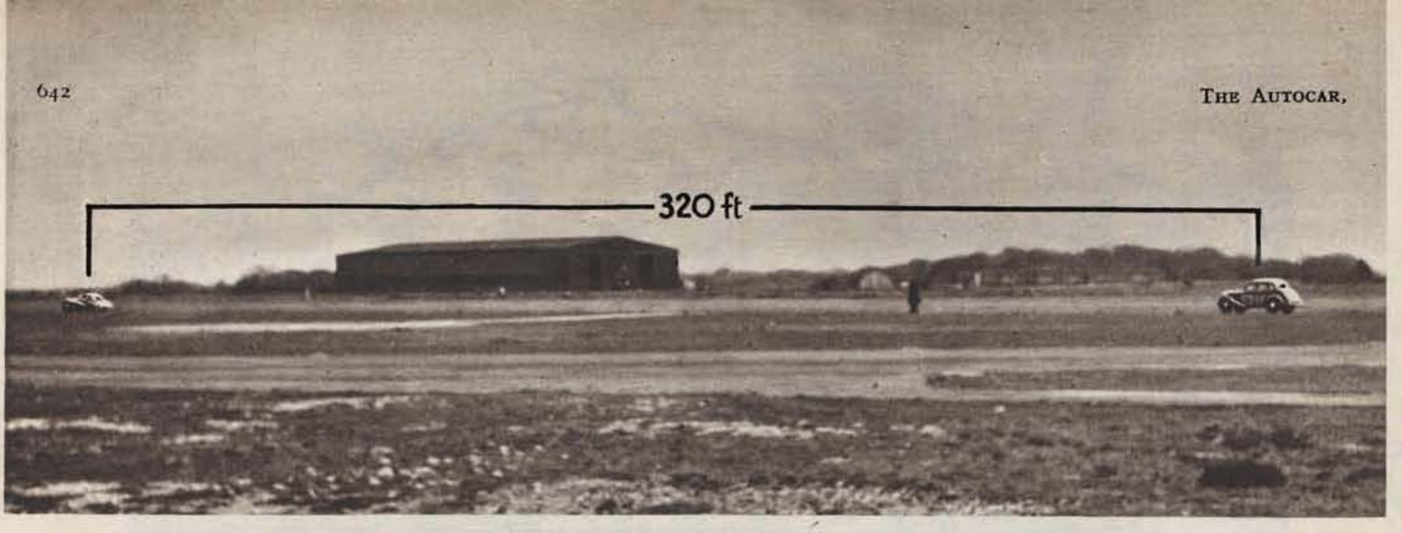


Most of us can recognize the good driver instantly. We travel with him, safe and unconcerned, the measure of our security being the ease and incident of our car conversation. But if one asks the good driver just how he does it, only rarely can the artist at the wheel give an adequate explanation. In the following article such an attempt has been made, not, let it be modestly said, because the author claims to qualify as a driving artist, but because he has had ample opportunities of studying the methods of others who are indisputably in that class.

Finesse

THE ARTIST (AND PHYSICIST) AT THE WHEEL

THE good *slow* driver earns respect but no admiration. Cars are so built nowadays that only a ham-fisted novice should subject his passengers to clumsy jerks, and low speeds today can be said to go up to 40 m.p.h., for ease of control makes that rate of progress a sedate stroll for the modern car. Admiration is therefore reserved for the good driver whose range is 50 to 90 m.p.h. From 90 to 130 m.p.h. we will accord him awe, reserving a measure of boyish adulation for the 400 m.p.h. John Cobb.

When it comes to defining how the expert does it one is in some difficutly. He goes fast; that much is obvious. His passengers feel safe; that is equally obvious. But what is there in it besides speed?

On British roads at least, a very great deal indeed. This can never be too often stressed, for the temptation to put the foot down is the first one to afflict the novice, and should be resisted. Any P. G. Wodehouse types who utter "Pshaw!" at this statement are invited to consider the physical facts of the matter, which follow.

There are two forces which can lead the car driver into trouble. One is momentum (mass x velocity) and the other centrifugal force (the force which impels a revolving body to fly outwards from the centre). The driver's skill is proportional to his ability to judge these. Momentum varies directly with speed, and driver judgment operates in overcoming momentum by means of the brakes. "Easy," comes the retort, "the faster I go the longer the distance it will take me to pull up." Quite right, but there are complicating factors—road surface, wet or dry, state of brake linings, shape of drums, condition of tyres, and so on. Enter the imponderables, in other words, with the result that it is impossible to give a formula which will precisely indicate the distance in which a car can pull up from various speeds. A table has, however, been prepared using the following incidental formulæ:

$\frac{V^2}{20}$ for a clean, dry surface; $\frac{V^2}{15}$ for an average surface; $\frac{V^2}{10}$ for a moderately slippery surface; $\frac{V^2}{7.25}$ for a very slippery road surface,

where V = velocity in m.p.h.

In each case the brakes are considered to be really good and properly set, and the resulting table is shown here:

To translate these figures into road conditions let us suppose that a driver is travelling along a straight road at 80 m.p.h. In the distance a lorry pulls right across the road. In order to decide what action to take the driver will, in theory, have to calculate almost instantly: How far off is the lorry? Where, between 320 and 883 feet, does the stopping distance on this surface lie? How quickly will the lorry straighten up to clear? Shall I have reached that point by then? Can I be *sure* that the lorry will clear? Is there anything behind the lorry that may "steal the gap?"

If he lacks the instincts referred to later and actually has to answer these questions, it may take him two seconds to decide the answers. His car will have travelled 234.7 feet in the meantime, so if the answer indicates a maximum braking effort he has lost 235ft of stopping distance. It can thus be seen that it is as well to be modest about powers of judgment regarding braking distances. In such circumstances as those quoted the instinctive course of action is to brake as a precaution, suspending judgment as to final action until one is closer to the obstruction; but the finesse of the good driver is seen in his decision as to whether and when braking is necessary.

Centrifugal force is the dig in the ribs that greets the car whenever the driver turns the steering wheel. It is most commonly felt on corners, and it is instructive to calculate just what this force amounts to in typical cornering circumstances. The formula is as follows:

$$F = \frac{MV^2}{32.16R}$$

where F = centrifugal force in lb
M = mass of revolving body in lb
V = velocity in ft per sec
R = radius at which body revolves, in ft

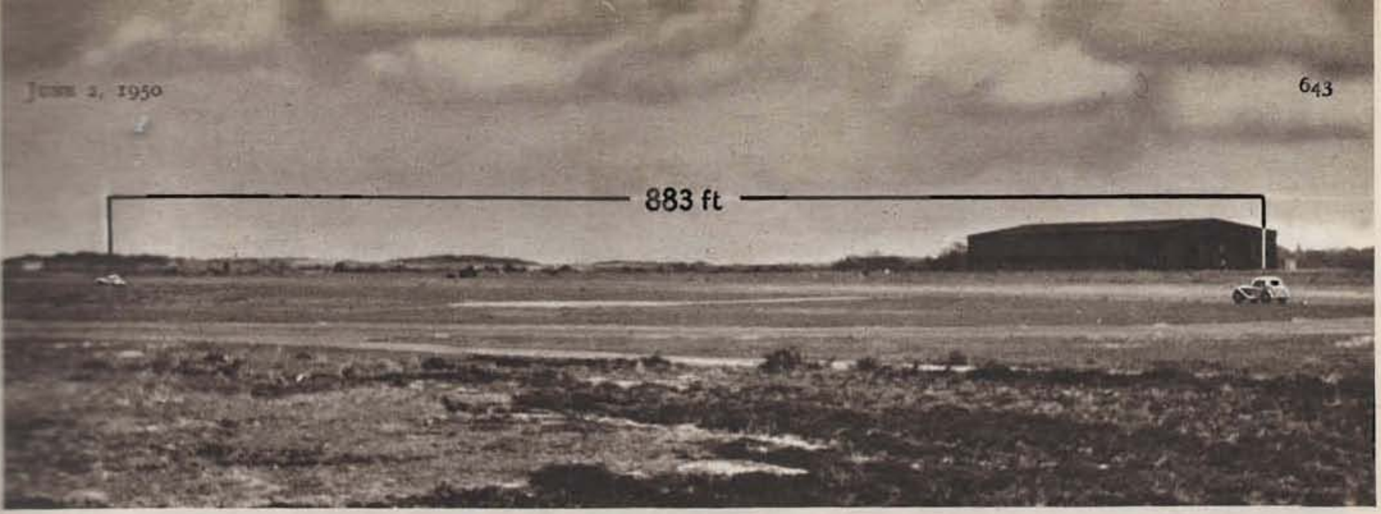
Let us suppose that a $1\frac{1}{4}$-litre M.G. is taking a corner. M will then be 2,340 lb. Let a certain section of that corner be at 150ft radius and the velocity of the M.G. 50 m.p.h. Then V will equal 73 ft per sec. We thus have

$$F = \frac{2{,}340 \times 73^2}{32.16 \times 150} = \frac{12{,}469{,}860}{4{,}824} = 2{,}568.4 \text{ lb}$$

So at the critical point on the curve there is 1 *tons*

BRAKING DISTANCES

Speed in m.p.h.	On good, dry clean road surface	On road surface in average condition	On moderate greasy road surface	On very greasy road surface
	ft	ft	ft	ft
20	20	26	40	55
30	45	60	90	128
40	80	106	160	228
50	125	166	250	355
60	180	240	360	500
70	245	327	490	676
80	320	427	640	883
90	405	540	810	1,117
100	500	667	1,000	1,375



at Speed

BRAKING FROM HIGH SPEEDS. Some idea of what braking distances from 80 m.p.h. mean in terms of vision can be gained from these two photographs. On ideal surfaces 320ft are required ; on a very bad surface (from the skidding point of view) 883ft are necessary.

By MICHAEL BROWN

trying to shoulder the car off the road; again, no force to trifle with.

I think that the best drivers have these two forces constantly in mind and that the time occupied in getting the instinctive measure of them is precisely the time in which it takes to become a good driver. Long before that point is reached the learner should have achieved instinctive operation of the controls, a necessary pre-condition for good driving, and a knowledge of the law of the road, the less predictable habits of other road users, and so forth; but if he achieves all these without appreciation of momentum and centrifugal force his victory is the Dead Sea fruit of never knowing quite where he is with a car.

The battle for perfection becomes, therefore, a fight against these two forces; to maintain military parlance, the object is to contain the enemy, and the great ally of the driver is the designer of his car, notably as regards brakes and suspension. The design of these has resolved into a critical point beyond which the forces cannot be contained. With braking this is the point at which the car skids, wheels locked, in the direction of travel, and with suspension it is the point at which the skid is lateral, being evident usually—and in all good designs essentially—at the back wheels, for a back wheel skid is correctable with some ease.

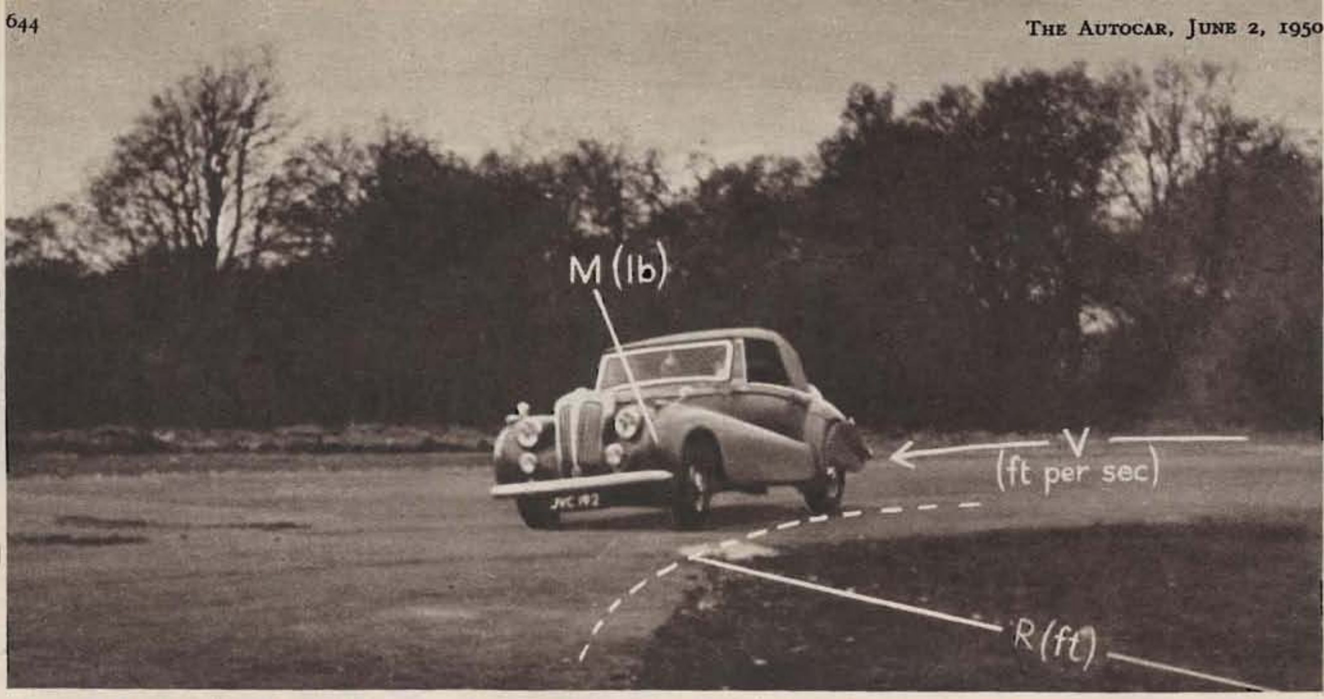
To mention skid correction is to recall one of the instinctive abilities of the best drivers, and it is interesting to see how the ability is related to the appreciation of the forces involved. When a car skids on a bend, the driver steers "into the skid"; that is, he turns the wheel in the direction in which the back of the car is sliding, invariably towards the outside of the bend if the skid is a straightforward speed skid. What has he done? If we consider the formula again we can see that he has reduced the centrifugal force: Suppose that he has turned the wheel sufficiently to increase the radius of the curve round which the car is travelling to 500ft. Then we have

$$F=\frac{12{,}469{,}860}{16{,}080}=77.6$$

The reduction therefore is from 2,568.4 lb to 77.6 lb, which is quite something. Of course, this simplification omits subsidiary and some intricate effects, such as the relevance of slip angle to the position. If he locks too far over the driver may induce a slide in the other direction, which is the result of over-correction causing centrifugal force to operate on the other side of the car. The road may permit only a few feet of travel at the new radius before it is necessary to pull the car back again on the sharp curve. But to the good driver the restored temporary adhesion will have given time to brake and he will probably come back on his line of travel sufficiently slowly for the adhesion to be maintained.

There is no need to outline the myriad circumstances on the road where these two forces come into play; a moment's

HOW FAR AHEAD? "Moron" driver blocks road in front of speeding car. How far ahead is it? The answer is 150ft, and on an average road the cars would almost certainly collide in spite of braking if the speed exceeded 50 m.p.h. In positions such as this, the ability to "steer out of trouble," possibly by accelerating hard, is at a premium.



CENTRIFUGAL FORCE. This photograph of a car cornering at speed shows the violent effect of the centrifugal "pushover," as it also illustrates the dimensions used to calculate the force applying.

Finesse at Speed . . . . continued

thought will show that every *impasse* is ruled by them and the driver's ability to contain them. So is every driving manœuvre of any importance at speed. The line on the fast bend is a matter of centrifugal force, the braking before the corner is a matter of momentum. Braking *on* a bend is a combination of the two in which extra careful judgment is called for. In overcoming momentum by means of the brakes the driver is approaching the critical point at which the wheels will lock. But in steering round the bend he is also approaching the critical point at which sideways adhesion is lost and the car skids. Both enemies, therefore, are attacking together, and he must make the quick decision as to the point at which he dare stand and give battle. If the line is too far forward he will be defeated and overwhelmed, and the situation is perfect for the renewed appreciation of the maxim that discretion is the better part of valour. The skid enemy approaches and is repulsed, and the driver can follow through as it retreats with a burst of throttle and a swing of the steering wheel.

Now, you may say, all this applies to the slow driver as well, for in his more modest way he, too, is dealing with c.f. and m. all the time. Alas, I am afraid not, however wounding that may sound. Quite frankly the car designer has done it for him. At speeds below 40 m.p.h. it is only the very rare instance when a thoughtless action on the part of the driver can allow c.f. or m. to take charge. If he jabs the brake pedal on wet tramlines, m. may give him a sly push in the rear, and if he locks hard over in similar circumstances to avoid a running child, c.f. may provide a swish of the skirt. In the main, however, he can do both and the car and tyre design will take care that the two enemies are kept at bay. The tyres are deliberately interposed at this point because we must never forget how much we owe to tyre manufacturers and their leech-like treads in pushing c.f. and m. away up into the realms of high speed.

The instinctive relation between the human being and these two natural forces is something that is surely inexplicable while at the same time being understandable. The relation is understandable because we and our ancestors have grown up with centrifugal force and momentum exactly as we have grown up with gravity, towards which our reactions are instinctive. But we meet gravity far more frequently than we meet c.f. and m., and that may be the reason why the instinctive dealing with gravity seems to be shared by everyone—except young children and unhappy folk whose equilibrium is not all that it should be—and in about equal measure. Half the population are fortunately

RECTIFYING SKIDS. The rear of the car, under the influence of a rear-wheel skid, is sliding outwards off the bend; the driver is steering off the bend also, and the manœuvre is commonly described as "steering into a skid."

not addicted to tumbling over. But the instinctive containing of c.f. and m. is nothing like so widespread. Some car drivers do not seem to acquire it at all, and even amongst the experts there are sharp differences of ability. A Fangio, Nuvolari or Moss have it to the highest degree, which is what brings them over the line first so many times.

Amongst my normal good driver acquaintances differences are easily observable. With the reader's kind permission the trumpet may be taken out of its green baize when I say that I am reasonably satisfied with my judgment of the buffetings of c.f. and m., but I will frankly confess that I will take a car round a corner as fast as I feel that it can stand (at which point, curiously, I cannot stop myself from leaning over towards the inside of the bend). I can then dismount and give the wheel to a colleague, who will proceed to take that car round the same bend a good ten miles an hour faster. Why should that be? Timidity does not enter into it, because the bend may be a staged one (on an airfield, say) and the car one in which I have deliberately and previously skidded with impunity.

The instinctive relation between humans and the forces, to me at any rate, remains inexplicable. Possibly it is a medical one, possibly it is a mere tuning of the human mechanism to its environment; but if that were so surely everyone would have it, or at least every car driver. It may be that the slight knowledge of how such forces work is the "theoretical" without which the "practical" cannot be acquired, much as it is said that a good driver must know what is going on in the engine and gear box. I doubt it, though. A number of my acquaintances are sufficiently well educated to have staggered through elementary physics. But behind the wheel of a car it is plain that the dynamics of moving bodies are as remote from their intelligence as next year's Grand Prix winners.

Originally printed in The Autocar, June 2, 1950