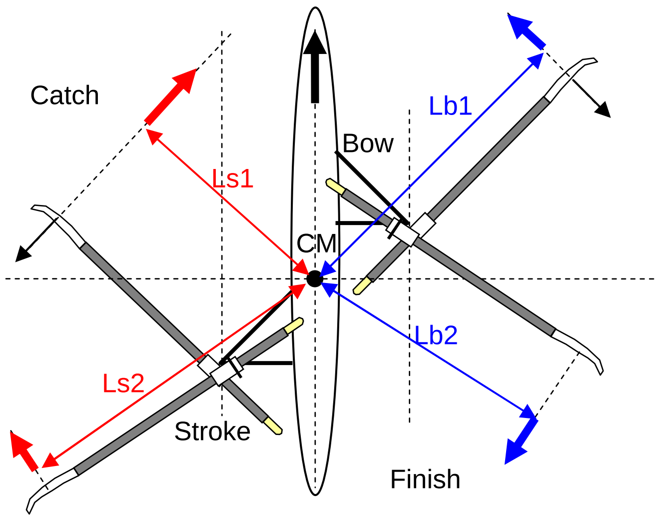
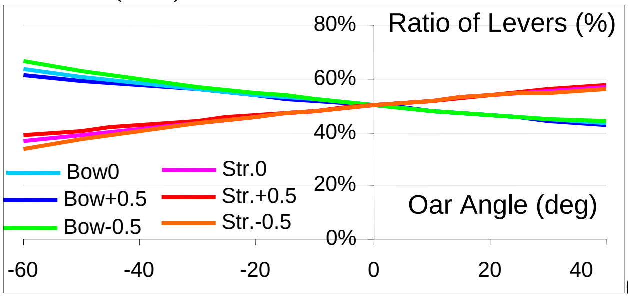
Facts. Did you know that…

…the stroke in a pair must apply more force at the catch and the bow must pull harder at the finish? In RBN 2002/04 we already gave some comments on synchronisation of forces in a pair. That time we derived turning moments using the pin forces. After that we received comments from Einar Gjessing (inventor of the famous rowing ergometer), where he derived levers for the blade forces. We found that Einar's method is the most correct way to solve the problem, because the blade force is the only external force in the system. The pin force is an internal force and must be considered in conjunction with other forces on the stretcher, handle and seat, which all can produce turning moments on the boat hull. It is difficult to measure all the above forces, while the blade force can easily be derived from the measured handle or swivel force. The Figure below shows the mechanics of the turning moments in a pair:



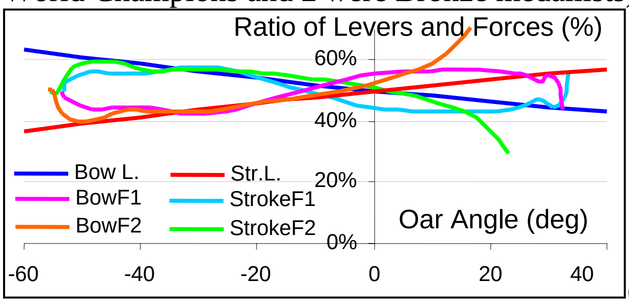
The actual outboard (from pin to the middle of the blade) was used in the model. The lever for the blade force is equal to the length of perpendicular from the line of the force to the centre of the boat. At the catch, bow has an advantage (Lb1 is longer than Ls1), so the stroke has to apply more force to produce the same rotating moment. At the finish, the opposite is the case (Lb2 is shorter than Ls2).

What is considered as the centre of the boat is an important point. We decided that it must be the centre of mass (CM) of the whole system (boat and athletes), because this is the only mechanically correct way to analyse the boat orientation and velocity vector. The rowers' masses make the largest contribution to the system, so the system CM moves together with the movement of the rowers' masses during the stroke cycle. The Chart 1 below shows the ratio of levers for stroke and bow, derived for various positions of the system CM: at the geometrical centre of the boat (0), 0.5m closer to the stern (+0.5) and the same distance closer to the bow (-0.5).



(1)

You can see that position of the CM of the system does not affect the ratio very significantly (±2.5% at 60deg oar angle). As the catch angle is longer than the finish angle, the stroke has to produce a higher average force. At angles of 56deg at the catch and 34deg at the finish, the contribution by the stroke must be 52.5% and by the bow 47.5%, i.e. 5% difference. The chart below compares the ratios of measured forces and the lever models for two international level pairs (1 were World Champions and 2 were Bronze medallists).



(2)

You can see that the ratio of forces is very close to the inverse ratio of the levers, which helps to keep the boat straight. The ratios of average forces were 51.5 : 48.5% for the 1st crew and 52.1 : 47.9% for the 2nd, which is also close to the model.

What we can do to reduce the difference in the leverage? Chart (1) suggests that we can move the CM closer to the stern relative to the pins. However, we can't alter this much because it will affect the geometry of the rowers' work. Another way is to use a longer spread/outboard for the stroke rower. The difference must be huge to make the ratio even (4cm difference in spread + 10cm in outboard makes the average leverage only 3% different). The third method was suggested before: the same 3% difference in leverage can be achieved if the bow rower were to move his arc 5deg closer to the bow.

Contact Us:

✉ *©2007 Dr. Valery Kleshnev, EIS, Bisham Abbey*
www.biorow.com *e-mail:* kleval@btinternet.com