Q&A

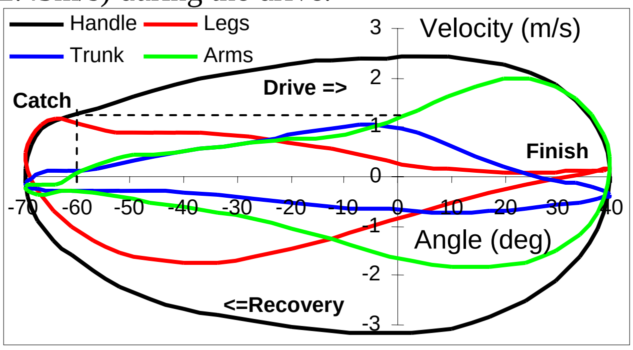
Q: A number of coaches sent us questions with the following general sense: "I agree that a large transverse force at acute catch angles may not cause energy losses in term of mechanics. However, it creates static work in the rower's muscles, which fatigues them and decreases muscular efficiency of their rowing technique".

A: There are three reasons why this concern does not make sense:

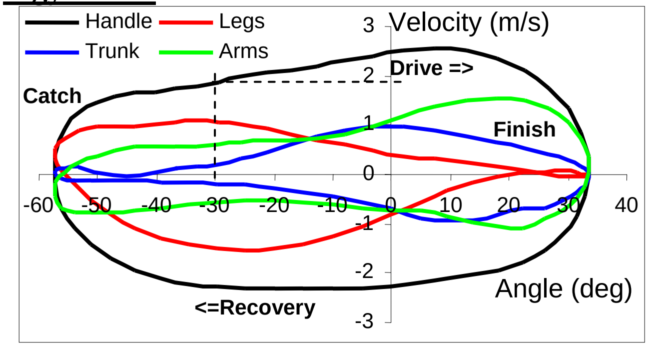
1. Absolute static action of the oar is not possible in rowing even when it is parallel to the boat. The blade slips through the water and any applied force creates some movement of the handle.

2. As you can see from RBN 2007/3 the real gearing ratio at a very long catch angle of 70 degrees is about 6. So, at a boat speed of 5m/s the handle should move at 0.8m/s even with the blade fully immersed in the water without slippage. However, as you saw from RBN 2007/4 it usually takes about 10 degrees of oar movement to immerse the blade fully. In this case, the blade is immersed at an angle of 60 degrees, when the gearing ratio is about 4 and the handle velocity must be at least 1.25m/s, which is quite a significant speed.

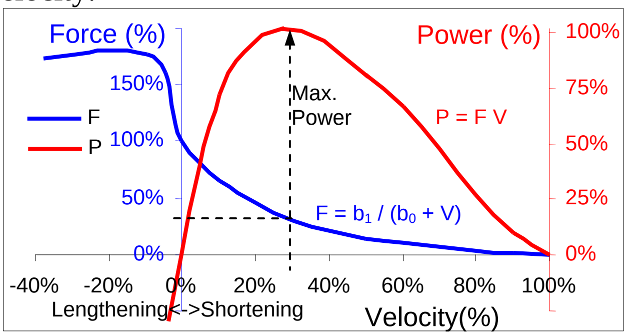
The chart below confirms our considerations. It shows the measured velocities of handle and body segments for a single sculler at a stroke rate 35str/min and average boat speed of 5m/s. The handle velocity at 60 deg is 1.23m/s, which is more than half of the maximal handle velocity (2.43m/s) during the drive.



3. Static and even eccentric work of some muscles and body segments happens very often in rowing even at significant handle velocities. The next chart shows that the trunk velocity in a sweep rower is close to zero during the first third of the drive, until the handle velocity reaches nearly 2m/s. All handle velocity is delivered by movement of the legs and arms only. This technical fault is usually called "grabbing with the arms". This example shows us that the static work of the trunk was caused not by heavy gearing or a long catch angle, but by an inefficient sequence of the body segments. Therefore, **a reasonably long catch angle does NOT itself create static work and energy losses.**.



Not only absolute static muscle contraction is a waste of energy. Movement with very slow or fast speed is also inefficient. The chart below illustrates the well-known Hill principle in muscle mechanics, discovered in the 1920s by the famous physiologist Archibald Vivian Hill. The hyperbolic relationship between velocity and force was obtained from a study of frog muscle tissue, but a number of recent researches confirmed that it can be valid for complex multi-joint movements, which we can measure as velocities of body segments. The Hill principle tells us that maximal power can be achieved in a movement at about 30% of both the maximal static force and the maximal unloaded velocity.



Negative power is the most inefficient unless it happens during very short time, when muscle works as a spring and returns energy to the system. In the second example above there is another technical fault of slide-shooting, when stretching of the back muscles consumes power produced by the legs. Obviously, too heavy or too light gearing can affect the force/velocity relationship and thus efficiency. However, **an optimal body sequence, (i.e. rowing style) matched to the rower's characteristics and boat speed plays the most significant role in rowing efficiency**.

Contact Us:

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