

ProRacing Sim, LLC



Drag-Racing Vehicle Dynamics Simulation

Program Guide And Drag Racers Handbook

For Windows95/98/Me/2000/XP

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Larry Atherton, Pres., CEO
Motion Software, Inc.



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INTRODUCTION

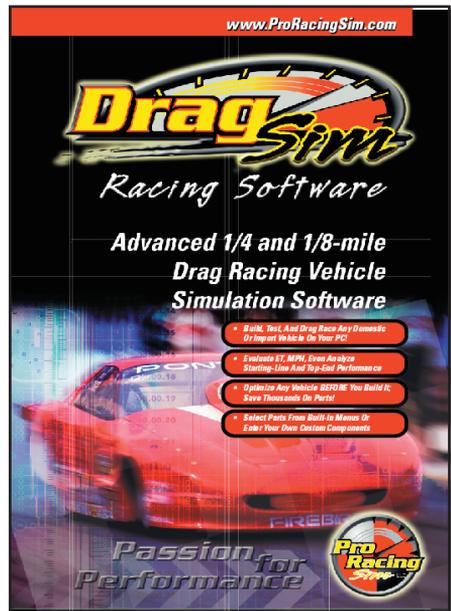
PROGRAM VERSION NOTE: While this manual primarily refers to the DragSim, the descriptions herein also apply, in large part, to the DeskTop Drag simulation. For a detailed list of the feature differences between these products, refer to page 74.

Note: *If you can't wait to start this simulation, feel free to jump ahead to **INSTALLATION** on page 12, but don't forget to read the rest of this manual when you have time. Also, make sure you complete the Registration Form that appears when you first start your software. It entitles you to receive tech support, obtain discounts on future releases, and participate in exciting contests sponsored by ProRacing Sim.*

HOW IT WORKS

The DeskTop Drag and DragSim packages are Windows95/98/NT/Me/XP, 32-bit, vehicle-dynamics simulations. They simulate standing-start, straight-line racing performance (in the 1/4- or [for the Advanced and ProTools versions] 1/8-mile) for a

The *DragSim™* is the most advanced vehicle dynamics drag-racing simulation ever offered to the performance enthusiast. It combines ease-of-use, rapid calculation times, powerful *Iterative Testing™*, and detailed graphics.



Introduction To The DragSim

nations may produce unreliable data. For example, a vehicle may have a selected *Redline Rpm* (maximum engine speed) of 6000rpm. If a launch rpm of 6300rpm is entered, the program indicates that this speed is greater than the redline and offers a solution. These, and other potential problems, are “trapped” by the program, and you are presented with information that will help you correct the problem to maintain the highest predictive accuracy and data reliability.

In addition to these major enhancements, you will find hundreds of other improvements to the DragSim. Updated features include a new, overall (WindowsXP) look, improved menu selections, a substantially expanded users manual, plus optional **Advanced** and **ProTool™ Kit™** versions described on page 74.

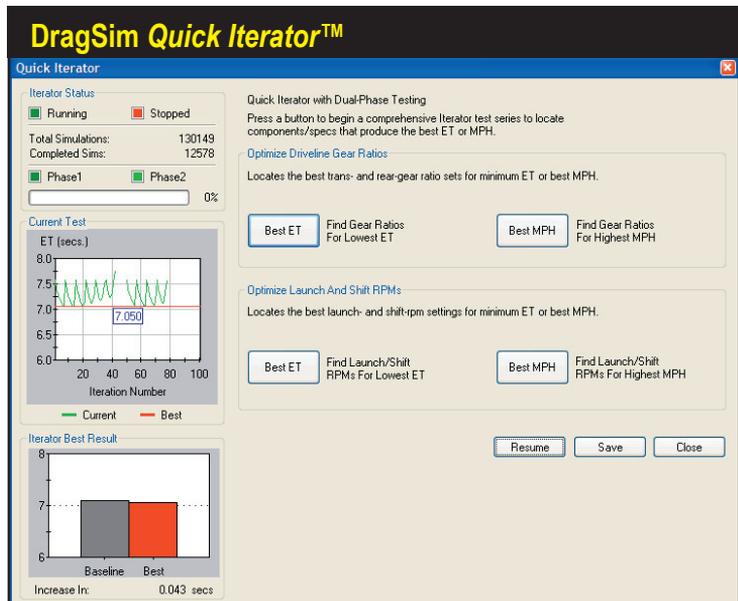
WHAT'S NEW IN THE *DeskTop Drag* and *DragSim*

The new features in this simulation include substantial enhancements to simulation modeling, including improved aerodynamics and traction models for high-horsepower vehicles (1500+ horsepower).

Another new addition to the Advanced version of the DragSim is a powerful, but easy-to-use *Iterative Testing™* feature called the **Quick Iterator™**. An exclusive feature of ProRacing Sim simulations, *Iterative Testing* allows you to automatically perform thousands of drag tests, keep track of all the results, and locate the best component combination that matches your search criterion. In the past, setting up *Iterative Testing* could be a time-consuming process. Now, the **Quick Iterator™** allows one-button testing, making this powerful tool available with a single mouse click!

In addition to these major enhancements, you will find hundreds of other im-

Iterative Testing™, using the new Quick Iterator™, is a powerful new feature of the DragSim. Here, a one-button-click test has just evaluated a series of components (over 2000 track tests were performed). Using this powerful tool it is possible to automatically run thousands or even thousands of tests to find the best combinations.



Introduction To The DragSim

provements to the DeskTop Drag and DragSim packages. In fact, nearly two years of programming and design effort were devoted to the DragSim simulation. Updated features include an improved interface and menu selections, substantially expanded users manual, optional program features described on page 74, and much more.

PROGRAM REQUIREMENTS

Make sure you have the basic hardware and software required to run the DeskTop Drag or the DragSim.

- An IBM compatible PC with a CD-ROM drive.
- 32MB of RAM (random access memory) for Windows95/98/Me; 64MB for WindowsNT; 128MB for Windows2000/XP.
- Windows95/98/Me or Windows NT/2000/XP (NT version 4.0 with SP6 or later)
- A video system capable of at least 800 x 600 resolution). Recommend 1024 x 768 or higher to optimize screen display of engine components and performance analysis graphics.
- A fast system processor (1GHz or faster) will improve processing speeds; especially helpful for iterative analysis. However, this software will operate on any Windows95/98/Me/NT/2000/XP system, regardless of processor.
- A mouse.
- Any Windows compatible printer (to obtain dyno-test printouts).

REQUIREMENTS ADDITIONAL CONSIDERATIONS

Windows95/98/Me/NT/2000/XP: The DragSim is a full 32-bit program designed for Windows95 through WindowsXP (all versions). The DragSim is also compatible with WindowsNT (we recommend that if you use WindowsNT, use version 4.0 with service pack 6 or later). If you use an early version of Windows95, make sure to install the latest service packs for both Windows and for Internet Explorer (use the Windows Update feature available in the Start Menu or visit www.microsoft.com to locate updates and service packs for your operating system).

Video Graphics Card And Monitor: Virtually any Windows compatible monitor and video display of at least 800 x 600 resolution is required. 1024 x 768 resolution or higher is recommended. This additional display resolution is very helpful in component selection and power-curve analysis.

Note1: See FAQ on page 94 for help in changing the screen resolution of your system and monitor.

System Processor: The DragSim is extremely calculation-intensive. Over 50 million mathematical operations are performed for each complete race simulation. While the program has been written in fast C++ and hand-tuned assembler to optimize speed,

Introduction To The DragSim

a faster processor will improve data analysis capabilities. Furthermore, the DragSim incorporates powerful *Iterative Testing* that can perform an analysis of hundreds or thousands of drag tests. To reduce calculation times and extend the modeling capabilities of the program, use the fastest processor possible.

The following table gives an approximation of the time required to complete a 100-drag-test *Iterative* run on various current and “antique” PC systems (this 100-cycle test is a very short run; *Iterative* tests can consist of hundreds or thousands of simulated drag races or more):

<u>Computer</u>	<u>Math Coprocessor</u>	<u>Calc. Time For 100-Test <i>Iterator</i>™ Run</u>
Pentium 3.0Ghz	Built-In	2 Seconds
Pentium 1.8Ghz	Built-In	4 Seconds
Pentium 400Mhz	Built-In	17 Seconds
Pentium 200Mhz	Built-In	75 Seconds
Pentium 133Mhz	Built-In	112 Seconds
Pentium 60Mhz	Built-In	4.3 Minutes
80486DX 33Mhz	Built-In	13.5 Minutes
80386DX 25Mhz	Yes (added)	49 Minutes
80486SX 25Mhz	No	6.4 Hours
80386DX 33Mhz	No	9.4 Hours
80286 at 10Mhz	No	24 Hours
8088 at 8Mhz	Yes (added)	3.2 Hours

Mouse: A mouse (trackball, or other pointer control) is required to use the DragSim. While most component selections can be performed with the keyboard, several operations within the DragSim require the use of a mouse.

Printer: The DragSim can print a comprehensive “Drag-Test Report” of a simulated

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INSTALLATION

Software Installation

The installation for the DeskTop Drag or the DragSim is a quick and easy process. Review these points and follow the installation steps below:

- Windows 95/98/Me® or Windows NT/2000/XP® is required and at least 64MB of installed memory (see page 9 for more information about system requirements).
- A software SETUP program will install onto the **Windows-Install** drive in the **DragSim** directory. Placing program files within this directory will ensure that future upgrades and enhancements will install correctly. Please accept the default installation path for trouble-free operation.

Read and perform each of the following steps carefully:

- 1) Start Windows.
- 2) Insert the DeskTop Drag or DragSim CD-ROM into your CD drive.
- 3) An *Installation Menu* will be displayed on your desktop within 5 to 30 seconds (depending on the speed of your CD drive). From the options provided, click on **Install DeskTop Drag** or **DragSim** (optionally, you can install demos of other ProRacing Sim software from this Menu).
Note: If the software *Installation Menu* does not automatically appear on your desktop within 30 to 60 seconds, choose **Settings** from the **Start** menu, select **Control Panels**, then double click **Add/Remove Programs**, finally click on **Install**.
- 4) Click **Next** to view the ProRacing Sim License Agreement. Read the Agreement and if you agree with the terms, click **I Accept...**, then click **Next** to continue with the installation.
- 5) A *Readme* file includes the latest changes made to this software and informa-

Installing & Starting The DragSim

tion not available at the time this *Users Manual* was published. After you have reviewed the *Readme*, click **Next** to proceed with the installation.

- 6) Next you will be presented a dialog indicating the recommended install directory and/or path. If you cannot install the program on the recommended drive or at the location indicated, you can click **CHANGE**, and enter an alternate location.
Note: If you do not install this software at the recommended location, updates or upgrades to this simulation released in the future may not install properly or function correctly on your system.
- 7) The **Ready To Install** screen gives you a chance to review installation choices. Press **Back** to make any changes; press **Install** to begin copying files to your system.
- 8) When main installation is complete, the **Setup Complete** screen will be displayed. Click **Finish** to close this window and a final dialog box will ask for permission to install a Camtasia™ Codec on your system (needed to display tutorial and help files). Choose **Install** to complete the installation.

Starting DeskTop Drag or DragSim

- 9) To start the *DeskTop Drag*: , open the Windows **Start** menu, select **Programs**, then choose **ProRacing Sim Software**, **DeskTop Drag Vehicle Simulation**, and finally click on the **DeskTop Drag Vehicle Simulation** icon displayed in that folder.

To start the *DragSim*, open the Windows **Start** menu, select **Programs**, then choose **ProRacing Sim Software**, **DragSim Engine Simulation**, and finally click on the **DragSim Engine Simulation** icon displayed in that folder.

- 10) When you first start the program, a Registration dialog will be displayed. Please fill in the requested information, including the serial number found on page 4 of the QuickStart Guide. Then press the **Proceed** button. If you have an Internet connection, your registration will be submitted to ProRacingSim automatically. If you do not have an Internet connection, you will be presented with other registration options. If you do not register this simulation, you will not qualify for tech support nor will you be able to participate in any of the exciting contests or special events that will be conducted in the weeks and months ahead.

Note: Demos of the new ProRacing Sim Software simulations have been included on the CD-ROM. They can be installed from the *Installation Menu* described in Step 3 on page 12. After installation, run any of the demos by opening the **Start** menu, select **Programs**, **ProRacing Sim Software**, then choosing the desired program.

Installing & Starting The DragSim

Most of these demo programs can be *Activated* to the **DeskTop, Advanced** or **ProTools™** versions by using the *Product Activation* menu within each program (see page 122).

- 11) You can access additional information about our simulation software and obtain technical support by visiting (www.ProRacingSim.com) or by opening the **Start** menu, select **Programs, ProRacing Sim Software**, then click on **Tech Support Website** icons found in any of the application folders.
- 12) Please review the remainder of this Users Manual for more information on menu selections, program functions, and simulation tips.
- 13) If you experience installation problems, please review program requirements on pages 9-10 and take a few minutes to look over the following sources of information before you contact technical support:
 - The FAQs on page 94 provide additional installation and operational questions-and-answers.
 - Visit the Tech Support section of the ProRacing Sim Software website for additional tips and FAQs.

If you cannot find a solution to your problem, use the mail-in form on page 157. Mail the completed form to:

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3400 Democrat Road, Suite 207
Memphis, TN 38118
Tech: 901-259-2355, or visit our
Web: www.proracingsim.com
Email: support@proracingsim.com

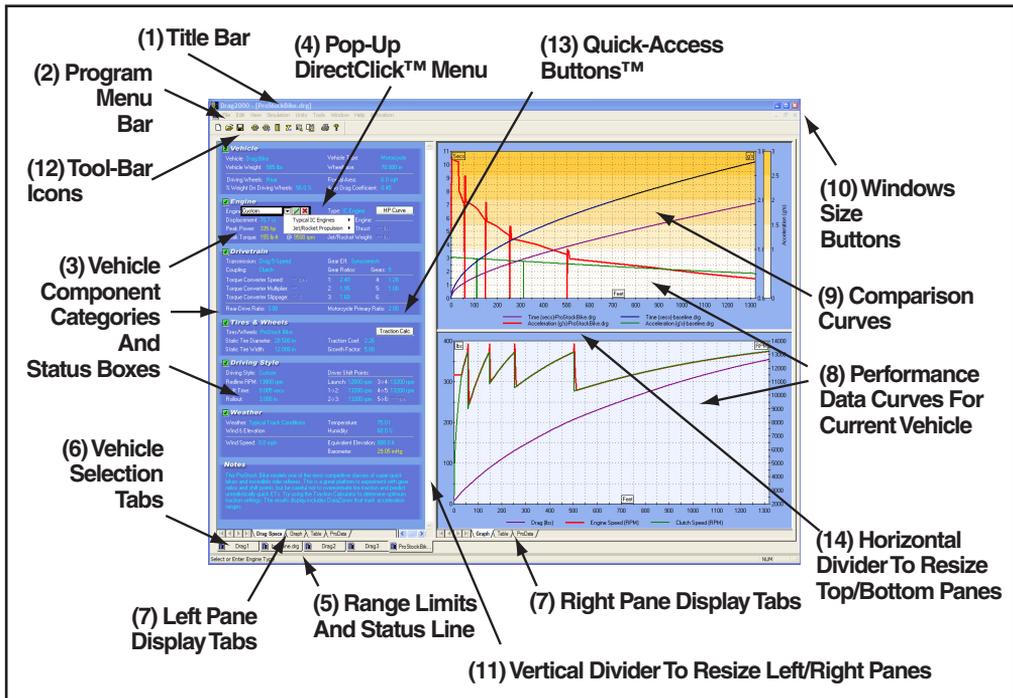
Support Note1: Tech support will only be provided to registered users. Please complete the *Registration Form* that appears when you first start your software to qualify for technical support from the ProRacing Sim Software staff.

Support Note2: If you need to change your address or any other personal information after you have registered this software, simply select *Registration* from the **Help** menu, make any necessary address changes, then press **Proceed** to send your updated info ProRacing Sim.



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OVERVIEW



THE MAIN PROGRAM SCREEN

The **Main Program Screen** allows you to select vehicle components, dimensions, and specifications. In addition, vehicle performance data curves and/or simulation numeric data is displayed in graphical and chart form. The Main Program Screen is composed of the following elements:

- 1) The **Title Bar** displays the program name followed by the name of the currently-selected vehicle filename.
- 2) The **Program Menu Bar** contains nine pull-down menus that control overall program function. Here is an overview of these control menus, from left to right

Program Overview

Program Menu Bar



Program Menu Bar contains nine pull-down menus that control overall program function.

(additional information on menu functions is provided elsewhere in this guide):

File—Opens and Saves drag test files, exports DOS Drag files to the Full Throttle Reaction Timer software, prints engine components and power curves, allows the quick selection of the most recently used Drag files, and contains an exit-program function.

Edit—Clears all component choices from the currently-selected vehicle (indicated by the *Vehicle Selection Tab* currently in the foreground; see **Vehicle Selection Tabs**, below).

View—Allows you to turn the **Toolbar**, **Status Bar** and **Workbook** layout on or off.

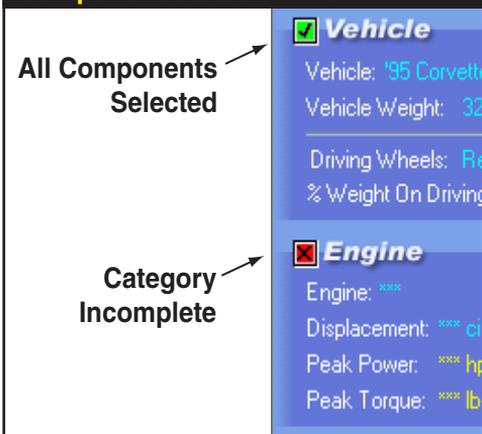
Simulation—**Run** forces an update of the current simulation. **Auto Run** enables or disables (toggles) automatic simulation updates when any vehicle component is modified. **1/8-Mile** and **1/4-Mile** selections set the length of the simulated drag race and rescale the graphs to reflect the new setting.

Units—Selects between **US** and **Metric** units.

Tools—Contains several tools and calculators that can be used to find optimum component combinations. The first two selections open the **Quick Iterator™** or **Prolterator™** (a *ProTools™* feature; see *Product Activation*, below). The **Time Slip** selection opens a quick-reference “time slip” that can be positioned anywhere on the DragSim window. The final selections allow **Engine Power Curve Data Entry** and **Importing DynoSim Engine Files**.

Window—A standard Windows menu for arranging and selecting simulation display screens.

Component Status Boxes



The **Component Status Check Boxes** are located in the upper left corner of each **Vehicle Component Category**. These boxes either contain a red boxed **X**, indicating that the category is not complete (inhibiting a simulation run), or a green-boxed checkmark **✓**, indicating that all components in that category have been selected.

Program Overview

Help—Gives access to this Users Guide, and other program help features.
Product Activation—Activates optional **ProTools™** features of the DragSim, including *ProIterator™*, *DataZones™* and other optional features (see page 74 for additional information on optional features).

3) The **Vehicle Component Categories** are made up of the following groups:

VEHICLE—Select the vehicle type, weight, and other vehicle specifications in this category.

ENGINE—Selects the type of engine (typical Internal Combustion [IC] or Jet/Rocket). Direct entry of horsepower data (in the form of a horsepower curve or peak power and torque values) is also supported.

DRIVETRAIN—Selects the transmission type, gear ratios, coupling (clutch or torque converter), rear-axle ratio, and other drivetrain specifications.

TIRES/WHEELS—Selects the type of tires and static diameter, wheel width, tire growth model, and traction coefficient.

DRIVING—Selects the engine redline, launch and shift rpms, shift time, and rollout distance.

WEATHER—Selects the temperature, barometric pressure, humidity, wind speed, and equivalent elevation.

NOTES—Enter any comments about the current simulation. Notes are saved with the vehicle *.DRG* file.

Note: Each component category (except *NOTES*) contains a **Status Check Box** located in the upper left corner. These boxes either contain a **red boxed X**, indicating that the category is not complete (inhibiting a simulation run), or a **green-boxed checkmark ✓**, indicating that all components in that category have been selected. When all component categories have green checks, a simulation will be performed using the current data values and the results will be displayed

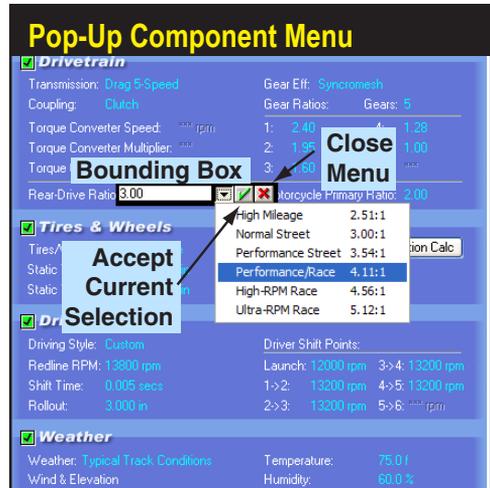
Component fields that do not yet contain valid entries are marked with a series of asterisks. This indicates that the fields are empty and (most) require data input. Numeric fields accept direct keyboard entry or selections from provided drop-down menus. Text selection fields (like the *Vehicle* or *Transmission* choice menus) only accept selections from the associated drop-down menus. When a valid selection has been made, it will replace the asterisks next to the field names.

Incomplete Component Fields

<input checked="" type="checkbox"/> Vehicle	
Vehicle: '85 Corvette	Vehicle Type: Automobile
Vehicle Weight: 3282 lbs	Wheelbase: 116.500 in
Driving Wheels: Rear	Frontal Area: 22.0 sqft
% Weight On Driving Wheels: 42.0 %	Aero Drag Coefficient: 0.32
<input checked="" type="checkbox"/> Engine	
Engine: ***	Type: IC Engine <input type="button" value="HP Curve"/>
Displacement: *** cu	Jet/Rocket Engine: _____
Peak Power: *** hp @ *** rpm	Jet/Rocket Thrust: *** lbs
Peak Torque: *** lb-ft @ *** rpm	Jet/Rocket Weight: *** lbs
<input checked="" type="checkbox"/> Drivetrain	
Transmission: ***	Great L1: _____
Coupling: ***	Gear Ratios: _____
Torque Converter Speed: *** rpm	Gears: ***
Torque Converter Multiplier: ***	1: _____ 4: _____
Torque Converter Slippage: *** %	2: _____ 5: _____
Rear Drive Ratio: ***	3: _____ 6: _____
	Motorcycle Primary Ratio: ***

Program Overview

The Pop-Up, DirectClick™ Component Menus list components and specifications for each of the Component Categories. Click on any component specification to open its menu. The menu will close when a selection is complete (or accept the current category by clicking on the green ✓). If you wish to close the menu before making a new selection, click the red X next to the drop-down box or press the Escape key until the menu closes.

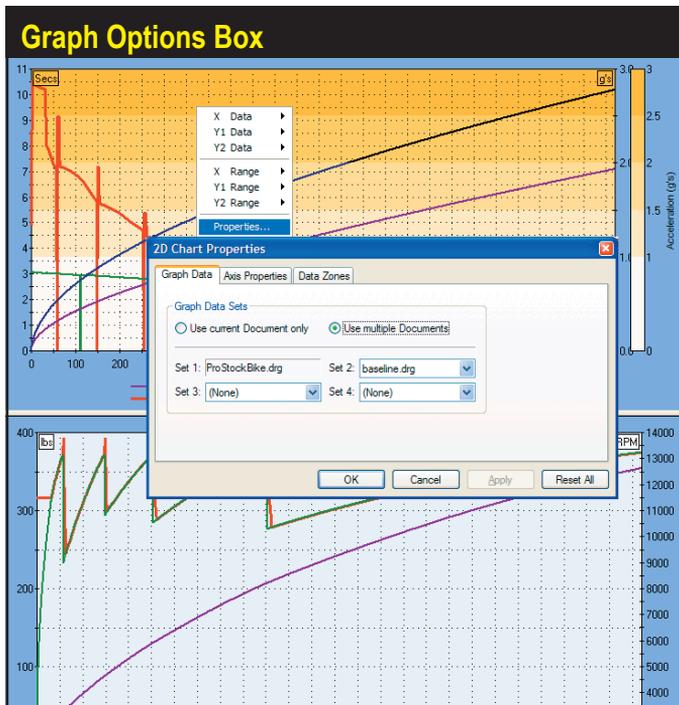


in the graph on the right of the Main Program Screen (the simulation and data plot will occur automatically providing **Autorun** is checked in the **Simulation** drop-down menu [default], see **Simulation Menu** description, above).

- 4) The **Drop-Down DirectClick™ Component Menus** contain components and specifications for each of the Component Category choices. Click on any component specification to open its menu. The menu will close when a selection is complete. If you wish to close the menu before making a new selection, click the red X next to the drop-down box or press the **Escape** key until the menu closes.
- 5) Several Component Category menus allow direct numeric entry. During this data entry, the range of acceptable values will be displayed in a **Range Limit And Status Line** at the bottom of the screen.
- 6) The Advanced and ProTools versions of the DragSim can simulate several vehicles at once. Switch between “active” vehicles by selecting one of the Tabs in the **Vehicle Selection Tabs**, just above the **Range Limit Line**. The currently-selected vehicle is indicated on the foreground Tab. The filename of the currently-selected vehicle is also displayed in the **Title Bar**.
- 7) The Main Program Screen is divided into three panes (the width and height of these panes is adjustable; drag the vertical and/or horizontal screen dividers to resize, see 11, below). The right and left panes contain **Screen Display Tabs**. Use the Tabs to switch the display in each pane to component lists and various data displays.
- 8) The **Current Performance Data Display Curves** display the acceleration, speed,

Program Overview

The graphic data displayed can be modified by right-clicking on either the upper or lower graph and reassigning each curve in the *Graph Options Menu*. In addition, you can use the *Properties...* choice available at the bottom of the Menu to setup comparisons between “active” vehicles.



shift points, clutch and tire slippage, and more about the simulated vehicle. The curves shown on page 14 are the default curves, however, the data displayed can be customized by right-clicking the graph and reassigning each curve in the **Graph Options Box**.

- 9) Use *Properties...* in the **Options Box** to setup comparisons between “active” vehicles.
- 10) The Main Program Screen also incorporates **Windows Size Buttons**. These buttons provide standard maximizing, minimizing, and closing functions common to all windows. Refer to your Windows documentation for more information on the use of these buttons.
- 11) The widths of program panes program panes are adjustable. Simply drag the **Vertical Screen Divider** to resize the Component-Selection and Graphics-Display panes. By dragging the **Vertical Screen Divider** to the left screen edge, the vehicle-performance graphs can be enlarged to full screen for maximum resolution.
- 12) The **Tool Bar** contains a series of icons that speed up the selection of commonly used program functions and features. The **Tool Bar** in the DragSim contains the

Program Overview

following icons: *Create New Vehicle*, *Open Saved Vehicle*, *Open Quick Iterator™*, *Open TimeSlip™*, *Open Power-Curve Dialog Box*, *Open DynoSim-File Importer*, *Print Current Vehicle Setup*, *Display Program “About Box.”*

- 13) Two component categories contain **QuickAccess Buttons™** that give “one-click” access to important data-entry functions and calculators. The **ENGINE** category contains an **HP Curve** button that opens the Power-Curve dialog box allowing direct entry of engine power data and importing DynoSim engine files; the **TIRES & TRACTION** category contains a **Traction Calc** button that opens the *Traction-Coefficient Calculator*, a tool that will determine an optimum traction coefficient for the current vehicle.
- 14) The height of right-hand, graphics-display panes are adjustable. Simply drag the **Horizontal Screen Divider** to resize the Graphics Displays. By dragging the **Horizontal Screen Divider** to the top or bottom of the screen, the upper or lower vehicle-performance graphs can be enlarged for maximum resolution.

USING THE MOUSE OR KEYBOARD TO BUILD A TEST VEHICLE

Begin using the DragSim by “assembling” a test vehicle from component parts. For example, select a basic chassis by using the **Vehicle** pull-down menu. Activate the menu by:

Mouse

- 1) Start the DragSim or select **New** from the **File** menu. All component categories start off empty, indicated by strings of asterisks (****) next to each incomplete selection.
- 2) Move the mouse cursor into the VEHICLE category and double click the left mouse button on the asterisks in the Vehicle component field.
- 3) When the component-menu bounding box appears, click on the ▼ symbol to open the Import/Domestic submenu.
- 4) Move the mouse pointer through the menu choices.
- 5) When the vehicle submenu opens, move the mouse cursor over your selected choice in the submenu.
- 6) Click the left mouse button on your selection. This loads the vehicle name, type (automobile or motorcycle), weight, wheelbase, location of driving wheels, percentage of weight on the driving wheels, frontal area, and the drag coefficient into the **VEHICLE** category. Note that the **red boxed X** (Status Box) on the left

Program Overview

of the **VEHICLE** category changed to a **green-boxed** checkmark ✓, indicating that all components in that category have been selected.

- 7) To close the menu without making a selection, click the red **X** on the right of the bounding box or press the **Escape** key until the menu closes.
- 8) Continue making component selections until all the category Status Boxes have changed to green. At this point a vehicle performance simulation will be performed and the results will be displayed on the graphs or tables on the right pane of the Main Program Screen.

Keyboard

- 1) Press and release the **Alt** key followed by the **F** key to highlight and open the File menu. Use the cursor-arrow keys to select **New**, then press **Enter** to create a new, blank component screen. All component categories start off empty, indicated by strings of asterisks (****) next to each incomplete selection.
Note: You can activate other menu choices—e.g., *Edit*, *View*, *Simulation*, etc., by pressing the **Right-Arrow** or **Left-Arrow** keys or by using the menu shortcuts (e.g., open the *Edit* menu by pressing **Alt E**).
- 2) A component menu bounding box is positioned around the **Vehicle** field in the VEHICLE category.
- 3) Press Enter to activate the box. Then press Tab to move the highlight (focus) to the ▼ symbol. Then press the **Spacebar** to open the **Vehicle** selection menu.
- 4) Use the **Up-Arrow** or **Down-Arrow** keys to scroll through the menu choices. When the menu selections direct you to submenus (a small arrow points to the right at the end of the menu line), use the **Right-Arrow** key to open the submenu.
- 5) When you have highlighted your choice, press **Enter** to make the selection. This loads the vehicle name, type (automobile or motorcycle), weight, wheelbase, location of driving wheels, percentage of weight on the driving wheels, frontal area, and the drag coefficient into the **VEHICLE** category. Note that the **red boxed X** (Status Box) on the left of the **VEHICLE** category changed to a **green-boxed** checkmark ✓, indicating that all components in that category have been selected.
Note: To close the menus without making a selection, press the **Escape** key.
- 6) Use the **TAB** key to move the component-selection bounding box to the next blank field (Engine). Continue making component selections until all the category Status Boxes have changed to green. At this point a vehicle simulation will be performed and test results will be displayed on the graphs or tables on the right panes of the Main Program Screen.

Program Overview

Fields Accepting Direct Input

Transmission: Drag 5-Speed
Coupling: Clutch
Torque Converter Speed: [redacted] rpm
Torque Converter Multiplier: [redacted]
Torque Converter Slippage: [redacted]

Rear-Drive Ratio: **3.00** [dropdown]

White Background:
Numeric input accepted. Enter value or make selection from drop-down menu.

Tires & Wheels:
High Mileage 2.51:1
Normal Street 3.00:1
Performance Street 3.54:1
Performance/Race 4.11:1
h-RPM Race 4.56:1
a-RPM Race 5.12:1

Weather: Typical Track Conditions
Temperature: 75.0 F
Humidity: 60.0 %
Wind Speed: 0.0 mph
Equivalent Elevation: 800.0 ft
Barometer: 29.05 inHg

Fields Not Accepting Direct Input

Transmission: Drag 5-Speed
Coupling: Clutch [dropdown]
Torque Converter Speed: [redacted] rpm
Torque Converter Multiplier: [redacted]
Torque Converter Slippage: [redacted]

Clutch [dropdown]

Gray Background:
No numeric input accepted. Make selection from drop-down menu.

Motorcycle Primary Ratio: 2.00
Traction Coef: 2.25
Growth Factor: 5.00

Component fields that support direct numeric entry have white bounding boxes (left). When the only selection possible is a choice from the drop-down menu, the bounding box will have a gray interior (below).

Note: The **Shift Tab** key combination will move the bounding box backwards to the previous component field.

DIRECT-ENTRY™ MENU CHOICES

When a component field supports direct numeric entry, the bounding box will have a white interior (see above photos). On the other hand, if the only selection possible is a choice from the drop-down menu, the bounding box will have a gray interior. The following menu choices permit direct data entry:

- Vehicle Weight
- Wheelbase
- Percentage Weight On Driving Wheels
- Frontal Area
- Drag Coefficient
- Engine Description
- Displacement
- Number Of Transmission Gears
- Gear Ratios (Trans, Rear Axle, and Motorcycle Primary, if applicable)
- Drive Wheel Width
- Traction Coefficient
- Growth Factor
- Tire Static Diameter
- Redline, Launch, and Shift Rpm's
- Shift Time
- Rollout
- Humidity

Program Overview

Wind Speed & Direction
Equivalent Elevation
Ambient Temperature

If you directly enter or select a new value from a pop-up menu, the new value will replace the currently displayed value. When you press **Enter** the new value will be tested for acceptability, and if it passes, it will be used in the next simulation run. If you press **Enter** without entering a new value, the currently displayed value remains unchanged.

Numeric Data entry into any field in the component-selection screen is limited to values over which the DragSim can accurately predict vehicle performance. The range limits are displayed in the **Range Limit And Status Line** located at the bottom-left corner of the Main Program Screen. If you enter an invalid number, the DragSim will sound the Windows error tone and wait for new input.

For example, to make direct numeric entry for **Frontal Area**, double-click on the current Area value (or asterisks). The range limits for **Frontal Area** will be displayed in the **Range Limit And Status Line** (in²). Make an entry within the acceptable range followed by **Enter**. If you select an invalid number, the DragSim will sound an error tone and wait for new entry.

THE MEANING OF SCREEN COLORS

The colors used on the component-selection screen provide information about various vehicle components and specifications. Here is a quick reference to screen color functionality:

White Field Labels: All vehicle component fields and specifications in each component category are displayed in white. These fields can be followed by either Yellow (calculated only) or Light Blue (changeable) values, as described below.

Yellow Numeric Values: Yellow specifications, such as Barometer, indicate that they are automatically calculated by program and cannot be directly altered.

Light Blue (cyan): All specifications that can be changed by the user through pull-down menus or direct numeric entry are displayed in light blue.



Advanced Drag-Race Simulation

COMPONENT MENUS

THE VEHICLE CATEGORY MENU

The **VEHICLE** component category is located at the top of the left pane on the Main Program Screen. This component grouping establishes the type of vehicle and the basic chassis configuration. This category has eight data-entry fields.

The **Vehicle** menu is located on the upper-left of the **VEHICLE** category. By opening this menu, you are presented with a variety of domestic and import “pre-loaded” vehicle configurations. If any one of these choices is selected, the appropriate vehicle name, type (automobile or motorcycle), weight, wheelbase, location of driving wheels, percentage of weight on the driving wheels, frontal area, and the drag coefficient are loaded into the **VEHICLE** category. In addition to, or instead of, selecting an existing vehicle configuration, you can directly enter individual vehicle specifications (within the acceptable range limits, displayed at the bottom of the screen in the **Range Limit And Status Line**).

What, Exactly, Is A “Vehicle”?

The **Vehicle** menu choices should be considered a “handy” list of some of the

Opening the **Vehicle** menu presents a variety of domestic and import “pre-loaded” vehicle configurations. Selecting any one loads the appropriate vehicle name, type (automobile or motorcycle), weight, wheelbase, location of driving wheels, percentage of weight on the driving wheels, frontal area, and the drag coefficient into the **VEHICLE** category. In addition, you can directly enter custom specifications in most component fields.

VEHICLE Component Category

Vehicle

Vehicle: Pro Stock	Vehicle Type: Automobile
Vehicle Weight: 2350 lbs	Wheelbase: 105.000 in
Driving Wheels: Rear	Frontal Area: 21.0 sqft
% Weight On Driving Wheels: 49.0 %	Aero Drag Coefficient: 0.22

Engine

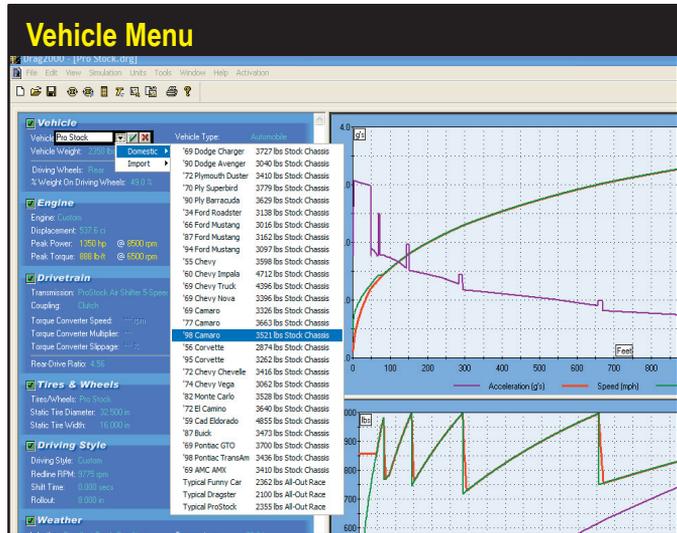
Engine: Custom	Type: IC Engine HP Curve
Displacement: 537.6 cu	Jet/Rocket Engine: ---
Peak Power: 1350 hp @ 6500 rpm	Jet/Rocket Thrust: --- lbs
Peak Torque: 888 lb-ft @ 6500 rpm	Jet/Rocket Weight: --- lbs

Drivetrain

Transmission: ProStock Air Shifter 5-Speed	Gear Eff: Synchronesh
Coupling: Clutch	Gear Ratios: Gears: 5
Torque Converter Speed: --- rpm	1: --- 4: ---

VEHICLE Category Menus

The domestic and import **Vehicle** component menus contain “preset” vehicle specifications that you can instantly select and use in a simulation. In addition, you can modify any of these vehicles with custom wheelbase, weight, frontal area, and other specs.



common specifications of a vehicle. The selection of any vehicle from this menu does not assume the use of any specific engine, trans, gear ratios, etc. The **Vehicle** menu loads only the specifications included in the **VEHICLE** category into the simulation database.

Each of the fields in this category are used by the simulation to determine acceleration and performance. Here is a short description of each **VEHICLE** component field:

Vehicle: The description of the vehicle as selected from the **Vehicle** menu is displayed here for easy reference. You may also change, modify, or enter your own vehicle description in this field. The vehicle name is an information-only field that has no direct effect on the simulation

Type: The vehicle types are either **Automobile** or **Motorcycle**. If changing the vehicle **Type** affects other components (such as **Motorcycle Primary Ratio**), a pop-up message box will be displayed.

Vehicle Weight: This is the total, static weight of the vehicle (the sum of the weights on each of the wheels). This field is used to determine the mass of the vehicle, and in combination with the **% Weight On Driving Wheels** and **Wheelbase** fields, to calculate the dynamic weight on the rear wheels throughout the race.

Wheelbase: The **Wheelbase** field indicates the distance between the front- and rear-axle centerlines, measured in inches (or millimeters). This value is used by the simulation, in part, to determine the center of gravity of the vehicle and the weight transfer during acceleration.

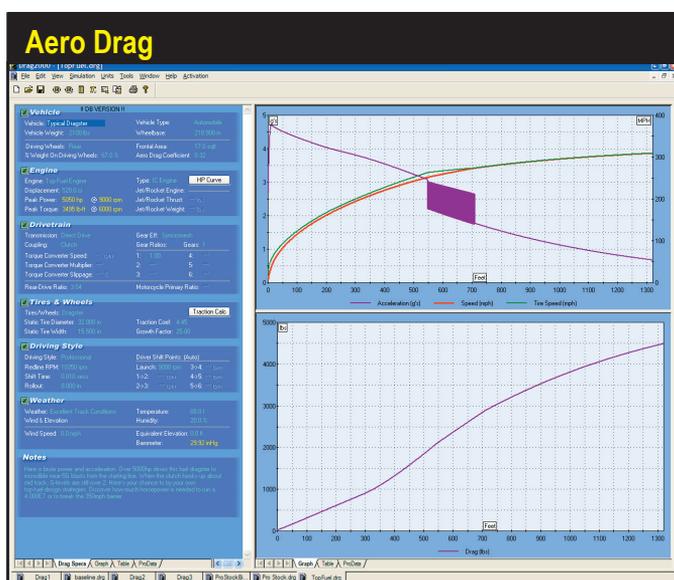
VEHICLE Category Menu

Driving Wheels: The Driving Wheel field accepts either **Front** or **Rear** entries. This field is used by the simulation to determine whether engine torque is applied to the front or rear wheels.

% Weight On Driving Wheels: The **Percentage Of Weight On Driving Wheels** field accepts a number that indicates the percentage of total vehicle weight that rests on the driving wheels (defined as either **Front** or **Rear** in the previous **Driving Wheels** field) as the vehicle sits, static, on the starting line, before the race.

Frontal Area: This field displays the square-foot area displaced as the vehicle moves forward through the air. Combined with the **Aero Drag Coefficient** (discussed next) the DragSim will determine the aerodynamic drag (in pounds) resisting the forward movement of the vehicle throughout the race.

Note: If you do not know the **Frontal Area** of the vehicle you would like to model, you can select a vehicle with a similar front-body design from the **Vehicle** menu. You can also calculate the **Frontal Area** by drawing representations of the main components of the front of the vehicle as rectangles on graph paper. For example, to determine the displaced area of the windshield, measure the true height of the windshield (the height of the top of windshield to the ground minus the height of the bottom of the windshield to the ground) and its width in inches and draw a rectangle of the same (scaled; perhaps 1 foot equals 1 inch) dimensions. Then multiply the height by the width and divide by 144 to obtain the square-foot frontal area of the windshield. Continue this process for the hood, grill, bumper, tires, and all surfaces that you can view from the front of the vehicle; the surfaces that deflect air as the vehicle moves forward. When you add up the area of all of the measured surfaces, you will have determined the **Frontal Area** of the vehicle.



Total Drag, as displayed in the DragSim (lower graph), is the force from wind and rolling resistance that resists forward motion. Notice how Drag increases as this Top Fuel dragster approaches 300mph. Nearly 5000 pounds of force are resisting forward movement (due, in part, to a high-downforce wing model used by the DragSim when modeling 200+mph vehicles).

ENGINE Category Menu

Aero Drag Coefficient: The final field in the **VEHICLE** component category, this is the ratio of the actual aerodynamic drag of the vehicle (usually measured in a wind tunnel) compared to the calculated drag of a flat-front object (like a box, generating the highest possible wind resistance) with the same Frontal Area. Smaller numbers indicate that the vehicle can move more efficiently through the air. The **Aero Drag Coefficient** is always less than 1.0.

Note: If you do not know the **Aero Drag Coefficient** of the vehicle you would like to model, you can select vehicles with a similar front-body designs from the **Vehicle** menu and, based on the coefficients displayed for these vehicles, you can make an “educated guess” of a coefficient that would approximate your vehicle.

THE ENGINE CATEGORY MENUS

The **ENGINE** component category establishes the type of engine used in the simulated vehicle and its basic power curve or thrust rating. This category has five data-entry fields (and five additional data display-only fields).

The menu selections in the **ENGINE** category are:

Engine: This menu is located in the upper-left corner of the **ENGINE** component category. This menu first presents two options:

Option 1) Choosing **Typical IC Engines** (**IC** stands for **I**nternal **C**ombustion; taken here, loosely, to mean piston-type engines) opens an additional menu from which you can load and test power curves from groups of Street, Track, or Race engines. At the bottom of this menu, you can select **Custom Engine Power Curve** which opens an additional dialog box that allows direct entry of any engine

ENGINE Component Category

Vehicle Type: **ProStock**

Vehicle Weight: **2350 lbs** Wheelbase: **105.000 in**

Driving Wheels: **Rear** Frontal Area: **21.0 sqft**

% Weight On Driving Wheels: **49.0 %** Aero Drag Coefficient: **0.22**

Engine

Engine: **Custom** Type: **IC Engine** **HP Curve**

Displacement: **537.6 ci** Jet/Rocket Engine: _____

Peak Power: **1350 hp** @ **8500 rpm** Jet/Rocket Thrust: ****** lbf**

Peak Torque: **888 lb-ft** @ **6500 rpm** Jet/Rocket Weight: ****** lbf**

Drivetrain

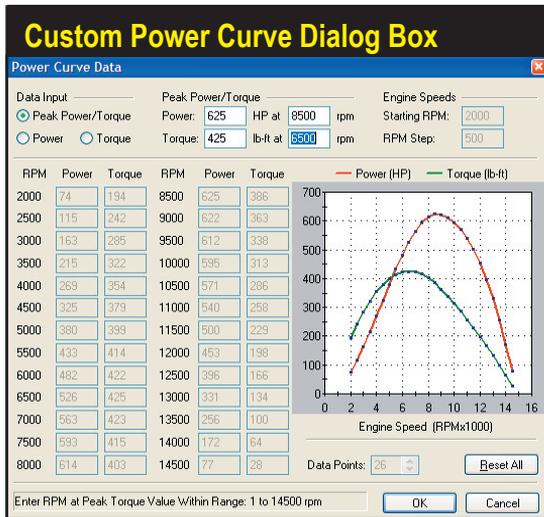
Transmission: **ProStock As Shifter 5-Speed** Gear Eff: **Synchronesh**

Coupling: **Clutch** Gear Ratios: Gears: **5**

Torque Converter Speed: **** rpm	1: 2.40	4: 1.24
Torque Converter Multiplier: ****	2: 1.39	5: 1.00
Torque Converter Slippage: **** %	3: 1.59	6: ****

The **ENGINE** component category establishes the basic type of engine used in the simulated vehicle and its power curve or thrust rating.

ENGINE Category Menus



The *Custom Power Curve* dialog box is versatile tool that you can use to quickly enter horsepower or torque values to define an engine power curve. Instead, if you only have *Peak Torque* and *Peak Horsepower* values, you can enter these in the *Peak Power/Torque* fields and the DragSim will automatically calculate the entire power curve.

power curve (the engine power curve dialog box can also be opened with the **HP Curve** button, discussed below). Finally, you can select **Import DynoSim Engine File**, which allows you to load and test any engine modeled in the DynoSim Advanced Engine Simulation.

Option 2) Jet/Rocket Propulsion can be chosen instead of **Typical IC Engines**. This option allows you to select any one of 14 aircraft-type jet engines with thrust values ranging from 30- to over 11,000-pounds (you can also enter up to 125,000 pounds of thrust in the **Jet/Rocket Thrust** field, described below). Further information on these menu choices follow:

Typical IC Engines: Opens a submenu that lists three groups of typical Street, Track, and Race engines. Use these choices to quickly load an engine power curve and displacement into a test vehicle. The power curves from these choices can be easily modified by clicking the **HP Curve** button.

Custom Engine Power Curve: This selection opens the **Custom Engine Power Curve** dialog box that allows direct entry of power/torque values or, by entering the peak torque and horsepower values, the DragSim can calculate the horsepower curve. Here are tips in using this dialog box.

Note: The **Custom Engine Power Curve** dialog box may be opened at any time by either clicking the **Custom Power Curve** icon in the Toolbar, by selecting **Custom Engine Power Curve** from the Tools menu (located in the Menu Bar), or by clicking on the **HP Curve** button in the **ENGINE** component category.

How To Directly Enter A Power/Torque Curve: To activate this method of data entry, click on either the **Power** or **Torque** radio button located at

ENGINE Category Menus

You can directly enter engine power curve data by clicking on either the **Power** or **Torque** radio buttons. If you select **Power**, the program will accept horsepower values; if you select **Torque**, the program allows the direct entry of torque values. The **Start** and **Step Rpm** values (located in the top-right corner of the dialog box) determine at what rpm the power curve begins and the speed increase for each power point up to 30 data-entry points or 16,000 rpm.

Using The Direct Data Entry Method

Power Curve Data

Data Input: Peak Power/Torque Power Torque

Peak Power/Torque: Power: 1350 HP at 8500 rpm Torque: 888 lb-ft at 6500 rpm

Engine Speeds: Starting RPM: 2000 RPM Step: 500

RPM	Power	Torque	RPM	Power	Torque
2000	154	404	8500	1350	834
2500	241	506	9000	1343	784
3000	340	595	9500	1296	716
3500	449	674	10000	1235	649
4000	563	739			
4500	679	792			
5000	794	834			
5500	905	864			
6000	1008	882			
6500	1099	888			
7000	1179	885			
7500	1249	875			
8000	1306	857			

Engine Speed (RPMx1000)

Data Points: 17

the top-left of the dialog box. If you select **Power**, the program will accept horsepower values; if you select **Torque**, the program allows the direct entry of torque values. The **Start Rpm** and **Step Rpm** values (located in the top-right corner of the dialog box, default to 2000 and 500rpm, respectively) determine at what rpm the power curve begins and the speed increase for each power point, up to 30 data-entry points or 16,000 rpm maximum. If you wish to extend the power curve beyond 16,000 rpm, simply increase the **Start** or **Step Rpm**.

Important Note: Set up the **Start** and **Step** values **BEFORE** you enter the power curve, or you may not obtain the power curve you desire. *If you change either the **Step** or **Start Rpm** values after a power curve has been entered, the program will attempt to change only the power-curve-rpm points; the horsepower and torque values will remain unchanged. In addition, if you select an rpm range that invalidates some of the power-point values used by the program (like shift rpm or redline rpm) some of the horsepower and torque values may be altered by the program to “fill-in” the discrepancy. As a result, we recommend that you establish the **Start** and **Step** values **BEFORE** you enter any power curve data and only change **Start** and **Step** values with caution.*

At this point you can enter the first horsepower or torque value, press the **TAB** key, and the *related torque or horsepower value* will be calculated and placed in the adjacent field. When you have entered the final value power-curve value, press **Enter** or click **OK** to close the dialog box and load the power curve into the simulation.

Tip: If you need to expand the power curve to higher rpm values, click the **up-arrow** next to the **Data Points** field (just above the **OK** button); or re-

ENGINE Category Menus

Using The Peak Power/Torque Method

Power Curve Data

Data Input: Peak Power/Torque Power Torque

Peak Power/Torque: Power: 625 HP at 8500 rpm
Torque: 425 lb-ft at 8500 rpm

Engine Speeds: Starting RPM: 2000
RPM Step: 500

RPM	Power	Torque	RPM	Power	Torque
2000	74	134	8500	625	386
2500	115	242	9000	622	363
3000	163	285	9500	612	338
3500	215	322	10000	595	313
4000	269	354	10500	571	286
4500	325	379	11000	540	258
5000	380	399	11500	500	229
5500	433	414	12000	453	198
6000	482	422	12500	396	166
6500	526	425	13000	331	134
7000	563	423	13500	256	100
7500	593	415	14000	172	64
8000	614	403	14500	77	28

Data Points: 26

Enter RPM at Peak Torque Value Within Range: 1 to 14500 rpm

The *Peak Power/Torque* data entry method lets the DragSim calculate the entire power curve from the peak-horsepower and peak-torque values (often published in “road tests” in magazines or books). To activate this method, click on the *Peak Power/Torque* radio button. When peak horsepower and torque values have been entered, the DragSim will extrapolate a complete horsepower and torque curve and replace any existing power values with the new, calculated values.

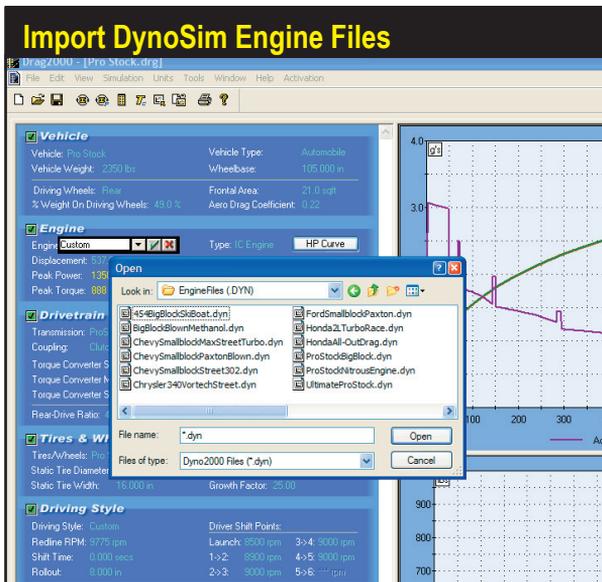
duce the number of power values by clicking on the **down-arrow** indicator. When you expand the number of power points, the horsepower value in the last entry field is duplicated in the added fields, however the torque value is recalculated for higher rpm values.

How To Enter Peak Power/Torque: The Peak Power/Torque data entry method allows the DragSim to calculate the entire power curve from peak-horsepower and peak-torque values (sometimes published in magazines or books). To activate this method of data entry, click on the **Peak Power/Torque** radio button located at the top-left of the dialog box. When activated, the individual Torque and Power fields for all rpm points are dimmed. When the peak horsepower and torque values are entered in the fields located at the top-center of the dialog box, the DragSim will extrapolate a complete horsepower and torque curve and replace any existing power values with the new, calculated values. Press **Enter** or click **OK** to transfer these the new calculated values to the simulation; click **Cancel** to discard any changes and revert to previous power values.

Note: If the horsepower and torque curve extrapolated from Peak values has an unusual “bump” or “dip,” it is probably caused by using Peak Horsepower or Peak Torque values that do not correspond to the Peak RPM points entered in the Power Curve dialog box. The DragSim will always attempt to draw power and torque curves that pass through the entered peak power and torque points. If these values don’t correspond with each other, a non-uniform curve will be generated.

Import DynoSim Engine Files: The DragSim will directly import DynoSim

ENGINE Category Menus



The DragSim will directly import DynoSim engine files. To load a DynoSim test engine, select **Import DynoSim Engine File** from the **Typical IC Engine** submenu. A file-open dialog box allows you select any DynoSim file on your system. The default location for DynoSim engine files is **C:\DynoSim\EngineFiles (.DYN)**

engine files. To load a DynoSim test engine into the simulated vehicle, select **Import DynoSim Engine File** from the **Engine/Typical IC Engine** submenu (or click on the **Import DynoSim** icon in the Toolbar). A file-open dialog box allows you select any DynoSim file on your system. The default location for DynoSim files is **C:\DynoSim\EngineFiles (.DYN)**.

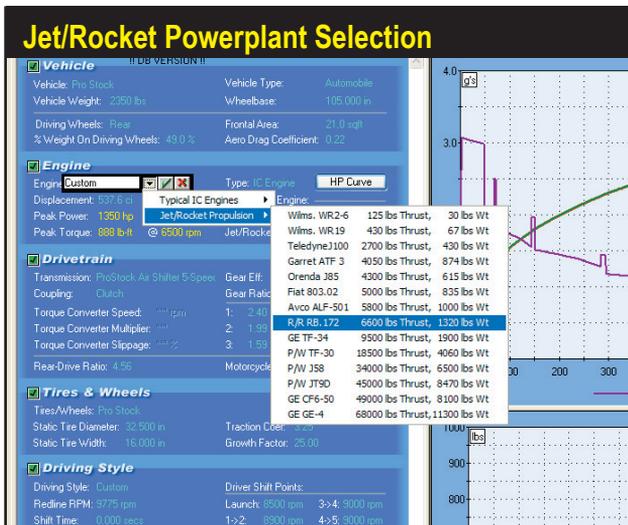
Note: If Shift, Redline, or Launch Rpm values of the current simulated vehicle map to zero values in the imported DynoSim engine file, the program will warn you that some rpm points reference zero horsepower values. To correct this problem, the DragSim will null the shift and/or redline rpms, allowing you to either set new shift rpm values that match the new power curve or you can open the **Custom Power Curve Dialog** box and extend the rpm range of the imported power curve. (If you don't know the power values for higher rpms, simply extend the curve using the final power value; this technique produces acceptable results).

Jet/Rocket Propulsion: This choice from the **Engine/Jet-Rocket Propulsion** submenu opens a list of 14 jet and/or rocket engines and indicates the thrust rating for each powerplant in pounds. Selecting any of these engines will display a message box indicating that several fields on the main component screen will not be used when simulating jet/rocket powered vehicles (like most Drivetrain components, Shift Points, etc.) and will be dimmed, however, their values are not erased; they are simply "ignored" while the Jet/Rocket engine selection is active.

The engine weight of many Jet/Rocket powerplants vary from relatively light to substantially greater than typical automotive engines. To compensate for

DRIVETRAIN Category Menus

Jet and Rocket engines can be tested in the DragSim. The *Jet/Rocket Propulsion* submenu lists 14 jet/rocket powerplants, and you can DirectClick™ on *Jet/Rocket Thrust* and *Jet/Rocket Weight* fields and enter your own custom specs. Selecting any of these engines will display a message box indicating that several fields on the main component screen will be dimmed during *Jet/Rocket* simulations.



this wide-ranging weight, the weight of the engine is entered as a separate specification in the **Engine Weight** field. When *Jet/Rocket* propulsion is used, the **Engine Weight** is added to **Vehicle Weight** (in the **VEHICLE** Category) to determine **Total Vehicle Weight** used during drag testing.

Note 1: You can directly enter your own custom specs for both **Jet/Rocket Thrust** and **Jet/Rocket Weight** in the fields provided in the **ENGINE** Category.

Note 2: To switch back to an IC engine from jet/rocket propulsion, click the *check box* next to **IC Engine** at the top-right of the **ENGINE** Category (resets the IC engine to the same powerplant used before *Jet/Rocket* was selected). Likewise, to switch back to a *Jet/Rocket* powerplant from IC engine power, click the *check box* next to **Jet/Rocket Engine** at the top-left of the **ENGINE** Category.

Displacement: For IC Engine powerplants, enter the displacement of the engine in this field. This value is not used to determine engine power, rather it is used to calculate the “rotational inertia” of the engine. This is a property of the engine (and all matter) that resists changes in speed. Rotational inertial hinders performance in a drag vehicle because the engine must not only accelerate the vehicle (and the driveline), it must also accelerate its own internal components (and repeat the process several times in vehicles with multiple-gear transmissions). The larger the engine, the greater the weight of these components, and the larger the losses from rotational inertia.

THE DRIVETRAIN CATEGORY MENUS

The **DRIVETRAIN** component category establishes the method of engine coupling to the remainder of the drivetrain (usually the transmission) and other basic driveline

DRIVETRAIN Category Menus

DRIVETRAIN Component Category

Displacement: 537.5 cc Jet/Rocket Engine: _____
Peak Power: 1350 hp @ 8500 rpm Jet/Rocket Thrust: [---] [B] [S]
Peak Torque: 898 lb-ft @ 6500 rpm Jet/Rocket Weight: [---] [B] [S]

Drivetrain

Transmission: ProStock Air Shifter 5-Speed Gear Eff: Synchronesh
Coupling: Clutch Gear Ratios: Gears: 5
Torque Converter Speed: [---] rpm 1: 2.40 4: 1.24
Torque Converter Multiplier: [---] 2: 1.99 5: 1.00
Torque Converter Slippage: [---] % 3: 1.59 6: [---]
Rear-Drive Ratio: 4.56 Motorcycle Primary Ratio: [---]

Tires & Wheels

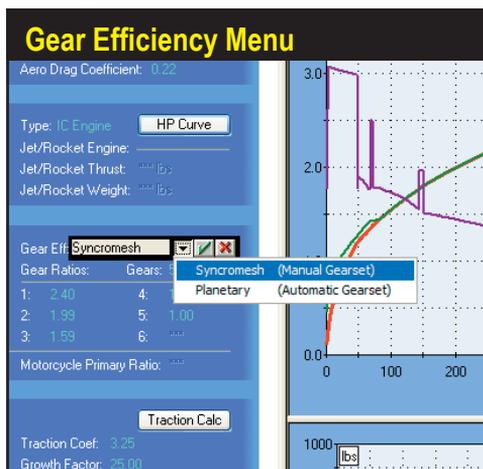
Tires/Wheels: Pro Stock Traction Calc
Static Tire Diameter: 32.500 in Traction Coef: 3.25
Static Tire Width: 15.000 in Growth Factor: 25.00

The DRIVETRAIN component category establishes the method of engine coupling and other basic transmission and driveline specifications.

specifications. This category has fifteen data-entry fields. The menu selections in the **DRIVETRAIN** category are detailed below:

Transmission: Located on the upper-left of the DRIVELINE category, this menu offers an extensive list of Manual and Automatic transmissions for both domestic and import applications. When you select any of the transmission types, the **Number Of Gears**, the **Gear Ratios**, and the **Gear Efficiency** are loaded into DRIVELINE component fields. It is also possible to DirectClick™ on any of these DRIVETRAIN data fields and enter custom transmission specs.

Note: The **Coupling Method** (either a **Clutch** or a **Torque Converter**) can be selected separately from the transmission type and is NOT determined automatically from a Transmission menu selection (**Coupling** is described later).



The **Gear Efficiency** menu selection establishes the power losses through the transmission gears. Manual transmissions are assumed to have Synchronesh gears that are, typically, 98% or more efficient. Automatic transmissions have Planetary gear sets and are slightly less efficient, typically 95%. However, **Gear Efficiency** is not directly linked to the Transmission Type, so it is possible to independently switch the **Gear Efficiency** between Synchronesh and Planetary for any transmission and measure the change in vehicle performance.

DRIVETRAIN Category Menus

The **Coupling** menu allows the selection of either a **Clutch** or a **Torque Converter**. Keep in mind that the **Transmission** (Manual or Automatic), **Gear Efficiency** (Synchromesh or Planetary), and **Coupling** (Clutch or Torque Converter) can be separately selected and independently evaluated by the simulation.



Gear Efficiency: This menu selection establishes the power losses through transmission gears. Manual transmissions are assumed to have **Synchromesh** gears that are, typically, 98% or more efficient. Automatic transmissions have **Planetary** gear sets and are slightly less efficient, typically 95%. **Gear Efficiency** is not directly linked to the Transmission Type, so it is possible to independently select the **Gear Efficiency** for any transmission and measure the changes in vehicle performance.

Number Of Gears: The **Gears** menu establishes the number of forward gear ratios for the transmission. You can choose **1** (for direct drive) to **6** forward gears.

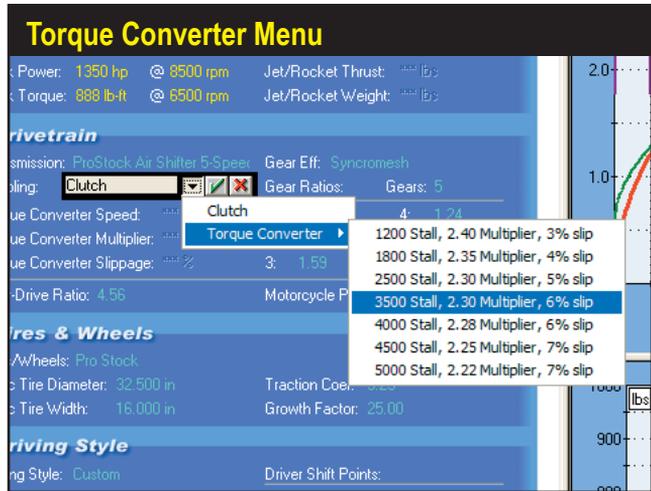
Transmission Gear Ratios: The DragSim will impose rules upon the entry of each transmission **Gear Ratio**. Each higher gear (2nd, 3rd, etc.) must be numerically lower than the previous gear, and all ratios must fall between 9.99:1 and 0.50:1.

Coupling: This menu allows the selection of either **Clutch** or **Torque Converter** coupling between the engine and the transmission. As mentioned earlier, this choice is completely independent of the **Transmission** or **Gear Efficiency** selections. In fact it is possible to “assemble” and test any of these driveline combinations:

- **Manual Transmission With A Clutch**
 - **Automatic Transmission With A Torque Converter**
- and the following two combinations are also possible:
- **Manual Transmission With A Torque Converter**
 - **Automatic Transmission With A Clutch**

While it may be rare (or impossible) to build either of the last two combinations in

DRIVETRAIN Category Menus



The *Torque Converter* sub-menu offers seven torque converter combinations. When any of these are selected, the appropriate *Stall Rpm*, *Torque Multiplier*, and *Slip* percentage will be loaded into the DRIVETRAIN category. It is also possible to DirectClick™ any of these data fields and enter custom values for *Stall*, *Multiplier*, and *Slip*.

In the real world, the DragSim makes it possible to try these unusual combinations. Keep in mind that the *Transmission* (**Manual** or **Automatic**), *Gear Efficiency* (**Synchromesh** or **Planetary**), and *Coupling* (**Clutch** or **Torque Converter**) can be separately selected and independently evaluated by the simulation.

Clutch: This *Power Coupling* method activates a sophisticated clutch model in the DragSim. The clutch will automatically adjust itself to the power, weight, and driving characteristics of the vehicle. It will offer sufficient slippage at the starting line to absorb high shock loads to the drivetrain. It will provide a near-slip-free shifts and hook up solidly during the remainder of the run. As horsepower increases, the clutch model will change to accommodate the needs of 2000+ horsepower applications (it even works with Top-Fuel dragsters and Funny Cars). You can consider the DragSim clutch model to be near-optimum, and the ETs predicted with this model to be in-line with competitive vehicles.

Torque Converter: This menu choice opens the *Torque Converter* submenu that offers seven torque-converter combinations. When any of these choices are selected, the appropriate *Stall Rpm*, *Torque Multiplier*, and *Slip* percentage will be loaded into the DRIVETRAIN category. It is also possible to DirectClick™ any of these DRIVETRAIN data fields and enter custom values.

The torque converter is composed of an impeller, turbine, and a stator fitted with blades that direct fluid and power flow. The engine drives the impeller that imparts energy into internal fluid. The turbine is attached to the input shaft of the transmission and is driven by the fluid flow generated by the turbine. The stator, locked to a fixed shaft, does not rotate. This stationary stator redirects fluid flow against the impeller and raises the torque on the turbine higher than the load imparted by the impeller alone. This *Torque Multiplication* dramatically increases efficiency and performance at the starting line. Typical torque multi-

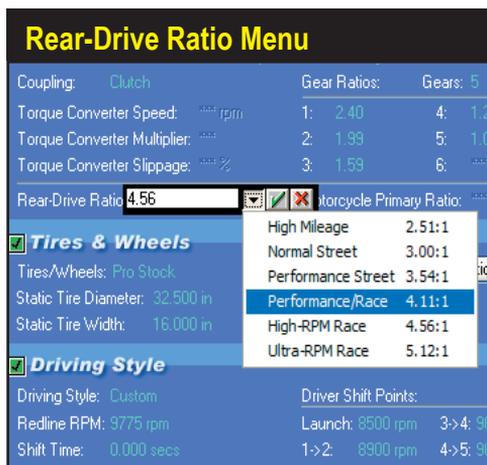
DRIVETRAIN Category Menus

pliers range from 1.9 to 2.5 for most automotive applications. In other words, the torque (lb-ft) measured at the turbine (input to the transmission before the vehicle begins to move) is 1.9- to 2.5-times greater than the torque generated by the engine.

Since the torque converter is a “fluid coupling,” it can never be as efficient as a clutch (some passenger-car torque converters incorporate a clutch that “locks up” the converter at higher road speeds and improves cruising efficiency; lockup converters are not modeled in the DragSim). The built-in inefficiency in all torque converters is measured (in part) as a **Slip Percentage**. The higher the slip, the greater the rpm difference between the input and output rpm above the stall speed (discussed next). Typical automotive torque converters slip between 6 and 15%.

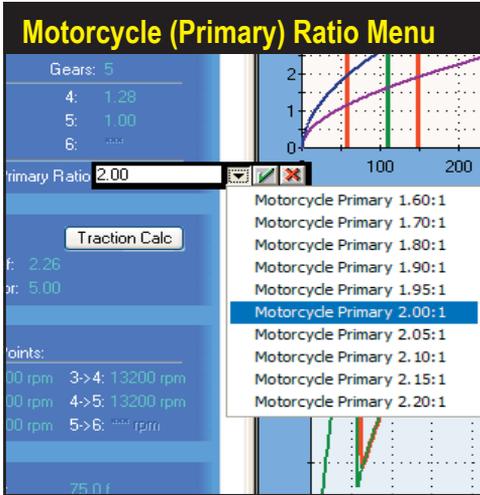
Finally, every torque converter has a rated **Stall Speed** that indicates the maximum engine speed that can be achieved at wide-open throttle with the vehicle standing still (i.e., before the transmission input shaft begins to rotate). For street applications, a low stall speed (1000 to 1500rpm) optimizes the efficiency of the converter and takes advantage of the low-speed torque capability of stock engines. Racing engines, on the other hand, produce peak torque at much higher engine speeds. To accommodate these higher speeds, a torque converter can be modified to stall at higher rpm (3000 to 5000 or more). At these speeds, a racing engine transfers near-peak torque loads to the rear wheels at the starting line, assuring maximum acceleration. However, high stall speeds also reduce low-speed efficiency and can dramatically increase transmissions fluid temperatures.

Rear-Drive Ratio: The **Rear-Drive Ratio** is the numerical gear ratio of the rear driving axle—or in the case of front-wheel drive vehicles, the front driving axle. This ratio indicates the number of turns the driveshaft (or pinion gear) rotates for each revolution of the rear wheels. The **Rear-Drive Ratio** submenu includes six



The **Rear-Drive Ratio** is the numerical gear ratio of the front or rear driving axle, depending on whether the vehicle is front- or rear-wheel drive. This ratio indicates the number of turns the drive-shaft (or pinion gear) rotates for each revolution of the rear wheels.

TIRES/WHEELS Category Menus



Many motorcycles have a primary speed reduction located within the engine case. This drive ratio is the (internal) crankshaft-to-primary-sprocket ratio (not including the standard transmission gear ratios). When a *Motorcycle Vehicle Type* is has been selected (see the **VEHICLE** category), the *Motorcycle Ratio* field in the **DRIVELINE** category is activated. The *Motorcycle Ratio* submenu includes several possible primary ratios from 1.60:1 to 2.20:1. You may also DirectClick™ this field to enter custom primary ratios from 9.99:1 to 0.50:1.

common (automotive) rear-drive or rear-axle ratios, ranging from 2.51:1 to 5.12:1. It is also possible to DirectClick™ on *Rear-Drive Ratio* and enter a custom ratio between 9.99:1 to 0.50:1.

Motorcycle (Primary) Ratios: Many motorcycles have two ratios of speed reduction from the engine crankshaft to the rear wheel (not including the transmission gears). The typical primary-drive-sprocket (external, front) to secondary-drive-sprocket (external, rear) ratio is analogous to the common automotive *Rear-Drive Ratio*. This reduction is often called the *chain ratio*. This secondary, external (chain) ratio is setup in the DragSim by selecting the appropriate *Rear-Drive Ratio*, as described above. Motorcycles often incorporate an additional *primary speed reduction* located within the engine case, defined as the speed ratio between the (internal) crankshaft and the primary-sprocket (again, this does not include any reduction due to transmission gears). When a *Motorcycle Vehicle Type* is has been selected (see the **VEHICLE** category on page 24), the *Motorcycle Ratio* field is activated. The submenu includes several possible primary ratios from 1.60:1 to 2.20:1. You may also DirectClick™ the *Motorcycle Ratio* data field and enter custom primary ratios from 9.99:1 to 0.50:1.

Note 1: The overall drive ratio (less the transmission) for motorcycles can be found by *multiplying* the *Rear-Drive Ratio* by the *Motorcycle Ratio*.

Note 2: If the motorcycle you are modeling does not use a Primary gear reduction, set the *Motorcycle Ratio* to 1.00.

THE TIRES/WHEELS CATEGORY MENUS

The **TIRES/WHEELS** component category determines traction and other basic tire and wheel specifications. The menu selections and component fields are detailed below:

TIRES/WHEELS Category Menus

TIRES/WHEELS Component Category

Torque Converter Speed: <input type="text"/> rpm	1: 2.40	4: 1.24
Torque Converter Multiplier: <input type="text"/>	2: 1.33	5: 1.00
Torque Converter Slippage: <input type="text"/> %	3: 1.53	6: <input type="text"/>

Rear-Drive Ratio: 4.56 Motorcycle Primary Ratio:

Tires & Wheels

Tires/Wheels: **Pro Stock**

Static Tire Diameter: 32.500 in Traction Coef: 3.25
Static Tire Width: 16.000 in Growth Factor: 25.00

Driving Style

Driving Style: **Custom** Driver Shift Points:

Redline RPM: 3775 rpm Launch: 3500 rpm 3->4: 3000 rpm
Shift Time: 0.000 secs 1->2: 3900 rpm 4->5: 3000 rpm
Roll-over: 0.000 secs 2->3: 3500 rpm 5->6: 3000 rpm

The TIRES/WHEELS component category determines traction and other basic tire and wheel specifications. The **Traction Calc** button opens the Traction Calculator, a **ProTool™** that will help you determine optimum traction values.

Tires/Wheels: Located on the upper-left of the TIRES/WHEELS category, this menu presents several “pre-selected” choices for tires and wheels for various applications, from street to drag-race-only vehicles. Each menu selection loads the application description, the **Drive-Tire Width**, **Traction Coefficient**, **Tire Growth Factor**, and the **Static Tire Diameter** (for the driving wheels). It is also possible to DirectClick™ any of these data fields and enter custom specifications. A further description of these data fields follows:

Drive-Tire Width: This is the width of the tire at the ground-contact patch. This field, along with Static Diameter, helps determine the mass and rotational inertia of the driving tires and wheels (these are the forces that must be overcome to rotate the wheels and drive the vehicle forward).

Important Note: **Drive-Tire Width** is NOT USED TO CALCULATE TIRE TRACTION. Traction is directly entered in the **Traction Coefficient** field (described next).

Traction Coefficient: Because tire traction is a real-world variable that changes with track and tire temperatures, rubber compounds, track conditions, traction-enhancing chemicals, varying torque loads, weight transfer and a slew of other unpredictable elements, the DragSim “standardizes” this variable by assigning a numeric value to traction. This concept allows the simulation to accurately model how the tires will react to varying force at the driving wheels. An entry in the **Traction Coefficient** field, along with **Vehicle Weight** (in the VEHICLE category), allows the simulation to calculate, at each instant throughout the race, whether the driving tires will “grip,” slightly slip (“haze”), or “spin” in clouds of tire smoke. For example, a **Traction** value of 2.00 on a wheel carrying 600 pounds of weight will allow 1200 pounds of acceleration force at the contact

TIRES/WHEELS Category Menus

at the starting line; a situation that is may not match real-world conditions and can produce unrealistically quick ET predictions. To prevent this, a slightly lower **Traction** value (one that shows some tire slip during the first 10- to 30-feet) often will better model tire traction and produce more accurate ETs.

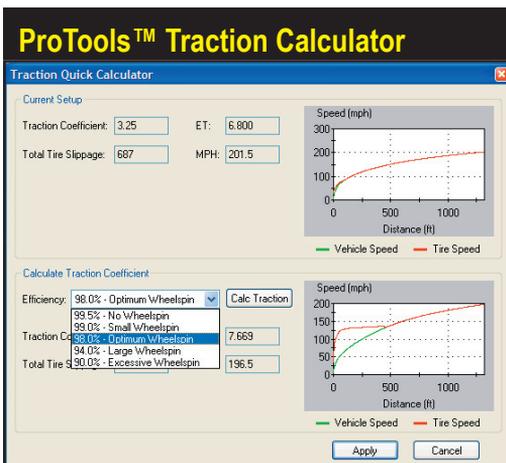
For most vehicles (under 2000hp) we recommend using this technique:

- 1) Build an optimized component combination
- 2) Select a high **Traction** value (producing no wheelspin)
- 3) Decrease the **Traction** value until some tire slippage is detected near the starting line.

ProTools™ Note: If you have activated **ProTools™** features, a **Traction Calculator** can be used (by clicking on the **Traction Calc** button in the **Tires & Wheels Category**) to help you determine optimum traction values. Enter how efficient the tires transfer power to the ground throughout the entire race (typically 98-to-99%), and the **Traction Calculator** will search for a **Traction** value that will produce this degree of tire slip.

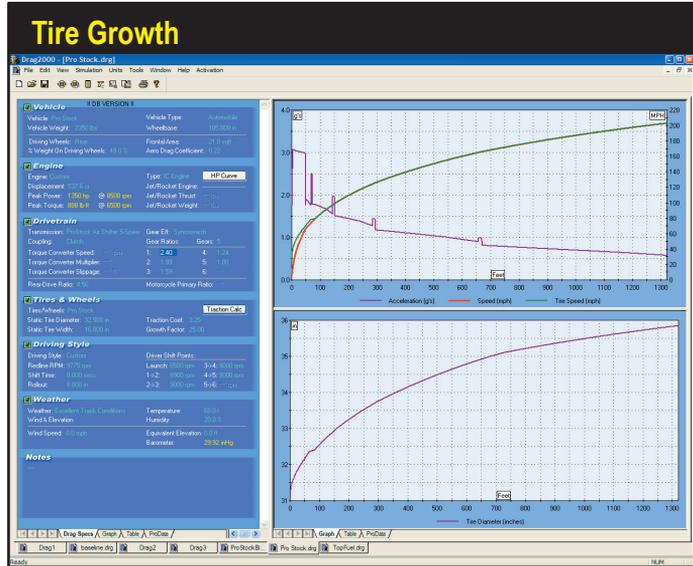
When tire slip occurs, the green tire-speed line (on the upper data graph) moves away from the red vehicle-speed line (indicating that the wheels are spinning faster than the vehicle is moving). When a vehicle is setup properly (both in the DragSim and on a real race track), tire slippage will be minimized but not eliminated during the first 30, 60, or 100 feet. At higher vehicle speeds, tire speed should match vehicle speed (the green and red speed lines should remain together). The most common exception to this occurs when modeling extremely powerful vehicles (with 2000+ horsepower) that often generate tire slip at just about any point on the track. In these situations, you'll find that locating a precise **Traction** value that allows some tire slippage near the starting line and good traction down the track can be difficult. For example, a value of 4.20 may allow too much tire slippage, while a value of 4.25 won't allow any. This

The **Traction Calculator**, available as a **ProTool™** feature, can be used (by clicking on the **Traction Calc** button in the **Tires & Wheels Category**) to help determine optimum traction values. Enter how efficient the tires transfer power to the ground throughout the race (typically 98-to-99%), and the **Traction Calculator** will perform an iterative search for a **Traction** value that will produce this degree of tire slip.



TIRES/WHEELS Category Menus

As the vehicle accelerates, the tires are subjected to centripetal loads that causes them to increase in diameter (wheel/tire diameter is shown in the lower plot on right). This increase in diameter changes the overall drivetrain “gear ratio.” To ensure accurate performance predictions, the DragSim incorporates a *Tire Growth* model that recalculates the “effective” gear ratio at each 0.001 second throughout the race.



same difficult tuning job occurs at the race track, except in this case, racers are trying to optimize traction by careful, and often illusive, clutch tuning (in effect, real-world clutch tuning and determining the optimum **Traction Coefficient** in the DragSim, are—at least when modeling extremely powerful vehicles—in the same issue).

Growth Factor: As the vehicle accelerates through the race and speed increases, the tires are subjected to centripetal loads that causes them to increase in diameter. This increase in diameter dramatically changes the overall drivetrain “gear ratio.” To ensure accurate performance predictions, the DragSim incorporates a *Tire Growth* model that recalculates the “effective” gear ratio at each 0.001 second throughout the race. The tire-growth model is established by entering a value between 0 (zero) and 30 in the **Growth Factor** field. A zero

Use **Growth Factor** to match the engine rpm to vehicle speed (mph) as the vehicle passes through the top-end lights.

Growth Factor also helps establish a “tire-squat” model for initial acceleration from the starting line. Drag slicks, modeled with **Growth Factors** of 15 or more, have weak sidewalls that distort during hard, initial acceleration. A large **Growth Factor** value applies a more aggressive tire-squat model to low-speed acceleration.

Optimizing Tire Growth Modeling

Drivetrain

Transmission: ProStock Air Shifter 5/Speed Gear Eff: Synchronesh
 Coupling: Clutch Gear Ratios: Gear: 5
 Torque Converter Speed: rpm 1: 2.40 4: 1.24
 Torque Converter Multiplier: rpm 2: 1.93 5: 1.00
 Torque Converter Slippage: rpm 3: 1.53 6: rpm
 Rear-Drive Ratio: 4.55 Motorcycle Primary Ratio: rpm

Tires & Wheels

Tires/Wheels: Pro Stock Traction Calc
 Static Tire Diameter: 32.500 in Traction Coef: 0.28
 Static Tire Width: 16.000 in Growth Factor: 25.00

Driving Style

Driving Style: Custom Driver Shift Points:
 Redline RPM: 3775 rpm Launch: 3900 rpm 3>4: 9000 rpm
 Shift Time: 0.000 secs 1>2: 3900 rpm 4>5: 9000 rpm
 Rollout: 8.000 in 2>3: 9000 rpm 5>6: rpm

DRIVING Category Menu

value turns off the growth model, entirely. Values between 1 and 10 add only small growth effects, while values between 20 and 30 instruct the simulation to apply much more aggressive tire-growth modeling to the driving wheels. Street tires with short, sturdy sidewalls grow very little (Growth Factors from zero to 5 typically model these tires accurately). Eight- to ten-inch drag slicks have much more flexible construction and markedly grow in diameter as speed increases (Growth Factors between 6 and 15 often work well in these applications). Very wide drag slicks, as used on Pro Stockers and dragsters, grow even more (Growth Factors from 16 to 28 usually apply the best growth modeling). Growth Factor numbers do not have a linear affect. Values between zero and 10 add only small growth affects; while numbers between 10 and 30 add increasing logarithmic growth.

Note1: If you know the speed (mph) and engine rpm of a particular vehicle as it passes through the top-end lights, you can adjust the **Growth Factor** until the top-end speed duplicates the known engine rpm, matching the tire growth for that vehicle. Then any additional changes you make, such as gear ratio modifications, etc., will continue to model accurately the tire growth for that vehicle.

Note2: The Growth Factor also helps establish a “tire squat” model that affects initial acceleration from the starting line. Drag slicks, with Growth Factors of 15 or more, have weak sidewalls that distort during hard, initial acceleration. This distortion not only increases the area of the contact patch, but also reduces the radius of the tires as measured from the center of the axle to the track surface. Tire squat effectively increases the numeric gear ratio of the overall drivetrain and can improve first-gear acceleration. As the **Growth Factor** is increased, a more aggressive tire-squat model is applied automatically to starting-line acceleration modeling.

DRIVING Component Category

Tires & Wheels

Tires/Wheels: Pro Stock Traction Calc

Static Tire Diameter: 32.500 in Traction Coef: 3.25

Static Tire Width: 16.000 in Growth Factor: 25.00

Driving Style

Driving Style: Professional Driver Shift Points: [Auto]

Redline RPM: 9775 rpm Launch: 8500 rpm 3->4: 9350 rpm

Shift Time: 0.010 secs 1->2: 9350 rpm 4->5: 9350 rpm

Rollout: 8.000 in 2->3: 9350 rpm 5->6: 9350 rpm

Weather

Weather: Excellent Track Conditions Temperature: 68.0 F

Wind & Elevation Humidity: 20.0 %

Wind Speed: 0.0 mph Equivalent Elevation: 0.0 ft

The DRIVING component category determines the shift points, the launch rpm, and other basic driving/driver characteristics.

DRIVING Category Menus

Built-In Driving Style Defaults

Launch Rpm (Torque Converter)	Launch Rpm (Clutch)	Shift Rpm	Redline Rpm	Shift Time (Clutch)	Shift Time (Torque Converter)	Rollout
Conservative Driving Style						
Converter-Stall Rpm	Power-Peak Rpm - 60%	Power-Peak Rpm	Power-Peak Rpm + 5%	0.250-seconds	Zero	Zero
Aggressive Driving Style						
Converter-Stall Rpm	Power-Peak Rpm - 30%	Power-Peak Rpm + 5%	Power-Peak Rpm + 10%	0.100-seconds	Zero	6-inches
Professional Driving Style						
Converter-Stall Rpm	Power-Peak Rpm	Power-Peak Rpm + 10%	Power-Peak Rpm + 15%	0.010-seconds	Zero	8-inches

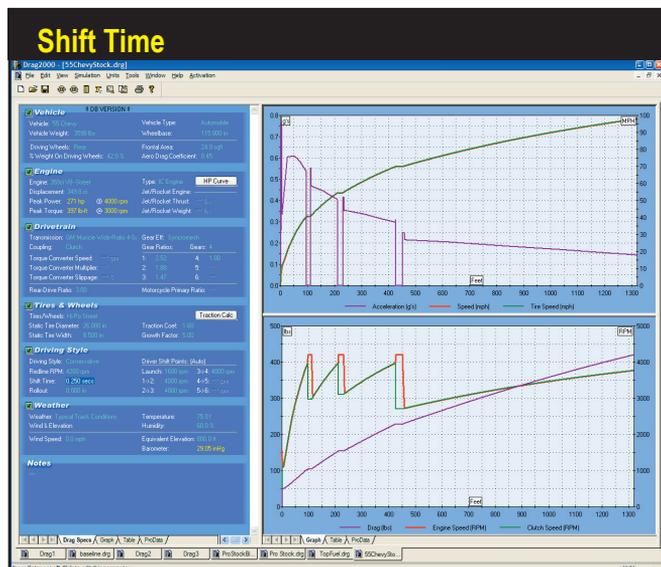
The *Driving Style* menu offers a simple and easy way to establish *Launch* and *Shift Rpm*s, *Redline Rpm*, *Shift Times*, and *Rollout* distance. Each of the three choices in this menu (Conservative, Aggressive, and Professional) apply unique model to these variables and emulate a specific driving style.

Static Tire Diameter: This is the diameter of the driving tires measured as they sit, stationary, at the starting line. *Static Tire Diameter* is used, as previously described, to determine the rotational inertia of the wheels, and—combined with *Growth Factor* (discussed previously)—is essential in determining engine rpm as the vehicle accelerates throughout the race.

THE DRIVING CATEGORY MENUS

The **DRIVING** component category determines the shift points, the launch rpm, and other basic driving/driver characteristics. The menu selections and component

During the *Shift Time* the driveline is effectively in “neutral,” sending the engine to the redline and the acceleration to zero. When the shift time has elapsed, the next gear is engaged and the vehicle continues to accelerate. The *Shift Times* on this vehicle are clearly visible as “spikes” during each upshift.



DRIVING Category Menus

fields are detailed below:

Driving Style: This menu offers a simple and easy way to establish **Launch** and **Shift Rpm**, **Redline Rpm**, **Shift Time**, and **Rollout** distance. Each of the choices in this menu apply unique model to these variables. The models are illustrated in the **Driving Style Defaults** table on page 43.

The three basic **Driving Style** choices offer a quick way to select the variables needed to simulate most straight-line racing scenarios. Each selection directs the DragSim to determine a specific launch, shift, and redline rpm points by analyzing the current engine power curve (visible by selecting the **Engine**, **IC Engine**, **Custom Power Curve** menus in the ENGINE category). An appropriate transmission shift time and rollout distance are also applied to each menu selection. It is also possible to DirectClick™ on any of these calculated data fields and enter custom values.

Redline Rpm: This is the maximum rpm allowed for the engine. The DragSim will never let the engine exceed this value. If the **Redline Rpm** is reached before the transmission shifts into the next gear (or before the vehicle reaches the end of the track in high gear) vehicle acceleration will drop to zero and vehicle speed will no longer increase. Various, automatic, pop-up QuickCheck™ Wizards may be invoked during the entry of values in the DRIVING category. If a user-entered **Redline Rpm** value is lower than the **Converter Stall**, **Shift Rpm**, or **Launch Rpm**, a Wizard will display an error message and offer a solution.

Shift Time: This value only applies to vehicles that use **Clutch Engagement**

Various, automatic, pop-up QuickCheck™ Data Wizards may be invoked during the entry of Rpm and other Driving Style values. For example, if a **Launch Rpm** value is higher than the **Redline**, **Stall Rpm**, or next-gear **Shift Rpm** a Wizard will display a warning message and offer a solution.



DRIVING Category Menus

(**Torque Converter** shift times are set to zero, since power flow to the driving wheels is not interrupted during a shift). During the **Shift Time** the driveline is effectively in “neutral,” sending the engine to the redline and the acceleration to zero. When the shift time has elapsed, the next gear is engaged and the vehicle continues to accelerate.

Rollout: This is the distance that the front wheels are “staged” or positioned behind the light beam that begins the timer for the drag race. Long **Rollout** distances give the vehicle a “flying start,” since it is already moving forward when it breaks the start beam of the elapsed timer. This is called “shallow” staging (because the vehicle is positioned just within the legal staging zone before the starting line), and it produces the best ETs and MPHs. Short or zero-rollout distances locate the front wheels nearer the elapsed timer start beam. This means that the timer is tripped almost immediately as the vehicle begins to move forward. This “deep” staging technique produces the slowest ETs and MPHs. However, in actual side-by-side racing, deep staging locates the vehicle slightly closer to the finish line (by up to several inches). Since the winning vehicle is usually the one that reaches the finish line first, deep staging can be an advantage in the real world of drag racing. **Rollout** can varied in the DragSim from 0 (zero) to 18 inches (some drag strips permit a maximum rollout of only 8 inches).

Launch Rpm: The speed of the engine just before the vehicle begins to move forward in the race is the **Launch Rpm**. For vehicles with **Clutch Engagement**, the **Launch Rpm** is the engine speed just before the clutch is engaged at the starting line. For “slipper” clutches, the **Launch Rpm** is the maximum engine speed that can be reached before the vehicle brakes are overpowered by clutch engagement. For **Torque Converters**, the **Launch Rpm** is the engine speed just before the throttle is opened **or** before the vehicle begins to move forward. In this application, **Launch Rpm** will never exceed the **Stall Speed** (see the DRIVETRAIN category for more information on Stall Speed). However, the **Launch Rpm** can be lower than the **Stall Speed** (this driving technique is sometimes used to “shock” the converter into slightly exceeding its rated **Stall Speed** and produce better initial acceleration). Various, automatic, QuickCheck™ Wizards may be invoked during the entry of **Launch Rpm** values. For example, if a **Launch Rpm** value is higher than the **Redline** or **Stall Rpm**, a Wizard will display a warning message and offer a solution.

Shift Rpm: The **Shift Rpm** fields determine the engine speeds at which the transmission shifts into the next higher gear. The DragSim uses the **Number Of Gears** field in the DRIVETRAIN category to determine the number of legal **Shift Rpm** fields. Data entry in each **Shift Rpm** field is carefully controlled to ensure reliable, accurate vehicle modeling. Various QuickCheck™ Wizards may be invoked during the entry of **Shift Rpm** values. For example, if a **1>2 Shift**

WEATHER Category Menus

WEATHER Component Category

Driving Style

Driving Style: Custom	Driver Shift Points:
Redline RPM: 13800 rpm	Launch: 12000 rpm 3->4: 13200 rpm
Shift Time: 0.005 secs	1->2: 13200 rpm 4->5: 13200 rpm
Rollout: 3.000 in	2->3: 13200 rpm 5->6: 13200 rpm

Weather

Weather: Typical Track Conditions	Temperature: 75.0 f
Wind & Elevation	Humidity: 60.0 %
Wind Speed: 0.0 mph	Equivalent Elevation: 800.0 ft
	Barometer: 29.05 inHg

Notes

This ProStock Bike models one of the most competitive classes of super-quick bikes and incredible rider reflexes. This is a great platform to experiment with gear ratios and shift points, but be careful not to overestimate tire traction and predict unrealistically quick ET's. Try using the Traction Calculator to determine optimum traction settings. The results display includes DataZones that mark acceleration ranges.

The **WEATHER** component category determines the ambient temperature, humidity and other basic weather conditions that exist during the race.

Rpm value is too close to the **Launch Rpm**, the transmission may skip gears. To prevent this, a Wizard will display a warning message and offer a solution.

THE WEATHER CATEGORY MENUS

The **WEATHER** component category determines the ambient temperature, humidity and other basic weather conditions that exist during the race. The menu selections and component fields in this category are detailed below:

Weather: This field allows you to select several common weather scenarios that exist during vehicle testing. Each menu selection loads default values for **Temperature**, **Wind**, **Humidity**, and **Equivalent Elevation**, simplifying and standardizing vehicle test conditions. In most cases, the selection of **Typical Race Track Conditions** from the **Weather** menu will produce the most accurate ET predictions during daytime conditions at “near-sea-level” race tracks. Optimum, or “track record” runs can usually be modeled with the **Excellent Track Conditions** choice. It is also possible to DirectClick™ on any of these data fields and enter custom values.

Humidity: Indicates the moisture (water) content of the air. The higher the water content, the less oxygen will be available for combustion. As oxygen content is reduced, engine power output will be factored. In addition, water vapor tends to quench combustion, so it further acts to reduce horsepower. Optimum power is produced at 0% humidity.

WEATHER Category Menus

Equivalent Elevation: This field accepts the altitude above sea level for the race simulation, assuming the barometric pressure at sea level is 29.92 inches of mercury (see the note, below). As altitude is increased, the atmospheric pressure (called barometric pressure) decreases, reducing the oxygen available for combustion. As oxygen content is reduced, engine power output will be factored. Elevation values from -2000 feet (below sea level) to 30,000 feet (above sea level) can be used for testing.

Note: The **Barometric Pressure** displayed in the WEATHER category is calculated from **Equivalent Elevation**. The calculated barometric pressure and the actual barometric pressure at the race track may be quite different. This is due, primarily, to the barometric pressure at sea level varying from the assumed standard of 29.92 inches of mercury. For example, if the actual elevation of a track is 1000ft, an **Equivalent Elevation** of 1800ft may be required to reproduce the barometric pressure reading taken at the track at the time of the race. *If the barometric pressure is known, enter an **Equivalent Elevation** that reproduces that same barometric pressure to obtain the most accurate simulation results.*

Wind: This data field establishes the ambient wind conditions during the race. The **Wind** conditions are used to determine overall vehicle drag. Positive values indicate a headwind (working against forward vehicle motion) and negative values simulate a tailwind (assisting forward motion). **Wind** values from -200 to 200mph are permitted. If the wind is not blowing directly along the centerline of the track, multiply the **Wind** speed by the cosine of the angle between the wind direction and the centerline of the track to determine the Equivalent Wind speed. For example, if a 100mph wind is blowing at a 45° angle to the front of the vehicle, the Equivalent Wind speed would be $100 \times \cos(45^\circ) = 100 \times .707 = 70.7$ mph.

Temperature: This field accepts the ambient air temperature. In combination with the **Humidity** and **Elevation**, the DragSim is able to calculate the oxygen content of inducted air. As oxygen content is reduced, engine power output will be factored. The **Temperature** field will accept -50°F to +180°F.



Advanced Drag-Race Simulation

SIMULATION RESULTS

(1) Main Program Results Screen

(2) Underlying Results Graph

(5) Underlying Table

(3) Axis Scaling

(6) Pop-Up TimeSlip

(2) Underlying Graph

(5) Underlying Table

(7) Underlying ProData™ Table

Windows Size Buttons

(2) Results Graphs

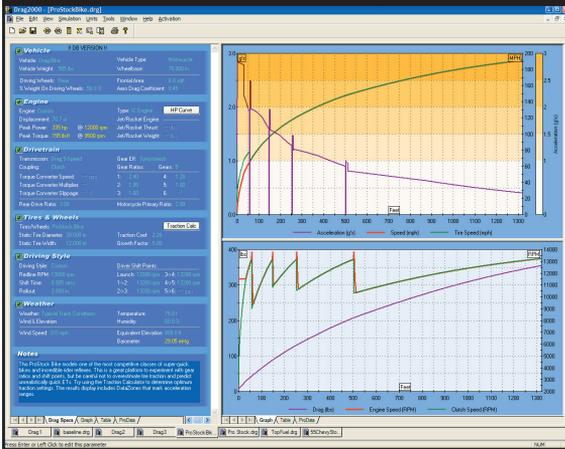
(4) Data Zones™ (ProTools™)

(4) Graph Options Box

The speed and ease of engine component entry in the DragSim is complemented by the power and versatility of the simulation results displays. Almost the same instant that all the component categories have been completed (all categories have green Status Boxes) the simulation results will be displayed on fully-scalable precision graphs. The default graphs begin at the starting line, marked by the left vertical axis, and continue to the end of the 1/4- or 1/8-mile, designated by the right vertical axis. The curves plotted on these graphs are the result of a comprehensive mathematical analysis of the forces acting on the vehicle, every one-thousandth of a second, as it moves down the track. The data graphs are fully customizable and will display virtually any performance variable on any axis. Auto scaling or manual axis scaling are easily setup by right-clicking within any graph. Up to four vehicles can be compared at once. And you'll find a comprehensive "table" display of elapsed

Simulation Results Displays

Two Panes Of Results Screen



Race results are displayed in top-and-bottom screen windows (called panes). The two results graphs on the right are the program default displays. The top graph is a *Speed Combo Plot* and the lower graph displays an *Rpm Combo Plot*.

times and speeds at various distances, acceleration and rpm data, times in each gear, horsepower and torque of the current engine and more.

The **Simulation Results** display, shown above and on the previous page, is composed of several elements that help retrieve the most information from any simulation test. An overview of each of these elements follows:

- 1) The **Main Program Screen** is divided into three sections (called panes), with the component selection categories on the left and the result graphs on the right (by default). The vertical and horizontal dividers between each pane can be moved (click and drag) to increase the size of the results screen to suit your requirements. The graphs will redraw and rescale to take advantage of

The horizontal and vertical screen dividers can be moved to allow the graph more display area.

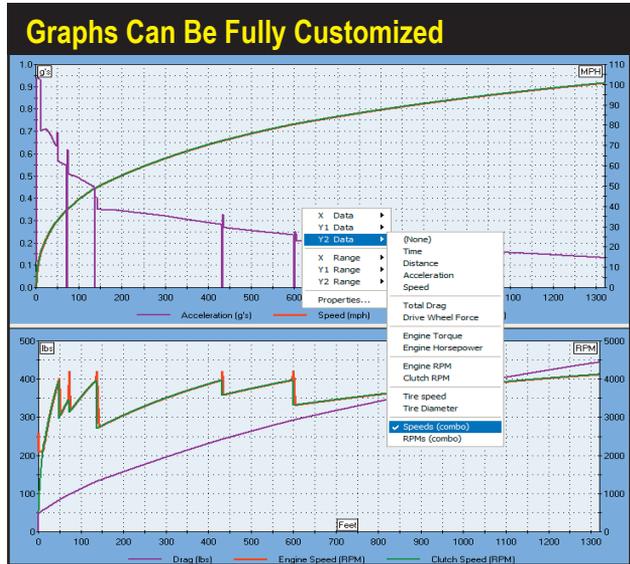
This display shows the dividers moved up and to the left to display graph data nearly "full screen."

Move Pane Dividers To Increase Graph Detail



Simulation Results Displays

Each of the results graphs consist of three axis; a left, right, and bottom (horizontal) axis. Each of these axis can be assigned an engine or vehicle data variable. Right click on the graph to display the *Graph Options Submenu* (or select *Properties*) to assign variables to graph axis (or display one of the *Speed* or *Rpm Combo Plots*). The DragSim will graph *Time*, *Distance*, *Acceleration*, *Vehicle Speed*, *Tire Speed*, *Engine Torque*, *Engine Horsepower*, *Engine Rpm*, *Clutch Rpm*, *Total Drag*, and *Tire Diameter*.



changes in display area.

- Each **Result Graph** consists of three axis, a left and right (vertical), and bottom (horizontal) axis. The upper graph displays Vehicle Acceleration, Vehicle Speed, and Tire Speed. This **Speed Combo Plot** indicates, for example, if the driving tires are slipping (shown by the green **Tire Speed** line moving away from the red **Vehicle Speed** line). The purple **Acceleration** line shows “Gs” at the starting line, at the shift points, and as vehicle travels throughout the race. The lower **Rpm Combo Plot** graph displays **Clutch Rpm** (can be thought of as transmission input-shaft rpm), **Engine Rpm**, and **Total Vehicle Drag** (total vehicle drag consists of both rolling resistance and aerodynamic drag). The red line indicates **Engine Rpm**, the green line shows **Clutch Rpm**. The posi-



Each graph includes a **Zoom** feature that you can use to closely examine any data set. Hold the **SHIFT** key down, press and hold the left mouse button, then drag a box around the graph area you wish to enlarge. When you release the mouse, the graph will redraw and zoom-in on the selected area. Reset the graph to the default scaling by either pressing the “r” key (for reset), or select **RUN** from the Simulation program menu.

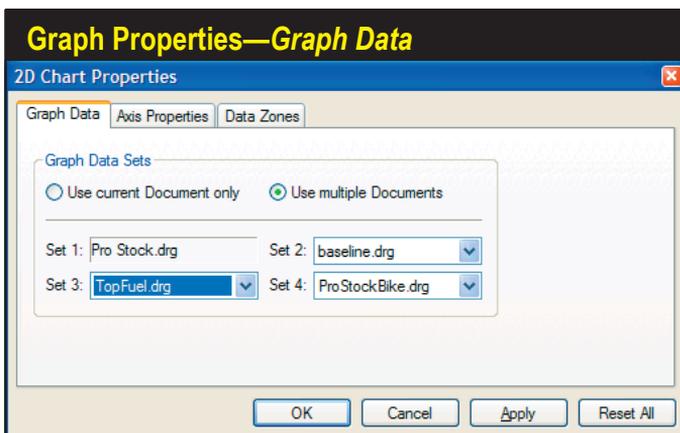
Simulation Results Displays

tions and differences between these lines indicate clutch or torque-converter slippage, stall speed, launch rpm, shift rpm, and redline limits.

Each graph axis can be reassigned to at least one variable. The DragSim will graph the following data: Time, Distance, Acceleration, Vehicle Speed, Tire Speed, Engine Torque, Engine Horsepower, Engine Rpm, Clutch Rpm, Total Drag, and Tire Diameter. *Right-Click* any graph to display the **Graph Options Submenu** and assign performance data to graph axis.

- 3) The results graphs support several methods of **Axis Scaling**. Each axis will scale to low, medium, high, and auto-scale ranges. When auto-scaling is turned off, the axis values remain constant, establishing a fixed baseline for direct curve comparison. Small values will display near the bottom of the graph; large values will position curves near the top of the graph or even disappear beyond the top margin. On the other hand, auto-scaling ensures that the data curves are always visible and display at 80 to 90% of full graph height for maximum resolution. When the same units are displayed on the left and right vertical axis, the DragSim will use “Intelligent Auto-Scaling” that maintains the same scaling for both axis (scaling values are determined by the minimum and maximum values derived from BOTH curves), making comparisons between data curves easier and more accurate.
- 4) Right click on the graph to open the **Graph Options Submenu**, then select **Properties**. This will open a dialog box that has allows three tabbed data pages:

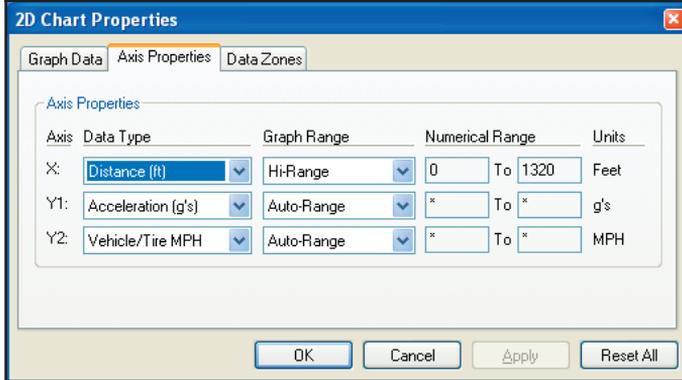
Graph Data—Use the **Graph Data Sets** page to establish on-graph comparison of up to four vehicles at once. The vehicles you wish to include in the comparison must be “open” with active tabs in the **Vehicle Selection Tabs** at the bottom of the Main Program Screen. Use the **Graph Data Sets** drop-down menus to select from currently-open vehicles. When you click **Apply** or **OK**, the graph will redraw with the desired data comparisons. A legend at the



Use the **Graph Data Properties** dialog box to establish on-graph comparison of up to four vehicles. Select the comparison vehicles from the **Graph Data Sets** drop-down menus.

Simulation Results Displays

Graph Properties—Axis Properties



The *Axis Properties* dialog box displays the current *Data Type*, *Graph Range*, and *Numerical Range* for the current graph. Change the characteristics of the display by modifying these properties. (*Numerical Range* modification is a *ProTools*-only feature)

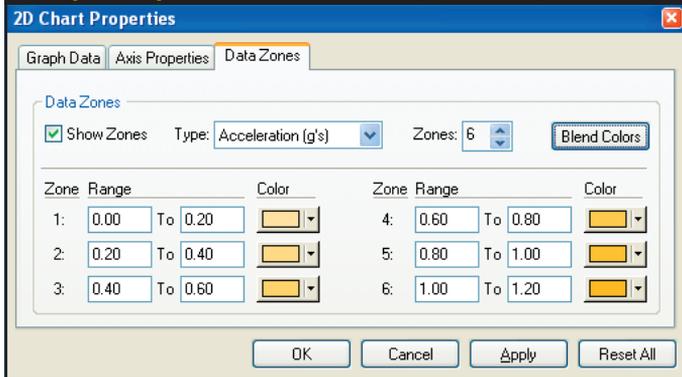
bottom of the graph provides a key to all graph curves.

Axis Properties—This page indicates the current *Data Type* and *Graph Range*, (*Numerical Range* modification is a *ProTools*[™]-only feature) for the current display. Change the characteristics of the display by modifying any of the graph properties.

Data Zones[™]—This *ProTools*[™]-only feature displays additional data and data-ranges on the graphs (see page 74 for more information on activating optional program features). **DataZones** extend the graphic-display and data-analysis capabilities of the DragSim. Using this feature, you can display additional vehicle data and/or show ranges for target values or clearly label dangerously high engine speeds, vehicle speeds, rear-wheel torque and more. To setup a *DataZone* display, first select the data that you would like to display from the **Type** drop-down menu.

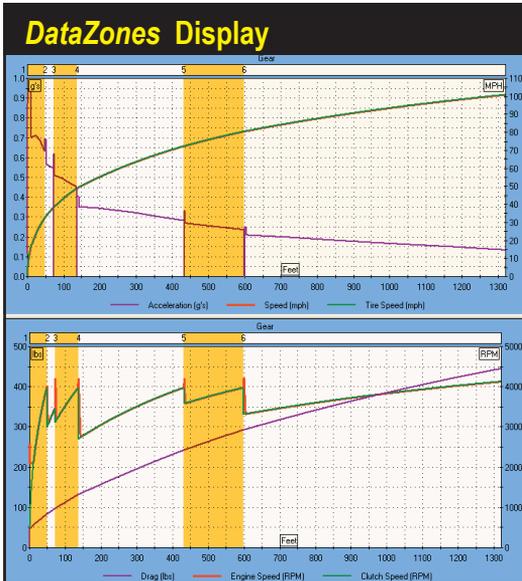
Note: *DataZone* variables must be the same as, or directly derived from, one of the variables currently displayed on the graph. For example, you can display *Speed DataZones* on standard **Speed Combo Plot** graph since *Vehicle Speed*

Graph Properties—Data Zones (ProTools™)



DataZones (ProTools[™]) extend the graphic-display and data-analysis capabilities of the DragSim. Using this feature, you can display additional vehicle data, show ranges, or clearly label high speeds, rpms and more.

Simulation Results Displays



This *DataZone* display (*ProTools*TM) shows *Gear-Change* bands drawn on the standard *Combo Plot* graphs. The range values are indicated at the top of the graphs, and the banded area orange color was interspersed with white bands to delineate each transmission gear-change.

is a variable displayed on one of the axis of the graph, but *Clutch Rpm* cannot be included on the *Speed* graph since there is no axis for *Rpm* (**Speed Combo Plots** axis consist of **G's**, **Distance**, and **Speed**).

Next, select the number of *DataZones* you would like to display by clicking on the “up” or “down” arrows next to the **Zones** field. You can modify the **Range** values and **Colors** for each zone (if you set a starting and ending color, press **Blend Colors** to have the *DragSim* build a uniform transition between these colors for intermediate zones). Click on **Apply** or **OK** to draw the specified zones on the main graphic display.

- 5) In addition to 2D graphing capability described above, a chart display is available by clicking on the **Table** tabs located at the bottom of both the Component Selection Category and the Results Display Panes. The chart lists a variety of elapsed times, speeds, rpms, and forces recorded during the test run. In addition, the power and torque values for the current engine are displayed in the lower table.

The topmost part of the table shows the 1/4-mile results: **E.T.** or **Elapsed Time** and the **Trap Speed**. The next **0-60** and **0-100** data points are the times it took for the vehicle to reach 0-60mph and 0-100mph, respectively. These times are measured with a “virtual 5th wheel” attached to the rear of the vehicle. The timer is started the instant the vehicle begins to move (not necessarily when the vehicle trips the ET starting timer) and ending when the vehicle reaches a specific speed. The timing method for these two variables (0-to-60 & 0-to-100 times) eliminate staging and driver variations at the starting line, providing more comparable times from race to race. **Time In Gear** data can also be found

Simulation Results Displays

Table Shows Exact Test Results

Vehicle Performance - 1/4 Mile

Race Results		Time in Gear	
Elapsed Time	6.800 secs	1st	1.353
Trap Speed	201.5 mph	2nd	0.604
		3rd	0.859
		4th	1.746
Time to Speed		5th	2.444
0-60 mph	1.076 secs	6th	0.000
0-100 mph	2.038 secs		

Track Data

Distance feet	Time secs.	Speed mph	Engine rpm	Accel g's	Tire mph	Drag lbs	Clutch rpm
Rollout	0.206	5.3	8000	1.77	25.1	30.9	2974
60	1.076	70.0	8583	1.83	75.3	120.9	8583
330	2.859	130.0	7336	1.15	130.8	379.9	7336
660	4.372	165.0	8327	0.99	165.3	618.5	7252
1000	5.684	187.0	8089	0.70	187.3	807.2	8090
1320	6.800	203.0	8679	0.58	203.0	984.2	8680

Engine Power Curve

Engine rpm	Power hp	Torque lb-ft	Engine rpm	Power hp	Torque lb-ft
2000	154	404	8500	1350	834
2500	241	506	9000	1343	784
3000	340	595	9500	1296	716
3500	449	674	10000	1235	649
4000	563	739	0	0	0
4500	679	792	0	0	0
5000	794	834	0	0	0
5500	905	864	0	0	0
6000	1008	882	0	0	0
6500	1099	888	0	0	0
7000	1179	895	0	0	0
7500	1249	875	0	0	0
8000	1306	857	0	0	0

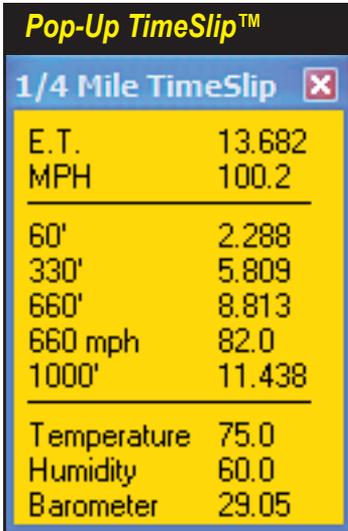
In addition to 2D graphing, the DragSim offers a table display, available by clicking the “Table” tabs located at the bottom of the Component Screen and the Results displays. The table lists a variety of elapsed times, speeds, rpms, and forces recorded during the test run. In addition, the exact power and torque values for the current engine.

The *ProTools™* option also activates a *ProData* tab at the bottom of the left and right display panes. Selecting this tab displays additional vehicle performance data, including *tire slip and size throughout the race, engine rpm, transmission-gear engagement*, and other race data. In addition, with *ProTools™*, additional data can be included on any graphic display.

ProData™ Table Display

Pro Data							
Distance feet	Time secs	Speed mph	Tire Speed mph	Tire Slip mph	Tire Dia inches	Engine rpm	Trans gear
2	0.154	12.7	36.9	24.1	31.3	8000	1
4	0.249	18.2	41.0	22.8	31.4	8000	1
6	0.309	22.7	43.7	20.9	31.5	8000	1
8	0.365	26.4	45.8	19.4	31.5	8000	1
10	0.413	29.7	47.8	18.1	31.6	8000	1
12	0.457	32.6	49.5	16.9	31.6	8000	1
14	0.497	35.3	51.1	15.8	31.7	8000	1
16	0.534	37.8	52.6	14.8	31.7	8000	1
18	0.569	40.1	54.0	13.9	31.7	8000	1
20	0.602	42.3	55.3	13.0	31.8	8000	1
22	0.634	44.4	56.6	12.2	31.8	8000	1
24	0.666	46.4	57.9	11.4	31.8	8000	1
26	0.697	48.4	59.2	10.6	31.9	8000	1
28	0.728	50.3	60.5	9.8	31.9	8000	1
30	0.758	52.2	61.8	9.0	32.0	8000	1
32	0.788	54.1	63.1	8.2	32.0	8000	1
34	0.818	56.0	64.4	7.4	32.1	8000	1
36	0.848	57.9	65.7	6.6	32.1	8000	1
38	0.878	59.8	67.0	5.8	32.2	8000	1
40	0.908	61.7	68.3	5.0	32.2	8000	1
42	0.938	63.6	69.6	4.2	32.3	8000	1
44	0.968	65.5	70.9	3.4	32.3	8000	1
46	0.998	67.4	72.2	2.6	32.4	8000	1
48	1.028	69.3	73.5	1.8	32.4	8000	1
50	1.058	71.2	74.8	1.0	32.5	8000	1
52	1.088	73.1	76.1	0.2	32.5	8000	1
54	1.118	75.0	77.4	0.0	32.6	8000	1
56	1.148	76.9	78.7	0.0	32.6	8000	1
58	1.178	78.8	80.0	0.0	32.7	8000	1
60	1.208	80.7	81.3	0.0	32.7	8000	1
62	1.238	82.6	82.6	0.0	32.8	8000	1
64	1.268	84.5	83.9	0.0	32.8	8000	1
66	1.298	86.4	85.2	0.0	32.9	8000	1
68	1.328	88.3	86.5	0.0	32.9	8000	1
70	1.358	90.2	87.8	0.0	33.0	8000	1
72	1.388	92.1	89.1	0.0	33.0	8000	1
74	1.418	94.0	90.4	0.0	33.1	8000	1
76	1.448	95.9	91.7	0.0	33.1	8000	1
78	1.478	97.8	93.0	0.0	33.2	8000	1
80	1.508	99.7	94.3	0.0	33.2	8000	1
82	1.538	101.6	95.6	0.0	33.3	8000	1
84	1.568	103.5	96.9	0.0	33.3	8000	1
86	1.598	105.4	98.2	0.0	33.4	8000	1
88	1.628	107.3	99.5	0.0	33.4	8000	1
90	1.658	109.2	100.8	0.0	33.5	8000	1
92	1.688	111.1	102.1	0.0	33.5	8000	1
94	1.718	113.0	103.4	0.0	33.6	8000	1
96	1.748	114.9	104.7	0.0	33.6	8000	1
98	1.778	116.8	106.0	0.0	33.7	8000	1
100	1.808	118.7	107.3	0.0	33.7	8000	1
102	1.838	120.6	108.6	0.0	33.8	8000	1
104	1.868	122.5	109.9	0.0	33.8	8000	1
106	1.898	124.4	111.2	0.0	33.9	8000	1
108	1.928	126.3	112.5	0.0	33.9	8000	1
110	1.958	128.2	113.8	0.0	34.0	8000	1
112	1.988	130.1	115.1	0.0	34.0	8000	1
114	2.018	132.0	116.4	0.0	34.1	8000	1
116	2.048	133.9	117.7	0.0	34.1	8000	1
118	2.078	135.8	119.0	0.0	34.2	8000	1
120	2.108	137.7	120.3	0.0	34.2	8000	1
122	2.138	139.6	121.6	0.0	34.3	8000	1
124	2.168	141.5	122.9	0.0	34.3	8000	1
126	2.198	143.4	124.2	0.0	34.4	8000	1
128	2.228	145.3	125.5	0.0	34.4	8000	1
130	2.258	147.2	126.8	0.0	34.5	8000	1
132	2.288	149.1	128.1	0.0	34.5	8000	1
925	5.407	183.0	183.0	0.0	35.4	8125	5
950	5.500	184.4	184.4	0.0	35.4	7981	5
975	5.592	185.9	185.9	0.0	35.5	8036	5
1000	5.684	187.0	187.3	0.3	35.5	8089	5
1025	5.774	188.7	188.7	0.0	35.5	8142	5
1050	5.864	190.0	190.0	0.0	35.5	8193	5
1075	5.953	191.3	191.3	0.0	35.6	8243	5
1100	6.042	192.6	192.6	0.0	35.6	8292	5
1125	6.130	193.3	193.9	0.0	35.6	8340	5
1150	6.218	195.2	195.2	0.0	35.7	8387	5
1175	6.305	196.4	196.4	0.0	35.7	8433	5
1200	6.391	197.6	197.6	0.0	35.7	8478	5
1225	6.477	198.8	198.8	0.0	35.7	8522	5
1250	6.563	199.9	199.9	0.0	35.8	8565	5
1275	6.648	201.0	201.0	0.0	35.8	8607	5
1300	6.732	202.1	202.1	0.0	35.8	8648	5
1320	6.800	203.0	203.0	0.0	35.8	8679	5

Simulation Results Displays



The screenshot shows a window titled "Pop-Up TimeSlip™" with a subtitle "1/4 Mile TimeSlip" and a close button. The window contains a table of performance data:

Category	Value
E.T.	13.682
MPH	100.2
<hr/>	
60'	2.288
330'	5.809
660'	8.813
660 mph	82.0
1000'	11.438
<hr/>	
Temperature	75.0
Humidity	60.0
Barometer	29.05

A *Pop-Up TimeSlip™* is available by clicking on the *Time Slip Icon* in the *Toolbar* or by selecting *Time Slip* from the *Tools* menu. The *Pop-Up TimeSlip* provides a quick overview of vehicle performance. It can be moved to any convenient position on the *Main Program* screen. The *Pop-Up TimeSlip* displays performance data for the currently-selected vehicle (the *Vehicle Selection Tab* that is currently highlighted).

at the top of the table. This indicates the duration of time the transmission was engaged in each gear during the race (a combination of the acceleration and shift times). The next category of data points includes a range of times, speeds, rpms, and other variables measured at critical points throughout the race (Rollout, 60, 330, 660 [1/8-mile], 1000 and 1320 feet). These data values indicate when the vehicle passed these fixed points on the track. The elapsed times listed here begin as soon as the vehicle starts to move and end when the vehicle reaches the indicated distances.

- 6) A *Pop-Up TimeSlip™* is available by clicking on the **Time Slip Icon** in the **Toolbar** or by selecting **Time Slip** from the **Tools** menu. The *Pop-Up TimeSlip* provides a quick overview of vehicle performance; it can be moved to any convenient position on the *Main Program* screen. The **TimeSlip** displays performance data for the currently-selected vehicle (as indicated on the **Vehicle Selection Tab** currently highlighted at bottom of program screen).
- 7) If you have activated the **ProTools™** features of the DragSim (see page 74 for more information on optional program features), an additional **ProData** tab will be displayed at the bottom of the left and right display panes. Activating either of these tabs displays a comprehensive table of additional vehicle performance data, including **Tire Slip** and **Tire Diameter** throughout the race, **Engine Rpm**, **Distance**, **Time**, **Trans-Gear Engagement**, and other calculated race data. Also, with **ProTools™**, much of this *extended* data can be included on any graphic display.



Advanced Drag-Race Simulation

QUICK ITERATOR™

The screenshot shows the 'Quick Iterator' software window. It is divided into several sections:

- Iterator Running Status:** Located at the top left, it shows 'Running' with a green square and 'Stopped' with a red square.
- Simulation Tests In Current Phase:** Below the status, it shows 'Total Simulations: 130149' and 'Completed Sims: 12578'. It also indicates 'Phase1' and 'Phase2' with progress bars.
- Current Results:** A line graph titled 'Current Test' plots 'ET (secs.)' on the y-axis (ranging from 6.0 to 8.0) against 'Iteration Number' on the x-axis (ranging from 0 to 100). A green line shows the current test results, and a red horizontal line indicates the best result at 7.050 seconds.
- Best Results:** A bar chart titled 'Iterator Best Result' compares 'Baseline' and 'Best' results. The 'Best' bar is red and shows an 'Increase In: 0.043 secs'.
- Quick Iterator™ Dual-Phase Status:** The main central area contains instructions: 'Quick Iterator with Dual-Phase Testing. Press a button to begin a comprehensive iterator test series to locate components/specs that produce the Best ET or MPH.' It includes two groups of buttons:
 - Find Optimum Gear Ratios Group:** Contains 'Optimize Driveline Gear Pairs' (text) and 'Locates the best trans- and rear-gear ratio sets for minimum ET or best MPH.' Below this are buttons for 'Best ET' (Find Gear Ratios For Lowest ET) and 'Best MPH' (Find Gear Ratios For Highest MPH).
 - Find Optimum Launch/Shift Points Group:** Contains 'Optimize Launch And Shift RPMs' (text) and 'Locates the best launch- and shift-rpm settings for minimum ET or best MPH.' Below this are buttons for 'Best ET' (Find Launch/Shift RPMs For Lowest ET) and 'Best MPH' (Find Launch/Shift RPMs For Highest MPH).
- Windows Close Button:** A small 'X' icon in the top right corner of the window.
- Save Iterator Result:** Buttons for 'Resume', 'Save', and 'Close' at the bottom right.

With the availability and low-cost of simulation software like the DragSim, the ability to fill file cabinets with *simulated* test data is available to just about anyone. In fact, many enthusiasts become “bogged down” in an overabundance of test data. Sorting through the results, analyzing the best performance curves, and selecting promising component combinations can turn into a job nearly as difficult as old trial-and-error track testing.

The solution to this problem is the introduction of *Iterative Testing™* in the Advanced and ProTools versions of the DynoSim, an exclusive feature of ProRacing Sim Software simulation technology. *Iterative* testing is a repeating series of simulation tests that methodically approach a final, optimum answer. While the *Iterator* (pronounced *IT-TER-A-TOR*) used in earlier DragStrip-simulations was powerful, the complexity involved in setting up an *Iterative* test limited its use. That limitation is now a thing of the past! The DragSim incorporates a completely new version of

Using The Quick Iterator™

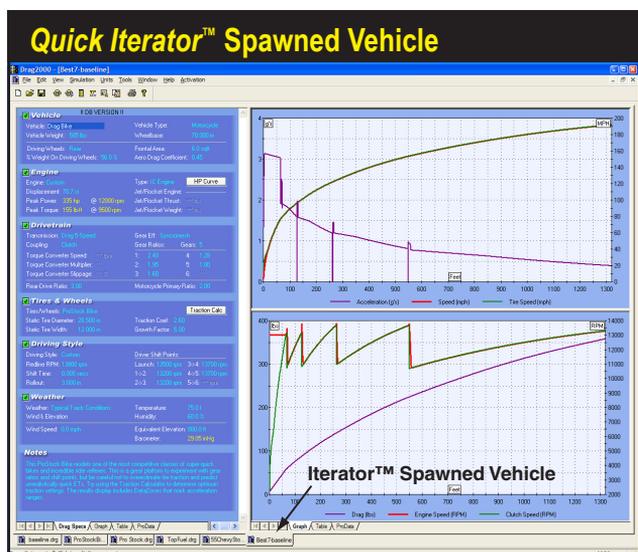
the ProRacing Sim Software *Iterator*. **The Quick Iterator™**. Now, click on only one button, and the DragSim will perform a comprehensive test series to find optimum elapsed times for just about any application. The *Quick Iterator* uses an optimization process called **Dual-Phase™** testing to find the best combination in the shortest time. The first test phase uses a wider range of values. After the best result has been found from this broad-based test, a second testing phase is performed using a much narrower range of testing values. This **Dual-Phase** approach greatly speeds processing time, allowing the *Quick Iterator*, for example, to perform a search for optimum gear ratios in less than five minutes of processing time (on 1.5 Ghz or faster computer systems).

Using The Quick Iterator™

To perform a **Quick Iterator** analysis, first select all the components for the baseline vehicle, making sure all *Status Boxes* in each Component Category are green. There are two testing groups in the **Quick Iterator**, and two buttons in each group. The upper group searches for optimum Gear Ratios that will produce the best ET or MPH. The lower group determines the Launch and Shift Rpm's that will produce the quickest ET or fastest MPH.

Press either the **Best ET** or **Best MPH** button in the upper group to begin an analysis of **Transmission Gear Ratios** and **Rear-Axle Gear Ratios** (if a Motorcycle is being tested, the *Motorcycle Primary Gear Ratio* will also be included). The *Quick Iterator* assumes that the current components selected for the test vehicle are “roughly” appropriate for the intended application and uses the current setup as a starting point. You can follow the progress of the **Quick Iterator** by viewing the indicators in the *Iterator Status* group (upper-left of the **Quick Iterator** screen).

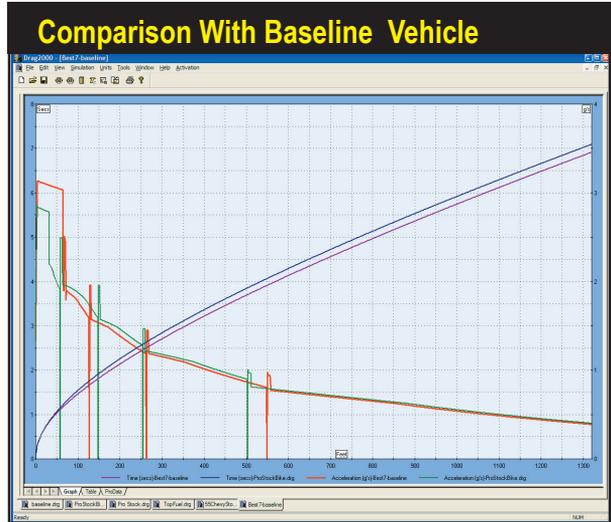
To perform an analysis of **Launch** and **Shift Rpm's**, press either the **Best ET** or



When the **Quick Iterator™** has completed its analysis, you can save the results (by clicking the Save button). The program will spawn a new simulated vehicle with the component combination that produced optimum ET or MPH. The new vehicle will be added to “open” vehicles included in the *Vehicle Selection Tabs* at the bottom of the *Main Program Screen* (arrow). *Quick-Iterator*-spawned vehicles can be analyzed, tested, and modified in any way, just like any other vehicle in the DragSim.

Using The *Quick Iterator*™

To pinpoint improvements located by the *Iterator*, you can setup back-to-back comparisons with the original, baseline vehicle. Right-click the graph, select *Properties*, then include the baseline vehicle in one of the *Data Sets*. The baseline performance curves will be drawn on the current graph, and the key-legend at the bottom of the graph will be updated. This graph, displayed full screen (by sliding the horizontal and vertical dividers to the left and bottom, respectively), shows an improvement in acceleration and time.



Best Mph button in the lower group. The *Quick Iterator* will determine the Launch and Shift Rpm's required to produce the quickest ET or fastest MPH using the current vehicle setup as a starting point.

When *Iterative* testing is complete (you can stop testing at any time by pressing the **Stop** button; press **Resume** to continue testing), the *Iterator Best Result* graph will show the improvement in ET or MPH found with the new component specifications. You can keep the results by clicking **Save**. In a few seconds, the DragSim will “spawn” a new, simulated vehicle incorporating the component combination that produced optimum performance. Switch between the new vehicle and the baseline engine by using the **Vehicle Selection Tabs** at the bottom of the *Main Program Screen*. The *Quick-Iterator*-spawned vehicles can be analyzed, tested, and modified in any way, just like any other vehicle in the DragSim. In fact, it is possible to begin a **new Quick Iterator** test to further “home in” on the desired results.

The *Quick Iterator* will almost always find a quicker ET or faster MPH. To pinpoint the improvements, setup a back-to-back comparison with the original, baseline vehicle. Simply right-click on either of the Results Graphs (on the right of the Main Program Screen) for the newly-spawned vehicle, select **Properties**, then include the baseline vehicle in one of the four **Data Sets** shown on the *Graph Data* page. The baseline vehicle curves will be included on the current graph, and the key-legend at the bottom of the graph will be updated.



Advanced Drag-Race Simulation

PRO ITERATOR™ (Pro-Tool™)

The screenshot shows the Pro Iterator software interface with several components labeled:

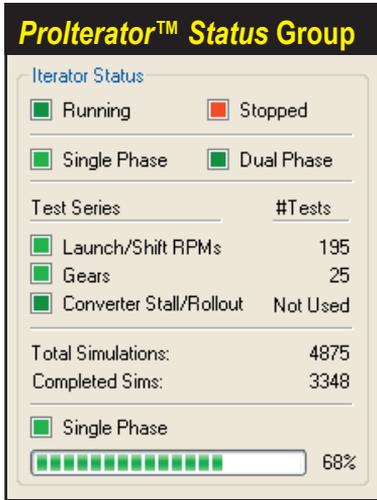
- ProIterator™ Title Bar**: Points to the top window title bar.
- QuickStart Presets**: Points to the 'Launch/Shift', 'Gear Ratios', and 'Converter Stall' buttons.
- Tabbed Data Pages**: Points to the 'Run/Results' tab.
- Windows Close Button**: Points to the 'X' button in the top right corner.
- Functional Group Boxes**: Points to the 'Test Series' and 'Current Test' sections.
- Lower ET/Higher Mph Found By Iterator**: Points to the 'Best Results' table.
- Reset Button**: Points to the 'Reset All' button.
- OK/Cancel**: Points to the 'OK' and 'Cancel' buttons.

The interface includes a 'Pro Iterator' title bar, a 'Test Series' section with checkboxes for 'Single Phase' and 'Dual Phase', and a 'Current Test' section with a graph of Acceleration (g/s) vs. Distance (ft). The 'Best Results' table shows 10 trials with values for Launch/Shift RPMs, Gear Ratios, Converter Stall, and Optimize For. The 'Best Results - 3D' section shows a 3D surface plot of acceleration vs. distance and time.

The **Quick Iterator™** (pronounced *IT-TER-A-TOR*—discussed in the previous chapter) provides a powerful and easy-to-use tool for anyone to optimize engine components. While this capability will satisfy most enthusiasts, the more serious engine builder needs the ability to perform Iterative tests on more than one component at a time and include the *Induction* system in the testing criterion. This, combined with greater flexibility in Iterator setup, area under the curve analysis, variable power-band ranges, and much more, is offered in the **ProTools™** version of ProRacing Sim Software's Iterator: **The ProIterator™ (ProTools™** must be activated to use this feature—see page 74 for more information on optional-feature activation).

Using The ProIterator™

Using The *Prolderator*TM



Indicators within this *Iterator* group show current testing status. *Running* and *Stopped* are located directly above the *Single-* and *Dual-Phase*TM indicators; the *Prolderator*TM can use *Single-* or *Dual-Phase*TM optimization to find the best combinations in the shortest time. The *Test-Series* markers show whether a particular vehicle component category will be included in the test series.

Open the *Prolderator*TM by choosing the *Prolderator*TM selection from the **Tools** menu or by clicking the *Prolderator*TM *Icon* in the **Toolbar**. The main screen consists of the following elements and groups:

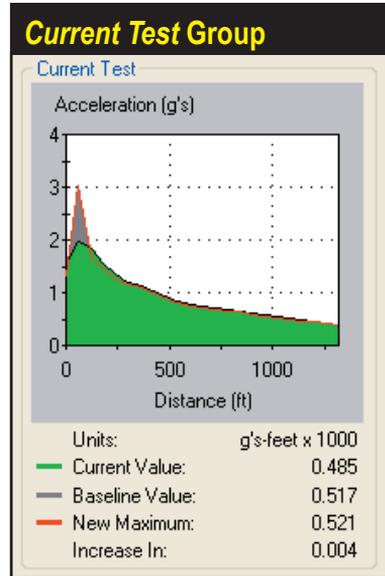
Iterator Status Group (upper-left corner)—Indicators within this group clearly show current testing status. The *Running* and *Stopped* “lights” are located directly above the *Single-* and *Dual-Phase*TM indicators. Like the *Quick Iterator*, the *Prolderator*TM can use a *Dual-Phase*TM optimization process to find the best combinations in the shortest time. The first phase tests over a wide range of values. After the best result is found, a second testing phase is performed using a narrower testing range. However, the *Prolderator*TM extends this capability by allowing all variables in each *Iterator* phase to be fully customizable. *Dual-Phase*TM and standard *Single-Phase*TM testing can even be toggled on and off as desired.

Below the phase indicators are four **Test-Series** markers that show whether a particular vehicle component category will be included in current tests. The three test groups, *Launch-Shift Rpm*s, *Gear Ratios*, *Converter Stall & Rollout* correspond to the first three tabbed pages in the center of the dialog box. A light-green color indicates that this group will be included in the test series, and **# Tests** shows how many tests will be performed within each category. The total number of simulations is shown below, along with the number of completed test runs. At the bottom of the *Iterator Status* group are the **Phase 1** and **Phase 2** indicators (only visible when *Dual-Phase*TM testing has been enabled) and a progress bar (indicates the progress of each phase in multiple-phase tests).

Current Test Group (bottom-left corner)—As each *Iterative* test is completed, the ET or MPH will be displayed in the **Current Test** graph (red points and lines indicate ET; green indicates MPH). As testing proceeds, the dotted line,

Using The *ProLterator*™

The *Current Test* group displays the results of the *Iterator* testing process. The dotted line the dotted line represents the best performance combination currently located by the *Iterator*. Exact values for the baseline, current, maximum, and gain-or-loss in ET and MPH are provided at the bottom of the group box.



representing the best performance combination currently located by the *Iterator*, moves down towards a quicker ET or up towards a faster MPH. The current best result is shown in the box that moves with the testing line. A key-legend is provided below the graph along with the exact values for the baseline, current, maximum, and gain-or-loss in ET or MPH. The best ten performance combinations are “stored” in the *Best Results* 3D graph (in the *Run/Results Page* described on page 65).

QuickStart Presets Group (top center)—The convenience of one-button quick testing incorporated in the *Quick Iterator*™ also is part of the *ProLterator*™. However, the *ProLterator*™ does not begin testing when a *QuickStart* button pressed, instead it loads a “typical” set of testing parameters in the appropriate tabbed data page (the five tabbed data pages are discussed next). For

QuickStart Presets Group

Use QuickStart presets or enter custom testing specification in the fields provided. Press "RUN" on Results Tab to begin testing.

QuickStart Presets

Launch/Shift

Gear Ratios

Converter Stall

Best ET

Best MPH

The convenience of one-button quick testing has been incorporated in the *ProLterator*™. Click any preset button (e.g., *Launch-Shift Rpm's* and *Best ET*) to establish a testing series on the appropriate tabbed data page. Use the *Reset All* button to clear all Presets and return the tabbed-pages to their default setup.

Using The *ProLterator*TM

Launch-Shift RPM “Tabbed” Data Page

The *Launch-Shift RPM* tabbed page establishes a *Single-* or *Dual-Phase*TM test of driving characteristics on ET or top speed. Select either the *Single-* or *Dual-Phase* radio button and enter the testing criterion in the *Single-* and/or *Dual-Phase Test* boxes. The range of individual *Launch-Shift RPMs* that will be evaluated during testing are displayed at the bottom of the data page.

example, if you click the *Shift-Launch Rpm*s and *Best ET QuickStart* buttons, the *Shift-Launch Rpm Page* establishes a *Dual-Phase*TM test series based around the current Shift and Launch Rpm's, and the *Optimize-For Page* selects *Best ET* as the principal search criterion. Use the *Reset All* button located at the bottom of the screen to clear all Presets and return the tabbed-pages to their default setup.

Tabbed Data Page Group (center of screen)—Five data entry- and display-pages are available as tabbed screens at the center of the *ProLterator*TM.

Launch-Shift RPM Tabbed Page—The first tabbed page and the default display when the *ProLterator*TM is opened, establishes a *Single-* or *Dual-Phase*TM range of tests of *Launch* and *Shift RPM* changes on ET or MPH (trap speed). Also by default, the *Launch-Shift RPM Page* is set to *Exclude* (perform no tests), as indicated by the radio buttons at the top-left of the page. To perform *Launch-Shift* Iteration, select either the *Single-* or *Dual-Phase* radio button and enter the testing criterion in the *Single-* and/or *Dual-Phase Test* boxes, located just below the radio buttons. The range of individual *Launch-Shift RPMs* that will be evaluated during *ProLterator*TM testing are displayed at the bottom of the data page. You can quickly setup an exhaustive test by clicking on the *Launch-Shift RPM* button in the *QuickStart Preset* group (described previously). This will setup a *Dual-Phase* test of 1250 simulations (completed in about 1 minute on a 1Ghz and faster computer).

Gear Ratios Tabbed Page—The third tabbed page sets up a *Single-Phase* test of the effects of various Gear Ratios on power ET or MPH (trap speed). By

Using The *ProLterator*™

The *Gear Ratios* tabbed page establishes an *Iterative* test of transmission and rear-axle gear ratios. Perform a *Gear Ratio Iteration* by selecting either the *Single-* or *Dual-Phase* radio button and entering the testing criterion. The range of individual *Gear Ratios* that will be evaluated during testing are displayed at the bottom of the data page.

Gear Ratios “Tabbed” Data Page

Launch/Shift RPMs **Gears Ratios** Converter Stall Optimize For Run/Results

Exclude Single Dual

Single Phase Test

1st Gear:	<input type="text" value="2.40"/>	+/-	<input type="text" value="1.50"/>
2nd Gear:	<input type="text" value="1.95"/>	+/-	<input type="text" value="1.50"/>
3rd Gear:	<input type="text" value="1.60"/>	+/-	<input type="text" value="1.50"/>
4th Gear:	<input type="text" value="1.28"/>	+/-	<input type="text" value="1.50"/>
5th Gear:	<input type="text" value="1.00"/>	+/-	<input type="text" value="1.50"/>
6th Gear:	<input type="text"/>	+/-	<input type="text"/>
Rear Gear:	<input type="text" value="3.00"/>	+/-	<input type="text" value="1.50"/>
Step Value:		<input type="text" value="0.75"/>	
Number of Tests:		12500	

Dual Phase Test

1st Gear:	<input type="text" value="2.40"/>	+/-	<input type="text" value="0.375"/>
2nd Gear:	<input type="text" value="1.95"/>	+/-	<input type="text" value="0.375"/>
3rd Gear:	<input type="text" value="1.60"/>	+/-	<input type="text" value="0.375"/>
4th Gear:	<input type="text" value="1.28"/>	+/-	<input type="text" value="0.375"/>
5th Gear:	<input type="text" value="1.00"/>	+/-	<input type="text" value="0.375"/>
6th Gear:	<input type="text"/>	+/-	<input type="text"/>
Rear Gear:	<input type="text" value="3.00"/>	+/-	<input type="text" value="0.375"/>
Step Value:		<input type="text" value="0.125"/>	
Number of Tests:		117649	

default, the *Gear Ratios Tabbed Page* is set to **Exclude** (perform no induction tests) with the radio buttons at the top-left of the page. To perform an Iterative test of Gear Ratios, select the **Include** radio button and setup the gear-ratio category ranges that you would like to include in the test series. You can quickly setup an exhaustive test of transmission and rear-axle ratios by clicking on the **Gear Ratio** button in the *QuickStart Preset* group (described previously).

Note: All gear ratios and rpms selected within the Iterator are tested for validity before a track-test simulation. Some combinations may not be legal or logical, and when the Iterator encounters an invalid combinations (e.g., 2nd gear ratio numerically higher than 1st gear ratio, etc.) the combination will be skipped. When this happens, you will see the **Current Test** counter continue to climb, but nothing will be displayed on the **Current Test Results** screen, or there may be blank spots between existing data. This “qualifying” process ensures that the Iterator will only test combinations that have promise in the real world.

Converter Stall Tabbed Page—The third tabbed page establishes a *Single-* or *Dual-Phase*™ test of torque converter **Stall Speed** changes in ET or MPH. By default, the *Converter Stall Tabbed Page* is set to **Exclude** (perform no tests) with the radio buttons at the top-left of the page. To perform *Converter Stall* Iteration, select either or both of the **Single-** or **Dual-Phase** radio buttons and enter the testing criterion in the **Single-** and/or **Dual-Phase Test** boxes, located just below the radio buttons. You can quickly setup an comprehensive test by clicking on the **Converter Stall QuickStart Preset** button (described previously). This will establish a *Dual-Phase* test of 14 simulations.

Optimize-For Tabbed Page—The fourth tabbed page establishes the desired result from Iterative testing. By default, the *ProLterator*™ will search for

Using The *Pro*lterator™

Converter Stall “Tabbed” Data Page

Launch/Shift RPMs | Gears Ratios | Converter Stall | Optimize For | Run/Results

Exclude Single Dual

Single Phase Test

Stall RPM: 4000 +/- 3000

Step Value: 1000

Number of Tests: 7

Dual Phase Test

Stall RPM: 4000 +/- 1000

Step Value: 250

Number of Tests: 9

The *Converter Stall* tabbed page sets up a *Single-or-Dual Phase* test of Torque Converter Stall speed. To perform an *Iterative* test, select the initial values, the testing range, and the step value for each component. To easily setup a Converter Stall test series, click on the *Stall Speed QuickStart Preset* buttons.

the combination of components and specifications that produces the quickest ET (*Optimize For Minimum ET*). Alternately, you can select *Optimize For Peak MPH*. In addition to these two options, two powerful *ProTools™ Optimize-For* choices are available: ***Optimize Area Under The Acceleration Curve*** or ***Optimize Area Under The Vehicle-Speed Curve***. While the best ET and MPH choices will focus on absolute maximum values, the areas under the curves selections will find parts combinations that produce the greatest “volume” of acceleration or speed within the selected rpm range. Think of this area as the maximum acceleration or speed produced throughout the selected range (or over time). In general, lowest ET searches may find optimum components with

The *Optimize-For* tabbed page establishes the desired result. By default, the *Pro*lterator™ will search for the quickest ET. While optimum ET or MPH choices focus on the absolute best results, the *Areas Under The Curve* selections locate component setups that produce the greatest “volume of performance” throughout specific portions of the race. This new method of analysis can lead to component combinations that solve specific problems in the real world.

Optimize-For “Tabbed” Data Page

Launch/Shift RPMs | Gears Ratios | Converter Stall | Optimize For | Run/Results

Optimize

Optimize for Best ET

Optimize for Top Speed

Optimize Area under Curve

Acceleration

Distance Range

Distance Range for Area under Curve:

From 0 To 330

0
10
20
30
60
330
660
1000
1320

Criterion

Acceleration (g's)

Distance (ft)

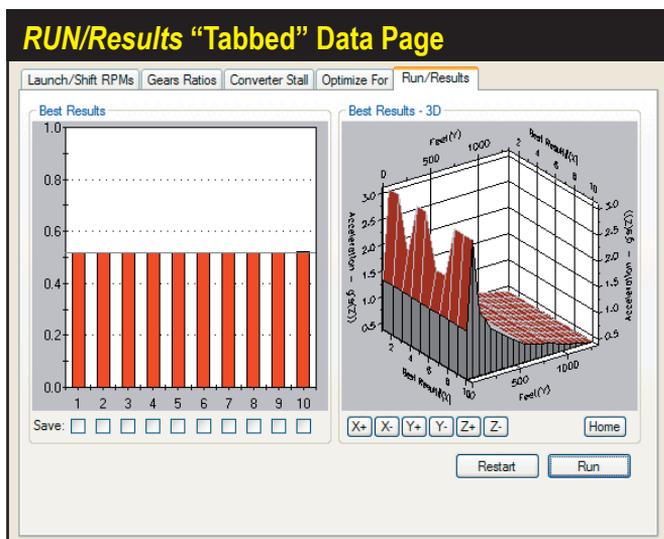
Using The *ProLterator*TM

a bias on peak acceleration during the first 60 feet, while maximum area under the curve can find the best components for optimum acceleration throughout specific portions of the race track. This technique can sometimes find a more “practical” component package, especially when optimum starting-line traction, or traction at other points on track, cannot be realized.

When either *Area Under The Curve* choice is selected, the **Range** choices allow you set the lower and upper limits through which the *Iterator* will search for optimum ET or MPH combinations. The *Testing Range* values will be displayed as a “bounded area” under the *Acceleration*, *Power*, *Torque*, or *Speed* curves.

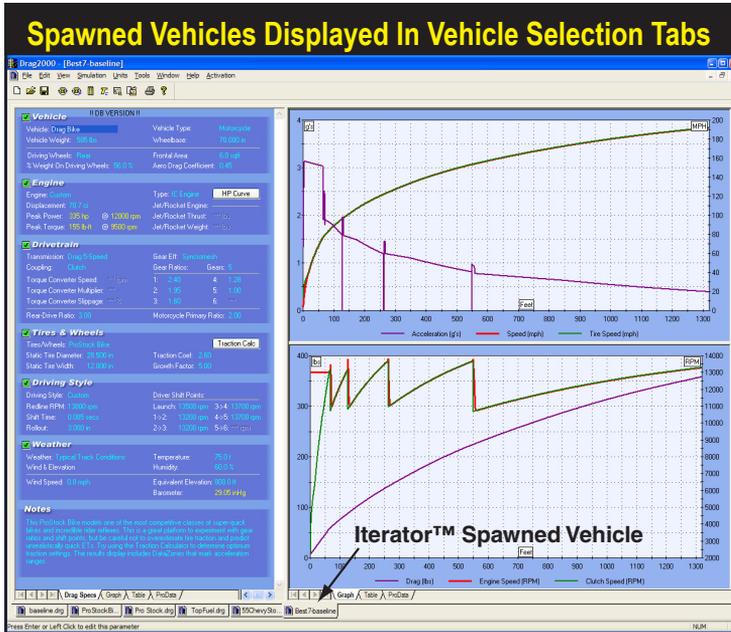
Note: Optimizing components for maximum area under the acceleration or speed curve is an entirely new way to look at vehicle performance tuning. There is almost no published data on this method of vehicle development, nor is there research available on what racing techniques and vehicles may benefit from this analysis. Rumor has it, though, that some ProStock, Funny Car, and other “very serious” racing teams have used this method to find a winning edge. Now you can use this powerful analysis method in the **DragSim ProLterator**TM to your advantage!

Run/Results Tabbed Page—The fifth tabbed page begins an *Iterative* test series, allows you to view testing progress, and displays the top ten results. Once you have selected the testing parameters (on the *Launch/Shift Rpm*, *Gear Ratios*, *Converter Stall*, and/or *Rollout* tabbed pages), click the **Run** button to begin an *Iterative* test. As the **ProLterator**TM finds promising results, they are displayed in the **Best Results** graph as vertical bars. A horizontal “baseline” on the graph indicates the performance level of the current vehicle (built from components on the Main Component Screen). As the *Iterator* finds better and



The *Run/Results* tabbed page begins *Iterative* testing, allows you to view testing progress, and lets you save any of the top ten results. When testing is complete, save any (or all) of the best results by clicking the **Save** boxes located below the vertical bars in the **Best Results** graph, then click the **OK** to spawn (create) these vehicles within the *DragSim*.

Using The *ProIterator*TM



When you close the *Iterator* screen, new “spawned” vehicles will be created and displayed in the *Vehicle Selection Tabs* at the bottom of the Main Program Screen. Each new vehicle can be brought into the foreground by clicking on its *Selection Tab*. *Iterator*-spawned vehicles can be analyzed, tested, and modified in any way, just like any other vehicle in the *DragSim*.

better component combinations, the bars continue to increase in height. If the *Iterator* finds combinations that produce more performance than the baseline vehicle, the vertical results bars will cross over the baseline indicator and grow taller (the baseline marker may rescale and move down the graph indicating a greater difference between the baseline vehicle and *Iterator* combinations). The top ten combinations that match the bar-chart results are displayed on the **Best Results—3D graph**. You can view these curves from any perspective using the **X+**, **X-**, **Y+**, **Y-**, **Z+**, and **Z-** buttons (**Home** returns the 3D graph to its original position),

During *Iterative* testing, you can view the number of completed and remaining tests in the *Iterator Status* box, as discussed earlier. You can stop testing at any time by pressing the **Stop** button; press **Run** to continue testing or **Restart** to clear current results. When testing is complete, save any (or all) of the top ten results by clicking the **Save** boxes located below the vertical bars in the **Best Results** graph. After deciding which vehicle setups to save, click the **OK** button at the bottom of the *ProIterator*TM dialog box. The *Iterator* will close and “spawn” new vehicles based on the components that were used in the selected tests. You can switch to any of these vehicles (and continue modification and testing as you can with any *DragSim* vehicle) by clicking on the **Vehicle Selection Tabs** at the bottom of the *Main Component Screen*.

The *ProIterator*TM will almost always find more performance. To pinpoint these improvements, setup back-to-back comparisons with the original, baseline vehicle. Simply right-click on either result graph of any of the newly-spawned vehicles, select **Properties**, then include the baseline vehicle in one of the four

Using The *ProIterator*™

Data Sets shown on the *Graph Data* page. The baseline vehicle performance curves will be included on the current graph, and the key-legend at the bottom of the graph will be updated.

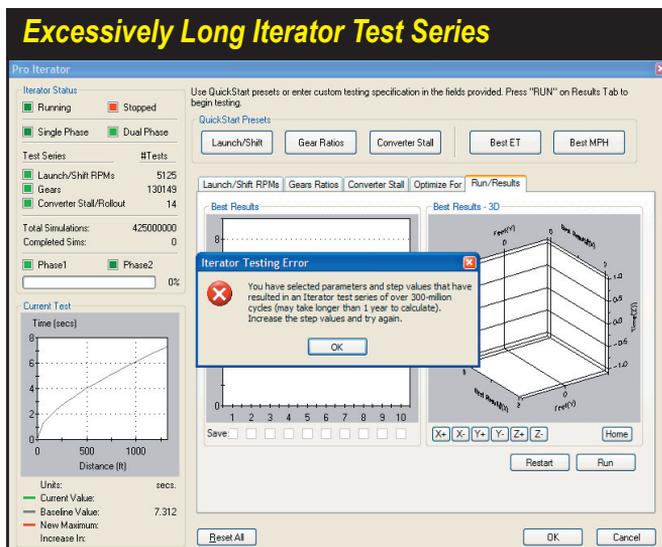
Reset All Button (bottom)—If you would like to return the *ProIterator*™ to the default state, resetting all tabbed pages to their original settings, press the **Reset All** button.

ProIterator™ Testing—A Quick Walkthrough

The first step in performing an *Iterative* test is to build the basic (or baseline) vehicle by selecting component parts from the *Main Program Screen Component Categories* (all component categories must display green status boxes) or by loading a completed vehicle (.DRG) file. When all parts have been selected, the *DragSim* will perform a simulation and display performance curves in the right results panes.

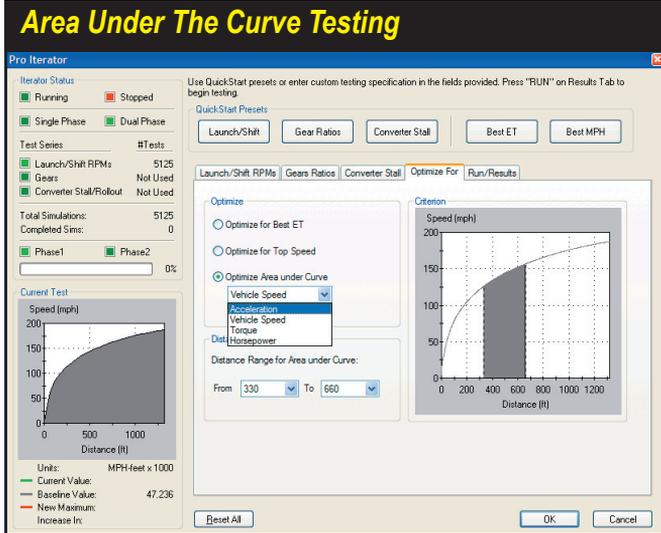
When the baseline vehicle simulation has been performed, you may conduct an *Iterative* test. Open the *ProIterator*™ by choosing ***ProIterator*™** from the **Tools** menu or by clicking the ***ProIterator*™ Icon** in the **Toolbar**. The tabbed data-entry-and-display pages establish a component or vehicle-system for testing and specify a search criterion and testing ranges (see the previous section for details on each tabbed data-and-setup page). As an alternative to setting up individual testing parameters, you can click on any of the *QuickStart Preset* buttons at the top of the *ProIterator*™ dialog box. Each button loads a “typical” set of testing parameters on the appropriate tabbed data page.

For Example: Click the **Launch/Shift Rpm** and **Best ET** presets to setup a *Dual-Phase™* Launch/Shift Rpm testing series on the **Launch/Shift Rpm** page that is based around current driving characteristics while the **Optimize-For** page estab-



Narrowly-focused or multiple-component tests may require several thousand, or even a million, test cycles to complete. A large test series can require several days of calculation time depending on the speed of your computer. Often the same results can be obtained by a more carefully designed test that takes less than half the time to complete. Use wide first-phase ranges and steps to keep the number of iteration cycles to a minimum.

Using The *ProIte*ator™



Optimizing components for maximum area under the acceleration or speed curve is a new way to look at vehicle performance tuning. Rumor has it that some ProStock, Funny Car, and other “very serious” racing teams have used this method to find a winning edge. Now you can use this powerful analysis method in the *DragSim ProIte*ator™ to your advantage!

lishes *Best ET* as the principal search criterion. Use the **Reset All** button located at the bottom of the screen to clear all Presets and return the tabbed-pages to their program defaults.

As you make selections from either the *QuickStart Preset* buttons or the tabbed data pages, the *Iterator Status* box (upper-left of dialog) shows the component groups that have been included and the number of tests that must be performed to complete the current series. Since the *DragSim* will typically perform 10 to 20 simulation tests per second (depending on the speed of your computer), keep in mind that it may take about an hour to execute 45,000 tests. Keep testing criterion limited and the range and step values as large as possible to minimize testing time.

After you have selected the components that you wish to evaluate, the **Optimize For** tabbed page establishes the search criterion and the distance range that the *Iterator* will use to find improved performance. By default, the *ProIte*ator™ will search for the combination of components that produces the Best ET throughout the entire race. Alternately, you can select *Optimize For Peak MPH*. In addition to these two options, two powerful new **Optimize-For** choices are available: *Maximum Area Under The Acceleration Curve* or *Speed Curve*.

Once you have selected the testing parameters, the **Run** button on the **Run/Results** tabbed page begins *Iterative* testing, allows you to view testing progress, and lets you save any of the top ten results. You can stop testing at any time by pressing the **Stop** button; press **Run** to continue testing or **Restart** to clear current results. When testing is complete, save any (or all) of the top ten results by clicking the **Save** boxes located below the vertical bars in the *Best Results* graph. After deciding which vehicles to save, click the **OK** button at the bottom of the *ProIte*ator™ dialog box.

Using The *ProIterator*™

When the *Iterator* closes, the newly spawned vehicles will be displayed in the **Vehicle Selection Tabs** at the bottom of the **Main Program Screen** (see page 18 for more information on Vehicle Selection Tabs). Each test vehicle can be brought into the foreground by clicking on its Tab. *Iterator*-spawned vehicles can be analyzed, tested, and modified in any way, just like any other vehicle in the DragSim. In fact, it is possible to begin a *new Iterator* test using any of the spawned vehicles as a new baseline to further “home in” on the desired results.

Tips For Running Efficient Iterative Tests

Setting up an *Iterative* series only takes a few seconds, however, if you include too many parameters, ranges that are too wide, or step values that are too small, you will create an *Iterator* series that contains too many tests. If you create a series longer than 300 million tests (one year of testing time on a fast computer system) the DragSim will request that you increase step values for selected parameters.

The best way to find optimum components, especially Gear Ratios and Shift Rpm's, is to setup a *Dual-Phase*™ test that uses large range and step values (20-to-40% of the current shift rpm) to “get in the ballpark” on the first phase, then the second *Iteration* phase with a narrower range of values (perhaps just 10% of the current shift rpm) and a smaller step value (perhaps 5% of the current shift rpm) to precisely locate the best results.

Narrowly-focused tests may still require several thousand test cycles to complete. A large test series may require several minutes, an hour or two, or even a day or two of calculation time depending on the speed of your computer. In these cases, you may continue to use your computer to perform other tasks. Simply use the **Start** menu to begin other applications or use **Alt-Tab** to switch between applications (see your Windows documentation for more information on program switching).

Note: If you are running Windows98/Me/2000/XP, you may also select the “DeskTop” icon (often located close to the *Start* menu on the task bar) to “minimize” the DragSim and regain your desktop during an *Iterator* test.



PRINTING

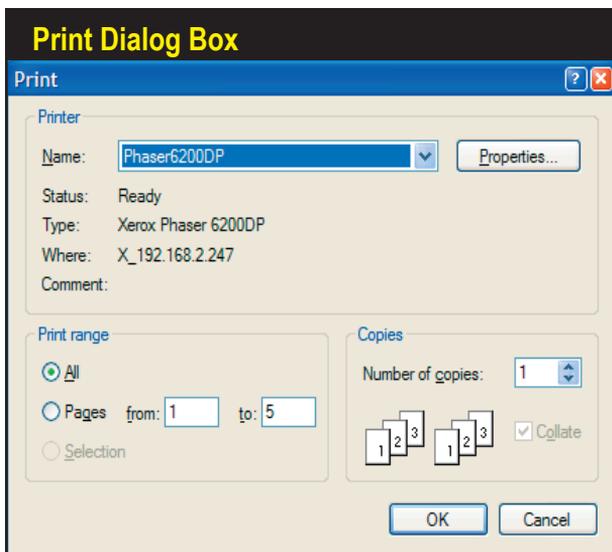
PRINTING DRAG-TEST DATA AND PERFORMANCE CURVES

The DragSim is capable of printing a complete list of vehicle components, exact test result values, and 2D graphic curves of speed, rpm, acceleration, and several other vehicle-test variables. Each of these data sets print on separate pages that comprise a complete multi-page, drag-test document of the currently-selected vehicle. You can determine which pages you would like to print, preview the pages before you print, and direct the output to any installed Windows printer.

Note: If you have activated **ProTools™** in the DragSim (see page 74 for more information on optional-feature activation), **ProPrinting™** options are available that produce comprehensive “presentation” reports of drag-test results. **ProPrinting™** features include special page graphics, a cover page with the name of your business (or you personal name), additional vehicle-data values, pressures, forces, and more.

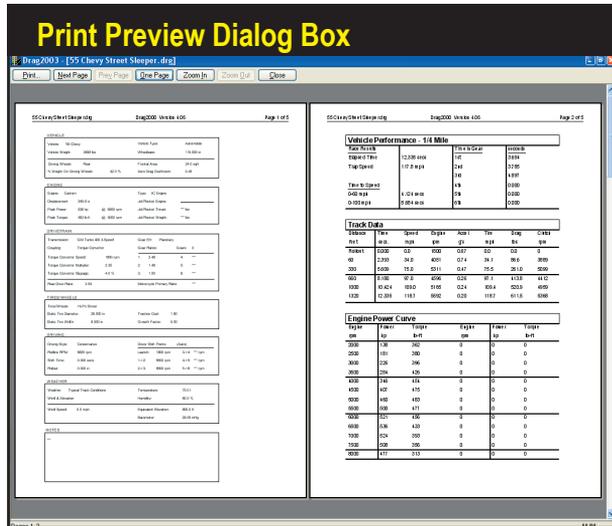
There are three choices in the **File** menu (located on the *Main Program Screen*)

The print dialog box, accessible from the **File** menu, allows the selection of a printer, access to printer Properties, and you can enter the range of drag-test report pages. Printing can be started from this dialog box.



Printing Drag Reports

Print Preview, accessible from the *File* menu, provides an on-screen rendering of what each page in the basic drag-test printout will look like when printed on the selected Windows printer. Use this feature to determine which pages you would like to include in the printout.



that will help you setup your printer and print dyno data. The choices are:

Print—Opens a dialog box that allows the selection of a printer, access to printer *Properties*, and the *Print Range* of drag-test pages. Printing can be started from this dialog box.

Print Preview—Opens the Print Preview Screen that provides an on-screen rendering of what each page in the drag-test report will look like when printed on the selected Windows printer.

Printer Setup—Similar to the Print dialog box (allows printer selection), except printing cannot be started from this box.

The drag-test report generated by the DragSim consists of 5 pages. Here is description of each page:

Page 1—This page prints all the components selected for the current simulated vehicle. The appearance of this page in the *Standard printout* is similar in layout to the *Component Selection Categories* of the *Main Program Screen*.

Page 2—Displays all calculated performance data in chart form. Values are listed in two groups, with 1/4- or 1/8-mile results data on the top and engine power and torque in the lower chart.

Page 3—The first of three vehicle-performance graphs is reproduced on this page (this is the graph located on the left side of the *Main Program Screen* under the *Component Categories*—select the **Graph Tab** at the bottom of the left of the pane to display this graph). Full color printing is supported.

Page 4—The second of three graphs of vehicle performance (this graph is located on the top, right side of the *Main Program Screen*, and the default display is a Speed-Combo graph).

Printing Drag Reports

Page 5—The third of three graphs of vehicle performance (this graph is located on the bottom, right side of the *Main Program Screen*, and the default display is an Rpm-Combo graph).

ProTools™ Printing Features

When **ProTools™** have been activated (see page 74 for more information on optional-feature activation), **ProPrinting™** options are available that turn simulation results into a comprehensive “presentation” report of vehicle-test data. **ProPrinting™** features include special page graphics, a cover page with the name and address of your business (or your personal name and address) and logo, a table of contents, optional text printed at the bottom of each page (can be a disclaimer, copyright notice or any other text you wish), optional “full” or “mini” glossaries, and a complete listing of all test data and results. This full-color report is built within the DragSim and delivered to your default Internet browser (e.g., Microsoft *Internet Explorer™*) for on-screen display and printing. To view a multiple-page print preview of this report, select *ProPrint Preview* from within the DragSim, then select *Print Preview* from within your browser.

Note: Some browsers, like recent versions of Internet Explorer) do not print “background graphics” by default. This will prevent the printing of background colors in many of the data tables in the **ProPrinting™** report. To enable full-function printing, open the *Internet Options* menu (often located at the bottom of the *Tools* menu within Internet Explorer), choose the *Advanced* tab, and click the box (to enable) *Print background colors and images*.

Use **ProPrinting™ Setup**, available from the **File** menu within the DragSim, to enable and configure **ProPrinting™** features. If you activate **Include Logo**, the logo file must be a .BMP file (should be square with the size near 100 by 100 pixels). If

ProPrinting™ Setup

Setup

Test/Engine Title: 55 Chevy Street Sleeper.dwg

Company/Name: Motion Software, Inc.

Address Line 1: 535 West Lambert Road, Bldg. E

Address Line 2: Brea, California 92821-3911

Phone/Fax: Voice: 714-255-2931 Fax: 714-255-7956

Email/Web: www.motionsoftware.com

Engine Tester: John Doe

Engine Designer: John Doe

Include Logo Bitmap: DefaultLogo.bmp [Browse...]

Include @ Page Bottom: DefaultCopyright.txt [Browse...]

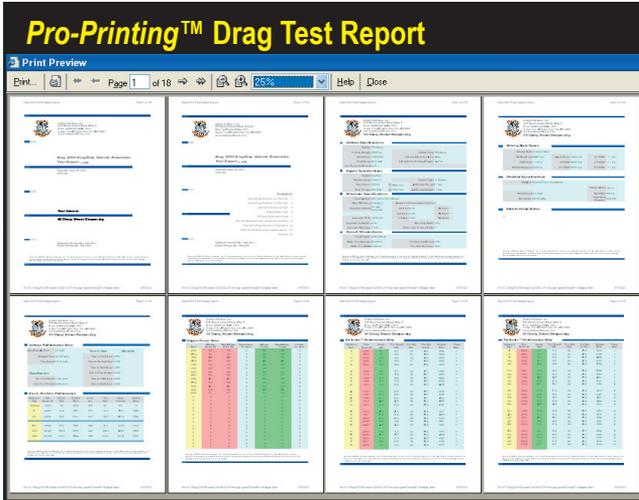
Include Table of Contents

Include Glossary: Full Glossary (5 pages) Mini Glossary (1 page)

[Default...] [Use Default] [Reset All] [OK] [Cancel]

ProPrinting™, a **ProTools™** feature, turns the results of any vehicle drag test simulation into a professional report. Use this **ProPrinting™ Setup** dialog box, available from the **File** menu, to enable and customize **ProPrinting™** features. You can add your name, address, your company logo, specialized (copyright) text, a table of contents, and even a short or long glossary to your **ProPrint** report. Use the **Default...** button to save your preferences that will be applied by default to new vehicle simulations. The files for the **Default Logo.bmp** and the **DefaultCopyright.txt** are located in the *DragSim/Manuals & Videos/proprint* subdirectory. You can modify these files to suit your requirements.

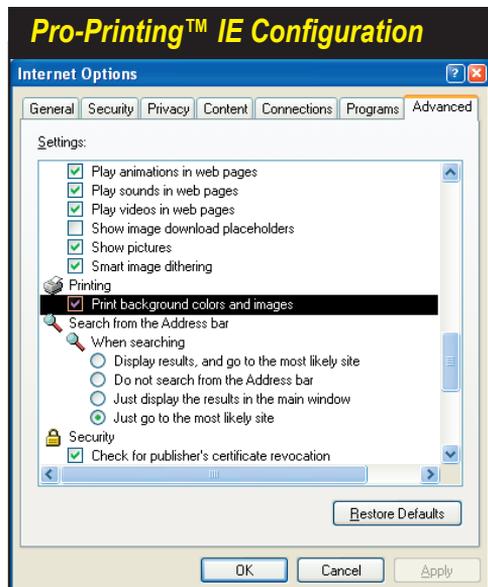
ProTools™ Printing Features



A *ProPrinting™* report includes “presentation” graphics, a cover page with the name and address of your business (or your personal name and address) and logo, a table of contents, optional text printed at the bottom of each page, optional “full” or “mini” glossaries, and a complete listing of all test data and results. The report is delivered to your default web browser for printing (or *print previewing* as shown here).

you activate ***Include @ Bottom Of Page***, the included file must be non-formatted text only (for example, created in *Notepad*) and no longer than about 50 words. You will find these files located in the ***DragSim/Manuals & Videos/proprint*** directory.

Some browsers, like recent versions of *Internet Explorer*) do not print “background graphics” by default. This will prevent the printing of data table background colors in *ProPrinting™* reports. To enable full-function printing, open the Internet Explorer *Options* menu (typically located at the bottom of the Tools menu within Internet Explorer), choose the ***Advanced*** tab, and click the box (to enable) ***Print background colors and images***.





Advanced Drag-Race Simulation

OTHER FEATURES

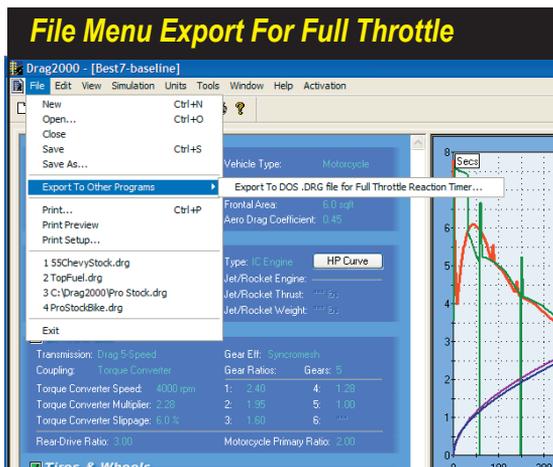
EXPORTING VEHICLE FILES FOR FULL THROTTLE

The DragSim includes a file export feature (see photo, below) that allows you to export vehicles into the DeskTop *Full Throttle Reaction Timer* and practice starting-line and shifting skills with vehicles designed in the DragSim.

FEATURE ACTIVATION

The DragSim can start-up and run in four distinct modes: 1) *Demo*, 2) *DeskTop Drag*, 3) *DragSim Advanced*, and 3) *DragSim With ProTools™*.

Demo Mode—If you have downloaded the DeskTop Drag or DragSim from an Internet site or installed the DragSim Demo on your system along with other, purchased ProRacing Sim Software simulations, the DragSim will start in the *Demo Mode*. The Demo presents a dialog box from which you can select any of several test vehicles. All the features of the DragSim are available, and you can fully explore the capabilities of the program, except that the *Demo Mode* does not allow changes to the weight and type of vehicle, and you cannot load or save files. For additional information about the *Demo Mode*, refer to the **Help**



The DeskTop Drag and DragSim simulations incorporate a **File Export** feature. Use it to transfer simulated vehicles to the *DeskTop Full Throttle Reaction Timer*, a reaction-timer/trainer from ProRacing Sim Software.

Other Program Features

Full Throttle Reaction Timer

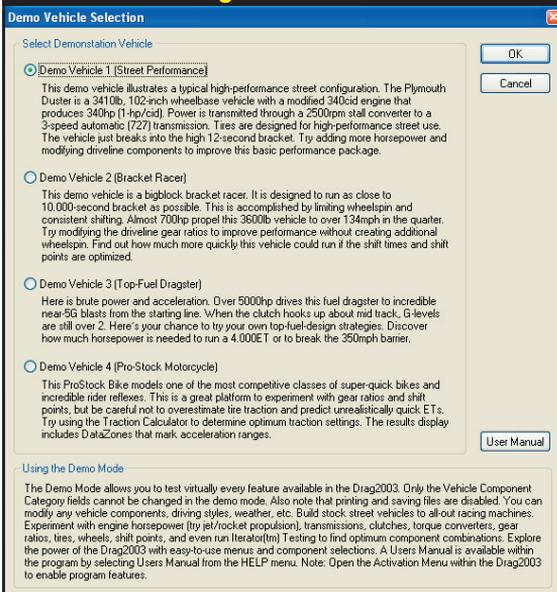


The *DeskTop Full Throttle Reaction Timer* software incorporates precision starting-line, shifting, and top-end simulations. Using basic vehicle parameters and performance data from the *DeskTop Drag* or *DragSim*, Full Throttle will simulate the driving characteristics of the vehicle at the starting “tree,” and throughout the 1/8- or 1/4-mile. Driver input is logged and analyzed, permitting anyone to improve their starting-line and shifting

button on the *Demo Vehicle-Selection Screen* (shown below).

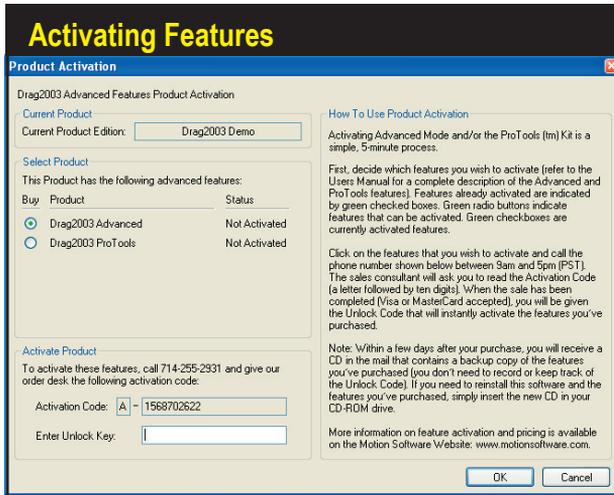
DeskTop Drag—(Basic Version Of DragSimulation) The *DeskTop Drag* contains features that most enthusiasts will find more than sufficient to allow them to test components and determine optimum combinations for most applications. All essential simulation features are included in the *DeskTop Drag*. In the *DeskTop* mode, the user can measure and monitor various vehicle data sets,

Demo Mode Engine-Selection Screen



If you've downloaded the DragSim from an Internet site or installed the DragSim Demo on your system, the program will start-up in the *Demo Mode*. The Demo presents a dialog box from which you can select any of several test vehicles. All the features of the DragSim are available, except that the *Demo Mode* prevents any changes to vehicle type and weight, and you cannot load or save files. For additional information about the *Demo Mode*, refer to the *Help* button on the *Demo Vehicle-Selection Screen* (shown here).

Other Program Features



Activating any optional features is a simple 5-minute process. Call the phone number shown in the *Activation Box* between 9am to 5pm (CST). A sales consultant will ask you to read the *Activation Code*, and when the sale has been completed, you will be given the *Unlock Code*. **Note:** Within a few days you will receive a new CD in the mail.

including Acceleration and Aero Drag, and Speeds. Plus the following features are included in the *DeskTop Drag*: 1/8-Mile Modeling, PopUp TimeSlips™, Direct-Click™ Menus, Multi-Page Drag-Test Reports, Real-Time Results Display, even load engine files from the *DeskTop Dyno*.

DragSim Advanced Mode—In ***Advanced DynoSim Mode***, you can run multiple, simultaneous simulations and perform on-graph comparisons of up to four vehicles. Comparisons can include any of the vehicle telemetry data sets. In addition, the Advanced Mode includes an extended User Interface, One-Click™ Iterative Testing™, and a unique Traction Calculator™ that makes tire and traction modeling easier and more accurate.

DragSim With ProTools™ Kit Activated—(Professional Version Of Drag Simulation) If you are a serious enthusiast or professional racer, you will find the additional tools and features supplied in the ***ProTools™ Kit*** a valuable addition to the *DragSim Advanced Mode*. Many features in the Advanced Mode have been enhanced with extended functionality. For example, the ***ProTools™ Kit*** includes additional dynamics and force measurements, including Tire Growth, Tire Slippage, Corrected Horsepower Values, a comprehensive *ProData™* results table, and features aimed directly at the professional, like the ***ProIteator™***, ***DataZones™***, and ***ProPrinting™***.

Here is a more information about key ***ProTools™ Kit*** contents:

ProIteator™—The one of the most powerful features of the ***ProTools™ Kit***. The ***ProIteator™*** retains all the simplicity and ease-of-use of the ***Quick Iteator™*** (supplied in the Advanced Mode), while adding powerful testing and analysis capability, including custom ranges, Stall Speed and Rollout

Other Program Features

DragSim Feature Activation

Drag Race Simulation Program Features	DeskTop Series	DragSim Series (4.x)	
	DeskTop Drag	DragSim Advanced	DragSim ProTools™
1/4-Mile Drag Testing	Yes	Yes	Yes
Load Engine Simulation Files	Yes	Yes	Yes
Optimized High-Speed Simulation	Yes	Yes	Yes
Pop-Up TimeSlip™	Yes	Yes	Yes
Direct-Click Menus™	Yes	Yes	Yes
Multi-Page DragTest Reports	Yes	Yes	Yes
Real-Time Results Display	Yes	Yes	Yes
U.S./Metric Units	Yes	Yes	Yes
Test Multiple Vehicles	No	Yes	Yes
On-Graph Comparisons With Up To Four Vehicles	No	Yes	Yes
1/8-Mile Drag Testing	No	Yes	Yes
Extended Color Display/Interface	No	Yes	Yes
One-Click Iterative™ Testing	No	Yes	Yes
Traction Calculator	No	Yes	Yes
ProData™ Graphic Displays	No	No	Yes
Full-Track ProData™ Table	No	No	Yes
ProPrinting™ Extended Reports	No	No	Yes
Graph DataZones™ Displays	No	No	Yes
Prolterator™ Advanced Testing	No	No	Yes
Analyze Area Under Data Curves	No	No	Yes

If you are a serious enthusiast, or professional racer, you will find the additional tools and features supplied in the *Advanced Version* and the *ProTools™ Kit* valuable additions to the DeskTop Drag. Many features in the *Advanced* version have enhanced functionality. In addition, there are *ProTools Kit* features aimed directly at the professional, like the *Prolterator™* and *ProPrinting™* (see text for further descriptions).

Iteration, analysis of areas under the acceleration and speed curves, and much more. For a complete description of *Prolterator™* features, refer to page 59.

DataZones™—Extends the graphic-display and data-analysis capabilities of the DragSim. Using this feature, you can add additional vehicle data and/or show ranges for target performance values and/or clearly label dangerously high speeds, accelerations, and more. To view *DataZones™* displays, see photo page 49.

Additional Simulation Data And Analysis—ProTools™ add additional simulated data to the graphs and tables. The additional data includes: *Corrected Horsepower, Tire Growth/Diameter Throughout The Race, Rotational Inertias, and more*. To support these additional variables, all graphs feature custom scaling and new Combo displays.

Advanced Traction Calculator—ProTools™ includes a *Traction Calculator* that can be used (by clicking on the *Traction Calc* button in the **Tires & Wheels Category**) to help determine optimum traction values. Enter the efficiency of power transfer through the tires to the ground (typically 98-to-99%), and the *Traction Calculator* will search for a *Traction* value that produces this degree of tire slip. *ProTools* features include distance range settings and selectable searches for either ET or Tire-Slip presets.

ProPrinting™—Turns simulation results into a comprehensive “presentation” report of dragstrip test data. *ProPrinting™* features include special page graphics, a cover page with the name and address of your business (or

Other Program Features

your personal name and address) and logo, a table of contents, optional text printed at the bottom of each page (can be a disclaimer, copyright notice or any other text you wish), optional comprehensive or “mini” glossaries, and a complete listing of all test data and results at over 90 points during the race and more not included in a Advanced Mode. To view **ProPrinting™** displays, see page 73.

Activating Advanced Or ProTools™ Modes

Activating **Advanced Mode** or the **ProTools™** Kit is a simple, 5-minute process. Open the **Product Activation** dialog box (the **Activation** menu is located just to the right of the **Help** menu) and decide which features you wish to activate. Features already activated are indicated by green checked boxes. Green radio buttons indicate additional features that can be activated. Select the feature you wish to activate and call the phone number shown in the Activation box between 9am to 5pm (CST). The sales consultant will ask you to read the **Activation Code** (a letter followed by ten digits). When the sale has been completed (Visa, MasterCard and others), you will be given the **Unlock Code** that will instantly activate the features you've requested.

Note: Within a few days after your purchase, you will receive a new CD in the mail that contains a backup copy of the features you've purchased (you don't need to record or keep track of the *Unlock Code*). If you need to reinstall the DragSim, including any or all of the optional features you have activated, simply insert the new CD in your CD-ROM drive.

GENERAL SIMULATION ASSUMPTIONS

The DragSim closely simulates the conditions that exist during an actual drag race. The goal is to reliably predict the torque to the driving wheels, the weight transfer that occurs during acceleration, torque losses through the driveline, and a myriad of other factors to accurately predict vehicle performance during an actual drag race.

It is well known that vehicle performance can vary considerably from race to race, and even more so from one track to another, since environmental and track surface conditions are no small contributors to on-track performance. Track operators and racers readily acknowledge that the ability to accurately predict vehicle performance at any specific time and at any specific place is nearly impossible. Only when you take great care to monitor and control the surrounding conditions, including weather, engine, suspension, tires, and clutch tuning, can you even come close to predicting the ET that any vehicle will run on any track.

However, controlling these same variables in an vehicle simulation program is infinitely easier, and this difference gives the user an advantage in locating slight improvements that can easily be covered up by changes in track conditions or other variables. For this to be possible, initial conditions of temperature, pressure,

Other Program Features

energy, and methodology must be established and carefully maintained throughout the simulation process. Here are some of the assumptions within the DragSim that establish a modeling baseline:

Engine:

- 1) The engine power curve used by the simulation is corrected to the weather conditions established in the Weather Category. (The ProTools™ ProData table lists Corrected Horsepower values).
- 2) Engine speed will never exceed the Redline Limit established in the Engine Category.
- 3) Full throttle engine power will be applied to the powertrain throughout the duration of the race.

Environment:

- 1) As engine inlet air gets colder and denser air, the higher horsepower the engine will produce. For induction air at the standard temperature and pressure (STP) of 68-degrees(F), dry (0% humidity), with a barometric pressure of 29.92-in/Hg, engine power will not be corrected and will be used as entered in the *Power Curve* dialog box (power values entered in the Power Curve dialog or imported from a DynoSim engine (.DYN) file are assumed to be corrected to STP).
- 2) The engine, oil, and coolant have been warmed to operating temperature.

Methodology:

- 1) When the simulation incorporates an IC engine (rather than Jet/Rocket propulsion), the effects of torque delivered by the engine and transmitted through the powertrain are analyzed at each one-thousandth of a second throughout the race. For Jet/Rocket propulsion, a steady thrust value is applied to the vehicle; the opposing forces are frictional losses at the tires and aerodynamic forces.
- 2) For drivelines that use clutch coupling (rather than a torque converter), the clutch is automatically setup to provide sufficient slippage at the starting line to cushion engagement. Furthermore, on high-horsepower vehicles that utilize “slipper” clutches, the DragSim automatically generates optimum slippage throughout the race to accurately model these vehicles.
- 3) Since tire traction is almost entirely dependant on track conditions (and, of course, the type of tires and the suspension setup, but without proper track conditions at the starting line, nothing else can create the desired traction) a numeric coefficient value for **Traction** is used to model tire traction during the race. A *Traction Coefficient* value of 2.00 on a wheel carrying 600 pounds of weight will allow 1200 pounds of acceleration force at the contact patch ($2 \times 600 = 1200$). If the force at the driving wheels exceeds 1200 pounds (with the current *Traction Coefficient*), the tire will break loose and the simulation will apply a “slip” model to tire/track interaction. You can use the new *Traction QuickCalculator* (a ProTool™ feature) to estimate optimum traction values.



**Advanced
Drag-Race
Simulation**

DRAG RACING HISTORY

DRAG RACING: 1945 - Present

Drag racing is a violent sport. Monstrous levels of torque are applied through a small pair of tires, hurtling a vehicle down 1320 feet of concrete and asphalt in search of a low elapsed time. It is a quest for speed, acceleration, and the desire to get there first. In fact, there is only one simple rule: First one to the finish line wins!

While the first drag race was, almost certainly, a foot contest of the distant past between two young men vying for the affection of the female of the species, the contemporary version of drag racing involves the use of a pair of vehicles, horsepower, and more than a little mechanical mayhem. Modern drag racing is defined by Top Fuel stilettos piercing the quarter-mile in thunderous 4-second blasts at over 320 mph. But it hasn't always been that way. Contemporary drag racing began in earnest after World War II. It took a few years, even after the end of the war, for racing and high performance automobiles to attract attention. The car companies had to reconfigure their assembly plants to again build cars after concentrating for four years on building bombs, bombers, tanks, and other material of war.

But the war effort also brought about change. It wasn't long before racers were again speeding down the dry lakes and streets of America. As the fighting men returned from war, especially from action in the Pacific, California became a hotbed of hot-rod activity. It was a natural place to foster the growth of "high performance." There was a warm climate, perfect for fenderless, topless, stripped-down street racers. Plus, Southern California had become a natural location for the budding aircraft industry and its related technologies. Howard Hughes was busy building giant airplanes (as well as "boulder-holder" bras for starlets like Jane Mansfield). It was a great place to live!

Aircraft technological development attracted many men with creative talent. Men like Ed Iskenderian, Howard Johansen, Louie Senter, Dean Moon, Clay Smith, Chet Herbert, and dozens more just like them. They were all looking for something—they were all in search of speed.

Drag Racing, 1945 to Present

Dry-lakes racing was still very popular, although the wild era of 1920 and 1930 was over. Organized car clubs and the SCTA had taken control, but a curious thing was happening a lot closer to home. On the streets, that wild, uncontrolled spirit belonged to drag racers. Speed was still the Holy Grail, but now it was only part of the quest. More important was *acceleration*. Street racing was quickly becoming popular and, unfortunately, dangerous. Los Angeles city officials tried hard to curb this trend, even going so far as a failed ban on street “hot rods.”

But rather than a new version of prohibition, what was really needed, simply, was a place to race. Like the dry lakes, street racers needed a safe and legal place to compete. While it seems obvious today, it was a big step in 1950 when C.J. “Pappy” Hart first negotiated a deal with the Santa Ana Airport, now the John Wayne International Airport. On June 19, 1950, Hart and two partners staged the first commercial drag race that is generally recognized as the first significant drag racing event even though the Santa Barbara Acceleration Association held an organized drag race as early as October, 1949.

Hart held “run what’cha brung” races for a few years, and then in 1954, created classes that grouped cars together based on their state of modification, much like the dry-lakes classes of the day. The racing was crude. Motorcycles were generally quicker than cars, and rolling starts were the norm, another holdover from the dry lakes. Rolling starts were used to avoid breaking the spindly axles of the day. Drag racing was also far removed from anything resembling modern electronic timing devices. Hart flagged the start of each race and measured elapsed times only later with the hand-held stop watches and rubber hoses strung across the track. Later, light beams would stop a large sweeping-hand timer. Speed was still a big part of the game, exerting its influence all the way from the dry lakes. But slowly, getting there first became more important, however, it was years before Elapsed Times (or ET) supplanted top speeds. For the first few years at Santa Ana, all the “fast” cars were rated by trap-speed ranking.

In 1949, Robert E. Petersen’s *Hot Rod Magazine* hired Wally Parks from the SCTA as its first “real” editor. Among Parks’ initial efforts was the creation of, what came to be called, the *National Hot Rod Association* (NHRA), funded for its first fledgling years by Robert Petersen. The association grew based on the work of Parks and many others, creating a Safety Safari in mid-1950 that toured the country to work with drag strips to improve safety in both cars and tracks. This message of safety, and its underlying push to legitimize the racing community at large, led to the success and growth of the NHRA, which Parks eventually removed from underneath the Petersen umbrella and began to operate as an independent sanctioning body.

Santa Ana Airport strip survived until 1959, but by that time, drag racers were proving their innovative spirit with numerous creative vehicles. Dick Kraft was one

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of the first, with a stripped-down creation dubbed “The Bug.” Track roadsters and stripped-down street cars were the norm, but soon dedicated “rail jobs” showed up. One of the first was a single-seat, 10.50-second machine fielded by the *Bean Bandits*, a car club from San Diego. Although history generally pays homage to Mickey Thompson as the first to build, what would be called, a “Slingshot” dragster in 1954 where the driver sat behind the rear axle, however, Melvin Dodd’s design of the same time is considered to be a far-superior design. Calvin Rice drove Dodd’s car on his way to winning the 1955 NHRA Nationals, beating Thompson and setting several mph records at (then 1/2-mile) Riverside Raceway. Calvin also grabbed the ET record at the 1956 NHRA Nationals. The design of Dodd’s car was so effective, that trackside wags quickly noted that it launched like it had been “shot out of a slingshot,” creating a name that has become synonymous with all front-engined dragsters. History is full of enigmas: The Thompson car was crude yet enjoys fame while Dodd’s car, now virtually unknown, won races. Regardless of who was “the first,” the slingshot design has become an icon for early drag racing.

By 1960, enthusiasm for drag racing was almost as powerful as the horsepower that the racers so avidly developed. Fuel for this fire also came from Detroit. The new-car companies realized that this groundswell of youthful enthusiasm could be transformed into profits, providing their cars could live up to a carefully-crafted image of “high-performance.” Adding to this infatuation with racing was the popularity of southern-style, stock-class racing. Stock-bodied 1960-era sedans became the other half of purpose-built racing machines, creating the “sportsman” classes that make up the majority of NHRA racing classes.

In the name of fair competition, NHRA was “carving up” various racing-machine designs into increasingly numerous classes. The first U.S. Nationals was held in Great Bend, Kansas in 1955 with only one class, Top Eliminator, won by Calvin Rice with a twin-engine dragster. By the first Winternationals at Pomona in 1961, classes had grown to five: Top, Middle, and Little Eliminators for the purpose-built drag cars along with two sedan classes: Street and Stock. Jack Chrisman won Top Eliminator with a twin-engine, smallblock Chevy-powered dragster that tripped the lights at a 8.99-ET at 170-mph. On the other end of the scale was Dyno Don Nicholson driving a 1961 Chevy to a Stock-Class championship, running a 13.59-ET at 105.88-mph.

While most enthusiasts credit the 1964 GTO as the first true musclecar, there were plenty of performance cars before 1964: The Ford 1963 Galaxie with a 390cid and a few 427cid bigblock engines, Chrysler waved its Pentastar flag with a 413cid and a 426cid wedge engines just before the introduction of the modern Hemi. And Chevy held a commanding lead in participation with its already legendary smallblock 283cid and 327cid engines, but was struggling to keep up in the bigblock arena with its 348cid and 409cid, referred to as a “W” engine because of the shape of its valve covers.

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By 1964, Chrysler introduced the Street and Race Hemi engines to replace earlier 392cid versions that were the darling of the fuel-racing set. At this same time, the Stock and relatively new Jr.-Stock classes were the bastions of blue-collar racing. *HOT ROD Magazine* devoted monthly columns to this new enthusiast class, and Detroit was ready to capitalize. Ford introduced pure-built drag cars that you could purchase directly from the manufacturer in the form of 1964, aluminum-endowed, lightweight Galaxies and fearsome 427-powered Fairlanes called Thunderbolts. Chevy removed the shroud from what had been called the Mystery Motor. The mystery soon revealed itself to be a complete redesign of the “W” engine. If popularity is judged by pseudonyms, then the bigblock Chevy was indeed a star, given its “porcupine” non-de plume, a reference to its staggered-valve arrangement. Later, hot rodders would forever label Chevy’s bigblock as, simply, “The Rat,” a rodent reference to its large size compared to the smallblock, which of course, became “The Mouse.”

This was also the year that Don Garlits first ran over 200-mph (201.34-mph) in August of 1964 (for more on Don Garlits, see page 87). The 7-second barrier had also been broken with a 7.96-ET in May by Bob Vodnick. Ever in search of quicker speeds, drag racing innovators looked to tire technology. For sedan racers, chassis tuning and something called “weight transfer” became an infatuation. In mid-1960, drag slicks used of a rock-hard tread and sidewall design. Traction was the new Holy Grail, now that Detroit had supplied engine foundations that could deliver unparalleled power. Fuel racers were still spinning the tires “all the way down the track.” Once racers determined that this wasn’t the “fast track” to winning races, slipper clutches became the norm (slipper-clutch design details are discussed on page 91). But for the “doorslammer” guys, things would get a little “funny” before racers started applying science to what had been a hobbyist sport.

In 1964-1965, the Chrysler race contingent began experimenting with wheelbase by literally moving the rear axle forward in the car. This was followed by moving the front axle forward. Fairly soon, these cars had enormous lengths of rear overhang that made the cars look, well, *funny*. At this same time many cars also began to forsake carburetors for mechanical fuel injection. With lighter weight and more power, these “funny” cars became increasingly quick. NHRA called them Factory Experimentals, with the quickest running in the A/FX class. The Chrysler cars were the first the play in this arena with the altered-wheelbase, quarter-dancers, running everything from carburetors to injection and even alcohol/nitro mixes delivering low-9-second ETs at 150-mph.

As it turned out, Chrysler was experimenting with what are now called the first Funny Cars; the supercharged, 426-wedge, Dodge sedans dubbed the Dodge Chargers, driven by eventual fuel racer Jimmy Nix and later by Charlie Allen and others. Jack Chrisman quickly followed Chrysler’s lead with a Ford Comet. It was powered by a supercharged 427cid Hi-Riser-engine using a 60/40 mix of alcohol

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and nitromethane. These were still stock-bodied sedans. But since weight was also critical, it didn't take long for the Logghe brothers in Detroit to build a complete tube-chassis, fiberglass-body Mercury Comet for Don Nicholson, running an injected 427 that tipped the scales at a svelte 2200 pounds. Later, Mercury also built a roadster for Chrisman and the war was on. These first Funny Cars, with rear-pivoting lightweight fiberglass bodies and engines ahead of the driver, were powerful, quick, and exceptional crowd pleasers. They were also skittish, bear-to-drive brutes that were guaranteed to bathe the driver in oil and fire when transmissions or engines exploded—something that occurred with alarming regularity.

By this time, Don Nicholson had driven Top Stocks, Super Stockers, F/X'ers and Funny Cars. But, as he readily admitted, the new Funny Cars were dangerous, and too many of these fiberglass bullets were crashing and hurting people. For Nicholson, it was time to go back to carburetors and gasoline. He was one of the few that was involved in almost every type of drag racing except fuel dragsters. And as Nicholson saw his participation change, the sport, itself, was about to metamorphose as the new decade loomed large.

1970 would become a pivotal year for the doorslammer crowd. The A/FX cars had exchanged their doors for fiberglass cocoons, and along the way split into two factions. The first consisted of supercharged, fiberglass-bodied monsters that became true Funny Cars, officially named AA/Fuel Coupes. The second A/FX faction buried its roots deeply in normally-aspirated engines, paying homage to carburetors and gasoline. While similar cars still raced in Super Stock, they were subject to index or "brake-light" racing, where, if it ran too quickly, it was declared a loser. Racers pressured NHRA for a "heads-up" eliminator where no index would limit performance. In 1969, the *American Hot Rod Association* (AHRA) created ProStock, followed quickly in 1970 by the NHRA with a class of the same name.

These early ProStock cars were merely enhanced street cars with stock floorpans, slapper traction bars, and four-speeds. The first years were dominated by Chrysler racers Ronnie Sox and Buddy Martin, but ProStock soon gave light to several personalities who would become closely identified with the class. The man who would become synonymous with all forms of Chevy racing engines for the next two decades was William Tyler "Grumpy" Jenkins. Other ProStock pioneers included Wayne Gapp and NASCAR-notorious "Cactus" Jack Roush, Frank Iaconio, Wally Booth and dozens of others.

Bob Glidden took up the ProStock challenge in 1972, much to the dismay of his competitors. By the time he retired almost 20 years later, Glidden had amassed an amazing 85 NHRA ProStock wins, a record that has rarely been equaled in any sport. Another ProStock juggernaut through the 1970s was a trio of Texans: David Reher, Buddy Morrison, and Lee Shepherd. Unfortunately, Shepherd was killed in a testing accident in March of 1985, but the team returned with driver Bruce

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Allen, although they never again ascended to the level of success enjoyed with Shepherd.

While 1970 was the inaugural year for Pro Stock, it was a watershed time for Top Fuel as well. At Lions drag strip in Southern California, Don Garlits suffered a horrendous transmission explosion that not only cut the car in half, but also severed half of his right foot. The major reason for his injury was the front-engine design of the slingshot dragster. After recuperating from his wounds, Garlits went back to Florida and developed the rear-engine concept. While Garlits' idea was hardly new—many had tried this configuration in the past—none had been successful. The difficult problem was that the car would get light at the top end and try to swap ends, a less than desirable effect.

Once again in Los Angeles in January 1971, Garlits debuted his new back-motored car at Long Beach at the AHRA Grand American race. The car ran a stout 6.55-ET and within a couple of months, it had captured the NHRA Winternationals at 7.03-ET at 214-mph. It continued to win at the March Bakersfield Fuel and Gas Meet. Garlits' car was not the first rear-engined Top Fuel car. It wasn't even the first winning car. But because it was Don Garlits who made the design work, by the following year, every competitive Top-Fuel team had switched to the “new” design.

In addition to increasing speeds and quicker ETs, drag racing in 1970-1980 became somewhat circus-like. This was not a sport that you could honestly call “gainful employment.” Yet for pro's like Garlits, Don Prudhomme, Tom McEwen and a few others, the match-race circuit could generate cash. In addition, the Barnum & Bailey aspect of drag racing mirrored the contemporary Disco-era dementia with wheelstanders, jet- and rocket-powered cars, and even jet-powered tricycles! Viewed mostly as absurd oddities, the cars even infested national events, used mainly as fillers for between-round down times. Earlier, NHRA had banned jet- and rocket-powered cars, but this didn't keep these awesome vehicles from running at non-NHRA tracks. Among these different drummers was land-speed artist Art Arfons who pushed his Cyclops jet-powered dragster to 5.90-ET at 229-mph in 1971, when the Top Fuel cars were running 6-second ETs.

In 1972, Mike Snively breached the 5-second zone with a 5.974-ET at 235.69-mph on November 17, 1972, in Ontario, California, during the NHRA Supernationals. By 1973, Garlits had traversed the 240-mph barrier, hitting the milestone 250-mph mark in 1975. By this time, Gary Beck grabbed the NHRA national Top Fuel record with a 5.698-ET, but that's when it seemed that the fuelers hit an invisible wall. It took Beck six years to drop the record to a 5.573-ET in 1981, which would again stagnate in 1983 with a 5.391-ET. It seemed that no one could run quicker.

In 1950, the late Roger Huntington wrote a story for a performance magazine

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that claimed, through mathematical miscalculation, that attaining 200-mph in the quarter mile was patently impossible. While mathematically-challenged drag racers proved the theory wrong in short order, the contention in late 1970 was that the Kings of the Sport—the big dogs of Top Fuel—had hit the acceleration barrier. Was it possible that no one could run quicker than 5.000-seconds at 250-mph? While the fuel racers continued to use the “more-horsepower” hammer to beat out a solution, it took a few math geniuses and some applied aerodynamics to finally solve the problem.

While Top Fuel cars had employed wings from the early days of drag racing to create downforce, these were crude applications of the concept. The 1970 solution was to drive the tires down into the pavement with hundreds of pounds of downforce to maintain traction. Unfortunately, this came at the price of excessive aerodynamic drag, which slowed the cars down. But in 1984, the breakthrough fell to Tim Richards, Top-Fuel racer Joe Amato’s innovative crewchief. He applied emerging Indycar aerodynamics information from Eldon Rasmussen to create a wing that solved the problem. At the Gatornationals, Amato blitzed the rest of the Top Fuel field with a series of 259-mph and later 262-mph blasts. Unfortunately, Amato’s innovation was impossible to hide, and in no time, every Top Fueler was sporting a seven-foot high cantilevered wing.

While the wing appeared little different from previous designs, Richards placed it up over the car in clean air. But more importantly, it sat further behind the car, using leverage to generate monstrous downforce at only a fraction of the usual cost in aerodynamic drag. At almost this same time, Funny-Car-Turned-Top-Fuel-Racer Kenny Bernstein was pioneering the use of a sophisticated data-recording device that revealed an immensely-critical piece of information. Since the earliest days of slipper clutches, fuel racers had assumed that the clutch completely locked-up at some point past the halfway mark on the track. Bernstein’s data recorder clearly pointed out that this was not the case.

Now armed with two significant pieces of information, Top-Fuel records began tumbling with increasing regularity. While Beck had owned the ET record for several years, the record tumbled within a short time. Darrell Gwynn called the record his in 1986 and 1987 with 5.28- and 5.17-second passes. Once the 5-teens were broached, racers started talking publicly about the once-unheard-of 4-second zone. Who would be the first? While the soothsayers had their favorites, it was Texan Eddie Hill who pummeled the record book with his historic 4.99-ET pass at Billy Meyer’s Ennis, Texas racetrack on April 9, 1988. Top-speed records also began clicking off big numbers faster than 29-cent hamburgers at McDonalds. Garlits ran 270-mph in 1986, Amato pushed the 270-mph mark in 1987 while Connie Kalitta bumped it over 290-mph in 1989 at Pomona, capping a drag racing career than had spanned over 40 years.

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It would take another perennial performer, Kenny Bernstein, to finally punch a Top-Fuel-sized hole in the other drag-racing millennium mark: 300 mph. On March 20, 1992, Bernstein blasted a 301.70-mph pass during the NHRA Gatornationals to become the first Top-Fuel pilot in NHRA drag-racing history to run 300-mph. Bernstein would later bump the record to 314.46-mph in 1994. At some point in the future, however, NHRA-imposed restrictions on Top Fuelers may make much higher speeds impossible. All along this record-setting continuum and through to today, NHRA continues to place restrictions on this “unlimited” class in an effort to manage speeds. One quick fix was to change the way the speeds are measured. From the first days of electronic timers, trap speed was chronicled by measuring the time it takes for a vehicle to traverse 66-feet before and after the finish line, or 1/10th of the 1320-foot quarter-mile. This required that the cars continue to accelerate 66-feet past the finish line to attain the highest trap speeds. This was called “driving the car out the back door.”

In the 1980s, NHRA eliminated the 66-foot timing zone after the finish line. This reduced recorded top-end speeds and no longer required the drivers to stay in the throttle past the finish line, in essence, lengthening the shutdown area. Other restrictions included tire size, rear-gear ratio, and blower-size limits as impediments to the inexorable march toward faster speeds. Currently, NHRA is looking at further restrictions, since Goodyear has made it clear that Top-Fuel cars are capable of faster speeds than current tire technology is capable of safely withstanding. Another major concern is that tracks built in the late 1950s and early 1960s now must handle cars running twice as fast as they were in the early days of the sport. Shutdown areas that could safely accommodate a careening 250-mph Top Fuel or Funny Car are being taxed to the limit with speeds in excess of 320-mph.

With large corporate sponsors, live television coverage, and increasing pressures to perform, drag racing is now the professional sport it has always aspired to be. Along the way, unfortunately, it traded its participant-oriented roots in favor of a slick, high-profile professional feel. In the beginning and through the 1960s, drag racing was a place where anyone with a hint of automotive skill and a little money could race competitively. While bracket racing has continued to address this need, the impression that anyone can successfully compete on the professional level is not as prevalent. Maybe that is the price of big-time auto racing. This is certainly not specific to just drag racing. The same situation applies to NASCAR and all forms of road racing. However, there is still, and hopefully always will be, a place to race for the entry-level enthusiast. And in fact, there are now more drag-racing tracks and classes than ever in the history of the sport. So perhaps these are really the golden years of drag racing after all. Only history will tell the true story.

DON GARLITS: DRAG RACING'S BIG DADDY

If there is one racer who is synonymous with drag racing and one who has done

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more to help the sport attain its current level popularity, it must be “Big Daddy” Don Garlits. While fame is fleeting, people only vaguely familiar with drag racing recognize the name Don Garlits. But that wasn’t always the case.

Don Garlits was a skinny 18 year-old from the humid lowlands around Tampa, Florida, when drag racing was in its infancy in 1950. The sunny climes of his home state, like California, contributed to his interest in performance. His first pass down a drag strip was in a 1940 Ford convertible, but a short time later he built a dragster from a ragged 1927 T-roadster in which he won an NHRA Safety-Safari race at Lake City, Florida. This led to the first of what would become the Swamp-Rat series of race cars, initially powered by a 331cid Chrysler Hemi engine with carburetors.

It was a larger 392cid Hemi running on one of the first sets of M&H slicks that Garlits drove to an 8.79-ET at 176-mph in 1957, but the West Coast contingent merely scoffed at his accomplishments. It wasn’t until Garlits beat the much-touted Emery Cook in the Cook & Badwell fueler that the fuel-establishment began to take him seriously. This led to a huge West-Coast challenge. A series of three tracks put up \$5000, win or lose, for the young racer to tow from Florida to the West Coast for a series of match races with some of the fastest fuel cars in the country. It was an offer Garlits couldn’t turn down. But it did not produce the fairy-tale result that Garlits intended.

The Bakersfield Smokers Meet was the premier event, but the best the “East Coaster” could manage no quicker than 9.00-ETs at 172-mph, while the local heroes were running 8.70-ETs at 180-mph. Garlits broke a cylinder block and was disgraced. The fans did little to help the matter, jeering him and throwing beer cans at the car on the return road. Despite his initial reception, he returned to the West for several races, and by 1965, he won not only that most prestigious of fuel races, but also won the admiration of the fans.

Fuel racing in the 1960s was made up of many unique characters, as was virtually every other class in drag racing. But even with this strange mix of personalities, Garlits always managed to keep his name in the press and not always by virtue of his on-track performances. It seemed from their first meeting that Garlits and NHRA president Wally Parks were destined to be at odds. In a later interview, Garlits said he always liked Parks, it’s just that a little controversy was a good thing. And Garlits never shied away from a fight.

While his performances kept him famous, it was always about the money. Garlits was smart enough to know that he could never race on his own nickel. By 1959, he was commanding no less than \$1000 in appearance money for each match race, far more than any other accomplished fuel racer from either coast. But the money didn’t make the racing any safer. Over the course of several years, a bad fire in 1959 left the corners of his mouth badly scarred and several crashes left

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their marks as well. All this time, Garlits kept thinking about a rear-engine car, even though conventional wisdom had “proven” it wouldn’t work.

By 1959, Garlits ran an 8.23-ET at 183-mph with the now-classic combination of a GMC 6-71 supercharger and heavy doses of nitromethane. But not everyone could make the nitro engines live, and engine explosions were commonplace. NHRA imposed a nitro ban on all cars in 1957 that lasted until 1963, keeping Garlits out of the field for several years, although he did compete with a gas-powered car at one NHRA Nationals in Indianapolis. But the NHRA was not the only game, and plenty of “outlaw” tracks still welcomed the cackling thunder of well-tuned nitro-burner.

By 1964, the NHRA nitro ban had been lifted and Garlits’ career along with it. Befitting his on-track ability, he picked up the now-famous moniker of “Big Daddy,” and he lived up to that name with the first NHRA 190-mph pass in 1963 in Connecticut. Shortly thereafter he was the first to run over 200-mph in New Jersey. His success continued through the late 1960s with front-engine dragsters. When the fuelers hit a slump and seemed to stagnate, Big Daddy proclaimed to the drag racing world in 1967 that he wouldn’t shave until he ran in the sixes. At the U.S. Nationals in 1968 he not only ran a 6.77-ET, but also won the race, celebrating the event by shaving while standing on the top of his push truck. Garlits knew the benefits of publicity.

But the quintessential event was held in Southern California at Lions race track in 1970. Garlits home-built, two-speed transmission exploded, frozen on film by photographer Steve Kelly as a moment-in-time when the face of Top-Fuel racing changed forever. The massive explosion, just past the starting line, cut the car cleanly in half—taking with it half of Garlits’ right foot.

As Garlits recuperated, his thoughts were not of quitting this dangerous sport, but instead of making this new-age joust safer for the man caged within the raging beast. Straddling a transmission while peering around a massive engine with a supercharger mounted on top was a perfect recipe for driver flambé anytime the engine exploded. Engine failures immediately bathed the driver with hot engine oil, fire and heat; hardly a pleasant combination. Yet conventional wisdom doggedly held that the mid-engine alternative was somehow less attractive. The thinking was that these were skittish machines that, simply, hadn’t proved themselves. Garlits simply chose to ignore the nay-sayers.

One year later Garlits returned to the same race with a rear-engine car. One that—he was convinced—would work. While many have given him sole credit for the design, Garlits was the beneficiary of previous mid-engine efforts. Tony Nancy built a beautiful mid-engine car in 1965 that subsequently crashed; James Warren and Robert Cobern tried the idea in 1959. Even the eclectic Jocko Johnson designed a mid-engine streamliner for drag racing as early as 1958. None were

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successful. But with help from several sources, including the idea of slowing the steering ratio to make the car less twitchy, Garlits succeeded where others had failed. He barnstormed the “Left Coast” and by the end of his westward jaunt, Garlits captured the NHRA Winternationals, the Bakersfield March Meet, and the NHRA Springnationals. It was clear the mid-engine curse was little more than a fairy tale. Garlits had proven his dogged determination once again. It was time for the rest of the field to catch up.

Innovation has always been part of the Garlits legacy. He dabbled with a short-wheelbase streamliner-fueler with a body built by the indomitable Jocko, but evil handling was an ever-present demon. Garlits ran the car a few more times and then unceremoniously retired the beast. Garlits again directed his attention to making horsepower. By 1975, he held both ends of the NHRA Top-Fuel record with an 5.63-ET at 250-mph and won the inaugural NHRA Winston points championship. Garlits chose to sit out most of 1976, then came back in 1977 but could only manage a disappointing 9th-place points showing. This was the same year Muldowney steam-rolled her way to the number one spot. The next year, 1978, Garlits was much more successful, trailing only Kelly Brown in the points race. This would be his best performance; he was third in 1979; slipping to 8th in 1980. “Retirement” was bantered about. Garlits had been racing for 25 years and everyone was talking about drag racing as a young-man’s sport. But like so many motivated men, the living legend wasn’t finished yet. In fact, Garlits career may be unique for another reason: The greatest number of retirements!

In 1984 Garlits was on the NHRA trail again and back in the Top-Fuel top ten. By 1985 that competitive fire was back in full force, and the Old Man squeaked out a Top-Fuel championship, his first since 1975. Garlits was on top of his game, but the challengers were coming fast. And one of the Garlits’ greatest was a youngster by the name of Darrell Gwynn. It was time for a changing of the guard, and while Garlits may not have wanted to admit to it, he knew that sooner or later it would happen.

There have been several watershed events in drag racing. Some are obvious, like the regularly-broken speed and ET “barriers.” But there are other more subtle events. One of note was the 1985 U.S. Indy Nationals. Indy could have be subtitled “Garlits’ track.” Over his tenure as the master of the Top-Fuel universe, Big Daddy earned his reputation with an incredible eight U.S. Nationals Top-Fuel victories between 1964 and 1986, winning this premiere event three straight times between 1984 and 1986.

In 1985, a new kid was setting his sights on Top Fuel. Darrell Gwynn had etched his name into Top-Alcohol-Dragster history and was searching for that same elusive Top-Fuel ring. It was a classic matchup come to the U.S. Nationals: The kid versus the old man; youth and enthusiasm heads-up against the warrior elite. Hollywood

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writes scripts like this all the time, but this was no fairy tale. This was history in the fast lane. The last race of the long Labor-Day weekend came down to just these two competitors. It looked like an even match going into the final, but the Old Man gunned the youngster down with a 5.57-ET at 260.56-mph (to Gwynn's 5.75-ET at 250.13-mph). The Old Man was still the king and proved it by taking the 1985 championship. Garlits beat Gwynn again in 1986 and, again, captured the Winston title. However, the tighter competition during these years served as a gentle foreshadowing of what would eventually come to pass, as the younger generation strived for its claim to fame.

It's often said, "It's not the years, it's the mileage," and eventually those miles pile up, even on a living legend. The following year of 1987 started out strong with a Winternationals win and another at Atlanta. But then Garlits flipped his ride three times in what are called "blow-overs," and at the end of 1987, out of the NHRA top ten, Garlits retired at age 55, after over 30 years of competition. Within those years, he amassed an incredible 35 NHRA event victories, placing him solidly in the top ten NHRA racers of all time.

Garlits has become a symbol for the best of drag racing: A man who represents the highest heights a competitor can attain. He believed in himself and never gave up. His accomplishments and contributions fill volumes, yet don't reflect the true nature of the man. A family man with two daughters and lifelong partner and wife, Pat, he was often embroiled in the politics of the time. Garlits traveled to Viet Nam with NASCAR driver Richard Petty and other racers, talked to the soldiers and reported his findings in the April, 1972, issue of *Hot Rod Magazine*. His strong political connections even led to a run for political office, but it ended in a defeat, largely because Garlits answered questions truthfully, nipping his political career in the bud.

Perhaps one way to get a clearer sense of the man is to travel to Ocala, Florida, south of Gainesville, and tour his museum. The cars are constantly changing and reflect the era when Garlits was nothing less than drag racing's premiere personality: Big Daddy.

THE SLIPPER FIT

Drag racing has always been a sport of experimentation. In the early years of unlimited class racing, the "rails" were crude cars with big engines and granite-like rear tires. Tire smoke from the starting line to the traps was as much a part of the show as the noise and flames from the headers. All through the 1950s and early 1960s, with cars running low 8-second ETs, the image of smoking tires was commonplace.

One of the most innovative men in drag racing was Keith Black. His involvement

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with the legendary Greer-Black-Prudhomme slingshot dragster in the early 1960s led him to work with Paul Schiefer on a clutch that would allow Black's team to "get a grip" on the track. Until that time, the belief was slippage had to occur, but it was easier to deal with this concept as it applied to the tires rather than the clutch. Black knew that moderating torque output was one way to manage tire spin, but this sometimes led to wheelstands, that while dramatic, weren't the fastest way down the track. Other racers also experimented with the concept of slipper clutches. At a time when 8.20-ETs were considered very quick, "TV" Tommy Ivo ran an incredible 7.99-ET in late 1962 by riding the clutch with his foot just off the starting line. But this tactic was inconsistent, requiring too much driver concentration and finesse. Black felt that consistency would be attained by building predictable and reliable slippage into the clutch.

Holly Hedrich also worked for Schiefer, and together with Black, spent hours turning the existing Schiefer Velvetouch dual-disc clutch into a slipper design. This work paid off for the Greer-Black-Prudhomme car in January of 1962 at San Gabriel Dragway: Prudhomme laid down what appeared to be a rather slow run, since very little tire smoke was evident on the pass. But the time slip told a very different story with an astounding 7.77-ET, later backed up by a 7.84-ET. The slipper clutch worked.

At the time, the existing fuel clutches used two clutch discs separated by a floater plate. The trick was to make the clutch accomplish several tasks at once. The sought-after slippage was only needed in the first portion of the race. At some point just before mid-track, the speed and tires could finally accommodate full power, and the clutch would lock up. While this was simply performed with weights added to levers on the pressure plate, the built-in slippage produced heat that was far more difficult to control. As racers dialed increasingly larger percentages of slip into their clutches, more and more heat was the inevitable result. Metal fatigue from excessive heat produced spectacular clutch explosions that quickly became the norm.

In a short time, NHRA mandated clutch cans, called scattershields, that helped reduce the carnage. But the earliest cans were made of aluminum with a thin, steel inner-liner, hardly capable of containing the shrapnel created by a disintegrating white-hot pressure plate, clutch disks, and flywheel. In one incident at Orange County, Mike Sorokin was driving Tony Waters' fuel dragster when the clutch exploded, ripping the car in two and instantly killing the young driver. In those days, driving a front-engine fuel car meant straddling the clutch can like stirrups on a horse. With the romance of speed removed, it was literally the drag-racing equivalent of tossing a grenade in the driver's lap with the pin missing!

It would take long years and several deaths before slipper-clutch design was significantly improved. Part of this evolution involved scattershields, with new

Drag Racing, 1945 to Present

specifications for hydro-formed steel cans with thick block plates between the flywheel and engine. These designs later evolved into titanium bellhousings that could contain the violence of exploding sixty-pound clutch assemblies at more than 6000rpm. Once these slider clutches were perfected, clutch technology struggled to keep up with the progression of increased horsepower. When the slipper clutches were first introduced, fuel engines were producing about 1500 horsepower. By the mid-1980s, the Kings Of The Sport were cranking out more than 5000 horsepower, but although clutch science had also progressed, everyone assumed that the clutch was “locking up” somewhere down track. The black art of clutch tuning continued to lay deeply mired in the muddy waters of assumption.

It wasn't until Kenny Bernstein employed the first computerized data-logging device that this long-held “belief” was revealed to be erroneous. The clutch wasn't locking up as previously believed. It didn't take the innovators long to create a series of sequential electronic timers to control a matching series of pneumatic solenoids. These sequentially-activated solenoids added additional clamping force to the clutch, ensuring lockup. This, in turn, led to more accurate and predictable operation and ever-increasingly sophisticated electronic controls. Eventually the NHRA had to step in and mandate that clutch management systems be strictly mechanical, with no external computer controls. The intention of this rule was to prevent the development of on-board, electronic, traction-control systems, that could instantly add tractive force when needed. The NHRA believed that this system would eliminate some of the challenge of racing, making racing too predictable. Of course, an electronic traction-control system also would make fuel racing more of a pure horsepower race, which it always has been. So, to this day, fuel racing continues to walk that treacherous path of balancing enormous power with limited traction by experimenting with the alchemy of slipper-clutch tuning.

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**Advanced
Drag-Race
Simulation**

COMMON QUESTIONS

COMMONLY ASKED QUESTIONS

The following information may help answer questions and solve problems that you encounter when installing and using this software. If you don't find an answer to your problem here, send in the **Mail/Fax Tech Support Form** on page 101 (*ProRacing Sim Software provides Mail/Fax technical service to registered users only—register your software today*). We will review your problem and return an answer to you as soon as possible.

INSTALLATION/BASIC-OPERATION QUESTIONS

Question: Received an “Error Reading Drive D” (or another drive) message when attempting to run or install the DragSim. What does this mean?

Answer: This indicates that your computer cannot read the DragSim CD-ROM installation disk. The disk may not be properly seated in your drive, the drive may be defective, or the disk may be damaged. If you can properly read other CD-ROM disks, but the DragSim distribution disk produces error messages, try requesting a directory of a known-good disk by entering **DIR X:** or **CHKDSK X:** (where **X** is the drive letter of your CD-ROM drive) and then perform those same operations with the DragSim disk. If you receive an error message only when using the DragSim disk, the disk is defective. Return the disk to ProRacing Sim Software for a free replacement (address at bottom of Tech Support Form).

Question: Encountered “Could not locate the DragSim CD-ROM disk” error message when trying to run the program. Why?

Answer: Please insert the DragSim disk in your CD-ROM drive. Occasionally, the DragSim will need to access the CD. Please keep the DragSim disk handy.

Question: The DragSim produced an *Assertion Failure* error. What should I do?

Answer: Please note down all of the information presented in the message box, provide a quick synopsis of what lead up to the error, then send this information to ProRacing Sim Software (support@ProRacingSim.com). Thank you for your assistance in helping us improve the DragSim.

Common Questions

QUESTIONS ABOUT RUNNING A SIMULATION

Question: The DragSim Iterator takes too much time to complete a several-thousand run test. Is there a problem with my computer or the software?

Answer: The DragSim uses a powerful simulation that performs millions of calculations for each track test, and this takes some time. Refer to page 10 for more information on computation times for several computer systems.

Question: When I run a simulation, part of the graphic curves don't appear on my screen. What can I do to correct the display?

Answer: Open the **Graph Options** menu (right-click on the graph) and select Auto Range for the **Y1** or **Y2** variable. See page 48 for more information about graph scaling and plotting variables.

Question: What are the **Frontal Area** and **Aero Drag**?

Answer: As a vehicle moves forward, it displaces the air around it. The larger the vehicle, the more air it must push aside. At its most basic, a vehicle can be thought of as a "brick wall," equivalent in size to the height and width of the vehicle. When the square-foot area of the brick wall is equal to the "head-on" area of the vehicle, they both displace the same amount of air as they move forward and, therefore, have the same frontal area. But a brick wall has much more *wind resistance* than most vehicles. The difference is a measure of the efficiency an object possesses as it moves through the air (i.e., how much energy is consumed at a specific speed relative to a moving flat "brick-wall" surface); this ratio is called the aerodynamic drag. The brick wall has an **Aero Drag** equal to 1.0. However, a well designed vehicle of the same frontal area may consume only one-half of the energy required as it "slices" its way through the air. In this case, the Aero drag would be equal to 0.5, or 50% of the flat surface. Review the list of vehicles in the **Vehicle Menu** to determine how the aerodynamic drag changes with vehicle design. Aero Drag can be reduced anywhere from 0.01 to as much as 0.1 by lowering the front of the vehicle to provide a better "angle of attack" and through the addition of aerodynamic "dams" that redirect air around the vehicle rather than allowing it pass underneath. The DragSim uses both Frontal Area and Aero Drag to calculate the energy required to move the vehicle through the air at any speed.

Question: The vehicle I am simulating runs quicker in the DragSim than at the race track. The MPH is about the same, but the predicted ET's are quicker by about .3 seconds.

Answer: The most common cause for this problem relates to using a **Traction Coefficient** value that is too high for your vehicle. In most cases, you will find that the DragSim will offer the best ET predictions when the **Traction Coefficient** is adjusted to allow the vehicle to produce slight tire slip at

Common Questions

the starting line and, to a lesser degree, through first gear. This can be detected when the green tire-speed line (on the upper data graph) moves away from the red vehicle speed line in first gear. Start off with a high traction number, then work your way down and home-in on a traction number that allows slight tire slip. When everything is set up properly, the green and red lines should remain together (indicating no tire slip) at all other times throughout the race (except when modeling extremely high horsepower vehicles).

If you have activated ProTools™, the Traction QuickCalculator will be available in the DragSim. This tool will help you quickly estimate the correct traction value. See page 40 for more information on this handy calculator.

Tech Support Request

Please use this form (or a copy) to obtain technical support for the DeskTop Drag and DragSim from ProRacing Sim Software, Inc. Fill out all applicable information about your system configuration and describe your problem thoroughly. We will attempt to duplicate the problem and respond to your questions as soon as possible. Mail or fax this form and any dyno-test printouts to the address below. *Note: We will only respond to problems from registered users—if you haven't already, please take a moment and fill out the registration form that appears when you first start your software.*

Your Phone () _____ - _____ Your Fax () _____ - _____

Your Name _____

Address _____ Apt. or Building _____

City _____ State _____ ZipCode _____

Brand of computer _____ CPU _____ Speed _____

Running Windows95 Windows9898SE Windows2000 WindowsXP
(If not listed here, what version _____)

Version of DeskTop Drag (see front of CDROM) _____

Version of DragSim (see front of CDROM) _____

Please describe the problem you encountered with the **DeskTop Drag or DragSim** and, if necessary, include any menu choices or other conditions that created the problem.

Can you duplicate the problem? _____

Mail/Fax this form to:

ProRacing Sim, LLC.
3400 Democrat Road, Suite 207
Memphis, TN 38118, Email: support@ProRacingSim.com
Fax: 901-375-3443



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