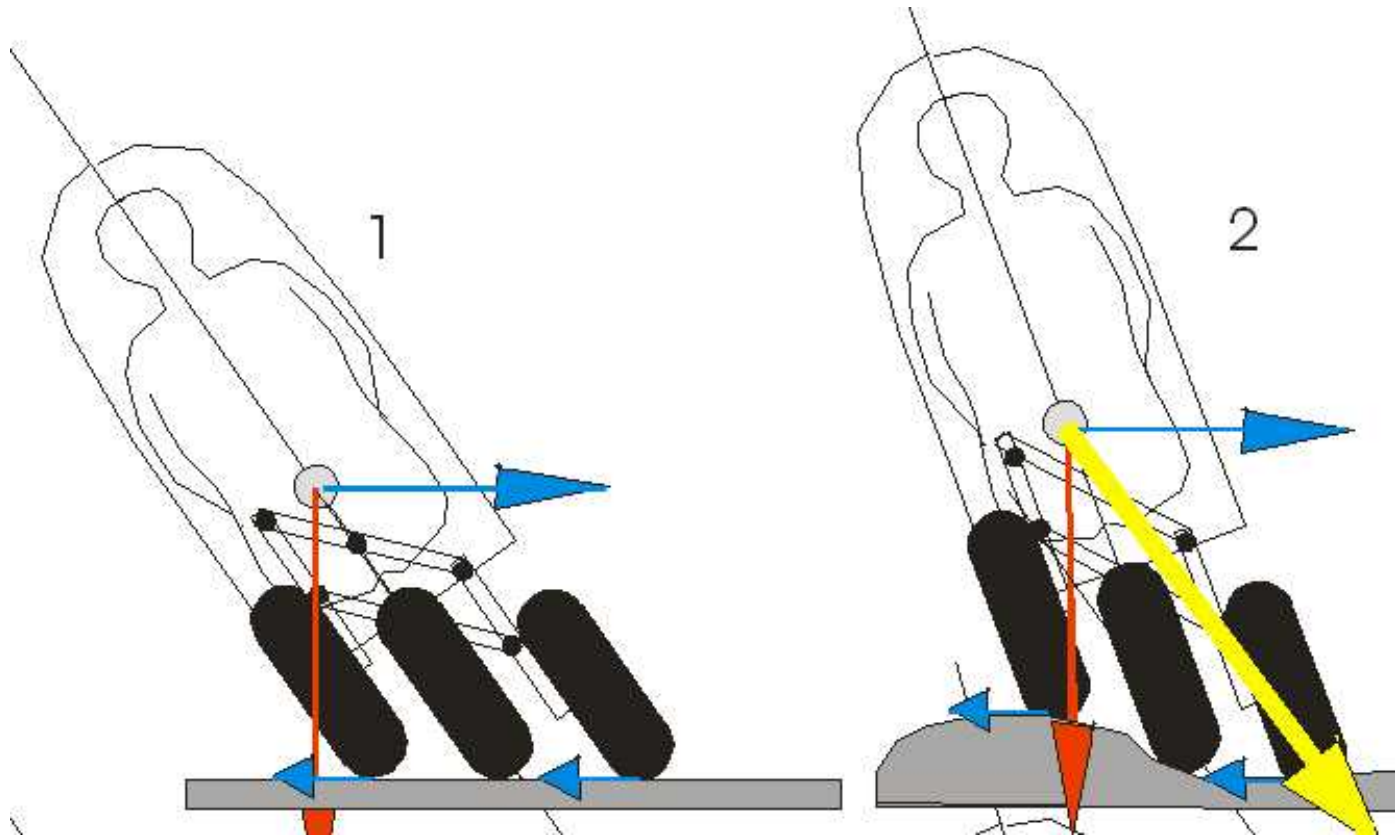


TTW CONTROL PROBLEMS



NATURAL OR FORCED LEANING?

In Fig (1) a TTW is in a curve at its maximum leaning angle for a certain type of pavement.

If the leaning mechanism is natural the typical accident is to slip sideways due to a driving error or to a sudden decrease of the coefficient of friction, oil spill, water, ice patch, or small size gravel on top of the hard pavement. Strangely enough the last was the most common cause of falls in Spain.

Also a sudden increase of friction, by whatever the cause like too much oversteering, cannot be counteracted by steering and cause a much more dangerous fall to the outside of the curve. This type of fall can be seen frequently now on Races on TV.

A natural leaner is practically equivalent to a single track vehicle. Nobody would dare say that it is intrinsically safe.

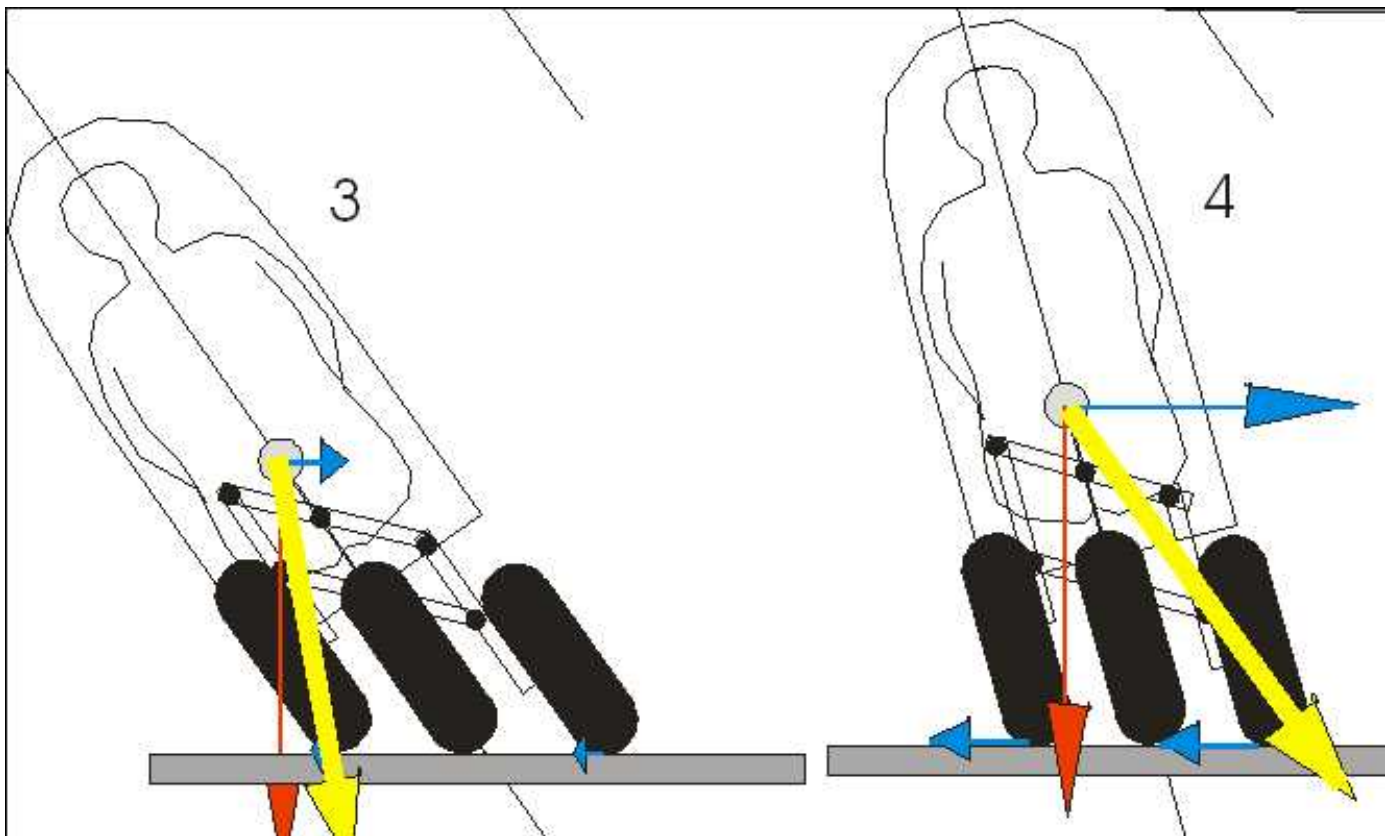
All you have to do is to watch the motorcycles running on loose

sand as seen from an helicopter in the Paris-Dakkar. It seems impossible that they could maintain the stability.

In Fig (2) we can see that the TTW hits a big boulder at the left side.

In a natural leaner practically nothing happens.

BUT if the machine is of forced leaning, using hydraulic, pneumatic or electric actuators, none of these systems is capable of acting so fast, so when the affected wheel goes over the bump. the leaning mechanism has not moved much, and so what tilts is the vehicle. This tilt might be fatal as seen in the figure. The yellow Resultant is just at the point of overturning to the outside



In Fig (3) in a forced leaner there is a sudden decrease of the pavement friction. The whole vehicle slides to the outside. This can be counteracted by fast steering to open the radius of the curve, if you have room for this.

But as the leaning mechanism is too slow the TTW would fall by gravity to the inside of the curve no matter what you do with the

steering bar.

In Fig (4) you can visualize another dangerous situation for a forced leaner.

You are sliding sideways as from Fig (3) and you have managed no to fall and then suddenly you find a pavement of high coef. of friction.

Again, as the response of the leaning mechaanism is slow you may overturn the vehicle and you can do very little with the steering to prevent it.

LEANING MECHANISM USING SOLID/SOLID DRY FRICTION.

This type of friction has very interesting properties.

1° You can apply large forces very fast as in an automobile clutch.

2° And more interesting is that the clutch can apply a metered force on a leaning mechanism,

BUT the leaning mechanism cannot increase or decrease the force on the clutch. And it does not depend on the actuating speed.

So this leaning mechanism is a highly potent system as "seen" from the vehicle but it is as if did not exist as "seen" from the road.

The big drawback is that this is an extremely wasteful system from the point of view of the needed energy.

But as this system is NOT intended to be used continously but rather to perform intense error corrections for fractions of a second or very small corrections for longer times, the average power needed would be quite small.

The questions to be solved before entering into a real prototype building are:

1° What is the maximum torque we can apply before lifting the

TTW from the floor?

2° How large would be this force?.

3° How fast do we need to apply it in any possible situation?.

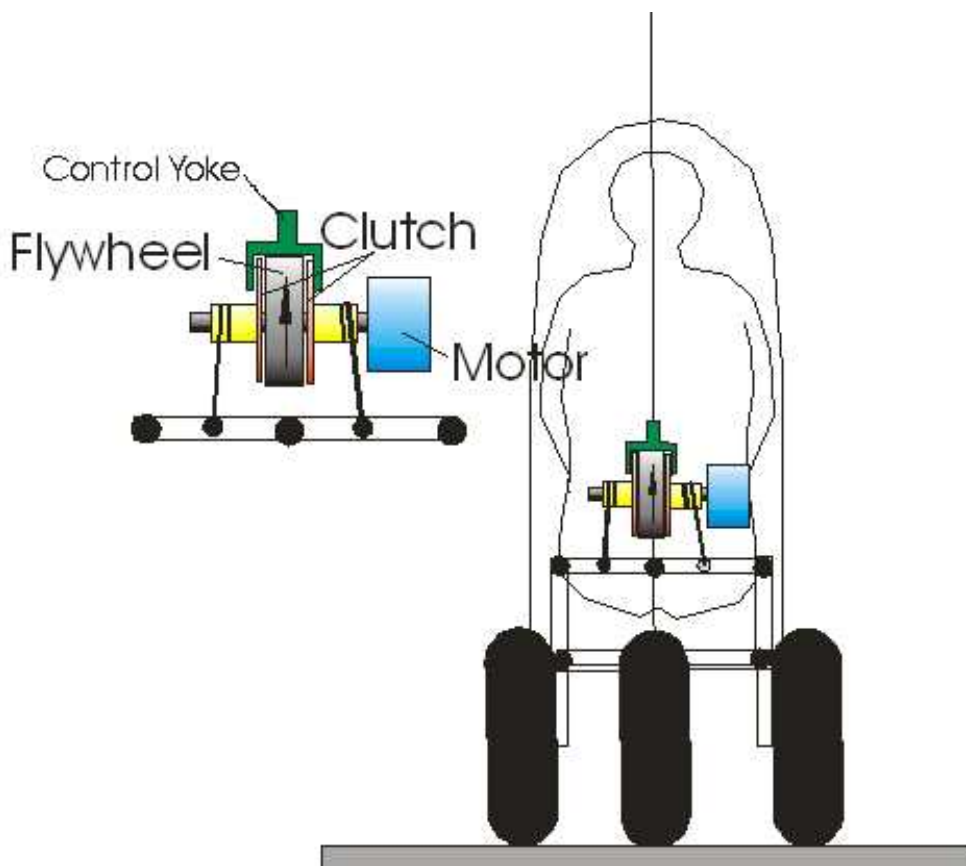
This would give us some numbers as for the size and rpm of the flywheel. the size and design of the clutches and the necessary manual force to operate it.

Also an average power estimate.

There is no reason why this system could not be made fully automatic using all the already existing control systems. Inverted pendulum. Steering angle versus speed, etc.

Melchor Duran

Paradas 2000



The forced leaning might be acceptable for relatively wide track TTWs as the Carver or Mercedes.

I have been fighting for over 50 years now in favor of the concept that what we need in mediterranean Countries or Countries with very crowded Cities is a VERY NARROW vehicle, not fatter than a scooter. For 1+1 people and a week's volume of groceries

It is an irony that most of the work on TTWs is made in Countries that do not really need them. As in USA, Canada, Australia, New Zealand

Not in a vital way as we do.

Melchor Duran

Aznalcollar.

Sept 2003