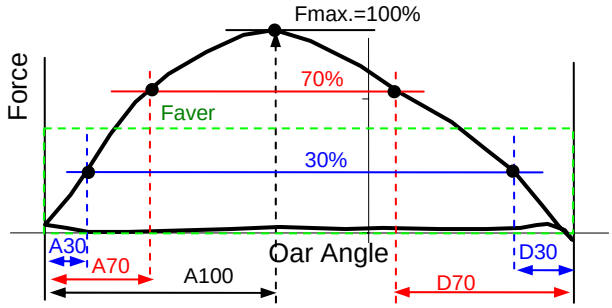
Q&A

Q: Rower and Ph.D student Alexey Volgin from Saint-Petersburg, Russia is asking: "What parameters of the force curve can be used for evaluation of rowing technique?"

A: We already discussed some parameters before (RBN 2001/07,12, 2002/06, 07, 2004/12). Now we will try to summarise definitions of force curve parameters and outline their usage for the assessment of rowing technique. The chart below shows a typical force curve and graphical representation of the parameters:



The most obvious parameter is a maximum force ***Fmax***, which is the highest point on the force curve. An average force ***Faver*** is equal to the height of a rectangle, of which the area is equal to the area under the force curve. The ratio of the average to maximal forces (***Ram=Faver/ Fmax***) reflects "fat" or "slim" force curves:

- For a perfect rectangular shape, ***Ram*** = 100%;
- For a perfect triangular shape, ***Ram*** =50%.

We found this ratio in rowing ranges from 38% to 64% with average 50.9±4.5% (mean±SD).

The term "catch slip" was traditionally used as a definition of how quickly the force increases at the catch and "release slip" was used to indicate its maintenance at the release. In fact, these parameters have very low correlation with a "slippage" of the blade in the water (vertical catch and release slips were mentioned in RBN 2007/04), so we prefer to use the term "gradient of force". The slippage can be long, but the gradient is steep if the blade moves quickly on a shallow path through the water. At a higher stroke rate, it usually requires a shorter angle to achieve 30% of max. force (r = -0.44), but a longer angle to bury the blade. (The vertical catch slip increases, r = 0.20).

Values of 30% and 70% of the maximum force were usually used as the criteria for the force gradient. We define the catch gradient as an angle, through which the oar travels from the catch point to the point, where the force **A**chieves the criterion (***A30*** and ***A70***). The release gradient is defined as an angle from the point, where the force **D**rops below the criterion to the finish of the drive (***D70*** and ***D30***). Parameter ***A100*** reflects the position of the peak force and can be used as a definition of a "front loaded" drive (RBN 2006/06). Why were values of 30% and 70% used as the criteria? The first of them was adopted from fixed criteria (100N for sculling and 200N for sweep), which were traditionally used in Australia, adjusted to accommodate various categories of athlete in both sculling and rowing. The purpose of this parameter was to determine how quickly the blade grips the water. We found that ***A30* has a correlation with the efficiency** of the blade (r = -0.34). ***Ram*** also slightly correlates with the blade efficiency (r = 0.32) which means that a quicker force increase and a rectangular shape of the force curve reduces slippage of the blade in the water.

The criterion 70% was used in Russia in 1960-80s. Contrarily, ***A70*** has an insignificant correlation with the blade efficiency (r = -0.13), but ***A70* relates to the effectiveness of rowing technique** (RBN 2004/12). Efficiency means minimising the energy expenditure for an equivalent performance. Effectiveness means the maximising of performance using all available resources. This fundamental difference can be explained by the mechanics of force increase: the 30% level can be achieved by good handling of the oar and using the small muscles of the arms and shoulders, but the 70% level is not achievable without dynamic acceleration of the rower's mass and involvement of the large leg and trunk muscles. As a confirmation, we found that only A70 and D70 correlate with maximal legs velocity (r=-0.28 and r=-0.38), i.e. quicker legs produce steeper gradients of force.

Parameters of force gradients depend on the stroke rate: A30 and A70 getting shorter at high rate (r=-30 and r=-43), but D70 and D30 getting slightly longer (r=0.21 and r=0.18). This reflects changes in the force curve at higher rates (RBN 2004/12). By way of illustration, we determined averages at training rates below 30 str/min (T) and at racing rates above 30 str/min (R):

Degrees	A30		A70		D70		D30	
Rate	T	R	T	R	T	R	T	R
Rowing	6.7	5.2	16.7	13.6	30.3	34.0	11.5	12.8
±SD	1.9	1.6	3.8	3.1	7.6	7.3	3.1	3.5
Sculling	5.8	3.8	17.2	13.4	35.6	38.2	14.5	15.7
±SD	2.0	1.5	4.8	4.6	7.0	6.6	3.3	3.3

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