

The **A**lternative **E**lfsteden **T**our

“ **S**kating away, skating away,
Skating away on the thin ice of a new day.
And as you cross the circle line,
The ice-wall creaks behind
You're a rabbit on the run,
And the silver splinters fly. ”

Iain Anderson, MBE, flautist and band leader

“Thank you kindly and good evening to you, heh! Now, this wee ditty was inspired by the dim and distant past, as it were, in fact so long ago it was damn nearly...”

...the first half of the last century, when the plassen (puddles) and vaarten (canals) of Friesland and Groningen in the North East of The Netherlands froze over most every Winter, fostering a great tradition: the Elfsteden Tocht (trip).

At 200km, a true Elfsteden is almost psychedelic in its intent and hallucinogenic in its effect; a true skating epic that takes its participants (up to 20,000 recreational skaters and 300 semi-pro marathon riders, veritably men-in-tights) through the eleven venerable cities of Friesland - Leeuwarden, Sneek, IJlst, Sloten, Stavoren, Hindeloopen, Workum, Bolsward, Harlingen, Franeker and Dokkum. Unsurprisingly, conditions are never clement, as the freezing cold is usually augmented by a stiff breeze. At least that's how it used to be, but then, after a particularly severe tocht in 1963, when only 69 of more than 10,000 starters finished, God decided enough was enough, and over the five decades since it has only been possible to run the event a further four times.

However, your typical elfsteden marathon skater is nothing if not resourceful. More than likely he (or she) is of farming stock, 6 foot 4 and full of muscles, and goes by the name of Van Benthum, Norg, Hielkema, Hulzebosch or similar. And clearly, if your sense of expediency allows you to house 10,000 pigs in 10 sq.ft. pens in low profile huts (no further details necessary) to guard against penury, you are not going to let a trivial thing like Global Warming stop you from a bit of fun going, as coined by your favourite local country rock band Normaal, 'oerend hard' (awfully loud/fast; https://www.youtube.com/watch?v=7Y_wUu99E7M). Thus the Alternative Elfstedentocht was born, which over the years has taken our Dutch farmers' sons and daughters to places like Lillehammer, Vermont, Lahti, Ottawa and the Lakes Akan and Khövsgöl in Japan and Mongolia. In more recent years, a recurring home has been found in Austria on the Weissensee.

If the skaters can dream up an alternative, so can SOLers. But, of course, SOLers SOL sitting down with both hands on the keyboard, not standing up with both hands folded out of the wind behind their backs. To meet this specific “please be-seated, all” requirement the obvious solution is a DN polar. DN stands for Detroit News, where the DN iceboat was conceived, back in 1937. This design, featuring a coffin-shaped, single-person cockpit, three steel blades in tricycle style arrangement, and a steeply raked 16 ft mast supporting a 60 sq. ft. sail, remains to this day the World's most popular and only truly international iceboat class.

Unfortunately, there is no off-the-shelf polar available for the DN. However, a certain amount of literature about the performance of the DN and of iceboats in general is out there on the interweb. In no particular order, I refer those interested to:

Physics of Sailing, by John Kimball

https://books.google.co.uk/books?id=Xe_i23UL4sAC&pg=PA45&lpg=PA45&dq=lift+to+drag+iceboat&source=bl&ots=k-nbcUDjYu&sig=AFRH-c34L4yUY3Cd2jwr-BuMuX0&hl=en&sa=X&ei=3ii8VOuRMsmyszcgYAM&ved=0CCMQ6AEwAA#v=onepage&q=lift%20to%20drag%20iceboat&f=false



Performance Characteristics of Ice Boats, by Peter K. McCrarry

<http://archive.sailingscuttlebutt.com/news/10/AI-V-1974.pdf>

Boat Speeds, by Bob Dill

https://ice.idniyra.org/Articles/Misc/DN_Ice_Boat_Speeds

Putting Numbers on Iceboat Performance, also by Bob Dill

<https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=12&ved=0CEYQFjAL&url=http%3A%2F%2Fwww.nalsa.org%2FArticles%2FCetus%2FIceboat%2520Sailing%2520Performance-Cetus.pdf&ei=wyC8VJ2tMMatUaWphMAC&usg=AFQjCNG1v6cpBJi3HOq80rnAh8H-V0gyTA&sig2=kYjTJHqSivgneaiz2IDjA>

Wikipedia's Sailing Faster than the Wind

http://en.wikipedia.org/wiki/Sailing_faster_than_the_wind

North Sails delivers Top Iceboating Sails, by North Sails

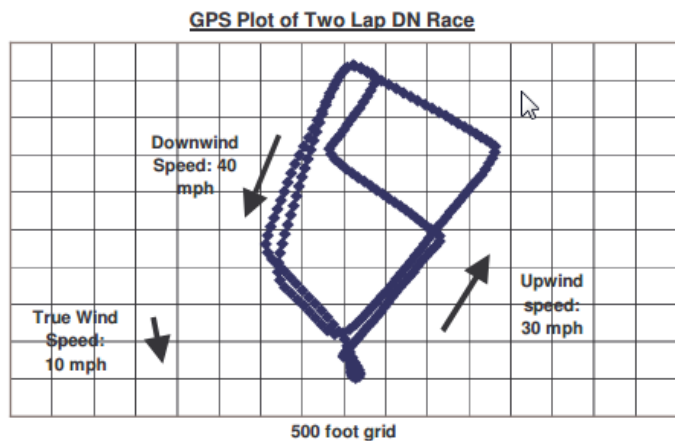
http://www.na.northsails.com/tabid/1945/default.aspx?news_id=4027

Sailing Yacht Design for Maximum Speed, again by Bob Dill

<http://lakeice.squarespace.com/storage/general/speed/Sailing%20Yacht%20Design%20for%20Maximum%20Speed.pdf>

It's a lot of reading, so let me summarize the jist of what I learned:

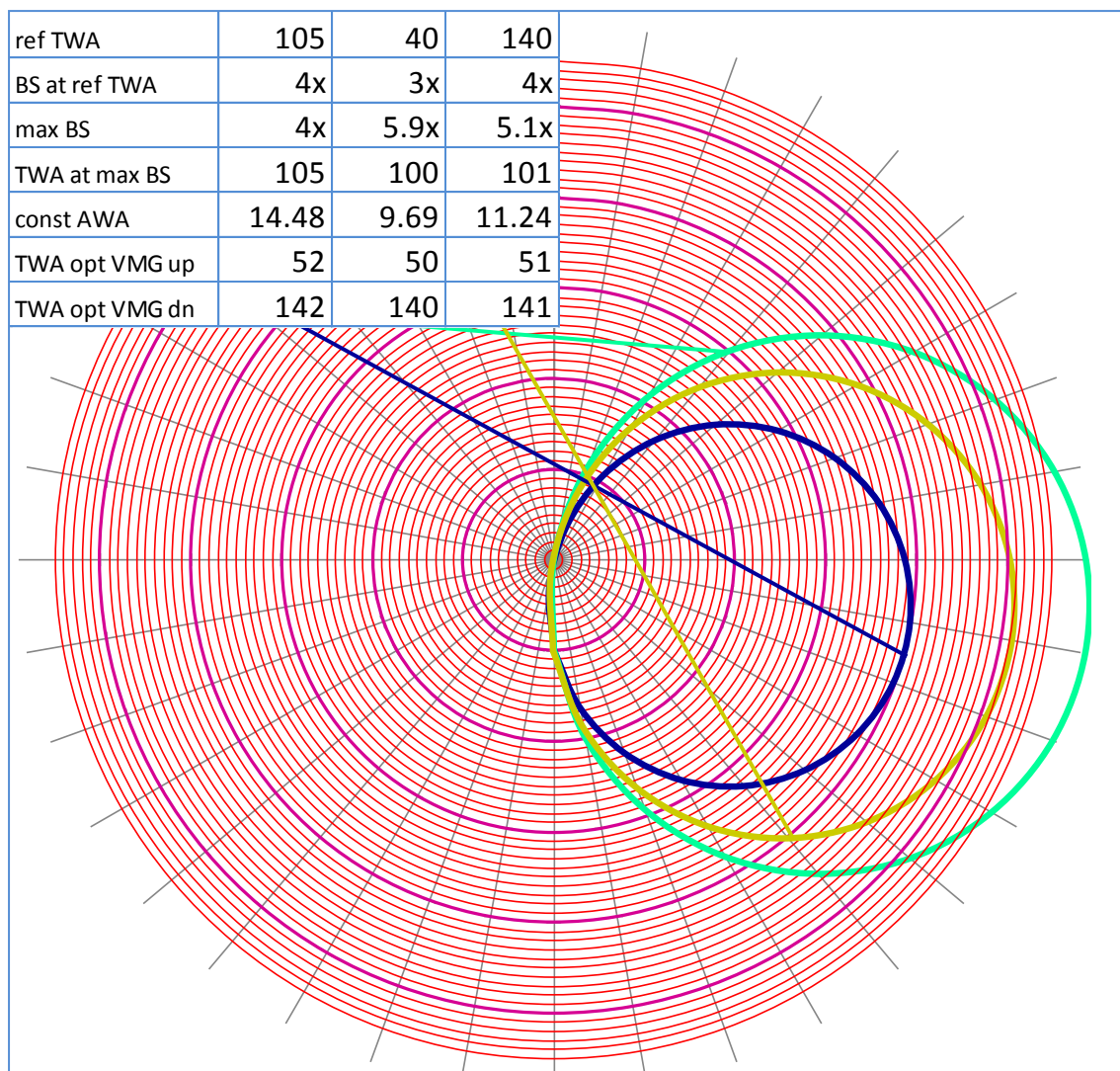
1. Because an iceboat experiences only very little drag from its skates on the ice, the relationship between lift and drag is determined almost entirely by the sailplan and is therefore (assuming shape does not or does not have to deteriorate with increasing windspeed) almost a constant.
2. The apparent wind angle (AWA) expressed in radians in fact equals the inverse of the Lift to Drag Ratio, and is therefore also almost constant for an ice boat.
3. AWA for the DN tends to range between approximately 8 and 12 degrees.
4. To maintain a constant AWA as the true wind angle (TWA) increases, BS must increase per the following relationship (thank you, kroppy): $BS = TWS \times \sin(TWA - AWA) / \sin(AWA)$
5. If you plot BS at constant AWA on a polar diagram you obtain a perfect circle, offset to one side from the origin of the diagram, so that at $TWA = 180$ degrees, $BS = TWS$
6. Typically, in 8 to 9kn of TWS, the DN sails upwind at 3x TWS and downwind at 4x TWS (see adjacent plot made by Bob Dill using readings with a Trimble AG132 apparently).
7. Tacking angles upwind are roughly 90 degrees, downwind a bit better than that.
8. Maximum recorded DN speeds approach 70 knots, and are limited by the righting moment (constant) provided by the skatebase.
9. If the wind falls away much below 2 knots, a DN simply remains stuck to the ice (just like your snow skis on a cold day).



Aided by the 5-point cubic spline User Defined Function written by Doug Jenkins of Newton Excel Bach (not Goedel Escher ..), a fellow countryman of sterling SOLers like Dingo, Tyger, m2c1lw, and intermezzo, which I found at <https://newtonexcelbach.wordpress.com/about/> some time ago, I considered the above guidelines could be sufficient to develop a set of smooth performance curves at 1 m/s intervals up to 11 m/s for the DN. But first of all, I checked:

- a/ does constant AWA return a circular BS plot on a polar grid?
- b/ given constant AWA, what are the optimum TWAs upwind and downwind?
- c/ what AWA is required to obtain a BS of 3x TWS full-and-by at say 40 degrees?
- d/ what AWA is required to obtain a BS of 4x TWS free-and-fast at say 140 degrees?

Below are the results of these checks:



It is clear from the above that constant AWA returns a polar curve that is indeed perfectly circular (as kroppy said: “makes perfect sense; maths, you gotta love it!”). It is also clear that:

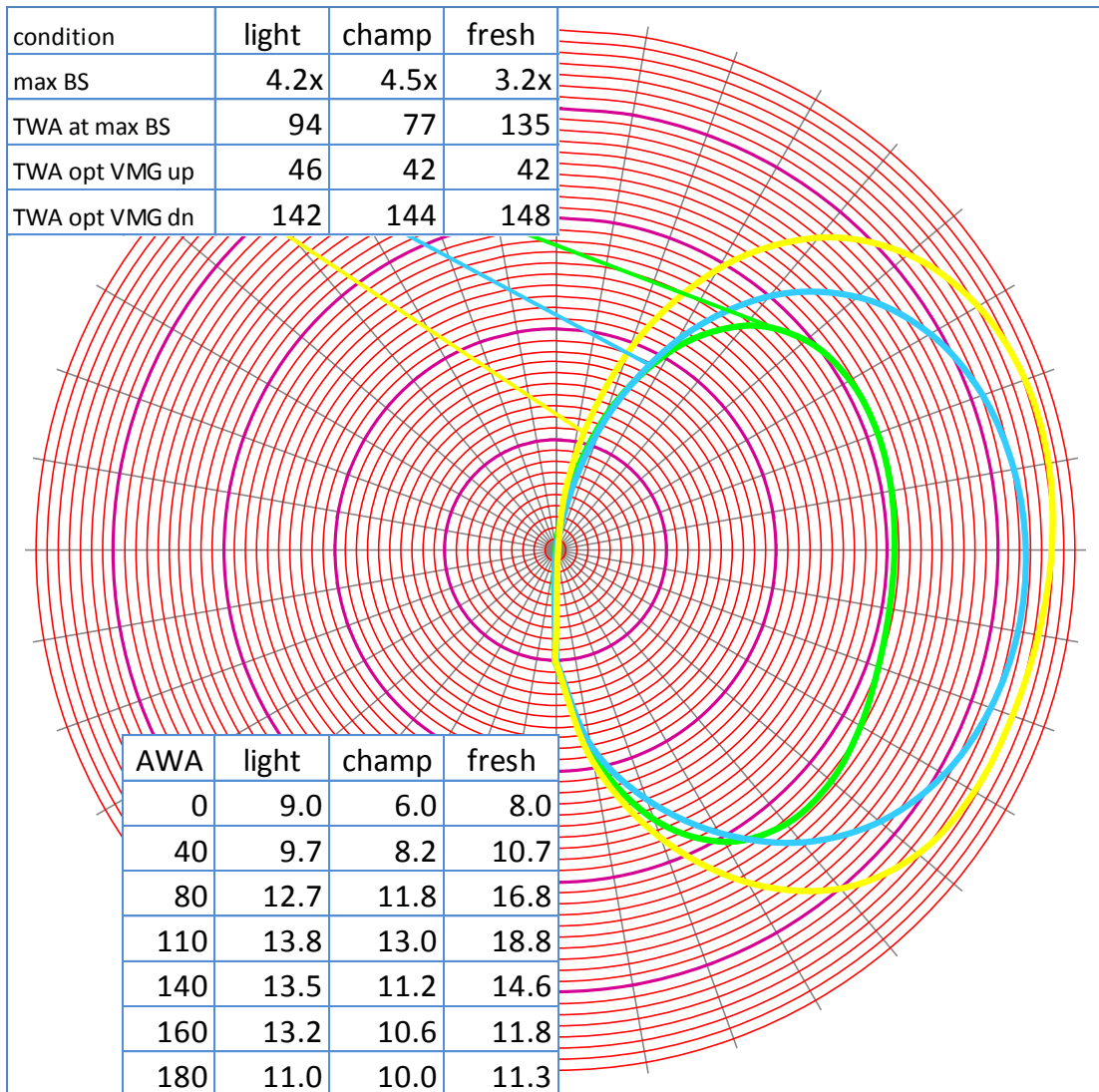
- as AWA reduces, max upwind VMG TWA moves from the low 50s into the 40s, but
- constant AWA will never give you downwind TWAs in the high 140s to low 150s, and
- constant AWAs for appropriate up and downwind TWAs will return unmanageable top speeds and toppling moment as TWA moves to the beam.

Armed with these further insights, and the following simplified boundary conditions:

- best upwind TWA at low BS > 40 degrees,
- best downwind TWA at high BS > 140 degrees,
- max BS c 70kn,
- no BS when TWS < 1.5kn,

I developed three AWA curves for different weather conditions – light airs, fresh winds, and champagne sailing – by selecting AWAs at seven TWAs, including the less-trivial-than-you-might-think 0 and 180 degrees TWAs.

Below is a summary and a polar plot for these three hypothetical scenarios.



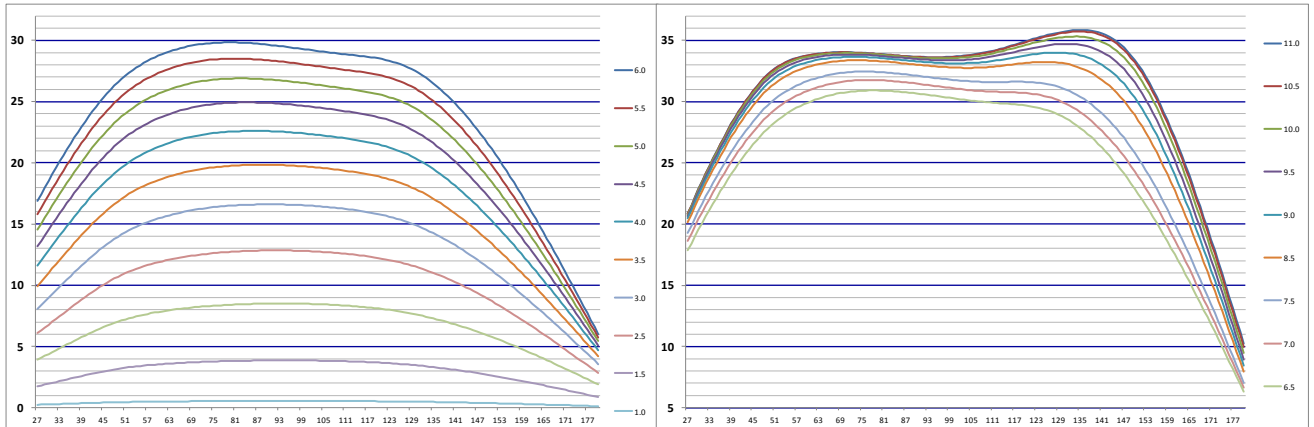
Finally, to create a full set of polar data, I applied the light AWAs to a 2 m/s zephyr, the champ AWAs to a 7 m/s breeze and the fresh AWAs to an 11 m/s small gale, and also set a series of 0.05 m/s decrements from 0.75 m/s down to 0 m/s BS across all TWAs and a series of 0.05 m/s increments from 11 m/s upward to the BSs calculated for 11 m/s TWS, as per the data table below.

m/s	0	30	50	60	80	90	100	110	130	150	180
0.0	0	0	0	0	0	0	0	0	0	0	0
0.05	0	0	0	0	0	0	0	0	0	0	0
0.10	0	0	0	0	0	0	0	0	0	0	0
0.15	0	0	0	0	0	0	0	0	0	0	0
0.20	0	0	0	0	0	0	0	0	0	0	0
0.25	0	0	0	0	0	0	0	0	0	0	0
0.30	0	0	0	0	0	0	0	0	0	0	0
0.35	0	0	0	0	0	0	0	0	0	0	0
0.40	0	0	0	0	0	0	0	0	0	0	0
0.45	0	0	0	0	0	0	0	0	0	0	0
0.50	0	0	0	0	0	0	0	0	0	0	0
0.55	0	0	0	0	0	0	0	0	0	0	0
0.60	0	0	0	0	0	0	0	0	0	0	0
0.65	0	0	0	0	0	0	0	0	0	0	0
0.70	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	0	0	0	0	0	0	0	0	0
2.0	0	4.3852	7.1273	7.8234	8.4141	8.5014	8.4865	8.3626	7.6353	5.8936	1.9000 light
7.0	0	20.3996	29.0801	30.8843	31.7468	31.4690	31.0920	30.8196	29.9745	24.2981	6.6500 champagne
11.0	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.4500 fresh
11.05	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.4975
11.10	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.5450
11.15	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.5925
11.20	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.6400
11.25	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.6875
11.30	0	22.8574	32.4813	33.7868	33.8737	33.6569	33.6656	34.0910	35.7181	33.4370	10.7350

And then interpolated all points in between in two steps:

- per every 0.1 m/s step from 0 m/s to 22 m/s, and these then
- per every 1 degree step between 0 and 180

The resultant performance curves, plotted on a cartesian grid for better clarity look like this.



The complete workings can be found in the attached macro-enabled workbook DNpolarV2. xlsx. Allow macro's and if you have the developer tab enabled in Excel, you can find Doug Jenkins' csplinea (x-values, y-values, x-int points) in the Visual Basic module1.

I considered tuning down the performance above 11 m/s but decided against it, since on the ice, more wind doesn't change the state of the water and thus slow you down. In hindsight I do wonder whether I have allowed the upwind tacking angles be a little too tight. I was surprised to see that interpolation introduced a small BS dip between c 80 and 130 degrees, but decided not to adjust it out, since it seems possible that with a strong wind abeam the sail has to flog so much that some speed is lost. Remember, DN racers tend to only sail up-and downwind sausages. Which, by the way, is not what I am planning to propose for the SOL Alternative Elfsteden Tour.

So, where to sail the DN? Well, obviously in high latitudes or altitudes or both. When? In Winter. How often? It would have to be 11 times a year. Perhaps the Elfsteden Tour could be a sub-series within the SOL Sprint Series?

To try our DN out, I propose we airfreight our skates, boxes, carbon masts and Kevlar sails to Ulan Bator and then truck them up to Khatgal at the southern end of Khövsgöl Dalai, where the alternative skating tourists actually raced in 2007.

I confess to finding Google Earth a relatively user-unfriendly tool for planning trips. Nevertheless, adjacent please find a screenshot from - Earth of the part of the world we are talking about. Khatgal lies on the cove in the very southern end of the lake.

South to North the lake is about 60 nm, but across no more than 10nm. Unfortunately the prevailing wind is WNW F3† so a simple race up to the Russian border and back will not be a good course. Instead some diagonal work across the lake will more than likely be required.



Where else could we sail our DNs? Well, there are plenty of interesting lakes that freeze over in the northern hemisphere's Winter, some already quite familiar to SOLers, but for a year-round event some southern locations will need to be found as well. An unabridged selection of potential venues not yet visited by SOL rounds of this proposal.

† see http://wisuki.com/statistics/6383/khovsgol-nuur?a_wi=4&wi_m=4&temp=monthly&rain=quantity

Some Interesting Lakes: a possible programme

Lago Fagnano, Tierro del Fuego, Argentina	June
Lago Sarmiento, Magallanes y la Antártica, Chile	July
Lake Manapouri, South Island, New Zealand	August
Ozero Taymyr, Krasnoyarsk Krai, Russia	September
Iliamna Lake, Alaska, USA	November
Lake Võrtsjärv, Estonia	December
Silvaplana, Engadin, Switzerland	January
Lake Pielinen, North Karelia, Finland	February
Kejimkujuk Lake, Nova Scotia, Canada	March
Stora Lullevatten, Norrbotten, Sweden	April
Reserve Month	May

Some Reserve Locations

Lake St Clair, Michigan, USA
Lake Balaton, Transdanube, Hungary
Jezorio Śniardwy, Masuria, Poland
Kyjiv's'ke Vodokhovyshe, Kiev Oblast, Ukraine
Balqaş Köli, Kazakhstan
Issyk Kul, Kyrgyzstan
Lake Baikal, Russia
Hülún Hú, Inner Mongolia, PRC
Pangong Tso, Kasmir, India
Ammersee, Bavaria, Germany
Attersee, Salzkammergut, Austria