Biomechanics for Rowing Technique and Rigging

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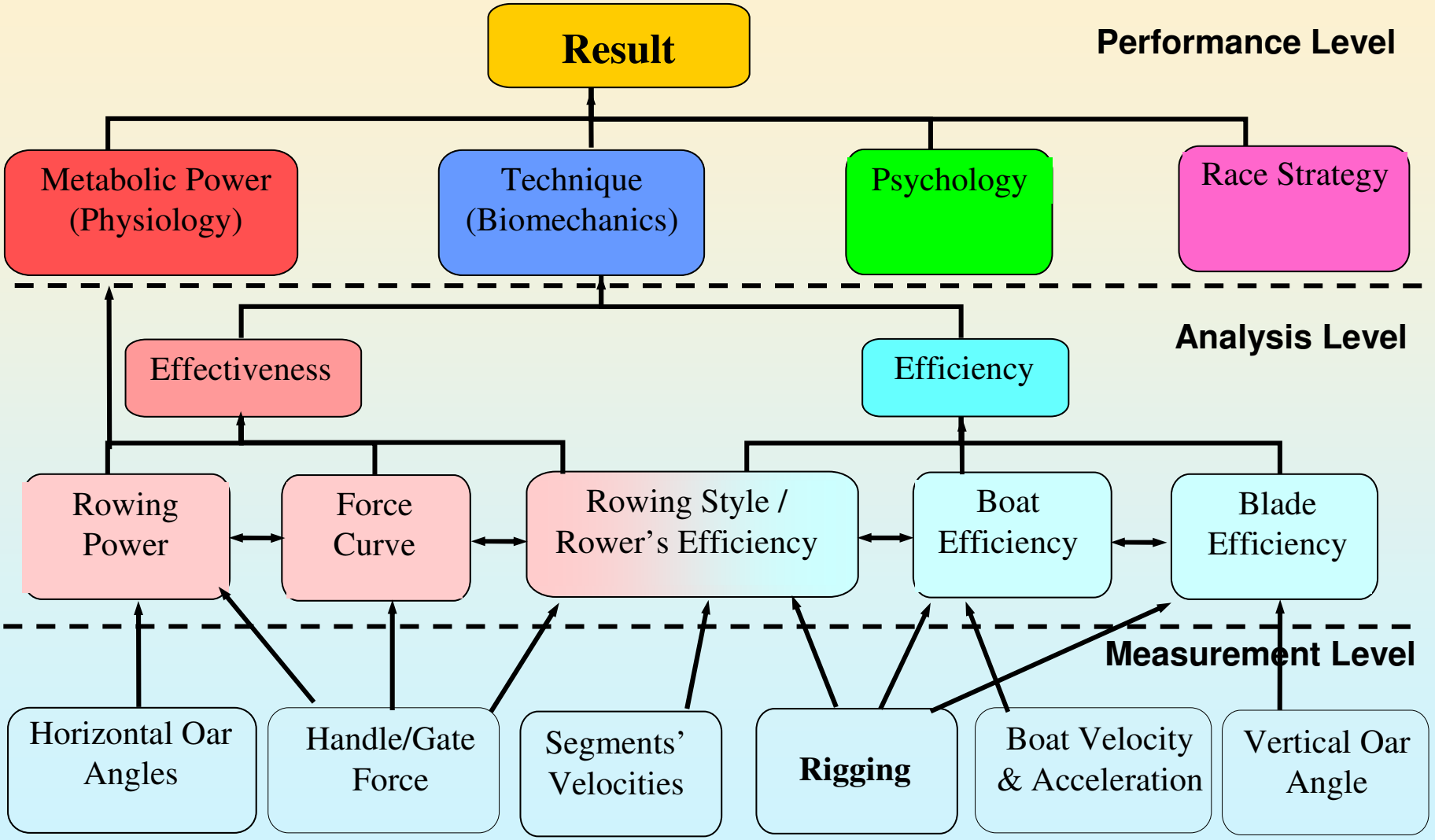
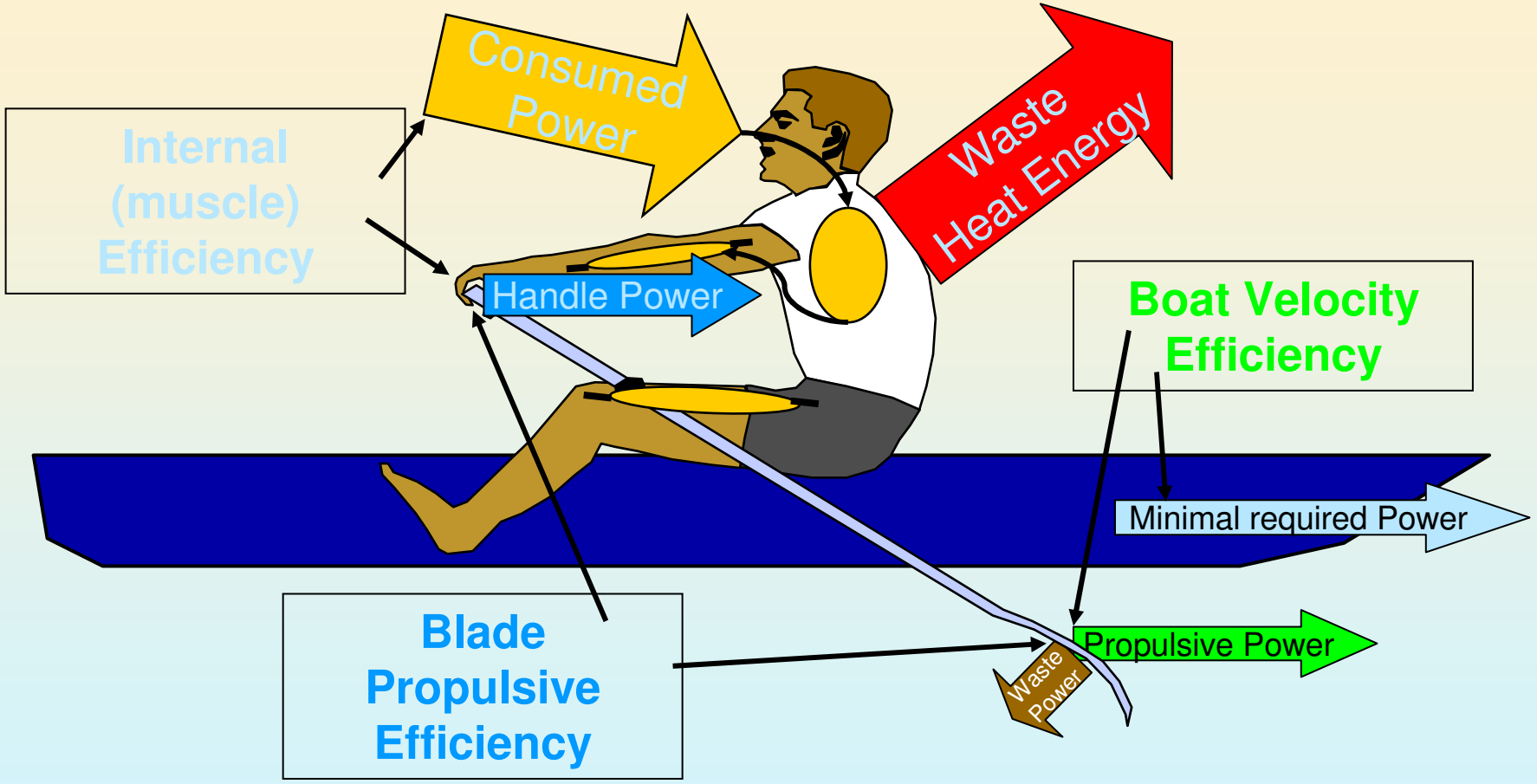
Contents

- ✓ Model of rowing efficiency;
- ✓ The main principles of effective rowing technique;
- ✓ Biomechanical basics of rigging;
- ✓ Biomechanical measurements and tools;
- ✓ Biomechanical feedback;

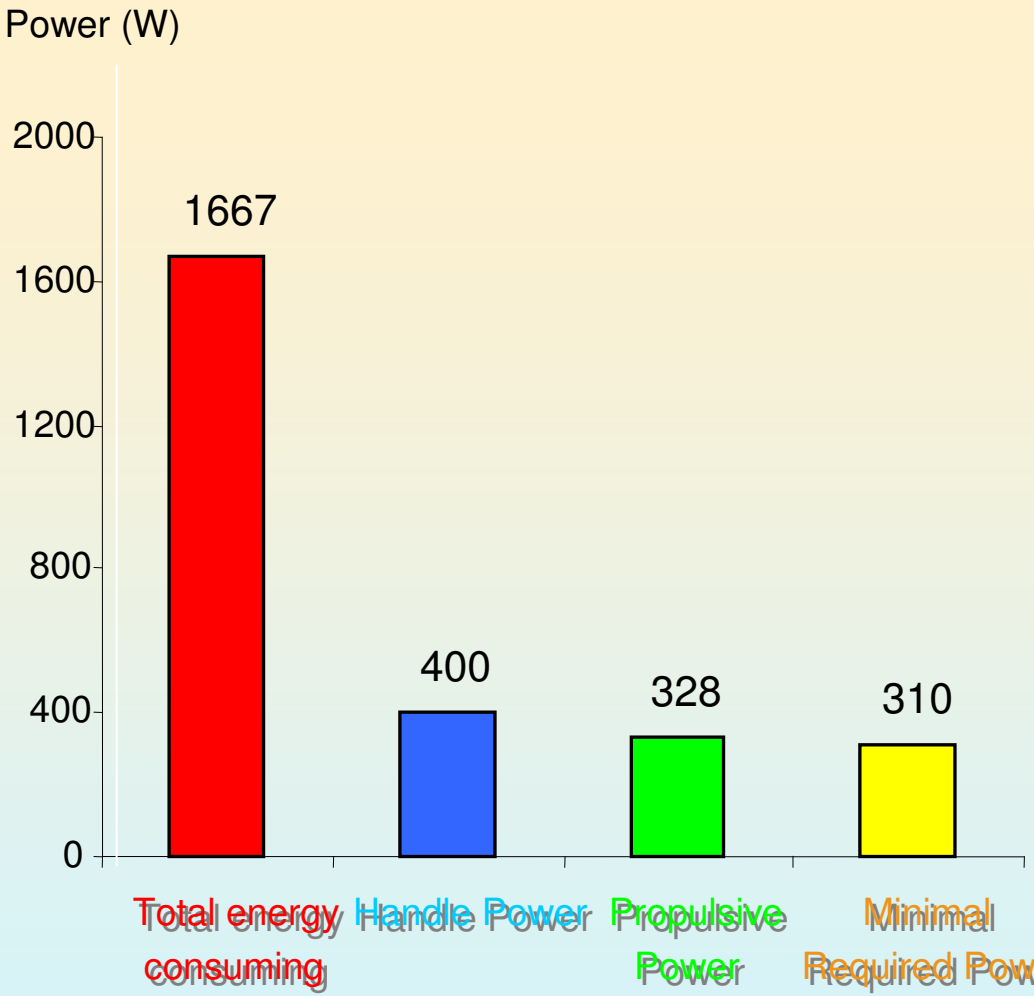
Efficiency and effectiveness of technique

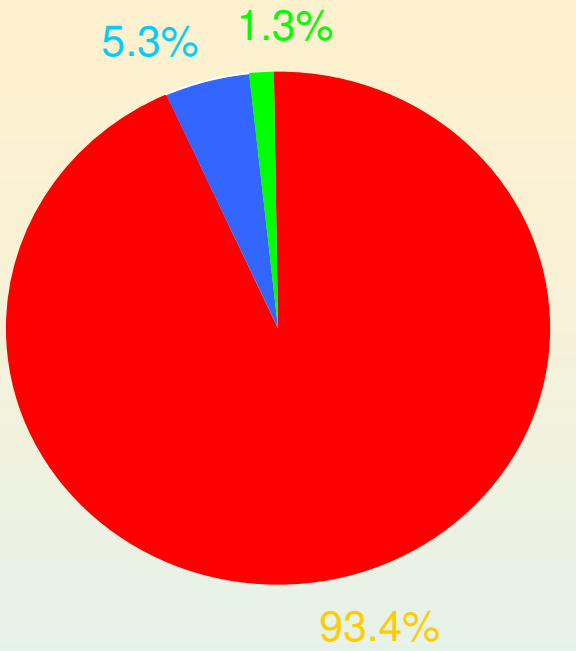


How we define rowing technique efficiency?



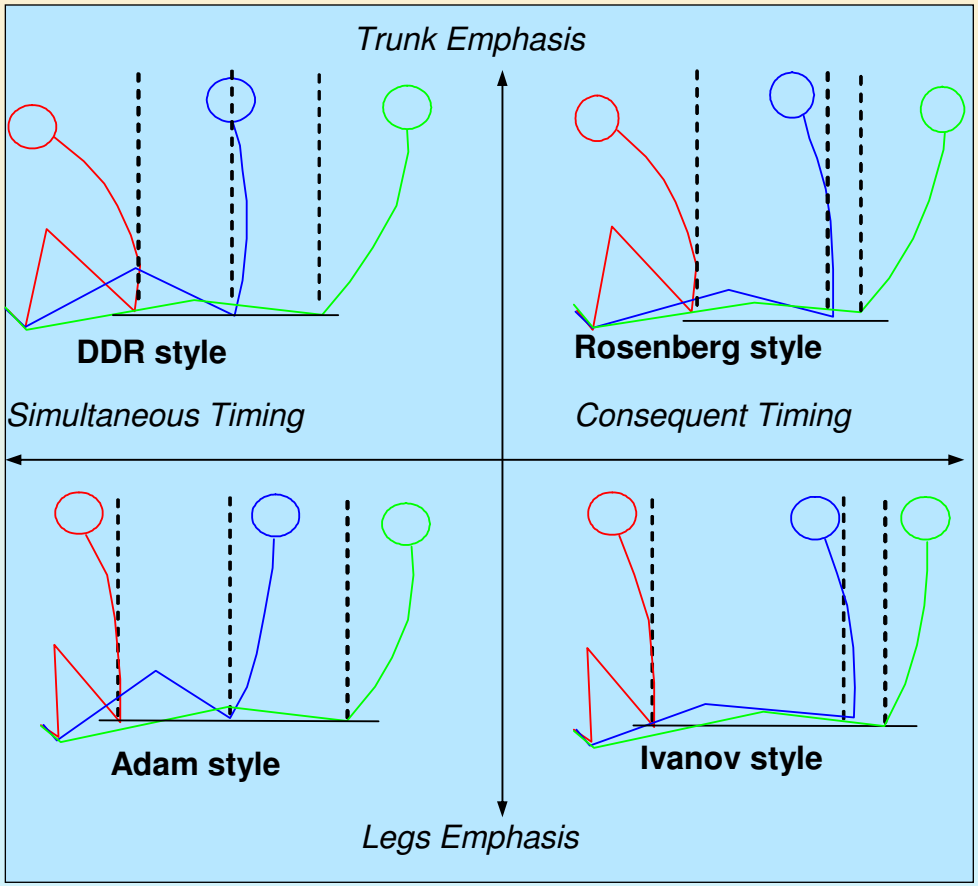
The three main parts of rowing as a process of energy transformation





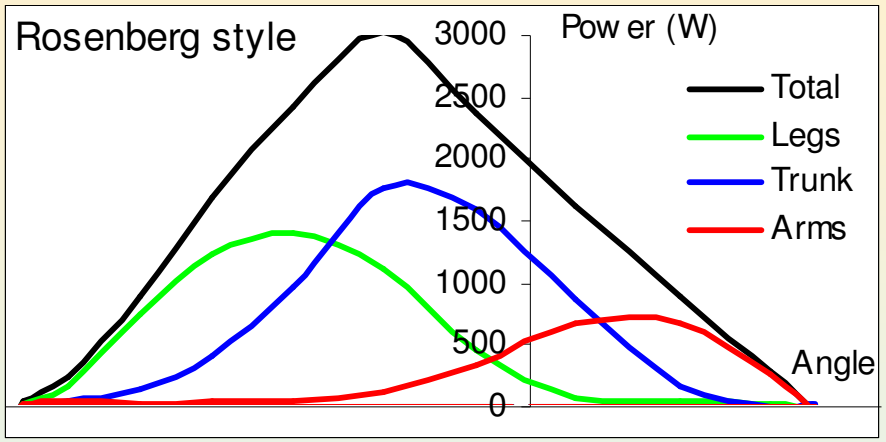
Amounts and Losses of energy during rowing (example values)

Rowing Styles



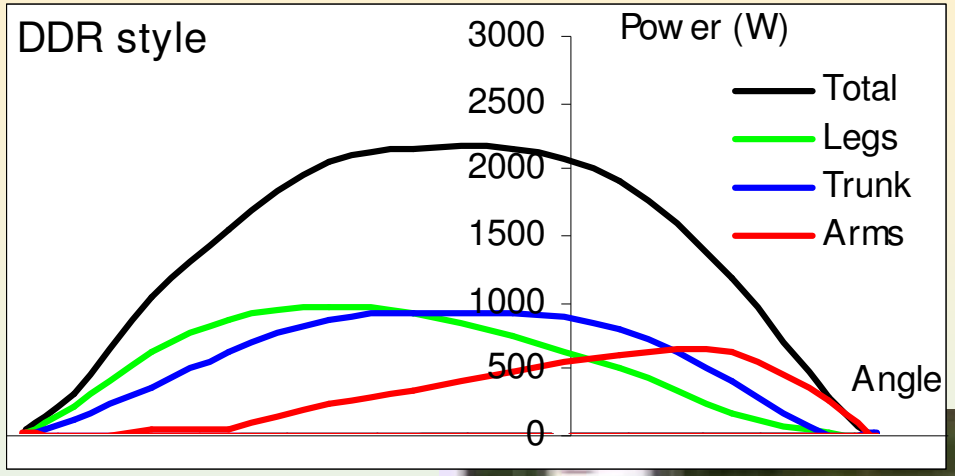
- ✓ **Rosenberg** - Large, forward declination of the trunk at the beginning of the stroke, then strong leg extension without significant trunk activation;
- ✓ **Adam** - Comparatively long legs drive and limited amplitude of the trunk. Simultaneous activity of legs and trunk during the stroke;
- ✓ **DDR** - Large, forward declination of the trunk, which begins the drive, followed by simultaneous activity of the legs;
- ✓ **Ivanov** - consequent timing and emphasis on the legs drive.

Rosenberg Style



Large, forward declination of the trunk at the beginning of the stroke, then strong leg extension without significant trunk activation

DDR style



Large, forward declination of the trunk, which begins the drive, followed by simultaneous activity of the legs

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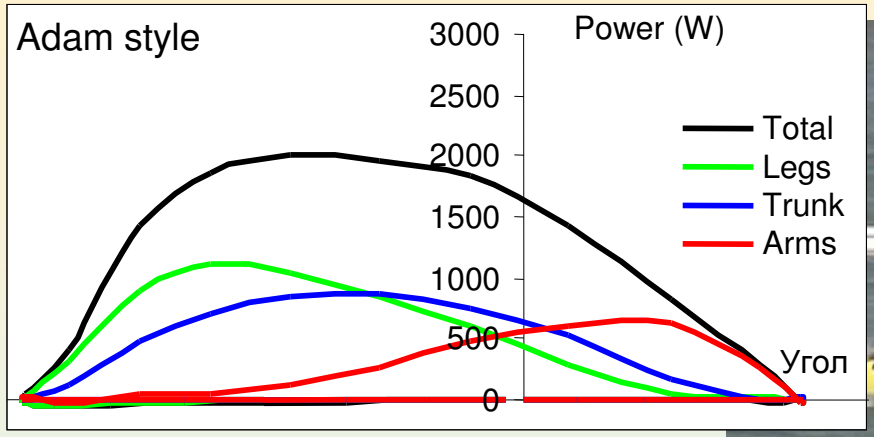
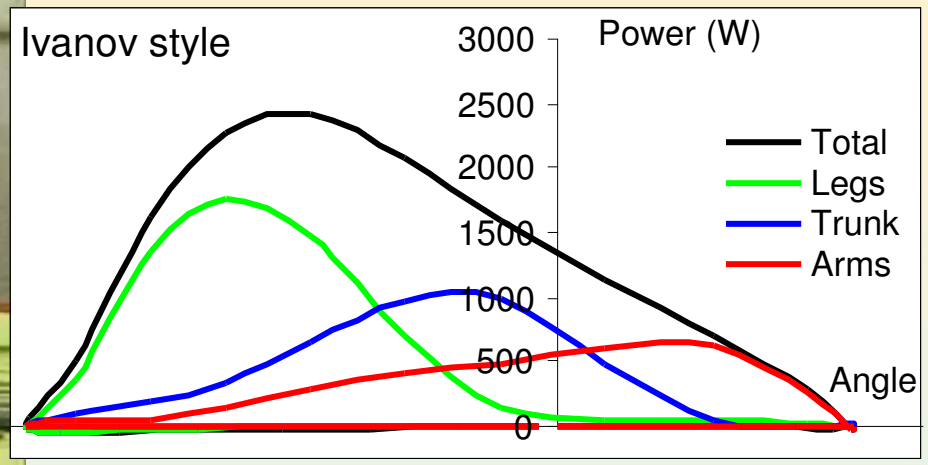
Adam Style



Comparatively long legs drive and limited amplitude of the trunk. Simultaneous activity of legs and trunk during the stroke

Ivanov Style



Consequent timing and emphasis on the legs drive

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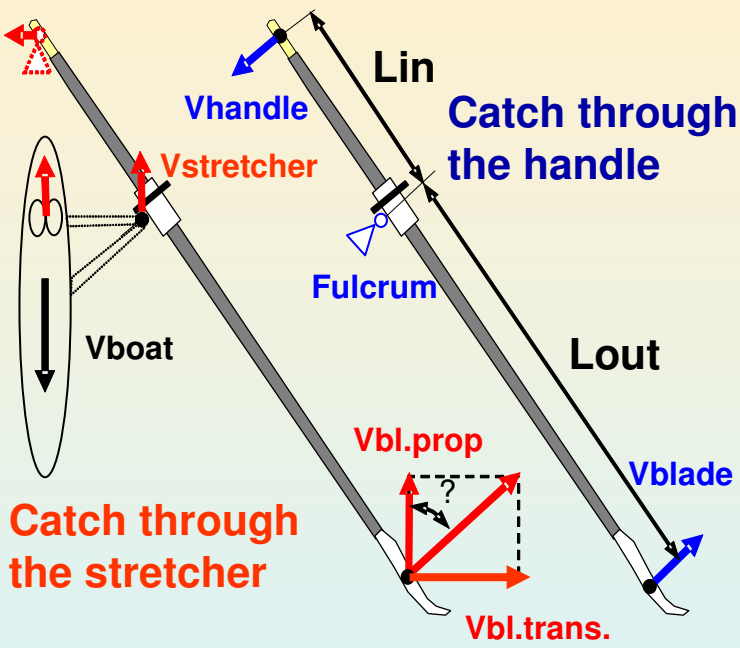
The main principles of effective technique

1. Catch through the stretcher;
2. Using the most powerful muscle groups first;
3. Optimisation of the velocity of the muscles contraction;
4. Strong posture: efficient back curve;
5. Emphasis of the force application at the front, “front-loaded” drive, the earlier, the better;
6. Coordinated and fast switching of the muscles-antagonists;
7. Effective acceleration of the centre of mass of the rower;
8. Efficient finish of the drive through the handle.

The main principle of effective CATCH



- ✓ «Catch through the stretcher» gives 46% higher velocity of the blade at the same handle velocity;
- ✓ «Catch through the stretcher» is preferable because of using of more powerful muscle groups.

In case of “Catch through the handle”:

Vblade = Vhandle (Lout / Lin)

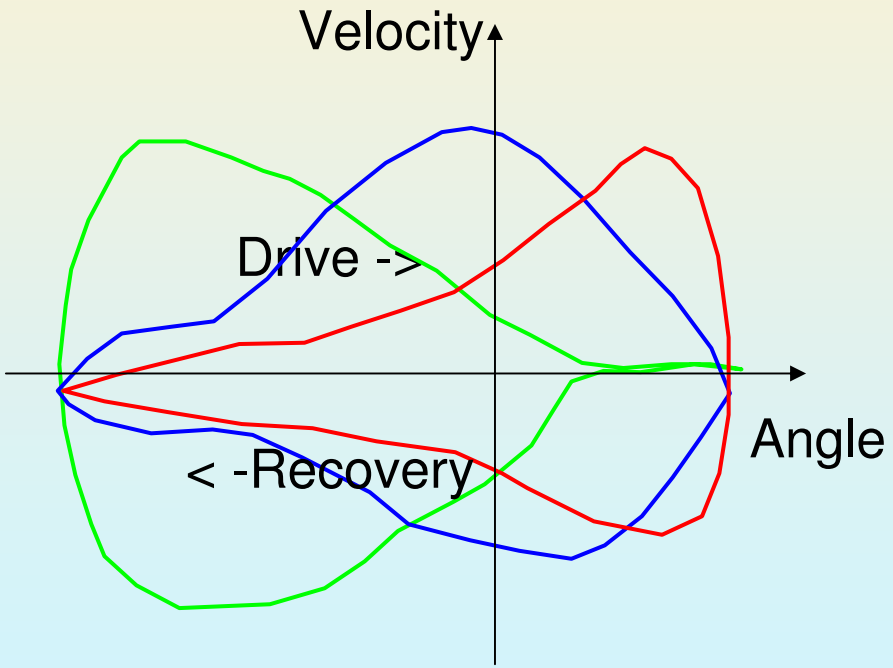
In case of “Catch through the stretcher”:

Vblade = Vstr. ((Lout + Lin) / Lin)

Using of the most powerful muscle groups

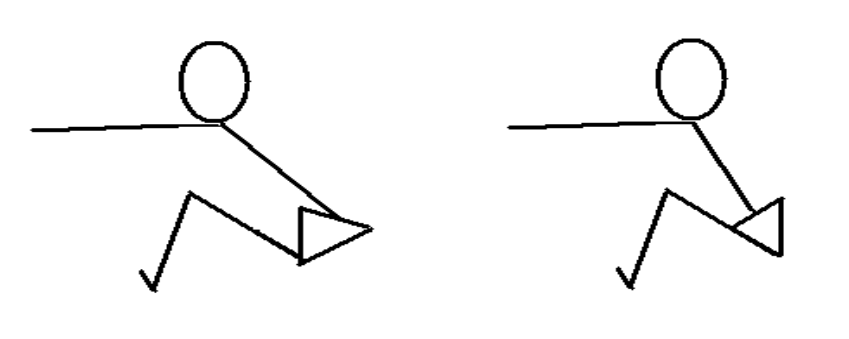
The most effective sequence of the segments:

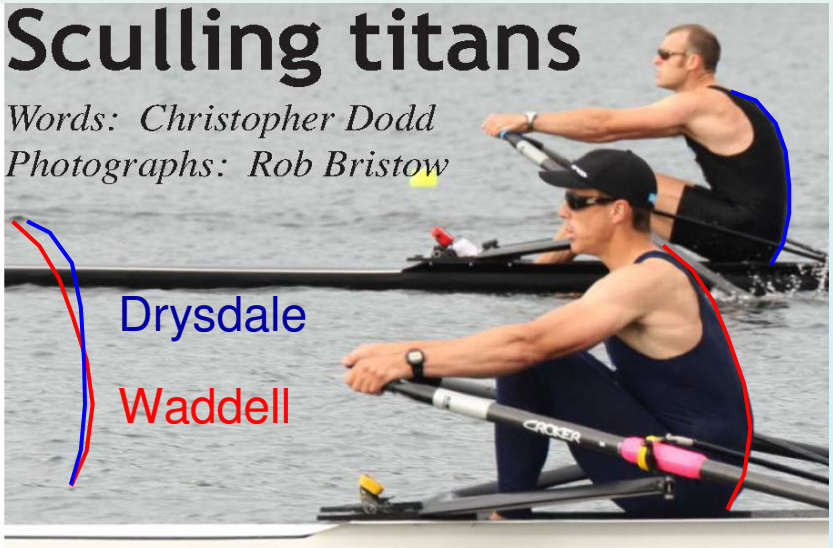
- The legs start the movement
- The trunk continue and accelerate the movement
- The arms finalize the movement



The sequence is mirrored during recovery

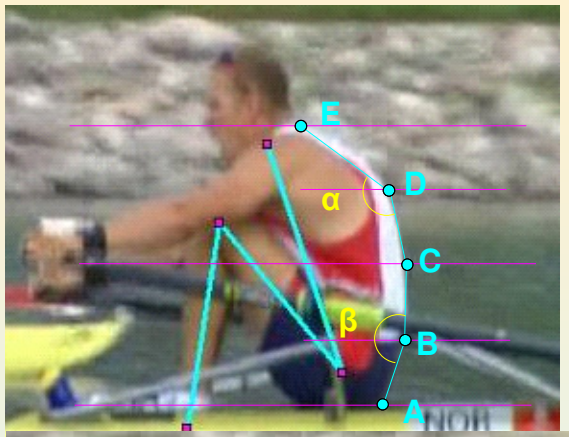
Strong posture: effective back curve

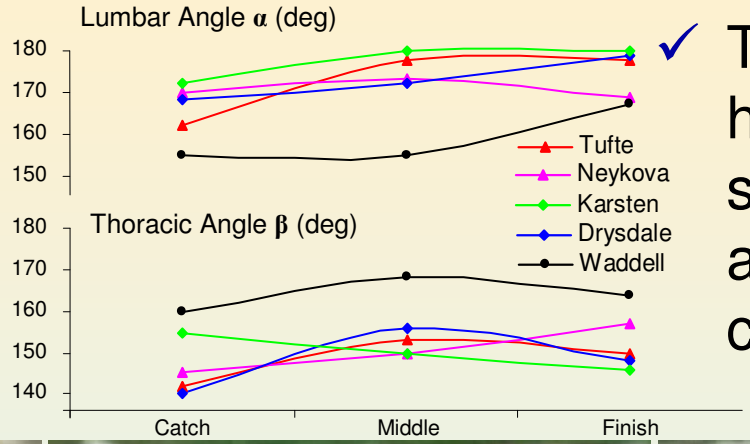




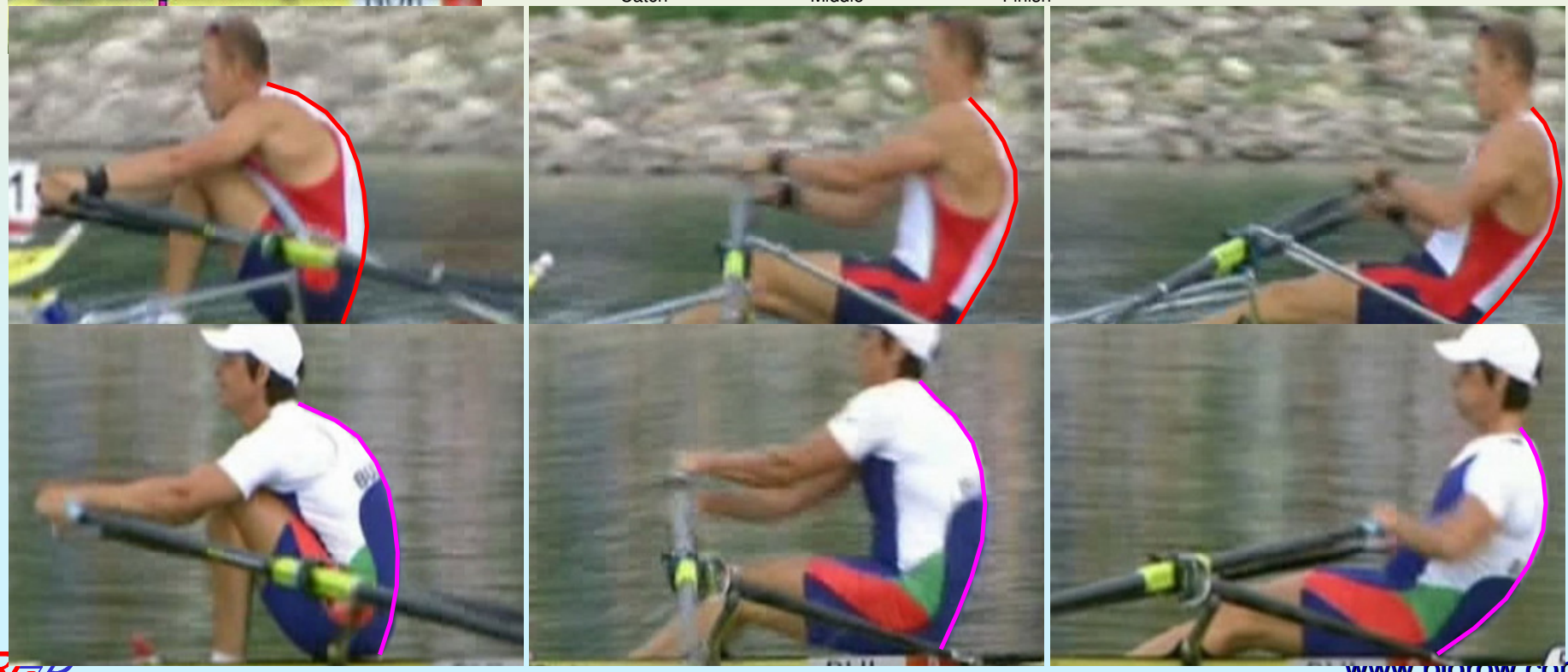
- ✓ Straighter lumbar area can help to transfer the force better from hips to shoulders and prevent injuries;
- ✓ more curvature in the thoracic area can be more economical because it uses more elastic properties of the muscles rather then its strength.

Analysis of Lumbar and Thoracic angles

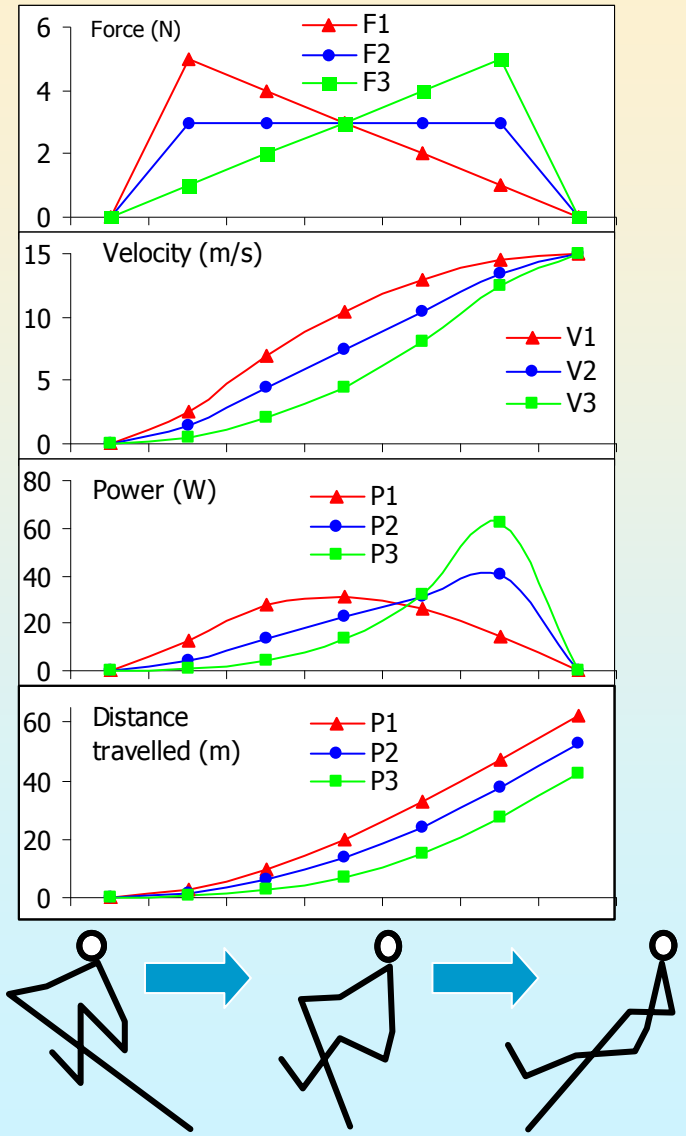




✓ The best scullers have significantly straighter lumbar angles and more curved thoracic angle



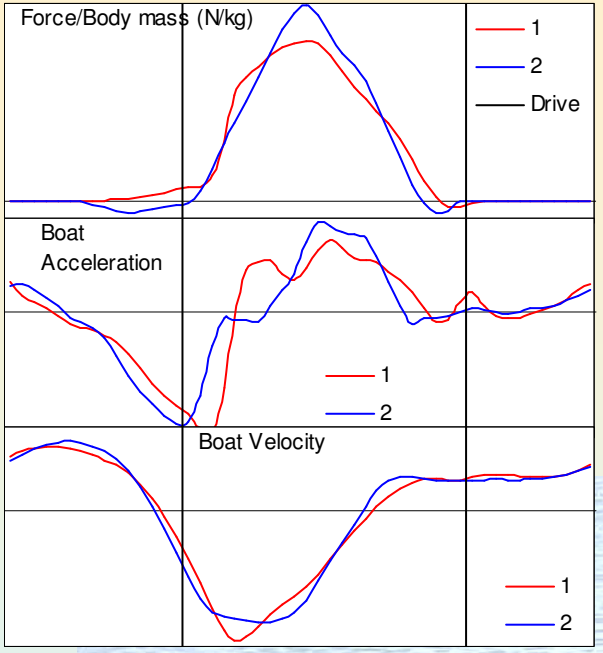
Advantages of the front loaded-drive



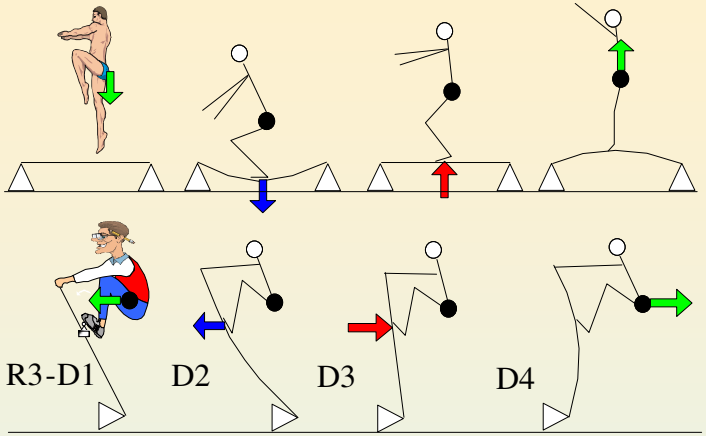
Front-loaded drive (F1):

- ✓ Gives 47% higher average velocity and distance travelled during the drive;
- ✓ Creates much more even distribution of the power;
- ✓ Provide better utilization of the most powerful muscle groups
- ✓ Hydro-lift force on the blade can be used better.

How the front-loaded drive looks like?

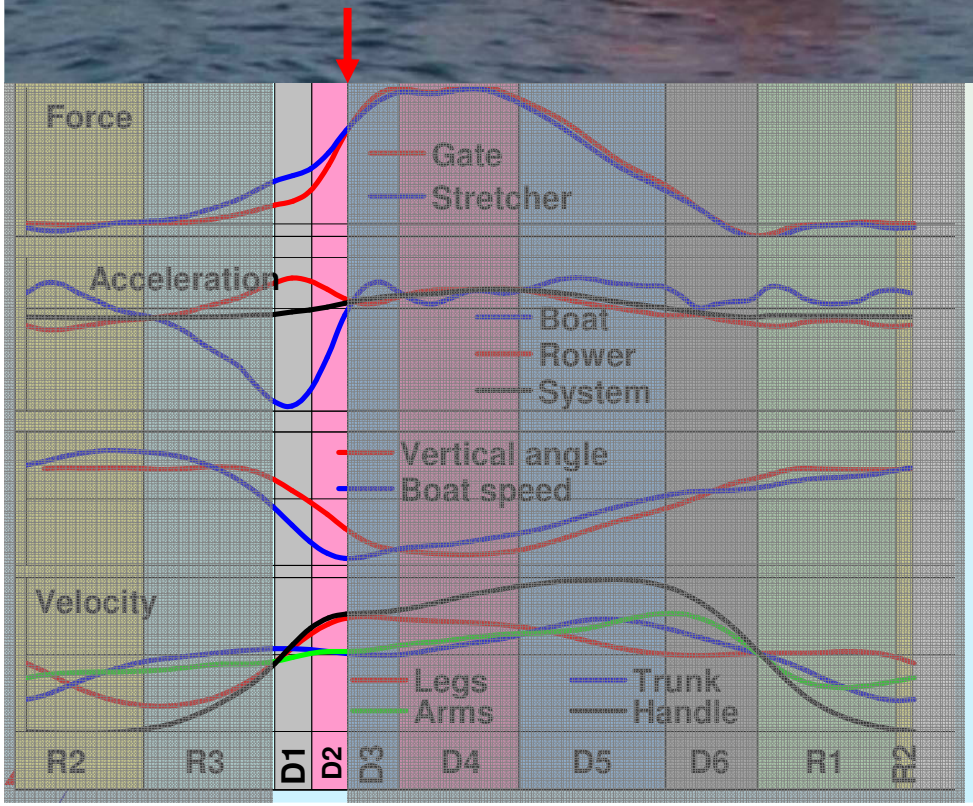


- ✓ It is important to increase force quickly up to 70% of maximum;
- ✓ "Trampolining" effect?



1. Front-loaded

1. Middle-loaded



Drive D1 Blade immersion; D2 Initial Rower's Acceleration

- ✓ Catch: the oar change the direction of the movement by means of legs kick through the stretcher.

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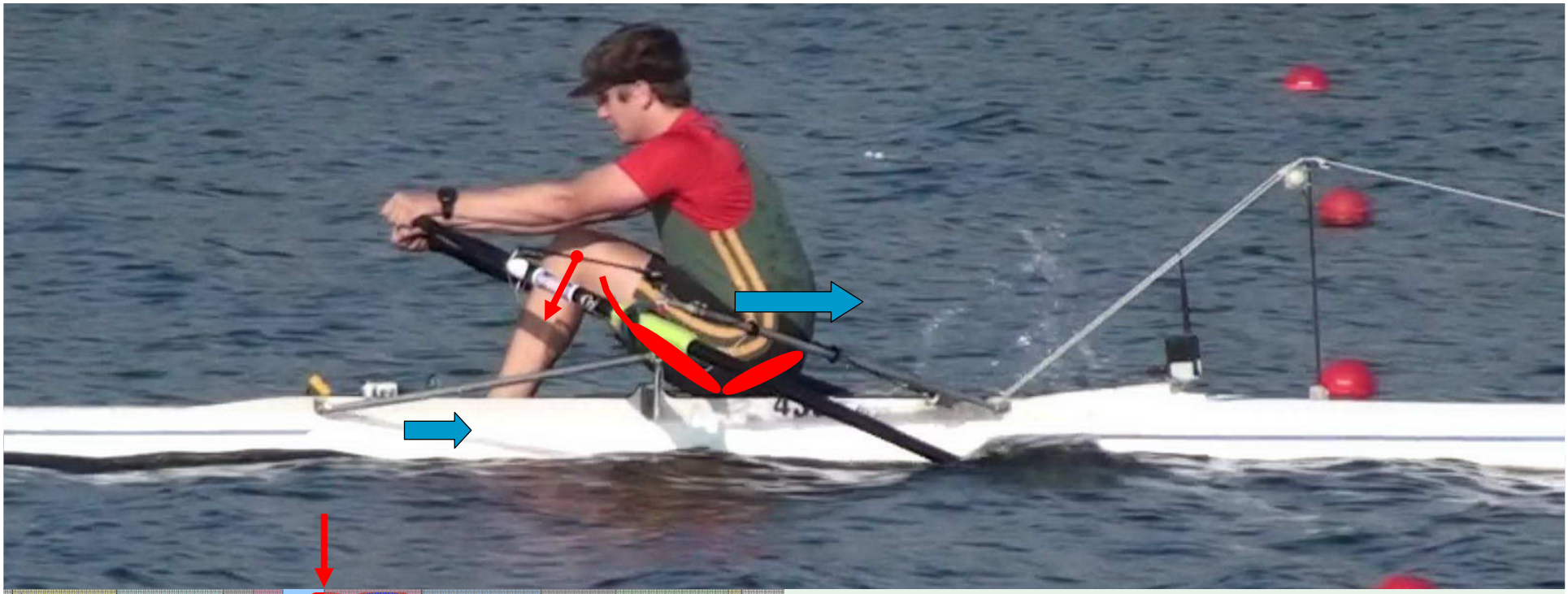

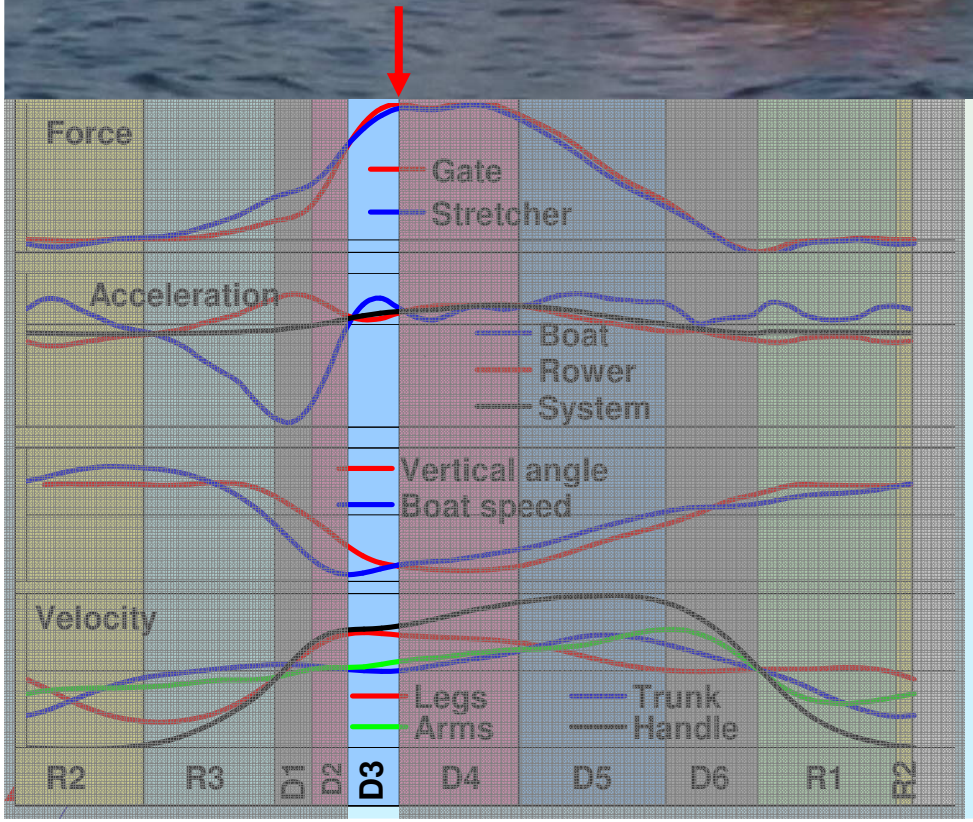

Drive D3 Initial Boat Acceleration

- ✓ Extending knees using quads,
- ✓ Pushing the stretcher through toes.

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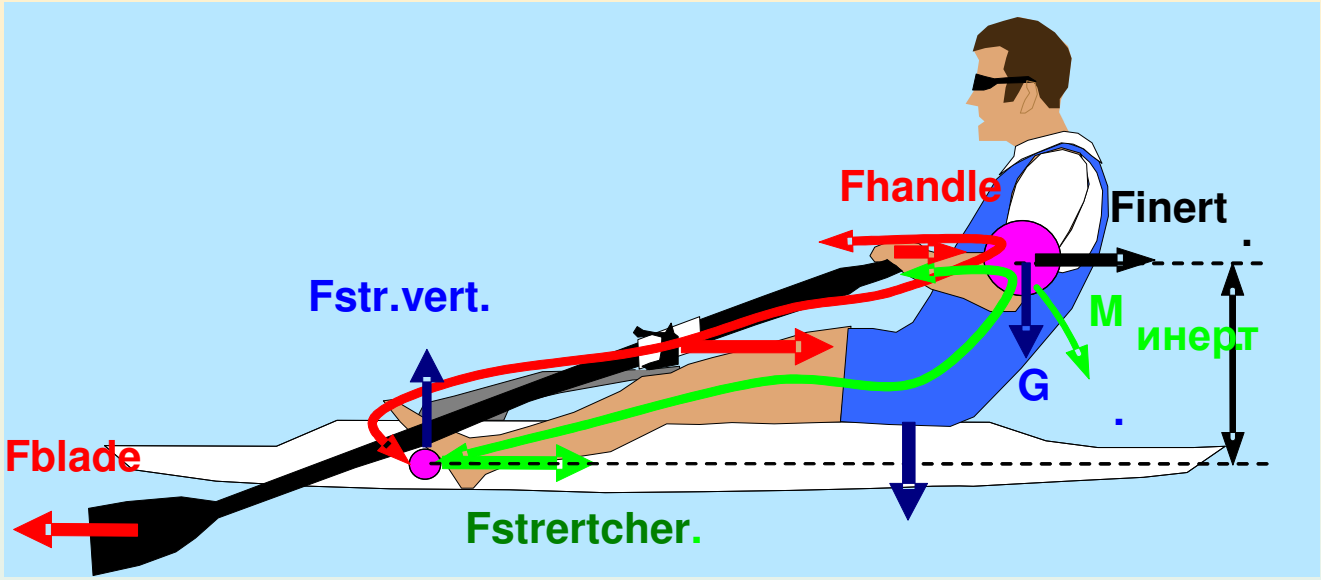
Finish



1. “Finish through the handle” creates additional force of the blade, which propels the boat-rower system;
2. “Finish through the handle” does not push the boat down;
3. “Finish through the handle” uses more effective leverage of the oar,
4. “Finish through the handle” allows earlier relaxation of the legs muscles.

✓ <u>“Finish through the handle” is the only effective way to finish the drive!</u>

Biomechanically based rowing drills

	Drill	Purpose
1	Rowing with feet out	Emphasise the stretcher pressure and fast arms drive at finish of the drive
2	Late squaring of the blades	Preventing feathering in the water and developing good balance
3	Arms with shoulders	Active using of the shoulders, arms – shoulders coordination.
4	**¼ slide – fast trunk**	**Push the stretcher through heels using gluts and hamstrings, fast horizontal trunk drive**
5	**Catch – legs only**	**Fast blade placement into the water, quick kick to the stretcher through toes using quads**

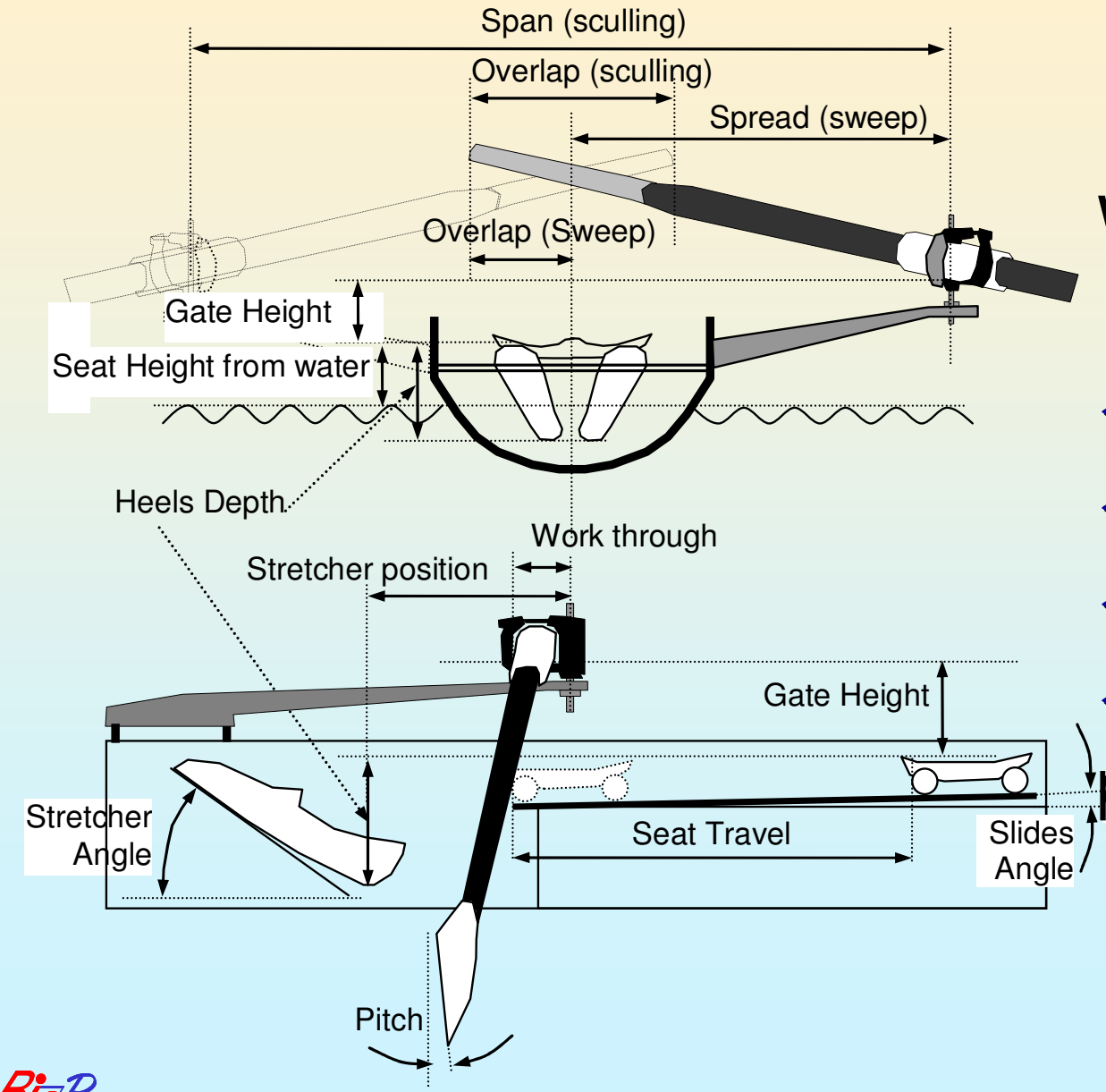
Catch – legs only drill

- ✓ **Fast blade placement into the water, quick kick to the stretcher through toes using quads**

Fast trunk drill

- ✓ **Push the stretcher through heels using gluts and hamstrings, fast horizontal trunk drive**

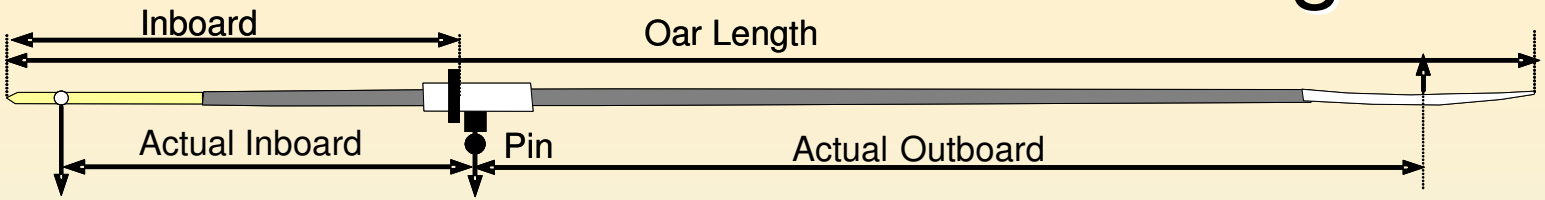
Biomechanical basics of rigging



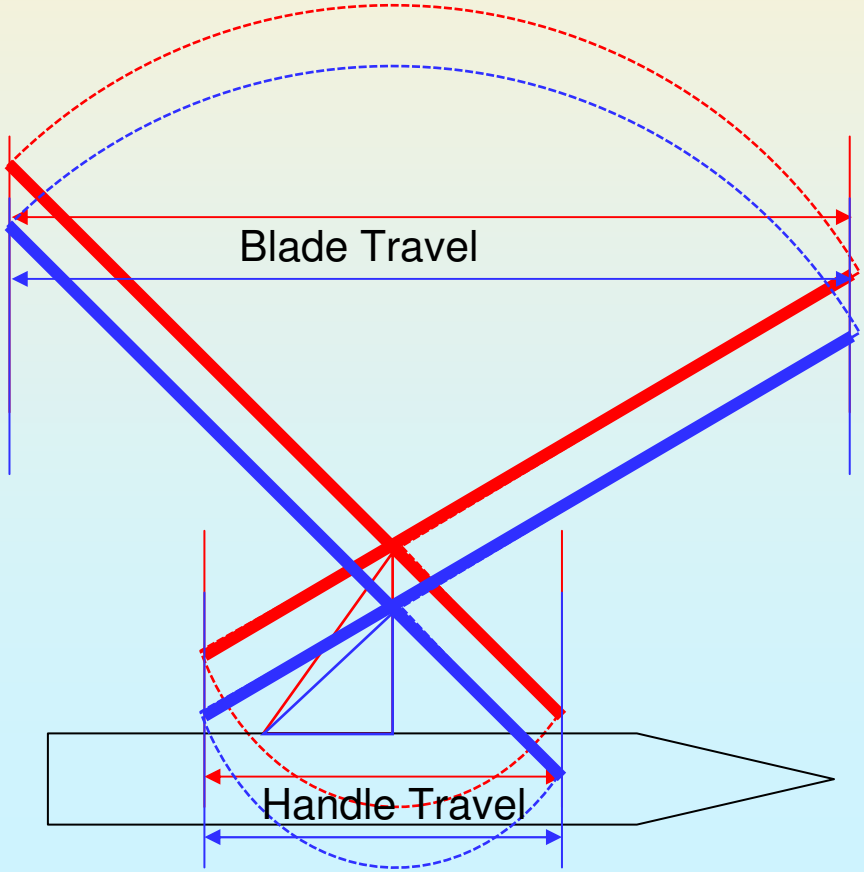
We will discuss:

- ✓Oar dimensions;
- ✓Gearing ratio;
- ✓Span/spread and;
- ✓Gate height and pitch;

Definition of the Gearing

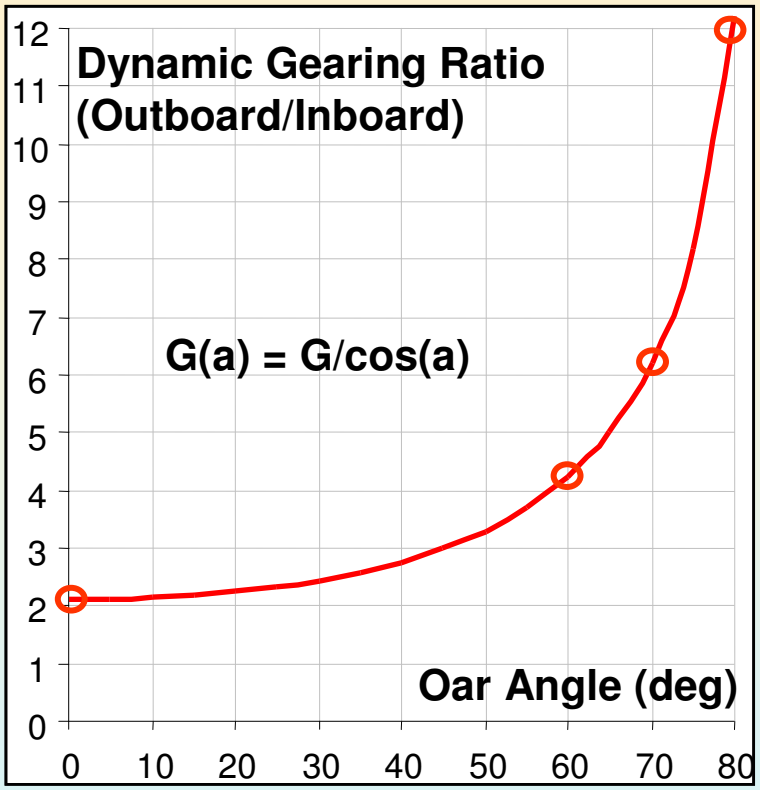


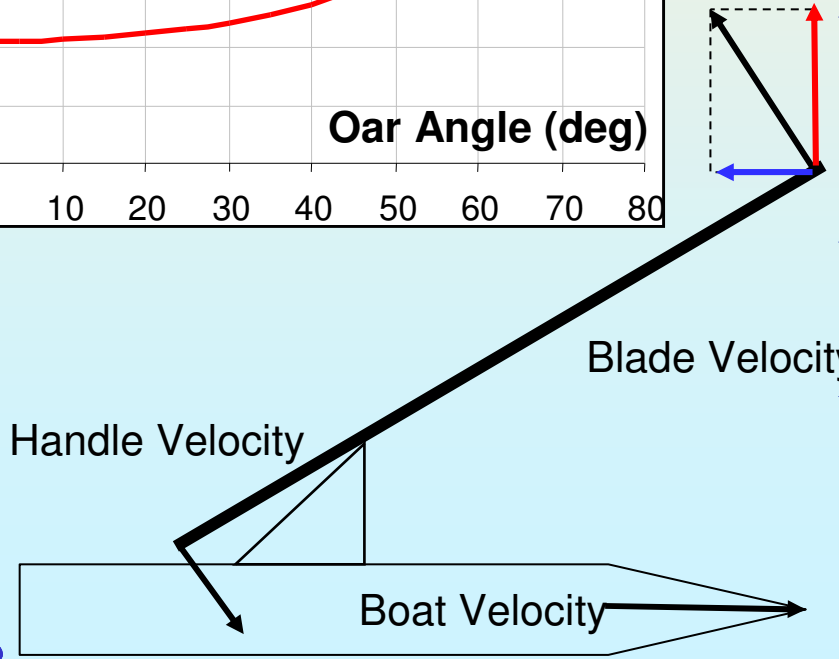
Gearing = Actual Outboard / Actual Inboard
= (Out.-SL/2- SW/2) / (Inb.-Hnd/2+SW/2)



- ✓ The standard definition of the gearing is the ration of velocities (or displacements, travels) of output to input;
- ✓ In rowing, velocity of the output is defined by actual outboard, input – by actual inboard;
- ✓ The span/spread does NOT affect gearing;
- ✓ Blade efficiency or “slippage” DOES affect Gearing.

Dynamic Gearing





- ✓ At sharp oar angles only part of blade velocity is parallel to the boat velocity;
- ✓ Effect of the oar angle is small until 45deg;
- ✓ Gearing ratio became twice heavier at the oar angle 60deg;
- ✓ Gearing ratio became three times heavier at the oar angle 60deg;
- ✓ Gearing ratio became six times heavier at the oar angle 60deg;
- ✓ The most common catch angles are between 55deg (sweep) and 70deg (sculling).

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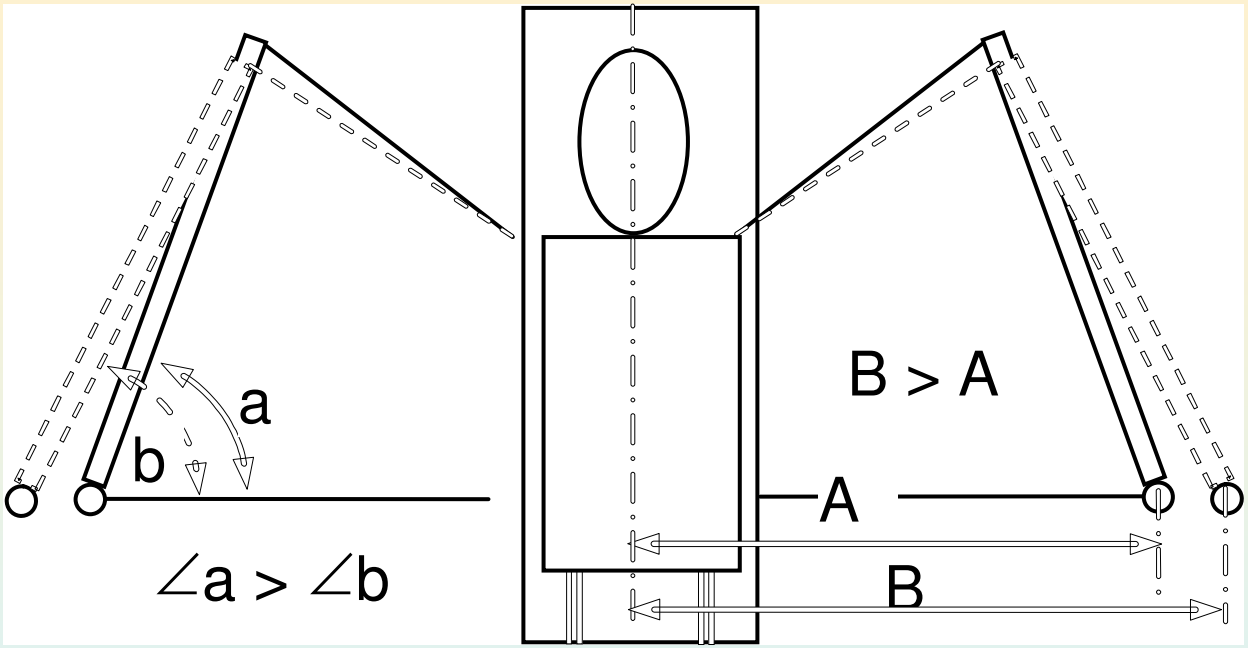
The span affects gearing indirectly



Effect of the span on the catch angle:

✓Two centimetres of shorter spread gives only 0.5 deg of extra catch angle;

✓If we change inboard accordingly to maintain overlap, this would gives us 0.8 deg of extra catch angle for every 2cm of extra spread.

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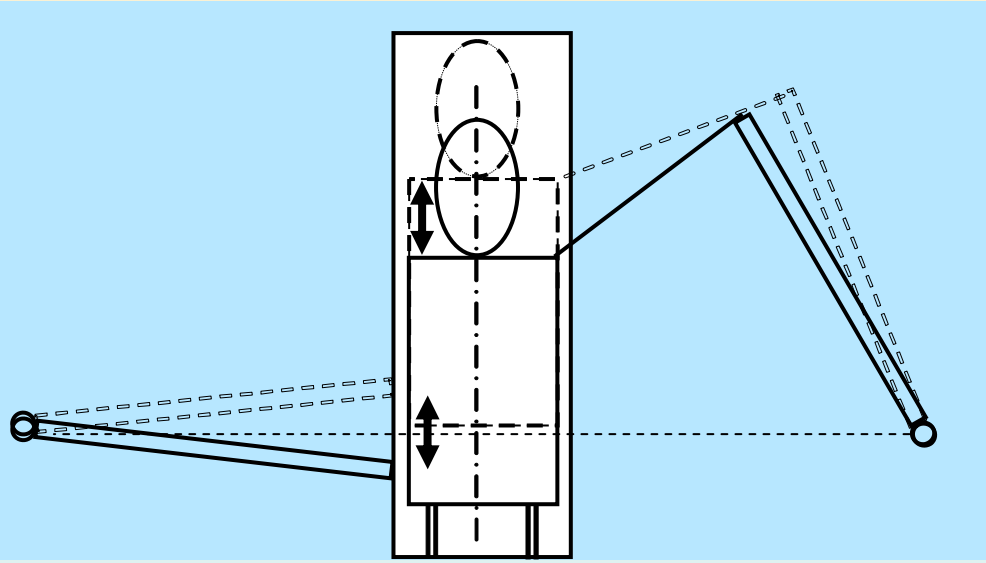
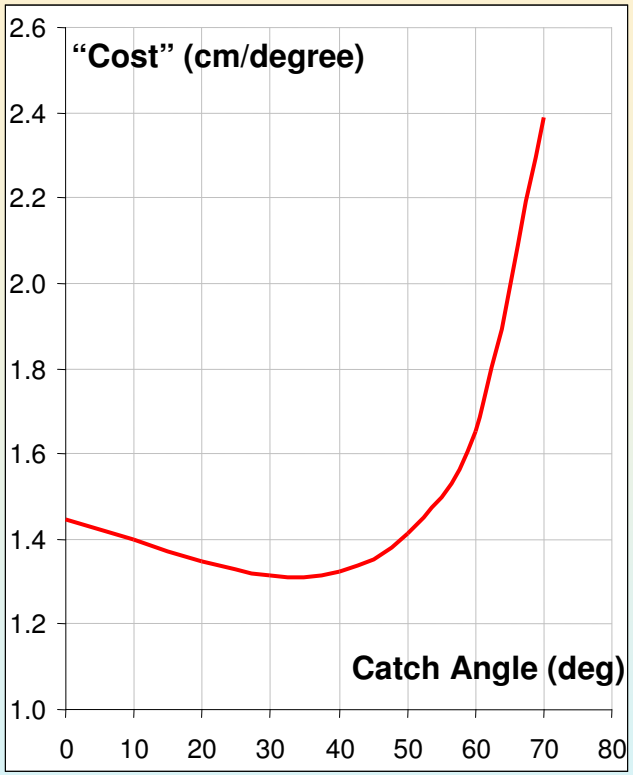
“Cost” of one degree of the oar angle at catch, when change the stretcher position





- ✓ One degree equal about 1.5cm of the arc length in sculling and 1.75cm in sweep rowing
- ✓ Change of the stretcher position affects more catch angle than finish angle

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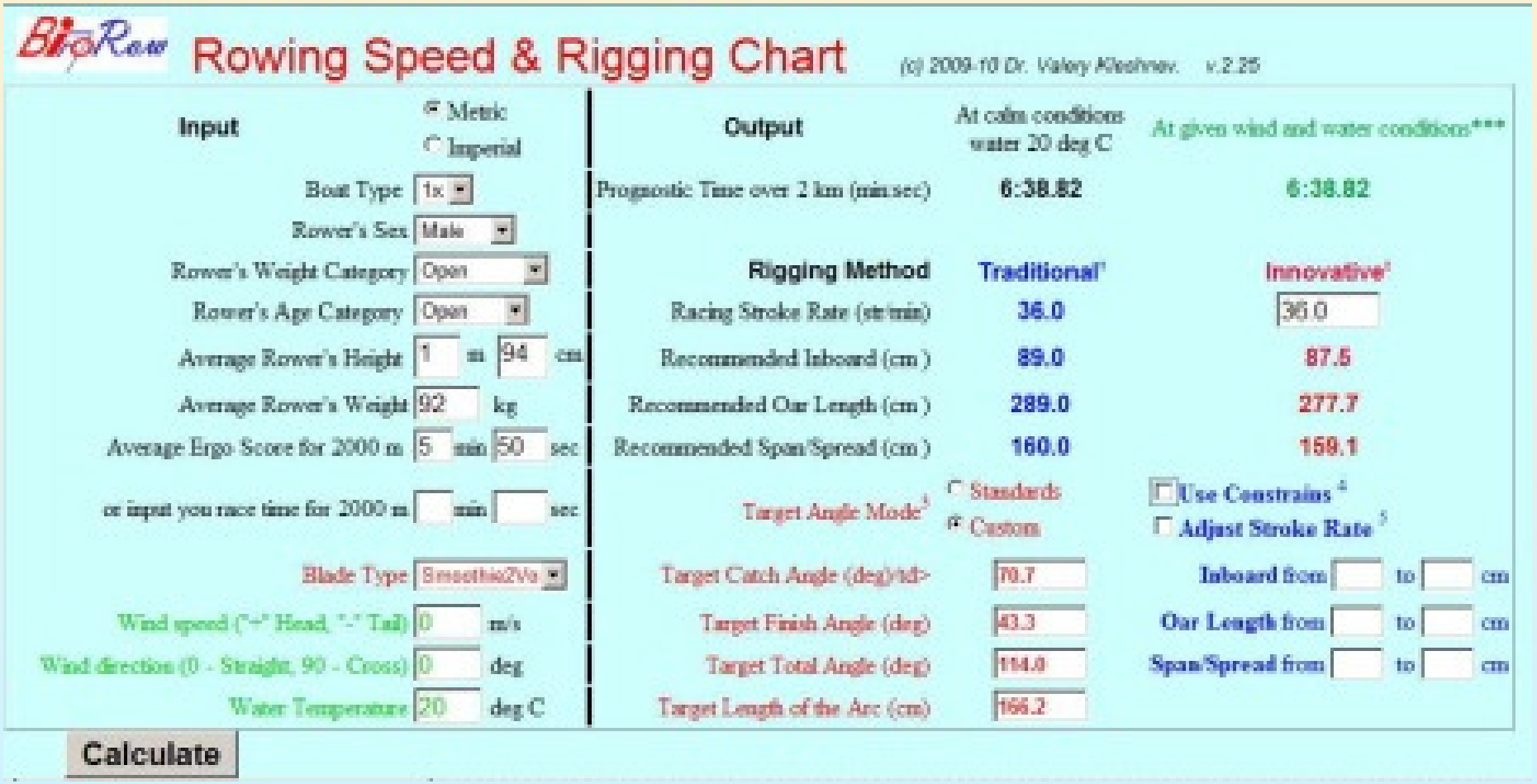
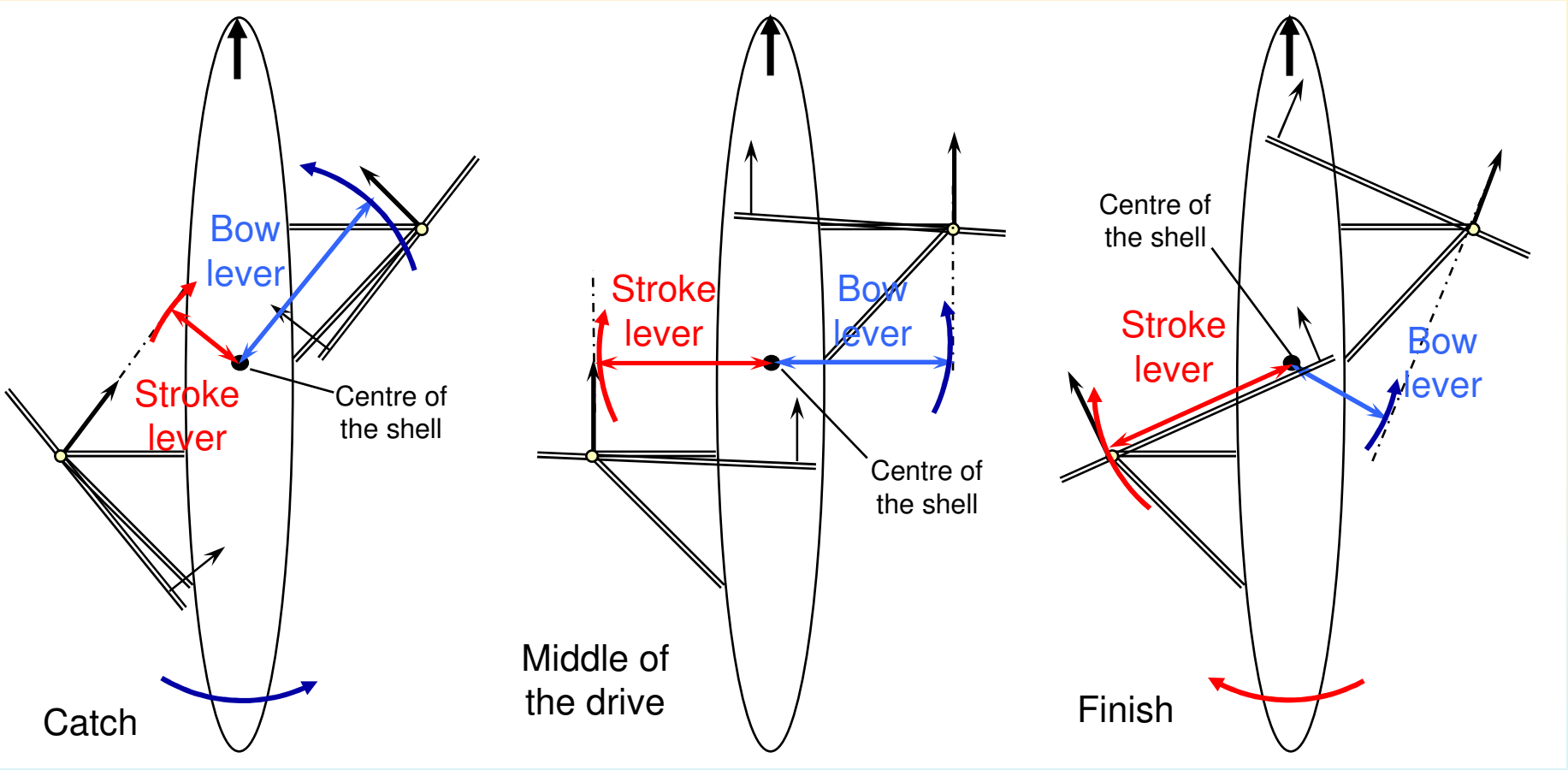
Rigging Calculator

www.biorow.com/RigChart.aspx





Lever of force of bow rower is longer

Levers are equal

Lever of force of stroke rower is longer

The difference in force lever is the main reason of boat rotation in a pair

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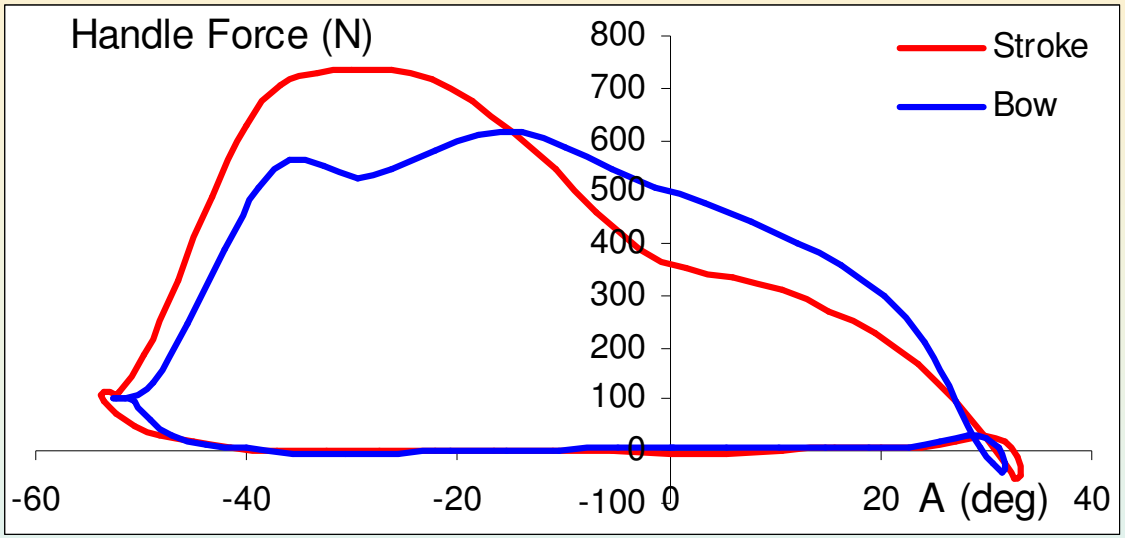
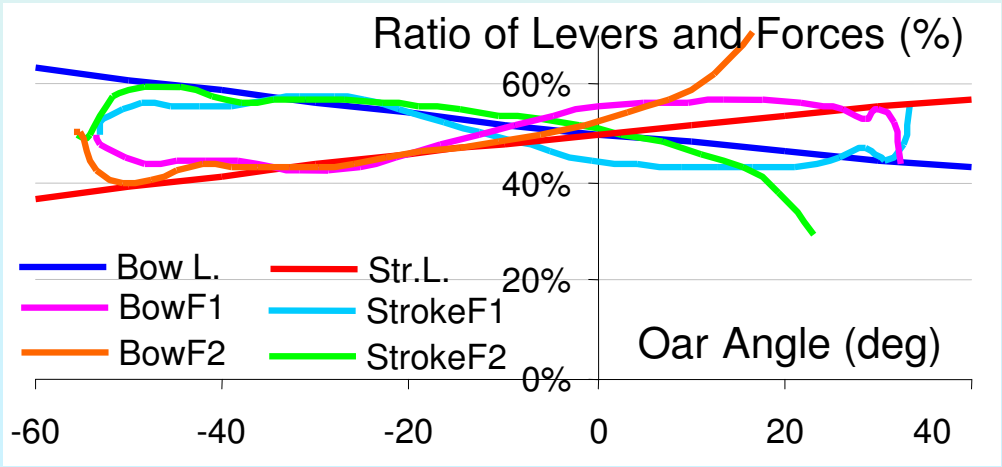
Coordination of forces in a pair



To prevent rotation of the boat:

- Stroke rower must apply higher force at catch;
- Bow rower must apply higher force at finish;

- Average force of the stroke rower must be about 5% higher than of the bow rower



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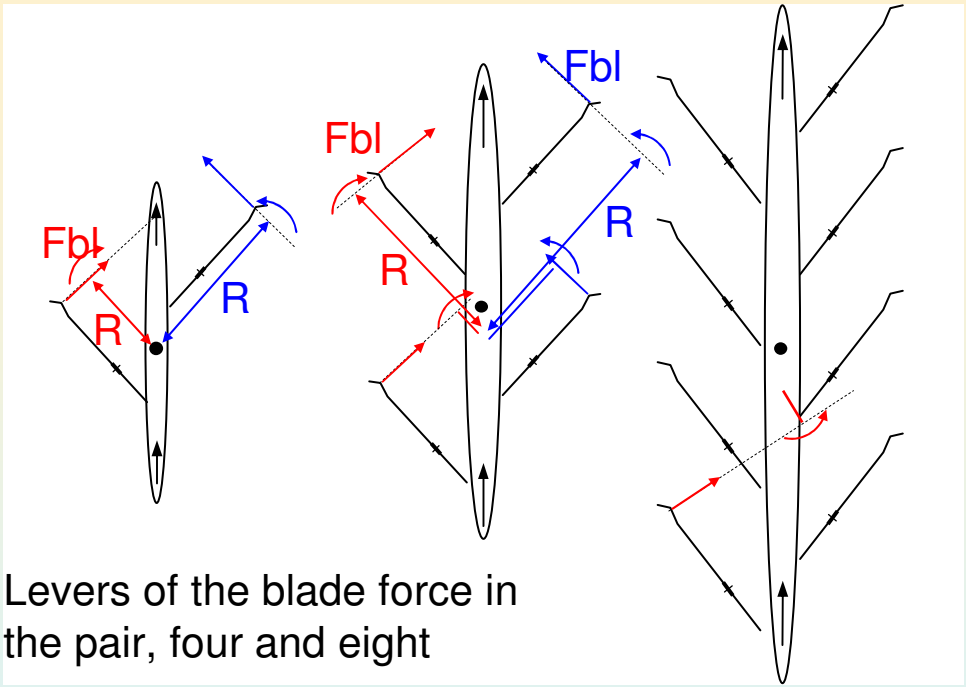
Big boats with the normal rig



Levers of the blade force in the pair, four and eight

- ✓ In the four and eight with the normal rig the sum of the levers turns the bow to the port side;
- ✓ The stroke rower can turn the eight at catch to the same side;

Each stroke with synchronous force application creates the boat yaw angle:

- ✓ 0.37 deg in a pair,
- ✓ 0.076 deg in the four,
- ✓ 0.015 deg in the eight

. Mass moments of inertia in various boat types (kg m^2)

	Boat	Rowers	Total
Pair	15	88	103
Four	243	882	1125
Eight	3360	7400	10760

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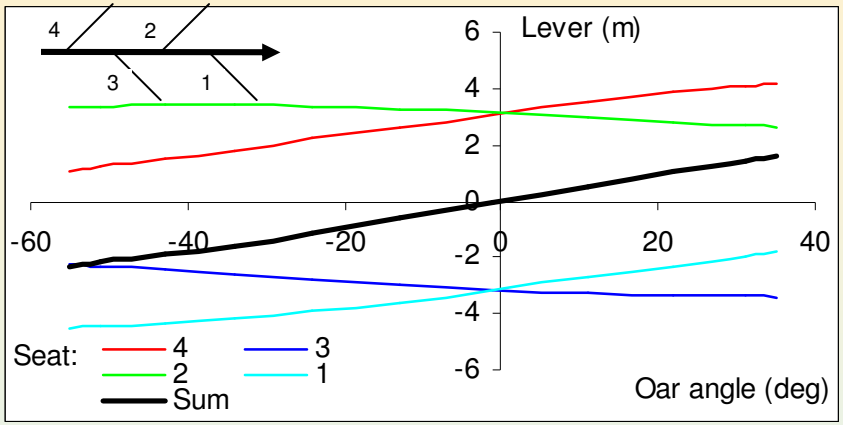
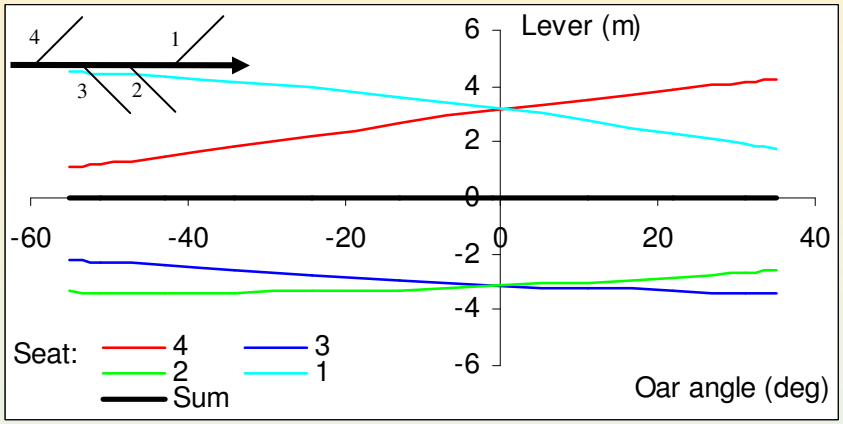
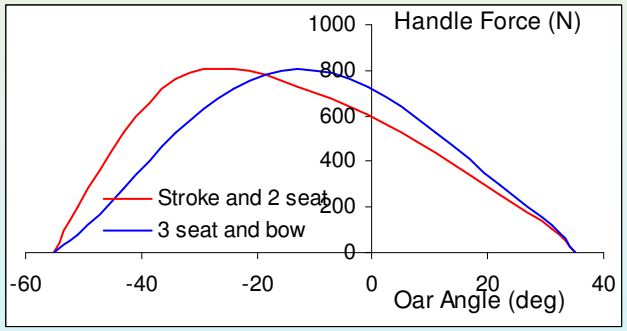
The normal and Italian rigs in the four

Normal rig



Italian rig





Average levers in fours (in meters)

Seat	4	3	2	1	Sum
Normal	2.66	-2.90	3.13	-3.36	-0.47
Italian	2.66	-2.90	-3.13	3.36	0.00

- ✓ In the Italian rig the sum of levers is zero, so the boat goes straight at the equal force application;
- ✓ The boat with normal rig can go straight, if stroke rowers apply force earlier and/or higher (5% difference in the average force).

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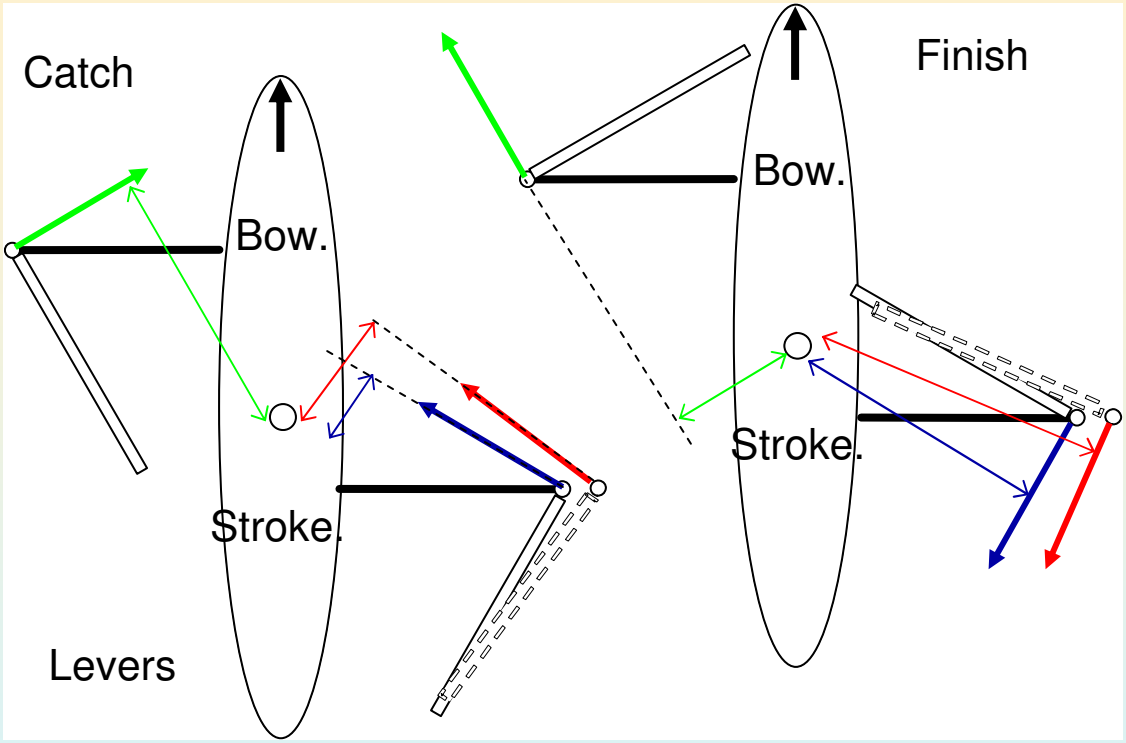
Effect of the span on the torque in pair



- ✓ A rower with longer span produces higher torque relative to the centre of the boat (CB) at the same force (or the same torque at lower force);

- This in not a real “gearing” because the ratio of velocities and forces on the handle and the blade remains the same irrelative to the span.

Handle and seat forces

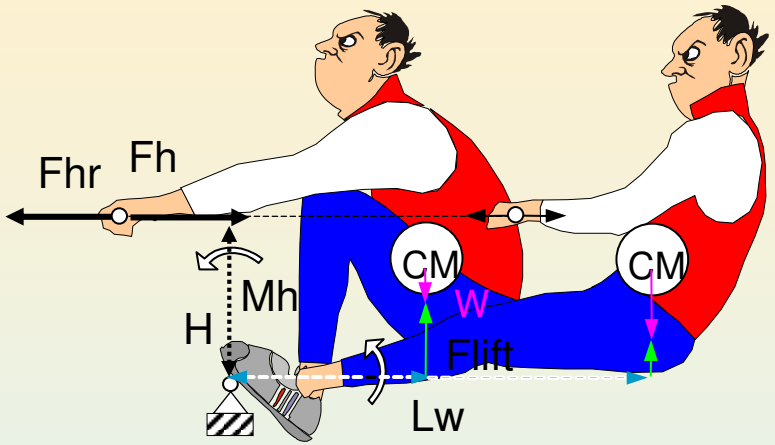
- ✓ Lift force depends on the height of the handle relative to foot-stretcher:

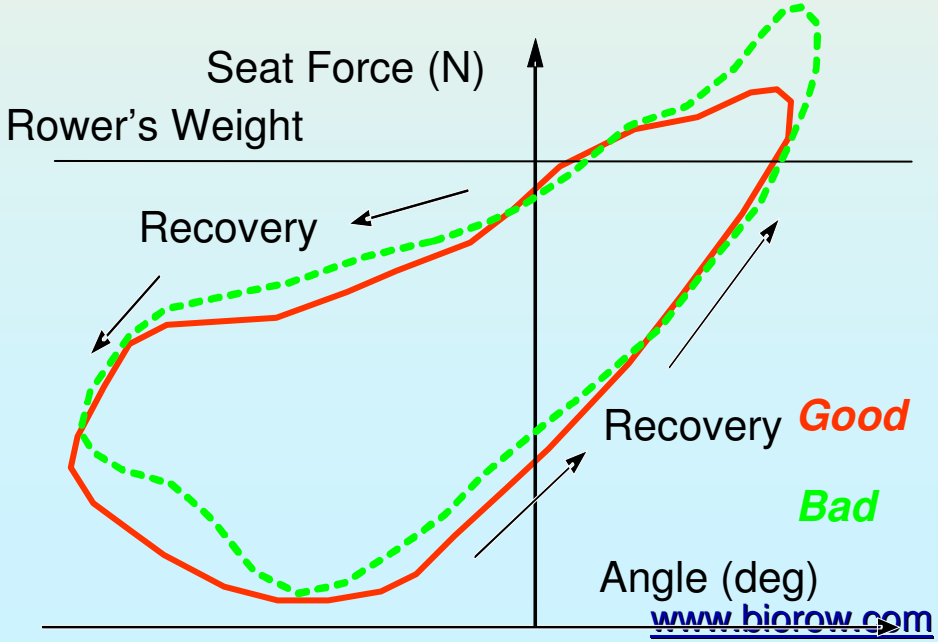
Flift = H / Lw * Fh

- ✓ Handle force is limited at certain handle height and rower's weight:

Fh.max = Lw / H *W

- ✓ Seat force can be good indicator of rowing technique.





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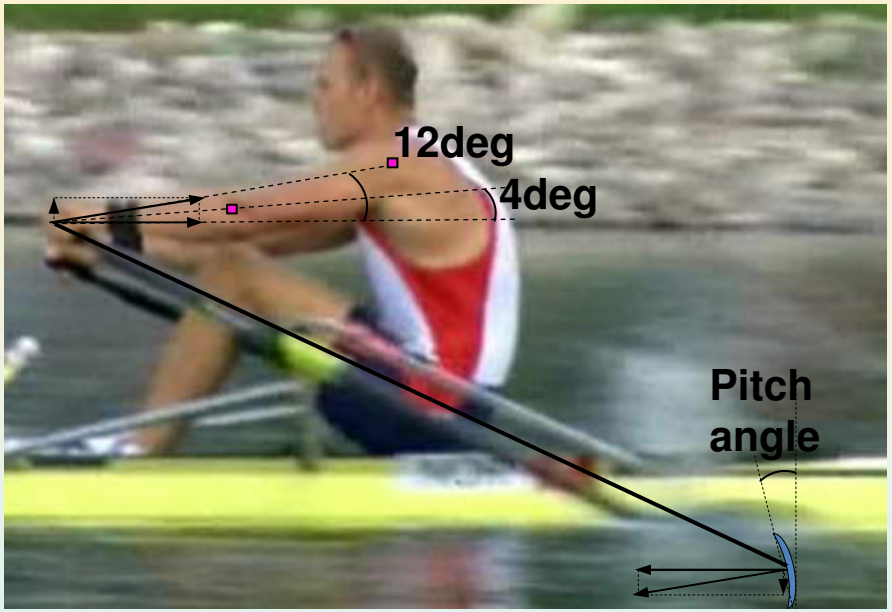
Gate height and pitch

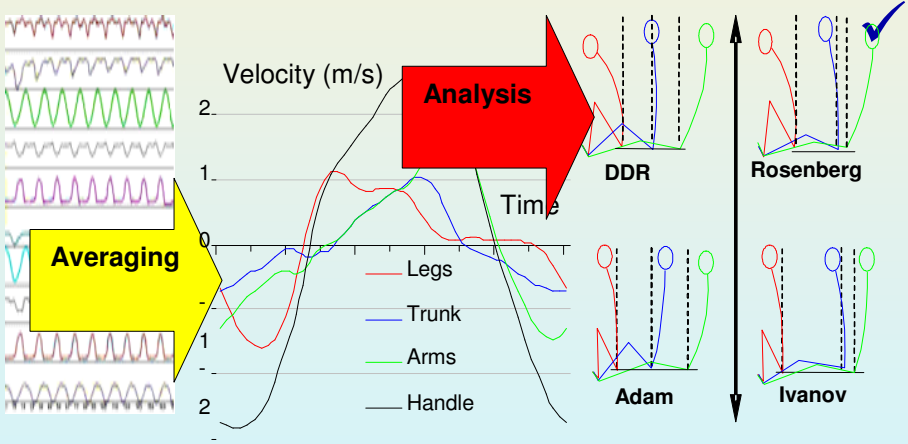


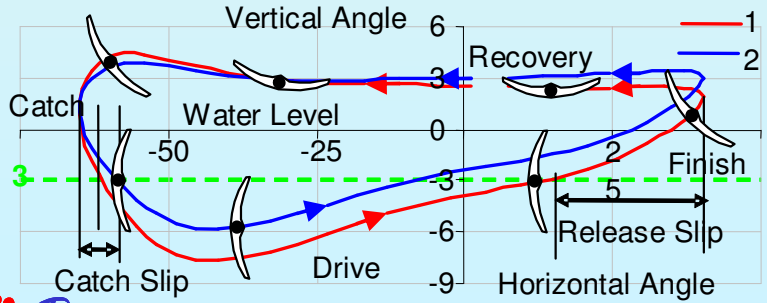
- ✓ In case of the most common pitch 4 deg, only 0.24% of the propulsive force is lost;
- ✓ the height of the handle (and gate) is defined mainly by a comfort for a rower at finish;
- ✓ a lower gate height requires more pitch and more significant arms “grubbing and vice versa;
- ✓ Lateral pitch is useful to overcome the difference in comfortable height of the handle.

Biomechanical Tools and Devices

- ✓ Telemetry system;
- ✓ Immediate feedback tools;
- ✓ “Stroke coaches” and “boat check” meters;
- ✓ Mobile rowing tank.

BioRowTel Telemetry System v.4.5





- ✓ The system is quick to setup (30-90 min for 1x - 8+) and remove. It does not affect any rigging settings, which is important before regattas.
- ✓ Two-dimensional (2D) oar angle sensor measures position of the oar shaft in horizontal and vertical planes, which allows to define a **path of the blade** relative to water.
- ✓ Position sensors of the seat and shoulders allow to derive their velocities and power, which defines a **rowing style.**

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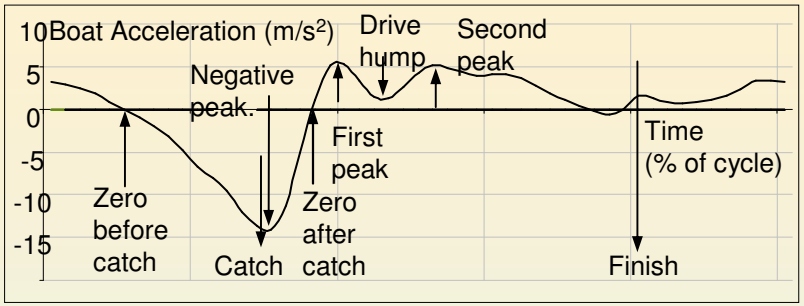
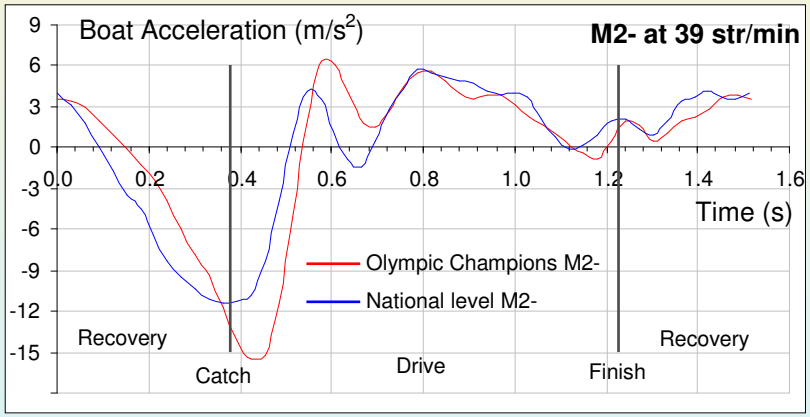
Visual Immediate Feedback System:

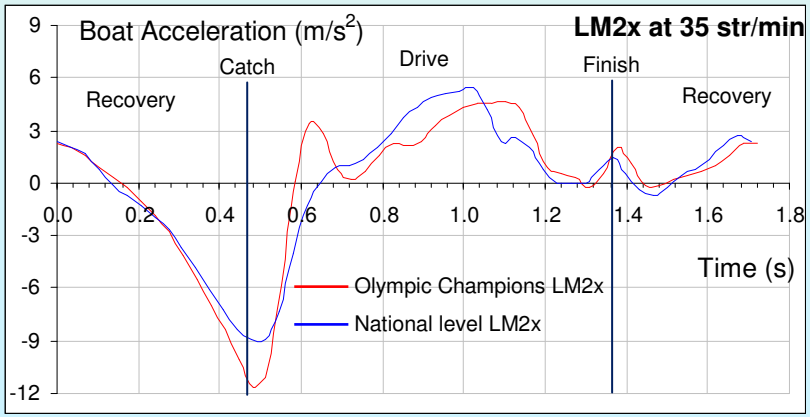
✓The System can be used with any standard video camera. The transmitter is attached to the video camera. VFS system worn by the athlete and the integral headphones allow the coach's comments to be heard.

✓VFS can be used for immediate feedback on various elements of technique: oar blade work, leg work, arm work, synchronization of the crew, etc.

Pattern of boat acceleration as a fingertip







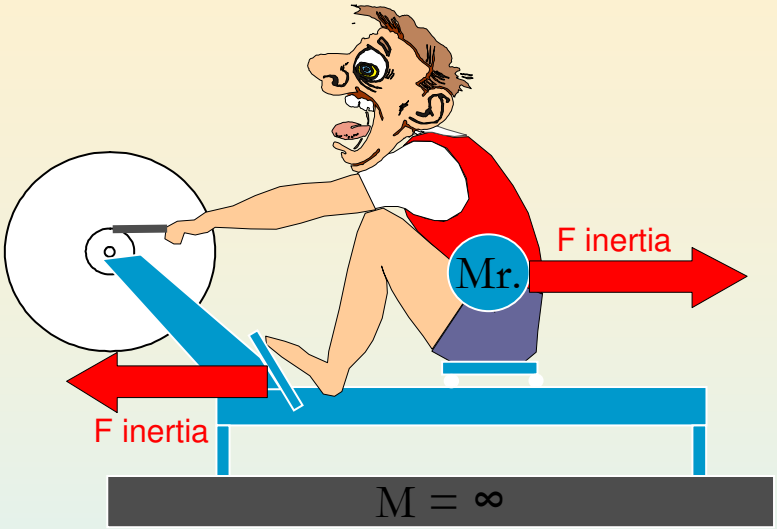
- ✓ Magnitudes of both negative peak and the first peak of the boat acceleration are highly dependent on the stroke rate.
- ✓ No significant difference was found between sculling and sweep rowing.
- ✓ The pattern is quite similar in all boat sizes.
- ✓ **<u>The best rowing crews have the highest magnitude of the negative peak of the boat acceleration at catch and the highest first peak.</u>**

New “check factor” for ActiveTime ™ stroke rate meter

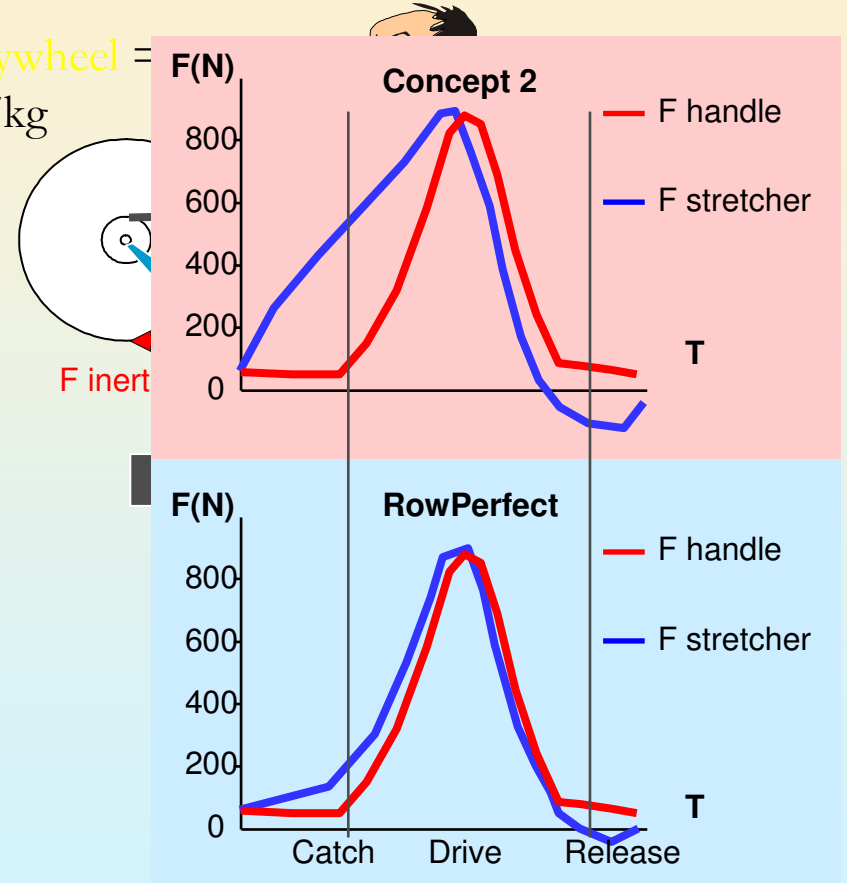
- ✓ Delta boat acceleration (DA) was selected as the most appropriate parameter for evaluation of technical skills of the crew.
- ✓ New algorithm was developed and implemented in the latest version of ActiveTime ™ stroke rate meter.
- ✓ The quality of each stroke is displayed as a score F from 0 to 100:

0-20	– Beginners
20-40	- Club rowers;
40-60	- National level;
60-80	- International level;
80-100	- Champions

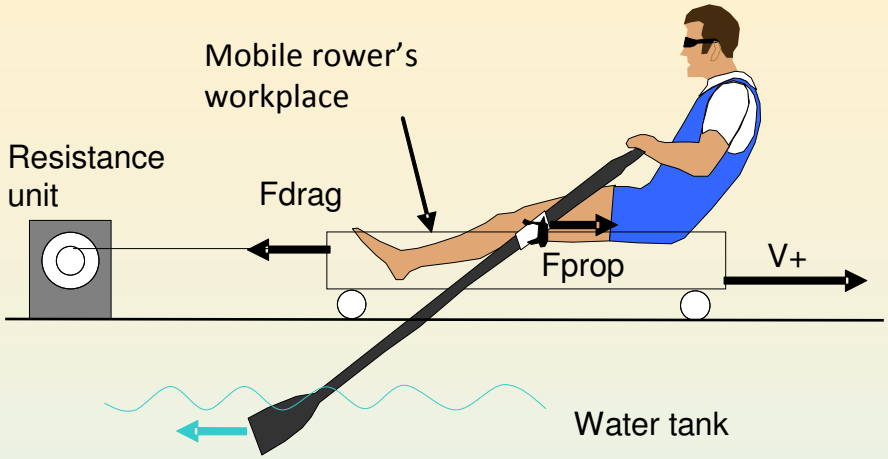
Rowing Machines



M flywheel =
= 17kg



Mobile Rowing Tank (MRT)



Advantages of MRT compare to a stationary tank:

✓There is power transfer through the stretcher, which contribute nearly 40% of power production in on-water rowing.

✓There is a gearing effect similar to on-water rowing, where the stretcher force is 40% higher than the handle force.

✓Similar to on-water rowing, MRT requires more legs power, while stationary rowing requires more upper body power.

✓The stretcher acceleration makes vestibular sensations of the rower very similar to the sensations during on-water rowing.

✓Rowers can interact through the stretcher to develop an accurate synchronisation, similar to on-water rowing.

Thank you for attention

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