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20/10/24

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1 Introduction

1.1 Project Overview

The planning process for a Level 5 group project that I will be working on with my teammates is examined in this report. It will also draw attention to the unique contributions I made to the project. We are tasked with designing and constructing a completely autonomous, repeatable vehicle that can complete a variety of tasks as part of the IMECHE Design Challenge. Along with designing and building the vehicle, we also have to do a video presentation that explains the design and development process and a poster that highlights and promotes the team's efforts.

2 Team Structure And Roles

2.1 Team Member Roles And Responsibilities

As a team we have developed a list of all the members rolls and responsibilities within the project. The list has been made in a model that can balance each members flaws and play to their strengths to improve team performance.

Team Member	Role(s)	Responsibilities
James	Designer & Organiser	- Lead the design of the autonomous vehicle. - Create CAD models and technical drawings. - Lead the team in terms of organising the workload that needs to be done and allocated.
TJ	Project Manager, Research Lead & Physics/Mathematical Theories	- Build and assemble the vehicle's mechanical systems. - Make all physical and mathematical calculations for the vehicle in terms of mobility. - Assist in vehicle testing for performance.
Sheunesu (me)	Electronics lead and programmer & Poster Designer	- Oversee the overall project planning and timeline management. - Conduct research on necessary electrical components needed. - Assemble all the needed electrical components on the vehicle. - Design and create the project poster to publicize the team's work.

Table 1: Shows the roles and responsibilities taken by the team.

2.2 Skills And Traits Required For Each Role

Belbin's model is a framework that explains the many responsibilities that members of a team often play (Aritzeta, Swailes and Senior, 2017). Belbin identifies nine essential positions, each of which adds something special to the team's accomplishments (Arantzabal, Epelde and Artetxe, 2021). The image below shows the nine personality traits that were identified by Belbin:

	Team Roles	Strengths	Weaknesses
Thinking Roles	Plant	Creative innovator, problem solver	Lacks detailed focus & communication
	Evaluator	Strategic overview, judges options	Cannot share their vision, maybe too critical
	Specialist	Self-starter, subject matter expert	Can be too focused, misses the bigger picture
Action Roles	Shaper	Good under pressure, overcomes obstacles	May offend others, can be provocative
	Implementer	Turns ideas into actions, effective and efficient	Inflexible & slow to respond to new ideas
	Completer	Detail oriented, precise, credible	Poor delegation, may have poor coping skills
People Roles	Coordinator	Coaches talent, shares the vision, delegates	May shirk work, can be patronizing
	Team Worker	Diplomatic, perceptive, listening skills	Indecisive, cannot handle pressure
	Investigator	Communicator, good network, builds options	Idealistic, loses focus, does not complete tasks

Figure 1: Image showing Belbin's 9 categories.

In this project I had 2 main roles and responsibilities which were electronics lead/programmer and poster designer. Below are the roles and the skills and personality traits needed to fulfil these roles with reference to Belbin's model:

1. Electronics lead/programmer

- **Responsibilities:** Design and test electrical circuits, develop the vehicle control software, and troubleshoot electrical issues.
- **Skills:** Circuit designing and programming.
- **Traits (Belbin):** Plant (PL) for innovation and implementer (IMP) for turning ideas into practical applications.

Plant and implementor are the personality traits that go with this role as it requires creative innovation, problem solving, and turning ideas into actions.

2. Poster Designer

- **Responsibilities:** The creation of a compelling poster that effectively communicates key aspects of the repeatable vehicle, including unique features.
- **Skills:** Graphic design, creativity, marketing insights, and branding.

- **Traits (Belbin):** Resource Investigator (RI) for the creativity and exploration of design ideas and Team Worker (TW) to adapt designs based on feedback.

These team role traits are accurate for the position of poster designer as the investigator has effective communication skills that help in making the poster communicate effectively. They are also a team worker as they have good listening skills by being able to listen to teammates to implement their designs into the poster.

3 Project Tasks And Timeliness

3.1 Overview Of Group Tasks

The deadlines and the general tasks that must be completed to finish the project are described in this chapter. To ensure the seamless transition from the initial planning to the final presentation the tasks are arranged logically. To guarantee an efficient and well-structured workflow the tasks are dependent on accomplishing earlier tasks (e.g. to start task 2 task 1 must be completed). The table below shows each task, hours taken, duration, and dependencies:

Task No.	Task Description	Hours Required	Duration	End Dates
1	Initial Project Planning	40	5 Days	08/10/04
2	Research And Data Collection	10	3 Days	24/10/24
3	Concept Design And Brainstorming	20	1 Week	28/10/24
4	Preliminary Design Development	30	1 Weeks	10/11/24
5	Prototype Construction	15	2 Week	02/12/24
6	Testing And Evaluation	30	1 week	10/01/25
7	Final Adjustments	10	2 Days	20/01/25
8	Sensor Programming	25	4 Days	05/01/25
9	Final Presentation Preparation	5	1 Day	09/12/24

Table 2: Shows the roles and responsibilities of the team and their duration.

3.2 Detailed Breakdown of My Tasks

This subsection is looking at the tasks that I had to perform for the group project in a more detailed manner. This shows the tasks and the duration of the task and the hours I require to finish the tasks. It also shows the tasks that are dependent on other tasks before they could commence. This will give a rough estimation of when these tasks should be completed.

Task No.	Task Description	Hours Required	Duration	Dependencies
1	Electrical components research	40	1 Week	None
2	Component Sourcing	10	3 Days	Task 1
3	Electrical System Design	20	1 Week	Task 2
4	Hardware Assembly	30	1 Weeks	Task 2 & 3
5	Programming The Control System	40	2 Week	Task 4
6	Testing and Debugging	30	1 week	Task 4
7	Gather Information for the Poster	10	2 Days	None
8	Poster Ideas Designs	10	4 Days	Task 7
9	Deciding Final Poster Design	5	1 Day	Task 8
10	Designing Final Poster	5	3 Days	Task 9

Table 3: Shows the roles and responsibilities taken by me and their duration.

Below is a table which shows the bill of materials needed for the tasks that I am required to do for the group project. This bill of materials includes the estimated cost, and the supplier/source of the components needed.

Item Description	Quantity	Estimated Cost (£)	Supplier
Microcontroller	1	24.50	The Pi Hut.com
Batteries(9V)	1	1.66	Amazon.co.uk
Sensors (various)	4	15	The Pi Hut.com
Wiring and Connectors(set)	1	6	The Pi Hut.com
Motors	2	25	The Pi Hut.com

Table 3: Shows the bill of materials for my tasks.

3.3 Specialist Equipment Required

To successfully complete the above tasks, specific tools and equipment are necessary such as:

1. Circuit Design Software: This is essential for designing and simulating the electrical system.
2. Soldering Kit and Multimeter: These are required for accurate assembly and measurement.

4 Project Milestones And Objectives

This chapter will investigate the milestones that we share as a group as well as a gateway for my section of the project. Milestones are events that are clearly and specifically defined. These events mark significant stages of the project such as building and testing our prototype vehicle.

4.1 Significant Milestones For The Project

This part of the chapter looks at the team's milestones. The team set out a few milestones that we should achieve by a particular date and time. Below is an image that shows the milestones we set out to achieve:

Milestones		
Position	Date	Milestone
1	08/10/2024	Start (08/10/24)
-2	24/10/2024	Prototype Designs (24/10/24)
1	28/10/2024	Rough CAD Design(28/10/24)
-1	10/11/2024	Detailed CAD Design(10/11/24)
-1	28/11/2024	CAD Base/Wheels/Brackets(28/11/24)
1	02/12/2024	3D Print Components(02/12/24)
1	09/12/2024	Presentation(09/12/24)
-1	18/12/2024	Programme Sensors(18/12/24)
1	09/01/2025	Assembly(09/01/25)
-2	10/01/2025	Mock Test 1(10/01/25)
3	16/01/2025	Mock Test 2(16/01/25)
-2	30/03/2025	Viva(30/03/25)
-1	04/04/2025	Internal UWTSD Heats(04/04/25)
1	04/05/2025	South Wales Reginal Heats(04/05/25)
-3	04/11/2025	National Finals London(04/11/25)

Figure 2: Image showing the group's set milestones.

These milestones act as a checkpoint to review the team's progress, address any issues that have come up, and to make sure we are ready for the next phases of the project. An

example of this is the assembly, which indicates that the project is ready for the testing phase, which helps us see how effective and efficient our design is and helps us see areas that need improvement.

4.2 Gateway Objective: Functional Testing Of Electrical Control System

A gateway shows a crucial checkpoint within a project that has to be successfully achieved before moving forward to other tasks. An important gateway in my section of the project is the testing of the electrical control system(Singh, 2017).

This gateway's objective is to thoroughly test all the components that make up the electrical control system. This is very key as it ensures that the system meets all the required requirements and safety requirements. It is also key as it shows that the car can operate reliably, can perform all the tasks that we require from it and, interact well with other systems.

Key testing steps:

1. Setup: This requires all the components to be assembled. After assembling all the components, preliminary checks will be performed to ensure that all wiring, connections and circuit pathways are insulated and secure.
2. Power and signal testing: Testing that the power button works correctly and powers the vehicle in the intended way. This is to also test that the system powers on in the correct sequence.
3. Performance test: Conducting the test in accordance with the IMechE design challenge. This is to see that the vehicle can complete the tasks set out in the design challenge and can complete the tasks under the required time of 3 minutes. This is to also see the vehicles accuracy and stability.
4. Safety testing: Carry out a number of tests to confirm the safety of the system. An example of these tests is circuit protection mechanisms such as a simple fuse that blows when the power is too much or when the batteries start to overheat.

After the completion of these tests, I expect the control system to pass all the safety and functional tests without any major issues, as this will allow the project to move to move to

its final stage, which is allowing us to be able to compete in the design challenge effectively. This will also help us stand a chance in winning the design challenge.

Approval criteria:

The approval criteria are a list of all the things that the system has to be able to do before the gateway objective can be declared as achieved. The list is as follows:

- Meet all the specified performance benchmarks.
- Be able to operate in a stable and reliable way for at least 24 hours.
- Have no safety failures in the stress and overload tests.

Achieving this gateway objective will ensure that as a team we have a solid foundation as it will reduce the likelihood of issues in later stages of the project.

5 Risk management And Mitigation Strategies

In this chapter, I will identify two key risks that are specific to my part of the project which are electrical system design and vehicle programming. To prevent delays, maintain quality standards and, ensure safety of the final product an effective risk management strategy is needed. Mitigation strategies are assigned to each risk that has been identified to reduce the likelihood of any issues(Erkoyuncu, Apa and Roy, 2015) (Ahmed, 2017)

5.1 Identified Risks And Mitigation Strategies

Risk 1: Component Failure During Testing

Risk description: In the electrical control system there is a major risk of the components failing due to many issues such as short circuits and incompatibility with other parts in the system. The image below shows a melted bread board circuit due to loading issues:

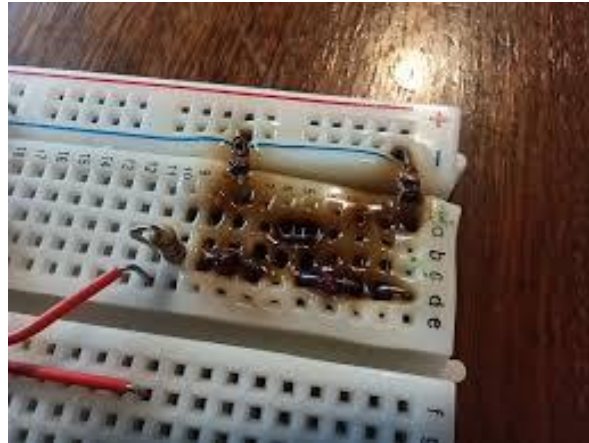


Figure 3: Image showing melted bread board circuit.

Impact: The component failure could result in delays which as a big impact on the projects timeline. Another impact of component failure is an increase in cost for the replacement components and a failure to source the same component as it could be sold out or no longer in production.

Mitigation strategy:

1. Current and voltage protection – to prevent ruining components, the incorporation of a fuse and voltage regulator into the design of the electrical control system will help prevent components being damaged from electrical overloads.
2. Use of high quality components- using reliable components that have been tested and used in the same applications and are from trusted sources will help prevent issues such as components not working or easily getting damaged.
3. Pre-testing components – the testing of components individually before integrating them with other parts in the system will help identify any issues early.
4. Spare parts – keeping an inventory of spare parts could also help with replacing said components without the delay of having to source new components.

Risk 2: Software integration errors

Risk description: Due to the project involving a programmable element, there is a risk that the software may not integrate/perform well with the programmable components. This can be due to a number of issues such as not updating the software used to the latest version.

Impact: Errors in the software can cause a number of the programable components not to function as intended. This will mean that time will have to be spent troubleshooting the issue, potentially leading to further delays in the project.

Mitigation strategy:

1. Documentation – documenting all the code can help to make troubleshooting easy and to ensure that all the team members understand the code’s structure.
2. Version Control – making sure that the programming software and supporting modules are automatically updated and automatically update the code will help reduce issues of incompatibility.
3. Simulation – the use of simulation software helps to see what the written code will do before applying it to the hardware. This will help reduce hardware damage due to software issues.

The identification of these risks and the application of the mitigation strategies, the team aims to reduce potential delays in the project and maintain reliability in the final product. This will mean that the team is prepared to handle issues efficiently if they arise.

6 Project Planning Using Gantt Chart

This chapter will look into the overall Gantt Chart for the entire group project by identifying both group and individual tasks, milestones, and gateways. The chart is an efficient way of managing tasks and time by allowing progress to be monitored and allowing adjustments to help the project stay on track.

6.1 Project Gantt Chart

The Gantt chart outlines all the key tasks, predicted duration, start and end dates, and milestones. This will help with management for the whole team, making sure that key tasks are managed in a way that they can receive adequate focus (Geraldini and Lechter, 2021).

Key milestones and gateways:

- Completion of project planning.
- Detailed CAD designs.
- First group project viva.

- **Gateway objective:** Functional testing of electrical control system.
- Prototype completion.
- Testing and evaluation completion.
- Final report and adjustments.
- Second group project viva.

The Gantt chart below shows the overall tasks that the group have to complete, start and end dates for the tasks, and the overall progress of the tasks that have been started.

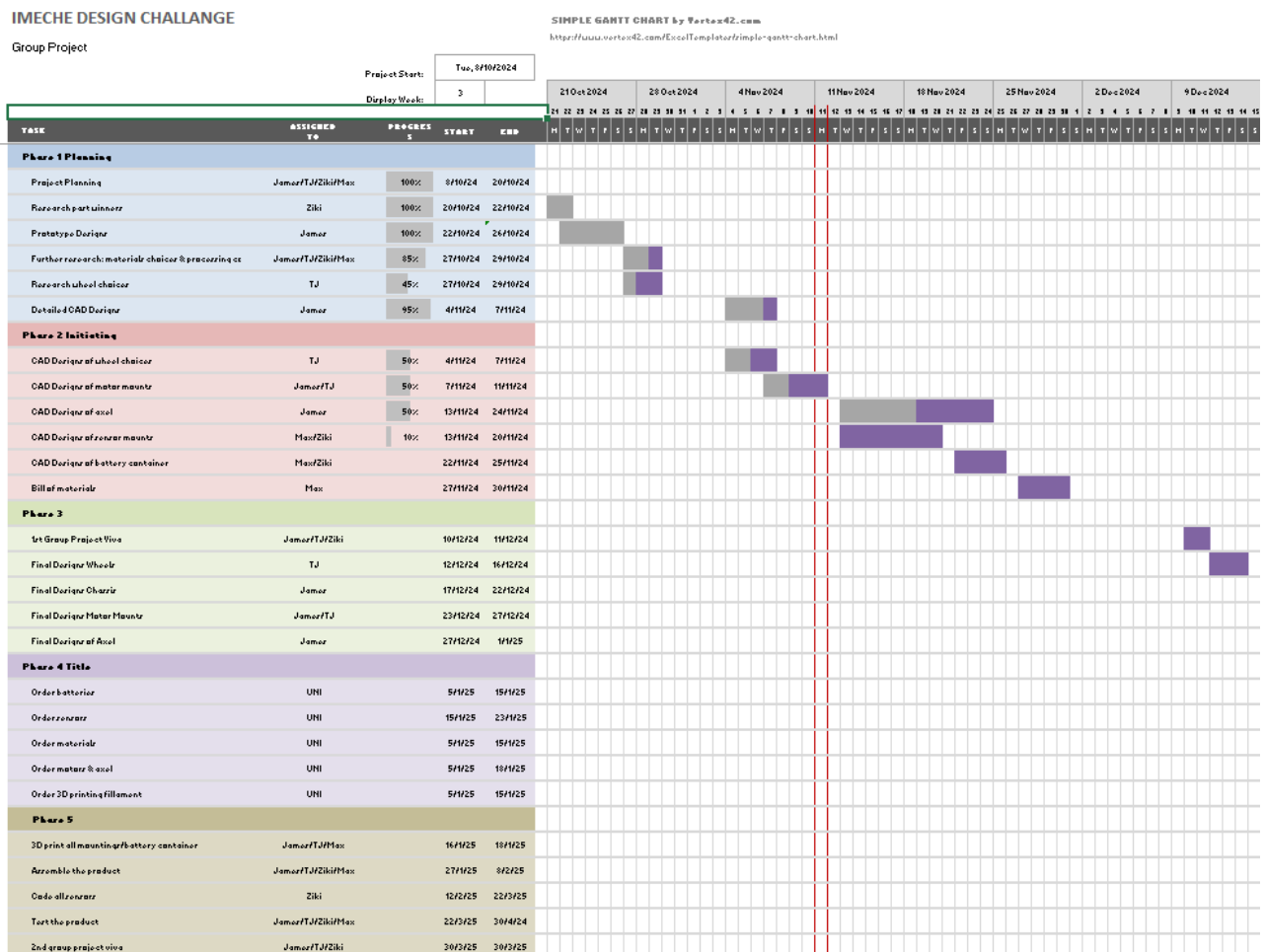


Figure 4: Image showing overall group Gantt chart.

The above Gantt chart provides a structured way of tracking the progress of the project, adapting hours worked, and adjusting timelines when needed.

6.2 My Responsibilities and Tracking Progress

Primary responsibility:

Within the overall project, my primary responsibilities include:

- **Electrical system design:** creating a design for the electrical control system and documenting the steps taken in the process.
- **Programming control system:** developing the code for the control system and testing it to ensure that it is efficient and works with no errors.
- **Hardware assembly:** assembling the electrical system and making sure it complies with the safety rules of the design challenge.
- **Testing and debugging** testing the system thoroughly to make sure it is reliable and performs as intended, with focus on the functional testing gateway.

Tracking hours and adjustments:

I created predictions of how many hours it should take me to complete these tasks, also leaving room for adjustments based on real time. I will monitor the following as the tasks unfold:

- **Hours worked vs predicted hours:** tracking my actual hours allows me to see whether I'm on track or need to make adjustments to my tasks.
- **Flexible task start:** if I complete a predecessor tasks early, I can start the next task ahead of the scheduled time. This will help in advancing the projects timeline.

7 Project summary

This final chapter provides an overall summary of the project. The main objective of this project was to develop an autonomous repeatable vehicle with a programable element which allows it to be repeatable. By following our project plan, we were able to achieve the following:

- **Design of vehicle:** we have managed to finish designing our final designs for the vehicle. This means we can proceed to the building stage.
- **Development of prototype:** we were able to reach a stage in the prototype development where we are ready to start building and testing the vehicle.

- **Team collaboration:** the team has effectively collaborated well together allowing for the completion of a lot of tasks that we had set out.

Each milestone at this stage has been met so far. These milestones have also been met on schedule and some earlier allowing for us to progress to other tasks that need to be completed. The structured planning shown in the Gantt chart has helped in ensuring that tasks are completed on time.

8 Conclusion

In conclusion, this project is currently on track to meet our overall objectives. The progress that the group has made so far shows how effective project planning has been to the project by setting milestones, timelines for tasks to be completed, and gateway objectives. The Gantt chart has been a great tool to help monitor our progress and see tasks that must be completed, which has propelled this group project in the direction of great success.

9 References

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