Q&A

Q: Ralph Earle, President of the Honololu Rowing Club, HI, US is asking: "In the January 2011 Newsletter you derive drag factors for ergs to match the perceived feel of various boat types on the water. That suggests that the OTW (on the water) equivalent DFs are dependent on boat speed, so I am writing to ask: Do you have formulae which take that into account?

For example, I row a 2x; your newsletter suggests an equivalent DF=103. The erg I use currently has DF ~110, but it feels noticeably "lighter" than when I'm rowing OTW @2:10/500m."

A: The following five factors affect the "lightness" or "heaviness" of rowing feelings:

1. Drag resistance force applied to a boat hull or to the flywheel of an erg.
2. Inertia forces, which are created at acceleration of rower-boat or rower-erg masses.
3. Gearing ratio, which affects transfer of above forces to the handle.
4. Blade slippage in the water, which is not presented on an erg.
5. Elastic force of a return cord on an erg, which is quite small and not presented in a boat.

Handle Drag Factor ***HDF*** (RBN 2011/01) represents a cumulative effect of all above factors, which work together and define rowing mechanics and rower's feelings. It will take many equations to estimate them separately, which will complicate the picture and not really necessary here. Instead, we will try to illustrate how main variables of rowing may affect rower's feelings.

Effect of the drag resistance is obvious: on water, head wind, cold water, small boats and water brakes make rowing heavier. Weather conditions always change, so, on an erg, it is difficult to simulate a specific boat type with a damper.

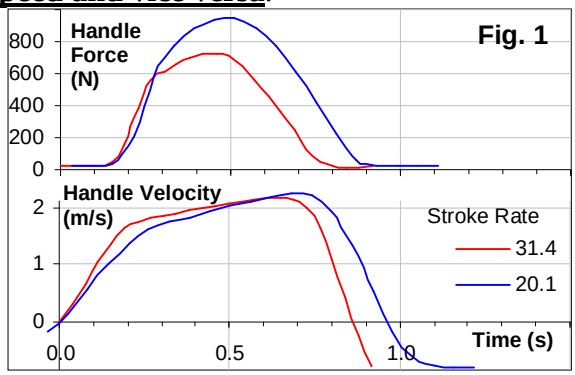
Gearing works differently: in a boat it vary during the drive (heavier at the catch and finish, lighter at the middle, RBN 2007/03), but it is constant on erg. Therefore, if a rower used to apply peak force at catch, it feels heavier on water than on erg and vice versa.

Effect of Stroke Rate (SR) vs. Work per Stroke (WPS). ***WPS*** is a product of the Stroke Length ***SL*** and Force ***F***. It is possible to achieve the same power ***P*** and speed using various combinations of ***SR, SL*** and ***F***:

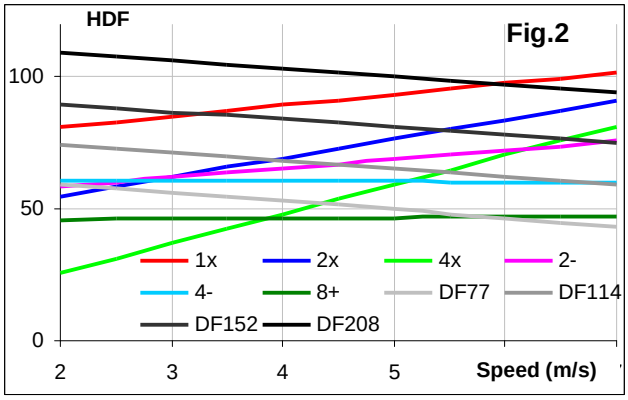
$$P = 60\ WPS / SR = 60\ F\ SL / SR \qquad (1)$$

To achieve the same power at lower stroke rate, a rower has to pull harder and longer, which feels heavier. Also, at lower rate, the recovery time is longer and the rower-boat system or the flywheel on erg decelerates more, so the rower has to start from lower velocity at the catch, which adds even more "heaviness".

Fig. 1 shows curves of the handle force and velocity, obtained on Concept2 erg model D at the same DF= 118, speed (1:46.6 /500m) and power (288W), but at very different stroke rates 31.4 and 20.1 str/min. In the second sample, the stroke length was 11cm (8%) longer and average forces 110N (26%) higher. HDF values were 71.6 and 79.3 correspondingly, which is closer to a double in the first case and to a single in the second case (RBN 2011/01). This means: **rowing at lower stroke rates with longer length and higher force makes feelings "heavier" at the same boat or erg speed and vice versa**.



Above data shows that rower's feelings are related to the rhythm (share of the drive time in the total stroke cycle time), which is very closely correlated with the stroke rate (RBN 2003/03) and, hence, with speed. We analysed dependence of HDF on the speed on a static C2 erg at four DF settings (77, 114, 152 and 208) and on water using our database (Fig.2).



It was found that HDF decreases at higher speed on erg, but it increases in sculling boats and 2-, and remains nearly constant in big sweep boats. We don't know the reasons yet, and only speculate that they could explain higher racing stroke rate usually used in big sweep boats. The correlations between speed and HDF were quite low (the highest r=0.33 in 4x), that means HDF was quite consistent across various speeds.

Concluding: **rower's feelings depends on many factors: stroke rate, rhythm, power, speed. Some factors are on-water specific: whether, boat type and variable gearing, other erg specific: erg type and DF. HDF factor can be used for general estimation of rower's feelings, providing similarity of other variables.**