Getting serious about data

If you really want to get serious about using data and video and understand “How” to drive better, you need to step up to a real camera and track oriented data acquisition tools.

Most professional race teams use integrated systems from Motec, Cosworth or the manufactures OEM sensors and data logging tools to monitor to monitor EVERYTHING. The good new for us, this that there are very affordable data logging tools from AIM Sports, RaceLogic and even smart phone apps for Drivers Education - HPDE 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 on board sensors. That’s a lot of zero’s and ones over the air in 2013!

Since that time, the number sensors and speed of real-time transmission 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 that’s the street car! Todays auto pilot systems transfer terabytes of data on top that of the traditional engine and performance data. It’s BIG DATA and it’s only getting bigger.

I’m a believer that data analysis can be an advantage no just for professional racer and engineers, but for drivers in Driver’s Education, Autocross (Solo) and even Carting. For DE, it comes down to three categories.

1. Learning what you can do as a driver to be quicker
2. Finding the fastest way around the track
3. Simple “setup” tweaks with tire pressure and sway bar and shock setting adjustments

Suspension setup, gearing, and downforce can be done with the tools mentioned above and it is fascinating but well beyond the intent of this article.

We are focused on using data to find the fast way around the track and how to improve our driving overall.

The fast way around the track deals with questions like:

- What is the fastest line around turn, segment and lap?
- 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 is the best braking point and that offered my my best turn entry speed?
- Is the time I loose “compromising” the left turn at Lime Rock Park worth the time I make setting up the right-hander going onto NoName straight?
- Should I charge into the Bus Stop at WGI or I concentrate my efforts on maximizing my exit speed?

What can I do as a driver to be quicker?

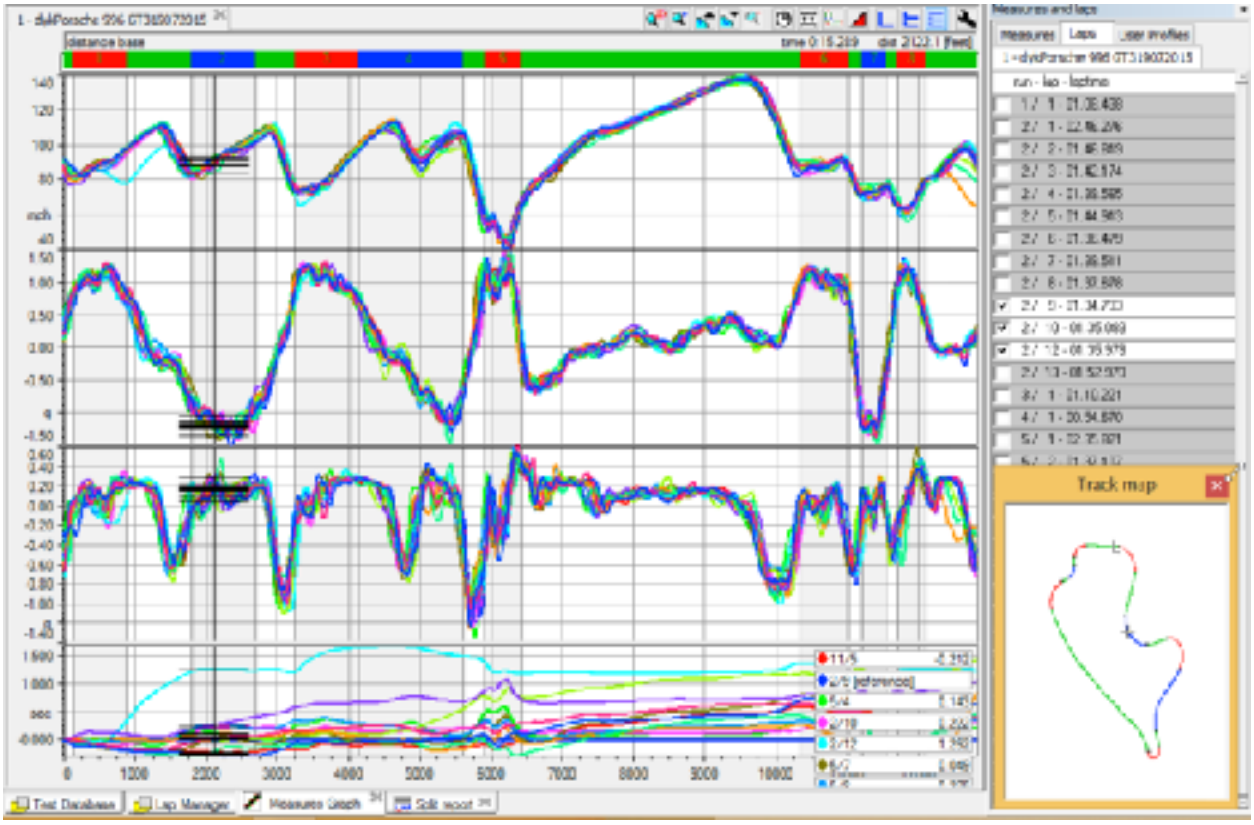
- How consistent am I driving?
- How “smooth” are my inputs?
- What is my braking efficiency?
- What is my maximum corner entry, mid corner and exit speed?
- Am I maximizing the car’s “grip” in transition from braking to turn-in, to track-out?

Data alone is fascinating, but it really comes to life when you "mash-up" your video. Manual matching your video with the data is easy if you start by speaking into the camera about what date, time and session you are currently recording. You can also record a running commentary from inside the cockpit as you try different approaches.

If you are using video along with data acquisition, before entering the track, simply speak (loudly) into the camera to record, weather and track conditions and any goal or technique you may be trying. After the session, this simple introduction to the video will make data and video analysis much easier to match your “goals” with each session. When you have 100 videos or more, it makes the organization of you video and data much easier as well. If you are using AIM or other systems that have their own camera - the analysis software join your video and data auto-magically.

Let’s go to the data and walk through a simple approach to “data analysis" that can help you become a smarter, more consistent and quicker driver. Most systems will give a main graphic that plots your data over time and distance.

Step 1 - Start Simple!



Look at graph above; crazy isn't it? The first time I saw the Measures graph, I dubbed it the "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. You will almost always start with a speed graphic over time or distance.

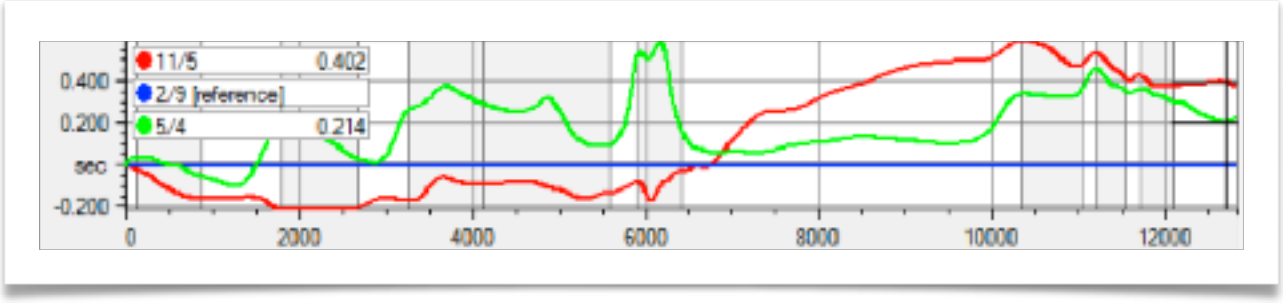
For nearly all driver focused analysis, you will need speed trace of your best laps. With this one input (measure) the software allows you to look at graphic representations of consistency, smoothness, braking, and corner entry and exit speeds. I will use the AIM's software for my examples below, but MoTec RaceLogic and others packages all offer very similar capabilities.

Always import all the measure data but only measure inputs to support what you are looking to achieve. This will dictate the Measures (variables) you will select to help you analyze you goals. For instance, if braking efficiency is your goal, brake pressure or longitudinal G force data will be required input along with the speed trace.

Go to you lap data set and unselect the outliers laps. Pay attention to the first and last lap as they may have generated data errors if you are using a GPS based system. I like to look at best three lap times. It doesn't help me to try to analyze every lap in the entire run session.

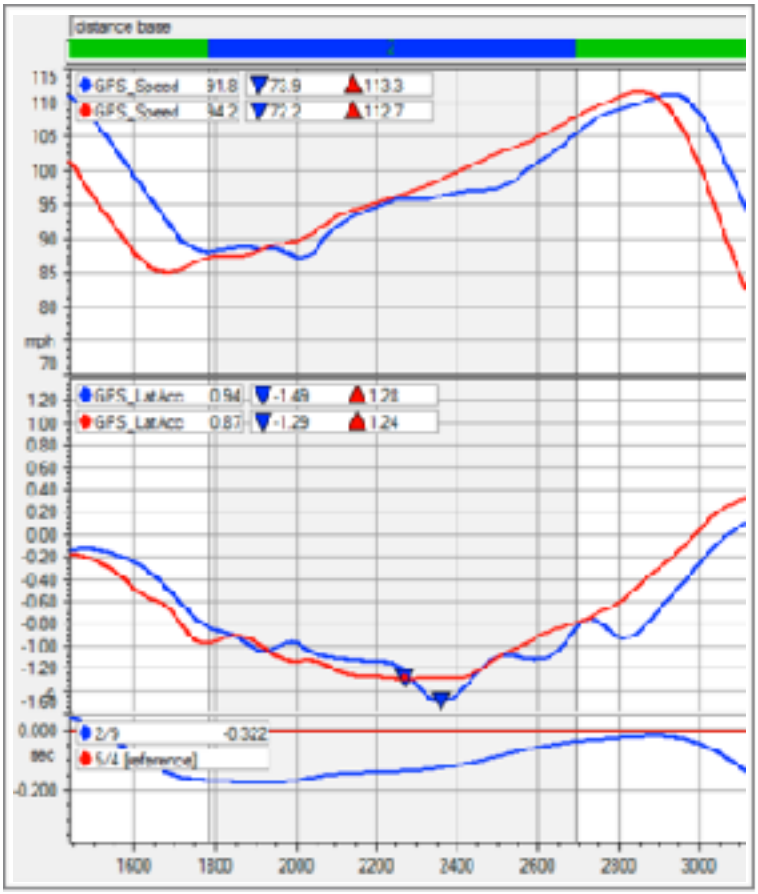
A extremely useful feature of the AIM software is delta graph at the base of the Measures Graph. This an excellent graphical view to zero in on where you are gaining or losing time over comparative session laps.

In the example below, I have selected three laps. The software has determined the blue line, lap 2/9, represents my "fastest" full lap of the three laps selected and has 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 converge to start to understand how you gained time, and where you lost it time. The supporting data will tell you how and why?

If you are more spreadsheet oriented, you look at Split Time report and look at the Min-Max values and std deviation for the segments in laps selected to look for inconsistency. The example above draws my attention to segment 3.



Let's open the tab for the Measures Graph (aka, squiggly lines) and zoom into a segment that has a significant speed trace difference. I will only show two laps represented by the blue and red lines to make a point.

The top graphic tile is GPS Speed scaled in MPH. The second graphic tile shows 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.

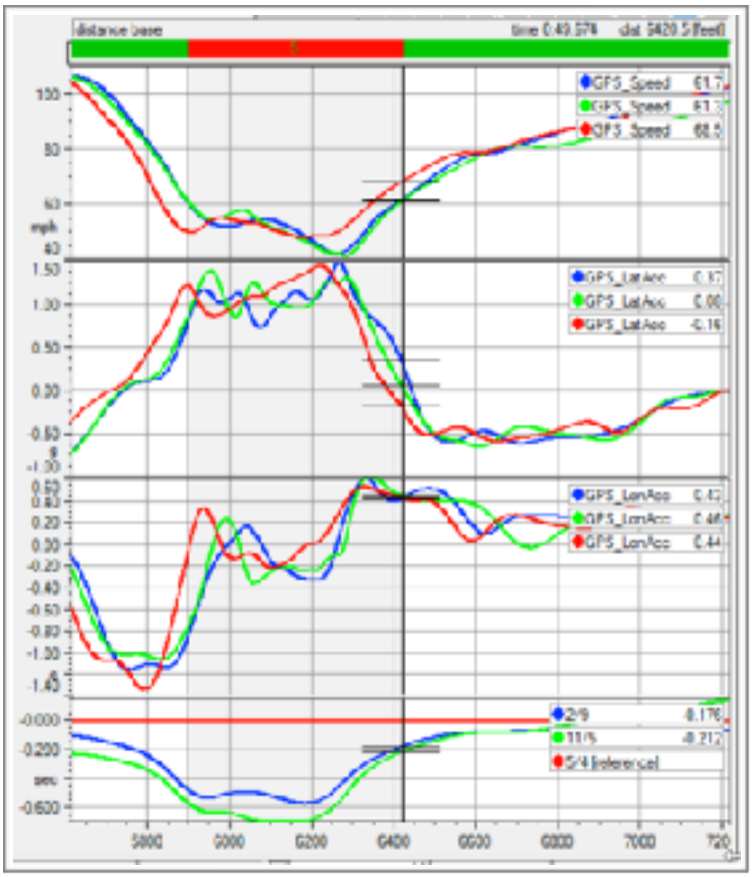
Look directly from that point straight up to the top GPS_Speed graph and you will notice a loss of acceleration. This highlights a significant steering correction at 1,900 feet. I can't pick up the throttle until I have the car back underneath me, which looks like 150 feet later when blue and red lines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

Now focus on the red line in the top speed trace panel. In this case, I broke earlier and the car took a solid "set" in the downhill section of the turn and I could steadily increases my 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. In this case, as smooth transition into the corner, steady mid corner and accelerating on exit, was ticket

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. 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 in my next session. 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 position on the actual track was

different. This an example of just one turn, in one session. Next time out I can develop a new strategy to work on using the insight from this data.



Let's look at another point on the track, turn 5 at Canadian Tire Motorsport Park (formerly Mosport International Raceway).

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, we 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 the turn earlier, 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' 00.34 seconds equals about 60 feet which or 4 car lengths at the end of the long straight

Interestingly, the fastest segment time through Turn 5 didn't translate to the fastest overall lap time. Turn 5 is all about exit speed. The data show us that going into turn 5a too fast and paying for it on exit of 5b with a slower exit speed, is clearly a losing strategy. 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. 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. Don't take G-Force data as an absolute of the car's cornering and braking capability. *"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. In this case, 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 braking on a downhill like the front straight at Watkins Glen. Use data to compare laps in each turn and brake zone separately.

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 what professional teams do every day. Data analysis is intoxicatingly fascinating and informative and now you can even actually import you real track data into you iRacing simulators, and practice at home. You can now spend weekend for hours practicing instead or returning emails or mowing the lawn.

It's such a great time to be a car enthusiast. 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 is great instructional videos on how to use track data analysis on the internet. Aim Sports Roger Caddell's "Learn Fast" Videos are a great place to start.