3 Weight Transfer

In my opinion, this is the most important chapter of the book because almost every chapter after this one is related to this chapter. Take the time to fully understand it.

Corner speed is where the race is won and corner speed is made with the correct amount of weight transfer at the correct time and the result is the correct amount of grip on each tire. The concept is simple but the execution is something else altogether. So, basically…

When riding a bicycle, you can make a turn by barely turning the handlebars if you shift your weight and lean to one side - that's a simple example of weight transfer. A speedway kart is designed to carry a large percentage of its weight (usually 55%-60% depending on the driver and chassis) on the left side tires because we race on oval tracks and we're turning left.

A chassis is designed to turn left and it's done in several ways. One is by locating the heaviest part of the kart, the driver, to the left of the kart's center line. The rear of the kart's frame is completely different from side to side with the right rear corner of the frame stiff and the left rear corner "soft." Soft, meaning that there isn't a lot of tubing to stiffen it so the chassis flexes a lot in that area. Each front tire is adjusted to different angles using the chassis, caster blocks, Heim joints, and spindles to shift weight from one corner to the opposite corner. A chassis transfers weight in the shape of an "X" and that's important to understand. For instance, if you lower the right front spindle one washer in relation to the frame, you actually increase weight to the right front and the left rear tires while decreasing weight on the left front and right rear tires.

Let's talk more about the "X". Imagine a wobbly four-legged table; wobbly because one leg is shorter than the other three. It's a little annoying because it's rocking back and forth while you're trying to eat your lunch but… look at it closer. If you balance the table, only two legs are touching the floor so the entire weight of the table is on those two legs. Now grab a couple of sugar packets off the table and slip it under the too-short table leg. Too many packets and you're back to the same problem - only now the table's weight is on the opposite legs because you "lengthened" the short leg with too many sugar packets. See how the "X" comes into play? Whatever adjustment I've made to one corner of the table affects the opposite corner. Your chassis is affected the same way. Now that you understand the "X", let's look at the way the "X" affects a chassis during weight transfer on the track.

Let's assume you're traveling down the frontstretch in a perfectly balanced 350-pound kart and it's time to start the turn-in into turn one. Let's breakdown what happens, step-by-step, as the steering wheel turns left from the center and begins a chain reaction of events. Keep in mind: Weight transfer involves increasing weight and decreasing weight at different points but the sum never changes. If you have a kart handy, it will help if you go through these steps with a kart but set it on the ground, and it'll make more sense. Sorry, but you'll have to flip to the next page to view the figures but I wanted to keep the graphics on one page so they're easier to compare to one another. Each figure has a diagram showing the turn, the line taken through the turn, and an arrow showing where the action in that specific graphic is taking place.

1. Corner entry. ***See Figure 1.*** The steering wheel will turn twice throughout the turn - from center to the left and back from left to center. The first slight turn of the steering wheel forces the Pittman arm on the steering shaft to swing right pulling the left tie rod and left front spindle arm with it. The left front (LF) spindle rotates on the king pin and the LF tire's leading edge will move left, backward, and down all at once. At the exact same time, the right front (RF) spindle rotates on the king pin and the RF tire's leading edge turns left, forward, and up all at once. Think back about the table. By turning the steering wheel, you just lowered the LF tire (in relation to the frame) and raised the RF tire which resulted in increased weight on the LF tire and the right rear (RR) tire (remember the "X") while decreasing the weight on the RF and the LR. The weight of the kart didn't change at all - it's still 350 pounds - but the weight has diagonally increased on the LF and RR tires and decreased on the RF and LR tires. The total weight of the kart can't change, but its location can. ***Summary:*** *LF and RR weight increase as RF and LR weights decrease.*

2. Center of turn one. ***See Figure 2.*** The kart has begun turning deeper into the corner so now centrifugal force begins to move weight from the left side tires to the right side tires. Since the LF has already traveled back and down and the RF has traveled forward and up, the weight transfer from left to right will force the RF tire to load and the left rear (LR) tire will begin to unload weight as the chassis "teeters" on the LF and RR tires. ***Summary:*** *Right side weight increases. Left side weight decreases.*

3. Center of turns one and two. ***See Figure 3.*** The kart has reached its full weight transfer and at this point, maximum grip is being planted on both right side tires. This is where the driver will feel the kart "pivot" and it has begun to accelerate off the corner. The LF tire is, at this point, is barely touching the track. On some high bite tracks, the LF tire may leave the track surface. The LR tire is as light as it is going to be through the turn but that's about to change in a split second as the steering wheel begins its turn to the right. ***Summary:*** *Right side tires are at maximum weight while left side tires are at their lowest weight.*

4. Center of turn two. ***See Figure 4.*** As the steering wheel begins turning right, back toward center, it this causes the LF tire to travel up and forward as it straightens while the RF tire travels down and backward as it straightens. As you may have guessed, the weight on the RF and LR tire increases. This is where the RR tire transfers weight back to the LR tire and drives the kart off the corner. ***Summary:*** *The LR and RF weight begins to increase while LF and RR weights decrease.*

5. Corner exit. With the wheel straight again, the kart is back to its static weight. Tire stagger, camber, and left side weight will still pull the kart to the left even though you're traveling in a straight line. That's normal - but you have to give up some straightaway speed to be fast in the corners.

Hopefully, I didn't lose you there but that's the basics behind weight transfer. Unlike race cars, a kart doesn't have suspension but the kart's frame acts as a spring itself and that's where the weight transfer magic happens as it flexes. Regardless if it's a speedway kart or a sprint car or a Formula 1 car, physics never change. We'll go deeper into handling in chapter 32, *Handling Tips*, and that will give a better understanding of how and when to make changes that affect weight transfer - but you have to nail the basics down first.

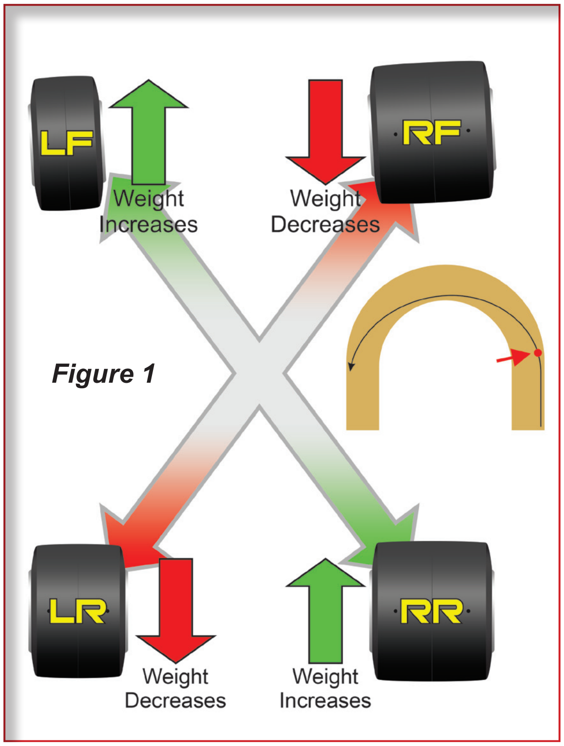


Figure 1

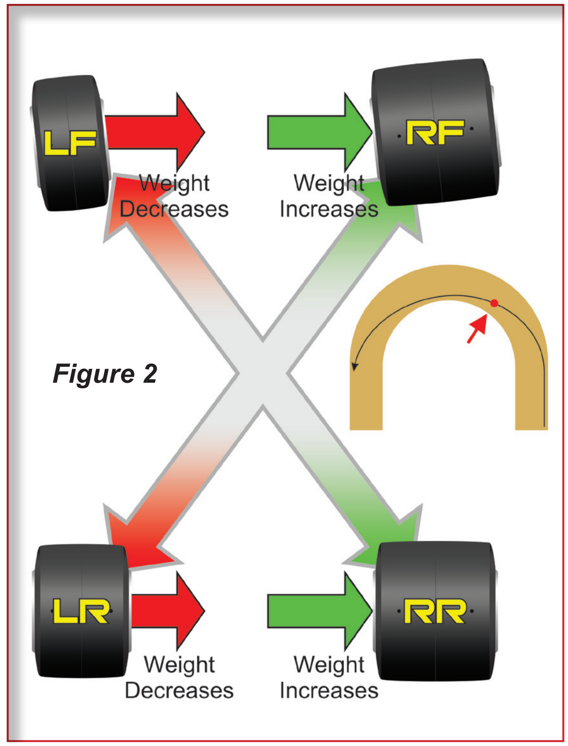


Figure 2

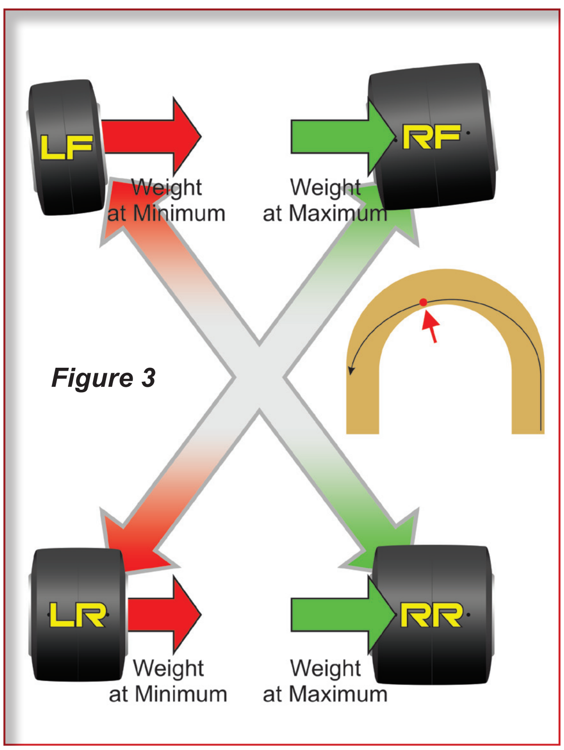


Figure 3

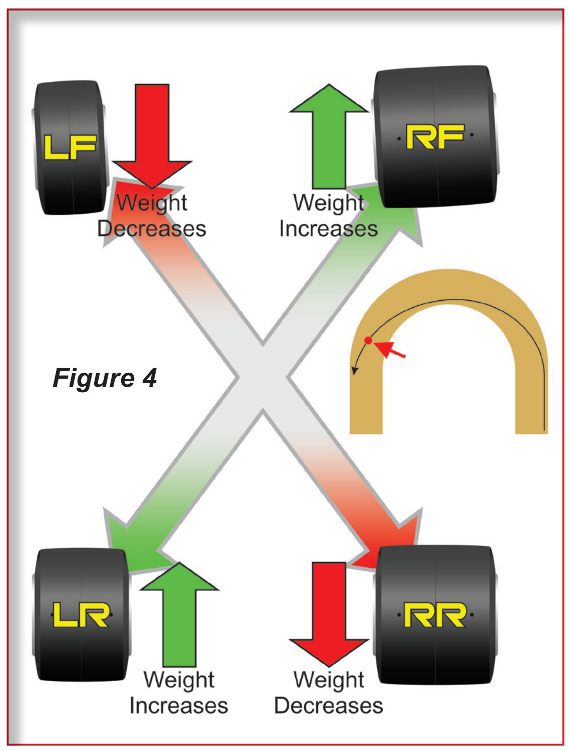


Figure 4

4 The Frame

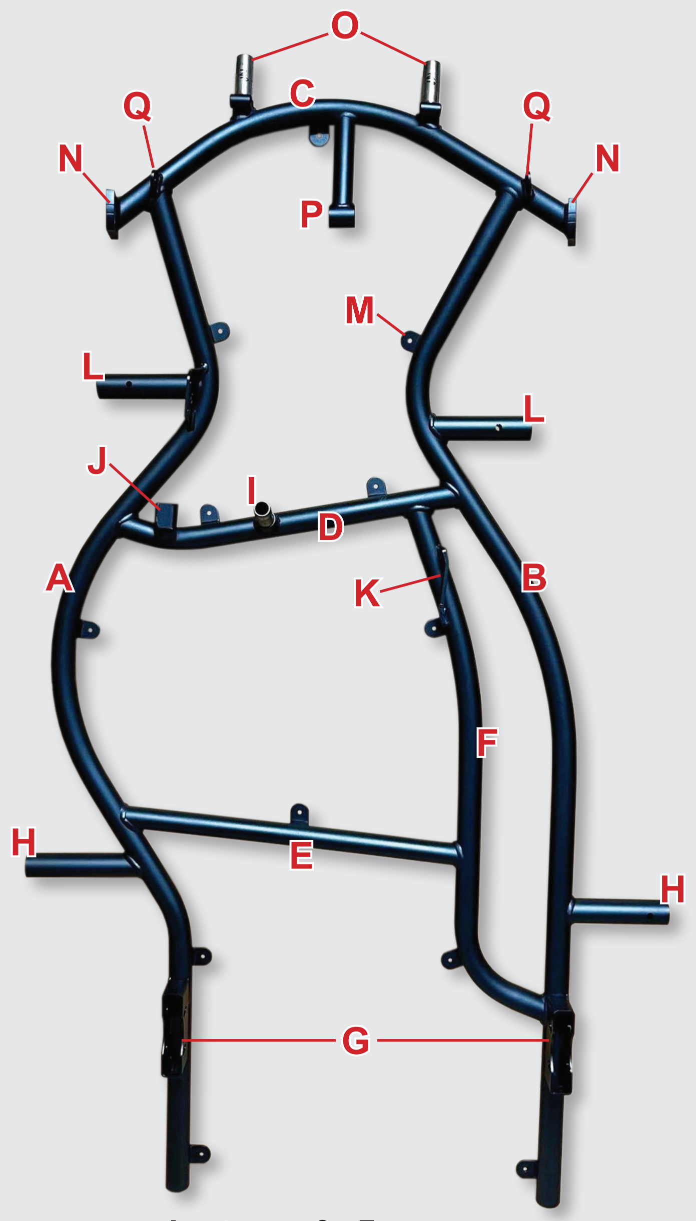
The frame holds it all together. There are thousands of parts that make up this racing machine and all are attached to the frame directly or indirectly. That's important to remember because the frame also serves another very important function - it is the only form of suspension in the kart aside from the tire's sidewall. It may appear as a collection of stiff, unyielding tubing, but in racing form acts as a big spring, flexing and twisting - individual tubes mated in a collective symphony. It's important that the frame performs exactly the way it was designed to so overall chassis assembly is critical. If not assembled correctly, the frame's ability to flex properly is affected.

The frame determines tire location in relation to each other, where the greatest amount of weight is located (the driver), where the engine mounts, and with tabs, tubes, and other projections to insert or bolt all of the other components to the frame. But, at the heart of the speedway kart, there's very little, if any, adjusting that can be done to the frame itself.

Most frames are made of chromoly 4130 and each manufacturer has a certain mix of tubing, whether it's tube diameter, wall thickness, or carbon content. It's their own special recipe that makes up the frame allowing it to flex at different points and rates to transfer weight when, how, and where they want it to. How the tubing is bent affects its ability to flex. Straight tubing flexes the most while a bend makes the tubing stiffer. The harder the bend, the stiffer the tubing.

Most frames are constructed of 1-1/4" or 1-1/8" tubing or a combination of each in a variety of wall thicknesses. Some frames go even larger to 1-3/8" tubing. When choosing the frame, you should consider a few things such as the size of the track, amount of grip, size of the driver, and engine class. For example, on a small, low-bite track, a 1-1/8" tubing chassis may out perform a 1-1/4" tubing chassis because it flexes more and generates more grip. But, on the flip side, a large track with a lot of grip may suit a larger tubing frame.

The most precise chassis are manufactured with CNC machines to precisely cut, bend, and notch the tubing. Some manufacturers use tube benders, notchers, and saws to prepare their tubing for the jig. Each manufacturer then fits the tubing into a jig so the tubing can be welded by hand or, more precisely, robotically. Chassis are



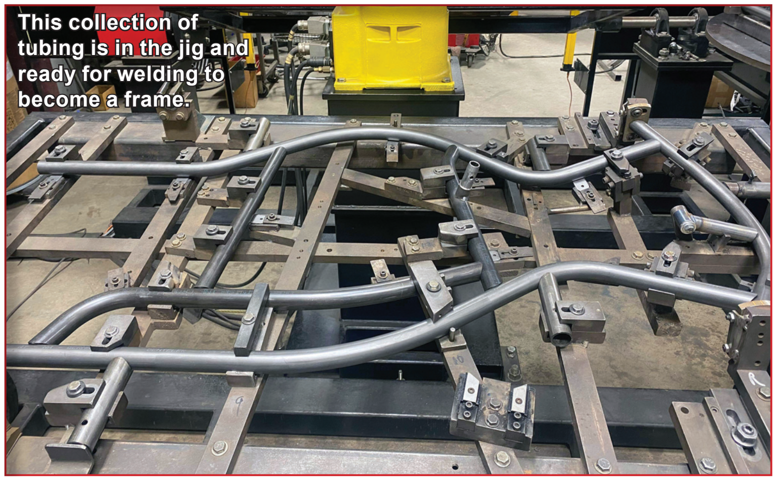
Anatomy of a Frame

A - Left side rail; **B** - Outer engine rail
C - Front axle/front "hoop"; **D** - Front seat rail; **E** - Rear seat rail
F - Inner engine rail; **G** - Rear cassette hanger
H - Rear nerf bar receiver; **I** - Steering post stud/receiver
J - Seat slide bracket; **K** - Seat bar bracket
L - Front nerf bar receiver; **M** - Floor pan tab; **N** - Caster plate
O - Front bumper stud/receiver; **P** - Lower steering shaft mount
Q - Front bumper tab

built either way, but when tubing is prepared on CNC machines and robotically welded, the precision allows little to no variation from frame to frame. That makes it easier to predict what the chassis will do under a given circumstance whether at the track with other drivers on the same chassis or if you call your manufacturer for tech support.

Once a frame is completed, it goes to a painter or powder coater for a clear coat or a splash of color. When cleaning your frame, don't use harsh degreasers or cleaners that may ruin the finish. Use a car wash detergent with a rag and elbow grease and once it's clean, a light coat of WD40 will protect it. It's a good idea to wax the frame every five or six races. For a detailed, post-race cleanup, check out chapter 33, *Post-Race Cleaning and Maintenance*.

If you're kicking around the idea to powder coat your chassis because it's looking rough, there are some things to consider. First, keep your powder coat to a single layer. Some special colors like a candy red require a base coat, then transparent red, and then clear coat. In that case, three layers of powder coat will add material to the tubing and can stiffen the frame affecting the way it was designed to flex. Additionally, three layers don't often work well together when the engine mount is slid back and forth along the frame rails and oftentimes the powder coat layers will separate and the engine mount won't seat like it should and can loosen on track. Finally, fluorescent colors look cool, but they are thick and the lighter colors stain easily and look rough after just a few races. Finally, clear coat is a good choice because you can easily inspect the frame's welds for cracks or damage and clear coat goes with any other color. Just something to think about.


This collection of tubing is in the jig and ready for welding to become a frame.


Fitted and ready to weld...


Welding complete. This was welded with a robotic welder.


A look at 1-1/4" diameter, 0.083" wall tubing on a completed frame.

5 Steering Wheels, Blocks, Locks, and Uprights

Let's optimize the operation and safety of our steering components. Before we dive in, safety is most important but there's another thing I can't stress enough - comfort. Make sure the driver is comfortable because, if not, discomfort will be a distraction on the track if the kart doesn't properly fit the driver. If the steering wheel is too high or low, too far to the left or right, strains the wrists, wheel grip is wrong… whatever it is, the driver has to speak up. If there's a concern about driver comfort, fix it! Don't be afraid to bug your driver over and over again by asking "Are you comfortable?" I've found that kids like to say, "It's okay," when it isn't. Get the driver comfortable and because being uncomfortable is a distraction.

Steering wheels come in different sizes, shapes, materials, angles, colors, yada, yada, yada. Choose a steering wheel that fits the driver. Don't pick one just because it looks cool. Steering wheels are available in various tube sizes for large or small hands, some wheels are all-aluminum and some have rubber grips - there are all sorts of designs. When starting out, a good idea is to have your driver grab a few steering wheels at the track and see what they like.

There are many different steering wheels on the market with the aluminum tube-style being the most popular. The solid-grip style steering wheel has become more popular recently because of the grips. The rubber grips give more bite for the driver's glove and because it's solid, the driver feels more vibration and feedback through the wheel. The tube-style wheels tend to absorb vibration and the driver loses some of that sensory input. Recently, we switched over to the solid-grip style wheels and my drivers immediately could tell the difference. That's just something to think about.

Let's say you've settled on a steering wheel so we'll discuss the top half of the steering shaft. At the top end, just below the splines, is a small groove in the shaft. A 5/8" snap ring goes into this groove and the purpose is to keep the steering wheel hub from being forced down the shaft in case of impact so it's an important safety item. If your snap ring is missing, damaged or just loose, put a new one on it - they're cheap insurance. It should fit tightly on the shaft.

Next, lock the steering shaft in place with the pin in the steering lock. It's normal to have a hint of play between the pin and steering lock but you don't want much. If the pin is flopping around in the lock or block, replace it. When it's time for the kart to go on scales, it's important that the front tires be locked into the same position every time using the steering lock and since consistency is critical in scaling, the steering lock is an important element in consistency. Once you have the pin in the lock, make sure the Pittman arm is perfectly vertical. If it isn't, loosen the bolt in the steering lock enough to allow the shaft to rotate within the steering lock. Adjust the shaft until the Pittman arm is perfectly vertical and then tighten the bolt in the steering lock. There should be 1/16" gap between the steering block and the steering lock to allow the shaft to move up and down in the block without the lock making contact when the chassis flexes.

Steering wheels may look the same at first glance but look and feel different from one another.

The snap ring on the steering shaft must be in good condition because it performs a vital safety function.