BALANCE ACHIEVEMENT PART ONE:

WEIGHTS AND PERCENTAGES

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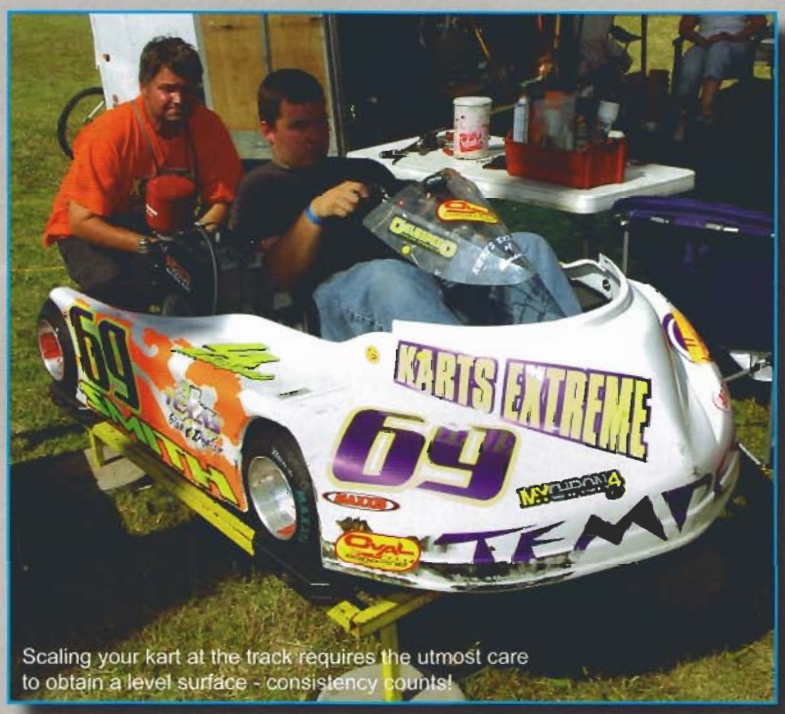
Percentages - Part 1 of 2: Weights and Percentages

The most discussed thing in all of karting seems to be the percentages or wheel weights which people run on their karts. A substantial amount of focus and effort is directed at getting the right numbers on a kart so that it will handle properly. Over the years, so much focus and effort has been put into weights and percents that there is a tendency to read more into them than may be wise. It isn't uncommon these days to see many karters in pursuit of the "magic" numbers which will immediately transform their karts from back or mid-pack runners to front runners. Sometimes we obsess over tenths of a percent on a particular setting spending hours on end on the scales, afraid to change even the slightest adjustment on the kart without it being on the scales. Other times we may study individual wheel weights until we start to see what we think is an important relationship that will surely provide the secret to success. Sometimes when we do either of these things we convince ourselves that it is the way it should be and will go from track to track, weekend after weekend struggling but being unwilling to deviate from our "special" numbers or relationships. What we are going to try to do in this series of articles is to study the weights and percentages, look at some of the things that tend to drive them and identify some of the relationships to which some hold fast but which may not be helping their racing.



Scaling your kart at the track requires the utmost care to obtain a level surface - consistency counts!

If we're going to understand weights and percentages then we need to start by getting accurate weights to begin with. If we're going to get accurate weights then we need to make sure that our scales all read the same if the same load is applied to them. The easiest way to get bathroom scales reading similarly enough is to determine approximately what weight range you expect to be measuring and get something that weighs that much and put it on each scale in turn and ensure that they all read the same. It's not a bad idea to do this same test with electronic scales from time to time to ensure that they are still in calibration. Once we've got all four scales reading the same the next thing which will influence our measured weights is the amount of deflection that occurs at each corner while we're scaling. This deflection comes from the scale pad itself, the scale stand if used, and the ground on which our scales or scale stand is sitting. The more stiff and solid everything is, the less deflection we will have and the more accurate and repeatable our numbers will be.

The next aspect of properly getting the scales ready is to ensure that they are level. Most karters start with a 48" level

starting on one pad and then moving around from pad to pad making adjustments or shimming until the bubble is in the middle. This is a decent way to get the scales level but we need to ensure two things: 1) that our level is accurate and 2) that we're centering the bubble in the center of the two lines and not just making sure it falls somewhere between them. The way we ensure our level is accurate is to take a measurement and then rotate the level 180° and take another – they should be the same. It is important to get the bubble exactly centered between the lines because there is a significant amount of difference between the bubble being between the lines but just barely and exactly centered between the lines. After getting things level with a bubble level, some will use a digital level or machinist's level to add further accuracy. Many digital levels measure to the tenth of a degree which over 40" (the distance form the front pads to the back), 0.1° is equal to 0.070" or about a washer of cross. Given this, even with a pretty nice level we can add another washer of cross of potential error on top of any that we obtain from scale inaccuracy or pad and ground deflection. The next step in accuracy is to use a machinist's level which will range from 0.005" per foot to 0.0005" per foot.

Now that the scales are ready, it's time to put the kart on the scales and take some weights. As we do this we record the weight of each tire and then perform calculations (if the computer doesn't do it for us) to get the total weight, nose, left and cross percentages. At this point we'll define the variables (figure 1) that we use when we calculate percentages from wheel weights and wheel weights from percentages.

LF - Weight of the left front
LR - Weight of the LR
RF - Weight of the right front
RR - Weight of the right rear
W - Total weight of the kart
Cross - Percentage of weight carried on the RF and LR
Nose - Percentage of weight on the RF and LF
Left - Percentage of weight carried on the LR and LF

figure 1

Now that we've identified the variables let's take a look at the equations we'll use (figure 2) to convert our wheel weights into the percentages that we most often talk about.

$$W = LF + LR + RF + RR$$

$$\text{Left} = \frac{LF + LR}{W} \times 100 \qquad \text{Nose} = \frac{LF + RF}{W} \times 100 \qquad \text{Cross} = \frac{LR + RF}{W} \times 100$$

figure 2

Okay, immediately we can see that if we know the four wheel weights we can calculate the percentages (this comes as no surprise I'm sure). At this point, I want to make a statement that may or may not be obvious: for any four wheel weights there is one and only one corresponding total weight and set of percentages; if we change any or all of the wheel weights then at least one of the calculated variables will change, be it the total, nose, left, or cross. The reason I state this so plainly is that it is very tempting to believe that not only are percentages important but so are the actual wheel weights themselves. The point I'm trying to make is that the two, be it wheel weights or be it the total and the percentages are exactly equivalent; any change in one will cause a change in the other. Where this shows up most often is when a racer will desire not only a given set of percentages but also a particular wheel weight relation as well. Sometimes they will be unable to get it and keep the percentages where they want them to be. In the end, the reason is that the two are conflicting and it is impossible to get both.

Just as we can measure the wheel weights and calculate the total weight and percentages, if we know what percentages we're looking for and at what total weight we can also calculate the wheel weights from this using the following equations (figure 3):

$$RF = 1/2 \times W \times (\text{Nose} - \text{Left} + \text{Cross})$$

$$LF = W \times \text{Nose} - RF \qquad LR = W \times \text{Cross} - RF \qquad RR = W - LF - LR - RF$$

figure 3

Hopefully by this point we're beginning to see that we can use percentages or wheel weights interchangeably since knowing either we can calculate the other.

Now that we have all these equations what to we do with them? The first thing we'll point out is that there isn't much need in using both to describe our setups. My preference is to use percentages for two reasons. The first is that percentages are used by most karters and most people have a good feel for normal percentage ranges. The other reason is that percentages won't change nearly as much over the different classes and weights as the actual wheel weights do. This also makes it easier to communicate effectively through a consistent method.

In order to better understand the relationship between the wheel weights and the total weight and percentages, let's run through some examples of a couple of the relationships on which some karters rely. We'll start with getting the LF to weigh the same as the RR. If we want this to be true then we can do some things

with our equations to see how this wheel weight relationship affects our percentages. Before we do this we need one more equation. If the nose percentage is the weights of the front tires divided by the total then the rear percentage is the weights of the rear tires divided by the total. So then, the rear percentage is:

$$\text{Rear} = \frac{LR + RR}{W} \times 100$$

Given this, let's use the fact that for this wheel weight relationship we want the LF = RR and plug this into our equation for left side percentage. Substituting RR instead of LR (which we can do if they're both to be the same), what we get is as follows:

$$\text{Left} = \frac{RR + RR}{W} \times 100$$

You can see that part of this equation to the right of the equal sign is identical to the right portion of the rear percentage equation.

What this means is that if we want our LF and RR to weigh the same then our left and rear percentages must be equal.

As a quick reminder, the rear percentage is 100 minus the nose percentage so we don't have to calculate it separately if we already know our nose percentage. Realize that we have not discussed cross, chassis design, class, track bite, tires, air pressures, class run, driver height or weight, or any other parameter. If we want the LF and the RR to weigh the same then all we need is for our left and rear percentages to be equal. We can get this with 60% rear and 60% left, 40% rear and 40% left or any other percentage. We also see that our cross will have no effect on it on obtaining this wheel weight relationship.

The next relationship we will look at is really an extension of the one above. This time, though, we will add the constraint that not only must the LF and RR weigh the same but they each must weigh the same as the RF. We've already seen what is required to get the LF and RR weighing the same and that remains the same. Let's look at what the RF having to weigh the same as the LF and RR means. To do this let's utilize the fact that the RF and RR must weigh the same and take our cross equation and substitute RR for RF.

What we end up with is this:

$$\text{Cross} = \frac{LR + RR}{W} \times 100$$

We again notice that the right portion of this equation is exactly like our equation for the rear percentage. What this means is that our in order to have our RR weigh the same as our RF we must have our rear and cross percentages equal. Finally, we see that if we want our LF, RF, and RR to all weigh the same then our rear, left, and cross percentages must all be the same. Again, this will be true regardless of anything else about our setup, the track, tires, class or anything else. One final note with respect to the equations which may not have been obvious is that regardless of what the LF weighs, if we want our RF and RR to weigh the same then all we need is for our rear and cross percentages to be the same; this remains true whether we want the LF to weigh the same or not.

I apologize for having to go through the equations and do the algebra but hopefully by now we understand a little about how to get good wheel weights on the scales and also the relationship between wheel weights and the total weight and weight percentages. We have also hopefully helped demystify a couple of the relationships that we may have heard or read about in various locations. This will prove a good foundation for our further discussion next month where we will look more in depth at nose, left, and cross percentages and what drives them.

See you next month with part 2...