The dream PART TWO

Mike Norman **of G-Force Engine Development outlines the trials and tribulations of being an independent engine builder and how the suppliers can make or break you.**

"One of the first areas of focus would be the intake ports as we had gone backwards in our first attempt"

It's ironic when you think about it – the actual race is what everybody watches with great anticipation – the big "show". We all line up at the edge of the track, or close to our televisions, to watch an event that lasts 20 minutes to an hour depending on the race but the meat of the story is what happens behind the scenes to get the racers to the "show".

If you were to make a DVD of an entire season of races it would fill up maybe 10 or 12 hours of space. On the other hand, if you were to burn only the behind-the-scenes footage, it would be months of continuous run-time on a DVD. I am not sure how many people realise the immense amount of work the entire team exerts in the background just to get to the "show" come race day.

Our story is not unusual and probably portrays that of many teams' development, be it factory or privateer. For us, we certainly feel like a factory team in some ways, but it is very apparent we are quite the privateer team.

In the first part of this article (*Moto Tech* volume 1, issue 6) I

discussed our goals for G-Force and the 450cc engine, our troubles with parts vendors and the component failures we encountered along the way. After finally getting past these obstacles, we achieved our goal of 90 hp in the beginning of the 2005 racing season. However, whilst there was a tremendous feeling of accomplishment, we also felt like we were just ready to start truly developing these engines. We left part one of the article with our new goal of 100 hp.

My head was spinning with ideas and I started to imagine the areas in the engine I wanted to develop. I made a list of the top items and tried to prioritise them: I needed to get the big-valve heads to work; I needed to get camshafts designed for more top-end power; I needed to design new valve train components to allow for the more aggressive cams; I needed to work on an exhaust system that would also allow for more power in the higher revs; I needed to look at alternate induction systems... the list in my head went on and on. As these items would take time, and we missed the winter development time chasing gremlins, we needed to try and develop the engines during the racing season. However, we knew conducting development testing while chasing a championship was going to be extremely difficult to do.

2005 – Back to Square One

At the first race weekend of 2005 we ran into a small problem with the manufacturing of the new Carrillo Ti rods. The slots on the thrust faces of the rods were missed in manufacturing. These slots acted as oil jets to direct oil to the wrist pins and the underside of the pistons for cooling. Unfortunately, we experienced piston seizures almost immediately on the first day of practice in both engines fitted with these rods.

After the weekend, Carrillo was quick to respond by adding the slots to the rods for us in record time. We replaced the pistons that seized, cleaned up the bores and were back in business.

Feeling comfortable that we had cured the cause of the crankshaft failure from last season, we were not expecting problems. However, our confidence was quickly crushed when the second crankshaft in Mike Lohmeyer's engine broke. In the midst of a points' race for the championship, he had to resort to his 400cc back-up engine to get him through the rest of the season. He had already earned a significant points lead and his riding ability was such that he was still able to win races in the 450cc Superbike class on the much less powerful 400cc engine. However, we were once again unable to make forward progress in the development of horsepower since we continued to chase several component failures.

At the end of the 2005 racing season, we looked back to reflect. We had definitely had better seasons. After conquering the gremlins that popped up, the bikes were running strongly before the second crankshaft failure. Lohmeyer proceeded to win races – including a Formula IV race – and set the lap records for 450cc machines at every track we raced.

After a hard-fought season, Lohmeyer won the 450cc Superbike Championship for the first time. Paul Yoshimune, the owner of the second G-Force 450cc machine, finished close behind in second place for the season. This was quite an achievement for us as Lohmeyer and Yoshimune were the first riders to beat the previously invincible class champion.

Even with the successful results at the end of the season, Paul Yoshimune had decided to step out of 450cc racing and sold his bike to Lohmeyer who decided to use the engine from Yoshimune's bike rather than invest more of his money into another 450cc engine. Mark Elrod, however, had committed even further by building a second NC-35 to race in the 450cc Production class.

2006 – A Glimpse of Hope

The beginning of the 2006 season saw Lohmeyer pick up where he left off, dominating the 450cc Superbike class over the previous champion. Formula IV was more of a struggle against the SV650s though, as Yoshimune's 450cc engine was not quite as powerful as Lohmeyer's 450cc engine from the previous year. By the third race of the season though, Lohmeyer was able to once again fight for the podium with some epic battles. Unfortunately, though, his challenge was shortlived as the upgraded crankshaft in Yoshimune's engine snapped as well – and each time a crankshaft snapped, it destroyed most of the engine. This third crankshaft failure was emotionally and financially devastating to the team.

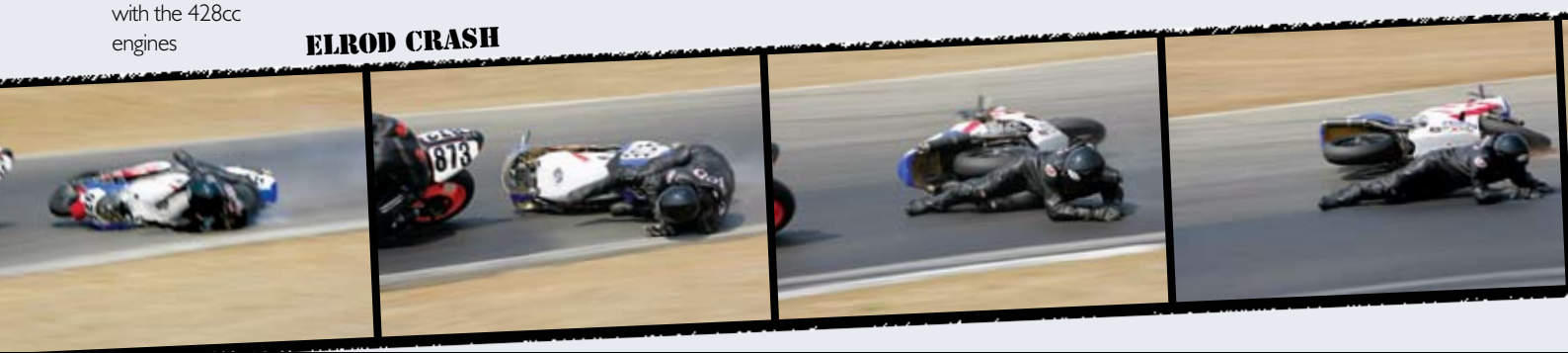
Regardless of the snapped crankshaft in the middle of the 2006 season, Lohmeyer was able to persevere on his back-up 400cc engine and again win the 450cc Superbike Championship. He was also able to borrow Elrod's 450cc bike to earn enough points to bring home third overall in the F-IV class for 2006.

After several seasons watching the F-IV championship slip through our fingers while chasing component failure after component failure, we had just about had enough. The results earned were not reward enough for the time, money and physical labour invested.

Frustrated with the myriad of

Mark Elrod crashing his 428cc machine while battling for the lead of the Production Class. A crash like this one caused the only engine failure with the 428cc engines

ELROD CRASH



problems, and feeling like I had lost my touch for building "reliable" race engines, I turned to my mentors for their advice. It was most revitalising what they told me. Kelley Roberts of REC (Racing Engine Components) enlightened me with new perspective saying: "Congratulations Mike, you're producing enough power from those little 400s to snap the stock crankshafts".

I also read a quote that said something to the effect of "behind the most knowledgeable engine developers will be a large pile of failed parts. The larger the pile of parts, the more knowledge he has". I wish I remembered where I read that so I could thank the originator.

This was the refreshing information I needed to come back at this project with a new fervour. I called the team together and we laid out our options. It was a time to decide to cut our losses and walk away, or make an even larger commitment to move to the next level. In the end, Lohmeyer was in for the long haul and Elrod decided to stay in it as well. To our surprise, Mike Sampognaro – who had been more a behind-the-scenes partner in all this before – also decided to join us.

New Directions: NC450V 5th Generation

In our discussion we all agreed that the weld-up crankshafts were not the way to go. There were too many variables such as non-homogenous materials, weakness from the welding process and too many variables with the original material of the crankshaft. We decided that a billet crankshaft made to our specification, using 4340 steel for the strongest possible base material, was the only way to overcome the durability issues we experienced. We just needed to find someone willing to make the crankshafts for us within our budget.

Due to the troubles we had getting pistons from the original supplier we decided to look around with one located in the US being the preferred option. Although the original pistons were already better than the stock ones and even much better than the alternatives already out there, we felt we could do better. I wanted to see if I could get the weight down even further as well as possibly further reduce the friction in the process.

Internal friction was actually a big part of the discussion and we discussed all of the variations in surface treatments and coatings. Our most important goal was to increase component strength. As our budget was small, reducing the wear – or increasing component life – was right there in order of importance.

As we researched the choices we found that most of the processes available to reduce the friction claimed benefits in wear and strength as well. It was decided that if we increased the strength, durability and longevity of the parts we were having trouble with, we would then be able to start chasing more power again.

One of the first areas of focus would be the intake ports as we had gone backwards in our first attempt. Getting the big valves and ports to work was, in our opinion, one of the first obstacles to tackle in our quest for more power. Once we optimised the ports and valves we could then start working with camshafts, exhausts systems and induction

2007: Mark Elrod (926) won the 450cc Production class with his 428cc machine

"This third crankshaft failure was emotionally and financially devastating to the team"

The NC-30 with the 450cc engine was a superior combination in the 450cc Superbike class. Lohmeyer often led a lonely race

The 450cc engine was more evenly matched against the SV650s in the Formula-IV class. Lohmeyer was constantly fighting for position among a large pack of riders

2005: Lohmeyer leads Yoshimune for one two finish in 450cc Superbike. The rest of the field was no where in sight

2005: Lohmeyer leads former Class Champion

systems. The design stage for these items would take the longest, so we started gathering what we needed with the expectation that it would be a long while before we could actually test parts in engines.

The Mule

We were very eager to get a head start tuning with a 450cc engine as soon as possible. So we decided to build a mule engine specifically for testing. Although the weld-up crankshafts were not lasting an entire season, we felt they were lasting long enough for a dyno-only test engine. Thus, with a newly modified weld-up crankshaft, we gathered all of the useable parts left from each of the previously failed engines and were able to assemble our mule.

The first tests I wanted to conduct were with the big-valve heads that failed to run after I ported them too large. To reduce the size quickly for testing, I epoxied the ports and purposely made them approximately 65 per cent of the stock size. The results were favorable in that the engine actually ran – and with an extremely crisp response. As I expected though, with restricted ports, the power in the upper rpm range was choked down.

"In our discussion we all agreed that the weld-up crankshafts were not the way to go"

This was actually what I was hoping to see. It verified that I did indeed originally make the ports too large and I would need to hone in on the optimum port sizes and shapes to get the right flow and velocity. A second test with the ports opened up a bit further, but still smaller than stock, produced the same predictable results – better mid-range and crisp throttle but still down on power from the standard ports. At that stage, being able to predict the results was exactly what I was after, regardless of the peak power output. Having a dyno-only mule had just paid off in bundles for us.

Pistons

The original pistons we had made by REC were of exceptional quality. The material and design were that you would see from Cosworth (given that they were designed by the former US Cosworth distributor). However, the extreme delays in getting the pistons delivered, and the lack of reaction to get the ring land issues resolved were enough to concern us about future availability. I decided to find a local vendor in the US in the hope of getting parts faster and easier and after researching several builders I trust it led me to CP Pistons of Irvine, California.

My requirements were that I had to be able to tailor the compression ratio, bore size and compression height to each engine and I also wanted a piston with less weight and less friction. In the end, we got everything we asked for – a higher compression piston that allowed for a shorter deck height allowing for a longer rod, with less skirt contact area and even less weight. To achieve an even further reduction in friction, we chose to try a 2-ring design instead of the traditional 3-ring design we had been running.

Crankshafts

I considered several of the usual crankshaft companies like Chambon, Arrow, Falicon and a few others but most of these companies required a very large non refundable engineering (NRE) fee which was not possible for a small privateer team such as ours. I was also uncomfortable with sending the parts across the country, or across the world in most cases. However, I soon discovered that there was a high-end crankshaft manufacturer just 600 miles from me in Southern California. SP Crankshafts, founded by Gerold Pankl Jr of Pankl connecting rods fame and Pete Spence of Toyota Racing Development (TRD) fame.

I took a drive to SP Crankshafts to discuss our project in person in the hope they would be interested in taking on the task of making such a small production run of crankshafts for our project. They debated the financial aspects, calculating this would be a loss to them and, after taking several long months to make the decision, they decided it was not in their best interests. However, they did refer us to Marine Crankshafts, a local crankshaft shop just down the street. SP felt that Marine Crankshafts would be able to make our crankshafts at a price we could afford.

Marine Crankshafts has been in the crankshaft business for many years and although the name implies boat engine crankshafts, I found

Top left: Marine Crankshafts' 4340 Billet crankshaft. Note centre gear and addition of Tungsten plugs **Upper left:** Close-up of the diagonal cross-drilled oil feed holes to the crankpins **Above:** Close-up of the Tungsten plugs necessary to correct the balance of the crankshaft

Left and below: 2006: Paul Yoshimura's update crankshaft was the third to fail on Lohmeyer

that it had been doing motorcycle work for some of the factory race teams for a while. After asking around about its reputation, and again driving down to meet with them face-to-face, I was assured it could make the crankshafts that would meet our needs.

Unfortunately, it took over a year of missed deadlines, long lists of excuses, several re-dos and general nightmares finally to get useable crankshafts. The trouble did not really lie with the

"The power was down and there was an extreme amount of noise from the cam gears, but we were running out of options"

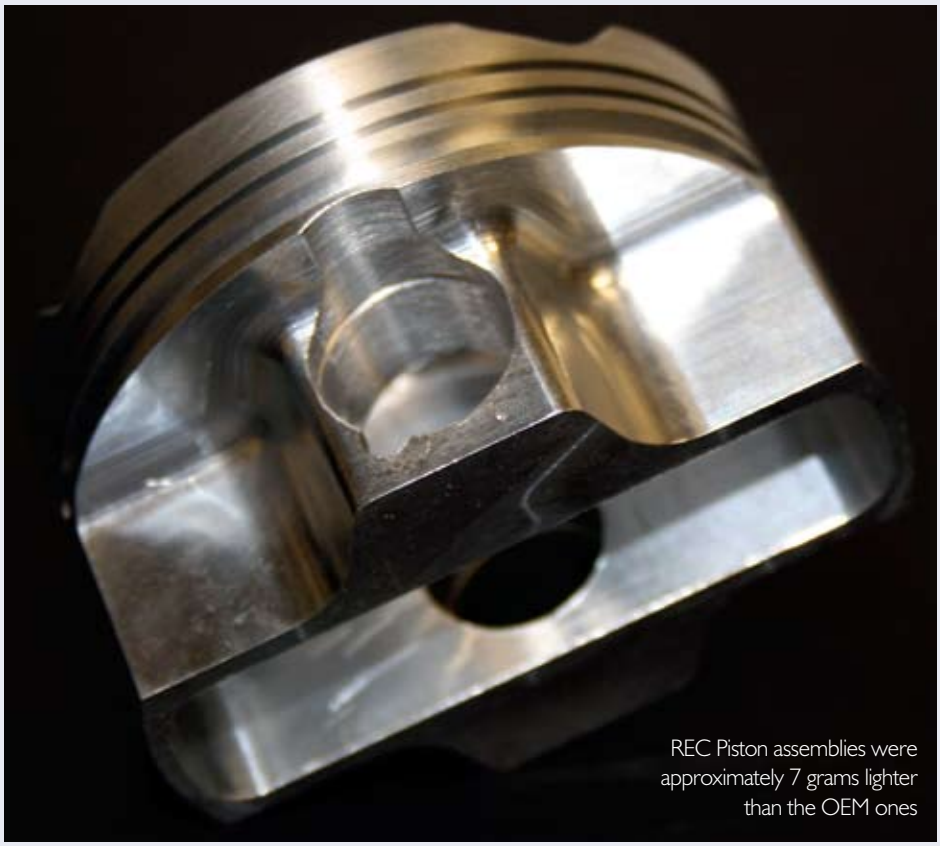
Below: By carefully removing material from everywhere possible and switching to a 2-ring design, CP (below right) was able to reduce the piston assemblies an additional 10 grams over the REC pistons (below left)

work being performed by Marine Crankshafts but by the outside vendors contracted to perform the gear grinding for the centre cam drive-gear. This process, as easy as it appeared, turned out to be one of the most difficult tasks in the entire engine.

Without the actual gear specification from the Honda blueprint, the gear company seemed to have great difficulties getting the correct gear tooth profile and centre. When we first received the crankshafts, the cam drive-gears were binding. We tried many different ways to gain the necessary clearance in the gears, including a

rework of the gear teeth altogether. None of these reworks had any success. We were about to throw in the towel when Marine Crankshafts was able to obtain a copy of the actual Honda blueprint leading to the gear cutters being able to re-cut the gears with success.

As soon as we confirmed the gears worked correctly, we put all of the engines back together as quickly as possible. Sadly, we found some other complications with the balancing of the crankshafts – again done for Marine by an outside vendor – that caused us yet more delays, expense and unnecessary rebuilds. The first bike we fired up nearly vibrated off the bench so the engines all had to come apart and the crankshafts had to be rush-shipped for re-balancing. One of the few saviours in our project was Larry Revis of Revco in Long Beach, California who was barely able to add enough Tungsten to the crankshafts to get them in balance again. Finally, after nearly a year and a half, we had working crankshafts.



REC Piston assemblies were approximately 7 grams lighter than the OEM ones

428cc Engine

So as not to stand around wasting time while waiting for the billet crankshafts, we spent our time looking at the 450cc Production class engine for Mark Elrod and a customer engine and were able to apply all that we had learned so far from the 450cc Superbike development over to the Production engine. This was essentially the 450cc engine less the stroker-crank with the final displacement for this configuration being 428cc. Although it did not have the torque of the 450cc engines, the peak power was surprisingly close.

These engines proved to be much easier to work with and caused far fewer headaches for us. With the exception of a spun bearing due to a crash, these engines had the reliability we were more accustomed to seeing. We were also able to use them to develop ideas that would transfer back to the 450cc engines.

2007 – The Next Weakest Link

By the time we did receive the billet crankshafts, the first race was quickly approaching. It was at that time we found the gears were incorrectly cut. We needed to run at least one engine as Lohmeyer was finally hoping to win the Formula-IV class in 2007. That meant having a stellar season right out of the gate. We therefore shimmed the gear towers up enough to prevent the gears from binding so we could run at least some races while we waited for a resolution on the other crankshafts. The power was down and there was an extreme amount of noise from the cam gears, but we were running out of options but as we hoped, we were able to run the engine for the first couple of races.

We then experienced our next catastrophic failure. At first we suspected the billet crankshaft failed then we wondered if the Carrillo "A" rods were not up to the job. Upon careful inspection, though, we were completely shocked to find the transmission had let go. One of the gear dogs had broken off, projecting towards the connecting rod beam causing it to fail which in-turn took out the entire engine. The old adage is "every time you strengthen one part, you find the next weakest link". So true!

Things to come

As with everything else, having a mule was only good while it lasted. Having run out of any other weld-

up cranks and not having a useable billet crankshaft yet, we were left with no option but to "borrow" the mule engine for a few races. It was our last choice, but we were there – and just as we all expected, the weld-up crankshaft did indeed snap leaving us with no mule and no 450cc engine.

I cannot put into words the amount of frustration and angst that we were all experiencing by this point. Being self-funded and trying to accomplish all of this while maintaining full-time jobs and family lives was definitely taking a toll on us. Most of us were run down and losing sight of why we were doing this.

Despite all of our frustrations, as racers we kept our heads up and did what was necessary to complete each season with the best results possible. As in past years, Lohmeyer was able to win the 450cc Superbike Championship using his back-up 400cc engine. However, with this he was only able to muster enough points for seventh overall in the Formula IV class for 2007. Elrod was able to use the 428cc bike to win the 450cc Production class and again finish second behind Lohmeyer in the 450cc Superbike Class.

Vendors and Relationships

Our crankshaft story is typical of many of the other parts we have tried to develop. It seems our entire project has been peppered with various vendors that over-promise and fail to deliver either on time or with acceptable quality to the point where I am losing faith in most of the motorsport industry vendors with which we have dealt. Only a small few have shone through as light in the darkness of this black art. In our experience, we are finding it hard to trust anyone, but those few who have come through now have customers for life.

It's not about making mistakes – that is going to happen from time to time. It's more about what they do to make it right. In my experience, this is what defines a great supplier over the rest.

It has been proven to us that we are mere dreamers. Without suppliers, we cannot turn those dreams into a reality. The relationship we build with them is one of the most important a race-team can ever build and should be cherished and respected by both sides. While most of our delays and heartaches had been caused by some of our suppliers most of our success can also be attributed to those that delivered and to whom we extend a huge thank you.

The next steps

During all of the distraction with the component failures, we still managed to plan for new modifications and design several new components that have not yet been tried. We had discussions with several cam companies until we found one to send us some different grinds to test. In anticipation for the more aggressive cams, I designed lighter valve train components that are being manufactured as I write this. We have also been working on a new exhaust system for more high rpm power delivery and have been able to obtain the ever-obscure Keihin FCR-32V "Flat Slide" racing carburetors as well. In addition to these items, we are building one engine with a host of additional strength-increasing, friction-reducing processes.

Lastly, for the final capper, Mike Sampognaro has decided to convert his motorcycle's electronics to a Pectel engine management system utilising full electronic fuel injection. My next article will discuss all of these items in detail.

Below: CP's 2-ring piston