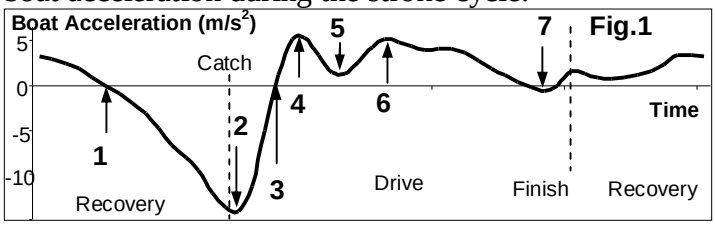
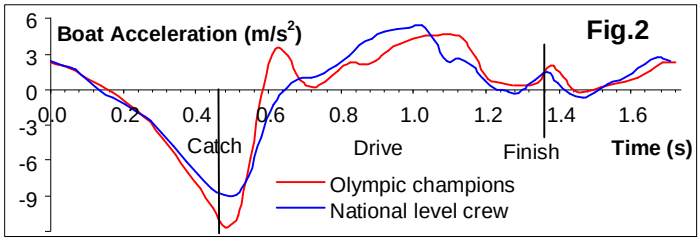
Analysis of 'boat acceleration'

Having briefly touched this topic quite some time ago (RBN 2002/06,08, 2003/11), we will now discus it in more details. Fig.1 represents a typical pattern of boat acceleration during the stroke cycle:



The following variables could be derived, which have specific interpretations in the evaluation of the rowing technique:

1. "***Zero before catch***" defines the moment, when the boat acceleration becomes negative during the recovery. At this moment, the crew changes the force application to the stretcher from pulling to pushing, which influences the deceleration of the seat movement and coincides with the peak leg velocity during the recovery. At high stroke rates and in better crews, this moment occurs later and closer to the catch, so its position relative to the oar angle and timing relative to the catch has a negative correlation with the stroke rate (r = -0.35, see Appendix 1).
2. "***Negative peak***" usually happens just after the catch (when the oar has changed direction), but before full entry of the blade. Its magnitude is highly dependant on the stroke rate (r =-0.82, RBN 2002/08). The best crews show a deeper, but narrower negative peak (Fig.2), which could be explained by a sharper "catch through the stretcher" (RBN 2006/09). Therefore, it is very unproductive to try to minimise this so-called "boat check", which is one of the myths of rowing biomechanics. The negative peak has a slightly lower magnitude in eights, which could be explained by a heavier boat mass with the coxswain, in proportion to the rowers' mass.



3. "***Zero after catch***" occurs, when the boat acceleration becomes positive due to the gate/handle forces increasing faster than the stretcher force. This moment happens earlier in better crews and at higher stroke rates (r = 0.37).
4. "***First peak***" is caused by the fast increasing of the gate/handle forces ("front-loaded" drive) and defines «the initial boat acceleration» micro-phase and "the trampoline effect" (RBN 2006/02). According to our statistics (n=5248), it is not observed in about 30% of crews at 20 str/min and in 6% of crews at 36 str/min, so its magnitude has a moderately positive correlation with the stroke rate (r = 0.41). The best crews usually have a higher first peak, which can be close and even greater than the second peak. No significant difference was found in the values of the first peak between various boat types.
5. "***Drive hump***" is explained by an increase of force on the stretcher during "the main rower's acceleration" micro-phase (1), which is caused by shortening the leverage of the stretcher force rel. hips at the placement of the heels onto the footplate (RBN 2008/07). The best crews manage to maintain the value of the drive hump just above zero. Negative values of this variable are usually related to the hump of the force curve, which could be caused by one or several of the following reasons:

- "Disconnection" of the legs and trunk due to a weak posture of the low back (RBN 2010/02);
- "Double trunk work", where the trunk opens early in the catch, causing a hump in the trunk velocity;
- Sinking the blade too deep into the water, which causes a longer vertical leverage of the handle force relative to the stretcher;
- Too quick an increase of force at the catch: "don't bite-off more than you can chew".

6. "***Second peak***" occurs, when leg velocity and stretcher forces start decreasing, while relatively higher handle/gate forces are maintained by fast movements of the trunk and arms. This causes the deceleration of the rower's CM and transfer of his kinetic energy to the boat mass. The value of the second peak has a small positive correlation with the stroke rate (r = 0.23).
7. "***Finish hump***" is related to the transition phase from the drive to recovery and blade removal from water. In the best crews, this value does not drop below zero, which is achieved by active arm-pull ("finish through the handle", RBN 2006/10) and clean blade work without feathering in the water.

The pattern of the boat acceleration should be considered as a resultant variable, a sort of "indicator" of rowing technique. Therefore, it is not very productive to target the boat acceleration itself, but better to look into the movement of the rower and acceleration of his/her CM. The great Steve Fairbairn said in 1930: "**Find out how to use your weight and you will have solved the problem of how to move the boat**".

References

Kleshnev, V. 2010. Boat acceleration, temporal structure of the stroke cycle, and effectiveness in rowing. Journal of Sports Engineering and Technology, 233, 63-73.

Appendix 1. Statistical values of the variables of the boat acceleration

	Variable	Mean (n=5248)	±SD	Correlation with Stroke Rate
Positions from Catch in % of Total Oar Angle	Zero Before Catch (%)	33.5%	8.9%	-0.35
	Negative Peak (%)	1.6%	1.7%	0.06
	Zero after Catch (%)	12.1%	3.7%	0.12
	First Peak (%)	16.8%	6.6%	0.18
	Drive Hump (%)	24.4%	7.2%	0.28
	Second Peak (%)	57.2%	15.6%	-0.07
	Finish Hump (%)	82.0%	24.1%	-0.16
Timing from Catch in % of the Stroke Cycle	Zero Before Catch (%)	-19.4%	5.2%	0.37
	Negative Peak (%)	2.9%	1.9%	0.11
	Zero after Catch (%)	9.7%	2.0%	0.37
	First Peak (%)	11.9%	3.0%	0.40
	Drive Hump (%)	15.8%	3.4%	0.60
	Second Peak (%)	27.6%	5.9%	0.37
	Finish Hump (%)	37.9%	9.8%	0.22
Absolute values (m/s^2)	Negative Peak (m/s^2)	-7.42	2.57	-0.82
	First Peak (m/s^2)	1.65	1.19	0.41
	Drive Hump (m/s^2)	0.50	0.88	0.01
	Second Peak (m/s^2)	3.88	1.19	0.23
	Finish Hump (m/s^2)	0.82	1.55	0.28