Paddling Made Easy

Part I: Perfecting the art of stroke efficiency is the first step

By George Arimond, Ph.D

"Anyone can learn to paddle. It's easy." How many times have you heard that said? But on the water, there is a big difference in paddling skills. Some paddlers make it look easy, even in the most challenging conditions – moving the canoe with amazing ease and speed while exerting little muscular effort. Some may even have less strength than you or me, yet their canoe moves with amazing speed. Their forward stroke is one fluid motion that wastes no energy. Such paddlers have perfected the art of stroke efficiency.

To investigate stroke efficiency, I filmed several top-ranked professional marathon paddlers, using a computer graphics program and high-speed film. These techniques provided a graphic, detailed analysis of each body segment during the stroke.

Good stroke efficiency can be defined as exerting the least amount effort to propel the canoe forward over a given distance. Thus, once you learn good stroke efficiency, you'll need less strength and endurance to propel the canoe, and you will be able to travel farther before exhaustion sets in. It is rather like having the perfect gear for an uphill climb on your mountain bike.

The key to understanding stroke efficiency is imagining the paddle blade's movement below the surface of the water. When the blade is nearly perpendicular with the water surface – or vertical – and fully submerged, it can exert the maximum leverage. The problem canoers face, however, is "blade paddle slippage." It is rather like spinning your car tires on ice: the tires turn very fast, but the car makes very little forward progress. The

Figure 1: Power Phase, Paddle on Right Side

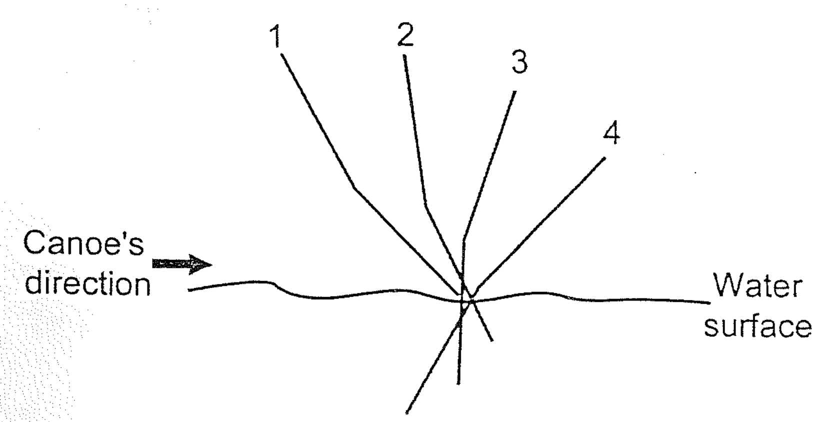
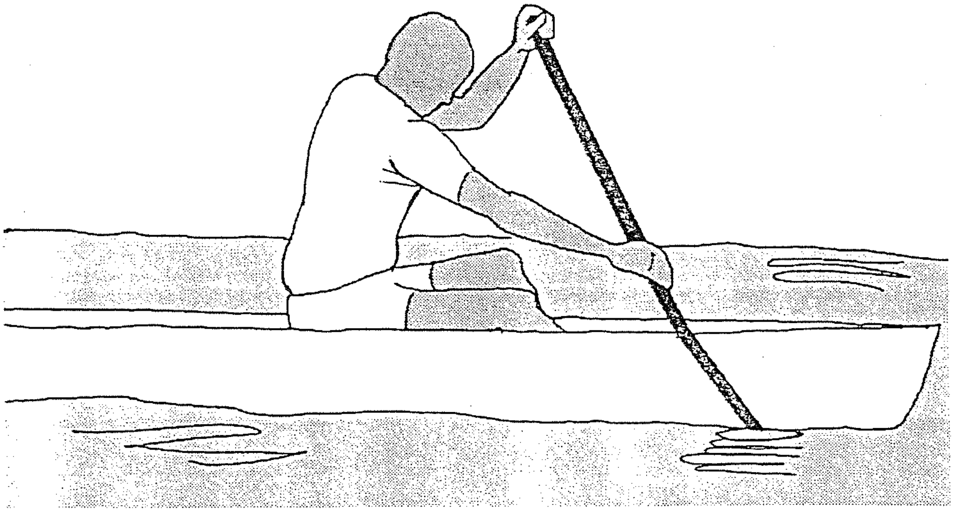


Figure 2: Preparatory Position



same thing happens whenever the blade pushes a lot of water rearward: the canoe's forward momentum decreases. Hence, your stroke efficiency improves whenever you exert maximum power while moving the water as little as possible.

Physics of the Stroke

The principle of fluid dynamics in physics helps to explain stroke efficiency. According to Newton's Laws of Motion and the Bernoulli Principle, maximum efficiency in water is achieved by moving a large amount of water a short distance while accelerating as little as possible. There are three elements critical to paddle blade efficiency:

- The volume of water the blade presses against;
- The distance the blade moves the water;
- And how quickly the blade begins to move the water.

To understand this, imagine a paddler violating each principle: She places only half the blade in the water (i.e. press against a small volume), pulls with a quick jerk (i.e. quick acceleration), and takes a very long stroke (i.e. a long distance moved). This stroke causes a very rapid movement of the water – and is the most inefficient stroke a paddler could take.

Instead, the blade should push against as much "still water" as is physically possible, while moving it as little as possible. (Think of "still water" as water that is standing still and has not yet begun to move under the pressure of your paddle.) Thus, an efficient paddler inserts the entire blade, exerts power gradually, and ends the stroke as soon as water movement occurs. This is your most efficient stroke.

Skilled paddlers do three things to reduce blade slippage and increase stroke efficiency:

- They fully submerge the blade as quickly as possible before exerting significant power, allowing them to exert pressure against the largest amount of water possible and minimize slippage.
- They exert power in a gradual progression; increasing and decreasing power in relation to the blade's angle. Even while the blade is submerging, they exert power, but they only exert full power when the blade has become fully submerged and the blade angle is nearing the perpendicular range (plus or minus 25 degrees). Leaving the perpendicular range, they gradually reduce power to avoid the rapid slippage that can occur at the end of a stroke.
- They try to extend the duration of the stroke's perpendicular range by delicately balancing the degree of power they exert between the two arms (top and bottom) during the power phase of the stroke. (How this is done will be explained later in the description of arm and shoulder movement.)

Some canoeing experts believe paddlers should quickly submerge the paddle to a perpendicular position and then hold that position while pulling rearward. However, the Bernoulli Principle tells us it is actually more advantageous to pivot the blade through the perpendicular range. Figure 1 (previous page) shows the actual blade and shaft movement (using a bent shaft paddle). Note how the blade tip quickly submerges and then slowly arcs through a perpendicular range. It does not simply stay at the perpendicular position for any duration of time. Since the fulcrum point of the paddle is near the water surface, the blade tip is actually curving into new still water during the entire perpendicular stage of the stroke. This is important because this motion increases the amount of still waters that the blade presses against.

Preparatory Position

To achieve blade movement, first look at how you position yourself to begin the stroke. Proper positioning in the preparatory position is a critical key in learning efficient stroke technique. The preparatory position is that point in the stroke where the blade tip is about to submerge. It is rather like the preparatory position we assume in opening a door. We usually stand well away from the door as we reach for the doorknob, giving us clearance to open the door without having to step back.

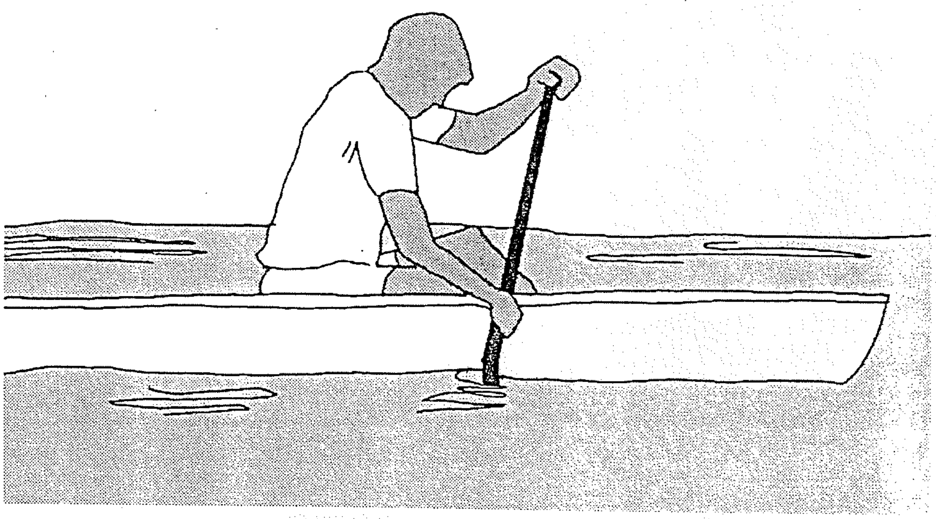
To help visualize this, actually reach for a door knob and then note the position of your arm and shoulder. Your arm is fully extended, and your shoulder is in line with your arm. In other words, the shoulder turns and points in the direction of the doorknob, slightly depressed. (The other shoulder will naturally move in somewhat the opposite direction.) This is the position for the bottom arm (the one holding the shaft), as you assume the preparatory position.

If you think of your arms as the hands

of a clock (remembering that the axis of your arms is the shoulder, not the elbow), the bottom arm (the one holding the shaft) will be at 4:00. This is the optimal position for the bottom arm during the preparatory position (see Figure 2 above).

With the bottom arm and shoulders in place, how do you position the top arm (i.e. the arm holding the top grip)? The elbow of the top arm is at about shoulder level and bent slightly. This means upper hand is either at or slightly above 3:00, positioned across the body directly over the forearm of the bottom arm. This is important: many paddlers tend to hold this grip hand directly in front of their face and chest. With a straight shaft, the paddle is angled back at about 40 to 50 degrees. With a bent shaft paddle (12 degrees), the angle of the shaft will be 52 to 62 degrees.

Figure 3: Middle of Power Phase



If your arms are properly placed, your trunk will lean forward (just above 1:00, about 20 to 25 degrees), but it will actually feel as if you're sitting almost perfectly erect. Avoid leaning too much or slouching. When you're leaning, it is harder to support yourself for any length of time against the pull of gravity. Slouching, on the other hand, makes it difficult to effectively use the strength in your shoulders, which reduces stroke efficiency.

Practice this preparatory position without actually taking a stroke. Hold it momentarily and look at your position. Have someone else look at your position. It takes a certain degree of hand-eye coordination and practice before this position becomes automatic. If, however, you master this position, the rest of the stroke will come together quite naturally. In fact, the rest of the stroke will become one fluid movement, and you will wonder why you did not discover this sooner. It will seem so natural and very graceful.

Power Phase

The next phase of the stroke is submerging the paddle and exerting power: the "power phase" or "water phase" of the stroke. To effectively execute this phase, envision pulling yourself to the point where you inserted the paddle blade. This is, in fact, what happens if you are getting an efficient stroke: the blade stays nearly stationary while you and your canoe move toward it.

To get this efficiency, the bottom arm (i.e. the arm holding the shaft) moves in a downward arc like the arm on a clock. Done properly, your elbow will actually bend about 40 degrees throughout the entire power phase (see Figure 3).

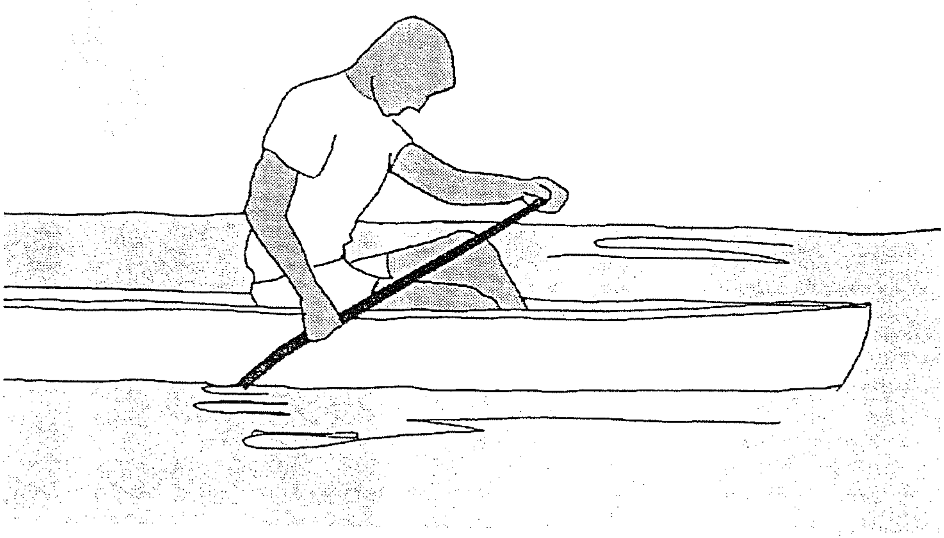
Best efficiency is achieved if your bottom arm starts at 4:00 (see Figure 2) and finishes at 7:00 (see Figure 4). Two things should be noted here:

- The power phase ends when your bicep is parallel with the chest (i.e. at 7:00).
- Your upper arm and forearm must move together as one, forming a long semi-rigid lever that mimics the movement of a clock arm with the shoulder as the pivot point or fulcrum.

This full-arm lever has a very important advantage over the motion of novice paddlers: It allows you to use more of the shoulder, chest, and back muscles. Inexperienced paddlers tend to flex the elbow more than 40 degrees, some bending it as much as 85 degrees. However, it is important to understand that elbow flexion of more than 40 degrees not only forces you to use more arm muscle, but it also reduces the effective use of the torso muscles. Why is this important? Because the torso muscles are not only stronger than your arms, but they have significantly more endurance. This is particularly important during lengthy paddles or when you are paddling in strong winds and current. The 40 degree flex of the elbow is extremely important: biomechanical strength research has shown that an arm pulling against resistance is strongest when the elbow is flexed 40 degrees. So, while you don't want to bend the elbow too much, you don't want it straight either.

The top arm (i.e. the arm holding the top grip) moves with the bottom arm, but instead of pulling, it presses in a forward/downward arc (see Figure 1). First, look at how the bicep moves (see Figure 2 and 4). It starts slightly above 3:00 and ends its downward press at 4:30. Next, look at how the forearm moves. During

Figure 4: End of Power Phase



the press, the elbow, which is slightly flexed at the preparatory phase, will gradually straighten during the power phase. How quickly or slowly your elbow straightens will be driven by a feeling of paddle blade slippage. You are feeling for blade slippage and trying to minimize this slippage through proper timing and speed of the extension.

Your trunk always has a slight forward lean, but never more than 20 degrees. (Inexperienced paddlers and tired paddlers tend to lean forward a lot to help power the paddle.) During the power phase, you will flex forward and then back, but the movement should be less than 10 degrees. This small movement may help in the rapid submersion of the blade. Any flexion beyond 10 degrees, however, is inefficient because it shortens the duration of the perpendicular phase (i.e. 5:00 to 7:00).

Your enjoyment of canoeing will be richly rewarded if you only try this technique

Refining the Stroke by Feel

You now know how the general body moves, but now the questions become, "How do I teach myself to refine and perfect this technique? How can I tell when my stroke is really efficient?" You can learn to perfect this technique by sensory feel. The expert paddlers filmed in this study had no formal training in fluid dynamics or human movement. Instead, they perfected their stroke by trial and error. They would paddle along side other canoers and watch the change in the canoe's speed as they tried different strokes, using their kinesthetic sense of feel to constantly monitor two things – 1) their arm and trunk movements, and 2) the water pressure against the blade. Here is what they suggest as a way to monitor your stroke's efficiency.

With an inefficient stroke you can actually learn to hear and feel the movement of the water near the blade. You will hear a sucking noise much like the sound you hear when the last bit of water drains out of a bathtub. As your sense of touch becomes more refined, you can actually feel a vibration in the lower hand. (An air pocket that forms on the front side of the blade causes both the noise and the vibration.) To get a sense of this, take two or three hard strokes, and watch the air funnel form in front of the blade.

As your stroke becomes more efficient, it will feel as though your blade is anchored in cement: no matter how hard you pull, it won't slip. If you exert very little power while practicing this technique, you can be fooled into thinking your stroke is efficient. You need to paddle semi-hard to properly monitor your technique. So when practicing, paddle for short intervals with rest in between.

If your blade is slipping, you need to do three things:

• Visually check to see whether your preparatory position is correct.

• Check whether your stroke is ending as your bottom arm approaches 7:00.

• And check how much power you are exerting with each arm throughout the power phase.

Remember, the bottom arm is pulling while the top arm is pressing down and forward. How much power each arm should exert could not be measured in this study. Like the experts, you'll have to learn this by feel.

Too much or too little power exerted by either arm causes paddle slippage. Thus, there is an optimum ratio of power between the two arms. Too much power from the top arm at the beginning or end of the power phase does little to propel the canoe forward and wastes energy. Sometimes it even causes the canoe to porpoise up and down, which also slows the canoe. However, a certain degree of power is needed from the top arm for the blade to press against the largest amount of still water possible. The bottom arm can also cause blade slippage – either by applying excessive power or by taking too long a stroke (moving the bottom arm beyond the 7:00 position).

To conclude, achieving this kind of stroke efficiency may seem unnecessary to some, and it does take some time and practice to learn. But think about how nice it would be to have a stroke that makes canoeing feel effortless. Your enjoyment of canoeing will be richly rewarded if you only try this technique.

Next month, a focus more on the feel rather than the mechanics of stroke. ❑

The author is a University of Wisconsin-La Crosse professor with academic training in biomechanics and outdoor recreation. He has been teaching canoeing and guiding wilderness canoe trips for over 30 years, and is a former professional marathon canoe racer.