BALANCE ACHIEVEMENT PART FOUR:

WEIGHTS AND PERCENTAGES

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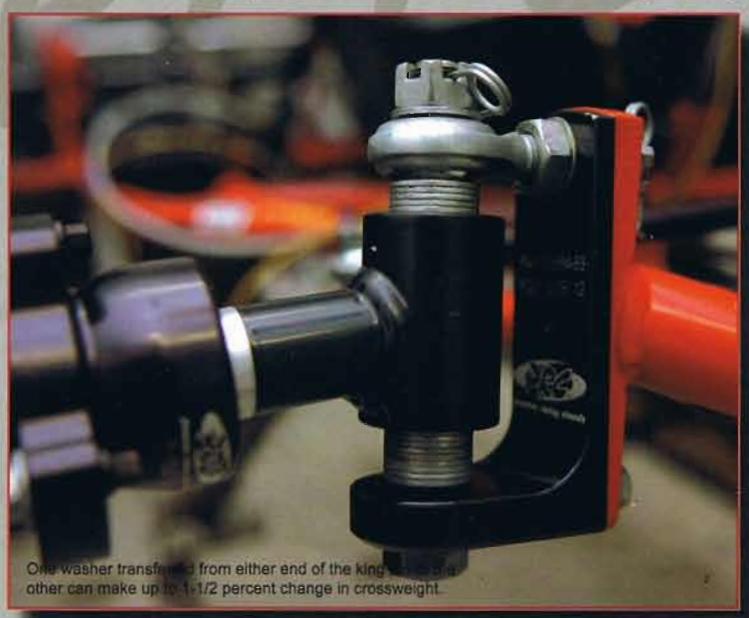
Weights and Percentages - Part 4: Crossweight

Over the last few articles we've taken an in depth look at percentages. We started looking at the equations we use to calculate the percentages as well as those required to calculate wheel weights if we know what we want our percentages to be. In that article, we also spent some time understanding a couple of wheel weight relationships that some karters try to obtain and what those relationships meant for our percentages. In the next article, we took an extensive look at noseweight percentages, what things control the ranges that we run, what it does to the kart's handling and when we might adjust it. Our third installment delved into left side percentages and showed us what sets the ranges of left side we run, what it does to the kart and how we can use it to help our kart handle better. Now we're at part four of our series, the final percentage, which is crossweight.



One washer transferred from either end of the king pin to the other can make up to 1-1/2 percent change in crossweight.

We know from the first installment in our series that the cross percentage is figured by adding the LR and RF corner weights, dividing this sum by the total weight of the kart and then multiplying the result by 100. We also know that more cross puts more load on the LR and RF. The last thing we know, or rather, that we've probably heard at one time or another, is that cross can fix all of a kart's evils. In order to fully understand what cross really does, we need to look at each segment of the corner because cross will cause different effects in each. We also need to consider the chassis because different chassis will have somewhat different responses to cross weight.

We'll start by looking at what happens when we put more cross in a kart. At this point we won't worry about where we are and how much we put in, just that we've got some (not to an extreme in either direction) and we are going to add more (a few percent). After our change we know that our RF and LR will be relatively heavier than they were before and the LF and RR will be lighter. On to the track with the kart at speed: right before we turn down into the corner we know that the four tires weigh nearly exactly the same as they did on the scales. At this point the front end must produce enough turning power to overcome the solid rear axle and inertia in order to get the kart to start to rotate and turn down into the corner. To a point, as we put cross in the kart we load the front end more optimally for it to make maximum bite. The added front bite will tend to grow a bit faster than the added resistance to turning that we get from adding weight to the LR so the end result is that the kart will typically turn in a little better. In the next segment of the corner where the kart has started to turn but must continue to make good front bite so that it will snap to the apex like it needs to, front bite continues to be very important. Just at the instant of turn-in, the added load on the RF and more optimal loading of the front end for maximum grip continue to dominate the equation. Another thing which further helps the extra RF load dominate the extra LR load from added cross through this segment of the corner is that weight is transferring to the right and forward which tends to unload the LR and load the RF. Once we get the kart turning well and we start to approach the apex the balance of power between the RF/LR begins to shift. At the apex, all the weight which is going

to unload off of the left side has been unloaded. On high bite tracks the LF may be completely unloaded, and if it is, then cross weight will tend to have very little effect. For this reason, on those high bite tracks, fixing apex problems with cross probably isn't going to work. On lower bite tracks where all four tires tend to stay more firmly planted to the track cross can have a small effect. What happens when the left sides carry weight through the apex is that the front end has gone right through its optimal loading and has started to lose bite because of an overloaded RF and under loaded LF. Because of this, more cross further reduces the front end's ability to make bite. This is to say that the RF is carrying nearly all the load and in order to get the front to make more bite we'd need for the LF to do more work; but the added cross goes the opposite way and thus reduces the front bite slightly. At the same time, the added LR bite moves the back end of the kart slightly closer to its optimal loading for grip and thus allows the back end to make more bite. As you can see, on tracks where the left side tires don't unload so much, cross can affect the kart at the apex. One final point on apex tuning with cross: even on tracks where the left sides don't completely unload, they do unload quite a bit so any changes caused by cross will be slight.

Now that we've got the kart to turn in and run through the apex we come to the segment of the corner where cross really does the business: corner exit. At corner exit, what we want is to get the back end optimally loaded for maximum grip and minimum rolling resistance at the right time. This ultimately is why karts run as much cross as they do. At corner exit, the LR dominates the equation over the RF because weight is transferring back to the left and also from front to back as the kart accelerates off the corner. This extra LR bite helps the LR plant earlier and harder so that it can help do its share of the work to drive the kart off of the corner. On most karts a 30 to 80 pounds of LR preload will allow the kart to run off the corner the best and the only practical way to get this much is through the use of cross weights in the high 50 to lower 70 percent range.

At this point we've taken an in depth look at how cross helps the front and then the back end make more grip, now we're going to look at a few of the problems that we occasionally run up against and see how cross can help us fix them. The first problem that cross can typically help is a push at the point of turn-in or between turn-in and the apex. In this area the RF tends to receive more grip than the LR and this extra RF load can help it make the extra bite we need to get the kart to turn well. At the same time, if a kart is loose from the center off then we can take advantage of added crossweight's effect of helping the rear of the kart produce more bite to help plant the back end of the kart so that it won't be loose. As you can see from these two situations, cross can, in fact, help both a loose or a push problem - it just depends on where the problem is. Just as you would expect, if the kart is loose in or pushing out, less cross can often help fix those problems. What we've just covered is a pretty good rule of thumb for using cross to tune handling problems. There are times when it doesn't quite work that way but we will cover that shortly. One last thing we need to cover before we do that is to talk a bit about lowering cross to fix exit pushes. As we mentioned above, one of the big issues that we use cross to help us with is to attain the optimum LR/RR load distribution at corner exit to allow the kart to accelerate off the corner well. If your setup has you running to the high side of the range then lowering cross may well be the best fix for a push out, but if you're closer to the center of the range lowering cross may not be the best solution to fixing the push. Lowering it might well cause the push to go away but what can happen is that the lower LR loading from the lower cross may cause the RR to overload center off and that may hurt the kart worse than the push. In this case, some other fix like more positive LF camber or less negative RF camber might be a better choice. The way I typically decide where to go is by understanding what my cross setting is and combining that with an understanding of what the particular chassis I'm tuning typically wants on that particular type of track. If you don't have all that info you can always drop the cross and see what happens; if it hurts the kart then put it back and if not then keep on riding.

Up to now we've looked only at what cross does to the kart from a tire loading standpoint and although we've touched on the notion that the chassis can affect what cross does to a kart we haven't gone into any detail. Now we will go into that detail. Karters often talk of a chassis being stiff or soft but this way of looking at it, that is to say the whole chassis being stiff or soft, is too simplistic to be of any use. In truth, most of today's chassis would be considered of similar stiffness. What is more critical to our analysis is the relative

stiffness of each corner of the kart. What we mean by this is that given the fact that weight transfers where there is stiffness, if one corner is appreciably stiffer or softer on one chassis than on a different chassis then those differences will cause the two chassis to respond differently to cross adjustments (and in fact, all adjustments). Alright, let's zero in on this concept by looking at two different karts. The first kart has a relatively stiff RF corner and a relatively soft LR corner and the second has a relatively soft RF and a stiffer LR. On the first kart, we can expect the stiffer RF to feel the effects of increased cross more quickly than the relatively softer LR. This will tend to increase the dominance of the effect of adding front bite getting in and this added front bite will tend to carry throughout the corner. In the end, the added cross will affect the RF a tad more than it does the LR. On the second kart, the opposite will happen. The softer RF will make it less sensitive to the added cross than the relatively stiffer LR. This will reduce the effect of the added cross's tendency to help a kart turn better into the corner and will increase its likelihood of pushing center off. This relative stiffness difference between karts is one reason that they respond a bit differently to cross adjustments.

Just as corner stiffness differences can affect how a kart reacts to adjustments in cross, so also will it respond differently as we move the LR or RF tire closer to or further away from the center of gravity (CG). As you might expect, if we move the RF further from the CG it will tend to be a little less responsive to the effects of cross adjustments and if we move it closer to the CG it will tend to be more responsive. In the same way, as we move the LR closer to the CG it will tend to be affected by cross more and if we move it further from the CG it will be affected less. These movements of tires can be the result of adjustments made in hub position by the karter but are more often changes resulting from the manufacturer's design intent. Karters tend to move the LR around a bit but it is the manufacturer that tends to move the RF and LF's position with respect to the CG and the rear tires. The result tends to be similar regardless of the source of the change.

The last thing we need to look at with respect to cross changes is what happens when our added cross causes the RF or LR to overload. As we have seen, added cross typically helps the front be more optimally loaded which will help it turn better from turn-in up to the apex. But, it is possible to put so much load on the RF that even with the added vertical load it is unable to produce enough lateral force to keep the kart turning. In this case, more cross will actually make a push worse. The other "overload" situation from cross tends to be in the opposite direction and at corner exit and really is more of an under load condition. It is possible to have a setup where, from center off, the cross is low enough that the LF ends up overloaded while the RF is under loaded. When this occurs the kart will push just as it can with too much cross but rather than the LR being overloaded causing the push, the LF is overloaded and RF under loaded so that the front is so far from its optimum loading that it cannot generate bite. You may ask how to tell the difference? On most chassis it's easiest to identify by understanding the typical ranges of cross that work on the kart under your conditions. Again, even in the absence of this knowledge, if you find that taking cross out of your kart to fix a push out either isn't helping or is making it worse then maybe the thing to do is to put some back in.

This brings our discussion on cross to a close but before we sign off there is one last thing I want to say. In the early 2000's it seemed karters could fix nearly any problem with crossweight. However, the chassis built today tend to rely less heavily on cross and thus, aren't as responsive to cross changes. While this is true, many karters are still stuck on the notion that cross fixes everything and they continue to not be as fast as they need to be because they are only using cross adjustments to work with the kart. As we've seen in this article, there are things that cross can do to help or to hurt a kart but it is only one part of a complete setup. Remember this: when you're at the track and the kart just doesn't seem to be responding to crossweight changes (and don't be stuck on cross alone!) work with all the percentages, tires, and entire setup to get the kart fast. Speed isn't about a single, magic bullet; it's about getting everything optimized.

This brings both our discussions on cross and on percentages to a close. My hope is that this series will help you better understand your setup so that you can better optimize it and use it to tune your kart. Next time we'll continue on with a new topic; until then...