News

We previously discussed relationships between boat speed, stroke rate and DPS: in RBN 2001/04 and 2004/03 in step test; in 2003/01 and 2005/02 race analysis was focused. Recently, we have developed a new method of assessment of these variables, which can be considered as a real breakthrough in this area. The method can be widely used in practice and bridges a gap between performance analysis and rowing biomechanics/technique. Below is the description of the new method.

It is obvious that the distance per stroke, *DPS*, decreases as the stroke rate, *R*, increases at constant speed, *V*, because the duration of the stroke cycle, *T*, becomes shorter:

$$DPS = V * T = 60\ V / R \qquad (1)$$

To maintain *DPS* at a higher stroke rate, we need to increase speed proportionally, which never happens in practice. So, let us ask: **What do we need to preserve as the stroke rate increases?**

From pure common sense, the main objective is to sustain the application of force, *F*, of stroke length, *L*, and of mechanical efficiency, *E*. **The effective work per stroke,** *WPSe*, integrates all these parameters and is used as the key variable of the method:

$$WPSe \sim F * L * E \qquad (2)$$

The hydrodynamic drag resistance force, *Fd*, speed, *V*, and power, *P*, generated by the athlete, are related as follows:

$$Fd = k * V^2 \qquad (3)$$

$$P = V * Fd = k * V^3 \qquad (4)$$

where *k* is some non-dimensionless factor depending on the boat type, displacement, weather conditions and blade efficiency.

WPSe can be expressed in terms of power, *P*, stroke cycle time, *T*, speed, *V*, and stroke rate, *R*, *thus*:

$$WPSe = P\ T = P\ (60 / R) = 60k\ (V^3 / R) \qquad (5)$$

If the two values of *WPSe* are equal ($WPSe_0 = WPSe_1$) for the two sections of the race with different stroke rates (R_0 and R_1), then using equation 5 we can derive the ratio of the boat speeds (V_0 and V_1) for these sections as follows:

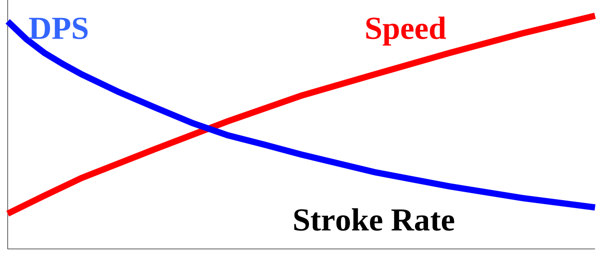
$$V_1 / V_0 = (R_1 / R_0)^{1/3} \qquad (6)$$

Correspondingly, the ratio of *DPS* values is:

$$DPS_1 / DPS_0 = (R_0 / R_1)^{2/3} \qquad (7)$$

To use equations 6 and 7, we don't need to know factor *k*, because we assume that it is the same for the two sections. However, remember that this is applicable only for the same boat, rowers and weather conditions, which is a limitation of the method.

The chart below illustrates the equations 6 and 7 and represents dependencies of the boat speed and DPS on the stroke rate at **constant effective work per stroke**:



The most practically convenient implication of the method is the definition of "prognostic" or "model" values of speed *Vm* and distance per stroke *DPSm*, which can be achieved at the constant effective work per stroke *WPSe*:

$$Vm = V_0\ (R_1 / R_0)^{1/3} \qquad (8)$$

$$DPSm = DPS_0\ (R_0 / R_1)^{2/3} \qquad (9)$$

An important question is what values we use for the base values of V_0 and DPS_0. The possible solutions are:

1. Average of all samples taken;
2. Minimal or maximal values of V and DPS;
3. Values obtained at the lowest stroke rate.

Obviously, the first option should be used for race analysis, because it represents the average speed and rate over the whole race. In a step test, we can use option 1 as well, but option 3 also makes sense.

Finally, ratios of the real values *Vi* and *DPSi*, for each race section, to the "model" values were used for evaluation of the effective work per stroke:

$$eVi\ (\%) = Vi / Vm \qquad (10)$$

$$eDPSi\ (\%) = DPSi / DPSm \qquad (11)$$

This method…

- …can be successfully used for race analysis in cyclic water sports (rowing, swimming, canoeing);
- …can be employed for evaluation of the strength- and speed-endurance using step-test in cyclic water sports;
- …does not require sophisticated equipment (except for a stop watch or StrokeCoach ®) and can be used in every day training.

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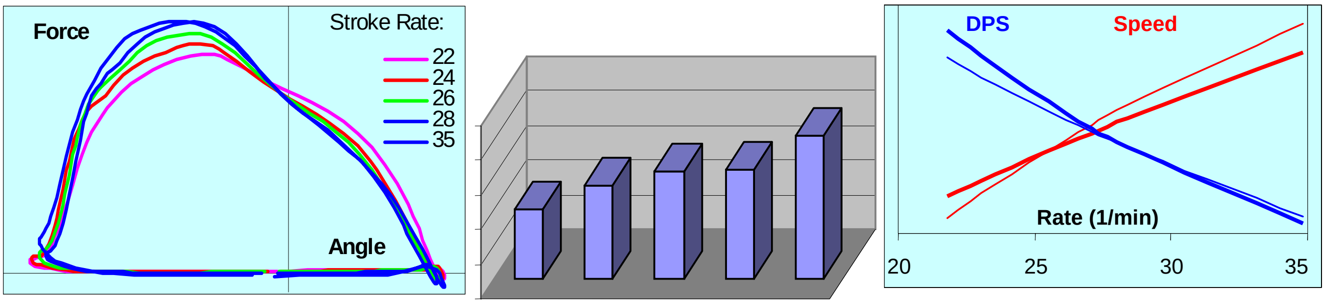
Appendix 1 of the Rowing Biomechanics Newsletter 10(5), October 2005.
Validation of the analysis method based on the effective work per stroke.

Three rowing crews performed the step test on water. Each row of charts below represents one crew.
Left column: Force curves at different stroke rate;
Centre column: Measured mechanical work per stroke;
Right column: real (thin line) and "model" (thick line) dependencies of the boat speed and DPS on the stroke rate



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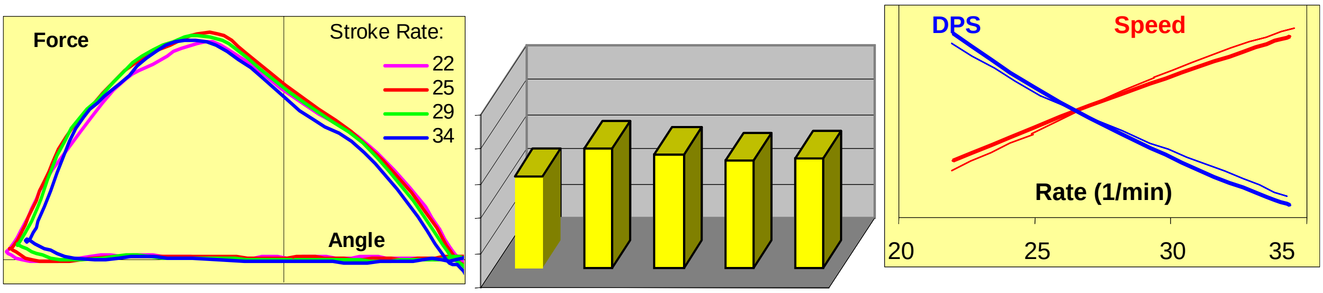

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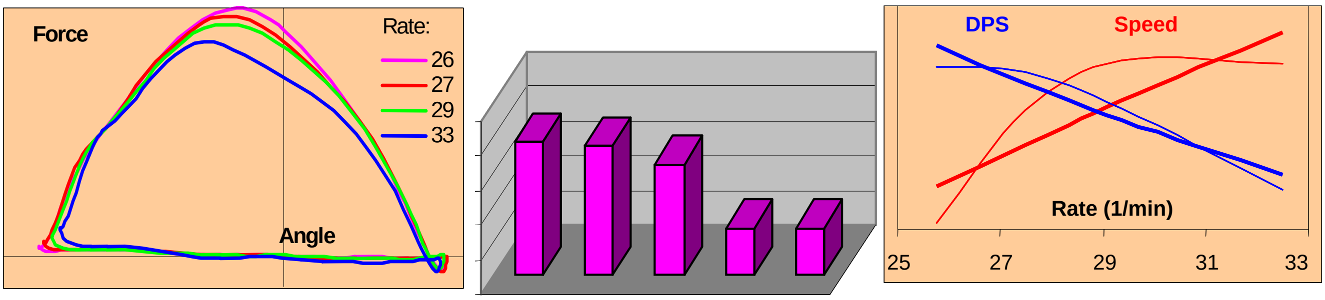

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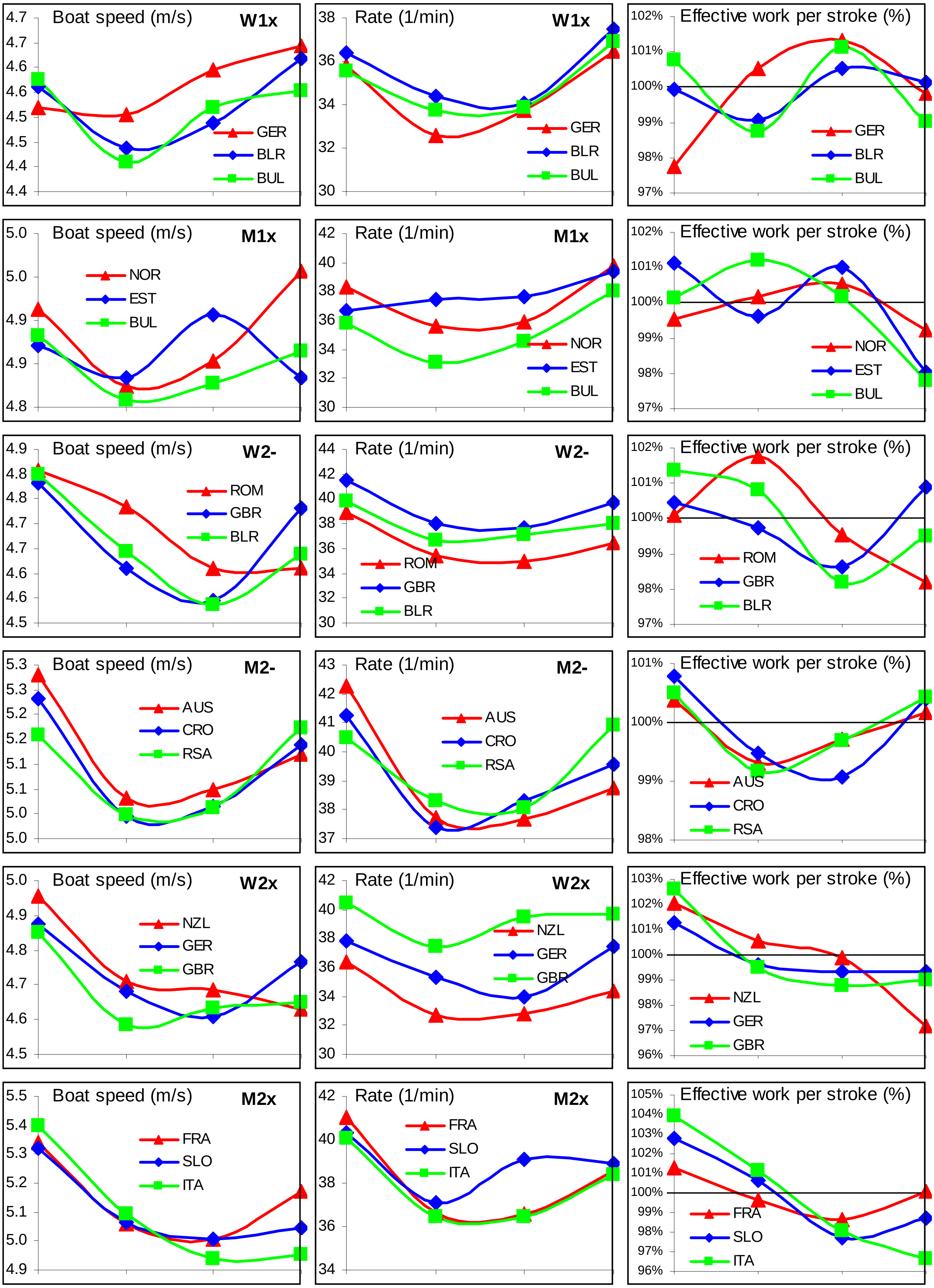
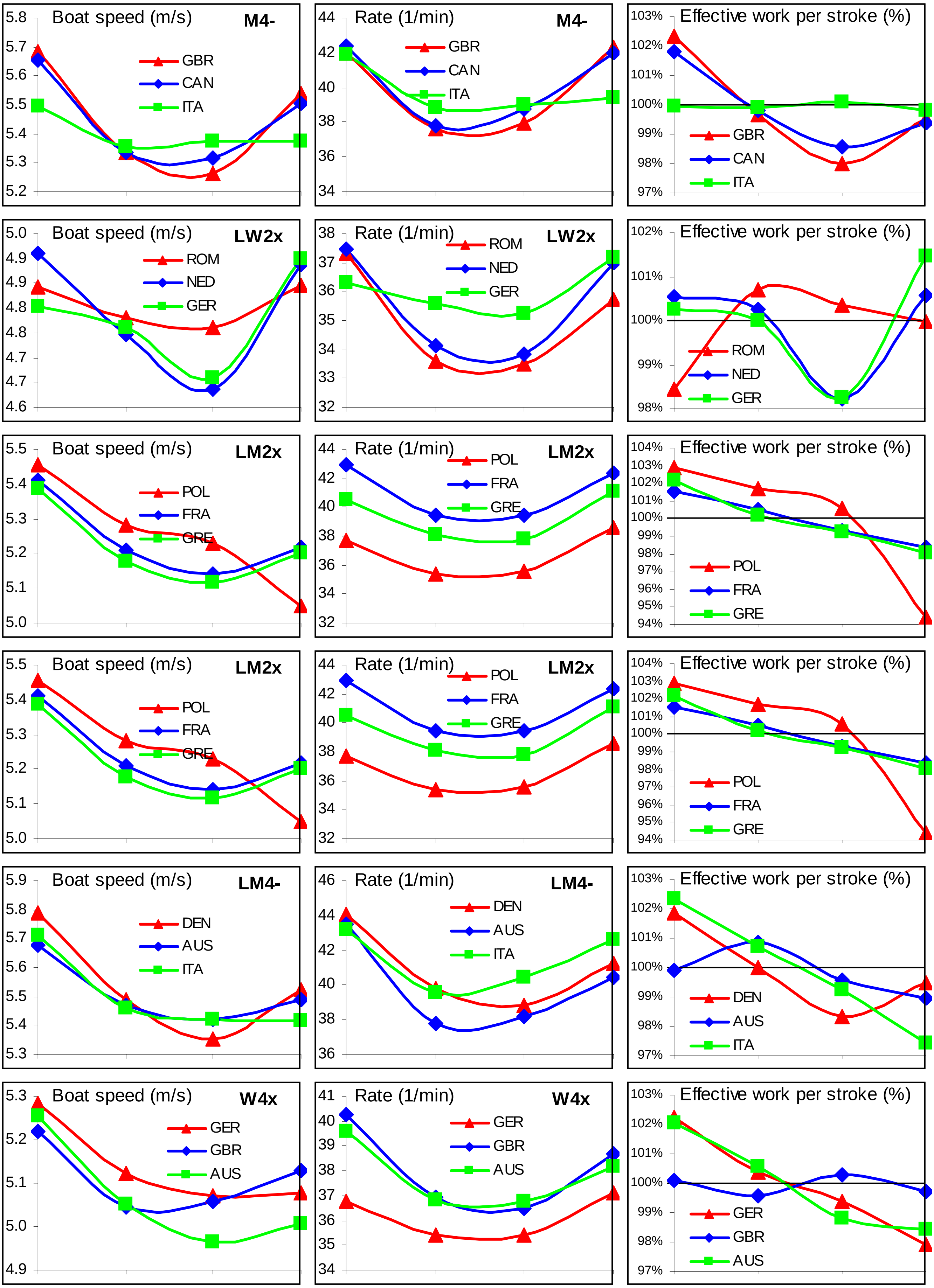
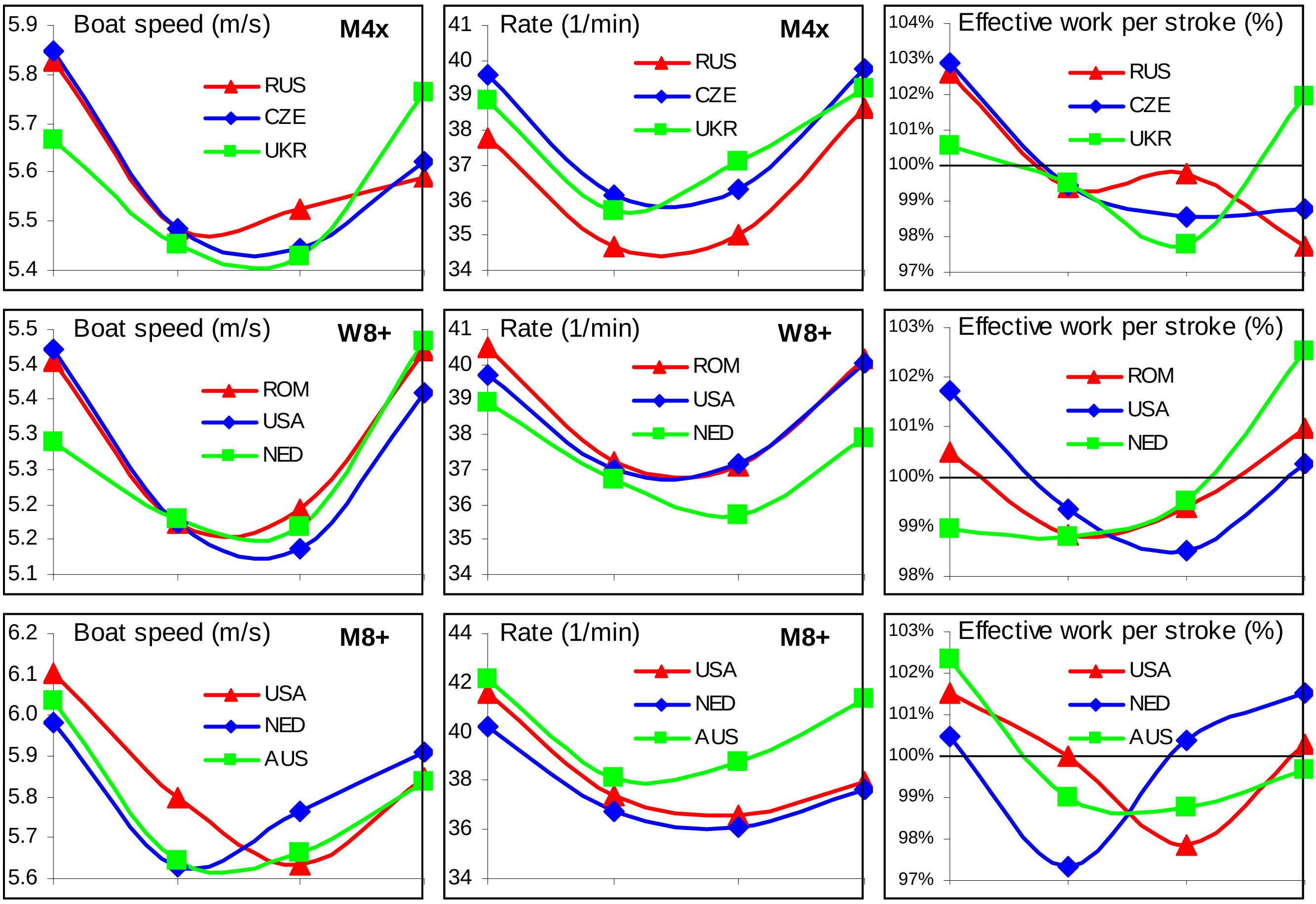
1. The first crew increases force and maintain length at higher stroke rates => mechanical work per stroke became higher => measured trends of the boat speed and DPS overtake "model" lines at higher rates.
2. The second crew maintain both force and length at higher stroke rates => mechanical work per stroke is nearly constant => measured trends of the boat speed and DPS follow "model" lines.
3. The third crew decreases both force and length at higher stroke rates => mechanical work per stroke became lower => measured trends of the boat speed and DPS go below "model" lines at higher rates.

Appendix 2 the Rowing Biomechanics Newsletter 10(5), October 2005.

Analysis of effective work per stroke in the rowing medallists of Olympics-2004 in Athens.




Boat speed (m/s)
M4-
GBR
CAN
ITA
Rate (1/min)
M4-
GBR
CAN
ITA
Effective work per stroke (%)
GBR
CAN
ITA
Boat speed (m/s)
LW2x
ROM
NED
GER
Rate (1/min)
LW2x
ROM
NED
GER
Effective work per stroke (%)
ROM
NED
GER
Boat speed (m/s)
LM2x
POL
FRA
GRE
Rate (1/min)
LM2x
POL
FRA
GRE
Effective work per stroke (%)
POL
FRA
GRE
Boat speed (m/s)
LM2x
POL
FRA
GRE
Rate (1/min)
LM2x
POL
FRA
GRE
Effective work per stroke (%)
POL
FRA
GRE
Boat speed (m/s)
LM4-
DEN
AUS
ITA
Rate (1/min)
LM4-
DEN
AUS
ITA
Effective work per stroke (%)
DEN
AUS
ITA
Boat speed (m/s)
W4x
GER
GBR
AUS
Rate (1/min)
W4x
GER
GBR
AUS
Effective work per stroke (%)
GER
GBR
AUS



Average data in 14 Olympic boats: