



# F Four Fifty From 600

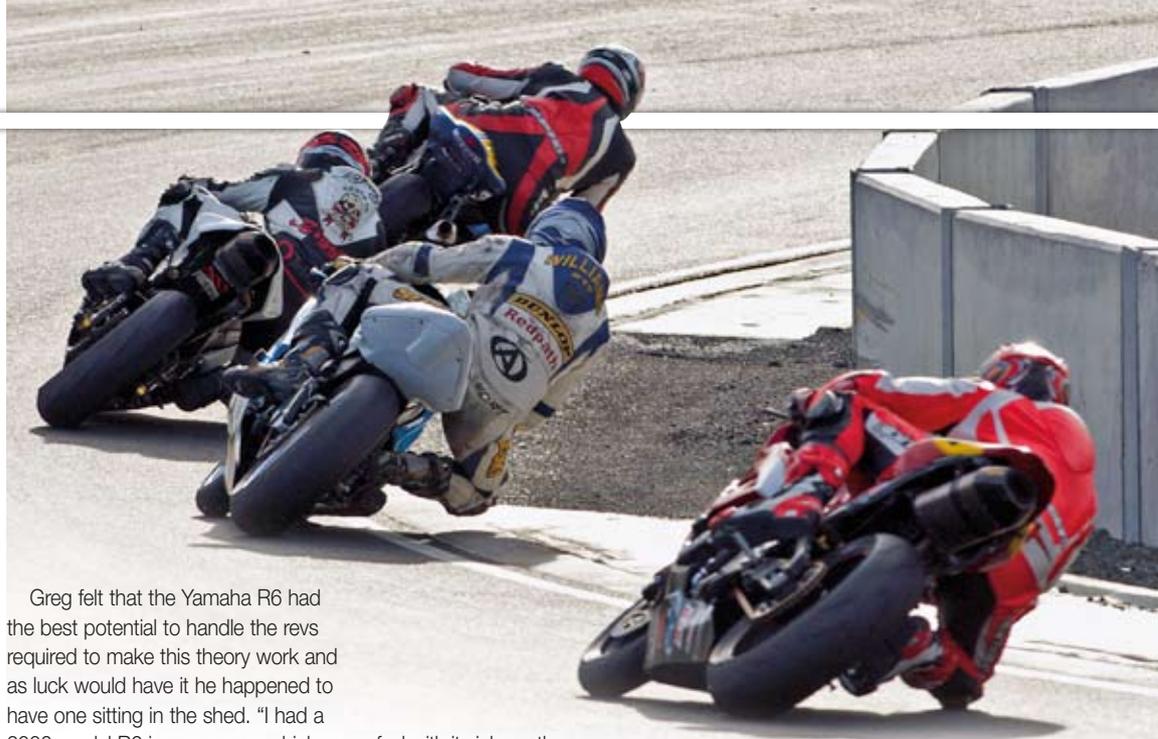
Words: Glen Williams Photos: Championship Digital

Yamaha has never made a 450cc four-cylinder motorcycle, so it's taken a bit of local Kiwi ingenuity to create one. This particular bike started life as a 2006 Yamaha 600cc YZF-R6; reigning F3 champion Glen Williams brings us the story and blags a ride on the wee screamer.

I first heard of this bike being built almost 12 months ago. The basic outline of the project was to take a modern 600cc supersport machine and then design and manufacture a crankshaft with a revised crankpin spacing to effectively 'de-stroke' the motor back to a 450cc capacity. The benefit of this short stroke motor would then allow it to compete in New Zealand's Formula 3 road-race class.

The man behind this creation is Greg Percival of Te Kauwhata - a long time Yamaha rider/racer, and a man that loves to tinker with engines and test out theories.

"I had this idea to build a high-revving four-cylinder 450 over a year ago and I wanted to get away from what I and others had previously been doing, which was to use an older style four-cylinder 400cc machine and bore them out a bit." Greg comments. "These older bikes can be unreliable and parts are becoming harder to find. I thought we could do much better if we took one of the latest supersport bikes with all its modern internal technology along with its naturally superior chassis specification and reduce it down to 450cc via running a much shorter stroke whilst keeping the bore size the same."



Greg felt that the Yamaha R6 had the best potential to handle the revs required to make this theory work and as luck would have it he happened to have one sitting in the shed. "I had a 2006 model R6 in my garage which was becoming ever less competitive in the cut and thrust of the supersport class, so decided that this would be the ideal development machine to get on with this project." Greg's scientific background as a chemist helped when he took to studying the dynamics of how to make it all work and he also spoke to specialist in the industry about the pros and cons of such an engine format.

"The main issues revolved around getting the engine to rev high enough to get half decent horsepower and also in ensuring it would flow enough air/

fuel with its inherently very over-square bore and stroke ratio." He didn't want to touch the bore size in the interest of maintaining the standard head on the bike and planned to do it all by clever crank and crankpin design and changing the conrod length.

"We eventually came up with a formula that on paper at least stacked up - and after that (in early 2009) I got on with drawing up the new crankshaft and the crank itself could then be cut from a solid billet. One of the tricks was to ensure that we only used components that would allow the engine to

electronics to run the new motor - so overall I was quite pleased how quickly it all came together." With the parts on hand it only took Greg a single weekend to build the engine and another to bolt it back into the frame. "The engine assembly was pretty straightforward with most of the time taken up by checking and re-checking valve/piston and piston/head squish clearances to be sure that we had safe tolerances." The engine ran sweet the first time they hit the starter button.

### The Day of Reckoning

We received a call from Greg to say that he was off to Hampton Downs for a track test on the wee beastie in November '09, and we were duly invited for a test ride.

Weather conditions were ideal, dry and warm. We turned up to find Greg fitting 'best guess' gearing to the bike and he was also punching away on his laptop trying to massage an improved fuel map on the Power Commander tuning module. Greg said he didn't really know what to expect performance-wise from the engine on the first ride as indications from the previous day's brief dyno run showed that the bike was running very rich and required a substantially different fuel map. Greg has in fact confirmed since our track test that a Yamaha tuning module was needed for the machine and now he runs this in 'sequence' with the Power Commander system on board. "We needed the specialty YEC engine management system to give us access to different options within the ECU - such as tuning individual fuel injector operation and ignition timing. This has helped to get the fuelling closer to the mark across the rev range."

hold together reliably at these elevated revs. The weight and balance interaction of the all the moving components in the engine had to be very accurately calculated in the interest of avoiding parts failure."

### Buy New Zealand Made

It took six months to receive the finished crankshaft - which was all proudly 'Made in New Zealand', Greg was happy with the timeframe as he didn't want to rush any aspect of the build and it gave him time to make other small parts for the bike and procure some new chassis parts such as a set of lightweight wheels. "I had to source some other engine parts (pistons and connecting rods) and also a bunch of engine management

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### Track Time

Standing beside the bike after starting her up it sounded not dissimilar to a bog stock R6, just maybe not quite as gruff or lumpy. Hopping on board and it was unsurprising to find that it felt just like an R6 (funny that), which is not a bad thing at all.

Moving out of pit lane the engine required close attention to the throttle at low revs to avoid it stalling and some slightly lower gearing may have helped here, that said it wasn't that bad and you just needed to be prepared to slip the clutch a little and keep the revs up at dawdling pit lane speeds.

Out onto the track and it was immediately obvious where this 450cc hybrid engine strengths resided – and it appeared they all lived at near stratospheric rev levels.

In its current set up the bike exhibited modest drive in the lower two thirds of its range (that being up to 12,000rpm!) From that point on it started to wake up a little and then from an indicated 14,500rpm it came on strongly to the limiter which sat a



mere 3000revs further up the scale at an indicated heady 17,500rpm.

When compared to say a Formula 3 spec Suzuki SV650 the difference is like chalk and cheese in how the power is delivered to the rear wheel and it was quite hard to acclimatise to initially. Even when compared to the Ozzy 450 triple cylinder layout (see test BRM issue 53, Nov 2008) this engine makes even further demands on the rider to keep the needle near the red zone. As long as you can do this it offers pretty respectable performance, drop out of the top 3000rpm zone at your peril though if you are seeking a

quick lap time!

It's similar in riding style to a two-stroke 125GP machine where you must keep the engine on the boil and employ extravagant use of the clutch when exiting slow corners if you wish to keep the 'go forward' motion happening with any vigour.

Needless to say the R6 chassis with Ohlins suspension fitted both front and rear, and a set of lightweight Dymag wheels thrown in for good measure, handles the reduced power of the 450cc horsepower with mind numbing ease. You can pretty much open the throttle fully from just before the apex of most corners and only need to be wary if the engine is in the very top part of its rev zone when you are fully leant over and on the very edge of the tyre. The big 190mm Pirelli rear slick was able to soak up the relatively soft demands placed on it by this engine's feeling of limited torque.

Greg had the standard R6 slipper clutch in the bike, but a bit more slip when changing down would assist in maintaining corner entry speed. The reduced inertia of the lighter 450cc crankshaft and its related spinning engine mass and lighter wheels may have been the reason for this – however its not really a problem, but worth refining for the future.

### Where to From Here?

Greg says that subsequent further dyno runs completed since our test ride have shown that they are getting a modest 67 rear wheel horsepower from the bike. "We will be looking to

improve not only the maximum hp figure but of more importance is to try and spread of the power delivery over a greater range. In its current state of tune we have a number of options to make these gains and these are mainly with increased engine compression and also some air velocity solutions that will speed cylinder filling and extraction – but overall we are pretty pleased that the bike at least appears to run reliably and is staying cool. We can only expect to move forward from here especially when we start removing some weight from the bike."

There is no denying that Greg has done extremely well to get this prototype engine up and running as well as it is. He is quite confident that there is a fair bit more to come yet and he is the type of bloke that will tinker away in his shed, testing one thing at a time in the interest of making steady improvement (this is often a simple secret in the racing game – namely hard work with a bit of trial and error thrown in for good measure).

Like Chris Osborne's 'Ozzy 450' triple concept where one cylinder is deactivated from a 600cc super-sport machine to create the 450cc capacity, the potential for this bike is definitely there and once again it's all offered in a very good chassis package. It is also pleasing to see yet another bit of diverse thinking with this new approach to the Formula 3 class - a class which was designed to foster and allow the design and development of novel ideas just like this.

**BRM**

