

University of Wales Trinity St David – School of Engineering

ACHA5012 – ENGINEERING MANAGEMENT PROJECT PLANNING
REPORT

RHYS TREMELLING (2102909)

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Project Introduction

The aim of the group project is to take the chassis from a formula 750 race car, which is normally powered by a Fiat 1108cc 'Fire' engine, with components such as camshaft, flywheel, induction, exhaust system and engine tune all limited, and design, create and put together an electric drive train to power the car. We are doing this as electric vehicles and components used in electric vehicles in the recent years have not only significantly reduced in price, but have improved significantly, allowing for certain advantages over internal combustion engines, such as instant peak torque, improved power delivery, improved size of the motor when compared to an internal combustion engine, and improved resistance to environmental factors such as temperature or atmospheric pressure. The aim of the project is to build a car that not only consistently competes with the fastest cars on the grid, if not consistently winning races in its category. And because of the aims of the project it will be very easily measured as we will be able to compare lap times between our electric drivetrain vehicle and an internal combustion drivetrain vehicle, and enter our vehicle in a couple of formula 750 races to see where it would come in the standings.

Team member roles and responsibilities

Team Member	Roles/Responsibilities
Oliver Moss	Leader & Final Drive
William Hare	Cooling System
Nick Davey	Brakes & EV Regen
Freddie Watkins	Packaging & Batteries location leading to Suspension
Ryan Calderon	Differential & Final Drive
Luke Dyas	Data & Sim
Owen Roberts	Leader & DVT
Daniel Hannis	Safety
Ross Burnside	Charging Trolley
Rhys Tremelling	Wiring
Peter Grima	Battery Management System

As mentioned in the table above, my roles and responsibilities are for the wiring of the vehicle, more specifically the wiring of the safety wiring harness of the vehicle, connecting components such as the driver and Marshall cutoff switches, status lights for the high voltage system and the ready to move light and the modules and switches for the fire suppression system. To carry out these roles and responsibilities that I have been given, I will need good teamworking skills, so that I can communicate with the other members of my group that are responsible for systems that I will have to interact with, such as having to communicate with Daniel as to what is needed to connect the fire extinguisher modules to the rest of the wiring and where they are going to be mounted on the chassis so that we can

measure the length of cabling that will be needed, similarly I will have to communicate with Freddie as to where the batteries will be mounted to measure the amount of cabling that will be needed to connect to them. I will also need to communicate with Peter and William as to how the system will connect to the battery management system, and how it would shut down all of the electrical systems in the event that the batteries and/or the motor were to overheat. I will also have to have good researching and problem-solving skills as there will be lots of research needed into all of the rules and regulations that both Motorsport UK and formula 750 have around electric vehicles, and all the specifications that they have when it comes to safety equipment. After completing the BELBIN self-analysis, I found that my strongest roles were team worker and plant. This means that I should be more than able to fulfil my roles and responsibilities, and have the skills needed to complete them efficiently and in a timely manner. This is because as a team worker, I am co-operative, perceptive and diplomatic, and even though I struggle to make unpopular decisions there should not be too many of them that have to be made. As a plant, I will be able to be creative and imaginative when it comes to designing the wiring harness and be able to solve difficult problems, however I will have to make sure that I communicate effectively even when I am preoccupied by tasks or research.

Group tasks and timings

Team Member	Tasks (Chronological)	Time to Complete
William Hare	-Heat generated by system -Flow rate -Heat exchange -Piping, pump, radiators and costs -Cooling Trolley	5-6 days 2-4 days 2-4 days 1-2 days 5-6 days
Luke Dyas	-Expected Duty Cycles -Obtain Quantifiable Data -Analyse Data -Create MATLAB base model -Research Battery Capabilities -Determine Realistic and Possible Energy Recovery Amounts -Determine what amount of Energy can be Recovered at different Velocities and Regen Amounts -Modify and Refine Simulation Data with Real World Results - Vehicle Data Fact File	
Nick Davey	-Look into KERS regen, decide which method to use which is most beneficial for application -Final decision on brake temp sensors -Look into larger rear brakes -Brake pad compound (higher temp ones)	
Freddie Watkins	-Take Measurements of the battery cells and motor -Mock up the configurations of each battery pack in SolidWorks -Come up with a design for each battery casing -Find model for EMRAX 268 and find a suitable mounting location in SolidWorks -Design and fabricate bracketry for mounting the motor and battery casings -Fabricate two battery casings using sheet aluminium	
Rhys Tremelling	-Design a mount for the throttle potentiometer -Research into wiring diagrams for the switching/safety wiring harness -Communicate with Daniel to find out the positions in which the fire suppression system will be mounted -Take key measurements of the chassis	-14 days -2 days -0.5 days

	-Research what wiring is needed and find a supplier -Research what emergency cut off switches are required, where they are going to be mounted, how they are going to be mounted and find a supplier -Research into any other components needed such as relays and find a supplier -Source all the components needed -Design the wiring harness -Mount all of the components to the chassis -Connect all the wires together to form the harness -Carry out tests to make sure that everything works correctly	-1 day -2 days -2 days -1 day -0.5 days -16 days -16 days -11 days -6 days
Ryan Calderon	-Calculate final drive and torque slip calculations -Create a list to have generate idea on a differential choice -Call up locations and collect selected differential -Consider differential housing manufacture process -Start developing a differential housing and consider mounting positions -Figure out belt tensioning mechanism -Mount up differential in harmony with other essential components	1-2 days 1-2 days 2-3 days 2-4 days 8-10 days 2-3 days 3-4 days
Peter Grima	-Research Battery Management system -Find optimal BMS for our car -Purchase / create BMS -Mount into vehicle -Program BMS -Integrate to driver display	2-5 days 1-3 days 2-4 days 1-3 days 2-7 days 1-4 days
Daniel Hannis	-Fire Extinguisher -Sort location for Fire Extinguisher in car and CAD -Sort the exact extinguisher positives and negatives of different ones -Crash Protection -Chassis rigidity -Further research crash protection in Formula 750 Cut Offs	

	-Handle for driver to pull and two for marshals, work alongside wiring and CAD model it in. -Adhering to safety regulations -Researching all aligned safety regulations -Ensure final car is legal	
Owen Roberts	- CAD of Chassis -Configuration of controller IO, CANBus, motor parameters & vehicle drive performance parameters -Controller status and fault diagnosis - Data logging of controller/motor performance on test bench or vehicle - Lead the team	
Oliver Moss	- Lead the team - Take Minutes - Create and maintain viva - Assist Measuring and CAD Chassis - Assist with Final Drive	-All Time -50 Hrs -25 – 30 Days -4 – 5 days -7 – 10 Days
Ross Burnside	-Establish charging method using the I-Pace battery pack including charge controllers/mobile DC to DC capabilities. -Research I-Pace cooling system and develop to work on/with the trolley. -Develop trolley idea to best suit the I-Pace battery pack layout. -CAD design of trolley/battery pack/dolly extension/cooling system. -Theoretical charging times. -Materials/manufacturing price list.	

My Tasks

My Tasks		
Task	Description	Time
Design a mount for the throttle potentiometer	The first task needed to be done was to design a mount for the potentiometer that is being used as the throttle in our vehicle to request power from the electric motor, as the chassis was not designed to be used with this so one had to be custom designed.	8 Hours – 14 days
Research into wiring diagrams for the switching/safety wiring harness	As this is my first time undertaking anything like this, a lot of time and research will be put into looking for existing harness' and wiring diagrams to give me a better understanding as to what they actually are, how they function and to help with leaning how I can create one for our vehicle.	4 Hours – 2 days
Communicate with Daniel to find out the positions in which the fire suppression system will be mounted and Freddie to see where the battery is mounted	I will need to know where the location of both the fire extinguishers and the batteries are going to be as I will have to include lengths of wire that are long enough to reach both of them.	1 Hour – ½ a day
Take key measurements of the chassis	Similar to the last point, I will need to take some measurements of key points of the chassis to make sure that I have lengths of wire for things such as the kill switches and the driver master switch so that they can be wired up when fitted to their correct locations on the chassis.	2 Hours – 1 day
Research what wiring is needed and find a supplier	I will need to research into if there are any regulations around what type or thickness wire is used, the thickness of the shielding of the wire and the location that the wire is mounted onto the chassis.	4 Hours – 2 days
Research what emergency cut off switches are required, where they are going to be mounted, how they are going to be	I need to research into what rules and regulations there are for what cut off switch can be used, how many of them are needed and where on the vehicle they need to be mounted. I will then need to find	4 Hours – 2 days

mounted and find a supplier	where they can be purchased from, and come up with a way to mount them to the appropriate location.	
Research into any other components needed and find a supplier	I need to research into all of the other components that the regulations require the vehicle to have, such as HV RESS status light and a ready-to-move-light, and find where they can be purchased from.	2 Hours – 1 day
Source all the components needed	All of the components that have been identified through the research that has been undertaken will then need to be purchased.	2 Hours – ½ a day
Design the wiring harness	Once all of the components have been ordered and have been delivered then they can be laid out and I can then design the wiring harness that will connect all of the components together.	8 Hours – 16 days
Mount all of the components to the chassis	Mounts will need to be designed for all of the components that have not already got mounting solutions for, and then everything can be bolted on to the vehicles chassis ready to be wired up together.	8 Hours – 16 days
Connect all the wires together to form the harness	After all of the components have been mounted to the vehicle, I will have to make sure that I have the correct lengths of wire to connect all of the components and wire everything up on the chassis and mount all of the cabling so that it is secure.	5 Hours – 11 days
Carry out tests to make sure that everything works correctly	The vehicle will then be ready for testing in a controlled safe environment so that if something has been done wrong we can find out without anyone being harmed and the issue can be rectified.	3 Hours – 6 days

I have calculated the total time that these tasks for my area of the project will take and it is around 50 hours, and that the total time for group work will total to around 120 hours, this includes the standard number of hours set aside for weekly meetings and for working on the vehicle once we start work. However, it also takes into account extra meetings during group project week, preparation for the written report and the interim and final VIVA's, and extra meetings in weeks where we have less or no lectures where further progress can be made on the project. This means that I have estimated that I will put 170 hours into the group

project over the academic year, 30 less than the recommended 200 hours. However, this is only an estimate and I believe that the actual amount of hours put in will be greater than that estimate, as there will be issues and problems that will need to be sorted or I may have to assist a group member with there area of the project where I have knowledge.

Bill of materials		
Material/equipment needed	Cost	Lead Time
Cabling	£15 for 1m	48 Hours
Driver Master switch	£55.	48 Hours
Race Marshall Neutral switch	£55	48 Hours
2 X pull extinguisher switch	£18 x 2	48 Hours
Driver push extinguisher switch	£35	48 Hours
HV RESS status light	£40	48 Hours
Ready-to-Move-light	£40	48 Hours
12V auxiliary battery	£130	48 Hours
12V Relay	£15	48 Hours
Miscellaneous equipment such as solder, cable ends	£20	48-72 Hours

There are a few pieces of specialist equipment that I will need to use in order to successfully complete my area of the project, and these are:

- Multimeter
- Calbe Crimper and wire stripper
- Equipment to mount to chassis (drill, tap, welder)
- Soldering wire and solder
- Heat gun and heat shrink
- Cable terminals

Significant Milestones

Group milestones		
What is the milestone	Why it is a milestone	When will it be achieved
Interim VIVA	This is a milestone for the project as it allows us to show our sponsor for the project, UWTSD, how much progress we have made with the project, the decisions that we have made and what we aim to do in the near future	This milestone will be achieved when we have presented the interim VIVA, Wc11th of December
Work on car started	This is a milestone for the project as it means that all of the theoretical work and the design work has been completed and as a group we are ready to start working on the car and assembling all of the parts together	This milestone will be achieved when we have started working on the car, which will hopefully start on Monday 22/02/24
Report	This is a milestone for the project as it details all of the technical progress that we have made in the project, it describes in detail how and why we made all of the choices that we did and it allows anyone that has not been involved in the project to get a good understanding of it	This milestone will be achieved when we have handed in the report, by the 17 th of march
Final VIVA	This is a milestone for the project as it allows us to show our sponsor for the project, UWTSD, how much progress we have made with the project, the decisions that we have made and what we aim to do in the near future	This milestone will be achieved when we have presented the Final viva, Wc18th of March
Car ready to be switched on	This is a milestone for the project as at this point we will have all worked	This milestone will be achieved when we have finished designing and

	together and finished our vehicle, and it will be ready for scrutineering and if it passes that ready to race	fitting everything to the car and it is ready to be driven, towards the end of the academic year in March 2024
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The most important gateway objective that I am going to meet during the group project is when my safety harness has been completed and is fully wired, and we are able to test all of the functions of the safety system. This gateway objective is one of the only gateway objectives for my particular area of the project as only a few of the milestones for my area of the project have a strict or measurable performance criteria, however when everything has been put together it can then be tested to make sure that every component works and that it meets all of the rules and regulations, providing us with an absolute definitive value.

Areas for Concern

The first area of concern is that there is something wrong with the wiring and it has been done incorrectly. As I have mentioned previously in the report, this is my first time undertaking a project similar to this and therefore I do not have much experience when it comes to what components are needed and how they will be wired up, mounted and connected. To mitigate this risk, I will make sure that I will perform large amounts of research into all of the different components that are needed, how they connect to each other, how they will mount to our vehicle and what the most cost-effective options are. I will try and find as many resources as I can to support my knowledge and I will ask for the help of my group members and/or lecturers when it is needed.

The second area of concern is that when the car is scrutineered it does not meet all of the rules and regulations. Similar to the last area of concern, this is my first time undertaking a project similar to this and therefore I do not have much experience when it comes to the rules and regulations that have to be followed set not only by Motorsport UK but also Formula 750. To mitigate this risk it will be similar to how I will mitigate the other risk, I will make sure that I will perform large amounts of research into all of the rules and regulations for safety equipment set by all of the relevant governing bodies and societies, I will try and find as many resources as I can to support my knowledge and I will ask for the help of my group members and/or lecturers when it is needed



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	October 2023							November 2023																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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Project: Group Gantt ChartV2

Date: Sat 18/11/23

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone















Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only















External Tasks

External Milestone

Deadline

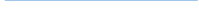
Progress

Manual Progress











ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	October 2023							November 2023		
								29	04	09	14	19	24	29	03	08	
26	🚧	Regenerative Braking System	8 days	Mon 27/11/23	Wed 06/12/23		Luke										
3	🚧	Group Project Interim Viva	1 day	Mon 11/12/23	Mon 11/12/23		Group										
14	🚧	Controller status and fault diagnosis	25 days	Wed 13/12/23	Tue 16/01/24		Owen										
27	🚧	Car Data Review and Accuracy Update	6 days	Mon 08/01/24	Sun 14/01/24		Luke										
15	🚧	Data logging of motor/controller	21 days	Tue 16/01/24	Tue 13/02/24		Owen										
12	🚧	Integrate BMS to driver Display	4 days	Wed 17/01/24	Mon 22/01/24		Peter										
9	🚧	Ensuring Car is Fully Compliant with the Regulations	14 days	Thu 18/01/24	Tue 06/02/24		Dan										
10	🚧	Carry out tests to ensure everything works correctly	20 days	Thu 18/01/24	Wed 14/02/24		Group										
28	🚧	Model and Calculations Validation and Integration with	16 days	Mon 22/01/24	Sun 11/02/24		Luke										
29	🚧	Simulation Analysis w/Real-World Comparison	11 days	Mon 26/02/24	Sun 10/03/24		Luke										

Project: Group Gantt ChartV2
Date: Sat 18/11/23

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only

External Tasks

External Milestone

Deadline

Progress

Manual Progress

Page 3

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	October 2023							November 2023		
								29	04	09	14	19	24	29	03	08	
4		Group Project Report	1 day	Thu 07/03/24	Thu 07/03/24		Group										
5		Group Project Viva Presentation	1 day	Tue 19/03/24	Tue 19/03/24		Group										

Project: Group Gantt ChartV2
Date: Sat 18/11/23

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone















Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only















External Tasks

External Milestone

Deadline

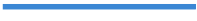
Progress

Manual Progress





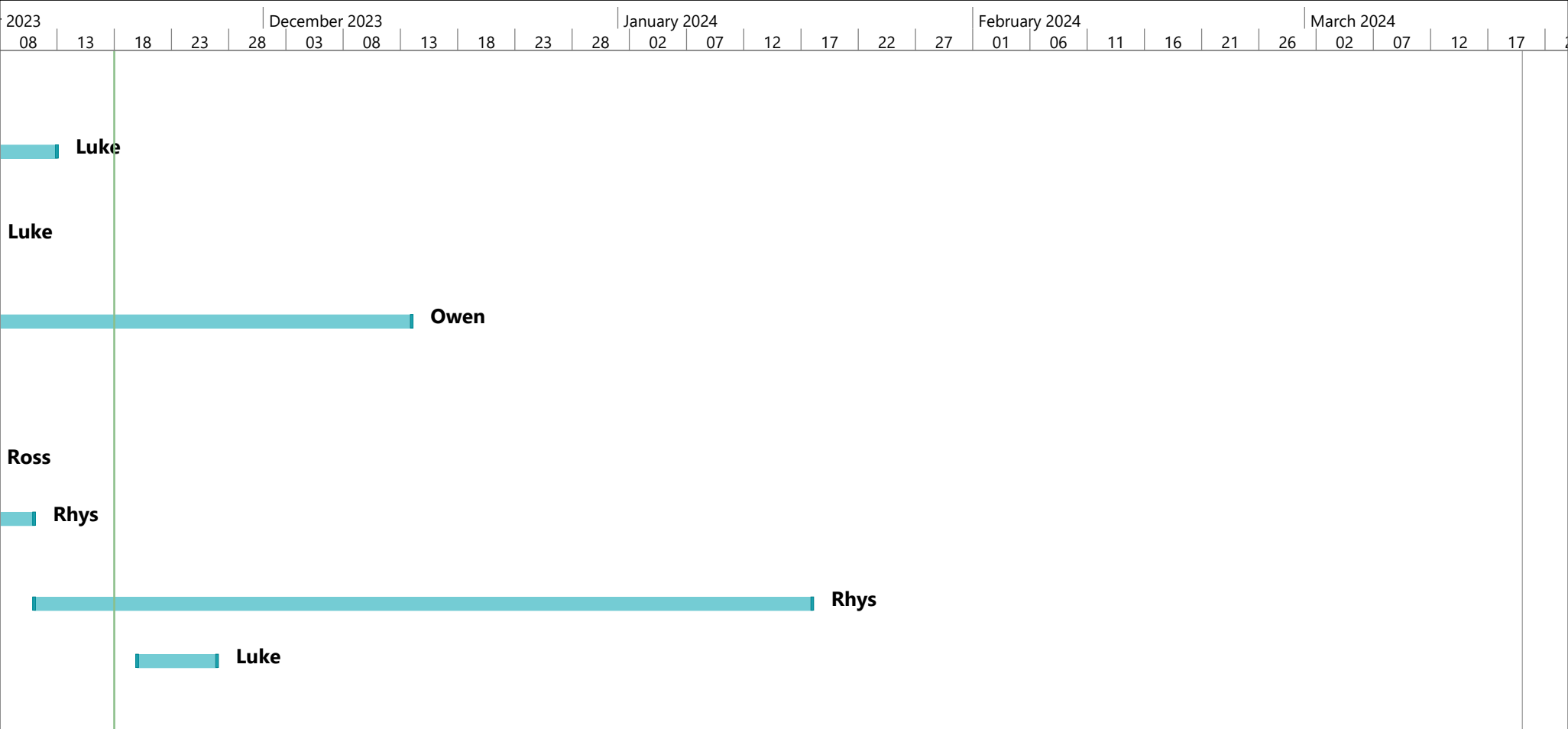




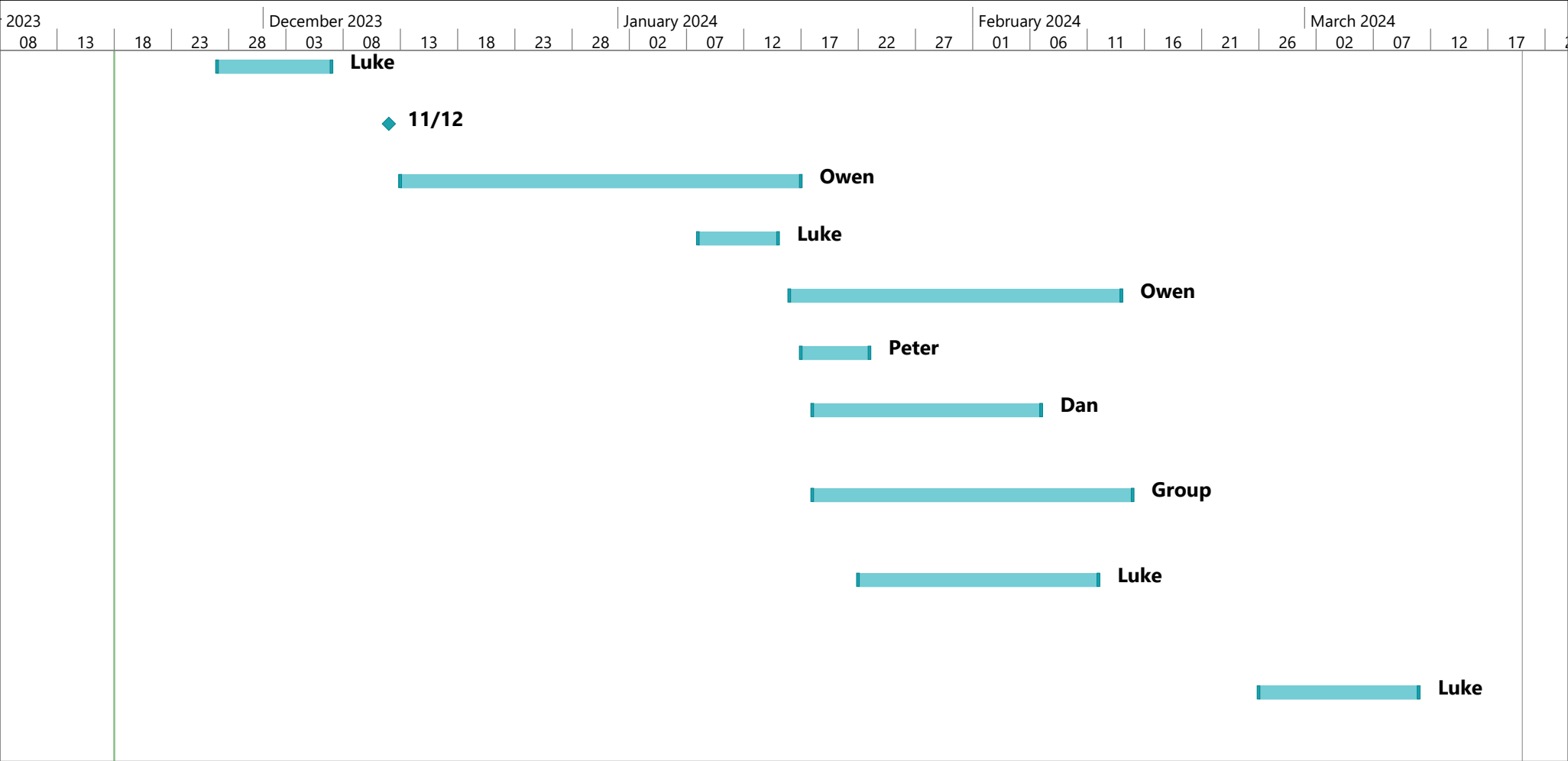




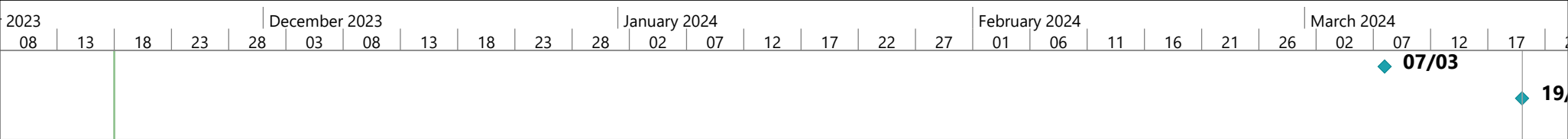
Project: Group Gantt ChartV2 Date: Sat 18/11/23	Task		Inactive Summary		External Tasks	
	Split		Manual Task		External Milestone	
	Milestone		Duration-only		Deadline	
	Summary		Manual Summary Rollup		Progress	
	Project Summary		Manual Summary		Manual Progress	
	Inactive Task		Start-only			
	Inactive Milestone		Finish-only			



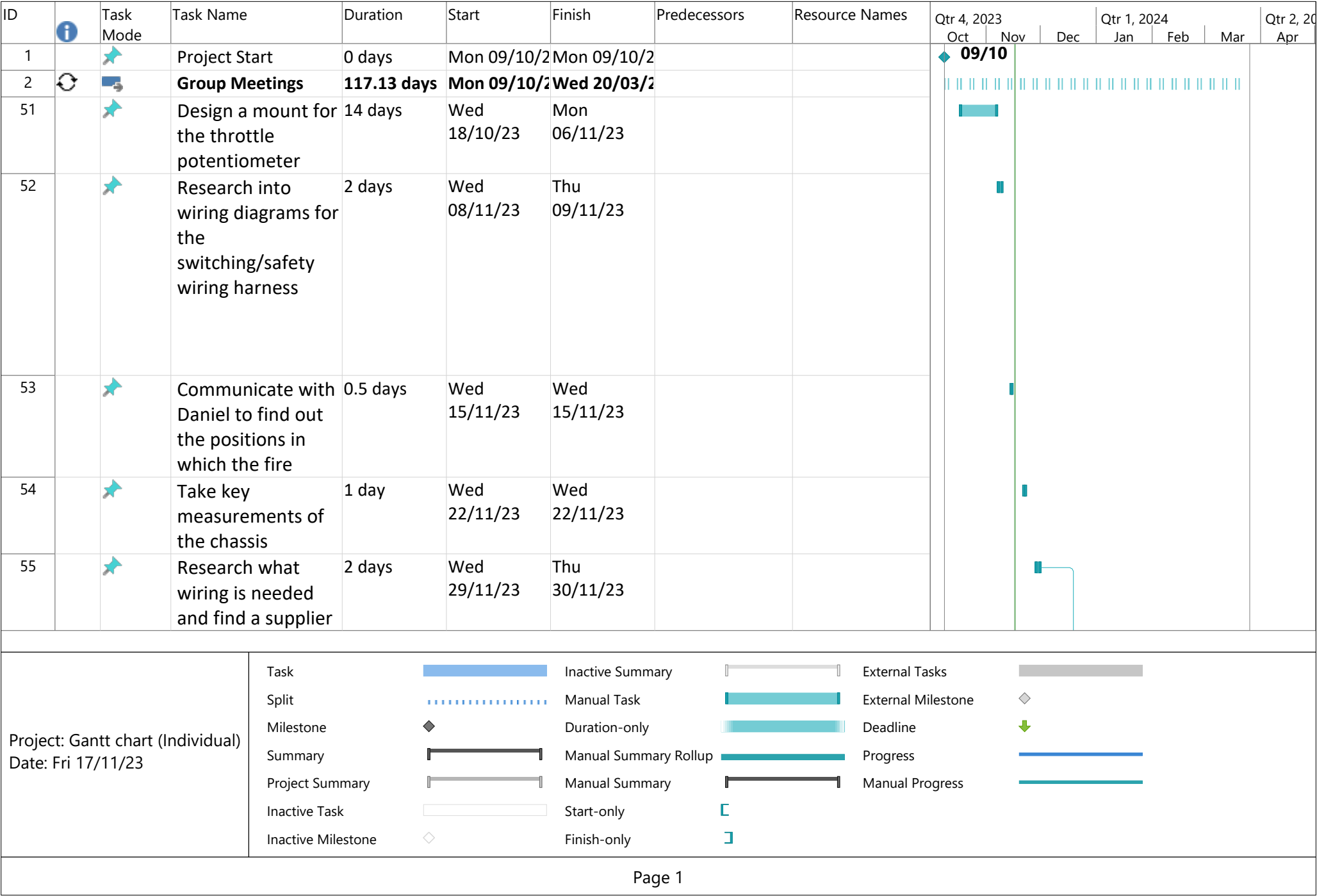
Project: Group Gantt ChartV2 Date: Sat 18/11/23	Task		Inactive Summary		External Tasks	
	Split		Manual Task		External Milestone	
	Milestone		Duration-only		Deadline	
	Summary		Manual Summary Rollup		Progress	
	Project Summary		Manual Summary		Manual Progress	
	Inactive Task		Start-only			
	Inactive Milestone		Finish-only			



Project: Group Gantt ChartV2 Date: Sat 18/11/23	Task		Inactive Summary		External Tasks	
	Split		Manual Task		External Milestone	
	Milestone		Duration-only		Deadline	
	Summary		Manual Summary Rollup		Progress	
	Project Summary		Manual Summary		Manual Progress	
	Inactive Task		Start-only			
	Inactive Milestone		Finish-only			



Project: Group Gantt ChartV2 Date: Sat 18/11/23	Task		Inactive Summary		External Tasks	
	Split		Manual Task		External Milestone	
	Milestone		Duration-only		Deadline	
	Summary		Manual Summary Rollup		Progress	
	Project Summary		Manual Summary		Manual Progress	
	Inactive Task		Start-only			
	Inactive Milestone		Finish-only			



Page 1

ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Qtr 4, 2023			Qtr 1, 2024			Qtr 2, 2024
									Oct	Nov	Dec	Jan	Feb	Mar	Apr
56			Research what emergency cut off switches are required, where they are going to be mounted, how they are going to be mounted and	2 days	Wed 06/12/23	Thu 07/12/23									
57			Research into any other components needed and find a supplier	1 day	Wed 13/12/23	Wed 13/12/23									
58			Source all the components needed	0.5 days	Thu 21/12/23	Thu 21/12/23	55,56,57								
59			All components on site ready to begin designing the	0 days	Thu 18/01/24	Thu 18/01/24	58						18/01		
60			Design the wiring harness	16 days	Wed 17/01/24	Wed 07/02/24	58								
61			Mount all of the components to the chassis	16 days	Wed 07/02/24	Wed 28/02/24	60								

Project: Gantt chart (Individual)

Date: Fri 17/11/23

Task

Split

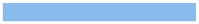
Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone















Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only















External Tasks

External Milestone

Deadline

Progress

Manual Progress











ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Qtr 4, 2023			Qtr 1, 2024			Qtr 2, 2024
									Oct	Nov	Dec	Jan	Feb	Mar	Apr
62			Connect all the wires together to form the harness	11 days	Thu 29/02/24	Thu 14/03/24	61								
63			Wiring harness completed and ready to be tested	0 days	Fri 15/03/24	Fri 15/03/24	62								15/03
64			Carry out tests to make sure that everything works	6 days	Fri 15/03/24	Fri 22/03/24	62								
65			Safety harness fully tested and up to standard set by rules and regulations	0 days	Mon 25/03/24	Mon 25/03/24	64								25/03

Project: Gantt chart (Individual)

Date: Fri 17/11/23

Task

Split

Milestone

Summary

Project Summary

Inactive Task

Inactive Milestone















Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

Start-only

Finish-only















External Tasks

External Milestone

Deadline

Progress

Manual Progress







