UliLines

Vers. 3.3

User's Manual

latest update available at
www.remmlinger.com
downloads from other sites are illegal

Compared to the initial release 3.1 the update 3.2 contains minor bug fixes. In 3.3 there is an additional format-option for the output file. This file can directly be used as input to the program UliTank.

Contents

1. INTRODUCTION

My work in yacht research is centered on the extended use of the computer in the design spiral. The computer is an ideal tool when it comes to multiple iteration loops as in the optimization process for the design of a sailing yacht. A detailed description of the idea can be found in [1]. A prerequisite for the automated design process is a "hands off" method for the creation of the lines plan. Based on as few input variables as possible the software should create the complete hull form in a way that the necessary parameters for the velocity prediction and stability calculation can easily be determined. It would be even more desirable, if the parameters that are used in the resistance prediction could directly be used as the input variables for the creation of the lines plan. This would enable a direct work stream in the optimization loop.

The industry standard for the resistance prediction of a sailing yacht in the preliminary design phase is the formula based on a regression analysis of the Delft Systematic Yacht Hull Series. The experiments started in 1973 and the latest version of the regression coefficients was published in 2008, see [2]. The program UliLines uses the parameters of the 2008 DSYHS formula as input parameters for the creation of a lines plan. The hull form is limited to round bilge sailing yachts.

2. THE GEOMETRIC DESCRIPTION OF THE HULL

The following parameters are used in the 2008 DSYHS formula.

Lwl	Length of waterline
Bwl	Beam of waterline
Tcb	Draft of canoe body
LCB	Longitudinal position of the center of buoyancy from fpp
LCF	Longitudinal position of the center of flotation from fpp
fpp	forward end of design waterline
Cp	prismatic coefficient
Aw	Waterplane area at zero speed
Cm	Maximum area section coefficient
∇c	Volume of displacement of canoe body

A detailed definition for all these parameters is e.g. given in [3].

Based on these parameters one could create many different hull forms, the input database does not define a unique hull. Therefore, the following additional parameters are used:

Alpha	Flare angle of the maximum area section at the level of the DWL
Gamma	Deadrise angle of the maximum area section at the keel
D	Depth of canoe body from keelpoint to decklevel
TOH	Transom overhang
TCL	Transom clearance

For clarification, the parameters of the maximum area section are depicted in drawing 1. To avoid any misunderstanding I want to point out that the section of maximum area is not located in the middle of the Lwl and should not be confused with the midship section. The parameters describing the stern of the vessel are explained in drawing 2.

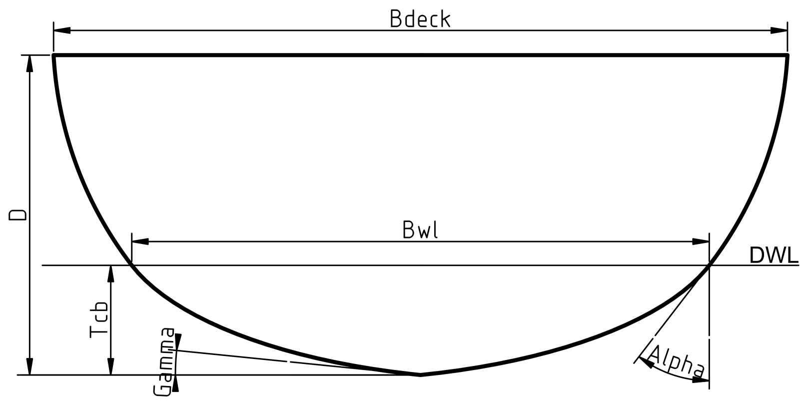

Fig. 1. Maximum area section

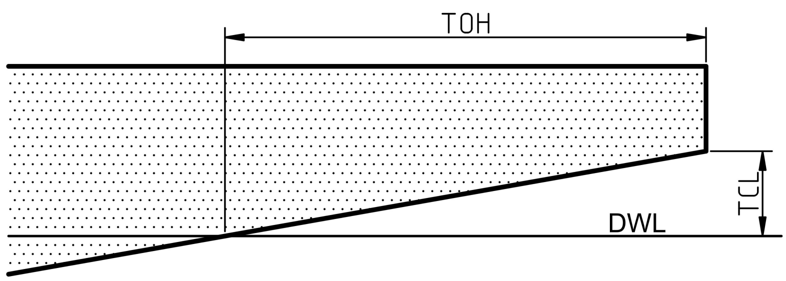

Fig. 2. Stern of the vessel, sideview

Additional control parameters are:

TRANSOM determines the center for the mapping of the afterbody.
U_SEC describes the bottom radius for the U-sections in the forebody
BOW_FLAR additional flare at bow above waterline

3. INSTALLATION OF THE PROGRAM

The zipped file that you downloaded contains the executable file UliLines.exe, this manual ULman.pdf and several input files UL##in.txt. You should unpack the zipped file into a folder of your own choice that you have named appropriately (e.g. UliLines). You can execute the program directly in this folder by clicking on the file UliLines.exe. The output files will also be stored in this folder. If you want to uninstall the program, you just need to delete this folder.

4. THE INPUT FILE

The name of the input file must be UL##in.txt. The ## stands for two digits or two characters that can be chosen by the user to distinguish between different input files. The two digits or characters will also be used in the names of the output files. The structure of the input file can best be understood by examining the example UL25in.txt that is contained in the downloaded folder.

The input file is built by a sequence of line-pairs. The first line always contains an explanation and the second line the numerical value of the parameter. The program reeds only every second line and in that line only the first number until the first blank behind this number. The rest of the line is ignored. This is convenient if one wants to test different values for a parameter and wants to memorize what has been tested: just move it to the right and type the new value in the left-most position.

With the exception of the Lwl, the program reeds only dimensionless parameters. If you want to change the scale of your model, you only need to change the Lwl and the rest will follow automatically. The units in the output files depend on the units that you have chosen for Lwl. If your yacht is 33 feet long and you type 33. in Line 4, then all dimensions on output will be in feet, areas in sq.ft. and volumes in cu.ft. If you type for the same yacht 10.058 in line 4, then all your results will be in meters, areas in m^2 and volumes in m^3.

Now let's inspect the file UL25in.txt line by line

```
Headline
*  Delft Series parent model Sysser 25       *
Lwl            Length of waterline
   10.0
Lwl / Bwl      Ratio of waterline length to waterline beam
   4.0
```

In the second line, the user can type a description of the yacht or of the project. This headline will also appear in the output file. Lwl has been discussed already and line 6 contains the first dimensionless ratio Lwl / Bwl.

```
Bwl / Tcb      Ratio of waterline beam to the draft of the canoe body
   5.388
Bdeck / Bwl    Ratio of beam at deck level to waterline beam
   1.12
Cp             Prismatic coefficient of the canoe body
   0.5483
Cm             Coefficient of the maximum area section
   0.727
LCB/Lwl        Longitudinal center of buoyancy, distance from fpp divided by Lwl
   0.5199
LCF/Lwl        Longitudinal center of flotation, distance from fpp divided by Lwl
   0.5554
Awl / Vol^2/3  Ratio of water plane area to the 2/3rd power of the volume
   6.048
```

These parameters are the ones that are used in the DSYHS regression formula for the estimation of the resistance. The following parameters provide an additional description of the hull and guarantee the uniqueness:

```
Alpha          Flare angle at max. area section, DWL-level,deg.outwrd from vertical
   32.5
Gamma          Deadrise angle at the keel, in degrees upward from horizontal
   0.0                                 combine larger values with U_SEC = 0.
D / Lwl        Ratio of depth of canoe body to Lwl
   0.13463
TOH / Lwl      Ratio of transom overhang to Lwl in percent
  20.0
TCL / TOH      Ratio of transom clearance to transom overhang
  0.141                                    if unknown use default 999
```

The angles alpha and gamma are explained in figure 1. The input is in degrees. Negative values for alpha are allowed (tumble home). If gamma is chosen to be lager than a few degrees, it should be combined with V-sections in the forebody. Otherwise, the sections in the forebody will exhibit inflection points. The ratios for the description of the transom are based on the definition in figure 2. The overhang is input in % of Lwl. For the transom clearance there is the possibility to use the default value 999. In this case, the program will extend the contour of the keel aft by the amount of the overhang in form of a faired curve.

The following parameters are used for additional control.

```
TRANSOM         Parameter for transom size
   3.
U_SEC           Parameter describing radius of U-sections in forebody
   3.                                          = 0. for V-sections
BOW_FLAR        Parameter causing additional flare at bow if > 0
   0.
```

TRANSOM determines the center for the mapping of the afterbody.
= 1. form of transom resembles main section
> 1. wide transom, top is cut off
< 1. small and low transom, negative shear in afterbody

U_SEC describes the bottom radius for the U-sections in the forebody
= 0. no radius, V-section in forebody
2. – 3. value for usual U-section

BOW_FLAR = 0. no additional flare at bow above waterline
> 0. additional bow-flare above waterline like in older yachts

Finally, the CAD-program can be specified that is used to process the offset tables that are computed by UliLines. Four formats are available at the moment.

```
CADOUT         specifies the output file. 1=Rhino, 2=DelftShip, 3=ProSurf, 4=UliTank
   1
```

The input needs to be in the integer-format
1 = file format for the Rhinoceros program
2 = file format for the Delftship program
3 = file format for the ProSurf program
4 = file format for the program UliTank

Since the input file for the CAD-program FreeShip is asking for the identical format as Delftship, CADOUT = 2 can also be used for FreeShip.

UliTank is not a CAD-program, but a program for the prediction of the bare hull resistance, based on tank test data. It can be downloaded at www.remmlinger.com.

It is advisable to save one of the downloaded input files without altering it. It can be used as a template for further input files in the future.

5. RUNNING THE PROGRAM

When opening UliLines.exe the following window will appear and will ask you for the identifiers of the input file (depending on the setting of your command prompt options, the background color might be black):

If you want to execute the program with the input file UL25in.txt then type 25 and press enter. Instead, if you want to use the file ULCAin.txt, then type ca (not case sensitive). The program will display diagnostic messages and will indicate the termination. If the run was not successful and an error occurred, you might be able to adjust your parameters based on the indicated task that could not be solved. After termination press Enter and the window will close and you can inspect the output files in your program folder.

6. THE OUTPUT FILES

The result of the computations is a table of offsets that describes the sections of the hull at 43 stations. The x-axis is the longitudinal axis of the hull, the y-axis is parallel to the water surface and the z-axis runs vertical from the water surface downwards. The origin of the system is on the water surface at the forward end of the design water line at rest.

A difficulty arises from the addition of an overhanging transom to the closely defined hull. In most cases, the result is a locally fast changing curvature in the area of the aft end of the design waterline. In the CAD-programs this change of curvature will lead to a wavy surface over several stations. This waviness can be reduced, if the station no. 4 at the aft end of the DWL is slightly moved in x-direction, without changing the offsets. The downside of this correction is a change in Lwl, which will also change the coefficients slightly from the prescribed value. This disadvantage was accepted, because a faired hull was considered more important than a 0.5% deviation in Lwl.

Somebody might wonder about the large number of points that are used to describe the outline of the sections. This was the result of a comparison of the intended outline with the result after lofting in the CAD-program. With fever points the CAD-programs "invented" sections with inflection points or negative deadrise angles. This was especially severe for U-shape sections with a radius at the keel.

The wetted surface is calculated in two ways. The first value in the output file is the sum of the true area of the surface panels. The second value is the sum of the projection of the panel area to a surface parallel to the x-axis. This value is needed when calculating the frictional resistance, as only the x-component of the surface friction contributes to the total resistance force. If the length/beam ratio is within the DSYHS, then an additional value for the wetted surface is displayed. It is calculated using the Delft-regression formula:

$$A_{wet} = \left(1.97 + 0.171 \cdot \frac{B_{wl}}{T_{cb}}\right) \cdot \left(\frac{0.65}{C_m}\right)^{1/3} \cdot \sqrt{\nabla_C \cdot L_{wl}}$$

If this value is close to the true wetted surface one can expect the hull to fall within the covered range of the Delft-regression and the calculated resistance according to the Delft-method should also be reasonably accurate.

The following files are created:

1. ULOut_25.TXT or in the second example ULOut_ca.TXT
   This text file contains the dimensions of the created hull. The appropriate units depend on the unit of Lwl, as described in chapter 4. Metacentric height, wetted surface, water plane area and volume of displacement are also displayed.

2. ASEC_25.CSV or in the second example ASEC_ca.CSV
   Many Excel-programs can read this file and you can create your own curve of sectional areas with the data in this file.

3. For CADOUT=1 the file Rhino_25.TXT or in the second example Rhino_ca.TXT
   This table of offsets can be read by Rhino. From Menu in Rhino use Tools > Commands > read from file > go to the file "Rhino_25.TXT" and open it. It will take some time till all curves are read. You have to wait until the "loft options dialog box" opens. Leave the surface as it is and type OK. It will again take a while until the process is finished. I recommend switching the isocurves off. This improves the visibility of the colors when doing a curvature analysis.

4. For CADOUT=2 the file DelftS_25.TXT or in the second example DelftS _ca.TXT
   This table of offsets can be read by Delftship. If the Lwl is measured in feet, please change the first number from 0 to 1. Select File > Import > Surface > go to the file "DelftS_25.TXT" and open it. The program will display the hull within seconds.

5. For CADOUT=3 the file ProSurf_25.NWS or in the second example ProSurf_ca.NWS
   This table of offsets can be read by ProSurf. From Menu in ProSurf go to File > Data File Input > NWS Input > go to the file ProSurf_25.NWS and open it. The program will display immediately all sections. Then you go > Create 3D > Sin/Loft Surf (as described in ProSurf-Help)

6. For CADOUT=4 the file OFFS25.TXT or in the second example OFFSca.TXT

This table of offsets can be read by UliTank. Just move the file into the folder OFFSETS that is contained in the Zip-file UliTank, which can be downloaded at www.remmlinger.com. UliTank performs a resistance prediction based on a regression analysis of tank test data.

7. If Lwl/Bwl is > 7 the file ca_sploff1.csv
   This is an input file for Michlet, see [4]. It contains the hull offsets in the spline format. If you change the name to sploff1.csv, you can copy this file directly into the Michlet-folder and, after modifying the in.mlt file, run Michlet.

7. Examples

There are four different input files in the zipped folder that demonstrate some of the capabilities of the program. The files UL01in.TXT and UL25in.TXT try to match the lines plans of two models of the DSYHS as closely as possible. "01" uses the parameters of the parent model Sysser 1 and "25" those of the parent model Sysser 25. Sysser 1 is designed with V-sections in the forebody, whereas Sysser 25 has U-sections.

The input file UL85in.TXT is included to demonstrate the influence of a large prismatic coefficient (0.85). The program creates a very "boxy" hull, but the lines are still fair.

The input file ULCAin.TXT produces a hull that is slender enough for a meaningful resistance prediction with the program Michlet. It could be regarded as one hull of a catamaran, but it is really only a test case.

8. References

1. Remmlinger U. (2006), "Design Process Automation for Sailing Yachts", *2nd High Performance Yacht Design Conference, Auckland*
2. Keuning, J. A. & Katgert, M. (2008), "A Bare Hull Resistance Prediction Method Derived from the Results of the DSYHS Extended to Higher Speeds", *Innovation in High Performance Sailing Yachts, Lorient, France*, RINA, pp 13-21.
3. Larsson, L. & Eliasson, R. E. (1994), *Principles of Yacht Design*, Adlard Coles, London GB
4. www.cyberiad.net/leo.htm

RHINOCEROS® is a registered trademark of Robert McNeel & Associates

DELFTship™ is a trademark of Delftship BV, the Netherlands

ProSurf is a program by Steven M. Hollister