From: Matthew Bulliman
Sent: 25 June 2007 11:55
To: Ben Ballard [mailto:ben.ballard@jbsracing.co.uk]
Subject: 105mm piston requirement

Hello Ben, apologies for the delay.

With regards to your questions, I have attached a response from our Technical Director, which hopefully answers your questions. However, if you do have any further questions please do not hesitate to contact me...

Matthew,

There are a number of things to address here

1) Forging work in ferrous material is not directly relevant to aluminium materials. In ferrous materials one of the benefits (non VAR steel) was minimising problems due to inclusions like manganese sulphide. Basically these inclusions are directional and forging had the benefit of it behaving like there was a lower concentration present in the direction of stress – then again a badly designed forging was even worse! With aluminium we are looking at about a 20% difference in terms of fatigue in the differing bar directions. However this is not strictly a good comparison – as the highest stressed areas often do not have the maximum amount of work done. In the case of a good forging – F1 for example, there is much work in the webs (shame the load is 90 degrees to the forging extrusion), and minimal in the crown (especially starting with directly sawn bar stock – where the crown centre is almost exclusively T direction material). I digress...
2) The real benefit of a forging is machining efficiency – however in cases of cost not an issue – high end F1 parts are almost exclusively machined from billet.
3) More importantly is the transverse fatigue properties of various wrought material – in billet or forging form. We have done many trials (elevated temperature fatigue tests), and as it is not a C of C requirement (like UTS and YTS), there is huge variation between samples taken from bar stock (from different mills), and those from parts etc. After many years we settled on one grade from a French mill supplier and in the case of billet machined parts we utilise a proprietary forging step in billet form. This provides work in the transverse direction – and coupled with better than composition required cleanliness gives a very enduring part. Further we shot peen our parts to further increase fatigue life. All parts are analysed using FE techniques for stress levels and values compared to allowable stress values (from our own in-house testing).

Regards,

Seb

Sebastian Howell-Smith
PMi Automotive Technical Director
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Perfect 10

An in-depth look at the detailed engineering principles behind recent F1 engine development

BY SAM COLLINS

A 3.0-litre, 1000bhp, 10-cylinder engine that had to last for 1500km of tough racing laps. 'It was a lot closer to 1000 horsepower than many people imagine,' reveals the executive vice president of Toyota Motorsport GmbH, Yoshiaki Kinoshita. Toyota had intended to run a 3.0-litre V12 in its new TF101 chassis, but a late regulation change on the grounds of cutting costs barred all but the 10-cylinder configuration. 'We started on the V10 in 2000 and had it running on the dyno in August of that year,' Kinoshita continues. The rapid gestation period was to indicate a development curve that lasted five years. The early V10 produced just under 800bhp but, at the end of its life, it had a longer life and an extra 200bhp. 'The first engine didn't look very different to the final 2005-spec unit. But inside it there has been a lot of work. In about five or six years you have a big power escalation and that's even more impressive when you consider that we also had to increase engine life. It was originally designed to do 400km, then we went to an engine for the whole weekend, after that for two races, so it was quite challenging,' he explains.

> "there has been a lot of evolution in manufacturing technology"

'It's funny, because in the past you could really see a lot of macroscopic differences in the engine – you could see different architectures, really different things that even inexperienced people would notice. In recent years though, most people are just working on details, things you don't see outside, or even going inside. If you had two iterations of the pistons sat on a table and you looked at them from a metre away you probably could not tell them apart. But if you go into the details, you will see huge differences. There has been a lot of evolution in manufacturing technology, coating technology, things that you might not see but make a huge difference. For example, in the past you could not think of machining a piston from solid, yet now it's almost standard. So I would say every bit of the engine has been improved or modified, you just don't see huge changes in the mechanical components themselves.'