Evolution of the Racing Mind

LEARNING Part III

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All right, this is Part 3 of how we can learn when we test and try things on our kart (and even when we're not trying things). We started in Part 1 looking at what things we might change as ways to improve our program, we looked at when to make those changes, how to make them and began to delve into how we could measure the effects of the change. Our studies into the types of improvements we are looking for brought us to needing more accurate methods of gathering data than a hand held stopwatch can provide. This brought us to our discussion on data acquisition. In Part 1, we looked at the basic information we can get from the gauge mounted to the kart (the test gauge we used was a MyChron4 from Aim Sports). From this we learned that there is a fair bit of very important data which nearly all karters already have access to but which is probably not well utilized. In Part 2, we downloaded that data to our analysis software (Race Studio 2 in our examples) and began looking at the more powerful things we can do with the data once it's on our computer. After looking at the basic information that we'd studied on the tach and understanding how we might more easily evaluate it on the computer, we added some channels to the mix which would allow us to create track maps, split those laps into segments and look at speed traces to see where our kart is making speed and where it's losing it. We also saw a little nugget about how we can use our data acquisition to help us evaluate our clutch's performance. This month we're going to continue to look at how we can improve our racing program with our data acquisition and delve further into some of the more advanced things we can do with it.

When we left off last month, we had created a track map, split that map into segments, and we were looking at speed traces to see where the kart was gaining or losing speed. The first thing we're going to look at this month is how to take what we can learn from having our laps split into segments one large step further.

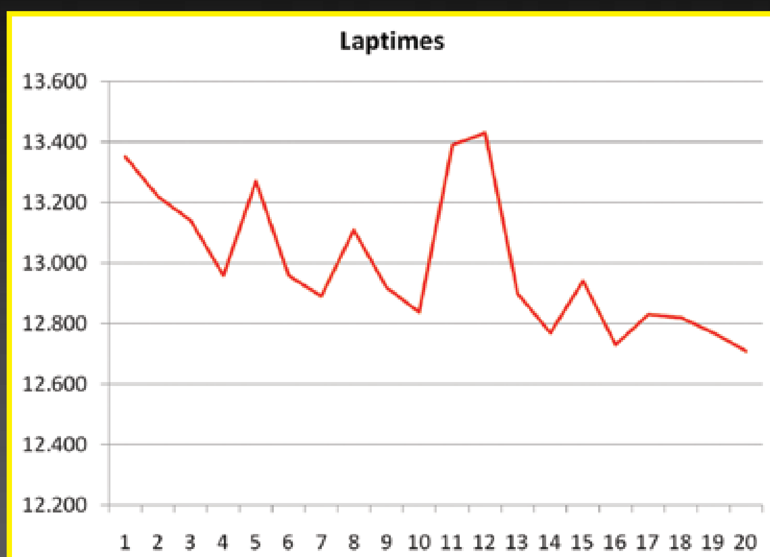

Corner speed + Consistency = Victory

Everything we've looked at thus far is very useful but what we're about to embark on is all the more so. Now that we have our map created, our corners marked and everything ready, we're going to look at a fairly simple report: the split time report. One thing I need to say about this before we dive in: this can be a humbling feature for the driver. The split report does a pretty good job of displaying the ***demonstrated*** capability of the kart. I say demonstrated because it shows us what the kart has ***actually*** done, rather than some theoretical mumbo jumbo. We'll continue this discussion after we've had a look at the actual split time report itself at the top of the next page.

	Lap	front stretch	1	2	back stretch	3	4	front stretch	total
Animal Heavy	1	0.910	2.406	2.490	1.848	2.285	2.604	0.806	00.13.350
Animal Heavy	2	0.882	2.295	2.452	1.898	2.304	2.701	0.688	00.13.220
Animal Heavy	3	0.884	2.299	2.490	1.854	2.247	2.588	0.778	00.13.140
Animal Heavy	4	0.878	2.299	2.438	1.845	2.207	2.611	0.682	00.12.960
Animal Heavy	5	0.866	2.273	2.382	1.834	2.297	2.777	0.842	00.13.270
Animal Heavy	6	0.908	2.276	2.453	1.845	2.193	2.599	0.685	00.12.960
Animal Heavy	7	0.860	2.213	2.393	1.802	2.174	2.725	0.724	00.12.890
Animal Heavy	8	0.884	2.266	2.528	1.861	2.227	2.605	0.740	00.13.110
Animal Heavy	9	0.872	2.242	2.450	1.825	2.207	2.589	0.735	00.12.920
Animal Heavy	10	0.860	2.234	2.405	1.807	2.131	2.664	0.740	00.12.840
Animal Heavy	11	0.870	2.209	2.510	1.902	2.215	2.979	0.704	00.13.390
Animal Heavy	12	0.928	2.478	2.476	1.838	2.236	2.641	0.833	00.13.430
Animal Heavy	13	0.916	2.279	2.399	1.829	2.148	2.615	0.714	00.12.900
Animal Heavy	14	0.862	2.189	2.447	1.815	2.142	2.647	0.668	00.12.770
Animal Heavy	15	0.870	2.319	2.462	1.845	2.165	2.613	**0.665**	00.12.940
Animal Heavy	16	**0.854**	2.192	2.387	**1.788**	2.131	**2.567**	0.811	00.12.730
Animal Heavy	17	0.875	2.249	**2.380**	1.818	2.187	2.585	0.736	00.12.830
Animal Heavy	18	0.859	2.202	2.428	1.828	2.122	2.667	0.713	00.12.820
Animal Heavy	19	0.859	2.222	2.406	1.818	**2.096**	2.695	0.675	00.12.770
Animal Heavy	20	0.862	**2.163**	2.381	1.804	2.135	2.573	0.792	00.12.710
minimum value		0.854	2.163	2.380	1.788	2.096	2.567	0.665	
maximum value		0.928	2.478	2.528	1.902	2.304	2.979	0.842	
average value		0.878	2.265	2.438	1.835	2.192	2.652	0.737	
std deviation		0.021	0.075	0.046	0.029	0.061	0.095	0.056	
Theoretical best lap									
Animal Heavy		0.854	2.163	2.380	1.788	2.096	2.567	0.665	00.12.512
Best rolling lap									
Animal Heavy	15							0.665	
Animal Heavy	16	0.854	2.192	2.387	1.788	2.131	2.567		00.12.583

What we see is every lap which was run in the outing, in this case - a race. I've done a little formatting on the raw output from the Race Studio software to help it all fit on the page of the magazine but if you look at the information, it'll look near enough like this table to readily identify everything. What we have is the name of the race, the lap, the time taken to cover each part of the lap (end of the frontstretch, turn 1, turn 2, the backstretch, turn 3, turn 4 and the beginning of the frontstretch) and then the total lap time. As you can see, our fastest lap time was a 12.710 which we turned on the last lap of the race. Looking at the table you will notice that I've made some segments bold red. These represent the minimum segment time for the given segment. Just so everyone is on the same level of understanding we'll do some review. In our last article we talked about how we can create a track map (as long as we have a lateral G sensor or GPS unit) and how we can split that map into segments. We then split the track into seven segments: the end of the frontstretch, turn 1, turn 2, the backstretch, turn 3, turn 4 and the beginning of the frontstretch. When we split the track into segments we saw that the speed trace vs. distance would show us the individual segments so we could look at the specific locations of where our kart was carrying more or less speed. This report is another tool we can go to once we have created a track map and split it into segments.

The first thing we're going to look at is the chart to the right of how the lap times progressed throughout the run:



The first thing we notice is that the kart got continuously faster thoughout the run and was it's fastest on the very last lap. Understanding this along with what the kart drove and felt like there is one thing that becomes obvious: I hadn't worked the tires quite hard enough for the conditions. If I had worked the tires a bit harder the kart would have started out faster and probably leveled off relatively more quickly and at a faster overall laptime. This is a piece of information that we covered back in part one when we discussed laptime evolution but I included it here because it's an easy export from the split report into Excel or some other spreadsheet to create this little line chart which makes seeing the evolution of the kart all the more easy.

Now that we've seen that little tidbit; let's delve back into the split report. If we look at the main body we'll see the amount of time we spent in each individual segment of the track on each lap. Don't worry too much about all of the individual segments; what we're going to look at is the ones which are highlighted (in this case, in red). Also, if we look at the first row underneath the lap segments we'll see the minimum segment times which are exactly the same as those highlighted in red; we'll come back to those minimums. The next row is the maximum segment times which we won't look at very much but the very next row is an interesting row. It shows the standard deviation of each segment. Don't worry about the actual equations or definitions of what standard deviation is; just remember this: if every time for a particular segment was exactly the same the standard deviation would be zero. This is unachievable but is still the goal; it would represent a perfectly consistent kart and driver. So then, we can look at the standard deviation and identify how consistent we were able to run each segment of the track. I can tell you that the standard deviation on those laps is a bit excessive. The reason in this case is that I hadn't ridden in three months and this particular track is a driver's track. Remember when

I spoke of the split report being humbling; well, here is where it starts. The standard deviation will tell the tale on how consistent a driver is able to navigate each segment of the track. If all of them are up (as is the case here), then we'd say the driver needs to get up on the wheel. However, what might we say if everything was good except for one or two segments? One thing it may be telling us is that our kart isn't able to produce the bite or balance necessary to really inspire confidence in the driver and this information could be very important as not all drivers may be able to notice such small issues.

If we move further down from the minimum segment times and standard deviations we'll see yet another piece of information: the dreaded "Theoretical Best Lap". This is the total lap time that we'd have obtained if we had actually been able to link our fastest segment times into a single lap. Realize here that this isn't a purely theoretical exercise because our kart *actually produced* each one of the segment times at some point during the race. What we see in our example is the open fisted slap in the face that our fastest *demonstrated* segment times yielded a lap time of 12.512 seconds. You may recall that this is ***two tenths of a second faster than the best lap time which we achieved!!!*** Is there anyone out there who wouldn't like to gain 0.2 seconds? And the cost of this is…working with the driver.

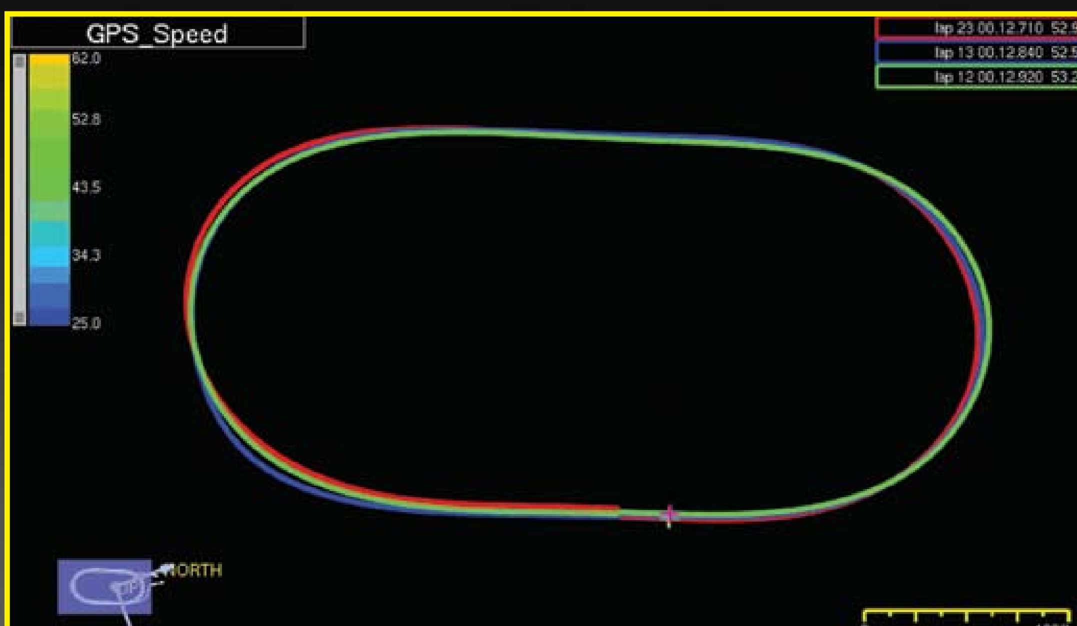
Once we've been broad slapped across the face with the theoretical best time, let's back up a step and look at the fastest rolling lap. The fastest rolling lap is the fastest lap that we achieved starting with any segment on the track and continuing through the next seven segments. The difference between this and the theoretical best lap is that these segments had to fall in order. Again, we see a large difference between the demonstrated best lap (the 12.710) and the best rolling lap of 12.583. Still, this tells us that we ***actually strung together seven segments which were a full 1.5 tenths of a second faster than we achieved between the track's scoring system.***

Let's put all this into perspective. By looking at the split time report we first saw that our lap times were constantly improving which, along with some good track notes, confirmed that we hadn't worked our tires quite hard enough. We next noticed that our consistency wasn't quite what we'd like it to be from our standard deviations. And finally we realize that beyond the shadow of any doubt, we left a tenth and a half of a second per lap on the table. Realize that we don't ***think*** we did, we ***know*** we did. One last tidbit, the fast time of the race was a 12.587. Given this, our best rolling lap was enough better to give us fast time and our fastest theoretical lap was enough to add a half a tenth pad to that fast lap. The moral of the story here is this: there wasn't a kart problem and although there was a tire problem; the biggest problem was the lump sitting in the seat. I cannot say how many times I've heard complaint after complaint about motor, chassis, etc. when all the time it was the driver.

But wait; what might we see if the driver was getting it done? Let's look at the chart below with data from a different track with a different driver:

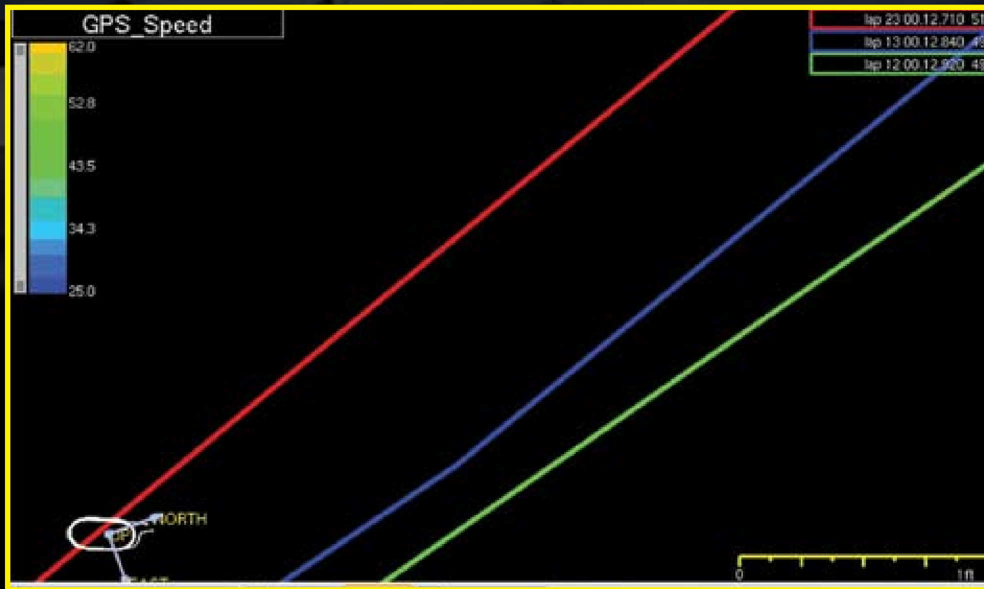
		Frontstretch	1	2	Backstretch	3	4	Frontstretch
Standard Deviation		0.035	0.129	0.193	0.077	0.071	0.062	0.053

You'll notice that the standard deviations at this track are nearly as big or bigger than those in our first example but the segment times are much greater too because the track is much longer; thus, we'd expect larger variations. One thing you may notice is that the deviation on the backstraight and turns 3 and 4 are very similar but those in turn 1 and 2 are much larger. In this case the issue was that the kart wasn't biting in 1 and 2 as well as it needed to and that condition created difficulty for the driver. So then, not only can we see when the driver isn't getting it done but we can also see if there are any locations which stand out which might be caused by the tires, setup, or chassis.



There's one final thing I want to have a look at before we finish this series on data acquisition: the power of GPS. Up until now, everything we've looked at could be done with the basic gauge (in part 1) or with a gauge equipped with *either* a lateral accelerometer and speed sensor *or* a GPS unit. This last thing is only available to those with GPS. The figure at the bottom of page 24 is a screen shot taken from Race Studio which displays the actual line that the kart followed on three laps: 12, 13, and 23. What we're going to look for is any difference in the line taken by the driver which might have yielded a lap time difference.

The first thing we see are three colors: green for lap 12 (12.92 seconds), blue for lap 13 (12.840 seconds), and red for lap 23 (the fastest lap, a 12.710 seconds). This view is zoomed out so we can see the entire track; we'll zoom in later to demonstrate just how accurate the gauge is. What I noticed is that on the good lap I turned into turn one a tad higher but pulled the kart lower at the apex and ran off the corner lower. Then, getting into turn three I again turned in higher, this time by a fair bit, but remained higher through the apex leading to a low corner exit. The importance of this information cannot be overstated! If I had taken the time to look at this data at the track before my last race I might have picked up a tenth per lap simply by choosing a different line through the corner. If this information is this telling for an adult racer, just think how much more critical it could be in teaching a purple plate racer about driving lines and their effects on lap times.



One last tidbit just to demonstrate how far we can zoom in is by looking at the figure above.

This, before the apex in turn one, view is shown from above. You may notice that the scale shows one foot which means that the difference between the lines is between 3 and 6 inches each. This resolution allows us to analyze with a fair bit of accuracy if we need to do so. One last word: driving a kart is high precision stuff. Imagine hitting a line with two inch precision at 60 mph - not an easy thing to do 20 consecutive times.

By this point I hope everyone is beginning to get a glimpse of just how much can be learned if we are able to capture additional data about our kart's performance on track. Realize that the possibilities go far beyond what we've looked at and that for $1,000 or less we can collect every piece of information we've looked at in all three of these articles (and there was a wealth of info we looked at in the first one which we probably already have the equipment mounted on our karts to collect).

Now that we understand when to test, how to test and how to evaluate our tests, let's ***go test!***