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Engineering Management

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1 Introduction

This assignment centres on the planning and management of our year 2 group project which aimed at upgrading the Honda NSF 250 race bike. The project requires structured collaboration within the team, with each member contributing to a specific area of development. This report will provide an overview of team roles, project milestones, potential risks, and resource requirements. A clear framework for managing tasks and timelines is established, with emphasis on setting and achieving measurable objectives to ensure the project's success. Additionally, risk mitigation strategies and project scheduling tools, such as Gantt charts, will be included to support effective project delivery.

2 Roles and responsibilities

2.1 Group roles

Group member	Role	Outline of role objectives
Harry Rogers	Triple clamp design and steering damper relocation	• Design and manufacture a replacement set of triple clamps for the NSF 250 • Improve strength-to-weight ratio • Enhance durability • Incorporate fore-and-aft adjustment • Accommodate relocated steering damper
Olly Gillson	Fuelling maps/engine strategies. Secondary injector and bell mouth	• Produce custom maps and engine strategies for the ECU • Research a replacement bell mouth • Incorporate a secondary injector for improved air and fuel flow
Edward Walden	Airbox design and optimisation	• Design a new air box to increase volume • Optimise air flow through the throttle bodies • Accommodate the new intake duct location
Aaron Lilly	Fuel tank design and subframe	• Redesign the fuel tank to fit around the new air box • Improve the bike's centre of gravity • Make the fuel tank smaller and lighter • Explore incorporating the fuel tank into the subframe for future development
Oska Robertson	Rear set design	• Redesign rear sets to make them adjustable • improve strength to weight ratio • Ensure ease of manufacturing for quick replacements • Design for durability, as they are often damaged in crashes
Megan Gwilym	Alternative fuels and fuel calculations	• Research appropriate air-fuel ratios • Optimise ignition timing • Investigate fuel options for performance optimisation
Jake Davies	Intake duct design	• Redesign the intake to relocate it from underneath the headstock • Improve air flow efficiency • Ensure compatibility with the new fairing design
Harvey Merrett	Front fairing design.	• Optimise the aerodynamics of the fairings • Incorporate the new intake design • Explore redesigning the fairing once aerodynamics are better understood

2.2 Personal role

My role in the NSF 250 project is primarily design based. There are several attributes outlined in Belbin's model affiliated with my role in the project, including completer finisher, team worker, implementer and monitor evaluator (Belbin, 2022).

2.2.1 Completer Finisher

The Completer Finisher attribute is important in a design role where meticulous attention to detail is crucial. For this project, achieving high standards of quality means ensuring that every component of the final product is carefully designed and rigorously tested. One key objective of the new yokes is to incorporate longitudinal offset adjustability, which will require precisely machined part clamping together. This aspect of the design may require multiple prototypes to refine the fit and functionality. As a result, the role calls for sustained focus and attention to detail throughout an extended development period. This is a strength I am well-suited for, given my high score in this attribute on my personal Belbin model. See Figure 1

2.2.2 Team worker

The team worker role is crucial for this project, as multiple components must integrate seamlessly. I will collaborate closely with Jake and Harvey to ensure that the yokes do not interfere with the new intake or contact the fairings. Additionally, I'll work with Oska to standardise tooling requirements for machining, thereby improving manufacturing efficiency. Since my assessment showed a lower score in the Teamworker role, see Figure 1, I'll need to make a concerted effort to work collaboratively and ensure that teamwork remains effective and efficient throughout the project.

2.2.3 Implementer

This role is key for translating designs into manufacturable parts with efficiency and reliability. For the yokes, this will mean paying close attention to the final design to ensure it is possible to machine in the university, and all tolerances are correct. Additionally, the part must be designed so that it is easy and quick to adjust at the track. Strong organisational skills are also essential to ensure all desired design features are incorporated into the final product. Since I scored above average in this attribute, I am well-suited to meet these requirements. However, I recognise that I can sometimes be resistant to change, which will need to be carefully managed as the project evolves.

2.2.4 Monitor Evaluator

The monitor evaluator attribute is particularly important in this project, as there are several aspects of the yokes with multiple possible approaches, requiring clear decision-making to determine the best options. Selecting a durable and reliable method for longitudinal adjustments is also crucial and will

demand critical judgment. My above-average score in this area indicates a strong fit for these responsibilities. However, Monitor Evaluators, myself included, can sometimes become overly focused on minor details, so I'll need to stay mindful of this tendency to avoid potential pitfalls.

	15	1	12	8	4	11	4	15
	IMPLEMENTER	COORDINATOR	SHAPER	PLANT	RESOURCE INVESTIGATOR	MONITOR EVALUATOR	TEAM WORKER	COMPLETE FINISHER
LOW 0-33%	0-6	0-6	0-8	0-4	0-6	0-5	0-8	0-3
AVERAGE 33-66%	7-11	7-10	9-13	5-8	7-9	6-9	9-12	4-6
HIGH 66-85%	12-16	11-13	14-17	9-12	10-11	10-12	13-16	7-9
VERY HIGH 85-100%	17-23	14-18	18-36	13-29	12-21	13-19	17-25	10-17
AVERAGE SCORE	10.0	8.8	11.6	7.3	7.8	8.2	10.9	5.5

Figure 1 personal Belbin's model (Belbin, 2022)

3 Group tasks

Name	Task	Start Date	End Date	Duration (Minutes)
Olly	Install & Test New ECU	9/30/2024	10/31/2024	31
Olly	Optimise Fuelling Maps & Strategies	10/31/2024	11/30/2024	30
Olly	Bellmouth/Secondary Injector RD&T	9/30/2024	1/31/2025	123
Olly	Design & Prototypes	10/15/2024	1/15/2025	92
Olly	CFD Bellmouth Designs	1/15/2025	2/14/2025	30
Olly	Production	2/14/2025	3/14/2025	28
Olly	Dyno Runs	1/1/2025	2/28/2025	58
Oska	Initial Measurements	9/30/2024	10/15/2024	15
Oska	First Design & Prototype	10/15/2024	11/15/2024	31
Oska	Design Refinement	10/15/2024	1/15/2025	92
Oska	Final Testing	1/15/2025	2/14/2025	30
Oska	Production	2/14/2025	3/14/2025	28
Harry	Initial Measurements	9/30/2024	10/15/2024	15
Harry	First Design & Prototype	10/15/2024	11/15/2024	31
Harry	Design Refinement	10/15/2024	1/15/2025	92
Harry	Final Testing	1/15/2025	2/14/2025	30
Harry	Production	2/14/2025	3/14/2025	28
Jake	Initial Measurements	9/30/2024	10/15/2024	15
Jake	First Design & Prototype	10/15/2024	11/15/2024	31
Jake	Design Refinement	10/15/2024	1/15/2025	92
Jake	Final Testing	1/15/2025	2/14/2025	30
Jake	Production	2/14/2025	3/14/2025	28
Harvey	Initial Measurements	9/30/2024	10/15/2024	15
Harvey	3D Scans	9/30/2024	12/31/2024	92
Harvey	First Design & Prototype	10/15/2024	11/15/2024	31
Harvey	Design Refinement	10/15/2024	1/15/2025	92
Harvey	Final Testing	1/15/2025	2/14/2025	30
Harvey	Production	2/14/2025	3/14/2025	28
Megan	Research Alternative Fuels	9/30/2024	1/31/2025	123
Megan	Research Secondary Injector	9/30/2024	1/31/2025	123
Megan	Check Championship Regulations	9/30/2024	10/15/2024	15
Megan	Dyno Runs	1/1/2025	2/28/2025	58
Ed	Retrieve CAD Drawings	9/30/2024	10/15/2024	15
Ed	Update Designs	10/15/2024	11/15/2024	31
Ed	Prototyping	10/15/2024	1/15/2025	92
Ed	Design Refinement	10/15/2024	1/15/2025	92
Ed	Final Testing	1/15/2025	2/14/2025	30
Ed	Production	2/14/2025	3/14/2025	28
Aaron	Initial Measurements	9/30/2024	10/15/2024	15
Aaron	First Design & Prototype	10/15/2024	11/15/2024	31

Aaron	Design Refinement	10/15/2024	1/15/2025	92
Aaron	Final Testing	1/15/2025	2/14/2025	30
Aaron	Production	2/14/2025	3/14/2025	28

4 Personal tasks

Start date	End date	task	description	Hours invested
07/10/24	02/04/25	Team meetings	Weekly team meetings will be held throughout the project. In this meeting, we will discuss everyone's progress in their part of the project, along with the progress of the project as a whole.	20
07/10/24	14/10/24	Measure existing fork yokes	Accurately measure the existing fork yokes and steering tube.	5
07/10/24	14/10/24	CAD existing fork yokes	Create an initial CAD model to analyse current geometry and dimensions.	5
15/10/24	18/10/24	Gather deceleration data for calculations	Analyse the data collected during the last season of racing to find out the maximum deceleration the bike experienced.	5
19/10/24	20/10/24	Calculate forces on the headstock bearings	Analyse the forces acting on headstock bearings based on the maximum breaking load. Calculate this regarding fork position in its travel.	5
20/10/24	23/10/24	Research yoke design from MotoGP and world SBK	Research how yokes are designed in high level racing and offset adjustment methods.	10
23/10/24	26/10/24	Decide on yoke design method of offset adjustment through research	Evaluate different offset adjustment methods for the yoke. Select a method that balances adjustability, simplicity, and weight.	5
26/10/24	29/10/24	CAD preliminary design for replacement yoke	Create a CAD model incorporating the offset adjustment design concept. Focus on overall shape and size of the yokes, as well as the dimensional requirements of the steering tube to fit with original bearings.	10
29/10/24	1/11/24	Refine model with various levels of hollowing	Refine the preliminary model into multiple different variations with differing amounts of hollowing for weight reduction.	5
1/11/24	15/11/24	Perform FEA analysis on yokes.	Run FEA on CAD designs to assess stress and performance compared to calculated values.	15
16/11/24	20/11/24	Finalise first prototype design	Decide a yoke structure and offset design to be 3d printed. This must incorporate all axillary parts so it can be test fitted to the bike.	5
21/11/24	28/11/24	PLA print first prototype to investigate part fitment	3D print a PLA prototype of the yokes.	10
29/11/24	01/12/24	Test fit PLA printed part	Evaluate fitment on the bike in the workshop to identify clearance issues or necessary adjustments.	5

01/12/24	10/12/24	Prepare slides for viva presentation and practice with group	Compile the work completed so far into 3 minutes' worth of slides. Rehearse the presentation with the group.	5
02/12/24	10/12/24	SLS print final amended prototype	Create a high-precision SLS printed prototype for functional testing.	10
11/12/24	15/12/24	Fit SLS yokes to bike for a floor rest	Fit yokes to the bike and floor rest the bike. Ensure design functions as intended in static and minor dynamic conditions on the bike. Test parts on different offset positions to ensure adjustment functions as designed.	5
06/01/25	15/01/25	Finalise yoke design and tolerances for machining	Based on testing feedback, finalise design specifications. Specify tolerances required for accurate machining and optimal fitment.	10
16/01/25	25/01/25	Machine finalised yokes and steering tube	Start machining the final yoke and steering tube based on finalised CAD and tolerance specs. Perform quality checks post-machining.	10
26/01/25	27/01/25	Test fitment on bike and clearances with other components	Assemble machined yokes onto the bike. Verify clearances and fitment with surrounding components like fork legs, clip ons and steering damper.	5
26/01/25	27/01/25	Ground test bike with yokes installed	Ground test the bike with the yokes installed in different offset positions. Get the rider to sit on the bike to ensure everything is positioned correctly.	5
04/02/25	01/04/25	Draft final report	Begin writing the final report for the assignment hand in.	15
04/02/25	01/04/25	Begin preparing for the group presentation	Begin preparing slides and explanations for the group presentation.	10
04/02/25	07/02/25	First track test on bike	Conduct an initial track test with new components installed. Assess component performance under realistic conditions, noting any areas for improvement.	15
24/03/25	27/03/25	First race with new components	Complete the first race using the newly designed yokes. Evaluate durability, performance, and overall effect on bike handling under competitive settings.	25
01/04/25	01/04/25	Present project viva	Present the project with the group in the final viva.	1
Total hours				221

4.1 Equipment costs

Equipment	Cost	Use of equipment
Socket set/ hand tools	£200	Hand tools will be used to remove and re-fit the current, prototype, and finalised yokes.
Vernier callipers	£50	Measuring old yokes and mounting hardware.
Micrometre	£50	Measuring fork upper tubes.
Shadow graph	£15,000	Measuring the base fork offset built into the current yokes.
PLA 3D printer	£400	Prototyping initial yoke design.
SLS 3D printer	£24,000	Prototyping finalised design for test fitting.
CNC milling machine	£500,000	Machining the finalised yokes for the bike.
SolidWorks student edition	£0	All CAD, FEA and CFD tasks during the project.
Total cost	£539,700	

4.2 Materials costs

Materials	Cost	Use of material
PLA filament	£10	First prototype.
SLS powder	£40	Final prototype.
7075 aluminium stock	£100	Final machined part.
Total	£150	

5 Project milestones

5.1 Group milestones

Milestone	Description
All measurements of existing components and mounting locations have been taken.	Everyone in the group has been to the workshop to collect all the measurements they need to begin researching and developing their part of the project.
First viva	The group has completed the first viva presentation.
Fairings 3D scanned and modelled	The fairings have been 3D scanned and ported into SolidWorks. This will allow the development of the bike's aerodynamics package and intake relocation.
All new chassis components are fitted	The replacement yokes, rear sets and tank have been fitted to the bike prior to testing.
Engine runs with all new components fitted	The engine is stable and running with the new airbox, bell mouth and secondary injectors fitted.
Pre-season testing finished	The first test day at Pembrey has been completed with all the new parts fitted.
First race finished	The first race of the season has been finished.
Final viva	The final viva presentation has been finished and the project report handed in.

5.2 Personal milestones

Milestone	Description
All stresses on the headstock have been calculated	All stresses on the headstock are calculated and are in a form that can be applied during the stress analysis of the new part.
Prototype model of new yokes has finished the stress analysis phase	Prototype model of new yokes has completed stress analysis and is ready for the first PLS prototype print.
First PLA printed yokes are fitted to the bike	Initial PLA-printed yokes are fitted to the bike and all clearances have been checked.

Final SLS printed prototype is fitted to the bike	Final SLS-printed yoke prototype is fitted to the bike and meets all the design goals required.
Final machined part is fitted to the bike.	The final machined yoke is fitted to the bike, thus making it ready for pre-season testing at Pembrey.

6 Gateway objective

One gateway objective for this project is to have the SLS-printed prototype triple clamp fitted to the bike, with key performance and design criteria achieved. The first KPI (key performance indicator) is achieving the desired 3mm of offset adjustability, in 1mm increments, with a tolerance of $\pm 0.1\text{mm}$. This tolerance will apply to all offset positions. Additionally, the 0-offset position on the new yokes must align within $\pm 0.1\text{mm}$ of the original offset position of the factory yokes, preserving the original handling characteristics as a baseline.

Another critical KPI is weight optimisation, with the new yokes targeted to be 10% lighter than the original parts. This weight reduction must be achieved without compromising the strength or stiffness, maintaining structural integrity under operational stresses. This balance between weight and durability will improve overall bike handling without sacrificing performance.

Finally, the new yokes must integrate seamlessly into the current headstock using the original factory bearings. This KPI is crucial to avoid additional replacement parts, keeping the design compatible with existing components and reducing costs and complexity. Together, these KPIs validate the functionality, accuracy, and performance improvements of the new yoke design. Meeting these standards with the SLS-printed prototype will provide confidence that the design is ready for aluminium production.

7 Potential risks

7.1 Fitment and Clearance Issues with Prototype Yokes

A key risk is that the prototype yokes may not fit precisely or could interfere with nearby components such as the fairings, intake, or other front-end parts. This could lead to delays and additional adjustments after each prototype iteration, especially with the tight tolerances required. To mitigate this, we can conduct comprehensive measurements of the existing setup, validated through CAD simulations, to predict and address any possible interference issues. Begin with a PLA prototype to test fitment on the bike at minimal cost, and then use this initial fitment feedback to refine the design before producing the final SLS or machined prototypes, reducing rework.

7.2 Reliability and Precision of Offset Adjustment Mechanism

The offset adjustment mechanism must be both reliable and precise to meet the $\pm 0.1\text{mm}$ tolerance target. Minor inaccuracies could impact handling and alignment, while repeated adjustments might degrade the mechanism over time. This can be mitigated by specifying exact tolerances for the adjustment bushes and these corresponding surfaces on the yokes. We can also simulate wear cycles on the mechanism to ensure it retains precision and reliability, providing consistent offset adjustments without degradation across its lifespan.

8 Gantt charts

8.1 Group Gantt chart

	TASK	STATUS	START	END	DUR
1	Project Conception and Initiation - Group				
1.1	Agree & Assign Roles	Complete	30/09/2024	07/10/2024	8
2	Bellmouth, Injector & Maps - Olly				
2.1	Install & Test New ECU	Complete	30/09/2024	31/10/2024	32
2.2	Optimise Fuelling Maps & Strategies	On Hold	31/10/2024	30/11/2024	31
2.3	Bellmouth/Secondary Injector RD&T	In Progress	30/09/2024	31/01/2025	124
2.4	Prototyping & Testing	Not Started	31/01/2025	28/02/2025	29
2.5	Production & Fitting	Not Started	28/02/2025	14/03/2025	29
2.6	Monitoring & Adjustments	Not Started	28/02/2025	02/04/2025	15
3	Rearset Design & Development - Oska				
3.1	Design Research	Complete	30/09/2024	14/10/2024	15
3.2	CAD Development	In Progress	14/10/2024	31/01/2025	110
3.3	Prototyping & Testing	Not Started	31/12/2024	31/01/2025	32
3.4	Production & Fitting	Not Started	31/01/2025	28/02/2025	29
3.5	Monitoring & Adjustments	Not Started	28/02/2025	02/04/2025	34
4	Adjustable Offset Yokes - Harry				
4.1	Analyse OEM yokes	Complete	30/09/2024	25/10/2024	26
4.2	Research	Complete	25/10/2024	01/11/2024	8
4.3	Custom Yokes Design & Testing	In Progress	30/10/2024	30/11/2024	32
4.4	FEA Testing & Prototyping	Not Started	30/11/2024	31/12/2024	32
4.5	Production & Realworld Testing	Not Started	01/01/2025	31/01/2025	31
4.6	Monitoring & Adjustments	Not Started	31/01/2025	02/04/2025	62
5	Intake Development - Jake				
5.1	Research	In Progress	30/09/2024	11/10/2024	12
5.2	Design	Not Started	11/10/2024	31/10/2024	21
5.3	Prototyping & Testing	Not Started	31/10/2024	30/11/2024	31
5.4	Production & Fitment	Not Started	30/11/2024	10/01/2025	42
5.5	Realworld Testing	Not Started	31/12/2024	28/02/2025	60
5.6	Monitoring & Adjustments	Not Started	28/02/2025	02/04/2025	34
6	Fairing Aerodynamics - Harvey				
6.1	Research	In Progress	30/09/2024	11/10/2024	12
6.2	CAD/3D Scan Fairing	On Hold	11/10/2024	31/10/2024	21
6.3	Prototyping & Testing	Not Started	31/10/2024	30/11/2024	31
6.4	Production & Fitment	Not Started	30/11/2024	10/01/2025	42
6.5	Realworld Testing	Not Started	31/12/2024	28/02/2025	60
6.6	Monitoring & Adjustments	Not Started	28/02/2025	02/04/2025	34
7	Alternative Fuels & Injection Research - Megan				
7.1	Alternative Fuels & Injection Research	In Progress	30/09/2024	01/01/2025	94
7.2	Apply research (Testing)	In Progress	01/01/2025	31/01/2025	31
7.3	Monitoring & Adjustments	Not Started	31/01/2025	02/04/2025	62
8	Fuel Tank Development - Aaran				
8.1	Research & Design	In Progress	30/09/2024	31/10/2024	32
8.2	Prototyping & Testing	Not Started	31/10/2024	31/12/2024	62
8.3	Production & Fitment	Not Started	31/12/2024	31/01/2025	32
8.4	Realworld Testing	Not Started	31/12/2024	31/01/2025	32
8.5	Monitoring & Adjustments	Not Started	31/01/2025	02/04/2025	62
9	Airbox Development - Ed				
9.1	Familiarise With Previous CAD drawings	Complete	30/09/2024	11/10/2024	12
9.2	Research Further Development Options	In Progress	11/10/2024	31/10/2024	21
9.3	Continue Development	In Progress	11/10/2024	30/11/2024	51
9.4	Prototyping & Testing	Not Started	30/11/2024	31/12/2024	32
9.5	Production & Fitment	Not Started	31/12/2024	17/01/2025	18
9.6	Realworld Testing	Not Started	17/01/2025	31/01/2025	15
9.7	Monitoring & Adjustments	Not Started	31/01/2025	02/04/2025	62

8.2 Personal Gantt chart

	✓	TASK	PRIORITY	STATUS	START	END	DUR
###		Research Phase					
###	##	Measure existing fork yokes	Med	Complete	07/10/2024	14/10/2024	8
###	##	CAD existing fork yokes	Med	Complete	07/10/2024	14/10/2024	8
###	##	Gather deceleration data for calculations	High	Complete	15/10/2024	18/10/2024	4
###	##	Calculate forces on the headstock bearings	High	Complete	19/10/2024	21/10/2024	3
###	##	Research yoke design from MotoGP and world SBK	High	Complete	20/10/2024	23/10/2024	4
###	##	Decide on yoke design method of offset adjustment	High	Complete	23/10/2024	26/10/2024	4
###	0%						
###		Design Phase					
	##	CAD preliminary design for replacement yoke	Med	Complete	26/10/2024	29/10/2024	4
	##	Refine model with various levels of hollowing	Med	In Progress	29/10/2024	01/11/2024	4
	##	Perform FEA analysis on yokes.	High	In Progress	01/11/2024	15/11/2024	15
	##	Finalize first prototype design	Med	Not Started	16/11/2024	20/11/2024	5
	##	PLA print first prototype to investigate part fitment	High	Not Started	21/11/2024	28/11/2024	8
	##	Test fit PLA printed part	High	Not Started	29/11/2024	01/12/2024	3
	##	SLS print final amended prototype	High	Not Started	02/12/2024	10/12/2024	9
	##	Fit SLS yokes to bike for a floor rest	High	Not Started	11/12/2024	15/12/2024	5
	##	Finalize yoke design and tolerances for machining	Med	Not Started	06/01/2025	15/01/2025	10
	0%						
###		Testing phase					
###	##	Machine finalized yokes and steering tube	High	Not Started	16/01/2025	25/01/2025	10
###	##	Test fitment on bike	High	Not Started	26/01/2025	27/01/2025	2
###	##	Ground test bike with yokes installed	High	Not Started	26/01/2025	27/01/2025	2
###	##	First track test on bike	High	Not Started	04/02/2025	07/02/2025	4
###	##	First race with new components	High	Not Started	24/03/2025	27/03/2025	4

9 References

Belbin, M. (2022) *The Nine Belbin Team Roles*. Belbin.