Seminar Series
Bringing Data Support and Training to You

Race Studio 2
Tips & Tricks

February 2016
Race Studio 2 Data Tips
How to Use Data Acquisition
Data Analysis Concepts

• **Data Analysis Triangle**
  – Driver Performance
  – Vehicle Performance
  – Vehicle Health

• **Money Channels**
  – Lap Times and Speed
  – All Other Channels Strongly Support the Money Channels

• **Basic Data Analysis Steps**
  – What is Happening (many stop here!)
  – Where is it Happening
  – Why is it Happening

• **Vehicle or Driver**
  – Is the Driver Reacting to the Vehicle Movement
  – Or is the Driver Creating the Vehicles Movement
  – Critical Component of the Why is it Happening

How to Use Data Acquisition
Data Analysis Concepts
Data Analysis Books

• Many Good Books are Available

  – A Practical Guide to Race Car Data Analysis
    Bob Knox (2011)

  – Making Sense of Squiggly Lines
    Chris Brown (2011)

  – Competition Car Data Logging: A Practical Handbook
    Simon Mcbeath (2009)

  – Analysis Techniques for Racecar Data Acquisition
    Jorge Segers (2008 and 2014) Recently Updated

  – The Competition Car Data Logging Manual
    Graham Templeman (2008)

  – Data Power: Using Racecar Data Acquisition
    Buddy Fey (1993)

Just a few, many are available!
<table>
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<th>F Key</th>
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<th>Alt+</th>
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<td>Only when all windows are closed</td>
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</table>
Race Studio 2
Data Tips

Race Studio 2 Tips and Tricks
Organizing Data
Organizing Data

- **RS2 Software is Very Flexible**
  - Store Data in the Default Location
  - C:\AIM_SPORT\RaceStudio2\DATA
  - Use the “Selection Criteria” Function
  - Full Use of the Test Information Box is Important
Organizing Data

• **Selection Criteria**
  
  – If you have used the Test Information box, the selection criteria function is very powerful
  
  – Editing the Test Information Settings is possible at any time
Race Studio 2

Data Tips

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Race Studio 2 Tips and Tricks

File Types
File Types

- **.dat and .imd**
  - The file generated by the data download. This file is a copy of the gauge memory .dat for most automotive gauges and .imd for others (MyChron4 and SmartyCam)

- **.drk**
  - The main data file

- **.gpk**
  - Contains the GPS line/trajectory data and it is used in analysis, with the .drk file data

- **.rrk**
  - Contains the Non Line/Trajectory GPS data, copied from the .dat or .imd files. Used internally as a redundant check

- **.bak**
  - File created as a backup of the .drk file

- **.fr .fl .rr .rl**
  - User settings of the Advanced suspension analysis function, bound to the drk file

- **.basic**
  - User settings of the Basic suspension analysis function, bound to the drk file

- **.engine**
  - User settings of the engine analysis function, bound to the drk file

- **.drk.bak.BeforeBeaconMng**
  - Copy of the .drk file before applying the “GPS Lap Insert” function

When “Sharing” data, include the **.drk file** and if GPS was collected, also include the **.gpk file**
Race Studio 2 Data Tips

Race Studio 2 Tips and Tricks
User Interface
Default View  1) Pull-Down Menu,  2) Primary Icon Toolbar,  3) Secondary Icon Toolbar,  4) Measures and Laps Toolbar,  5) Test Laps Toolbar,  6) Main Window

Race Studio 2 Tips and Tricks
User Interface
Now, all these sections of the Race Studio 2 software are actually "Dockable" sections and can be placed where you want them.
Or can even be “Undocked” completely if you want by just dragging and dropping them where you want.
But really the typical view is best as shown here. But another couple of tricks can be used to make this view even better. To maximize screen area quickly especially when analyzing data on a smaller laptop, we can quickly “Hide” the Measures and Laps Toolbar by just pressing the spacebar on your keyboard once.
Notice how the **Main Window** is now full width and we have more room to analyze our data. We can also quickly “Hide” the **Test Laps Toolbar** by holding the **Control Key** and pressing the **Spacebar** on your keyboard once.
Notice how the main window is now full width and height and we have Maximum Room to Analyze the data. The toolbars can be toggled back on very quickly by pressing the control and spacebar again for the Test Laps Toolbar and the spacebar alone for the Measures and Laps Toolbar.
And it is back to the Default View.
Race Studio 2
Data Tips

Race Studio 2 Tips and Tricks
Zoom Functions
Zooming in the main window can be done in several ways. 1st is in the zoom area of the toolbar. (Highlighted above) Zooming can also be done with the up and down arrows on the keyboard or with the scroll wheel on the mouse.
Race Studio 2
Data Tips

Min - Max Visual
Open the settings dialog box Options=>Settings. ‘Always’ is the default setting of the Race Studio 2 software.
The Min - Max Visual function displays the minimum and maximum values for each channel shown. By clicking on the triangle by the channel tags, the cursor will jump directly to the position in the data the Min - Max Visual is displaying.
Min - Max Visual  The Min - Max Visual function displays the minimum and maximum values for each channel shown, here when “On Selected” is chosen and the Channel Tag has been selected.
Race Studio 2
Data Tips
Channel Reports are a valuable tool. They are user definable and provide Min, Max, Avg, etc. values for each channel for each lap. All Min or Max values are hyperlinked and when clicked on take you back to the Measures Graph and place the cursor right were the Min or Max value occurred. To view more detailed information, double click on the value in the report.
Channel Reports  After the double click on the Channel Reports hyperlinked value, the software opens the Measures Graph, opens the correct lap, and places the cursor on the point of in this case the Max RPM. In this case the highest RPM recorded during the test was because of a poorly timed downshift during braking.
Race Studio 2 Data Tips
Split Reports are a valuable tool. They calculate segment times for each lap based on the segments of the active track map. Also provided are the “Best Rolling Lap” and the “Theoretical Best Lap”. The blue segment times are the best times in that segment for the entire test. Pay attention to the “Std Deviation” value; 0.0 to 0.1 should be the goal. The lower, the better.
Race Studio 2 Data Tips
The Engine Analysis function calculates horsepower and torque from data gathered on the track. The data used for calculations is the data viewed in the measures graph.
Engine Analysis  The Engine Analysis function calculates horsepower and torque from data gathered on the track. Here is the “Settings” dialog box.
Race Studio 2

Data Tips
User Profiles are user defined shortcuts, quick pre-defined ways to look at data with keyboard shortcuts, exportable, and easy to update. Make sure you use the default “New user profile with all current settings” choice as you save your User Profiles.
Now your new User Profile is stored in the list and can be activated in several ways; by the listed shortcut of “Ctrl+7”, by clicking on the User Profile name and then clicking on the red and green arrows, or by just double clicking on the User Profile name. Here you can also delete or save any changes to your User Profile.
Race Studio 2
Data Tips

Race Studio 2 Tips and Tricks
Per Lap Color

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The **Per Lap Color** option quickly changes all of the colors and traces for each lap to a single color. This is especially helpful when you have more than one lap active with more than one channel selected.
The Per Lap Color option quickly changes all of the colors and traces for each lap to a single color. This is especially helpful when you have more than one lap active with more than one channel selected. Now the lap color = time compare color = lambda color = speed color. Much easier to understand what you are looking at.
Race Studio 2 Data Tips

Race Studio 2 Tips and Tricks
You can easily **Sort Channels** in the measures and laps toolbar by clicking on the **Sort Channels** button. The resulting dialog box allows you to highlight a channel and then move it up or down. When you get the order the way you want it (typically the most used channels at the top) just press the apply and exit button and the channels will be sorted.
Race Studio 2

Data Tips

Race Studio 2 Tips and Tricks
When looking at multiple graphs the screen can get very hard to read. In this example we have 4 channels active (speed, rpm, throttle position, and gear) to make this much easier to read, use the Views Function. You have 3 choices; overlapped, mixed, and tiled. This is the Overlapped View. All of the channel traces fit into the main viewing area based fully on the graphing scaling values as seen on the left edge of the graphs. Very busy!
This is the Mixed View. You control the placement of the data traces in up to 6 windows by the window values to the left of the channel names and colors. Here I have split the 4 channels into 2 groups, Speed and Throttle Position in window #1 and RPM and Gear Position in window #2. The Mixed View is typically the most popular way to view data.
This is the Tiled View. This view places all of the active channels into their own window in the main window.
Race Studio 2 Data Tips

Race Studio 2 Tips and Tricks

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The **Time Compare** function is a tool that makes it easy to compare laps and pinpoint areas where one lap is faster than another. The fastest lap is the reference line and the slower lap is compared against it. In this case the red lap was the fastest of the 2 active laps. Where the blue line is below the red line, the blue lap was actually faster than the red lap. Areas of quick changes are areas you should focus on.
### Race Studio 2 Data Tips

**Global Positioning System (GPS)**

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**Race Studio 2 Tips and Tricks**

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GPS System Information:

- 31 Sats Currently orbiting
- 6 different orbital planes
- Each orbit is 11hrs 58min
- Moving at about 7000mph
- Designed to have 9 Sats visible worldwide
- Min 4 Sats needed for good 3d location, more is always better
- Orbiting at about 10,988mi above Earth
- Early L1 GPS Sats output power is about 25.6 watts! Newer Sats have more power
Trilateration:

The process of calculating location by the measuring of distances.

- GPS receivers constantly receive and analyze radio signals
- Calculate the precise distance to each satellite
- 1 satellite determines position to a large area on earth
- 2 satellites narrows the position to where they overlap
- 3 satellites provides a fairly accurate position
- 4 satellites is better and give elevation

GPS - How Does it Work?
This is the default view of GPS data in the Race Studio 2 Analysis software. This data is a qualifying session with 3 laps of data. You only see the yellow lap as it was the last lap ran and they appear right on top of each other at this zoom level. On the next slide we zoom in to see the accuracy/repeatability of the GPS driven line on a slow corner where the driver should be placing the car at the same location.
The same GPS data in the same location, a slow corner where the driver should be hitting the same spot. The image on the left is in Race Studio 2 Analysis/GPS, zoomed in and with the data right on top of the scale bar showing a difference of about 3” The image on the right is from Google Earth after a .kml export and using their “Ruler” tool shows a difference of 2.96”, a good check.
Google Earth Image Accuracy: Using the Timeline Function in Google Earth, here are the same 3 laps of AiM Sports data we viewed in the last 2 slides but now exported and positioned on Google Earth imagery from 1998 thru 2009.

Keep in mind the AiM Sports data is exactly the same data from image to image.

As you can see here even in just this one corner the accuracy of the imagery varies based on the quality of the images Google Earth is using. But you can still get a good idea of the driving lines taken from lap to lap.
Race Studio 2
Data Tips

Race Studio 2 Tips and Tricks
Track Maps
To generate an AiM Sports Race Studio 2 Track Map, select the Map pull-down menu and the New command.
The Modify Track Map dialog box will appear. Typically it will display your best lap time, however you can select any of your laps. You have options to modify the default settings; track shape, channels threshold, corners identify, and rotation. When you have the map the way you want it, input a file name and click on the OK button. This now becomes the default Track Map for this test.
Track Map Differences

Race Studio 2 Creates two Different Types of ‘Track Maps’. Both Have Value for Your Data Analysis. Here are the Differences and Where you Will use Them Both.

- **‘Standard’ Track Map**
  - Generated by the Roll Out Distance and Lateral Acceleration Values
  - Used in the Split Report, Track Report, and Lap Relay Functions
  - Just for General Track Location, not the Actual Driven Line

- **GPS ‘Driven Line’ Track Map**
  - Generated by the GPS Sensor
  - Actual Driven Line
  - Can be Colorized Based on a Channel
Race Studio 2

Data Tips

Race Studio 2 Tips and Tricks

Delta Function
The Delta Function makes measuring differences very easy. After selecting starting and ending points, each ending point value is reported in the Channel Tags along with the difference between the 2 points for all visible data.
Race Studio 2 Data Tips
Math Channels are powerful tools. They use existing data and manipulate it to view the existing data in other ways. The limit is your imagination. Here is an example of a Coasting Time/Lap channel. Taking the Throttle, Brake, and Cornering values (sensor or GPS based data), then build BRK on, TPS On and CST On Math Channels, then when none of these are active, the driver is “Coasting” and we add up that time and display it.
Here we are zoomed in on an area and the BRK on, TPS On, and CRN On channels are shown. There are 3 areas we need to focus on. #1 is a true area of coasting, #2 is where the driver is not on the TPS or BRK but in a corner, and #3 is a shift point that is shown as coasting. The Coasting Time per Lap (CST LapT) is increasing in #1 and #3.
Here we are looking at the same 27 laps of data but in a Channel Report. We are looking at all enabled laps for this session. The values we have configured the report to show are: the GPS_Speed, CST LapT, CST LapD, TPS Full LapT, and TPS Full LapD and values. Clearly, lower CST LapT max values are desired but not a guarantee of better laptimes. Better laptimes are always created by doing many things right.
To show more information about the Math Channels used, here we have opened the Math Channel dialog box and have highlighted the CST LapT math channel to show its details.
Math Channels Examples

Here are some “Switch” Math Channels:

**BRK On:**  IF(LT(GPS_LonAcc,-0.05),1,0)  or  IF(GT(Brake,200),1,0)

**CRN On:**  IF(GT(abs(GPS_LatAcc),0.20),1,0)

**TPS On:**  IF(GT(GPS_LonAcc,0.05),1,0)  or  IF(GT(Throttle,15),1,0)

**CST On:**  IF(GT(BRK On,0.5),0,IF(GT(CRN On,0.5),0,IF(GT(TPS On,0.5),0,1))

**TPS Full On:**  IF(GT(Throttle,85),1,0)

Here are some “Driver Performance” Math Channels:

**CST LapT:**  lap_integ(CST On)

**BRK LapT:**  lap_integ(BRK On)

**BRK LapD:**  lap_integ(BRK On*Speed*MPH2FTS),0

**TPS Full LapT:**  lap_integ(TPS Full On)

**TPS Full LapD:**  lap_integ(TPS Full On*Speed*MPH2FTS),0

Here are some Math Channels examples. All of these plus many more are available to you in the electronic handouts (on the AiM USB thumb drive) at this seminar.
Here we show the same Math Channels we discussed on the prior slide: CST LapT, BRK LapT, BRK LapD, TPS Full LapT, and TPS Full LapD.
Here is a Channel Report of the Math Channels shown in the previous slide. Channel Reports are a great way to quickly look at a lot of data and start to see trends in the data.
LearnFast™ Video: www.youtube.com/aimdata

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