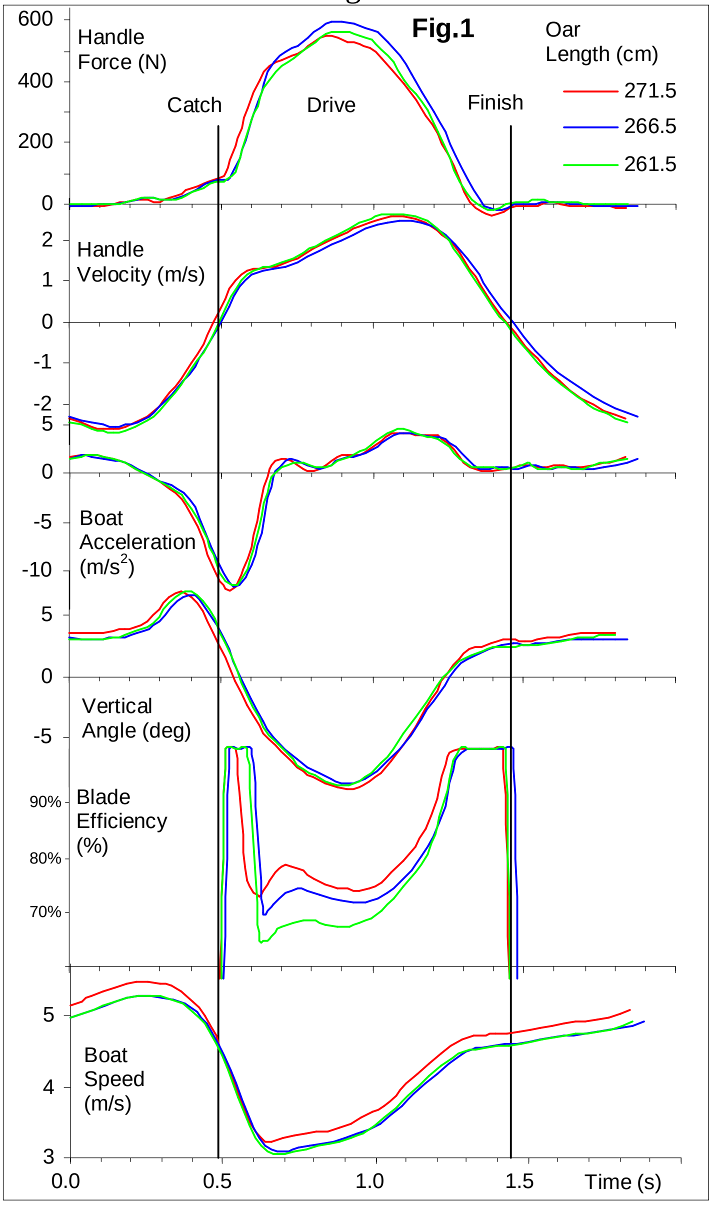
Facts. Do you know that…

…changing oar length a few cm does not dramatically affects rowing biomechanics? Recently, an experiment was conducted on two single scullers with three sets of sculls of the same Concept2 vortex-smoothie type, but of different lengths: 271.5 cm, 266.5 cm and 261.5 cm. Inboard was set to 86.5 cm in all sets. In each session data samples were taken during 20 stroke pieces at stroke rates 20, 24, 28, 32 str/min and max.

The Fig.1 shows comparison of the main biomechanical variables of one of scullers at the stroke rate 32 str/min with various lengths of sculls:



Some variation in force application is noticeable, but the majority of variables are quite similar in these very different rigging settings. Boat acceleration with the shortest oar length was slightly higher in the middle of the drive, but it was lower during the first half of the drive. The highest average boat speed with the longest sculls was related to a light tail wind. The main difference was found in the blade efficiency, which decreases significantly with decreasing the oar length, especially during the first half of the drive.

Table 1 represents average values of the main biomechanical variables of two scullers at all stroke rates:

Table 1. Biomechanical Variables	**Oar Length (cm)**		
	271.5	**266.5**	**261.5**
Gearing	1.976	1.915	1.855
Average stroke rate (1/min)	28.2	30.7	31.5
Drive Time (s)	1.051	0.966	0.930
Angle (deg)	108.5	107.9	111.8
Effective Angle (%)	74.7%	76.5%	77.7%
Blade Efficiency (%)	78.5%	77.2%	73.7%
Max. Handle Velocity (m/s)	2.35	2.52	2.71
Average Handle Velocity (m/s)	1.52	1.64	1.77
Max.Force (N)	574	629	616
Average Force (N)	336.8	368.7	370.5
Max.Force Position (% Angle)	33.3%	35.3%	35.5%
Work per stroke (J)	618.6	663.5	694.0
Rowing Power ***P*** (W)	299.0	349.0	375.9
Propulsive Power ***Pprop*** (W)	234.6	269.6	277.2
Boat Speed ***V*** (m/s)	4.17	4.32	4.38
Drag Factor **= *Pprop / V³***	3.25	3.34	3.30
Total Drag Factor =***P / V³***	4.14	4.32	4.48
Handle Drag Factor ***HDF***	81.6	75.8	64.5

Shorter scull allow faster handle velocity, which leads to shorter drive time even at slightly longer rowing angles and, hence, allow higher stroke rate and rowing power. However, shorter outboard at the same inboard makes the gearing lighter by about 12%, which means blade force became higher at the same handle force. Higher blade force at the same blade area increases water pressure per square cm and, hence, blade slippage through the water. Therefore, blade efficiency of lighter gearing appeared to be lower and rower have to spend more energy for moving water at the blade.

However, lighter gearing allow faster rower's movements, so it could increase power production (see Hill law in RBN 2007/09). HDF factor (RBN 2011/01) shows that "heaviness" of the shortest sculls was similar to rowing in a quad or on Concept2 erg with the damper settings 1. Medium oar length 266.5 was close to a double or erg damper setting 2 and was the optimal for the given sculler, which corresponded with results, produces by our Rigging Chart (http://biorow.com/RigChart.aspx).

Concluding:

- **Changing oar length in quite large scale doesn't affect significantly forces, power and boat speed, so it should not scare coaches and rowers.**
- **Shorter oars and lighter gearing allow faster drive and, hence, higher stroke rate, but decrease blade efficiency.**
- **An optimal gearing is a balance between rower's and blade efficiencies and depends on rower's dimensions and boat speed.**

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