## Q & A

**Q.**: During the last World Rowing Forum (www.worldrowing.com/news/fullstory.sps?iNewsid=272187&itype) British National coach Miles Forbes-Thomas asked us a question with the following meaning: "Can we use hydro-dynamical drag factors of the various boat types for defining their relative speeds and Gold Standard Times?"

**A.**: First, let us mention two serious limitations of this analysis method:

1. There is no such a thing as generic drag factor for certain boat type, because different boat brands have different dimensions and other parameters (riggers, surface finish, etc.).

2. The method assumes constant rowing power production, which is obviously not the case in different rowers' categories (man vs. women, heavyweight vs. lightweight, sweep vs. sculling) and may vary even in the same category with different boat size (single-double-quad).

For these reasons, we didn't use the drag factors in the Forum presentation. However, now we've decided to investigate it further. We took boat dimensions from www.empacher.com because this brand was the most popular in elite rowing. Matthew Findlay, an Eng.D. scholar at Southampton Uni., made calculations of the **drag factor k1 using computational fluid dynamics (CFD), 1st and 2nd rows in the tables below**.

Also, we derived **drag factor k2 based on statistics of our biomechanical measurements during 7 years in AIS, Canberra: 3rd and 4th rows** (total sample size 1102 points).

The next six rows in the tables represent ratios of the boat speeds based on prognostic times:

**5th row - Average of the winners of Worlds and Olympics during 1993-2005;**

**6th row - World Best Times;**

**7th row – Australian Gold Times [1];**

**8th row – Dr. Peter Schwanitz prognosis [2];**

**9th –Our moderate trends (RBN 2005/5);**

**10th– The best case trends (RBN 2005/5).**

| | W1x | W2- | W2x | W4x | W8+ |
|---|---|---|---|---|---|
| k1 | 1.000 | 0.749 | 0.748 | 0.662 | 0.624 |
| 2 | 100.0% | 110.1% | 110.2% | 114.8% | 117.0% |
| k2 | 1.000 | 0.693 | 0.692 | 0.530 | 0.425 |
| 4 | 100.0% | 113.0% | 113.1% | 123.6% | 133.0% |
| 5 | 100.0% | 104.0% | 107.6% | 114.9% | 117.2% |
| 6 | 100.0% | 103.4% | 107.3% | 115.3% | 120.0% |
| 7 | 100.0% | 104.1% | 107.8% | 117.2% | 121.2% |
| 8 | 100.0% | 103.4% | 107.1% | 113.4% | 118.4% |
| 9 | 100.0% | 105.6% | 109.2% | 117.7% | 121.6% |
| 10 | 100.0% | 104.4% | 108.7% | 116.1% | 120.0% |

The similar ratios of the speed in men's boat types, assuming M1x is 100%:

| | M2- | M2x | M4- | M4x | M8+ |
|---|---|---|---|---|---|
| k1 | 0.744 | 0.743 | 0.667 | 0.664 | 0.615 |
| 2 | 110.4% | 110.4% | 114.5% | 114.6% | 117.6% |
| k2 | 0.711 | 0.778 | 0.514 | 0.619 | 0.480 |
| 4 | 112.0% | 108.7% | 124.8% | 117.3% | 127.7% |
| 5 | 105.4% | 108.2% | 114.4% | 115.2% | 119.7% |
| 6 | 105.9% | 108.8% | 116.1% | 117.4% | 123.9% |
| 7 | 104.8% | 108.6% | 114.7% | 117.4% | 122.6% |
| 8 | 106.6% | 109.3% | 115.5% | 115.5% | 120.9% |
| 9 | 104.5% | 107.7% | 114.8% | 116.6% | 120.9% |
| 10 | 105.0% | 107.9% | 115.7% | 116.5% | 120.8% |

The calculations were done assuming equal power production in open men's (or women's) boat types and using equation: $V = (P / k)^{1/3}$ Therefore, we do not compare lightweight categories here.

In the big boats, 4x, 4- and 8+, computational values are very close to average of the winners of Worlds and Olympics over the last 13 years. It is interesting that computational ratios are similar (117.0%-117.6%) between 1x and 8+ in both men and women, but the observed ratios show 2-3% faster speed in M8+ compared with W8+ This could tell us that W8+ has more reserve to increase the speed. (It is unlikely that W8+ will use this reserve owing to less competition at International regattas). In pairs and doubles, computational boat speed must be much higher that we observe now. We can only speculate now why it happened.

Considering boat speed ratios based on our biomechanical measurements, we can say that only the ratio of speeds between M1x and M2- is very close to the ratio observed at the Worlds and found in the best times. For other big and medium boats this data says that they must be much faster than singles. This, probably, can be explained by specifics of the sample tested: singles have shown much better performance than crew boats.

In conclusion, prognostic times based on boat hydrodynamics have significant limitations and not applicable for comparison between rower's categories. They require further investigations, which may involve measurements of the real drag factors and/or more accurate modelling.

## References

1. Australian "Gold Standard Times" on www.rowingqld.asn.au/Documents/Prognostics

2. Schwanitz. P. 2005. Vollzogener Entwicklungstrend und mogliche Prognose 2005-2008. Rudersport, 16, p.526-527

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