Gettin' It

FRONT STAGGER

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As the second installment in our discussions on stagger we're going to look at front stagger and its effects this month (see last month's article for an in depth look at rear stagger). The first thing we see when we consider front stagger and its differences from rear stagger is that, unlike the rear tires which are joined by a solid rear axle forcing them to rotate at the same RPM, the front tires are able to rotate independent of each other. This difference is enormous and is what changes the way stagger is used at the two ends of the kart. For instance, a rear stagger change will change cross and camber just like a front stagger change will but we didn't even include those effects in our discussions of rear stagger – they just aren't big influences on handling compared to the effects caused by the rear axle. With front stagger, cross and camber changes tend to be the dominant effects and as we will see, on modern chassis most of the effects we can get with front stagger can also be obtained using the front end adjustability.

Does more front stagger help the kart turn better?

Just as we did for rear stagger we'll start out very simple with what it is. The way we calculate front stagger is to subtract the circumference of the LF from that of the RF. For example, if we have a 34" RF and a 32-3/4" LF then we end up with 1-1/4" of front stagger. The RF is almost always the larger of the two tires so we subtract the LF from the RF to get a positive number. Very rarely a karter might run the LF bigger and when this happens it is referred to as "reverse stagger." Running reverse stagger really isn't done any more but it wasn't uncommon in the 1980s and early 1990s when everyone was running sprint chassis on ovals.

As we discuss front stagger and its effects we need to consider how we change it. There are some who say that the size of the RF tire should always be changed or the size of the LF should always be changed. As far as the kart goes the difference comes in the ride height of the front end and of the center of gravity (CG). If we want to add front stagger and we do it by running a smaller LF then we have lowered the ride height of the front end and of the CG as well. The changes calculate out to approximately 0.040" at the tire so the front end would move down approximately 0.020" and the CG by some value less than that. It is unlikely that even the best karter would be able to feel any discernable difference with this small of a change. Likewise, running a bigger RF will raise the front end and CG a similar amount to that which the LF lowered it. In the end, any

change is most often made based on the availability of a tire which will match with the set on prep, cut profile, and cut depth.

Now that we know what it is and how to measure it, let's start looking at what it actually does to the kart. The most obvious thing that it does and one of the easiest things that we can measure is that it changes cross. Running more front stagger will add cross and running less will reduce it; this effect is nearly identical to making a washer change. If we add front stagger by going to a smaller LF then what we have done in reducing the circumference of the tire is to make it shorter as well. If we calculate the radius of a LF which has a circumference of 32-3/4" then we get 5.212". If we then make a stagger change such that our LF now measures 32-1/2" then its new radius will be 5.173". This isn't a huge change but it is, nonetheless, a change. The effects of this change will be nearly identical to those which would be experienced if we made the cross change by moving the spindles themselves. The difference being that when a cross adjustment is made by moving a spindle up and down the spindle moves along the angle of the king pin, whereas when the tire's radius is changed it moves more or less along the camber angle. For this reason the scrub radius will decrease slightly more with a stagger change than it will with a washer change. This difference would be measured in single digit thousandths of an inch and isn't noticed.

Adjustable front ends took some of the need for critical front stagger away

Caster helps the front end to turn without the need of excessive stagger

The next effect of front stagger we will consider is its effects on the camber in the front tires. If you've ever added a fair bit of cross or front stagger and then measured your camber you've probably noticed that the amount of positive camber in the LF and negative camber in the RF increases. If we calculate it out for a typical kart we see that ¼" more front stagger can add somewhere around 0.7° of positive camber in the LF and 0.7° of negative camber in the RF – a large camber change across the kart (due to a number of variables, your results may vary a bit on the scales). The effects on the tire's camber tends to be the dominant effect on the kart as today's karts tend to be very sensitive to camber changes. Like the changes in cross brought on by front stagger, the effects of the camber change will be very similar to those experienced if the camber was changed by adjusting a heim joint or changing a pill in the two front spindles. One thing must be done though, if one were to make a camber change of adding 0.7° of positive camber to the LF and 0.7° of negative camber to the RF then the cross would go down a fair bit. To get the cross back in the kart we'd have to make a spindle adjustment. After this adjustment the kart would perform pretty much the same as if we had made the adjustment with the front stagger. The small difference being found in the difference in scrub radius which resulted from the spindle moving along the king pin as mentioned above when we talked about cross changes.

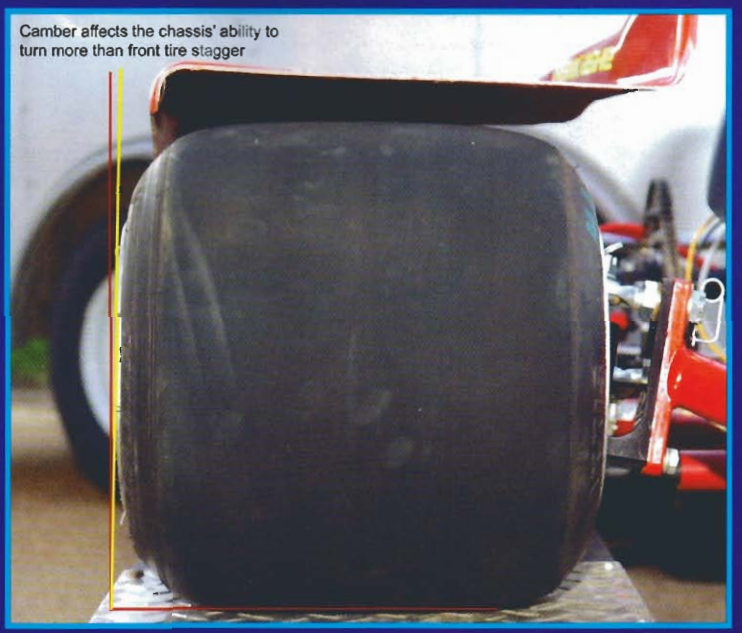
Since the camber change tends to be the dominant effect of a stagger change we'll spend just a moment going over the basics of what effects a camber change will have on the kart – we'll start with the LF. When we run more LF camber we can help the kart a little at turn-in but most of the effect occurs at corner exit (although even there it tends to not be

a really large effect). Most of the time running more positive LF camber will cause the LF to bite more and can help get rid of a push; especially a small push center off. Likewise, running less positive LF camber will tend to take bite out of the LF which can help a loose condition. On the RF the effects tend to be a bit more difficult to predict. Running less negative RF camber will typically help the kart plant the RF better and thus help it bite more; this effect is especially dominant at corner entry but it can be felt the whole way through the corner. Occasionally something about the track configuration, chassis or tires will occur where more negative camber will help the kart turn better. In this case the camber thrust from the higher camber as well as the effects the camber has on the rest of the chassis dominate over the better planting of the RF resulting from less camber. Typical RF cambers on generation 3 and 4 chassis run from the low negative 2's on lower bite tracks up to the mid negative 3's on harder biting tracks and pavement. On the LF, typical numbers range from positive ¼ degree on higher bite tracks up to +1-1/4 degrees on really small or low biting tracks (although many run between ½ and ¾ everywhere).


Chassis rake is an affected by front tire stagger

The actual mechanism which causes the camber change resulting from a stagger change is the third thing about our kart which changing front stagger will change: this change is the rake of the kart. When we say rake what we are talking about is the angle of the front end with respect to the ground. As we make the RF larger we raise the RF corner of the kart itself which increases its angle with respect to the ground. Likewise, going to a

smaller LF lowers the LF and creates the same increase in angle of the front end to the ground. As we would expect, decreasing the front stagger reduces the angle and thus the rake on the chassis. Chassis rake isn't something that is discussed very much in karting and it isn't an adjustment that we use because of that. What it does is that the greater the angle of the kart with the ground, the more the forces have to work uphill as they transfer. This tends to slow the weight transfer at the front of the kart and can affect the amount of weight which is transferred at the rear of the kart versus the front (although the total transfer will not be affected). Because rake angle changes are the same no matter whether they come from stagger changes or spindle height changes, the rake angle effects of either change will be the same.

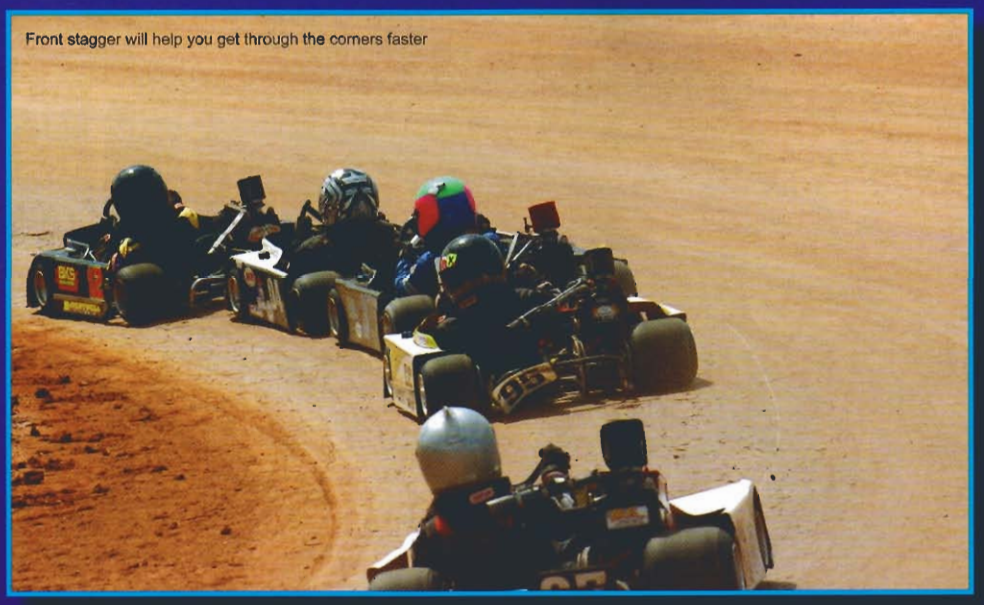

Camber affects the chassis' ability to turn more than front tire stagger

There are a few more changes which a change in front stagger will bring about but they do not have as large an effect as those previously mentioned. As we alluded to in earlier discussions, front stagger changes will affect the scrub radius in the kart (which will in turn affect the amount of weight jacking done by the tires as they are turned). As we make the tire larger, the scrub radius at that corner will go down but the actual change will be very small (around 0.015" on the LF for a ¼" stagger change). Another front end geometry-related measure that the stagger will change is the trail (explain trail)– a larger tire will yield more trail. Just as with stagger's effects on scrub radius, the changes in trail are not exactly duplicated by moving the spindle up or down but the differences will be minimal and won't produce a noticeable effect.

At this point we've gone over the changes that front stagger causes on a chassis and also identified how, in most cases, very similar effects can be made by moving the spindles themselves rather than changing the stagger. You'll notice that we haven't said anything about "more stagger will help the kart turn better" or "less stagger will help the kart turn better." The truth is that depending on the circumstances, it could go either way. As we mentioned above, the dominant effect that stagger has on the kart is to change the camber, and the way camber affects a kart can very depending on the chassis and track. On some tracks and chassis, adding front stagger can help the kart turn a little better and on some tracks, reducing the front stagger may help it turn. In the end, the only way to know exactly what it will do in your circumstances it try it.

Summing things up, front stagger tends to be something that isn't tuned with a lot these days. One of the reasons is that most people run their tires in sets and they don't have the tires available to be able to change stagger and not also end up changing the prep, cut profile, rubber depth, etc. Another of the reasons is that today's chassis typically come with a large amount of adjustability in camber and cross built into the front end so making the changes with stagger just isn't necessary. With

respect to the actual stagger values that most run, most manufacturers recommend 1-1/4" to 1-1/2" or so in the front end and that's what most I know run. This recommendation tends to be pretty consistent across generation 3 and 4 chassis. If you are running an older generation 1 or 2 kart then you might try a little more than that (up to around 2") to help get cross and camber in the kart and help the kart turn a little better. To those who are wondering what to do to make speed with front stagger, none of the testing I have seen has produced any discernable differences - I've seen 1" win nationals, 2" win nationals and just about everywhere in between. Hopefully between this month's and last month's articles you have a better understanding of what stagger is, what it affects and how you can figure out how to set and adjust the stagger on your kart. Have fun!


Front stagger will help you get through the corners faster

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