Burning Questions

BOAT TRIM

How to level your boat?

By Brent Reitz

“Brent -- I've heard you say "squat"! What do you mean? What’s it all about?”
Signed, Don't Know Squat.

My Dearest "Don't Know Squat", I am not really sure when, or where, you've heard me use the word "squat"? My only guess is that I must have been referring to the "trim" of one's boat. It was either used in that context, or, you were hanging around with me in a bar after some late-night blues jam? If it was the latter, I choose not to elaborate.

Assuming the former, let's talk "TRIM"! A boat's stern will sink deeper in the water as more power is applied. Basic physics apply here as the hull is put under more power, the bow will rise and the stern will, well,"squat" (a highly technical term, used only in the most hallowed-halls of kayaking think-tanks across the globe). We want to avoid a "squatting stern", which creates unwanted drag. Drag, of course, cuts into our efficiency, and heaven-forbid, we lose one fraction of that!
I think it's important for every paddler to understand that boat designers, (which I am one), are forced to place the seat of their crafts in a spot that will provide the least amount of "stern squat" and the best overall boat trim to an "assumed payload". Since my first days of racing, (1982), I have been taught to adjust my seat to a spot that is best for MY PERSONAL weight and speed. Since entering the world of "boat design" , I've become keenly aware that many boats out there should be "dialled-in," or trimmed out by their new owners. The variables are too great for any boat designer or manufacturer to "nail" the exact spot for the seat, right off the shelf. The computer calculates the centre of the boat and they do all the math that they can do in order to place the seat in it's appropriate spot. However the best placement is really an individual thing. The shape and weight of one paddlers body can vary greatly from the next, (which is a beautiful thing!), and these differences can affect boat trim.

Every time I get a new race boat I check the trim and adjust it accordingly. It makes no difference to me whether it's a Phantom, a Surf-ski, or a Prijon 89 Wildwater boat. I guess I don't pay that much attention to my river play boats, as straight-line speed is not a requirement. However, when I get my New Perception Avatar touring boat, I'll check the trim on this "recreational toy" also. Efficiency, folks, is important not only in your stroke technique, but also in your equipment!

Here's how I trim my boat to eliminate “squat.”
1. Place your boat on a "true" flat surface - A large table, a smooth absolutely flat piece of concrete, a steel I-Beam... you get the idea.
2. Take a tape measure and a waterproof magic marker
3. Go to the bow and measure off
the flat surface, making marks every 1/2 inch from the surface up the bow. Place a large number representing one-inch, (or centimetres) increments off the surface next to each mark where appropriate. Leave the 1/2 inch marks unnumbered if you wish, but make them large enough to see from shore.
4. Go to the Stern and do exactly the same thing. Depending on the rocker of the boat, some numbers will not be available, just measure up until you get to the first one that corresponds to the bow measurements and then mark upward from there.
5. Go to the water, and take a friend (preferably one you can trust, who has no agenda of beating you in

your next race). You need to find a dead-flat piece of water where your friend can clearly see the boat markings from either the shore or the water. The shore seems to work best.
6. Do sprints back and forth in front of your buddy to see how the numbers in the bow match up to the numbers on the stern when the boat is under RACE-PACE POWER. You must get your boat to hullspeed to perform this test. If you are checking the trim on your touring boat, do the same thing but simply paddle at normal "Touring-Pace" vs. Race-Pace.
7. If the stern is "squatting" when the boat is under the proper amount of power, you need to "scootch" (yet another highly technical term), your seat forward a bit. If the bow is sinking deeper than the stern, the seat needs to move backward a bit. One inch can make a difference, so do this a little bit at a time.
8. Repeat the drill until the numbers at the bow, match those at the stern.
9. Take the waterproof marker and make marks on the inside of the hull where the proper seat placement should be once your pal gives you the "thumbs-up". Go home and readjust the placement as required.

Please note that this is the method I was taught "many moons ago". If there is a Hydro-Physicist, Olympic Coach or a Marine Architect out there somewhere that begs to differ, lets hear about it! If there are more scientific methods to go about trimming a kayak, our readers would love to hear about them. The bottom-line is, that a paddler should NOT automatically assume his or her seat is EXACTLY in the correct spot straight out of the box. Check it out for yourself, cuz after-all, "nobody wants "squat"!

Cheers, Brent Reitz

Peter Gimpel, Naval Architect, adds to technical talk to the discussion of boat trim.

To the Editor,
Re Brent Reitz's article "Avoid the Squat"
Congratulations on a great article re trimming the boat (or was that something about avoiding the squats like you might avoid the push-ups). You asked for comments from Marine Architects etc. As a Naval Architect and paddler of several types of boat including Surfski and K1, who has spent time checking and optimizing trim on many boats, I do have some comments.

The method described to check trim by placing the boat on a flat surface and measuring up from the flat surface at both the bow and the stern assumes that the boat will lay on the flat surface at the correct trim. If this happens it will be coincidence only and in the majority of cases will not give a trim that matches the designer's designed trim. Having said that, this method at least prompts the paddler to check the trim of the boat under power and that is always a good thing. In most cases the result will be better than no trim optimization and even if for some reason the result is way off, at least the paddler can see what the trim looks like (have the guy on shore take photos).

So what do I suggest as a better method?
Not wanting to take an easy cop out but this subject could easily fill a book. As such I am going to focus on some basics with the hope of giving some understanding as to the reasons for correct trim and what is correct trim.

What is the correct trim?
Obviously the correct trim is that which allows the hull to generate the least amount of resistance while still behaving in wave conditions. For a moment let us ignore the effect of waves. In flat water, changing the trim will have the effect of changing the following drag producing characteristics:-
Surface Friction - a direct function of the wetted surface area

Primary Wave Making Drag - defined by the immersed hull shape, this is a complex issue but the size,

location and shape of the waves can be seen as the boat moves through the water

Secondary Wave Making Drag or Form drag - another complex issue an example of which would be when the rocker on the bow sections creates lift at the bow which as a direct result, creates additional drag from the inclined surface. (This bow lift also produces increased trim at speed and also (using that highly technical term) “stern squat”.)

There are other induced drag types and eddy form drags depending upon the individual hull shape (for instance, the immersed stern tip that has some thickness creates eddy drag).

The Effects of Forward Trim
On a typical race boat the bow sections are finer than the stern and a depressed bow will tend to increase the wetted surface area in the bow more than the corresponding reduction in wetted area at the stern. However, the fine sections of the bow are such that a depressed bow often reduces the primary wave making drag (dependant upon the shape of the stern sections). For a boat with rocker in the bow, depressing the bow can eliminate the lift from the bow sections and so tends to reduce drag.

At slower speeds, wave making is not much of an issue but at high speeds it starts to become significant. Often the reduction in wave making due to forward trim will more than offset the increase in wetted surface area and so bow trim can be beneficial (in flat water).

The Effects of Aft Trim
Aft trim tends to produce the opposite effects of bow trim and so at race speeds aft trim would be a negative feature for most hull shapes.

Additional Factors
A long water line length is very important for minimizing drag. If the trim of the boat at speed creates a length of bow overhanging just above the water then additional bow trim will generally be beneficial by immersing the overhanging bow and maximizing the waterline length. This same effect would apply to an overhanging stern but this feature is not so typically seen on a racing kayak.

If the boat has even a small transom then it is important to keep that transom from being immersed as it would be a large drag producing element.

So how can you optimize the trim?
The following method will give a very close approximation for most hull forms however without a designer who understands the individual hull shape there is no way to be 100% sure of the optimum trim. This method is perhaps a little tedious but it will allow the paddler to gain a more thorough understanding of his boat and how it behaves.

Place a piece of tape vertically up both the bow and the stern with marks every half an inch (in a similar way to Brent’s method but with no need to measure from a flat surface). Number the marks (1, 2, ... etc.). Do the same thing up the side of the boat at ¼, ½ and ¾ of the way back from the bow. The marks are arbitrary and each set of marks does not need to relate to another.

Paddle the boat at race speed using your normal stroke and have a friend take a series of photos from the side. View the photos and determine an average waterline position at the bow and at the stern (where the waterline coincides with the tape marks).

Place a round bar on the floor (a broom stick handle or similar will work). Place a board or plank of wood onto the round bar. The plank should be big enough to sit on with both your backside and your feet on the plank when in the paddling position. (Ideally the plank needs to be light in weight so as to not effect the result.) We could get complicated and take account of the weight of the plank but for the sake of page space we will ignore this error.

Sit on the plank so the bar is running from side to side underneath. With your feet in the normal paddling position gradually move yourself over the bar until you find a balance point. Put your arms and upper body in stroke position and check for the balance point. Note where the balance point occurs (for me it is half an inch in front of my crotch).

Place the boat in the water and protect the seat area with towels or some such. Gently place weights (lead bricks are ideal) into the boat. To begin, make the center of the weight coincide with a point just behind your broom stick balance point. Keep the weight as low as possible as some of the tippier designs will tend to fall to one side. The amount of weight should equal the paddlers body weight. If the boat refuses to stay upright it will be necessary to have a helper who's job will be to gently keep the boat upright while not altering it's trim.

Make note of the waterline at the bow and at the stern and then by trial and error move the weight forward or aft so that the waterline most closely matches the at-speed waterline. When moving the weight, do not be tempted to just move a couple of pieces of lead in one direction as when you are done it is necessary to know to position of the centre of the lead collection.

Notice the shape of the boat at the waterline at the bow and at the stern – look for any fullness or maybe concavity and be aware how that shape will change if the trim is altered.

Think about how the trim could be improved? If the bow was immersed more would the waterline length increase? If the bow was immersed more would it mean that fuller sections of the bow become immersed and lead to increased wave drag? Or are the bow sections fairly constant in fullness in the vertical direction (like most K1's) and so perhaps increased trim might give minimal additional bow wave making while lifting the stern and might reduce the fullness of the immersed stern sections which may reduce the stern wave making?

If you feel that a change in trim might be beneficial, move the seat position and paddle the boat again. Compare the before and after photos. Use the ¼, ½ and ¾ tape locations to help compare wave height. Larger waves indicate greater wave drag.

All of the above will have given the paddler a better understanding as to how the trim changes from at rest to at speed, what shapes are immersed at the bow and stern and how those shapes can change with trim. The boat will be trimmed to a level of optimization that would otherwise not be possible.

Remember I have only just scratched the surface of this topic and without all the necessary input full optimization of trim is be a trial and error process.

Also remember that if you have changed the trim much and particularly if you have increased the bow down trim, take the boat out in waves and check that she still behaves properly.

If you are looking for lead weights, the rectangular blocks (about 15" x 4" x 1 ½" – 30lb each) that come from the old style sash windows are ideal. I found mine at a scrap metal dealer.

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