Do You Need Hatchets to Chop Your Water?

An Analysis of Big Blades and How They Work

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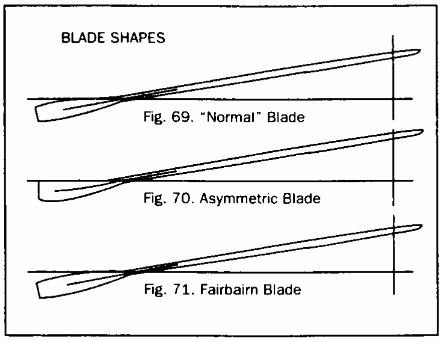
Big blades came onto the American rowing scene in the fall of 1991 and were greeted with much interest and speculation. The new blades are shorter than "traditional" blades have a larger spoon area and an asymmetric shape. The reaction of rowers and coaches was "Do we really need the new blades? Are they faster? Do they require a new rowing technique?"

People have been experimenting with the blade shape for years. When oars were made of wood, almost every coach had his preferred shape, and you could find many different templates in boat-building shops. Even asymmetric blades were available back then (see figure 1).

Figure 1: Different blade shapes in a German rowing textbook (Ruder, Boot und Bootshaus) from over 50 years ago.



Theoretical research indicates very clearly that there is a lot of room to improve on the efficiency of the "normal" symmetric blade. For instance, figure 2, from research in Germany, illustrates that the "normal" blade is far from being optimal.

Most of the boat builders currently offer asymmetric oars. The British company, Hi Lock, claims to have started the new development and points out that a British double scull used Hi Lock Power Blade sculls at the 1991 World Championships.

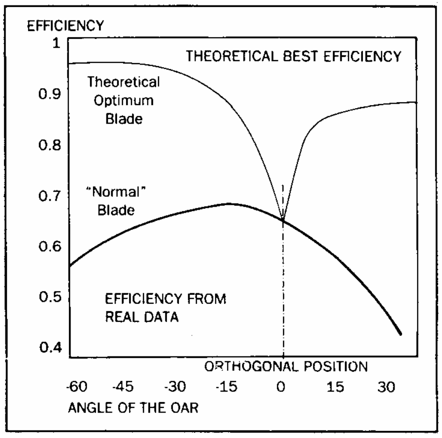
How Does the Big Blade Work?

Any new blade design would let you row faster if it were hydrodynamically more efficient, which means the power you apply on the oar handle results in a greater power output on the blade, resulting in acceleration of the whole mechanical system of rower/boat/oar. The definition of efficiency (E) namely is:

$$E = (Output/input)$$

Output = propulsion *in the rowing direction*, and input = power applied on the oar handle.

Figure 2: Hydrodynamic efficiency of a "normal" sweep blade as it compares to the theoretical best efficiency of a blade as a function of the oar angle. Note that the figure indicates the efficiency of the blade can be improved about 15% overall (from Affeld/ Schichl).



Therefore, the first explanation for the higher efficiency of the big blade was that because of its shorter outboard lever, applying the same force and velocity at the handle would generate a greater force and slower velocity at the blade, and that the greater force would propel the boat faster.

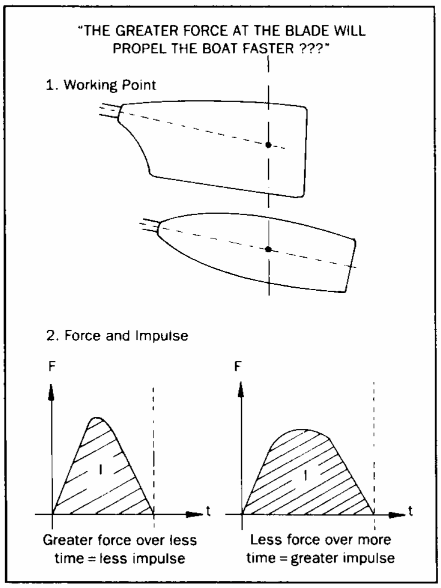
Although this explanation sounds logical, there are some doubts. First, this argument applies only for the larger spoon area. The asymmetrical shape would not have any effect. Furthermore, based on this theory, it would be logical to extend the area even more; however, the modified version of Concept II's big blade (introduced to make retrofitting easier) has a smaller area rather than a larger one (3 cm shorter) and has performed comparably to the original.

Secondly, only further research could verify whether the working points (the centre of the pressure) on the "normal" and big blade are a different distance from the oarlock. If the working points for both oars were the same distance from the oarlock, both blades would effectively have the same outboard length and therefore produce the same amount of force on the blade.

Thirdly, further research is also necessary to determine whether the impulse (the amount of force applied over the duration of the drive) is affected by the different blades. For instance, a higher peak force doesn't automatically ensure greater propulsion. If the force is greater, but it is applied over a shorter period of time, the impulse could be less than if you applied less force over a longer period of time (see figure 3). The impulse is the real measure of the amount of propulsion produced by a blade, and the big blade's effect on it is not yet known.

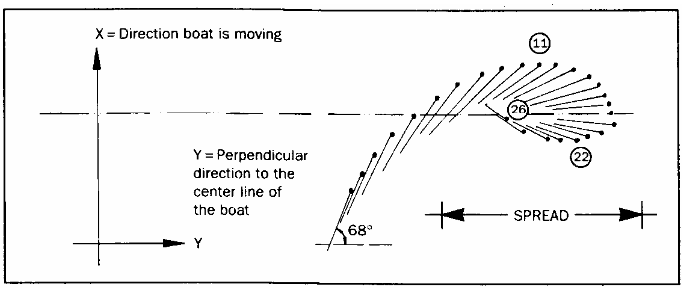
Another theory to explain the effect of the new blade is that the assumed slower velocity of the blade through the water means the blade slips less through the water as Concept II states in their advertisements. Stämpfli goes on to say their blades can eliminate all the slip. However, the propulsion force on the blade is directly proportional to the square velocity. Therefore, as indicated by proven physical laws, we must have movement of the blade relative to the water because without movement, no force can be put on the blade. And there is only one way to get more force on a given blade: the blade must move faster through the water.

Figure 3: A larger spoon area does not automatically mean that the propulsion would be higher because it is not known how the working point and the impulse are affected by the new blade design.



Some video footage borrowed from Dick Dreissigacker helps provide a clearer understanding of how a blade works in the water. The video was shot from a bridge down to the water. The camera was fixed, and some scullers rowed through the picture. A video camera shoots 30 pictures per second, and in figure 4, the position of the blade is shown for every picture in which the blade was in the water. The boat is moving in x-direction, and since you can take the spread as a reference distance, the displacement and consequently the velocity of the blade, as well as the angle of the oar can be measured.

Figure 4: The movement of the starboard blade of a single during the drive. Data from a video film, made with a stationary camera vertically down from a bridge (x = rowing direction, y = perpendicular direction to the centreline of the boat).



The bigger points indicate the end of the blade, and the connected lines show the angle of the oar for every picture. The oarsman who rows close to race speed catches 68 degrees from the orthogonal line (the point at which the oar is perpendicular to the centreline of the boat). The blade moves for 11 pictures (= 0.37 seconds) *in* rowing direction, then another 11 pictures *against* the rowing direction, and in the finish, four pictures again *in* rowing direction (= 0.13 seconds). The drive lasts 26 pictures (= 0.87 seconds). The blade travels 57% of the time in rowing direction, which corresponds with data found in literature (Nolte, Affeld/Schichl). This finding may be surprising in the first place, but there is evidence that the rowing blade acts like an aeroplane wing, when it travels in the rowing direction. Lower pressure occurs on the back side of the blade, which therefore gets sucked in the rowing direction. This phenomenon is called *hydrodynamic lift* (Counsilman, Nolte), comparable with the aerodynamic lift of the aeroplane wing. It is important to understand that *lift* indicates a force pulling on the back of the blade.

The velocity of the blade in x- and y- direction is shown in figure 5. At the catch, the blade travels more than 2 m/sec in the rowing direction. A few pictures later, the velocity in y-direction is maximal. This means the blade has a huge velocity relative to the water in the beginning of the drive. Therefore, the forces on the blade are maximal at this moment, and the blade has a *positive slip*, which is movement of the blade relative to the water, in the rowing direction. Only when the blade moves with a negative x-velocity (this means the blade moves against the water and produces drag), can you find a *negative slip*.

Figure 5: The velocity (v) of the blade in the water during the drive (x = rowing direction; y = perpendicular direction to the centre line of the boat; p = number of picture; t = time in seconds.)

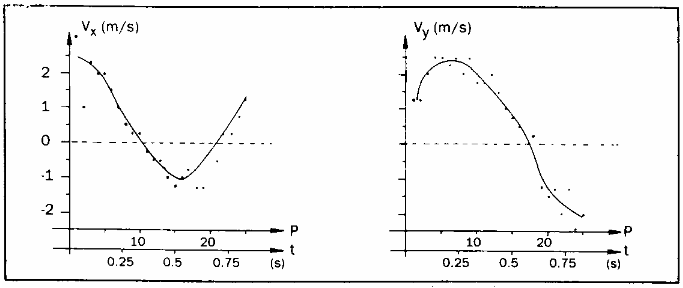
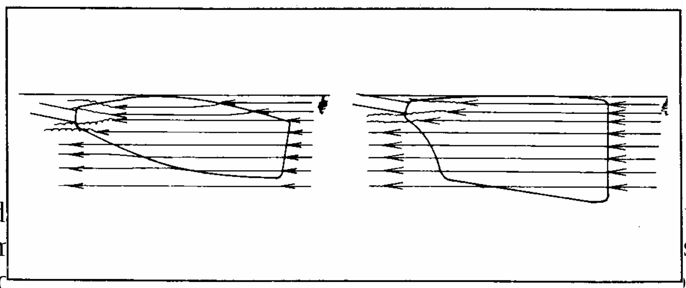


Figure 6: The flow of the water around the big blade is hydrodynamically better because the blade allows the streamlines to pass more undisturbed.



With the und why the big blade presum s the water streamlines tc rtex that are hydrodynamically less effective. Figure 6 illustrates this idea.

These thoughts indicate the big blade could work more efficiently than the symmetric blade. This means it seems possible to produce more positive slip with the asymmetric blade which would give the boat a longer travel distance during the drive, which implicates a higher velocity of the boat. It's now up to scientific tests to prove this theory.

Some Experience with Hatchet Blades

Some research has already been done with the new blades. Concept II has reported on a large number of test races and announced the new blade seemed "a few percent faster." Anyone who has ever tried to validate a technical change in rowing by comparing times of test races knows how difficult it is. Not only weather conditions but also the psychological and physical condition of the rowers (can they work on the same performance level for different races?), and the technical requirements (can they row with each piece of equipment in the same way?) change from test to test, which makes comparisons and conclusions difficult. The following analysis tries to overcome these problems by using results from official races, assuming that the world's top national team eights perform their best at major regattas, and that they are able to repeat their performance consistently. Last year's major regattas were chosen for this comparison. The final times were almost the same, which means that the conditions were very similar.

Table 1: Comparison of resulting times in international races in 1992 of the top men's eights. Direct comparisons are only done if both boats were in the same race.

Part I

Nation	Heat - Olympic Games			Final - Olympic Games		
	Blade	**Time**	**Difference**	**Blade**	**Time**	**Difference**
ROU	Big	5:30.21	2.77 sec	Big	5:29.67	1.33 sec
GER	Macon	5:32.98		Big	5:31.00	
2.77 sec - 1.33 sec = 0.44 sec ≈ 0.4%						

Part II

Nation	Final - Luzern			Semi-Final - Olympics			Final - Olympic Games		
	Blade	**Time**	**Diff.**	**Blade**	**Time**	**Diff.**	**Blade**	**Time**	**Diff.**
USA	Big	5:30.35	1.64 sec	Big	5:37.11	1.51 sec	Big	5:33.18	2.18 sec
GER	Big	5:28.71		Big	5:35.60		Big	5:31.00	
2.18 sec - 1.51 sec = 0.67 sec ≈ 0.2%									

In the first part of table 1, the eights from Germany and Romania are compared. The Germans rowed in their heat at the Olympic Games with the Macon ("normal") blades, and in the final with the new hatchet blades. The Romanians won the heat by 2.77 seconds, and beat Germany in the final by 1.33 seconds. The Germans rowed 1.44 seconds or 0.4% faster in the final, relative to the Romanians. From the comparison with the U.S. eight we know that the Germans rowed a good race in the final, which indicates that the change of the blades resulted in a maximum increase of 0.4% of the speed.

Obviously, the comparison only includes one example. Therefore, the results of the analysis do not constitute a final conclusion, but they do support some theories:

- A boat gains a little advantage by using the big blades.
- The increase in speed is less than 1%.

Further Considerations

Some coaches may have observed greater improvements in the speed of their crews after switching to the big blades, and some results may even prove it. In particular limited technical abilities seem to have a greater advantage, but it's worthwhile to study this phenomenon more closely. There are reasons other than physical or biomechanical for a change in speed after switching to big blades:

- ***Psychological:*** Especially inexperienced rowers may be very excited to get the new oars they've heard so many magical things about.

- ***Rigging:*** The big blades react less sensitively to the pitch of the boat. One degree more or less pitch can be absorbed, which means that a poorly rigged/pitched boat has less influence on the rowing. Assuming that less experienced teams normally also have less experienced coaches, and lesser quality equipment, the new blades may help adjust these disadvantages.

- ***Technique:*** Inexperienced rowers with less technical skill can apply more force with the big blades since these oars do not react so sensitively.

- ***Inconsistency:*** Development teams are inconsistent from race to race. Therefore, it's very difficult to judge where the differences come from.

Rowing with the big blades also raises some problems. It's even more important to work on rowing technique, since the oars are more forgiving. Otherwise, novices may not learn good technique and may not reach their rowing potential. Some coaches might be carried away with their novice crews by overemphasising the rough power before the rowing technique is well developed. In addition, the big blades increase the load on the lower back in particular during the first part of the stroke, which means without proper rigging and technique, more injuries are possible.

Conclusions

The new blades generated a lot of excitement in the rowing world. Several issues of *FISA Coach* included articles about the blades - no other topic has received as much attention. Some coaches were so excited about the hatchet oars that they wanted to prohibit their use, but none of the national or international governing bodies banned them. A development like the big blade can only help rowing over the long run, and a ban would have been a step in the wrong direction. Consider that we would still be rowing with heavier, more expensive and more fragile wooden oars if boat builders hadn't developed the plastic ones.

Likewise, there's no need to overreact and replace all Macon blades. The new oars do not increase the speed of a boat so dramatically that everyone needs them to stay competitive. The vast majority of high school, university and club races are decided by more than the difference the big blades could make. Most of the crews could probably improve their times more with proper physical and technical rowing training. It's also important to consider that the big blades can increase the possibility of injury and complicate learning technique, which is especially critical for masters and beginners. The decision whether to buy big blades should be based on common sense.

If you have a team that depends on every little advantage to stay competitive (a national team or a crew that has legitimate hopes for a championship) you should get the newest oars. All the other teams should consider very seriously whether they really need to spend additional money on new oars. If your rowing program plans to buy new oars anyway, then you should certainly buy the newest type of blades.

Further Reading

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