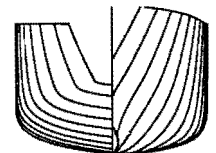
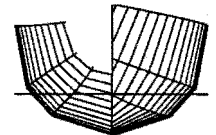
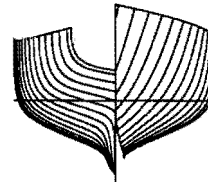
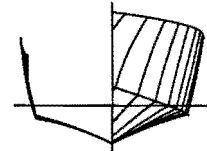
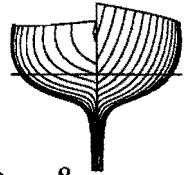
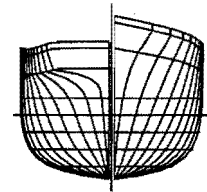


FAIRLINE® Marine Design Software / Consulting / Technical Services

# Selected AHI News Reprints 1988-1992

<b>MultiSurf</b>	MultiSurf making waves at M. I. T. .... 2
	Bruce King jumps in with MultiSurf ..... 2
<b>FAIRLINE</b>	User to User: Tips, Techniques, and Insights — Bob Davis on setting up Master Curves in FAIRLINE/1 ..... 18
	Form, Function, Economy: JBF Scientific Co. uses DEVELOP/2 and FL/2B to design oil skimmer ..... 4
	FAIRLINE boats going lickety-split ..... 6
	More FAIRLINE boats: three European designs ..... 7
	Skin deduction, more screen editing tools, new stretching option: FL/2B upgrade ..... 8
	Combine the powers of C3D and FL/2B ..... 12
	FAIRLINE and Microsoft Windows 3.0 ..... 10
	The MacSurf-AeroHydro Connection ..... 5
	FAIRLINE Design Partners: an invitation to join the team ..... 12
<b>Design Optimization</b>	Keel optimization with AeroHydro software ..... 9
	Behind the scenes of the America's Cup ..... 17
	New Iris Workstation Programs ..... 16
	Sizing up <i>New Zealand</i> ..... 11
	DSA and SSR go to work in Germany ..... 13
	<i>Il Moro di Venezia</i> on top in AC Worlds ..... 5
	"I always wanted to know: just <u>why is</u> that boat faster?" ..... 16
	What do charged particles have to do with marine design software? ..... 8
<b>Custom Projects</b>	And another race won in Australia: GM <i>Sunracer</i> had AeroHydro help ..... 17
	Breakthrough in compound plate expansion ..... 19
	<i>Shining Sea</i> , a new American clipper ship ..... 15
	Supertanker support: a new use for AeroHydro technology ..... 10
	Bells and Whistles: BuoyCAD released ..... 5
<b>Computer Lofting</b>	Even faster, accurate loftings — the fully digital kind ..... 3
	Computer lofting saves time, money — and your knees! ..... 14

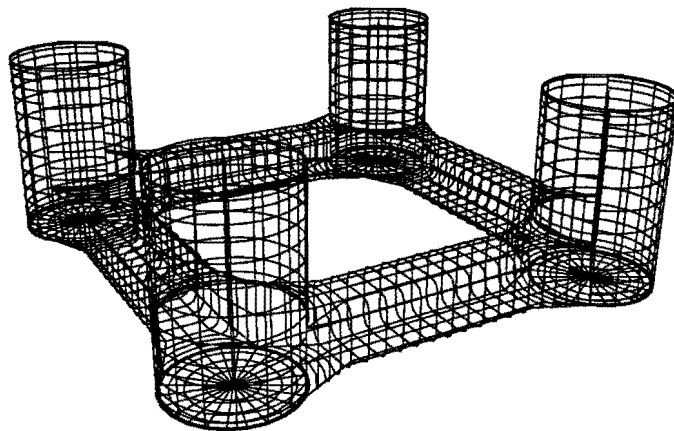


## MultiSurf making waves at M.I.T.

AeroHydro welcomes M.I.T.'s Ocean Engineering Department as one of the first MultiSurf licensees. At M.I.T. MultiSurf is being used to create "panel models" of ship hulls and complex offshore structures for analysis of seakeeping and wave loads. As in other computational fluid dynamics (CFD) applications, wave-body programs are computer-intensive, but the real bottleneck in their use is usually in creating the geometric models for input.

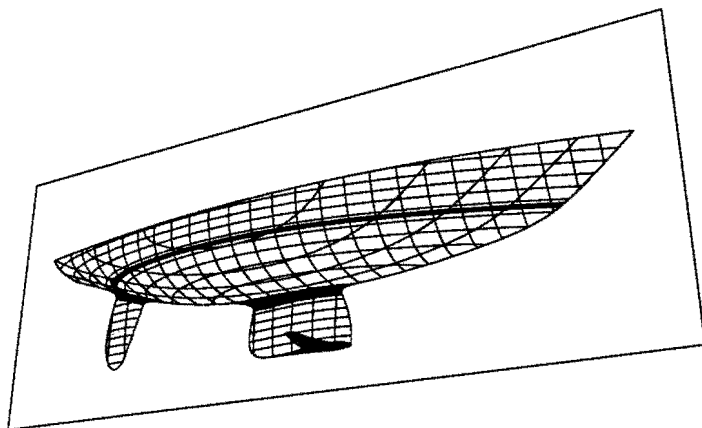
Professors Nick Newman and Jake Kerwin, beta testers for MultiSurf, were quick to perceive the potential of the program's Relational Geometric Synthesis (RGS) for streamlining the modeling process. They invited John Letcher and Michael Shook to Cambridge to demonstrate MultiSurf to several groups of faculty, students, and researchers working in areas ranging from wave loads to propeller design and computer-aided manufacturing. Interest was high and many potential applications were identified. If you would like to see MultiSurf in action,

please contact us. We may be able to arrange for a demonstration in your area or to send you our low-cost demo version of the program. ✱ 11/92



*MultiSurf model of tension-leg platform with 4800 panels.*

## Bruce King jumps in

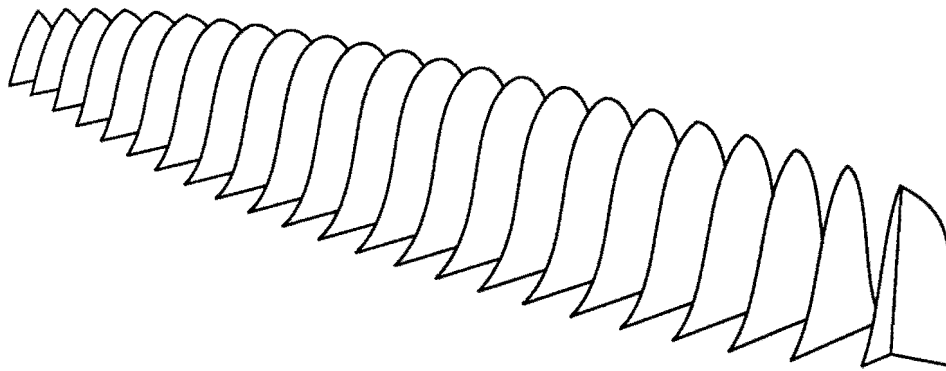


Bruce King and Steve Jones at Bruce King Yacht Design in Newcastle, Maine, received the very first production copy of MultiSurf, as an upgrade to FL/2B. They promptly put it to work completing the design of the new Ericson 43. The hull had been designed with FL/2B (and full-size frame patterns had been generated at AeroHydro for the builder). Continuing, Bruce and Steve converted the FL/2B rep into a MultiSurf rep, then added the deck, keel, and rudder to complete the model for hydrostatic and velocity prediction analysis. As is usual, based on these analyses, they are making changes to the shape and position of the appendages. What is unusual, unique in fact, is that by using MultiSurf, when they make a change to one part of the boat, the program updates the entire unified model so that all the durable joins, surface relationships, etc. remain intact. Inspired by the advantages of designing such a durably complete model, Bruce and Steve have already launched into a second project — a new production 70' sloop — created entirely in MultiSurf, and they are well on their way to completing it. ✱ 11/92

**Thumbs up from Gary:** Naval architect and boatbuilder Gary van Tassel, president of Ocean Tech Marine in Solomons, Maryland, has been using MultiSurf for a variety of design tasks since receiving the beta test version in June. His projects include deck and superstructures for a 65' yacht now under construction, new hull designs, and modification of an existing hull to incorporate propeller tunnels. "I'm impressed with the talent at AeroHydro," says van Tassel. "MultiSurf is quite user-friendly and is the most flexible 3-D program I have used." ✱ 11/92

## Even faster, accurate loftings — the fully digital kind

This spring, we at AeroHydro celebrated our first fully digital FAIRLINE lofting job. Roger Gump of Bluffton, South Carolina was on the receiving end. We provided Roger with transverse frame patterns in the form of an AutoCAD DXF file which he then fed into his numerically controlled (N/C) router to cut the plywood mold frames. In went the numbers, out came the frames, with no hands-and-knees lofting work in between — a “fully digital” process. And what a savings! Roger estimates that with N/C cutting “the hours saved from loft to frame set up would have to be a gain of 85%; not to mention the accuracy is within .003 of an inch.”



Roger is a principal in Cornelius & Gump Woodworks, an architectural millwork company which, in addition to millwork, manufactures components for the furniture industry and builds custom yacht interiors. To improve their manufacturing efficiency for stock pieces, they recently acquired an N/C router. But through a series of unanticipated connections, this narrow vision of the router's use has expanded into a whole new custom cutting angle for the business.

Two seemingly unrelated events, coinciding, set the stage:

(1) Roger and his wife Sara decided to build a 48' Dick Newick cruising trimaran. Wanting to avoid the time and aggravation of doing a manual lofting, Roger contacted us to do a FAIRLINE computer lofting of both the vaka and the ama, plotting the mold frame patterns on mylar.

(2) C. & G. Woodworks delivered the entire prefabricated interior of a new Deerfoot 67 from their plant in South Carolina to the Deerfoot Samples Shipyard in Boothbay, Maine. That put Roger in a perfect position to visit our office in Southwest Harbor and watch his patterns be plotted ... which he did.

However, when Roger saw our large plotter drawing full size patterns, he was struck by the analogy to his router: how about transmitting the pattern information via DXF

files directly to the router? We were immediately enthusiastic to embrace such an advance in technology.

After two days of fitting and adjustments to the vaka, Roger returned to South Carolina with a DXF file of the mold frame shapes, plus a set of mylar patterns for verification. Using AutoCAD, he compared the CAD shapes with the mylar patterns and found perfect agreement. Encouraged, we sent down the frame information for the ama as only a DXF file (no mylar backup).

Roger fed the DXF files into the N/C cutting program, added a scribed waterline and text label for each frame, and in 6 1/2 hours had cut all 20 frame patterns for the vaka and both amas! In short order, the frames were set up and on went the cedar strip planking — an easy job over the smooth, fair frames. The use of the N/C cutter on the project not only saved several days of labor in transferring the patterns from mylar to plywood and in cutting the frames by hand, but it also saved a considerable amount that would otherwise have been spent on mylar and for plotting time.

Following the success of this first project, Roger had us do a digital lofting for a 16' tender which he intends to market as a precut kit boat for construction in DuraKore. With frame and stem molds all precut, construction is simply setting up the molds and applying the DuraKore. From Roger's end, the lofting of the 16' model cost \$346 for ready-to-cut DXF mold frames. And we were able to make him a frame file for a similar 14' model for just \$173.

These projects are yet another step forward in our effort to provide fast, accurate loftings. For one-off and semi-production boat builders, it may not make economic sense to own N/C machinery, but N/C cutting services such as Roger's are becoming more readily available. If you are not equipped to make DXF files yourself, we can do a FAIRLINE fitting and create the DXF file for you. ✻ 9/92

*Editor's Note: Roger Gump is actively soliciting custom N/C work supplied in the form of DXF files (this keeps the router busy without requiring much labor overhead to get paper drawings into machine-readable form). You are welcome to contact Roger personally at 803-757-3931 for details on his service.*

## Form, Function, Economy

JBF Scientific Company Inc., with offices and manufacturing facility right here in Southwest Harbor, is a leading force in oil spill recovery systems. Their patented Dynamic Inclined Plane method has proven successful in a wide variety of adverse environmental situations. A large part of this success lies in the novel design of the vessels that carry the clean-up equipment. And a large factor in the vessel design has been JBF use of AeroHydro software.

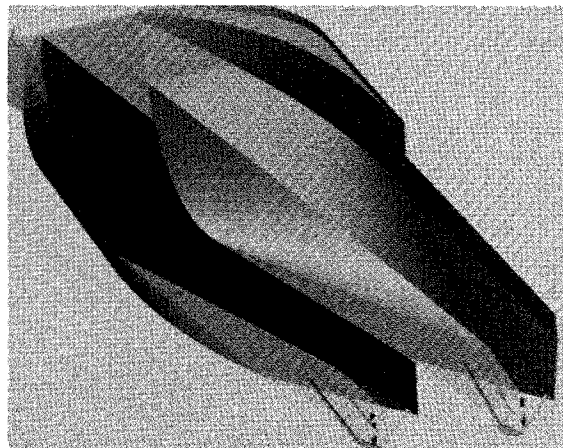
General manager and chief designer Bob Watkins and marine designer Steve Hudson have been longtime advocates of developable plate software technology to create unique hull shapes that are at once aesthetic, practical, and easy to build. Since 1985, we have worked closely with them on a series of developable designs that can take advantage of JBF's computer-controlled plasma arc torch and their 100-ton press brake. Many of the advanced features in our DEVELOP programs have resulted from meeting their requirements in a real-world production environment. By using DEVELOP/2 and other AeroHydro/FAIRLINE computer-aided design and manufacturing tools, Bob and Steve estimate engineering time savings of 50% and labor savings of another 10-15%. "No one has to plot points and loft; and no one has to cut and fit. We go directly from the computer to burning plates," remarks Steve.

Among our earlier collaborative projects was the workboat *Constitution*, designed and constructed for the Army Corps of Engineers in 1987. Since this 42-foot landing craft with a double tunnel hull would be beached for loading and unloading equipment, the specifications called for  $3/8$ " plate in the bow. Using FL/2B, Bob shaped the sheer, chines, and profile. We then provided patterns, both for the flat plates, including bend lines, and for two jigs to hold the plates in position. Looking at the curve and sweep of the jigs, the construction foreman was convinced that the plates would have to be tortured into position. But when the plates were cut and bent, they fit perfectly on the jigs — looks can be deceiving.

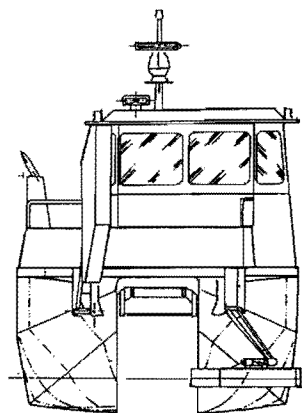
In the wake of the *Exxon Valdez* disaster, the demand for oil recovery equipment has taken a dramatic upturn. JBF has developed several new skimmer models to meet the pressure for vessels with faster response times. The design for the first of a larger class is much more ambitious and complicated than was previously required. The design parameters — 42 foot length, 14 foot beam, 2 foot draft, and service speed of 20 knots — required careful hull shaping to obtain sufficient volume for engine placement and adequate volume forward to support the full pilot house, sweep booms, and pickup equipment.

Bob used FL/2B to create the preliminary hull design with six panels on each hull. Then Steve and AeroHydro programmer Ed Stanley used DEVELOP/2 to clip the

panels and add the deck structure. The shaded solid model (above) was produced with C3D on our Silicon Graphics workstation for presentation to the client.



With the initial design approved, JBF invested in their own copy of DEVELOP/2 to finalize the design. In addition, throughout the design process, Steve used HYDRO/2's ease and speed to monitor displacement, volume distribution, and stability. The final lines for the oil skimmer show highly curved sections in the bow which would not normally be associated with a developable shape.



42' oil skimmer, bow view

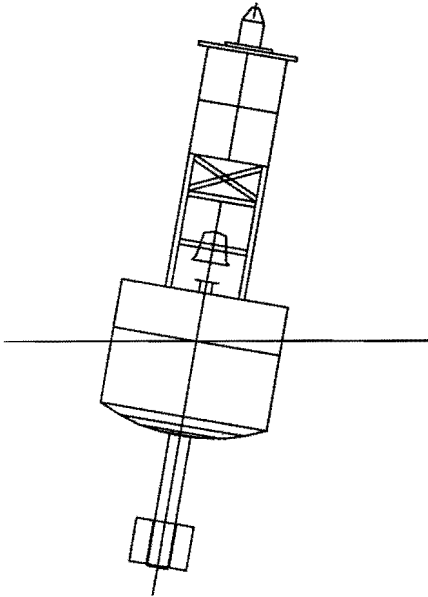
As an accessory craft for a 120-foot super skimmer under construction at Goudy and Stevens (E. Boothbay, Maine), JBF recently designed a 22' boom tender. The design is based on a John Alden New Jersey Sea Skiff, but in metal rather than wood. Requirements were a flat bottom for deck-stowage on the parent vessel, placement of the engine low in the boat, a protected aperture for the propeller,

plus speed of 20 knots. The design required some very fine tuning of the plate boundaries to maintain developability — one plate even has a reverse bend in the middle.

The tender's design was so unusual that Bob decided to build a  $1/4$  scale model, which also provided a trial of the

Continued on page 5 — JBF

## Bells and Whistles



In June, AeroHydro completed a major joint Navy/Coast Guard contract, delivering BuoyCAD to five U.S. government agencies concerned with the design of navigational and mooring buoys. BuoyCAD combines interactive design, hydrostatic and hydrodynamic analysis, and database functions. This is the only CAD program we know of where bells and whistles can literally be picked off a menu and added to your project!

As stated by USCG Cmdr. Ted Colburn at the M.T.S. Buoy Technology Workshop in April, BuoyCAD is a cornerstone of a long-range Coast Guard project to develop new buoy series with improved visibility and station-keeping characteristics, as well as reduced repair and maintenance costs. ✪ 10/91

## Il Moro di Venezia on top in AC Worlds

AeroHydro salutes the Italian team on their victory in the first World Championship for the new America's Cup class. In the 7-race series held off San Diego in May, Italy's red-hulled *IT-15* and *IT-1* placed second and fourth in the fleet races, showing excellent performance in both light and heavy winds. In the match-race finals *IT-15* finished 67 seconds ahead of *New Zealand* to take the championship. The series was widely viewed as the warmup for the 1992 America's Cup, to be held in the same waters next spring.

We send our congratulations and take pride in our contribution to the Italian effort. Since 1989, AeroHydro's Dr. John Letcher, Edward Stanley, and Michael Shook have been providing consulting and custom programming services to *Il Moro* on many aspects of yacht performance prediction and design. ✪ 10/91

JBF — Continued from page 4

entire process from design, to N/C cutting, to fabrication. Using  $1/8$ -inch plate, equivalent to  $1/2$ -inch full scale, the model went together flawlessly, giving Bob great confidence for proceeding on the full scale project. Bob asserts that "the design was too complex to even be considered using manual methods...[with our computer and software] the design goals were met without sacrificing the ease of building a developable hull."

JBF also designs and fabricates truck tanks for heating oil delivery. Designs for the four basic models have evolved over time within a framework of manual drafting and manufacturing refinement. Steve predicts that JBF's acquisition of DEVELOP/2 will permit economical design customization. Whether it's boats or tanks, "with DEVELOP/2, I can optimize a design with functional elements I would never attempt manually." In addition, "tying directly in to N/C cutting saves on labor hours, which also keeps us competitive." ✪ 10/91

## The MacSurf-AeroHydro Connection

If you happen to be a MacSurf user, you now can connect into the computational power of FAIRLINE® marine design software. Our new program MS2OFE creates an .OFE file from a text file of MacSurf control points. An .OFE file can be used as input into such diverse AeroHydro programs as:

- OFE/3 - Offset File Editor (maintenance and refinement of surface representations, including addition of appendages and superstructures)
- HYDRO/1 or /2 - Hydrostatics (hydrostatics, intact stability, damaged stability, floodable length)
- panelization programs for DSA (Doublet-Source Aerodynamics) and SSR (Slender Ship Resistance)
- USYRU LPP and VPP - Lines Processing and Velocity Prediction Programs

If you do not have IBM-PC compatibility, take advantage of our technical services and have us run your MacSurf design through our software calculations. ✪ 3/91

# FAIRLINE boats going lickety-split

AeroHydro software and services have contributed to recent breakthroughs in speed sailing by vanguard designers Greg Ketterman and Dan Cohen. While their boats are highly dissimilar in appearance, both are counteracting the speed-limiting effects of heel by using dynamically generated lift on submerged foils.

Greg Ketterman of Long Beach, CA is the designer of the trimaran hydrofoil *Trifoiler*, which currently holds the Class B speed record of 39.7 mph and the Unlimited class record of 42.8 mph (pending ratification by the Royal Yachting Association). Greg uses FAIRLINE to design all the hull components; this allows him to design and build multiple prototypes quickly and easily.

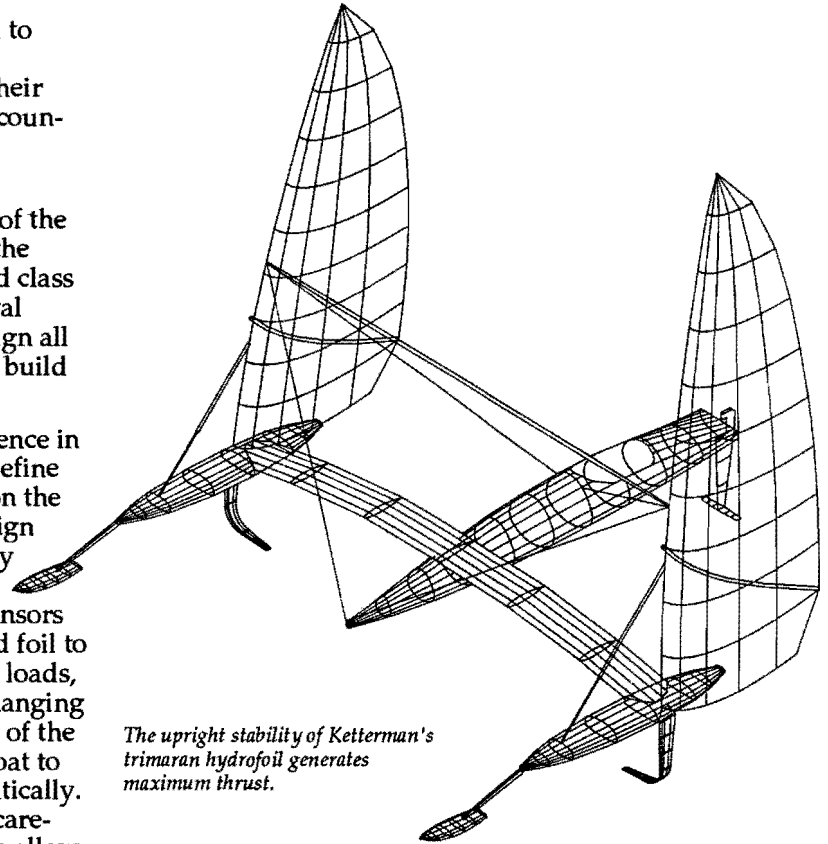
Greg is a mechanical engineer with extensive experience in composite construction; FAIRLINE allows him to define hull shapes with little effort so he can concentrate on the structural and control properties that make the design work. The key to the speed of the *Trifoiler* is stability which maintains the sails in an upright attitude generating the maximum thrust. The mechanical sensors on the front of the amas allow the ama and attached foil to pivot independently in response to wind and wave loads,

thereby slightly changing the angle of attack of the foil, causing the boat to right itself automatically. The crossbeam is carefully engineered to allow torsional bending with no vertical deflection.

Greg is working with the Yamaha recreational product group to design a commercial version for use in more moderate wind speeds. He also reports serious inquiries to design larger versions to tackle ocean speed and distance records.

FAIRLINE allows him to stretch and modify hull shapes to meet these needs.

Dan Cohen of Venice, CA is another pioneer in the effort to bring exciting high speed sailing to market. The patented Cohen Keel uses lift generated on a very deep 2-part rotating keel to

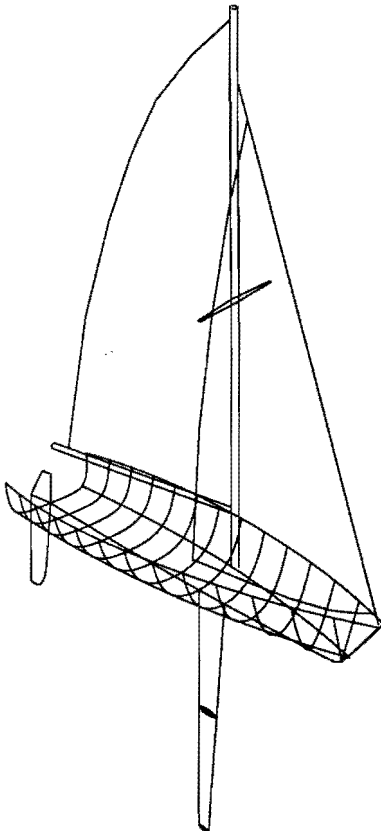


*The upright stability of Ketterman's trimaran hydrofoil generates maximum thrust.*

provide dynamic righting moment; this allows the super-lightweight craft to attain speeds of well over 20 knots in moderate winds of 10-12 knots. Dan is still in the prototype phase and we have helped him by designing and lofting new hulls from his specification of 3 or 4 cross-sections. We also developed a custom Velocity Prediction Program (VPP) which allows him to model these complex sailing forces to optimize hull and keel shapes and weights.

We at AeroHydro extend hearty congratulations to both of these inspiring innovators and we would like to hear from other FAIRLINE users who are involved in high-speed sailing.

✻ 3/91



*Cohen's deep, articulated keel provides dynamic righting moment.*

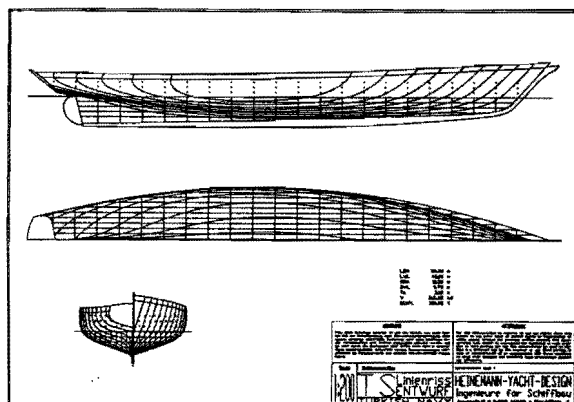
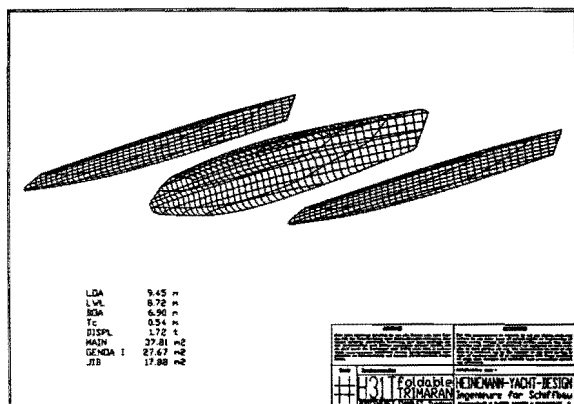


## More FAIRLINE Boats

by Reinhard Siegel

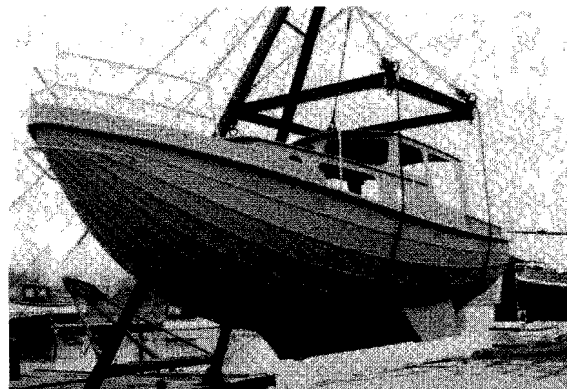
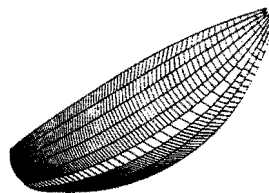
Here come from Europe three diverse examples of FAIRLINE/2B hull designs.

Uli Heinemann of Heinemann-Yacht-Design, Aachen, Germany gratefully sent us two designs he and his partner Tom Zint recently worked out with FL/2B. Uli is a FAIRLINE user since 1987; he has designed boats from 22 to 116 ft.



The H31T is a trimaran design of 9.45 m LOA, 8.72 m LWL, and 6.90 m BOA. She is sporting outriggers that fold aside the center hull in the harbor (space is short and fees are high in European marinas). Three Master Curves each were used for the main hull and the outrigger, with 11 and 6 Vertices respectively. In this design, Uli and Tom included the deck in the hull surface representation, using a double Vertex at the sheer line to make the sharp angle from deck to topsides.

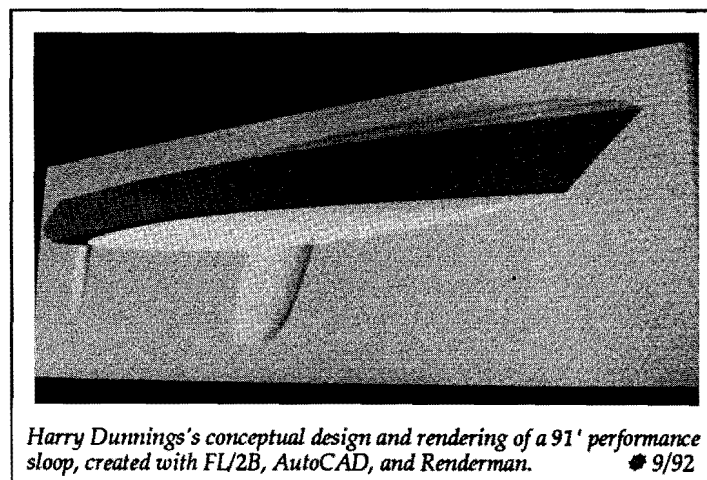
The second design is a sail training vessel for the Turkish Navy. Being rigged as a schooner, she carries 1000 square meters of sail area on her hull of 59.20 m LOA and 321 t of displacement. The shape is given by 5 Master Curves, each with 6 Vertices. The FL/2B representation goes just to the rabbet line; keel and stem deadwood were added with a CAD program.



The third boat is a 9.75 m LOA multichine designed by H. T. Langenberg of Nieuwebrug, Holland. The boat is a "Vlet" type, a traditional Dutch design still used for rescue vessels and working boats. AeroHydro's developable surfaces program DEVELOP/2 was used to create patterns for the developable panels that form the hull.

These three hull designs show in their wide differences the flexible computer power a designer can tap using FAIRLINE surface definition and other AeroHydro software. The programs not only are fast and accurate; the price of FAIRLINE/2B also fits into the budget of most boat designers, even ones with small offices. \* 3/91

Note: Reinhard Siegel is our European representative for all AeroHydro programs. You can contact him at Bogenstrasse 60, D 8501 Feucht, W. Germany; telephone 49-9128-12751; FAX 49-9128-12744.



## Skin deduction, more screen editing tools, new stretching option: FL/2B upgraded to version 2.85

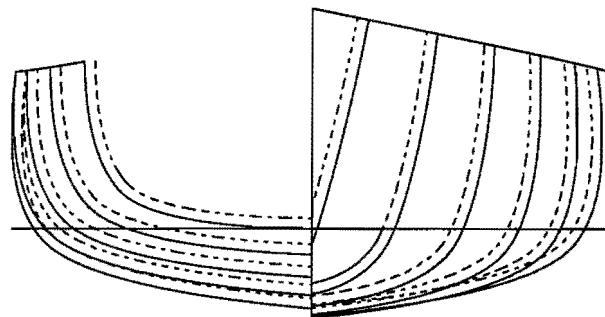
FL/2B version 2.85 has an outstanding new option in the Table Calculations Menu: Skin Deduction. In addition, screen editing of Master Curves and of longitudinal splines contains new tools, and Rep stretching includes a new option.

The skin deduction routine allows you to modify the Internal Offset Table by shifting each point to a new location that is a specified uniform distance inside or outside the actual FAIRLINE/2 surface. This produces a true parallel surface that has many important applications in computer-aided manufacturing. For example, it allows you:

- to produce full-size mold patterns having the correct deduction for ribbands, core and skin, or planking
- to create overlays for planning interior layouts and structures
- to get correct hydrostatic results with the skin as flotation or as an appendage

Skin Deduction is not just a constant deduction in the plane of the station, as was sometimes used to simplify the

traditional lofting process; although the FL/2B points are moved only in the plane of the station, the amount of movement accurately includes the correct effects of bevel toward the ends of the boat.



FAIRLINE surface (solid) and surface with skin deduction of 0.167 (dashed).

In Rep Development Tools, screen editing of Master Curves and of longitudinal splines now offers a "free

Continued on page 9 — FL/2B

## What do charged particles have to do with marine design software?

We have hired a new software engineer onto the AeroHydro team. Dr. John French's diverse repertoire includes skills in boatbuilding, physics research and applications, and computer programming. It all began years ago in Eastport, Maine (just about as far east as you can get in the United States) where as a high school student, John encountered the phenomenon that two charged particles could affect each other over a distance — they didn't need to touch each other! Why? How could that be?! His curiosity was sparked by the question "and that kept going and going and going... and I still don't know the answer — nobody does!"



In the mean time, John's "going and going" has led him along a variety of paths that eventually intertwined here at AeroHydro. He began boatbuilding solo, rebuilding a 14-ft wooden boat while still in high school and subsequently building a 15-ft peapod from scratch. Later, at the Marine Trade Center, also in Eastport, he pursued boatbuilding with other students in the trade; his program included lines drafting and basic naval architecture with designer

and long-time FAIRLINE user Ernie Brierly of Camden, Maine. Still later, he returned to boats as a carpenter for John M. Williams Co., Ralph W. Stanley Inc., and most recently the Hinckley Company in Southwest Harbor, Maine.

But beyond and in between the boats, the question of particles still beckoned. Off John went to the University of Maine at Orono, where he explored a wide range of physics topics. At Dartmouth, he finally settled into a focus on relativity and eventually earned his PhD. In the process, he learned computer programming and became fascinated with computer simulations.

The serendipity of the grapevine brought John to our office last summer. We hired him to stay and are currently taking advantage of his extensive mathematical and programming talents on two complex projects: one dealing with the bending of compound curved plates and the other addressing wave resistance and the performance of hulls.

Off the job, John says you'd likely find him hiking, playing computer games, out mackerel fishing, or maybe even pondering charged particles. Here at AeroHydro, we think those charged particles initiated a highly valuable series of events; we're glad to have you here, John, and we plan to keep you very busy!

✻ 3/91

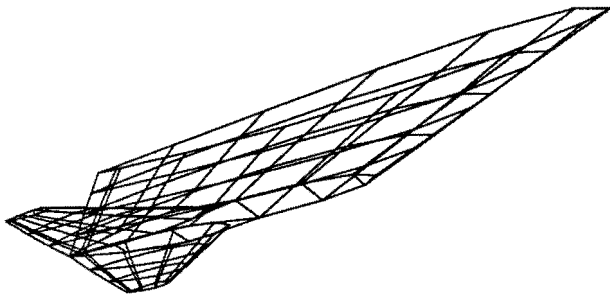


# Keel optimization with AeroHydro software

by Michael Shook

AeroHydro recently completed a project assisting Bruce King in optimizing the keel design for a 40 meter (131 ft) sloop to be built at the Mefasa yard in Aviles, Spain.

Draft is a big problem in a such a large sailboat, so Bruce decided to use a winglet keel. He supplied AeroHydro with preliminary lines, offsets, and sail plan. Working with Bruce, Dr. John Letcher and I at AeroHydro planned the following program to investigate the keel design.



One of the configurations tested.

1. Create a systematic series of keel design variations using Bruce's keel and winglet configuration as the base configuration
2. Perform hydrodynamic and hydrostatic evaluations of each configuration
3. Use the results to evaluate each configuration with a VPP (Velocity Prediction Program)
4. Compare the performance of each configuration with the base configuration

We used a selection of AeroHydro programs to implement the plan. In FL/2B, John Brown created a hull which fit Bruce's drawings. OFETOPAN converted the resulting offset file into a panel file representing the canoe body. We designed the rudder and base keel with KEELDSGN, which also merges the canoe body panel file with the appendage and wake panels it creates. After we had the base keel design, for each variation we needed to change only a few lines in the parameter file which KEELDSGN uses as input. Here are the 12 variations we created:

- four pairs of winglet variations:
  - vary chord 50% and 150%
  - vary span 50% and 150%, constant area
  - vary span 50% and 150%, constant chord
  - vary taper 10% and 190% (tapers 3% & 58%; see fig.)
- one pair of fin variations:
  - leading edge truncated, trailing edge truncated
- one variation of winglet location
- one variation with no winglets

From the panel files, DSA (Doublet/Source Aerodynamics) determined the lift, drag, and moment coefficients for

each configuration. And from these coefficients, we easily calculated the effective draft and vertical center of pressure, parameters required by the VPP. We used a hydrostatics program under development at AeroHydro to determine the vertical center of gravity and the wetted surface, the other two VPP parameters which changed for each configuration.

Finally, we used AHVPP1, AeroHydro's new VPP, to measure the canoe body and sail plan, predict the performance of each design, and then compare the performance of each design variation with the base design. Based on Bruce's comment that the owner likes nothing better than to "work to windward in a blow," we compared the designs on our VPP's simulation of an Olympic course, since this emphasizes windward performance without totally disregarding other headings.

We provided Bruce with a detailed report tabulating our results. While there are other factors he will take into account, the AeroHydro results provide Bruce with objective performance data to work with when he draws the final keel design. ✳ 3/91

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## FL/2B — Continued from page 8

cursor" (not attached to any Vertex). This feature is particularly useful for finding the coordinates of specific intersections without having to leave screen editing to run a separate routine. For instance, you might want to know the X value where an edited bow profile crosses the DWL or a Y or Z value at a particular station.

In addition, in Master Curve screen editing, you can measure the distance and angle between two adjacent Vertices, a capability that allows measurement of the deadrise angles on a planing hull.

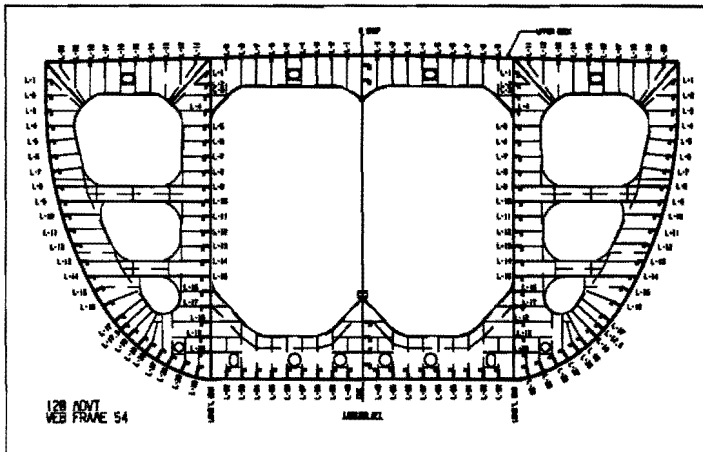
Finally, when you specify stretching factors, you now have the option to have FL/2B use those numbers to actually change all the Rep entries (rather than just use the stretches internally as multipliers when it is making calculations).

These substantial program enhancements are available now; and best of all, the price of FL/2B remains unchanged. To order your copy of version 2.85 or for more details, call John Brown at our office: 207-244-7347. ✳ 3/91

## Supertanker support

### A new use for AeroHydro technology

At AeroHydro we have expanded our capabilities in a new direction in a project with ARCO Marine, Inc., the transportation division of Atlantic Richfield Co. ARCO operates a fleet of 10 super-tankers to carry North Slope crude oil to various Pacific ports. Although it is accepted that during their lifetimes, such ships will experience structural fractures due to metal fatigue, ARCO naturally would like to keep such failures to a minimum. We have combined our proven experience in computer graphics with new skills in the use of relational databases to create an integrated system that allows ARCO to analyze the oil tanker fracture information it has been recording and filing.



The new "Hull Fracture Database" program uses information about hull structural failures from the biennial inspection and overhaul cycle, maintains it in a relational database, and presents selections of the data in several 2-D and 3-D displays. The overall purpose is to reduce the incidence of structural damage and to make improvements in design, inspection, and maintenance by being able to see patterns in the data.

AeroHydro programmers Michael Shook, Ned Ames, and John Letcher worked closely with ARCO engineers in designing the system. The program takes its primary input from a graphics tablet, allowing fracture locations to be readily entered from fracture report forms developed during the project. Screen graphics displays let the user visually verify input data and select specific categories of output information. Graphical output displays show the location, frequency, and severity of fractures as a function of ship name, ship class, type of structure, and time interval.

We are pleased to have been able to put the power of PC graphics and database systems to yet another important use and wish ARCO the best of success in improving their fleet and protecting the oceans. ✪ 10/90

## FAIRLINE and Microsoft Windows 3.0

Although FAIRLINE® System software is not written specifically to utilize the Windows 3.0 environment, it runs under Windows and we have found major advantages in using Windows capabilities.

Windows is a graphically based operating system which replaces the character based MS-DOS command process. It makes it very easy to view and manipulate files and directories, and it comes with several practical utilities for text editing, communications, and freehand drawing.

One of the biggest Windows benefits is that we can load several programs concurrently and readily switch from one to another. For instance, in producing a FAIRLINE fitting and lofting, we start up C3D and load a wireframe of the digitized offsets of the target vessel. Then we hit the Windows hotkey to switch back to Windows without quitting C3D. Here we load FL/2B, where we commence the fitting process and save a wireframe of the initial trial. With another stroke of the hotkey, we return to Windows and select C3D, which comes back just as we left it. We load our trial wireframe on top of the target wireframe and look for discrepancies. We make some notes on which areas to modify, then switch back to FL/2B to make the changes. When we want to save a wireframe of our second trial fit, our previous selection of stations and lines to draw is still available in FL/2B (because in switching with Windows we haven't had to exit FL/2B). This is especially helpful when we need to look at a set of irregularly-spaced stations.

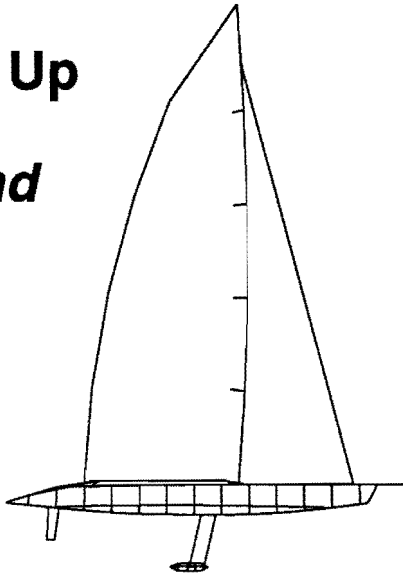
With Windows, we can also run multiple copies of FL/2B at once, with sequential modifications of one hull. This way, we can switch between versions to check measurements of a hull modification against a base design.

Another Windows advantage is being able to handle customer support without quitting our work in progress. Furthermore, we can keep our client database available in the background in order to have program version and date information when answering support inquiries.

In practice, we feel that Windows requires a minimum of an AT class computer with 2 to 4 megabytes of memory and approximately 5 megabytes of free hard disk space. Although the task switching capability is not instantaneous with this hardware, it is decidedly fast enough to be practical. And since Windows makes file handling so much easier, it encourages us to keep our hard disk free of unwanted or outdated files.

We expect that the wide acceptance of Windows 3.0 will mean the availability of development tools which will allow us to modify our programs to full Windows capability. ✪ 10/90

## Sizing Up New Zealand



At the New England Sailing Yacht Symposium, held March 23-24 by the Society of Naval Architects and Marine Engineers, AeroHydro's Michael Shook and Dr. John Letcher presented a paper entitled "Monitoring Performance of the Sloop *New Zealand*." The paper details critical work they performed for SAIC, Inc. and Sail America for the 1988 defense of the America's Cup.

In July 1987, New Zealand challenged San Diego Yacht Club to a one-on-one race for the Cup. Already in the process of organizing a multinational regatta, San Diego declined, but in November the Supreme Court of New York County ruled that the New Zealand challenge was valid, and the U.S. must either race or forfeit the Cup. At that point San Diego had barely nine months to design and build a defending yacht, to meet what was likely to be the fastest monohull sailboat in the world — Bruce Farr's huge *New Zealand*, already at an advanced stage of construction.

In order to make appropriate decisions for the defense, it was necessary to develop as much knowledge as possible about the real speed potential of *New Zealand*. Initially, all we knew was her declared leading dimensions: 90 ft. waterline, 26 ft. maximum beam, 14 ft. waterline beam, one mast. Because of the time constraints, our defender had to be designed with hardly more information than this. Later on, as more information arrived in the form of photographs of *New Zealand* under construction, being transported and launched, and then sailing, we could gradually fill in the details. AeroHydro had the task of assimilating this information and maintaining the best possible estimates of her performance.

The principal computational tool we used was the Velocity Prediction Program (VPP). A VPP is a computer program that models and balances the hydrodynamic and aerodynamic forces on a yacht, projecting her speed performance for a variety of winds and courses.

by D. Michael Shook and Dr. John Letcher

AeroHydro applied the VPP in a novel way, building it into a loop containing hull design, rig scantlings, weight schedule and hydrostatics programs, and a multidimensional optimizer. On a 386 PC, this program system (MONOPT) could design, "build," and "sail" about one boat per minute, 60 per hour, or 1,000 in an overnight run. Altogether MONOPT evaluated about 10,000 possible monohull designs, narrowly defining the best performance that could be attained within New Zealand's declared hull dimensions, as well as the broader possibilities available to the U.S. in a monohull defender.

A second major component of this effort was quantitative analysis of photographs of *New Zealand*'s hull, keel, and rig as they became available. We used FAIRLINE/2 to design candidate hull forms, saving them as 3-D wireframe files. We then used the prototype of our visualization program C3D to compare true perspective projections with those in the film images. In this way we could quickly refine the hull shapes until they closely matched the photographs. Naturally, this process involved some trial-and-error with respect to the viewing distance, angles, and the camera focal length, but all these can be quickly adjusted in C3D. Similarly, we maintained wireframe files for *New Zealand*'s rig, hiking platforms, keel, and rudder, which we could add to the hull and adjust to reproduce what we were seeing on film.

AeroHydro was also deeply involved in SAIC's development of multihull VPP's capable of evaluating the performance of the wide range of configurations which the U.S. considered as defender candidates. Through this process San Diego was able to be fairly confident that their radical solution of a modest-sized wing-sail catamaran offered the best chance of successfully meeting the radical challenge of *New Zealand*. ✻ 4/90

## Join the Team!

# FAIRLINE Design Partners

*an invitation from Dr. John Letcher  
— President, AeroHydro, Inc.*

We are pleased to announce a new and unique AeroHydro service: FAIRLINE Design Partners, a database referral system designed to link FAIRLINE program users with new business and business contacts.

We receive a significant number of inquiries from:

- owners and/or builders looking for a designer of a specific type of craft
- designers looking for builders
- designers or builders looking for employees
- program users looking for jobs

In addition, sometimes we get more calls for technical services (for example, hydrostatics and fitting/lofting) than we can handle ourselves.

In some cases we have been able to pass these inquiries on to some of our users, resulting in new contacts or business for them, perhaps a lofting job or some consultation for us — good business all around. But this has been rather a hit-or-miss affair. We aim to systematize it, using a computer database.

So, we now offer FAIRLINE Design Partners as a FREE service to any licensed user of the current version of a major FAIRLINE program (as of now: FL/2B, DEVELOP, HYDRO, or DSA). All you have to do — beyond becoming a licensed user, if you aren't already — is fill out a brief application form. We'll put you right into our database.

Join the revolution — and join the FAIRLINE team. Together, we are changing the way boats are designed and built, all over the world. Together, we can do more. ✻ 4/90

### Tips for users:

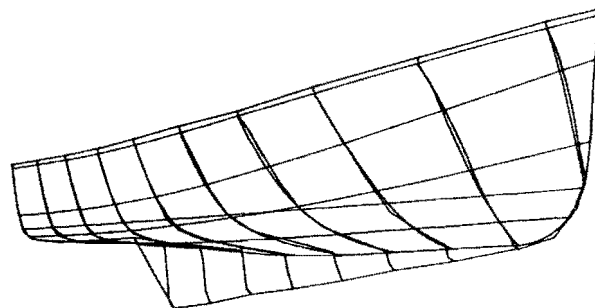
## Combine the powers of C3D and FL/2

During development of our new C3D program, we knew we were creating a powerful and user-friendly design aid, but we didn't realize just how great until we began using it on some of our in-house projects. For example, we now use the viewing versatility of C3D when we fit a set of lines with FAIRLINE/2. We'd like to pass our experience on to you.

FAIRLINE/2 was originally conceived as an initial design tool — you sit down in front of the computer with a sketch and create a fully-faired hull. Often, though, it is employed as a surface fitting tool — you want your created hull to match a pre-existing set of lines as closely as possible.

When we do this in our office, we start out by digitizing a body plan with OFE/3 and fitting Master Curves to some of its stations in FAIRLINE/2. Then we embark on a cycle of plotting out lines from FL/2, overlaying the original lines on a light table, identifying areas of disagreement, and adjusting the FL/2 Rep to reduce them. Typically, 5 to 20 cycles of this process are required for an accurate fit. Plotting is slow, and as the fit gets better, it becomes progressively harder to spot the differences by eye.

C3D offers a great alternative. After digitizing the target body plan, we output the stations from OFE/3 as a .DRW wireframe file. We then make our trial fit in FL/2, but rather than plotting lines we save them as a second



*Wireframes nested in C3D — from this perspective the discrepancies are readily visible.*

wireframe file, using the same stations as in the offset file. Switching to C3D, we load both the "target" wireframe and our "trial" wireframe, giving them different colors. Since the coordinates are basically the same, the two wireframes nest more or less perfectly, but you can tell them apart by their colors. Using the viewing power of C3D, we can "walk around" the objects in the drawing and "zoom in" on specific stations to identify areas of disagreement. Although we may not reduce the total number of iterations required to get a good fit, we do substantially reduce the time required. ✻11/89

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*by John Brown and John Letcher*

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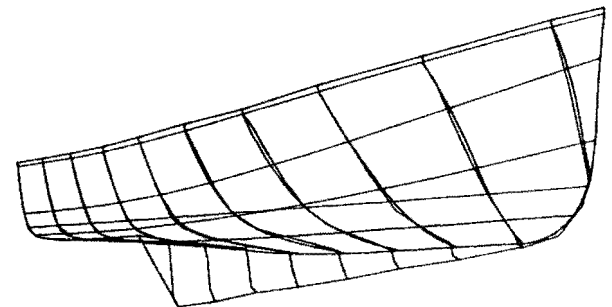
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# Computer lofting saves time, money

— and your knees!

The computer has revolutionized the traditional method of translating a scale drawing into full-sized patterns for parts of a boat (i.e. lofting). A boat hull presents a unique challenge to the loftsmen, since the surface is curving in all three coordinates at most places. The task of making the three different projections of the drafted lines agree is particularly difficult. Our answer is to create an accurate and continuous mathematical model of the surface.

FAIRLINE is the tool. Its mathematical method allows the designer to shape the hull to his exact desires, while being assured that surface offsets will be accurate and fair. With these offsets in hand, we can loft directly from the computer.

The traditional method of lofting by hand is a time-consuming process, typically two weeks on your hands and knees for a modest-sized boat. With computer lofting, the design can proceed from final definition to full-sized patterns in a day or less — a phenomenal advantage to a builder anxious to get a project under way or to a designer keen on having a boat built accurately to his design.

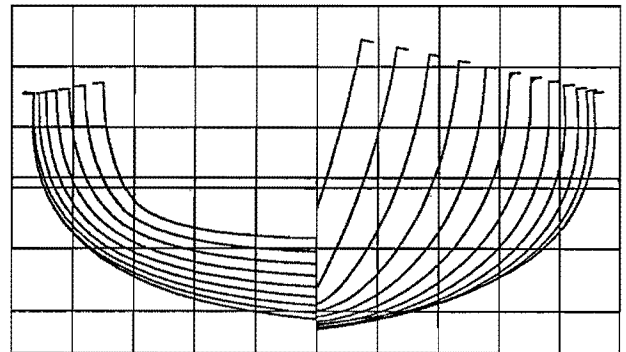
AeroHydro software now plays a potent role in many design projects. Craig Walters of Greenwich, CT has used the FAIRLINE System for several years. His first complete project utilizing the software was the Walters 34, produced by Holby Marine of Bristol, RI and winner of Sailing World's 1988 "Boat of the Year" award.

Once Craig finalized his design with FAIRLINE/2B on his PC, he phoned (in the morning) and read us a table of some 50 control points for the surface. We used those points as input for our custom lofting program, producing full-sized station patterns on mylar film with a true perpendicular skin thickness deduction for ribbands and foam core (fig. at right). We sent off the patterns by Federal Express that afternoon and the crew at Holby Marine was cutting wood the next morning. Barrett Holby and Craig were extremely pleased with the smoothness and fairness of the completed plug and with the rapidity of the project's completion. In addition, Holby enjoyed a considerable savings in labor expense — his cost for the patterns was just \$412.

We worked with Craig again this year, on a 48-ft. cutter to be built in DuraKore® by Russell Yachts of Morehead City, NC. In this case we were asked to provide 18 frame patterns and 12 bulkhead patterns at irregular spacings. Since intersections can be cut anywhere on a mathematically defined surface, the unequal spacing presented no problem. Two weeks from the day Craig completed the design, the DuraCore application was complete. Russ Russell comments that "using traditional lofting methods we would not even have begun applying the DuraKore in those two weeks."

These two projects were especially quick to loft and, therefore, inexpensive for Craig's builders because Craig provided us with hulls already mathematically defined by FAIRLINE/2. We can also loft directly from most AutoYACHT Reps. But we are not limited to these models. With somewhat more time and effort (and cost), we can begin a computer lofting job from a set of hand drafted lines, a carved half-model, an actual boat, or...you name it.

A project with MDI Boatworks of Ellsworth, ME, allowed us to bring computer technology to bear in the design of a traditional Maine lobster boat. Merton Rich and Weldon "Bunny" Leonard, the principals of MDI Boat (Ellsworth, ME), represent a wealth of downeast boat knowledge.



Both have extensive experience in lobster fishing and dragging in a variety of boats, and Merton, as befits his heritage as a member of one of the area's premier boat building families, has become a yacht builder and a lobster boat designer and builder.

What Merton brought us was the lines plan for a 20-year-old design that he felt was aesthetically pleasing but required substantial reworking to meet the performance needs of the modern fisherman. We began by fitting the original lines with FAIRLINE/2, being very careful to capture the sheer and profile exactly. Then the task shifted to stretching the hull to meet Merton's new target dimensions. Over a two week period, we made many trials. Merton was continually amazed that each time he wanted some change, we could move a couple of control points, he immediately could see the results in a lines plan on the computer screen, and then he could take a plotted, fair plan home to think about.

When Merton decided he had the lines he wanted, we made station patterns and construction got under way. It

*Continued on page 15 — LOFTING*



## Shining Sea, a new American clipper ship

In the 1840's and 50's, U.S. naval architects and shipyards evolved a breed of fast commercial ships, considered by many to be the pinnacle of the age of sail. New England clippers roamed the globe by the hundreds, carrying passengers and freight to their destinations at unheard-of speeds and setting hundreds of sailing speed records that stand to this day. If the plans of the Shining Sea Foundation and its advisory council of top maritime professionals come to fruition, the 1990's will see a new ship of this lineage plying the seas once again.

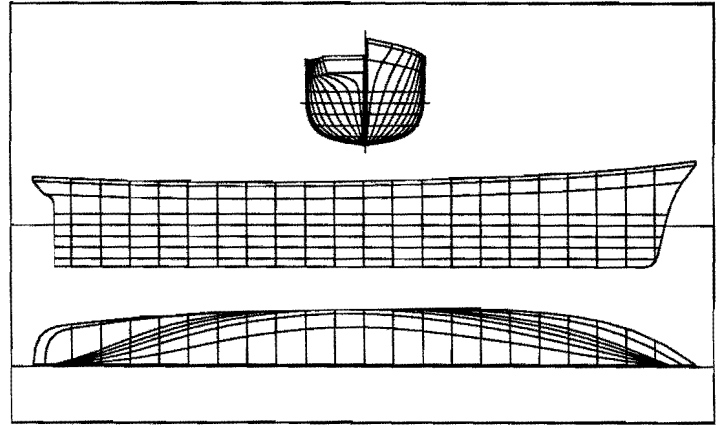
To serve as a testimonial to all the great clipper ship designers, the *Shining Sea* will not be a replica of any particular vessel, but a blend of lines from four famous ships by four great designers:

*Sea Witch* — John W. Griffiths (1846)  
*Sovereign of the Seas* — Donald McKay (1852)  
*Young America* — William H. Webb (1853)  
*Red Jacket* — Samuel H. Pook (1853)

The leading dimensions and sail plan will be taken from McKay's 236-foot *Flying Cloud*, widely regarded as the greatest of all the clippers. Although the Foundation intends the new ship to be extremely traditional in lines, appearance, and detailing, it plans to make full use of modern materials and technology to produce a ship that will be a formidable Tall Ship racer, while serving to generate national pride and respect for American craftsmanship in our time and long into the future.

AeroHydro is working closely with Capt. Charles Quinlan, Project Director, and students at Webb Institute of Naval Architecture in researching and developing candidate lines for the *Shining Sea*. Dr. John Letcher conceived a unique way of using FAIRLINE/2 to accomplish the goals of blending lines from several ships:

- (1) Fit the best available lines of the selected clippers, using the same number of Master Curves and Vertices for each (6 by 6 in this case).
- (2) Apply "stretching factors" to convert each Rep to the target leading dimensions.
- (3) Use a small BASIC program to read in the several basis Reps and perform weighted averages of the Vertex locations. This program writes a new Rep for the blended lines.
- (4) Load the new Rep back into FAIRLINE/2 for display and hydrostatic calculations. During display, save each view of the lines as a .2DD file.
- (5) Use 2DDLINK to convert the .2DD files to .TXT drawing files for Generic CADD.
- (6) In Generic CADD, read in the several views on different layers; slide them into appropriate positions; and add border, detailing, and text before plotting.



AeroHydro is honored to have a part in this splendid and ambitious project. For more information contact: Shining Sea Foundation, P.O. Box 2023, Wilmington, Delaware 19899; 302-429-8923. ✻ 11/89

### LOFTING — Continued from page 14

was with a shock that Merton and Bunny discovered the sheer was not high enough to accommodate some popular engines under the working deck. Even at this late stage, we easily solved the problem. With only a few more trials, we obtained a new sheerline. We then generated patterns for pieces to be added to the existing frames. Construction proceeded with the application of C-flex® and FRP skin. The result was an extremely smooth plug requiring very little filling to complete.

From start to finish, FAIRLINE software and computer lofting provided the flexibility, accuracy, and speed needed for this complex job. An added bonus to the project was the "design" of a smaller version of the first boat in only a day and a half — simply by applying shrinking factors to the existing design and slightly modifying a couple of areas. Ultimately, Merton and Bunny got two boats, that were *exactly* what they wanted, built in the same time as they would have been able to design and loft only an *approximation* of what they originally envisioned.

AeroHydro has been involved in many other successful projects, providing builders all over the world with computer loftings for all types of vessels. You, too, can take advantage of our services (and software). Call or write for information to help speed your next project. ✻ 11/89

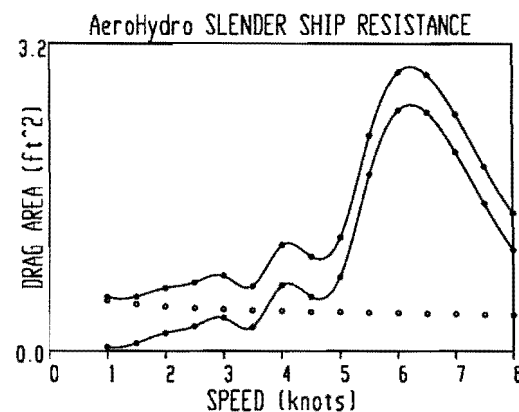
## New Iris Workstation Programs

In 1988 AeroHydro qualified as an Independent Software Vendor for Silicon Graphics and acquired a Personal Iris workstation for development of hydrodynamic analysis programs requiring more speed, memory, and graphics capability than available on PC's. The Personal Iris is an extremely powerful machine with 10 MIPs performance (at least 4 times faster than a 25-MHz 386 PC), 8 megs of RAM, UNIX operating system, and very fast, high-resolution hardware-based color graphics.

In May we announced two new programs for the Iris and other comparable workstations, providing yacht design capabilities hitherto unavailable from any program supplier:

SSR (Slender Ship Resistance) is an implementation of Noblesse's "zero-order" slender ship approximation, a new theory published in 1983, which was used to evaluate wave resistance and optimize hull forms for both *Stars & Stripes* — the 12-meter that won the America's Cup in 1987 and the catamaran that defended the Cup in 1988. SSR is organized to work from an Offset File, so it can conveniently evaluate the resistance of hulls created in FAIRLINE, or digitized from any other source through OFE/3.

DSA (Doublet/Source Aerodynamics) is a "panel code" for flow simulation and evaluation of lift and induced drag of aerodynamic or hydrodynamic configurations. It



is based on the same theory as NASA's VSAERO code, but it has much greater accuracy than VSAERO in some areas, particularly in drag calculations, through use of innovative analysis techniques developed by Dr. John Letcher for keel design in the *Stars & Stripes* 12-meter project.

These innovative programs can equip any design organization with the essential computational capabilities that won the America's Cup two years ago. Beta test versions are available at a discounted license fee until September 1, 1989. ✻ 7/89

## "I always wanted to know: just why is that boat faster?"

### AeroHydro makes a dream come true

Last October, John hired Michael Shook to put his programming skills to work improving various AeroHydro programs. As you might expect, Michael set to work on his transformations...until a more urgent task descended: to help with the 1988 America's Cup defense. Now that's a proposition with a little glitter on it, but for Michael, it's what is on the inside that counts most. "I've always wanted to know how things worked. Sailing is an intricate challenge — just why is one boat faster than another?... Everything before was qualitative...Working with mathematical surface definitions and VPP's, I'm finding the quantitative answers. I'm learning a whole lot, and that's what is so exciting!"

Michael comes to AeroHydro as a skilled programmer with a great love for boats (among other things). He began his programming career at Bowdoin College in 1970, before the era of personal computers. "They had a new PDP-10 system that no one really knew how to use — some one had to, so I did." His independent study topic: learn something and tell everyone else. Later, he continued his formal studies in graduate courses at Boston University, where he gained experience in diverse topics such as artificial intelligence, compiler theory, and linguistics.

Since then he has worked in communications programming, systems analysis and programming for micro and main-frame based systems, market analysis, hardware trouble shooting, and the development of help systems and outliner packages. We are delighted to have him bring such quality and assortment of skills to the AeroHydro team.

And boats? They first arrived in Michael's life when, at the age of nine, he crossed the Atlantic aboard the *SS Constitution*. At summer camp, he got his first taste of sailing — and liked it a lot — this was getting to know how that business of sailing worked, first hand. In 1967, impressed by a speech made by an alumnus of his high school who happened also to be the skipper of *Intrepid*, Michael began following a new tack in the intricacies of sailing: the America's Cup races. All the while, he continued to avail himself of the good fortune of friends who owned boats, sailing whenever he could.

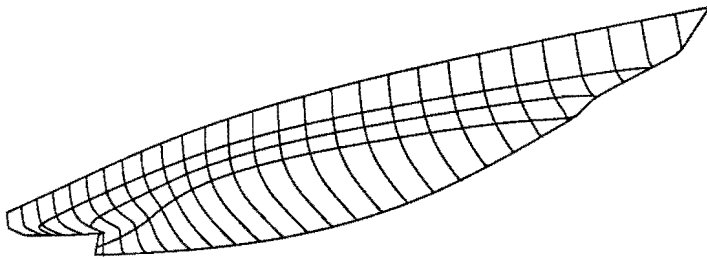
And now that he is here, working on the inside of the most high tech aspects of sailing, he ruefully comments, "I've been so busy I've had no time to be out on boats!" Michael, we'll try to remedy that...how about next spring, when the weather is better for boating? ✻ 3/88

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## Behind the scenes of the America's Cup

### New challenges for Sail America and AeroHydro

For many of us, the 1987 America's Cup ended with the final race and we settled into a 3 1/2 - year resting period. Not so for John Letcher and others of the *Stars & Stripes* '87 design team. The high-pressure season of research, design and computer modeling is over, and it has been replaced not by the season of loafing on the shore, but by the season of writing and presenting technical papers.



John, with team members Chris Cressy, Clay Oliver, and Marty Fritts of Science Applications International Corporation (SAIC), coauthored and presented at the February meeting of the Chesapeake Section of SNAME "Hydro-Numeric Design of Winglet Keels for *Stars & Stripes*." This paper (published in the October issue of *Marine Technology*) details the work they did adapting the NASA flow code VSAERO to keel design, and how they used it in developing and optimizing the keels used on *Stars & Stripes*. The paper received the Admiral E. L. Cochrane Award from SNAME for the best Section paper of 1987.

John, Clay Oliver, and Nils Salvesen (also of SAIC) coauthored and presented at the annual SNAME meeting in November "Performance Predictions for *Stars & Stripes*." This paper describes the whole program of computer modeling, simulation, and optimization that went into the design of the winning boat. It will be published in the annual volume *Transactions of SNAME*.

Many of you probably saw the "*Stars & Stripes*" cover article in August's *Scientific American*, by John Letcher, coauthored by John Marshall, Clay Oliver, and Nils Salvesen. It is a highly readable discussion of the concentrated technological effort that produced *Stars & Stripes* '87, including the significant role played by computer modeling.

And now, as of late November 1987, the "off-season" has been turned into an immediate "open-season" by Sail America's forced acceptance of the surprise New Zealand challenge! With only a slight respite, the rush is on again. And while it certainly is a rush to meet a possible September 1988 sailing date, it is also an exciting new technical opportunity without the confines of squeezing minimal performance gains out of a 12-meter boat. With waterline length as the only constraint, the new territory available for exploration seems limitless: hull shape, size, materials; game theory to optimize the race location; even the definition of what is a "sail" is open!

It is no secret that San Diego is considering using a multihull, so John is launching into VPP programming and configuration optimization for catamarans and trimarans as well as far-out monohulls. Challengers, here we come! ✻ 3/88

## And another race won in Australia

### GM Sunraycer had AeroHydro help

Between the America's Cup Challenge and the America's Cup Defense, Dr. John Letcher had a few weeks to help with an entirely different kind of race "down under." As a result of his successful application of the NASA flow code VSAERO to keel design, he was invited to join the team at AeroVironment, Inc., Monrovia CA, as a consultant for the aerodynamic design of the record-breaking GM solar-powered car *Sunraycer*. John worked closely with AeroVironment aerodynamicist Bart Hibbs, applying VSAERO to define, evaluate, and optimize the aerodynamic envelope of the futuristic car.

In the Caltech wind tunnel, a scale model of the streamlined car lived up to the computer predictions by registering the lowest drag coefficient for any road vehicle ever tested there. In November, *Sunraycer* won the 1950-mile World Solar Challenge, crossing the continent of Australia at a record setting 41.6-mph pace, and finishing 600 miles ahead of its nearest competitor.. ✻ 3/88

## User to User: Tips, Techniques, and Insights

**“I use FAIRLINE and other AeroHydro programs in all my design work now.”**

Bob Davis at Southwest Boat, Southwest Harbor, Maine, is a downeast fisherman turned boat builder and boat designer. His vessels primarily are commercial boats of steel and aluminum. Bob has been one of our users since FAIRLINE/1, and from his experience over the years, he here shares some of his technique in setting up Master Curves for his new designs.


“I sketch the basic lines of the hull. I often use just 5 Master Curves. I space them out along the hull. I place Vertices on the important lines: sheer, deck, chine, bottom of keel.

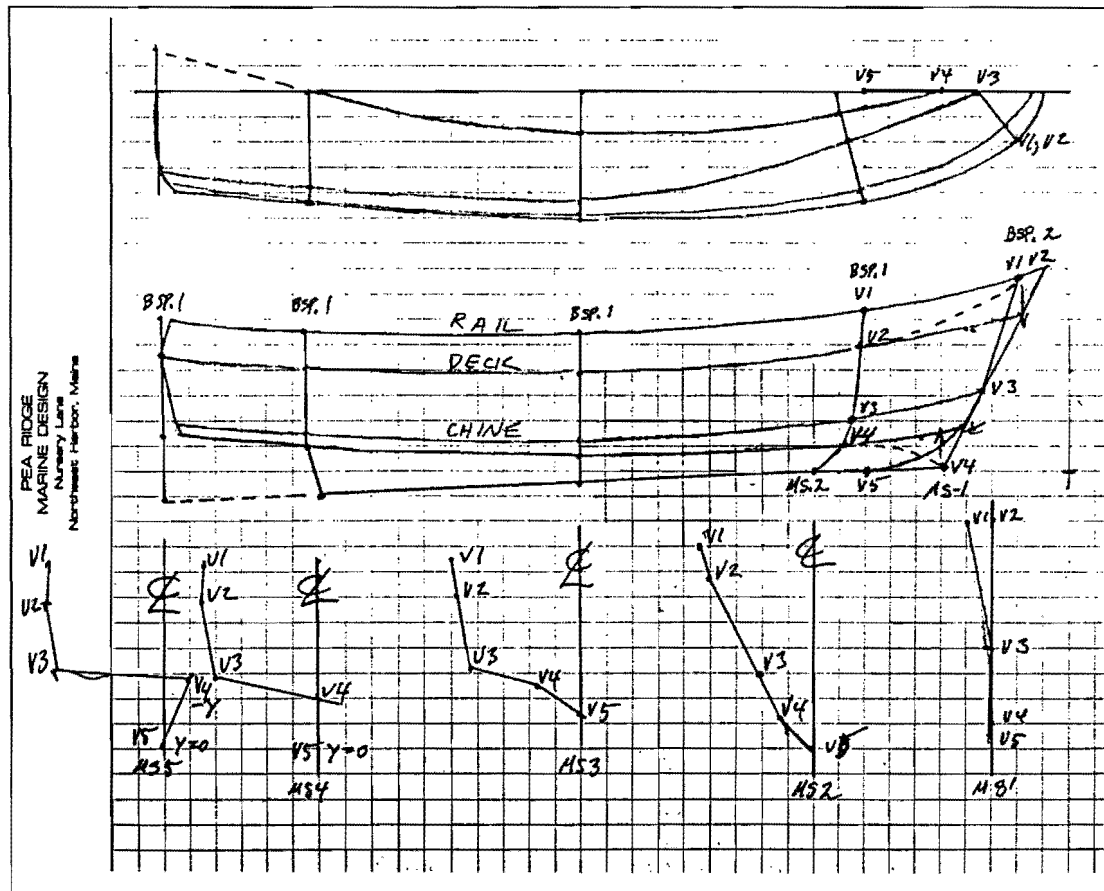
“MC1 is the trickiest. First of all, you need to know that when I build, I use a conical triangular piece to form the wide upper part of the bow (see sketch), so I don’t put V1 of MC1 at the point of the bow; I move it back along the sheer a bit — to the edge of the cone.

“Next, in order to get the rounded forefoot, I use a type-2 B-spline for MC1. But I also want to be able to have a longitudinal define my deck line. If I were using a type-1 MC, I’d have direct control over the longitudinals — with 5 Vertices,  $t = 0$  would pass through V1,  $t = 0.25$  through V2, etc. (as they do on my other MC’s). If I were to move a Vertex to a new point, the longitudinal associated with it would change shape to pass through that point. But a type-1 MC won’t make the bow profile I want. So, working with a type-2 MC, I have to experiment somewhat, adjusting the interior Vertices up and down — it doesn’t take long. To get  $t = 0.25$  to be my deck line, I’ve found I have to put V2 very high, almost on top of V1. I have to play with V4 a little, too.

“All the other MC’s are type-1 B-splines. They’re pretty easy. On MC4, V4 and V5 follow the trailing edge of the

keel. MC5 is a little different. As you can see in the plan view, the longitudinal that runs through the V4’s is in negative-Y when it reaches MC5, therefore V4 on that MC has a negative Y-value; V5 is at  $Y = 0$ . And there you have it.”

Bob has used FAIRLINE and a number of other AeroHydro programs in his designs of craft as diverse as 50-ft fishing vessels and powered barges with tunnel sterns. He also enjoys finding pictures of boats, “all kinds,” and trying to see if he can get FAIRLINE to do them. “I like experimenting to see just what I can get the programs to do.” And Bob gets them to do a lot..  3/88



# Breakthrough in Compound Plate Expansion

**A unique new solution promises to take the trial-and-error out of round-bilge metal construction.**

Inspired by his success in streamlining developable surface construction, John Letcher has launched us into the bigger challenge of quantifying compound plate expansion. The big question: how to accurately describe the initial lofted outline of the plate and the degree of compounding in each area required to perfectly match a specified portion of the hull surface?

This is an area where apparently even the most advanced shipyards still rely on expensive trial-and-error cut-and-try techniques.

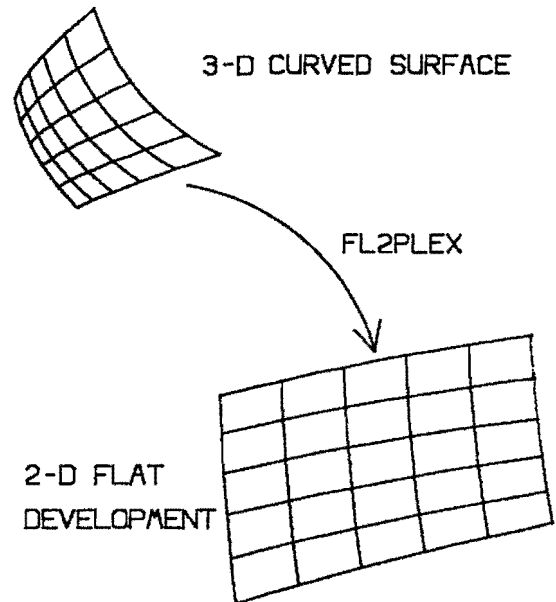
Compound curvature is formed in initially flat plates by a variety of compounding processes, including die pressing, peening, planishing, and line heating. Each of these processes necessarily involves some degree of in-plane stretching and/or shrinking of the plate, leading to two interrelated problems:

A. the relationship between the curvature developed and the degree and distribution of working is very complex and has heretofore been known only qualitatively; and

B. the in-plane distortions involved in the compounding have defeated all previous attempts to develop systems for lofting accurate initial contours.

During the past year, John Letcher has developed new mathematical models for the compounding process that (in principle) solve both these problems. Now AeroHydro programmers, including Christine Chatterton and John Costello, are forging ahead in reducing these theories to computer program practice. As part of this process, they are comparing their computer predictions with actual compounded plates produced by Virginia boatbuilder (and FAIRLINE user) Lynn Davidson. So far, the calculations have been demonstrated principally on FAIRLINE/2 surfaces, but in many ways they are independent of the specific surface definition, and John is confident there will be no major problems in applying them to arbitrarily defined surfaces.

"It's no wonder they had trouble trying to do this on the loft floor," says John. "The mathematics of modeling thermoplastic stress and strain in arbitrary 3-D curvilinear coordinates is marvelously complex. Our most efficient computer solution so far still keeps a hopped-up AT busy for a good part of an hour. It is actually solving over 3,000 simultaneous equations."



Boatbuilders who are interested in making use of this emerging technology, and participating in initial field trials, should contact: Dr. John Letcher, AeroHydro, Inc., P.O. Box 684, Southwest Harbor, Maine 04679 U.S.A.; telephone 207-244-7347. ✻ 3/88

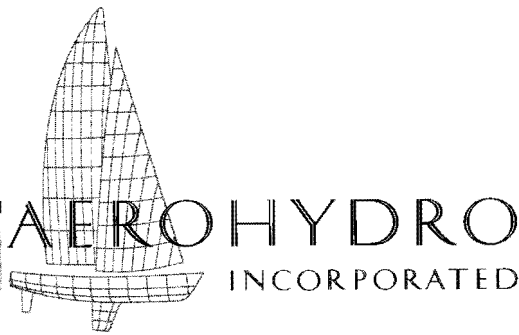
Editor/Designer: Heidi Welch

Contributors: Dr. John Letcher, President; John Brown, Michael Shook, Edward Stanley, Heidi Welch, Reinhard Siegel, James Robinson

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## Rotations, 1K objects head list of MultiSurf 1.3 enhancements

by Michael Shook

MultiSurf version 1.30 has many enhancements and new features (yes, and bug fixes, too). For sheer power, the most important new features are rotated entities, model-level rotational symmetry, another doubling in the number of objects per model, and input file conversion utilities that allow you to import models from several other surface design programs.

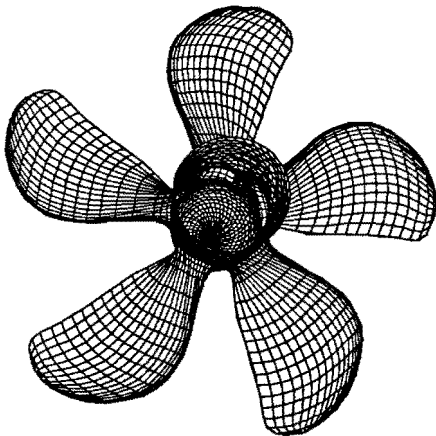
### Rotated Entities

Version 1.30 adds three new *rotated* entities — RotatPoint, RotatCurve, and RotatSurf — which allow building of angular relationships and rotational symmetries into models. Each of these entities requires three parameters in addition to the standard parameters for a point, curve, or surface: a *basis object*, a *line*, and an *angle*. The *basis object* is rotated the specified *angle* (degrees) about the *line* to create the new rotated object.

Building a boom on a point rotated about a mast is an example of the utility of rotated entities. Simply changing the angle for that rotated point allows you to change the location of the boom.

### Model-level rotational symmetry

For some models you may want to use the new model-level rotational symmetry rather than rotated entities. The relationship between model-level rotational symmetry and rotated entities is analogous to the relationship between model-level mirror symmetry and mirrored entities (MirrPoint, MirrCurve, and MirrSurf), the model-level symmetries affecting entire models, the rotated/mirrored entities



Propeller model made with 5-fold model-level rotational symmetry.

coming into play where only a portion of a model is symmetric. For example, in designing a propeller, a model that is entirely rotationally symmetrical, you can design a single blade and use model-level rotational symmetry to display the other blades.

Using rotational symmetry instead of rotated objects cuts down on the number of objects you need to create and usually leads to faster image updates.

### Capacity increased to 1024 objects

For designers wanting to boldly go where no MultiSurf designer has gone before (and wanting to boldly split infinitives that have never been split before), version 1.30 supports 1024 objects, doubled from the 512 in version 1.20. I have no examples to offer here — I leave that to your creative imagination.

### FL/2B, FastYacht, MacSurf compatibility

MultiSurf is now distributed with three input file conversion utilities that allow you to import models from FL/2B, FastYacht, and MacSurf. The converted models replicate the originals with 100% accuracy, so you can move smoothly into MultiSurf and continue where you left off in your previous design program.

### SURFMODL free-ware rendering program

Version 1.30 supports SURFMODL, Ken Van Camp's free-ware rendering program. The MultiSurf distribution disk includes PAT2SM.EXE, a utility that converts surface patch files into SURFMODL files. Contact us for a free copy of SURFMODL.

So much for the tip of the enhancements iceberg. The best way to discover the rest is by prowling around in your own version 1.30 of MultiSurf (207-244-7347). □

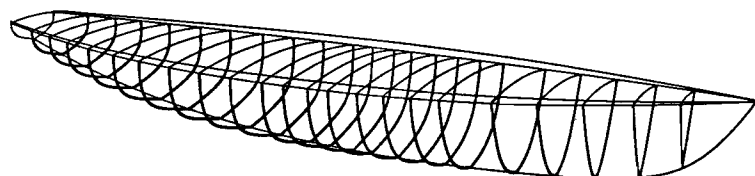


## MultiSurf put to task on two more big boats

This spring, AeroHydro assisted in the development of designs for two more big sailing yachts: a 106-ft ketch by the Hood Design Group, and the 74-ft ketch *Dragonera* designed by Joel White. The projects gave AeroHydro personnel hands-on experience participating in major design work — a process we see as crucial to the continued development of MultiSurf as a practical design tool — and gave the designers involved a fast, intense introduction to MultiSurf's power and versatility.

Both projects started with the digitizing of drafted body plans and production through OFE/4 of 3-D wireframe files of the drafted stations, which were loaded into MultiSurf as WireFrame objects. In both cases, the canoe bodies are C-Lofted surfaces with about 8 type-3 B-spline master curves.

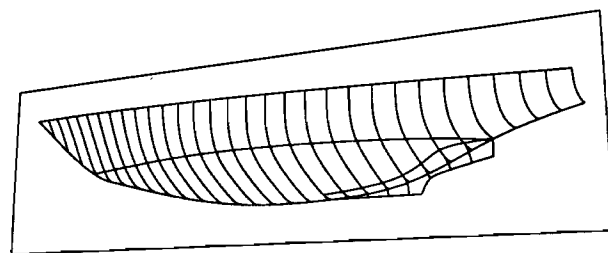
Joel White, known for his finely-crafted, wooden sail and power yachts, joined us in our Southwest Harbor office for a day, to observe the process of



fitting and fairing master curves, sheer and profile lines, and to provide immediate feedback along the way. He went home that evening with a nicely-faired hull closely matching his drafted lines and displacement. Later the deck, pilot house, and NACA foil appendages were added, and full-sized mylar patterns were produced for the bulkheads and laminated frames.

David Moffet came from Hood Design for a 3-day visit. After some concentrated MultiSurf training, he participated in the fitting of the Hood 106 lines.

Two or three times a day, we sent DXF files via modem to the Hood office in Portsmouth, RI, where the three Teds — F.E. (Ted) Hood, Ted Fontaine, and Ted Hood, Jr. — examined our



progress, conferred amongst themselves, and faxed us back requests for alterations. The task was complicated by the presence of two overlapping appendages — a keel skeg housing the centerboard and a bustle fairing into the rudder — and (we have to say it) by Big Ted's legendary perfectionism. Despite the obstacles, after several modem-fax cycles, everyone was pleased and we had a hull. Ted Fontaine, Hood's lead designer comments, "Over the years we've tried them all — FAIRLINE, FastYacht, Nautilus, AutoYACHT, and none of them could handle our complex shapes and fairing requirements. With MultiSurf it looks like you've really done it!"

Now Dave Moffet is well along on his first MultiSurf design — a 60-ft power yacht — and Chuck Burns is putting together a very complex model of decks, cabin, pilot house, and cockpits for the Hood 106.

We're proud to be working with such prominent designers as Joel White and the Hood Design Group on these magnificent yachts. The experience we gain will benefit all MultiSurf users. □

## Surface development for MultiSurf

by Ed Stanley

We are pleased to announce the release of MSDEV, a new MultiSurf module that reads in panel ruling files made by MultiSurf and outputs DXF and/or text files of the developed shapes of those panels. In the DXF file, each panel is placed on a different layer and is marked with the X, Y, and Z contours contained in the MultiSurf model file from which the ruling files were made. The text file contains the 2-D coordinates of the developed panels as well as the coordinates for the marks previously mentioned.

You can substitute equal bend lines for ruling lines in either file. Equal bend lines show where a panel must be bent for any given bend angle.

MSDEV also writes a text file containing each panel's area, center of gravity (in 3-D), and weight, as well as the totals for each of these amounts. These figures are very useful for estimating the total weight and center of gravity for the boat.

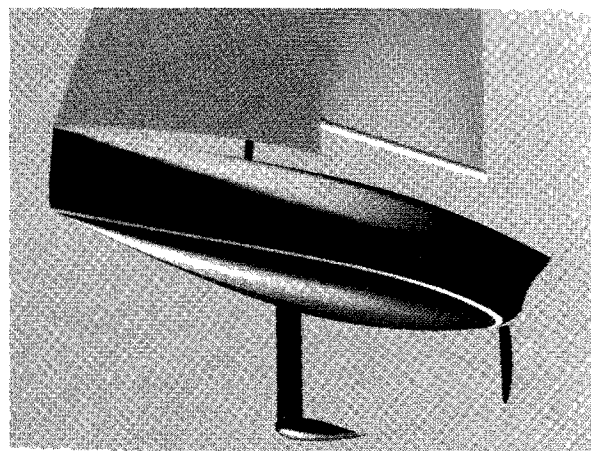
The combination of MultiSurf and MSDEV provides a powerful means of designing and manufacturing vessels with developable or partially developable hulls and structures. □

## You don't have to be a computer whiz to succeed with MultiSurf

Bill Sill, sailboat racer-builder-become-designer from Sodus Point, NY, did not let lack of computer experience put him off from taking advantage of MultiSurf's rich design powers. No way! And he didn't let failing kidneys stop him either.

When just a few days before going into the hospital for his latest kidney transplant Bill bought MultiSurf, we didn't think we would be hearing from him for a long time — if ever. Then, a week after his operation, he sent us a disk with a complete new boat design with four sculpted surfaces neatly joined and perfectly executed! "He must have been reading the manual in the operating room," exclaims John Letcher, company president and chief MultiSurf inventor.

Overcoming, circumventing, living with physical challenges is not new to Bill — he was diagnosed with diabetes at age 11 and now has limited eyesight and needs a cane to walk. But Bill is just



not one to quit — he has learned to challenge his challenges right back. True to this bold nature, his first MultiSurf design is not just any old generic sailboat. *Bird of Prey*, as she will be called, will be Bill's ideal racing boat — ideal for *him* sailing on Lake Ontario. MultiSurf is proving well up to the task; and Bill is proving without a doubt that MultiSurf is open to the world of the novice computer user.

Bill, we wish you all success in your ventures. Newsletter readers, we point you to the Personality Profile (pg. 8) in the June 1993 issue of *Sailing World* for more about Bill's project. □

## Toward maximizing boat performance: AHVPP writes Ockam Polar Files

by Ed Stanley For those of you interested in maximizing your boat's performance, we offer a new alternative: use AHVPP to link into OCKAM Instruments' OckamSoft™ 2 program. AHVPP now writes Ockam polar files for input into OckamSoft 2. The polar file contains speed predictions for true wind angles from 22 to 180 degrees at 2 degree intervals and for true wind speeds from 1 to 25 knots. It is in Lotus 1-2-3 spreadsheet format, so it can also be loaded and viewed in 1-2-3.

Velocity polars are used as a tool to maximize boat performance. For a given true wind angle and speed, they will tell you the speed your boat should be able to attain. The OckamSoft 2 program uses the speed predictions contained in the polar file to interpolate a complete velocity polar, so that it can predict your speed at any heading to the wind.

OckamSoft 2 runs on PC's and links with boat instruments made by OCKAM. It provides many useful features that interface with the instruments and also shows polar curves of the current conditions under which you are sailing. □

## ORCCON writes new USSA offset file

ORCCON (the OFE/4 custom utility for converting AeroHydro Offset files to US SAILING's .OFF format) has been updated to write the new US SAILING offset file format. The update was prompted by the announcement by US SAILING that it will no longer sell the BASIC version of its LPP and VPP — it will now only sell the FORTRAN versions of these programs. The FORTRAN LPP requires a slightly different format in its offset files than the previous BASIC version. So if you plan to get the new US SAILING LPP and VPP and already have OFE/4, call us to get this latest update. □

## Sometimes it's the small things that really count

### Ease-of-use enhancements in MultiSurf 1.30

Some of the enhancements in MultiSurf version 1.30 don't sound like much — they just make the program much more pleasant to use. This time, we're not talking about the powerful pizzazz of rotated entities and model-level rotational symmetry — instead, we're talking about niceties such as that now *all* models you output to AutoCAD® or SURFMODL will include the symmetry images you had specified in MultiSurf. Dare I say it?! — what you see is what you get. Previous to version 1.30, this was true *only* for wireframe output.

In another vein, forget for a moment that now you can have over a thousand objects in a model, and focus in on the fact that in MultiSurf 1.30 you can easily toggle the display of contours on and off. So what, say you? Contour calculation is one of the slowest parts of updating a model — turning them off speeds model updates. This is especially important if you're using most of that 1K of objects. Lastly, when you turn the contours back on, MultiSurf recalculates them then and there, so you never see outdated contours.

Ready for more? — introducing a few other version 1.30 quiet innovations for the easy life:

- the Show/Hide status of objects is retained when you save your model, when you edit the model file, and when you undo an edit
- you can Zoom Previous with <F8>
- you can Auto Zoom (to center and size the image to the screen) with <F9>
- crosshairs and Ortho mode while moving a point give you much greater control
- more divisions are permitted on curves and surfaces
- when rotating your model with the cursor keys, <PgUp>, and <PgDn>, holding down <Shift> as well will rotate one degree per key press rather than ten degrees
- one of my favorites: when you add an object, MultiSurf provides meaningful defaults
- you can create user-defined foil surfaces, foil curves, and foil snakes
- Calcs/ Mass Properties displays the 6 moments of inertia as well as the center of gravity of curve, snake, and surface objects

The list goes on and on. The best part is that all these things which make life easier are available *free* and *automatically* to licensed MultiSurf users. We'll begin shipping the updates mid-August. □

### From the source:

### New technical papers by John Letcher

AeroHydro's president Dr. John Letcher is the author of technical articles on diverse topics in two current issues of the *Journal of Ship Research*, published by the Society of Naval Architects and Marine Engineers (SNAME).

His March 1993 article, "Properties of Finite-Difference Operators for the Steady-Wave Problem," explores fundamental aspects of Dawson-type codes for simulating wave flows, illuminating the reasons why most programs of this type fail to provide stable, reliable resistance predictions. AeroHydro has an ongoing development project aimed at overcoming these problems.

"Lofting and Fabrication of Compound-Curved Plates," appearing in the July 1993 issue, presents the theory underlying Dr. Letcher's patented process for accurate numerical plate expansion procedures and the quantitative control of plate compounding operations such as peening, planishing, and line heating. These methods have been recently introduced with excellent success in several U.S. and foreign shipyards. □

Editor/Designer: Heidi Welch

Contributors: Dr. John Letcher, President; John Brown, Michael Shook, Edward Stanley, Heidi Welch

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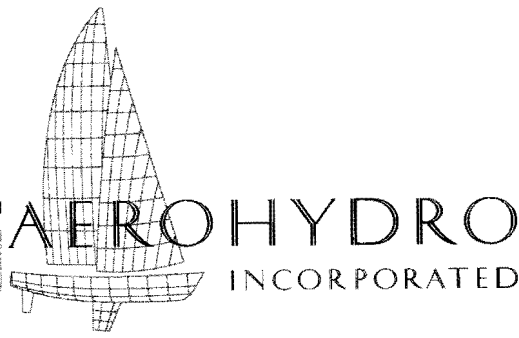
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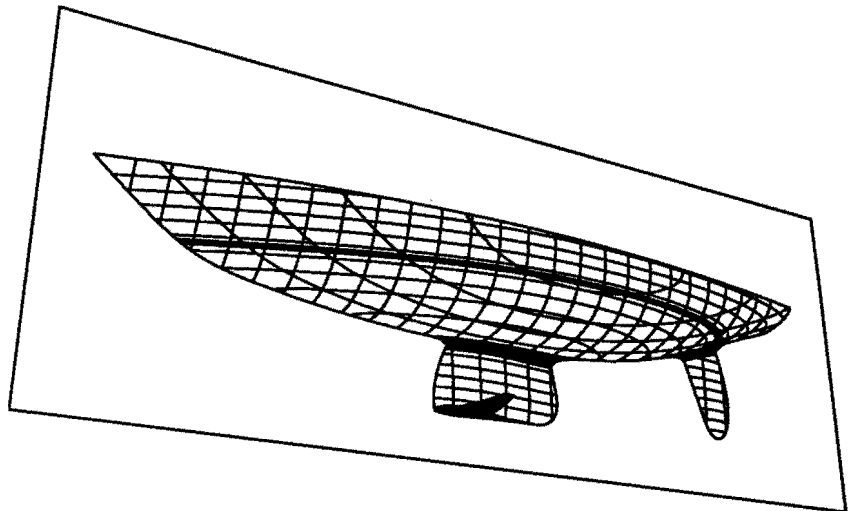
## Bruce King Yacht Design on a roll with MultiSurf

Bruce King Yacht Design in Newcastle, Maine, was the recipient of the very first production copy of MultiSurf in September 1992, as an upgrade to FL/2B. The program was promptly put to work completing the design of the new Ericson 43. The hull had already been designed with FL/2B (and full-size frame patterns had been generated at AeroHydro for the builder). The FL/2B rep was put through the FL2MSF utility which translated it into a MultiSurf rep; then deck, keel, and rudder were added to complete the model for hydrostatic and velocity prediction analysis. So went the beginning of MultiSurf in Newcastle.

Not many weeks later, the week before Christmas in fact, we at AeroHydro discovered just how rapidly new plans were moving along — we were engaged to make full-size mold frame patterns for not one but *two* new big yachts from Bruce King's board (*motherboard*, that is). The first is a 70' production sloop for The Hinckley Company. Again, this hull was originally developed in FL/2B, but was ported to MultiSurf for addition of keel and rudder. Using our full-size patterns, Hinckley had plug construction underway within two days of delivery of Bruce's final lines.

The other big new King design is a 79' cold-molded power yacht being built at Hodgdon Brothers in East Boothbay, Maine. This all-MultiSurf design combines the traditional flared bow and torpedo stern of the "commuter" style yachts of the 1920's (in which Wall Street tycoons made daily runs between their offices and their Long Island estates) with a modern planing bottom suited to attaining a top speed of 35 knots.

"MultiSurf has overcome the limitations of previous hull fairing programs," says King. "It offers an almost unlimited ability to model and combine complex shapes, allowing complete freedom of control by the user, rather than the user being



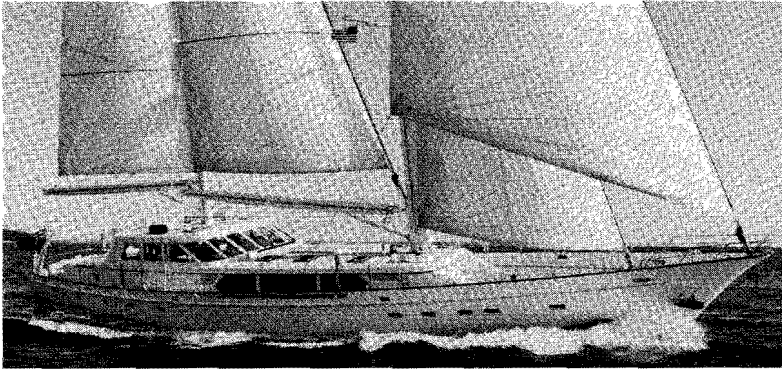
controlled by the software. With MultiSurf we no longer need to resort to conventional lofting methods, because this new software can handle our complex hull shapes."

Another large Bruce King project coming together with AeroHydro assistance is the 135' aluminum ketch *Alejandra*, now in the final stages of construction at MEFASA in Aviles, Spain. AeroHydro helped King to develop a systematic series of proposed winglet keel configurations, which were evaluated with DSA (Doublet/Source Aerodynamics) for lift/drag characteristics and VPP performance comparisons.

Continued on page 4 — KING

## Camden design hub

Chuck Paine and Ernest Brierley both have offices located on the wharf at Wayfarer Marine in Camden, Maine. They remain independent businesses but they have cooperated closely on many projects, the largest being the 125' aluminum schooner *Mandalay* built by Palmer-Johnson in Sturgeon Bay, Wisconsin.



Chuck is well known as the designer of many beautiful sailing yachts built by Able Marine, Morris Yachts, and Kanter Yachts. Recently he has expanded his portfolio with a 42-ft power cruiser for Able Marine. Chuck is also a well regarded author on many topics of sailboat design and performance.

Ernie's background, on the other hand, is in design and building of luxury yachts, high-speed military PT boats, and commercial craft, as well as in teaching naval architecture. He obtained his training in the classic English apprentice system, beginning at the John Samuel White yard in Cowes, then moving on to Vospers in Portsmouth where he was involved in early wood/metal composite construction techniques. From there, he crossed the Atlantic to Maine, where he and Otto "Junior" Miller helped rescue Southwest Boat Corporation from bankruptcy. They continued their success in Eastport by creating the Marine Trades Center which won national recognition as the best maritime vocational/technical program.

We first got involved with Ernie while he was in Eastport seeking to meld the traditional wooden boat school of design with the high tech of computer aided design. In 1984, Ernie took over the residential program at the Yacht Design Institute in Blue Hill and continued to advocate the use of computer tools in the design process. Finally, when he opened his own design office in Camden in 1986, a computer and AeroHydro software

were among his early acquisitions. "I have always felt, since my first introduction to FL/2B some 14 years ago, that the future use of this program would be exciting and a tremendous tool," Ernie explains. "I was not disappointed. Today, the program is excellent and extremely flexible."

Two of Ernie's original designs were for Southwest Harbor builder Mac Pettegrow. The first was a 38' downeast lobsterboat hull. We helped him finalize some details and then plotted full-size female frame patterns which gave Mac a real boost in constructing the DuraKore® hull in time to meet an exhibition deadline. His second effort with Mac was a 42' modified V-bottom sportfisherman. Although the aft portion of the sheerline was modified during construction, using FL/2B we were able to redesign the sheer and plot new patterns for the affected area without having to relift the entire topsides.

Ernie was approached to design *Mandalay* which was his and Chuck's first major collaboration. Chuck drafted the initial hull lines by hand; Ernie used FL/2B to fair and tweak the design to its final form and to generate a standard table of offsets. Those offsets, delivered to Palmer-Johnson, were "the fairest offsets we were ever provided by a designer," according to project manager Bjorn Johansen. The casting of the 90,000 pound keel provided another confirmation of computerized accuracy — the poured lead line was within  $\frac{3}{8}$ " of the projected line calculated with HYDRO/1. *Mandalay's* commissioning was completed in Bermuda last February and both the owner and

*Continued on page 4 — CAMDEN*

## MultiSurf version 1.20

In early January, AeroHydro released version 1.20 of MultiSurf. Compared with the original version 1.00, the program upgrade

- doubles the capacity (to 512 objects)
- updates up to 20 times faster following edits
- quadruples the capacity for complex wireframes and panels

Also included are many large and small improvements to the user interface — and correction of some elusive bugs (yes, we have 'em).

Version 1.20 is being sent to all MultiSurf users as a free upgrade. Demo users may also receive the new trial version, on request. □

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## Special offer to students of naval architecture

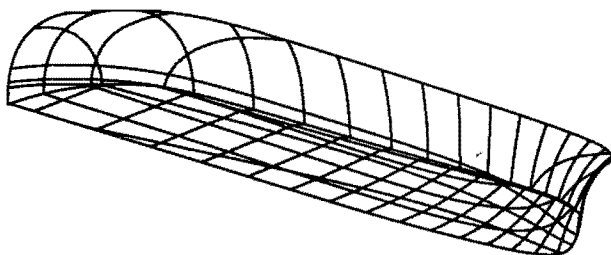
Over the past decade, AeroHydro software has been part of the curriculum at many schools including the University of Strathclyde in Scotland; the Yacht Design Institute and Maine Maritime Academy in Castine; the Marine Trades School in Eastport, Maine; The Landing School in Kennebunkport, Maine; and The Artisans School in Rockport, Maine. We provide software to these schools at a 50% discount from list price in order to acquaint students with the benefits of computer aided design and the leading edge of modern naval architecture.

Now we are expanding the program to include individual students in any bona fide residential or correspondence program of naval architecture. This was in part prompted by a new curriculum at The Westlawn Institute of Marine Technology which allows their students to submit projects generated by AeroHydro programs. We are supplying Westlawn with our software so that instructors will be able to evaluate the design project in the originating software and make design suggestions that can be returned to the students. We heartily support Westlawn's efforts

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**KING** — *Continued from page 1*

"Bruce has always been an inspiring designer to work with," says AeroHydro president Dr. John Letcher. "He's always pushing the capabilities of the software, doing new things with it that surprise us and challenge us to make improvements. We love it -- this is how we get better." □



to expand the use of computer aided design among its students.

For students to be eligible for the discount, we require a letter from the institution certifying student status. The software is distributed with a hardware lock and will be supported for a period of three years. At the end of that period, the student can either upgrade to the current commercial version of the software (with credit for the 50% originally paid) or return the hardware lock. □

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**CAMDEN** — *Continued from page 3*

the designers have been exceedingly pleased with the outcome.

The success of *Mandalay* convinced Chuck to use FL/2B in two subsequent design projects: a 60-ft aluminum sloop built by Kanter Yachts in Ontario, Canada, and a 50-ft sloop for Able Marine. Chuck, who is a renowned draftsman and regards yacht design as a true artistic endeavor, for a long time had resisted computer technology — it would "take the character out of my hulls," he insisted. His recent experiences have changed his mind and he now embraces the aid of computer tools: "We have found the lines generated using FL/2B to be perfectly fair, even to our exacting standards. And the ability of AeroHydro to produce accurate frame patterns, especially for the aluminum boats with 50 to 75 frames, is an invaluable time saver."

Ernie updates his story, commenting on a 28-ft aluminum high-speed launch he recently designed using the AeroHydro plate development program DEVELOP/2: "The plates were cut by JBF Scientific in Southwest Harbor then shipped to Hard Chine Engineering in Camden, Maine, where they were assembled on a simple jig. The fit ups were perfect."

"The AeroHydro programs are wonderfully supported by John Letcher, John Brown, and the rest of the gang," he continues. "Their support directly over the phone is first class."

We are very pleased to have Ernie and Chuck as users of AeroHydro software. That such creative and demanding designers have chosen to use our programs in their design process reflects the power and versatility of those programs. For AeroHydro software details, call us at 207-244-7347. For more information on Paine and Brierley services, call Chuck at 207-236-2166 or Ernie at 207-236-8726. □



FAIRLINE® Marine Design Software / Consulting / Technical Services

## MultiSurf 1.5 — faster, bigger, better

### Speed, intersections, offsets top improvements

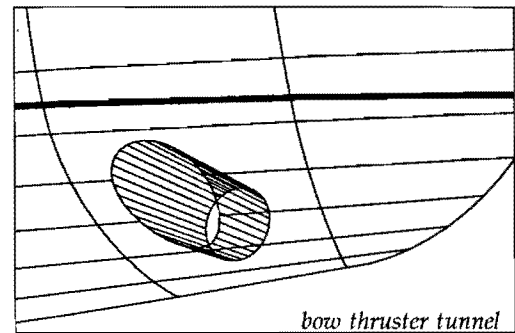
The users have spoken, and Dr. John has answered. In response to the questionnaire that accompanied distribution of MultiSurf version 1.3 upgrades, the newest release incorporates many of the features most in demand by experienced users.

**Deferred update** — MultiSurf's most remarkable feature is its ability to automatically update a complex model following a change in an underlying point, curve, or surface object. However, there are times when you plan to perform a series of edits, and the update time following each one becomes a nuisance. A new "update depth" setting gives you full control over the timing and extent of model updates.

**Speedup in contours and many surfaces** — A fresh look at cutting contours on surfaces led to a new contouring algorithm that operates much faster. In addition, new arrangements for storing surface and snake tabulations provide major speedups in Offset Curves and Surfaces and in surfaces which are based on snakes, such as Fillets, Blisters, SubSurfs, and any surface using a snake as a master curve or edge curve. In combination, these speed improvements make most complex models load and update 2 to 4 times faster.

**Six intersection entities** — Although MultiSurf sidesteps most of the difficulties of surface intersection and trimming that beset conventional surface and solid modeling systems, there are still

times when intersections need to be addressed head-on. Six new entities in version 1.5 — four new points and two new snakes — provide powerful capabilities for solving intersection problems.



The IntSnake (intersection snake) is the one most often requested. This turns any contour that can be cut (by a plane, cylinder, or sphere) on any surface object into a snake that can then be used like any other snake or curve to build other objects. A common IntSnake application is cutting waterline and boottop snakes on a boat hull, allowing the areas above and below the boot stripe to be rendered as separate SubSurfs with different colors.

The ProjSnake (projected snake) has also been frequently requested. This creates a snake by projecting any curve onto a surface object. A typical ProjSnake application is a bow thruster tunnel (see figure above), made by projecting a circle transversely onto a hull surface. The tunnel itself can then be easily made as a RuledSurf between the ProjSnake and the circle.

The new point entities embodying intersection capabilities are:

- IntBead and IntRing — the point where a curve or snake intersects a contour-cutting surface (plane, cylinder, sphere)

### CADalyst rates MultiSurf tops

MultiSurf was selected by *CADalyst* magazine as the best CAD product of 1993 in the category "Mechanical and Modeling Software." *CADalyst's* annual awards were announced in the December 1993 issue.

*CADalyst* is a reference magazine for AutoCAD® users. For subscription information, call 1-800-949-6325.

Continued on page 4 — MSURF

## Hands-on software training

### Another chance to learn from the AeroHydro team

If you missed it last spring, you have another chance: AeroHydro, in conjunction this time with the WoodenBoat School, will offer an expanded software training seminar June 20-24, 1994.

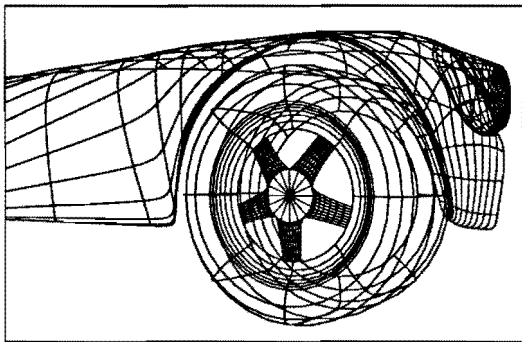
The course will provide hands-on experience with AeroHydro software, including the MultiSurf® surface modeler and hydrostatics and VPP analysis programs. Before using each program, students will have the benefit of several hours of explanation and demonstration in a classroom setting. Then in afternoon "lab sessions," under the tutelage of Dr. John and other AeroHydro personnel, students will be encouraged to carry out their own design projects.

## On Modeling a Cobra

(close encounters of the sportscar kind)

by Edward Stanley

How am I going to model *that*? Where do I begin? These were the thoughts that ran through my head as a tiny toy car was held out to me. Fifty-nine surfaces later, I had a fairly complete model of the popular 1960's sportscar known as the Cobra.



The project was given to me to test MultiSurf's capabilities. The only things I had to guide me were the toy model and several pictures from magazines. As I sat down to plan out how I would accomplish the modeling task,

it was quickly evident that looking at the whole car and trying to plan everything in advance was overwhelming. So I decided to work on different parts one by one, concentrating on only one part at a time.

I began with the body of the car, which for convenience I subdivided into four surfaces: hood, front fender, rear fender, and trunk. Because of the varied curvatures and shapes present in the body

*Continued on page 4 —COBRA*

The personalized nature of the course lends itself to everyone from novice to expert. For the novice, it provides an opportunity to see what the different program modules can do and to get firsthand assistance in creating an initial computer aided design. For the expert, it is a chance to tap the wealth of experience of the AeroHydro team — to expand understanding of the programs and to push the capabilities of the software.

Last June in Bar Harbor, the course attracted eight students from as far afield as Taiwan and Finland and as nearby as Castine and Camden (see Rob Eddy story on page 3).

For this year's course, we'll use computer facilities at the Hancock County Technical Center in Ellsworth, Maine. This location provides easy access to the WoodenBoat School and its dormitories in Brooklin and to the myriad recreational activities available on the Blue Hill Peninsula and Mount Desert Island.

Enrollment limit: 16. Tuition: \$500. A discount is available for WoodenBoat School Alumni. For more information about the *course contents*, contact John Brown at AeroHydro: phone 207-244-7347; FAX 207-244-7249. For *enrollment* information, contact the WoodenBoat School: 207-359-4651. □

## IBEX 94

by Michael Shook

John Letcher and I will again be in the AeroHydro booth at the International Boatbuilders Exposition (IBEX) in Miami, Florida on February 10-12. The show is sponsored by *Professional Boatbuilder* magazine and caters to professionals in all facets of boat building and repairing.

Stop by and talk to us at booth number 412. We'll be happy to demonstrate the latest versions of AeroHydro software as well as offer technical insight into the many interesting and complex projects in which we have participated.

We will also be presenting a workshop (WK-2) about the use of MultiSurf in boat design and construction on Thursday the 10th from 1:30-2:30. An hour later, John Letcher will be participating in a panel discussion titled "Case Studies in CAD/CAM Capability" from 3:30-5:00. This will be a step by step presentation of how specific construction projects have benefited from computer aided design.

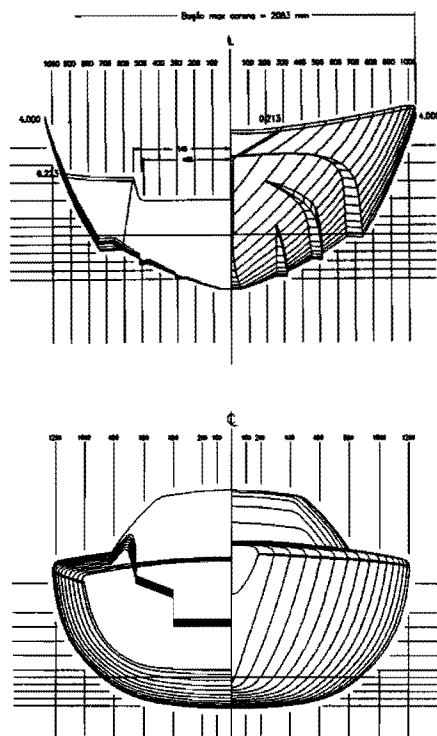
For more information on IBEX please feel free to contact us. We look forward to seeing you at the show. □

## There are not only 79' sailing boats...

Inspired by the prevalence of big yachts in the articles of last winter's AeroHydro newsletter, Italian yacht designer Sergio Abrami of Studio Sergio Abrami & C. sent us a note: "In the world of FAIRLINE there are not only 79' sailing boats but also small and fast 23' ULDB roaring offshore..." He enclosed two examples of their recent production, the sailboat *Atmosfera* and a class 3 powerboat.

*Atmosfera's* main dimensions are LOA 7 m, LWL 6.41 m, B 2.44 m, and Displ. 1100 kg. Four Master Curves with 5 Vertices each were used for the FAIRLINE hull. The bow MC is a half-sidingline. Bow rounding, deck, cabin, and cockpit were done in a CAD drafting program.

The 6.26 m LOA offshore powerboat (LWL 5.22 m, B 2.09 m, 143 KW engine) is created with two Repts, split along the upper spray chine, 6 Master Curves each. The surfaces were joined together in CAD. The last Vertex at the keel line is not on the centerline. The bow is defined by a half-siding line and rounded in a CAD drafting program. The lower spray rails are not incorporated in the Master Curves but were added later with CAD.



Sergio Abrami has been using the FAIRLINE programs since 1988.

"We have already many boats in the water, designed by FAIRLINE without any problem. The first was an aluminum sailing yacht of 10.5 m LOA and the latest one is a small workboat in GRP. We like best the easy use of the programs. The greatest advantage is the possibility of checking and selecting in a short time between a lot of solutions in the preliminary phase of the project. In this way one can optimize the quality of the project."

Very recently Sergio Abrami was invited to speak at the University of Genoa on the occasion of the opening of its new School of Yacht Design. Not surprisingly, his topic was

the use of CAD in yacht design. The success was so great, he has been invited to hold a series of lectures about using the FAIRLINE programs in the practice of yacht design.

We wish Sergio Abrami all the best for this project and look forward to seeing more of his outstanding design work. □

## From zero to CAM in 8 months

### Meet AHI Software Seminar alumnus Rob Eddy

Rob Eddy of Camden, Maine builds fine yacht models. He also designs and manufactures a line of gold nautical jewelry. He bought a computer (his first) in January 1993, but "waited a week before I plugged it in and waited another week before I turned it on." He played around some with AutoSketch®, a low-cost 2D CAD program from Autodesk® but soon realized that he really needed to be doing 3D design.

In April, Rob purchased MultiSurf and started working through the tutorials. To get a concentrated shot at using MultiSurf he signed up for the marine design software training seminar which AeroHydro offered in June 1993. His course project was a 10' dinghy design.

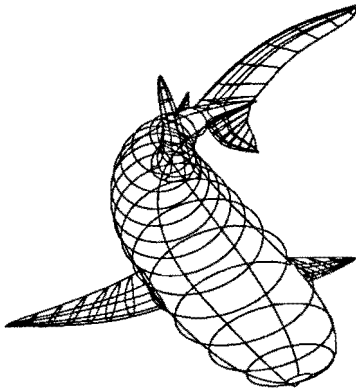
In the months since the course, Rob has used MultiSurf to design sailing models, mock-up models, exterior hull shape mock-ups, sectional model displays to work on mock-ups for interiors of boats, and designs for jewelry. He has used a numerically-controlled laser cutter to make various parts for his models. In addition he has been experimenting with a numerically-controlled overhead router/cutter from USA Robots in Portland, Maine. With USA Robots he milled two 20-inch MultiSurf hull shapes in about 35 minutes.

Rob's motivation and hard work have made him a MultiSurf success story. We're pleased that from his experience he now considers computer-with-software "the most useful tool in the shop." □

**MSURF** — Continued from page 1

- IntMagnet — the point on a surface where a line passes through the surface
- ProjMagnet — the projection of any point onto a surface

These solve many problems requiring location of beads or magnets at fixed X, Y, or Z coordinates or at fixed distances from other point objects. In particular, connecting rods, links, and cams in many mechanisms can be modeled with these new point entities.



*This shark model illustrates the versatility of the new SweepSurf. The body and each of the fins are tapered SweepSurfs!*

**Hydrostatic offsets** — A new method is proving much more reliable in the generation of offsets across complex combinations such as fillets, bulb keels, and superstructures.

**SweepSurf generalized** — The SweepSurf allows a surface to be generated by sweeping a cross-section curve, the "shape," along another curve, the "path." In version 1.5 this entity is generalized by allowing a very general "stretching" of the shape as it sweeps along the path. This allows SweepSurfs with a variable cross-section.

**Show supports, show dependents** — New ShowHide options allow you to visually track dependency relationships between objects, and to turn on groups of hidden objects based on their dependency roles. For example, you can turn on all the control points of a selected curve, for convenience in editing the shape of the curve.

**Other improvements**

- New utility, DXF2MSF, converts subset of AutoCAD entities (points, lines, circles, arcs, 3D polylines, curve-fitting 3D polylines, 3D meshes, and smoothed 3D meshes) to appropriate MultiSurf objects.
- Options/ Set View allows explicit control of eye point and viewing direction.
- Dragging of beads and magnets more accurate.
- New Arc types 4 and 5 offer control of tangent direction at either end of Arcs, ArcSnakes, ArcLoft surfaces.
- Scale values displayed on grid lines.
- Hydro dialog box settings preserved, and specific weight added to MSURF.CFG for convenience of metric users.

Version 1.5 is scheduled for release Jan. 15, 1994. Call us for your upgrade or new program. □

**COBRA** — Continued from page 2

parts, I modeled them with BLoftSurfs. Many of the other surfaces were built off these four initial surfaces. For example, I modeled the areas around the headlights and tail lights with Blisters made from snakes on the front and rear fenders, and I derived the edge of the scoop on the hood from magnets on the hood surface.

The convoluted exhaust? It's a SweepSurf and two more BLoftSurfs. The front tire lent itself to being made with a Revolution Surface, after which it was a simple matter to make a Relative Surface from this tire to create the rear one. BlendSurfs worked well for the bottoms and backs of the seats, while a RuledSurf did fine for the dashboard which was flat in this car. For the hub cap, I created one spoke as a BLoftSurf, then made the rest by copying the first one with Rotated Surfaces.

This project really exposed me to the power and versatility of MultiSurf. Indeed, there were times when I found it difficult to choose from the rich variety available just *which* surface to use -- experimentation was key to the process. Being a naval architect (not a car-designer) by training and only a relatively new MultiSurf-user, the project took several weeks to complete — the 59 surfaces are just part of the 1015 object total!

Happily done with the modeling challenge, I presented the Cobra (in bright red paint) and breathed a sigh of relief. "Far out!" they all exclaimed, and I smiled ... but then they pointed at the computer monitor before me and continued, "Now, see if you can model that!" So once again I am probing the depths of MultiSurf's capacities (and of my own ingenuity). □

Editor/Designer: Heidi Welch

Contributors: John Letcher, John Brown, Michael Shook, Reinhard Siegel, Edward Stanley, Heidi Welch

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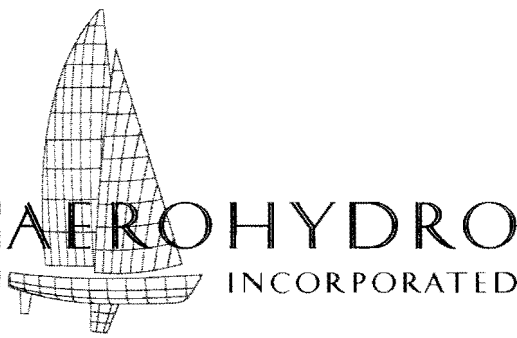
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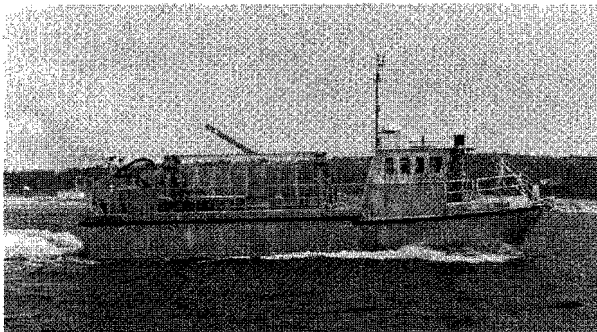
FAIRLINE® Marine Design Software / Consulting / Technical Services

## Design Under Pressure — the DIP 4500 Story

by Dick Akers

### A Short Fuse...

Sea tested and at the ready in Canadian waters is the DIP 4500, a new oil skimming catamaran designed with MultiSurf® by Bob Watkins and Steve Hudson, at the JBF Scientific Co. in Southwest Harbor, Maine. The major requirements of the contractor, Irving Oil Company of New Brunswick, were speed, seaworthiness, and an 1100 barrel/



hour capacity for cleanup. By the time the Irving Co. accepted the preliminary sketches and was ready to go ahead to the detailed design, they were almost *too* ready — they wanted

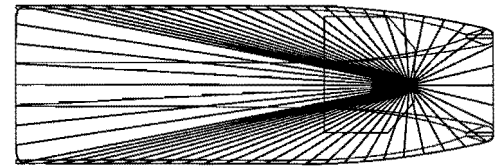
the boat by the end of the year, and this was in *November*. Although a finished boat was out of the question, Bob generated the surface design for this complex project and they ordered the aluminum within six weeks, thus allowing Irving to complete needed financial transactions before its year-end deadline.

The next hurdle was that the boat was to be assembled in Canada by STENPRO (Steel and Engine Products Ltd.), a company with limited boatbuilding experience. "Fortunately," comments Bob, "we had a great deal of control over the outcome because *we* N/C cut all the parts — the frames, the plates; everything. And we knew they would fit because of MultiSurf's accuracy."

### A Developable Cambered Deck

Among the design challenges Bob addressed was making the aft deck cambered, yet guaranteeing that it could be fabricated out of aluminum plate. His solution? A conical ruled surface. Bob used the sheer line (a PolyCurve) for one edge of the ruled

surface and a single point (the apex of the cone) for the other "edge." Voila! He carefully placed



the apex of the cone where it would be cut out of the deck surface by the pilothouse.

### A Planar Chine

The shape of a chine curve is important both hydrodynamically and aesthetically. One not-well-known trick to making a pretty chine is to make it lie in a plane. MultiSurf offers several ways to do this. Bob chose the projection method: create a fair spline curve in the centerplane, then project the curve onto the inclined plane of the chine.

### Beyond the Surface

As Bob finished each portion of the surface design (hull/deck, pilothouse ...), he passed the MultiSurf model to Steve who tackled the structural design, detailing, and N/C cutting setup. Under time pressure and already a well-versed user of DEVELOP/2, he chose to use it rather than the new MSDEV utility for trimming the ruled panels created with MultiSurf. For final detailing and dimensioning, Steve moved the model parts into Drafix®2D drafting and CAD software. Nesting and tool paths for the Burney plasma cutter were done in SmartCAM®.

### Concurrent Engineering

The rest of the success story was the time savings of concurrent engineering. "MultiSurf let us dramatically collapse the production time for this complex project by doing design and construction at the same time. While STENPRO was assembling the jig, we detailed and cut the frames; while they

Continued on page 4 — JBF

# Which Surface Do I Use?

by Dick Akers

MultiSurf offers so many surfaces — which one do I use? The cardinal rule of choosing a surface is “Choose the *simplest* entity that will do the job.”

As a first approximation try using the following question-and-answer list — just choose a surface from the list that corresponds to the first question for which you can answer “yes” (the most specialized surfaces are first because these have special characteristics to solve specific problems):

2nd, 3rd, ... blades of propeller

Q: Is the surface a mirror image of some other surface, a projection of a surface, or a rotation of a surface?

If yes: Use a MirrSurf (mirror surface), ProjSurf (projected surface) or RotatSurf (rotated surface) respectively.

Q: Can you make the surface by sliding one curve along another?

If yes: The simplest surface you can use is a TranSurf (translation surface). In this surface the moving curve stays parallel to its initial position.

Mast, spar, daggerboard

Pipes, tubes, ducts

If the moving curve is to stay perpendicular to the guide curve or to be variable in shape, use a SweepSurf (sweep surface).

Keel bulb is foil revolved around axis

Q: Do you think of the surface as being formed by rotating one curve around a centerline or axis?

If yes: You can use a RevSurf, a surface of revolution.

Aluminum, steel, or plywood construction

Q: Do you want to be able to build your surface out of a flat plate and to fabricate it by bending alone? That is, is your surface required to be *developable*?

If yes: Use a DevSurf, a developable surface.

Floor of deckhouse taken from deck

Q: Is the surface a piece of a larger surface?

If yes: We call this a SubSurf, a subsurface.

Wing, keel, rudder

Q: Are you making an airfoil or a hydrofoil?

If you are creating a stand-alone surface, use an FLoftSurf (foil-lofted surface).

If your surface will be attached to another surface, use one of the other lofted surfaces with FCurves (foil curves) for master curves.

Bow bulbs, sonar domes, bustles, skegs, keels, propeller bosses

Q: Do you need to connect one surface smoothly to another — such as a bustle to a hull, or a wing to an airplane?

If yes: Use a Fillet or Blister to make a smooth surface-to-surface connection.

Sides of deckhouse, surfaces of trapezoidal keel

Q: Do you need a simple, somewhat “flat” surface to span the distance between two curves smoothly?

If yes: A RuledSurf (ruled surface) probably will meet your needs. If you want to expand it into a flat plate you can use a DevSurf (developable surface) instead, but this takes more computer time to draw.

Sails, round-bottomed hulls

Q: Do you think of the surface as being the area inside three or four boundary curves?

If yes: Use a BlendSurf (blended surface). If you need more control over the middle of the surface, try adding a single control point in the middle with a BlendCtr (blended surface with center point).

Q: Do you want the surface to be freeform, but fixed to two edge curves (the sheer line and chine for example)?

Decks, chine hulls

If yes: There are several choices: you can use a RuledSurf (ruled surface), ALoфтSurf (arc-lofted surface), BLoфтSurf (B-spline lofted surface), or CLoфтSurf (C-spline lofted surface).

Hulls, rounded bows, general surfaces

We recommend a CLoфтSurf (C-spline lofted surface) running through BCurves for boat hulls. This is a good compromise between the flexibility of B-spline curves and the stiffness of cubic splines.

Lofted surfaces from measured points

Q: Do you need a surface to pass through a series of control points exactly?

If yes: Use a CLoфтSurf that is defined by CCurves (C-spline curves).

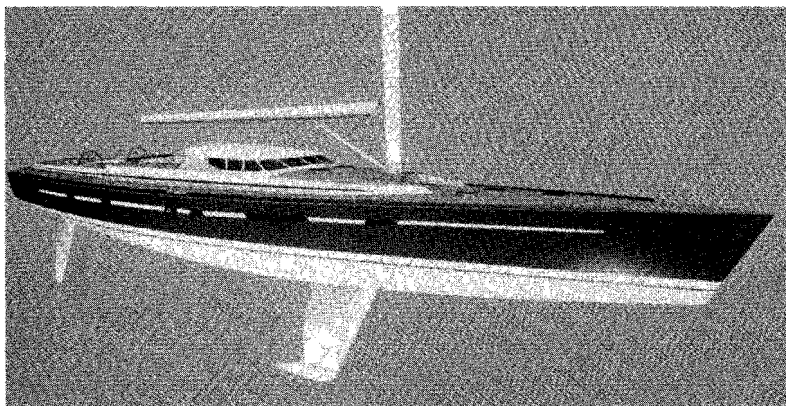
These are general guidelines. They don't guarantee that you'll determine the perfect surface type the first time, every time; but they will give you a good place to start. Experiment! — the richness of MultiSurf is at your fingertips. □



## NewCruise Yacht Design

by Reinhard Siegel

Wireframe models are good for designers, but not suitable for their customers. This quickly became apparent to Jens Cruse and Frank Neubelt when they established in 1989 the NewCruise yacht design office in Hamburg, Germany. Consequently, they rely heavily on in-house expert Jorn Erdmann to squeeze their computers to the utmost to present their designs in vivid, photo-realistic rendered pictures or even videos. It is worth the trouble. The design palette of NewCruise now spreads from a 7.5 m ULDB production racing sailboat to a 180-ft luxury schooner.



Preparing renderings takes its full measure of time because of the many details required to bring about the realistic impression. However, as Jens Cruse

states: "Such pictures are also of value for our design work. Recently, when modeling a 60-ft racer, the deck house looked too high in sideview; but when we made a rendering and walked around the boat, the breadth of the house on the deck became visible, and it did not appear bulky at all."

The basis for the renderings is surface meshes created in MultiSurf. When modeling the 88-ft fast cruiser (see picture), all surfaces — hull, deck, house, coamings, rudder, keel etc. — were created in MultiSurf. Soon after MultiSurf's first release, NewCruise put trusty FL/2B aside and started to learn the new surface modeler. Jens Cruse remembers: "At first, the amount of new objects was overwhelming — what is best used where? But after a while, we recognized that everything is necessary. The more complex a model to shape, the more tools you need."

Very welcome to the NewCruise designers is the DXF2MSF file conversion utility, now part of MultiSurf. While discussing a project amongst the designers or with the client, they typically work with freehand drawings or sketched changes on trial plots. For use in CAD, the sketches are scanned and vectorized. If the underlying MultiSurf model is touched by an alteration, a corresponding DXF file is translated by DXF2MSF to a temporary model, of which a 3DA wireframe is saved. This wireframe is added as a wireframe object to the model in question and used as a visual aid to change the model accordingly. □

## MultiSurf Version 1.6

Dr. John just can't keep his hands off MultiSurf. He always has a list of new ideas (his own or customer suggestions) to make it better. Version 1.6 includes:

**Graphs** — You can now use graphs to gain more control over the shape of several entities: Relative Curves and Snakes, Offset Curves, and Blended Surfaces. (Note: all existing objects of these entity types will still work — and still look the same.)

**New entity** — The Polar Relative Point is a second type of relative point, located by distance and direction (polar coordinates: latitude, longitude, radius) from the basis point, rather than coordinate offsets (dX, dY, dZ)

**New options in Save/ 3D** — The NBS option saves a file of the currently shown surfaces in the model approximated as B-spline surfaces, thus making it possible to export most MultiSurf models to CAD, CAM, or rendering programs that support NURBS surfaces.

The POV option saves a file of the currently shown surfaces in the model in the format required for the Persistence of Vision ray tracing/rendering program POV-Ray (freeware available from AHI).

**Save RUL enhancements** — The positions of visible snakes, magnets, rings, and contours are saved in the .RUL file and transferred by MSDEV to the flat development. These kinds of marks are useful for accurately lining up the plate with frames, bulkheads, or whatever other structures you have chosen to mark.

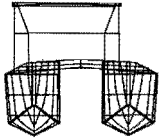
**New menu option** — Calcs/ Angles provides three calculations of angular measure:

- 2 Points gives Lat, Lon from *point1* to *point2*
- Line gives Lat, Lon of positive direction along *line*
- 3 Points gives the angle *point1-point2-point3*

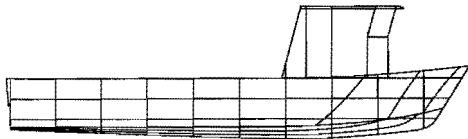
**Creating a Hull from Scratch** — In this appendix, we take you through the process of creating a hull model from an initial sketch and making refinements using MultiSurf's curvature profile, surface curvature, and ship lines tools. □

JBF — Continued from page 1

were assembling the frames, we detailed and cut the plates; while they were installing the plating, we detailed the propulsion, steering, electrical, and hydraulic systems. The more than 200 pieces fit like a kit!" declares Bob with satisfaction.



"On top of that," Steve adds, "the design process with MultiSurf makes it possible to build a boat rapidly and correctly the first time, even with fabricators who don't normally build boats. We can design a line of commercial vessels, cut the parts, and ship them anywhere in the world for assembly — this



capability is an exciting development in the commercial boatbuilding industry." And yet another win for MultiSurf! □

*Editor's note: Bob now runs his own company, Watkins Associates, specializing in design and in construction supervision of marine and non-marine products ranging from creation of a standard series of pre-cut "kit" tow-boats to production engineering for self-tracking solar arrays. You can contact Bob at 207-374-2218.*

## IGES comes to MultiSurf

MultiSurf now includes utilities for import and export of IGES type 128 (NURBS surface) entities. On import, an exact MultiSurf NURBSurf representation of any IGES type 128 entities in the input file is created along with the necessary supporting control points. On export, each MultiSurf surface is approximated by a NURBS surface using a least-squares fitting process. The NURBS representation is then output as an IGES type 128 entity.

IGES is an international standard for exchange of CAD data. While the AutoCAD .DXF file format is a *de facto* standard which may be more widely used, IGES supports more complete capabilities for the exchange of surface definitions. In particular, it is the only widely-accepted exchange format for NURBS surfaces and as such is widely used for the exchange of models between high-end 3D CAD/CAM systems. □

## Customer Support On-line

The advent of electronic mail, e-mail, has been a great asset in helping us improve our customer service — our customers can send us data for plotting or for help on a thorny design problem; we can send out updated or customized programs.

Lately, we have had several occasions where we were able to provide timely assistance on a design project with the instantaneous transmittal of MultiSurf model files back and forth via e-mail. With e-mail, the model file arrives in a form that can be immediately read into MultiSurf without any re-keying of information. We can then analyze the model and assist the customer in obtaining the desired configuration.

When we released our IGES output translator, we had a customer who needed it immediately to program an N/C milling machine. We transmitted the program enhancement to him in only a few minutes, at a cost less than US Priority Mail.

We are currently using the CompuServe network to receive e-mail. If you have a question for us about our software or a design problem you would like help with, please ping John Brown at 71551,2764 on CompuServe; from an Internet address use 71551.2764@compuserve.com. A further benefit of CompuServe membership is access to a wide variety of information about buying and using computer products. □

## Make a date in Europe

Come see the latest developments. AeroHydro's European sales representative Reinhard Siegel will be presenting MultiSurf and other FAIRLINE System marine design software at the following European exhibitions:

**Hanseboot 94** — International Boatshow, hall 10, stand no. 10015 B, Hamburg, Germany, 22 to 30 October 1994.

**METS 94** — Marine Equipment Trade Show, hall 9, stand no. D 992, Amsterdam, Netherlands, 15 to 17 November 1994. □

**Editor/Designer:** Heidi Welch

**Contributors:** John Letcher, Dick Akers, John Brown, Michael Shook, Reinhard Siegel, Heidi Welch

**AeroHydro, Inc.**

P.O. Box 684, Southwest Harbor, Maine 04679-0684 U.S.A.  
Phone 207-244-7347; FAX 207-244-7249

**European Representative:** Reinhard Siegel, Dipl.-Ing.

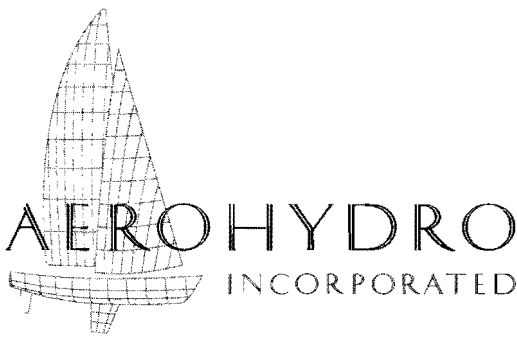
P.O. Box 60 2441, 22234 Hamburg, Germany  
Phone 49-40-511-7052; FAX 49-40-511-7053

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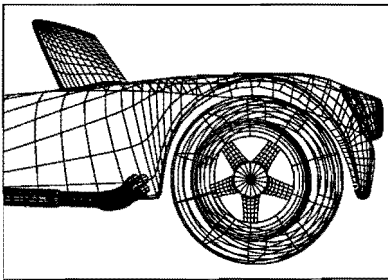


FAIRLINE® Marine Design Software / Consulting / Technical Services

Welcome to our design software catalog. Reflecting our expansion beyond marine-specific software, we've organized the program listing into two groups: the first, General 3-D Surface Design, and the second, Marine Design and Analysis.

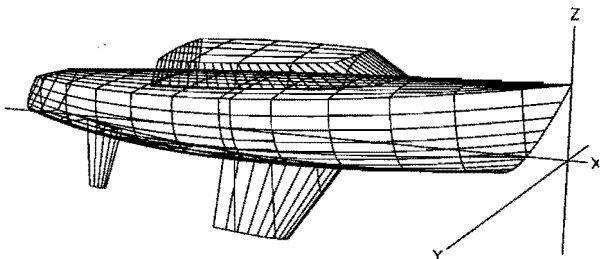
## General 3-D Surface Design

**MultiSurf®** — Rich and versatile system for parametric design of 3D geometric objects, particularly complex objects involving free-form curves and surfaces.



Build up models from points to curves to surfaces, with durable qualitative geometric relationships between them — when underlying objects are altered, the program automatically updates entire model.

Mix a wide variety of surface types in a single model. Create accurate and durable joins between surfaces. Use curvature profile and surface curvatures displays to refine curve and surface shapes. Scale model in any/all coordinate directions.

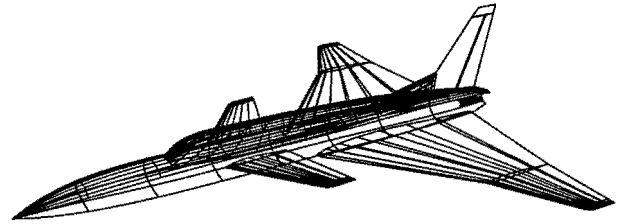


Display model in 3D and 2D, as wireframe or as panels, from any viewpoint. Show or hide any part of model.

Output DXF drawing files, IGES NURBS surface files, POV-Ray rendering files, .PAT mesh files, OFE-compatible offset files, ruling files for input to MSDEV utility. Import DXF, IGES, FL/2B, Autoshop, MacSurf, and FastYacht files.

Calculate absolute coordinates, clearance, distance of points, angles, upright hydrostatics, surface curvatures.

Control by mouse (primarily) and keyboard. Requires mouse and VGA graphics.



In many cases, MultiSurf will be the only AeroHydro program you need. Here are some cases in which you might want additional programs we offer:

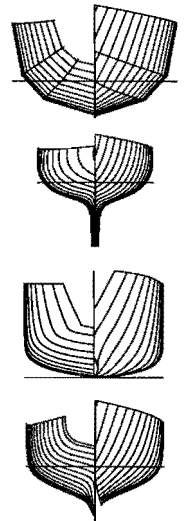
- Developable plate expansion — MSDEV
- Balancing, or cycling through hydrostatic cases — HYDRO/1
- Sailboat performance analysis — AHVPP/1

**MSDEV** — Develop surfaces for MultiSurf. MSDEV module reads in panel ruling files made by MultiSurf and outputs DXF and/or text files of the developed shapes of the panels. Panels are marked with snakes, magnets, rings, and contours visible in the MultiSurf model file from which the ruling files were made. Equal bend lines option. Other outputs: panel area, 3D center of gravity, and weights.

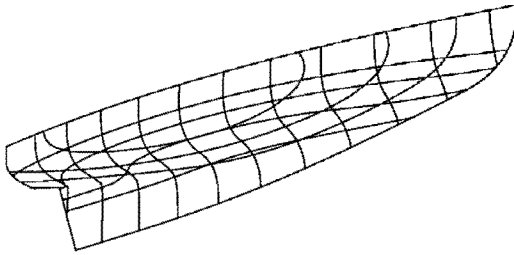
## Marine Design and Analysis

**FL/2B** — Interactive surface design program, especially adapted to creation of fair hulls. Generates a complete, mathematically precise and fair surface from a small set (2-10) of user-controlled "Master Curves."

Capabilities include: offsets along any plane section; OFE-compatible offset files; fitting a pre-defined curve; upright hydrostatics; calculation of surface curvatures, true skin deduction, clearance; ruling generation; stretching or shrinking hull in any or all coordinate directions;



color screen display of component curves, lines plans, and perspective views.



Powerful Rep development tools allow detailed visual and numerical refinement of curves.

Unlike MultiSurf, FL/2B handles only one surface at a time (and it works with only one surface type).

If you will be creating offset files, you can use the Offset File Editor utility MERGE to put two or more FL/2B surfaces into OFE/4.

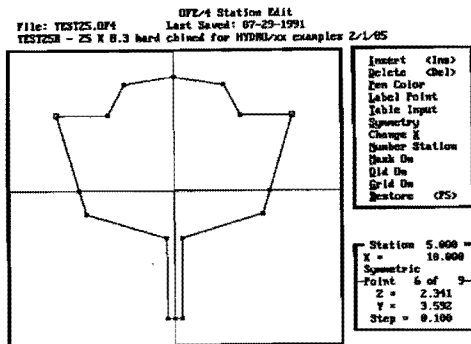
If you want balancing, or cycling through hydrostatic cases, you will need HYDRO/1.

**OFE/4** — Offset File Editor for entering, editing, and disk storage of an offset table in standard format needed for input into HYDRO/x and AHVPP/1. Also used for adding appendages and deck contours to a FAIRLINE hull. (Not a surface fairing program.)

Includes scaling factors, waterline adjustment, and interpolation/extrapolation for inserting new stations. Graphic

display of offsets (body plan, profile, plan, 3D) allows visual check of data. Ability to save 2D files for CAD.

OFE/4 has a graphics-based user interface and capabilities to create



(Tab) switches windows, < > select, arrows move, (F10) accepts

asymmetrical stations, to run in any units, to associate pen color and label with points. Includes several custom utilities:

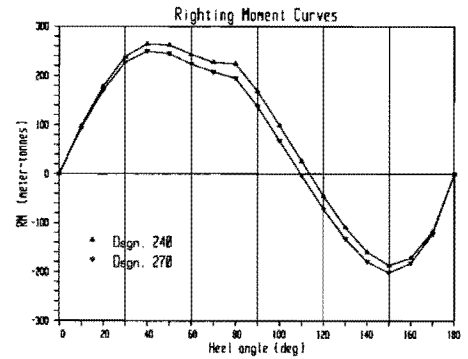
**MERGE** — merges two Offset Files (such as a hull file and a keel file) into one file

**ORCCON** — converts .OFE files to .OFF for input into the USYRU 1993 LPP/VPP programs

**MONO2CAT** — automatically converts single hulls into catamarans

**HYDRO/x** — Hydrostatics and Stability. Screen display of boat's attitude and of summary graphs. Option to save to disk and/or print all results. Quick escape from any calculation.

**/1** — Calculates section areas, girths, displaced volume, center of buoyancy, waterplane area, center of flotation, wetted surface, and righting moments for any symmetrical vessel (described by an AeroHydro .OFE Offset File) at arbitrary loadings and heel angles.

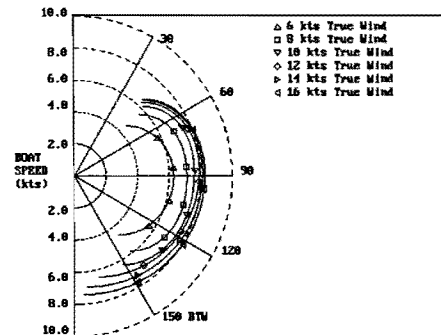


Automatic balancing algorithm brings the model into a position of hydrostatic equilibrium under specified conditions of heel and loading. Trim can be allowed to equilibrate automatically or can be held fixed. Option to view attitude of boat.

Includes automatic cycling through cases of heel or rise, generating the data needed to plot stability curves and curves of form. Bonjean curves and dynamic stability included.

**/2** — Adds floodable length and damaged stability calculations: the effects of flooding any combination of transverse, half-breadth or full-breadth compartments with specified permeabilities. Includes ability to save data setup files and to shell to MS-DOS.

**AHVPP/1** — Velocity Prediction Program for sailing yachts. Incorporates lines processing utilities. Performance prediction module accepts input of up to 10 wind speeds and 10 headings.



Reports include: heel angle, velocity made good, apparent wind angle and velocity, optimum upwind and downwind performance, velocity polar diagram.

Race model comparison module calculates win/loss probabilities between boats or differences in seconds/nautical mile for up to 10 boats.

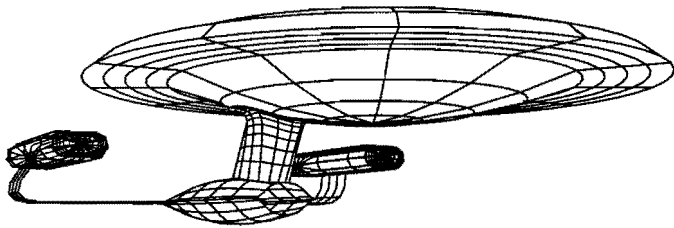
## General Software Information

**Units** — Programs can be used with either English or metric units.

**Further information** — More detailed information about AeroHydro software, showing program features and sample output, is available free on request. A demo disk and user manual are available for most programs; the price is applicable to the license fee.

**Upgrades** — When programs are upgraded, licensed users are notified and are entitled to full credit toward the upgrade price.

**Customized software** — If you have a specialized need, we would be glad to discuss the feasibility of adapting an existing program or of developing a new method to meet your needs. Please contact us for details.



## Hardware Compatibility

**Program requirements** — Our programs run on the full range of IBM-PC's: PC, XT, AT, PS/2, and all compatibles, to the best of our knowledge. Programs require 640K RAM, 2 disk drives, and a VGA graphics adapter.

**Printing/plotting** — Any printer should work adequately for text output. We do not recommend using a dot matrix printer for dumping a graphics screen — scaling and aspect ratio often are inaccurate. Various 2D CAD packages do make good quality drawings on a dot matrix printer, and they support a wide variety of pen plotters.

**Digitizing** — OFE/4 can read any digitizer run by an ADI driver.

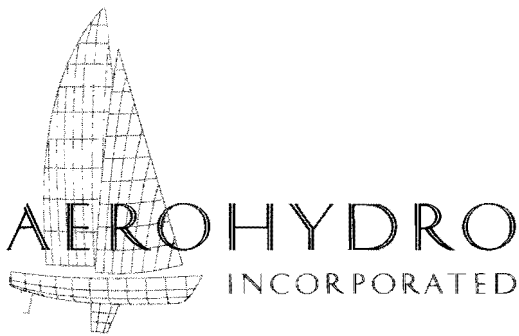
**Recommendations** — As with most current engineering software, the use of a math coprocessor, hard disk drive, and higher resolution color graphics is becoming the expected norm. A math coprocessor makes a marked improvement in computational speed, a hard disk facilitates handling large program and data files, and VGA color graphics really improve visualization. It is likely that future AeroHydro program releases will require these hardware standards.

## Price List

Program	Current Version	Date	License Fee	Demo Disk & Manual
MULTISURF	1.62	8/26/94	\$1975	\$90
MSDEV	1.23	7/27/94	\$500	
HYDRO/1	3.03	3/17/94	\$795	
HYDRO/2	3.03	3/17/94	\$1295	\$50
OFE/4	4.30	3/17/94	\$299	\$25
AHVPP/1	1.23	12/9/93	\$975	\$50
FL/2B	2.85	6/13/91	\$849	\$75

Please be aware that availability and fees are subject to change without notice.

*only developable surfaces* →



# Software License Agreement and Order Form

September 1994

FAIRLINE® Marine Design Software / Consulting / Technical Services

In purchasing from AeroHydro Inc., hereinafter called the Vendor, the use of the below-circled computer programs:

**MULTISURF**

**OFE/4**

**HYDRO/1**

**FL/2B**

**MSDEV**

**AHVPP/1**

**HYDRO/2**

the undersigned Licensee agrees as follows:

1. The programs remain the exclusive property of the Vendor; the Licensee receives only a royalty-free license to use the programs in object code form on a single computer system.
2. The Licensee receives the executable programs as a service and not as merchantable goods.
3. The Licensee will not, without prior written approval from the Vendor:
  - (a) make or authorize any copies of the programs or manuals,
  - (b) make any modifications or enhancements of the programs,
  - (c) merge the programs into any other program,
  - (d) sublicense, rent, assign or transfer this license, any rights under this license or the programs to anyone else,
  - (e) adapt, translate, reverse engineer, decompile or create any derivative works based on the programs, or
  - (f) use the programs in any other manner except as expressly authorized by this license.
4. The Vendor shall have no liability to the Licensee or to any other person or entity with respect to loss or damage caused or alleged to be caused by the use of these programs, including but not limited to interruption of service, loss of business or anticipatory profits, or consequential damages.
5. The Vendor warrants that the programs will be in good working order when delivered to the Licensee and will, for a period of ninety (90) days after delivery to the Licensee, work in a satisfactory manner when properly used by the Licensee. In the event, through no fault of the Licensee, the programs fail to work to the Vendor's specifications during the ninety (90) day period, the Vendor shall correct or replace the software within thirty (30) days after receiving notice from the Licensee of the failure. Except as otherwise provided in this paragraph, the Vendor **MAKES NO OTHER WARRANTIES, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**
6. It is a condition of this license that neither the programs licensed nor the license itself shall be re-exported or transferred to any person, business, firm, government, government agency, armed force or treaty organization.

Signed \_\_\_\_\_ Date \_\_\_\_\_

Print Name \_\_\_\_\_ Title \_\_\_\_\_

Organization Name \_\_\_\_\_ Telephone \_\_\_\_\_

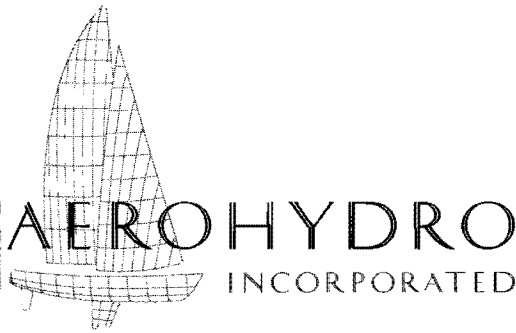
Address \_\_\_\_\_ Computer \_\_\_\_\_

\_\_\_\_\_ Math Coprocessor Y / N

\_\_\_\_\_ Plotter \_\_\_\_\_

Disk 5.25": 360K 1.2M 3.5": 720K 1.4M Digitizer \_\_\_\_\_





FAIRLINE® Marine Design Software / Consulting / Technical Services

# MultiSurf® for Windows™

## FAIRLINE® SYSTEM RGS SURFACE DESIGN PROGRAM

*In its transition from DOS to Windows, MultiSurf — already the premier surface modeling and marine design program for PC's — has gained tremendous new speed, power, and features.*

### Speed!

Models load and update up to *20 times* faster than in MultiSurf for DOS. See chart on page 2 for some hard — and hard-to-beat — figures.

### High-resolution graphics!

Through Windows, essentially all high-resolution video boards and monitors are automatically supported.

### Rendering!

Smooth shaded, lighted rendering with hidden surface removal is available — it's fast, too. Or you can export files to POV-Ray® or 3D Studio®, for photo-realistic rendering.

### Multiple views!

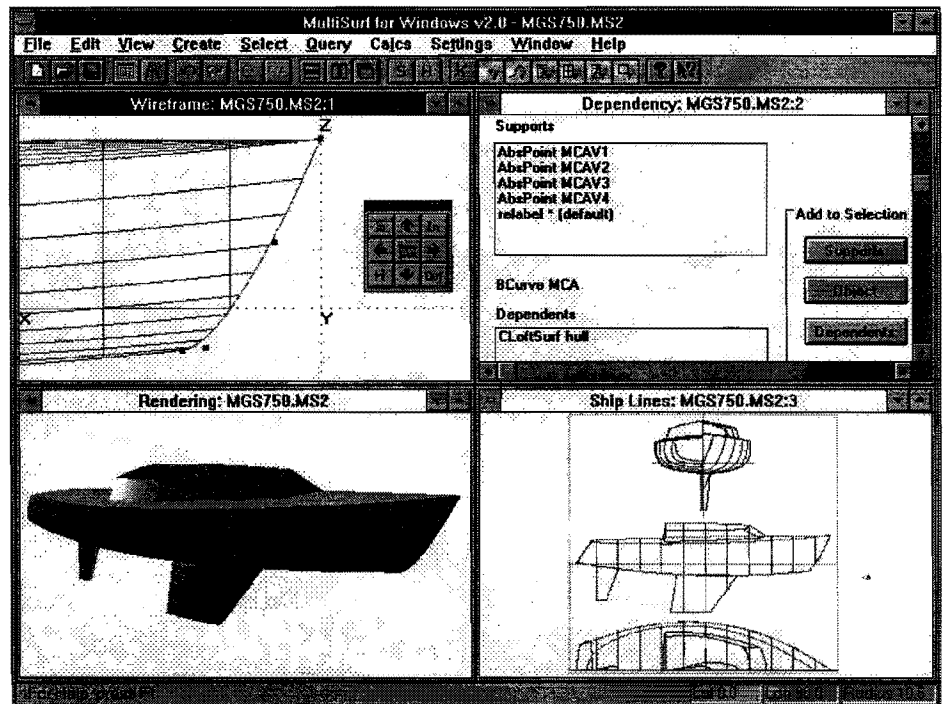
Windows allows many views of the model to be open simultaneously: wireframe and rendered views as well as text windows displaying model data, mass properties, weights, hydrostatics. Views are tied together so a change in one view automatically updates the others.

### Multiple models!

You can load two or more models simultaneously for comparison, to copy portions of one model into another, or just work concurrently on them.

### Unlimited model size!

The 1000-object limit of DOS MultiSurf is history. Model



size is now limited only by the size of memory and disk space, and your imagination. We have loaded models with over 6000 objects, with room for lots more.

### Built-in weight schedule!

In MultiSurf for Windows, all objects have an optional weight attribute. A weight schedule is maintained, giving the total weight, center of gravity, and moments of inertia for your model. This file is displayed on request, and is automatically updated as the model changes.

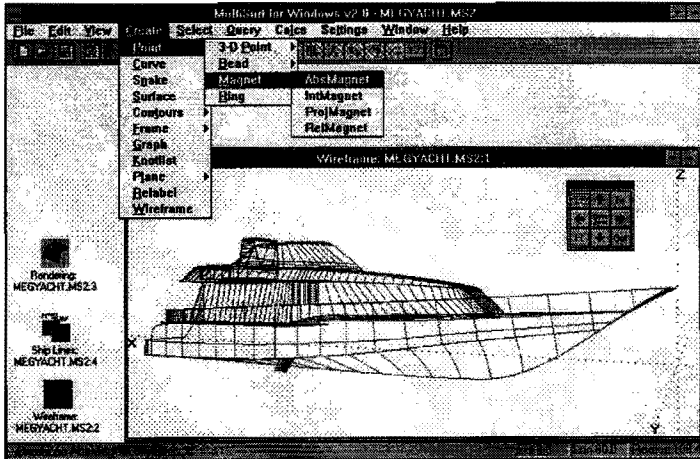
fired Windows 7-  
B-release

swap file - in windows program

DOS 138621  
working on Windows manual

### Simplified editing and selection!

The selection set simplifies and standardizes the way you interact with your model. You can select single objects or sets of objects for display, dragging, editing, deletion, interrogation, or file export. Objects can be added to the selection set by picking on the screen or by name from lists.



### Customizable toolbar and floating palette!

You can build your own toolbar and palette, selecting from over 45 icons which invoke your most commonly used menu selections.

### 10 levels of Undo/Redo!

Step forward or backward through your last 10 edits, precisely restoring the model to its previous state. MultiSurf's fast operation makes these steps quick and painless. In the event of a power outage, your latest version will be safe and sound on the hard disk.

### Standard Windows interface!

Windows users will feel immediately at home, already knowing how to operate the menus, dialogs, file handling and Windows management, as MultiSurf adheres strictly to standard Windows user interface conventions.

### Multitasking!

Of course, the Windows environment allows MultiSurf to operate simultaneously with other Windows-compatible applications and to switch instantly between them.

### Context sensitive help, with figures!

Wherever you are in the program, <F1> will get you a pertinent, context-specific help screen from the over 300 pages of on-line documentation, with more than 200 figures.

### History spans multiple sessions!

A History file associated with each model logs all edits and file operations performed on it. This file is preserved from session to session.

### Attach user data to objects!

User data can be attached to any object; for example, part numbers, material, finish, or notes about the purpose and role of the object.

### Plus it does everything MultiSurf for DOS did!

MultiSurf for Windows has all the capabilities of the DOS program, including the ability to:

- export 2D and 3D DXF drawing files for most CAD programs, including AutoCAD®, Generic CADD® and Visual CADD™
- import most DXF curve and surface entities *required*
- import and export IGES NURBS surfaces
- save offset files (.OFE) compatible with OFE/4, HYDRO/x, ORCCON, and AHVPP/x
- save ruling files (.RUL) compatible with MSDEV
- query the curvature distributions of curves and surfaces
- calculate areas, centroids, and moments of inertia of curve and surface objects

### Hardware requirements

386 or higher; *built in with Pentium* math coprocessor; *get 16* 8 MB RAM; WIN 3.1, 3.11, or Windows for Workgroups 3.11, *256 color display* *Super VGA*

### Speed! — Comparison Table and Machine Specifications

Model	# of objects	Time to open and display model			
		#1 DOS	#1 Windows	#2 Windows	#3 Windows
COBRA	1020	3:56.2	0:11.5	0:08.7	0:04.6
MONITOR	612	1:46.5	0:08.1	0:06.5	0:03.5
MEGYACHT	538	1:05.1	0:06.8	0:05.5	0:03.4
HX321	310	0:45.3	0:04.5	0:03.5	0:02.5
DEMO	19	0:01.5	0:00.4	0:00.3	0:00.3

Machine #1 is a 486 DX-50 with 8 megabytes of RAM and a 20 MB permanent swap file under Windows. It is running MS-DOS 5.00 and Windows for Workgroups 3.11 with 32-bit disk and file access disabled. It has a 2 MB SmartDrive cache. It is not running any memory manager.

Machine #2 is a 486 DX4-100 with 16 megabytes of RAM and a 53 MB temporary swap file. Machine #3 is a Gateway Pentium P5-90 with 16 megabytes of RAM and a 20 MB temporary swap file. Both Machines #2 and #3 are running DOS 6.22 and Windows for Workgroups 3.11 with 32-bit disk and file access disabled. They have a 4 MB SmartDrive cache, and are running EMM386.

MultiSurf and FAIRLINE are registered trademarks of AeroHydro, Inc. All other product or brand names are trademarks or registered trademarks of their respective companies or organizations.

### AeroHydro, Inc.

P.O. Box 684, Southwest Harbor, Maine 04679-0684 U.S.A.  
Phone 207-244-7347 FAX 207-244-7249

100% recycled paper



# MultiSurf® 1.3

## A NEW APPROACH TO DESIGNING WITH 3D SURFACES

by Bill Wendel

# REVIEW

AEROHYDRO, INC.  
**MultiSurf v1.3**

**Pros:** Comprehensive system for surface design.

**Cons:** Repeated delays due to autoregeneration. **Address:** P.O. Box 684, Main Street, Southwest Harbor, ME 04679 **Phone:** (207) 244-7347, **fax** (207) 244-7249 **List price:** \$1,975



A propeller modeled in MultiSurf and rendered with IRISView on a Silicon Graphics Personal Iris.

Finally, someone has developed a truly versatile program for designing objects composed of 3D surfaces. MultiSurf from AeroHydro is a whole new approach to this type of design. MultiSurf is based on a building-block philosophy, whereby each object is defined in relation to one or more other objects in the model. Changing an object automatically updates any objects that are related to it. They in turn trigger an update of other objects, and this process continues until all dependencies have been satisfied.

This is a fully hierarchical, or associative, system. The drawback of this system is that every change you make involves a complete regeneration of the entire model. For a large project the regeneration can be somewhat distracting and, cumulatively, time-consuming. On the other hand, MultiSurf seems every bit as fast as AutoCAD, if not faster, and MultiSurf's modeling features go way beyond what I have seen in AutoCAD or other PC software. Regeneration of surfaces and contours is simply a computation-intensive task.

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*"Finally, someone has developed a truly versatile program for designing objects composed of 3D surfaces."*

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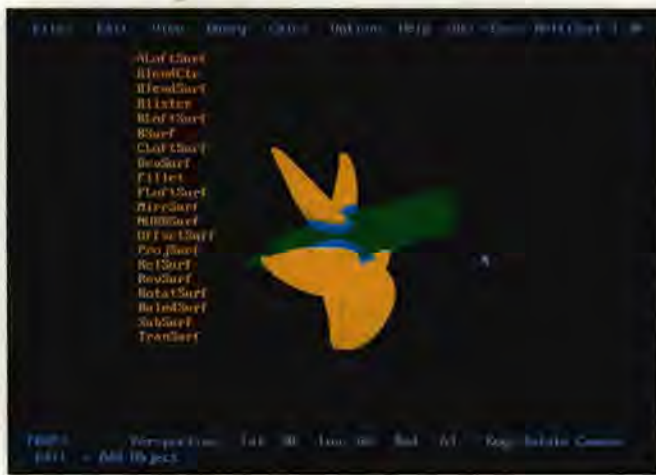
### MultiSurf terminology

MultiSurf is a new world in itself. First, MultiSurf introduces some new terminology. The principle entity classes are Points, Beads, Magnets, Rings, Curves, Surfaces, Snakes, Contours, and Planes. If some of these sound a bit foreign, the names are quite descriptive of their respective functions. Every object has a name. MultiSurf assigns a default name comprised of the entity type and a sequence number, but you

can assign any name and change the name later if you want. You can define objects as being located at specific coordinates or relative to other objects. Cartesian and polar coordinates are both supported. You can also define objects as copies, transformations, projections, or mirrored images of other objects.

There are, in turn, several entities in each class. The Point entity is the fundamental building block. A B-spline curve, for instance, is defined by a list of points. This is somewhat analogous to a polyline in AutoCAD, but in MultiSurf you retain direct access to each point definition. You can place an object relative to another object by definition. The simplest example of this type of object definition is a *relative point*, or one point given relative to another. If you move the first point, the relative point moves as well. Another example is a *relative surface*. Suppose you are making a golf cart. You want to maintain a minimum clearance between the roof and the floorboards. If you raise the floorboards higher above the ground, you want the roof to be raised with it; so you define the roof as a relative surface associated with the floorboards.





**A propeller, shaft, and hub designed with MultiSurf. You can change the number of blades, the pitch angle, the width or skew of the blades, the foil section, and the size of the hub by making only minor changes to the model file.**

There are 13 types of curves (or more—the list is growing), the simplest of which is a Line. The other curve types are Arc, PolyCurve, Bcurve, Ccurve, NURBcurve, Conic, Helix, Foil Curve, MirrCurve, ProjCurve, RelCurve, and SubCurve.

MultiSurf provides 19 types of surfaces, including NURB (nonuniform rational B-spline) surfaces, surfaces of revolution, and ruled surfaces. A number of surfaces are derived from other surfaces: Mirrored Surface, Offset Surface, Projected Surface, SubSurface, and Relative Surface. Some interesting new types of surfaces are Blister, Swept, and Fillet. A Swept Surface is like a curved extrusion. An example of a Swept Surface is the gutter and rim of a free-form swimming pool. You simply define the cross-section shape and specify a path for it to follow, which in this case is the edge of the pool. A Blister has edges that are constrained to lie on another surface, but which otherwise you can shape as desired. You can design a jet aircraft canopy by using a Blister attached to the fuselage. A Fillet joins two surfaces with a softened, or filleted, intersection.

To facilitate the precise attachment of various objects to surfaces, AeroHydro invented the Magnet and the Snake. The Magnet is a special type of point that is associated with a surface object and always stays on that surface. Similarly, a Snake is a curve that remains on the surface. You can define the outline of the hood of a car using a Snake on an otherwise smooth body. If you change the car body, the hood outline is automatically adjusted to fit. You can also use a Snake to define the root of an airplane wing where it attaches to the fuselage. There are eleven Snake entities, mostly analogous to the various types of curves. Additionally, there are Rings and Beads. A Bead is a point that is attached to a curve. Its location is given relative to the start and the end of the curve. A Ring is similar, except it is attached to a Snake.

This new terminology may be confusing

at first, but it doesn't take long to assimilate it. MultiSurf comes with a step-by-step tutorial that guides you through the development of a simple project and teaches you about the different entities and techniques for using them.

#### Using MultiSurf

How do you use MultiSurf to do a real project? Suppose you are designing an access door for an aircraft. You begin by placing one absolute Magnet and several relative Magnets on the fuselage to define the corners of the door. Then you use the Magnets to define a PolySnake which constitutes the outline of the door in the fuselage. If there is a small gap between the door and its associated fuselage cutout, then you use a Relative Snake to specify the shape of the cutout relative to the door outline. Once this is done, you can change the fuselage and the door



**Cobra sports car modeled in MultiSurf by Ed Stanley. 88 surfaces; 830 objects.**

and cutout automatically conform to its new shape. Or you can widen the door, and the cutout adjusts itself to suit. Finally, you can further develop the door by using the outline and a cross section of the seal and a Swept Surface. You can define the inside skin of the door using an Offset Surf. Now, the most likely scenario for design change: You need to move the door aft 3' to make more room for a navigation station or additional passenger seat. Simply move the Absolute Magnet,

and MultiSurf updates the entire door.

The entire MultiSurf model is defined by an easy-to-understand, concise ASCII file. MultiSurf contains an editor so that you can manipulate the Model file directly during an editing session and see the results immediately. You can alternate back and forth between the text and graphical interfaces. A well-written on-line help system is also provided. The ASCII file format is considerably more concise and understandable than an AutoCAD DXF file. This makes MultiSurf an ideal platform for developing parametric applications that generate a MultiSurf model file as their output.

MultiSurf is a DOS-based program but runs under Windows in the DOS shell. It has a graphical user interface and supports a mouse. MultiSurf exports 2D and 3D AutoCAD DXF files. It conforms to the right-hand rule, so its models render easily in programs such as Autodesk's 3D Studio.

#### *A surface for every reason (and the list is growing):*

- |                    |                    |
|--------------------|--------------------|
| <i>Arc-lofted</i>  | <i>Offset</i>      |
| <i>Blended</i>     | <i>Projected</i>   |
| <i>Blister</i>     | <i>Relative</i>    |
| <i>B-lofted</i>    | <i>Revolution</i>  |
| <i>C-lofted</i>    | <i>Rotated</i>     |
| <i>Developable</i> | <i>Ruled</i>       |
| <i>Fillet</i>      | <i>Sub</i>         |
| <i>Foil-lofted</i> | <i>Swept</i>       |
| <i>Mirror</i>      | <i>Translation</i> |
| <i>NURBS</i>       | <i>X-lofted</i>    |

MultiSurf offers a new approach to modeling objects composed of 3D surfaces, and its building-block method and object orientation facilitate the process of changing a model. Highly Recommended. □

*Bill Wendel is a naval architect and president of Wendel and Associates in Bellingham, Washington.*



FAIRLINE® Marine Design Software / Consulting / Technical Services

# MultiSurf version 1.6

## FAIRLINE® SYSTEM RGS SURFACE MODELING PROGRAM

**Relational Geometric Synthesis (RGS)** is a new object-oriented framework for 3-D computer-aided geometric design, developed by AeroHydro in 1991-1992 (U.S. patent pending). This advance in structure offers dramatic advantages over conventional 3-D CAD.

**MultiSurf** is a powerful interactive PC program implementing RGS for the creation and viewing of complex models consisting of points, curves, and surfaces.

### Relational Geometric Synthesis

Relational Geometric Synthesis allows you to:

- create and manipulate geometric models composed of multiple surfaces
- utilize many different curve and surface types interchangeably in the construction of models
- create surfaces that join accurately and durably along common edges or along the intersection of two surfaces
- preserve many qualitative and quantitative relationships between the various objects in a model, enabling automatic update of the entire model following changes in underlying objects

RGS provides a new logical structure for 3-D design that is easy to learn, easy to understand, and easy to remember.

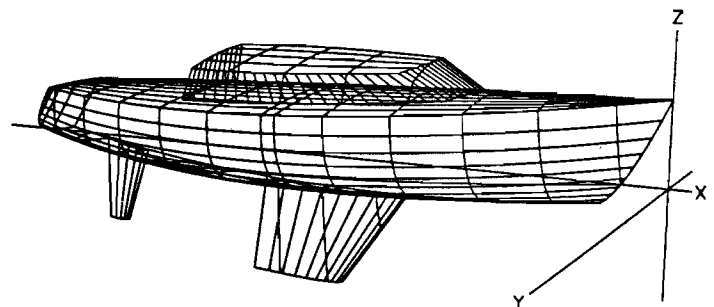
The MultiSurf model at right is made from nine connected surfaces, representing three different surface types. 'hull' and 'deck' are each C-lofted surfaces with B-spline master curves. The three cabin side surfaces are ruled surfaces constructed between a series of three snakes on 'deck' and three relative curves based on the snakes. The cabin top is a blended surface based on its four edge curves. 'keel' and 'rudder' are ruled surfaces built off B-spline snakes on 'hull'. All joins between surfaces are fully accurate and durable.

Every object in a model — point, curve, or surface — has a unique *object name* that you assign when you create the object. You use the name to identify the object, to interrogate its properties, and particularly to utilize the object in creating other objects.

RGS provides a rich set of related object types called *entities*. These are the raw materials of your design work. You build objects by filling in the blanks in an entity specification. For many of the blanks, you name other objects of an appropriate type. You build most curves by naming two or more points, most surfaces by naming two or more curves. RGS tools also include:

- *beads* — points constrained to lie on a curve
- *magnets* — points constrained to lie on a surface
- *snakes* — curves constrained to lie on a surface
- *rings* — points constrained to lie on a snake
- a set of *relative* objects defined by offsets from another object of the same type:

relative point  
relative bead  
relative magnet  
relative ring  
relative curve  
relative snake  
relative surface





The support/dependency relationships that are captured by the use of object names are the key to RGS's most innovative feature — the automatic update of the model following changes in underlying objects. This capability adds remarkable freedom to design work, transforming it from a linear process in which many elements must be frozen in non-optimal states into a fluid, multi-dimensional process allowing optimization of the total design.

## MultiSurf Program Features

MultiSurf supports more than 70 RGS entities.

Point entities include:

Absolute and Relative Points	
Absolute and Relative Beads	
Absolute and Relative Magnets	
Absolute and Relative Rings	
Projected Points	Mirror Point
Rotated Point	Offset Point
Intersection Points	Frame Points

Curve entities include:

Line	Arc
Conic Sections	Helix
B-spline Curve	C-spline Curve
NACA Foils	NURB Curve
SubCurve	PolyCurve
Relative Curve	Projected Curve

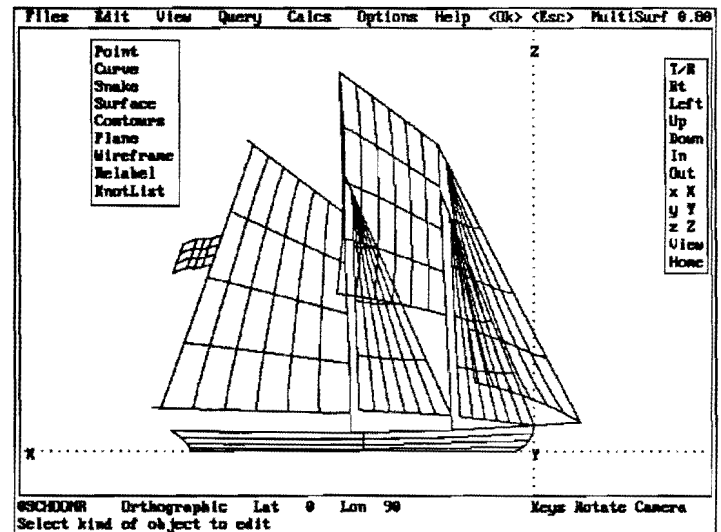
Surface entities include:

Revolution Surface	Translation Surface
Ruled Surface	Developable Surface
B-lofted Surface	C-lofted Surface
Foil-lofted Surface	Arc-lofted Surface
Blended (Coons) Surface	NURB Surface
Relative Surface	Offset Surface
Blister	Fillet

MultiSurf provides a highly interactive, highly visual user environment, in which you can:

- create, load, and save model files of up to 1024 objects
- view models as wireframes or solids with free 3-D rotate, pan, and zoom
- view ship lines — orthographic body, plan, and profile views showing arbitrary plane sections through all surfaces; your selection of lines is stored in the model file
- save offset files (.OFE) compatible with OFE/x, HYDRO/x, ORCCON, and AHVPP/x
- save ruling files (.RUL) compatible with MSDEV
- save 2-D and 3-D drawing files for most CAD programs, including AutoCAD®
- import most DXF curve and surface entities via DXF2MSF

- create and edit objects using either dialog and list boxes or a text editor
- edit your model by clicking and dragging points, beads, magnets, and rings
- scale, translate, and rotate your complete model with respect to any of the three coordinate axes
- calculate areas, centroids, and moments of inertia of curve and surface objects
- display and trace support/dependency relationships between objects
- undo the last edit/create operation
- review and save the history of changes made and of files saved during your MultiSurf session
- select sets of objects to be displayed or hidden
- query the identity (entity type and object name) of any visible object
- display object names for objects of selected classes
- query the orientation of curves and surfaces
- query the curvature distributions of curves and surfaces
- access indexed on-line help system with a single mouse click or a single keystroke

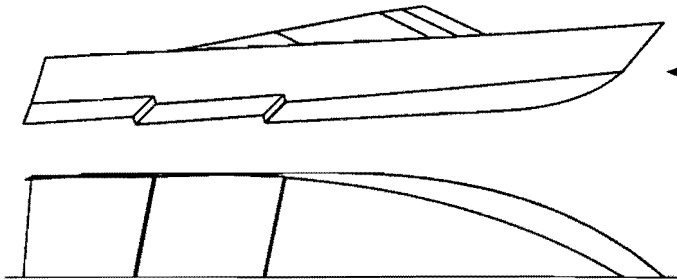
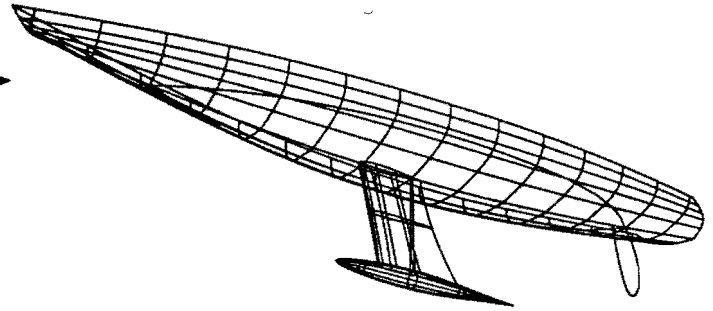


MultiSurf is operated primarily by mouse, using pull-down menus, dialog boxes, list boxes and screen buttons. The top line of the screen holds the top-level menus and the most frequently used buttons. The next-to-bottom line is a status line, telling the file currently loaded, the viewpoint, and the current cursor-key action. The bottom line is a message line, now reporting the last menu action selected. This schooner model uses line objects for 'main mast' and 'fore mast'. The other spars and stays are all line objects, durably connected to the masts by use of beads. The sails are all blended surfaces.



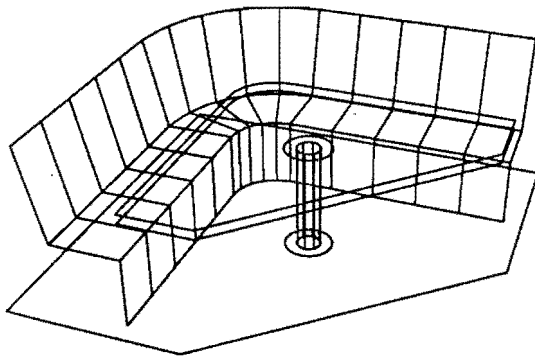
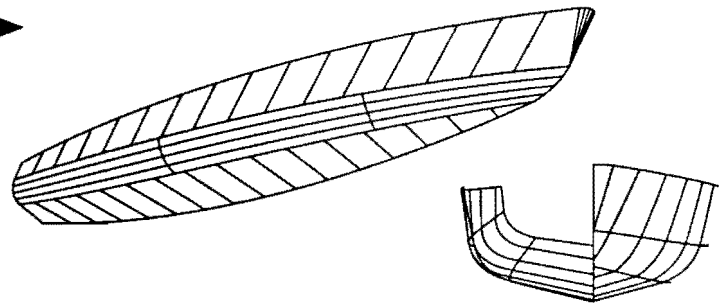
## Examples

(A) This MultiSurf model (54 objects) is a bulb keel racing yacht design. 'hull' is a B-lofted surface with five B-spline master curves. 'bulb' is a revolution surface using a NACA low-drag airfoil section for its meridian. 'keel' is a C-lofted surface whose end master curves are foil snakes on 'hull' and 'bulb'. The joins between 'keel' and 'hull' and 'bulb' are accurate and durable.



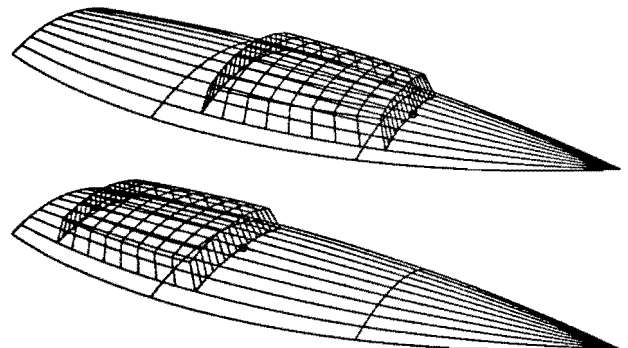
(B) This stepped-bottom planing powerboat (62 objects) uses two surface types. 'topside' is a C-lofted surface with four B-spline master curves (not visible). The stepped 'chine' is a polysnake on 'topside'. 'keel' is a polycurve. The whole bottom, including the steps, is a single ruled surface between 'chine' and 'keel'. 'deck' and 'windshield' also are ruled surfaces.

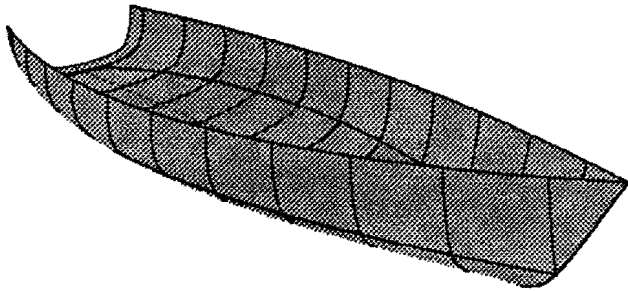
(C) This round-chine or radius-chine sailboat hull (42 objects) mixes developable and non-developable surfaces. The principal framework is four longitudinal C-spline curves. 'topside' and 'bottom' are developable surfaces (rulings are shown). The 'bow-cone' is a ruled surface which is developable by virtue of being a cone. All compound curvature occurs in the narrow chine strake, which is a C-lofted surface with four B-spline master curves.



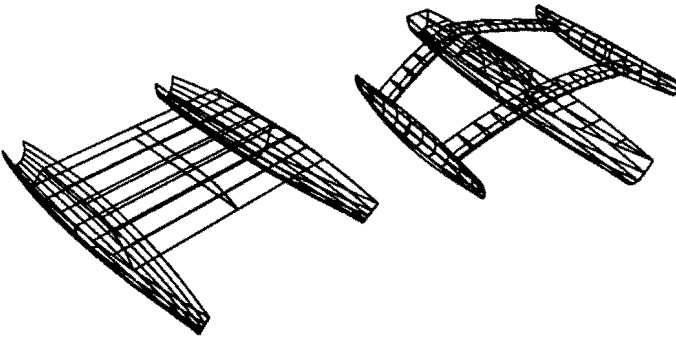
(D) MultiSurf can be used to design interiors. This settee (65 objects) is constructed from ruled surfaces based on two polycurves and two relative curves. The table surface is a rectangular translation surface (invisible); the visible outlines are a polysnake made up of a series of arc and line snakes, and a relative curve based on the polysnake.

(E) This pair of models (34 objects each) demonstrates the great flexibility RGS permits in modifying a design. The second model was derived from the first model by moving a single magnet, which locates the forward end of the cabin, from (0, .3) to (0, .6). The connections of the cabin to the deck and of the four cabin surfaces to one another are preserved automatically during the model update, since they are qualitative relationships captured in the model.



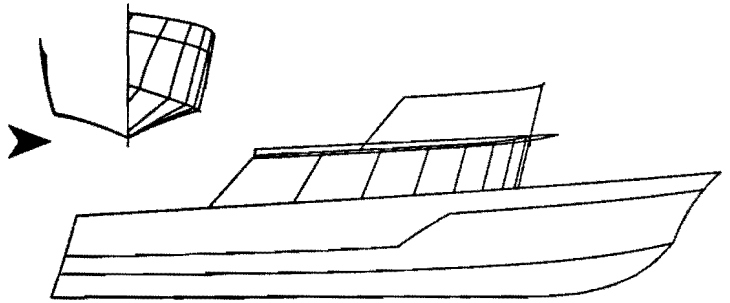


(G) This powerboat model (71 objects) is constructed from three blended surfaces and four ruled surfaces. Models made from these surface entities are designed primarily by shaping their edge curves. The surfaces are automatically updated if any of the edge curves are changed. The decorative stripe is a polysnake on the 'topside' surface.

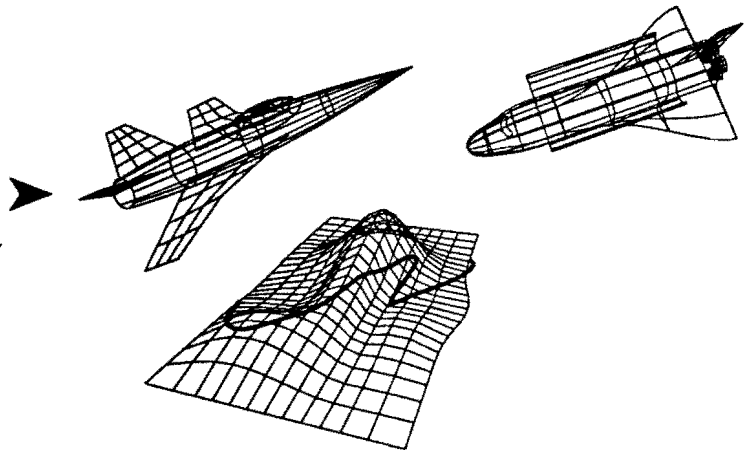


(I) MultiSurf applications go far beyond marine design. For any 3-D design problem involving arbitrary curves and surfaces, RGS offers unprecedented precision, flexibility, and adaptability.

(F) MultiSurf can display models as wireframes or as solid surfaces (panels). Using symmetry images which can be turned on and off, models can have mirror or rotational symmetry with respect to the X, Y, and/or Z axes. Mirror and rotated curves and surfaces permit symmetry with respect to arbitrary points, lines, or planes. (19 objects)



(H) MultiSurf is well adapted to multihull design. In these two examples (30 and 60 objects), all the hulls are C-lofted surfaces with B-spline master curves. The trimaran's curved crossbeams are revolution surfaces with NACA 0030 foil sections. Both these models have Y-symmetry and are displayed with symmetry images turned on.



### Connection to FL/2B and other hull design programs

MultiSurf comes with translation utilities that allow you to import (with 100% accuracy) models from FL/2B, AutoYACHT, AutoSHIP, FastYacht, and MacSurf.

### Manual


The MultiSurf manual is comprehensive and fully indexed. Sections include: Installation, Concepts, Tutorials (step-by-step introduction to most entities and program features), Entity Descriptions (with illustrated examples of each), Program Operation, Utilities, and Error Messages. Most of the manual material is available as on-line help.

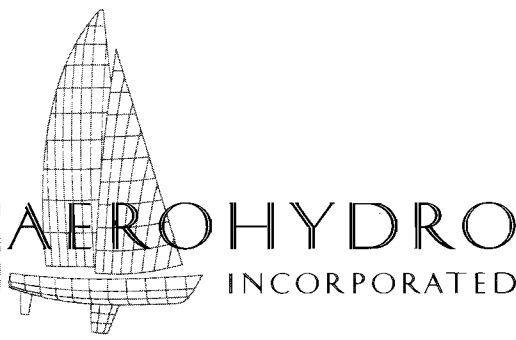
### Hardware requirements

MultiSurf requires an IBM-PC or compatible equipped with a mouse, a hard disk, and VGA (640 x 480) graphics. The program and its files require approximately 2 megabytes of hard disk space. A math coprocessor is highly recommended.

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100% recycled paper 



FAIRLINE® Marine Design Software / Consulting / Technical Services

# AHVPP/1

## FAIRLINE® SYSTEM

### VELOCITY PREDICTION PROGRAM

AHVPP/1 is a tool for predicting the performance of sailboats. In essence, it is a mathematical model of a sailing yacht. The program takes a yacht's hull offsets along with several other measurements, reduces them to a set of characteristic curves which are then used in formulas giving the surge and moments on the hull and sails as functions of boat speed, wind speed, course angle, etc. When solving a particular case, the program adjusts boat speed, heel angle, sail trim, sail reefing, and (when doing an optimum downwind or upwind case) heading angle to obtain the equilibrium of all surge forces and rolling moments and simultaneous optimization of sail settings.

AHVPP/1 can be a powerful aid in the design process of new boats as well as in fine tuning boats that already exist. Designs can be systematically varied and compared to find the best configuration of hull design and rig. The relative performance of a new design can also be compared with other existing designs.

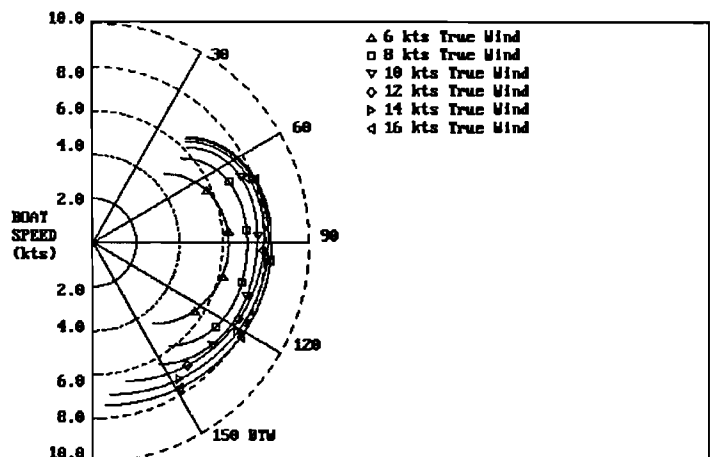
AHVPP/1 is a generalized VPP, not designed to any "measurement rule." Specifically, it does not give IMS ratings and thus is not intended to replace the specialized USYRU IMS Velocity Prediction Program. Instead, AHVPP/1 includes numerous advantages over the USYRU program. AHVPP/1:

- combines an LPP (lines processing program) and a VPP in a single program
- handles more diverse types of rigs
- allows user input of true wind speeds and headings to solve for
- has greater reliability in finding solutions to different cases
- uses a race model to compare the performance of two yachts in a variety of conditions
- calculates speed predictions for sailing, motorsailing, and powering
- makes input easy with screen-based forms

- delivers screen and printer output of polar diagrams
- comes with personalized technical support

To make velocity predictions with AHVPP/1, you begin with an AeroHydro Offset File, created either with FAIRLINE (hull design program) or OFE (Offset File Editor), along with several rig, hull, and weight measurements, in either English or metric units. The Offset File generally needs to include appendages. You can easily add them to a FAIRLINE hull using OFE.

Once AHVPP/1 processes the offsets and other dimensions, you enter up to ten different wind speeds and ten different headings that define the cases the program is to solve. For each case, the program reports the velocity prediction and information such as heel angle, velocity made good, and apparent wind angle and velocity. For each wind speed, the program reports the optimum upwind and downwind headings and speeds. Display of a velocity polar diagram is available. You can also dump this plot to your printer.



Below is sample output for a potential America's Cup boat, with 7 wind speeds and 4 headings selected. The output quantities are:

**VTW:** The true wind velocity in knots.

**BTW:** The track angle with respect to the true wind direction. BTW = 0 is dead to windward, BTW = 180 is dead downwind. This is the true course of the boat relative to still water (heading plus leeway angle) — not just where the boat is pointing, but where it's actually going.

**VAW:** The apparent wind velocity in knots. This is the velocity of the wind as it appears to the boat.

**BAW:** The apparent wind angle. This is the angle at which the wind appears to be coming at the boat in relation to the course the boat is sailing.

**V:** The speed of the boat along the boat's true course.

**VMG:** The speed that the boat is making in either the windward (positive VMG) or downwind (negative VMG) directions. VMG is most relevant in regards to the optimum upwind and downwind cases.

**HEEL:** The heel angle of the boat.

**FLAT** (range 0 to 1): The extent to which the sails' lift coefficient is reduced below its maximum value for this apparent wind angle. FLAT = 1.00 is maximum lift; FLAT = 0.00 is zero lift; FLAT = 0.70 means a 30% reduction in lift from the maximum.

**REEF** (range 0 to 1): The extent to which the span of the rig is reduced by reefing. REEF = 1.00 is full hoist; REEF = 0.00 is bare poles; REEF = 0.80 means sail is reduced by 20% in span (measured from the deck).

**SEC/N.M.:** The boat's speed expressed in seconds per nautical mile.

**N/S:** An "N" appears at the end of each result where the best speed was accomplished without the spinnaker raised or a spinnaker was nonexistent. An "S" appears at the end of each result where the best speed was accomplished with the spinnaker raised.

Velocity Predictions File: AMCUP1.VPP — 07-24-1991 10:50:48  
Predictions for Am. Cup base boat

VTW	BTW	VAW	BAW	V	VMG	HEEL	FLAT	REEF	SEC/N.M.
4.0	47.61	8.24	21.73	4.8623	3.28	4.0	1.00	1.00	1098.16 N
4.0	138.47	3.59	50.96	5.4096	-4.05	1.8	1.00	1.00	888.96 S
4.0	100.00	7.02	36.07	6.4034	-1.11	3.9	1.00	1.00	562.20 S
4.0	135.00	4.03	47.60	5.6885	-4.02	2.2	1.00	1.00	632.85 S
6.0	46.33	11.79	22.00	6.6499	4.59	10.1	1.00	1.00	784.07 N
6.0	138.61	5.07	55.17	7.6300	-5.72	3.3	1.00	1.00	628.94 S
6.0	100.00	9.83	38.13	8.8272	-1.53	11.6	1.00	1.00	407.83 S
6.0	135.00	5.68	51.58	7.9893	-5.65	4.1	1.00	1.00	450.60 S
8.0	44.40	14.76	21.72	7.8316	5.60	18.4	0.95	1.00	643.40 N
8.0	145.76	4.94	73.02	8.3972	-6.94	2.9	1.00	1.00	518.59 S
8.0	100.00	11.33	41.58	9.9159	-1.72	23.4	0.97	1.00	363.05 S
8.0	135.00	6.76	61.02	9.2206	-6.52	5.9	1.00	1.00	390.43 S
10.0	41.30	17.07	21.45	8.1960	6.16	22.6	0.81	1.00	584.68 N
10.0	150.16	5.23	91.28	9.0037	-7.81	2.7	1.00	1.00	460.97 S
10.0	100.00	12.50	45.13	10.6123	-1.84	29.4	0.84	1.00	339.23 S
10.0	135.00	7.83	69.77	10.1312	-7.16	8.5	1.00	1.00	355.34 S
12.0	39.69	19.18	21.54	8.4111	6.47	25.8	0.69	1.00	556.17 N
12.0	151.00	6.24	101.97	9.7405	-8.52	3.0	1.00	1.00	422.56 S
12.0	100.00	13.66	48.93	11.1094	-1.93	31.6	0.80	0.96	324.05 S
12.0	135.00	8.97	76.01	11.0651	-7.82	11.9	1.00	1.00	325.35 S
14.0	39.00	21.14	22.02	8.5576	6.65	27.6	0.63	0.97	541.33 N
14.0	150.31	7.59	106.55	10.6261	-9.23	3.9	1.00	1.00	389.97 S
14.0	100.00	14.95	52.63	11.5383	-2.00	31.6	0.86	0.87	312.01 S
14.0	135.00	10.09	80.92	11.9455	-8.45	15.9	1.00	1.00	301.37 S
16.0	38.76	23.02	22.73	8.6784	6.77	28.1	0.65	0.91	531.99 N
16.0	151.28	8.74	112.81	11.3626	-9.97	4.3	1.00	1.00	361.26 S
16.0	100.00	17.69	58.72	12.0396	-2.09	20.7	1.00	1.00	299.01 N
16.0	135.00	11.11	85.23	12.7187	-8.99	20.1	1.00	1.00	283.05 S

These results show the boat's optimum downwind heading is quite broad, while its optimum upwind heading is rather typical. Up to VTW = 8 knots, REEF and FLAT remain at one — the sails require no adjustments until then. From VTW = 8 knots up, the value of FLAT decreases for the optimum upwind case. It also decreases for the BTW = 100 deg. cases from 8 to 12 knots. This means the sails need to be trimmed away from their optimum lift positions for those cases. For BTW = 100 degrees, the program found that above VTW = 12 knots the boat sails better without the spinnaker. These results could serve as a base against which to compare design modifications.

When you have velocity predictions for two or more boats, you can compare their performance by:

- having the program calculate and report differences in speed
- using AHVPP/1's sophisticated race model

In the speed differences routine, the program compares up to ten boats and reports the differences in seconds per nautical mile:

Difference Comparison File: CRUISERS.DPP — 07-24-1991 11:24:06

BOAT A: 42' Cruising Boat  
 BOAT B: 42' Cruising Boat - 5% taller rig  
 BOAT C: 42' Cruising Boat - 5% longer boom  
 BOAT D: 42' Cruising Boat - 10% lower VCG

Windward Case		True Wind Speeds (knots)					
BOAT		6.0	8.0	10.0	12.0	14.0	16.0
Base Sec/NM	A	1149.75	937.23	828.71	781.01	757.82	748.37
Differences	B	-14.36	-9.18	-2.55	-0.69	0.63	1.72
	C	-6.34	-3.38	0.55	0.75	0.96	1.24
	D	-0.46	-0.98	-1.98	-2.43	-2.93	-3.34

BTW = 45 deg.		True Wind Speeds (knots)					
BOAT		6.0	8.0	10.0	12.0	14.0	16.0
Base Sec/NM	A	812.99	662.72	585.99	553.25	537.84	531.38
Differences	B	-10.15	-6.49	-1.80	-0.44	0.43	1.12
	C	-4.49	-2.39	0.39	0.48	0.60	0.76
	D	-0.33	-0.69	-1.40	-1.65	-1.93	-2.19

BTW = 60 deg.		True Wind Speeds (knots)					
BOAT		6.0	8.0	10.0	12.0	14.0	16.0
Base Sec/NM	A	646.68	533.26	486.47	467.66	458.16	453.13
Differences	B	-8.11	-6.26	-0.88	-0.31	0.20	0.49
	C	-4.82	-3.91	-0.10	-0.00	0.18	0.25
	D	-0.18	-0.63	-0.80	-0.95	-1.14	-1.28

...

Downwind Case		True Wind Speeds (knots)					
BOAT		6.0	8.0	10.0	12.0	14.0	16.0
Base Sec/NM	A	979.11	770.22	651.73	573.47	522.03	487.95
Differences	B	-7.33	-5.72	-3.33	-3.09	-2.45	-2.12
	C	-5.01	-3.98	-2.14	-1.95	-1.60	-1.42
	D	0.00	0.09	-0.01	0.00	-0.00	0.00

In the race model, AHVPP/1 compares the performance of 2 boats and reports the probabilities of one boat beating another, given a particular race course, variations in wind speed, and other randomizing factors which are accounted for in "Band Width" and "Edge" estimates:

Race Predictions File: AMCUP1-2.RPP  
07-24-1991 11:26:31

BOAT A: Predictions for Am. Cup base boat  
BOAT B: Predictions for Am. Cup 5% longer

Course: America's Cup Band Width:2.00% Edge:0.00%

Probabilities that BOAT B beats BOAT A

Standard Deviations from Mean True Wind Speed

	0%	10%	20%	30%	40%	50%
6	24.0	25.1	27.0	28.6	30.3	32.5
8	55.7	54.0	51.5	49.7	48.9	49.1
10	71.5	70.8	68.2	64.9	62.2	60.8
12	81.3	80.9	78.7	74.8	71.3	68.9
14	89.1	87.7	84.9	81.2	77.4	74.6
16	90.8	90.1	88.6	85.5	81.8	78.7

N/A - No Answer: Insufficient range of VTW's in Velocity Prediction Files.

The column under 0% standard deviation shows the probabilities for races where there is no variation from the mean wind. The columns under increasing values of standard deviation show probabilities for races where there is increasing variation in the wind speed from the mean value.

In this particular example, we are specifically interested in which boat will do better in winds around 10 knots. For all standard deviations at 10 knots, the second boat (the modified hull that is 5% longer) has better than a 50% chance of winning against the base design.

Total Seconds to Complete Course

VTW	BOAT A	BOAT B	DIFFERENCE
6	14501.1	14652.9	-151.8
8	12064.8	12037.5	27.4
10	10920.8	10827.5	93.4
12	10240.2	10112.7	127.5
14	9759.8	9612.8	147.0
16	9377.1	9225.3	151.9

The above comparison of the performance a base boat and a 5%-longer boat would be one of many we would expect to run in a complete design program. A good way to apply AHVPP/1 is to create a matrix of boats by systematically varying two or more dimensions or by varying keel and/or rig configurations. You can refine this process even more with the application of game theory.

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FAIRLINE® Marine Design Software / Consulting / Technical Services

# OFE/4

## FAIRLINE® SYSTEM OFFSET FILE EDITOR

The Offset File Editor is an interactive program for the creation, maintenance, and editing of disk files representing the three-dimensional shape of a boat hull or other surface by a series of transverse sections.

That's old hat, but OFE/4 definitely is not! This new version has been reorganized and enhanced inside and out. The modern user interface is graphics-oriented, includes pop-up menus and dialog boxes, and allows you to shell to DOS. You can customize the screen colors, too! The mathematics now accommodate asymmetric as well as symmetric body plans, permit specification of discontinuous stations, work to three-decimal-place accuracy, handle any units, accept negative as well as positive scaling factors, and allow you to translate coordinates in X (as well as in Z or by changing trim). Points can be given labels and pen colors, stations can be labeled (numbered). OFE/4 will save 2-D and text files (in addition to Offset Files and 3-D wireframe files), and it will display a full-rotate, zoom and pan 3-D image (as well as the standard three orthographic views).

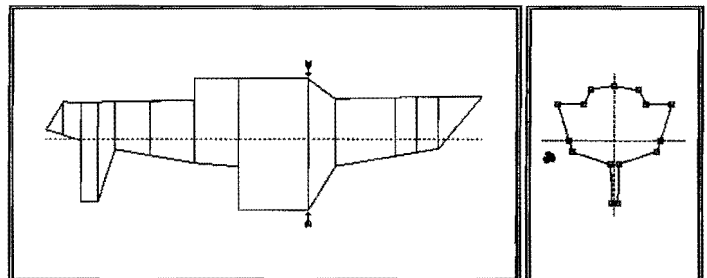
You can use any digitizer for which you have an ADI driver! Besides entering points, you can now select and move them with the digitizer, and you can activate menu options with a click.

As of old, data in the program is stored in a standard format compatible with FAIRLINE/2B (hull design), HYDRO (hydrostatics), SSR (slender-ship resistance), and other AeroHydro programs. But, OFE/4 is not limited to the old .OFE format. It can also save Offset Files in a new .OF4 format that takes advantage of the program's greater capabilities and stores more information.

OFE/4's extensive capabilities for creating, editing, recovering errors, and maintaining disk file data allow you considerable flexibility in creating and refining surface representations. For example, you might use FL/2B to design your hull, have FL/2B save an initial Offset File for

you, use OFE/4 to add the keel and superstructure, and then use the edited Offset File as input for our hydrostatics programs HYDRO/x.

OFE/4 Choose Station  
File: TEST25.OF4 Last Saved: 07-29-1991  
TEST25B - 25 X 8.3 hard chined for HYDRO/xx examples 2/1/85



Station	Pt	Z	Y	Label	Pt	Z	Y	Label
5.000	1	-1.003	0.000		6	2.341	3.592	
	2	-1.003	0.210		7	2.341	2.001	
X Position:	3	-1.501	0.250		8	3.252	1.501	
10.000 ft	4	-0.751	2.673		9	3.502	0.000	
√ Symmetric	5	0.000	2.897					
Asymmetric								

Arrow keys select station to edit, <ESC> exits.

**To create** an .OF4 or an .OFE file from scratch, you first specify the X-position for the station (stations can be regularly or irregularly spaced) and the number of points that you want to represent the station with. Then you place put the points by either:

- digitizing them
- entering first and last point coordinates from the keyboard and screen editing the automatically-inserted set of points
- entering first and last point coordinates from the keyboard and editing offsets in a tabular form

**File editing** options are numerous. They include:

### Editing stations

- by interactively moving, inserting, or deleting point(s)
- by editing the pen color or the label of point(s) - using Pen = 0 (pen up), you can create a discontinuous station, such as one passing through the hull and the trailing end of a bulb keel
- by altering the symmetry of the station
- by changing the X-position or the label (number) of the station

Toggled (on/off) screen aids include displays of the unedited station, a second station "mask," and a unit grid. The "Restore" option returns the station to what it was when you began the editing session, allowing you to begin editing again from scratch.

**Inserting or deleting an entire station** - insert procedures include adding a new station:

- by interpolation or extrapolation
- by copying another station
- by user input

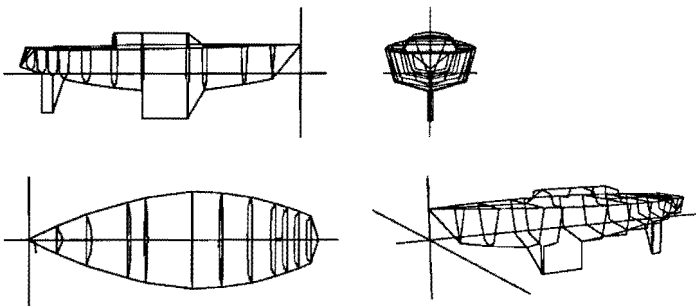
**Stretching or shrinking** any of the three dimensions of the model

**Raising, lowering, or trimming** a hull to any waterplane

**File display and saving** functions include:

**Displaying a screen plot** of body plan, plan, profile, or 3-D wireframe views, as represented by the stations

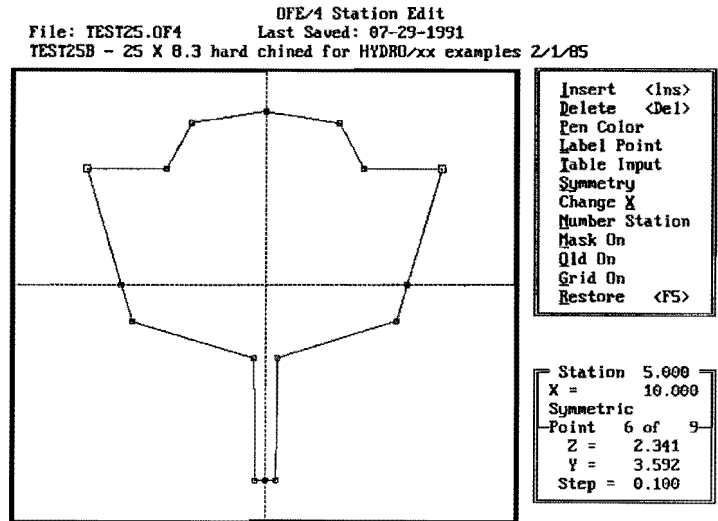
**Saving a 2-D file** of any of the screen plot views, to send to a CAD program



**Printing out or saving to a text file offsets** for the whole boat or for any set of stations you select

**Saving the Offset File to disk**, for storage or for input into another AeroHydro program

**Saving a 3-D wireframe file** that can be read by our C3D program for viewing and plotting



<Tab> switches windows, < > select, arrows move, <F10> accepts


**Custom modules** that hook directly into OFE/4 make the program expandable to meet your individual needs. Current custom modules include:

- MERGE — merges two Offset Files (such as a hull file and a keel file) into one file
- MONO2CAT — automatically converts single hulls into catamarans
- PANEL — produces 3-D panelizations of hulls
- ORCCON — converts .OFE files to .TXT for input into USYRU 1988-89 LPP/VPP programs

We welcome the challenge of creating new modules. Call us to discuss your needs.

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FAIRLINE® Marine Design Software / Consulting / Technical Services

# MSDEV

## FAIRLINE® SYSTEM

### DEVELOPABLE PANEL EXPANSION FOR MULTISURF®

#### Overview

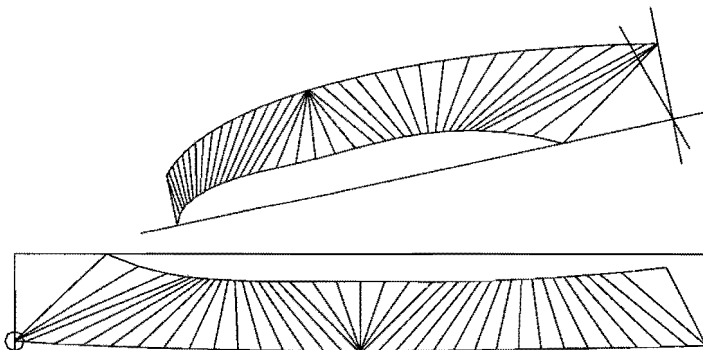
MSDEV is a MultiSurf utility that reads in ruling files (.RUL) of developable panels made by MultiSurf and outputs a DXF and/or text file of the expanded shapes of those panels. Panel marks include the positions of contours, snakes, magnets, and rings transferred from MultiSurf and/or rulings (bend lines).

#### Developable surfaces

A *developable surface* is a surface that can be rolled out flat onto a plane by *bending* alone, with no stretching. Common examples are cylinders and cones. A simple example of a *non-developable surface* is a sphere — you can't take any finite portion of a sphere and flatten it without stretching.

Non-developable surfaces are often referred to as having *compound curvature*. Gaussian curvature is a quantitative measure of compound curvature. A developable surface has zero Gaussian curvature everywhere.

The process of rolling a surface out flat is called *development* (or expansion), and the resulting shape in the plane is referred to as the *developed shape* (or the expanded shape) of the particular surface.



3D shape (top) and developed shape (bottom).

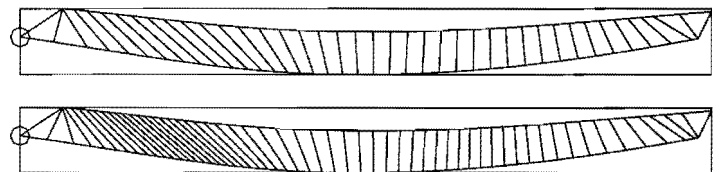
#### Developable surfaces and ruled surfaces

A *ruled surface* is a surface that can be created by the motion of a straight line in space. The successive positions of the straight line are called *rulings* — they are a family of straight lines embedded in the surface. Since any developable surface can be created by the motion of a straight line in space, all developable surfaces are ruled surfaces; but *NOT ALL* ruled surfaces are developable!

#### Manufacturing precision

MSDEV provides several unique features critical for manufacturing precision:

- During development, MSDEV compensates for thickness effects in the bending of the panel.
- At concave seams, MSDEV automatically trims back edges, based on thickness and seam angle, to accurately eliminate interferences between abutting panels.



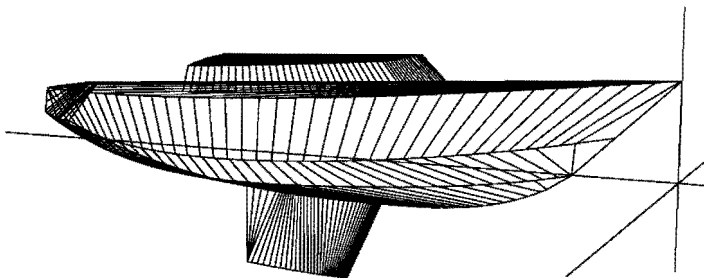
Regular rulings (top) and uniform bend lines (bottom).

- MSDEV optionally will mark uniform bend lines which show where to press-brake the flat panel at a user-specified, constant angle to produce the finished 3D shape of the plate.
- MSDEV transfers the positions of contours, snakes, magnets, and rings into marks on the development to provide for accurate part alignment.

- MultiSurf and MSDEV are so robust that, with reasonable care, you can expect *millimeter accuracy* in the fit-up of all parts of a developable model created with them.

## Input files

You create the input .RUL files for MSDEV in MultiSurf, using the Files/ Save RUL option.



*MultiSurf model for hard-chine sailboat made up of 9 developable surface panels.*

Any kind of surface entity is eligible for saving as a .RUL file, as long as the resulting surface object is actually ruled in either the u or v direction. MultiSurf automatically scans the surface for Gaussian curvature and warns you if the maximum Gaussian curvature, multiplied by the total area of the surface object, is over a limit which corresponds to a 1 mm arch in a 1 meter diameter spherical cap.

Note that MultiSurf allows you to create a ruling file for *any* ruled surface, and it will load into MSDEV. However, if the surface is not developable, plate development in MSDEV will NOT be true a expansion of the panel. If a panel you intend to develop does not pass MultiSurf's automatic Gaussian curvature scan, you can use the Gaussian curvature display to improve it before you save a .RUL file.

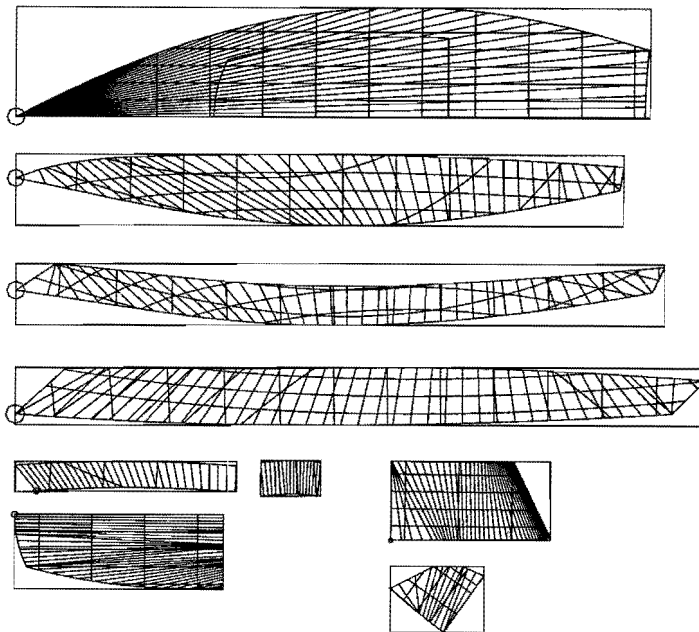
The positions of *visible* contours, snakes, magnets, and rings on the selected surface are saved in the .RUL file.

## Program operation

Since the work of creating the panels for expansion is all done in MultiSurf, MSDEV just has the job of creating the developed plates and transferring your marks (snakes, contours, etc.) to them. All you do to run MSDEV is fill in a couple of forms: the first specifying the set of ruling files (.RUL) you wish to expand, plus a specific weight and thickness for each panel; the second specifying the type of file output, whether you want equal bend lines marked, and if so, for what angle. MSDEV does the rest.

## Output files

- The DXF file will contain the outlines of the developed panels as well as the ruling lines. Each panel will be on a different layer in the DXF file, so they can be easily manipulated individually once they are loaded into a



*MSDEV expanded panels for hard-chine sailboat at left, with positions of stations, waterlines, and buttocks marked.*

CADD program. Each panel in the DXF file will also be marked with any contours, snakes, and/or magnets that were visible on the panel when it was saved in MultiSurf. This DXF file typically is the basis for specification of cutter paths for N/C flame or water-jet cutting, for N/C routing, or for plotting full-size patterns.

- The text file will contain a list of the 2D coordinates of each developed panel, the coordinates of any intersections with contours, and the coordinates of any snakes and magnets present. The angle of bend, in degrees, will be noted for each ruling line next to the coordinates of its end points. These coordinates are plotted on flat stock for manual laydown and cutting of panels.
- MSDEV also writes a .WTS text file containing each panel's area, 3D center of gravity, and weight, as well as the totals for each of these quantities. These figures are very useful for estimating the total weight and center of gravity for the model.

## Note

CADD files and/or offsets of transverse frames, bulkheads, floors, etc. can be saved directly from MultiSurf. MSDEV is not involved in the design of these flat parts.

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