

Project Planning
Engineering Management
Nathan Skyrme

Introduction

In our rapidly growing economy and ever-increasing culture of consumerism, the manufacturing sector is becoming vastly reliant on speed and efficiency to keep up with soaring levels of demand. Once upon a time factory floors would have been swamped with workers toiling away for hours on end, repeating the same menial task until the end of the workday. Now however, many of these jobs have since become redundant, with the development and expansion of automated robotics offering a level of accuracy, efficiency and speed that it would not be possible for your average worker to achieve. As of 2020, 31% of all companies currently use at least one form of automated function, up slightly from 29% in 2018.[1] This number is only set to rise with it being estimated that at least 64% of global manufacturing activities are capable of being automated.[2] Understanding this shift in industry is vital as businesses cannot afford to fall behind. For automated robotics to be utilised effectively, their work rate will need to exceed that of a human manually performing it's given task. Acknowledging that this is a key aspect of automation, the group project being undertaken focuses specifically on it. The project we are undertaking aims to successfully implement a Festo Cobot into an automated mobile phone production assembly line. Presently once a phone has completed production it needs to be manually removed from the out-tray; unfortunately, there are only two out-trays each capable of holding a maximum of two phones each, leaving the overall capacity poor at only four phones. Once the out-tray reaches maximum capacity, the assembly line is automatically forced to a halt, as nothing more can be produced until at least one of the phones is removed. By implementing a Festo Cobot we aim to rectify this issue, creating a solution that will allow the assembly line to continually produce mobile phones without excessive need of human intervention. Focally we will be using the Cobot to remove each completed product from the out-tray and into storage, this storage will then likely need to be dealt with manually, but our primary aim will be to always keep as much of the out-tray free as possible, (maintaining at least one free space), and to increase the assembly lines output capacity, (aiming to achieve at least a 500% increase in capacity). To achieve our aim, we'll need to design and create a head attachment for the Cobot that will allow optimum affixing of a completed product and ensure a secure out-tray to storage transition. Understanding this we'll also need to create a storage system and container that allows our storage container to be removed or emptied manually without disrupting or halting the rate of production.

Roles & Responsibilities

Josh – Team Leader

- Tooling/Storage Design and Confirmation
- Group Project Cohesion and Work Approval
- Construction of Tooling and Storage
- Air Monitoring System integration

Oliver – CAD and 3D Printing

- Storage Design and Confirmation
- Tooling/Storage Dimensioning and Fine-Tuning
- Construction of Tooling/Storage

Jamie – Budgeting & Material Selection

- Material Selection/Purchase
- Budget Monitoring

Abdulahzim – CAD and Design

- Tooling Design and Confirmation
- Tooling/Storage Dimensioning and Fine-Tuning
- Construction of Tooling/Storage

Callum – Storage and Project Planning

- Storage Design and Confirmation
- Storage Dimensioning and Fine-Tuning
- Construction of Tooling/Storage

Nathan (Myself) - Robotic Programming

I will be contributing to the group project by taking on the responsibility of robotic programming. This will mean I will be solely responsible for ensuring that the Cobot can perform its task of removing completed products from the out-tray and into storage correctly. The script I write will need to consider any errors that may occur and contain suitable script paths to counteract any problem that could feasibly arise. Robotic programming is one of the most important elements to the project, as this is one of the few areas that could cause the whole project to fall apart. If not programmed in a diligent and considered manner, unexpected problems may render the Cobot useless. While this is quite a large responsibility to bear, it was most logical for me to take it; Festo Cobots are typically programmed in Python and whilst rusty, I am the only team member who has any prior experience programming in this language.

Skills & Traits Required:

Programming can come with a plethora of tricky issues which require an adaptive mind to overcome. To create a concise yet functional script this role will demand that I have exceptional critical thinking skills and a versatile approach to problem solving. Most importantly to write the script I will have to relearn and become proficient in Python which will require a high-level of dedication. Self-motivation will also play a key role and is required to first relearn Python, but to also enable me to push through until all issues are resolved and to ensure that the program is working and completed to a high standard in a timely manner. Under Belbin's Model this role would be most suitable for someone who falls under the 'Specialist' category. Belbin's Model states that a specialist's strengths are, singlemindedness, dedication and an ability to self-start, as well as provision of specialist knowledge and skills.[3] Each of these are traits that I believe I have and will be able to execute successfully, the skills Belbin notes here all relate back to the abilities the task requires noted above. Belbin also however defines a specialist as having one major weakness being that '[a specialist] tends to contribute on a narrow front and can dwell on the technicalities.' [3] This trait for many group projects and roles may be quite a hinderance, however for this specific task this may not become too much of an issue. While I could easily contribute to other aspects of the project and would, if necessary, robotic programming being such an integral pillar of the project, will require a hard dedicated focus from one person, unlike other more open tasks where several members could play a role. Dwelling on technicalities is something that is needed here, as one or two lines of poorly written code could potentially jeopardise the whole script. According to my Belbin's Model self-assessment, I would fall into the category of an 'implementer', while this isn't the ideal type for this task, it isn't too bad either. Belbin says that implementers are, 'Practical, reliable, efficient. [And they] turn ideas into actions and organise work that needs to be done'. [3] For this task these are all great skills to have and aren't that much different from the strengths of a specialist. In terms of weakness however an implementer is stated to '[...]be a bit inflexible and slow to respond to new possibilities.' As well as being '[...]slow to relinquish their plans in favour of positive changes.' [3] These are both weaknesses that if being honest I possess, to counteract these I will need to be open to criticism and constructive feedback to allow the program to be as scripturally sound, even if it causes me extra work and hassle. While my determined type does not line up with a specialist the skills listed in both categories are skills I will both need and believe I can execute to my role's success.

Group Tasks

<u>TASK</u>	<u>START</u>	<u>END</u>	<u>DESCRIPTION</u>
Team Role Assignment	3/10/2022	10/10/2022	Delegation of roles and responsibilities.
Material Selection	10/10/2022	24/10/2022	Selection of appropriate materials based on necessity and budget.
Tooling Design and Confirmation	3/10/2022	24/10/2022	Initial tooling design completion and confirmation.
Material Purchase	24/10/2022	31/10/2022	Purchase order of components and materials needed to begin construction.
Storage Design and Confirmation	3/10/2022	24/10/2022	Initial storage design completion and confirmation.

Budget Monitoring	10/10/2022	14/11/2022	Active monitoring of purchases made, and components required in relation to budgetary constraints.
Selection/Purchase of Arduino and Sensors	7/11/2022	14/11/2022	Selection and purchase of compatible Arduino and light-gate sensors.
Tooling Dimensioning and Fine-Tuning	24/10/2022	12/12/2022	CAD 3D modelling, dimensioning and fine-tuning of tooling and tooling components.
Storage Dimensioning and Fine-Tuning	24/10/2022	12/12/2022	CAD 3D modelling, dimensioning and fine-tuning of storage and storage components.
Viva PowerPoint and Preparation	28/11/2022	12/12/2022	Preparation of content for and delivery of interim viva presentation.
Robotic Programming and Planning	7/11/2022	27/3/2023	Planning and coding of Python script.

Construction of Tooling and Storage	12/12/2022	9/1/2023	Completion of tooling and storage construction in preparation for integration with Cobot.
PLC/Arduino Communication	9/1/2023	23/1/2023	Coding and testing of PLC and Arduino communication between sensors on the out-tray and storage with Python script.
Air Monitoring System Integration	9/1/2023	6/2/2023	Coding and integration of air monitoring system into tooling, for the purpose of maintaining air pressure and detecting loss.
Sensor Setup and Program Integration	9/1/2023	6/2/2023	Integration of sensors into storage unit and Python script.
Program Integration of Tooling and Storage	6/2/2023	13/2/2023	Physical testing and fine-tuning of Python script using the Cobot.
Completion of Primary Script	13/2/2023	20/2/2023	Completion of Python script in preparation for testing and fine-tuning.
Cobot Reliability Testing	20/2/2023	27/3/2023	Reliability, efficiency and safety testing of Cobot integration into the assembly line.
Final Viva Showcase and Preparation	6/3/2023	27/3/2023	Preparation and delivery of content for the final Viva showcase.
Final Report	20/2/2023	26/3/2023	Construction and completion of final report detailing the project.

Recurring:

Weekly Team Meetings – Occur on: Monday (13:00 – 15:00). **Expected Hours:** 2 Per Week

To ensure that we work as a cohesive effective unit and that all team members are completing their respective tasks and upholding their responsibilities, we will be holding team meetings each week. These meetings will be used to discuss progress and plans for the project. Holding these meetings hold us each accountable for the work we have produced and ensures that we all understand the direction of the project.

Personal Tasks - (In Order of Completion Date)

Selection and Purchase of Arduino and Light-Gate Sensors – **Completed By:** 14th November. **Expected Hours:** 2 Hours

The simplest task I will need to find and select an appropriate and compatible Arduino that can be used to communicate with several light-gate sensors and Python. Cost will need to be minimised whilst not jeopardising the integrity of the project. Arduinos typically cost around £20 - £30, whilst light-gate sensors typically cost around £20 per pair.

Interim and Final Viva Presentation Preparation – **Completed By:** 12th December (Interim). 27th March (Final). **Expected Hours:** 5 Hours

To clearly convey all work planned and completed for the interim viva assessment, I will need to dedicate time to creating detailed yet concise content for the group PowerPoint that effectively communicates my role, what I have contributed to the project, as well as what work is planned to be completed and the aimed dates of completion. In preparation for the final viva, I will need to ensure that the Cobot and my script are working as intended and that we have a completed project to present for assessment.

Sensor Setup and Integration – **Completed By:** 6th February. **Expected Hours:** 28 Hours

For a Python script to understand when storage is full sensors will need to be integrated. I will be making use of sensors for two reasons. The first will be to use the existing light-gate sensors on the out-tray to communicate to the script when the out-tray is full and therefore ready for product removal. The second will be to place light-gate sensors into our storage to communicate to Python when it's full and when it has been emptied. Implementing sensors into the program will make it far less primitive and will allow us to avoid a whole series of issues that would otherwise arise, this is the only real way for the program to self-regulate and understand where and when it should be acting.

PLC/Arduino Communication – Completed By: 6th February. Expected Hours: 25 Hours

For effective sensor communication, I will need to connect both the Arduino and the PLC console to my script, allowing them to send and receive information/commands that will dictate how the Cobot operates. This will allow communication between Python and the light-gate sensors, both pre-existing and self-installed. Connection to the PLC console will also be required for Python to halt the assembly line, should error or maximum-capacity occur.

Program Intergration of Tooling and Storage – Completed By: 13th February. Expected Hours: 20 Hours

The program I create will need to take into consideration its practical implication of how it will interact in conjunction with both our created tooling and storage. The program will need to consider all movement restrictions and how to counteract these. If more than one storage container is used, I will further need to consider how my program will distinguish between them. The script additionally will need to travel the most optimum path for efficiency whilst still maintaining the integrity of the tooling's affixation to a completed product. I be required to test extensively and determine exact positioning of the Cobot to ensure confidence in the Cobot's performance and the programs validity.

Robotic Programming and Planning – Completed By: 27th March. Expected Hours: 120 Hours

Robotic programming will consume most of my focus as it is one of the most vital pillars of the project and cannot afford to be underdeveloped and must be scrutinised appropriately. I will be solely responsible for, researching, writing, error-proofing, integrating and completing a Python script that allows the Cobot to recognise and distribute completed products from the out-tray and into storage. The aims of the script must be clearly planned and outlined before programming begins, ensuring that a clear method has been defined, that the script is as efficient as possible and that each segment of code has a unique purpose. Alongside planning I will be pouring time into researching and relearning Python as I haven't used this language in quite some time. Further this requires me to need to continually check each line and segment of code, testing and rewriting for scriptural rigidity, effectiveness and usefulness. Frequent error-proofing will embolden confidence in the program and protect from unexpected issues. Additionally, it will be important to deliver the script ahead of time to allow for an extra extended period of testing.

Bill of Materials:

<u>COMPONENT</u>	<u>COST</u>	<u>PURCHASE LEAD TIME</u>
Arduino Uno	\$39.95 AUD	~ 1 Month
(2x) IR Break Beam Sensor – (3mm LEDS)	\$7.40 AUD (Per Pair)	2-5 Days
Shipping	\$20 AUD	-
TOTAL	\$74.75 AUD	-

Significant Milestones and Gateways

Team Milestones and Gateways

The following are significant milestones/gateways throughout the entirety of the project:

- **Primary Tooling/Storage Design and Confirmation (24/10/22)** – Gives the project a clear direction and start. Allows 3D CAD modelling to begin dimensioning and fine-tuning components. This also allows Arduino sensors to be selected and purchased.
- **Arduino and Sensor Selection/Purchase (14/11/22)** - Opens program planning and structure formation.
- **Final Tooling/Storage Design and Confirmation (12/12/22)** - Allows 3D-printing and component construction/assembly to begin. Fine-Tuning in the programming can begin with more precise information on spacing and movement tolerances.
- **Interim Viva Assessment and Presentation (12/12/22)** - First of two assessments.
- **Tooling/Storage Construction (9/1/23)** - Allows sensor setup, air monitoring and PLC/Arduino communication to begin. Also allows precise positioning of the Cobot to be found.
- **Sensor-Storage Integration and PLC/Arduino Communication (6/2/23)** - Integration of Cobot with tooling/storage can begin.
- **Completion of Primary Script (20/2/23)** - Allows focus on testing and fine-tuning.
- **Final Viva Assessment and Showcase (27/3/23)** - Second of two assessments, unbiased showcase of project success.

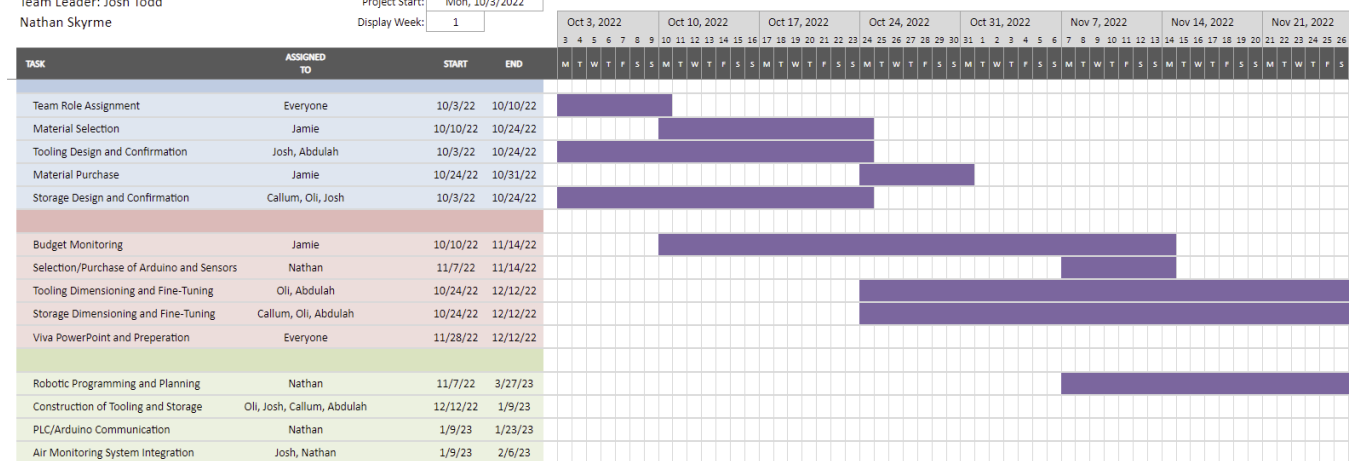
Programming Gateway – Completion of Primary Script

For the Cobot to be able to function at all it is extremely important that the script is completed to a high-standard in a timely manner. To achieve this a supreme dedication is required, working ahead of time to ensure that the program does not fall behind. Script content will be contingent on other elements of the project, such as tooling and storage placement; because of this I will need to make sure that I understand all areas. Without delivery of the script in time the Cobot will be non-functional. By 20th February (but ideally sooner), the script will need to be capable of achieving at least 90% accuracy in transferring products from the out-tray and into storage and should be able to receive data from sensors, acting in conjunction with it. Without appropriate time for testing and fine-tuning the Cobot will not be able to perform to a high enough level or be accurate enough to meet the project objectives. This extra time will embolden our confidence in the Cobots ability to perform and allows me to patch any holes in the script. Slight changes in code could significantly boost accuracy, efficiency and reliability; which an unfinished script will block.

Areas of Concern

Movement Restriction:

To ensure a smooth out-tray to storage transition, the complete area of operation will need to be accounted for. The Cobot will be working in conjunction with the robotic arm that currently takes completed products from the assembly line and places them into the out-tray. The out-tray



Nov – Dec

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme

Project Start: Mon, 10/3/2022

Display Week:	5
---------------	---

[illegible]

Dec – Jan

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme

Project Start: Mon, 10/3/2022

Project Start:	Mon, 10/1/2018
Display Week:	9

[illegible]

Jan – Feb

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme

Project Start: Mon, 10/3/2022

Display Week:	13
---------------	----

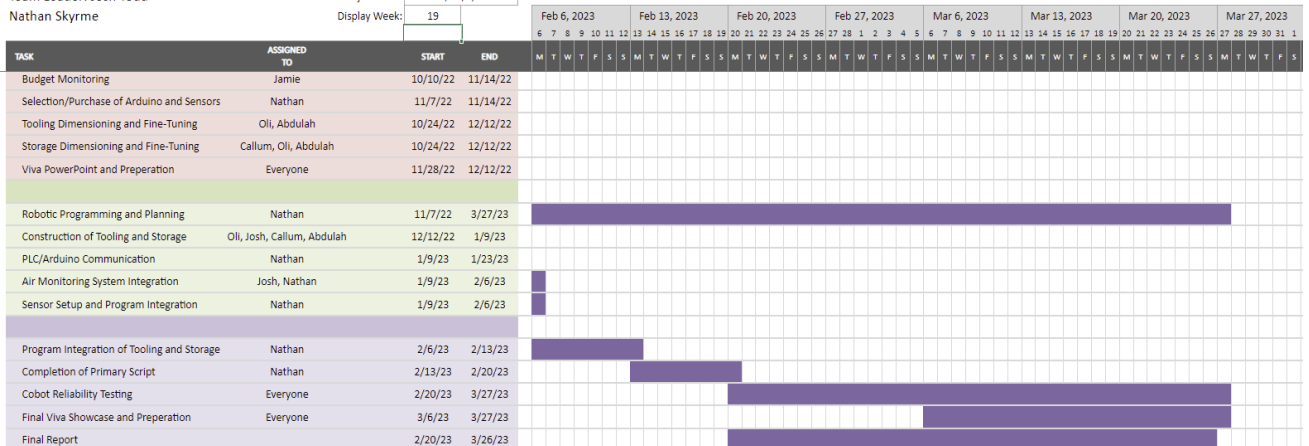
[illegible]

Feb – Mar

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd
Nathan Skyrme

Project Start: Mon, 10/3/2022
Display Week: 19



Embedded Gantt Chart Link: (https://uwotdsd-my.sharepoint.com/:x/r/personal/2111290_student_uwotdsd_ac_uk/_layouts/15/Doc.aspx?sourcedoc=%7B2CBED476-63B0-482D-9603-C04407988407%7D&file=FRESH%20Gantt%20Chart1.xlsx&action=default&mobileredirect=true&DefaultItemOpen=1&login_hint=2111290%40student.uwotdsd.ac.uk&ct=1668633897728&wdOrigin=OFFICECOM-WEBSITE.MAIN.EDGEWORTH&cid=f66a8404-ff07-4649-a3e2-40d12bd3069c)

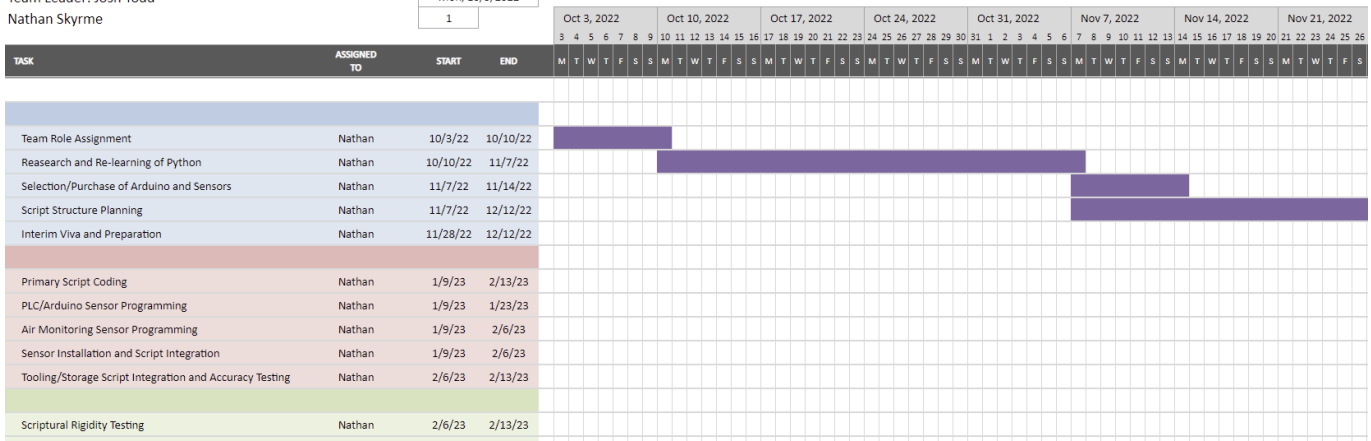
Personal Chart

Oct – Nov

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd
Nathan Skyrme

Mon, 10/3/2022
1



Nov – Dec

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme

Team Leader: Josh Todd			Mon, 10/3/2022																																																								
Nathan Skyrme			5																																																								
TASK	ASSIGNED TO	START	END	Oct 31, 2022					Nov 7, 2022					Nov 14, 2022					Nov 21, 2022					Nov 28, 2022					Dec 5, 2022					Dec 12, 2022					Dec 19, 2022																				
				31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
				M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
Team Role Assignment	Nathan	10/3/22	10/10/22																																																								
Reasearch and Re-learning of Python	Nathan	10/10/22	11/7/22																																																								
Selection/Purchase of Arduino and Sensors	Nathan	11/7/22	11/14/22																																																								
Script Structure Planning	Nathan	11/7/22	12/12/22																																																								
Interim Viva and Preparation	Nathan	11/28/22	12/12/22																																																								
Primary Script Coding	Nathan	1/9/23	2/13/23																																																								
PLC/Arduino Sensor Programming	Nathan	1/9/23	1/23/23																																																								
Air Monitoring Sensor Programming	Nathan	1/9/23	2/6/23																																																								
Sensor Installation and Script Integration	Nathan	1/9/23	2/6/23																																																								
Tooling/Storage Script Integration and Accuracy Testing	Nathan	2/6/23	2/13/23																																																								
Scriptural Rigidity Testing	Nathan	2/6/23	2/13/23																																																								

Dec – Jan

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme

Team Leader: Josh Todd Nathan Skyrme			Mon, 10/3/2022																																																															
			9																																																															
					Nov 28, 2022							Dec 5, 2022							Dec 12, 2022							Dec 19, 2022							Dec 26, 2022							Jan 2, 2023							Jan 9, 2023							Jan 16, 2023												
					28 29 30 1 2 3 4 5 6 7 8 9 10 11							12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21																																																						
TASK					ASSIGNED TO		START		END																																																									
Team Role Assignment					Nathan		10/3/22		10/10/22																																																									
Reasearch and Re-learning of Python					Nathan		10/10/22		11/7/22																																																									
Selection/Purchase of Arduino and Sensors					Nathan		11/7/22		11/14/22																																																									
Script Structure Planning					Nathan		11/7/22		12/12/22																																																									
Interim Viva and Preparation					Nathan		11/28/22		12/12/22																																																									
Primary Script Coding					Nathan		1/9/23		2/13/23																																																									
PLC/Arduino Sensor Programming					Nathan		1/9/23		1/23/23																																																									
Air Monitoring Sensor Programming					Nathan		1/9/23		2/6/23																																																									
Sensor Installation and Script Integration					Nathan		1/9/23		2/6/23																																																									
Tooling/Storage Script Integration and Accuracy Testing					Nathan		2/6/23		2/13/23																																																									
Scriptural Rigidity Testing					Nathan		2/6/23		2/13/23																																																									

Jan – Feb

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme

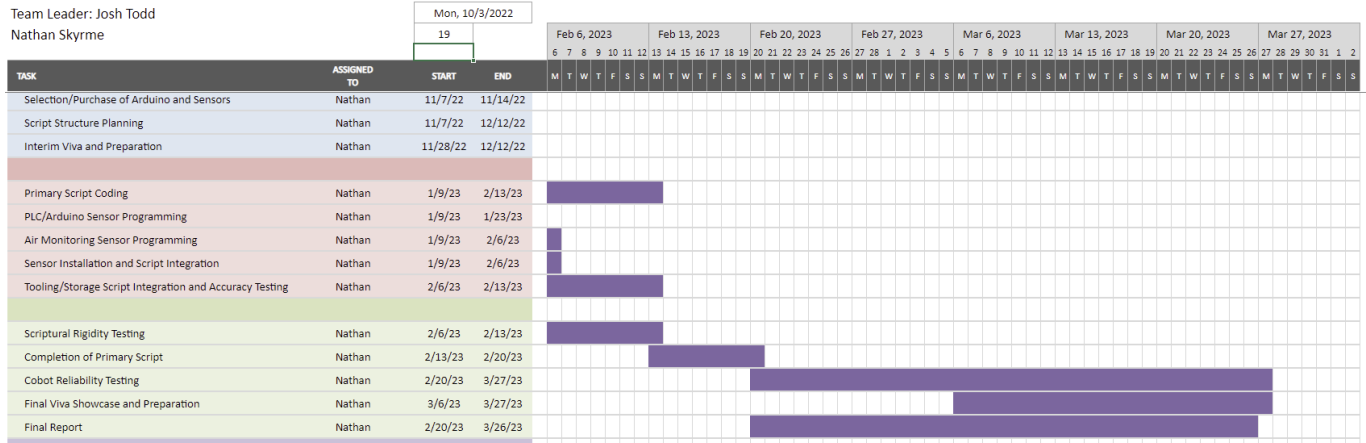
Team Leader: Josh Todd Nathan Skyrme			Mon, 10/3/2022																																																									
			14		Jan 2, 2023							Jan 9, 2023							Jan 16, 2023							Jan 23, 2023							Jan 30, 2023							Feb 6, 2023							Feb 13, 2023							Feb 20, 2023						
					2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
TASK	ASSIGNED TO	START	END																																																									
Selection/Purchase of Arduino and Sensors	Nathan	11/7/22	11/14/22																																																									
Script Structure Planning	Nathan	11/7/22	12/12/22																																																									
Interim Viva and Preparation	Nathan	11/28/22	12/12/22																																																									
Primary Script Coding	Nathan	1/9/23	2/13/23																																																									
PLC/Arduino Sensor Programming	Nathan	1/9/23	1/23/23																																																									
Air Monitoring Sensor Programming	Nathan	1/9/23	2/6/23																																																									
Sensor Installation and Script Integration	Nathan	1/9/23	2/6/23																																																									
Tooling/Storage Script Integration and Accuracy Testing	Nathan	2/6/23	2/13/23																																																									
Scriptural Rigidity Testing	Nathan	2/6/23	2/13/23																																																									
Completion of Primary Script	Nathan	2/13/23	2/20/23																																																									
Cobot Reliability Testing	Nathan	2/20/23	3/27/23																																																									
Final Viva Showcase and Preparation	Nathan	3/6/23	3/27/23																																																									
Final Report	Nathan	2/20/23	3/26/23																																																									

Feb – Mar

Festo Cobot Assembly Line Integration

Team Leader: Josh Todd

Nathan Skyrme



Embedded Personal Gantt Chart Link:

https://uowtsd.sharepoint.com/:x:/r/teams/L5GroupProject580_GRP/_layouts/15/Doc.aspx?source=doc=%7B2A177B1C-BEDE-44AC-8BF4-0E7042E9D653%7D&file=FRESH%20Gantt%20Chart1.xlsx&action=default&mobileredirect=true&DefaultItemOpen=1&login_hint=2111290%40student.uwtsd.ac.uk&ct=1668774529460&wdOrigin=OFFICECOM-WEB.MAIN.EDGEWORTH&cid=bbe4c387-1bc0-417d-ad01-6cc611a684b8

References

1. Lisa Schwarz, "32 Business Automation Statistics for 2021," Oracle Netsuite, Dec. 3, 2020. [Online] Available: <https://www.netsuite.com/portal/resource/articles/business-strategy/business-automation-statistics.shtml>
2. Patrick Lemay, "The Growth of Manufacturing Process Automation," Tulip, Jun 30, 2022. [Online] Available: <https://tulip.co/blog/manufacturing-process-automation/#:~:text=According%20to%20McKinsey%2C%20manufacturing%20is,activities%20considered%20to%20be%20automatable>
3. Belbin, "The Nine Belbin Team Roles," Belbin, 2022. [Online] Available: <https://www.belbin.com/about/belbin-team-roles>

[Word Count w/o References]: 2750