Evaluation of individual rowing technique

Recently, a new evaluation method was developed for of the data obtained with the BioRow™ measurement system. The method is based on the previous evaluation template and was further improved in an attempt to make it clearer, more adequate and effective. In the previous method (RBN 2013/03), the measured data was compared with "targets" or "Gold Standards", which were based on the highest rowing performance at the level of world records. Though, it was useful for elite athletes, this approach was not very practical for students and club level rowers.

Usually, the evaluation criteria were set in one direction: the target was only to increase values of some variables (force, power, stroke length, effective angle), or to decrease others (catch and release slips, gradients of force at catch and finish). The first step away from this approach was made in RBN 2015/08, where the blade depth was targeted at an optimal level, and deviation in both directions was considered as undesirable.

Now the method of optimal values will be used for all variables, except work per stroke and rowing power, which will remain one-directional: the higher the power, the better.

An available "targets" method is now also complemented, with a "standardization" method, which was implemented as a comparison of the measured value ***V*** with average values ***Av*** in a relevant rowers' group (men-women, sculling-sweep, elite-U23-juniors, etc.). The evaluation mark ***E*** is expressed as a ratio to the standard deviation ***SD*** of the variable in the group:

$$E = (V - Av) / SD \qquad (1)$$

Seven ranges of the ***E*** benchmark were defined and could be described as the following (assuming the distribution of the variable is close to normal):

- The value V is evaluated as an **Average,** if it fits the range from -0.5 to +0.5 ***SD*** from the group average **Av**. Usually, this range contains 38.3% samples of the whole group population;
- **Below Average** (from -1.5 to -0.5 ***SD***) and **Above Average** (from +0.5 to +1.5 ***SD***) ranges contain 24.2% of the population each;
- **Low** (from -2.5 to -1.5 ***SD***) and **High** (from +1.5 to +2.5 ***SD***) ranges each contain 6.1% of the data;
- **Very Low** (below -2.5 ***SD***) and **Very High** (above +2.5 ***SD***) ranges are usually observed only in 0.6% cases for each extreme.

The standardization method could give a good impression on the rower's ranking in their category. However, the average values of any variable should not be targeted, because they are mixture obtained from rowers of different skills and levels of performance. Very high or very low values can't be the targets either, because they do not necessary lead to the best performance.

For example, generally a steep force gradient from the catch to 70% of maximal force (RBN 2008/02) is an important feature of a dynamic and effective "front-loaded" drive. However, some rowers increase their force too quickly by means of engagement of the upper body or "slide-shooting", instead of using their legs properly for acceleration of the body mass. Usually, these rowers hit the water with their blades too aggressively, so their catch slip is also short and the blade being dug into the water too deeply. As a result, they usually have a gap in the force curve: "a disconnection" between the legs and upper body, which makes the drive "broken" and ineffective. These rowers also cannot maintain a sufficient force production during the middle and second half of the drive, where most of rowing power is produced (RBN 2014/03).

Therefore, the current "targets" method still remains in use and defines the optimal values for each variable. Despite all the attempts made to derive these targets objectively, most of them still remain a piece of "art" rather than a science. A combination of two methods was used to produce the targets:

- Trends of the given variable in relation to the rowers' performance: if the data of the best rowers consistently deviates from the group's average, it is quite likely that this feature of their technique helps them to achieve a better performance;
- Biomechanical modelling helps to relate the variables between themselves, and, starting from the target boat speed, derive other variables required to achieve it.

25 biomechanical variables were selected for the evaluation template and classified into the following five groups: 1) Work and power, 2) Work components, 3) Oar work geometry, 4) Force curve, 5) Rowing style. (see Appendix 1 below). Stroke rate and boat speed are not included in this evaluation, because they are not characteristics of an individual rower, but the whole boat, and will be discussed further.

The report template contains evaluation of the numerical variables as well as a comparison of the measured curves with target ones: for the force curve, blade work, legs velocity and for the trunk-arms velocities (the last is shown as a sum for big boats).

The target curves were based on target values of the numerical variables. E.g., the target force curve was built around three points: the position of the peak force, catch, and finish gradients, where the curve crosses the level of 70% of the maximal force.

The target curves were scaled, which means the Y axis shows the percentage of the maximal value of the variable (except the blade depth, which is shown in degrees), and X axis shows the percentage of the drive length. This allows **comparison of the shape of the curves only, not magnitude of the variables**.

The evaluation method provides easy and comprehensive understanding of the results that biomechanical testing provides and will help to define the clear ways to improve rowing technique.

Appendix 1. Description of the variables for evaluation of individual rowing technique

1 Work and Power

This group is the only one, where unidirectional evaluation remains implemented: the higher, the better. This group contains the following variables:

1.1 **Work per stroke** (J) - **WpS** is an integral of products of instantaneous values of the handle displacement and applied force.

1.2 **Relative WpS (%)** is the ratio of WpS to the product of the rower's height and weight

1.3 **Rowing power** (W) is a work per unit of time. Equal to the product of WpS and stroke rate (in 1/min) divided by 60;

1.4 **Power projected to 2km** (W) shows the predicted power for the standard 2km test, if the duration of the performed test was different (RBN 2012/01).

1.5 **Relative power per 2km** (W/kg) as the ratio of the power projected to 2km to rower's weight.

2 Work components

This group shows the components, which result work per stroke (WpS) as their product. As the same WpS could be achieved at various combination of these variables, the "targets" method defines their most optimal combination observed in the best rowers.

Stroke length is expressed in two variables:

2.1 **Total angle** (deg), which oar sweeps from catch to finish, presents the absolute stroke length;

2.2 **Relative stroke length** (%), shows ratio of the stroke length (travel of the middle of the handle in m) to the rower's height (RBN 2007/03);

Force production also has two variables:

2.3 **Average force** (N) shows its absolute value;

2.4 **Relative Force** (N/kg) gives average force above in relation to the rower's weight.

3 Oar work geometry

This section reflects the oar movements geometry:

3.1 **Catch angle** (deg) is the furthest oar position at catch;

3.2 **Finish angle** (deg) is where the oar stops at finish.

Both these variables above are directly related to the stroke length;

3.3 **Catch slip** (deg) shows the oar travel from catch to the point, where the blade is fully buried into the water (RBN 2009/10);

3.4 **Release slip** (deg) indicates the oar travel from the point, where the blade appears above water level to the finish ("washing out");

3.5 **Effective angle** (%) is the part of the stroke length, where the blade is fully covered under the water.

3.6 **Max.blade depth** (deg) – see RBN 2015/08

4 Force curve

This section shows dynamics of the force application (RBN 2008/02):

4.1 **Max.force** (N) – magnitude of the peak force;

4.2 **Position of the peak force** (% of stroke length) is a part of the stroke length from catch to the point, where peak force is achived;

4.3 **Ratio Average / Max Force** (%) reflects the shape of the force curve (100% - rectangular, 50% - triangular);

4.4 **Catch force gradient** (deg) –the oar travel from catch to the point, where force increases up to 70% of max force;

4.5 **Finish force gradient** (deg) – the oar travel from the point, where force decreases below 70% of peak force, till the finish of the drive.

5 Rowing Style

This group indicates coordination of two largest body segments: legs and trunk.

5.1 **Catch Factor** (ms) indicates coordination of the handle and seat movements at catch (RBN 2015/09)

5.2 **Rowing Style Factor** (%) – emphasis on legs or upper body at the beginning of the drive (RBN 2015/10);

5.3 **Legs drive** (m) – amplitude of the seat travel;

5.4 **Legs contribution** (%) – percentage of the seat travel in the drive length;

5.5 **Max. Legs Speed** (m/s) – peak seat velocity during the drive.