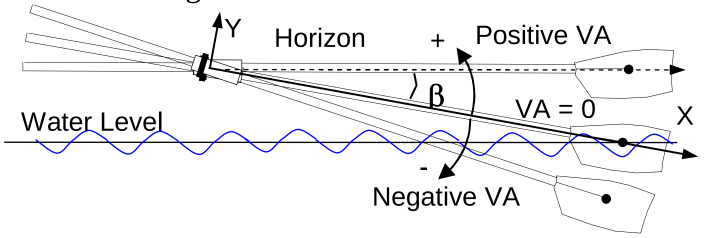
Q&A

Q: John Ewans of Upper Thames Rowing Club is asking: "What is the approximate angle that the blade goes below horizontal on both sculling and rowing"

A: We have already touched upon vertical oar angles in previous Newsletters (2001/04, 2007/04, 2007/06, 2008/03). The picture below shows the reference system, which we use for the measurements of the vertical angle.



For practical reasons we assume that, when the centre of the blade is at water level, the vertical angle (VA) of the oar is zero. It is easy to set the zero VA during measurements, when the feathered blade is floating at water level. For the positive direction, we assume VA of the oar is above the water level, and for the negative direction, below the water level.

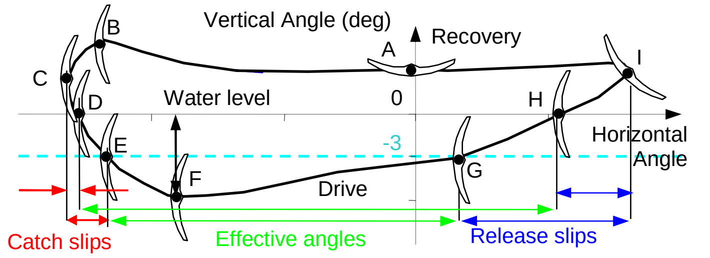
The table below can give you an impression of how angle β (between zero oar angle and the horizon) depends on the outboard and height of the swivel above water level (WL). As the latter usually ranges between 22 and 26cm (1) the most common angle β is 9-10deg in sculling and 6-7deg in rowing.

Angle β (deg)	Outboard Sculling (cm)			Outboard Rowing (cm)		
Swivel Height above WL (cm)	190	195	200	260	265	270
20	8.2	8.0	7.8	5.9	5.8	5.7
25	10.0	9.7	9.4	7.2	7.0	6.9
30	11.7	11.4	11.0	8.4	8.2	8.1
35	13.5	13.1	12.7	9.7	9.5	9.3

Suspension of the rower's weight during the drive and changes in the roll and pitch of the hull affect the height of the swivel above the water and subsequently the VA. The amplitude of this variation could be up to 5cm within one complete stroke cycle, which would change the vertical oar angle by up to 1.7 deg in sculling and 1.2 deg in rowing. This limitation could be corrected using measurement of the roll and 3D acceleration of the hull.

The trajectory of the blade relative to the water level can be plotted using the above reference system. Let us describe the criteria of the blade trajectory, which could be used for evaluation of the rower's bladework skills. The analysis is based on our database (n=6600).

The stroke cycle starts at point A during recovery (at which the the oar axis is perpendicular to the boat). The VA here is 2.4±0.8 deg (mean±SD) and does not differ between sculling and rowing. Before catch the blade rises to provide space for squaring. The VA reaches its maximum elevation at point B which is 4.9±1.2 deg in sculling and 4.1±1.2 deg in rowing. The blade starts descending after this point, moving horizontally a further 2-4 deg towards the bow and changes direction at point C, which represents the catch angle. The VA at point C is very close to +3 deg, which means the bottom edge of the blade is close to the water level.



Catch slip could be defined in two ways:

- From catch point C to point D, where the centre of the blade crosses the water level. We found that this is enough to apply propulsive force, which overcomes the drag and starts moving the system boat-rower forward.
- From catch point C to point E, where the whole blade is immersed below the water level and full propulsive force is applied. The VA at this point may vary depending on the blade width and outboard length. For simplicity, we set the criterion at -3 deg, which would guarantee blade coverage at all oar dimensions.

At point F the blade achieves its minimal (deepest) VA, which is -7.2±1.3 deg in sculling and -5.7±1.2 deg in rowing. Similarly, release slips could be defined in two ways: starting (1) from point G at -3 deg VA or (2) from point H at 0 deg VA, both ending at the release angle at point I. The table below shows catch and release slips and the corresponding effective angles, which are components of the total angle, within which the blade is immersed according to the defined slip criteria:

	Catch Slip to 0 VA (deg)	Catch Slip to -3 VA (deg)	Release Slip to 0 VA (deg)	Release Slip to -3 VA (deg)	Effective Angle at 0 VA (%)	Effective Angle at -3 VA (%)
Sweep	4.8	13.1	3.4	14.3	90.1%	68.4%
±SD	2.9	5.1	3.2	7.2	4.6%	8.1%
Scull	4.1	10.0	6.5	18.5	89.7%	73.1%
±SD	2.0	3.1	3.9	6.5	3.8%	6.7%

It was found that blade propulsive efficiency has moderate correlations with both effective angles (r=0.45 for 0VA criterion and r=0.38 for -3VA). **Measurements of the vertical oar angle can help to improve the blade propulsive efficiency and increase boat speed**. Telemetry system BioRowTel v.4 allows to measure and analyse both vertical angle and propulsive efficiency of the oar, as well as the roll and 3D acceleration of the boat.

References

1. Filter K.B. 2009. The System Crew – Boat. Lecture during FISA juniors' coaches' conference, Naples, 15-18 October 2009

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