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Chapter 11

The driver

If Steve McQueen was right, and racing is living and everything else is just waiting, it makes sense to spend some of the waiting time with the data. For a driver, the whole point of logging is to go faster, and, as this can be at least a three phase operation, this chapter is split into 'before the event', 'during the event', and 'after' sections. The emphasis tends to be on what the data can tell you on the day, and this is obviously a key function, but don't forget that even before the event, the data from the last time out in the car, and the previous outing at that track, can be valuable reminders of what goes on. You must also take time for a really thorough look at the data after the event, but while things are still fresh in your mind. In this way, you stand a chance of uncovering the secrets locked in the data, but which are temporarily obscured by the pressures of competition.

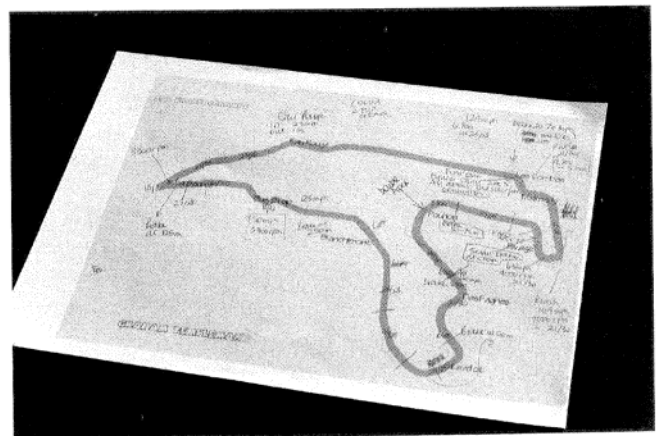
BEFORE THE EVENT

Review the data from this track a few

days before the event, to remind you of what happened last time out. The software will provide a list of lap times and detailed information about speeds, rpm, gear ratios, shift points, and a hundred and one other things. You don't actually need logged data to do this, because, as an intelligent driver you'll have brought all the important points together in notes written during the last event and at the debrief afterwards. But, having the data adds another dimension

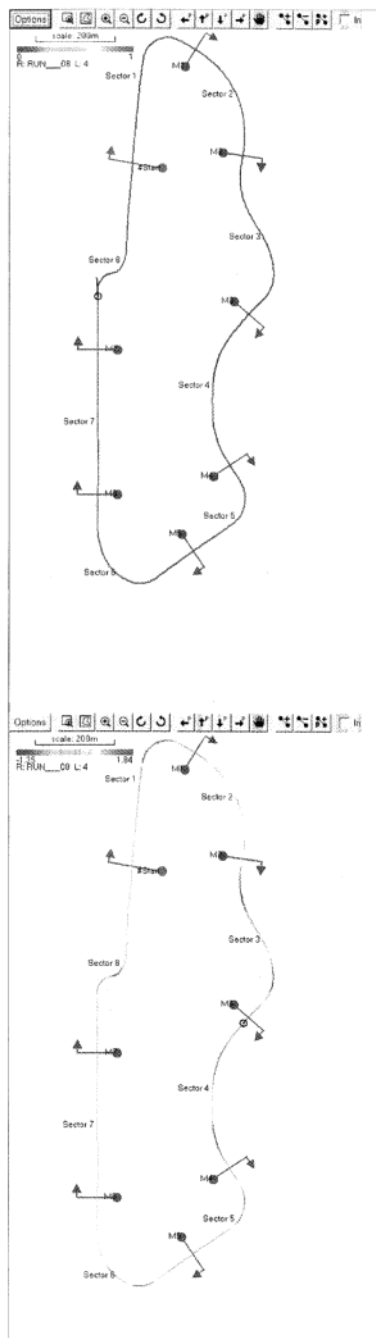
to your preparation; since the last outing at that circuit it's likely that things have changed, and part of the preparation should be to evaluate the effect of those changes on the current event.

One thing that the logger will do for you is to print out a track map. You can then annotate it with information about



11.01. The logger can provide a track map for the driver to keep notes on.

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11.02. Two track maps showing different information about the track.

The top one shows positive and negative long g – whether the car is braking or accelerating. The blue zones indicate the braking areas, and also give an indicator of gearchange points.

The bottom map is shaded to show lateral acceleration, and indicates how hard the corners were being taken.

the lines, the braking points, gear ratio, and expected revs. In fact, it's well worth printing off several copies of the track map to take with you. They'll be useful for updating the existing map, for the debriefs, and for communication and explanation purposes.

Other information can also be recorded that will not only help remind you, but can improve your understanding of the data. Bumps, poor surfaces, track cambers and so on all show up in the data with an impact on many of the channels, and knowing about these things can help understand why a particular piece of data is not as expected.

A typical case here is the extent to which the driver uses the kerbs. If you're in the habit of getting on to the kerb on the outside of a right-hand bend immediately before turning in (to maximize the corner radius and optimise the line) this can show as a brief instance of lateral g on the accelerometer. Anyone reading the lateral g trace would see this as the car moving to the left and might assume that the driver is flicking the car left to get it to turn right more convincingly, and might worry about lack of bite in turn-in. But the clue to the correct interpretation is that all this happens with very little steering input, so that the flick explanation could not have been correct. Easier to know this from a track map with notes on than to waste time finding and verifying an explanation the hard way.

Similarly, using the kerb at the apex of a corner will show as a small

increase in the lateral g trace. It's fairly easily recognisable, being of very short duration, but again, it's easier for the driver to provide the explanation than to have to work out the amount of kerb that the driver is taking from the size of the bump.

The notes are a starting point, but the analysis software lets you look at the data in detail. This will enable you to visualise the shape of the track and the speeds that you should be achieving. A good way to get a quick overview of what happens at a particular track is to use shaded track maps. If the software allows it, have a look at a range of maps that show the track shaded according to such things as speed, mph/1000rpm or gear, and throttle position. In this way, you can remind yourself about the speeds that you could achieve, the gear ratios you used, and which corners were taken with wide open throttle and those where you needed to be a bit more circumspect. The throttle position map also gives some clue as to braking points. The two coloured maps shown in Chart 11.02 show the braking flag (whether long g was above or below zero – red for accelerating and blue for losing speed) and lateral g to separate the on-the-limit corners from the rest. A few minutes playing with this feature will refresh the memory on many aspects of driving the track.

Once the memory is refreshed about the general business of driving the track, time to go into a bit of detail. A good place to start is braking points. Plotting long g trace and corner radius, or lateral g against distance, will help you identify whether corners are early or late apex and precisely how many metres before the apex you start to brake. This latter figure is not much use, but it does give you a starting point to relate it to the countdown boards on the track. Similarly, target rpm, gearchange points, and cornering lines and speeds

can all be reviewed. This is where video is invaluable; it will tell you more about what a circuit looks like in a way that no amount of walking the course can do. It also gives a pretty instant view of cause and effect with driver inputs. The objective is to go to the track knowing what to expect, and having some sort of idea where improvements can be made.

AT THE RACE TRACK

Properly prepared, you should be able to minimise the time spent familiarising yourself with the track, and get on with the business of driving quickly. After the run you need to review the data and compare it with previous events. Chapter 6 tells you how to review the data as efficiently as possible. Patience is needed here, because the first priority in reviewing the data is to identify what needs to be done to the car before the next run. When your turn comes, the first thing to look at is the list of lap times. The fastest time is always interesting, but the spread of times is probably more significant. There is something very satisfying about the 'banzai' qualifying lap, and it's worth looking at it in detail, even though, by its very nature, it's not something that you would want to try to repeat on every lap throughout the race.

Generally, a consistent list of lap times is what you're looking for, with the times early in the session perhaps being a couple of seconds slower than the absolute fastest lap, and then working up to a time within a second or so of the fastest. Obviously this will vary according to circumstances, and the first time at a particular track will show much greater variations than when you return to a track that you know well. The obvious first candidate for scrutiny is the fastest lap, but fascinating as that lap is, don't forget the others. Unless the lap was perfect, there'll be parts of other laps that were quicker in certain sectors, and this need to be looked at too.

Split times

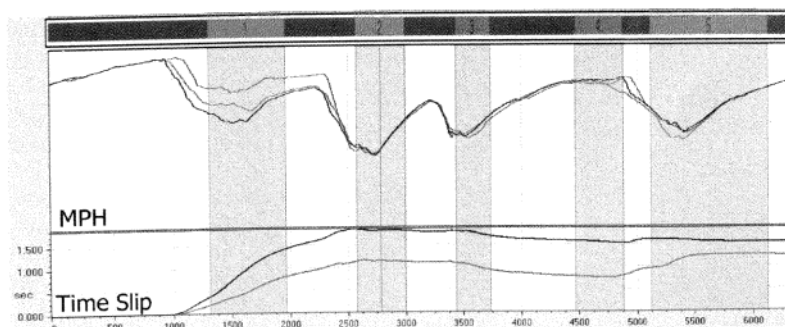
Start with the lap and sectors report that shows lap times and sector times. Generally, these will also calculate the fastest theoretical lap and, while this is great in theory, don't forget that there's a good reason why some teams call this the fantasy lap. By all means enjoy the thought of the fastest theoretical lap, but pay more attention to the fastest rolling lap.

Traditionally, laps were split into much longer sectors – three or four to the lap – and this can have its advantages. Longer can be chosen to reflect different aspects of the track. For example, somewhere like Spa in Belgium splits conveniently into a fast first sector on the old circuit, a technical middle sector with the majority of the bends, and then the high speed return to the start/finish area. The first and the last sector require low drag, low downforce settings, and the middle part needs higher downforce to cope with the corners. Splitting the lap into three sectors allows the team to understand and balance the conflicting demands of the various parts of the circuit.

As driver though, you need to understand your strengths and weaknesses over individual laps and over a session as a whole. If, over time, the fastest rolling laps all tend to start

at the official start/finish line, then this is evidence that you're the type who tends to screw up the level of effort and go for a 'split-or-bust' frightener of a lap. The other way of looking at this is that there is a certain amount of cruising going on that is possibly a waste of track time. Would it be better to try to be always on the case and looking for the chance to improve? Generally, fast times happen toward the end of a session, but if they're clustered in the early stages or towards the middle, there might be a lesson. There are lots of possible explanations, such as lack of traffic, track condition, or fatigue, each of which should tell you something about how to approach the next session.

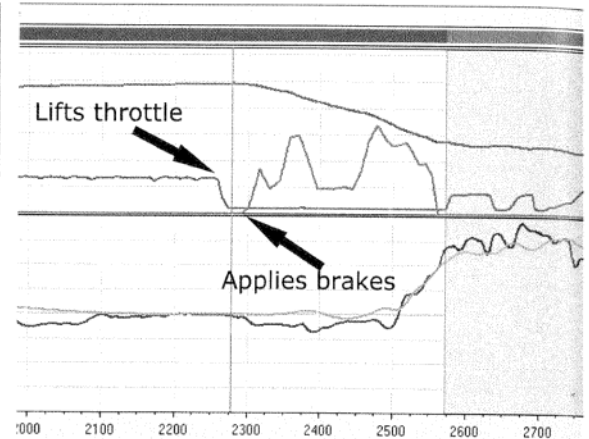
If the fastest times are clustered together, then you know where to direct your attention. If they're spread across the table, then you need to look for fastest sectors and other laps where similar sector times were recorded. This should point you in the direction of examples of driving a part of the track well, and other data should then be explored to see what you do that works. The point is not just to concentrate on the three or four fastest laps, but to dig around and find lessons in the other laps as well. Chart 11.03 used the split times to find the best times through two sectors, but the interesting thing is that



11.03. The red and the blue lap were over a second off the fastest lap, but still show that time can be saved in Turn 3.

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If there is ...	Then ...	
Understeer on turn-in and ...	Mechanical grip	Aero grip
... it won't point	blame the driver	more splitter
	less front bar	
	softer front springs	
	lower front ride height	
	increase front bump damping	
	increase camber	
... it points but fades	blame the driver	more splitter
	increase toe in	
	increase front bump damping	
... it is unstable at turn-in	blame the driver	
	less front bump stop	
Understeer mid-corner and on exit	blame the driver	more splitter
	reduce relative front roll stiffness	lower spoiler
	reduce front droop damping	
Oversteer on turn-in	blame the driver	
	check for rear toe-out	
	look for something broken	
Oversteer mid corner and on exit	blame the driver	increase rake (as an aero fix)
	reduce rear roll stiffness	raise spoiler
	reduce rear camber	



11.04. Evidence of a problem (the driver lifts off the throttle but waits 0.3sec before braking), but is the car or the driver at fault?

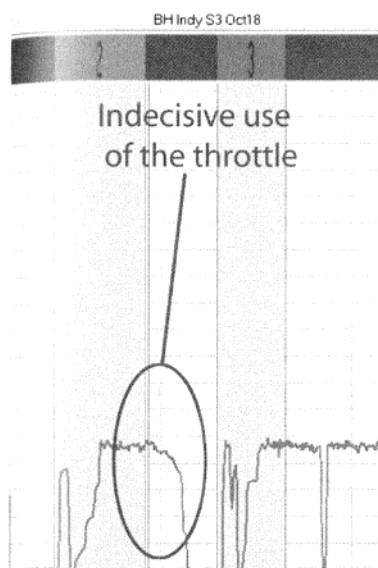
they came from laps that were around a second off the pace. Generally, laps like this would be ignored. They show clearly that there is a little bit of time to be saved on Turn 3 that pays dividends all along the straight to Turn 4.

Driving style

When a good performance depends partly on the driver and partly on the car, it's only natural for each party to blame the other. Natural, but not productive unless it's done in the right spirit. Many race engineers keep an 'if-then' list to prompt them in the heat of competition.

This one always starts with 'blame the driver'. This is not simply a joke or a tactic to shift the blame away from poor engineering, but a recognition that almost any symptom can be caused by driving technique. Sometimes it's just poor driving; arriving at any corner much too quickly will always promote understeer. What seems like poor driving technique, however, can be brought about by trying to drive around problems caused by poor engineering. The reason the driver arrives at a turn at impossibly high speeds may be because the car is so slow everywhere else that he or she is trying to compensate in any way possible. Hence the turn-in understeer that might be completely different when driven under less pressure.

So, when reviewing the data, it's vital to be honest with yourself and with the others in the team. There's often a testosterone-driven tendency for people to reach an early diagnosis from the data, and then spend time arguing for the original diagnosis, not testing it further to see if it's a good one. People come up with a pet theory, and then defend vigorously until absolutely proved wrong. This tendency is particularly



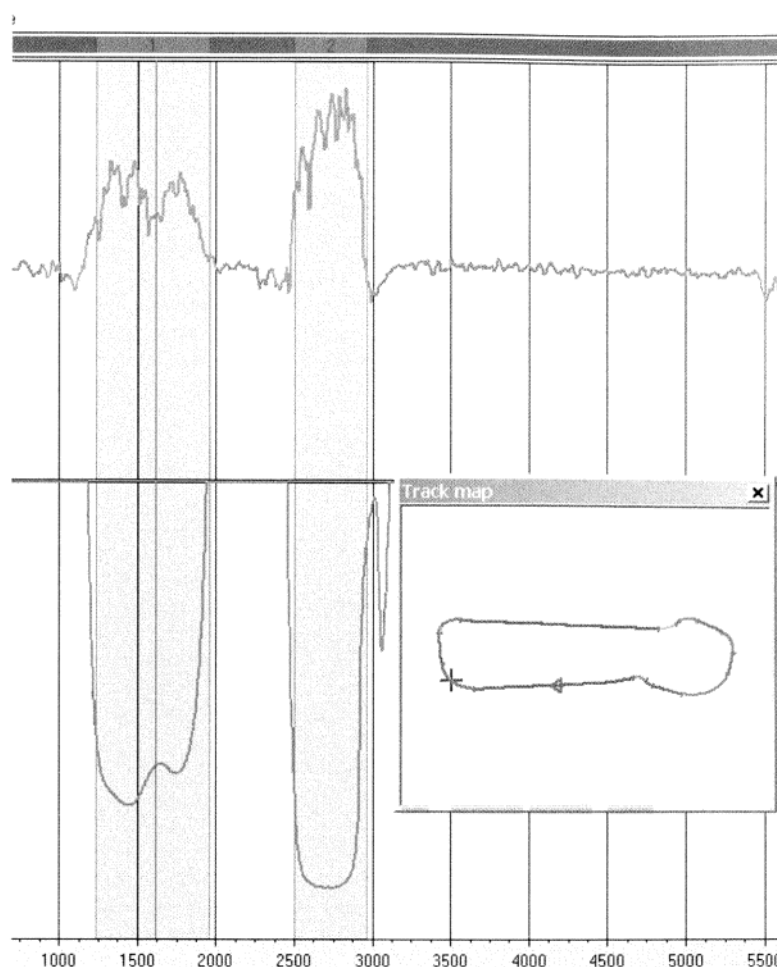
11.05. The driver is indecisive about when to come off the throttle here.

likely in the discussions between engineer and driver – ‘It’s not my driving that’s at fault, it’s the car you provided me with ...’ – so you really need to be aware of it and make sure that egos don’t get in the way of honest analysis.

Chart 11.04 shows a typical problem. Turn 3 at Castle Combe in the UK is a fierce combination of high speed uphill approach, a fast left turn over a brow, and g-forces throwing the car to the wrong side of the track for a long right-hand hairpin bend. The data shows a measurable gap (0.3sec) between getting off the gas and onto the brakes, and this was visible in every lap of the session. Is this the driver’s self-preservation instinct kicking in, or is the car just too lively in this complex for him to have complete confidence? Chart 11.05 shows the same symptoms at a different circuit.

Cornering

The datalogger can provide insights

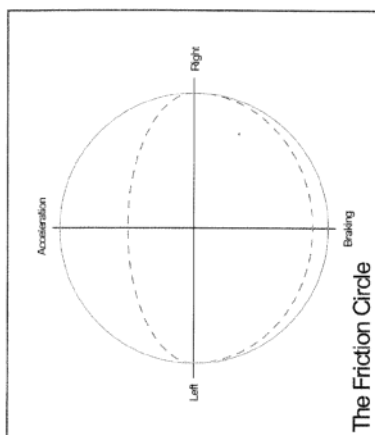


11.06. Lateral g (pink) and corner radius (green) both indicate problems with the racing line. In the first turn (first shaded area) the driver released the steering and reduced the corner radius. This bend is faster when treated as a single constant radius curve. There is another (unexplained) adjustment to the line at the very end of the second turn.

into cornering style and cornering effectiveness. Chapter 7 on handling and steering deals with steering input and corner radius in some detail, but much can be learned from a plot of the corner radius. It is tempting to see the corner radius curve as a map of the line through the corner, but it isn’t.

Figure 11.06 shows lateral g (pink) and corner radius (green). Turn 1 is taken as a double apex bend – the tighter radius of the first part is eased in the middle of the corner, and then tightened again towards the end. Turn 2 shows a rapid turn-in (indicated by the steep initial phase of the turn), a period

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11.07. The friction circle.

of almost constant radius in the middle phase, followed by rapid release of the steering and a strange little adjustment at the end of the turn. This trace can be useful for recalling what lines were actually taken through a corner.

Using the tyres

It is the driver's job to maximise the grip that the tyres provide, and the usual way of demonstrating this is by use of the friction circle. In case you're not familiar with the concept, the theory goes that, for any car, it's possible to plot a circle which shows the absolute limits of grip, and a good driver will be able to operate at the limits. The size of the circle varies from car-to-car (Formula 1 might be looking at 4 or 5g, a roadgoing saloon would be good if it reached 1g) and it's unlikely to be truly circular.

Diagram 11.07 shows a typical, theoretical friction circle. The green circle represents the maximum grip that a tyre can give. If we assume an arbitrary value of 1.5g, the idea is that the car can achieve that grip in all directions. But not only can it give the grip under acceleration, braking and cornering, it can do it in the transition phases. This provides us with a justification for staying

on the brakes after the car has been turned in, and also reflects the reality that any real racing driver will get on the throttle long before the car is out of the corner.

The red line is closer to reality. The bottom part of the red curve represents braking, and is about 85 per cent of the 1.5g. This is usual, and is a function of the shape of the tyre contact patch. A road car with a square contact patch generally seems to have about equal braking and cornering power. A racing car with a contact patch that is wider than it is long will have less braking grip than cornering power. There isn't a fixed definable relationship, but the rule holds good in most cases, and it helps in interpreting friction circles created using logged data.

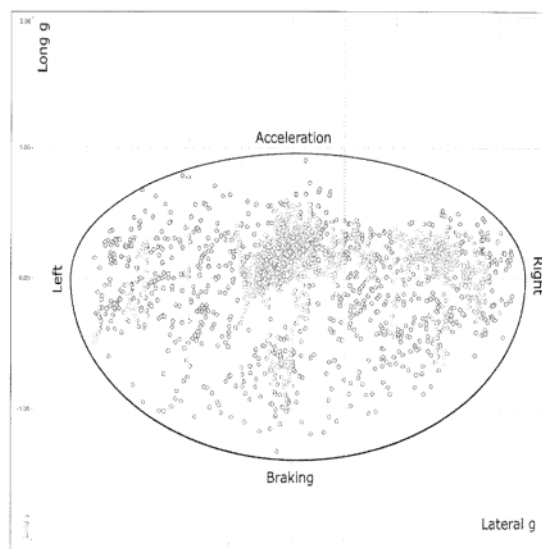
The top part of the red curve represents acceleration, and, in this case, is about half of the 1.5g of the full circle. This is a power and weight problem, and has nothing to do with the available grip. With more power and the torque multiplication that comes with low gearing, this tyre should reach the 85 per cent that was possible under braking.

On the X axis, the left and right limits will be represented by the steady state cornering potential. On the Y axis, the positive values will be limited by the maximum rate of acceleration, and the negative values by the maximum braking ability. So, the starting point is that the driver will be able to reach these maximum values. But, better than

that, he or she will be making most use of the tyres in the transition phases from braking to cornering, and from cornering to acceleration.

Going through a corner, the first thing that shows on the friction circle is that the g force plunges downwards as maximum braking is achieved. If the driver then gets off the brakes and turns in, the trace will climb back to zero, and then head off sideways as cornering force is built up. At the exit of the corner, the lateral g trace moves back to zero and the throttle can be opened and the long g trace will head upwards. With this sort of cornering style, the friction circle is more like a friction cross and indicates that there is much more grip to be extracted from the tyres by exploring the perimeter of the circle.

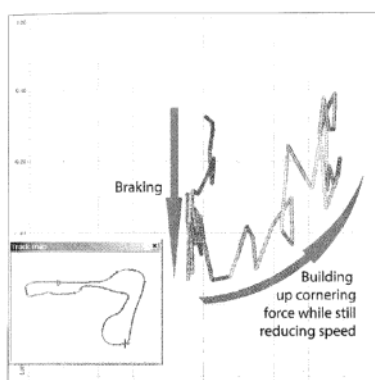
Turning in on the brakes will move the trajectory around the outside of the circle. What is happening is that there is a transition from longitudinal to lateral g. The driver is not using absolutely all of the available grip when he or she is



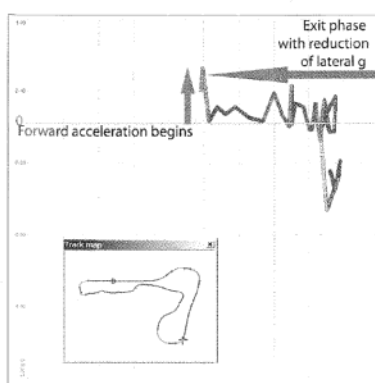
11.08 An XY chart showing a whole lap friction circle drawn by the logger.

coming off the brake pedal. So, some of the grip could be used for turning into the corner. This is quite convenient really, because the turn-in phase of the corner is transitional, gradually building up cornering force as the tyres develop their optimal slip angle. So, if the driver can judge the braking so that he or she still needs to shed a small amount of speed while the car is being rotated into the corner, the tyres can provide the grip.

The logger will be able to provide an XY chart with lateral g on the X axis and longitudinal g on the Y axis. This provides you with a real friction circle as opposed to one from the vehicle



11.09. Looking in detail at a single corner friction circle.



11.10. One corner friction circle exit phase.

dynamics text books. You can present this in two forms; one for a complete lap, or even the whole run that shows the general use that is being made of the available grip, and another for a single corner or sequence.

This sort of friction circle provides a general commentary on the driver's style, but it also reflects the nature of the car. A small single-seater should respond well to turning in under the brakes and accelerating long before the exit of the corner. A powerful, heavy car might only be capable of being driven in a series of point and squirt actions, and driver survival might depend on slowing down in a straight line, negotiating the corner, and waiting until the car is settled before getting back on the gas. Chart 11.08 is for a whole lap, and shows that improvement is possible. Although the turn-in phase seems to blend braking with cornering, there's very little evidence of acceleration out of right-hand turns.

Using a single corner trace is also useful. If the software allows it, select the corner that you're interested in and create an XY diagram with the data points joined by a line. This will show your progress through the corner in terms of getting the best from the tyres, especially during the transition phase where there can be surplus tyre grip available that you're not using. You can see the initial braking effort, the transition into the corner, whether any adjustments had to be made, and the commitment to the exit phase. Charts 11.09 and 11.10 show a typical set of traces. The blending of the brakes and steering on turn-in are handled well, but there's no



11.11. Lateral g (Y axis) vs steering. The two traces are indicative of the amount of effort shown by the driver at two different tracks. Everything seems to be slightly more under control with the red data than with the black.

evidence of forward acceleration until the car is running in a straight line.

How hard were you trying?

There are days when everything is just easy, and fast times come with very little effort. On the other hand, there are days when no matter how you try, competitive times just don't seem to be there to be had. The data can show when things are difficult. One good indicator is to plot steering on the X (horizontal) axis and lateral g on the Y axis. Some people suggest that this is a measure of the tyre's slip angle, and if you squint your eyes a bit you can see the relationship between the two curves. Interesting, and probably useful if you have definitive data about the real slip angle, because

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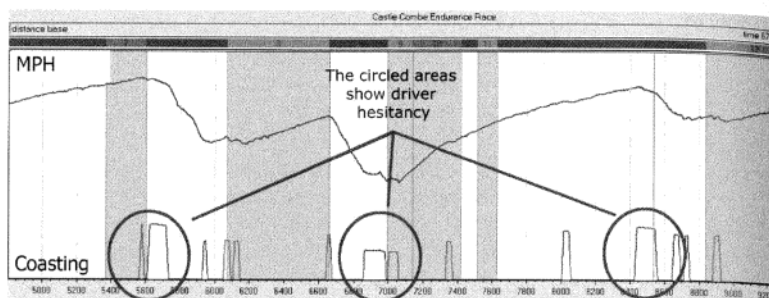
then you could evaluate the amount of time spent operating outside the proper operating envelope. In the real world that club competitors inhabit, it is a bit difficult to see what use can be made of it. On the other hand, creating this plot for five or six of the fastest laps in a session can give some insight into just how hard the driver is trying.

The two XY graphs in Chart 11.11 are both taken from the same car, with only minor changes in set-up, and in a period when the car wasn't going particularly well. The red figures relate to a track which is only visited once a year and is not a favourite of the driver. On the other hand, the black figures were taken at a track that he regards as his 'home' track. The difference in shape is subtle, but real. The black trace shows lots of occasions when the car was outside the expected performance envelope. The explanation we reached was that at the red track, expectations were low, and the performance shortcomings accepted as inevitable. At the home track (the black figures) the driver expected to be at the front and was driving much harder to compensate for the inadequacies of the car. This difference in expectation and effort was reflected in the significantly different shapes of the two sets of data.

Coasting

When thinking about how hard you were trying, one thing to consider is coasting time. This unforgiving trace lays bare the amount of time spent each lap with the throttle shut, and not yet on the brakes. One way to show this is display a speed trace every time that the car is coasting. If the speed trace is measured in metres per second, the 'integral' function can be used to calculate either the number of metres per lap, or the number of seconds per lap that meet the coasting criterion.

The maths is fairly complex because you'll be relying on an 'if'



11.12. The coasting trace (red) records when the driver is off the throttle and not on the brakes.

statement inside another 'if' statement. 'If the throttle position is less than 50 per cent, and if the brake pressure is less than 2bar (30psi), then display the speed, or else show zero. Depending on software, that would translate into a formula something like the one below.

Coasting = if (throttle < 50, if (brakes < 2, speed, 0), 0)

The syntax for most if statements does not actually include the words then and else, but just assumes that the then will start after the first comma and the else after the second. Reading the above formula from left to right gives us if throttle less than 50 per cent, then if brakes are less than 2bar, then record the speed, or else return zero. The previous part of the expression is the then part of the first if, and, in fact, because it is itself an if, it has its own then and else inside its brackets. So, now that the first if and the first then are dealt with, we need to go on to the else that belongs to them and that is the final ,0) of the equation. If this makes your brain hurt, find an Excel expert, he or she should be able to guide you through it.

This gives a nice trace that shows the speed when the car was coasting. It graphically demonstrates the parts of the circuit where the driver is being indecisive. Chart 11.12 is an example, and picks out major areas of indecision

by the driver, each taking almost a whole second. Small upward blips are inevitable, either during gear changes or in corners when the driver gets out of the throttle, but there should be no marked 'flat top' areas.

If you found the logic statement an interesting challenge, then you can add another if into the nest and check to see that the car was not in a corner. So, if you're off the throttle, and if you're not on the brakes, and if the lateral g is between -0.8g and +0.8g, then put up the coasting flag. For most of us that may well be a refinement too far.

Using the controls

You can get a bit of a picture of your driving style by looking at the way in which you use the controls. For instance, it's possible to measure the speed at which you apply the throttle, or get onto the brakes, or turn the steering wheel, and these plots can be very revealing.

Throttle control

Virtually every text-book on how to drive a racing car stresses the importance of driving smoothly and not upsetting the car, or more importantly, the tyre contact patches. Typically, you're told to feed the power in gently, and you sometimes wonder if the author has ever sat in a racing car. Nothing seems very gentle at the time, but with a logger we can measure the vigour with which the pedal

is hit as a change in the throttle position per second. Some people suggest that a rate of somewhere between 150 and 200 per cent per second is the maximum, and that fast drivers stay below this throttle speed. They don't jump on the pedal, they feed it in as quickly as the car will allow. So a throttle speed trace might be worth looking at. The maths is simple enough:

Throttle speed = derivative(throttle)

If this gives a noisy trace, go back to Chapter 4 and decide whether to use some method of cutting out the unwanted readings. In any case, the values will need to have the maximum level of filtering applied to them to give an understandable trace. The trace shown in Chart 11.12 cuts out any speed below 20 per cent per second simply to smooth the signal when the driver is fully on or fully off the pedal, and has the maximum filter applied.

If you think that this might be one of the areas for improvement in the driving and the numbers give cause for concern, it's an easy enough thing to do a few laps making a conscious effort to be more circumspect with the throttle pedal. The data will tell you whether there was a pay off in terms of speed. It may work, or it may not, but it will have added to your knowledge. Don't forget, though, that there's still the chance to lean on the engineers for a car that will react better to the more urgent approach.

Chart 11.13 shows throttle speed in the lower section of the chart. It's plotted in red against the throttle data in blue with a green line representing the threshold of 200 per cent. It shows that the driver is at the upper end of what is recommended, and might consider a change of driving style.

Steering speed

What works for the throttle works for the

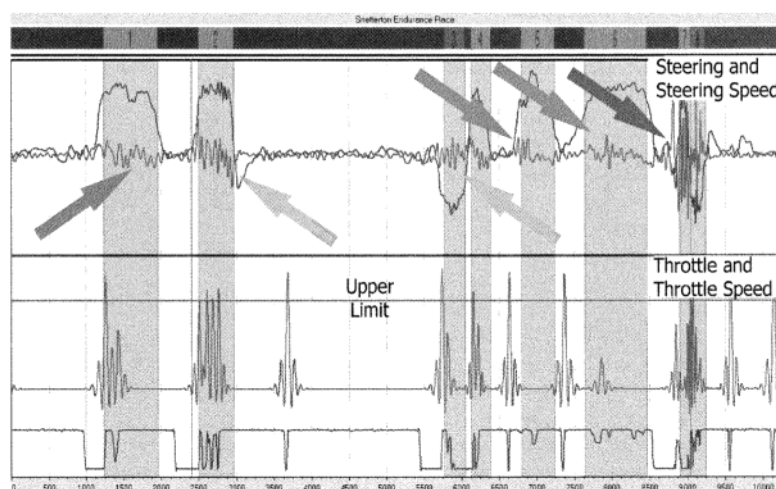
steering as well, although, in this case, it makes a pretty good indicator of where the driver has to work hard. Steering speed can be calculated in the same way as the throttle speed, but it does not need a dimension. It does not matter whether you show it as change in logger volts per second or radians or degrees of steering wheel or road wheels, it's the shape that's interesting. It still needs quite heavy filtering to provide a trace that gives any insight.

Steering speed = derivative(steering)

In Chart 11.13, arrows are used to indicate the areas for concern. The turns where the driver is not under much stress have green arrows pointing to

steering speed is high at some particular phase of the corner (turn-in, steady state or exit) then this is one more clue to how the car is handling.

Some analysts extend this idea into looking at the braking application as well. They construct an index of braking aggression by measuring how quickly you build up braking effort, with the idea that quicker is better, and they measure the braking finesse by looking at how gently you come off the brakes. It uses exactly the same logic as for throttle speed and steering speed, but needs a lot of filtering to make a readable trace. It definitely seems like one for dark winter evenings when there's absolutely nothing on TV.



11.13. The raw data for steering (top) and throttle (bottom) are shown in blue, and the steering speed and throttle speed are shown next to them in red. See text for an explanation of the meaning of the arrows.

them. The orange arrows point to the turns where the driver is busier, and the red arrow points to the final turn of the lap where the driver is really earning his keep. If you relate the steering speed to the speed, you might get an insight into whether this is a factor in fast or slow corners. If there's evidence that the

Using the gears

The precise way in which you change gear will depend primarily on the type of box, and the data can help identify the correct technique because it's relatively straightforward to measure the time taken to change gear with a strip chart. You might have to nurse a production-

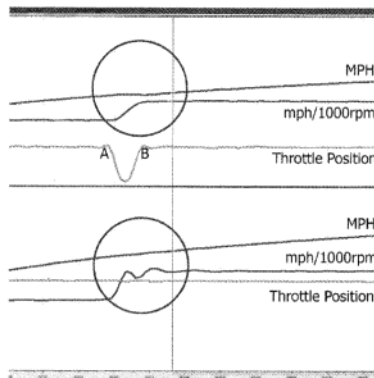
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based synchromesh box and get off the throttle, use relatively light pressure on the lever, and still have to wait for the synchro hubs to do their stuff. With a dog-clutch gearbox, simply putting a bit of pressure on the lever and relieving the load on the dogs by either hitting the clutch or momentarily lifting the throttle will make the change.

Whatever type of box it is, you can measure with some degree of certainty which is the fastest method. Chart 11.14 shows comparisons of two gearchanges, one with a lift of the throttle, and one without. Looking at the top part of the chart first, this is a traditional lift and shift approach. The way to measure this is to measure the time gap putting the cursor on Point A, reading off the time into the lap, and then doing the same for Point B. This amounts, in this case to 0.35sec. An alternative way would have been to measure the time that it took for the mph/1000rpm trace to make the step up from one gear to the next.

The lower part of the chart shows a flat shift where there is no characteristic vee in the throttle trace, so this method of measurement won't work. Instead, it's worth looking at the speed trace (within the blue circles). In the top half of the chart there's a small but distinct flattening out of the mph trace while the change is being made. In the lower part of the chart, this doesn't happen, so we assume that no time was lost during the shift. Don't take this to mean that you should always flat shift, but that you can learn what works best for your car by zooming in on a few gearchanges and evaluating which ones work best.

In the lower set of traces, the step up into the next gear (as shown by the mph/1000rpm line) is distinctly lumpy, indicating that the transmission in general is having a harder time. However, do you compete to preserve transmission components or to go fast? As for when to change gear, that



11.14. A tale of two gearshifts, with and without lifting the throttle.

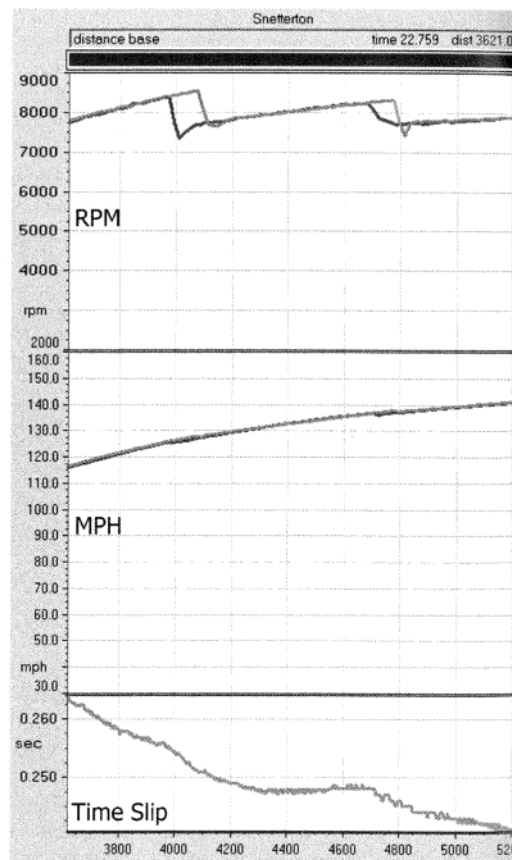
depends on the gap between the ratios; there's no 'magic bullet'. Every combination of gear ratios for a car will have a different set of change up points. Chapter 8 deals with how to calculate optimal gearchange points, but it needs full rolling road data and a mathematical model. From the pragmatic viewpoint, the only way to find out is to try things. You should have a pretty good idea where the optimum point is just from the feel of the car. You can refine this by looking at the data.

If you have a long g sensor fitted, then some people suggest that you can identify the optimum acceleration in any gear by inspecting the curve – the long g will climb and then fall, and the peak

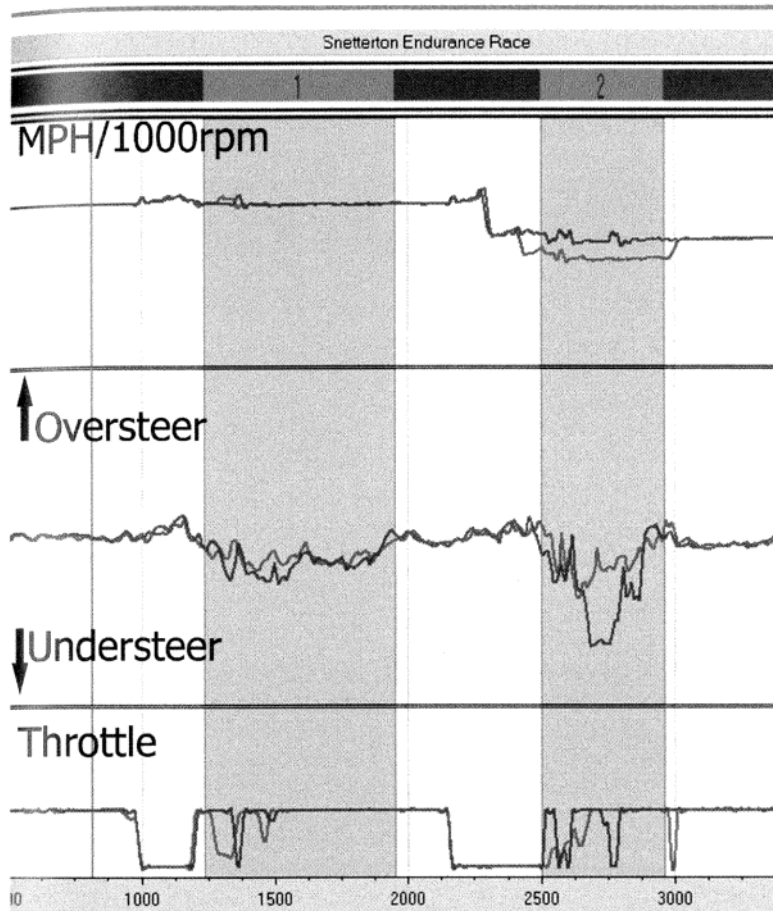
11.15. Checking to see whether higher rpm shifts make time. The time slip indicates that they do in this instance.

value represents the best time to change up. The problem with this method is that it doesn't take into account the gap between this and the next ratio. If there's a big gap, there can be a payoff in hanging on to the lower gear, just to put the engine higher up its power curve in the next gear.

A better method is to examine acceleration after the gearchange. Early in the session you should do a series of laps with different change points, say one lap at 8200, one at 8400 and one at 8600, and then get on with qualifying in the normal way. Looking at the data afterwards, you can see which was



THE DRIVER



11.16. Using second gear (the red trace) reduces the understeer and allows earlier throttle application.

the most effective. In Chart 11.15, the orange traces relate to a lap where the driver used higher revs. The speeds are almost identical, but the time slip

trace indicates that higher is better. The problem is that the amount of time saved is only a couple of hundredths, so what we take from this is that the shift point in

this instance, with these ratios, is not too critical.

Which gear to use is not always a clear cut decision. Chart 11.16 shows a driver experimenting with different gears through a turn. The top trace shows the driver experimenting with a lower gear on the red lap. The trace below that shows understeer (when actual steering is greater than the required steering for the turn) and there was significantly less understeer on the red lap.

This is backed up by looking at the throttle trace which shows that the driver was able to get back on to the gas about a third of the way through the corner, rather than have a couple of attempts on the other lap. Using the lower gear was obviously the way to go, and this led on to discussions about whether it was worthwhile running a slightly higher ratio to avoid over-revving the motor.

AFTER THE EVENT

To get the best from your system, it's crucial to spend time with the data after a competition and while the events are still fresh in people's minds. A trip to the pub on the Wednesday after the race works best for us. Everyone has questions and pet theories, and it's a good time to brainstorm your way through the data. This often raises issues that lend themselves to a more considered approach on an individual basis afterwards. Whatever happens, don't just file it away until next time. There are secrets in there waiting to be unearthed.

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