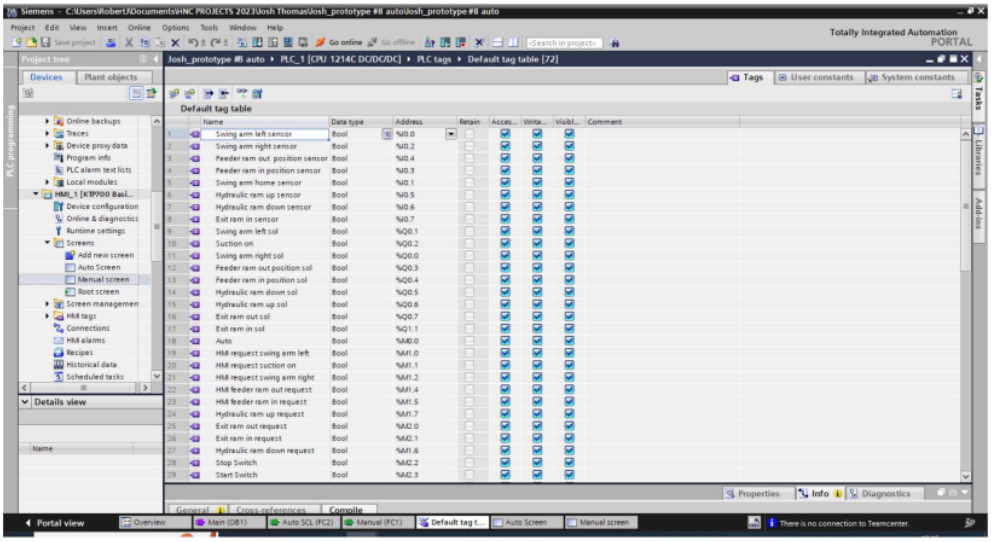



*Figure 35*

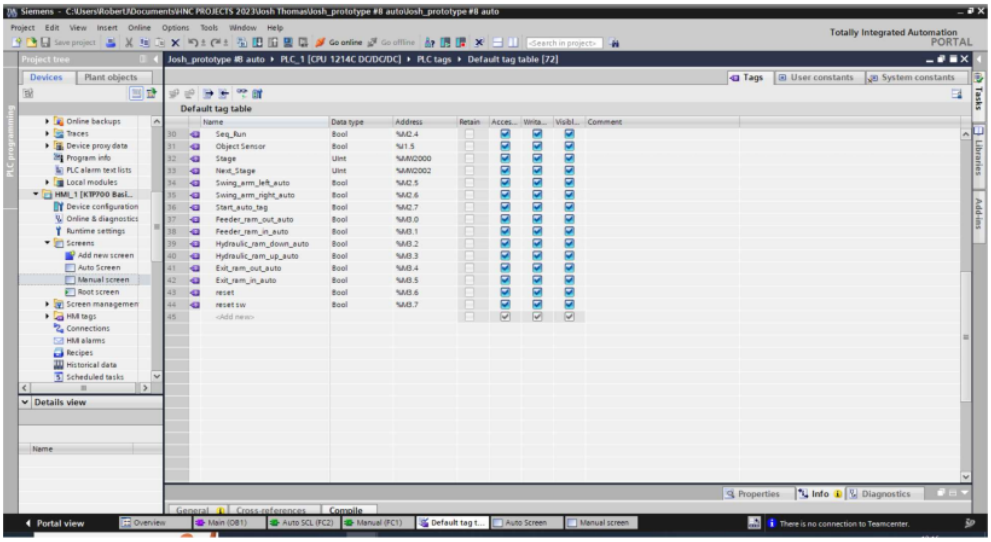



*Figure 36*

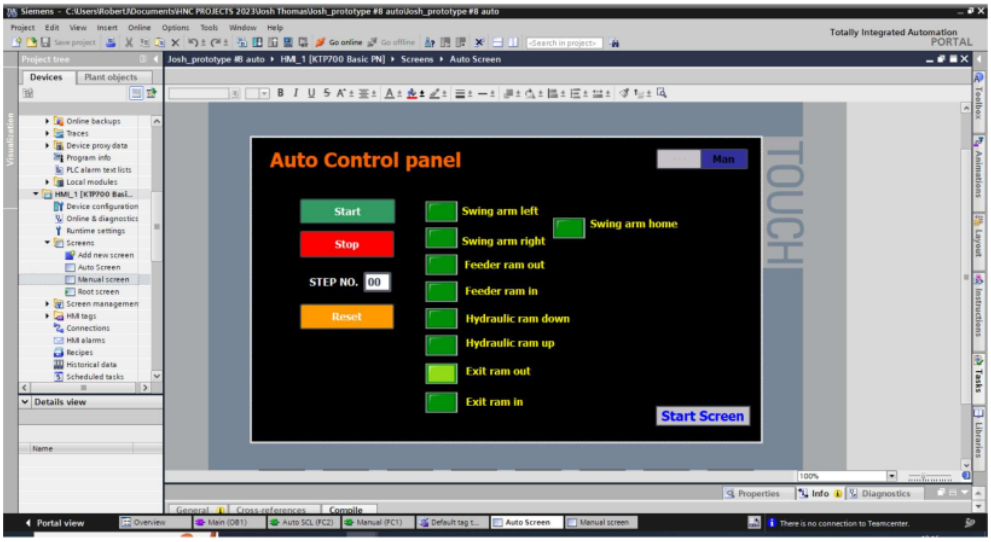



*Figure 37*

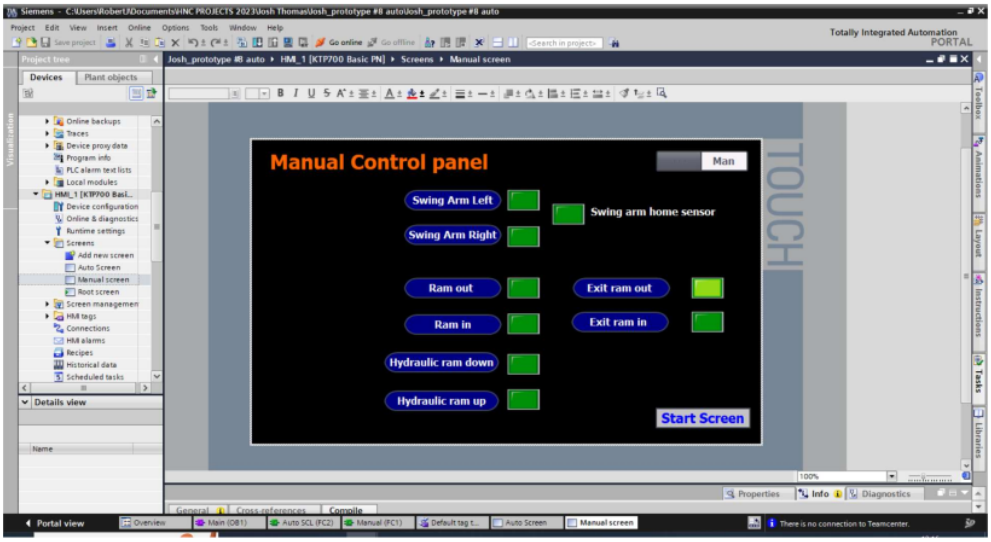



*Figure 38* *Good evidence of prototype #3*

## Prototype #4

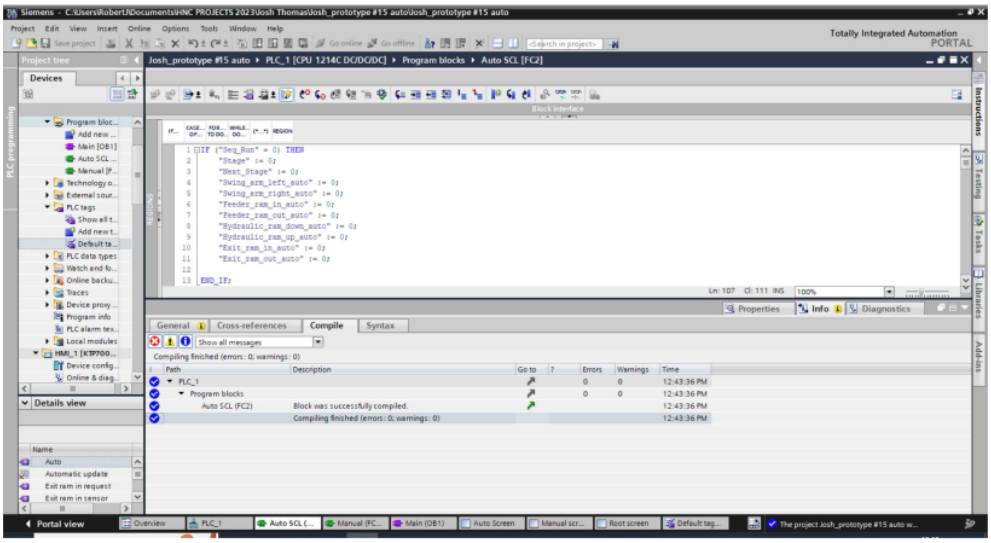


*Figure 39*

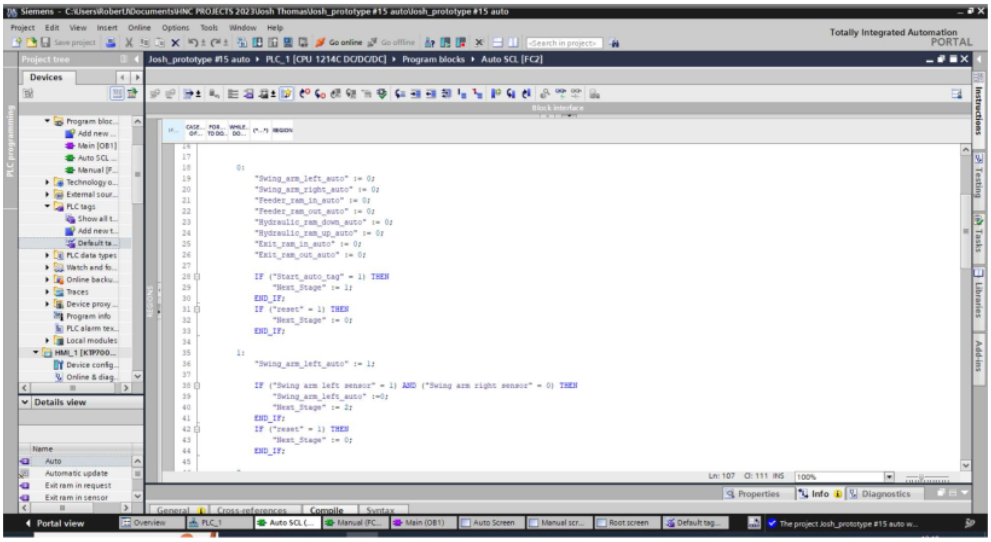



*Figure 40*

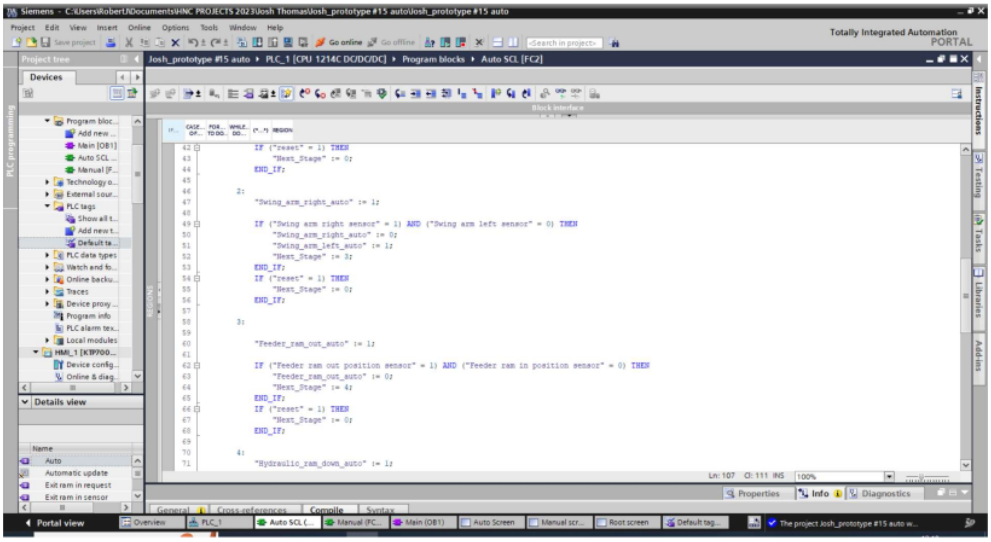



*Figure 41*

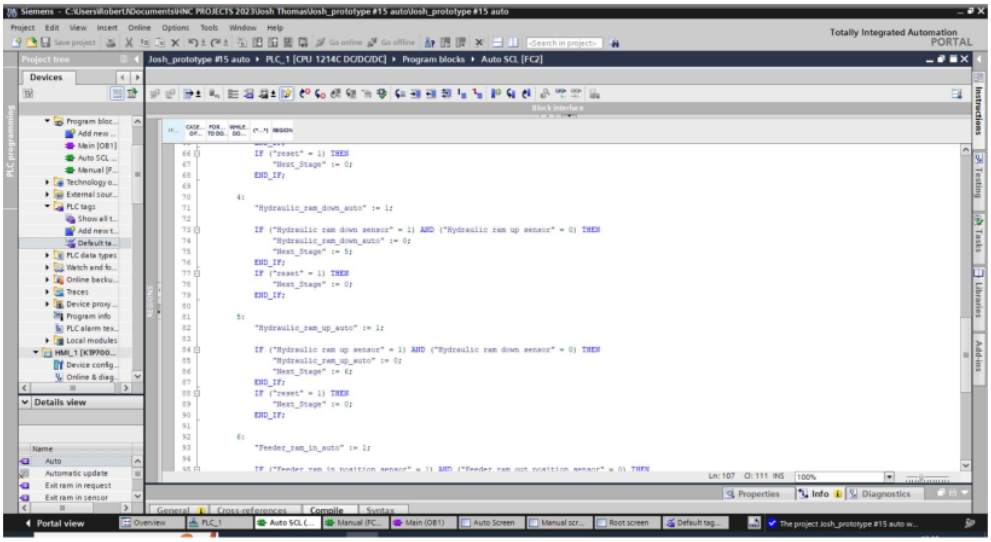



Figure 42

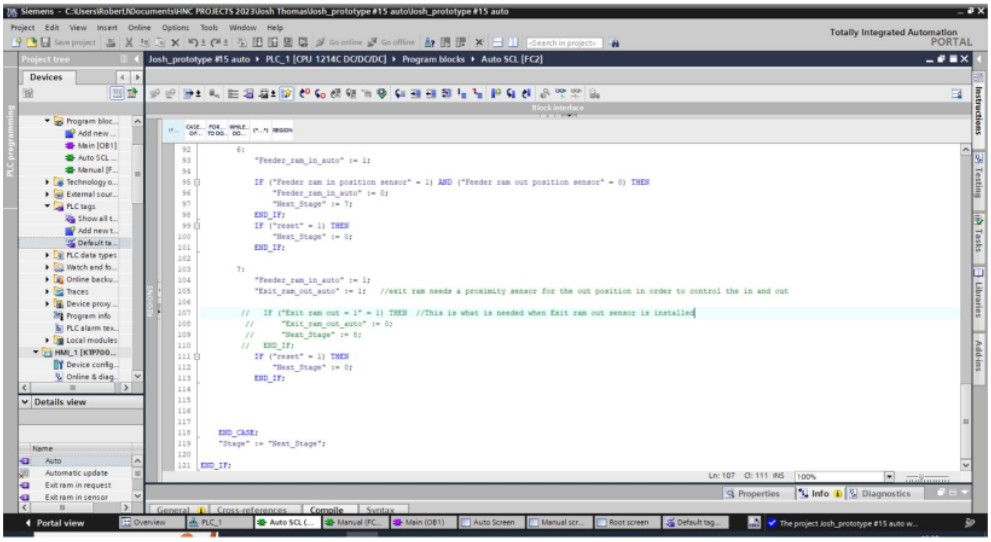



Figure 43

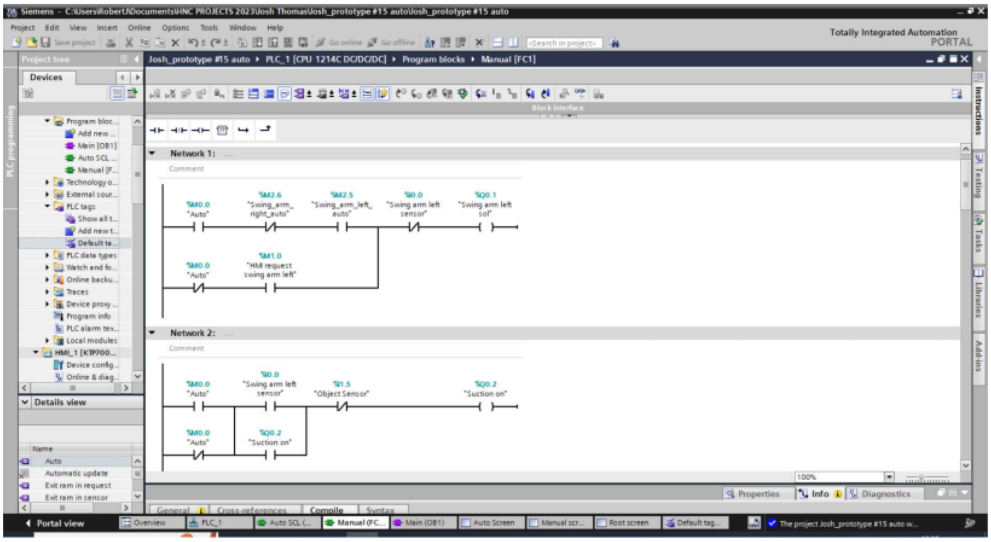



*Figure 44*

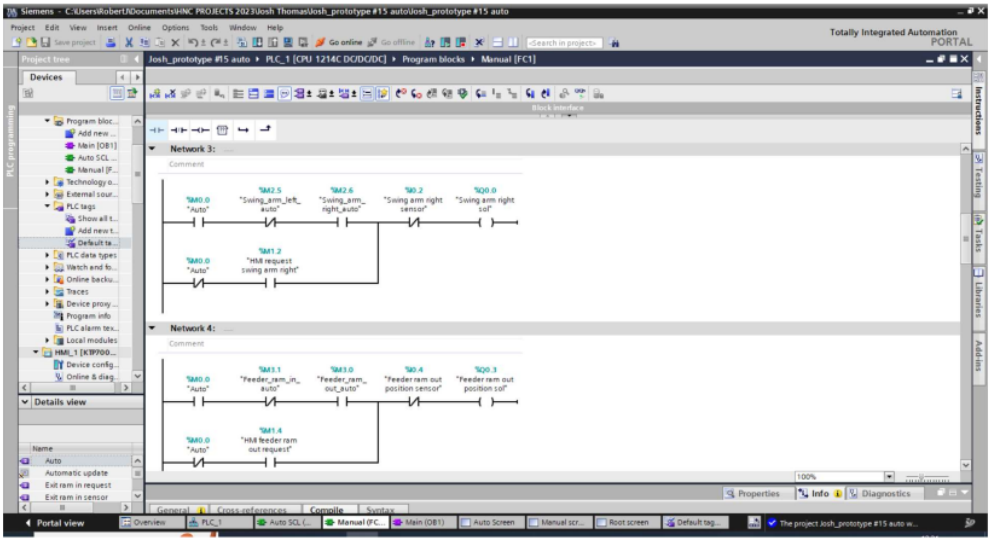



*Figure 45*

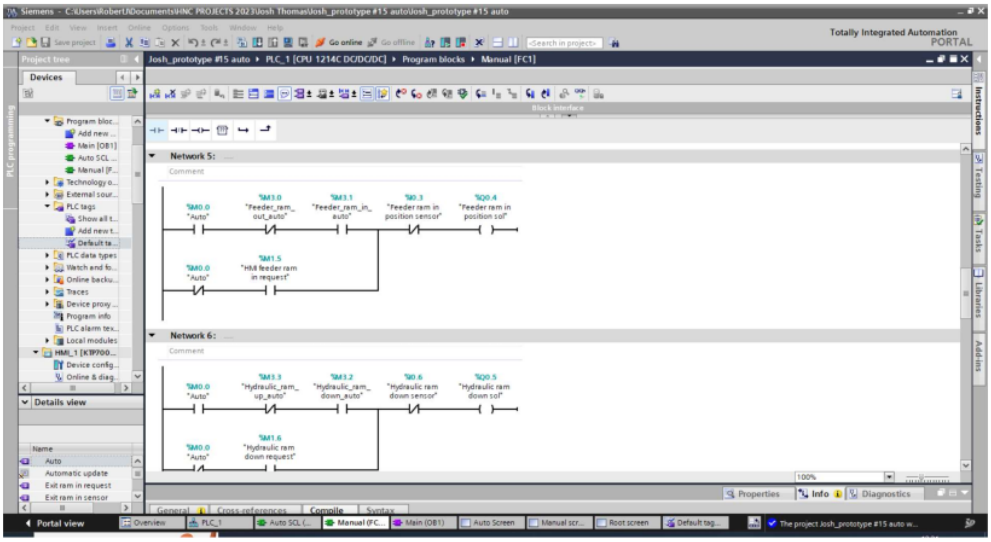



*Figure 46*

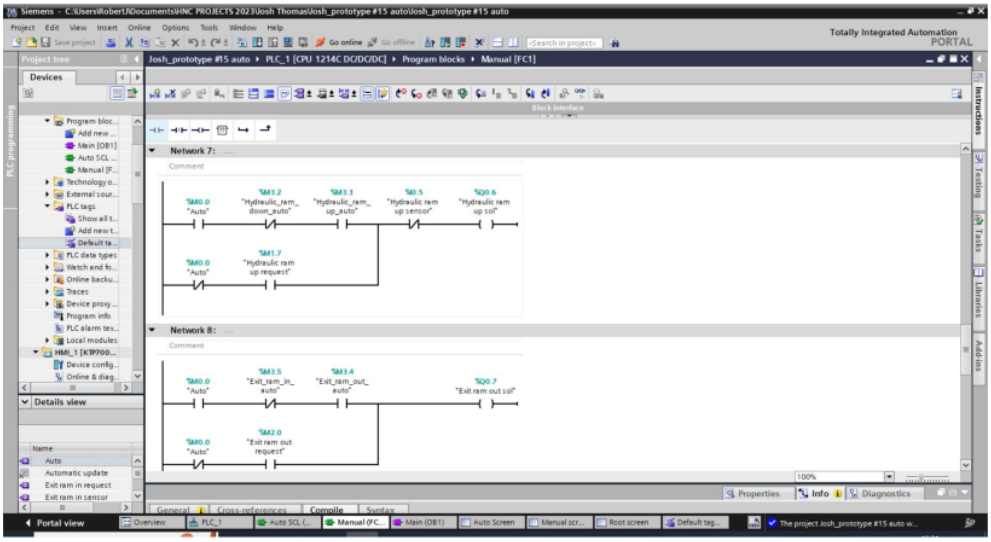



*Figure 47*

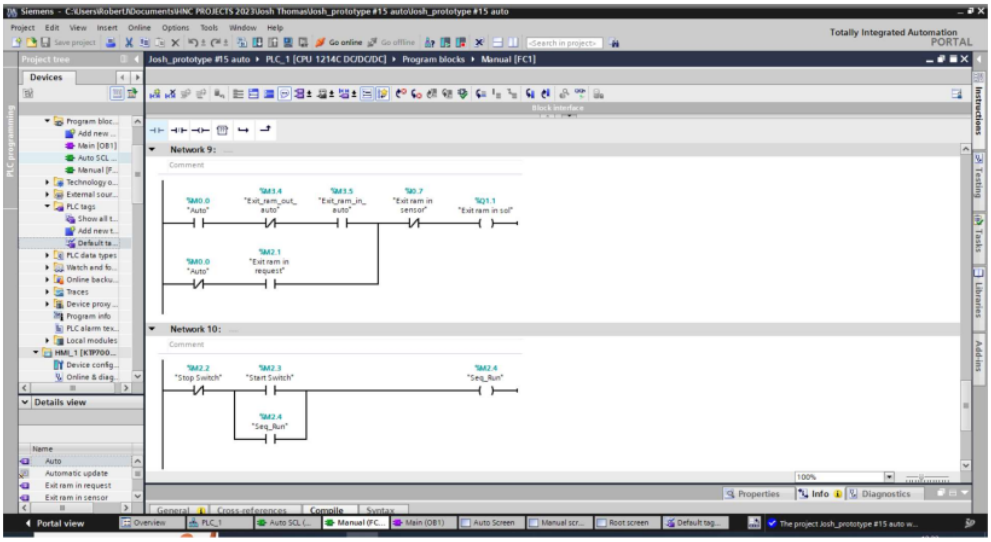



*Figure 48*

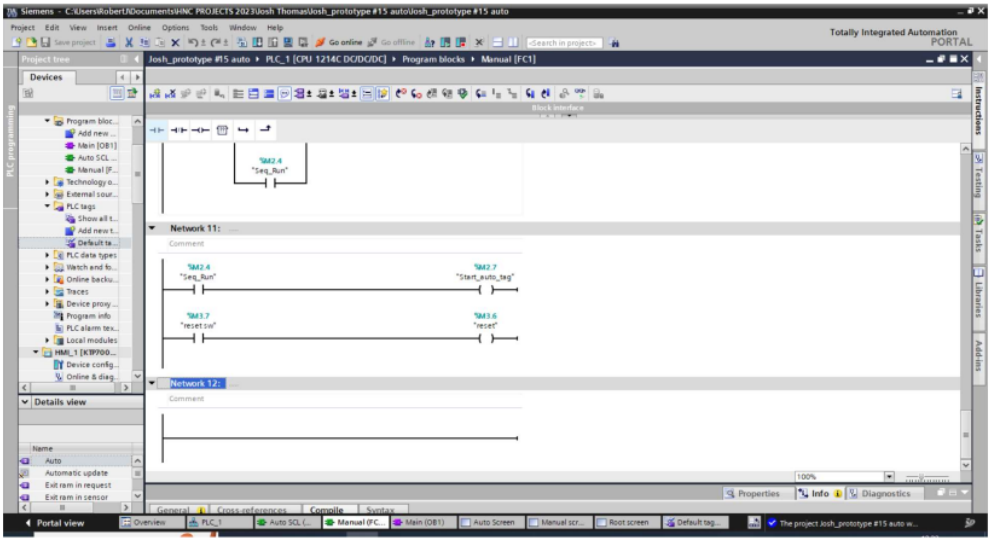



*Figure 49*

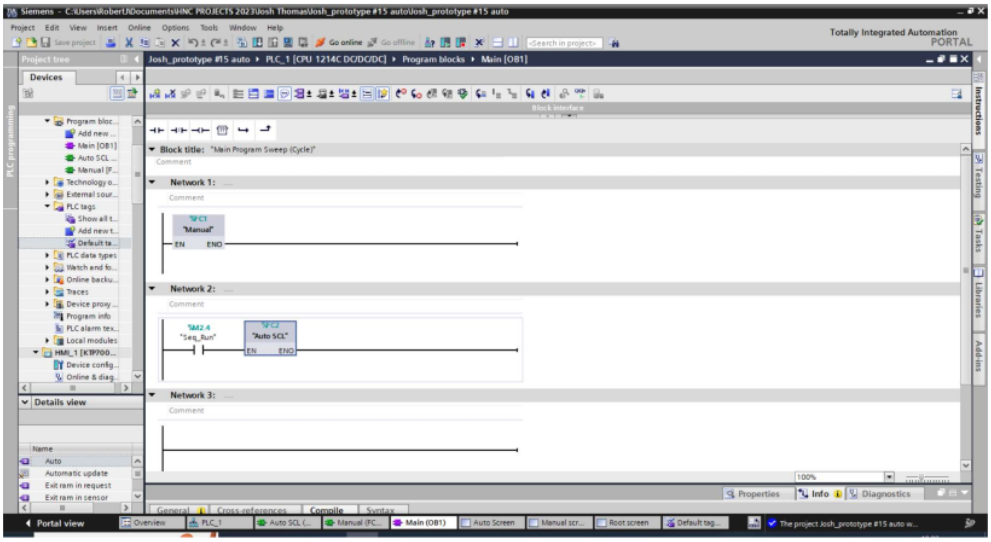



*Figure 50*

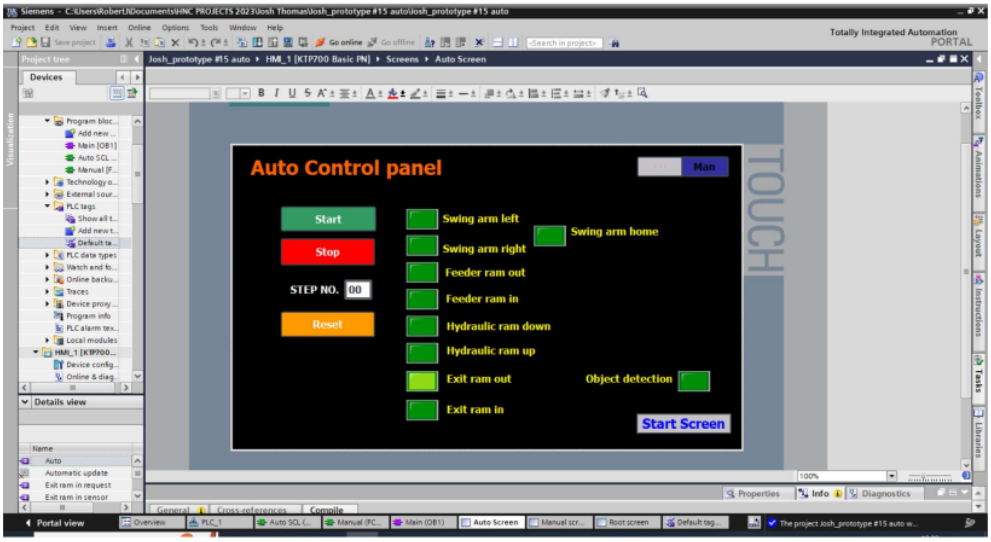



*Figure 51*

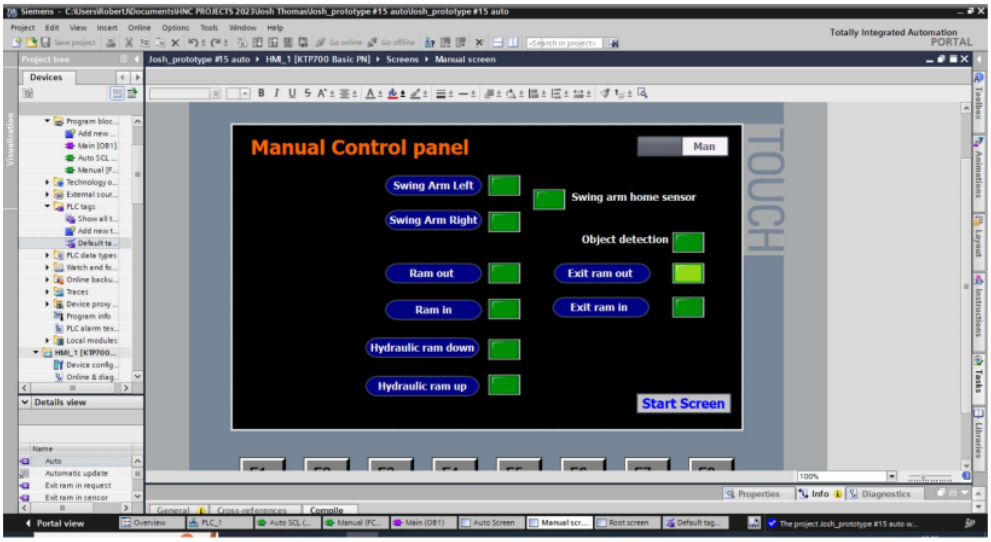



*Figure 52*

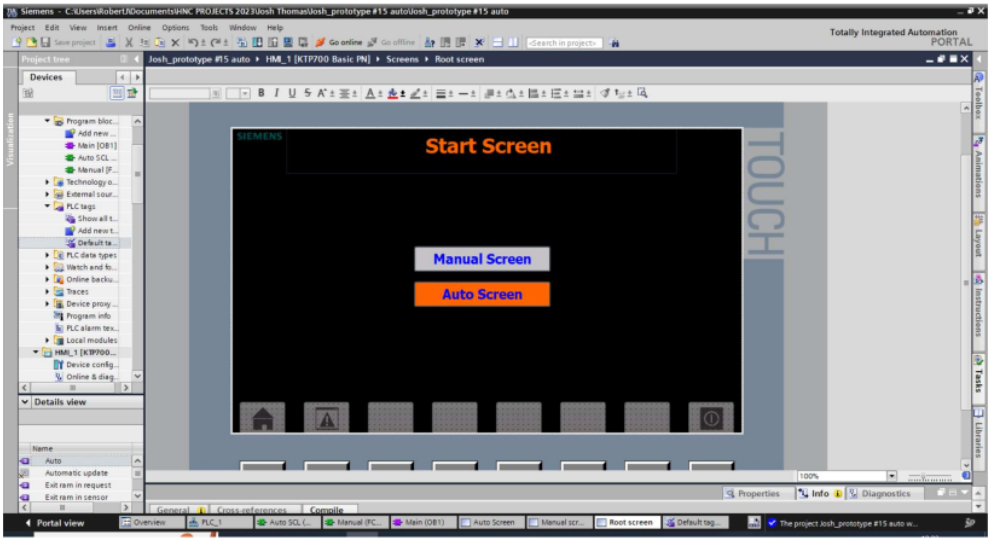



*Figure 53*

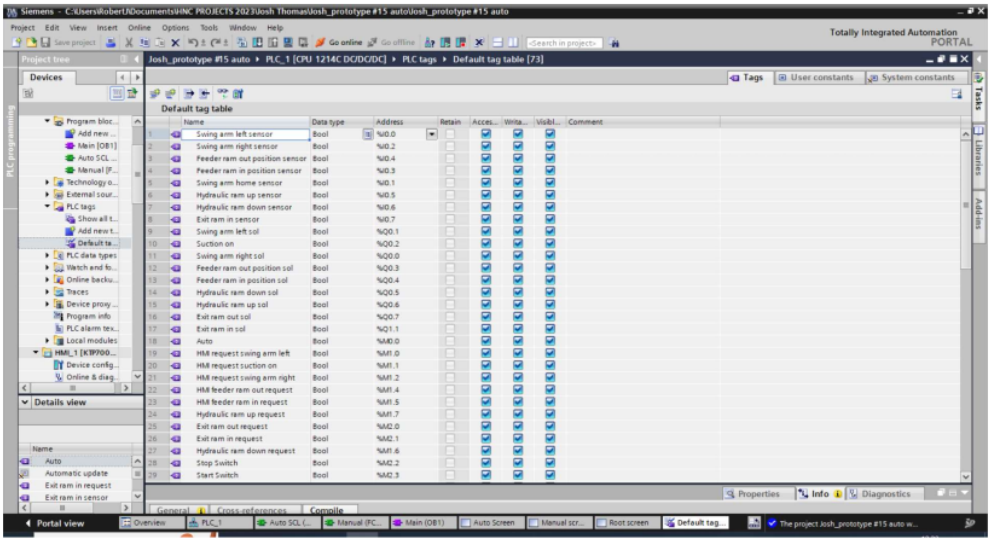



*Figure 54*

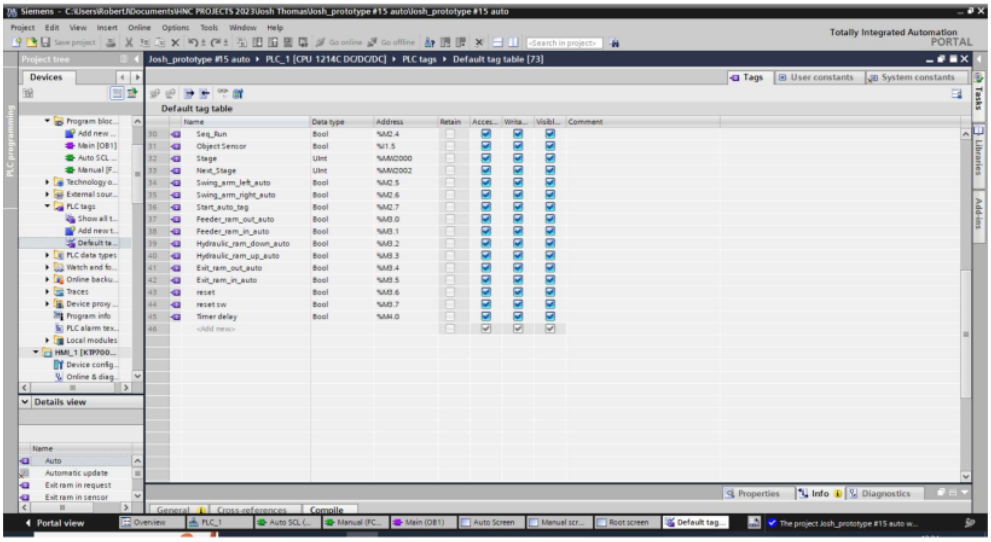



*Figure 55*

*Good evidence of prototype #4*

2119237

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

51 /100

PAGE 1

PAGE 2

**Text Comment.** Table of contenets could be more detailed

PAGE 3

**Text Comment.** Comprehensive list of figures

PAGE 4

**Text Comment.** Good introduction that identifies requirements

**Text Comment.** There are no ref sources to support the research element of this section

PAGE 5

**Text Comment.** Good use of table

**Text Comment.** The spec should include more functional requirements

**Text Comment.** Budget should be included

PAGE 6

**Text Comment.** Good overview of the Gantt chart and its purpose

**Text Comment.** The chart has a comparison timeline, hwever, the actual timeline has no plots

**Text Comment.** The actual timeline should be present so that an evaluation can be carried out!

PAGE 7

**Text Comment.** There are significant points highlighted here, however, there should be at least one ref source and a supporting image.

**Text Comment.** Good supporting block diagram

**Text Comment.** This should include at least one ref source

PAGE 8

**Text Comment.** There is an argument here, the main being that Siemens uses Profinet. This would be more effective and better presented in a table with pros and cons for the evaluation.

PAGE 9

**Text Comment.** Good use of prototype method to devlope the system

**Text Comment.** Good evidence

**Text Comment.** Good explanation

**Text Comment.** develope

**Text Comment.** The HMI should be included here, since it is covered in the explanation

PAGE 10

**Text Comment.** Good evidence of the ladder logic

**Text Comment.** Good sample and explanation

PAGE 11

**Text Comment.** Explanation is too brief, there are many parts to the system that could be explained.

**Text Comment.** Good supporting evidence

PAGE 12

**Text Comment.** Good HMI design

**Text Comment.** The manual function screen is included in the appendix

**Text Comment.** Good use of table for output mapping to new system

PAGE 13

**Text Comment.** Good use of table for input mapping to new system

PAGE 14

PAGE 15

**Text Comment.** Very good detailed test evidence

PAGE 16

**Text Comment.** Good functional test evidence form PLC

PAGE 17

PAGE 18

**Text Comment.** Very good detailed test results

PAGE 19

**Text Comment.** Good functional test results from PLC

PAGE 20

**Text Comment.** Good evidence of live auto test

PAGE 21

**Text Comment.** beginning

**Text Comment.** Good conclusion with a very relevant recommendation

PAGE 22

PAGE 23

PAGE 24

PAGE 25

**Text Comment.** Good evidence of prototype #1

PAGE 26

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**Text Comment.** Good evidence of prototype #2

PAGE 32

PAGE 33

PAGE 34

PAGE 35

PAGE 36

PAGE 37

PAGE 38

**Text Comment.** Good evidence of prototype #3

PAGE 39

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PAGE 42

PAGE 43

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PAGE 45

PAGE 46

**Text Comment.** Good evidence of prototype #4

PAGE 47

GRADING FORM: CSG-RUBIC

| JOSHUA THOMAS | **0** |
|---|---|

**RESEARCH-INFORMED LITERATURE**

Research cintect is far too brief and should be separate from the introduction
Research of solutions has been carried out, however, no ref sources are used.

**4/20**

**KNOWLEDGE AND UNDERSTANDING**

Specification is descriptive, and includes significant parameters and constraints. this is supported with relevant block diagram.
There should be more functional requirements included. 5/10
Explanation and justification for solutions considered could be improved.
The evaluation carried out is too brief and should include pros and cons. 4/10

**9/20**

**ANALYSIS**

Very good detailed test table of results with supporting images. Explanations are included.
Prototypes are tested and explained.
Good test evidence in appendix which includes auto and manual test. 8/10
Conclusion covers good significat points,  and recommendation is valid. 7/10

**15/20**

**PRACTICAL APPLICATION AND DEP.**

Good planning method used.
Timeline plan Gantt chart includes comparative timeline.
No data is included in actual timeline.
No initial test plan included. 2/5
Solutions considered are explained, but lack detail.
Evaluation needs more detail. 4/10
Implementation is explained with good sequential evidence and using prototype method for development process. 7/10

**13/20**

**SKILLS FOR PROFESSIONAL PRAC.**

Report is logical and there is a sequence
Minor errors are present.
Refs to appendix are missing

**10/15**