



Rowing Instrumentation & Technology



Dr. Valery Kleshnev

BioRow Ltd.

www.biorow.com

valery@biorow.com

BioRow Vision:

To continue the process of creation of this World by means of discovering new phenomena and inventing new things, even in such a “simple” thing as rowing

BioRow Mission:

To help those rowing people, who are curious enough, to improve rowing technique and row smarter and faster, by means of essential measurements, objective analysis and practical feedback

What *BioRow* does:

- ✓ Consultancy service for rowers, coaches and managers of rowing teams in the area of Rowing Biomechanics and technique improvement. We install our equipment on boats, test your rowers and measure the most essential biomechanical variable.
- ✓ We sell equipment for biomechanical measurements & rowing technique perfection: from very simple BioRow Angle Guides and books, to more complicated: BioRowTech erg system and BioRowTel telemetry system for boats.
- ✓ Research & Development consultancy for manufacturers of rowing equipment. We have successful experience working with such well-known companies as Concept2, Nielsen-Kellerman, WinTech, RP3 and other smaller companies.
- ✓ Studies and Publications in rowing-related projects for Universities, Sport Institutes or Rowing Academies. We can consult you, provide equipment for both rowing machine and on-water measurements, and help with data analysis and publications.

First measurements in rowing biomechanics

The history of rowing biomechanics begun in the end of XIX century with studies of Atkinson, Le Feuvre – Pailliotte and Alexander:

- ✓ 1896. Atkinson E. A rowing indicator. *Natural Science*, 8, 178
- ✓ 1898. Atkinson E. Some more rowing experiments. *Natural Science*, 13, 89
- ✓ 1904. Lefeuvre and Pailliotte. Etude graphique du coup d'aviron en canoe. *Bull. de l'Association Techn.Maritime*, Paris, 115
- ✓ 1927. Alexander F. Propulsive efficiency of rowing
- ✓ 1953. Krasnopevtsev G.M. Study of rowing technique using dynamo-graphic method. Ph.D thesis, Leningrad

Rowing science always makes positive effect, Really?

5

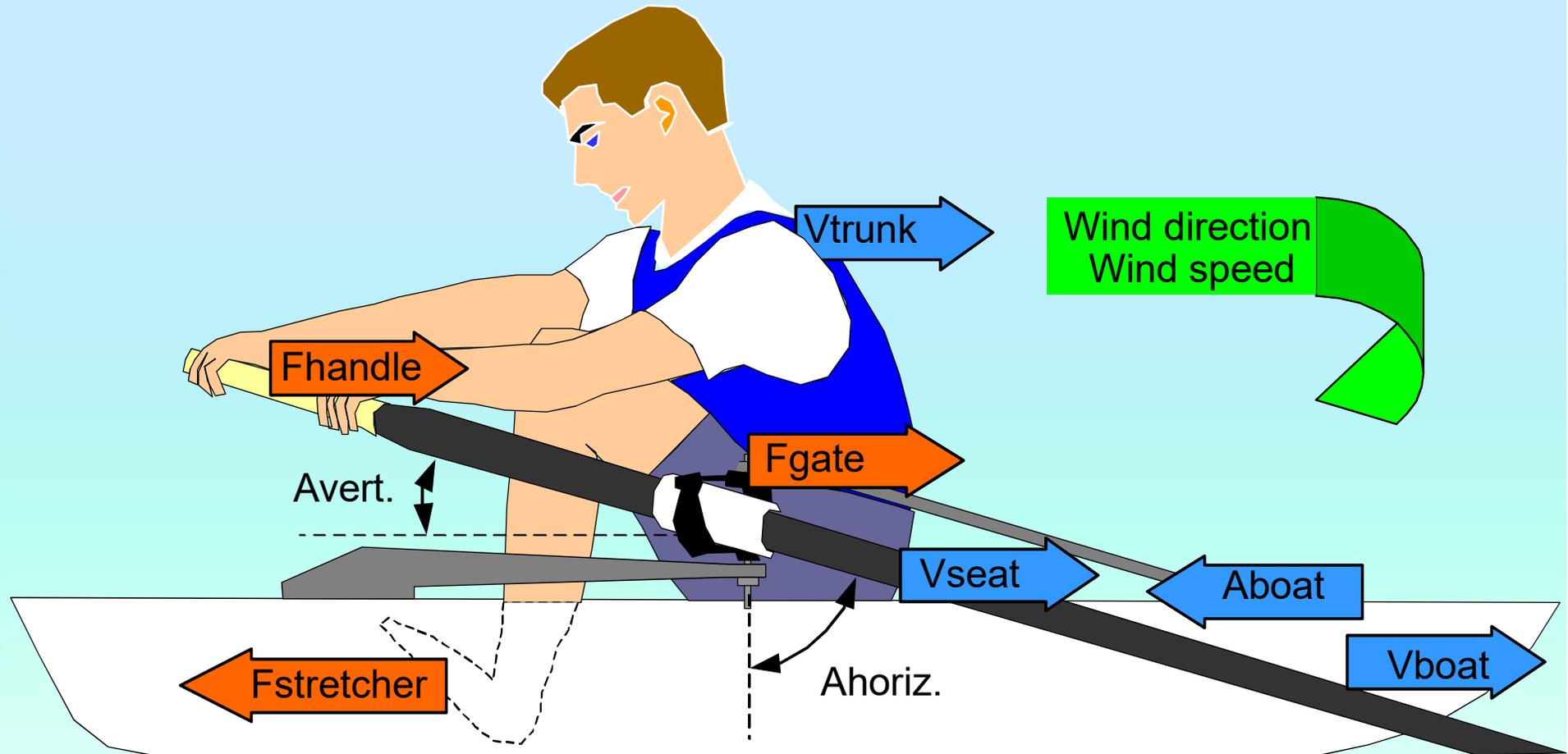
Common rowing “myths”
created by “science”:

- ? Variations of the boat velocity is the main reason of the energy losses?
- ? Blade efficiency decreases at long oar angles, so peak force must be applied at the middle of the drive?
- ? Stretcher force is negative, push the stretcher less and pull more?

Realities:

- ✓ Only about 1% of total energy losses are related to variation of the boat velocity;
- ✓ Hydrolift effect makes blade efficiency higher at long catch angles and sharp angle of attack;
- ✓ Stretcher force is compulsory to create blade propulsive force. About 40% of rowing power is transferred through the stretcher

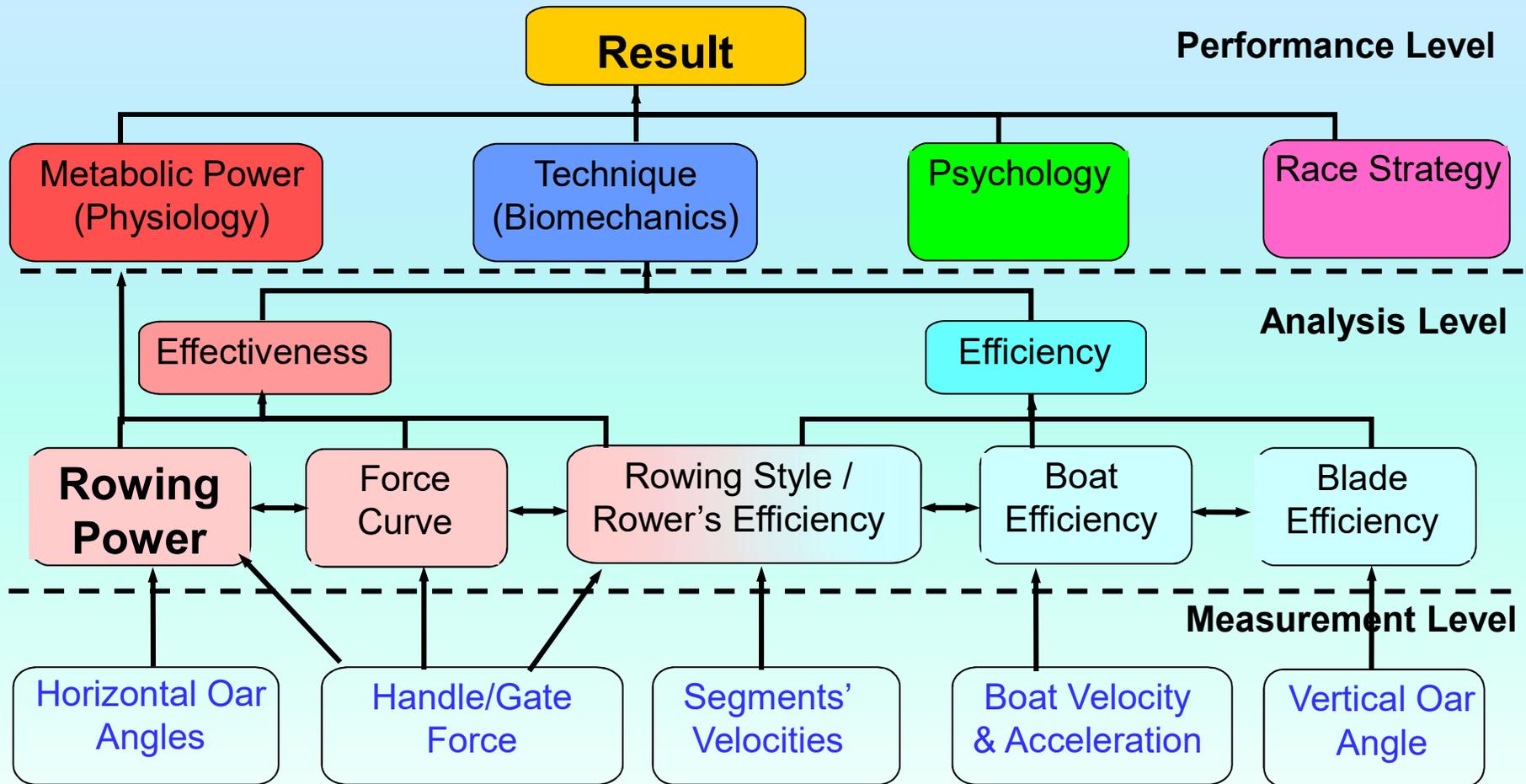
The main variables measured in rowing



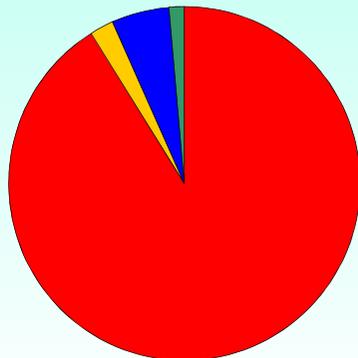
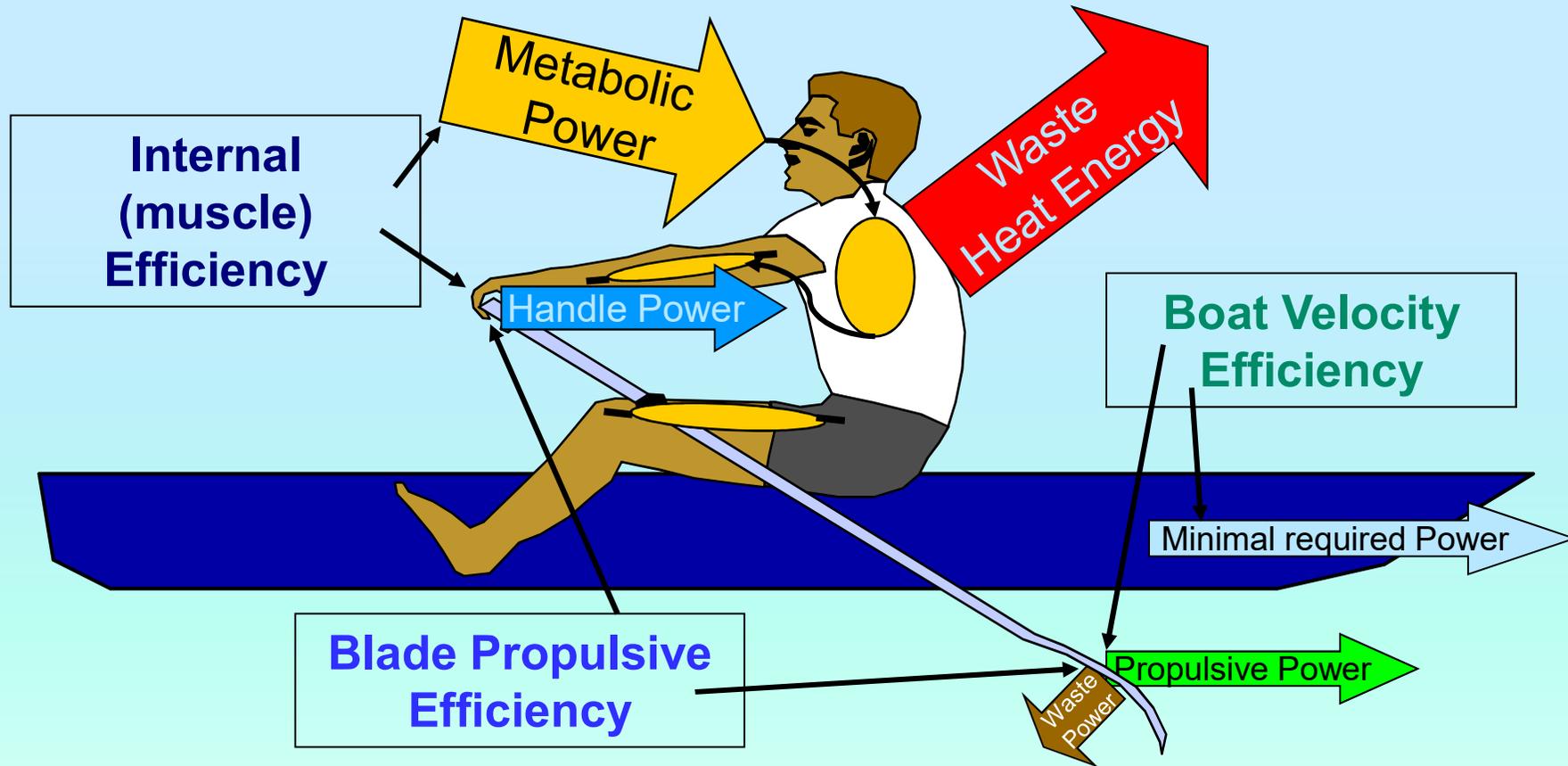
The variables could be classified in kinematics, kinetics and environmental areas

Flow-chart of Rowing Biomechanics

- WHAT we need to measure in Rowing?
- HOW to measure it correctly?



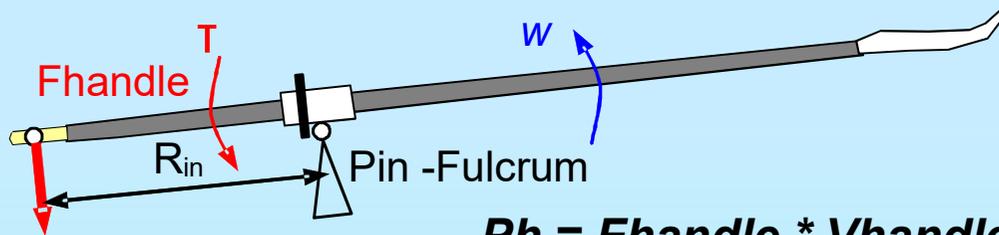
How we define rowing efficiency?



- 91% - In rower's body
- 2.4% - Inertial losses
- 5.3% - In blade slip
- 1.3% - Variation of boat speed

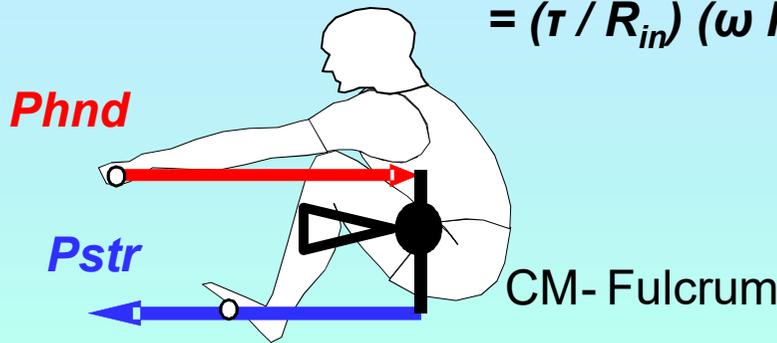
The most of energy is lost in rower's body.

Definitions of Rowing Power



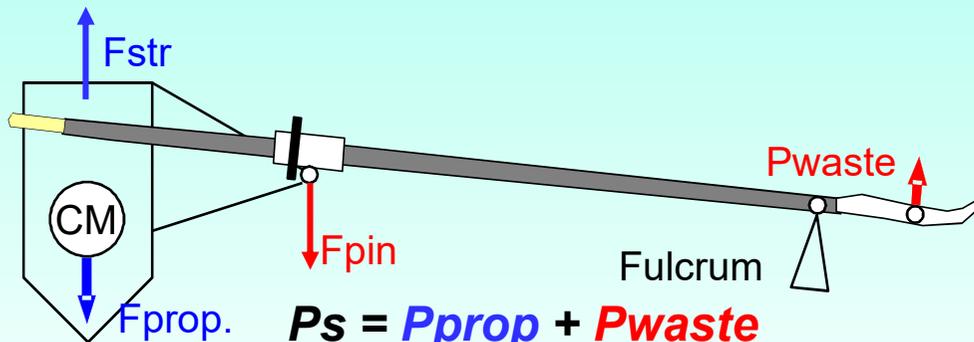
$$P_h = F_{handle} * V_{handle} = (\tau / R_{in}) (\omega R_{in}) = \tau \omega$$

1. Traditional method – Handle Power ***P_h***



$$P_r = P_{hnd} + P_{str} = F_h V_h + F_f V_f$$

2. Rower's power ***P_r***
 $P_r = P_h + P_{boat\ inertia}$
 It correlates well with handle power;



$$P_s = P_{prop} + P_{waste}$$

$$P_{prop} = F_{prop} V_{cm}$$

$$P_{waste} = F_{blade} V_{slip}$$

3. Boat-Rower system power ***P_s*** is the most complicated method

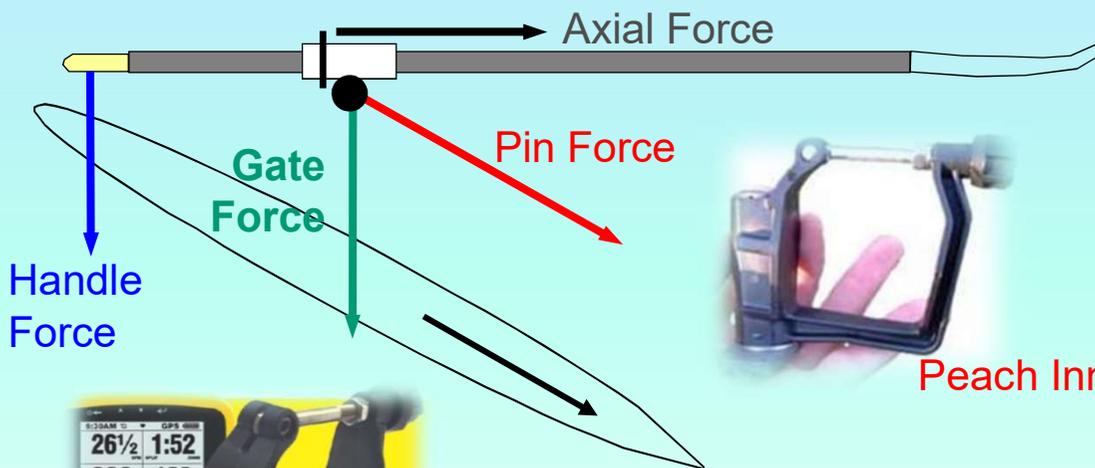
What is best method to measure rowing power?



✓ Handle Force gives the most accurate power measures, but require calibration of every oar.

✓ Pin Force is affected by oar angle and axial force, so power inaccuracy could be up to $\pm 20\%$;

✓ Gate force require inboard for power calculation, which could vary during the drive $\pm 5\%$;



Peach Inn. Ltd.

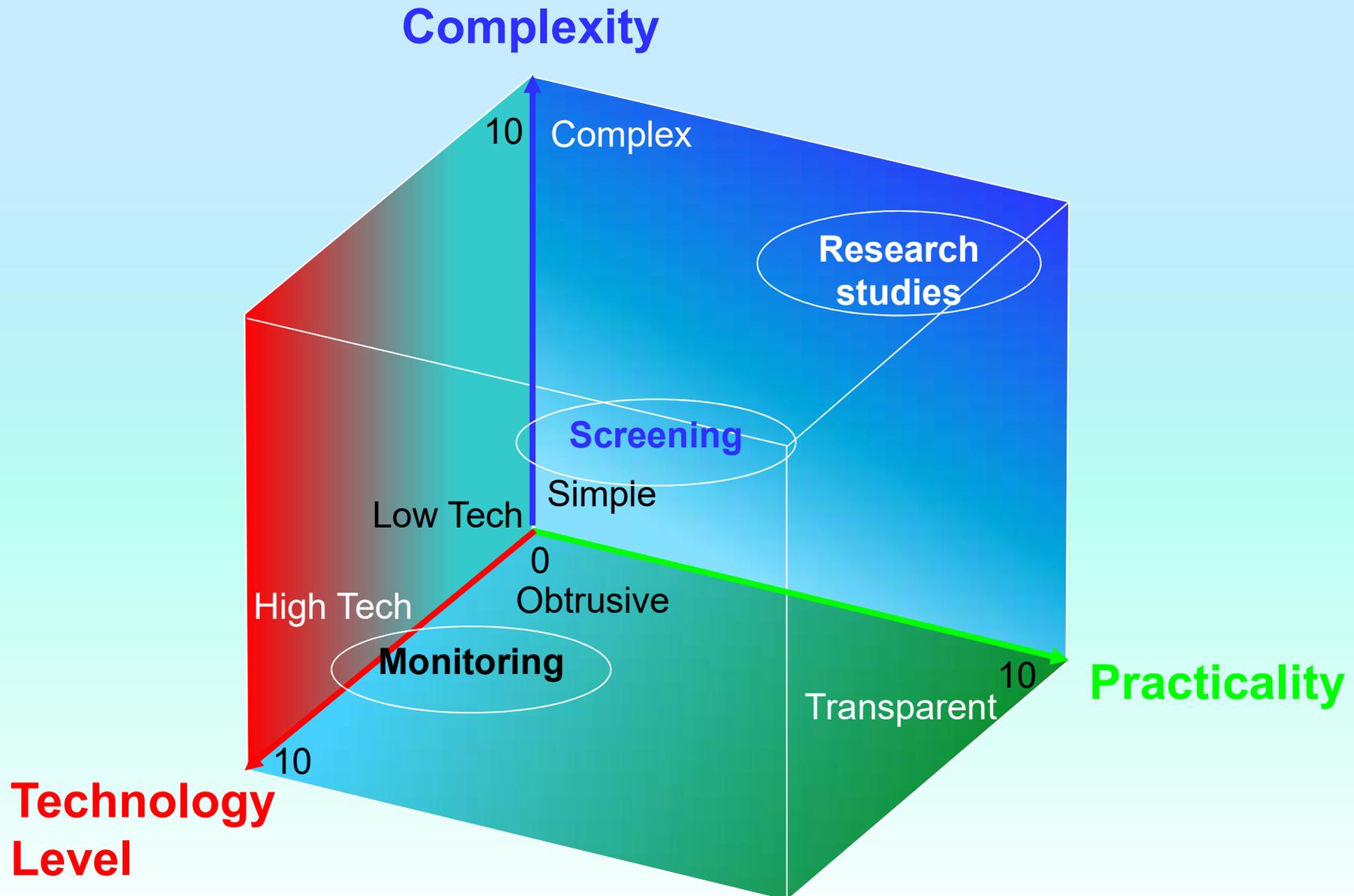


NK EmPower oarlock

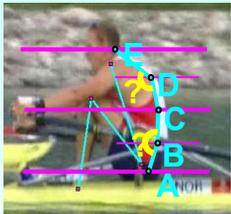
In all systems, the traditional method (Handle Power) is used anyway, because only one force is measured

Classification of Sport Technology

11

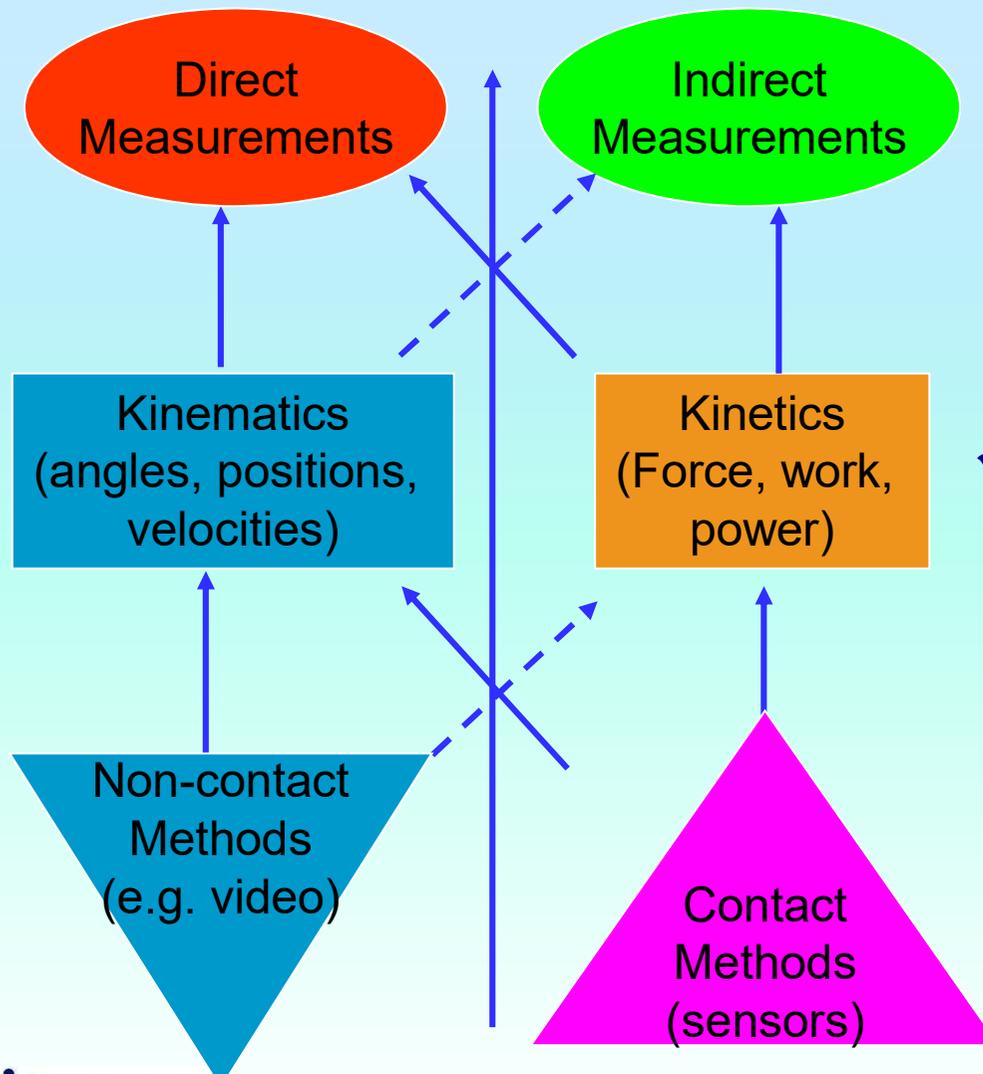


Estimation on rowing instrumentation



Product	Practicality	Complexity	Technology
NK EmPower oarlock	8	3	7
BioRowTel system (standard)	5	8	5
Peach Inn. system	7	4	6
Video analysis	5-10	1-10	1-10

Classification of Technology methods

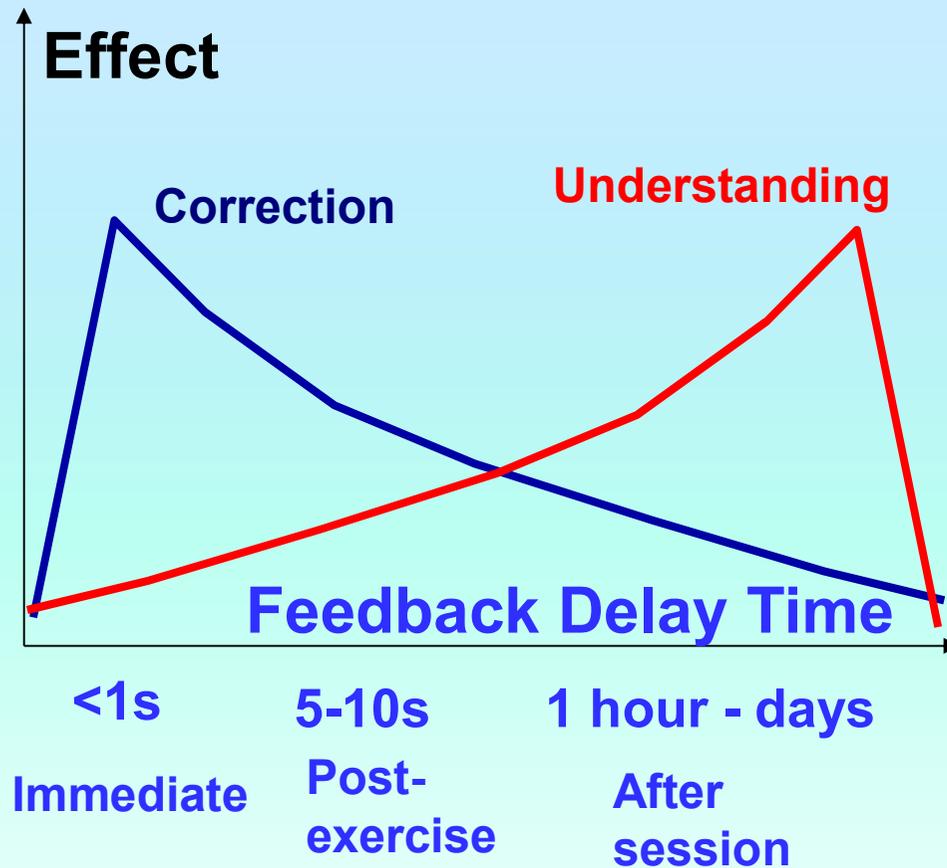


✓ Direct measurements are easier for analysis, so and more accurate, but could be obtrusive;

✓ Kinematics variables can be measured using non-contact methods, but kinetics usually requires contact sensors.

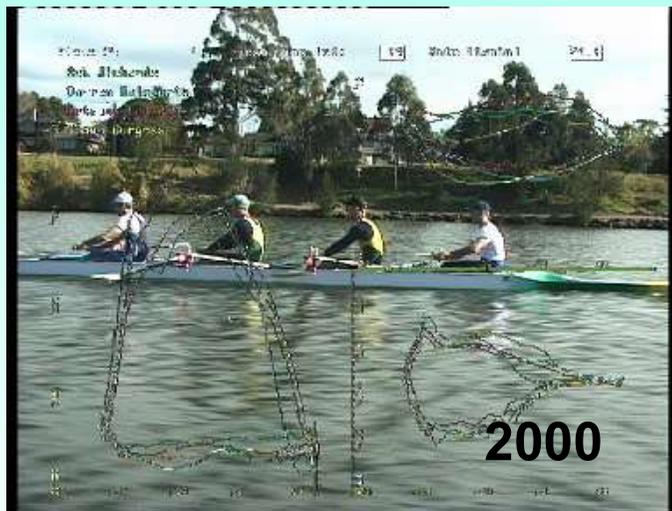
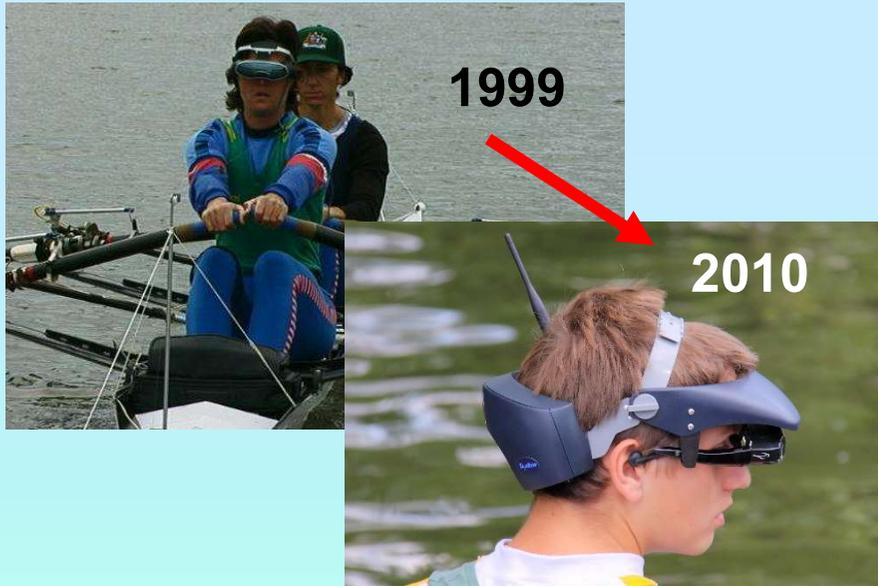
Feedback Factor:

How to make it more effective?



- ✓ Immediate feedback is effective for correction of motor-control patterns, providing an athlete understands what is required.
- ✓ After-session feedback allows detailed analysis and explanation of technical faults and correction methods, but is difficult to relate to motor control;
- ✓ Post-exercise feedback is widely used in artistic sports (gymnastics, diving, etc.) and athletics.

Immediate Feedback in rowing



- ✓ In 1999 we have invented the first “Virtual goggles” system for rowing, which consists of a personal head-mounted display, video source and radio link between them;
- ✓ In 2010 together with ActiveTools Ltd., the “goggles” were combined into one unit with video-receiver;
- ✓ In 2000 we used augmented video feedback, where biomechanical information was overlaid on top of the video.

Rowing technology people



Techi



Knowledge in Technology
HOW to measure



Expert

Knowledge in Rowing Science
WHAT to measure

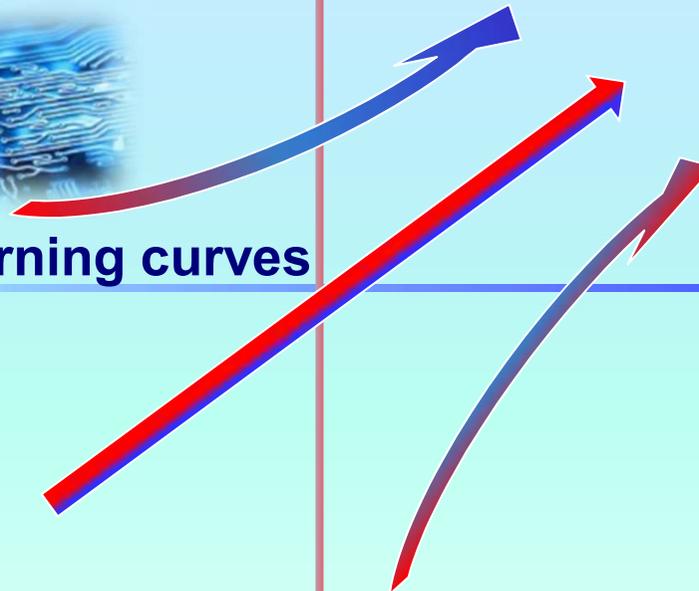


Scientist



Dummy

Learning curves



BioRow™ developments in instrumented oarlocks



Referenced by Peach Inn.

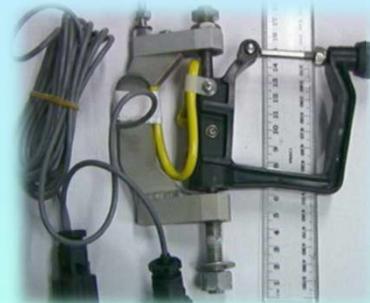
WEBA RowX

2001



2014

NK EmPower



2000

AIS gate



2011

Rotating cylinder load cell

1987

2 Ring sensors



4 Ring sensors & angle

1988



1992

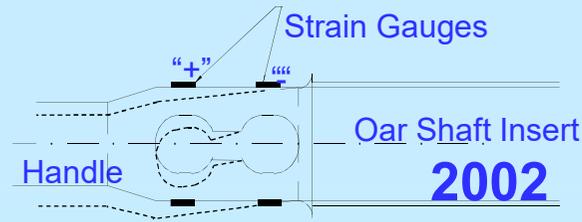
Rotating pin



2005

Rotating binocular-shape load cell

BioRow™ Handle Force sensors



6 channels
Torque-force system



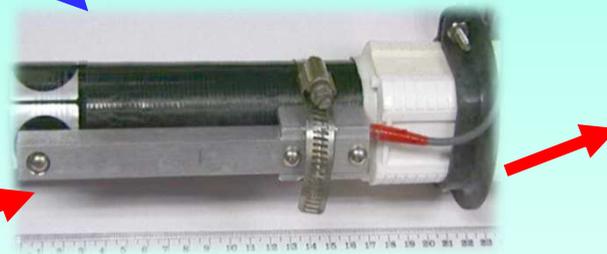
2014 Wireless 8D sensor



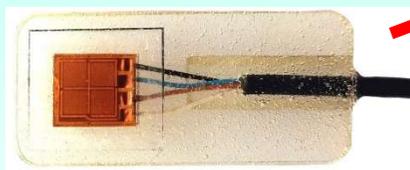
Proximity sensor
was used in AIS



2005 Removable sensor
with amplifier



1998
Removable sensor
without amplifier



1986 Strain gauges
on oar shaft

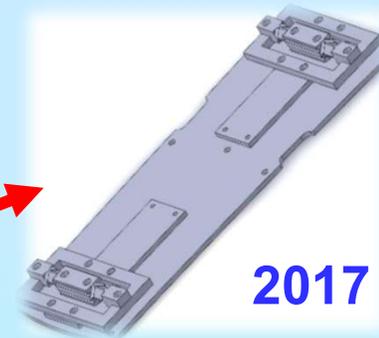
BioRow™ Stretcher sensors



Three external load cells simplified



Four points Normal force



Four points 2D force

Single load cell adjustable angle



Two load cells on tube slider at the bottom



Two 2D load cells Inside the tube & one at the bottom



Three external 2D load cells

Other BioRow™ developments



Oar angles sensors



Seat & trunk position sensors

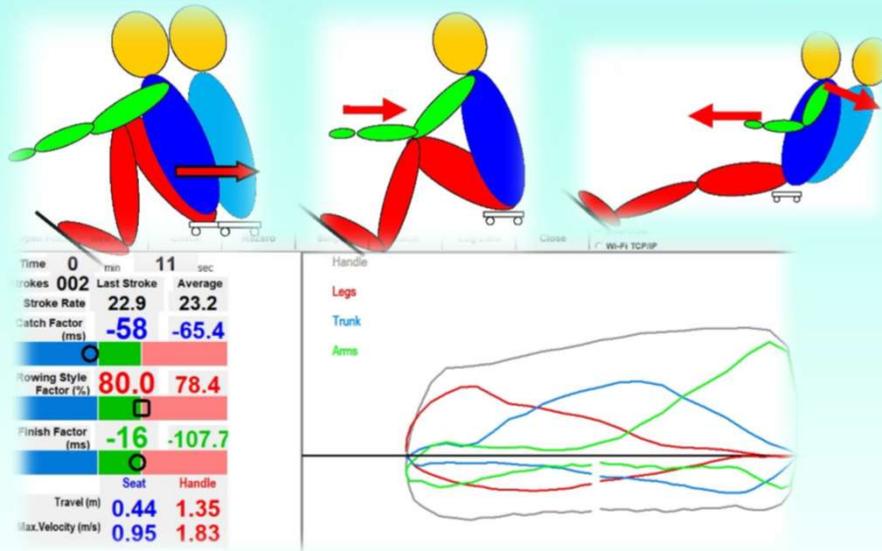
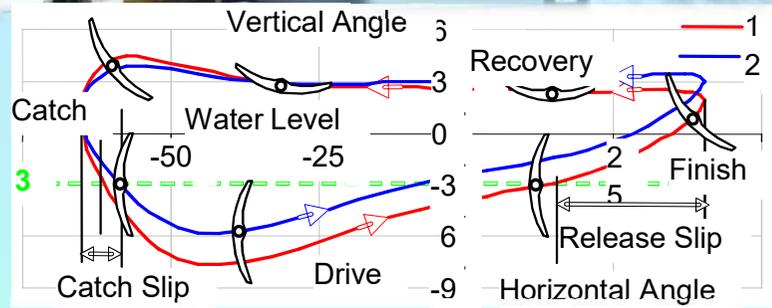
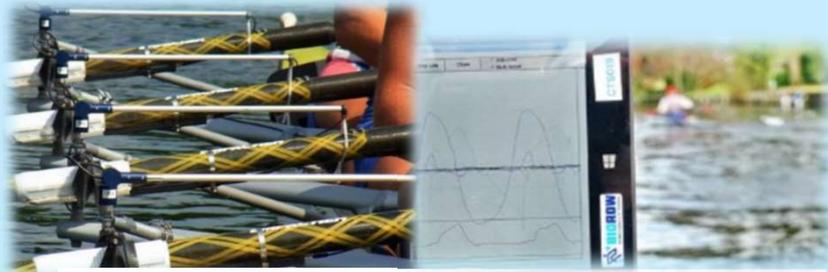
Vertical seat force



Wind speed & direction

Angle Guides

BioRow™ measurement & feedback systems



- ✓ BioRowTel system is quick to install on a boat and remove. It does not affect rigging settings and measures reliably the most essential biomechanical variables;
- ✓ BioRowTel system can connect wirelessly to NK EmPower oarlocks and send data through WiFi to a coach's tablet PC;
- ✓ BioRowTech system is a simple & effective tool for rowing technique improvement on a rowing machine

Conclusions

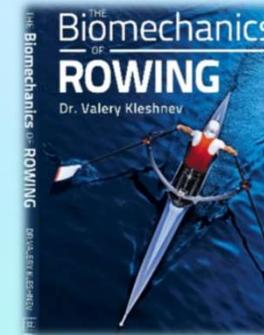
- ✓ We live after the 3rd industrial revolution, in the era of booming technologies, so ability to handle information is critical for success;
- ✓ “Gadgets” and “gizmos” are getting more and more accessible, practical and easier to use;
- ✓ Technologies not always play positive role in our culture, practical habits and rowing technique;
- ✓ It is very important to choose the most valid and informative variables to measure, and give them correct interpretation, reliably related to rowing performance.



Thanks for your attention

For more information see:

- “Biomechanics of Rowing” book;
- Rowing Biomechanics Newsletter on www.biorow.com



Dr. Valery Kleshnev

BioRow Ltd.

www.biorow.com

valery@biorow.com