Design Debrief Notes Friday 7th July 2006 Bruntingthorpe.

Introduction.

We start in the traditional manner by offering a huge thanks to all of you that contributed to the success of Formula Student 2006.

The Judges; these people give up a huge amount of their (often highly lucrative) time to be here but please also remember the amount of work they put in beforehand. Reviewing the Design Reports and Specification Sheets in detail is pretty time consuming.

The Organisers; all of the staff at the IMechE, Motion Works and all the marshals, scrutineers and volunteers.

The Students; building a car is not easy, keeping it running reliably and safely is also not to be underestimated.

The Objectives.

3 things are evaluated: the pre event paperwork submitted, the car and the student team's understanding of the engineering principles involved.

The car is perhaps the easiest bit to assess, the understanding and knowledge less so.

The basics need to be correct. This is true in motorsport and any industry. So you are penalised heavily for errors, be they formatting or punctuality. You will learn eventually!

The car should impress, the importance therefore of neat preparation is paramount. Unfinished cars will be harshly looked upon. You will learn eventually!

The team members must be prepared to display their knowledge, often despite nights without sleep etc. Please do not let Faculty Advisors etc. answer Judges questions. You will learn eventually!

One thing to note is that the actual points vary from year to year, i.e. just because you scored 90 in 2005 and 120 in 2006 does not automatically mean that you have improved in absolute terms. ALL of the points are purely comparative with the best overall team/car obtaining 150 points. Please also note that any Judging Team that wrote the words "dangerous" or "unsafe" or "unfinished" against ANY team or brought those concerns to the attention of the Chief Judge or Scrutineers were automatically demoted to pretty near the bottom.

The Basics.

It therefore continues to both stagger, amaze, annoy and even amuse me that some of the brightest students in the World can neither read plain English, nor count up to 8, nor record time correctly. These are not new Rules, and have been highlighted so many times we are sick of saying it!

Please note that the penalties applied to Documentation errors were pretty severe but consistently fair. The calculation of these penalties was laid out well in advance. You have your

own individual summary of your Report and paperwork penalties, I have the fully detailed scheme should you request, individually, to see it. Please note however that almost universally those of you that came to see me with reference to the pre event documentation penalties went away accepting your mistakes, often it must be said with good grace and a grim determination not to lose so many easy points again next year. Thanks for your understanding, it was appreciated.

You will note, from comments made on Friday night as well as the published scores, that this year, the documentation penalties seriously affected your overall Design position. The team that came second, Queen's University Belfast gained places here because of their zero documentation penalties. You could all have had zero penalties here if you simply read the rules! By contrast the teams from Oxford Brookes, Helsinki and Munich really paid the price for sloppy paperwork.

Please note we do not see the Report in anything other than its native electronic format. It should not contain basic errors be they spelling or date errors. It should not be a copy of last years and still more than one of the Universities entered in two classes showed remarkable similarities between their Reports!

The Report must meet all of the common sense requirements, i.e. it should explain WHY and HOW you ended up with the Design presented, it must be reasonably truthful, we forgive things that have obviously changed between the Report submission and the competition. It should provide a balanced logical discussion as to the relative merits and potential drawbacks of your chosen solutions. It is not enough to simply state that "we chose a single cylinder engine because it is lighter". You need to show the reasoning with a comparison of the options that could have been used and then explain why and how your choice was best.

The Report should not be simply a description of what you did, where you found the parts and numerical parameters that mirror those in the Specification Sheet. Please use all of the allowed pages wisely and in the correct format. You must respect this competition in its own right; those Teams that simply filed their FSAE paperwork will have suffered for that lack of recognition of the end customer.

We asked for a word count, how can you forget or ignore this? We specify the portrait orientation, how can you present it as landscape? We specify the page content and the drawing views required etc., how is it possible to get this wrong? Most of these requirements have been in place for a long time now.

When you are ready to submit your paperwork online do so in good time so that you can trial it by sending it yourself first: this way you avoid the embarrassing mistake of the software adding a (ninth) advert page!

<u>The Design Aims.</u>

Many of you list, quite rightly, the usual aims (e.g. low CG, light weight, good torque, etc.). Quite a few now consider the noise test as a fundamental part of the engine

development programme; this is a good recognition of the changing face of motorsport and legislation across the world.

The new crash structure rules seemed to have been overlooked by many of you in your Reports. I personally would have thought that you would have highlighted your philosophy behind any newly introduced rule or regulation as a matter of course.

The general use of validation techniques to back up your undoubtedly high CAD skills is improving, for this we real world end users are grateful.

Many teams mention the benefits found from being members of the SAE Tyre Consortium, an excellent initiative.

There is often mention of the use of the engine/transmission as a stressed member and how this saves weight etc. But rarely is there any mention as to whether the chosen engine is indeed suitable as a stressed member, any basic tests of e.g. block or bore distortion under chassis torsion, chain tension effects etc.? All of these would be quite simple to arrange. Some teams did at least comment on the engine being installed similarly to its motorcycle origins and thus anticipated no problems etc. This simple extra reasoning gained them precious respect from the Judges.

Many do now seem to realise and value the precision and feel of the steering linkage, its weight and accuracy etc. This is an area of great personal preference and does often need to be revisited once basic reliability testing has been successfully undertaken. It is worth repeating again that any slop or friction in the steering is a nasty thing. Acute UJ angles really make things worse here as wear is increased and any UJ fixed with a bolt through a tubular column with no inserted bush is going to last only a few miles and will never be properly tight. Similarly there was at least one car with two UJ at strange angles and with poor relative phasing such that the effective steering ratio between steering wheel angle and road wheel angle varied dramatically differently either side of centre. It is possible to calculate the ideal phasing if you have the 3D UJ centre locations but it is quite easy to measure it on the car, or even on a mock up to avoid any confusion.

Lots of you harp on about the steering arms (trackrods really) being in line with the wishbone links. Some proffer a guaranteed lack of bumpsteer as a reason. Unless the lengths are also the same and there is minimal 3D disturbance (e.g. no anti dive etc.) then there are no guarantees. In most single seaters there are aerodynamic benefits to doing this that do not apply to FS cars. One assumes that the geometry and bumpsteer are checked, initially by drawing or computer modelling at the concept design phase and at the finished car assembly/final setup stage to ensure no serious manufacturing/tolerance errors.

Very few outline mass targets or their breakdown or a contingency plan for when it gets too heavy.

The finish built car should be checked for steer compliance as well as bump steer as well as a fully functional through suspension travel clearance check to ensure no parts foul or bind up. This can easily happen on the assembled car compared to the model on the screen,

due mainly to tolerance build-ups, machining and assembly errors. It takes time but will improve reliability massively.

Prioritising the common design aims is important. This is true both in motorsport and in production. Many teams seemed to lack balanced logic here; examples being the retention of a standard exhaust system (i.e. going beneath the sump) raising the engine CG by about 80mm and the desire (in itself a valid one) to use common front and rear wishbones that had the huge drawback of serious structural compromises in their attachment to the chassis structure. As ever, teams that understood their limitations early on and planned accordingly got more sympathy (especially first year entrants) than those that turned up with the excuse "well we ran out of time so were not able to finish bleeding the brakes/painting the suspension/securing the wiring loom/fitting the supercharger etc. etc. etc."

Communication skills.

Please be aware that in the Design event you need the engineers who know the facts to be able to explain their decisions. It therefore helps if they are actually present! This is a different test to that of the separate Presentation event! It is your responsibility to convey the balanced reasons for your design to the Judges. Some Judges may probe you for the negatives to your choice, some may not. Those that don't (and if you don't mention them) may be assuming that you do not actually know the drawbacks and therefore will mark you down.

Crowding the Judges with many keen team members actually works against you in the small pits area as this can be a touch overbearing. Organise your team to take best advantage of their interpersonal skills and their knowledge. Accept the fact that some Judges may want to dictate the discussion but try to steer it around yourself to your team's advantage. Watch how a good live show host chairs the audience and panel like a ringmaster for a few tips, better still get along a s a member of the audience.

Class 1 200 Series.

Staring with a running vehicle, with an additional 12 months to fix, refine and develop it should produce something that is pretty special in the dynamic department at least. We can all see the benefits to a University of having a Class 1 200 entry to back up and help provide data for, the Class 1 entry but the fact remains that the 200 teams do not appear to learn as much in general. We ask that these students consider thorough research into the Rules of the event and possible alternative solutions before starting the development of the "inherited" vehicle. Simply fixing the unfinished parts, or those that break in testing is not enough. One team even admitted to not reading their previous summary from the Judges from last year! Similarly we ask that the Universities consider carefully the relative merits alongside the inevitable costs etc. of running the two entries side by side.

University Staff & Team Managers.

On a similar note a number of University's appear reluctant, for the best of reasons I am sure, to allow the students practical experience of machining, welding etc. These students will ALWAYS suffer at this event as a result. If the students cannot persuade the University to compromise over this practical involvement, and as a Team you want to be up at the top then you have no choice but to try and set up construction etc. elsewhere. Try some local engineering companies; speak to local motor clubs for possible premises etc. Please don't expect much leeway from the Judges however if you simply accept that your chosen University does not allow you to perform practical work/tests on their premises under their insurance obligations etc. Such Universities would be well advised to consider fully the implications of such restrictive practices: expecting the students to liase with the technicians to do all of the practical work is rather optimistic. In the future this stance will affect the quality and quantity of your engineering undergraduate intake and dictate their graduate results. You must campaign internally on the student's behalf for their access to the facilities that will enable them to get their hands dirty; otherwise you, as a University, will suffer. Even today this can be done with relentless persuasive argument.

The Future.

I am guessing that there is an impression that traditionally in England we are obsessed with light weight and fancy cars. This is not completely true but I can recognise where it comes from. It is true to say, that if ALL other things are equal (which they rarely are), then the lighter car is the better car. It is also true to say that under the same circumstances and considering the nominal 1000 per year production target, then the cheaper car is the better car. Please note that, with the same proviso, the car that will actually sell initially to the customer is the most visually appealing. However in the longer term the ONLY car that will sell in quantity is the one that WORKS pretty well, and has spares back up etc. Most of these factors are scored directly in other events but the Design event does attempt to consider these factors (cost to manufacture, aesthetic customer appeal, likely performance/tuning/set-up potential) as part of the engineering assessment.

The key point I suppose is that it is very difficult to not be impressed by students who have learnt more. Inevitably those that have refined the "standard" SAE style car will learn less than those that take to risk of bonded carbon tube wishbones etc. Teams that did this properly learnt from first hand experience the issues involved with glue film thickness, material preparation and the practical difficulties involved. They also learnt that bonded parts do not distort like welded ones and therefore fitting time upon car assembly is less, accuracy is greater etc. My instinct is that for 1000 cars per year volumes then the (well researched, intelligently designed and completely tested) carbon tube wishbones are probably cheaper overall but the Cost Judges would perhaps be able to answer that one?

We can also be accused, I suspect, of being against innovation. This again is partly true, innovation usually implies risk and risk almost certainly equates to cost (both financial

and reliability). To convince us you need to have ensured that you have tried to minimise the associated risks through careful consideration of the negatives and positives and made a balanced decision.

We hope that you can see this point as otherwise the ultimate future car will simply be a perfect refinement/evolution of the "standard" Formula Student car. But for Teams that have entered a few times (and gained a reputation, perhaps find it easier to recruit members, find sponsorship and manage themselves effectively) perhaps now there is a chance to take a real clean sheet approach, balance all of the requirements and offset the known risks etc. to produce an original concept that is tested and works.

Summary.

Formula Student is one of those very rare things, a "win-win" situation for everyone involved. Universities get better applicants if they provide a good Formula Student experience, students learn far more of the real world practicalities, financial and temporal use of resources etc., prospective employers get better quality new graduate recruits and even the Judges usually learn something!

Thank you all for coming; let's hope next year sees a similar variety and an even higher standard. Who knows, the paperwork may even be faultless too!

Neill D Anderson
Chief Design Judge