

# MILLDENT MOTORSPORT

## SET UP THOUGHTS

Steve Farrell    January 2009

What do they say about economists? Ask three of them for an opinion on something and you'll get five versions back. Whilst they may not be everyone's favourite group of people at the moment, I have some sympathy for their situation. An economic model is a very complex one; a heady mix of mathematical laws with theorems based on historical events mixed together with the hard-to-predict human elements of greed and fear that makes all the previous work subject to complete reversal. Does it start to sound familiar? In my more than 25 years working to try to beat the other bloke on the track I think the economist adage could well be directed at race engineers. Now don't think for a moment that I'm making out I'm the second coming of Carroll Smith but I like to be able to engage with my fellow professionals, be able to follow the thread of their argument, to be able to see that they have a basic grasp of the physics, that they have a philosophy that underpins their overall approach so that the team and driver can see that there is a plan and that its not trial and error!

Resources at every level, from karting through to F1 are not limitless, and the trend will be for less rather than more! And by resources I include not only money and people but also track time. We would all test more if we could, so based on the fact that we can't, we need to really focus on what will give us the best return on our spend. We need to identify areas that will reap the biggest benefit for our effort. If you are fortunate enough to have a team of data analysts to draw upon then you are home and hosed: you've (hopefully) worked all this out for yourself. However, if you are in that vast group that are the owner/driver/engineer all wrapped up in one and are as likely to have a sophisticated track simulation programme to guide you as Boris Johnson has a comb then time spent pondering your particular situation may prove fruitful. I would like to focus this on those stalwarts who, like me, started out with the most sophisticated piece of technology we owned being a 5/16" ring spanner. I may have moved on a bit since then but I haven't forgotten that whilst technology is nice, its not essential.

In any class of four wheeled vehicle (I've never had the pleasure to try to win a race on two wheels regretfully so I'll keep to what I know) there are various areas that are adjustable and so available to us to affect our performance (affect meaning we can improve it as well as erode it!). I've classified them in what I believe are their orders of importance. They may not be in the order that everyone would place them but hopefully my explanations will give you the rationale for my selection. I have also assumed that you are not designing a car from scratch; that you have what you have, more or less. This would include categories where you all have the same basic car: from GP2 down to FBMW, but equally Formula Ford and saloon car racing.

Some basic things apply before we get into the details. Make good notes. Keep accurate records of as much as you can handle. Firstly, of course, the set-up, but then tyre set numbers, air and track

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temperatures, wind direction, and comments as they are said. It may seem obvious but if I hadn't seen it done badly at professional level I wouldn't mention it!

What are the first order items?

1. Centre of gravity: yes, sure, you can't go lowering the engine but think ride height. A good lower car will beat a good higher car. A good low car has got the right spring/packer/damping combination that combines the low centre of gravity with the ability to take the kerbs, not hurt traction too much, ride the bumps and keep the tyres on the ground as much as possible. This definitely does not just mean stiff either. Assuming the your car has been designed around the tyre diameters you are using then its got to be riding on the deck. Its not easy, but I've seen this one factor make the most grid positions of any other change. And when I see the guys being laughed at for dropping their cars 0.5mm I see someone who is devoting time to something important. It of course depends on what type of floor you have and how resilient it is to impact, but if the driver complains a little about it being a bit uncomfortable then its about right! The only proviso on this is if you have a car with a lot of aerodynamic downforce, AND if the manufacturer has supplied you with some form of aero map, then just be sure that you are running in a good, efficient part of the map. If you have a big aero car, you are likely to have damper pots and maybe even lasers for ride height, so you should have all the information available to you.
2. Tyres: mostly you are probably on the same spec tyres as your competitors, so you have to manage your tyres better. On the simplest level, I'd have a new set of tyres over another 10hp, if that choice is an option. But let's say you can afford to buy the maximum allocation that the series permits. Now its down to how well you extract the maximum performance available. This comes down to tyre pressures and temperatures (and we'll put aside the subject of tyre heaters). The tyre characteristic will change with pressure, so the most consistent pressure is vital. Use dry air, nitrogen or the famous Ferrari gas rather than the damp output from your 15 year old compressor. Don't let the tyre fitters coat your lovely tyres with soap to make it easier for them. And even if you don't have a tyre pyrometer, just look at what the tyre surface is trying to tell you. Fine tune the camber until all four tyres look happy. OK, the inside front is always going to look a little different, but do your best. Most people can be taught to use the kit to monitor this; they don't have to analyse it, just record it accurately. Mark each set clearly, and keep a log of their use on your lap chart. Even the best tyre manufacturer has some tolerance on their product's performance and this database will help you spot it.
3. Driver: now we engineers would like to claim the credit for good performances and drivers will get the blame for bad ones. However I think we have to concede that we engineers operate in the 5% influence range and drivers have got about 20% to play with (the rest is down to the car's designers). We've seen some old nails win races and that's because the driver not only has natural ability, but also is focused, has confidence in himself and those around him, has prepared himself well and can perform under pressure. We can do our 5% well, and then help

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the driver extract the most of his quota too. We engineers have probably sent perfectly good drivers to the back of the grid through some ill advised set-up change, and once that is done the relationship starts to erode. As one famous IndyCar engineer said to me once: “the BEST spring (or damper, anti-roll bar of whatever) is the spring that the driver THINKS is the best spring”.

4. Suspension compliance: this is how much the mechanical components twist, bend and squirm under load. Very important, but if everyone else has the same rubbery suspension then fine. There are a few basic numbers to look out for but they will be different depending on the weight of the vehicle and the cornering forces (for instance does it have a lot of downforce?) to name but a few. However if you can attached a 2 metre hefty bar to your axle and you can move it lots then that’s not good. Equally, the suspension articulation joints must be in good condition: no play but also not too stiff. It simply means that the wheels are pointing where you think they are rather than where they choose. Friction should be restricted to brakes and tyres, everywhere else it’s the devil’s work.

Second order items:

1. Engine Power: This one always fascinates me. I was tempted to make this third order. Of course I’m assuming that there is a sensible level of parity to start with. At one particular establishment I was once with, where they dealt with customers, it was easier to sell an engine upgrade that gave maybe 2% more power than ANY other upgrade on the whole car. As a matter of fact you could name your price. We pondered whether this was just because you could give them a dyno sheet to prove what they were getting. I’d keep my money, make sure the engine runs properly, is warmed up correctly and concentrate on other things. Take it if its cheap and reliable.
2. Suspension geometry: I guess I include here anti-squat / anti-dive options and roll centre. Rarely a magic bullet but I have seen drivers adamant that change “A” has made a “massive” difference. Nine times out of ten there will be no improvement in lap time, and as long as there are no other indicators to counter the driver’s opinion I’ll roll over and run what the driver wants. Life is too short.
3. Tracking: there are some wild and wacky methods and equipment up and down the average pit lane. However the most important thing is to make sure your equipment gives you consistent readings. I’ve seen ride heights being done with verniers, and that’s OK for those with OCD, but if the equipment is not robust enough to give consistent readings time after time then it’s a waste of time. String and rulers have yet to be fully superceded in my book, but any system should be repeatable. Understand your level of error. There’s no point thinking you are running 2mm toe out if your measuring system has a potential error of +/- 2mm. The reason why I have put it down in the second category is because I have seen cars involved in first corner nudges, with clearly bent suspension, still blitz the field because the driver is fired up! But I am still a believer in getting it right just because its not that difficult to do right.

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4. Springs & anti-roll bars: Car balance is very important. But of course one driver's balance is another driver's pig. So springs and roll bars are our best friend to finding the balance that best suits us/our driver. I know that many multi-car junior category teams try to enforce a "team" set-up on everyone. That does make managing the team easier, and prevents one driver and his trusty young "keen as mustard" engineer getting lost but it does not optimize each driver. If you are going off on your own don't forget some basics. If the set-up is wildly different from the one the other bloke is running, or that the manufacturer recommended then you are either the next Sam Michael or you are wrong, and I'd back the latter. However small changes that might give that slightly better feedback to your pilot is worth doing. But equally don't be afraid to go back and re-check it, and if necessary, admit you were wrong (on that day, on that particular track).
5. Brakes: once again, assuming the manufacturer hasn't dropped a big one, making sure that each component of the system works as designed is the most effective. Without servicing, piston seals wear out and allow more pad knock-off, the bearings in the pedal and adjuster mechanism become stiff and it will result in variable brake balance and a driver who is not confident that he can stop the same way every lap. Once again I've seen big claims for Joe's calipers and Fred's pads but if it was that simple everyone would be on them. I assume that those who run carbon brakes haven't even bothered to read this article so I won't go there just now, but the same principles apply.
6. Differentials: again I've seen those same guys with OCD ordering their ramp angles in 1/10s of a degree! Making sure you know your diff (lets assume you are running the Salisbury type) has the preload you think it has, the plates are not trashed and again, you are not running extreme settings, then it's a good play thing if you can be bothered, but its not something to invest your life savings in.

## Third order items:

1. Gear ratios: I put this here, slightly controversially because I am weary of the about of time engineers have wasted on gear ratios. Drivers are as much to blame but together the time could have been put to better use. Yes, sure, if you are sitting on the rev limiter for 500 metres down each straight, then there is some room for improvement. But assuming that that is not the case, and that you have more than 4 forward gears available and your engine has a reasonable torque spread then go and polish the driveshafts: at least others can admire that. I will race anyone with the same budget with one set of ratios sealed in my box over one who has bought Hewland's entire range any day. And one can always play the "Schumacher in Spain 1995 stuck in one gear but finished second" card to make your point.

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If you are making a good fist of all of the above and you are still being beaten then you may need to think through it all again. Someone has to finish last, so that's no disgrace, but to finish last twice in a row IS a disgrace and you should ask for help.....or find another career...maybe an economist?