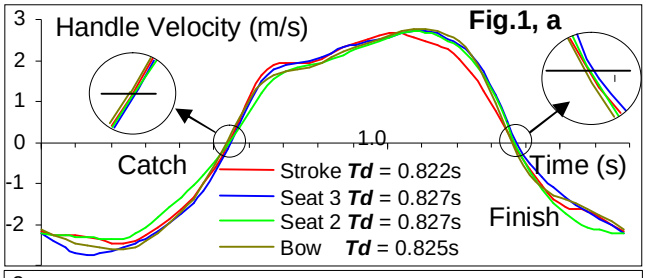
Q&A

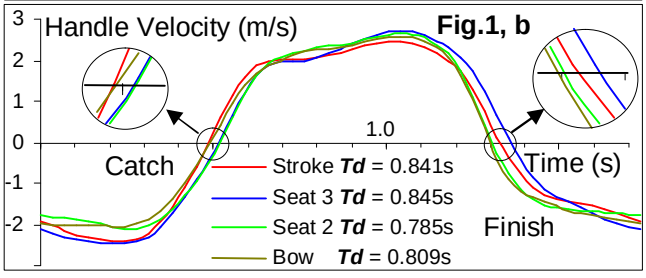
Q: Often we receive questions from coaches with the following sense: "How should I change rigging to make rowing angles the same in my crew, if the rowers have different height and physique?"

A: For a number of reasons, time synchronisation of rowers' movements and force application at the catch and finish is the most imperative condition of effective rowing. There are no direct biomechanical reasons, why rowing angles and drive length must be the same in all crew members. However, the spatial variables are closely related to timing and, therefore, important for synchronisation.

The rowers in a crew are mechanically connected to each other through the stretcher and boat hull. It could be illustrated using a concept of "the trampoline effect" (RBN 2006/07), which explains the summation of accelerations the boat and rower's mass. Imagine two jumpers hit the same trampoline board at different times: when it recoils to accelerate the first jumper, the second one arrives. Acceleration of the board would be stopped by impact of the second jumper and the first one couldn't jump high. The second jumper would receive a jolt from the board, which moves fast towards his feet and could be injured. Therefore, rowers have to move and apply forces synchronously, otherwise effectiveness of the crew would be diminished.

The simplest method to measure synchronisation is to check the time of catch and finish, when the oar changes direction of movement. This could be done with frame-by-frame video analysis (high speed video is recommended for accuracy) or with biomechanical equipment (telemetry system). With the last method, the handle velocity could be derived from measured oar angle and known actual inboard. Fig.1 shows patterns of the handle velocity in two men's fours:





- The first crew (a) of World medallists level has very good synchronisation at the catch (max. time difference ΔT=12 ms) and finish (ΔT=13 ms).
- The second crew (b) of a club level has poor synchronisation in both the catch (ΔT= 34ms) and finish (ΔT= 61ms).

How could synchronisation in a crew be improved? **Synchronisation at the catch depends completely on the skills of every crew member**, which usually improves with experience of rowing together. Uniformity of the rhythm of movement of each rower during recovery is important. Every rower in a crew should pay special attention to the forces on the stretcher, which forms a specific "feeling" of the boat and other crew mates. Using drills could accelerate improvement (1).

Synchronisation at the finish depends on one at catch and duration of the drive time ***Td***. Theoretically, ***Td*** depends on the following factors:

- Longer angles, less force, deeper blade path, heavier gearing increase duration of the drive time;
- Shorter angles, more force, shallower blade path, lighter gearing make the drive time shorter.

To analyse effect of above factors, it doesn't make sense to use absolute values, because they are affected significantly by the variation in various boats and rower's categories. Therefore, we analysed deviations of each variable from the average in a crew in the same data sample. It was found that the total oar angle and arc length has significant correlation (r=0.59) with the drive time within a crew. Force application and blade depth has shown very small and statistically insignificant correlations (r=-0.09) with deviation of the drive time in a crew. This means that drive time is defined mainly by its length.

The drive time ***Td*** can be related to the length of the arc ***L*** and average handle velocity ***Vh.av.*** as:

$$Td = L / Vh.av. \quad (1)$$

The instantaneous handle velocity ***Vh*** depends on the gearing (ratio of the actual outboard ***Lout*** to inboard ***Lin***), boat velocity ***Vb***, oar angle θ and velocity of blade slippage ***Vbl*** in the water.

$$Vh = (Lout / Lin)\,(Vb\cos(\theta) + Vbl) \quad (2)$$

Combining equations 1 and 2 and assuming the same boat speed ***Vb*** and very similar blade slippage ***Vbl*** in a crew, we can conclude: **To achieve the same drive time, difference in the drive length can be compensated by reversely proportional difference in gearing ratio.** E.g., 1% shorter drive length (about 1deg or 1.5cm), could be compensated by 1% heavier gearing ratio (about 2cm longer outboard or 1cm shorter inboard) and vice versa. However, it could be better to work on rowers' technique to achieve similar time and length of the drive.

References

1. Williams R. 2011. All together now. Rowing & regatta. #50, March 2011, 34-35