Chassis tuning for good turn in

This seem familiar to you . . . you reach the turn-in point of the corner, turn the wheel, and the kart seems to abruptly go into oversteer. It then misses the apex and slides wide into the middle of the corner, scrubbing speed and bogging down through the corner exit? If it is, then the problem may have little or nothing to do with the rear end.

Poor corner turn-in is a very common handling problem. If the kart understeers at the instant you turn the wheel, the front tyres are momentarily sliding. Often they suddenly regain grip, causing a violent change of direction, which upsets the rear end giving the rear tyres little chance to produce grip, so the kart slides into the corner in an oversteering condition.

As this initial understeer may only last a fraction of a second it's often not noticed, and can lead the driver to think the problem is in the rear end of the kart. This condition (turn-in understeer/oversteer) is usually caused by not having enough scrub radius (front track width) and / or caster angle in the front end. This can easily be made much worse by incorrect toe and camber settings.

If the kart just understeers at corner turn-in, the problem may still be not enough scrub radius and / or caster, but may also be that you are still braking when turning-in. Too much rear weight bias can also cause both turn-in understeer and understeer/oversteer.

For effective chassis tuning, certain basic things have to be at least close to correct to begin with, or you are likely to only be getting seat time. When trying to diagnose handling problems, it is very important to make sure the problem is not the tyres or the toe and camber alignment.

Tyres are the point of contact between the kart and the track, and are the single most important part of the chassis, as this is where the grip happens. The best chassis in the world is only able to grip and handle to the capacity of the tyres. If the tyres are old and hard, any chassis adjustments you make will only result in different kinds of bad handling (with poor grip).

So tyres must be in good condition (the newer the better, and usually no more than 4 meetings old for YEQ's). They should also be at least close to the correct pressures, (tyre pressures should be set for maximum consistent grip, and only adjusted to fine tune the handling, not to make large changes). I personally prefer about 20 to 23 psi in YEQ's, but this will vary with kart make / model, track conditions, total kart weight etc. As a general rule you should use more pressure in hard tyres and less in soft ones (YEQ tyres are a fairly hard compound).

Even if you manage to find a half way reasonable set-up with old (hard) tyres, the settings are likely to be useless as soon as you put new tyres on the kart, resulting in the waste of the new rubber and uncompetitive times.

Toe and camber, at least as the basic starting point should always be set to zero settings (ie. the front wheels parallel to each other both horizontally and vertically). Zero toe and camber may not always be the absolutely perfect settings, but are going to be very close.

A zero toe setting will lessen tyre scrub and friction on the straights, which will lessen the rolling resistance of the kart. Rolling resistance lowers the acceleration and top speed the kart can produce, resulting in wasted engine power (which you've probably paid your engine builder lots of money for).

Zero (or very close to zero) camber settings will help to keep the full width of the front tyre's tread in contact with the track surface when cornering, particularly at mid corner and corner exit.

As it's very common to see full sized racing cars using obvious negative camber settings, some karters conclude that if this is OK for F1 and Indycar teams, it must be the right thing to do. Unfortunately for those karters thinking this way, the tyres used in most other forms of motorsport are radically different in their construction being radials, while kart tyres use cross-ply (bias-belted) construction. Radial tyres have much more flexible sidewalls than cross-plies, and because of this can work well at larger camber settings. The stiffer sidewall of a cross-ply tyre means it has to be kept very close to vertical to work correctly.

Inaccurate camber incorrectly loads the tyre and lessens the size of the contact patch. As a result this smaller tyre 'footprint' will have a tendency to overheat. Especially in hot conditions, this contributes strongly to premature tyre wear and inconsistent handling (ie. the kart will handle differently as the race progresses, probably tending to increased understeer).

At most race meetings you will see plenty of front tyres with substantial wear on the inside edge, yet virtually unworn on the outside. You won't see many, if any tyres looking like this at the front of the grid for the final.

It's really very simple, if the rubber's not in firm contact with the track, it's not providing grip, and the rubber which is contacting the track is being asked to do the work of the entire tread width, which it wasn't designed to do. Poor camber settings can have a similar (but not identical) effect as fitting undersized (narrow) tyres. I'm sure nobody would deliberately put narrow tyres on their kart!

In racing, it takes only a tiny deficit to lose large amounts of track distance. For instance, if you're only losing 1% to the kart in front due to poor alignment (or any other reason), then in ten laps on a 700-metre track you will lose 70 metres.

Looking at this another way; on the same track, assuming a 'hot lap' time of 30 seconds, then a 1% deficit is equal to losing 3 tenths of a second per lap. An expensive engine blueprint might gain you 3 tenths. So why waste this costly and valuable advantage with poor alignment?

Toe and camber are among the most important settings on the kart, but they are also the two settings most likely to significantly alter when the driver's weight is placed in the seat. This shouldn't be surprising, since driver weight can easily be over half the on-track kart weight.

If a kart is aligned to zero toe and camber without the driver seated, it is certain to have some unpredictable amount of negative camber with the driver. Most karts (but not all) will gain some unpredictable amount of toe-in, up to three millimetres is quite possible (this is equal to about 8 to 10 mm's on a full size car tyre). Toe-in can easily contribute to poor turn-in as it makes the kart more resistant to change of direction and lessens turn-in weight transfer (see below).

As the kart will always be raced with the driver in it, it is strongly recommended both the toe and camber be adjusted to zero settings with the driver seated in the kart.

This is by far the best starting point for setting camber, and the exact setting can be fine tuned using tyre wear as a guide. If you're lucky enough to have a tyre temperature gauge, adjust from tyre temperatures across the tread. A kart set up to zero toe and camber with the driver will have some positive camber and probably some toe-out without the driver.

Worn steering components can cause substantial increased toe and camber change with driver weight, and can also contribute to unstable alignment settings in transitional stages of the corner. It doesn't take very much wear in the tie-rod ends, king-pin bearings or wheel bearings to affect alignment.

To check for worn tie rod ends, attempt to move the rod end up and down vertically. Any up and down movement indicates wear is present (some cheaper rod ends have some movement even when new).

Scrub radius (also called 'kingpin offset') and caster angle work together to produce a diagonal mechanical weight transfer from the inside rear tyre and the outside front tyre, to the outside rear tyre and the inside front tyre. This weight transfer causes the inside rear tyre to be physically lifted from the track surface at turn in. If this weight transfer is not great enough, the combined grip of the rear tyres can simply push the front wheels straight ahead.

This mechanical weight transfer means the inside front tyre is much more heavily loaded than the outside front tyre at turn-in. As a result, the inside front tyre provides most of the front-end grip at turn-in. Once into the middle part of the corner most of the kart weight is transferred to the outside tyres (due to cornering force). The mechanical weight transfer then becomes far less important (and can even be counter productive) and is largely superseded by weight transfer due to cornering forces (lateral 'g' forces, causing frame flex).

A wider rear track width will also make lifting the inside rear wheel off the track more difficult. As it's often necessary to use a wide rear track, this makes it all the more important to have the front-end settings properly sorted out.

Many people will advise you to add toe-out if the kart won't turn-in to the corner properly. This may help turn-in, but introduces it's own problems. I would recommend instead, increasing the scrub radius, and / or the caster angle. The only conditions in which I would recommend using toe settings other than zero would be in the rain, or if all other means of improving the turn in have failed (in which case some extra toe out may be an acceptable compromise).

Increasing either caster angle or scrub radius will increase the inside rear wheel lift at corner turn-in, which is really what you are after (if the kart is turning in badly). Increased caster may require using more positive camber to keep the tread flat on the track during cornering. Be aware that increased scrub radius and / or caster can contribute to front tyre overheating in some conditions.

A very flexible chassis may need more scrub radius and / or caster than a more rigid chassis, as much of the mechanical lift can be taken up with excessive frame flex, especially if the kart is a bit of an old floppy noodle!

Too little weight over the front wheels (and too much over the rear wheels) could also be the problem. If you suspect this, try moving the seat forward. Because moving the seat is such a pain and can result in lots of holes in your nice seat, many people don't experiment with moving it. When moving the seat, don't move it more than 2 cm's at a time. Trying to tune a chassis with bad weight distribution is often impossible.

Incorrect driving style can easily cause poor turn-in as well. When turning into a corner, many racers (in an effort to be smooth) turn the steering wheel too gently. This causes an indecisive lifting of the inside rear wheel, when what you want is for the wheel to lift AT the point of turn-in.

Poor turn-in tends to get worse during the course of a race. When the tyres are sliding they are subject to more friction which increases the amount of heat build up in the tread. This sets up a downward spiral of grip loss and exaggerated tyre wear.

One of the keys to a good handling chassis, is balanced grip front to rear. This balance can be greatly enhanced if the tyre footprints can be kept as large and consistent as possible, for as much of the corner as possible.

Many racers will try to balance the handling by reducing the grip at the end of the kart they perceive has too much. A better approach is to increase the grip at the end of the kart that has less grip. Grip is only too great if the chassis cannot use it, usually manifested by chassis hop. If this happens, do whatever is necessary to stiffen the chassis and / or lower the centre of gravity until the hop goes away. Only if the hop can't be eliminated, or the other end of the kart just can't be adjusted to give equal grip front to rear, should you consider deliberately reducing grip at either end of the kart. Always go for the more grip option if possible.

Good turn-in is usually not that difficult to tune into the chassis, if you know what to adjust. Be careful not to go too far though, as too much turn-in can make the kart twitchy and difficult to drive smoothly. Too much scrub radius and caster makes the kart overly sensitive to steering input, and can result in a chassis that needs constant steering corrections. Remember that every time the steering wheel is turned it causes substantial diagonal weight transfer between the front and rear wheels. If you're sawing away at the wheel, the tyres are being rapidly loaded and unloaded, which really upsets the stability of the chassis.

It's not unusual to spend a day testing and still be unsure if any improvement has been made. Lap times may well be better at the end of a test day, but this is often due to the driver improving with practice. It's very possible to be faster at the end of testing, with a worse set-up! This can be especially true if the number of practice days are limited.

All else being equal, a well set-up 'bad' chassis will always handle better than a poorly set-up 'good' chassis, and there is usually more gain to be had from a good chassis set-up than a good engine set-up. Keep in mind that a handling problem may not occur during practice, but can raise it's ugly head in racing. This is usually the result of the driver being able to find just that bit extra on race day!

Front-end settings have a huge effect on the overall handling of the kart. If your kart turns-in to a corner the way it should, then the rest of the corner will be easier and faster to negotiate as you are not having to catch up with the effects of poor turn-in. In addition, the rest of the chassis is likely to be easier and less confusing to tune if the front end is functioning properly.

Finally, many handling problems that may at first seem similar can easily stem from different causes. Any adjustment you make to your kart is only correct if it lowers your lap times, assuming that the basic alignment is at least close to accurate.