HOW IS PROPULSION PRODUCED ON THE PADDLE?

Falk Hildebrand and Volker Drenk

Institute for Applied Training Science, Leipzig, Germany

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INTRODUCTION: In kayak sports, the paddle is moved mainly in the frontal plane then amidships. To explain the propulsion the Bernoulli equation is predominantly used. The scope of this equation is considered only for stationary water flow. However, one paddle stroke takes about 0,3 seconds, which is too quick to stabilize static conditions. Therefore, an explanation based on the general equation of hydrodynamic is required. The Bernoulli equation only describes the hydrostatic pressure in dependence to the velocity plot of the water flow.

METHOD: 3D-video data were taken during canoeing regattas in May and August 2005 in Duisburg, Germany. Two DV cameras (50 Hz) with freely chosen positions on the banks were panned, tilted and zoomed when recording the boat, while calibration information was gained using measured buoys, background landmarks and the positions of the cameras (Drenk,1994; Drenk & Hildebrand 2002). Landmarks of the body, the canoe and the paddle were digitized. Based on these 3D-data the under water paddle curves were reconstructed.

RESULTS: A paddle stroke begins with immersion of its tip into water. The paddle moves together with the motion of the kayak and both velocities are directed forwards. About 0,06 seconds later the velocity of the tip nears zero and becomes negative against the still water. A limit of 0,18 seconds remains to obtain water resistance on the paddle blade. Finally, the paddle will be pulled out and its velocity equals the velocity of the boat again. At the moment of propulsion the tip reaches a maximum depth of 45-50 cm, the slippage is around 17-33 cm, and the circumference right-angled to the boat amounts 33-45 cm. Therefore we found a proportion of laterally elongation relatively to slippage from 1 until 2,5. These values are depending on the velocity of the kayak. For this example, the mean velocity of the kayak rises up to 5,67 m/s. Both the short duration of stroke and the accelerated motion of the paddle prevent the development of steady state water flow. Therefore, the run cannot be explained with Bernoulli's equation.

DISCUSSION: The general equation of hydrodynamics involves three kinds of forces: vis inertiae, power of resistance and hydrodynamic pressure. Hildebrand and Kliche (2005) describe the swimming propulsion by this equation. Analogous, the motion of the blade generates these three forces. Slippage results from pressure of the blade against water. The significance of the paddle movement abeam to the direction of the moving boat is to again find still water.

CONCLUSION: Further research will focus on the measurement of actual forces on the blade to proof our results.

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