Efficient Rowing

What if I were to tell you that everything you believe about rowing is wrong? Some things you read in the following article may seem counterintuitive, but they derive from observation and theory, have been verified experimentally (see Turbo Oar) and employed in oar design. Doesn't make sense you say? When Einstein was told that his theory of time dilation at speed didn't make sense he observed that: "Common sense is merely a set of prejudices we acquire before the age of eighteen."

It is the bane of my life getting my galley slaves to take long slow strokes on our excursions. How can I convince them that long slow strokes driven by the strong torso muscles are less effort than arm driven short strokes? I believe that we can improve our rowing by a careful analysis of the ergonomics of the process.

Galley slaves bank oars for a rest with the author as stroke. Drug of choice, exercise induced endorphins

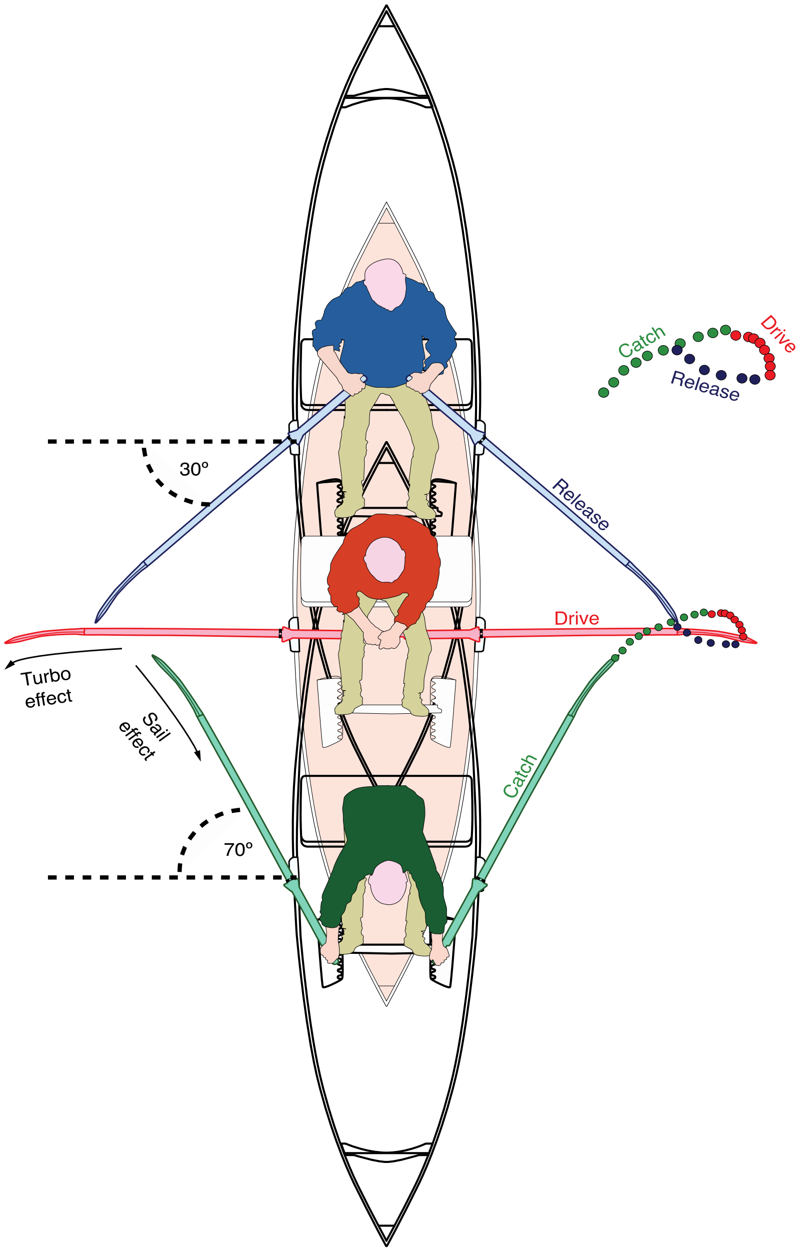
It is an extraordinary fact that the oar of a racing scull is only 9 feet long. Based on this, we should be able to calculate the comparative length of an oar for a fixed seat rowing boat. Some rough measurements show that extensions of the body in rowing are as follows:

- Legs: About 50 cm. or 30% (strong).
- Torso: About 50 cm. or 30% (very strong).
- Arms: About 60 cm. 40% (relatively weak).

Thus body extension in a fixed seat rowing boat is 70% (arm and torso) of the extension of the sliding seat boat. Consequently the fixed seat boat should have an oar 70% of 9 feet which is 6.3 feet. At this stage it behoves us to analyse why the racing sculls use such short oars.

It is commonly believed and is even mentioned on some websites, that every effort should be made to row with the oar at right angles to the boat as this is thought to be the most efficient mode. Racing sculls have the chance to maximise this option of widening spread by extending the outriggers, so that longer oars can be used. We might expect that moving the oars through an arc of about 60 degrees would then give the optimum performance. However this is not the case. Racing sculls choose to use shorter oars and swing them through an arc of 100 degrees.

Below is a representation of a rower photographed at three stages of the same stroke. The dots represent the position of the blade tip at every 5 degrees of stroke angle. The boat is moving up the page relative to the oar blade. Careful study shows that the oar at the end of the stroke has unexpectedly moved forward in the water. The only phase of the stroke where the oar moves in the expected backwards direction is at the drive. This requires some explanation.



One stroke: Position of the blade tip is derived from a photographic record of a racing stroke.
A less forceful stroke is likely to exhibit a greater sail and turbo effect.

At the catch the blade is moving forward in the water at three quarters the speed of the boat because of its 70-degree angle. This forward motion establishes a flow of water from the tip of the blade to the root as shown in the left side of the diagram. A gradual application of effort encourages this water flow with the blade acting like a sail. As the rower applies force to the handle the blade moves 3/4 outward and 1/4 rearward. According to some theories 3/4 of our effort is being wasted. Instead we have a forward impetus in the water that is especially effective in the same way as a wing or a sail. A rowing blade due to the density of water is equivalent to a 270 square foot windsail. If the blade is stall free then the boat will move forward over 3 times faster per change of oar rotation than at the drive, but with 1/3 the force.

As it travels through its stroke the blade changes its angle of drive so rapidly that water begins to slip off the end of the blade due to centrifugal force. This happens about 10 degrees after the catch. This is where the spoon blade is effective as it redirects this departing water in a rearward direction giving more thrust (action and reaction). I have argued in another article “The Turbo Oar” on my website (www.gacooarlocks.com) that a curve of over 50 degrees will be even more effective. This turbo effect obtains only on a spoon oar. The flat blade oar misses out to a large extent on both the sailing and the turbo effect as it stalls in the water and loses energy because of this. It effectively spends more energy stirring the water and is best used with longer oars.

At the drive the oar has the most power but is less efficient because it is stalling with water flowing around the blade in eddies and wasting energy. When starting, racing sculls use short strokes around the drive angle for acceleration but as speed increases the more efficient large catch angles are employed. Ordinary rowboats suffering heavy loads or headwinds will benefit from shorter strokes around the drive angle. You might say that changing stroke length is the same as changing gears.

The oar is released from the water at less than half the angle at the catch. There are many reason why this is so:

1. At the catch the water is fresh and undisturbed.
2. At the catch both the torso and leg muscles are fully employed.
3. The boat is now travelling at full speed and it is advantageous to make the recovery stroke at this point.
4. The curve of the spoon oar that works to the advantage of the catch does the reverse at large release angles.

How theory informs our rowing:

Based on the above the following rules may help guide to a more enjoyable rowing experience.

1. Spend some money on spoon oars, as they are the most important part of the boat. You might even try the Turbo blades. (There is an excellent article appearing in Ash Breeze, 1990 winter edition, that describes among other things how to make a spoon blade. It can be found by googling “John DeLapp, spoon oars.”)
2. Use oars that are no longer than 7 ½ feet unless the beam of your boat requires it or if you are using flat blade oars. The rowlock blocks or side mount sockets on beamy boats might be mounted on the inside of the gunwale. I have reduced the turbo oars to 7 feet.
3. Take short strokes when starting or against strong winds.
4. **Correct setting up for the backstoke allows for the legs to have a bend at the knees. Move the footstrether a little closer to allow for this. Do not bend the spine on the**

backstroke but rather pivot the pelvis such that the knees now bend more. Not only will this give a longer backstroke but it will also bring more muscles including the thigh and calf into powering the stroke.

5. Have a good follow through for the release. A golfer always has a good follow through else he will start easing his stroke at the drive. The rowing stroke needs a good follow through for the same reason. Ease your effort into the catch to avoid stalling the oar, then pull harder than for the rest of the stroke.
6. Mount the sockets 9" (23cm) from the rear of the rowing seat. If the oarlocks have pins at the front (such as the Douglas and Gaco) mount them 7" (17cm) from the rear of the seat. Consider two socket positions about 2" apart. Make sure that the sockets are high enough above the seat (9") so that the pulling stroke is towards the shoulders and that the blades can have a high recovery to avoid waves, without the handles striking the knees.

Here is a little story to illustrate how long strokes can work to your advantage: During one of our annual races around Dangar Island a young and strong nephew of mine, who is bicycle fit, was neck and neck with me for the entire race. Near the end, I had nothing left but was determined to beat him and in desperation lengthened the stroke of my turbo oars. Then I began to gradually draw away from him and managed for an old fella like myself (70 at the time) a credible second to Hercules (Asher Ashwood a super fit 20 year old).

Hercules, super fit record holder, averaged 5.6 knots (displacement speed) around the island.

Now give it a try. Get yourself a decent pair of spoon blades or even the turbo blade. Keep lengthening your backstroke till further extension appears to have no benefit. Feel the delight of having the skiff slip further through the water with each stroke. Pull fairly hard at the catch and gradually ease up through the powerful drive. Then lean the body well back and pull upright with the arms just before releasing. Work on the rowing style at each outing. Remember that the effort required to row is more than the cube of the velocity (i.e. 8 times the power to double speed) so keep the speed as even as possible. Rowers that put the maximum effort into the drive cause the boat to have a jerky motion that can be uncomfortable for the passenger. Row for the comfort of, rather than to impress the passenger.

Efficient Oars

It took over 100 years, for any significant development to take place, when the oars and blades both got shorter. The West German team introduced the Macon blade in1959 where it won all male sweep events except the coxless four. Part of the problem of the long thin blade is that a portion of it moves the wrong way through the water. There is a point of the blade that remains stationary in the water with the portion outboard of the point providing drive and the area inboard providing drag, thereby wasting energy.

Diagram illustrating oar development over 170 years.

Note that the part of the oar inboard of the rowlock remains the same whilst the outboard part gets shorter. Thus we have the following ratios. I have included a figure for the “Turbo” oar that I have designed and favour for use.

Oar	**Outboard/Inboard**
Square	2.7
Macon	2.4
Cleaver	2.3
Turbo	2.2

These figures give a theoretical speed magnification of the oar. If all oars were 100% efficient the Square blade would give a greater speed, that is the boat would move 2.7 times as far as the oar handle. However it is more likely that the more efficient cleaver blade will move the boat just as far while using less energy in the ration 2.3/2.7. As a percentage this is 85%. Or it might be said that the cleaver blade is almost 20% more efficient than the straight blade with the Macon not far behind.

Left to right: Flat blade, 1955 Spoon blade, and the Turbo blade. Could it be that the material used dictates the narrow blades on the first two?

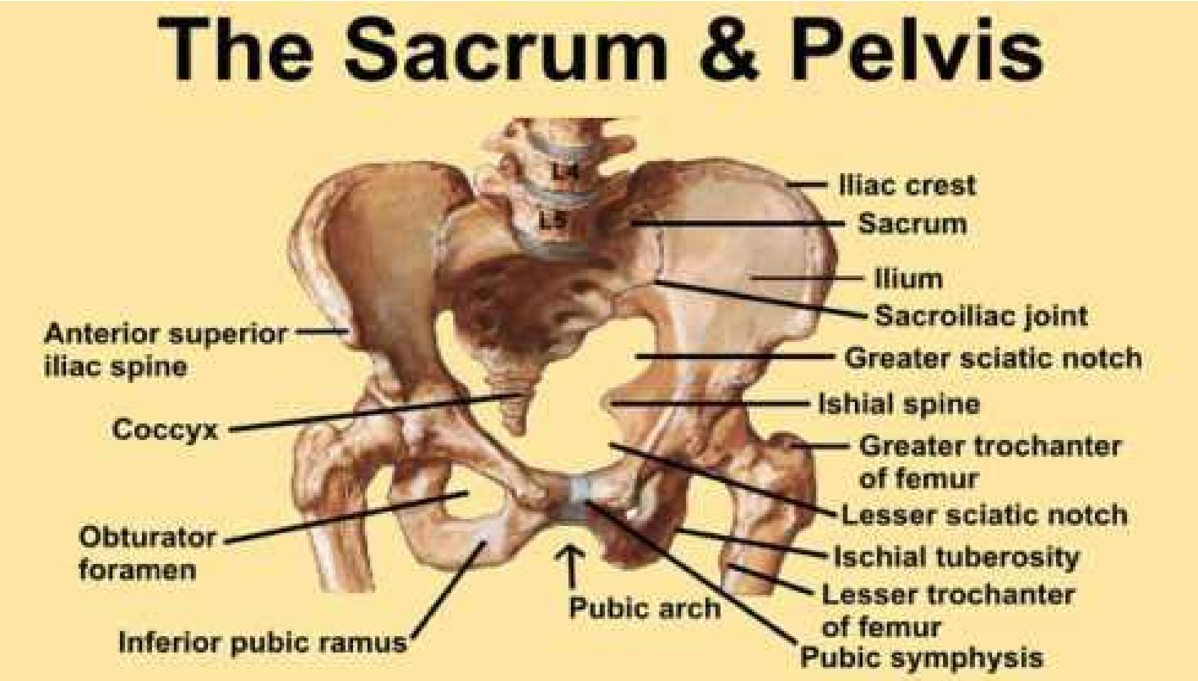
The only reason to use a flat blade is that it is much easier to make but its efficiency is certainly going to be less than the Macon blade by about 30%. Consequently it should be longer even that the square oar. I would suggest in a ratio of 3 outboard to one inboard and a smaller stroke angle. This compares with an astonishing 3.5 to one ratio that I have been able to measure from a photo in the magazine Ash Breeze. Such an oar will have twice the imbalance of an oar with a 2.5 to one ratio. I am aware that the long thin flat blade is allegedly easier to use in a seaway. However I urge you to watch “A surf boat tale” on youtube. Nobody rows in rougher waters than those blokes and you will notice their very fine rowing with heavily spooned oars. The efficiency obviously outweighs the inconvenience of using the broader spoon blade.

It should be remembered that long strokes save energy from the reduction of movement reversal. Try the rowing stroke without entering the oar into the water and you might be amazed at the energy expended achieving nothing. As well the shorter lighter oars are much easier to work and require less rowing room on the water. I have been surprised by the size and weight of whaleboat oars, and, feel that they may have been better off using lighter shorter oars. Certainly the weight of the oars is part of the complaint about the effort required to row them.

Thirty four foot replica of a six oar, NZ bay whaler, built by The Living Boat Trust, Franklin, Tasmania. Note the different oar lengths for the varying boat widths. It is "awkward" to row because the oars are heavy, the rigging needs attention, and, a regular crew would help.

We can describe three categories of rowers:

1. The beginner rows with his arms and there is little movement of his back.
2. The experienced, rows mainly with his back and to a lesser extent with his arms.
3. **The expert rows with his pelvis, back and arms**.



Notice that the thigh bone (femur) connects about a third of the way up the pelvis. If the legs are not bent then the pelvis cannot move. Bent legs allow the pelvis to bend while keeping a straight back. The advantages are a longer backstroke and the employment of extra muscles (leg) in the rowing stroke.

A stylish rower is elegant but he must have the right equipment. It is my hope that this article will encourage more rowers to aim for this. We may have a long way to go, as, of the 16 oar photographs in the fall 2013 issue of Ash Breeze, not one is a spoon oar. Nobody bats an eyelid to paying over $4000 for an outboard but rowers seem to object to paying less than a tenth of this for a decent spoon blade oar. Before even starting on this quest the rower needs to pay attention to the rigging of the rowboat. This will include:

1. Having an adjustable foot stretcher.
2. Acquiring a decent spoon blade or turbo oar, preferably with a D-shaped shaft.
3. Using D-shaped oarlocks to relieve some of the stress of gripping the oar (The Gaco and Douglas oarlocks.)
4. Paying careful attention to the height of seat and the placing of oarlock sockets.
5. Acquiring a nice light, easily driven skiff or dory.

So there you go, why not set yourself the goal of turning your boat into a refined rowing craft, one step at a time, such that it is a delight to stroke efficiently down the waterway. You will find yourself looking forward to it and your health and enjoyment will benefit. As Francis Herreshoff has said: “Almost nothing will give a person a greater feeling of wellbeing than a good long row.”

Postscript: I have emphasised the importance of buying or making efficient oars. I include comments by users of the Turbo oars below to illustrate the point. It must be remembered that similar comments could be made about any well made oar.

Charles Rablin of Queensland wrote:

“I got a chance to try out the new oars yesterday and I must say they are perfect for my boat. The first go, I rowed about 200 yards in a straight line against an incoming tide. The shop bought oars don’t even compare.”

David O’Dempsey of Victoria wrote:

“Hi John, blades arrived promptly and I have subsequently (but not so promptly) made up the oars. I made the oars full length so that I could give the blades a go in the conventional way, and didn’t find them very comfortable to use in the short time I employed them – HOWEVER …. When I chopped the shafts down and fitted the truncated oars to the forward rowing system, I found them easy to use. I noticed that in my row today (2 hours 12 minutes) the boat made a chuckling sound through the water virtually the entire voyage, even in dead flat water – I usually only get that with a big effort, or in wind ripple conditions. Also, I did the same trip last week with my old oars, and took at least 3 hours – even allowing for pre knowledge of the snags (I still managed to get caught up 4 times!) it was a big improvement, as the current was also up a little. I attribute the improvement to the new oars and the blade appended to its far end! Thanks John – worth the purchase.”

“David,

Because the blades are wider than normal they react more if they hit the water. I must admit I found them a little uncomfortable till I realised this. So you need to make sure they clear the water properly on the recovery stroke. This will be aided by making sure that the sockets are high enough to easily clear the water. None of us bother to feather the oar unless we are going into a strong headwind.

John”

“You’re right again John, and I probably will have to put blocks under the rowlocks (as per Oughtred’s plans). I rooftop a couple of the boats and it means removing the blocks each time I load –but – it looks as if I’ll just have to go down that path again. Oh well, life wasn’t meant to be easy – as you backwards rowers know from experience.

An exponent of front-looking rowin’,
When asked by onlookers unknowin’,
Explains with a grin
That it really suits him,
‘Cos he likes to see where he is goin’!

Sure it’s not quite the way oars are seen
Articulated and facing aft of beam.
But with standard oars the view
That confronts you anew
Is of everywhere you have just been!

So despite the occasional stare,
Like all thinking people who care

He likes to see -
Just what confronts he;
At each bend, at each snag – everywhere.

Do you walk backwards in life he exclaims?
It would be silly and daft he explains!
Why not be like me
He announces with glee –
I always arrive - where I aims!

Regards

David"

"Stuart,

Would you mind giving me a brief report on the performance of the oars and mirror. I trust they arrived safely and hope they exceeded expectations.

Thank you

John Murray"

"Hi John,

The oars and mirror arrived safely, and are very good. I like the design of the blade and the way they bite in and give you extra power when rowing against the tides, which up here can move very quickly through some of the passages.

Regards,

Stuart (From Queensland)"