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.

Professional teams use high-end AIM, Traqmate and MoTeC 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.

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!. Todays auto pilot systems transfer additional terabytes of data on top that!

I'm a believer that data analysis can be an advantage no just for racers, but also in Driver's Education. 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 and sway bar adjustments

Suspension setup, gearing can be done with the tools mentioned above and it is fascinating subject but well beyond the intent of this article. Today we are going to concentrate on using data to find the fast way around the track and how to improve our driving techniques.

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 redline 3rd?
- Does running to redline in each gear give me the fastest terminal velocity at the end of the straight or does shifting in the "power band" produce a higher terminal velocity?
- What was my best braking point and turn in speed that resulted in the quickest segment and overall lap time?
- Is the time I loose "compromising" the (only) 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 or I concentrate my efforts on maximizing my exit speed?

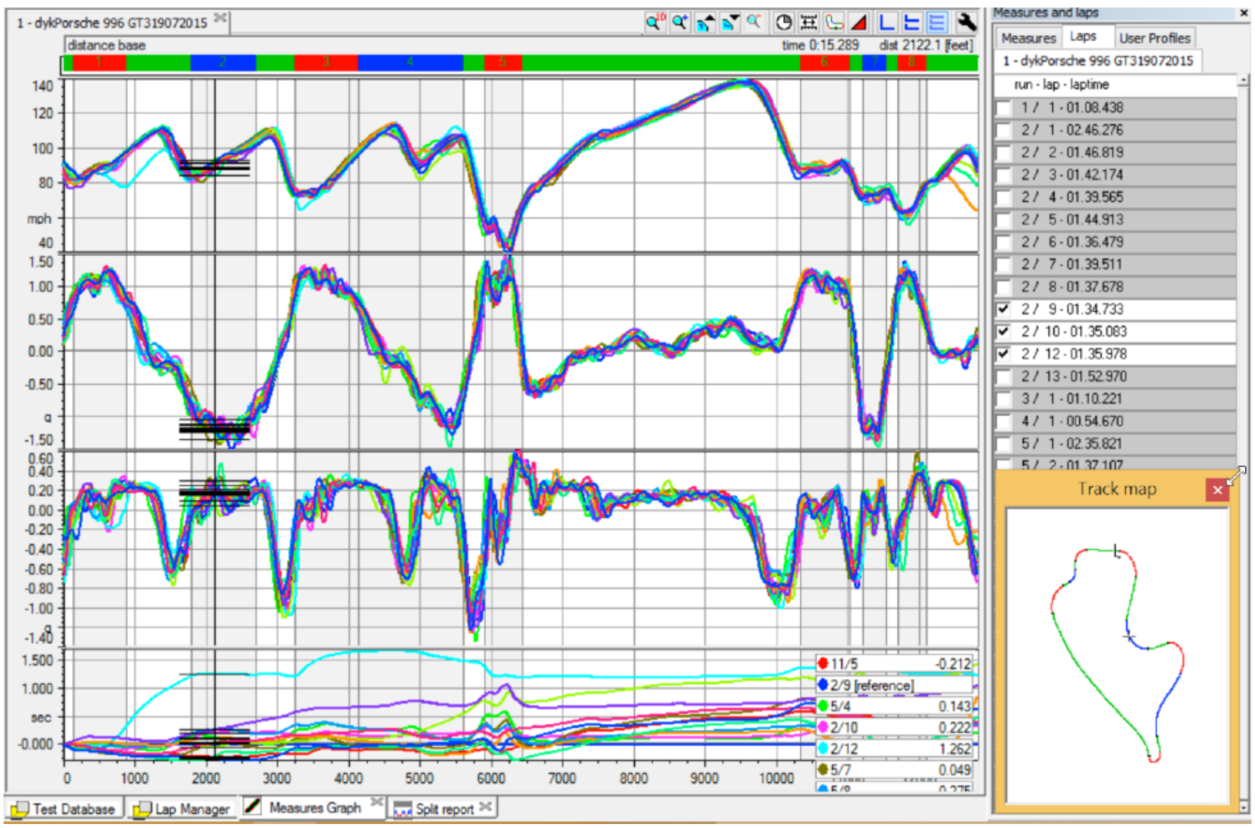
What can I do as a driver to be quicker?

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

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.

Before entering the track, record the day, the session and any goal or technique you may be trying. After the run group, you can simply review video and the data to see if your technique “worked” and allows for easier file management. 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!

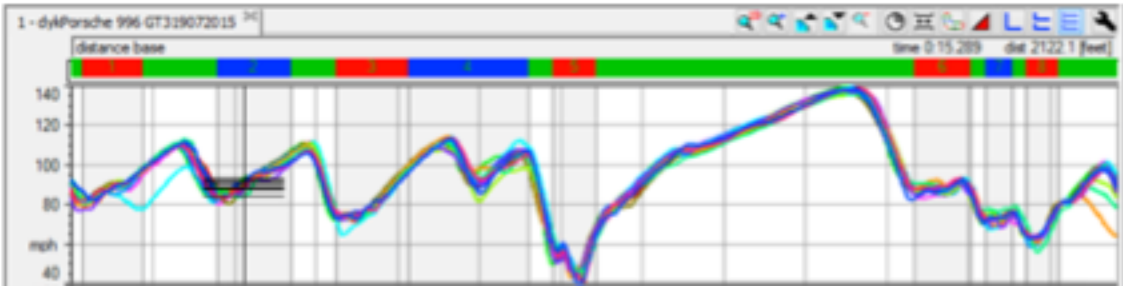


Look at graph above; crazy isn’t it? The first time I saw the Measures graph in AIM, I dubbed it “Etch-a-Sketch on Acid”. Today’s tools are so capable, you can log and chart just about anything. The trick is learning to only look at what you need. Start Simple!

Always import all the measure data but only measure to support what you are looking .Is it a particular turn, braking zone, or skill you are targeting for improvement. That will dictate the Measures (variables) you will select to help you analyze you requirement.

In the most basic driver analysis, start with a speed trace of your best laps. With just one inputs the software allows you to look at graphic representations of consistency, smoothness, braking, and corner entry and exit speeds. I will use the AIM’s software for my examples below, but Traqmate, MoTec and RaceLogic and others packages all offer very similar capabilities.

Look for is consistency in lap times with a speed trace and the basic lap time report.

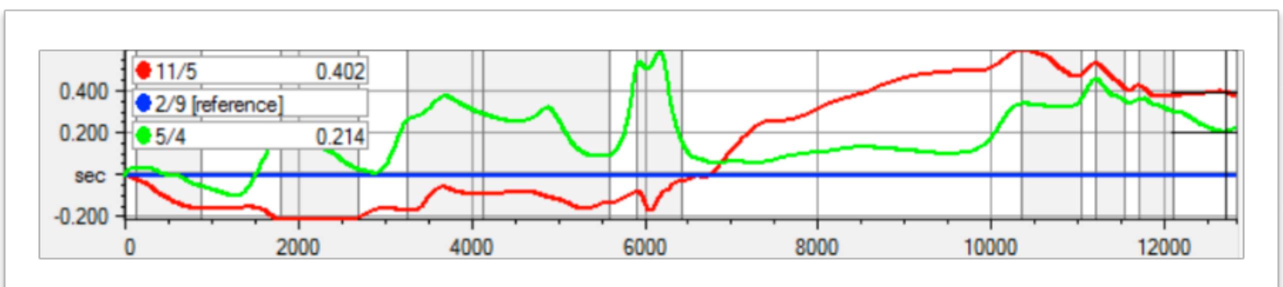


If your set up captures Throttle and Brake pressure, I would add them as well if not add Lateral G force for later analysis or acceleration and braking.

Unselect all the default measures (data inputs) leaving just the ones mentioned. Unselect the outliers laps and try and get down to your best three laps. It doesn't help to try to analyze every lap in the entire run session for this purpose. Later you can set up additional inputs to analyze a specific skill in more detail like turn in speed by RPM, pedal pressure for braking and throttle position for power.

The AIM software allows you to run a "Split Report" to calculate the time delta graph for the Measures Graph. This an excellent graphical view to zero in on where you are gaining or losing time over comparative cumulative lap times.

For this example below, I have selected three laps represented in the graph below. The software has determined the blue line, lap 2/9, represents my "fastest" full lap of the three selected and created the flat reference baseline. The red and green lines represent the delta from the fastest lap. Any point above the baseline means I am "behind" in lap time and any point below means I am "ahead" of the reference lap. In the graph itself the gray and white background areas highlight where the software has used lateral acceleration determined if the car is in a turn or on a straightaway.



Focus on where the lines separate and where they converge and start to investigate why in both the graphical and tabular split report. I want to find where I gained time, and where I lost time and most importantly; why?

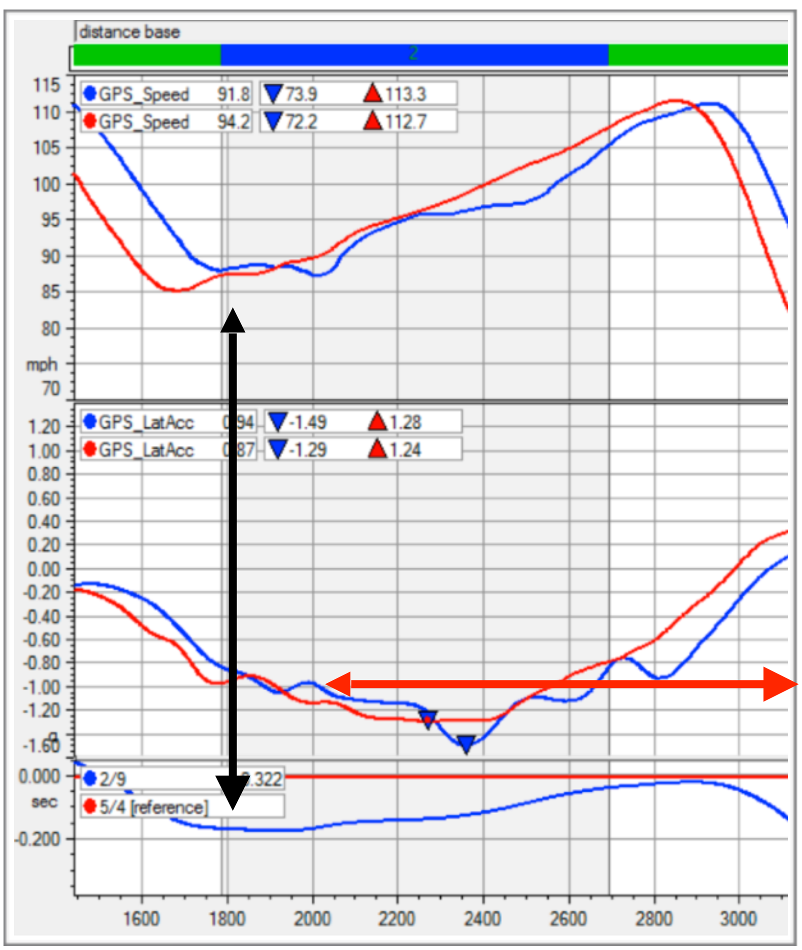
I can now go to the Split Time report and look at the Min-Max values and std deviation for the laps selected to and the turn in question. Consistency The example above draws my attention to segment 3.

The commutative time graph also shows a loss of time in segment 3 turn which is the infamous

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**

Mosport diving turn 2a2b. it's a very fast and very intimidating turn. There is a significant difference between my fastest and the slowest laps with a high std deviation. Turn 2a2b is a downhill sweeping turn with a compression on the exit. You commit at the turn-in, hang on and pray the mechanical grip shows up when the car compresses at the exit. I made it through a couple of times faster than others, so let's see if we can figure out why. Why was one lap faster than the other? 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.

Let's open the tab for the Measures Graph (aka, squiggly lines) and zoom into just that turn for just for my fastest laps. I will only show two laps represented by the blue and red lines to make a point.



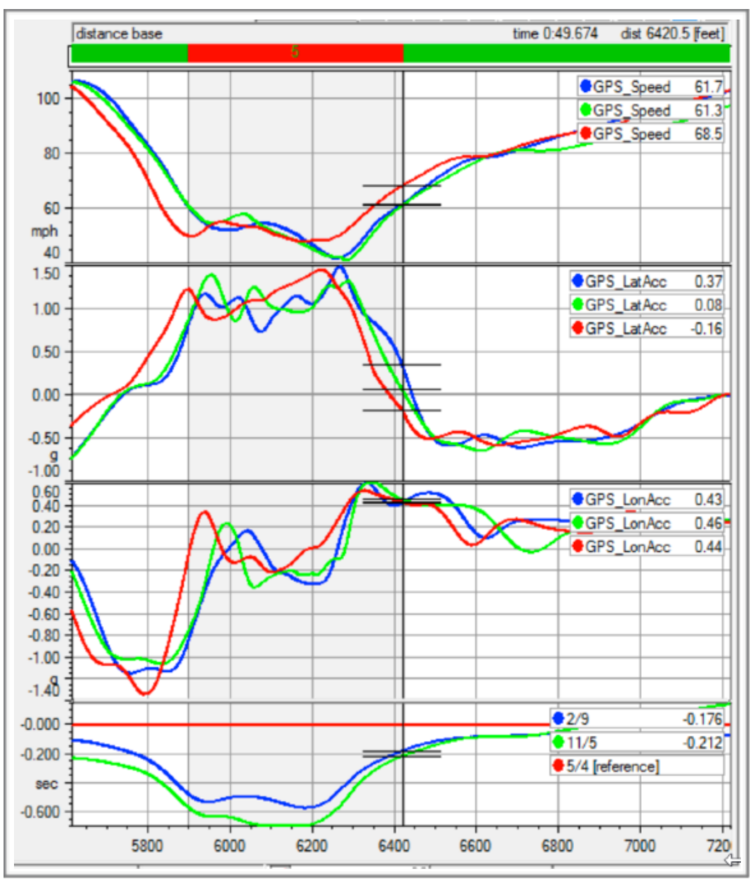
In this view, the top graphic tile is GPS Speed scaled in MPH. The second graphic tile shows left and right lateral G-Force and the bottom tile is the accumulated time with the X-axis showing distance in feet for all three.

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. The blue line rises on the vertical Y-Axis showing a loss of lateral traction in the start of the turn

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. I'm chasing the chassis almost to the exit of the turn.

Now focus on the red line in the top speed trace panel. I broke earlier, set the car 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 settled 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 was the ticket, with no drama.

The blue lap sure felt fast with a later braking point and all that drifting and sliding through the corner, but the data doesn't 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 sliding correcting, heart palpitations and cold sweat. This hints that the fastest technique could somewhere in between the two. If I had access to the RPM data through the ODBII, I can calibrate my entry speed more precisely by looking at the tachometer on entry. 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. That's an example of just one turn, in one session. Next time out I a new strategy to work on 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 long Andretti straight. Turn 5 requires threshold braking up hill, leading into a double apex. The first apex is situated on the crest of a hill and the second apex is on a downhill. This time, will add in one more measurement, the LogAcc graphic tile to look at braking as well as cornering G-Force.

In this segment my fastest reference is lap is the Red 5/4. The top graphic tile shows I entered the first apex slower. The third graphic highlights my braking, which is earlier and more aggressive on lap 5/4. 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 exiting on to the longest straight.

Picking up the throttle earlier in 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 from the 6,500-12,000 foot marker on Mario Andretti straight. That's 00.34 seconds equals about 60 feet which or 4 car lengths!

Interestingly, fastest segment time through Turn 5 didn't translate to the fastest time down the long back stretch. Turn 5 is all about exit speed. This is an example of going into turn 5 too fast and paying for it on exit with a slower exit speed. Turn 5's double apex is the classic "compromise" turn complex where the goal is to maximize exit speed for onto the long straight.

A real eye opener for me in seeing the potential of data happened while working at Monticello Motor Club. We have two young and very fast, professional drivers that were driving the same Porsche 2.7 Cayman. They posted laps times consistently within two-tenths of a second to each other lap after lap. One young gun was a hard charging, late brake artist. The other used an earlier and lighter brake pedal with significant trail braking at turn in. 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 where posting lap times 0.5 seconds faster. You gotta love data.

One word of caution; 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 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, right?"* This is so WRONG. 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 the 3 degrees of banking in turn 9 will pull the same 1.35G's on a flat turn 12, be prepared to buy a section or guardrail. The same holds true for longitudinal G's (braking force). Braking into an uphill will give you higher LongG then raking 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 and why, which allows you to reinforce techniques that result in better, faster and safer laps. This is exactly what professional teams do today. Data analysis is intoxicatingly fascinating and informative. When you get back from the track, you can relive your past weekend for hours instead or returning emails 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. Years ago I would tell my students, "You can learn something every lap you are on a track". Now you learn from every lap while sitting at home!

There are also some excellent "how to" videos on YouTube featuring Roger and others on how to set up and use the AIM Race Studio software.