POWERSEA Planing Hull Simulator

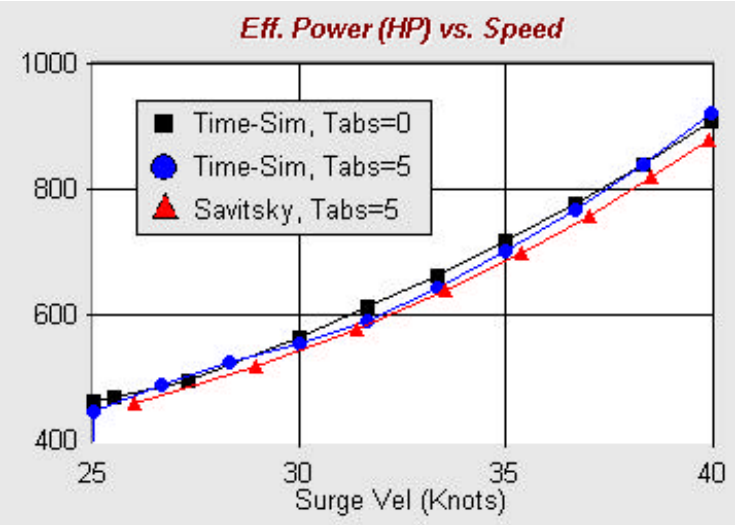
POWERSEA predicts the motion of a planing boat in calm water, regular or irregular seas. You specify the forward velocity or thrust and the shape of the waves or wave spectrum – POWERSEA calculates the hull's motion including surge, heave and pitch displacements, velocities and accelerations.

You can use POWERSEA for:

- Speed/Power analyses in calm water or waves.
- Predicting heave, surge and pitch amplitude, velocity and acceleration at any point on your design.
- Investigating porpoising (vertical oscillations) behavior.
- Estimating dynamic natural frequencies of hull with respect to incident waves.
- Investigating time dependent effects such as porpoising, deck wetting and boat accelerations.

POWERSEA can be controlled via OLE Automation and can be extended using external DLL models to satisfy virtually any design simulation requirement.

POWERSEA



Speed-Power Analysis Results from POWERSEA

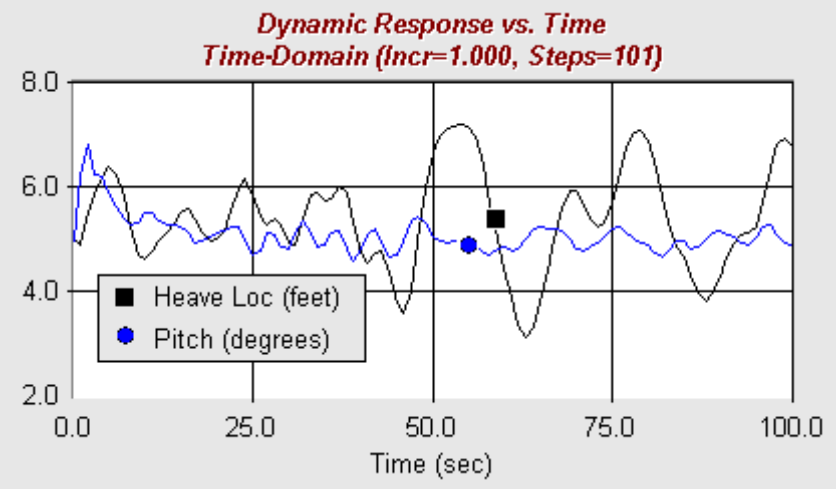
Capabilities of POWERSEA

Time-Domain Analysis

You can specify the surge velocity or the thrust – POWERSEA predicts the corresponding thrust or velocity for you. Thrust can be specified in terms of steady or ramped force, power or velocity. In all cases POWERSEA will predict three vertical degrees of freedom: surge, heave and pitch.

POWERSEA can tell you whether the ride will be comfortable and safe. Acceleration time-data generated by POWERSEA can be used to predict the probability of damage to materials stowed on deck due to extreme accelerations. You can use the POWERSEA acceleration spectra to predict the incidence of seasickness in a given set of sea conditions.

The dynamic stability of a planing craft is a serious concern to the designer. It is much more cost effective to use a computer to predict porpoising behavior in advance than to build the boat and find out that it porpoises afterwards. POWERSEA can



A time-domain history of the heave and pitch response of a high-speed boat in a random sea specified by an ITTC spectrum.

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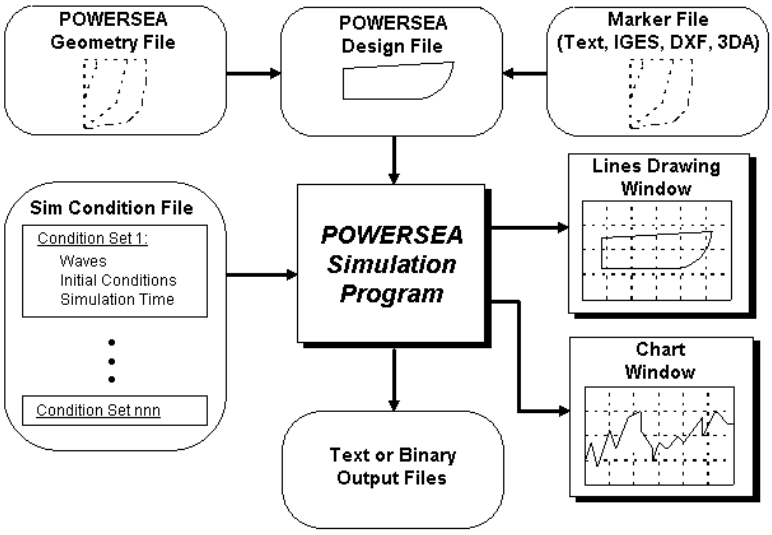
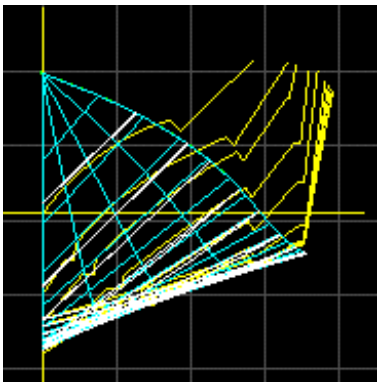


Files and Windows in the POWERSEA system.

simulate your boat's performance in a calm sea, so that any oscillatory steady-state pitch or heave that results is due to porpoising.

Response Analysis

When you design a high-speed planing boat, one of your concerns is the dynamic stability of the vessel. Each planing hull will respond strongly to certain frequencies of encounter – you need to know that your hull-form does not have a strong negative response to waves that you are likely to encounter.

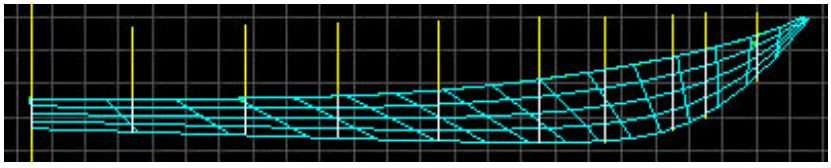


A graphical display allows you to see and edit your hull-form. Offset lines are calculated automatically by POWERSEA.

You can use the Response Analysis capability of POWERSEA to run repeated analyses at different wavelength-to-boat length ratios, finding the surge, heave, pitch and power response to each frequency. A Response Analysis is especially useful when you want to make sure that your high-speed craft does not exhibit extreme responses to waves in a given lake or river, or to commonly-encountered wakes in a particular shipping channel.

Empirical Analyses

To increase your confidence in the results of a POWERSEA analysis, POWERSEA can perform Savitsky planing and pre-planing analyses. These analyses use the same geometry data that you use for time-domain simulation, so you know you are comparing "apples to apples."



Graphical editor makes it easy to adjust keel and chine curves

Modeling a Hull with POWERSEA

The Pieces of the POWERSEA System

The POWERSEA system consists of the POWERSEA program and a series of data files. The files, which are easily read by both humans and computer programs, specify the hull geometry and simulation conditions. Additional files (marker files) are used as aids in the creation of hull designs within POWERSEA.

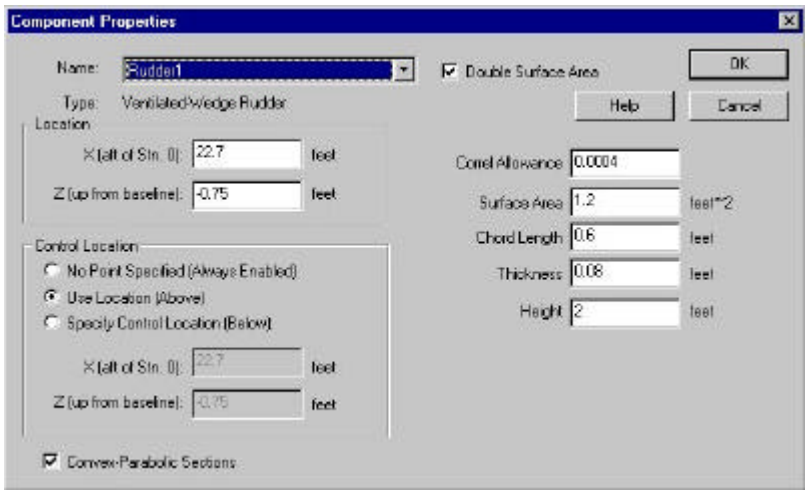
Creating a Hull Model

POWERSEA includes a powerful graphical design editor that makes it easy for you to create and edit the governing keel and chine lines. POWERSEA supports straight lines, piece-wise linear curves, parametric and B-spline curves, and composite curves to give you a great deal of flexibility in describing your hull-form.

Importing Text, DXF, IGES and 3DA Files

Most free-form hull design programs and CAD programs can export DXF, IGES, or 3DA files so you will not have to reenter design data. You can import data in the form of construction lines or as actual design data.

POWERSEA has the ability to display marker lines and points



Custom dialog boxes for each appendage type make it easy to add or modify appendage data.

that you can use as a guide for creating your designs. Marker information can be created from an offset table and read in from a text file, or POWERSEA can accept DXF and IGES industry-standard geometry file formats.

Modeling Appendages

POWERSEA has built-in models for many types of appendages such as skegs, shafts, rudders (fully wetted and ventilated), trim tabs and more. Appendage models are valid in both time-domain and empirical analyses, so you only have to create the models once.

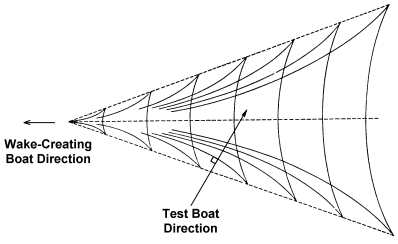
Incident Waves

You can run analyses in calm water, in regular waves (single frequency sinusoidal waves), or in irregular, random seas. Regular waves are specified by amplitude and wavelength.

Oceanographers have developed many families of spectra that can be used to describe random seas, and POWERSEA supports the Pierson-Moskowitz, JONSWAP, ITTC, ISSC and Ochi spectral density functions. Wave data is synthesized from these functions by combining sinusoidal components with:

1. Frequencies chosen at random from within regular bands spaced over the range of the spectral density function,
2. Wave numbers calculated for those frequencies based on the depth of the water,
3. Amplitudes for each component calculated using the spectral density functions, and
4. Random phase angles.

POWERSEA can support up to 1024 frequency components, synthesizing an irregular sea with high precision.



POWERSEA can model Kelvin diverging waves.

In addition to modeling regular and irregular seas, POWERSEA includes a built-in model for ship wakes. You specify the characteristics of the leading and following wave packets; POWERSEA simulates the wake motions in time.

To help you to specify how much time you should simulate or what the step size should be between iterations, POWERSEA can suggest the step size and run time based on your initial speed and choice of wave spectrum parameters.

Extending POWERSEA

Automating POWERSEA

Automation (formerly called OLE Automation) makes it possible for one application to manipulate objects implemented in another application. POWERSEA includes an automation interface, providing methods and properties that you can access from other applications.

You can write Visual Basic or Visual C++ scripts to automate POWERSEA simulation runs or to step through design variations. You can even automate POWERSEA from scripts in Microsoft's Excel, running the Excel "solver" to find optimal design parameters.

Adding External Components

There are times when the built-in components are not adequate to model a specific vessel or appendage. POWERSEA allows you to create your own components in the form of dynamic link libraries (DLL's). There are no limits to the number of external DLL's or instances that can be referenced by a POWERSEA design. You can create your external components with a number of development tools including Microsoft's Visual

C/C++ and Compaq's Visual Fortran.

Adding State Variables

POWERSEA predicts the motion of a vessel by solving the differential equations of motion at each time step. Advanced users can add state variables to model special equipment or control systems. For example, state variables could be used to model the properties of an engine mount or a captain's chair.

Plotting and Saving Results

The results of an analysis can be plotted using a built-in charting facility, saved in a column form that is easy to import into a spreadsheet, or saved in reports summarizing the simulation runs. You have complete control over the file format of the output data. You control whether or not headings, variable units, and titles are included in files.

POWERSEA can create time history plots or spectral plots of more than 30 different variables. Plot windows include a special toolbar that allows you to modify almost any aspect of your plots. Using the toolbar commands you can copy charts to the clipboard and paste them into other documents. You can even save chart data to read in and display at a later date.

	Heave Loc feet	Pitch degrees	Surge Vel Knots	Eff Power HP (British)
Min	-4.1104	-0.10310	23.000	-551.0
Mean	0.48496	5.988	23.000	944.4
Max	5.228	10.208	23.000	17108.4
Std Dev	1.5536	1.9412	1.095e-012	1323.3
Max Ht	4.7426	4.2199	0.0	16164.0
H(1/3)	6.323	6.510	0.0	12430.9

POWERSEA generates detailed reports after each analysis.

How POWERSEA Works

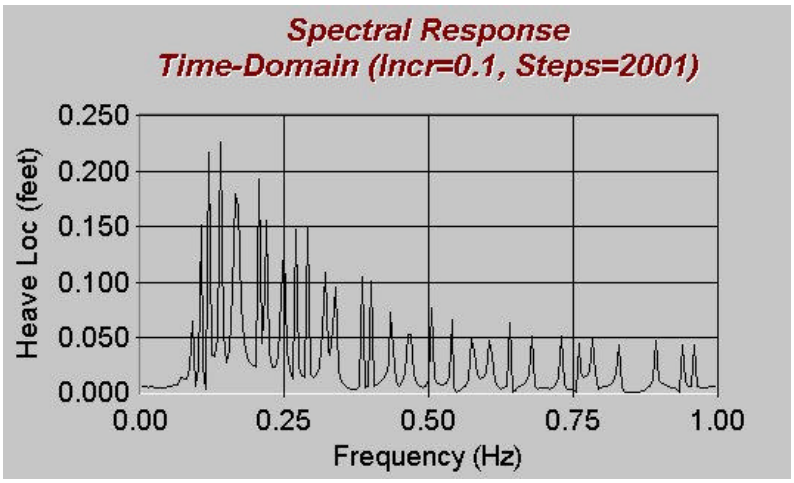
POWERSEA uses a low aspect ratio strip theory to calculate the motions of variable deadrise planing boats in waves. Hydrodynamic forces are calculated for each strip and integrated to produce forces and moments in each of the primary axes. Accelerations and velocities are integrated over time to solve for new velocities and displacements.

POWERSEA solves the equations of motion in the vertical plane only. It cannot be used to predict horizontal or coupled instabilities (such as chine walking, for example).

POWERSEA assumes that the sea wavelengths are large relative to the boat length. Only non-breaking gravity waves are supported – the program has a built-in test to make sure that waves are not breaking and will warn the user if breaking waves are detected.

Platforms

- Intel PC or compatible (Windows NT 4.0 and Windows 95 or 98)



Pitch spectrum of high-speed craft in irregular sea.

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