Q&A

Q: We have received a number of positive replies to our spreadsheets on the ratio of speed to stroke rate on water and on erg (RBN 2007/10). The most common question was: "**How the speed/rate ratio depends on the duration of the exercise?**" In other words: "If we know some normative speed/rate data for one distance, how can we extrapolate for another workout?"

A: To answer this question, we need to derive an equation describing dependence of speed and power (***y***) on the distance and time of the workout (***x***). Previously, the power or logarithmic functions were used for this purpose (1). The power function $y=x^a$ was used here for simplicity. Instead of absolute values of speed ***V*** and distance/time ***D/T***, their ratios (%) to corresponding values obtained in 2k race were used:

$$rV = rD^p \quad (1) \qquad rV = rT^q \quad (2)$$

Two sources of data were used, both obtained on Concept2 ergometer: the world best times at various distances (2) and average data on a group of 20 elite rowers (unpublished data). The last sample fits very well with the power regression line (R^2=0.99), but world record data has lower determination (R^2=0.96) because of some outliers (e.g. world men's record on 500m 1:10.5 = 119.4% to 2000m record 5:36.6):

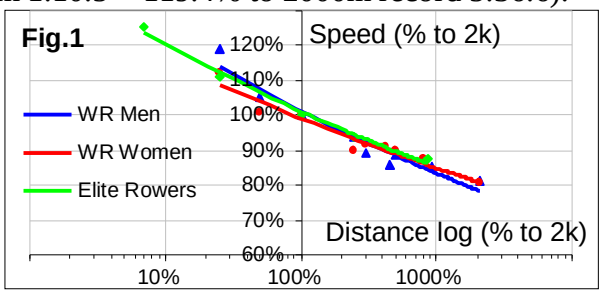

Fig.1 shows that men have higher factor in the equation 1 (p=-0.08385) than women (p=-0.07104). This means **men are better sprinters, while women are relatively better in long distances**. The general factors in all studied groups were found as p=-0.07748 and q=-0.07228.

Let's leave to physiologists the discussion of the sources of metabolic energy at various distances; here we are interested in pure mechanical aspects. The 2nd and 3rd columns of Table 1 show normative percentages of speed and power at various distances based on general trends.

To achieve the variation of power ***P*** at various distances, a rower has two options: vary stroke rate ***R*** or work per stroke ***WPS***:

$$P = WPS / T = 60\ WPS\ R \quad (3)$$

(where ***T*** is duration of the stroke cycle)

Practically, WPS means force application, because the stroke length usually does not change much and even has an opposite trend: it is getting shorter at higher rates. Usually, both options are used together. Rowers use higher stroke rate and apply more force at shorter distances, and vice versa, so "constant WPS" method doesn't make sense here.

Various strategies can be used to vary power and speed. Some rowers and crews prefer to vary stroke rate and maintain forces more or less constant. Others vary force application quite significantly. Also, various strategies could be used at shorter and longer distances:

- At short distances a rower may not have enough capacity/skills to increase speed and stroke rate, and have to use higher force and WPS.
- At long distances, force and WPS may drop due to muscles fatigue, which must be compensated with the stroke rate.

Stroke rate and force application must be optimised individually to achieve the best performance.

In the last four columns of the Table 1 we tried to give a feeling of how stroke rate and force application may vary, when using different strategies. Percentages of "Effect of the stroke rate" show its share in the variation of power/speed:

- 100% means all variation of power is achieved by the variation of stroke rate while WPS remains constant.
- 50% means variation of the power is produced by equal variations of both stroke rate and WPS, etc.

Racing stroke rate 34 str/min was used as the most common for 2k race distance.

Table 1			Effect of the stroke rate (1/min)			
Distance (m)	Speed (%)	Power (%)	25%	50%	75%	100%
250	117.5%	162.2%	39	45	50	55
500	111.3%	138.0%	37	40	44	47
1000	105.5%	117.5%	35	37	38	40
2000	100.0%	100.0%	34	34	34	34
5000	93.1%	80.8%	32	31	29	27
6000	91.8%	77.5%	32	30	28	26
20000	83.7%	58.6%	30	27	23	20

Tables in the attached spreadsheet (3) give more detailed information on these variables with one additional dimension - relative intensity. In training athletes usually perform exercise with efforts lower than in racing (100% of their speed/power at the given distance), so percentage of intensity shows speeds at corresponding relative efforts. These tables would work perfectly on an erg, because the indicated speed is impacted by power only. In a boat speed is affected by weather conditions. In the spreadsheets users can input their own data, calculate individual factors in power equations 1, 2 and compare them with the general trends. This exercise will indicate if the rower/crew is better in sprinting or in long distances.

References

1. Gordon S.M. 2008. Sport training. Moscow, FK, 256
2. World best times on Concept2 ergometer. www.concept2.com
3. Rowing Distance-Speed-Rate Calculator. http://www.biorow.com/RBN_en_2012_files/Distance-Speed-Rate%202012%2001.xls