ROWING TECHNIQUE • ANTIQUE BOAT MUSEUM • SAILMAKER'S MACHINE

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The Geometry of Rowing

Or: Why do I need a sliding seat for that nice wherry?

Text and illustrations by John C. Harris

My email software has a cunning, if slightly cynical, feature called "Canned Responses." Faced with a common boatbuilding question, I can select a friendly and articulate response that I composed long ago, add my correspondent's name to the top, and press "send." If my canned response feels facile, I might add a line or two of exposition and a note of sympathy. Invariably, a canned response is explaining why people *can't* do what they hope with their boats.

When this kind of response starts to feel worn with overuse, I take it as a signal that I ought to address the issue in public somehow. Which brings us to a sleek, low-slung 18′ lapstrake wherry that's among my stable of build-it-yourself designs. With a freeboard of scant inches, it depends upon a sliding seat and outriggers to elevate the oarsman and the oarlocks so that the 9′6″ sculls can clear the water—and the oarsman's knees.

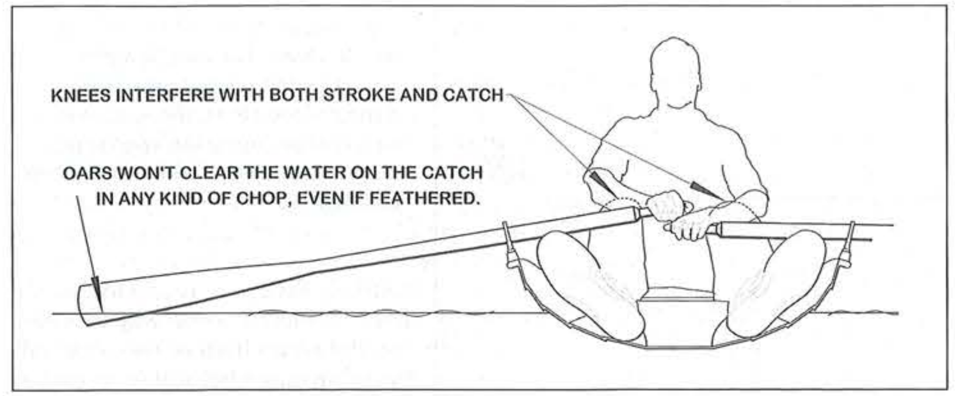
Wherry builders often contemplate the $1,000 cost of the drop-in sliding-seat unit and specialized sculls, then send me emails. "Why," they ask ruefully, "can't I mount ordinary oarlocks on the rails of that boat and use short, inexpensive oars?"

The glib answer is, "Because the oar handles will hit your knees every stroke," though my canned response limns on for a few paragraphs, attempting to explain why exactly this is so. The length of the oars and the three-dimensional interplay of a rowing boat's width and freeboard, and its seat location and height, determine whether you'll glide across the harbor like a swan or thrash the sea into foam.

Talking to other designers of pulling boats about the problem of getting all of the parameters in order on the drawing board, I learned that they had applied the same method I had: they experimented until it felt right. Physical mock-ups of seat height and oar length will eventually untangle the multi-dimensional riddle of a comfortable rowing experience, but it doesn't feel very *scientific.*

So, in hopes of retiring my canned response explaining why a skinny sliding-seat wherry is a lousy fixed-seat boat, I set forth with ruler, calculator, and a big spreadsheet. I surveyed a dozen fixed- and sliding-seat boats, recording every dimension and noting how the boat *really felt* on the water in all conditions. I mounted many of the boats of our demonstration fleet in cradles in the parking lot and had a photographer record the positions of the oarsman's body at different stages of the stroke, which I could then digitize and study on the computer screen. I wanted to devise a simple algorithm for oar length and a set of rules guiding the positioning of the seat in relation to the oarlocks.

Above—**Subtle changes in the geometry of a rowboat can have a profound affect on the boat's performance. The boat above would be faster and easier to row if the oars were about six inches longer; note the broad span between the hands halfway through the stroke.**



Here we see why a fixed seat and gunwale-mounted oarlocks don't work on a 38″-wide wherry with 6″ of freeboard: The oars will slam the rower's knees on each stroke.

The Characteristics of the Boat

Most of the formulae in circulation for calculating oar length use just a single parameter: the beam of the boat at the oarlocks. However, freeboard—the height of the oarlocks above the water—must be considered along with beam. Relying only on the boat's beam to calculate oar length results, for example, in oars that are too short if the boat is narrow but has relatively high freeboard. The oarsman's hands will swing high into the air during the stroke, which isn't efficient and looks sort of silly.

For the sake of simplicity, I'll confine these remarks mostly to traditional fixed-seat rowing boats such as peapods, dories, Whitehalls, dinghies, and so on. High-performance rowing craft like racing shells stretch or break most of the rules in the interest of speed. For example, a shell's freeboard is very low, yet the oars are very long, and racers accommodate this mismatch simply by using outriggers and by being very skilled. They feather oars precisely, barely skimming the surface on the catch. The best of them can make it look easy even in waves, but the rest of us find ourselves undone the first time our surface-skimming shells encounter a big motorboat wake. What I'm proposing here will give recreational rowing craft an agreeable feel in all conditions.

Rowing Posture

I still occasionally encounter people who hate the idea of overlapping the hands while rowing, but the reason for doing it couldn't be any simpler: An oar is a lever, and the oarlock is a fulcrum. The length of oar inboard of the lock determines the leverage applied. Every extra inch means more power. No one is making you row that way, but it's worth getting used to. A hand's width might give you 10 percent more power, depending on the beam of the boat.

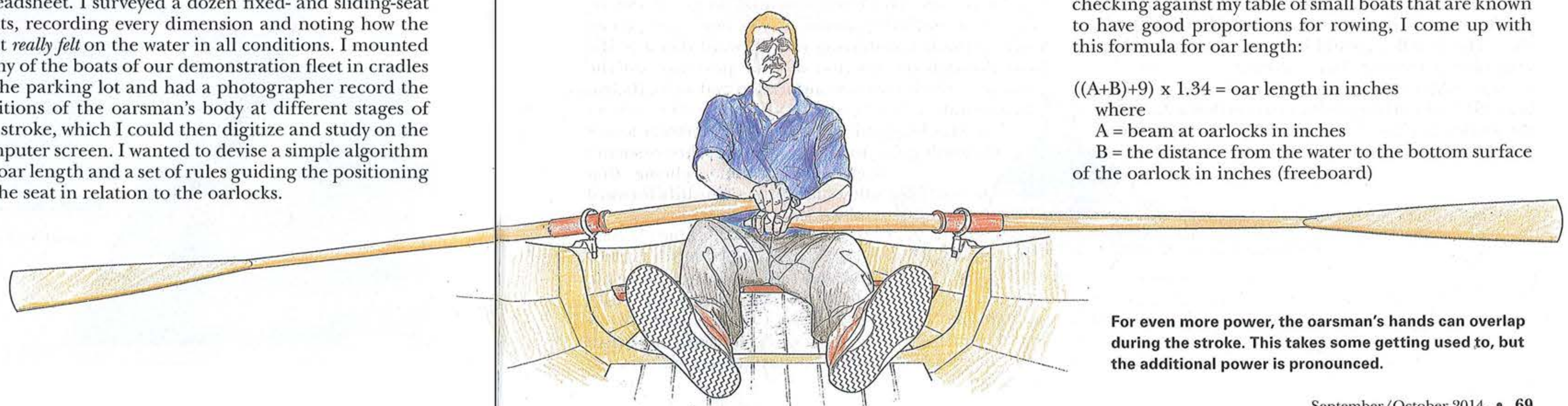
Oar Length Considerations

After 35 years of rowing fixed-seat boats—sometimes for days at a time—I know just how I like it. The blade of the oar should be immersed just to the throat, no more nor less, and I always row with about a hand's width of overlap at the handles.

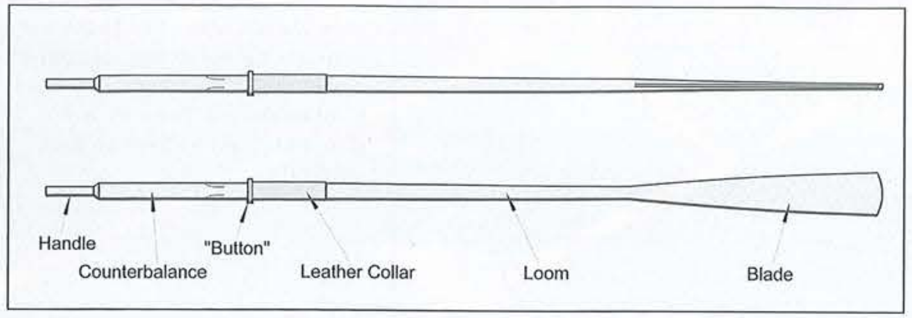
Oars that are too short for the boat will lack power and require an awkward windmilling stroke. Sometimes, such gyrations can actually chafe the boat's gunwales. I've seen people using the round, enclosed-type oarlocks rip the oarlock sockets off the rails when short oars bind in the oarlocks. Oars that are too long may prove impossible to lift clear of the water on the catch, and the inboard "lever" will feel too short for the oar and prove highly fatiguing. Long oars will also require feathering no matter what the conditions, and I try to avoid feathering unless I'm in a rowing shell or I've got a long way to go upwind. It's hard on my old wrists.

With freeboard as part of the calculation, and cross-checking against my table of small boats that are known to have good proportions for rowing, I come up with this formula for oar length:

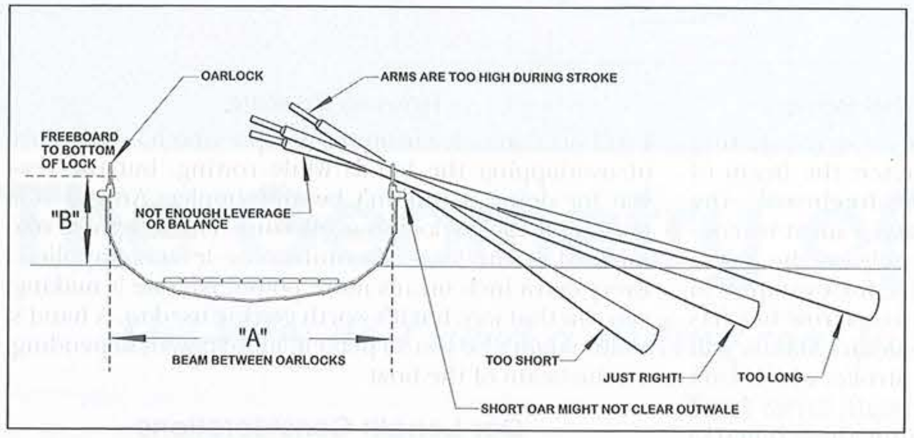
$((A+B)+9) \times 1.34$ = oar length in inches
where
A = beam at oarlocks in inches
B = the distance from the water to the bottom surface of the oarlock in inches (freeboard)



For even more power, the oarsman's hands can overlap during the stroke. This takes some getting used to, but the additional power is pronounced.



Top—The anatomy of a standard oar. *Bottom*—The oars' lengths are critical to rowing geometry: If they're too short, the arms will be too high during the stroke; too long, and they'll provide insufficient leverage.



The small Whitehall shown in the accompanying drawings is 39½″ wide and the freeboard (taken from the plans) is just under 12″. This gives us an oar length of 81″. Since oars come in 6″ increments, we can round up to 84″, or 7′. These 7-footers feel natural; other calculations based only on the beam suggest 6½-footers, which in trials feel stubby on the boat.

Characteristics of the Oarsman

What if you're very tall or very short? In years of having people test boats in my shop's demonstration fleet, I've observed that oar lengths based on beam and freeboard seem to fit the middle 75 percent of humanity, even for serious rowing. If you're quite short, you are effectively sitting lower in the boat than a tall person, which means that in relative terms you'll be reaching "up" to the oar handles. Longer oars—within reason, keeping in mind the leverage dynamics of the oar—will lower the handles. The handles should be level with the middle of your ribcage throughout the stroke.

Especially tall oarsmen have a different problem: knee clearance. Using shorter oars makes it easier for the blades to clear the water without banging into your knees on the catch, but a taller oarsman is unlikely to want to resort to shorter oars. If there's some way to lower the thwart an inch or two, that will be a lot more helpful in creating knee clearance.

Seating Considerations

Nothing turns a nice row into a forced march more than uncomfortable seating. Fortunately for designers and builders, my survey suggests that the geometry is very consistent, from small dinghies right on up to big dories.

The height between the top of the seat and the bottom of the oarlock should be the beam in inches multiplied by 0.17. Thus our Whitehall finds a height of 7″ for the oarlocks above the thwart, and everyone from about 5′6″ to 6′3″ reports comfortable clearance all around.

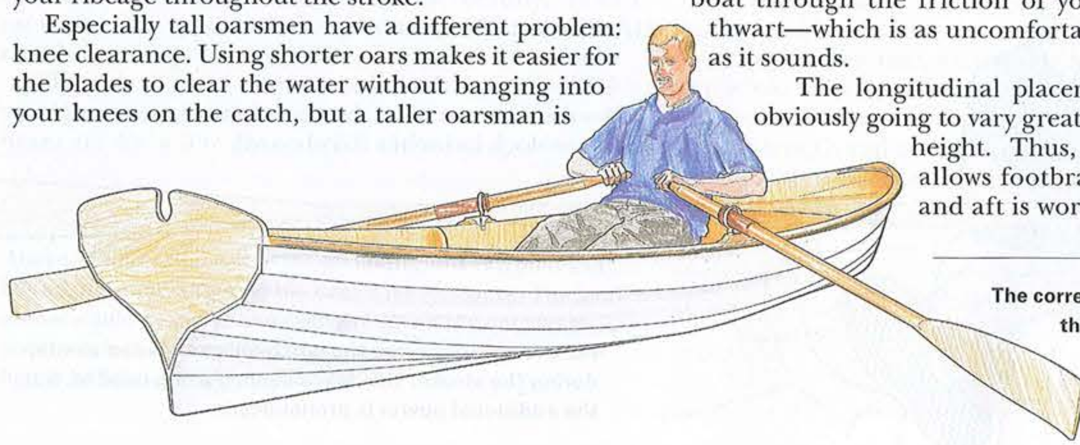
Likewise, I found broad consistency in the distance of the oarlocks aft of the after edge of the thwart. Multiply the beam in inches by 0.22, yielding just under 9″ for the Whitehall. Thwarts ought not to be narrower than about 9″. Making them as wide as possible allows rowers of differing heights to scoot forward or aft for more comfort.

For rowing in a variety of conditions—for example, when a passenger is seated in the sternsheets—the location and geometry of additional rowing stations should be given equally careful thought so that comfort and efficiency are maintained.

Footbraces

Footbraces are absolutely essential in good rowing craft for transferring power. If you don't have them, you're actually transferring your forward thrust to the boat through the friction of your posterior on the thwart—which is as uncomfortable and as inefficient as it sounds.

The longitudinal placement of footbraces is obviously going to vary greatly with the oarsman's height. Thus, some scheme that allows footbraces to shift forward and aft is worthwhile.



The correct oar length for you and the boat will keep the oar handles about mid-height on your ribcage through the stroke.

Why Adirondack Boats Break All of the Rules and Get Away with It

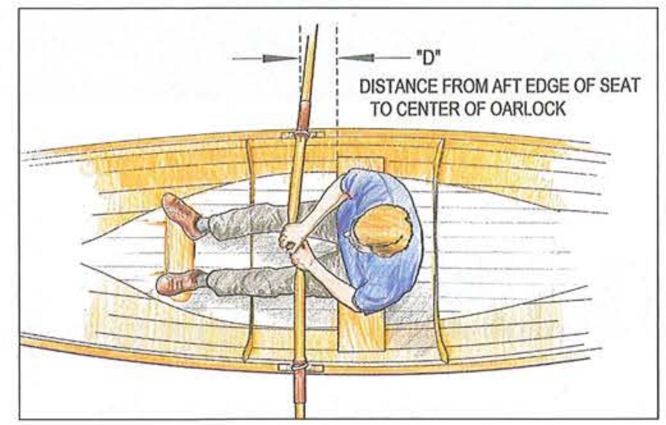
Adirondack guideboats are a historic type of hunting and fishing skiff evolved by 19th-century sportsmen for angling in the eponymous lakes. They are famously fast under oars, but compared to conventional skiffs and dories they have somewhat peculiar rowing geometry. Anticipating an avalanche of letters from guideboat partisans, I decided to take a look at why they work the way they do.

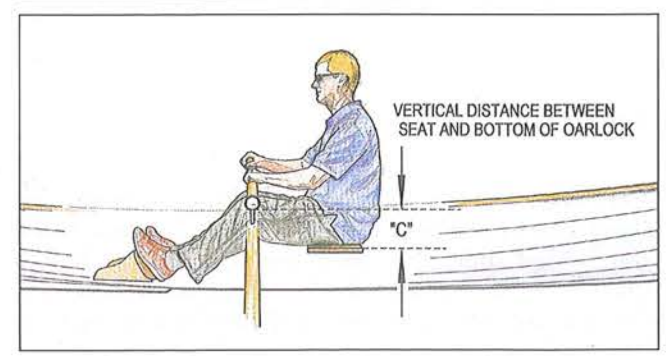
Guideboats are low and narrow. 36″ of beam is typical, and that's far below the usual threshold for oarlocks mounted on the rails. The oarsman sits in a reclining caned seat, and the seating position most resembles that of a kayaker: The knees are bent and flattened out towards the rail to create clearance for the oars. Even so, the stroke tends to be shorter than in a conventionally proportioned rowing boat.

The overlap of the oar handles is pushed to extremes. Something like 5½″ of overlap is typical, says guideboat builder and designer Steve Kaulback. The oars are springy and light, and handling is simplified in some ways by having them pinned at the locks. With a lot of leverage thanks to the overlap, plus a narrow waterline and light hulls, guideboats are capable of startling bursts of speed.

It really works because guideboaters are willing to have so much overlap of the oars at the handles. "It's a tough argument to win," says Kaulback, who's probably built and sold more Adirondack guideboats than anyone in the last century. His 13′ "pack boat" uses 7′ oars, whereas my formula suggests 5½-footers. The success of guideboat oar geometry offers useful lessons for anyone contemplating mounting oars on low and narrow boats: You'll need to sit very low in the boat, you'll need a lot of overlap at the handles, and you'll be taking a shorter stroke. So maybe you can make fixed-seat oars work on that low-slung wherry after all.

—*JCH*





The longitudinal and vertical placement of the thwart and oarlocks is the difference between a nice row and a painful slog.

The vertical height of the oarsman's heels will also vary greatly depending on the depth of the boat. A deep-bodied traditional rowing boat will have the thwart set comparatively high above the floorboards and the oarsman's knees will be bent comfortably. A shallow boat will require the legs to be straighter. If you find that you just can't fit your knees under the oar handles during the catch, that's a signal that you need to elevate the oarlocks with outriggers or taller oarlock pads. The engineering of oarlock pads, especially high ones, is not trivial; your leverage on the oars puts a great deal of torque on the pads. I've torn off more of them than I care to admit.

Conclusions

I tried plugging boats with oddball dimensions into my spreadsheet to see whether garbage begat garbage. Reassuringly, these calculationss spit out short oars for narrow, shallow boats, and long oars and logical seat heights for wide and deep boats. But this is the place where a warning for the boffins is in order: If you're designing a boat with odd proportions, expect odd results. The formula works well for the middling spectrum of traditional smallcraft.

My experience in issuing mathematical prescriptions of this sort also suggests that the math will bang up against common sense sometimes. I've sold about a thousand 8′ dinghies whose proportions suggest 7′6″ oars. But storing such long dinghy oars is a hassle quite out of proportion to any advantage you'll gain paddling the thing across the harbor. We've always shipped 6′6″ oars and the dinghy goes just fine. So don't get too hung up on the numbers.

Likewise, most sliding-seat boats are exempt. Every rowing shell or wherry of my acquaintance has a beam of 63″ between the locks, uses 9′6″ sculls, and the drop-in sliding seat units takes care of the seat height question. The sliding-seat guys have been refining that geometry for 150 years and we'd best not monkey with it.

John C. Harris designs, builds, and writes about boats at Chesapeake Light Craft in Annapolis, Maryland.

Please visit the Bonus Content section of our website (www.woodenboat.com) to view a list of boat examples and their dimensions, and to receive further guidance on oar selection.