HydroComp, Inc.

FOR IMMEDIATE RELEASE
February 21, 2014

Fuel Optimization with HydroComp NavCad®

New features for the industry-standard resistance and propulsion software

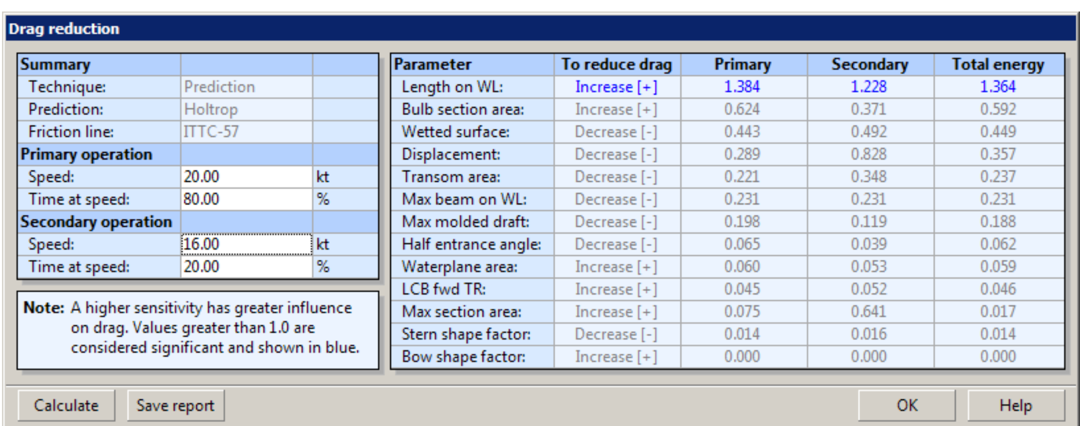
HydroComp NavCad® is the most widely used software for predicting vessel resistance and propulsion within the marine design community. With growing emphasis on fuel consumption and efficiency, naval architects and marine engineers are continually looking to reduce fuel consumption; both as part of the design spiral and also during operation.

Drag reduction

Strategic design-side fuel savings can be found by using optimized hull forms. According to Donald MacPherson, HydroComp Technical Director, "NavCad's drag reduction tool provides designers with a meaningful metric to identify changes to the present hull design that will reduce drag and increase performance and efficiency. For example, it offers practical insight into the 'What if' questions: *What if half angle of entrance is decreased? What if I add a bulb? What if the LCG is shifted aft?* Designers and naval architects now have the ability early in the design to rapidly evaluate the influence of various hull parameters on vessel drag, and more importantly, on real operational efficiency."

The *Drag Reduction* analysis can be applied to any vessel in NavCad. Once the initial hull parameters have been entered, the predicted resistance can calculated using one of NavCad's more than three-dozen resistance methods. The designer's selection of the most appropriate resistance prediction model is assisted by NavCad's *Method Expert* ranking system.

The resistance curve for the initial design is known as the "basis" resistance. The *Drag Reduction* analysis then evaluates the influence on resistance (increasing or decreasing plus its significance) of the change in various hull parameters – length, displacement, and transom immersion, to name a few. The hull parameters are then organized by influence, with the most significant parameter presented at the top of the table. (See figure.)



Drag reduction

Summary		
Technique:	Prediction	
Prediction:	Holtrop	
Friction line:	ITTC-57	
Primary operation		
Speed:	20.00	kt
Time at speed:	80.00	%
Secondary operation		
Speed:	16.00	kt
Time at speed:	20.00	%

Note: A higher sensitivity has greater influence on drag. Values greater than 1.0 are considered significant and shown in blue.

Parameter	To reduce drag	Primary	Secondary	Total energy
Length on WL:	Increase [+]	1.384	1.228	1.364
Bulb section area:	Increase [+]	0.624	0.371	0.592
Wetted surface:	Decrease [-]	0.443	0.492	0.449
Displacement:	Decrease [-]	0.289	0.828	0.357
Transom area:	Decrease [-]	0.221	0.348	0.237
Max beam on WL:	Decrease [-]	0.231	0.231	0.231
Max molded draft:	Decrease [-]	0.198	0.119	0.188
Half entrance angle:	Decrease [-]	0.065	0.039	0.062
Waterplane area:	Increase [+]	0.060	0.053	0.059
LCB fwd TR:	Increase [+]	0.045	0.052	0.046
Max section area:	Increase [+]	0.075	0.641	0.017
Stern shape factor:	Decrease [-]	0.014	0.016	0.014
Bow shape factor:	Increase [+]	0.000	0.000	0.000

Calculate | Save report | OK | Help

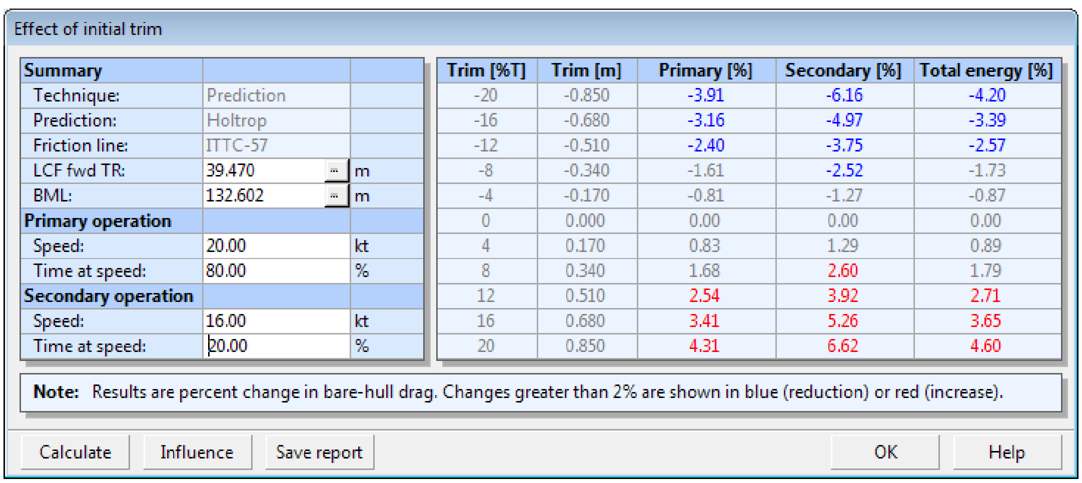
HydroComp NavCad "Drag reduction" tool

Development of an optimized system also needs consideration of the hydrodynamic influences of the parameters across the operating speed range. For example, transom immersion is beneficial at high speed, but detrimental at lower speeds. In order to consider the influences on overall operation, NavCad's drag reduction analysis allows the user to enter primary and secondary operating profiles using speed and time at speed.

Additionally, since the motivation for drag reduction is typically fuel consumption, the magnitude of the drag at speed must be part of the assessment, not solely the proportional reduction in drag. In other words, since resistance at top speed can be substantially higher than lower speeds, it should have greater significance in the analysis. NavCad's *Drag Reduction* analysis includes a "Total energy" weighted influence, which is calculated based on the primary and secondary operating profiles. This "total energy" approach allows the user to truly evaluate the effect of a hull parameter on the change of overall energy consumption of the vessel.

Effect of initial trim

The benefits of trim optimization have been well documented for some years. NavCad's *Effect of initial trim* tool provides useful information to designers and operators alike. In an effort to reduce fuel consumption, ship operators are often interested in the effect of initial trim on the performance of the vessel. This supplemental tool will provide an essential assessment of the effect of initial trim on bare-hull resistance for ships large and small.



Effect of initial trim

Summary		
Technique:	Prediction	
Prediction:	Holtrop	
Friction line:	ITTC-57	
LCF fwd TR:	39.470	m
BML:	132.602	m
Primary operation		
Speed:	20.00	kt
Time at speed:	80.00	%
Secondary operation		
Speed:	16.00	kt
Time at speed:	20.00	%

Trim [%T]	Trim [m]	Primary [%]	Secondary [%]	Total energy [%]
-20	-0.850	-3.91	-6.16	-4.20
-16	-0.680	-3.16	-4.97	-3.39
-12	-0.510	-2.40	-3.75	-2.57
-8	-0.340	-1.61	-2.52	-1.73
-4	-0.170	-0.81	-1.27	-0.87
0	0.000	0.00	0.00	0.00
4	0.170	0.83	1.29	0.89
8	0.340	1.68	2.60	1.79
12	0.510	2.54	3.92	2.71
16	0.680	3.41	5.26	3.65
20	0.850	4.31	6.62	4.60

Note: Results are percent change in bare-hull drag. Changes greater than 2% are shown in blue (reduction) or red (increase).

HydroComp NavCad "Effect of initial trim" tool

Once hull data has been entered and a resistance prediction built, you can use the supplemental *Effect of initial trim* calculation to evaluate how much change in bare-hull resistance can be achieved for a constant displacement with different amounts of trim. A trim range of +/- 20% draft is presented. Like the *Drag reduction* tool, you can define Primary and Secondary speeds of operation, and NavCad evaluates a Total energy weighted average of two speeds.

This analysis modifies certain hull parameters based on the trim position, and then the new resistance for the revised "trimmed" hull is predicted. Given that the hull data is parametric, NavCad will internally predict the changes in corresponding hull data based on fundamental geometric and hydrostatic relationships. A change in trim will also affects other data, such as things like LCB position, bulb or transom immersion, and wetted surface.

Is "optimum" attainable?

NavCad's tools specifically do not identify a singular optimum figure, but rather indicate trends and influences. "How much authority does a designer really have to implement a drag-optimized hull form? Or an operator to run with a precise trim?" asks Mr. MacPherson. "So many different design requirements – stability, structure, loading, producibility – influence a vessel's design and construction that employing a unique hydrodynamic optimum is rarely attainable. The same is true for operational constraints. You can only trim so far."

The hunt for precise optimum design characteristics and operational settings can also lead to increasingly complex design procedures. "You will not need to go to school to effectively utilize these tools" states MacPherson. "By knowing the general hydrodynamic influences and trends as suggested by these tools, a designer can fulfill exceptional hydrodynamic performance in a way that does not compromise the larger system. It is extremely valuable for a naval architect to simply know which direction to push a parameter when juggling the various – and often competing – design requirements."

About HydroComp

Celebrating thirty years in 2014, HydroComp has been a leader in providing hydrodynamic software and services for resistance and propulsion prediction, propeller sizing and design, and forensic performance analysis. Through its unique array of software packages and services, HydroComp is able to service naval architectural design firms, shipyards, yacht owners, ship operators, propeller designers, universities and militaries around the globe.

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For more information, please contact:
Jill Aaron, Managing Director
HydroComp, Inc.
13 Jenkins Ct, Suite 200
Durham, NH 03824 USA
Tel (603)868-3344
Fax (603)868-3366
ja@hydrocompinc.com
www.hydrocompinc.com
www.hydrocompinc.com/blog