Getting serious about data

If you really want to get serious about using data and video to improve your driving, you need to step up to a real camera and track oriented data acquisition tools.

Many professional teams use high-end MoTeC and Cosworth Pi integrated systems to monitor their drivers and their car setup but there are very affordable data logging tools from AIM Sports, Traqmate and RaceLogic for DE and track day use as well.

MoTeC and Cosworth are in another universe in terms of capability and price and is used by the Porsche and other professional factory teams. To give you some idea of how much sensor data can be captured in a system like MoTeC, you need to look no further than an F1 car way back in 2013. A McLaren Formula 1 car transmitted, in real-time, over 15-20MB of telemetry data, PER LAP, from 150-160 sensors. That's a lot of zero's and ones! Since that time, the number and speed of real-time sensors in cars has exploded. The Porsche 918 logs over 40,000 types of powertrain data every fraction of a second through its myriad of ECUs - and it's a street car!

For DE, I think it comes down to three categories.

1. Learn what you can do as a driver to be quicker
2. Find the fastest way around the track
3. Experiment with simple "setup" tweaks with tire pressure, sway bar adjustments and shock tuning

True car set up is fascinating subject but well beyond the intent of this article; let's just concentrate on finding the fast way around the track and improving technique and consistency.

The fast way around the track deals with questions like:

- What is the fastest line around turn 2 and 3?
- Should I shift to 4th at the end of the straight or just redline 3rd?
- Does running to redline in each gear give me the fastest terminal velocity at the end of the straight or does shifting 500 RPMs before redline produce a higher terminal velocity?
- What was my best braking point and turn in speed that resulted in a quicker segment and overall lap time?
- Is the time I loose "compromising" the left turn at Lime Rock Park worth what I make setting up the right-hander going onto NoName straight?
- Should I charge into the Bus Stop at Watkins Glen or should I concentrate my efforts on maximizing exit speed?

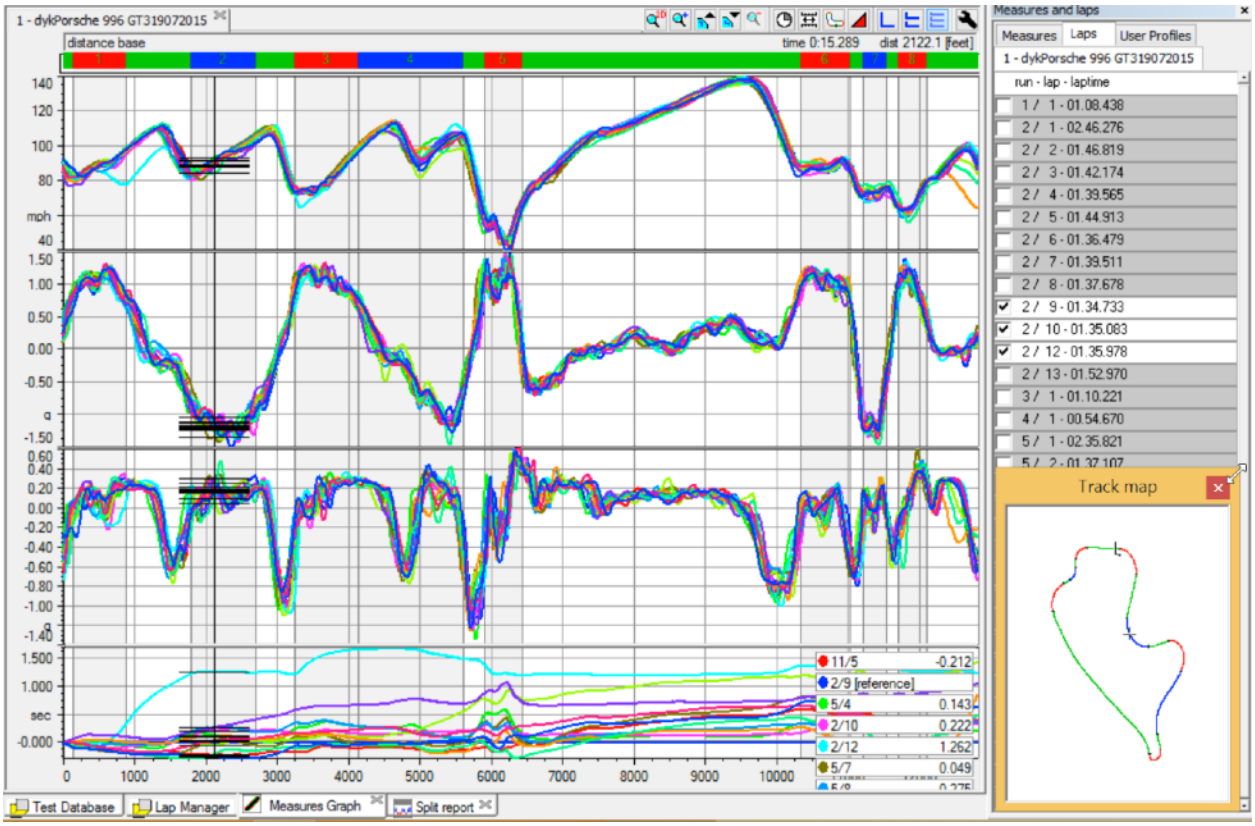
What can I do as a driver to be quicker?

- How consistent am I driving?
- How smooth am I driving
- What is my braking efficiency?
- What is my maximum cornering and exit speed?
- Am I maximizing transition from braking to turn-in, to track-out
- Am I "coasting" where I could be accelerating?

Data alone is fascinating, but it really comes to life when you "mash-up" your video and a running commentary from inside the cockpit as you try different approaches.

Learn to talk to the camera to produce your own play by play annotated video with the technique you were trying. After the run group, you can simply review the data to see if it “worked”. I’ll walk you through a simple approach to "data" that can help you become a smarter, more consistent and quicker driver.

Step 1 - Start Simple!



Look at the “Etch-a-Sketch on acid“ graph above; crazy isn’t it? Today’s tools are so capable, you can log and chart just about anything. The trick is learning to only look at what you need.

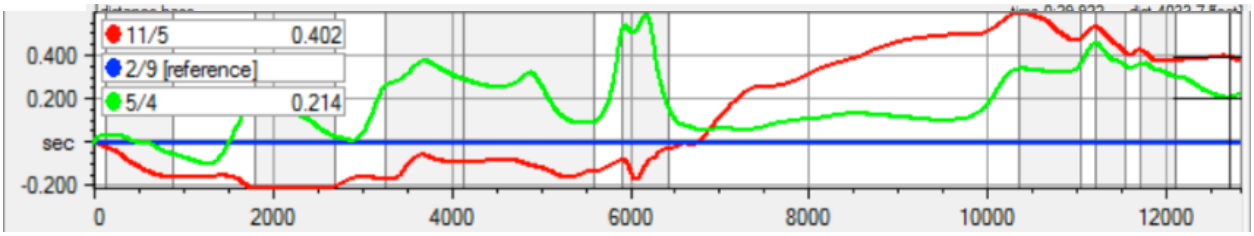
After a session, decide the turn, track segment, or skill you are targeting for improvement and then just select the data that supports the questions you are asking. In basic driver analysis, start with three data inputs; speed, lateral, and horizontal G-Force. With just these three inputs the software allows you to look at graphic representations of consistency, smoothness, braking, and corner entry and exit speeds. I will be using AIM’s software, but the same applies for MoTeC, TrackMate, RaceStudio and others that offer segment times and squiggly line capabilities.

The first thing to look for is your consistency in lap times with the basic lap time or split time report. The split report allows you to quickly spot the area you can make the up the most time and key laps to focus on. Unselect all the default sensor data inputs leaving just the three I mentioned. Throw out the outliers laps. It doesn’t help to try to analyze every lap in the entire

run session. Later you can set up additional inputs to analyze a specific skill in more detail like, pedal pressure, steering angle and GSum and “coasting” alerts. The AIM software requires you to run the Split report to calculate a summary cumulative time window for the “Squiggly Lines” Measures Graph above, so I always do that first. Just select the Split report from the main menu and AIM will automatically populate your dataset and update the Measures Graph.

All good track analysis will create segments so you can quickly compare each straight, braking zone and corner selectively. The split report creates a critical view shown in the bottom pane showing comparative deltas in cumulative lap times. You can jump directly from the calculated split report window Measures Graph window, or look at both by sizing each window. I know this all sounds overwhelming, so I will walk you through the sequence below.

For this example below, I have selected three laps represented in the graph below. The software has determined the blue line, lap 2/9, which represents my “fastest” full lap and created the flat blue reference baseline. The red and green lines represent the delta from the fastest lap. Any lap trace point above the baseline means I am “behind” in lap time and any trace below means I am “ahead” of the reference lap time. All three laps were within four-tenths of a second of each other. In fate full screen the headers top green-red-blue banner bar shows right turns (red) left turns (blue) and straights (green). In the graph itself the gray and white background areas highlight where the software has used lateral acceleration determined where the car was loaded in a turn or on a straightaway. Now, you want to focus on where the lines separate and where they converge and start to investigate why. All split time reports will automatically break the



circuit down into segments and calculate comparative split times highlighting the fastest segment and the variance in each lap. Most will produces your theoretical fastest lap by combining all you fastest section times into one great lap. It’s not there just to frustrate you and I will discuss it later as a way to measure improved consistency. For now, I want to find how I gained time, and how I lost time and most importantly, why.

I typically look at the Min-Max values and std deviation for the laps selected. Consistency is critical so look for large values in std deviation. The example above draws my attention to segment 3.
The highlighted segment 3 is the infamous Mosport turn 2a2b. In this turn, across all the laps, there was a significant difference between my fastest and the slowest laps with a high std

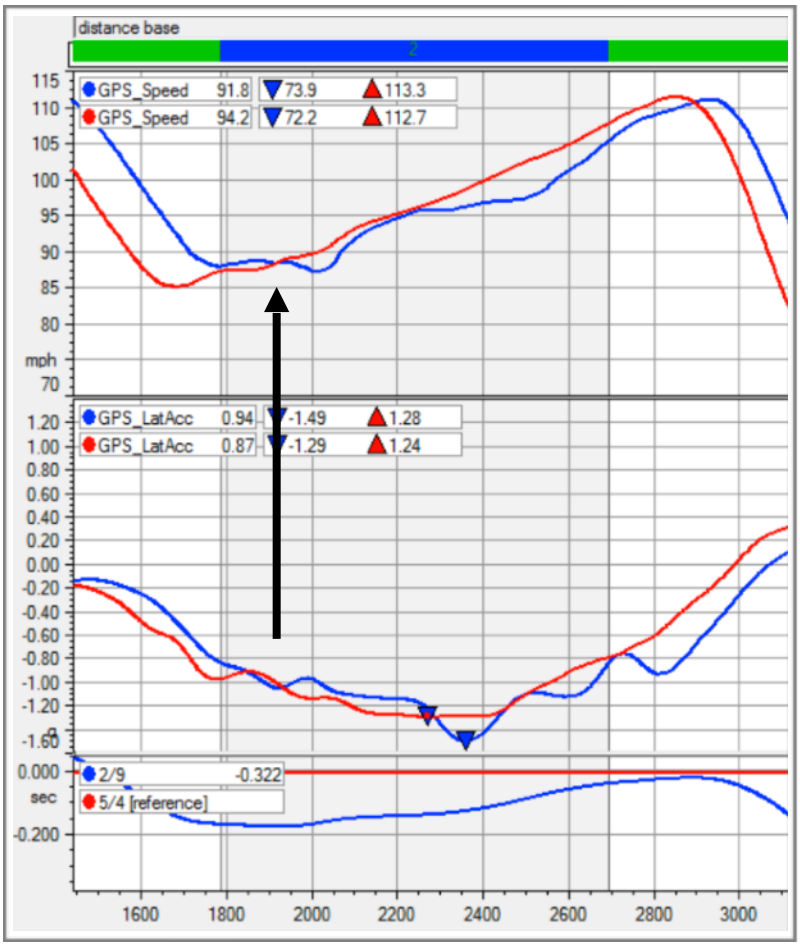
minimum value	0.960	5.630	6.142	6.485	3.574	7.025
maximum value	1.011	6.049	7.238	6.866	3.834	7.370
average value	0.978	5.732	6.299	6.715	3.705	7.207
std deviation	0.016	0.124	0.289	0.130	0.072	0.107
Theoretical best lap						
dykPorsche 996 GT319072015	**0.960**	**5.630**	**6.142**	**6.485**	**3.574**	**7.025**

deviation. 2a2b is a very fast downhill sweeping turn with a compression on the exit. You commit at the turn-in and hang on and hoping the mechanical grip shows up when the car compresses and grips just past the apex; it's a very intense turn. I made it through a couple of times faster than others, so let's see if we can figure out why.

From the Split Report, I would then open the tab for the Measures Graph (aka, squiggly lines) and zoom into just that turn, just for my fastest laps.

For simplicity, I will only show two laps represented by the blue and red lines to make a point.

Was it a higher entry speed or higher cornering G-Force or exit speed that gave me a faster time? The data tells the story.



In this view, the top graphic tile is GPS Speed scaled in MPH. The second graphic tile shows left and right lateral G-Force and the bottom tile is the accumulated time with the X-axis showing distance in feet for all three.

The blue 2/9 lap in the top graph shows that I broke later gaining two-tenths of a second on the 5/4 (red) reference lap time. Now look at the second graph that shows lateral G-Force and focus in on the blue line just before 2,000 foot X Axis. Can you spot where the blue line rises on the vertical Y-Axis showing a loss of lateral traction?

Now, look directly from that point straight up to the top GPS_Speed graph. Can you see the loss of acceleration? This highlights a significant steering correction at 1,900 feet. I can't pick up the throttle until I have the car back underneath me, which looks like 150 feet later when blue and red lines in bottom graphic start to converge. You can also see by the oscillating blue LatAcc line in the second graph that I'm chasing the chassis almost to the exit of the turn.

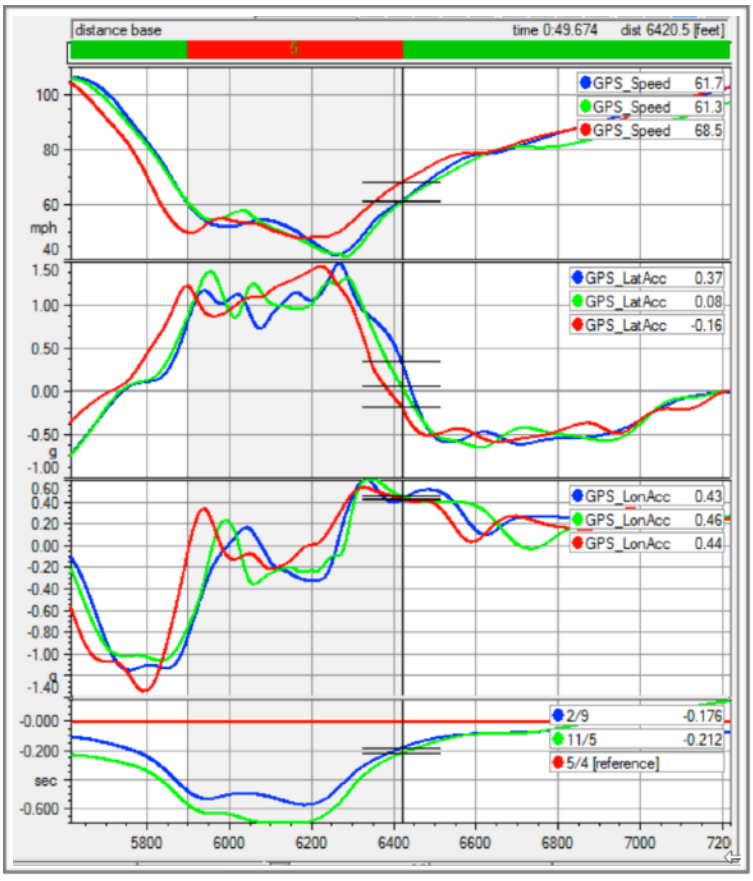
Now focus on the red line in the top graph. I broke earlier, set the car and immediately and I could get smoothly and progressively back into the throttle. The car took a solid set in the downhill section of the turn and it steadily increases speed shown by rising red line in the top

graph. You can also tell that chassis was “set” by the smooth LatAcc red line in the second graph. Finally, look at elapsed time graph on the bottom. Almost all the time I gained by charging the corner I gave up mid corner to exit. Smooth transition into the corner, steady mid corner and fast out is the faster approach, with a lot less drama. This is where data tells the true story.

The blue lap sure felt fast with a later braking and all that drifting and sliding through the corner, but the data does not lie. In this case, a little slower in, setting the car early and acceleration throughout the turn was within .019 seconds of the late brake entry without the heart palpitations and cold sweat. This hints that the fastest way is somewhere in between the two. I would then bring in RPM data so I could calibrate my entry speed more precisely by glancing down at the tach next session out. I can also go back and run each lap’s video's side by side or zoom into the GPS track map and plot the two traces and see if my actual line was different. You just can not do this level of analysis with Harry’s or video alone.

That’s an example of just one turn, in one session. Next time out I could come up with a new strategy to work on this turn using this insight.

Let’s look at another point on the track, turn 5. Turn 5 should be the most important turn to get right because it leads to the longest straight. Turn 5 requires threshold braking leading into a double apex turn with the first apex situated on the crest of a hill and the second apex dropping downhill. This time, we will add in the LogAcc graphic tile to look at braking as well as cornering G-Force.



In this segment my fastest reference is lap 5/4. The top graphic tile shows I entered the turn slower. The third graphic highlights my braking, which is earlier and more aggressive. The bottom tile shows the time I gave up on entry. But like turn 2, I was able to get back to the throttle earlier as you can see by the red 5/4 LonAcc in the third tile and my exit speed was 7 MPH faster in the top graph exiting the turn onto the longest straight.

That better line off the second apex gave me a higher exit speed that allowed me make up for the lost time entering turn 5 and gain another 00.34 seconds to the braking zone at the end of Mario Andretti back straight. A 0.34 seconds gain equals approximately 60 feet, nearly 4 car lengths.

The fastest time through Turn 5 didn't translate to the fastest time down the long back stretch, the fast exit did. This is another example of me "overdriving it" going in, and then paying for it coming out might feel fast, but it isn't. This is the classic "compromise" turn complex with the goal to maximize exit speed for on the long straight. Now go out and practice but remember, keep it simple and work on no more than two turns and one or two techniques in each run session.

A real eye opener for me in seeing the potential of data happened this past year at Monticello Motor Club. We have two very young and very fast, professional drivers that were both driving the same Porsche 2.7 Cayman and posted laps times consistently within two-tenths of a second to each other. That is on a 3.8-mile circuit with 18 turns. One young gun was a hard charging, late brake artist. The other used an earlier and lighter brake pedal with significant trail braking. One liked to create oversteer on turn-in with a small "lift" to rotate the car, while the other liked to set up turn in with a bit more trail braking resulting in a little understeer. Can you tell which combination of techniques was faster? The data could. After comparing data, each driver discussed the other's techniques in different corners and by the end of the day, they both went faster. You gotta love data.

One word of caution, and I have seen this happen on more than one occasion so it is worth mentioning. Don't take G-Force data as an absolute of the car's cornering and braking capability. I have heard more than one racing student say, *"I see the car generated 1.35 G's in turn 9, but I'm only showing only 1.1 G's in turn 12. I guess I can go in into turn 12 much faster then, right?"* This is so wrong. Some back of the napkin calculations at Monticello shows that , 1 degree of banking seems to "add" about one-tenth of a "G" in lateral grip. Turn 9 at Monticello is a sweeping banked uphill turn while turn 12 is a flat 90-degree right-hander. If you think a car that pulls 1.35 G's in 3 degrees of banking pushing into an uphill will pull the same G's on a flat track, be prepared to pay for a section or guardrail. The same holds true for longitudinal G's (braking force). Are you braking into a hill or braking on a downhill like the front straight at Watkins Glen?

Data and video are a revolution in track driving and coaching. You can spend hours looking at three, two-minute laps. You will see all the detail that you thought you might have felt. You can set up your car and you can compare you driving technique to other drivers or a driving coach. Data will help you better understand what is happening, why, and allow you to reinforce techniques that result in better, safer laps. This is exactly what professional teams do today. High performance data analysis is just so intoxicatingly fascinating and informative. The following weekend, you can relive your past weekend instead or returning emails, painting the bathroom or mowing the lawn.

It's such a great time to be a car enthusiast. Gas is cheap, cars are terrific and the new frontiers of data acquisition and video are affordable and getting better every day. I used to say you can learn something every lap you are on a track. Now you learn from every lap while sitting at home!