Roadmap on Rowing Biomechanics

Some coaches think that to effectively use biomechanics they must prepare for the onslaught of numbers and high level math. Here we illustrate a straight and logical path to the successful application of biomechanics in rowing.

Performance in rowing is a complex matter as it is in any sport. It requires high physiological power production, effective technique, mental toughness and smart management of an athlete's lifestyle and training. The main purpose of biomechanics in rowing is improvement of technique. The main questions are:

- **What components of rower's skills can be analysed to develop optimal technique?**
- **What biomechanical variables need to be measured to provide data for the analysis?**

Fig.1 schematically shows relationships between components of rower's skills and biomechanical variables. The real picture is more complicated, since the components of technique are interrelated and usually affected by many other biomechanical variables.

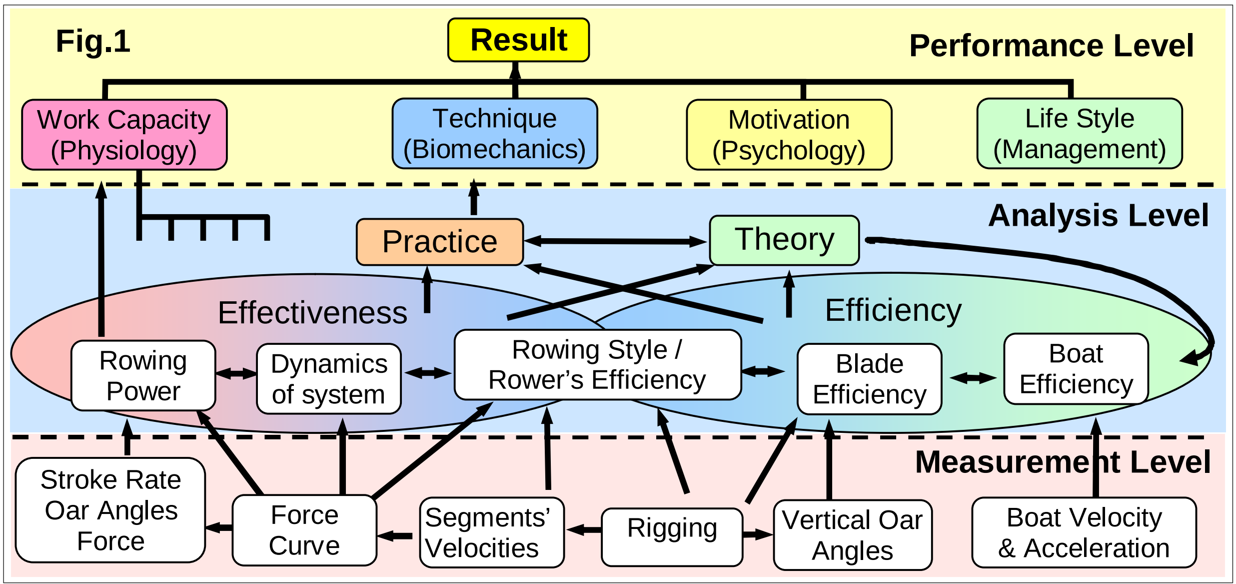

Fig.1

The road map of rowing biomechanics has three levels: *measurement, analysis* and *performance*. At the *Measurement* level we collect information from sensors, process it (apply calibration, filters, averaging, etc.), store and feed into the next analysis level.

During *Analysis*, we combine data from various variables, calculate derivative variables (e.g., power from measured force and oar angle, etc.) and values (e.g., max. and average force), and produce some meaningful information. There are two separate areas at the analysis level: theory and practice. In the *Theory*, we produce and publish some common knowledge, e.g., average values in athlete groups, correlations, normative criteria, etc. In the *Practice* area, we compare the acquired data with the normative criteria and produce recommendations for a specific athlete or crew, which are then fed into the next *Performance* level.

At the *Performance* level we try to correct rowing technique with instructions obtained at the *Analysis* level. Various methods of feedback can be used at this level: after a session, post-exercise and real-time feedback as well as various drills and rigging adjustments. After a technical correction is made, variations of rowing technique should be measured and analysed to check their impact and evaluate an athlete's adaptability.

At the *Measurement* level, there are three groups of variables related to very basic mechanical categories: *Time* (stroke rate), *Space* (drive length – rowing angles) and *Force* (applied by a rower). Together these three variables produce the fourth mechanical category: *Energy* (rowing power), which is very closely related to the average speed of the rower-boat system and, hence, with *Result*. To evaluate these four types of variables we usually compare them with target values (see RBN 2007/08, 2009/06) and established Biomechanical Gold Standards.

Force curve defines the total impulse supplied by the rower as well as dynamics of the system (RBN2006/02). An optimal force curve must be "frontloaded", full and not have any humps (RBN 2006/06, 2008/02).

Coordination of the body segments velocities is related to the force curve and defines rowing style, which is the key component of technique (RBN 2006/03, 05).

Rigging defines kinematics of oar and rower and through gearing ratio – kinetics of the system. Lighter gearing makes rower's movements faster and, possibly, increases power production but reduces blade efficiency (RBN 2011/09).

Oar handling skills of a rower could be evaluated using measurements of vertical angle, which is related to the rigging (blade pitch and height of the gate, RBN 2010/09) and could impact blade efficiency.

Patterns of the boat velocity and acceleration during the stroke cycle result from the dynamics of the system and should be good indicators of quality of rowing technique (RBN 2002/06, 2002/08).