Cornering

The Formula 1 racetracks are a series of corners interspaced with straight stretches of varying lengths. The first lesson in learning how to drive well is that the errors made on the bends are paid with precious time loss in a category where every millisecond makes a difference.

Therefore, the driver should try to execute the fastest line in which they can take maximum advantage of the course to take the corner at the fastest speed possible. Instead of using the same angle as the racetrack, the driver should try to find a wider arc with more passing opportunities and reference points.

To help find the ideal racing line of each corner – of which is only one – the driver should divide it into three phases: the entry into the corner or turn-in, which is generally the end of the straight when the driver begins to brake and points the car into the corner; the apex or ‘clipping’ point, when the driver is in the innermost and therefore the slowest part of the corner; and the corner exit, when the car returns to a straight line and gains speed or when the corner can be considered completed and there is a new one to follow.

Simply put, it is possible to say that every corner is made in the same way: enter from outside, taking advantage of the entire track to go to the inside most part and exit from the outside driving near or even over kerbs. The ideal line is the one with the greatest radius – or, in other words, the straightest line – possible between the entry, apex and exit. Of course, there are differences among each type of corner.

In the case of a slower or medium speed corner followed by a straightaway, it might be more beneficial to take a line in which the greatest speed loss in fitting the curve is made up by greater acceleration on the exit. In this case, braking should be delayed and the apex radius will be smaller. A saying about this situation is: “to come out fast you need to enter slowly”. This is the case as well with longer curves and 180-degree hairpin turns.

The racing line is the imaginary line which marks the path of the car. The straighter it is, in other words the wider the radius, the more the difference between the speed of the car before the bend and after the bend will be reduced. Thus it is essential to find the ideal racing line, or trajectory, for each bend. There is only one and it allows us to round off the angle of a corner.
As an example, let's look at a 90-degree bend. Instead of taking it by following its direction exactly, it is possible to cut it and take a wider radius: in this way we will exit at higher speed. By doing this we have also encountered another fundamental principle of circuit driving: you have to use the full breadth of the track. And beyond too, as in the case of hairpins and especially chicanes. To cut a bend means looking for a racing line which corresponds to a corner with a wider radius than the one we are driving through. The car will then find new points of reference.

There are three fundamental points in a bend: the turning-in point, or start of the corner, which can be described as the end of the straight; the apex, where the car brushes past the kerb on the inside of the comer, the slowest part of the bend; and the exit, or end of the corner, when the car begins to travel in a straight line again, or when the bend can be said to have finished and another started. In this case, the exit (the fastest part of a corner and the entry point of the next bend obviously overlap)

To sum up, we could say that a bend is always taken by going first to the outside, then to the inside, then to the outside again, using as much of the track as possible and maybe even climbing up on the kerb.

The ideal line in a 90-degree corner is in theory the curve with the maximum constant radius, which links the three main points of the bend with the same curving radius.

Within this racing line we have to get used to identifying the three phases already mentioned which correspond to the three main points. This is a very important distinction, which enables us to embark on a deeper analysis of the car and the way we drive. This is how we will identify any defects and subsequently put them right.

The maximum constant radius around a bend is not always the most effective solution. It is certainly useful when approaching a big fast bend, when there isn't much acceleration at the exit. But when the bend is slow or medium-fast, and especially if it is followed by a long straight, the line must be changed to allow you to accelerate earlier. In this case the apex will not correspond to the geometric apex (which divides the inside of the bend into two equal parts in accordance with the line which bisects the angle of the bend), but will be somewhat before it. Thus the cornering phase is brought forward by comparison with the maximum constant radius line and you can accelerate earlier.

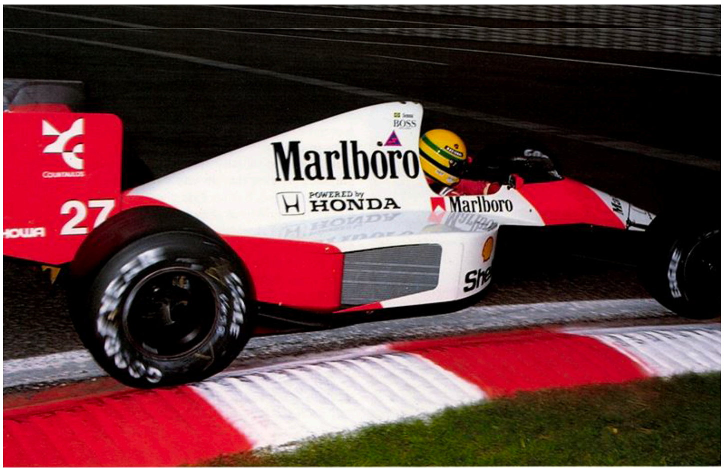
Braking will have to be later, the entry phase will have a smaller radius and the exit phase -accelerating throughout - will have a variable radius line and will be longer than the equivalent phase in the case of the maximum constant radius line. This type of racing line is easier to understand if applied to a hairpin. which is where the most advantage is to be found: the time lost in the first and second phases is much less than the advantage given by accelerating earlier (giving rise to the old cliche 'to exit fast you have to enter slow). The real apex varies in relation to the geometric apex depending on the tightness of the bend. At a hairpin it will be brought forward by about 10 per cent of the length of the inside kerb; at a longer bend by up to 20 or 25 per cent.

In the case of a series of bends not interrupted by straights (the most obvious example is a chicane, but it could also be two bends close to each other or dependent on one another) the rules described so far are perfectly valid, but we need to introduce a new principle: the last bend always takes priority.

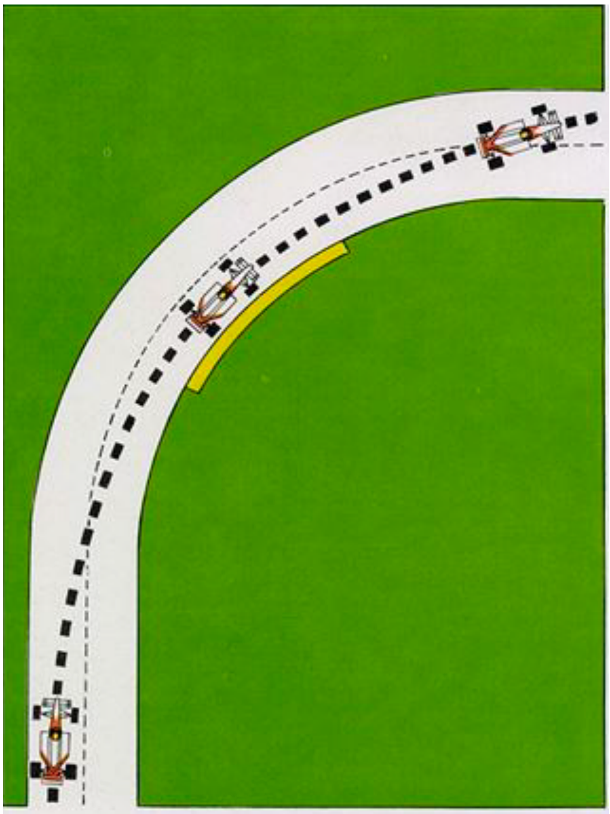
In these cases you have to sacrifice the first bend in favour of the second (or of the last if there are more than two) because, as we have already seen, gain or loss are linked to the exit from the bend (or bends) and to the length of the following straight.
For example, in the case of a chicane followed by a long straight (such as the first chicane at Monza) it will be necessary to sacrifice the exit of the first section in order to be in a better position for the entry of the second and last part of the bend. In this way we will lose something at the start (where it is almost impossible to overtake anyway) so as to exit the second half with greater speed. And in the end, this is what matters.

In the reverse situation, when we have a long straight preceding two or more bends, we cannot sacrifice the first bend in order to favour those that follow because, due to the high speeds involved, the loss of time would be too great. Thus you have to brake as late as possible and take the maximum constant radius line in the first bend, knowing that the loss of time you will incur at the end of the straight following the bends (which we assume to be short) will be less than the advantage earned by taking the first bend as fast as possible.

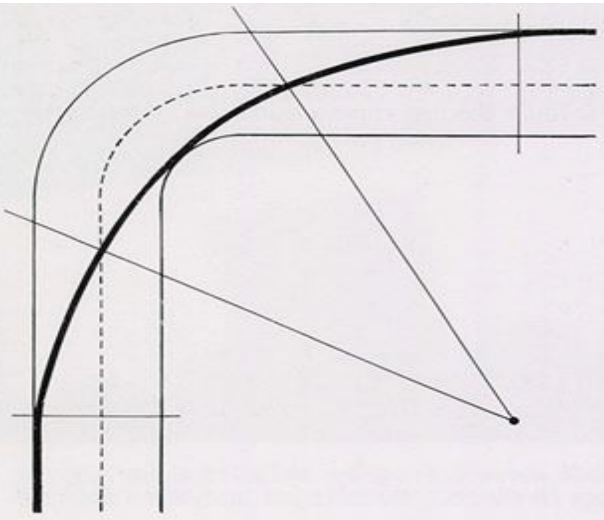
This picture shows the car at the apex of the corner; a few inches later the inside front wheel, tighter than the outside load-bearing one, will climb slightly over the kerb.
This line has been chosen to straighten the bend as much as possible and thus allow it to be taken as fast as possible. Sometimes, because of the traffic on the track, it is hard to take the ideal racing line.



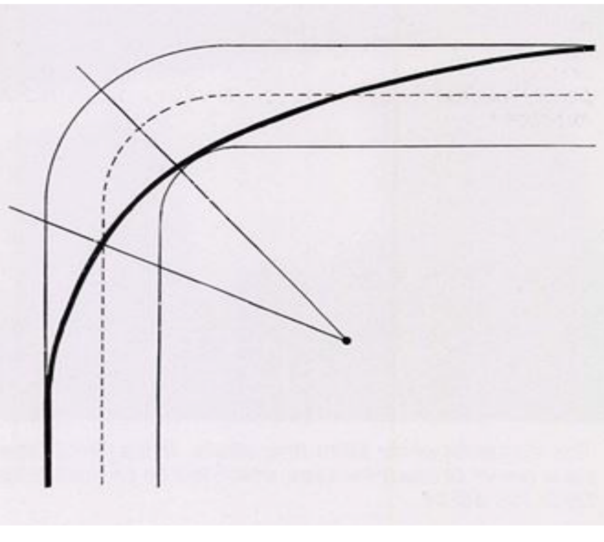
In this picture the rear wheel is at the apex of the bend, while the front wheel has just passed it. This is when acceleration begins. The photo was taken in Belgium, at Spa-Francorchamps, a fast and difficult circuit which also features some slow bends, like this one called La Source.

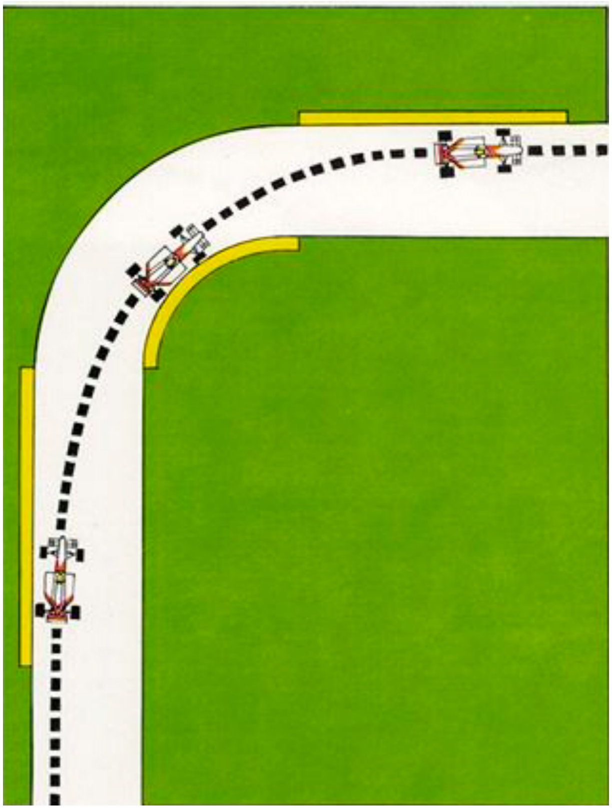


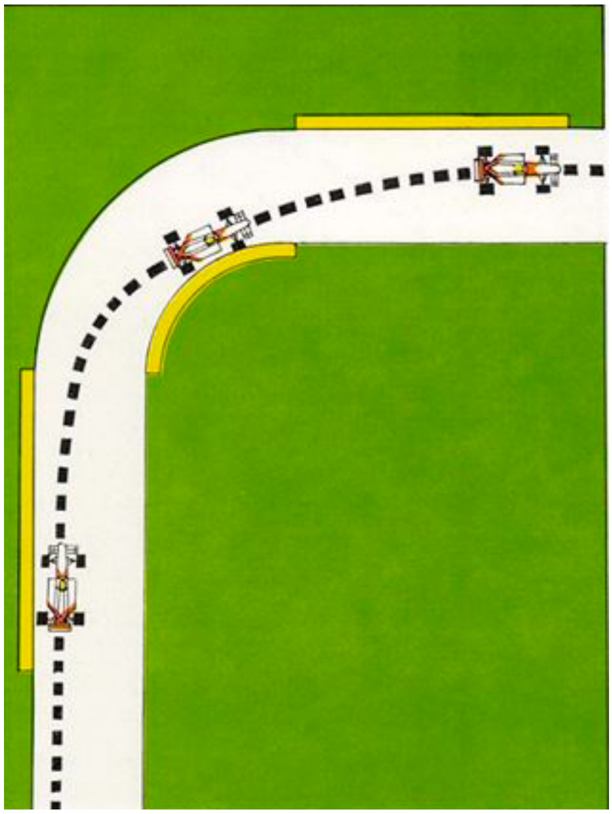
The difference in line between driving on the road and on the track is shown in this Illustration. The driver at the wheel of a single seater cuts the corner to achieve a higher travelling speed. The fainter line represents a normal line, which follows the radius of the bend, while the thicker line is the maximum constant radius, which allows for the maximum exit speed.



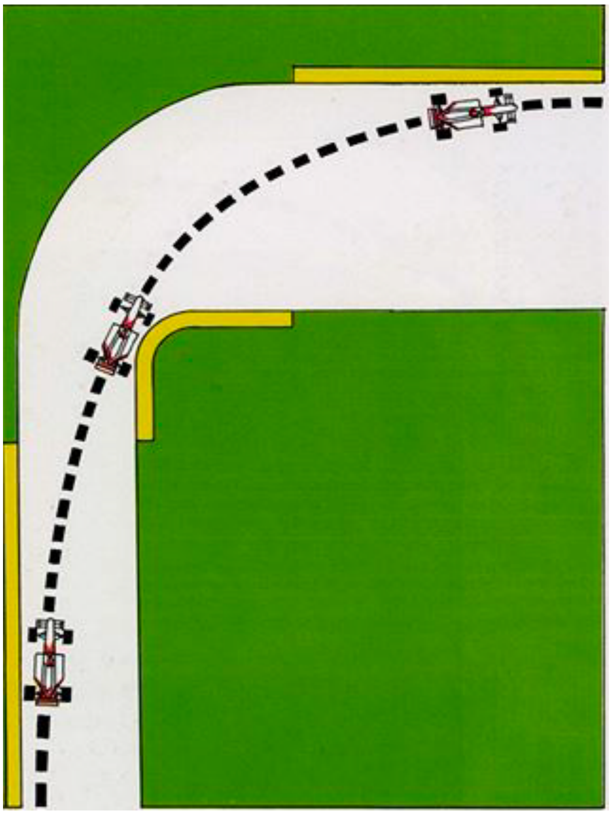
A single-seater driver must quickly get used to dividing a bend into three parts: the entry, the middle phase and the exit. In the illustrations below we have two examples of corners: on the left, the normal constant maximum radius bend; on the right the one which advances the middle phase. The latter permits the driver to bring for ward the point of acceleration because the exiting phase is much straighter. Thus the car will already be faster when it reaches the straight.



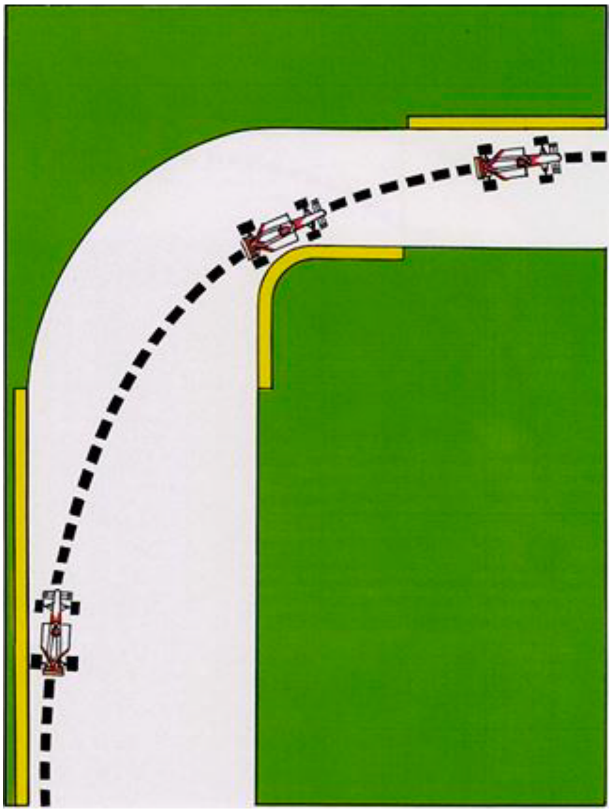




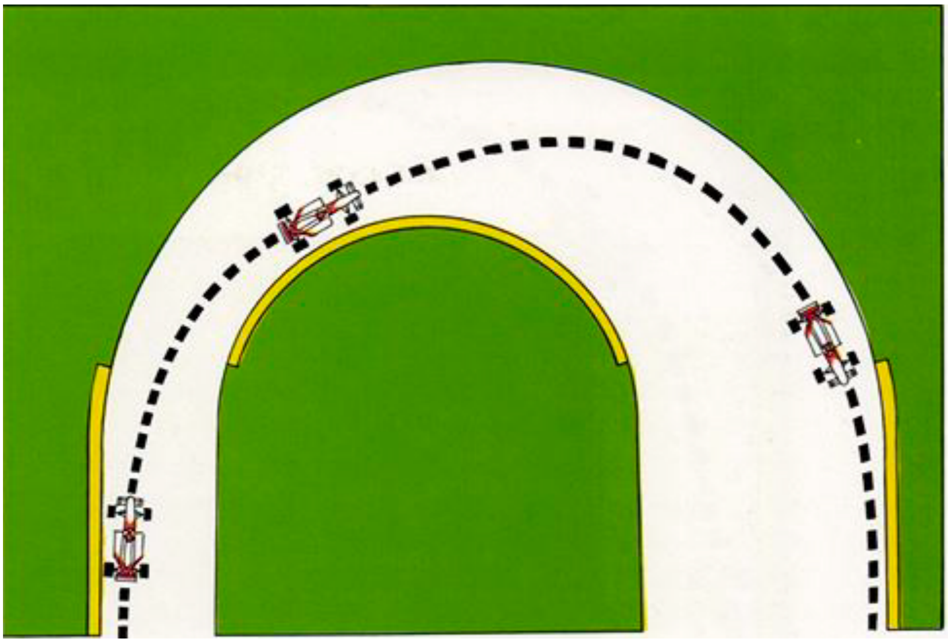
In these two illustrations you see the maximum constant radius line (left) and the line which advances the middle phase. The second is very useful, particularly for certain types of bend, such as medium-fast and slow corners and especially hairpins. For bends which do not require much acceleration at the exit, like wide sweeping bends which are taken flat out, the maximum constant radius line proves to be the most effective. When you bring forward the middle phase, you Jose time because your line has a tighter radius, but in reality this loss is more than offset by your higher exit speed.

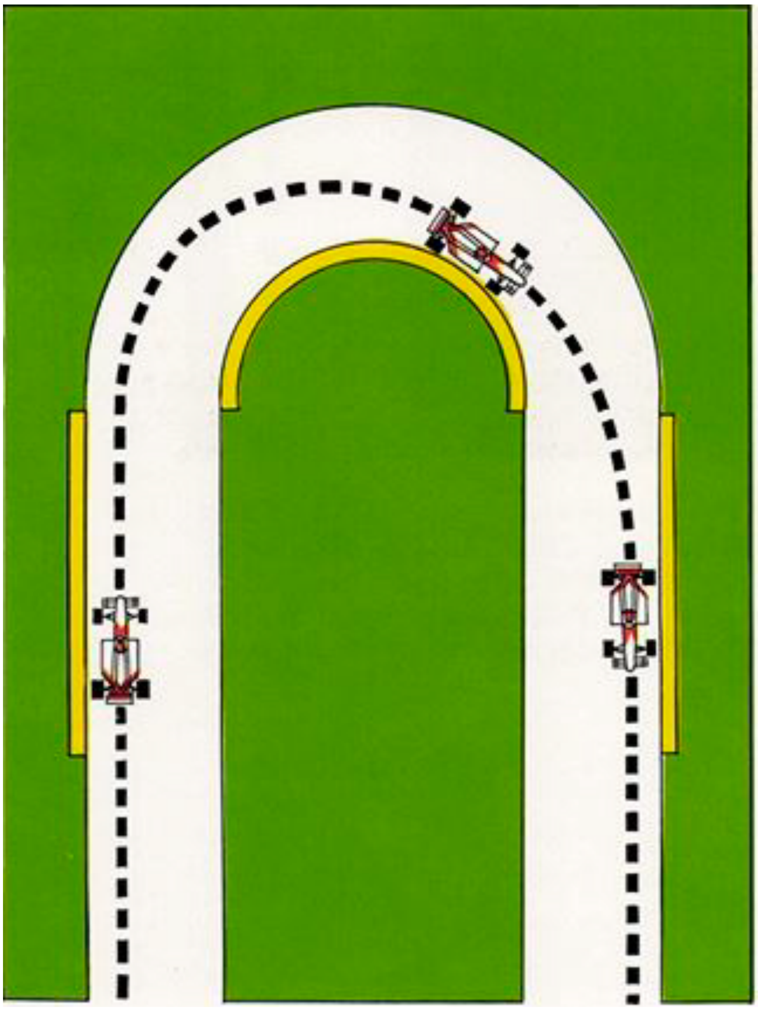


Years ago, when many of the tracks were sited at air fields and there were few permanent sites, it was common for drivers to come across bends like the one above, where the straight leading into the corner is narrower than the one after it. In this case the driver must take an early apex in order to exploit the full width of the track while exiting and thus gain speed.



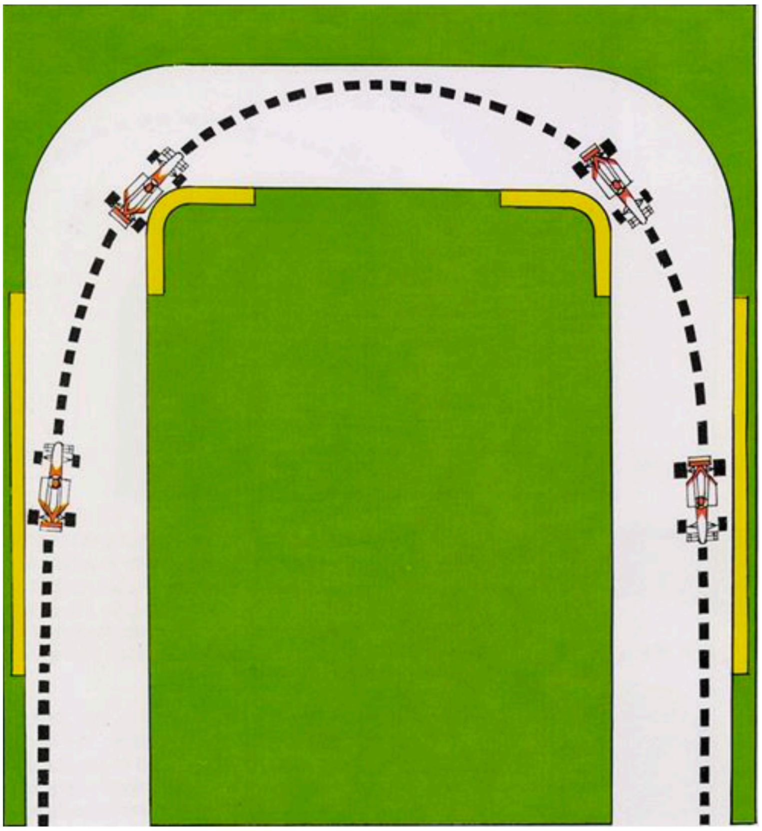
This is the opposite case: the straight after the bend is narrower than the one before it. Here the driver must delay the entry to the corner so as not to run out of track at the exit. This situation will create a lower exit speed than that illustrated on the left. It is possible to compare this bend to one which has a tendency to tighten on exit, which is not uncommon on modern circuit



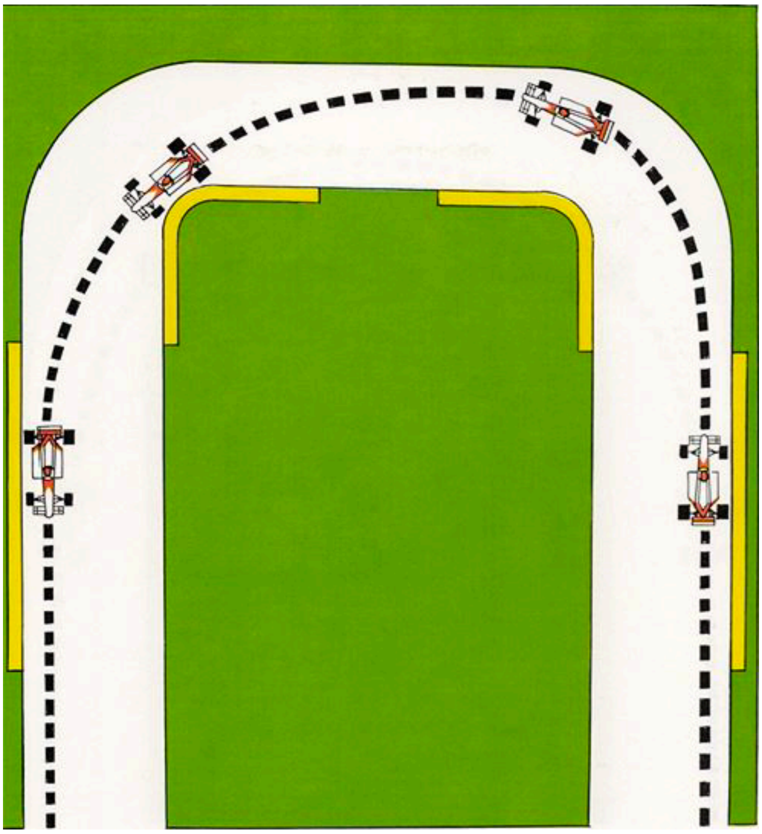


The illustration above shows a situation we find at modern Formula 1 tracks - for example the Parabolica at Monza, where the apex is taken early in comparison with the theoretical one, because the bend is linked to a straight which is much wider than the one leading into it. A similar line can be employed where it is possible to run wide at the exit.

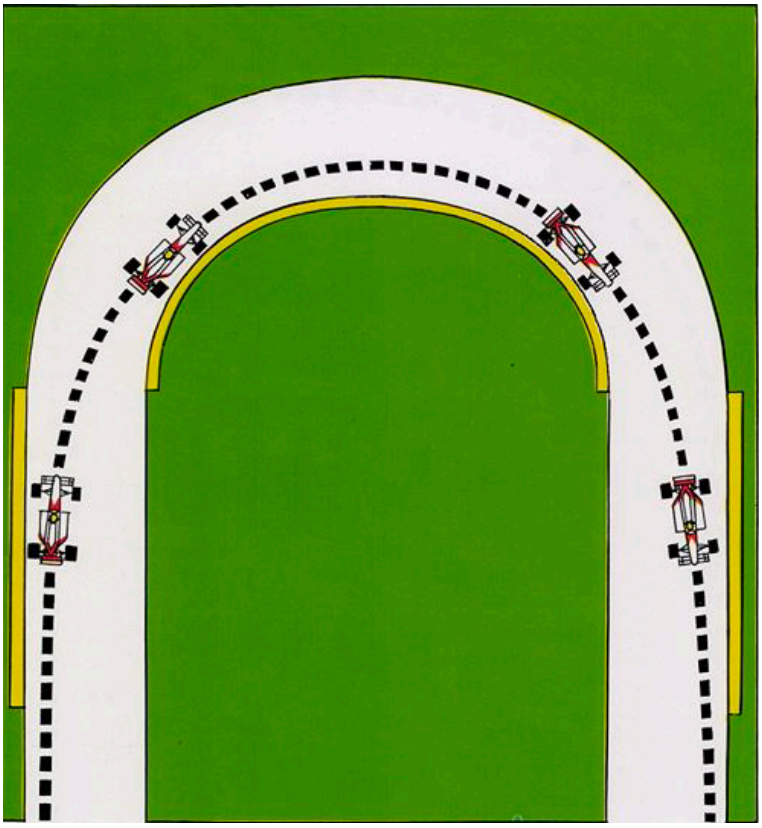
Left: The line with the early middle phase is often applied to a 90-degree bend. However, this kind of racing line is even more apt for a corner of the sort shown on the left. If you approach a hairpin bend where you need to accelerate strongly at the exit, it is important to start to turn in as early as possible: it is obvious that a car that is already pointing in the right direction, with the wheels at less of an angle, will be able to accelerate earlier.



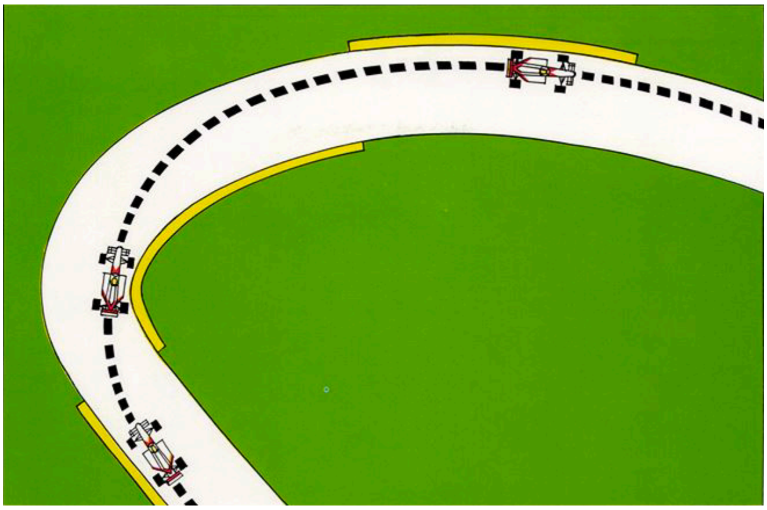
Something that happens quite often on race circuits is to find two bends linked by a short straight. So as not to lose speed, the driver must take both bends as if they were one. He will turn the steering wheel only once and will have only one racing line. Sometimes. in order to find the most fluid and natural line, a driver may choose not to exploit all of the track on the short straight, but stay instead in the middle. The illustration shows how the ideal racing line has to be set up.



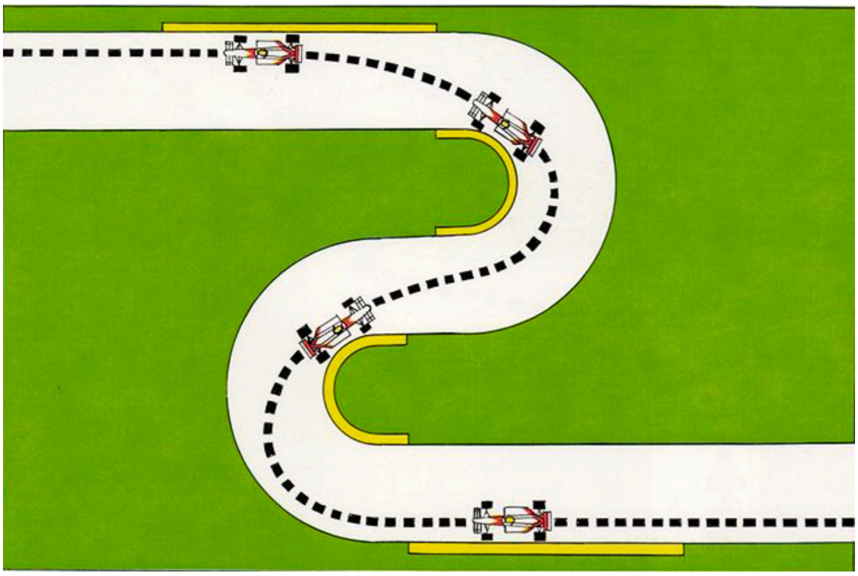
When two bends are linked by a short straight, it may not always be best to adopt the racing line described previously. It may be more effective to take the first bend away from the apex and instead aim for the apex of the next one. Here too the distance from the kerbs is dictated by a perfect line and exit. This technique is also useful when confronted with wide bends which tend to narrow near the end: by going to the kerb late vie can maintain the car's speed and overcome the difficulties of a tightening bend.



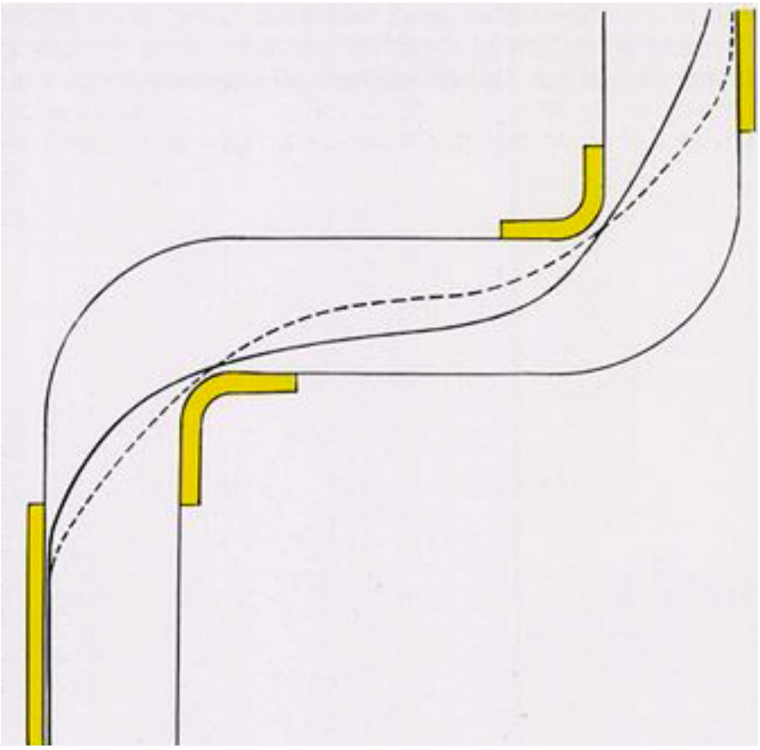
The accepted way to tackle a bend is for the car to brush the inside kerb once only and for the briefest of moments. Sometimes, though, it is necessary to stay on the inside, to follow the kerb for a great deal of its length, because the layout of the bend will not allow you to find the apex and then widen your line towards the outside. To execute this technique correctly a driver must turn into the corner early and move to the outside only when the bend is almost complete.



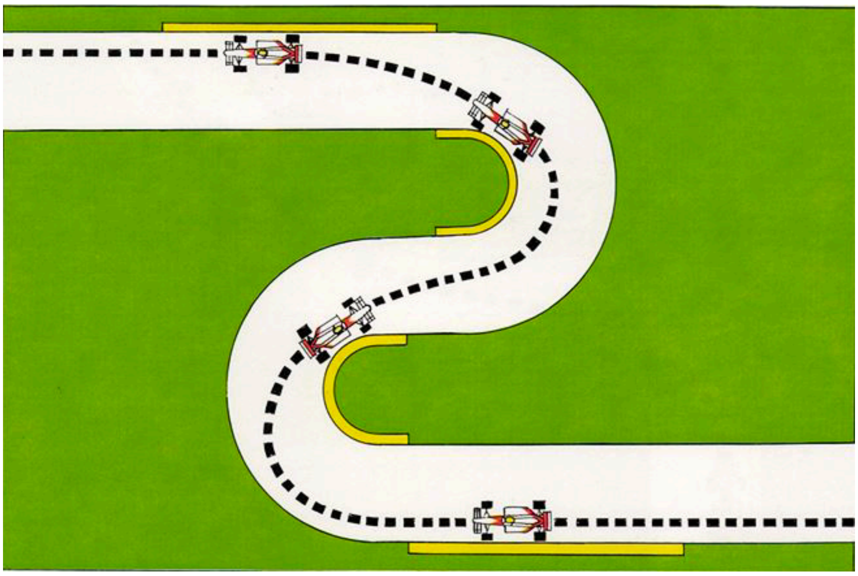
This is a variable radius bend, where the corner opens progressively after the apex. This is good for the driver because the bend opens just as the driver's own tine does. In these cases you have to take an early apex and then concentrate on the natural fine - which will have no reference points - in order to accelerate hard and progressively at the exit.



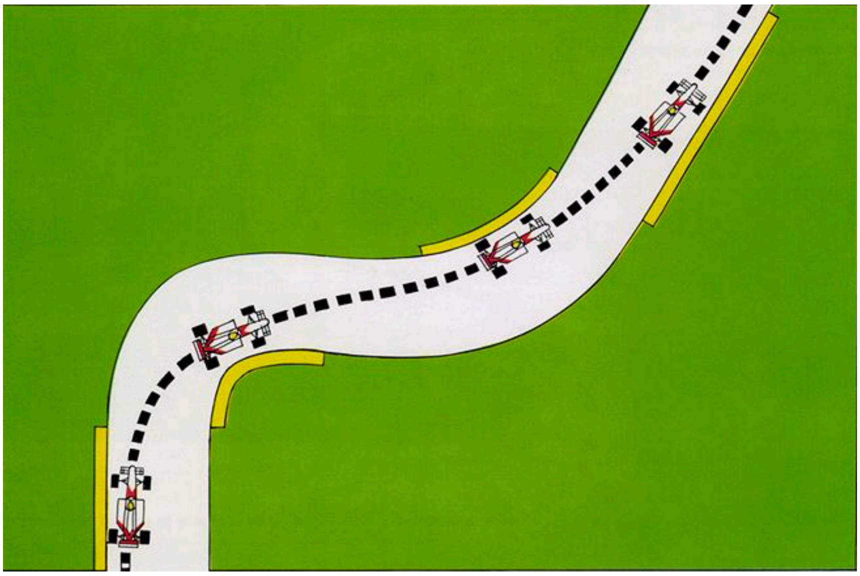
Variable radius curves aren't always an advantage for the driver, as is illustrated above. In this situation it is best to stay wide on entry and go to the apex relatively late. If there is a long straight before the bend, it will be possible to delay the point of entry and of braking in order to make the most of those last few metres when the car is travelling at its maximum speed. The advantage in terms of cornering speed will certainly be greater.



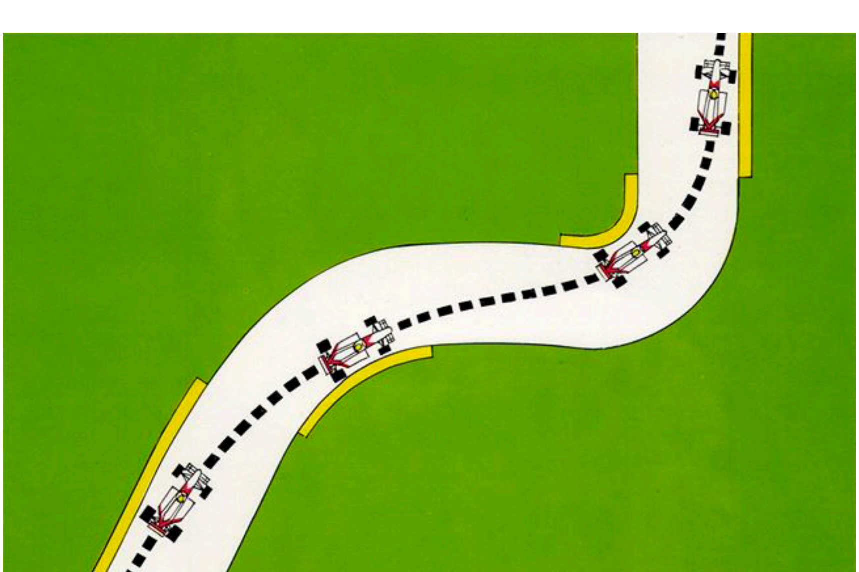
On modern Formula 1 circuits it is common to have a succession of bends not linked by any straights. The idea when tackling a chicane of this kind is to concentrate on the last bend and sacrifice the early ones. In the illustration, the car indicated by the continuous line is wide on entry and tight on exit in the first right-hand bend, in order to take the second bend as effectively as possible and accelerate early on exit, whereas the driver of the car following the dotted line is obliged to delay the moment when he can accelerate and regain speed.



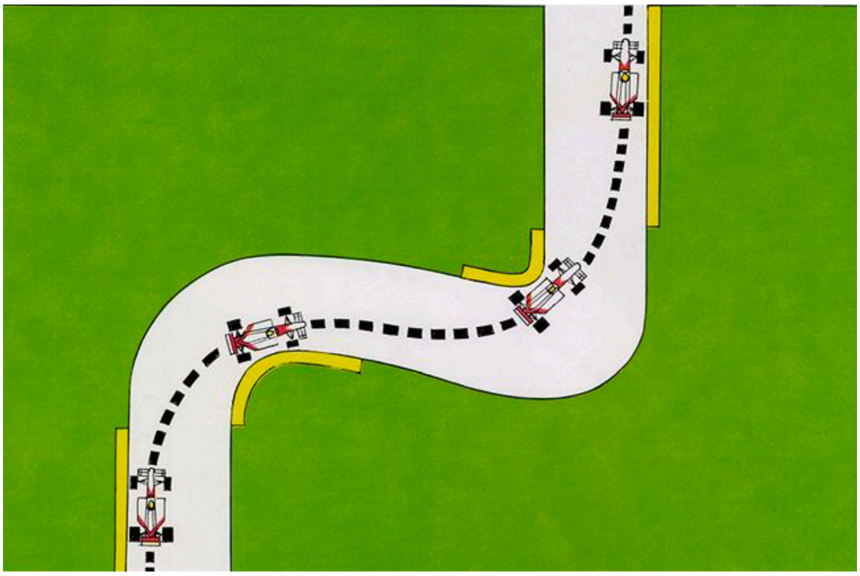
This illustration shows the application of the rules which have been explained so far. The racing line is planned to achieve the best possible exit from the second hairpin. This means taking a wide line on the entry to the first bend in order to be i na better position to tackle the second. Although he has sacrificed the first bend and increased the time it takes to drive through it, the driver is in a position to accelerate early and approach the following straight at higher speed. As can be shown, the old rule of 'slow in, fast out' is always valid.



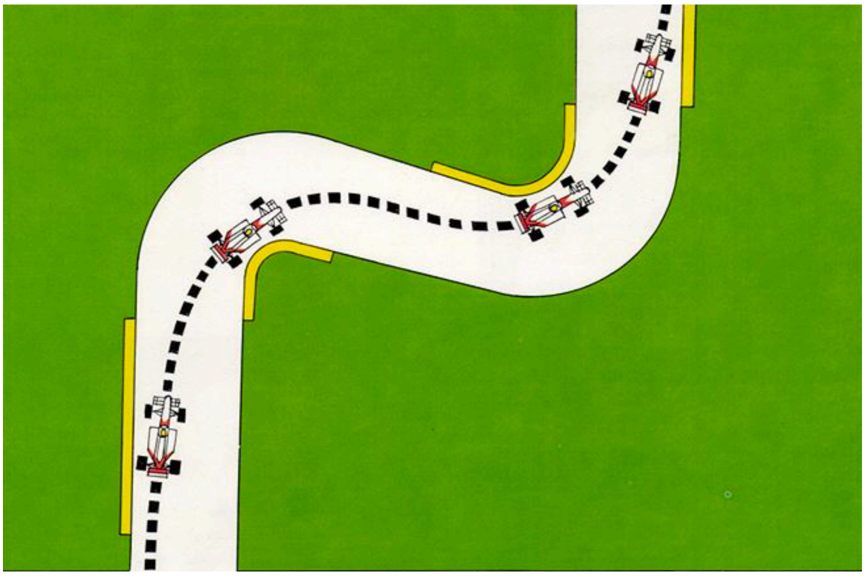
This is a chicane where it is the exit which must take priority because it is a fast bend. The driver sacrifices the first right-hander by going to the kerb very late: in this way he will find himself in a position to attack the second left-hand bend at higher speed. The illustration shows this situation, which is not uncommon on modern Formula 1circuits.



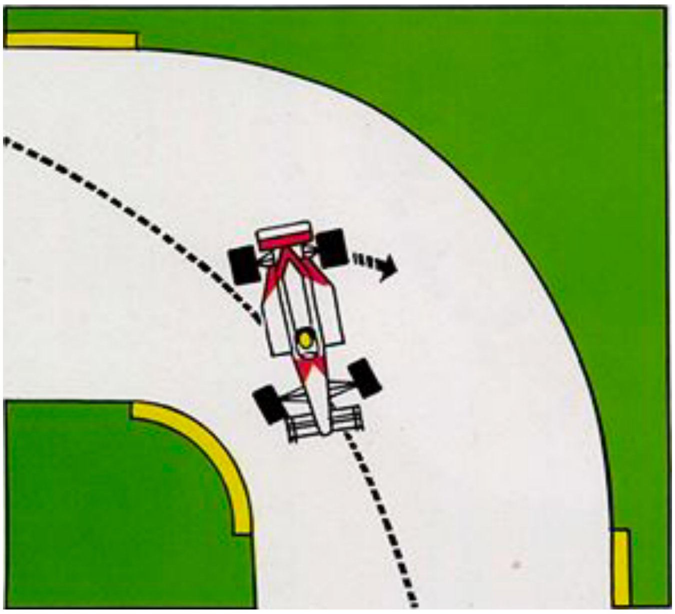
In this case, on the other hand, you must give priority to the first part of the chicane because it is the first corner which is the fast one, while the second is slower. The driver will hold a straight line until the second apex, keeping his speed up as much as possible. You should brake just before the second bend, which will then be tackled with a less favourable line.



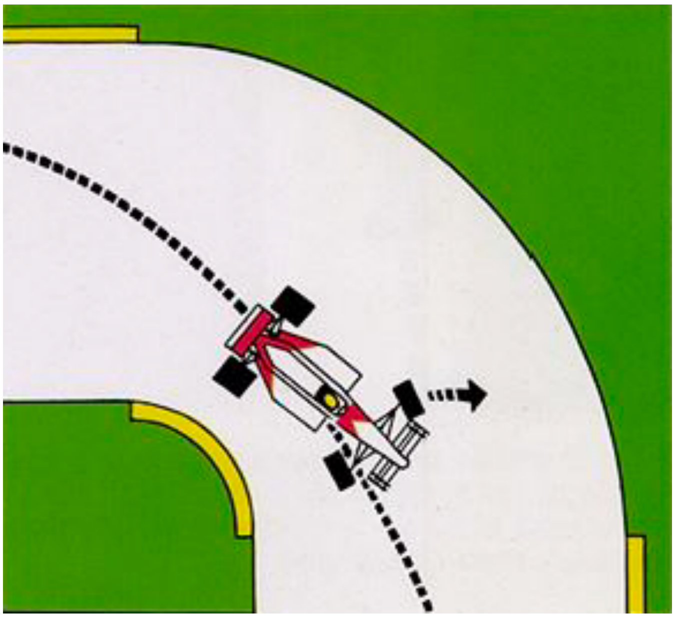
In taking this chicane, the driver must sacrifice the entry so as to exit faster. This style of driving is dictated by the length of the straights which come before and after the chicane rather than the layout of the bends. The illustration on this page is an example of when the longer straight is immediately after the chicane.



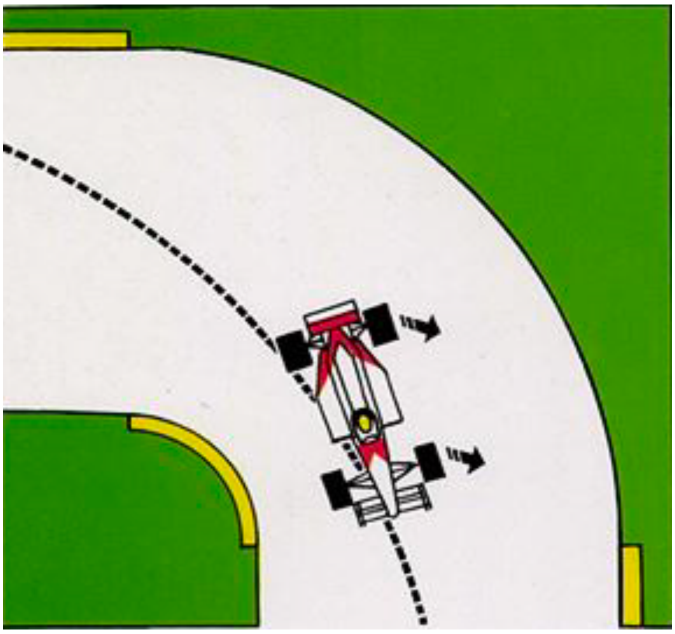
In the illustration we see a chicane which comes after a long straight. In this case the driver must compromise the second half of the chicane so as to lift off and brake as late as possible and thus lengthen the straight. In so doing he will come to the left-hand bend too near the inside kerb and on the exit he will have to wait to have the car straight before he can start accelerating.



Oversteer. The front of the car grips and holds its line while the rear has a tendency to widen to the outside of the bend. There are two kinds of oversteer: power or deceleration. The first is caused by excessive whee/spin, the second by the absence of traction (that is to say rear-wheel grip) and the subsequent increase in drift. This behaviour will always cause the car to 'wiggle'.



Understeer. The rear grips and holds its line while the front runs wide. Understeer will slow a car down less than over steer and this is why many drivers set the car up so that it is slightly understeering on fast bends. Understeer can be caused by a lack of grip at the front or by too strong a push from the rear wheels: this situation can be a constant one or be caused by outside factors.



The four-wheel drift (or controlled skid). The front of the car and the rear increase their drift simultaneously and the car slides towards the outside of the bend with all four wheels in a fine. The steering wheel is straight and the driver controls the car with the throttle (rear wheels) and the steering (front wheels). This technique was often used with the cars of the 1950s and 1960s and is still found in rallying. It can be used in medium-fast bends.