SCREAM AND FLY.com

THE MAGAZINE DEDICATED TO PERFORMANCE BOATING

Fine Tuning For The Future

An Evaluation of Aeromarine Research's Tunnel Boat Design Program

Article and Test by Greg Terzian and Helmut Freitag

Photos by Greg Terzian

With winter fast approaching, boaters' thoughts turn to winterizing and the dull, boat-less months ahead. It is during these months that we take the time to reevaluate our rigs, and think about changes for the next season. Many of us think of ways to extract every last ounce of performance from our rigs as we wait for the warmer weather.

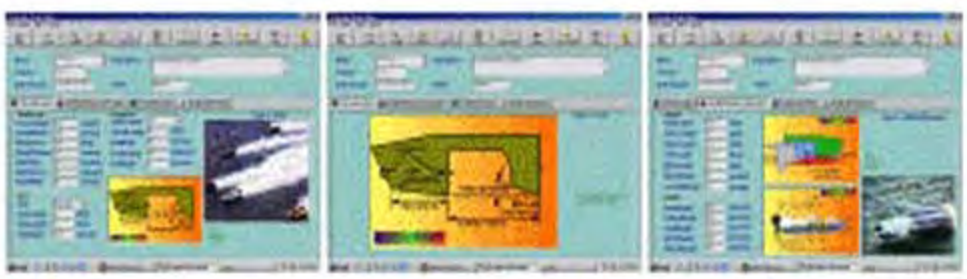
Fortunately, if you own a tunnel boat, Aeromarine Research has a way to use this downtime very productively. Their Tunnel Boat Design Software can turn the winter into the perfect time to optimize or design your tunnel boat configuration, all without leaving your home. The Tunnel Boat Design Software promises to help you optimize the performance of your tunnel boat – off the water. Now, that's a pretty impressive claim. So, first we'll look at how the software works, and then we'll see how well its results compare to real life performance. Even if you're one of the lucky few that lives in a climate that permits year-round boating, this software will prove very valuable – after all, how else can you test such a huge variety of performance enhancing features without breaking the bank? Essentially, this software allows the tunnel boat enthusiast to alter a 'virtual model' of their current hull, or create an entirely new design and see the results of your changes in real time as you alter each of the many hull variables. The power of the PC can now be leveraged to offer insights into your hull configuration never before possible with such ease and accuracy.

Test Subject: Lightweight STV Euro / stock Mercury EFI 260.
Our test hull features a non-stepped ski bottom.

Aeromarine Research's Tunnel boat Design Software is used by professionals and individual high performance enthusiasts worldwide to improve the performance of their tunnel boats. The program uses three different methods of optimization to generate predicted performance results: angle of attack optimization, power optimization, and velocity prediction. After you input the data on your boat, the program makes all the necessary calculations to predict actual performance. As you optimize each factor, the remaining two are set as constants. Optimizing for each factor will give you a huge amount of critical information on everything from actual hull design to high-speed stability. Normally, it would take an enormous amount of time and dedication to acquire this information – even learning all the background theoretical knowledge would take quite some time. Aeromarine has taken their years of experience and knowledge and put them all together in this program. The Tunnel Boat Design Program is used by pros and individual enthusiasts alike - the program is very straightforward and includes a great deal of support for all types of users.

Left: Where to begin: The splash screen features help, the tutorial wizard, and start.
Middle: Design File Selection screen, where you manage your designs.
Right: Quick Start Wizard walks you through the data input and analysis process.

The program begins with its four "Design" screens. Each screen has a wealth of parameters to assign and adjust in the quest for more speed. These are the places where you can experiment with actual hull design, set up, and much more to see which changes will result in better performance. Thanks to Aeromarine Research, you no longer have to spend hours with complex calculations and confusing formulas. You can also be spared costly "trial and error" alterations that can damage your boat or result in more downtime. After all, would you rather spend hours experimenting with and testing motor height, for example, or spend just a few minutes entering data so that the software can help you predict the optimum placement?



Left: Boat Data Input screen - basic hull data goes here.
Middle: Larger view of illustration to aid in measurement accuracy.
Right: Weight and Measurements screen.

The first Design screen is the "Boat Data" screen. On this screen, you enter figures for the hull design - tunnel and pad height and width, number of steps and their length, and pod measurements. A note to non-North American users: all measurements are Standard, so if your measurements are metric, you'll have to convert them. The screen also has a useful picture with the different measurements labeled, so if you're not sure what the "Pad Deadrise" is, a glance at the picture will show you exactly what to measure. There is also a detailed User Manual and on-line context-sensitive help manual that explains each of these design parameters in detail.

The second Design screen is the "Weight/Measurement Data" screen. This is where you'll put in figures like total boat length, and motor length and height. You'll also assign values to boat weight, motor weight, fuel weight, and even driver weight. Like the Boat Data screen, the Weight/Measurement Data screen includes a diagram that shows the listed measurements

Fine Tuning For The Future

An Evaluation of Aeromarine Research's Tunnel Boat Design Program

Article and Test by Greg Terzian and Helmut Freitag

Photos by Greg Terzian

The third design screen is the "Setup Data" screen. Skeg, Torpedo, and Drive Type information goes here. Aeromarine includes setup data for a variety of popular drive units, so you might not even have to measure yours. If you do though, they helpfully include a clearly labeled diagram (which, like the others, can be enlarged for better detail). You also give a starting velocity and angle, and choose which factor you want to optimize - velocity, angle, or power. Aeromarine's Tunnel Boat Design Software is extremely comprehensive - you must also choose the altitude and type of water in which you'll be running your boat. You even have the option of using a constant, straight line, or custom acceleration model for the final calculations.

Left: Large diagram of hull measurements.
Middle: Large diagram of lower unit relation to running surface.
Right: Setup Data Input screen - adding the dynamics to your rig.

The final Design screen is the "Design Detail Data" screen. This screen includes cowl measurements, open deck measurements, and aerofoil details. Like the other screens, the Design Detail Data screen includes a diagram so that it is clear what each measurement refers to.

The Design screens are all easy to navigate, and the helpful diagrams make entering the correct data a breeze, even for a beginner. The Design screens also include a velocity range calculator and an incremental angle calculator, so you're spared having to do any calculations on your own. The only thing you need to do is measure accurately, and feed the information to the program.

Once you've designed the boat, you move on to the Performance Analysis screen. This screen is where you find out how your boat (real or imaginary) would perform under the specified conditions. The Performance Analysis screens show the predicted results of all your tweaking and experimentation. You can look at data throughout your full velocity range (say, 10 to 100 mph), or you can highlight a specific troublesome velocity range (say 50-60 mph) in small steps to examine what is causing a specific behavior. Performance Analysis consists of two important parts - the actual performance data and data on stability – a remarkable asset, since safety is always the first concern of any responsible high-performance boater. Fantastic.

Left: Large diagram showing proper measurement points on a lower unit.
Middle: The final step - the Design Detail Input screen.
Right: Again, large diagrams aid in measurement accuracy.

The performance data can be viewed in many different forms. A chart lists all of the information and the changing values as hull velocity increases. Here you'll find elapsed time, the location of the static and dynamic centers of gravity, motor and cowl drag, the total hydrodynamic and aerodynamic lift and drag, and many other variables.

Of course, looking at rows of numbers isn't always the clearest way to visualize performance. So Aeromarine Research has included another very useful feature - a total of 34 different graphs. These graphs are pictorial representations of the information on the Performance Data screen. Very often it is easiest to just pull up a graph and see at a glance how your changes have affected performance. You can view any of the listed values as a graph versus velocity, giving you a variety of easy to read and informative graphs.

Left: Cockpit view of our test STV Euro.
Middle: Stepless ski bottom on the Euro.
Right: View of tunnel - accurate measurements here are crucial.

The Stability screens are also very valuable. Here you'll find the estimated acceleration, coefficients of aerodynamic and hydrodynamic lift and drag (and breakdowns for each part of the hull) and predicted stability data. And as with all the other screens, the context-sensitive help makes this program especially valuable for the amateur boater. The help screens are comprehensive and clearly written, and provide quite an education on their own. Each term used in the program is clearly defined, along with some of the theory behind it. If you are relatively new to tunnel boats, you may not necessarily realize what certain ranges of numbers mean. So Aeromarine also includes special notes that both alert you to dangerous results and give advice on how to correct the problem.

Now, the software is designed to accurately predict real world tunnel boat performance. Aeromarine Research developed the proprietary algorithms used to do the detailed performance prediction through years of wind tunnel testing, water channel testing, and racecourse proving. And yes, the founder of AeroMarine Research is a tunnel designer, driver and racer himself. But no matter how thorough and impressive the program seems, it is only worthwhile if it can help you improve your boat's performance. So, we decided to put the Tunnel Boat software to the test on our Kevlar STV Euro.

Fine Tuning For The Future

An Evaluation of Aeromarine Research's Tunnel Boat Design Program

Article and Test by Greg Terzian and Helmut Freitag
Photos by Greg Terzian

We started with a lightweight 1998 STV Euro, equipped with a factory stock Mercury 2.5 liter EFI powerhead rated at 260 horsepower. We elected to use a stock powerhead to better reflect the average hull/power combination this software might face. Also, stock power is more consistent in performance, and will yield greater accuracy for our purposes.

Left: Measuring the outer sponson width.
Middle: Measuring the skeg width.
Right: After careful measurements are complete, it's time to hit the water.

The first step was to accurately measure the hull, as per the requirements of the Tunnel Boat Design Program. Although some boat owners will already know their boat's details intimately, the measurement process also became a learning process for me, as it no doubt will for others. During this process, the user will become very familiar with the components of a tunnel boat, as well as all facets of its setup. This process really helps you understand what features make your tunnel boat perform as it does. The measurements start off with basic hull attributes – sponson width, deadrise angle, center pod properties, and so on. As on all the data input screens, a diagram is supplied that shows the proper measurement points to ensure accuracy. I found it most helpful to print the illustration, and have it handy while making my measurements.

As you progress through the measurements, the data input requirements become more involved, requiring weights, engine and lower unit locations, lower unit measurements, maximum horsepower output, propeller slip, and much more. One feature I found very helpful is the preset lower unit measurements. Most lower unit configurations are covered, and it saves the user the time of those measurements. Of course, if you have a lower unit that is customized or unusual, you can manually input your specifications

Left and Middle: Helmut runs the STV Euro to establish performance figures.
Right: The Tunnel Boat Design Provides us with its maximum velocity estimate - 115.1 mph.

It is important to be accurate with your measurements – which may require the help of others during the process. As the Tunnel Boat software shows, it's amazing how small dimensional differences can really affect the performance of the boat. The entire process of measuring the boat, cockpit, and setup characteristics should take no more than an hour for the experienced tunnel boat enthusiast. The software's online help system and detailed diagrams go a long way for those of us that are not very familiar with tunnel boats. It's then very easy to enter your boat's design dimensions and setup into the software.

When all of the measurements are completed and entered into the Tunnel Boat Design Software, the real fun begins. This is where the computer, predicting results on acceleration, velocity, and stability, analyzes our virtual model of the STV. Before we tell you what our computer told us, let's run the boat first.

Left: Detailed performance output data.
Middle: Performance Data Graph.
Right: Stability Data Graph.

With Helmut Freitag operating the STV Euro/Mercury 260 in optimum water and weather conditions, he was able to achieve a top speed of 115.1 mph on the first run, and 115.4 mph on the second run – all while noting the performance nuances and idiosyncrasies of this rig. We had our top speed numbers, with our optimum setup. Let's see what the Tunnel Boat Design Software predicted:

With the data already saved in the software, a simple mouse click on the "Calc Perform" button provided us with the output of the software's analysis. The result? Astonishingly, the Tunnel Boat Design Program predicted that our setup would achieve a maximum velocity of 115.1 mph! Taking this even further, the TBDP also accurately predicted our acceleration model – a big plus for drag racers. The software noted that our rig would accelerate at a constant rate up to about 103 mph, and that from 103 to 115 mph the climb would be much slower. This prediction was within 5 mph of our performance with the STV, as we noted that our STV began to "crawl" to 115 mph at about 108 mph. Impressive accuracy, to say the least.

Fine Tuning For The Future

An Evaluation of Aeromarine Research's Tunnel Boat Design Program

Article and Test by Greg Terzian and Helmut Freitag

Photos by Greg Terzian

Taking this yet another step further, the Tunnel Boat Design Program assessed the stability of our STV, arriving at the conclusion that our particular rig would experience relative instability throughout the 55-80 mph range (often referred to as the "hump" zone). Again, the software was remarkably accurate: our STV did "settle in" over 80 mph. All of the data can be displayed as graphs, with user-adjustable increments and ranges. This really helps if there is a specific zone you want to zero in on for analysis.

Left: Extensive help system.
Right: The Wizard tutorial makes getting started easy.

The real fun begins when you alter your setup parameters in the program, and watch the results of your changes. Adding more setback? Relocating your fuel tank? How about adding a canopy? The Tunnel Boat Design Software can tell you the results of your changes – before you spend any money or make any physical changes to your rig. How's that for safe experimentation? A word of warning about this program though – you will get hooked. I found myself making data changes and analyzing the results for hours at a time. The information you will learn along the way is invaluable.

What are our plans for the future? Well, in the coming months, our heavily modified 2.5 EFI will trade places with the stock unit. We'll get an accurate assessment of the power output of our modified 2.5, and we'll put the Tunnel Boat Design Software to use once again. It would be safe to assume that this program will be right at home here, and we'll be incorporating its resources for future tests involving tunnel boats.

Although the Tunnel Boat Design Software is highly advanced, it does not have steep hardware requirements. The software will run quite easily on a Windows 9.x or Windows 2000-based Pentium-class system with 32 MB of RAM. 128 MB is required for Windows XP.

On or off the water, Aeromarine Research's Tunnel Boat Design software is a performance-predicting program that is more than worth the price. There's just nothing like it anywhere else. Although it was originally designed for professionals (the sheer attention to detail is astounding), it is accessible and easy to use for even complete novices. Pros can dive right in, and amateurs will find that the program can guide users through each step. There is even an option that will validate all the data you input, and alert you if your value falls outside the appropriate range for that variable. The Design screens all clearly illustrate the required measurements, and the included Help file is a gold mine of performance boat knowledge. Each design measurement and aspect of performance is clearly and accurately defined, along with the related background theory. The beauty of it is that the more you use the Help file, the more you'll find yourself with an increased understanding of what makes a tunnel boat tick. And that can only make you a better and safer boater.

You can purchase the TBDP, Version 6.5 at Aeromarine Research's website by clicking here

---

A Note: Although this program provides an extraordinary amount of information regarding tunnel boats, Aeromarine Research also publishes an absolutely comprehensive book on tunnel boat design called *The Secrets of Tunnel Boat Design*. This book is highly recommended for those who want to explore the actual theory and mathematics behind tunnel boat design.

About the Tunnel Boat Design Program's creator, Jim Russell:

Jim Russell is a professional engineer with a mechanical and aeronautics background. Currently living in Canada, he has done extensive aerodynamic research at Universities of Michigan, OH and Toronto, Canada and marine research at the NRC water channel laboratory in Ottawa, Canada. His published papers are highly acclaimed, and are specifically related to the aerodynamics and hydrodynamics of high performance catamarans and tunnel boats. Russell has designed and built many tunnel boats. As a professional race driver, he piloted tunnel boats to Canadian and North American championships. He has written powerboating articles for many worldwide magazines and covered UIM and APBA powerboat races. Russell is the author of *Secrets of Tunnel Boat Design* (reviewed here), *History of Tunnel Boat Design*, and *History and Design of Propellers*. His company has designed and published the well-known powerboat design software, "Tunnel Boat Design Program ©," specifically for the design and performance analysis of tunnel boats and powered catamarans.

Aeromarine Research

jimboat@aeromarineresearch.com
67 Highland Cres.,Cambridge,
Ontario,Canada, N1S 1M1

About AeroMarine Research:

Jim Russell is a professional engineer with a mechanical and aeronautics background. Currently living in Canada, he has done extensive aerodynamic research at University of Michigan, OH and University of Toronto, Canada and marine research at the NRC water channel laboratory in Ottawa, Canada. His published papers are highly acclaimed, and are specifically related to the aerodynamics and hydrodynamics of high performance catamarans and tunnel boats. Russell has designed and built many tunnel boats. As a long-time professional race driver, he piloted tunnel boats to Canadian and North American championships. He has written power boating articles for many worldwide performance magazines and has covered UIM and APBA powerboat races. He has also appeared on Speed Channel's 'Powerboat Television Show' speaking on tunnel boat design. Russell is the author of the "Secrets of Tunnel Boat Design" book, ""The Wing in Ground Effect – Their relation to Powerboats©", book, and the "History and Design of Propellers." His company has designed and published the well-known powerboat design software, "Tunnel Boat Design Program© ", specifically for the design and performance analysis of tunnel boats and powered catamarans.

Get your fully illustrated, 12th edition copy of the "***Secrets of Tunnel Boat Design***" book, with over 200 pages of design practices and formulae and over 150 photographs.

The publications "History of Tunnel Boat Design" book, "History of Propellers" e-book, the "Tunnel Boat Design Program©" software, and the "PropWorks2" software for speed prediction and propeller selection are available at the AeroMarine Research web site.
http://www.aeromarineresearch.com

"Secrets of Tunnel Boat Design©" book, 12th edition –
http://www.aeromarineresearch.com/stbd2.html

"History of Tunnel Boat Design©" book -
http://www.aeromarineresearch.com/history.html

"History & Design of Propellers©" e-book -
http://www.aeromarineresearch.com/historyofpropellers.html

"Tunnel Boat Design Program© ", V7 software -
http://www.aeromarineresearch.com/tbdp6.html

"PropWorks2©" software for propeller selection and powerboat speed prediction -
http://www.aeromarineresearch.com/prop2.html