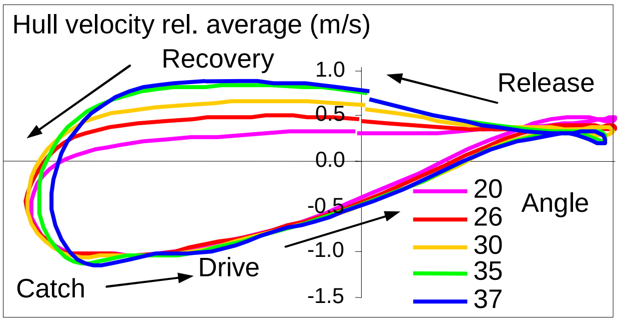
Questions and Answers:

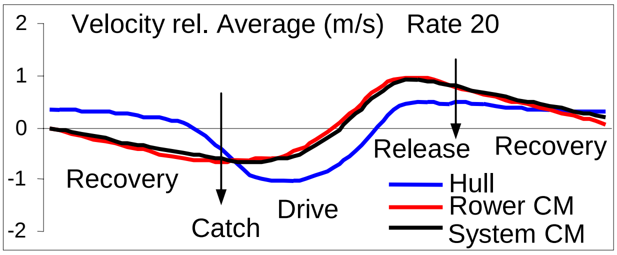
Q: Stuart Wilson of Jeff Sykes & Associates asked: Is that true that "…the peak speed of the hull is just before the catch, not as previously thought, just after the finish?"

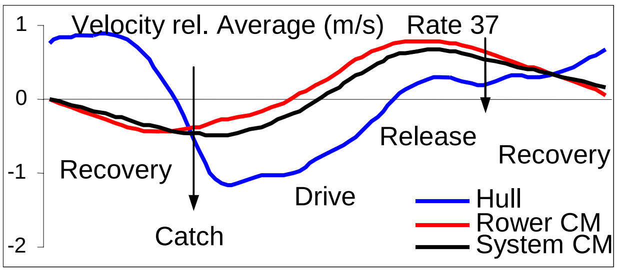
A: In fact, this depends on the stroke rate. Below are typical graphs of the hull speed at different stroke rates (M1x, X-axis is the oar angle):



You can see that at low rate 20 str/min (pink line) the old thought is true. However, the hull speed increases through recovery at higher stroke rates. The higher the rate, the closer the peak speed to the catch.

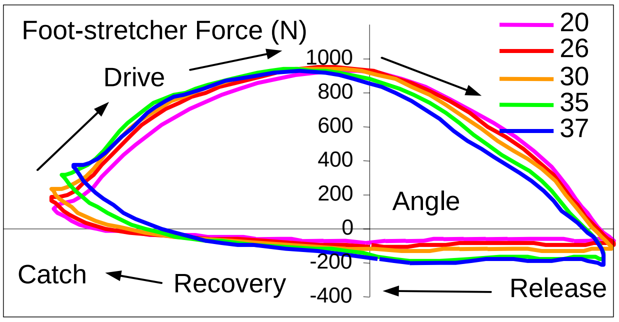
The reason for this phenomenon is in interaction of the rower's and the boat masses. The following graphs show velocities of the hull, the rower's centre of mass (CM) and the system CM (rower + hull + oars) at stroke rates 20 and 37:





In both cases, the peak velocity of the system CM happens at the end of the drive, when the propulsive force became lower then drags force acting on the hull. At the higher rate the rower's CM velocity decreases much faster during recovery, but boat speed increases. This means the transmission of the kinetic energy from the rower's mass is to the hull. This happens by means of more active pull through the foot-stretcher.

The graphs below show foot-stretcher forces, measured simultaneously with the hull speed:



We assume positive force acts towards the stern (push) and negative acts towards the bow (pull). At lower rating the pull force was about 50N that was lower than the drag force (60N). At the higher rating the pull force exceeds 200N and overcomes the even higher drag force (100N). This creates acceleration of the hull during recovery and increasing of the hull speed.

Above acceleration increases fluctuations of the hull speed and create excessive energy losses. The measure of fluctuations is a variation of the hull speed (ratio of its standard deviation to the average). Generally, the variation increases from 11.7% at the stroke rate 20 up to 13.7% at the rate 40. This decreases the efficiency of the boat speed (ratio of the actual propulsive power to the minimal required for the same average speed) from 96.25% down to 94.79%. This difference (1.5s over 2000m) is quite small compare to the difference in the speed between 20 and 40 str/min.

What can we do to decrease the losses even more? The obvious solution is to minimize the foot-stretcher pull and make the hull speed smoother during recovery. There are two methods of doing this:

1. Avoid too fast body return at the finish of the drive. This method is well described mathematically in (1). From this point, Australian rowing style looks very efficient.
2. Increase the recovery time that means shortening the drive time at the same stroke rate and decreasing the rhythm value (RBN 2003/03). Crews with a fast dynamic drive have more time for the recovery phase and muscles relaxation, and can make boat run more evenly.

References

1. Sanderson, B., Martindale, W. (1986). Towards optimizing rowing technique. Medicine and science in sports and exercise, 18, 454-468.

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