

UWTSD

WISA



Honda NSF250 Group Project Report

Group Project Design ACHA5014

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Honda NSF250 Group Project Report

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1 Introduction

1.1 Project Overview

For this project, Charlie and Reuben will be looking at improving the performance of the UWTSD Honda NSF250. To do this, Charlie will be analysing past data using the MARData software to calculate the ideal gear ratios for the bike. Alongside this, she will use a gear ratio calculator where she can test the ideal ratios for a range of different final drive ratios. She will then research what other gearing options are available from HRC and how they would affect acceleration and top speed. As well as this, she will see what other transmission styles are available, such as a seamless shift style gearbox.

For Reuben's area of the project, he will be looking at improving performance by altering the bikes Dellorto ECU. To do this, Reuben will first build a Ricardo Wave model to replicate the NSF250 engine and run simulations to see what changes improve the horsepower and torque. From here, Reuben will make changes to the ECU to see where advantages can be gained and from there create an ideal map that can be used across all gears.

1.2 Project Organisation

In terms of organisation, Charlie took the role of team leader and focused on organisation whilst Reuben focused on the engine mapping. Every fortnight, both members would meet up on a teams call and discuss what progress they had made with the project and talk about future steps for the project. The team also attempted to follow a planned gannt chart to reach milestone along the projects timeline to make sure progress was made.

2 Engine Mapping (Reuben)

2.1 Work Content

For this area of the project, there were several aspects that needed to be looked at in order to improve the performance of the Honda NSF250 engine by modifying the Dellorto ECU on the bike. The initial plan for this was to look at how injector timing and advancing the ignition could give the Honda more torque and potentially smooth out the power curve towards the top of the RPM range, as on the standard Dellorto maps the power dips slightly around 13,000 RPM. Once the ideal injection and ignition parameters had been calculated, these changes would be made to the ECU and tested on the dyno before heading to Pembrey to see if improvements in lap time could be made over the standard maps.

2.2 Research

As to not put too many miles on the NSF250 engine, it was decided that the engine would be replicated inside of Ricardo Wave. This meant that the engine could be simulated with changes made before being implemented onto the bike, and the model could simulate whether the modifications would improve performance of the NSF250. Before the engine could initially be modelled in Ricardo Wave, a few key aspects needed to be measured to make sure the model matched the power output the NSF250 produces as standard.

To start with, the Inlet and Exhaust Valves were measured. This was key in the wave model to make sure the flow was correct, which is highly important for the Ricardo Wave software to give accurate results.



Figure 2-1 - Measurements taken of the Inlet (Top) and Exhaust (Bottom) Valves.

After this, the exhaust length was measured. To do this, wire was taped to the exhaust with dots every 5mm along the wire to get an accurate exhaust length. This again is also crucial for the Ricardo

Wave model as the flow of exhaust gases creates pressure within the exhaust as not having it accurate can lead to a fluctuation of around 5% in power. This means that if the exhaust length was incorrect and modifications were applied to the model, it could give false readings which may not see improvement when applied onto the Dellorto ECU (Gajula & Bari, 2017).



Figure 2-2 - Measurement of the Exhaust.

After this, an experiment to verify the clearance volume was conducted. This was done to get an accurate compression ratio for the wave model. To do this, the crankshaft was turned until the piston was at Top Dead Centre (TDC). From here, engine oil was dripped into the head from a volumetric pipette. Once the head was full of the engine oil, the amount of oil that had dripped from the pipette to see what the clearance volume was.



Figure 2-3- Clearance Volume verification experiment.



Figure 2-4 - The calculated clearance volume in the pipette.

As seen in figure 2-4, the clearance volume came out as 22.5 cc. In the Honda NSF250R manual as seen in figure 2-5, it states the swept volume is 249.3 cc (*Nsf250r 2012 Owners Manual English PDF | PDF | Motor Oil | Transmission (Mechanics)*, n.d.). The two values were then put in the following equation:

$$\text{Compression Ratio} = (\text{Clearance Volume} + \text{Swept Volume}) / \text{Clearance Volume}.$$

This gives a compression ratio of 12.08, slightly lower than in the manual. However, the experiment could be repeated 3 times and give different clearance volumes each time, as it's based on judgement when the oil reaches the top of the head.

Specifications	
Item	Specification
Dimensions	
Overall length	1,809 mm (71.2 in)
Overall width	660 mm (26.0 in)
Overall height	1,027 mm (40.4 in)
Wheelbase	1,219 mm (48.0 in)
Ground clearance	107 mm (4.2 in)
Seat height	726 mm (28.6 in)
Dry weight	84 kg (185 lbs)
Frame	
Type	Aluminium, twin tube
Front suspension	Telescopic, inverted type
Rear suspension	Swingarm, Pro-link
Front tire size	90/80 H17
Rear tire size	115/75 R17
Front brake	Single disc 296 mm, with 4-piston caliper
Rear brake	Single disc 198 mm, with single piston caliper
Fuel capacity	11.0 liter (2.91 US gal, 2.43 imp. gal)
Caster angle	22° 30'
Trail length	84 mm (3.3 in)
Engine	
Type	Liquid cooled 4-stroke engine
Cylinder arrangement	Single cylinder, inclined 15° from vertical
Bore and stroke	78.0 x 52.2 mm (3.07 x 2.06 in)
Displacement	249.3 cm ³ (15.21 cu in)
Compression ratio	12.3:1
Valve train	Chain driven, DOHC
Valve timing	
Intake opens	35° BTDC
Intake closes	50° ABDC
Exhaust opens	50° ABDC
Exhaust closes	20° ATDC
Lubrication system	Wet sump
Oil pump type	Pressure, forced pressure and wet sump
	Trichol

Figure 2-5 - The Honda NSF250R Engine Specifications

After this research had been carried out, it was time to create the first Ricardo Wave model.

2.3 Ricardo Wave

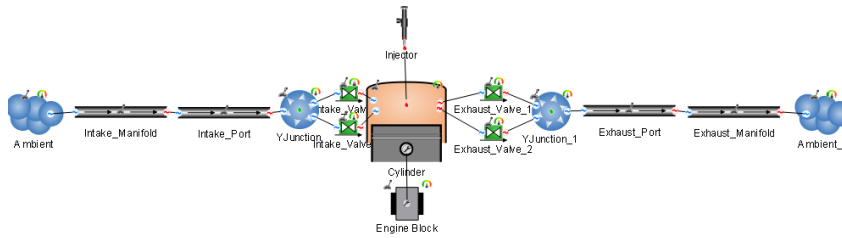


Figure 2-6 - The first Ricardo Wave model.

As seen in figure 2-6, this was the first version of the NSF250R engine inside of Ricardo Wave. This was made from the initial measurements taken from the valves, exhaust and compression ratio. However, the model didn't simulate and output results similar to the actual bike.

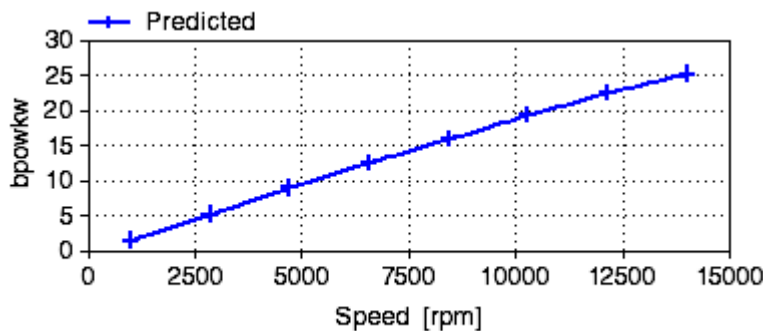


Figure 2-7 - The Power curve simulated from the first version of the NSF250R in Ricardo Wave.

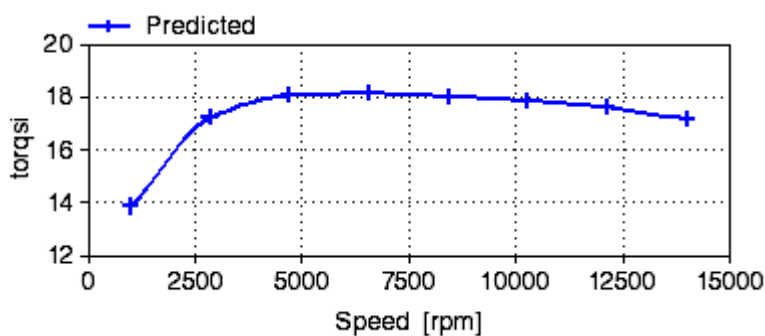


Figure 2-8 - The Torque curve simulated from the first Ricardo Wave Model.

As seen in figure 2-7 and 2-8, the values produced from the Wave Model are a fair way off from what the bike produces as standard on the dyno. For example, the standard Dellorto map produces around 43 Horsepower and around 26 Nm of torque. From this point, the Wave model was refined until it produced a Torque curve which gave results closer to what the NSF250R produces.

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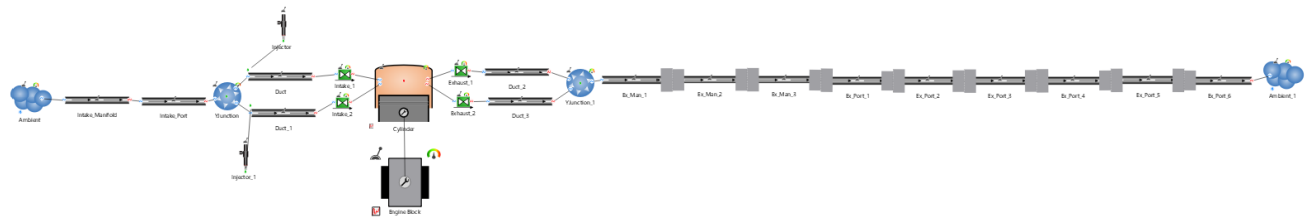


Figure 2-9- The refined Ricardo Wave model.

As seen in figure 2-9, this was the revised Wave model. It included a corrected exhaust length, a corrected compression ratio and the addition of the bottom Injector which replicates what the real bike has. After the model had been refined, it was simulated again to see what Power and Torque outputs it would produce.

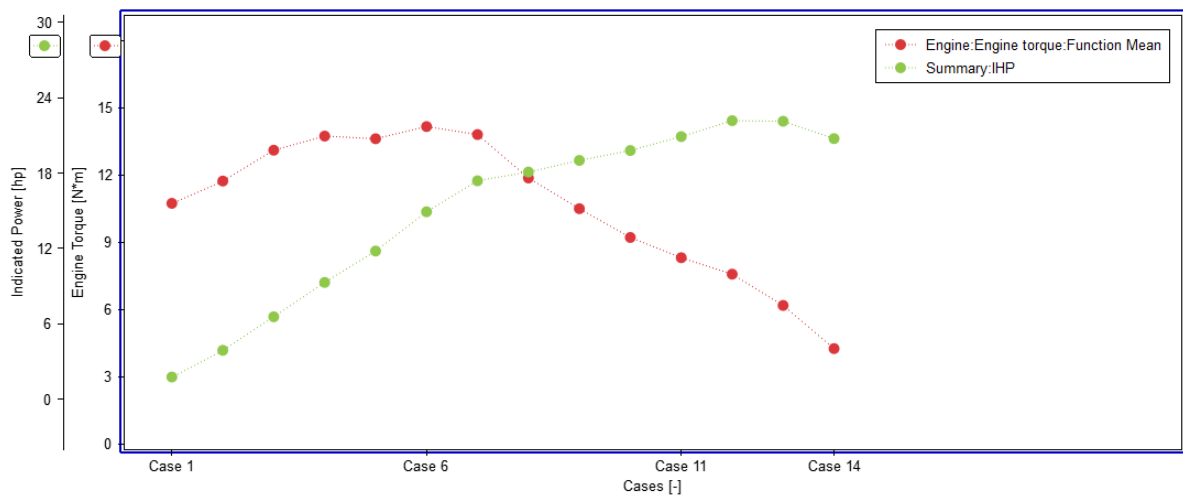


Figure 2-10 - Refined Ricardo Wave model Power and Torque curves.

As seen in figure 2-10, the curves on the graph have significantly improved compared to the initial model. Although the actual values are still not as close to the real bike as they should be, the actual shape of the curves match what the real dyno data show. From research of looking at other Wave models that simulate motorcycle engines, such as a Ducati 1199, getting the correct power output is quite difficult to match, but like the NSF250 model the curves on the graph match the real Ducati 1199 dyno curves.

Now that the model was refined, parameters of the engine could now be modified to see if more power and torque could be produced. One area that made more power when altered was the injection timing. In the model, if the injection timing was increased the power and torque would also slightly increase. This causes the engine to run a little richer, which is quite crucial at low RPMs for a

small capacity race bike. This was one area that would then be carried forward when modifying the ECU.

From further research, another area of the engine that modified could produce more power was by advancing the ignition. By doing this, more pressure is created within the cylinder as well as giving the air-fuel mixture more time to burn, which also improves combustion efficiency (*Ignition Timing Explained | Understanding the Basics & Importance*, n.d.). The benefit of this is more top end power, which will be key for the NSF250 on track. However, the ignition cannot be advanced by too many degrees as this could cause knock, which can lead to overheating and reduced power ultimately damaging the engine.

2.4 ECU Remapping

2.4.1 Mapping Overview

After simulations were ran inside of Ricardo Wave, it was time to remap the ECU. It was decided that initially two separate configurations would be created. One would be for ignition advance whilst the other would be for injection time. In the Dellorto ECU, each configuration contains three maps within it, meaning the rider can change between them for whatever he feels is best. It can also be used for doing back-to-back dyno runs and comparing how each map performs.

2.4.2 Ignition Advance

For the ignition advance, Map 1 was left as standard, Map 2 was set to 2 degrees advance, and Map 3 was set to 4 degrees advance. This meant that the ideal amount of ignition advance could be found without the risk of engine knock.

		Advance [DEG]															
		Map info															
		<	Gear 1	0	Gear 2	1	Gear 3	2	Gear 4	3	Gear 5	4	Gear 6	5	>		
RPM	6000	36.5	35.3	34.2	34.4	35.6	39.0	42.7	44.9	45.6	45.2	44.7	43.3	42.0	40.2	38.4	38.0
	6500	37.8	36.7	35.3	35.2	36.4	39.7	43.3	45.2	45.7	45.2	44.7	43.3	42.0	40.8	39.6	38.5
	7000	39.1	38.1	36.4	36.0	37.2	40.4	43.7	45.5	45.8	45.3	44.7	43.4	41.9	40.9	39.8	39.0
	7500	41.2	40.7	38.1	36.8	38.1	41.1	44.2	45.7	46.0	45.5	44.9	43.6	42.0	41.0	39.8	39.0
	8000	43.3	42.5	39.9	38.9	39.3	41.8	44.7	46.0	46.2	45.7	45.2	43.8	42.3	41.1	39.7	39.0
	8500	46.1	45.4	42.9	41.0	40.1	42.4	45.1	46.2	46.4	45.8	45.3	44.0	42.6	41.3	39.8	39.0
	9000	48.9	48.2	45.9	42.9	40.8	42.6	45.4	46.5	46.5	46.0	45.5	44.2	42.8	41.5	39.9	39.0
	9500	49.0	48.3	45.8	43.1	41.1	42.8	45.8	46.9	46.8	46.2	45.6	44.2	42.7	41.4	40.0	39.0
	10000	49.0	48.3	45.9	43.3	41.3	43.0	46.1	47.1	47.1	46.3	45.6	44.2	42.7	41.6	40.2	39.0
	10500	49.0	48.3	46.0	43.4	41.4	43.4	46.4	47.6	47.4	46.7	46.1	44.5	43.1	41.8	40.2	39.0
	11000	49.0	48.3	46.1	43.6	42.0	43.5	46.6	47.8	47.8	47.2	46.6	44.9	43.5	41.9	40.2	39.0
	11500	49.0	48.6	46.4	44.0	42.2	43.9	47.0	48.2	48.3	47.7	47.1	45.4	44.0	42.2	40.5	39.5
	12000	49.0	48.9	46.8	44.3	42.6	44.2	47.1	48.5	48.6	48.1	47.5	46.0	44.4	42.6	40.6	40.0
	12500	49.0	49.0	46.9	44.6	42.9	44.5	47.4	48.9	48.8	48.2	47.6	46.1	44.4	42.6	40.6	40.6
	13000	49.0	48.9	46.9	44.7	43.1	44.8	47.7	49.0	49.1	48.4	47.8	46.1	44.4	42.5	41.1	41.1
	13500	49.0	49.0	46.9	44.9	43.5	45.2	48.1	49.1	49.0	48.4	47.8	46.1	44.4	42.5	41.1	41.1
	14000	49.0	49.0	46.9	44.9	43.6	45.3	48.4	49.4	49.1	48.4	47.8	46.1	44.4	42.5	41.1	41.1
	14000	49.0	49.0	46.9	44.9	43.6	45.3	48.4	49.4	49.1	48.4	47.8	46.1	44.4	42.5	41.1	41.1
	14000	49.0	49.0	46.9	44.9	43.6	45.3	48.4	49.4	49.1	48.4	47.8	46.1	44.4	42.5	41.1	41.1

Figure 2-11- The standard ignition advance.

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Advance [DEG]

Map info

</

Figure 2-12 - Ignition Advance 2 degrees.

A	Gear 1	0	Gear 2	1	Gear 3	2	Gear 4	3	Gear 5	4	Gear 6	5					
RPM	6000	40.5	39.3	38.2	38.4	39.6	43.0	46.7	48.9	49.6	49.2	48.7	47.3	46.0	44.2	42.4	42.0
	6500	41.8	40.7	39.3	39.2	40.4	43.7	47.3	49.2	49.7	49.2	48.7	47.3	46.0	44.8	43.6	42.5
	7000	43.1	42.1	40.4	40.0	41.2	44.4	47.7	49.5	49.8	49.3	48.7	47.4	45.9	44.9	43.8	43.0
	7500	45.2	44.7	42.1	40.8	42.1	45.1	48.2	49.7	50.0	49.5	48.9	47.6	46.0	45.0	43.8	43.0
	8000	47.3	46.5	43.9	42.9	43.3	45.8	48.7	50.0	50.2	49.7	49.2	47.8	46.3	45.1	43.7	43.0
	8500	50.1	49.4	46.9	45.0	44.1	46.4	49.1	50.2	50.4	49.8	49.3	48.0	46.6	45.3	43.8	43.0
	9000	52.9	52.2	49.9	46.9	44.8	46.6	49.4	50.5	50.5	50.0	49.5	48.2	46.8	45.5	43.9	43.0
	9500	53.0	52.3	49.8	47.1	45.1	46.8	49.8	50.9	50.8	50.2	49.6	48.2	46.7	45.4	44.0	43.0
	10000	53.0	52.3	49.9	47.3	45.3	47.0	50.1	51.1	51.1	50.3	49.6	48.2	46.7	45.6	44.2	43.0
	10500	53.0	52.3	50.0	47.4	45.4	47.4	50.4	51.6	51.4	50.7	50.1	48.5	47.1	45.8	44.2	43.0
	11000	53.0	52.3	50.1	47.6	46.0	47.5	50.6	51.8	51.8	51.2	50.6	48.9	47.5	45.9	44.2	43.0
	11500	53.0	52.6	50.4	48.0	46.2	47.9	51.0	52.2	52.3	51.7	51.1	49.4	48.0	46.2	44.5	43.5
	12000	53.0	52.9	50.8	48.3	46.6	48.2	51.1	52.5	52.6	52.1	51.5	50.0	48.4	46.6	44.6	44.0
	12500	53.0	53.0	50.9	48.6	46.9	48.5	51.4	52.9	52.8	52.2	51.6	50.1	48.4	46.6	44.6	44.6
	13000	53.0	52.9	50.9	48.7	47.1	48.8	51.7	53.0	53.1	52.4	51.8	50.1	48.4	46.5	45.1	45.1
	13500	53.0	53.0	50.9	48.9	47.5	49.2	52.1	53.1	53.0	52.4	51.8	50.1	48.4	46.5	45.1	45.1
14000	53.0	53.0	50.9	48.9	47.6	49.3	52.4	53.4	53.1	52.4	51.8	50.1	48.4	46.5	45.1	45.1	
14000	53.0	53.0	50.9	48.9	47.6	49.3	52.4	53.4	53.1	52.4	51.8	50.1	48.4	46.5	45.1	45.1	
14000	53.0	53.0	50.9	48.9	47.6	49.3	52.4	53.4	53.1	52.4	51.8	50.1	48.4	46.5	45.1	45.1	

Figure 2-13- Ignition Advance 4 degrees.

These three maps were then tested on the UWSTD dyno to see how they performed.

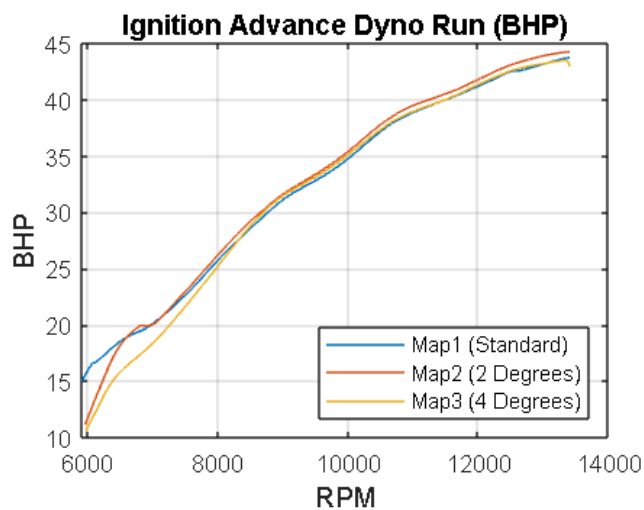


Figure 2-14 - Ignition Advance power curve.

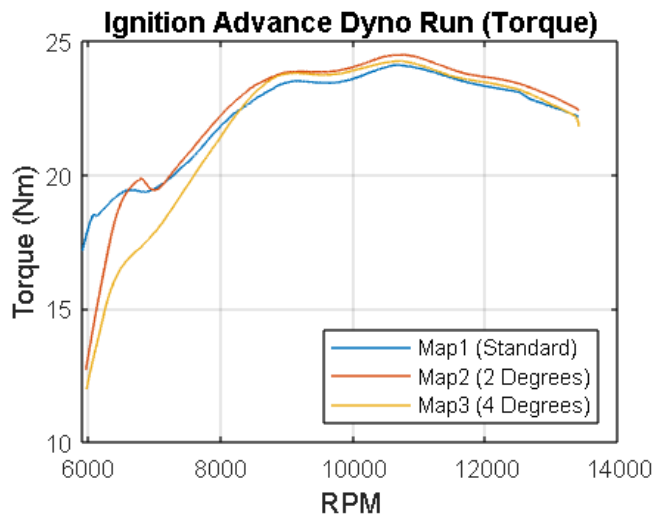


Figure 2-15 - Ignition advance torque curve.

As seen in figure's 2-14 and 2-15, up to around 7000 RPM, the standard ignition map is best for producing power and torque. However, from 7000 RPM onwards, Map 2 with 2 degrees of advance performs best, providing a decent amount more power than the standard map, and just a little bit more than Map 3. After analysing the dyno curves, it was decided from this point that mostly Map 2 with 2 degrees of advance would be used for the ideal map, as the power delivery was the best and provided quite a bit more torque, key for this little bike. Other areas of the map would include the standard and 4 degrees advance, and an ideal ignition advance map was created.

		Advance [DEG]															
		Map info															
		Gear 1 0		Gear 2 1		Gear 3 2		Gear 4 3		Gear 5 4		Gear 6 5					
RPM	6000	36.5	35.3	34.2	34.4	35.6	39.0	42.7	44.9	45.6	45.2	44.7	43.3	42.0	40.2	38.4	38.0
	6500	37.8	36.7	35.3	35.2	36.4	39.7	43.3	45.2	45.7	45.2	44.7	43.3	42.0	40.8	39.6	38.5
	7000	41.1	40.1	38.4	38.0	39.2	42.4	45.7	47.5	47.8	47.3	46.7	45.4	43.9	42.9	41.8	41.0
	7500	43.2	42.7	40.1	38.8	40.1	43.1	46.2	47.7	48.0	47.5	46.9	45.6	44.0	43.0	41.8	41.0
	8000	45.3	44.5	41.9	40.9	41.3	43.8	46.7	48.0	48.2	47.7	47.2	45.8	44.3	43.1	41.7	41.0
	8500	48.1	47.4	44.9	43.0	42.1	44.4	47.1	48.2	48.4	47.8	47.3	46.0	44.6	43.3	41.8	41.0
	9000	50.9	50.2	47.9	44.9	42.8	44.6	47.4	48.5	48.5	48.0	47.5	46.2	44.8	43.5	41.9	41.0
	9500	51.0	50.3	47.8	45.1	43.1	44.8	47.8	48.9	48.8	48.2	47.6	46.2	44.7	43.4	42.0	41.0
	10000	51.0	50.3	47.9	45.3	43.3	45.0	48.1	49.1	49.1	48.3	47.6	46.2	44.7	43.6	42.2	41.0
	10500	51.0	50.3	48.0	45.4	43.4	45.4	48.4	49.6	49.4	48.7	48.1	46.5	45.1	43.8	42.2	41.0
	11000	51.0	50.3	48.1	45.6	44.0	45.5	48.6	49.8	49.8	49.2	48.6	46.9	45.5	43.9	42.2	41.0
	11500	51.0	50.6	48.4	46.0	44.2	45.9	49.0	50.2	50.3	49.7	49.1	47.4	46.0	44.2	42.5	41.5
	12000	51.0	50.9	48.8	46.3	44.6	46.2	49.1	50.5	50.6	50.1	49.5	48.0	46.4	44.6	42.6	42.0
	12500	51.0	51.0	48.9	46.6	44.9	46.5	49.4	50.9	50.8	50.2	49.6	48.1	46.4	44.6	42.6	42.6
	13000	51.0	50.9	48.9	46.7	45.1	46.8	49.7	51.0	51.1	50.4	49.8	48.1	46.4	44.5	43.1	43.1
	13500	51.0	51.0	48.9	46.9	45.5	47.2	50.1	51.1	51.0	50.4	49.8	48.1	46.4	44.5	43.1	43.1
	14000	51.0	51.0	48.9	46.9	45.6	47.3	50.4	51.4	51.1	50.4	49.8	48.1	46.4	44.5	43.1	43.1
	14000	51.0	51.0	48.9	46.9	45.6	47.3	50.4	51.4	51.1	50.4	49.8	48.1	46.4	44.5	43.1	43.1
	14000	51.0	51.0	48.9	46.9	45.6	47.3	50.4	51.4	51.1	50.4	49.8	48.1	46.4	44.5	43.1	43.1

Figure 2-16 - Ideal ignition advance map.

2.4.3 Injection Timing

It was a similar situation when it came to remapping the injection timing. Map 1 was left as standard, Map 2 had a 2% increase in injection time and Map 3 had a 5% increase in injection time.

Honda NSF250 Group Project Report

Injection time [us]																	
Map info																	
< Gear 1 0 Gear 2 1 Gear 3 2 Gear 4 3 Gear 5 4 Gear 6 5																	
RPM	6000	1100	1209	1330	1679	1989	2299	2608	2914	3140	3273	3343	3426	3507	3602	3704	3843
	6500	1042	1145	1260	1579	1822	2122	2427	2727	2972	3146	3303	3436	3570	3683	3824	3969
	7000	1008	1113	1224	1518	1792	2107	2390	2699	2936	3160	3322	3521	3708	3855	3984	4173
	7500	979	1090	1202	1516	1778	2108	2449	2767	3093	3334	3510	3776	4005	4141	4311	4492
	8000	953	1097	1198	1516	1823	2177	2546	2913	3293	3610	3848	4130	4327	4486	4641	4895
	8500	950	1076	1178	1494	1867	2260	2634	3072	3486	3853	4189	4509	4754	4882	5056	5367
	9000	926	1032	1147	1486	1915	2316	2701	3135	3588	3996	4373	4832	5096	5229	5427	5717
	9500	928	1036	1142	1508	1929	2342	2736	3170	3616	4007	4399	4883	5176	5314	5533	5862
	10000	921	1028	1122	1527	1983	2385	2771	3212	3647	4034	4456	4922	5220	5374	5581	5896
	10500	908	1021	1100	1484	1929	2342	2717	3099	3527	3965	4363	4830	5139	5310	5516	5839
	11000	898	984	1081	1470	1897	2286	2614	3003	3456	3860	4255	4721	4998	5180	5381	5730
	11500	906	982	1088	1420	1853	2234	2566	2922	3362	3805	4168	4596	4879	5068	5223	5563
	12000	891	990	1069	1394	1793	2170	2515	2872	3302	3737	4091	4491	4774	4941	5113	5448
	12500	893	988	1064	1364	1761	2142	2463	2848	3276	3712	4058	4455	4727	4897	5069	5390
	13000	899	984	1048	1354	1730	2110	2427	2816	3245	3668	4032	4439	4722	4866	5030	5368
	13500	937	1016	1080	1377	1692	2069	2416	2811	3235	3671	4054	4457	4740	4859	5016	5390
	13950	937	1016	1080	1355	1698	2063	2416	2821	3234	3675	4061	4469	4754	4876	5036	5385
14000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 2-17- Standard Injection Timing.

Injection time [us]																	
Map info																	
< Gear 1 0 Gear 2 1 Gear 3 2 Gear 4 3 Gear 5 4 Gear 6 5																	
RPM	6000	1122	1233	1357	1713	2029	2345	2660	2972	3203	3338	3410	3495	3577	3674	3778	3920
	6500	1063	1168	1285	1611	1858	2164	2476	2782	3031	3209	3369	3505	3641	3757	3900	4048
	7000	1028	1135	1248	1548	1828	2149	2438	2753	2995	3223	3388	3591	3782	3932	4064	4257
	7500	999	1112	1226	1546	1814	2150	2498	2822	3155	3401	3580	3852	4085	4224	4397	4582
	8000	972	1119	1222	1546	1860	2221	2597	2971	3359	3682	3925	4213	4414	4576	4734	4993
	8500	969	1098	1202	1524	1904	2305	2687	3133	3556	3930	4273	4599	4849	4980	5157	5474
	9000	945	1053	1170	1516	1953	2362	2755	3198	3660	4076	4460	4929	5198	5334	5536	5831
	9500	947	1057	1165	1538	1968	2390	2791	3233	3688	4087	4487	4981	5279	5420	5644	5979
	10000	939	1049	1144	1558	2023	2433	2826	3276	3720	4115	4545	5020	5324	5481	5693	6014
	10500	926	1041	1122	1514	1968	2390	2771	3161	3598	4044	4450	4927	5242	5416	5626	5956
	11000	916	1004	1103	1499	1935	2332	2666	3063	3525	3937	4340	4815	5098	5284	5489	5845
	11500	924	1002	1110	1448	1890	2279	2617	2980	3429	3881	4251	4688	4977	5169	5327	5674
	12000	909	1010	1090	1422	1829	2213	2565	2929	3368	3812	4173	4581	4869	5039	5215	5557
	12500	911	1008	1085	1391	1796	2185	2512	2905	3342	3786	4139	4544	4822	4995	5170	5498
	13000	917	1004	1069	1381	1765	2152	2476	2872	3310	3741	4113	4528	4816	4963	5131	5475
	13500	956	1036	1102	1405	1726	2110	2464	2867	3300	3744	4135	4546	4835	4956	5116	5498
	13950	956	1036	1102	1382	1732	2104	2464	2877	3299	3749	4142	4558	4849	4974	5137	5493
14000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

☒ Show map values ☐ Show original values ☐ Show values differences

Figure 2-18- 2% increase in Injection time.

Injection time [us]																	
Map info																	
< Gear 1 0 Gear 2 1 Gear 3 2 Gear 4 3 Gear 5 4 Gear 6 5																	
RPM	6000	1155	1269	1397	1763	2088	2414	2738	3059	3297	3437	3510	3597	3682	3782	3890	4035
	6500	1094	1202	1323	1658	1913	2228	2548	2863	3121	3303	3468	3608	3749	3867	4015	4167
	7000	1058	1169	1285	1594	1882	2212	2509	2834	3083	3318	3488	3697	3893	4048	4183	4382
	7500	1028	1145	1262	1592	1867	2213	2571	2905	3248	3501	3686	3965	4205	4348	4527	4717
	8000	1001	1152	1258	1592	1914	2286	2673	3059	3458	3791	4040	4337	4543	4709	4873	5140
	8500	998	1130	1237	1569	1960	2373	2766	3226	3660	4046	4400	4734	4992	5126	5309	5635
	9000	972	1084	1204	1560	2011	2432	2836	3303	3783	4216	4612	5096	5370	5508	5718	6003
	9500	974	1088	1199	1583	2025	2459	2873	3329	3797	4207	4619	5127	5435	5580	5810	6155
	10000	967	1079	1178	1603	2082	2504	2909	3373	3829	4236	4679	5168	5478	5638	5859	6191
	10500	953	1072	1155	1558	2025	2459	2853	3254	3704	4163	4581	5072	5396	5576	5792	6131
	11000	943	1033	1135	1544	1992	2400	2745	3153	3629	4053	4468	4957	5248	5444	5650	6017
	11500	951	1031	1142	1491	1946	2346	2694	3068	3530	3995	4376	4826	5123	5321	5484	5841
	12000	936	1040	1122	1464	1883	2279	2641	3016	3467	3924	4296	4716	5013	5188	5369	5720
	12500	938	1037	1117	1432	1849	2249	2586	2990	3439	3898	4261	4678	4963	5142	5322	5660
	13000	944	1033	1100	1422	1817	2216	2550	2957	3407	3851	4234	4661	4960	5109	5282	5636
	13500	984	1067	1134	1446	1777	2172	2537	2952	3397	3855	4257	4680	4977	5102	5267	5660
	13950	984	1067	1134	1423	1783	2166	2537	2962	3396	3859	4264	4692	4992	5120	5288	5654
14000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 2-19 - 5% increase in Injection time.

These maps were also run on the UWTSD Dyno. To get the data from the UWTSD dyno, the results were downloaded as a CSV file to then be graphed in MATLAB.

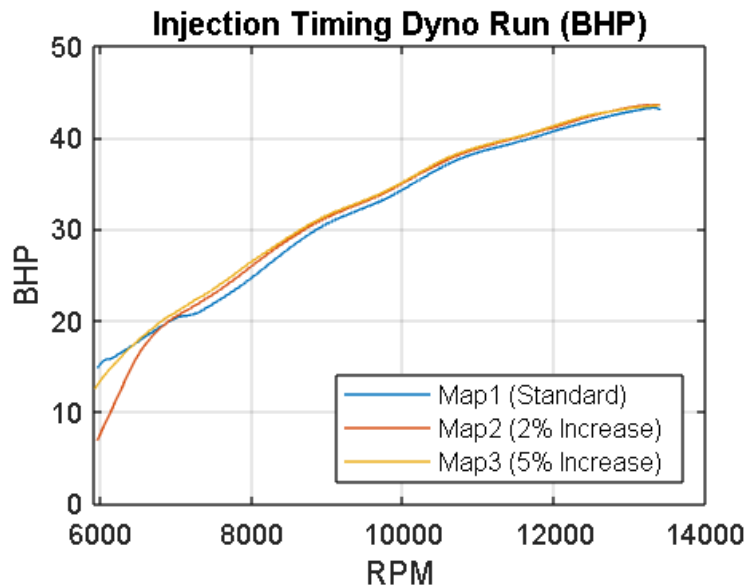


Figure 2-20 - Injection timing power curve.

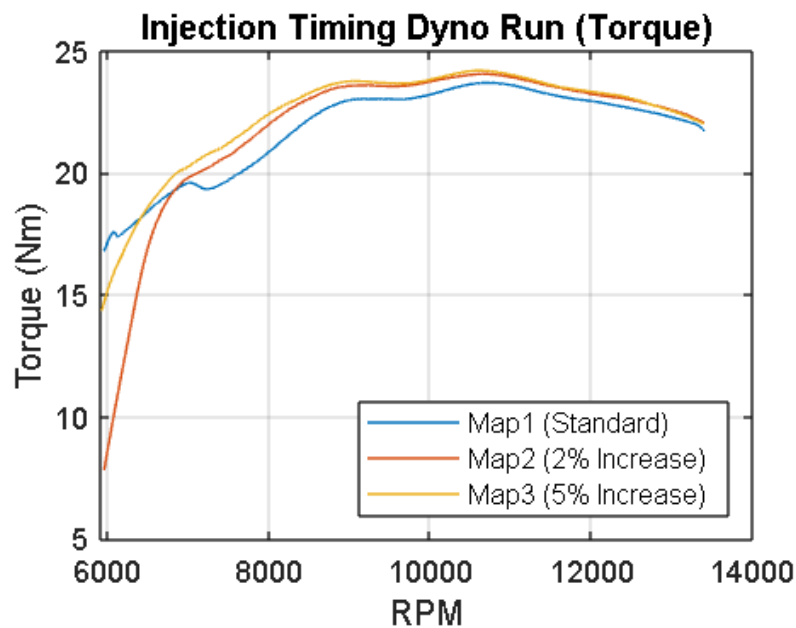


Figure 2-21 - Injection Timing torque curve.

As seen in both figure 2-20 and 2-21, up to around 7000 RPM the standard Dellorto map creates the most power and torque, similar to the ignition advance. However, from that point onwards there is a lot of overlap between the 2% and 5% increase in injection timing, producing a little bit more power and a significant amount more of torque than the standard map. After some analysis of the dyno curves, an ideal injection map was created.

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Injection time [us]																	
Map info																	
	Gear 1	0	Gear 2	1	Gear 3	2	Gear 4	3	Gear 5	4	Gear 6	5					
RPM																	
6000	1100	1209	1330	1679	1989	2299	2608	2914	3140	3273	3343	3426	3507	3602	3704	3843	
6500	1063	1168	1285	1611	1858	2164	2476	2782	3031	3209	3369	3505	3641	3757	3900	4048	
7000	1028	1135	1248	1548	1828	2149	2438	2753	2995	3223	3388	3591	3782	3932	4064	4257	
7500	999	1112	1226	1546	1814	2150	2498	2822	3155	3401	3580	3852	4085	4224	4397	4582	
8000	972	1119	1222	1546	1860	2221	2597	2971	3359	3682	3925	4213	4414	4576	4734	4993	
8500	969	1098	1202	1524	1904	2305	2687	3133	3556	3930	4273	4599	4849	4980	5157	5474	
9000	945	1053	1170	1516	1953	2362	2755	3198	3660	4076	4460	4929	5198	5334	5536	5831	
9500	947	1057	1165	1538	1968	2390	2791	3233	3688	4087	4487	4981	5279	5420	5644	5979	
10000	939	1049	1144	1558	2023	2433	2826	3276	3720	4115	4545	5020	5324	5481	5693	6014	
10500	926	1041	1122	1514	1968	2390	2771	3161	3598	4044	4450	4927	5242	5416	5626	5956	
11000	916	1004	1103	1499	1935	2332	2666	3063	3525	3937	4340	4815	5098	5284	5489	5845	
11500	924	1002	1110	1448	1890	2279	2617	2980	3429	3881	4251	4688	4977	5169	5327	5674	
12000	909	1010	1090	1422	1829	2213	2565	2929	3368	3812	4173	4581	4869	5039	5215	5557	
12500	911	1008	1085	1391	1796	2185	2512	2905	3342	3786	4139	4544	4822	4995	5170	5498	
13000	944	1033	1100	1422	1817	2216	2550	2957	3407	3851	4234	4661	4960	5109	5282	5636	
13500	984	1067	1134	1446	1777	2172	2537	2952	3397	3855	4257	4680	4977	5102	5267	5660	
13950	984	1067	1134	1423	1783	2166	2537	2962	3396	3859	4264	4692	4992	5120	5288	5654	
14000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Figure 2-22 - Ideal Injection timing map.

2.4.4 Ideal Maps

For the ideal maps, a new configuration was created. In this configuration, Map 1 was the ideal ignition advance, Map 2 was the ideal injection time and Map 3 was the two ideals combined in the hope they would both work together. This configuration was tested on the UWSTD dyno the day after the previous dyno runs.

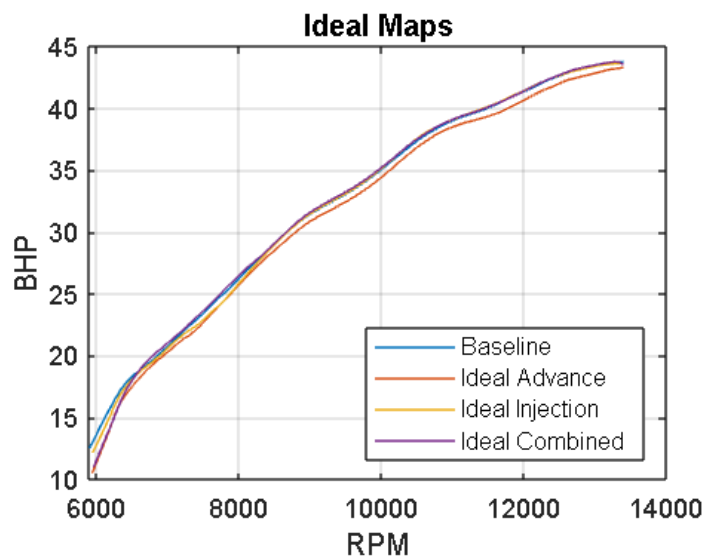


Figure 2-23- Ideal maps power curve.

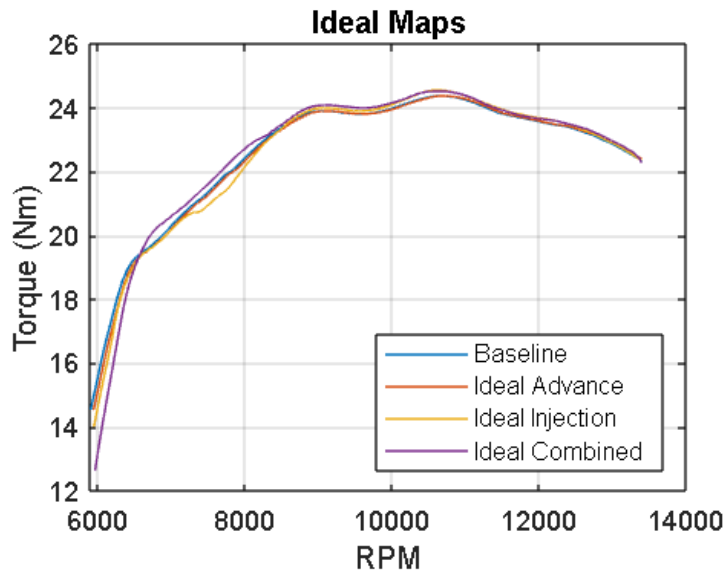


Figure 2-24 - Ideal maps torque curve.

As seen in figure 2-23 and 2-24, the results did not come out as expected compared to the results that had been collected the previous day. For example, the ideal advance was now making less power than the standard map, whereas on the previous run the 2-degree advance made about 5% more horsepower and 10% more torque. This was a similar case with the ideal injection, it made a similar amount of horsepower to the ideal advance but made less torque. For the ideal combined, it only made a slight bit more power and torque when theoretically there could have been a 10% increase in power. After this set of runs the same maps were tried again with race fuel, as the standard Dellorto map makes at least one horsepower more. This run was going to test how much power and torque could be made when combining the ideals and race fuel.

2.4.5 Ideal Maps with Race fuel

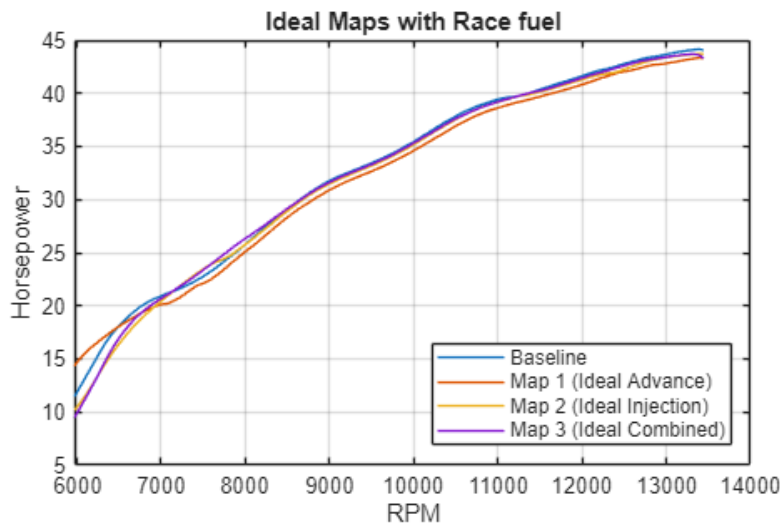


Figure 2-25 - Ideal Maps with Race fuel power curve.

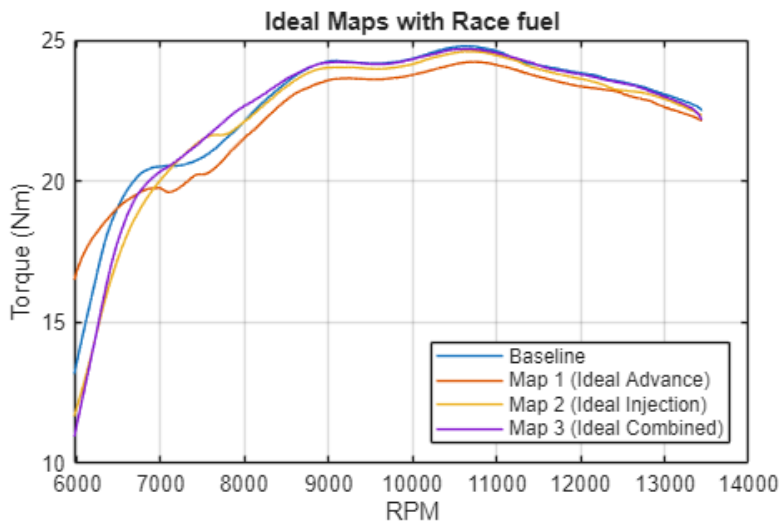


Figure 2-26 - Ideal Maps with Race fuel torque curve.

Again, like the previous set of results they did not come out as predicted. This time with the race fuel, the baseline made more power and torque however the other maps made the same amount of power and torque as with the standard fuel. This is believed to be due to the lambda sensor not reading correctly, as on the dash of the bike the lambda was reading zero. This meant that the ECU was not correcting the air-fuel ratio meaning the added race fuel was not combusting as expected. In conclusion, this meant the ideal maps true potential was not shown on the day of the dyno run.

2.5 Further Work

One area of further work that will be undertaken is re-doing the dyno runs for the ideal maps with a new lambda sensor. With a new lambda sensor, the ECU will see the correct lambda reading and alter the air-fuel ratio as the fuel is injected. This should lead to a higher power and torque gain over the standard maps, around 5-10% compared to the 2% seen on the final dyno run. As well as this, the race fuel will be tested again once the ideal maps have been run and it is confirmed the lambda is reading correctly. With the race fuel, this should easily increase the power of the NSF250 by over 10%. Once the maps have been run in 4th gear, all the other gears will have the same modifications so power delivery is similar and should improve performance on track.

Another area of further work will be taking these ideal maps on to track at Pembrey. This will truly tell whether the maps have made improvements to the bike in a dynamic environment. In terms of mapping, the bike can run one of the maps as standard and another one as the ideal modifications. Here, there can be a direct comparison in terms of lap time between the two maps to see how much lap time has been gained.

3 Gearing Development, Research, and Team Management (Charlie)

3.1 Team Management

For this team's structure, the decision was made to split the roles between the members like so:

Reuben would be focusing solely on engine mapping, and I have the role of team leader and focusing on the gearing development for the proposed set-up for the engine. This meant that any mapping set-up that Reuben developed I would then have to look at the effect that mapping has on the engine and then understand how a gearing setup would differ for helping to improve the changes made by the new engine mapping.

The professional tools used to aid our team's workflow was mostly the use of Microsoft Teams and WhatsApp for communication and such. These tools helped me to keep in constant contact with the team and to ensure that everybody kept on track and met their deadlines for specific parts of the project, for example Reuben had to make different maps to test on the dyno and I kept in contact with him to ensure that he was confident in the task he had set out and wasn't struggling.

To manage the different deadlines and achievements for the project, the use of gantt charts proved the best way to keep track of them. The different points of the project had changed due to different changes in circumstances with both team members and staff aiding the group and this had to be reflected in the gantt charts.

The way meetings were managed is every other Tuesday our team met either in person or over a Microsoft Teams call and discuss progress made and how every member of the group was handling their workload and if they needed help or parts of their task timelines needed to be changed and such.

Furthermore, expanding on the point made about circumstance changes, the team had to overcome numerous setbacks and delays with the work due to scheduling differences and personal circumstances changing. These were thoroughly communicated to the other members of the group and meetings took place to ensure that everyone was up to speed with the altered timings for the report and the altered tasks as well.

3.2 Analysing Data

This project requires the team to test the engine already in the motorcycle to gather data from both the track and a dyno. This is to ensure that all data gathered is relevant to each part of the project.

3.2.1 Track

To gather the data from the track, the motorcycle is fitted with data loggers that communicate with the ECU and then that data is transferred to a laptop via ethernet cable into the MARdata software. MARdata had the ability to download a session, and MAT lets me see the live data while connected to the bike. It allows me to look at many things, such as suspension travel, rev counter, temperature, etc. Then to analyse this data I used the 2D DataRecording software to analyse the different channels and data displayed in the software.

Using 2D, I was able to analyse the lap consistency from last racing season to the most recent test day and found.

3.2.2 Dyno

Having the motorcycle run on the dyno allows us to see whether different changes to the set-up of the motorcycle. It allows the team to see how the motorcycle performs and how the data may differ depending on what changes have been made to the set-up. The current engine compared to similar engines runs.

Analyze the difference between crank and wheel horsepower to justify the setup. Focus on how the gearing choices maximized torque multiplication while minimizing parasitic drivetrain losses

Discuss how the dyno data ensured the current setup may compare to the proposed setup. Relate this to sustainability by showing the proposed setup improves fuel consumption through better RPM management.

3.3 Honda Gear Setup Research

- Component Compatibility

Detail your research into various Honda OEM and HRC gear sets to identify viable ratios for the project

- Ratio Calculations

Use mathematical formulas to compare the theoretical formulas to compare the theoretical top speeds and acceleration rates of different Honda sprocket and internal gear combinations

- Selection Justification

Provide a reasoned argument for the final setup chosen, supported by your research into industry standards and specific track requirements

3.4 Enhance Development

- Alternative transmission styles

Look into systems available from Honda like a seamless shift technology to reduce the “shift-cut” time which would further optimize power delivery (already have a quick-shift)

- Material optimization

Research into lightweight titanium or composite sprocket materials to reduce rotational unsprung mass and improve the drivetrain’s overall efficiency

- Telemetry Integration

Look into integrating real-time wheel-speed sensors into the track data to provide a direct feedback loop for validating gearing choices against actual rear-wheel slip

- Expand the testing slope

Expand testing to a broader range of locations so the gearing setup isn’t bias to just Pembrey and can be optimized for the most common tracks on the NG calendar

4 Conclusion

Overall, this project hasn't been the smoothest of which, but the group as a whole has learned many things about how to use different software, such as Ricardo Wave and MARdata, to aid in research and setting up different changes to the motorcycle. Reuben specifically had to learn and adapt to the Ricardo Wave software to build a virtual model of the Honda NSF250 engine to simulate the different mappings before applying them to the actual motorcycle. Charlie had to get familiar with the process of downloading data from the NSF250, saving that file to a safe and accessible folder and then viewing it in the 2D DataRecording software. During this process, the switch from WinARace 2025 Moto3 to WinARace 2026 Moto3 had its own drawbacks of not being able to access the licensing portal which hindered progress from that point onwards.

In future, the group wishes to look at the possibility of re-doing dyno runs with a new lambda sensor to better see how the different maps effect the horsepower output and then taking these maps out onto a track setting, like Pembrey, to see if the maps improve or reduce the power output of the NSF250. Another possibility is looking at both engines in current possession and seeing if a different gearing set-up on both would differ on power output and what tracks each engine works better on with the different maps and gearing ratios.

5 References

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Retrieved March 16, 2026, from <https://www.scribd.com/document/445934893/nsf250r-2012-owners-manual-english-pdf>