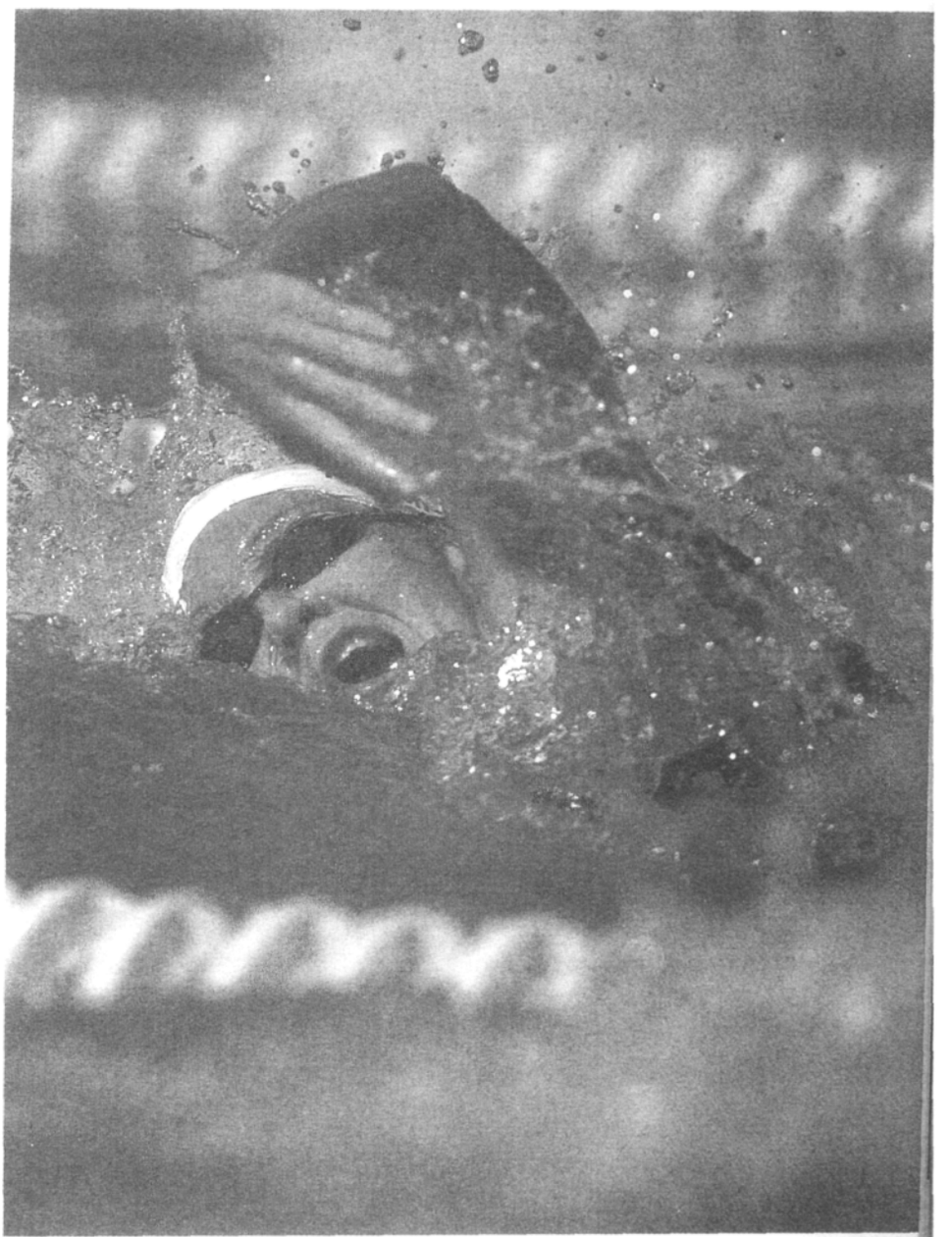
Chapter 6

Coaching the Feel of the Water

The *feel of the water* refers to a swimmer's intuitive ability to feel and effectively handle the water. It is generally believed that feel of the water is an elusive quality unique to the talented athlete; swimmers of only average ability cannot hope to emulate the acute sensory perception of the talented motor genius. Nevertheless, I intend to show that by heightening the sense of touch and learning how to interpret sensations of moving pressure, swimmers of average ability can acquire the subtleties of advanced stroke technique. Talented swimmers coached in this method will likewise achieve greater expertise.

A more apt title to this chapter may well be "Coaching the Feel of the Flow." Water flows when a force acts on it; a swimmer's hand always propels against the pressure of moving water. The force exerted by a skilled swimming stroke causes the water to flow in a distinct pattern (Colwin 1984a). The method in this chapter shows swimmers how to feel for the ideal flow reaction to their stroke mechanics and thus receive instant feedback on their efficiency.

This new approach teaches swimmers to anticipate, control, and manipulate the flow of the water. They learn that the arm functions not only as a propelling instrument but also as a skilled and sensitive shaper of the flow.



Ideal Flow Reactions

The first step is to explain how the flow behaves during each phase of an efficient swimming stroke. The flow directions that can be anticipated in the different swimming strokes can be described simply. The oncoming flow—which in the crawl-stroke hand entry moves from the fingertips to the wrist and along the arm—is known as *distal* in its direction. A flow that moves toward the radial bone (or from thumb to little finger) is termed *radial,* for example, the flow produced when the elbows bend to bring the hands under the body in the crawl, butterfly, and breaststroke. An *ulnar* flow moves toward the ulnar bone or from little finger to thumb, for example, the flow produced as the arms extend and the stroke rounds out to the hips in the crawl and butterfly. A flow is *proximal* when it moves from the wrist toward the fingertips, as happens in the backstroke as the arm straightens at the end of the stroke (Schleihauf 1979).

The Importance of Hand-Forearm Rotation

Swimmers are shown how flow behavior is related to an important aspect of stroke mechanics: emphasizing hand-forearm rotation within comfortable limits for each individual swimmer. This is the mechanism that sets up the ideal flow around the hand and forearm in all the strokes. The practical application of this mechanism for swimmers of all strokes is simple: Start the stroke with the palm(s) facing outward and gradually rotate your hand-forearm unit throughout the stroke, with particular emphasis on achieving the maximum amount of elbow bend in midstroke that is comfortable. Find the amount of hand-forearm rotation and elbow bend that develops the strongest pressure on the moving flow but still feels comfortable.

New Terminology Related to Feedback on Flow Reactions

Introduce a new terminology. Short descriptive phrases such as "trap, wrap, unwrap" tell a swimmer how to handle the flow correctly during the split-second action of a swimming stroke. This differs from previous methods that describe only the mechaniçs of the stroke. In addition, the new terminology relates to obtaining feedback by feeling the flow on the hand and forearm. These verbal cues are important to the effectiveness of the method and are valuable as rehearsal techniques to enhance subsequent performance. Later in this chapter, I will discuss appropriate descriptions of what pressure sensations a swimmer should feel.

Flow-Shaping Skills

The swimmers are taught flow-shaping skills by which they create and detect specific flows in the water. These *flow shapers,* as they are called, have a beneficial two-way effect, in that a swimmer's efforts to shape the flow cause a reciprocal shaping effect on the limb itself. The feedback received from the flow reaction causes the proprioceptors in the muscles to respond by adjusting the posture and attitude of the propelling arm. Flow shapers produce positive and even exciting results because they instantly groove the hand and arm in accurate stroke patterns. Even the skeptics become convinced that this is a unique and effective way to teach efficient stroke mechanics. The essence of the method is: the feel of the flow shows a swimmer exactly where to place each moving sequence of the swimming stroke.

Sensitizing Procedures

Special sensitizing procedures are introduced to sensitize the sensory nerve endings to the moving pressure of the water (or, more precisely, transient pressure induced by motion). The propelling surfaces of the hands and forearms are also sensitized to simulate specific flow reactions. The method is simple. Sensitivity to the flow increases at once. Swimmers of average ability learn to regulate a smooth and efficient stroke.

Although these techniques quickly stimulate the sensory nerve endings, this is of little value unless the swimmer makes an association between the feel of the moving water and the particular phase of the swimming stroke.

Only then can meaning be given to the sense of touch and an intelligent concept formed of the desired stroke mechanics.

Connecting Sensory Information With Stroke Effectiveness

The method short circuits the motor-learning process and renders the complex more simple. The deliberate intention is to cause an immediate connection between sensory information and stroke effectiveness. By giving instant meaning to the sense of touch, the procedure adds a new perspective to traditional methods, so it is used even in the early stages of learning. Young swimmers rapidly improve their ability to seek out and recognize ideal flow reactions.

It is unnecessary to burden a swimmer with academic considerations—valid though they may be—such as lift, drag, ideal angles of attack, and which movement planes to emphasize. Talented swimmers, when exposed to the method, develop unusual dexterity in directing and channeling the flow efficiently. Even accomplished swimmers improve their techniques when made aware of the exact flow reactions they can anticipate; in fact, they become enthusiastic and keen to learn more about the process.

The Goal of the Method

The goal of this method is to coach the feel of the water by showing swimmers how to use their sense of touch to interpret and improve stroke effectiveness. The method encompasses the following tasks:

1. Describe and explain the flow reactions that can be anticipated during each phase of a skilled swimming stroke.
2. Demonstrate and explain hand-forearm rotation and elbow bending and how these mechanisms set up the ideal flow around the hand and forearm in all the swimming strokes.
3. Demonstrate flow-shaper skills and explain how they shape ideal stroke patterns for the individual swimmer.
4. Demonstrate sensitizing procedures and explain how they can be used to simulate specific flow reactions.
5. Emphasize the importance of regular practice. Ensure constant repetition by swimmers of all the procedures outlined in the preceding tasks.

Using Appropriate Descriptions

What sensations of touch should a swimmer experience when manipulating water efficiently? How should they be described? Little thought has been given to this aspect of coaching, which is not surprising when even acknowledged stroke technicians have used such descriptions of water as "fickle substance." We have all been guilty of inadequately describing how the water should feel to a correctly stroking swimmer.

For years, one of my favorite descriptions was "Enter your hand and feel the pressure of the water on your palm. Try to make the pressure progressively harder as you drive through." Although this may have been as good a description as possible at the time, it does not describe the desired feel accurately enough in the context of existing knowledge.

A once popular and comparatively apt description of the feel of the water likened it to the feeling of pulling through soft mud. More recently, however, a "fixed point of resistance" description has become popular. (This probably resulted from biomechanical studies based on the convenient assumption of essentially still water.) To convey the concept of a force acting on a mass of water, the act of propulsion has been variously described as feeling for undisturbed water, anchoring the hand on a fixed spot in the water and pulling the body past it, pulling along an imaginary knotted rope, and other similar descriptions.

These descriptions, strictly speaking, are inappropriate because the propulsive force is not applied against a solid or rigid resistance. Coaches should use carefully chosen words when instructing a swimmer. Many of our well-worn coaching terms may not produce the reactions we desire.

Understanding the Concept of Relative Flow

A good example of a potentially misleading term is the word "catch," which has been used since the early days of swimming to describe how a swimming stroke should begin. The old idea of feeling for the catch point is incorrect, however. Fluid dynamic principles contradict the popular notion that the hand attaches to a fixed point in the water and levers the body past it. Instead, one should feel the oncoming, or relative, flow advance over the palm of the hand and along the forearm. The hand always encounters an oncoming flow of water.

The instant the fingertips enter the water there is a reacting flow that continues throughout the stroke. Like all fluids, water responds immediately to any movement through it; like all fluids, water changes shape under the action of forces. These changes are known as deformation and appear as elasticity and flow. When a swimmer propels efficiently, the flow and the elasticity of the water will be felt as a stretching effect.

Correct Manipulation of the Hand

Swimming skill is dramatically increased by learning the simple act of splitting the flow with the fingers and hand throughout the stroke. Flow separation causes different patterns of pressure to form around the hand. There is always flow from an area of high pressure to one of lower pressure in a correctly performed stroke. This causes a bound circulation of water around the hand that generates the propulsive force. All one needs to do is to continue splitting the flow to maintain this propulsive force.

The contour of the hand and the angle at which it is held while splitting the flow will affect the amount of propulsive pressure produced. This is based on sound principles of fluid dynamics. It is more efficient to split the flow with the edges (either the fingertips or sides) of the hand than to use the hand like a paddle and pull with the palm of the hand flat against the pressure resistance of the water.

When the edges of the hand are used to split or separate the flow, the hand is used as a foil, causing a fine, thin, shearing separation at the trailing edge rather than the broad, blunt, excessively turbulent separation that results from the straight backward paddle action.

To avoid pulling straight backward, the hand is moved in a slightly curved path across the line of forward progress (Counsilman 1971). Another way of describing this action is to say that the hand is moved in the lateral, or transverse, plane. (Of course, the path of the hand actually moves in three planes simultaneously, namely, the lateral, vertical, and horizontal.) By moving the hand along a curved path a swimmer will be able to tilt its leading edge slightly upward, thus creating a foil-like effect that will increase the pressure resistance on the palm of the hand. In this manner, a swimmer can feel the pressure of the flow on the palm of the hand without pulling directly backward.

Pressure Sensations Caused by Different Propulsive Mechanisms

The obvious question at this point is what the differences are in the feel of the water between using the hand as a foil and using it as a paddle. When the hand is used as a foil, pressure resistance is felt on the palm of the hand and the flow is felt on the backs of the hands and fingers, particularly on the skin over the knuckles. The water is also flowing over the palm of the hand, but its presence is felt as pressure resistance, not flow, because the water flows more slowly over the palm of the hand than over the knuckle side, thus creating an area of higher pressure. The swimmer feels this pressure instead of the flow.

When the hand is used as a paddle, the pressure resistance is also felt on the palm of the hand, but there is no sensation at all on the knuckle side because the flow separates around both edges of the hand, not one edge only (the trailing edge) as in the foil-type method. Pulling the hand like a paddle causes excessive drag turbulence on the hand and results in wasted energy when compared with the more efficient foil-type method. Obviously, the previously cited descriptions are inadequate to

convey the tactile sensations ("feel") of modern stroke mechanics.

Describing Flow Manipulation

Assuming a swimmer has been taught the function of hand-forearm rotation and elbow bending in manipulating the flow, the swimming stroke should be taught as a working sequence of "trap, wrap, and unwrap the flow." This helps relate each important phase of the stroke with the relative flow reaction. In the crawl stroke this sequence works as follows:

1. The *trap* occurs as the arm enters the water with elbow up and hand pitched diagonally outward. The swimmer feels an oncoming flow of water advance along the entire undersurface of the arm from the palm of the hand to the armpit. At this point the flow is considered to be trapped under the arm.
2. The *wrap* occurs as the flow is wrapped around the hand and forearm as they rotate inward after a short downward press. The wrap is completed when the elbow reaches maximum bend (approximately 90 degrees) and the hand has moved across under the body.
3. The *unwrap* occurs as the elbow extends and the arm straightens. At the end of the stroke the flow is finally unwrapped from the forearm and hand as the stroke rounds out past the hip joint.

The entire sequence of trap, wrap, and unwrap occurs within a fraction of a second. The swimmer is taught to think of the sequence as a very quick passage of events. Each successive phase happens with increasing speed to produce the desired stroke acceleration (Counsilman and Wasilak 1982). The precise application of the trap, wrap, unwrap concept of flow manipulation varies with each swimming stroke.

Manipulating the Flow at the Hand Entry

The way a swimmer controls the hand at entry is usually a first indication of talent. The hand entry of a talented swimmer often seems almost leisurely. The swimmer feels for the moving pressure of the oncoming flow and gradually starts to apply force against it. The hand of the talented swimmer possesses a complex sensitivity (or, more accurately, a sensibility) that almost seems to give it sight.

The talented swimmer appears to possess an innate awareness of not only the exact speed at which to enter the hand but also how to time the start of the stroke effectively. The hand neither slows to a stop out in front of the swimmer nor starts the stroke too soon, before the oncoming flow has been accepted and trapped under the arm.

The hand's first contact with the water at entry is critically important. Coaches often correct the middle part of a stroke before checking to see if the entry has been made efficiently. If the oncoming flow has not been engaged initially, there is no sense in correcting a subsequent phase of the stroke.

Anticipating the Oncoming Flow

Most faulty handling of the flow originates from incorrect technique at entry. The entry hand's forward motion into the water produces an oncoming flow. If this flow is broken up or disturbed at entry, the swimmer will have difficulty manipulating the water during the later phases of the stroke. A swimmer should know in advance the nature of the pressure sensation that will be experienced when the hand enters. In this way a swimmer can anticipate the oncoming flow and handle it effectively. The aim is to insert the hand smoothly into the oncoming flow and immediately feel the flow move along the palm and under the forearm and upper arm.

As mentioned earlier, the arm enters the water with elbow up and hand pitched diagonally outward. It is easy to imagine the hand and arm in this position as being shaped similarly to the side of a ship, which gradually slopes backward from the bow and bulges at the waist. By imagining this portion of a ship moving forward under the water, cutting the water sharply at the bow and channeling it backward around and slightly under the hull, a

swimmer will form a good concept of the function of the hand at entry: The hand, pitched diagonally outward as it enters, performs much the same function as the bow of a ship.

As stated before, the entry is the preliminary phase of the stroke—the trap phase—during which the flow is allowed to advance along the undersurface of the arm as the swimmer maneuvers it into position for the wrap phase.

Entry Errors

Unfortunately, a swimmer can easily commit several errors at the hand entry that diminish the efficiency of the stroke and cause the swimmer to muscle through the water in a futile attempt to gain purchase on it. Probably the most harmful error is to crash the hand into the entry, attempting to start the stroke before subtly accepting the oncoming flow.

The effect of this error can be understood by imagining a fast naval destroyer equipped with a guillotine-like device fixed to the bow at a right angle to the oncoming flow. At intervals, this guillotine suddenly drops into the water and disturbs the flow. The effect is to continually interrupt the vessel's forward momentum.

A similar effect, surprisingly enough, can frequently be seen in competitive swimmers—even talented world-class ones—particularly distance swimmers using an inertial type of stroke. As the stroke starts with what used to be called a *dig-pull* or *chop-catch,* the bow wave drops, or splutters, indicating sudden interference with the body's momentum.

The rationale behind the inertial type of hand entry may be based on a technique used in athletics and rowing. At the start of a stride, a runner's foot is already moving backward to maintain the runner's momentum and prevent jarring the foot on the ground. Similarly, a rower's blade travels backward before it enters the water.

If the dig-pull is based on this principle, it cannot be applied successfully to swimming. The body is not favorably positioned in the water to perform such a technique; moreover, a swimmer cannot generate sufficient speed to achieve this effect.

Detecting the Stretching Effect in the Oncoming Flow

Great emphasis and attention should be given to adequate coaching of the entry phase of the stroke. Engaging the water correctly at entry is crucial to an effective stroke. The ship drill, which will be explained presently, is designed specifically to simulate the posture of the hand and arm at entry and to teach a swimmer to feel the moving pressure sensation of the oncoming flow.

The ship drill is perhaps the most valuable drill I've ever used in coaching. It is extremely effective in helping a swimmer form a concept of the entry phase of the stroke. As proficiency in discerning the sensation of moving pressure increases, it becomes possible for a swimmer to detect the stretching effect in the oncoming flow. A swimmer learns to relate the amount of stretch in the flow with swimming speed and correct timing of the arms.

The Role of Touch in Motor Learning

Skilled swimmers create a fast output of high-quality movements. Yet even when swimming at high speed, they frequently give the impression of being unhurried. The expert seems to have all the time in the world when compared with the novice, whose forward progress is more like a series of emergencies.

In skilled performance no surprises occur. The swimmer is always ready for each changing sequence of the stroke. Exact timing is an obvious element of skill, which largely involves the predictable repetition of many successive movements in accurate and precise patterns.

How are the components of each sequence coordinated and organized? We tend to think of skill mainly in terms of movement. In describing a swimming stroke, we focus on what is done. The analysis usually breaks the action down into detailed units of movement. This represents the swimmer's output, but we tend to ignore the input, partly because it is taken for granted and partly because it is difficult or impossible to observe directly.

I have often witnessed over an hour of stroke instruction without hearing any reference to the water or what a swimmer should feel. Many otherwise excellent technical articles make little or no reference to the water. Most descriptions of swimming technique neglect to mention the role played by the water, the very medium in which the activity takes place.

Many highly skilled swimmers cannot explain why they perform as they do. They may be unaware of the particular sensory input that controls their activity, which may be why a skilled swimmer is not always a particularly good teacher. Usually, a skill is taught by demonstrating how the desired movement should look rather than by explaining how it should feel.

The more purposeful or skilled the movement, the more it depends on sensory impulses, which in swimming are primarily those associated with vision and touch. In learning the more precise movements of swimming, visual information is essential while the degree of muscle tension and amount of muscle contraction are being delicately adjusted to the task, a point we easily appreciate if we try to learn any precise movement with eyes shut.

Voluntary movements are modified by sensory stimuli received from the skin, muscles, and joints. Sensory impulses act at all times to guide muscular contractions. The muscles are under the direct and perfect control of the motor neurons; these neurons never stimulate the muscles to action except when influenced to do so by other neurons.

Water pressure on the sensory nerve endings, the sense of balance, and the relationship of the limbs help to produce a smoothly coordinated stroke. Attention may be divided between different kinds of sensory messages. Confronted with a mass of available information, a swimmer learns to notice only some of it and ignore much that is irrelevant to the immediate task. Via the process of facilitation at the synapses, repetition causes special pathways to be slowly laid down so that the skilled movements become more accurate.

Muscular movements are driven by a servomechanism similar in many respects to the automated feedback systems used in modern aircraft to control various mechanisms. All these mechanisms have devices (sensors, we may call them) that measure some physical variable and use this feedback information to control the mechanisms that assist the pilot.

Modern aircraft controls are linked by servomechanisms to either electric or hydraulic actuators that automatically maintain the aircraft at the chosen altitude and speed. Servomechanisms sense an error (e.g., departure from the intended course) and apply a correction to the relevant control. Signals from the sensor, called the misalignment detector, activate a small servomotor (from the Latin *servus,* meaning slave), which turns the control surface in the direction necessary to correct the misalignment. Thus, the procedures are performed without the pilot's intervention.

The point is that these devices function automatically to help the pilot. Similarly, in coaching the feel of the water, the aim is to allow a swimmer to rely on only a minimum number of consciously perceived cues and let automatic feedback systems control other functions of the stroke without too much conscious effort.

The Use of Simultaneous Visual and Tactile Impressions

The traditional emphasis when teaching a stroke pattern to a novice has been on the visual. I, too, long believed that the sense of touch was usually too imprecise to be the source of form and shape in the early stages of learning. Furthermore, though some people learn more by means of tactile feedback whereas others receive more beneficial information visually, it is difficult to know whether this difference in perceptual capacity among individuals is significant.

Over a period of about six years, I experimented with developing a method of coaching stroke technique that would involve using simultaneous visual and tactile impressions. I had long before become uncomfortable with merely explaining the shape, form, and pattern of a desired movement without being able to relate its effect on the water. The aim of my method is to teach a swimmer to relate each

phase of a swimming stroke with the feel of the flow and thus obtain instant feedback on stroke efficiency.

This method allows a certain amount of individuality. At first, the learner is shown a few sample flow-shaper skills and left alone to play around with them in the water.

After a week or so, some instruction is begun, usually individual. Not everyone is given the same instruction because each learner is directed to a particular phase of the stroke that appears to need attention. This is generally how the method is applied—not so much on items of technique but on particular movement phases of the stroke.

Using visual and tactile impressions simultaneously from the start in a definite teaching format causes noted changes in the sensitivity of the learner to particular features of the swimming stroke and its effect on the water.

Tactile perception can be developed to where a swimmer can receive continuous feedback on propulsive effectiveness. This information helps the swimmer to keep adjusting and refining the stroke at the delivery end to maintain efficiency. For example, the link between seeing the hand entering the water and bringing the hand into contact with it is somehow obvious. The hand just seems to move in the right way. If the swimmer's hand is alive and sensitive to the feel of the water, it acts as a sensing device that transforms the incoming signal into appropriate action. Equally important is that the swimmer has been taught not only to anticipate the oncoming relative flow but also to handle it in the most effective way.

The following sections contain descriptions of the flow-shaping skills and sensitizing techniques used in this conceptualizing process.

Flow Shapers

A flow shaper is an exercise that teaches swimmers to create and detect specific flows in the water. It operates in much the same way as the aircraft servomechanisms already described.

Flow shapers are remarkably effective in helping a swimmer automatically find the most effective path, posture, and attitude of the hand and arm during a swimming stroke; for example, they help the swimmer position the arm correctly at entry, correct a dropped elbow, or, for a butterfly swimmer, know whether to pull wider or narrower. Most important, the flow shaper helps a swimmer find the stroke pattern that accords naturally with the characteristics of individual physique. Some examples of flow shapers follow.

The Ship Drill

This important exercise teaches swimmers how to insert their hands into the oncoming flow prior to starting the swimming stroke. The swimmer pushes off from the wall with body outstretched and hands back to back and touching, forming a shape akin to the prow of a ship. The swimmer will feel the oncoming flow produced by the pushoff as it advances along the palms of the hands and under the forearms and upper arms to the armpits. The pressure sensation of the oncoming flow can be prolonged by continuing momentum with the dolphin kick or by using fins (figure 6.1).

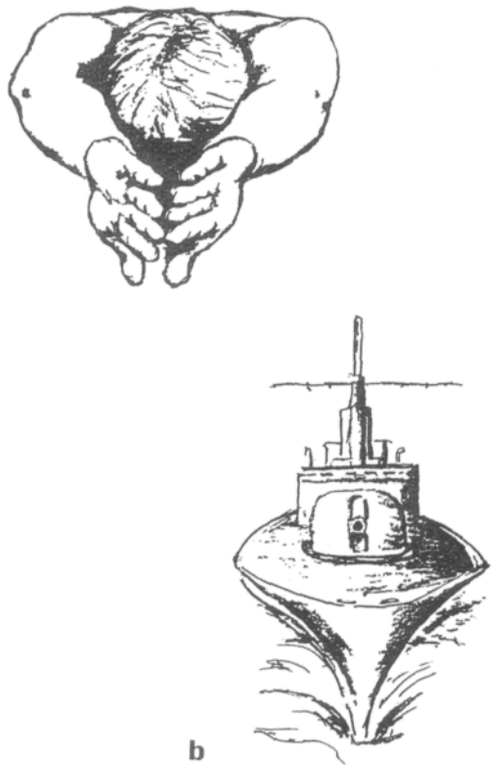


Figure 6.1 The ship drill: *(a)* ship drill posture and *(b)* action of the ship's prow.

The ship drill should be performed daily. It is more valuable than any other procedure in teaching a swimmer to feel and recognize the oncoming flow.

Beginning in the ship-drill position, the freestyle stroke should be started with elbow up, palm turned outward and pressing downward in a curved, diagonal motion. The palm gradually rotates inward as the hand moves inward in the lateral plane toward the center line of the body. During this motion the hand and forearm rotate as a unit. This motion changes the direction of the oncoming flow as it is wrapped around the hand and forearm in a strong swirl.

The swimmer should concentrate on bending the elbow to approximately 90 degrees or as much as feels comfortable. As the elbow bend increases, some swimmers may turn the palm of the hand slightly upward toward the chest to obtain maximum forearm rotation, but such extreme rotation may feel comfortable only to tall, lean swimmers.

Destroyer–Ocean Liner–Barge Drill

Practice ship drills with hands in the three different positions shown in figure 6.2. These drills show swimmers how the changing postures of the hands and arms cause a transition from streamlined flow to turbulent (resistive) flow. In figure 6.2a there is a free movement of the oncoming flow felt on the palms of the out-turned hands and along the forearms. In figures 6.2b and 6.2c, the flow gradually becomes more resistive as the hand and forearm posture changes.

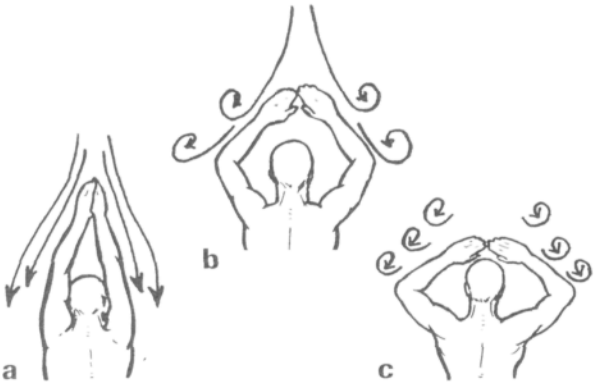


Figure 6.2 Ship drill variations: *(a)* destroyer; *(b)* ocean liner; *(c)* barge.

Half-Ship Drill

Use this drill to enhance feel of the flow at hand entry, especially for swimmers who experience difficulty in feeling the flow. The swimmer kicks while wearing fins and holding one arm out front simulating the entry posture. The hand should be pitched diagonally outward and the elbow up; the other arm is held at the side. The swimmer should feel for the oncoming flow.

Tunnel Flow, or A-OK

Press the thumb against the forefinger to form a tunnel through which the flow is channeled as the hand changes direction in the stroke (figure 6.3). This exercise effectively teaches flow recognition and how to angle the hands efficiently; in fact, it often will groove a stroke pattern automatically. If a butterfly swimmer's pull is too wide or narrow, for example, this exercise will direct the swimmer accordingly.

Figure 6.3 Tunnel flow, or A-OK.

This exercise also indicates if a crawl swimmer is allowing the elbow to drop during the pull because, if so, the flow will not pass through the tunnel. In fact, this drill should be used in all strokes. Swimmers may try forming the tunnel with one hand while keeping the other hand closed. When both hands are opened and used in the normal fashion, however, the hand that was closed will be found also to have improved its feel.

Piano Playing

In this exercise the swimmer pretends to play the piano by using individual finger movements while swimming. This helps the swimmer feel how separate finger movements influence flow channeling (figure 6.4).

Figure 6.4 Piano playing.

Sensitizing the Sensory Nerve Endings

In developing this method I soon realized that there's no difficulty in increasing the sensibility of the nerve endings. There are many methods to achieve this, including the rehabilitative techniques used after hand surgery, the touch method for learning to type, and the methods used to learn to read Braille. The heightened tactile sensibility must be related to the various sequences of the swimming stroke, however. The swimmer should be able to recognize and interpret the feel of moving pressure against the hand and forearm during every phase of the swimming stroke.

A vast literature exists on the complex neurological functions of the human hand, which, as we know, is a truly remarkable instrument. Because of the complexity of the subject, I decided to concentrate on a few aspects that I thought most germane to my purpose. I found the experiments of A. Lee Dellon (Dellon, Curtis, and Edgerton 1974) particularly valuable. As late as 1972, Dellon showed that the sense of touch could be divided into two main areas: moving (transient) touch and constant (or static) touch.

Using this distinction, I experimented with sensitizing techniques for swimming that alternate the application of transient and static pressures. I found that such techniques as applying different pressures (including static and transient pressures), rubbing the hands and forearms in the desired flow directions, using a loofah as a sensitizing device, and several other procedures quickly stimulated the sensory nerve endings.

Interestingly, sensitivity to the water appears to decrease as a workout progresses, even for talented swimmers. There also appear to be day-to-day variations. I can only guess at the reason for this—perhaps fatigue or overstimulation of the sensory nerve endings.

Although swimmers have little or no difficulty in learning to recognize the oncoming (distal) flow at hand entry, some encounter difficulty in recognizing the subsequent flows (radial, ulnar, and proximal) set up by the hand and forearm as they move through the swimming stroke. This can be overcome by teaching swimmers to rub the hand and forearm in the direction of the appropriate flow.

I borrowed from the biomechanists another very effective procedure. Instead of videotaping swimmers underwater *after* they have learned their stroke mechanics, I videotape them *while* they are learning. Instead of the old method of practicing on land in front of a mirror, they practice—still on land—in front of video monitors while they are being videotaped simultaneously from front and side. Three large electric fans (kept well away from the water for safety) are placed around the swimmer to simulate the reacting flows of the water that occur during the various stages of the swimming stroke. Should a swimmer have difficulty in sensing the flow, the palm of the hand and forearm are wiped with a damp cloth to heighten the sense of touch.

A swimmer can thus simultaneously see front and side views of the stroke on the monitors and feel a simulation of the reacting flow. In addition, the swimmer can receive instruction while this is happening. The three stages of visualize, verbalize, and feel (Counsilman 1968) can occur almost simultaneously.

Sensitizing procedures dramatically enhance a swimmer's feel of the water and should be an everyday feature of the workout. Great emphasis should be placed on sensitizing the hands to the feel of the water, and the hands should remain sensitized throughout the workout. When questioned, even talented swimmers admit that their feel of the water tends to diminish as they progress through a workout, however. Whenever sensitivity to the water seems to lessen, a swimmer should resensitize the hands so that the sense of touch becomes more acute as the workout continues.

Fist Clenching

The nerve endings on the palms quickly become highly sensitized when subjected to contrasts between static and transient pressures. Thus, if a swimmer clenches the fists tightly for two or three minutes before starting a swim, the sensory nerve endings overcompensate in reaction to the static pressure. When the hands are opened again, they are particularly sensitive to the pressure of the moving flow.

Swimmers should sensitize the hands at the beginning of every workout by swimming the first 200 meters with their fists tightly clenched. Because they will feel that they are slipping the water, they should pull a little more slowly while doing this exercise, concentrating on keeping tightly clenched fists. The swimmer should start the stroke with wrist turned outward, thumb down, and emphasize hand-forearm rotation throughout the stroke while bending the elbow to approximately 90 degrees in midstroke.

Fist swimming was named by the great stroke technician Howard Firby. Firby recommended fist swimming to develop "the feel of pulling not only with the hands but with the forearms as well" and to correct dropped elbows and induce the "over the barrel" feeling of the pull (Firby 1975, page 15).

My rediscovery of fist swimming resulted from reading Dellon's reports and from my desire to develop as a sensitizing procedure a method of applying contrasting static and transient pressures on the sensory nerve endings of the hand. Clenching and then opening the hand was a natural choice. I also use fist swimming to show how hand-forearm rotation develops flow circulation. My personal belief, however, is that the greatest value of fist swimming is as a sensitizing procedure for stimulating the sensory nerve endings of the palms of the hands.

An effective exercise for sensitizing the hands and feet is to swim a set distance by alternating fist swimming and overkicking (kicking with more force than necessary) on successive laps of the pool. This can also be a demanding workout. Another variation is to swim with one hand clenched while keeping the other hand open. This contrasts the static pressure on the closed hand with the transient pressure on the open hand, increasing the swimmer's awareness of the water's flow reactions.

The breaststroke and butterfly should frequently be swum with fists clenched. While pulling in the breaststroke, the swimmer should use a slight dolphin kick for counterbalance. Emphasis should be on hand-forearm rotation and elbow bending because this action develops the flow circulation necessary for propulsion. This drill highlights the surprising amount of propulsion this mechanism can develop even when the hands are not open to provide as much propulsion as possible. Although the forearms do not provide a great amount of propulsion, their rotation is necessary and significant in setting up the desired flow circulation. When the hand is open, the hand and forearm work as a unit. The hand is capable of developing more efficient circulation than the forearm because it has a more favorable shape and can be manipulated on the wrist with more dexterity and through a larger range of movement. When the hand and forearm are used as a unit, they form a most effective mechanism for setting up flow circulation.

Fingertip Pressing

These exercises sensitize the fingertips to the oncoming flow as the hands enter the water.

1. Press each fingertip in turn against the thumb (figure 6.5).
2. Now use both hands. Press the fingertips of one hand against those of the other. Press hard and repeat frequently.

3. Now press each fingertip of one hand separately against its counterpart on the other hand. This develops dexterity.
4. Press the fingertips hard against the pool deck while waiting for the start of next training set.

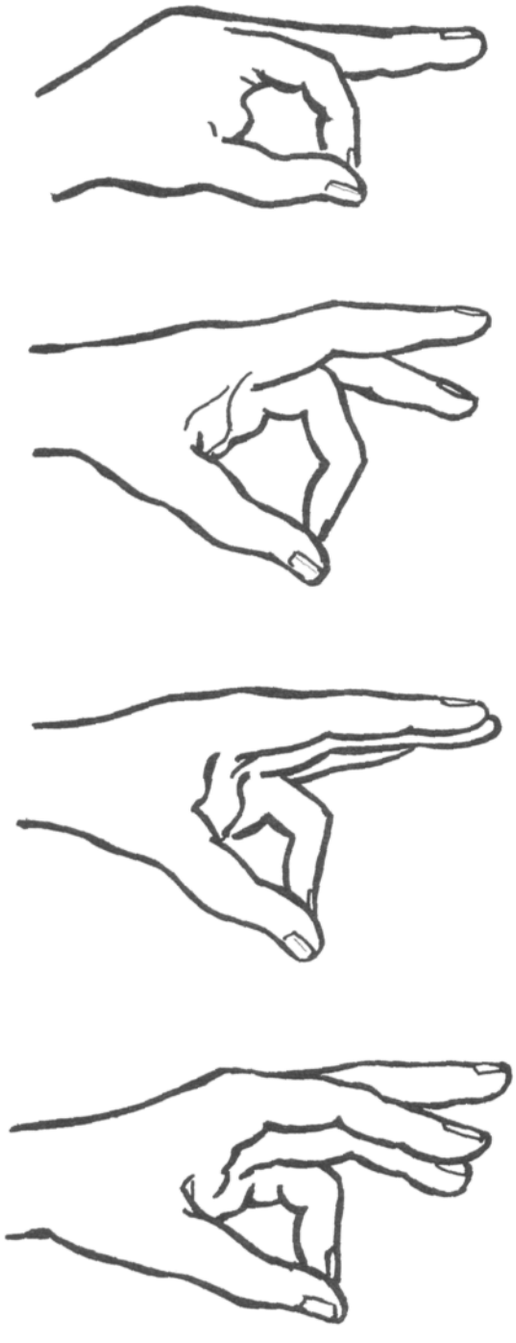


Figure 6.5 Fingertip pressing.

Simultaneous Sensitization to Static and Transient Pressure

The hand can be held in a variety of postures during swimming to sensitize fingers, individually or in groups, to the sensation of moving pressure. Keeping the palm closed sensitizes it via static pressure. These exercises greatly sensitize the hands to the feeling of moving pressure once normal swimming is resumed (figure 6.6).

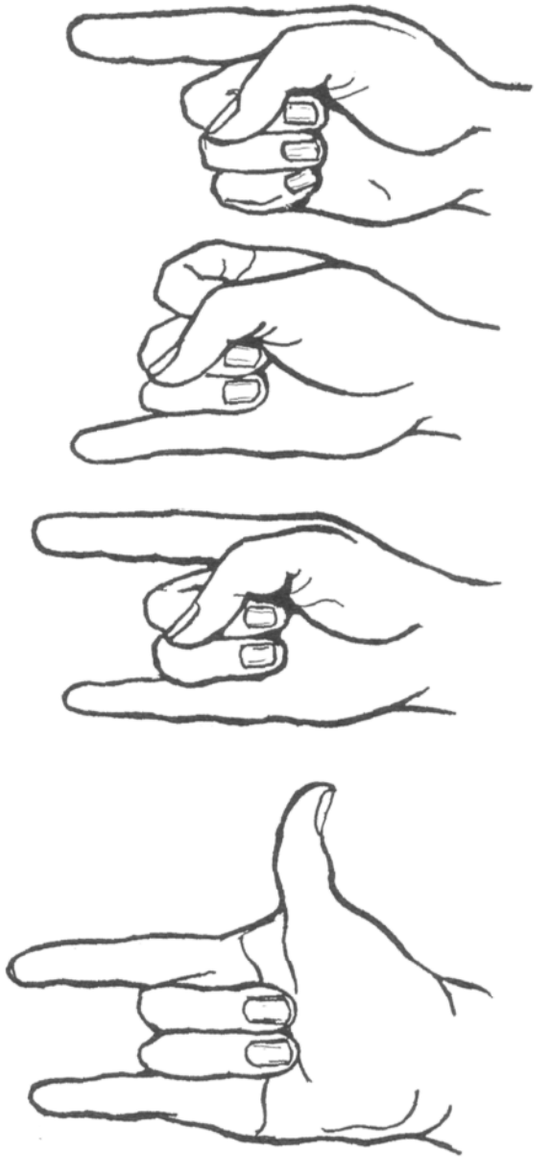


Figure 6.6 Simultaneous sensitization to static and transient pressure.

Hand-Rubbing Exercises

Swimmers find hand-rubbing exercises very effective in sensitizing the hands to recognize precise flow reactions. Rubbing one hand against the other can simulate a desired flow direction, which helps make each phase of the stroke consistently efficient.

1. Rub one hand against the other from the fingertips along the palm to the wrist and forearm. This teaches the feel of the oncoming flow as the hand enters the water and is inserted into the oncoming flow at the start of the stroke.
2. Rub one hand across the other hand in the desired direction to simulate transverse (lateral) flows as they occur in either an inward or outward pitch of the hands.
3. Rub one hand along the other down the palm to the fingertips to simulate the finish of the stroke.

The Use of a Loofah as a Sensitizing Device

A highly effective method of sensitizing the entire body to the flow of the water is to scrub the skin lightly with a dry loofah immediately before every practice or competition. (A loofah, or luffa, resembles an elongated sponge and is coarse and fibrous. It is the fruit of a herbaceous plant, *luffa cylindrica*.) The swimmer should scrub the entire body and, in particular, perform a routine in which one arm is held overhead while the loofah is rubbed from the fingertips down the palm of the hand, along the undersurface of the arm, and down the side of the trunk to the hips; the procedure should be repeated on the other side of the body. This exercise will sensitize the hand, arm, and trunk side to the oncoming flow of the water. After several days of using a loofah this way, most swimmers experience a noted improvement in their sensitivity to the flow of the water.

Daily Application of the Method

In applying the method to daily practice, focus on three areas: flow manipulation, stroke timing, and flow-shaper drills and sensitization.

For flow manipulation, swimmers should be taught always to feel they are inserting the hands into the oncoming flow instead of attacking the water and trying to push it directly backward. After feeling the oncoming flow, swimmers should be told to wrap, or swirl, the flow around the arm by gradually rotating the hand and forearm. The elbow at maximum bend should reach approximately 90 degrees and be comfortable to the swimmer; if it is not comfortable, adjust the amount of elbow bend to suit the swimmer.

After some practice, swimmers will improve in stroke efficiency and be able to recognize weak spots in the stroke through tactile feedback from the flow reaction. They can eliminate weak spots by experimenting with the amount of hand-forearm rotation and the degree of elbow bend they perform.

The timing of the stroke depends greatly on the desired speed. Swimmers should be told that the entry hand, palm turned outward, acts as a sensor, or radar, as it accepts the oncoming relative flow and helps them know exactly when to start applying force at the beginning of the stroke. The amount of oncoming flow to accept before starting the stroke depends on the pace and stroke length each swimmer wishes to establish.

Feeling the differences in pressure on the entry hand at various speeds helps the swimmers learn pacing. Feeling the oncoming flow is an important element in learning split-second timing. The swimmers should be taught to think momentum. By feeling the amount of stretch in the flow, each swimmer learns to judge the body's momentum and know when to start the stroke. For example, in a short race, the stroke may be started after allowing the flow to move along only as far as the wrist. Over a longer distance and at a slower speed, a swimmer may let the oncoming flow move along the forearm before starting into the stroke.

Swimmers should do flow-shaper drills and sensitizing procedures every day as part of the regular workout. Fist swimming should be done in all strokes at slow and fast speeds. Swimmers should always start the stroke with the hand turned outward. The fists should be tightly clenched throughout. Fist swimming in the breaststroke and butterfly is particularly effective for coaching effective hand-forearm rotation and elbow flexion and also has a positive transfer to the other strokes.

Swimmers should be aware that sensitivity to flow will vary from day to day. Every workout should start with skin sensitization—hand rubbing, the use of a loofah, fist swimming, tunnel flow (A-OK), and fingertip-pressing exercises. Every now and then during the workout, swimmers should push off from the pool side using the ship-drill posture instead of the conventional locked hands. These occasional ship pushoffs enable swimmers to test hand sensitivity to the pressure of the oncoming flow.

Swimmers should resensitize their hands during the workout, especially during the middle stages of the workout or at the onset of fatigue. If this is done, swimmers will complete the workout with a greater feel for the water. The coach should not permit swimmers to regard these procedures as a passing fad because over the weeks and months, most swimmers will experience a pronounced improvement in technique resulting from their enhanced ability to feel and manipulate the flow of the water.