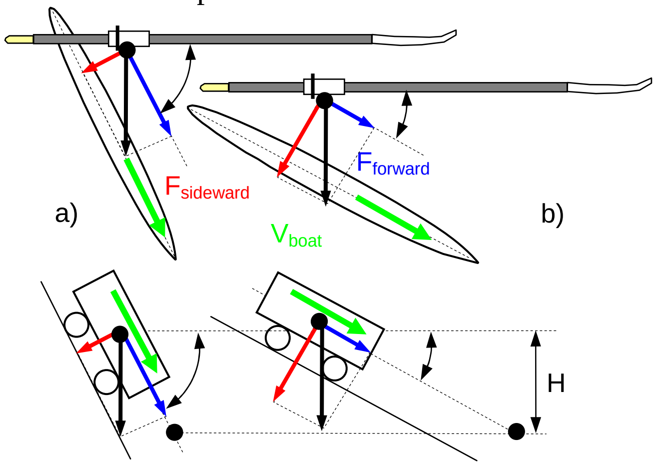
Q&A

? We receive a lot of comments and questions like these: "Applying high force at the catch is not efficient, because it pushes the pin inwards, which is a waste of power. Why do you tell us that the front loaded force curve is more efficient?"

✓ We would split the answer in two parts:

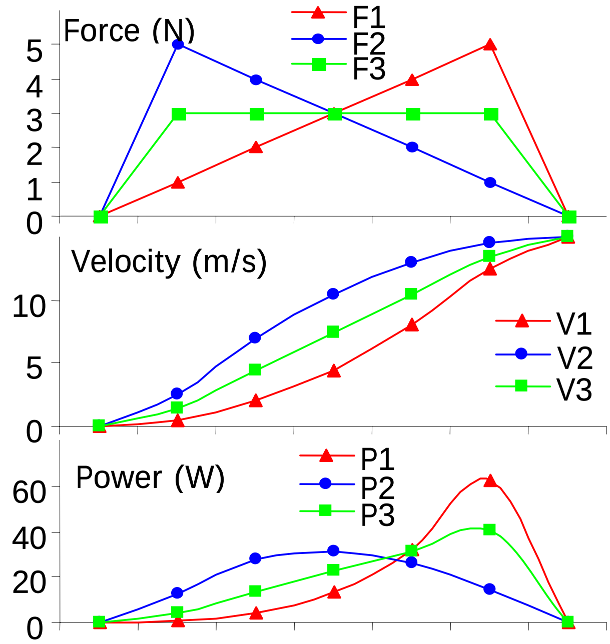
1) Why is a long catch not a waste of energy? In the 1960s-70s, a popular concept was that a long angle at the catch was inefficient, but we can still hear it in some articles and comments. The picture below illustrates the pin forces at different oar angles in comparison with similar forces acting on a cart on slopes with different inclination:



In both cases the resultant force acts at the angle to the velocity vector and can be resolved into perpendicular and parallel components. Power is the scalar product of the velocity and the force component parallel to it. Scalar product of two perpendicular vectors is equal to zero, so **sideward force does not produce any power and can not cause energy waste itself**. Analogy with the cart shows us that at any angle the resultant force produces the same amount of work proportional to the height H of the centre of mass displacement. Finally, at any slope angle the cart will achieve the same velocity, if no friction acts on it. The differences are in acceleration and time. With a smaller oar angle and steeper slope (a) $F_{forward}$ is higher, which produces higher acceleration. With a greater oar angle and flatter slope (b) the acceleration is lower and it takes longer to achieve the final speed. It works like a gear in your car: you can achieve faster acceleration on a low gear at the same engine torque. A high gear requires less RPM from your engine at a higher speed of the car. Concluding, **longer catch angle makes the oar gearing heavier**, but does not create energy waste.

2) Why is a front loaded drive more efficient?. Let us use a very simple model for analysis of the force curve. Imagine three force curves: F1 (back-loaded) increases from 0 to 5N with simple arithmetical progression, F2 (front-loaded) jumps to 5N and then decreases, F3 is constant at average 3N. Imagine that each of these three forces act on a body mass 1kg. We can derive the body's acceleration, velocity and applied power:

	Force (N)			Velocity (m/s)			Power (W)		
T(s)	F1	F2	F3	V1	V2	V3	P1	P2	P3
0	0	0	0	0	0	0	0	0	0
1	**1**	**5**	**3**	0.5	2.5	1.5	0.5	12.5	4.5
2	**2**	**4**	**3**	2.0	7.0	4.5	4.0	28.0	13.5
3	**3**	**3**	**3**	4.5	10.5	7.5	13.5	31.5	22.5
4	**4**	**2**	**3**	8.0	13.0	10.5	32.0	26.0	31.5
5	**5**	**1**	**3**	12.5	14.5	13.5	62.5	14.5	40.5
6	0	0	0	15.0	15.0	15.0	0	0	0
Sum	15	15	15				113	113	113



In all cases we have the same total amount of force and power**,** and the same final speed of the body. However, the front-loaded curve F2 creates the most even power distribution. The back-loaded F1 requires double the peak power. In rowing this late power peak would overload the trunk and arms, which are weaker body segments than legs.

Therefore, **one of the advantages of the front-loaded drive in rowing is a more even power distribution**, when the handle is accelerated. On ergometers**,** the advantage is much smaller owing to a more even handle velocity (RBN 2005/3). Athletes with a late force peak are more likely to achieve success on ergometer.

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