Q&A

There were discussions on rowing forums about setting the drag factor (DF) on ergs and about differences and similarities of a new Concept2 Dynamic erg (DIR) with its static and on-slides analogies. To provide an objective analysis of mechanical conditions and the rower's feelings, we used a concept of "Handle Drag Factor" (***HDF***), which can be derived similarly to the boat drag factor:

$$HDF = P / V_{h.av}^3 = P / (L / T_d)^3 \quad (1)$$

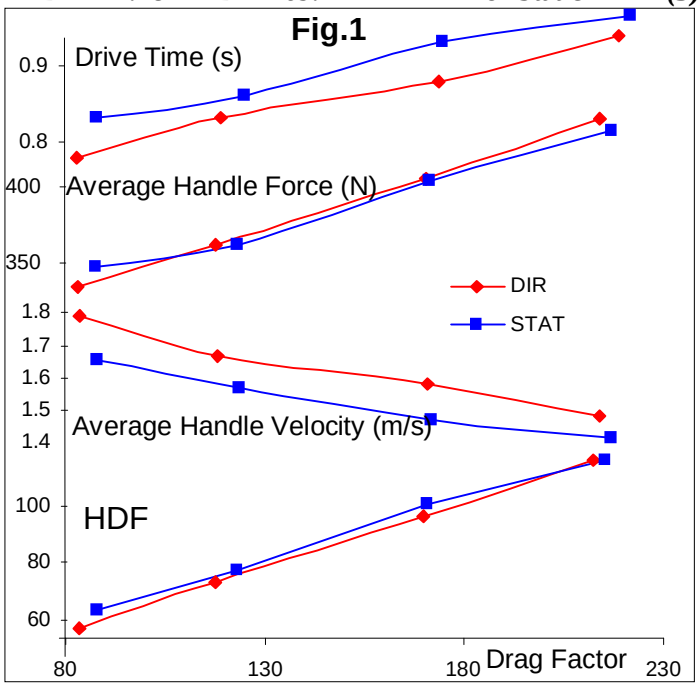
where P is rowing power, $V_{h.av}$ is average handle velocity during the drive, which equal to a ratio of the drive length L and time T_d.

For analysis we used the data of the previous measurements in a boat and on various types of ergs (RBN 2010/10). Also, additional measurements were conducted on DIR and on static erg model D with various Drag Factors (DF). Four 1 min samples were collected at shutter settings 1, 4, 7 and 10 and DF was recorded. The target was set to maintain an average racing intensity. The measured stroke length and average force application was very similar on both ergs.

When DF increases, the drive time also increases on both ergs, force application grows and average handle velocity slows (Fig.1, Appendix 1.). However, drive time was shorter and handle speed was higher on DIR than on the static erg at all DF settings. Very high correlation (r=0.998) was found between calculated ***HDF*** and ***DF*** recorded from the erg monitor, which confirms validity of the measurements and allows us to determine the equations:

$$DF = 2.34 * HDF - 51.0 \quad \text{for DIR} \quad (2)$$

$$DF = 2.48 * HDF - 69.1 \quad \text{for Static} \quad (3)$$



On average, ***HDF*** was 5% lower on DIR than on static erg at the same DF settings, which could be explained by lower inertia forces.

To compare mechanical conditions of rowing on both ergs with on-water rowing, we derived ***DF***s, which correspond to various boat types (Table 1) using the following method. Race times were taken and average boat speed was derived in the six men's events as an average of the winners' times of the Worlds and Olympics from 1993-2009. This corresponds to rowing in some average conditions, not in strong tail wind, which usually corresponds to the World Best times. Rigging dimensions were taken based on results of rigging surveys and gearing ratios **G** were calculated using actual inboard and outboard lengths (RBN 2006/11). The maximal blade ***Vb.max*** velocity relative to the boat was calculated as a sum of the boat velocity and blade slippage through the water at perpendicular oar position to the boat (RBN 2007/12). The values of the slippage velocity are higher in rowing than in sculling, which reflects bigger total blade area and higher blade efficiency in sculling (RBN 2010/08). The maximal handle velocity ***Vh.max*** was derived as:

$$Vh.max = Vb.max * G \quad (4)$$

To produce an average handle velocity ***Vh.av*** during the drive we derived its ratio ***R*** to ***Vh.max*** using our database (n=5522) and found it has very low variation across boat types ($R = 0.667 \pm 0.03$). So,

$$Vh.av = 0.667 * Vh.max \quad (5)$$

The value of rowing power was taken as 550W as an average across all boat types, which corresponds to the model of the World record times (RBN 2007/08). ***HDF*** was derived using equation 1 and corresponding ***DF***s were derived for DIR and the static erg using equations 2 and 3. Finally, the damper settings ***S*** were derived using a common equation for both ergs:

$$S = 0.065 * DF - 4.32 \quad (6)$$

Table 1	1x	2x	4x	2-	4-	8+
Race Time (m:s)	6:47.0	6:16.1	5:49.7	6:26.3	5:55.1	5:35.5
Boat Speed (m/s)	4.91	5.32	5.72	5.18	5.63	5.96
Inboard (m)	0.89	0.88	0.87	1.16	1.15	1.14
Oar Length (m)	2.89	2.90	2.91	3.75	3.76	3.77
Actual Inboard (m)	0.85	0.84	0.83	1.03	1.02	1.01
Act. Outboard (m)	1.76	1.78	1.80	2.30	2.32	2.34
Gearing Ratio ***G***	2.06	2.11	2.16	2.23	2.27	2.31
Blade Slip (m/s)	1.00	1.00	1.00	1.20	1.20	1.20
Vblade max (m/s)	5.91	6.32	6.72	6.38	6.83	7.16
Vhand. max (m/s)	2.86	2.99	3.11	2.86	3.01	3.10
Vh average (m/s)	1.91	1.99	2.07	1.91	2.01	2.07
Power (W)	550	550	550	550	550	550
HDF	79	69	62	79	68	62
DF DIR	**133**	**111**	**94**	**134**	**108**	**95**
DF Static	**127**	**103**	**84**	**127**	**100**	**86**
Damper DIR	**4.4**	**2.9**	**1.8**	**4.4**	**2.7**	**1.9**
Damper Static	**4.0**	**2.4**	**1.2**	**4.0**	**2.2**	**1.3**

Conclusion: **setting damper on the static erg to 1 corresponds to rowing in 8+ and 4x, to 2-2.5 – in 4- and 2x, to 4 – in 2- and 1x. On DIR the damper should be opened a half unit more.** Check DF from the monitor and adjust it to the values in Table 1 for more accurate settings.

Appendix 1.

Comparison of mechanical variables of the static and dynamic ergs at various settings of the Drag Factor (DF).

Low DF **High DF**