Chapter I

Surfboard Evolution

Evolution in surfboard design is a continuous process of changing and modifying current shapes and ideas to create new performance characteristics. Many thanks go to individuals who experiment with unorthodox shapes and attempt to refine current shapes. Without these people the surfboard would be a very static and stagnant subject, and surfing itself would lose much of its charm for newness and variety of experience.

A look at the past history of present shapes will show how performance has been the ultimate criteria for a surfboard. In the early 1960's, surfboards began to grow shorter. The introduction of the Vee-bottom surfboard increased manuverability. Twin-fin surfboards further expanded manuverability. Then there were short mini-guns with hard turned down rails for speed. Considerable work in refining the round tail and square tail surfboards with the egg rail led to short multi-purpose performance surfboards that worked well in all kinds of surf.

Early 1970 produced a spin off shape from a kneeboard that was called the fish. Which at the time was an odd looking twin-fin surfboard with a notch cut out of its tail. This shape evolved into the currently popular swallow tail. The fish still remains as a unique entity in its own right because of its speed and manuverability on certain kinds of waves.

Today in the mid 1970's there is literally a profusion of new shapes being developed by individuals, that offer a great variety of ideas a designer can choose to work with to learn his trade or develop his art form, whichever the case may be.

Sometimes radical new ideas lead to creating completely new and different types of surfboards. Whatever the reason for a surfboard shape to come into being, it usually comes from three sources.

1. Previous shapes
2. Fluid dynamic theory
3. Pure imagination

It does not really matter where ideas come from, whether they work or not is what counts. Serious attention to surfboard design has only been going on for a little more than 10 years. Hardly enough time to evolve into a highly technical art like that of aerodynamics or ship building, but it is becoming more so each year.

What is presented here is a system approach toward this evolution. The method is rather easy to understand. Following through on it is a bit more work than simply making a surfboard with an approximate desired shape, but the results should prove to be well worth the effort.

There are five phases involved in arriving at a refined surfboard. Each phase is related to the next to create a continuous circle of development.

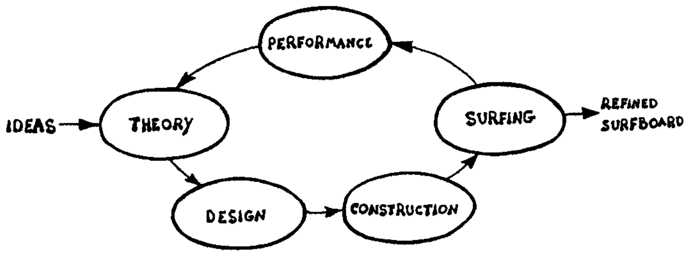


FIG. 1-1 SURFBOARD REFINEMENT

What makes a surfboard function seems to be a mysterious, undefinable thing in the minds of many surfers. Each has his own ideas flavored by past surfboards he has ridden. He has become familiar with shapes from experience gained in repeated riding of particular shapes. Some surfboards he could ride well and others be encountered difficulty. I hazzard to guess that certain shapes are going unexplored because of reluctance on the average surfer's part to change his "style" to allow a surfboard to perform.

The final test of a surfboard is how well it works in the water. Improvement in a particular surfboard comes through understanding deficiencies in its design, and building another surfboard like it with added modifications to correct these deficiencies. To do this the designer must be able to build two surfboards that are functionally identical, otherwise the added modifications become meaningless and building an effective surfboard becomes a matter of chance.

It is a general assumption that an optimum surfboard should be of minimum weight, and that means that control, stability, and performance are more a result of a surfboard's shape. Sometime in the future, a way may be developed to make surfboards much lighter than the 8 to 10 pound minimum possible today. When that time comes, shapes will be undergoing major changes to effectively utilize new and unknown possibilities opened up by extremely light surfboards. It is hard to imagine what would be possible with a 4 pound surfboard, not to mention what is would look like. It would also very likely place new demands on a surfer's ability to ride it. So we can see the importance of careful shaping and design with desired performance characteristics in mind.

Surfboard shapes should be compared with each other. There is no easy way to clearly define how fast a surfboard can move across a wave, how fast it can turn, or how stable it is to ride. Its ability to do these things is made clear by comparing it with other surfboards. This means surfing two or more surfboards on the same day, in the same waves, attempting the same manuevers, and sensing by direct experience which seems to work better. Not to say that this or that surfboard is good, but to say that this surfboard makes doing a particular manuever easier, faster or more controlled.

Analyzing the performance will tend to reinforce or change current surfboard theory and ideas of what makes a surfboard work. Changes in theory will be reflected in new designs and refinement of established shapes.

To some people the endless circle of development may be seen as a cycle that repeats itself and not particularly worthy of so much attention. They are simply satisfied with the surfboard they are currently using. But for some reason, when another surfboard comes along that enhances their experience of surfing, there is no question in their mind. They just have to ride that new shape. That to me, is a part of what surfing is all about.

Chapter 2

Surfboard Dynamics

A basic law of fluid dynamics says that whenever the velocity of water is changed in either direction or magnitude, a force is required. By the law of action and reaction from Sir Isaac Newton, an equal and opposite force is exerted by the water upon the surfboard producing the change. So anytime the surfboard diverts the flow of water, there are some forces at work somewhere on the surfboard.

In a typical ride, the surfer drops into the wave going straight off, drives straight to the bottom and punches a full turn that curves back onto the face. With the speed and momentum acquired from the drop, he flies across the face out onto the shoulder. He then banks off the face of the wave, reversing direction and drives back toward the bottom again. By this time the wave is starting to get hot, so he turns on the face in time to lock himself under the lip that is throwing out top to bottom. When the wave backs off a bit, the surfer seizes this opportunity to pull out over the feathering lip before hitting the inside bar where the whole wave closes out.

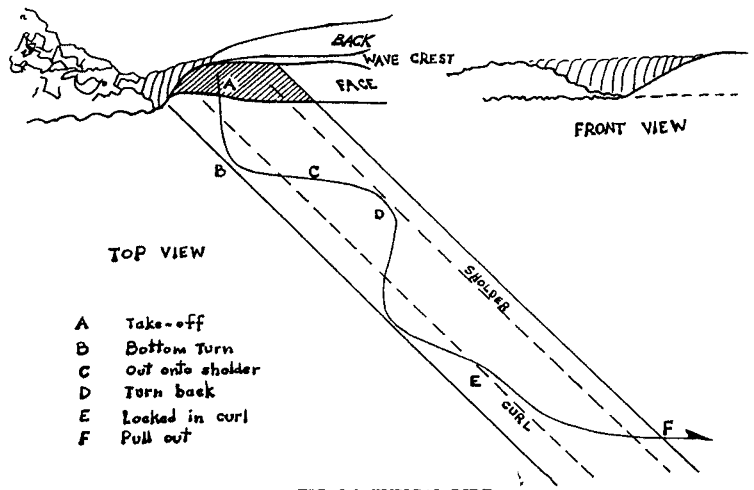


FIG. 2-1 TYPICAL RIDE

The path of the surfboard on the water can be seen in a top view of this ride. In Figure 2-1, the shaded area is the face of the wave ahead of the curl where the surfboard can ride the wave. The path of this shaded area, the surfable area of the wave, is assumed to move along the extended lines for the curl and shoulder.

The water surface and available energy in the wave is usually in a continuous state of change. You can see from the top view of the surfboard's path, that the angle it moves with the wave is also changing. The position and velocity of the surfboard in the water making up the wave, determines the resultant force acting on it. The resultant force is the total of all the separate forces acting on the surfboard.

FORCES AT WORK

General forces acting on the surfboard are:

- weight of surfer
- weight of surfboard
- buoyant force
- orbital force
- water inertia
- force on the fin
- surface drag
- shape drag

A description of each of these forces is as follows.

WEIGHT OF SURFER – A force due to the surfer standing on the surfboard is usually straight down.

The surfer's effective force on the board is not always equal to his weight. He can change this force temporarily by raising or lowering his body as he supports himself on the surfboard.

If he is in a crouched position and suddenly stands up, his effective weight will increase due to the extra force required to raise his body up. If he changes from a standing position to a crouch, the force will decrease temporarily. The force becomes equal to his body weight when he stops moving up or down.

The weight force will deviate from his actual weight depending upon the rate at which he raises or lowers himself.

For example if he takes ½ second to rise to his full height from a crouch, his effective weight will temporarily increase about 25%. This is often refered to as weighting and unweighting.

Effective weight will appear to increase during a hard turn due to centripetal force.

In dropping down the face of a wave his effective weight will be less. If both board and surfer are free-falling, the force is practically zero, but soon to change on impact at the bottom.

WEIGHT OF SURFBOARD – This force is straight down and passes through the center of mass of the surfboard.

BUOYANT FORCE – The water exerts an upward force on the submerged part of the surfboard which is equal to the weight of water originally occupying the volume displaced by the surfboard. The line of action of the force passes through the original center of volume of the displaced water. The buoyant force is always perpendicular to the water surface.

ORBITAL FORCE – Water particles tracing out eliptical orbits in the wave will exert a force perpendicular to any surface that gets in their path. Force increases with particle velocity relative to the surfboard.

WATER INERTIA – A moving surfboard experiences a force on its bottom by onrushing water being deflected underneath the board. It results from the effective inertia of the water, or more correctly, the momentum of the water relative to the surfboard. This is often refered to as the "planing effect", when a surfboard rises up out of the water as the surfboard velocity increases. This force acts perpendicular to the surfboard's surfaces.

FORCE OF THE FIN – Generally, this is a resultant of two forces acting perpendicular to each side of the fin. Direction of the force depends upon which surface is presented to the onrushing water. The magnitude of the force depends upon the projected area of the fin in the direction of the onrushing water, the fin being similar to the rudder on a boat.

SURFACE DRAG – Friction due to wetted surface area moving parallel to the water is surface drag. It is proportional to the surfboard velocity and the wetted surface area. The water viscosity produces resistance by sliding fluid layers, one upon another near the surface. Direction of this force is along the surface in the direction of water flow.

SHAPE DRAG – Flow characteristics around the surface contour of the surfboard also inhibits movement due to redistribution of water, creating wakes resulting in loss of energy to the water.

To analyze these forces, the surfboard can be looked at in certain positions on the wave.

Conclusions can be drawn about the control the surfer has over these forces. The first step is to look at the wave itself.

THE WAVE

The nature of an ocean wave is simply particles of water rising and falling as the wave passes over the surface of the water. Up until the wave begins to break, the water is rising up the face and dropping down the back. When the wave breaks, the water is falling over itself down the front. The manner in which this takes place is not as simple as it sounds.

Figure 2-2 shows the path of movement a single water particle will follow as a wave moves to the right in the drawing. Each water particle actually traces

out a near circular orbit as the wave passes by. The particle begins moving slowly at first, increasing its velocity as it nears the crest. Maximum velocity is at the crest. It then slows down again on the back part of the wave, coming to rest after the wave has passed.

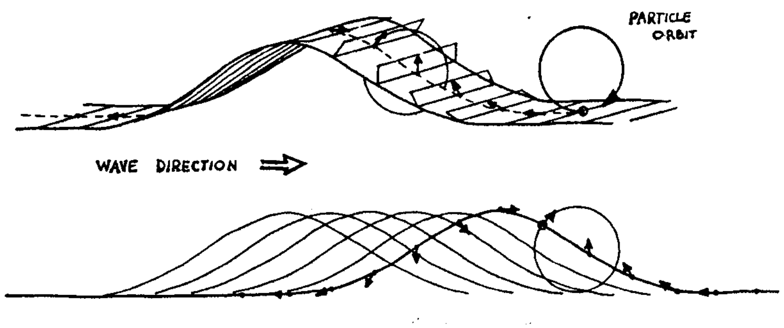


FIG. 2-2 PARTICLE MOVEMENT IN AN OCEAN WAVE

In the lower drawing, the wave has moved forward so that the particle is on the wave face, having traced out part of its orbit and moving upward and forward about equally. All the arrows represent the direction of movement of similar water particles on the surface. Below the surface other particles are tracing out similar orbits, creating waves of constant pressure below the surface, that are similar in contour to the wave on the surface. This seems obviously necessary to completely fill the wave with water. These drawings apply to waves that are not necessarily approaching a shore line or preparing to break.

Any object that gets in the path of these particules will experience a force on it by the particles trying to continue in their orbital path. The force is proportional to the velocity and mass of the particles involved. In general, the faster these particles move the more powerful the wave. This force is in addition to the normal buoyance force due to pressure that is exerted on a submerged body.

As the wave moves into shallow water the circular orbits become eliptical and the partical velocity at the crest increases with wave height. The wave becomes steeper and increasingly unstable.

When not enough water is available in the shallower water ahead of the wave to maintain these orbits, the onrushing crest will spill over onto the wave face creating, hopefully, a nice hollow tube as the wave breaks.

Water of the broken wave continues forward in a confused mass of bubbles plowing into anything that gets in the way. A final rush at the end of a long trip.

This discussion of orbits is presented to show that in an unbroken wave there is water moving along with the wave that can push against a surfboard.

It also points out a way to artificially control the way a wave breaks by simply controlling the amount of water the wave uses to maintain its orbits.

CATCHING A WAVE

To catch a wave on a surfboard you have to get energy from the wave to overcome drag forces limiting movement of the board and surfer through the water. That energy comes primarily from the buoyant force of the moving wave face and the weight of the surfboard and surfer. These two forces add together resulting in a forward force of the surfboard. When this forward force is greater than the drag, the surfer will catch the wave.

In most cases, the wave is not able to provide a forward force great enough to provide enough acceleration for the surfer and surfboard to increase their velocity sufficiently to match that of the wave, the surfer has to create some movement of his own by paddling ahead of the wave so the buoyant force from the wave can take over the work of propulsion at the moment the wave passes beneath.

A buoyant force always acts perpendicular to the water surface. The weight of the surfer and surfboard is straight down. Before the wave arrives, the buoyant force is vertical matching the surfer's weight. As the wave passes underneath, the buoyant force begins to point away from vertical toward the direction of the wave movement, always being perpendicular to the surface of the water, in this case the increasing steepness of the wave face.

The amount of buoyant force required by the surfer to catch the wave depends upon the force required to overcome drag and provide enough acceleration to increase the speed attained by the surfer's paddling to match the speed of the advancing wave.

Smaller boards have to catch waves in the steeper part of a wave because they need more buoyant force pointed in the direction of movement.

Drag and buoyant forces change drastically after the wave is caught. The surfer stands up on the board, removing the drag of his body in the water, and the board comes up out of the water, tending to plane on the surface. The surfer's weight is now supported in part by buoyancy and in part by water inertia.

In surfing the wave, the buoyant force generally has to be greater than the drag forces on the surfboard, otherwise the surfer could not stay in the wave.

There are a few common instances in which the buoyant force may become very small compared to the drag. One such situation is when the board races out in front of the wave, planing on the water ahead of the wave face. Support of the surfers' weight is primarily due to planing on the surface. All the forward forces on the board went into increasing momentum. Velocity increases to a maximum and then decreases as the drag forces take over.

To continue surfing the wave, a turn must be made to put the board back onto the wave face with sufficient speed to utilize some more available buoyant force, which is pointed in the direction of the wave movement.

GOING STRAIGHT OFF

When the surfboard is moving in the same direction as the advancing wave face, it is either moving down the face, remaining in the same position on the face, or moving up the face.

The surfboard remaining on the face has all the forces acting on it cancelling each other out and the surfboard is moving at the constant wave velocity. The forward forces are balanced by the drag forces. The buoyant force always is perpendicular to the wave face, so the horizontal component is pushing the surfboard forward.

Assuming that the wave has some size, meaning that the surfboard is not so big that it extends out into the water ahead of the wave, the surfboard will be approximately level. The plane of the surfboard will be close to horizontal. (The plane of the surfboard is an imaginary plane that would be parallel to the bottom of a flat bottomed surfboard.)

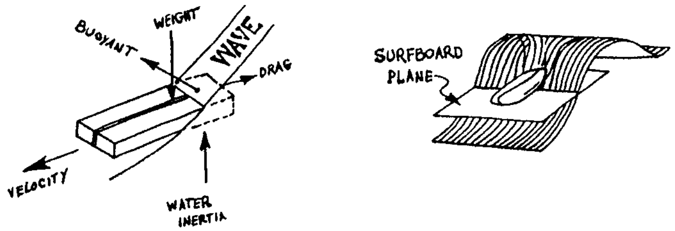


FIG. 2-3 PLANE OF THE SURFBOARD

If the surfer moves his weight forward the surfboard will rotate in a vertical plane lowering the nose in relation to the tail, tending to streamline the surfboard more with the wave face. The surfboard will increase its velocity and begin to slide down the face, eventually moving out ahead of the wave.

Moving his weight backward on the surfboard will do just the opposite, causing the surfboard to slow down and move up the face.

The surfboard has a strong tendency to move in a direction that lies in the imaginary plane of the surfboard. What is meant by this is that if the surfboard plane is horizontal, the surfboard will try to move horizontally through space. To present this graphically in an ideal situation the cut-away view below shows how a surfboard tends to climb up the face as the wave advances. This view shows the plane of the surfboard as an edge.

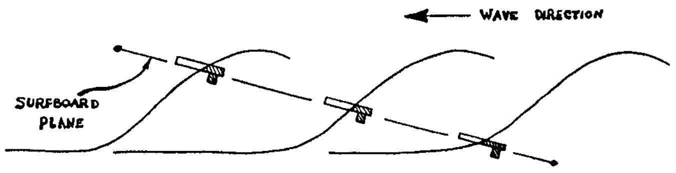


FIG. 2-4 SURFBOARD MOVING IN ITS PLANE

When coming down the face there is water displacement underneath the surfboard. The exception being when the surfboard is planing on the surface.

This water displacement is extra drag limiting maximum velocity. The surfboard is mushing through the water. Insufficient surface area exists on the bottom to utilize water inertia forces to point the surfboard in the direction it is moving.

Boards with different bottom rocker will have different effects on water flow. Figure 2-5 shows a few examples of different bottom rockers.

In most cases a small amount of rocker lift, or kick, in the tail will make turning easier. This is often done at the expense of some added drag that goes unnoticed by the surfer. The same sort of drag exists with a vee placed in the tail. Here again the vee is kept very slight and is usually only around or behind the fin.

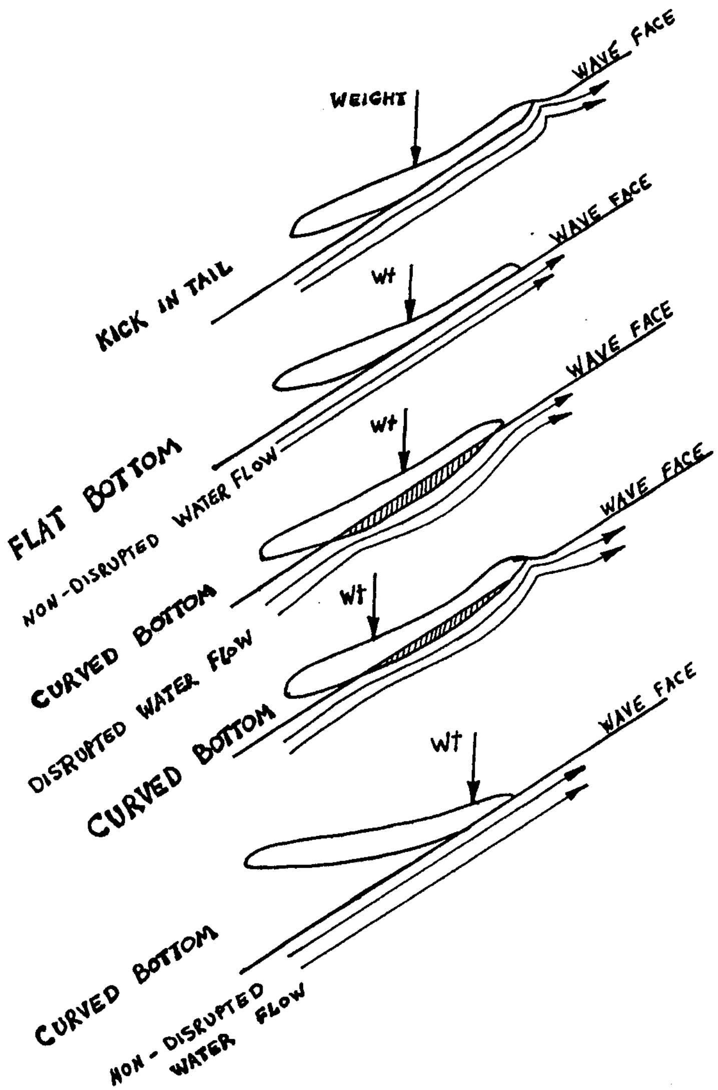


FIG. 2-5 BOTTOM ROCKER

Boards with a large bottom curve generally do not work well, because to get the board planing on the water, the surfer's weight has to be placed far back on the surfboard. With his weight so far back it is hard to get the board up to speed in the first place, requiring special wave conditions to make it work. If he moves his weight forward on this kind of board, the drag increases immediately making his attempts to trim the surfboard to maximize speed ineffective.

THE BOTTOM TURN

In making a turn at the bottom of a wave, usually the surfboard is planing on nearly flat water, not always the case, but for examining a turn as simply as possible, it is easier to assume that the water is flat and not moving. So the initial condition is the surfboard has dropped down the face and raced out ahead of the wave.

To begin the turn, weight is placed near the inside rail in the turn. In doing so the nose is raised above the tail and the inside rail is lowered below the right. The surfboard assumes a bank angle with the water and the fin has one surface area projected in the direction of movement. For a left turn the left fin surface area, the right side is then a lee side. The surfboard has generally rotated about an oblique axis along the surfboard that passes near the base of the fin. In this case the axis is along the water line on the surfboard.

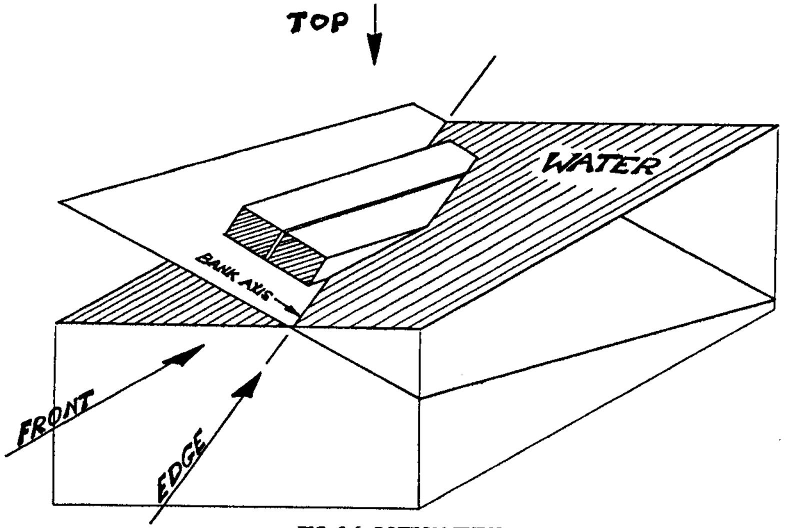


FIG. 2-6 BOTTOM TURN

The surfer must lean in the direction of the turn because his weight must lead the turn, otherwise as the board comes around in the turn he will tend to fall off the other side. Of course, if he leans too far he will fall off anyway. The whole idea being to keep up with whatever the board is doing.

The actual direction taken by the surfboard in the turn is generally determined by three factors.

1. Bottom surface area below the water line

2. Inside rail shape

3. Fin surface area

When the tail is sunk into the water a force due to effective water inertia acts on the bottom surface to deflect the surfboard into the turn. The force is perpendicular to the bottom. The amount of deflection depends upon the surface area involved and the bank angle of the surfboard. In effect the surfboard is banking against a wall of water it has created for itself. The surfer's weight is supported in part by this wall of water and the buoyant force.

The inside rail will be, to some extent, moving through the water as a leading edge for the part of the surfboard below the water line. Rail shape will take part in determining how the surfboard behaves in the turn.

Onrushing water will be putting pressure on the fin surface that is facing toward the turn, resulting in a torque on the surfboard similar to the effect of a rudder on a boat. The force is proportional to the fin surface area and is acting away from the direction of the turn. It is this force that actually makes the surfboard continue turning.

To help explain these concepts further, Figure 2-7 shows the top view of a theoretical surfboard in the process of beginning a turn. The surfer rotates the surfboard about the bank-axis shown. Each of the successive views A through F are looking at the surfboard along the water surface from possible directions the surfboard could begin to take as it starts to turn.

The surfboard will tend to move through the water along a path of least resistance, which ideally should be in the plane of the surfboard.

In each case, except for F, the surfboard is slipping out of the turn. In F, the surfboard is moving in its plane, offering the least projected bottom surface area in the direction of turn. The rail is a true leading edge. As the surfboard moves in this direction, the fin will catch water and begin to turn the surfboard to point into the turn. As long as the bank angle is maintained, the surfboard will continue turning.

The difference between this so-called optimum turn and a slipping turn is explained in different ways.

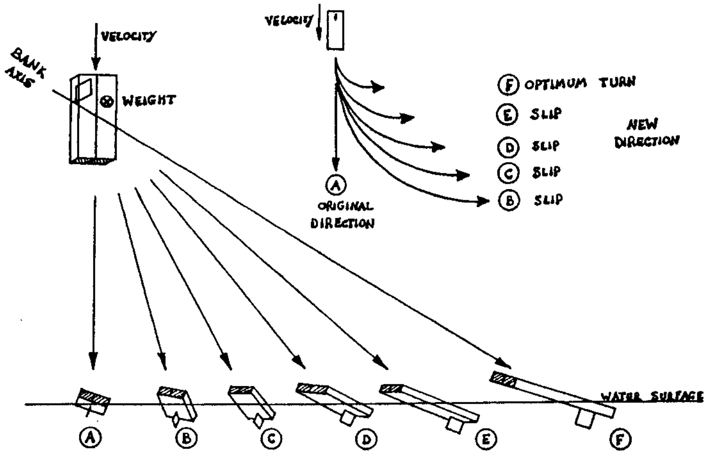


FIG. 2-7 SLIP IN A TURN

One explanation is that the bank-angle the surfboard assumes in attempting the turn is too small. Relatively speaking, the water inertia force on the bottom will be small and the surfboard would not be fully deflected into the turn. If the bank angle is too great, the surfboard will tend to stall.

Another explanation is the fin (or fins) surface area is too small. It does not provide enough force to maintain the turn.

A third explanation is in the rail. As the surfboard tries to move in its plane, the rail tries to change the bank-angle or slip out of the water. If the rail is the type that digs in, quite possibly it could pull the board more up on edge increasing the bank-angle and actually improving the turn, as long as it isn't over done.

A fourth explanation is in the rail outline of the tail. The bottom surface area shape or distribution determines the surfer's ability to sink the tail by over-powering the initial water inertia force before the turn. Effective water inertia increases with velocity making it more difficult to overpower. Wider tail area requires greater weight force to sink the tail than a narrower tailed board moving at the same velocity. Along with this surface area, is the matter of buoyancy. In sinking the tail the surfer is also acquiring a buoyant force resisting further increase in bank angle, another factor related to the surfer's weight.

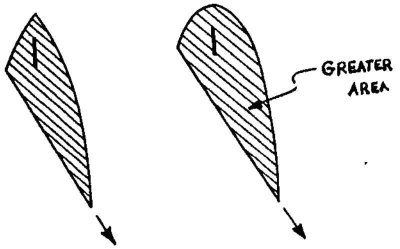


FIG. 2-8 BOTTOM SURFACE AREA IN TURN

In effect, the tail area below the water line in a turn can be thought of as another fin. If the board is moving in its plane, there is a leading edge and a trailing edge.

Comparing two surfboards, one a round tail and the other a pin tail, each attempting the same three turns, the areas moving through the water are as shown.

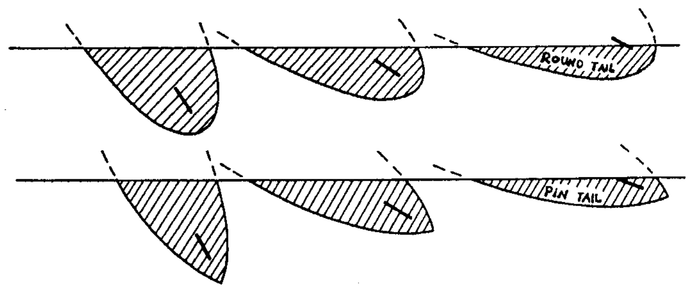


FIG. 2-9 BOTTOM THOUGHT OF AS A FIN

These drawings show a relative indication of the possible turn radius. The water lines on the board tend to become part of the arc traced out by the turn. The boards on the right are into a greater radius turn.

Fin location will influence ease of turning. Generally moving a fin forward on a surfboard makes turning more difficult, the surfboard is less sensitive to direction changes. The reason being that to make a turn the bank axis usually passes near the base of the fin. It is the easiest way to establish a bank angle without a lot of extra force. If the bank axis was away form the fin, not only would greater bottom surface area be displaced down into the water, so must the fin. With the bank axis near the fin, the fin doesn't move sideways through much water.

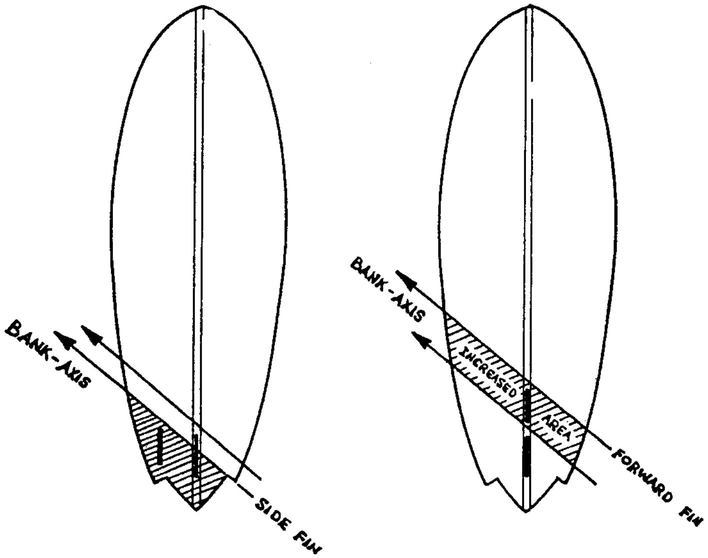


FIG. 2-10 FIN LOCATION IN TURN

If the fin is moved forward, so is the most effective bank axis. With the bank axis moved forward the tail area to be sunk in the water for a turn is increased, requiring extra force to sink the tail. Also the turns will tend to be wider because the flow lines on the surfboard will be longer.

If the fin is moved sideways toward the rail, turns made to that side will be much easier and sharper.

MOVING ACROSS A WAVE FACE

In moving across a wave face at an angle, I have used the word translation to mean uniform motion of the surfboard in a straight line.

In simple translation, the board is moving in its plane. The board is at an angle to the wave face. The board has a velocity component along the face and another velocity component in the direction of the advancing wave. The board is not moving up or down on the face. It is remaining fixed in position relative to the wave height.

The fin is aligning the board in the direction of movement. The advancing wave is pushing on the board by the buoyant force and the orbital force. Drag forces are acting to slow the board down.

When the board is in equilibrium its velocity is constant. The surfer's weight is primarily supported by the vertical component of the buoyant force and water inertia. The forward forces are equal to the drag. The velocity is determined by the angle the board makes with the wave face. The more closely the board comes to moving parallel to the wave face the greater its velocity.

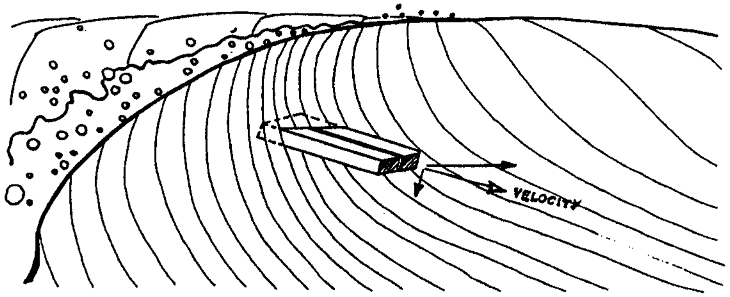


FIG. 2-11 MOVING ACROSS THE FACE

To examine this idealized case of simple translation, two examples are described in which the surfer makes a small shift in his weight during a state of equilibrium. In each example, assume that the water inertia force is large compared to the vertical component of the buoyant force, the water inertia force is in the center of the bottom surface area, and the surfer's weight is totally supported by effective water inertia.

A force into the page is represented by $\odot$, and a force out of the page by $\otimes$.

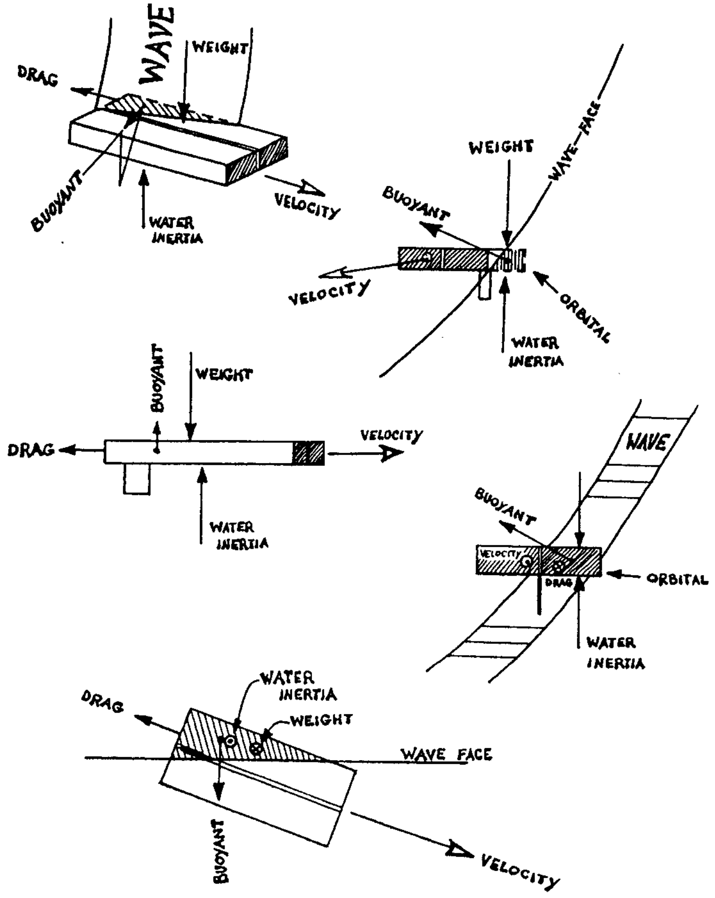


FIG. 2-12 TRANSLATION – GENERAL FORCES ON SURFBOARD

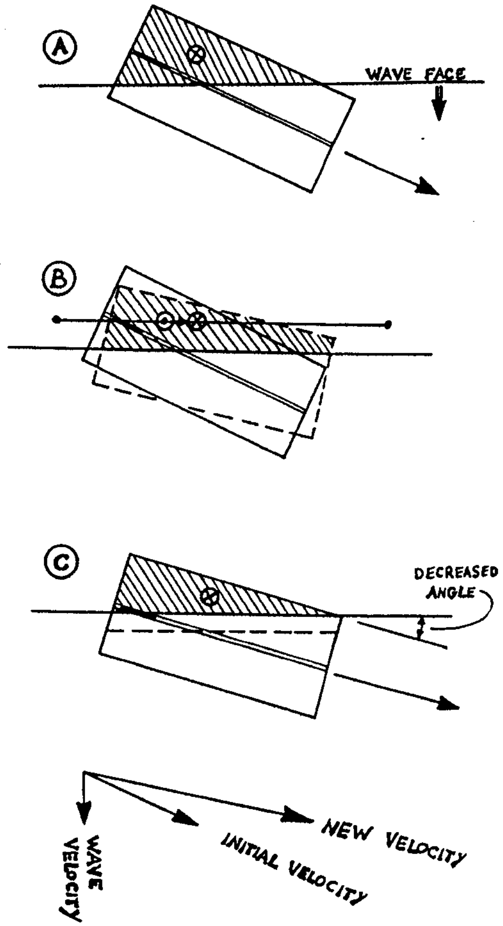


FIG. 2-13 WEIGHT SHIFT – 1st EXAMPLE

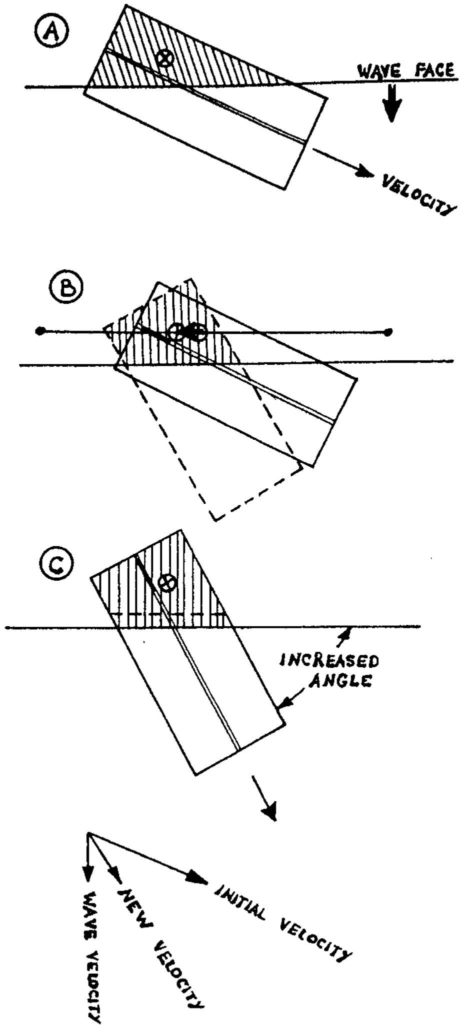


FIG. 2-14 WEIGHT SHIFT – 2nd EXAMPLE

When the surfer moves his weight around on the board, he changes the attitude of the board by creating a torque that tends to rotate the board in a vertical plane defined by a line between the two forces. Inertia and weight are now separated by some distance.

The surfboard moves toward a new attitude on the wave resulting in a new direction of movement. The inertia force moves toward the new location of the weight force. In doing so, the wetted surface area changes so that its center is under the weight force. There is a period of change during which the board moves to the new equilibrium attitude.

In the first example, the weight is moved slightly forward along the wave face. The surfboard will tend to point down the face and pick up some speed. As the surfboard does this the bottom wetted surface area will move forward on the board to place the inertia force under the surfer's weight. To do this, the board has to make a smaller angle with the wave face. When the board is in equilibrium again the velocity will be greater because of the smaller angle with the wave face. With greater board velocity the effective inertia force per area is greater so the required wetted area to match the surfer's weight is less at the new higher velocity.

This means that less of the surfboard is in the water.

In the second example, the surfer has moved his weight back slightly along the wave face. The board tends to point up the face and slow down. The wetted surface area will move back on the board as the inertia force moves to support the surfer's weight.

The result is the board changes direction to increase its angle with the wave. The surfboard comes to a new equilibrium position, moving in the plane of the surfboard at a lower velocity. The surfboard remains in a fixed position on the wave face as the wave advances.

Because the velocity is lower, the effective water inertia force per area is less and the board will sink deeper into the wave to increase the wetted surface area.

There are other general places the surfer can shift his weight on the board creating more than just a direction change across the face.

Refering to a third example in Figure 2-15:

1. The surfboard will turn up the face.
2. The surfboard will drop down the face increasing its velocity as it moves out ahead of the wave in approximately the same direction as the initial direction.
3. The surfboard will turn down the face with the direction of the advancing wave, increasing its velocity as it moves down the face. Very likely, if the weight is kept here, the outside rail will bury itself at the bottom of the wave and the ride will be over.
4. The surfboard will turn back sharply on the face and reverse its direction to move across the face the other way.

These changes are related to making forced turns on a wave face using the fin, which will be discussed later. In this current discussion on traversing, the fin is assumed to be large enough to maintain the generally straight line movement

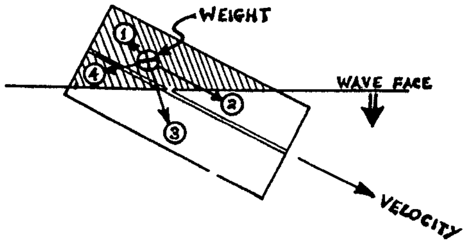


FIG 2-15 WEIGHT SHIFT – 3rd EXAMPLE

of the board. The only requirement here on the fin is that it be in the water at all times.

The first two examples just described are comparisons of two simple equilibrium conditions that bring out the concept of relative surface area, planing across a wave face, and how the surfboard tends to create its own water surface to plane on. Weight movement around on the board was very small, so as to not get involved much with fin forces in a full-on turn. The two examples are simply idealized states of equilibrium in translation.

Drag is the ultimate force limiting velocity, drag increases with velocity. With a well designed board, the drag will be very low at high velocity. When the surfboard is moving in its plane, the drag forces on the board are minimized. To get up to high velocity depends upon the forward forces on the board. The greater these forward forces, the shorter length of time required to attain maximum velocity. In other words, a surfboard can be a super-low drag shape but be inefficient in obtaining large forward forces. This type of surfboard will require a longer time to accelerate to top speed or require special wave conditions to get moving. If the surfboard has medium drag and a lot of surface area, sometimes the surface area can be used to acquire extra forward forces to get it going.

In practical wave situations it is often the case to resort to a trade-off between drag and forward forces, maximum speed occurring when the board is not moving in the plane of the surfboard.

One such case is when the surfboard is driving down the face at an angle for maximum speed, trying to beat a breaking section that is closing out. The surfer's weight is forward on the surfboard ahead of the wetted bottom surface area. There is a constant torque on the board tending to rotate the surfboard down the face. The surfboard will rotate to an attitude where the torque is balanced out by drag due to water "pulling" underneath the tail.

As much of the inside rail is in the wave as the situation permits. The advancing wave face pushes on the rail and bottom. The drag is greater because the surfboard is tending to pull water. The extra drag is overpowered by the forward forces on the rail and the torque due to the surfer's weight being far forward.

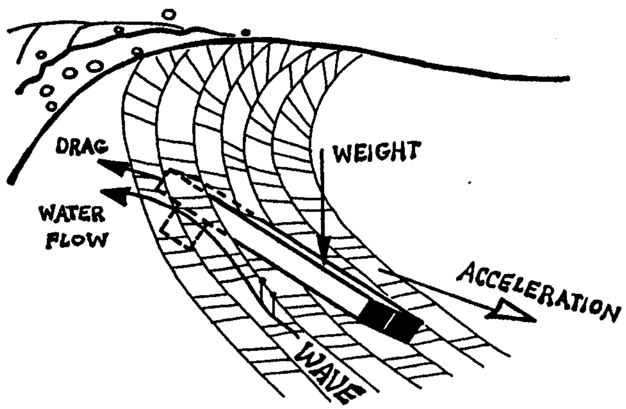


FIG. 2-16 DRIVING DOWN A FACE

The surfer is making a trade-off between forward forces and drag to get a maximum resultant forward force on the surfboard. This is often called trimming up the board.

Velocity will continue to increase until a terminal velocity is attained, or the board moves out onto the flat water ahead of the wave, which ever comes first. In the flat water, the forward forces disappear and all the surfer has going for him is lots of momentum.

When terminal velocity is reached while still on the face, two results can occur. If the component of surfboard velocity in the direction of the advancing wave is greater than the wave velocity, the surfboard will still move out ahead of the wave.

If the velocity component is equal to the wave velocity the surfboard will stay on the face in a state of equilibrium at the mercy of the wave. This is usually the case when locked into the tube on a steep face in an all-out attempt to keep up with the curl. The surfboard will remain in equilibrium as long as the wave maintains its relentless attempt to suck-up the surfer.

This business about pulling water can be explained by the direction the surfboard is moving through space, relative to its position with the water, When pulling water, the top of the surfboard is facing the direction of movement. Water trying to move away from the bottom creates drag acting to limit maximum velocity.

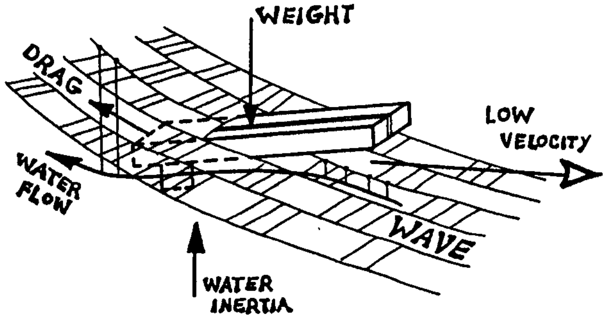


FIG. 2-17 PUSHING WATER

When mushing along, the surfboard is pushing water underneath the tail, with the water inertia forces acting to slow the surfboard down. The surfboard is moving through space with the bottom facing in the direction of movement.

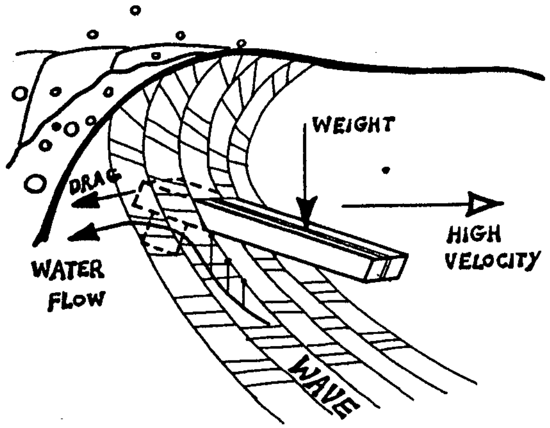


FIG. 2-18 PULLING WATER

TURNING ON A WAVE FACE

Making a turn on the face of a wave is much the same as described for the bottom turn. There are some marked differences. The water line on the board in the turn is not usually pointed in the direction of turning movement, because the board is not usually moving in the plane of the water surface. The board is moving out of the water surface. The board never gets out of the water because the wave always moves along with the surfer, pushing on the board as the two go along.

When the board assumes a turn bank angle in the water, the effect of the water wall created by the bottom of the board is determined by the initial direction of the surfer's momentum.

To explain this, Figure 2-19 shows a board in position for making a left turn away from going straight-off. The surfer has put the board in this position by shifting his weight on the board.

Initially the board could have been moving in two different positions before changing to the turn. From each position the forces creating the turn are different.

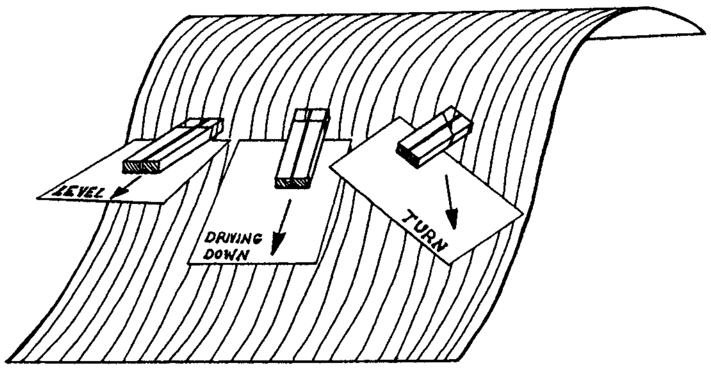


FIG. 2-19 IN POSITION FOR A TURN

In the first case the board could have been in general equilibrium moving along with the wave at the wave velocity. The surfer's velocity and momentum directed approximately horizontal. In changing to the turn position the left rail is lowered below the right rail.

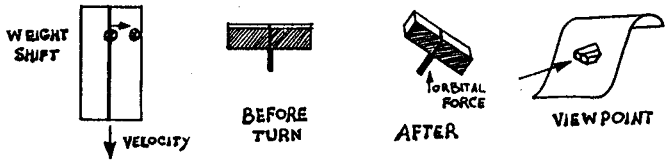


FIG. 2-20 TURN FROM LEVEL

There is no great change in the inertia force on the surfboard bottom. There isn't even a fin surface area presented to the onrushing water in the direction the surfboard is moving.

What forces the turn then? The orbital force. When the left rail is lowered below the right, the fin rotates about an axis along the center line of the surfboard. When the fin rotates like this it presents its left surface area to water moving straight up into the bottom of the surfboard. Water particles tracing out their orbits near the face of the wave have a direction that is generally upward. These particles apply a force on the fin.

In the second case the board is driving down the face before the turn. Its velocity and momentum is directed down at an angle away from horizontal. In changing the surfboard attitude for the turn, the nose is raised in relation to the tail and the left rail is lowered below the right. This is apparent when the surfboard is viewed coming straight at an observer, both before and after the change. This is generally the view seen by the onrushing water.

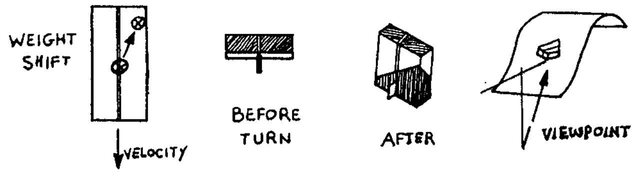


FIG. 2-21 TURN FROM DRIVING DOWN FACE

There is an impulse force on the bottom of the board deflecting the surfboard into the turn. The left surface area of the fin is presented to the onrushing water creating the required torque on the board to continue forcing the board into the turn. The board is banking off a wall of water against the bottom. Looking at the board after it has changed to the turn position, (Figure 2-22) the change in momentum resulting from the new water displacement is approximately as shown.

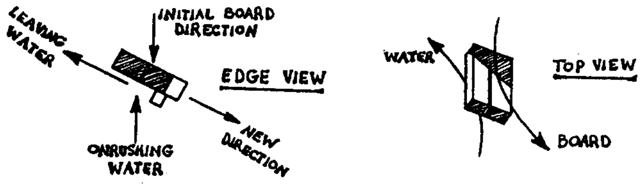


FIG. 2-22 MOMENTUM CHANGE

The turn radius will be controlled by the water line on the board being an approximation of the arc traced out by the turn and the ability of the fin and rail to hold the board in the turn. Usually on the wave face the board is riding more out of the water so there is not as much wetted area as in the bottom turn. This means that the water line will be shorter because the tail of the board is usually narrower than in mid-board.

The new direction the board takes in making its turn in both cases cannot easily be defined because it depends upon many variables. There is a shape trade-off here in how the rail outline is curved on the surfboard. The rail outline determines the bottom surface area available for banking off the water inertia. Greater surface area provides more banking force, as long as the surfer is able to use his weight to change the bank of the surfboard. The surfer's weight is generally supported by water inertia and buoyancy. In sinking the tail he is overpowering both surface area forces and buoyancy forces to create whatever bank angle is necessary.

In general the greater the bank angle the sharper the turn possible. The shape of the inside rail cross-section has a lot to do with holding an edge in the turn, and resisting the fin torque. The shape of the outside rail will also affect the turn, because water deflected across the bottom will be trying to leave the board via the outside rail. If the water can't make a clean break with the board, it will tend to curl around the outside rail, and in effect stick to the board. When the water does this, the effective weight of the board is increased making the board react more slowly to changes in velocity.

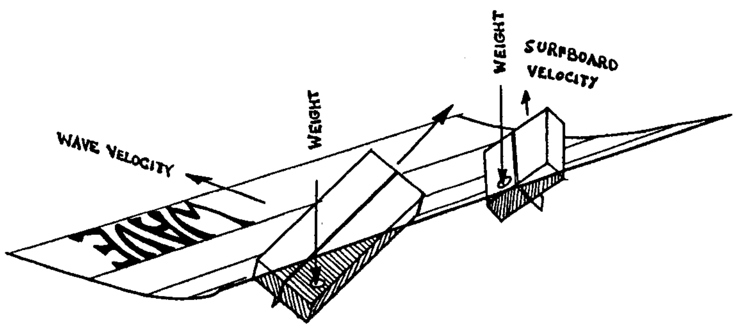


FIG. 2-23 VIEW OF TURNS FROM INSIDE CURL

The inside rail is the leading edge of the board as it moves through the water sideways in the turn. Fluid dynamic forces on the rail will affect the direction of the plane of the board, depending upon the shape of the rail. This effect will cause a turn on the face to depart radically from the straight forwardness of the bottom turn. The rail can cause the board to dig into the wave deeper or the, opposite of trying to pop it out of the wave. When it digs in it is said to be "holding an edge".

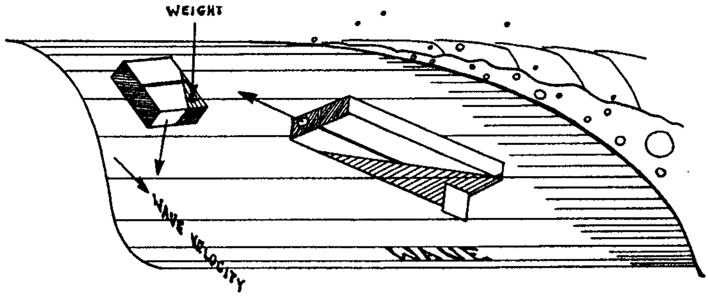


FIG. 2-24 FRONT VIEW OF TURNS

So much for little weight changes in translation. Now let's get into big changes; where the action is.

If, instead of moving his weight slightly back, the surfer stomps on the back inside rail, the board will react by digging the rail into the wave face and rotating the fin so its inside surface starts catching water. In doing this the plane of the surfboard assumes an angle up the face. Ideally, as the wave advances the surfboard is pushed up its plane and the surfboard carves up the face heading for the sky. But, of course, there being as many variables as there are, a number of different things can happen.

For one, the surfboard could side-slip out of the turn getting nowhere. For another, the board could be stuck in the wave at a funny angle and instead of moving across the face, rise up the face with the water, like an elevator. The surfboard would reach the top pretty fast, but with no speed across the face.

Putting a big weight change on the outside rail will pull the inside rail out of the wave and turn the board down the face. If the inside rail is really stuck in the wave the surfboard will hang-up and the turn back will be slow.

SURFBOARD DRAG

From basic fluid mechanics theory on emersed body movement, there are two water properties that contribute to drag; water inertia, and water viscosity.

The effect of water inertia is to create a pressure drag, or lift on the body. Pressure drag is proportional to the projected area of the body normal to the flow.

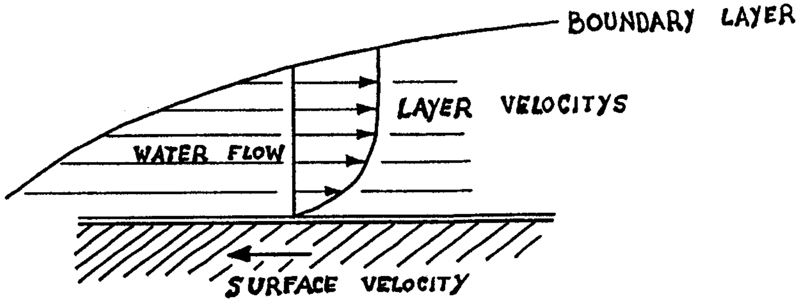


FIG. 2-25 SURFACE DRAG

The effect of water viscosity is friction, or surface drag, and is proportional to the area of wetted surface paralleled to the flow. Surface drag results from resistance of water layers sliding one upon another as the body moves through the water, changing the momentum of the water. The water touching a surface is moving along with the surface. Just off the surface the water is moving slower. Surface drag increases with velocity. Smooth water flow (laminar) will sometimes change to turbulent flow at some point along the surface, if the surface is long and the velocity is high.

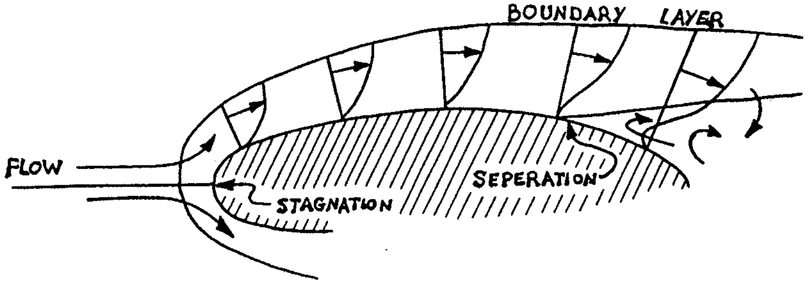


FIG. 2-26 SHAPE DRAG

When the leading edge has a surface area projected into the direction of movement, such as water flowing into a surfboard rail, there is a pressure gradient due to water inertia, that tends to hold the boundary layer close to the surface. There is a high pressure stagnation point on the rail, which water particles avoid as they come into the boundary layer and move into the lower pressure region along the surface inboard from the rail. There is accelerated flow over and under the rail.

Downstream from the rail the water slows down and depending upon the surface curve, could pull away or separate its flow from the surface. If this occurs there is reverse flow along the surface beyond the point of separation. In other words, water would be trying to flow along with the surfboard in the direction of it movements. Some water could be "pulled" along with the surfboard.

The pressure in the region beyond the point of separation is less than the pressure at the stagnation point, resulting in a net pressure difference on the board directed into the rail. This is called pressure drag, or shape drag.

The wake is characterized by turbulent eddies that slowly dissipate themselves far downstream.

Total drag is the sum of the pressure and surface drag.

Usually in a well streamlined body, the surface drag is a major part of the total, but in the case of a surfboard, pressure is a major factor in determining

changes in direction. The board is constantly using pressure on its surfaces to maintain stability and hold in turns and wave faces.

The object of streamlining a surfboard is to move the point of separation as far back as possible to reduce the turbulent wake to a minimum. This decreases the pressure drag, but making the surfboard longer increases the surface friction drag.

The shape of leading edges, such as rails, are important concerning drag in that they govern the location of the separation point back from the rail.

Two other factors enter into the shape of the rail that are probably more important than drag due to separation. That is the stagnation point and the resulting pressure distribution around the rail.

RAILS

A rail moving into a water surface will penetrate the water as deeply as it can, until the buoyant force stops its movement. Rail velocity relative to the water will give rise to water inertia forces to further impede its penetration.

The shape of the rail cross-section will determine dynamic pressure distribution around the rail, resulting in a possible change in its direction as it moves further into the water. For example, the three rails shown below are pushed directly into the water at an angle, such as might be experienced in a bottom turn.

The hard rail will tend to put the board more on edge. The soft rail will go straight in. The third rail will tend to level the surfboard out.

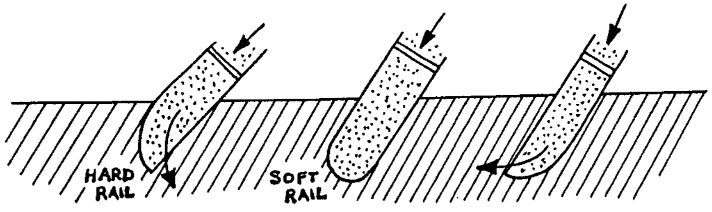


FIG. 2-27 RAILS PUSHED INTO WATER

If the water happens to be on the face of a wave, and the surfboard is level, the hard rail will bite into the wave with the bottom catching more water rising up the face. The board will tend to move with the water flow up the wave face.

The soft rail won't change its angle with the water. The third rail will tend to turn down the face.

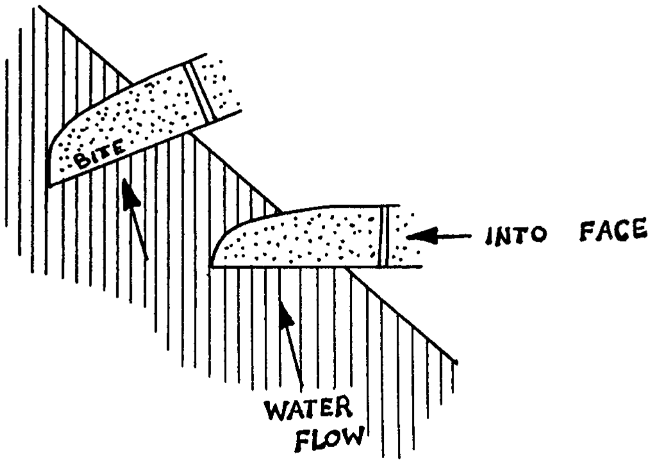


FIG. 2-28 RAIL BITE

The hard turned-down rail has evolved into a very popular rail with many variations tending toward the soft or egg rail.

In moving across a wave in translation, the movement of the rail relative to the wave is in two directions. There is a small velocity component directly out of the wave approximately equal to the wave velocity, and a larger velocity component along the face of the wave.

Water flow around the rail can be examined individually for each velocity component. Looking at the rail cross section perpendicular to the wave face, water flow is diverted along the bottom and cleanly released by the hard edge of

the rail. There is an area of suction or low pressure directly behind the rail because the water cannot follow the curvature of the sharp corner. The surfboard will tend to move further into the face until this area is filled with water. If this was the tail of the board instead of the rail, it would constitute a high drag situation. The speed of the board would be limited to the wave velocity, relying primarily on the buoyant force to push the board along. To get the board moving again the tail would have to break free of the water filling in on the upper surface and back into simply releasing water off the lower edge. Needless to say, this kind of tail sucks!

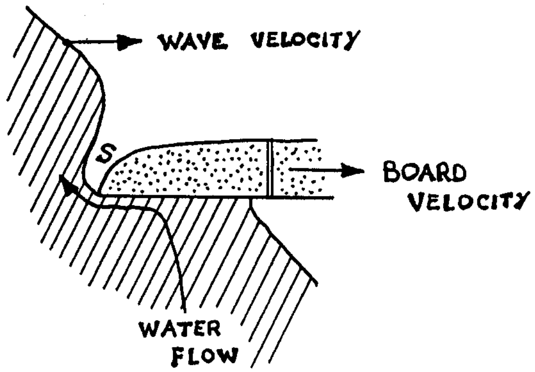


FIG. 2-29 RAIL SUCTION

Looking at the rail cross-section paralleled to the wave face from inside the board, the water flow is much more streamlined. The velocity component of the surfboard along the face is generally cutting through the water rising up the wave face. The flow lines tell the story and show that this is a low drag situation in the major direction of movement.

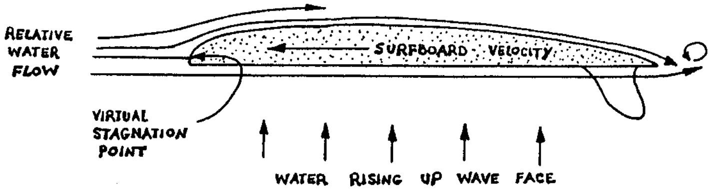


FIG. 2-30 RAIL FOIL

There is an apparent stagnation point on the leading edge of the rail, but it is not a permanent one. Water flowing into this leading surface is diverted along the inside rail edge, tending to fill in or sweep away the suction. Water is flowing under and over the rail. There is some disagreement as to whether it is better to have the water flowing over the deck or pushing off and away from the board by the rail. A surfboard that takes a lot of water over the rail onto the deck, usually creates more problems than it cures, the surfboard tends to hang-up with rails biting deeper into the water than necessary.

The surfboard is planing on a "ledge" it has created for itself. The shape of this ledge is in large part determined by the rail outline and the location of the fin. A fin has to be in the water to maintain the surfboard's direction.

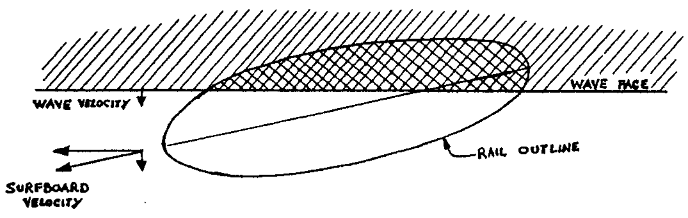


FIG. 2-31 PLANING ON A LEDGE

The amount of ledge area required to support the surfer is determined by the surfboard velocity. Higher velocity permits less area. A narrow ledge usually requires that the rail have a hard edge on it to hold on the wave face.

Other factors enter into the shape of the rail, because the surfboard is not always screaming across the face of a wave. A general purpose rail should permit many maneuvers on a wave and leave as much control to the surfer as possible.

Curve in the bottom rail edge will permit rolling up on a rail somewhat, without changing the buoyant force.

Most of the time the surfer's weight is supported by both buoyancy and water inertia. If the rails are hard down all around the board, the water inertia force will predominate. When this situation exists, to change the aspect angle of the surfboard, the surfer has to overcome the inertia force and a newly acquired buoyant force as the surfboard sinks further into the water. If there already is a buoyant force, changing the surfboard aspect angle will simply move the buoyant force to another part of the board without requiring as much extra force, making the attitude of the surfboard more sensitive to shift in the surfer's weight. Such is the case with soft rails and rounded bottoms.

Of course the ideal would be to design the surfboard so that overpowering the inertia forces is relatively easy and the surfboard would not acquire extra drag by displacing water around the part of the surfboard immersed in the water.

A case in point is a Vee, placed in the tail around the fin. At high velocity it is relatively easy to change from planing on the forward flat bottom to planing on one surface of the Vee. Planing on the Vee rotates the fin into a position to begin the turn. Once into the turn, the rail can dig in and the surfer is banking off the water into a turn that might otherwise have been a major effort.

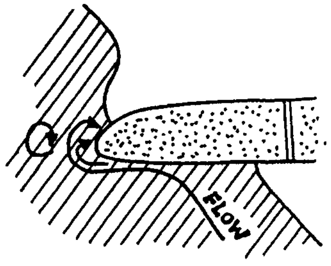


FIG. 2-32 RAIL DRAG

A soft rail on the bottom side generally has higher drag associated with it. There is no definite point on the rail where water can cleanly release from it. The water flow will try to continue flowing along the curved surface as it curves up onto the deck. This creates extra turbulance at the rail and pulls water along with the board. The effective weight of the surfboard is increased and energy is dissipated in creating eddy currents behind the rail.

A rail that changes in general cross-section shape along the length of the surfboard, can produce all kinds of interesting effects on performance. The full range of possibilities seem yet unexplored. The winged rail is one example.

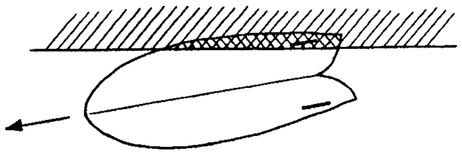


FIG. 2-33 PLANING ON A LEDGE

Chapter 3

Design Layout

A surfboard can be designed by putting down on paper specific dimensions for shapes that can be built accurately.

A basic design is made up of three (3) drawing and two (2) tables.

- rail outline
- rail cross-section
- fin outline
- rocker table
- thickness table

From the drawing, templates are made out of heavy paper and posterboard, to be used as guides when shaping the surfboard. The two tables are used during shaping to define thickness and rocker.

With this design method and the shaping procedure described later, it is possible to build two surfboard that are near enough alike to be considered functionally identical. The following sections explain how to make these drawings, tables, and templates.

RAIL OUTLINE DRAWING

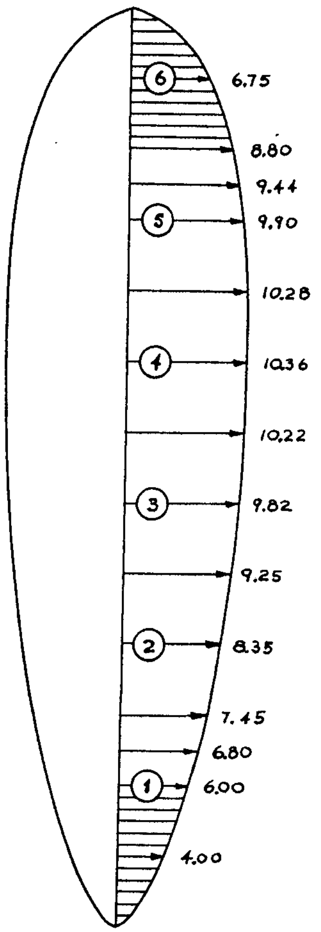
The rail outline, or plan view, is the outline of the surfboard seen when looking directly down onto the top of the surfboard. This drawing is made accurately to scale. Any scale is acceptable as long as an accurate template can be made from the drawing. The example below is an explanation and suggestion of how to make this drawing and derive a template from it.

EXAMPLE Use a scale of 5 to 1. Use tracing paper that is quadrille lined, 10 lines to an inch, on one side and unlined on the other side. Draw on the unlined side. The quadrille pattern can be seen through the paper, making drawing erasure possible without erasing the quadrille pattern.

With a scale of 5 to 1, one inch on the paper represents 5 inches on the full size surfboard. This scale matches with the quadrille pattern on the paper. Full size surfboard dimensions can be read on the drawing without using a ruler scale. In other words, 10 spaces on the quadrille pattern under the drawing represents 5 inches on the full size surfboard, 2 spaces represent 1 inch. Accurate full size

6' 6" TEAR DROP

NOSE	1/2 WIDTH	
6"	0.0	inches
5	2.50	
4	3.80	
3	4.80	
2	5.55	
1	6.15	
6 FOOT	6.67	
11"	7.12	
10	7.52	
9	7.90	
8	8.25	
7	8.56	
6	8.80	



1 FOOT	6.00	inches
11"	5.70	
10	5.42	
9	5.10	
8	4.75	
7	4.40	
6	4.00	
5	3.60	
4	3.10	
3	2.60	
2	2.00	
1	1.25	
0	0.0	
TAIL	1/2 WIDTH	

FIG. 3-1 RAIL OUTLINE DRAWING

dimensions to within one tenth inch (0.1") can be read from the drawing using the quadrille pattern.

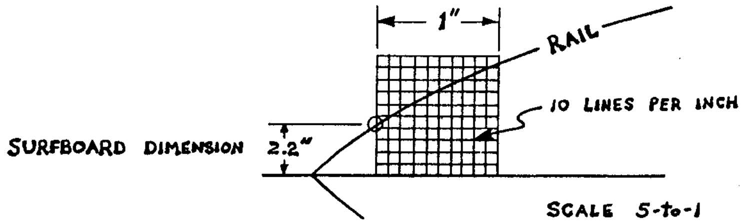


FIG. 3-2 RAIL OUTLINE SCALE

All the drawing dimensions are in inches. Avoid working with dimensions using feet and fractions of an inch because it tends to create confusion. For example, a number like 15.3" is easier to work with than 1'3-5/16".

Begin the drawing by marking the surfboard width one foot from the nose and tail, and the width at its widest point somewhere around mid-board. Draw the rail curve through these points using a french curve. All the drawing equipment and paper you might need is described at the end of the chapter.

Try to make the curve as continuous as you can. Sometimes a drawn curve will appear to be smooth when looking straight down at it, but actually may have some irregularity in it. These can be spotted by sighting down the curve with the drawing just below eye level. Draw both sides of the surfboard to get an idea of what the completed view looks like.

A template is made by magnifying the curve drawn over the quadrille lines and recreating the relative points on the expanded pattern where the curve and pattern lines cross each other. Make the pattern 5 times bigger and the curve will be that of the full size surfboard. The template can be made of heavy butcher paper.

Figure 3-3 shows circles around points on the curve that are sufficient to recreate the curve on the template. Only those lines of the quadrille pattern intersecting these points need be drawn on the template paper to define the curve. Use a straight edge to draw the center line of the surfboard on the template paper, and a right triangle to draw perpendicular lines extending away from the center line to the points on the curve. A smooth line drawn through these points that is good enough to follow with a pair of scissors, a little cutting, and you've got yourself a very practical template. The template is to be laid out on the surfboard blank and the curve traced with a soft lead pencil.

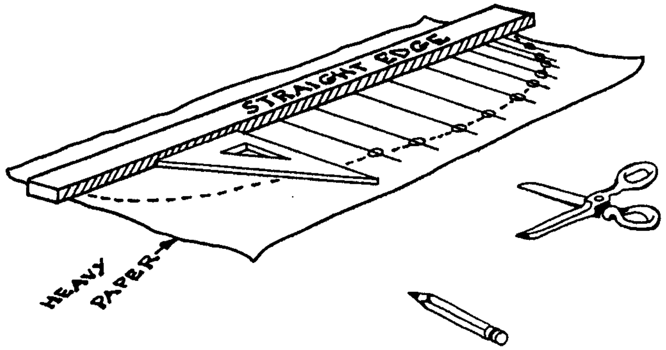


FIG. 3-3 RAIL OUTLINE TEMPLATE

Only one side of the outline need be made because the other side is a mirror image and can be turned over to trace out both sides on the blank. The template can be made in two sections, one for the nose and one for the tail. The center line is a reference that will line up the two sections together.

Later on a permanent template can be made out of heavier material if the curve turns out to be a functional one and you are making a lot of surfboards with it.

If you are taking a rail outline from another surfboard, simply lay the surfboard on the paper and trace it out with a pencil run along the rail. Be sure to mark the location of the nose and tail center line.

ROCKER

Rocker is the longitudinal curve of the surfboard bottom along the center line from nose to tail. It is referenced to a straight line. The amount of deviation in inches can be defined at specific points along the straight line.

Since most surfboards have little or no rocker or lift in the tail, it is a good idea to use the tail as a primary point of reference. Moving from the tail along the bottom center line, the rocker curve will deviate away from a straight line as it curves upward toward the nose.

Measuring this deviation is easier to visualize by an example. The 6' 6" surfboard design described in this chapter has a rocker curve that is ½" away from a straight edge held flat against the tail, at a point that is 48" from the tail. The rocker curve is 1" away at 56" from the tail. As the curve progresses toward the nose succeeding points are noted for deviations of 2", 3", 4" and so on.

6' 6" Teardrop
ROCKER TABLE

POSITION	DESIRED ROCKER
Nose ⑥ + 6"	5 inches
⑥ + 3"	4
⑤ + 10"	3
⑤ + 5"	2
④ + 8"	1
④	½
Tail	0

6' 6" Teardrop
THICKNESS TABLE

POSITION	DESIRED THICKNESS
Nose ⑤ + 8"	2.4 inches
④ + 8"	2.9
④	3.0
③	3.0
②	2.5
①	1.8
Tail + 3"	1.2

Some surfboards have so much lift in the tail that by the time you get to the nose, the deviations away from straight are so large that it is almost impossible to accurately measure them. In cases like this, choose a primary reference point that is 2 feet from the tail and hold the straight edge against the bottom at that point.

Shaping rocker can be a difficult part of shaping a surfboard. Often times a shaper will rely on using the rocker that is already in the rough blank as it comes from the manufacturer.

The chapter on shaping explains in further detail how to arrive at a close approximation of a desired rocker curve from a rough blank that has less rocker in it than desired.

Measuring rocker on a surfboard is relatively easy and should be done on every surfboard design you make.

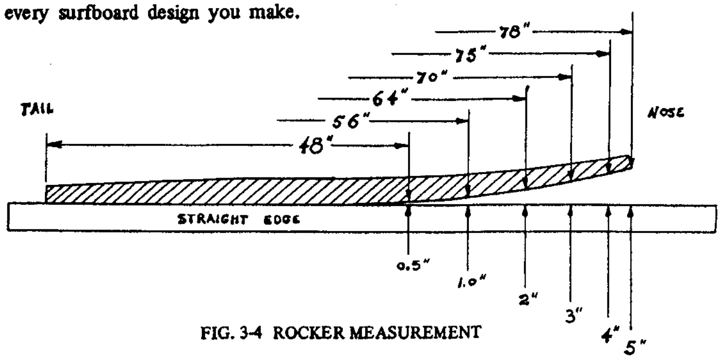


FIG. 3-4 ROCKER MEASUREMENT

CENTER THICKNESS

Surfboard thickness can be defined at 1-foot intervals along its center line. The tapered thickness from nose to tail is often refered to as the over-all foil of the surfboard. A foil is one of several arcs or lines that enclose a complex shape, in this case the surfboard.

It is usually best to coordinate thickness with width because the surfboard will be more balanced. Thickness is a general indication of buoyancy. When the distributed buoyancy is related to width, the surfboard will tend to have the same responses at different speeds. At slow speeds the lost support from planing over water on the bottom surface area is taken over by buoyancy in approximate proportion. At higher speeds the planing effect predominates and buoyancy is secondary.

RAIL CROSS-SECTION DRAWING

The rail cross-section is a cut-away view of the rail that would be seen if the surfboard was cut in half perpendicular to the center line of the surfboard.

Figure 3-5 is a dr[illegible]wing of a single rail cross-section showing the intersection of bevels and the re[illegible]sulting rail shape. This drawing is actually one of a set of drawings for rail cr[illegible]ss-sections at 1-foot intervals along the length of the surfboard. Each can be [illegible]rawn full size.

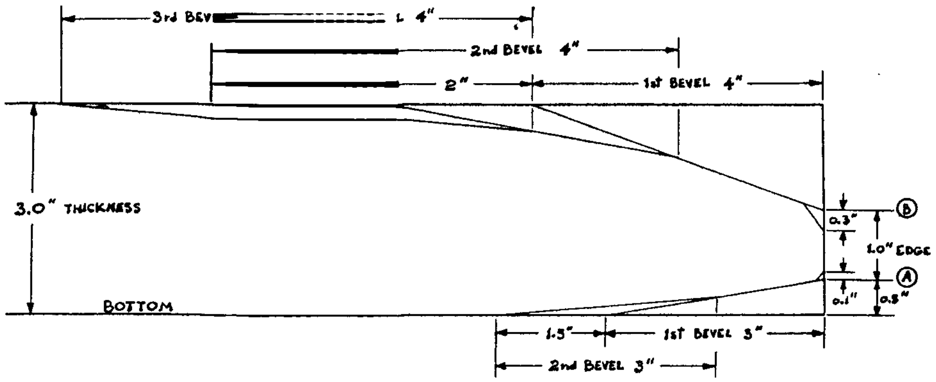


FIG. 3-5 RAIL CROSS-SECTION DRAWING

Templates cut out [illegible] of poster board are made using the dimensions of the rail cross-section drawing [illegible]. A first template has both the first and second bevels in it. The second template [illegible]as only the first bevel in it.

A surfboard 6' 6" [illegible] long could have as many as six rail cross-sections drawings and twice as many c[illegible]rresponding templates. Usually this many drawings are not necessary because so[illegible]e cross-sections are identical.

The templates are [illegible] intended as a guide to check the rails during the shaping process. Once a pers[illegible]n gets the hang of shaping the rails with this method, the templates are not use[illegible] so much.

Most designing o[illegible] a rail can be done by simply defining these bevels. Of course, if a rail curv[illegible] is obtained from another surfboard or just plain thought up and drawn out o[illegible] paper, the bevels to shape can be fitted around the curve.

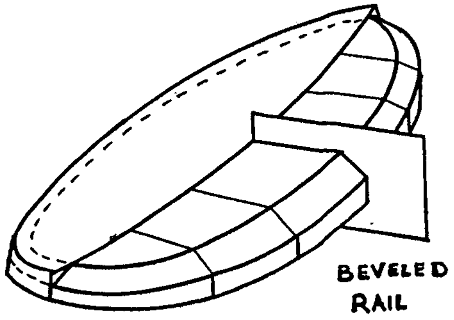


FIG. 3-6 RAIL CROSS SECTIONS

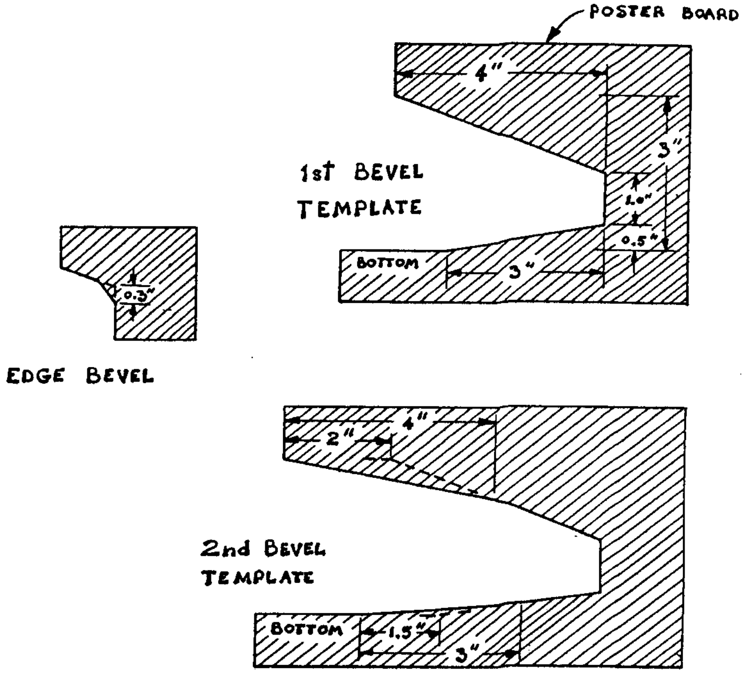


FIG. 3-7 RAIL CROSS-SECTION TEMPLATES

Figure 3-5 is a drawing of a single rail cross-section showing the intersection of bevels and the resulting rail shape. This drawing is actually one of a set of drawings for rail cross-sections at 1-foot intervals along the length of the surfboard. Each can be drawn full size.

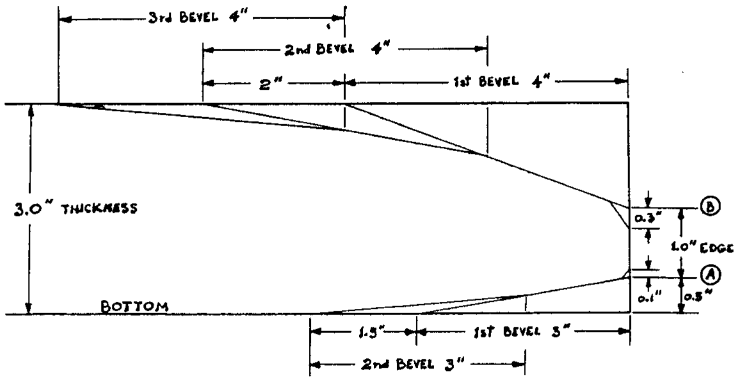


FIG. 3-5 RAIL CROSS-SECTION DRAWING

Templates cut out of poster board are made using the dimensions of the rail cross-section drawing. A first template has both the first and second bevels in it. The second template has only the first bevel in it.

A surfboard 6' 6" long could have as many as six rail cross-sections drawings and twice as many corresponding templates. Usually this many drawings are not necessary because some cross-sections are identical.

The templates are intended as a guide to check the rails during the shaping process. Once a person gets the hang of shaping the rails with this method, the templates are not used so much.

Most designing of a rail can be done by simply defining these bevels. Of course, if a rail curve is obtained from another surfboard or just plain thought up and drawn out on paper, the bevels to shape can be fitted around the curve.

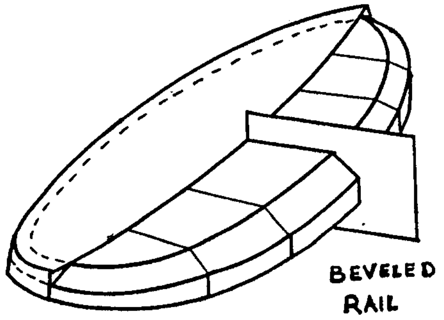


FIG. 3-6 RAIL CROSS SECTIONS

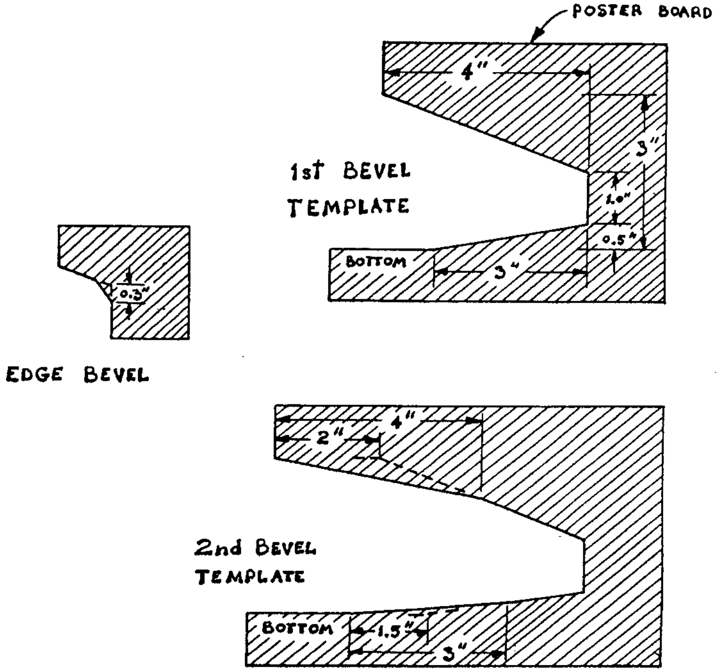


FIG. 3-7 RAIL CROSS-SECTION TEMPLATES

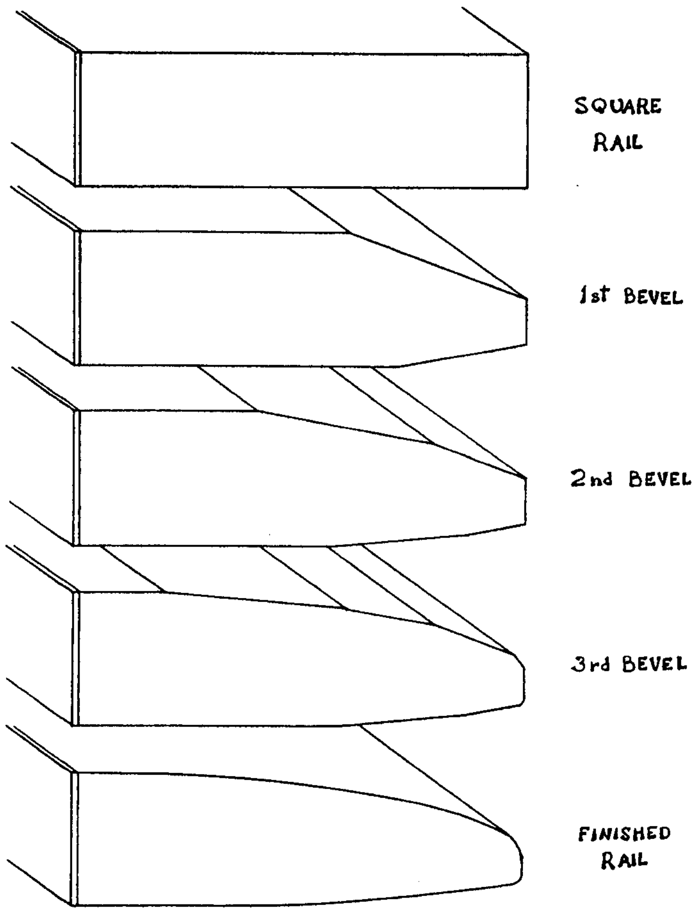


FIG. 3-8 SHAPING A SINGLE RAIL CROSS-SECTION

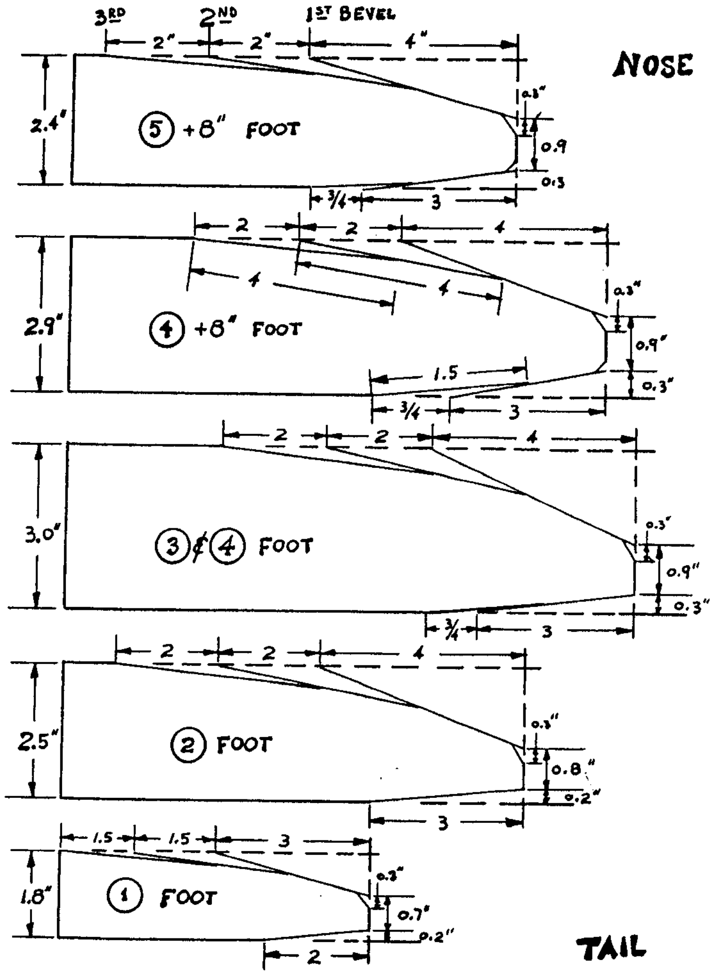


FIG. 3-9 SET OF RAIL CROSS-SECTIONS

A good approximation of a rail cross-section on another surfboard can be obtained with a piece of soft lead wire, or solder, wrapped smooth around the rail.

The rail is shaped by planing each bevel, or bands as they are often called, along the full length of the rail. All cross-sections are involved in each beveling step.

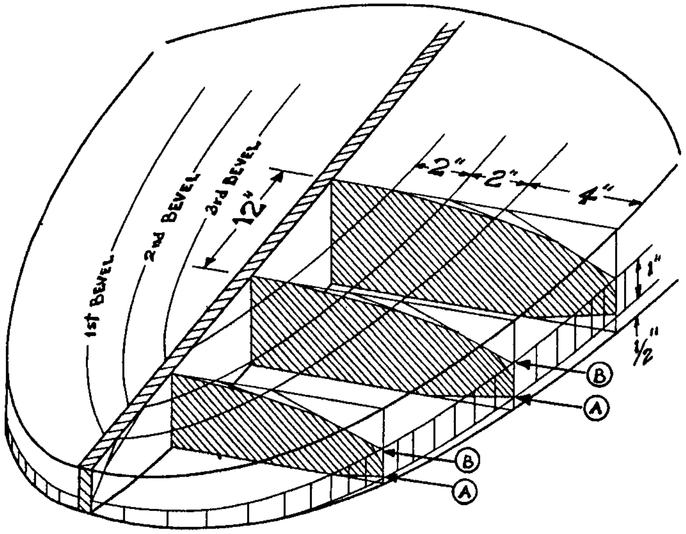


FIG. 3-10 BLENDING TOGETHER RAIL CROSS-SECTIONS

Rail shaping begins with a rail that has been made square with the bottom of the surfboard after the rail outline has been cut out on the blank. Bevel position should be accurately referenced to the bottom edge. In this way the position of the rail relative to the bottom surface can be controlled. If this part gets screwed up the performance of the surfboard can be drastically affected.

Defining dimensions Ⓐ and Ⓑ at the rail is critical, because they determine the location of the rail edge and the general flow of the rail along its length. These two dimensions should always be refenced to the bottom.

Blending together successive rail cross-sections on paper is a bit tricky. Begin by defining check points Ⓐ and Ⓑ along the rail so the flow lines will be continuous curves of straight lines. Change in thickness should be gradual. For

cross-sections 1 foot apart a 0.4" change in check points is an extremely big change and often impractical. Small changes on the order of 0.1" will produce a pronounced rail change. If repeated over a distance of 4 feet, about half the length of most surfboards, the rail would rise or fall about 0.4". For a surfboard 3" thick this would be equivalent to about a 30% change in rail position considering that the surfboard has a top and bottom with the rail equally shared by both.

It should be obvious that considerable lattitude is available in defining a rail with these drawings. Accurate modification of a specific rail is relatively simple and shaping the rail can be accomplished with a good degree of confidence.

NOSE AND TAIL SHAPE

In special cases, a template for the tail cross-section can be made. The tail is not usually shaped by its own bevels because the rails from both sides merge together at the tail.

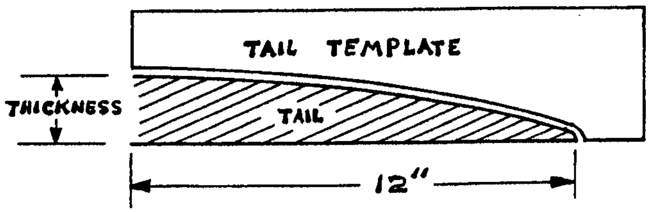


FIG. 3-11 TAIL CROSS-SECTION

The nose often does not adapt itself easily to making a cross-section drawing because it is usually part of an oblique curve of the rocker line curving upward. The shape of the nose can be left to be defined by the merging rails.

SPECIAL SHAPES

Vee bottoms, concave surfaces, special rails and tails can be treated as deviations from basic shapes. Each deviation being a special case.

An approach to defining these special cases should be to first design the basic shape, and then make modification. Changes of a design should be done in a way that does not make shaping marginally affected areas more difficult.

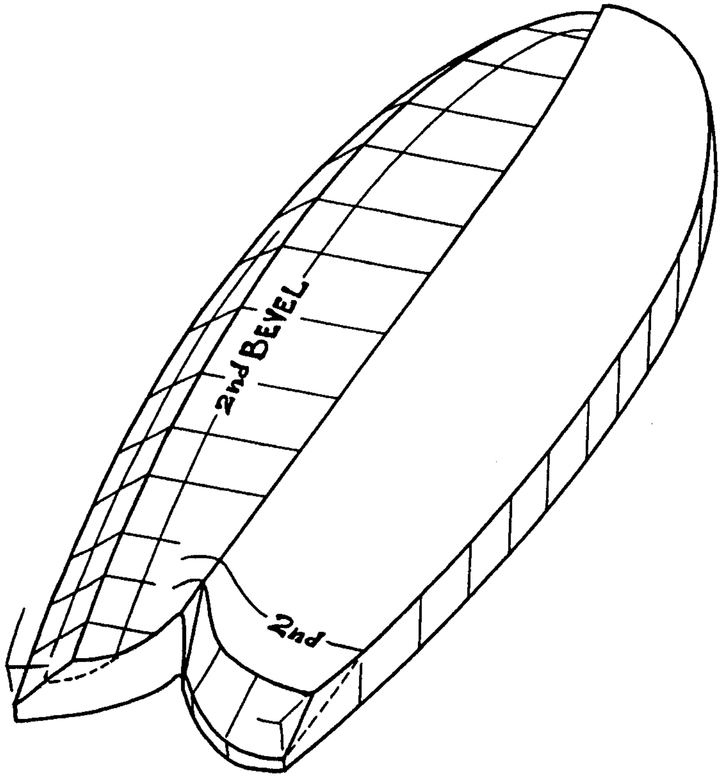


FIG. 3-12 SHAPING A FISH SURFBOARD

Shaping a Vee in the tail for instance, can be controlled by measuring its deviation away from the flat bottom. Use a 6 foot straight edge laid on the flat part of the bottom forward of the tail. A very slight vee will be about 1/8" higher than the center of the tail. Shaping a vee should be done before the rails are shaped, because the bottom edge rail line can be made fair without screwing up the rail lines.

Concave surfaces are a bit more complicated to shape. Define a concave by its depth into the surfboard and its surface area. Templates can be made up for specific sections along the concave.

Let your imagination fly and see what you come up with.

FIN DRAWING

A side view of a fin, drawn over a ¼" quadrille pattern makes it easy to measure its surface area by counting the squares.

The center can be located by finding a horizontal line through the fin that has an equal number of enclosed squares above and below the line, and then finding a similar vertical line. Where the lines cross is the center.

Projecting the center down onto the surfboard is a good way to define its location on the surfboard. In this way non-identical fins can be placed at the same location on the surfboard for comparison. They could be fins of the same surface area but different outlines or completely different fins.

Other notes about a fin can be put on the drawing such as; thickness, foil or mounting angle on the surfboard.

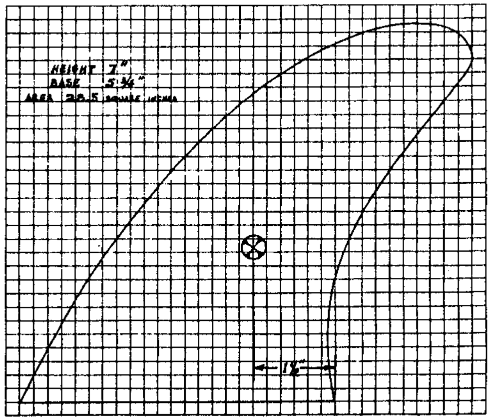


FIG. 3-13 FIN OUTLINE DRAWING

DRAWING EQUIPMENT

The list of drawing equipment below is all that is needed to make the drawings for a surfboard. The total cost of everything is about $20. Of course, you don't have to rush out and buy all this stuff; make do with whatever happens to be around the house.

- drawing board 20 x 26"
- T-square, 24" long
- 18" ruler marked in tenths of an inch
- 45° right triangle
- 2 french curves
- backing paper for drawing board-unlined
- masking tape
- tracing paper

The backing paper should be taped over the drawing board. Leave one edge of the board exposed for the T-square to rest against.

The two french curves shown below have enough curves in the right proportions to draw just about any rail outline.

Tracing paper with 10 lines per inch on one side can be purchased in 17" x 22" sheets. A number to ask for is Clearprint No. 1000H-10, or efficiency cross-section paper No. 1110.

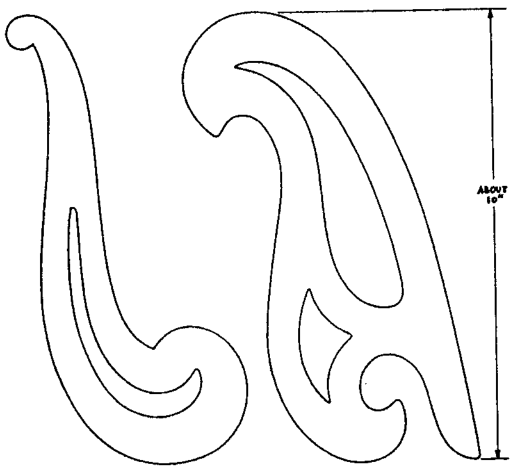


FIG. 3-14 FRENCH CURVES

Chapter 4

Surfboards to Build

The surfboards described in this chapter are just a few of the many shapes that are currently popular. All of the possible variations on these shapes are not discussed because the intention here is to provide basic shapes.

Usually a surfboard is tailored for the person who is going to ride it. Length and thickness depend partly on his weight. It is not easy to say that a particular surfboard should be riden by a particular weight surfer because there are many surfers weighing over 180 pounds that are riding a surfboard that would be recommended for a much lighter surfer with less experience. A beginning surfer will find a larger surfboard much easier to learn on. Greater floation will make catching waves easier and the surfboard will seem more stable to ride.

Most of the surfboards given here are for experienced surfers whose average weight is between 140 to 160 pounds. A large surfboard for a 130 pound surfer would be a small surfboard for someone weighing 180 pounds. Each would find the same surfboard different to control. The shapes given here can be made a few inches longer or shorter by adding or subtracting from the length in the middle of the rail outline (plan) template when it is laid out on the foam blank. They can also be made slightly thinner or thicker in the center without greatly changing the basic shape of the rail cross-section. It is also possible to use the rail outline from one surfboard and the rail cross-sections from another as long as the thickness corresponds.

There is an endless variety of fins that can be used on these surfboards. Use of a fin box makes experimentation easy because fins can be interchanged. Only a few fins are given here as examples.

I want to thank the people who provided some of the surfboard shapes and have given a brief discussion about them and their involvement with surfing.

STEVE LIS

Steve is the original developer of the fish. He first built it as a kneeboard for himself, then he built a few as surfboards for his friends. The transition between the super slow paddling take-off to the super fast speed turn-on shocks your awareness into a new time frame. The fish has affected a lot of surfers the same way. You have to ride it to believe it.

Steve has been surfing in and around San Diego for the last 11 years. Living close to Sunset Cliffs has provided him with a good proofing ground for his kneeboarding and surfboard shapes. He makes occasional long term trips to Mexico and has spent 3 years on Kauai.

He is totally involved in the discovery that surfing has to offer and is currently working on a new dimension by combining the kneeboard and surfboard.

TONY STAPLES

Tony likes to surf with a strong accent on hot dogging and manueverability. He grew up surfing in Pacific Beach and La Jolla, California. He got into shaping his own surfboards in the 8th grade. For the last 5 years he has been riding rounded egg type surfboards that he specializes in shaping. Tony has recently opened the Solana Beach Surf Shop where he takes custom orders for his shapes. His father helps him operate the shop. Tony has placed well in a number of surfing contests, and is respected for his surfing and shaping ability.

RICK McHALE

Rick is a student studying criminal justice in Long Beach, California. He is also an independent student of art, doing mostly paintings and drawings of surfing and ocean scenes.

He began shaping his own surfboards about 4 years ago. Once past the trial and error stage he began making surfboards for side money, and set up an arrangement with a friend to do the fiberglassing. An original home grown business was born. He is open to sharing techniques of surfboard shaping with beginners because he finds it expands his interest in surfing.

Rick has experimented with the swallow tail for about 3 years, doing most of his surfing in and around Huntington Beach. The 6' 7" swallow tail given here is one that he is currently riding.

ED TALBOT

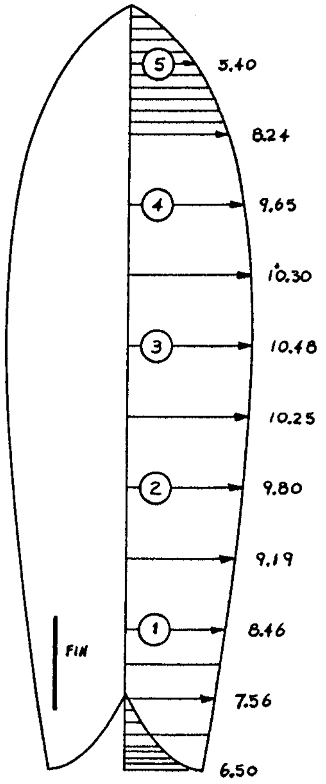
Ed has been involved in surfing and making surfboards for the last 8 years. He originally worked on surfboards in Greg Noll's shop in Hermosa Beach, California. Within three years he was signing checks and handling other responsibilities. He found that he liked working with customers and was good at the business end of operating a surf shop.

Three years ago he opened his own shop in Hermosa Beach with expert shapers Bob Moore and Pat (Gumby) Ryan doing the shaping. He co-sponsored a winter surfing contest that went off very well. Ed frankly admits that the energy he gets from surfing helps him do all the things he is into.

STEVE LIS

NOSE	1/2 WIDTH	
5"	0.0	inches
4	1.72	
3	2.89	
2	3.88	
1	4.70	
5 FOOT	5.40	
11	6.02	
10	6.57	
9	7.08	
8	7.50	
7	7.89	
6	8.24	

FIN POSTIONS: 1/2" OVER FROM PIN TOWARD CENTER AND TRAILING FIN BASE 5" FROM PIN.



1 FOOT	8.46	inches
9"	8.00	
6 1/2		0.0
6	7.56	–
5		0.80
4		1.44
3	7.06	2.15
2		2.90
1 1/2		3.33
1		3.84
1/2		4.55
0	6.50	6.50
TAIL	1/2 WIDTH	

FIG. 4–1 5'5" FISH KNEEBOARD – RAIL OUTLINE

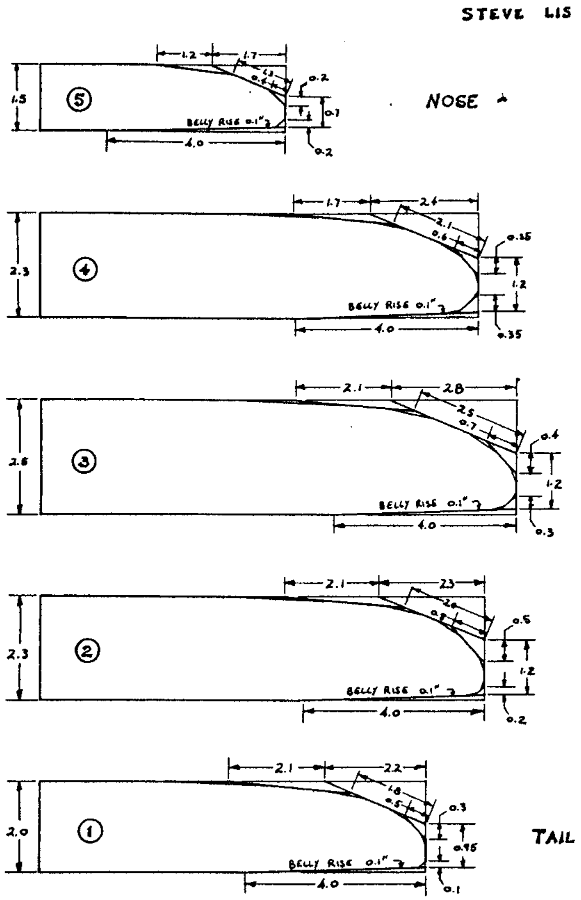


FIG. 4–2 5'5" FISH KNEEBOARD – RAÍL CROSS-SECTIONS

5'5" FISH KNEEBOARD

ROCKER

POSITION	ROCKER
Nose	3 1/4"
63"	3
58	2
52	1
44	1/2
37	1/4
Tail	–

THICKNESS

POSITION	THICKNESS
Nose	
5	1.5"
4	2.3
3	2.5
2	2.3
1	2.0
Tail	

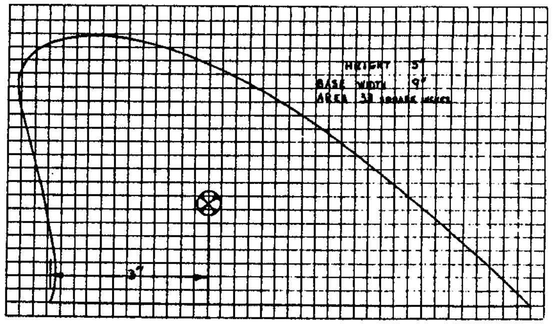


FIG. 4–3 FISH KNEEBOARD FIN

NOSE	1/2 WIDTH
8"	0.0 inches
7	2.50
6	3.58
5	4.36
4	5.05
3	5.60
2	6.10
1	6.51
(6) FOOT	6.92
11	7.30
10	7.69
9	8.00
8	8.30
7	8.55
6	8.50

FIN POSITION:
CENTER OF FIN
8 1/2" FROM TAIL

(1) FOOT	7.55 inches
11	7.30
10	7.02
9	6.78
8	6.46
7	6.10
6	5.73
5	5.30
4	4.81
3	4.24
2	3.50
1	2.53
0	0.0
TAIL	1/2 WIDTH

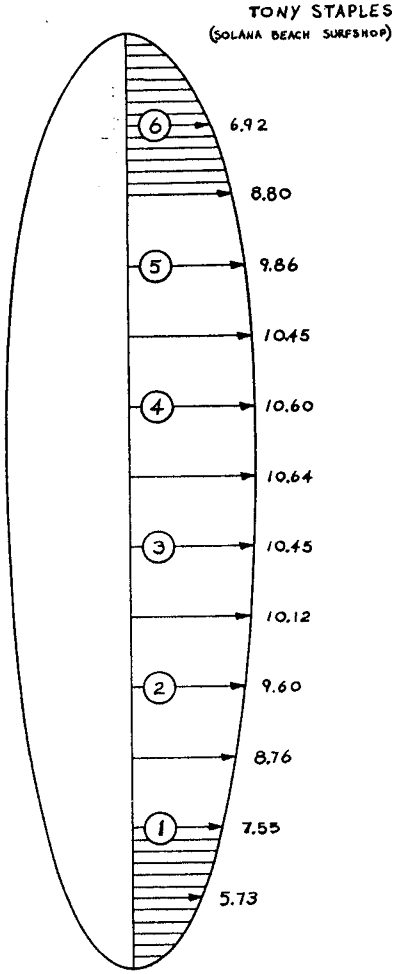


FIG. 4–4 6'8" EGG ROUND TAIL – RAIL OUTLINE

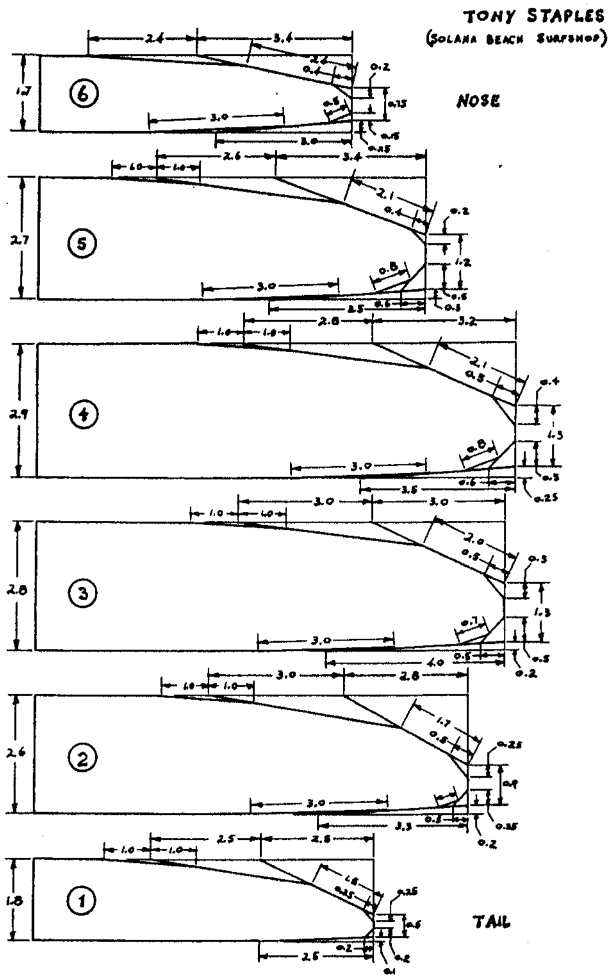


FIG. 4–5 6'8" EGG ROUND TAIL – RAIL CROSS-SECTIONS

6'8" EGG ROUND TAIL

ROCKER

POSITION	ROCKER
Nose	
80"	5"
77	4
73	3
67	2
58	1
51	1/2
Tail	

THICKNESS

POSITION	THICKNESS
Nose	
6	1.7"
5	2.7
4	2.9
3	2.8
2	2.6
1	1.8
Tail	

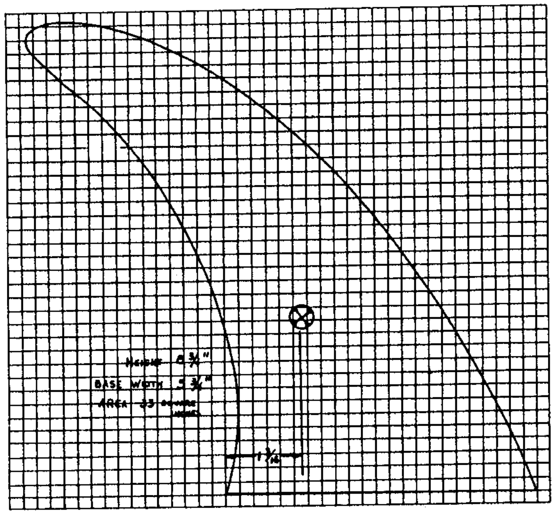
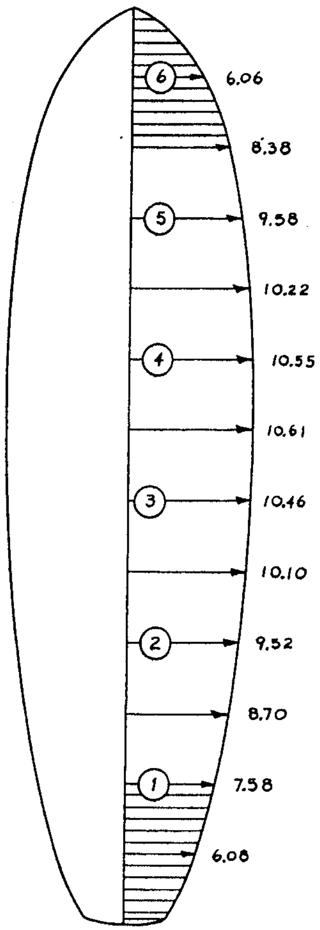


FIG. 4–6 FIN FOR EGG ROUND TAIL SURFBOARD

TONY STAPLES
(SOLANA BEACH SURFSHOP)

NOSE	1/2 WIDTH
6"	0.0 inches
5	2.05
4	3.20
3	4.10
2	4.82
1	5.47
6 FOOT	6.06
11	6.55
10	7.00
9	7.40
8	7.78
7	8.10
6	8.38



1 FOOT	7.58 inches
9"	6.88
6	6.08
5	5.78
4	5.43
3	5.04
2	4.60
1	4.00
1/2	3.50
0	0.0
TAIL	1/2 WIDTH

FIG. 4–7 6'6" ROUNDED SQUARE TAIL – RAIL OUTLINE

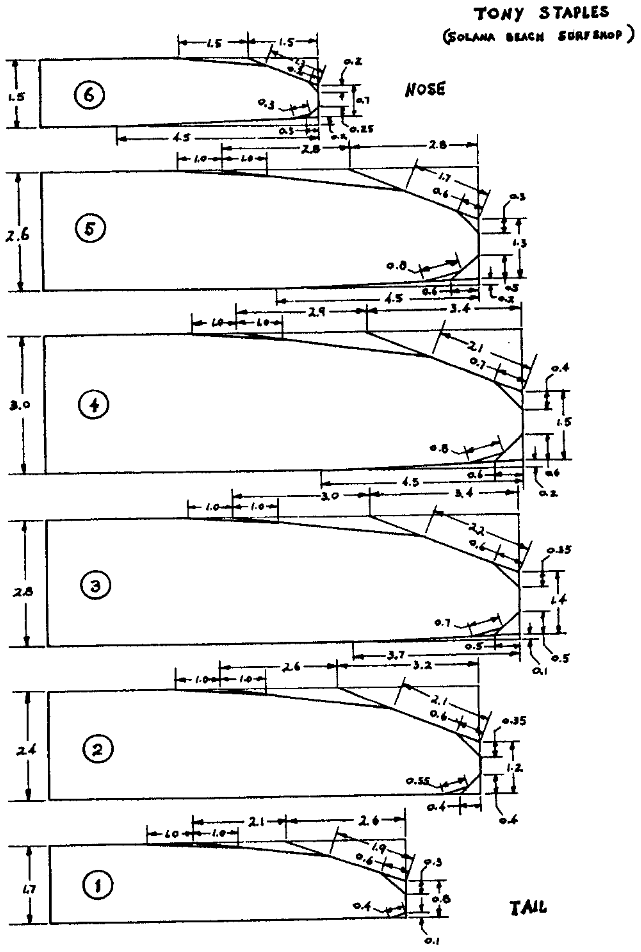


FIG. 4–8 6'6" ROUNDED SQUARE TAIL – RAIL CROSS-SECTIONS

6'6" ROUNDED SQUARE TAIL SURFBOARD

ROCKER

POSITION	ROCKER
Nose	
78"	6"
76	5
72	4
67	3
62	2
54	1
46	1/2
Tail	

THICKNESS

POSITION	THICKNESS
Nose	
6	1.5"
5	2.6
4	3.0
3	2.8
2	2.4
1	1.7
Tail	

6'7" SWALLOW TAIL SURFBOARD

ROCKER

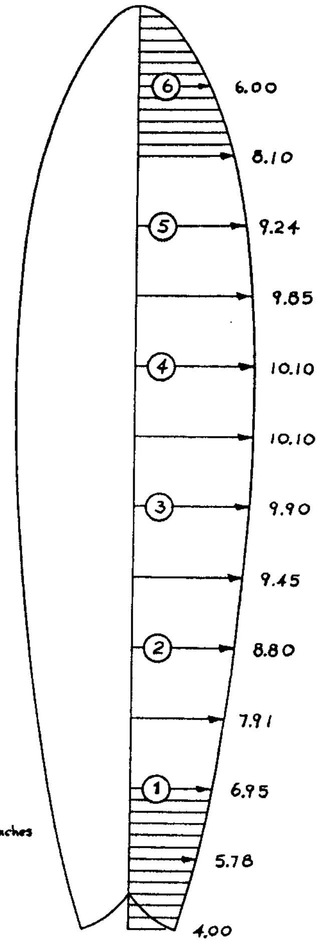
POSITION	ROCKER
Nose	
79"	5"
75	4
71	3
65	2
57	1
49	1/2
Tail	

THICKNESS

POSITION	THICKNESS
Nose	
6	2.3"
5	2.75
4	3.0
3	2.75
2	2.3
1	1.7
Tail	

NOSE	1/2 WIDTH	
7"	0.0	inches
6	2.14	
5	3.05	
4	3.78	
3	4.42	
2	5.00	
1	5.50	
6 FOOT	6.00	
11	6.40	
10	6.80	
9	7.18	
8	7.50	
7	7.80	
6	8.10	

RICK McHALE



1 FOOT	6.95	inches	
11"	6.78		
10	6.60		
9	6.40		
8	6.20		
7	6.00		
6	5.78		
5	5.55		
4	5.30		
3	5.05		
2	4.75	0.0	inches
1	4.42	.90	
1/2		2.65	
0	4.00	4.00	
TAIL	1/2 WIDTH		

FIG. 4–9 6'7" SWALLOW TAIL – RAIL OUTLINE

RICK McHALE

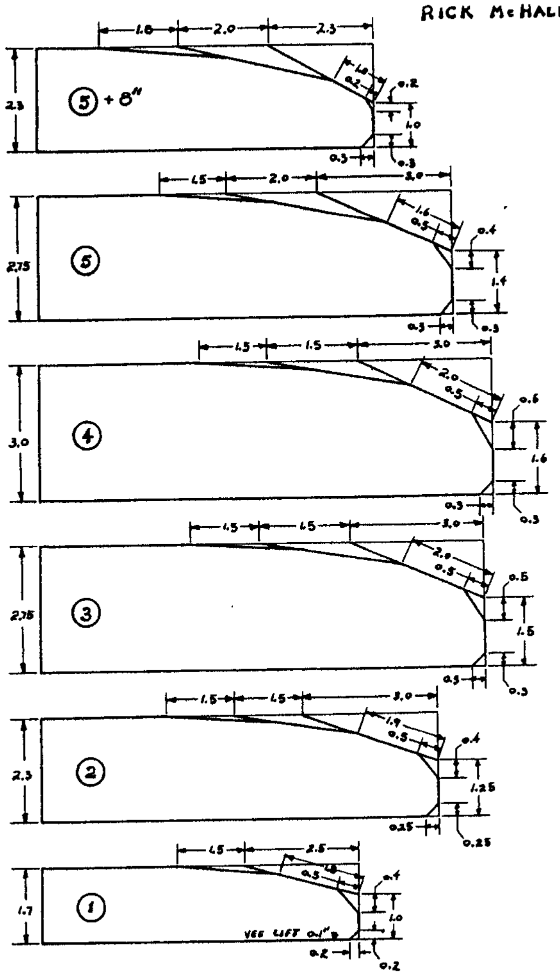
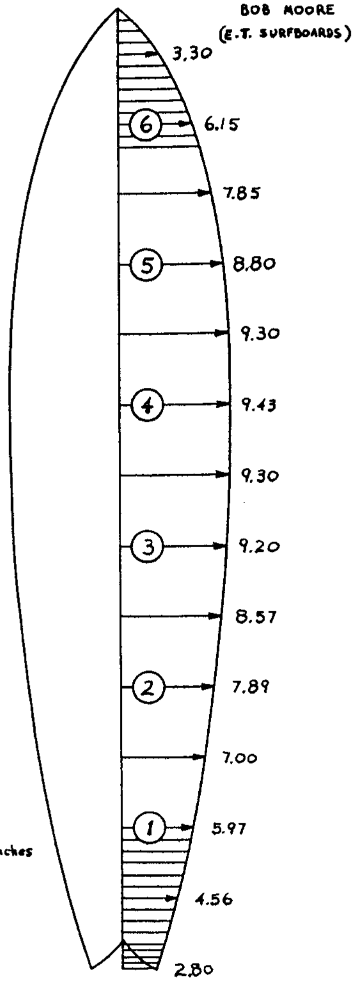


FIG. 4–10 6'7" SWALLOW TAIL – RAIL CROSS-SECTIONS

NOSE	1/2 WIDTH
10"	0 inches
9	1.15
8	2.00
7	2.70
6	3.30
5	3.87
4	4.40
3	4.88
2	5.34
1	5.78
6 FOOT	6.15
11	6.50
10	6.81



1 FOOT	5.97 inches	
11"	5.68	
10	5.45	
9	5.25	
8	5.00	
7	4.80	
6	4.56	
5	4.32	
4	4.05	
3	3.78	
2	3.50	0.35 inches
1 ½		0.82
1	3.18	1.38
½		1.97
0	2.80	2.80
TAIL	1/2 WIDTH	

FIG. 4–11 6'10" SWALLOW TAIL – RAIL OUTLINE

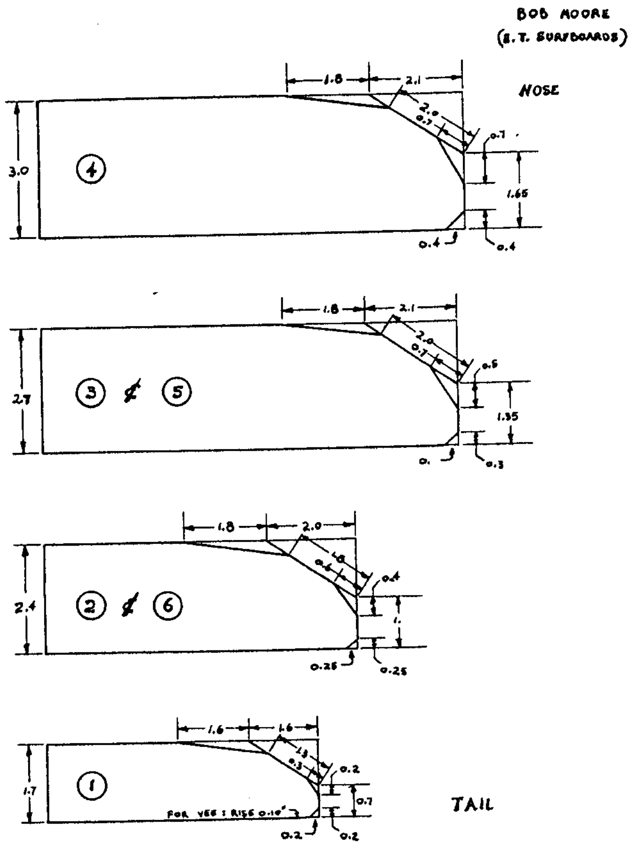


FIG. 4–12 6'10" SWALLOW TAIL – RAIL CROSS-SECTIONS

6'10" SWALLOW TAIL SURFBOARD

ROCKER

POSITION	ROCKER
Nose	
81"	6"
77	5
73	4
68	3
62	2
53	1
45	1/2
Tail	–

THICKNESS

POSITION	THICKNESS
Nose	
6	2.4"
5	2.7
4	3.0
3	2.7
2	2.4
1	1.7
Tail	

Note: Vee at tips of swallow are 3/16" away from flat, extends almost 2 ft. up from tail.

6'3" WINGER SWALLOW TAIL SURFBOARD

ROCKER

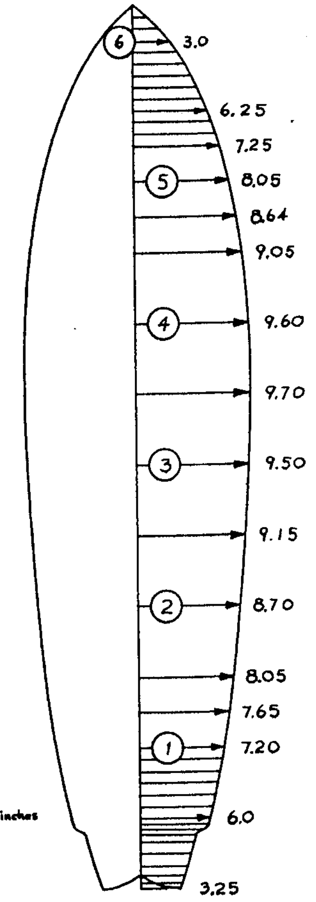
POSITION	ROCKER
75"	5"
72	4
67	3
62	2
53	1
46	1/2
2 Foot	Ref. Point
Tail Lift	1/2"

THICKNESS

POSITION	THICKNESS
Nose	
5 + 8"	2.1"
5	2.5
4	3.0
3	3.0
2	2.7
1	2.0
Tail	

PAT (GUMBY) RYAN
(E.T. SURFBOARDS)

NOSE	1/2 WIDTH
3"	0 inches
2	1.26
1	2.20
6 FOOT	3.00
11	3.65
10	4.30
9	4.85
8	5.35
7	5.80
6	6.25
5	6.64
4	6.95
3	7.25



1 FOOT	7.20 inches	
10	6.85	
8	6.43	
6	6.00	
5½	5.78	
5	5.50	
4½	5.00	
4	4.75	
3	4.45	
2	4.10	
1	3.80	0.0 inches
½		1.00
0	3.25	3.25
TAIL	1/2 WIDTH	

FIG. 4–13 6'3" WINGER SWALLOW TAIL – RAIL OUTLINE

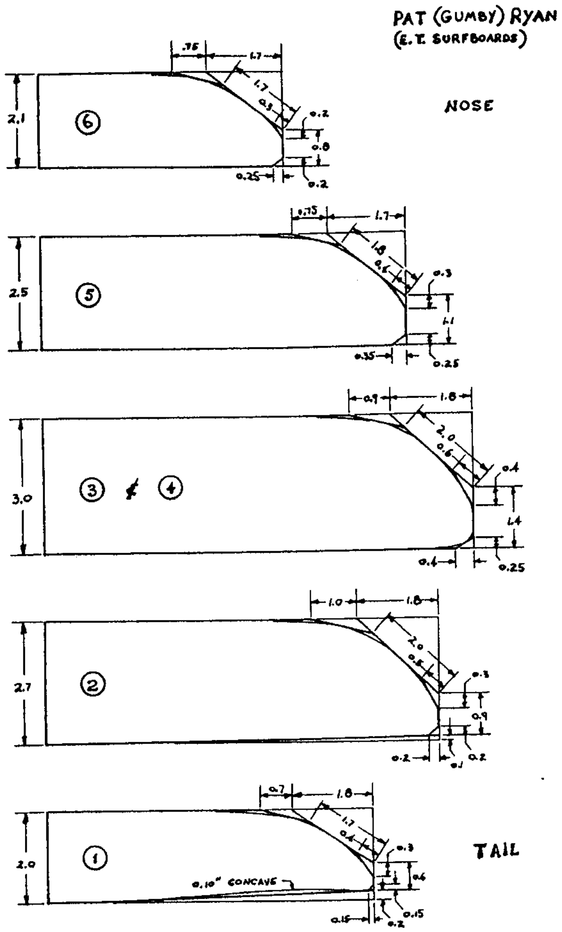


FIG. 4–14 6'3" WINGER SWALLOW TAIL – RAIL CROSS-SECTIONS

NOSE	1/2 WIDTH
10"	0.0 inches
9	2.56
8	4.05
7	5.10
6	5.90
5	6.54
4	7.10
3	7.55
2	7.95
1	8.35
(6) FOOT	8.70

FIN POSITION:
CENTER OF FIN
9" FROM TAIL

(1) FOOT	6.50 inches
11"	6.20
10	5.90
9	5.55
8	5.20
7	4.80
6	4.45
5	4.00
4	3.55
3	3.00
2	2.35
1	1.60
0	0.0
TAIL	1/2 WIDTH

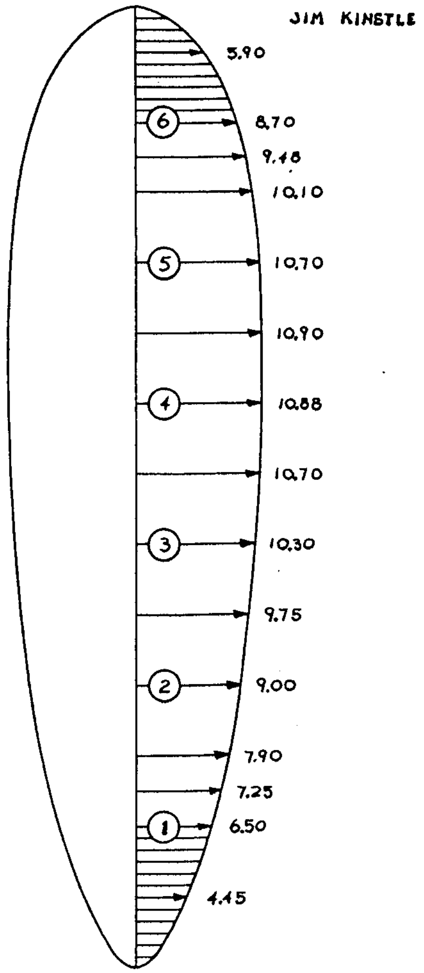


FIG. 4–15 6'10" TEARDROP – RAIL OUTLINE

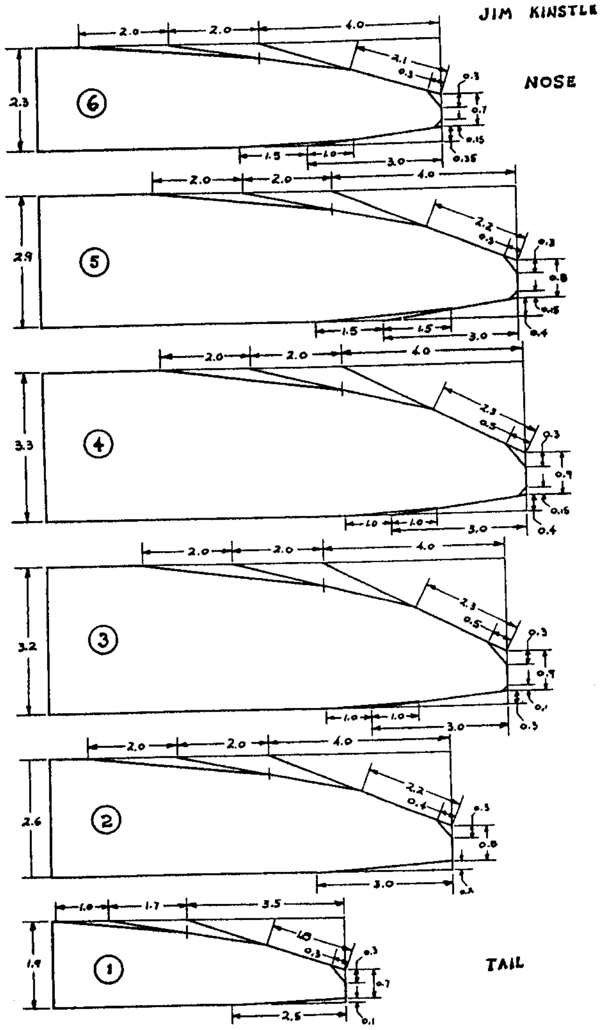


FIG. 4–16 6'10" TEARDROP – RAIL CROSS-SECTIONS

6'10" TEARDROP SURFBOARD

ROCKER

POSITION	DESIRED ROCKER
Nose	
82"	5 1/2
80	5
77	4
73	3
67	2
59	1
52	1/2
Tail	0

THICKNESS

POSITION	DESIRED THICKNESS
Nose	
6 + 6"	1.7"
6	2.3
5	2.9
4	3.3
3	3.2
2	2.6
1	1.9
Tail + 6"	1.4

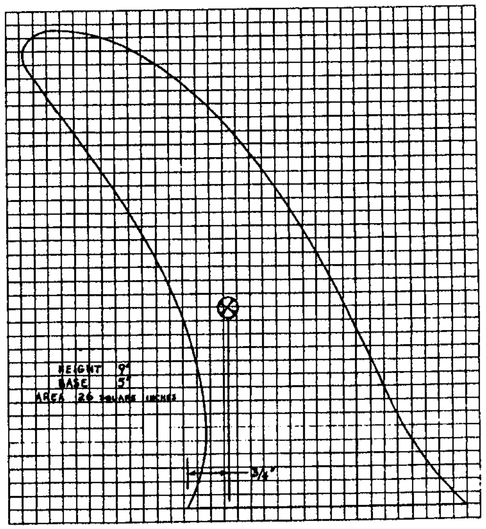


FIG. 4–17 FIN FOR TEARDROP SURFBOARD

JIM KINSTLE

NOSE	1/2 WIDTH
11"	0.0 inches
10	2.20
9	4.08
8	5.13
7	6.00
6	6.70
5	7.35
4	7.90
3	8.35
2	8.75
1	9.05
5 FOOT	9.35
11	9.60
10	9.80
9	10.00
8	10.15
7	10.30
6	10.40

FIN POSITION:
TRAILING BASE 6" FROM TAIL, FINS SEPARATED 11½"

1 FOOT	7.80	inches
7"		.00
6	7.10	.40
5		.90
4		1.40
3		1.90
2		2.50
1		3.40
0	6.35	6.35
TAIL	1/2 WIDTH	

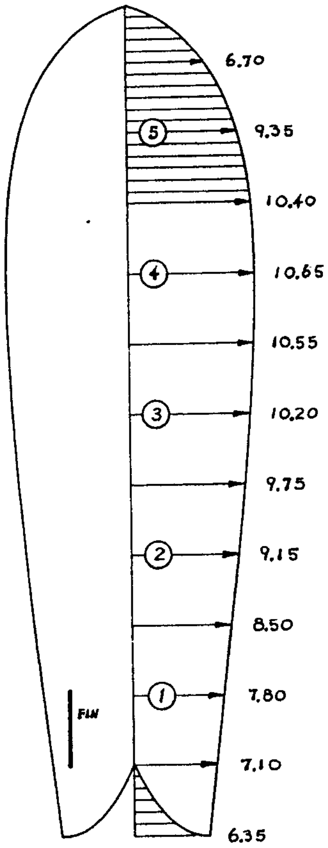


FIG. 4–18 5'11" FISH SURFBOARD – RAIL OUTLINE

JIM KINSTLE

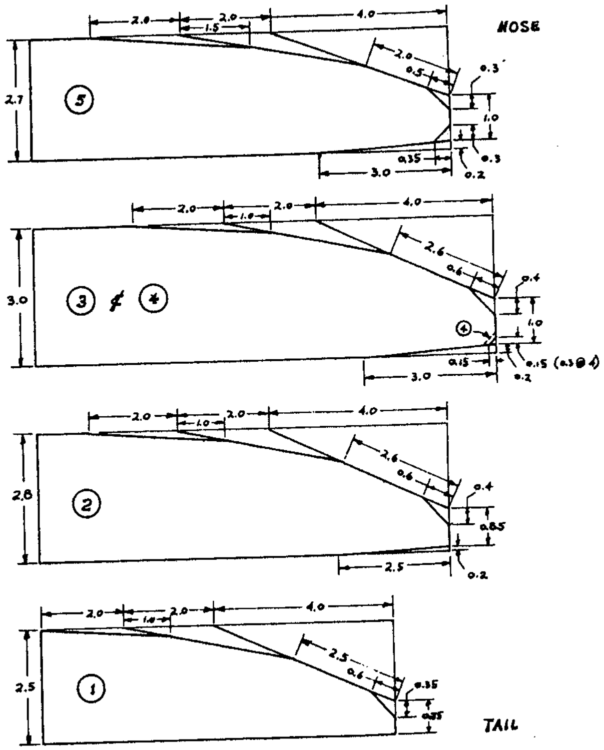


FIG. 4–19 5'11" FISH SURFBOARD – RAIL CROSS-SECTIONS

5'11" FISH SURFBOARD

ROCKER

POSITION	ROCKER
Nose	3 3/4"
68"	3
63	2
55	1
48	1/2
Tail	—

THICKNESS

POSITION	THICKNESS
Nose	
⑤ + 6"	2.3"
⑤	2.7
④	3.0
③	3.0
②	2.8
①	2.5
Tail	

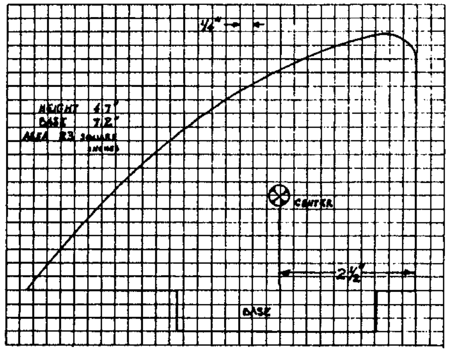
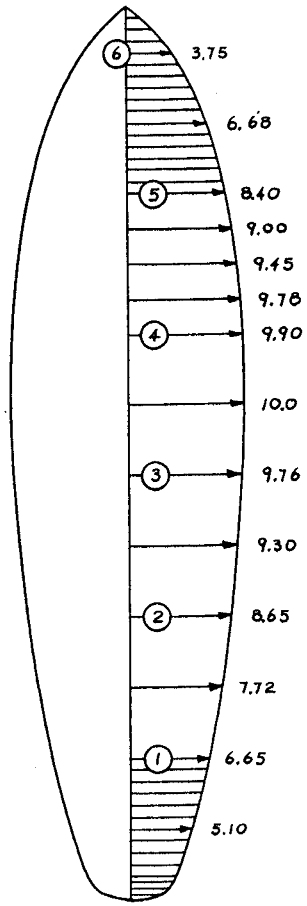


FIG. 4–20 FIN FOR FISH SURFBOARD

NOSE	1/2 WIDTH
4"	0.0 inches
3	1.46
2	2.40
1	3.15
⑥ FOOT	3.75
11	4.36
10	4.90
9	5.40
8	5.89
7	6.30
6	6.68
5	7.00
4	7.30
3	7.60
2	7.89
1	8.15
⑤ FOOT	8.40

HAWAIIAN SHAPE



TAIL	1/2 WIDTH
① FOOT	6.65 inches
11"	6.32
10	6.08
9	5.84
8	5.60
7	5.36
6	5.10
5	4.85
4	4.55
3	4.27
2	3.84
1 1/2	3.50
1	2.98
1/2	2.15
0	0.0

FIG. 4–21 6'4" HAWAIIAN SHAPE – RAIL OUTLINE

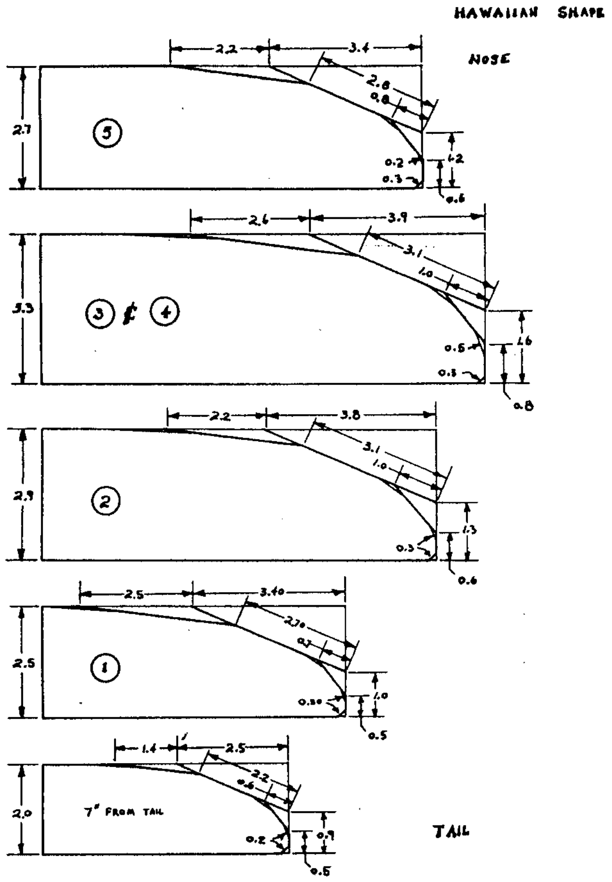


FIG. 4–22 6'4" HAWAIIAN SHAPE – RAIL CROSS-SECTIONS

6'4" HAWAIIAN SHAPE SURFBOARD

ROCKER

POSITION	ROCKER
Nose	
76"	5 1/2"
75	5
72	4
68	3
63	2
55	1
47	1/2
Tail	

THICKNESS

POSITION	THICKNESS
Nose	
6	1.4"
5	2.7
4	3.3
3	3.3
2	2.9
1	2.5
7"	2.0
Tail	

PLACES TO BUY SURFBOARD CONSTRUCTION MATERIALS

Green Room Surfboards and Supplies
4992 Newport Ave.
Ocean Beach, California

Mitch's Surf Shop
631 Pearl Street
La Jolla, California

Koast Surfboards
1575 South Highway 101
Cardif, California

Hanifin Surf Shop
111 22nd St.
Newport, California

Wind and Sea Surf Shop
520 Pacific Coast Highway
Huntington Beach, California

Marina Fibercraft
702 Marina Drive
Seal Beach, California

E.T. Surfboards
916 Aviation Blvd.
Hermosa Beach, California

Chapter 5

Garage Workshop

A place to make surfboard does not have to be a specialized area. There should be room to move around and stand back away from the board a bit.

Basic requirements are proper lighting, 115 vac power, ventilation, running water in a sink of some sort, and a place for trash. A simple work bench is also convenient.

Shaping and glassing racks should be permitted relatively fixed locations. Less moving around of furniture is also desirable to avoid extra hassle. Lay down heavy tar paper underneath the glass rack so resin can pile up on it instead of on the floor. Building a surfboard tends to make a big mess; with foam dust, cuttings, and sanded fiberglass building up a layer on everything in sight. Usually a mess doesn't detract from involvement with the work, seemingly riding on a crest of anticipation that builds as the surfboard takes shape.

If the place is rented, you might have to do some persuasive talking to convince a landlord that his space is going to remain nice and neat and you have his vested interest at heart. Some landlords are a special breed of worry-people who need lots of coddling.

LIGHTING

Surface continuity will show up immediately with good lighting. Two lights, one off to the side, and another above, that can be turned on and off independently, works out pretty well. Light from a single source will cast clean shadows on the foam shape. Do not try to shape a surfboard outside with sunlight. Bright light on a foam blank is like trying to look at snow in direct sunlight; it can be seen, but its shape cannot.

VENTILATION

Good air circulation throughout the work area is a must. A source of fresh air should be available at all times so you can breath. Vapor from fiberglass resin is highly inflammable.

Fiberglassing in an enclosed room can concentrate the resin vapor to the point where it could be set off by a lighted match or the pilot light of a water heater. Your local fire department can provide you with all kinds of requirements for safe working conditions.

SHAPING STAND

The shaping stand is a holder that craddles one rail and holds the other up in the air at about chest level for shaping. The surfboard blank can also be placed horizontal on the stand for working on the top and bottom surfaces.

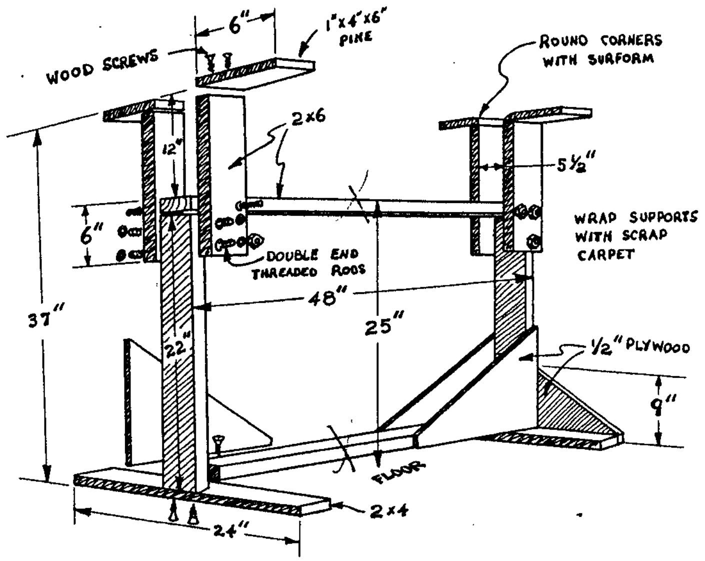


FIG. 5-1 THE SHAPING STAND

GLASS RACK

The glass rack supports the blank for fiberglassing and serves as an alternate support for shaping.

Foam rubber over the contact points will provide a firm non-slip contact that holds the blank on the rack.

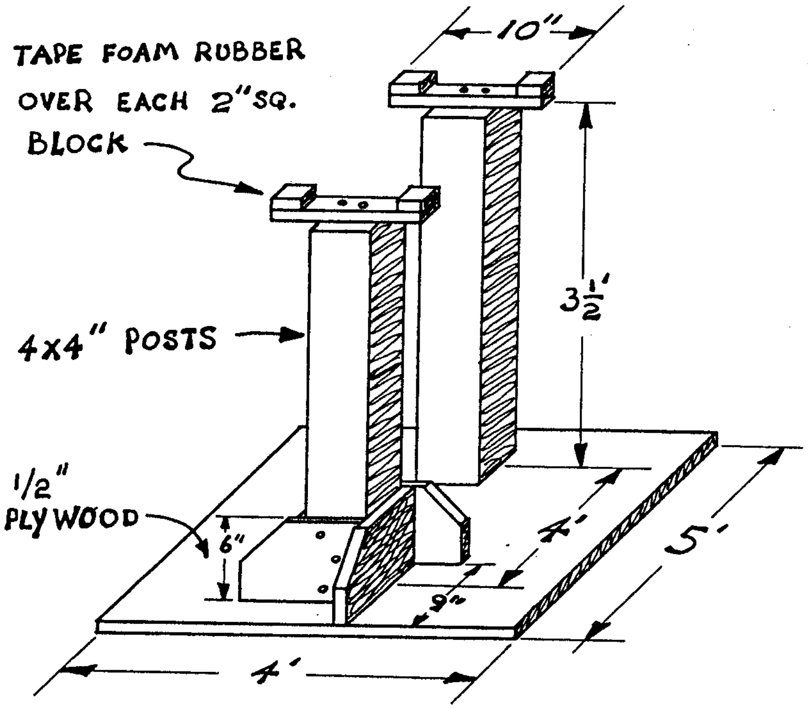


FIG. 5-2 THE GLASS RACK

POWER PLANER

Selection and purchase of a power planer is probably the first step toward serious surfboard construction, since it is the largest single capital outlay toward shaping. Shaping without one is extra work. The cost ranges from $50 to $230.

An inexpensive planer is sold by Montgomery Ward for $50, model B8989. In the high price range there is the Rockwell model 653, and the Skil model 100.

Features to look for are weight, width of cut, variable depth of cut, and overall length.

Lighter weight planers are preferred because they are easier to hold and control. Working with foam, the foam itself cannot always be replied upon for supporting the plane. It must be primarily supported by you holding it.

Width of cut varies from 1¼" in cheap planes to 3" in higher quality planes. A wide cut is preferred because you have more control over the area being shaped.

Depth of cut should be adjustable; the adjustment should be possible when the plane is in use, although it is not necessary.

Overall length should be around 16". Short planes will tend to create irregularities in long, flat cuts.

Two kinds of cutting blades are available, hardened steel and carbide tips.

The less expensive hardened steel blades are good enough because cutting foam does not put much wear on the blade.

ROUTER

An inexpensive router will usually do most routing jobs related to surfboard construction. Most routing is for fin slots in foam. Sometimes routing is done through a layer of fiberglass for a fixed fin instalation. It is a light load on a router, so excessive power is not needed. Cost is about $45.

For routing slots, a 3/8" straight bit (Rockwell #80114) and a 3/8" template guide work well. The bit has a carbide tip for cutting through fiberglass.

JIG SAW

A small hand-held electric jig saw or bayonet-type saw is useful for cutting rail outlines in blanks and fins out of fiberglass panels. It is also very useful for wood cutting and odd jobs that show up from time to time like cutting out templates and making special jigs. The prices ranges from $25 to $135.

The saw blades are interchangeable so it's really many saws in one. Depth of cut ranges from 1-5/8" to 2½".

DISK SANDER

A portable electric disk sander cuts down a lot of the manual labor in finishing fiberglass. Try to avoid using a high powered, high RPM sander. No load RPM should be between 2000 and 4500; the lower the better. A light weight sander is easier to control. Cost ranges between $35 to $100.

Most sanders have 5/8"-11 spindle thread for attaching the soft sponge rubber backing pad used to save the board. A foam pad is necessary to help avoid gouging and for working on curved surfaces. The pad consists of two parts; a hard rubber back-up, and a foam replacement pad, such as made by Bear—part numbers 8B and 7MR, respectively. Sandpaper disks are glued to the foam pad with contact cement or disk adhesive.

SURFORM

The most useful hand tool for finish shaping foam and smoothing rough fiberglass edges, is the surform.

It is actually a sophisticated file. It is a good idea to buy two sizes. A larger one for surface planing and a smaller pocket plane for detail work. Cost for both is about $8.

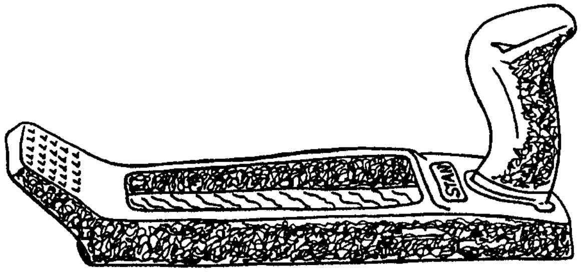


FIG. 5-3 THE SURFORM

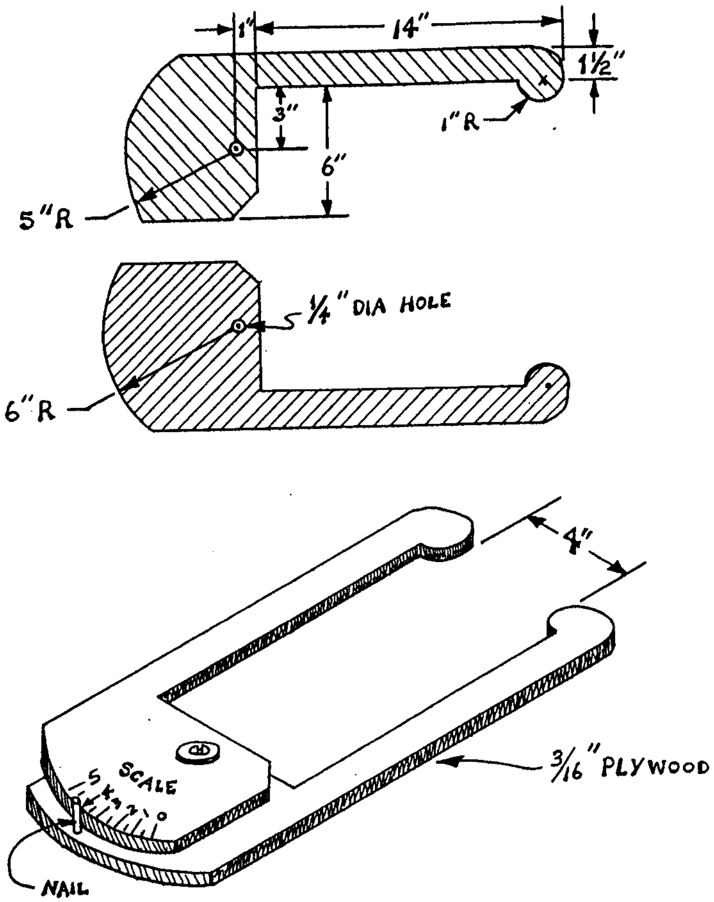


FIG. 5-4 THICKNESS CALIBERS

RULER

A rigid ruler at least 18" long with scale markings graduated in 1/10ths of an inch is needed for marking rail bevels corresponding to the template dimensions.

CALIBERS

Surfboard thickness can be measured with calibers made out of wood. The number scale on the back is made by opening the Calibers to 1", 2" and 3" etc., then marking the scale accordingly.

STRAIGHT EDGE

A straight edge used for measuring rocker can be bought at a hardware store for about $3. Ask for a 6' to 8' length of right angle extruded aluminum. Be sure to sight down its length to assure yourself that it doesn't have any bend or warp in it.

BLOCK PLANE

A small block plane is used to remove very small amounts of foam during the final shaping of the blank. Its usefulness over a surform is that it is more accurate for removing very small uniform strips of foam when blending the rail surface into a foiled surface. Be sure to keep its blade very sharp. A good small block plane costs about $8.00.

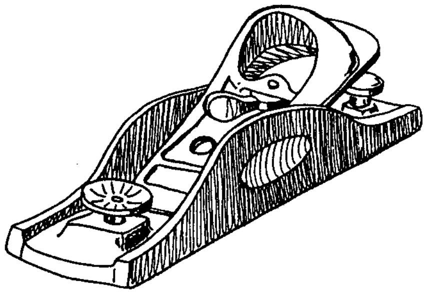


FIG. 5-5 BLOCK PLANE

SANDING BLOCKS

Two blocks can be made that meet most of the sanding block needs for foam shaping. One is a 24" length of 2" x 4" wood. Its wide side is planed flat with the power planer and # 36 grit sandpaper fixed to it with contact cement.

The second block is a 1" x 4" x 8" piece of wood, flat on one side with a door handle on the other. Sandpaper is held in place over the flat side by large tacks driven into the ends through the sandpaper. Removing the tacks permits changing to different grades of sandpaper.

A third sanding block, handy to have around for multi-purpose use, is a small rubber block that fits into the palm of the hand. One type is called a "speed-holder".

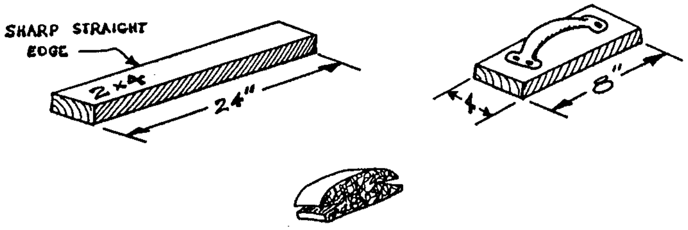


FIG. 5-6 SANDING BLOCKS

FIN SLOT TEMPLATE

A slot in the surfboard for a fin or fin box is cut out using a router and a template. The template is needed to cut out a clean slot with proper dimensions.

The template is nothing more than a flat piece of 3/8" thick plywood with an oversize slot in it. The dimensions of the slot in the template are the dimensions of the slot to be put in the surfboard, plus an extra fraction of an inch to allow for the space taken up by the template guide on the router.

The router template guide is a small circular insert on the router that surrounds the shaft of the router bit and extends below the router's bottom surface about ¼". This template guide comes up against the inside of the slot in the template and contains the cut of the router within the limits of the slot.

To make the template, use the router to cut the oversize slot in the plywood. Use a 3/8" bit and a ½" dia template guide. The difference between these two diameters is the space taken up by the guide, in this case 1/8". The dimensions of the oversize slot will be ¼" greater than the slot to be made in the surfboard. The oversize is twice the space taken up by the guide because there are two sides to the slot.

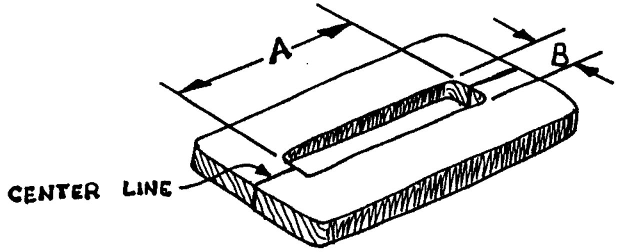


FIG. 5-7 FIN SLOT TEMPLATE

Get a flat piece of 3/8" plywood and four more pieces of the same thickness. Cut the four pieces so they have straight sides that are longer than the dimensions of the slot to be made in the surfboard.

Nail the four pieces onto the template to form a temporary template for routing the oversize slot in the real template.

Rout the slot and remove the four pieces.

Saw around the template so there is at least 3" of surface on all sides of the slot to provide for router support when using the template. Mark a center line for alignment.

FACE MASK AND GOGGLES

When shaping foam and sanding fiberglass, protection for your eyes and breathing is a good idea. There are two types of masks that can be worn. One is a particle mask, an inexpensive paper or plastic mask that fits over the nose and mouth to filter out particles and non-toxic vapors.

The other is a rubber mask called a respirator and is used by spray painters. It has an interchangeable cartridge that will filter out toxic vapors. A good respirator mask is made by Binks, model 40-28, for about $8.

MISCELLANEOUS

Other small tools and materials that are useful in making surfboards are listed below.

- 10' metal tape
- 115 vac power extension cord
- key hole saw
- semi-stiff hand brush
- soft lead pencil
- masking tape
- 10" 4-in-1 file
- sanding screen
- squeegee
- single edge razor blades
- mixing bucket
- 4" paint brush
- cleaning rags
- acetone
- sandpaper
- 2" thick sponge

BARE BONES

Reading through this chapter may scare you about the cost of power tools if you don't have the money to buy them. As far as making a surfboard goes, you can get by with the bare bones list below for about $35.

- surform
- 6' to 8' straight edge
- 24" sanding block
- small sanding block
- glass rack
- key hole saw
- hand brush
- 10' metal tape
- 18" ruler (1/10th inch markings)
- wood calibers
- squeegee

All you have to do is add the extra labor. One step you may have difficulty with is routing a fin slot. A router can be rented to do the job or you can take the blank to a surfshop, and ask them to rout out a fin slot for you.

Chapter 6

Shaping a Surfboard

Important factors to consider when picking out a foam surfboard blank are; foam quality, center stringer, rocker, thickness, width, and length. Foam quality is based upon its strength relative to its weight. It should be as light and strong as possible. Most surfboard blank manufacturers produce blanks out of the same type polyurethane foam. Strength and weight are determined by the foam density. High density foam is strong and heavy, low density foam is weak and light.

Blank manufacturers usually sell two or three different density foam. Since most of the overall strength of a surfboard comes from its center stringer and fiberglass coat, it is usually best to use a blank that is made of the lowest density foam that the blank manufacturer produces, rely on his integrity and assume that he is supplying optimum quality foam.

Center stringers are necessary to help control the longitudinal rocker of the blank, when shaping and glassing the surfboard. They also help to retain the rocker long after the surfboard is built. Usually a 1/8" stringer of cedar or redwood, placed down the center, is sufficient. Blank manufacturers put the stringer in by sawing the blank in half, placing the stringer between the two halves and glueing them back together.

Rocker of the blank should be checked with a straight edge that is as long as the blank. Place the straight edge up to the bottom side of the blank. Measure the rocker curve deviation away from straight at approximate points defined by the design. The rocker curve of the blank should be slightly less than the rocker desired on the finished surfboard, because it is much easier to shape more rocker into a blank than to shape it flatter.

Thickness should be at least 1/2" thicker than the desired surfboard thickness. Usually the extra thickness should be more than 1/2" because once the rocker is shaped, there should be enough thickness left to complete the surfboard.

Thickness out toward the rails should be close to the center thickness so a square rail can be obtained for marking off bevels. Some blanks have the foam out toward the rails tapered thinner with the intention of making shaping easier. These blanks should be avoided because the shaped rail will end up thinner than desired when bevel dimensions for a square rail are used.

Width and length of the blank should, of course, be greater than the surfboard to be built.

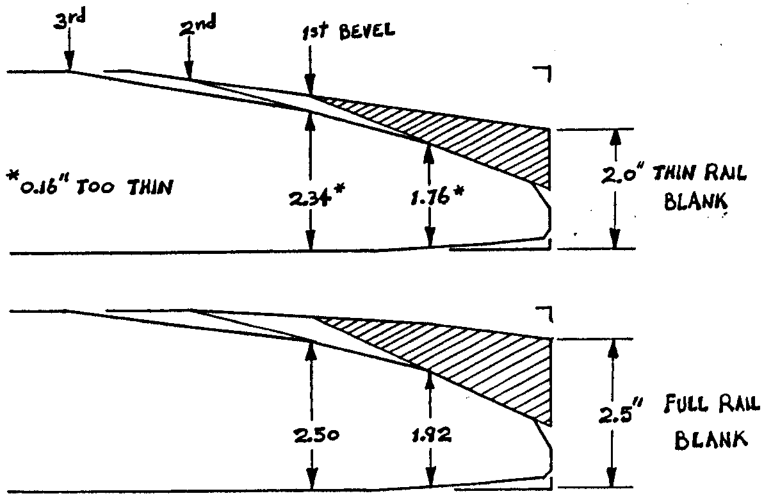


FIG. 6-1 EFFECT OF THIN RAIL ON BLANK

SHAPING PROCEDURE

The shaping process described is a working description of steps in a natural sequence. Read it through to get a clear picture in your mind of how the shaping is done. Sanding blocks should have about #36 grit sandpaper on them, unless stated otherwise.

① Rough plane the bottom surface down to clean foam (about 1/8" into the blank) by making lengthwise cuts from tail to nose. Generally work the bottom toward making it flat, rail to rail.

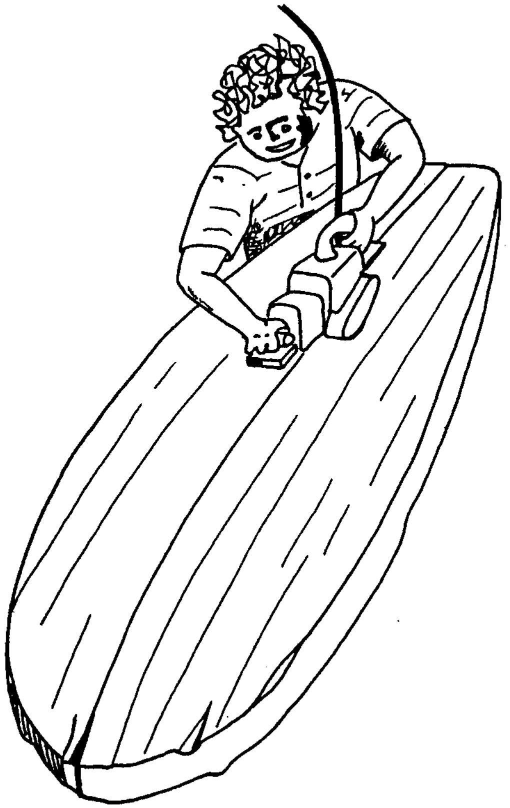


FIG. 6-2 PLANING BOTTOM SMOOTH

② Tape the rail outline template (plan shape) in place on the bottom and mark the foam with a soft lead pencil run along the edge of the template.

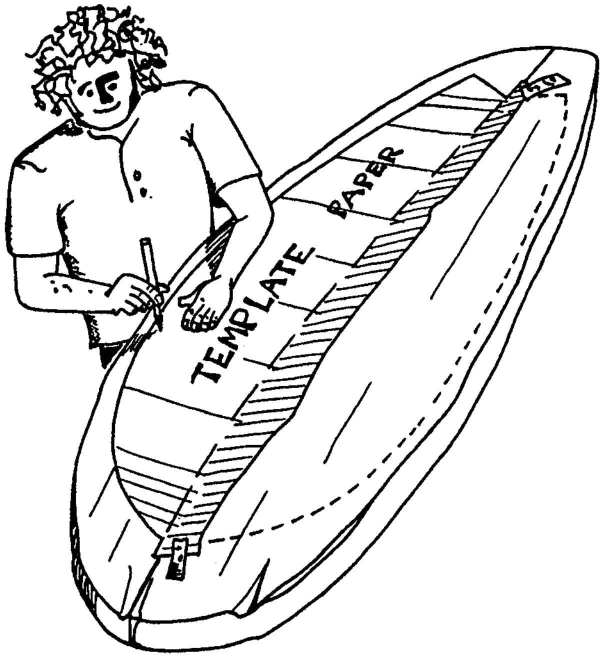


FIG. 6-3 MARKING RAIL OUTLINE

③ Cut away the excess foam with a saber saw or small hand saw at a right angle to the bottom of the blank around the outline (about 1/8" outside the line).

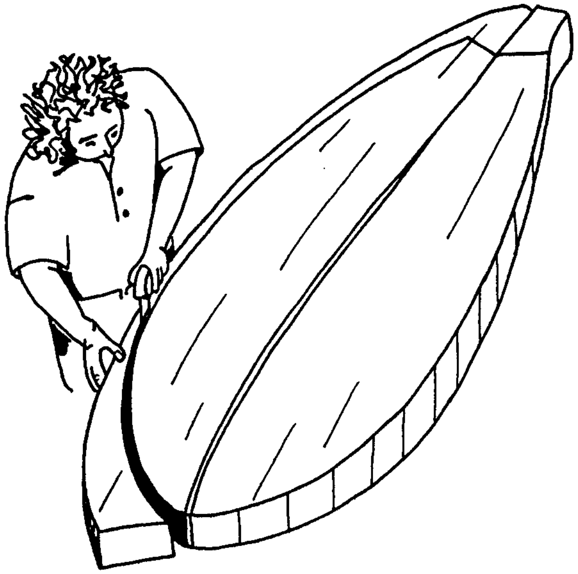


FIG. 6-4 CUTTING OUT RAIL OUTLINE

④ Rough plane the top surface down to clean foam. Start from the tail and plane toward the nose (again about 1/8" into blank).

FIG. 6-5 PLANING DECK SMOOTH

⑤ SQUARE RAIL – Sand or surform the rough sawed rail square with the bottom surface. Make it co-incident with the rail outline curve drawn on the bottom. Sanding should be done with long strokes along the length of the rail. As you do this, clean up the curve to suit your eye.

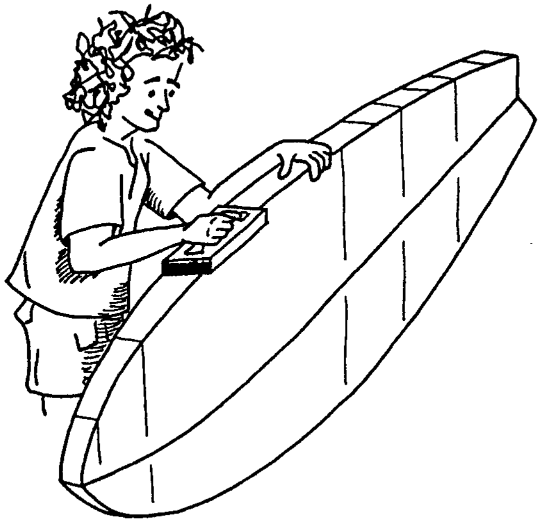


FIG. 6-6 SANDING RAIL SQUARE

⑥ FLAT BOTTOM – Make the bottom flat from side to side using the 24" sanding block. Sanding should be done with long strokes up and down the board with the sanding block placed across the stringer and its ends extending over the rails. Use the surform to level the stringer with the foam otherwise the sanding block will see-saw over the stringer and create a rounded bottom instead of a flat bottom.

Sight down the blank from time to time to assure yourself that one side is not becoming higher than the other, creating a warped bottom. Since important shaping dimensions are referenced to the bottom, a clean unwarped bottom is quite important.

Check the bottom with a straight edge to make sure it is flat rail to rail, at about 1 foot intervals along the length of the board. Back lighting the straight edge will light up cracks between the blank and straight edge where low areas exist. Mark the high spots with a pencil and slowly bring these areas down until the blank is flat.

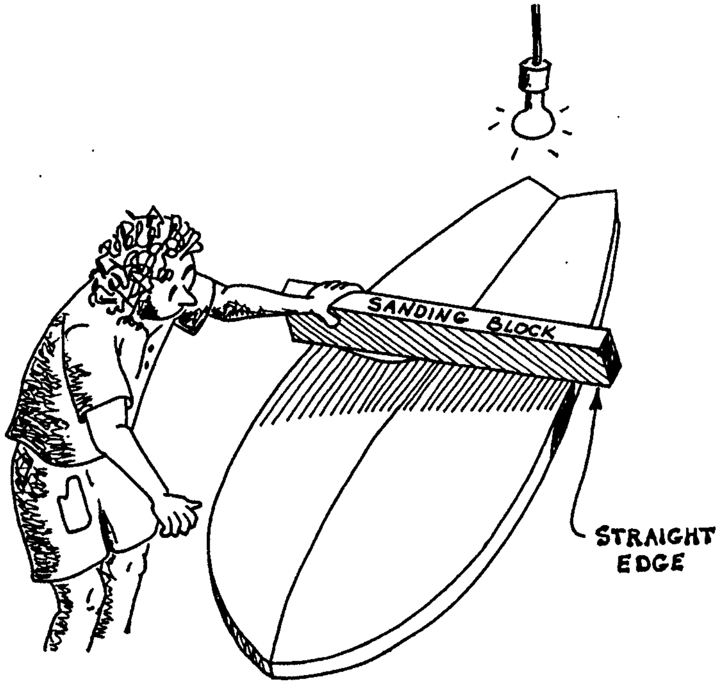


FIG. 6-7 MAKING THE BOTTOM FLAT RAIL-TO-RAIL

⑦ ROCKER – The rocker in the partially shaped blank is now checked to see if it will require any changes. Do this by placing a straight edge flat against the tail along the center line of the surfboard. Measure the rough rocker, by measuring the separation between the center line and the straight edge. At distances from the tail where the desired rocker measurement is supposed to be ½, 1", 2", and 3" etc. up toward the nose, the rough rocker measurement should be smaller.

Compare the rough rocker with the desired rocker to determine how deep into the foam you will have to plane to correct it. Measure the blank thickness in these areas and compare with the desired thickness. Sometimes at this point it will be obvious that to obtain the desired rocker, too much foam would have to be removed and would result in a thin surfboard. If this is the case, all you can do is to shape as much resired rocker as possible into the blank. Usually it is not a good idea to sacrifice thickness for correct rocker.

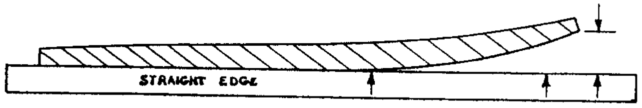


FIG. 6-8 MEASURING ROUGH ROCKER

6' 6" Teardrop
ROCKER TABLE

POSITION	DESIRED ROCKER	ROUGH ROCKER	REMOVE
Nose ⑥ + 6"	5 inches	4¼ in.	¾ in.
⑥ + 3"	4	3¼	¾
⑤ + 10"	3	1⅞	1⅛
⑤ + 5"	2	1⅛	⅞
④ + 8"	1	½	½
④	½	¼	¼

Shaping the rocker is done by removing successive thin layers of foam from the bottom, usually in the nose area, until the rocker conforms with what you want.

An example may help to clarify this procedure. Say for example, that 1/4" of foam has to be removed from the area 2½ feet back from the nose. Along with this 1/2" has to be removed from the area 1 foot 10 inches from the nose.

The steps to do this will be to first take a 1/8" layer off the nose that extends 3 feet back from the nose. Second, another 1/8" layer is removed that extends 2 feet back from the nose. (This kind of work is very accurate with a power planer, because of its fixed depth of cut.) Third, use a surform to smooth out the bumps in the bottom left by the planer stopping its cut at the 3 foot and 2 foot points. After this little operation you will have removed very close to a 1/4" layer of foam from the nose extending back about 2½ feet and will bave blended it in with the rest of the bottom.

Now only 1/4" has to be removed from the area 1 foot 10 inches from the nose, so repeat the same operation over again, but only go back 2 feet 4 inches and 1 foot 4 inches with 1/8" level cuts with the planer. The rest can be cleaned up with the surform.

The last thing now to be done is to take the 24" sanding block and make sure the bottom is flat rail to rail like it was before. This is so you will have a good bottom rail edge for a reference line when you get around to shaping the rails in cross-section.

All this business about shaping the rocker is a bit difficult, because you are trying to shape a long curved surface to conform with a line that is almost straight.

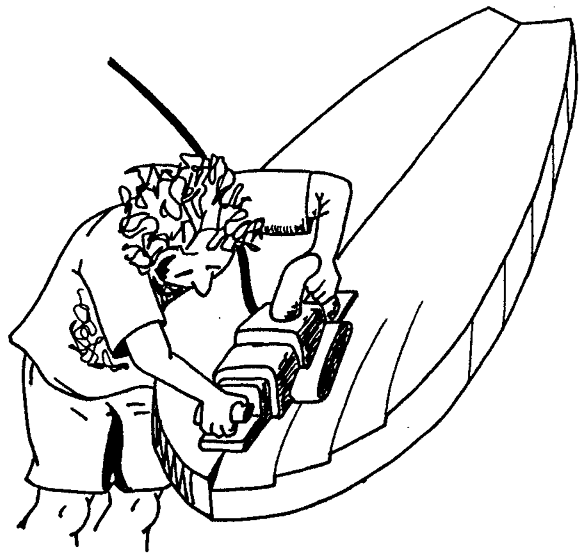


FIG. 6-9 SHAPING NOSE FOR ROCKER

⑧ THICKNESS – Thickness is shaped by planing foam from the top after the rocker is completed. Measure the thickness at 1 foot intervals along the blank and compare it with the desired thickness to find out how much to remove.

6' 6" Teardrop
THICKNESS TABLE

POSITION	DESIRED THICKNESS	ROUGH THICKNESS	REMOVE
Nose ⑤ + 8"	2.4 inches	2.5 in	0.1 in.
④ + 8"	2.9	3.0	0.1
④	3.0	3.3	0.3
③	3.0	3.2	0.2
②	2.5	2.9	0.4
①	1.8	2.5	0.7
Tail + 3"	1.2	2.3	1.1

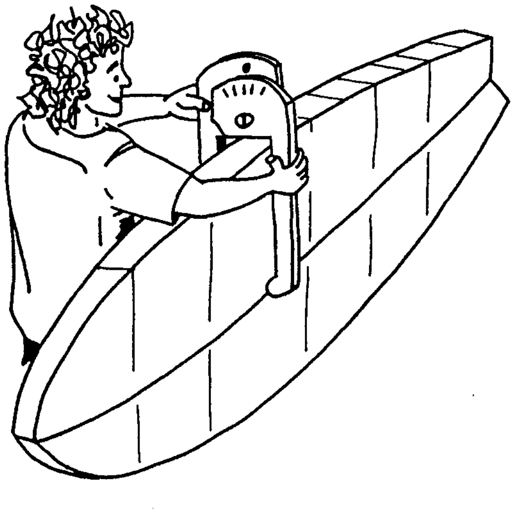


FIG. 6-10 MEASURING THICKNESS

Use the power planer to take foam layers off the top of the tail, just like explained for shaping the nose for rocker. Smooth the ridges or high spots with a surform and sanding block, generally making the top flat rail to rail. Removing foam from the top of the nose usually has to be completed by hand because the upward curve of the nose does not allow the power planer to make an even depth of cut.

Usually there is a question of how thick to make the blank right at the nose and tail, before the rails are shaped. Leave the nose and tail thickness as they are after the inboard thickness has been shaped (between 3/4" to 1"). Shaping the rails will bring this thickness into range. At that time you can thin it down to suit yourself.

The surfboard now has its rail-outline, rocker and thickness completed. All that remains is shaping the rails and any special surface contours such as a Vee bottom, concaves, or whatever else you have decided to do. Shape a Vee before the rails are shaped.

In shaping a Vee in the bottom at the tail use the 24" sanding black. Place it sort of parallel to the stringer and move it back and forth parallel to the stringer. This will fair the Vee into the bottom. A Vee at the tail actually extends about 2 feet up from the tail so the surface change is very slight.

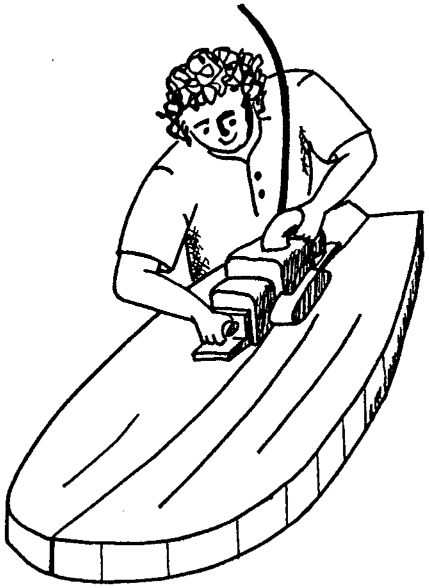


FIG. 6-11 PLANING TOP FOR THICKNESS

⑨ 1st RAIL BEVEL – Mark on the blank with a soft pencil the limits of the first bevel at 1 foot intervals along both rails. Do this for both the top and bottom sides of each rail. Bevel limits on the side of the square rail are measured from the bottom edge. If the bottom is not flat all the way out to the rail, a straight edge laid against the bottom that extends out beyond the rail, should be used to measure where the bottom rail line is supposed to be. If this is not done, the resulting rail will be incorrectly displaced away from the bottom.

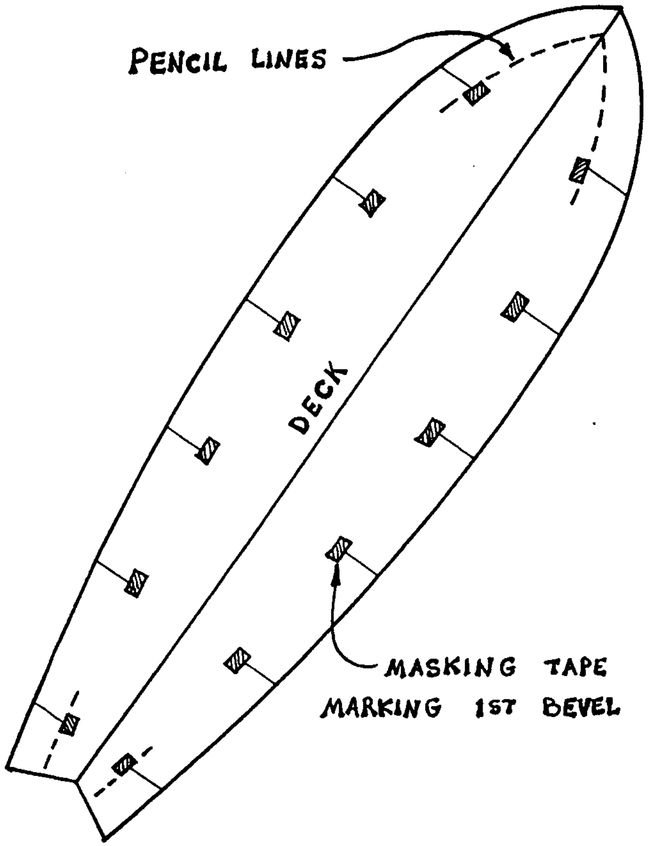


FIG. 6-12 MARKING FIRST RAIL BEVEL

Rail bevels that extend into the nose and tail areas can be marked by pencil lines drawn on the blank. It is usually helpful to place small strips of masking tape along these pencil marks to further preserve their location, in case they are sanded over by accident. This is particularly useful on the vertical side of the rail.

The objective to be followed in making a bevel is to concentrate on shaping a flat band that twists along its length. The edges of the band should hit the check-points of each rail cross-section template. A pencil line drawn on the blank passing through the check-points will be a guide to where the band edges are. The idea here is to avoid smoothing and rounding the rail contour until after these specific bevels have been made into flat twisting bands.

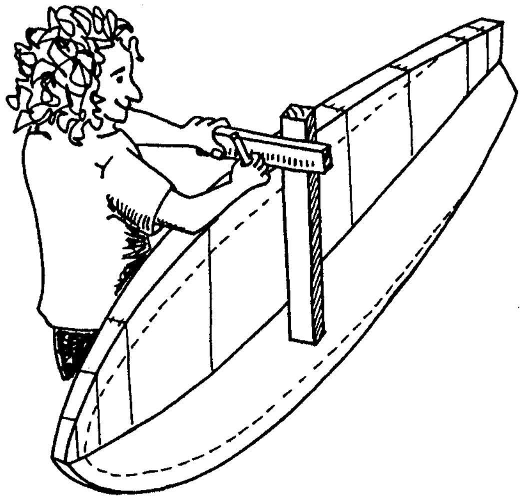


FIG. 6–13 MARKING SQUARE RAIL FOR FIRST BEVEL

Use the powerplane to make these bevels. The bevel is made by planing the full length of the rail by walking the length of the blank several times, cutting away long strips of foam. Plane to within 1/4" to 1/8" of the final bevel. Use a surform to complete the bevel.

Visually check for continuous flowing lines along the rail by looking at shadows cast on the blank. Stand at a distance from the blank and sight down the rails from behind both the nose and tail. If you make a mistake working with the surform or power planer and accidently slip into an area that is not supposed to be cut, it will look like a horrible mistake. You will be strongly tempted to try to fix it by making some changes. Don't try to correct it. Remember that there are some more bevels to be made, so ignore it for the time being and continue as if it was not there.

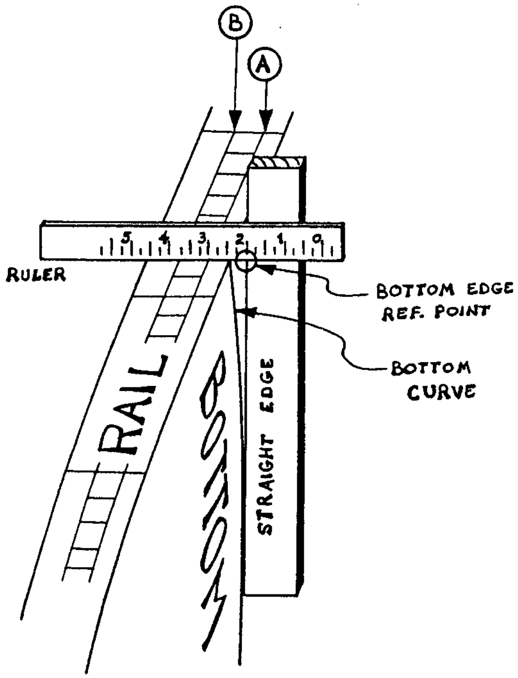


FIG. 6-14 BOTTOM EDGE REFERENCE POINT

In cases where the particular design being shaped has never been attempted before, it sometimes becomes obvious that the design itself does not lend itself to continuous flowing lines. It may be necessary to change the design slightly to obtain better flow. Any changes made during shaping should be written down so a second surfboard like the first can be built.

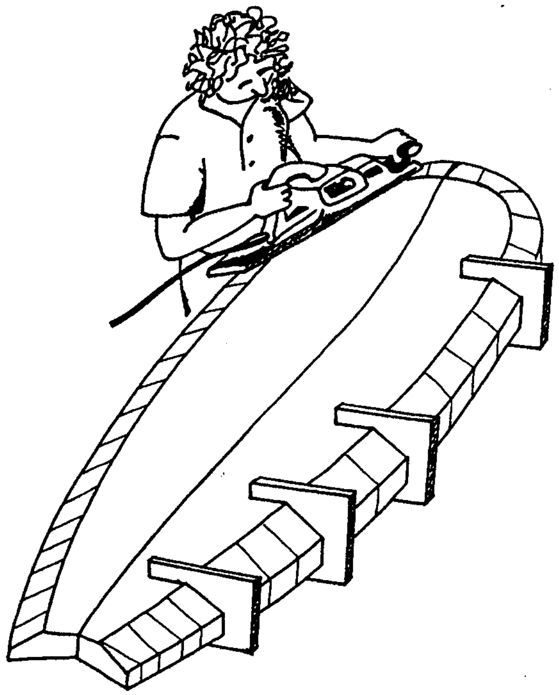


FIG. 6-15 SHAPING FIRST BEVEL

The purpose of the rail cross-section templates is to give you an indication of how close you are coming to the intended design. Often the rail will not match up perfectly with the template because the mid-board thickness is slightly off. Usually the template will be a close match to the rail a few inches to one side of the place on the rail where it is supposed to be. This is OK to be left as it is. Don't try to make any drastic changes to the board just because the template does not fit perfectly.

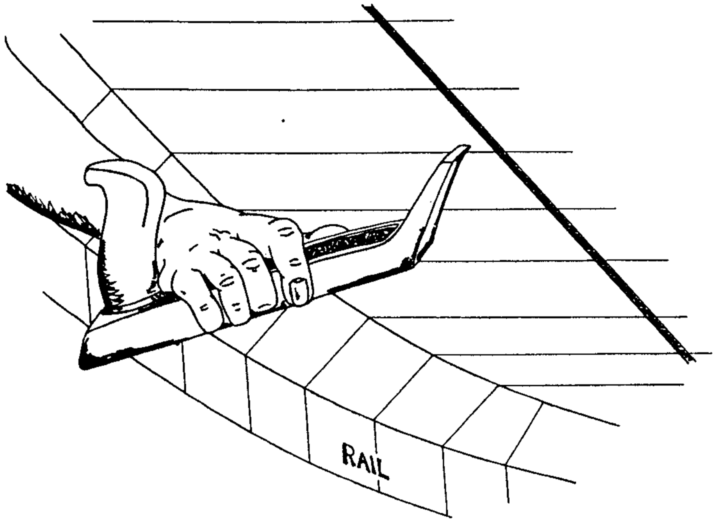


FIG. 6-16 HOLDING THE SURFORM

⑩ 2nd RAIL BEVEL – Mark and shape second bevels on the blank as you did for the first bevel. Shape these new bevels as before. Again visually check the emerging rail for continuous flowing lines by light and dark shadows cast on the blank. Check the completed bevel with the second bevel cross-section templates.

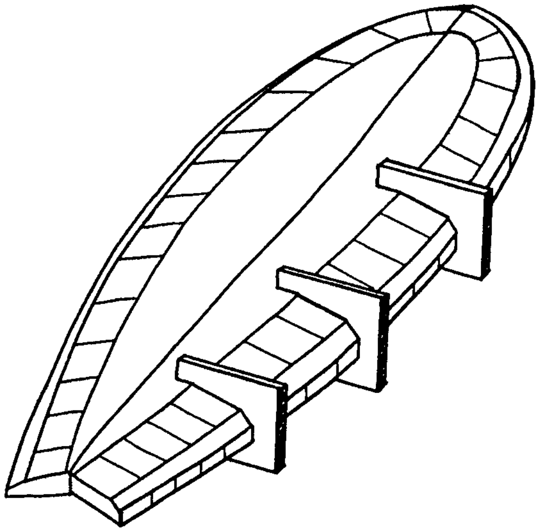


FIG. 6-17 SECOND BEVEL

(11) 3rd RAIL BEVEL – Mark and shape the third bevels. Small corner bevels at the very edge of the rail can be marked by hand. This is easily done by holding the pencil firmly with the fingers in a fixed position, resting one finger against the rail edge and moving your hand along the rail edge as a guide.

Rounding the small corners remaining along the rail after the major bevels are shaped is accomplished by first using a small block plane (a surform can be used

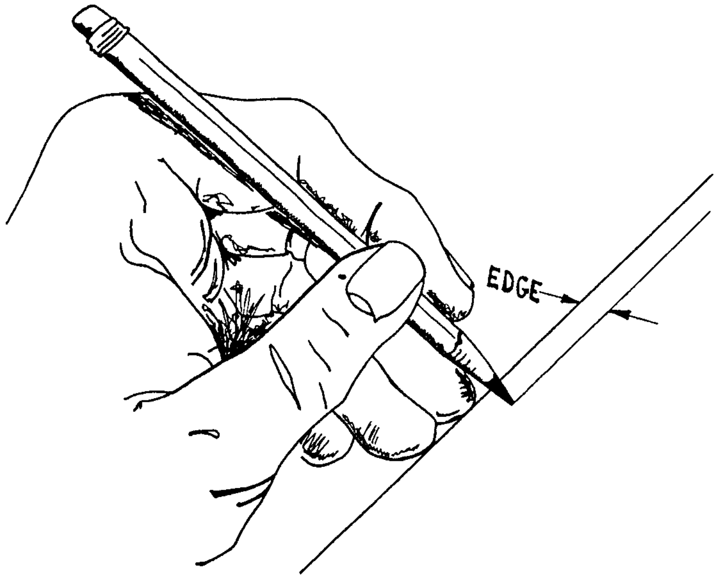


FIG. 6-18 MARKING EDGE BEVEL

but it is harder to control the foam cutting.) Run the block plane along a bevel corner in one continuous stroke from tail to nose about six or seven times. Each time change the angle of the block plane's cut. The major bevels will slowly blend together into a foiled curve. Each cut of the block plane is so small that it will be barely noticeable.

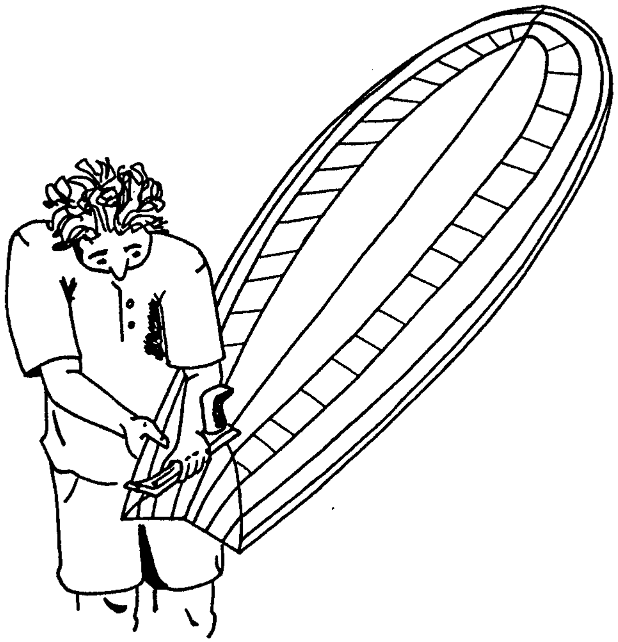


FIG. 6-19 SHAPING THIRD BEVEL AND TAIL

⑫ FINISH RAIL – After all the bevels are completed take a piece of No. 100 to No. 220 grit sand paper or sanding screen and lightly run it along the rounded edge just like was done with the block plane. This will completely blend the foiled curve into a finished rail.

Finally, place a super soft 2" thick sponge (about 8 x 11" rectangle) over a similar size sanding screen on the foam surface sand the whole top and bottom surfaces smooth. This will remove the coarse surface texture of the foam, making a good surface for fiberglassing.

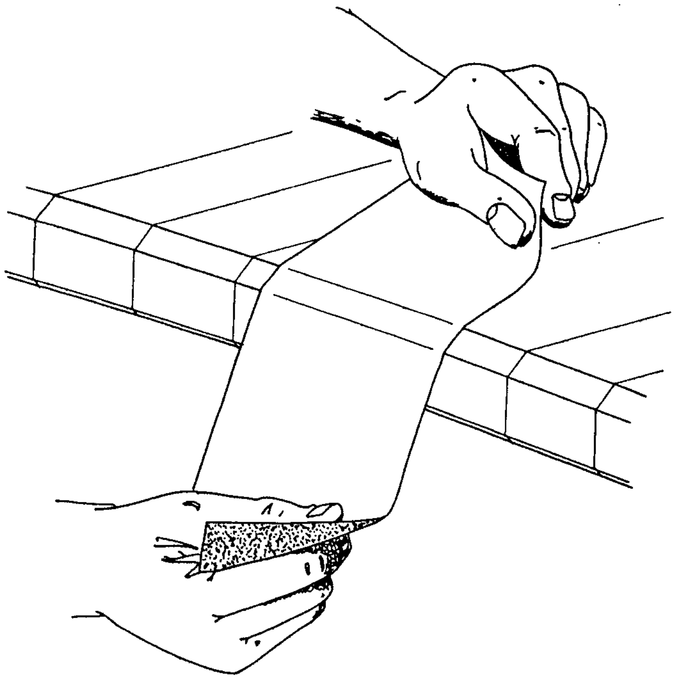


FIG. 6-20 SANDING RAIL EDGE

⑬ NOSE AND TAIL – Usually there is some fine tuning to be done on the nose and tail. This amounts to simply shaping the area about 3" into the surfboard from the nose and tail to blend the top and bottom surfaces with the rail.

⑭ Visually examine the whole blank using contrasting light and dark shadows for high spots and irregularity. The final shape should have a continuous curve in rail cross-section and a flowing surface lengthwise.

This completes shaping the surfboard. It is now ready to be fiberglassed.

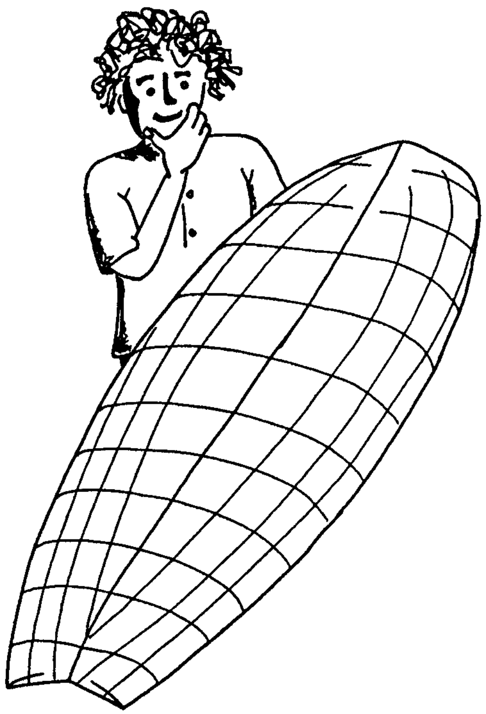


FIG. 6-21 INSPECTING FINISHED SHAPE

Chapter 7

Fiberglassing a Surfboard

The general technique of fiberglassing a surfboard is to apply one or more layers of fiberglass cloth to the top and bottom in such a way that the layers wrap around the rail onto the other side. These layers of overlaps, produce an extra hard surface along the rail, which is the part of the surfboard which is most susceptible to dings.

Increasing the fiberglass layers increases the general strength of the surfboard. The surfboard becomes stronger in both local resistance to dents and in overall rigidity against flexing under stress. Fiberglass cloth comes in many different weights and types of weave. For surfboards, a 6 oz. flat weave cloth is best. There are some occasions to use 8 oz. cloth for greater strength, or 4 oz. for lighter weight.

The glassing process described below is sequence of steps presented in a way similar to the shaping sequence. The bottom is glassed first with one layer of cloth and the top glassed second with two layers. This is usually adequate for most surfboards.

Two types of resin are used, laminating and surfacing resin. Laminating resin cannot easily be sanded after it has hardened, because it gums up the sandpaper. Surfacing resin can be sanded and comes off as a fine powder when sanded. Laminating resin can be converted to surfacing resin by adding a wax solution called styrene monomer. The mixing ratio is 4 oz. styrene monomer to 1 qt. laminating resin.

The advantage of using laminating resin in the fiberglass cloth is that you don't have to sand it before putting another coat of resin over it.

Both resin types are a thick liquid that becomes hard like a rock a short time after a small amount of catalyst is mixed into them. Resin will remain as a liquid for 10 to 40 minutes after the catalyst is added, depending upon how much catalyst is added and the temperature of the resin. If pigment or color tint is also mixed into the resin the cure time will be extended about 1½ times normal.

When the resin begins to "go-off," it becomes much thicker and changes into a semi-solid. It doesn't flow any more, but it can be pushed around like jello. This condition lasts about 4 to 6 minutes. By this time no further work can be done with it. From this point on, the resin slowly becomes harder and harder. After 1 to 3 hours it can be handled without being sticky to touch. After 24 hours it can be considered completely cured, although curing continues for several days.

The trick to mixing resin and catalyst is to estimate the time between adding catalyst and when it begins to "go-off." This is the working time available to do the fiberglassing.

Resin manufacturers give some general mixing instructions such as 1 oz. of catalyst per 1 gallon of resin. This is not always an optimum ratio because the temperature affects working time. Higher temperatures cause the resin to "go-off" sooner. A safe ratio to use is about 1 teaspoon of catalyst to 1 quart of resin. Try this ratio first, if it takes too long add another ½ teaspoon next time.

FIN TIME

Before glassing is begun the time to put on the fin or fins must be decided. If a removable fin with a fin box is to be used a slot is routed in the foam blank and the box is glassed in place at the same time the bottom is fiberglassed.

A fixed fin can be installed after the bottom is fiberglassed. A slot in the tail is routed out through the fiberglass and the fin glassed in place as a separate operation.

ROUTING A FIN SLOT

Make up a router template as described in the tool section and follow the procedure below.

① Mark the location of the fin slot with a pencil.

② Adjust the router for depth of cut. The router bit should extend beyond the router surface a distance that is equal to the depth of cut into the board, plus the thickness of the template.

③ Place the router template over the area, line it up, and tape it firmly place with several strips of masking tape.

④ Rout out the fin slot.

⑤ Remove the template and clean the foam cuttings from the slot.

⑥ Check for fit by placing the fin box or fin into the slot. The top of a fin box should be flush with the surface of the surfboard.

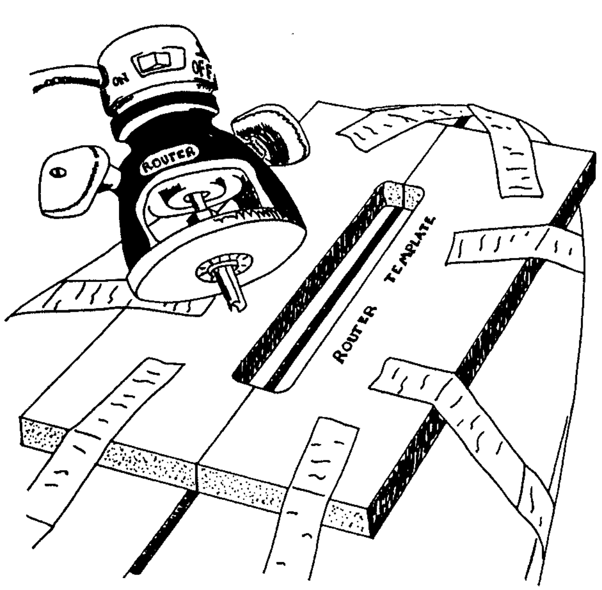


FIG. 7-1 ROUTING OUT A FIN SLOT

FIBERGLASSING THE BOTTOM

The foam surface should be free of any loose material left over from shaping. Brush all remaining foam dust off the blank with a semi-stiff brush. A slot for a fin box should already have been routed in the tail, if a removable fin is to be used. Follow the steps below.

① MASKING – Place 2" wide masking tape along the top side of the rail around the perimeter about 2" inboard from the rail edge. The edge of the tape closest to the rail will be the limit of fiberglass lap around the rail from the bottom.

A second and third strip of tape, inboard of the first strip can be added to provide a wide band of tape around the top. The reason for this is to prevent excess fiberglass applied to the bottom from adhering to the top.

Mask over the open cavity of the fin box to prevent it from filling up with resin.

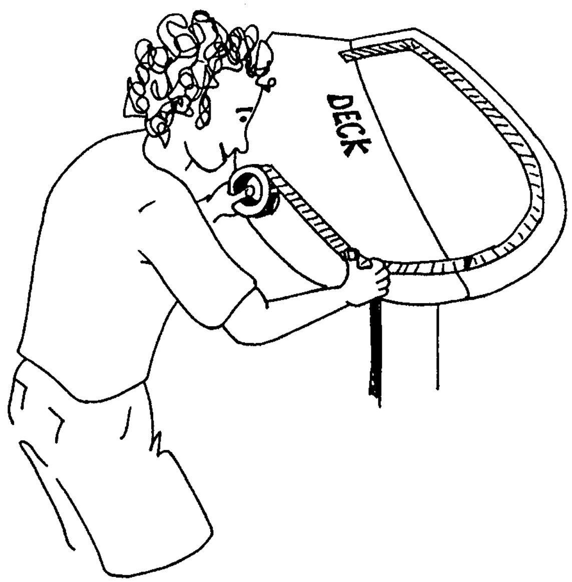


FIG. 7-2 TAPING OFF TOP FOR FIBERGLASSING THE BOTTOM

ROUTING A FIN SLOT

Make up a router template as described in the tool section and follow the procedure below.

① Mark the location of the fin slot with a pencil.

② Adjust the router for depth of cut. The router bit should extend beyond the router surface a distance that is equal to the depth of cut into the board, plus the thickness of the template.

③ Place the router template over the area, line it up, and tape it firmly place with several strips of masking tape.

④ Rout out the fin slot.

⑤ Remove the template and clean the foam cuttings from the slot.

⑥ Check for fit by placing the fin box or fin into the slot. The top of a fin box should be flush with the surface of the surfboard.

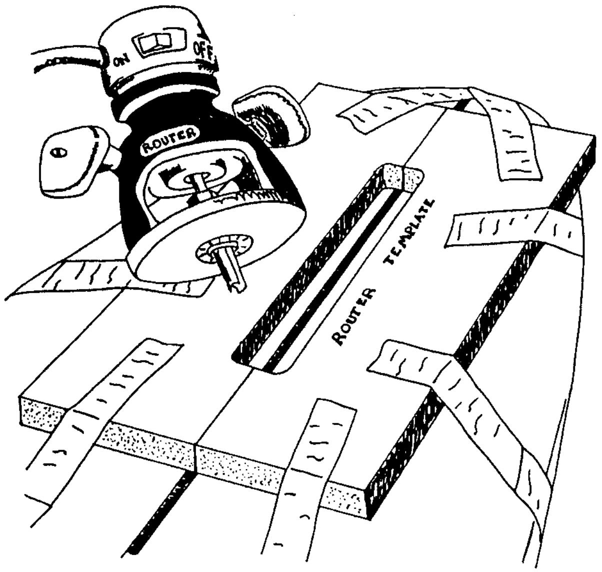


FIG. 7-1 ROUTING OUT A FIN SLOT

FIBERGLASSING THE BOTTOM

The foam surface should be free of any loose material left over from shaping. Brush all remaining foam dust off the blank with a semi-stiff brush. A slot for a fin box should already have been routed in the tail, if a removable fin is to be used. Follow the steps below.

① MASKING – Place 2" wide masking tape along the top side of the rail around the perimeter about 2" inboard from the rail edge. The edge of the tape closest to the rail will be the limit of fiberglass lap around the rail from the bottom.

A second and third strip of tape, inboard of the first strip can be added to provide a wide band of tape around the top. The reason for this is to prevent excess fiberglass applied to the bottom from adhering to the top.

Mask over the open cavity of the fin box to prevent it from filling up with resin.

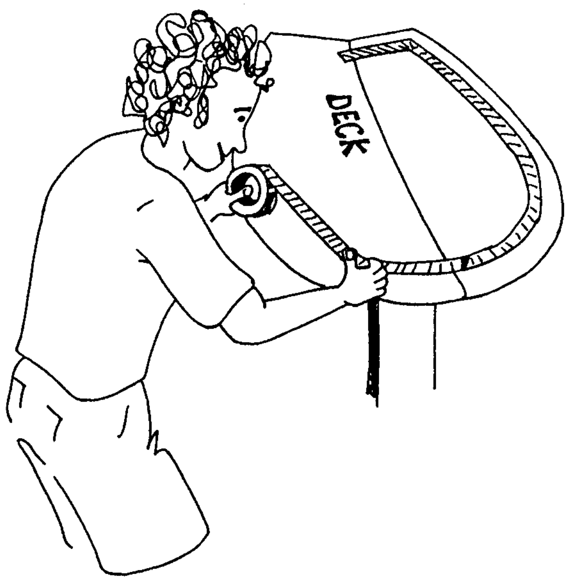


FIG. 7-2 TAPING OFF TOP FOR FIBERGLASSING THE BOTTOM

② CLOTH PREPARATION – Place the blank bottom-side up on the glass rack. It should be fully supported by the glass rack so the rocker will not change under the weight of the resin and cloth when doing the glass job. Particular attention should be given to the tail. A small amount of bend in the tail can change the performance of the surfboard.

Drape the fiberglass cloth over the bottom. Smooth the cloth with the palm of your hand to remove wrinkles. Cut away excess cloth around the rail with a pair of sissors. Allow sufficient cloth overhang for lapping around the rail onto the masking tape on the other side. Cut notches in the cloth at the nose and tail for lapping around corners. Cut the notch right up to each corner.

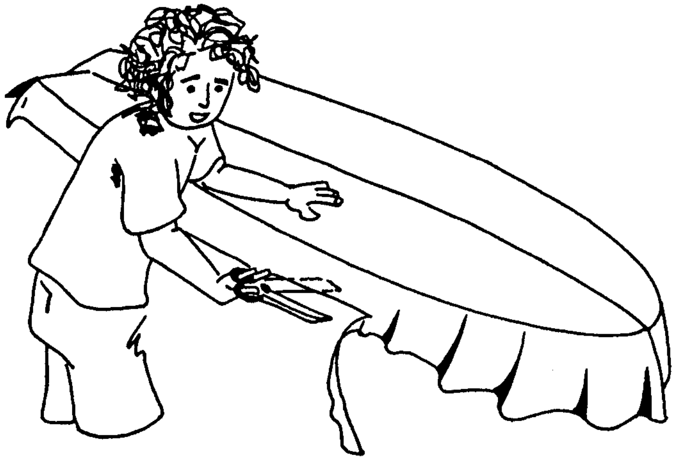


FIG. 7-3 CUTTING CLOTH OVERHANG

③ MIXING RESIN – Mix catalyst into laminating resin in a clean medium size container that can be held in one hand. Sufficient resin should be prepared to completely do the bottom (about 1¼ quarts for one layer of cloth.) Add color pigment or tint to the resin before mixing in the catalyst, if it is to be a color coat. It takes from 20 to 40 minutes to do one side.

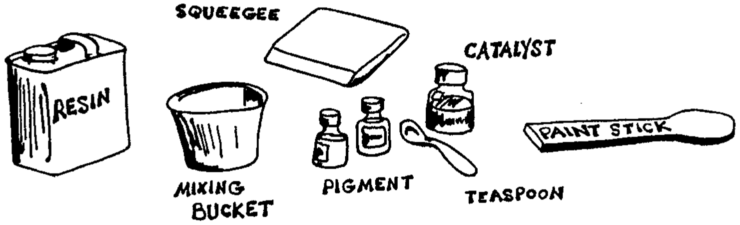


FIG. 7-4 FIBERGLASSING SUPPLIES

④ INSTALL FIN BOX – The sides of the fin box should be lightly sanded so the resin will have a rough surface to adhere to. Cover the top of the fin box with masking tape so it will not fill up with resin. Lift up the cloth over the fin slot and fill it about a quarter full of resin. Push the fin box into the slot, forcing the resin up along the sides. Assure yourself that it is snug enough not to float up out of the slot. A small piece of wood stuck in the crack at one end should stop it from floating. Lay the cloth over the fin box and smooth it out over the tail.

⑤ RESIN APPLICATION – With the resin container in one hand and a squeegee in the other, pour about half the resin onto the cloth along the stringer in mid-board. Use the squeegee to push the resin around the whole surface, working the resin into the cloth, adding more resin as needed, until the cloth is completely saturated.

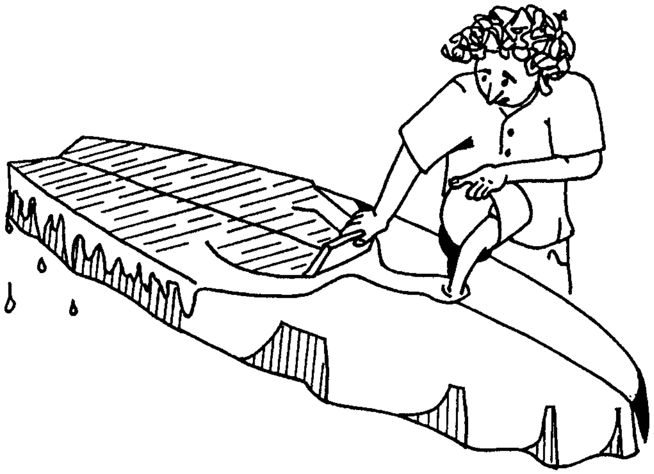


FIG. 7-5 FIBERGLASSING THE BOTTOM

Medium firm pressure, exerted with the squeegee moving across the cloth in smooth strokes from center board out toward the rails, will remove excess resin. Excess resin is unnecessary weight.

Proper saturation of the cloth is when the resin is almost to the top strands of the cloth. When the resin is too thin, small air bubbles and holes will form between the interwoven strands of cloth resulting in weak spots.

Allow the excess resin to flow off the board at the rails. As the resin does this it will begin to saturate the overhanging cloth. Usually it is necessary to pour more resin along the rails to completely saturate the overhang. Brushing the squeegee lightly against the hanging cloth as the resin is running off will help the resin make contact with unwetted sections and speed up saturation.

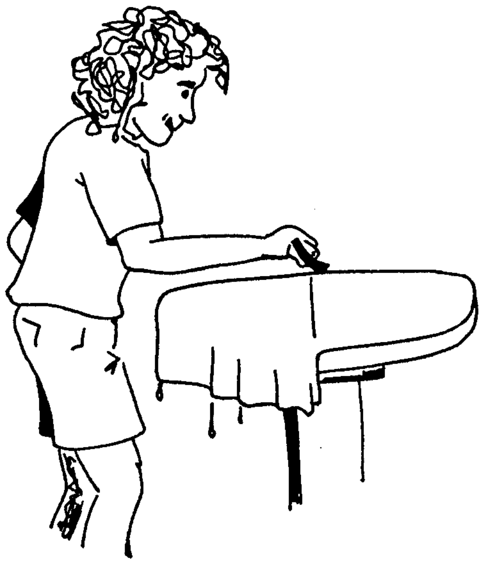


FIG 7-6 REMOVING EXCESS RESIN

Lapping each rail should be done as a single operation. Begin by pushing the cloth around the rail at mid-board with the squeegee and working toward the nose and tail. The resin will stick to the under side of the rail and hold the cloth in place. Nose and tail lapping sometimes become frustrating when the cloth refuses to lap smooth. Don't worry about it. Keep working with it, maybe it can be fixed before the resin goes off. If not, it can be patched later. Resin in the bucket usually begins to go-off before the resin on the board, thus serving as a finish up work shortly.

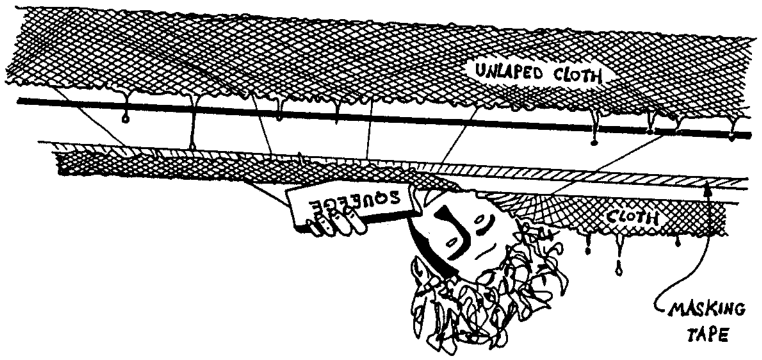


FIG. 7-7 LAPPING FIBERGLASS AROUND THE RAIL

⑥ TRIM – When the resin has set-up to the point where the surfboard can be handled, use a razor blade to cut away the fiberglass over the cavity of the fin box.

Use the razor blade to remove the excess fiberglass from the deck by cutting down into the blank through the fiberglass directly over the edge of masking tape closest to the rail. Try not to cut into the foam more than ¼". Pull up the tape and throw away the excess.

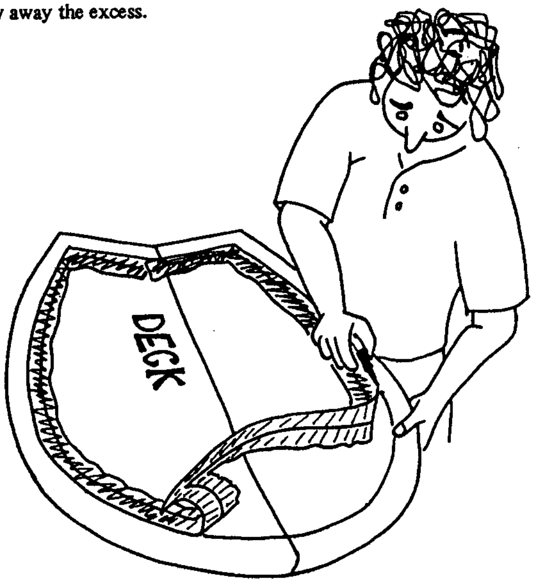


FIG. 7-8 CUTTING AWAY THE EXCESS

There is a funny thing about the chemical balance between the masking tape and resin. The cure time of the small amount of resin in immediate contact with masking tape will be much longer than the rest of the resin. What happens is the whole board will cure, except for a thin strip along the edge of the tape. This makes it easy to cut through the fiberglass cloth along this line when you are cutting away the excess.

⑦ Surform the edge of the fiberglass lap smooth so it is almost flush with the foam. When the edge of the first lap is made flush with the foam, the next layer laid over it, it will not have a bump in it to be sanded down later. Sanding down a bump here would be cutting into a layer of cloth along a line parallel to the rail around the whole surfboard. Strength and rigidity would be reduced.

Generally smooth rough areas of the fiberglass with a surform. This completes fiber glassing the bottom.

FIBERGLASSING THE DECK

The top is fiberglassed in much the same way as the bottom. There are some differences. The procedure is described below to cover these differences.

(8) MASKING – Place masking tape along the bottom side of the rail around the board 2" in from the rail edge. Add an extra strips to protect the bottom against the fiberglass over lap.

(9) CLOTH PREPARATION – Drape a first layer of cloth over the top. Cut away excess cloth around the rail, leaving no overhang. The cloth edge should fall about at rail center.

Drape a second layer of cloth over the first. Cut away excess around the rail, leaving sufficient overhang to overlap the masking tape on the bottom side of the rail.

Notch the cloth overhang at the corners of the nose and tail. Smooth the wrinkles in the cloth.

(10) RESIN APPLICATION – Mix enough laminating resin to impregnate both layers of cloth (about 1½ quarts.) Add color or tint if it is a color coat. Don't forget to add the catalyst.

Pour the resin onto the two layers of cloth and work with the squeegee until they are completely saturated. Technique and proper saturation is the same as was done on the bottom. Removing excess resin is a little bit harder with to two layers of cloth than with one. Here again excess weight is a real concern.

(11) Saturate the cloth overhang and lap the rails.

(12) Wait for the resin to set-up to the point where the board can be handled. This is a good time to do gneral clean-up.

(13) TRIM AGAIN – Remove excess fiberglass overlap by cutting along the masking tape with a razor blade. Be careful to avoid cutting through the previously glassed bottom. The bottom should have hardened well enough by this time to make it relatively difficult to cut into with a razor.

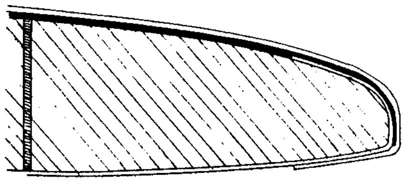


FIG. 7-9 FIBERGLASS OVERLAP AROUND THE RAIL

(14) Surform the rough edges smooth. The edge of the overlap should be made flush with the fiberglass layer underneath. The amount of fiberglass overlap remaining at the rail should be about 3" centered around the rail.

FIN PANEL

To make a fiberglass panel for a fin is relatively easy. A flat rectangular mold about 3/4" deep is made out of wood for holding the resin and is lined with wax paper. The wax paper should have no wrinkles or buldges in it. If it does, the fin paned panel will have these imperfections in its surface.

Lay pre-cut layers of cloth in the bottom of the mold and fully saturate with surfacing resin (don't forget to mix catalyst in the resin). Five or six layers can be easily saturated at one time using a small squeegee. When it is fully saturated, with no air bubbles remaining, lay in another 5 or 6 cloth layers and saturate them with resin. Continue doing this until all the cloth is laid in place and saturated. About 30 layers of 6 oz. cloth will make a fairly rigid fin.

Remove the panel from the mold, pull away the wax paper, and you've got yourself a fin panel.

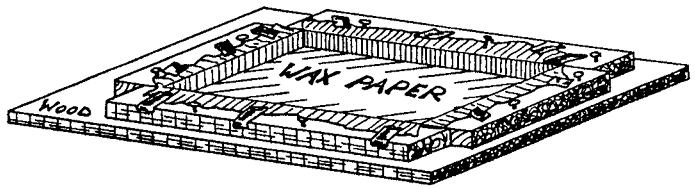


FIG. 7-10 MOLD FOR FIN PANEL

FIN SHAPING

A fin can be purchased at a surfshop or made yourself. If you make it yourself, a fiberglass panel is made up and the fin outline cut from it. Trace out the fin outline on the panel by scratching the hard resin with a safety razor. Cut around the outline with a saber saw or hand saw. Due to the fiberglass cloth, a metal cutting blade is necessary. A regular saw blade will dull very quickly.

Foil the fin with a file, surform, or disk sander. The rough fin can be placed in a vice, or it can be laid flat on a piece of wood and held in place by 3 or 4 headless nails driven into the wood around the fin. The nail heads should be below the upper surface of the fin so the surform will not catch on them. Considerable pressure can be exerted on the fin to make sanding easier. Work on one side for a while then change to the other side to avoid creating a non-symmetrical foil. As the foil begins to take shape, layers of laminated cloth will show up as approximate contour lines, making progress relatively easy to estimate.

Fine sanding of the fin is done by starting with # 100 grit sandpaper and working down to about # 400 grit, wet or dry. A final gloss coat of resin can be up put on to make it look nice.

FIXED FIN INSTALLATION

The procedure below is for installing a fixed fin on the surfboard after the bottom has been fiberglassed. A slot is routed in the tail through the fiberglass layer to accept the base of the fin or tongue.

There are other ways to put on a fixed fin, such as at the time of fiberglassing the bottom or simply fiberglassing a fin directly onto the fiberglassed bottom without making a slot. You can try these variations out yourself. With the fin embedded into a slot, the fin is more firmly attached to the surfboard. The procedure:

(1) Rout a slot in the surfboard that is 3/4" to 1" deep and about ¼" wider than the thickness of the base of the fin.

(2) Prepare the fin by drilling four ¼" dia holes in the tongue and lacing a length of fiberglass rope through them. This will make the fin fit snug in the slot and hold it in position while the resin is setting up.

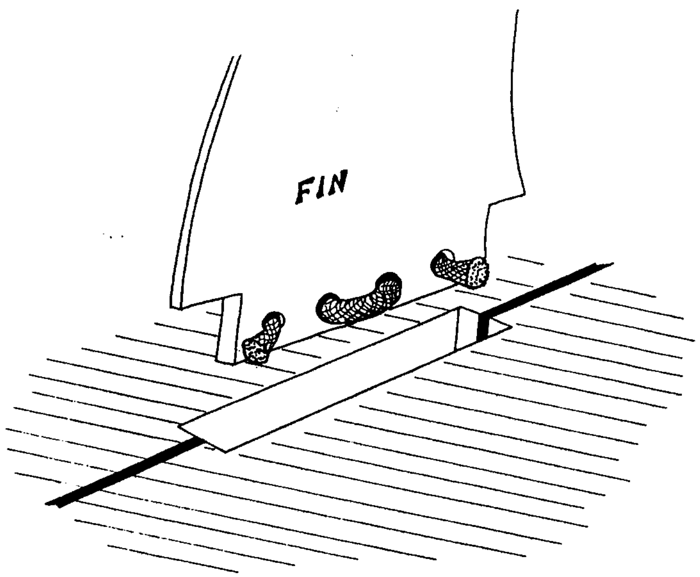


FIG. 7-11 PREPARATION FOR FIXED FIN INSTALLATION

③ Cut 4 or 5 staggered layers of fiberglass cloth and two lengths of fiberglass rope that are as long as the fin base is wide. Place them where they are handy to reach.

④ Mix up about 8 oz. of surfacing resin, and 1/8 teaspoon of catalyst.

⑤ Pour resin into the slot to about half full. The resin should be level in the slot.

⑥ Push the fin into the slot.

⑦ Place a first layer of cloth on each side of the fin base and saturate with resin. Use a squeegee to work the resin into the cloth. The cloth should be lapped up onto the fin and out onto the board at least 4 inches. Use the squeegee to push the cloth into the crotch between the fin and the board so that the cloth forms a square corner.

⑧ Dip the lengths of rope in the resin to saturate them. Lay one along the fin base on each side.

⑨ Place another cloth layer over the rope and saturate with resin.

⑩ Place the remaining layers along the fin and saturate with resin.

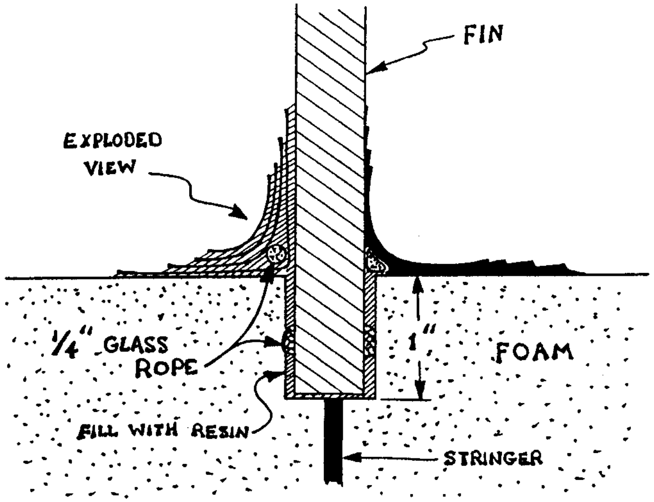


FIG. 7-12 FIXED FIN INSTALLATION

⑪ Squeegee out the excess resin and bubbles from the cloth. Carefully smooth the whole thing to form a smooth curve at the fin base.

⑫ Line up the fin angle by sighting down the surfboard from the nose.

⑬ Allow the resin to harden;

⑭ Sand the fiberglass flush with the surfboard and fin. The job is done.

THE HOT COAT

The hot coat is a brush coat of surfacing resin to fill in the uneven surface of the cloth. It is mixed with about twice as much catalyst as was used for the cloth layup. This batch will go off rather quickly in about 10 to 15 minutes.

The surfboard is prepared by lightly smoothing all rough edges with a surfoam or about # 100 grit sandpaper. Either the top or bottom can be done first.

Place masking tape around the perimeter of the board at the center of the rail. This will prevent the resin run off from streaking around onto the underside.

Coat the board by brushing the resin onto the board with a 4" wide natural bristle brush. Start at one end and quickly work toward the other end, applying approximately an equally thick coat all over.

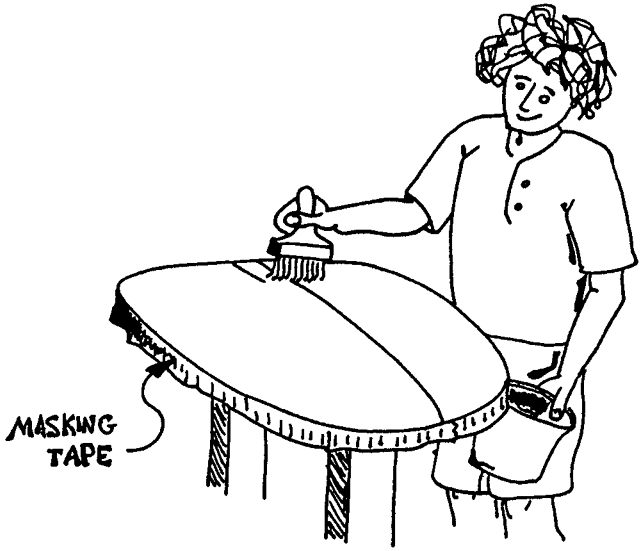


FIG. 7-13 APPLYING THE HOT COAT OF RESIN

Once the whole surface is covered, smooth the coat by holding the brush with moderate pressure exerted on the board and walking its length, moving the brush along the center from tail to nose in one continuous stroke. Repeat this smoothing in over lapping strokes out from the center toward the rails until the entire surface is smooth. Go over the board about 5 times to get an even distribution of resin over the entire surface.

Clean the brush in acetone cleaning solvent.

When the resin has begun to go-off and does not flow, pull away the masking tape around the rails. After the hot coat has become hard, turn the board over and repeat the same operation to hot coat the second side. Be sure to adequately clean the brush to remove all resin so it can be used again.

RESIN BEAD

On some surfboards it is advantageous to add a bead of resin along a rail edge to make the edge a very sharp corner. This corner will increase water release from the rail.

This addition is done by placing masking tape along the rail to form a channel into which surfacing resin is poured and held along the rail edge until it hardens. After the resin is hard the tape is removed and the rail edge sanded square with a sanding block to form the corner.

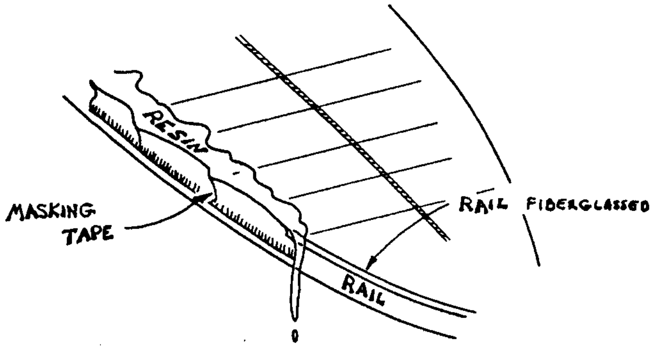


FIG. 7-14 BUILDING UP RAIL WITH A RESIN BEAD

SANDING

Since the hot coat is surfacing resin, it can be sanded. Completely sand the whole board to remove surface irregularity and take off the shiny spots. If the cloth begins to show you have gone too far.

If you are adept with a disk sander, this is the time to save some labor. With a disk sander use #80 or #100 grit sandpaper on a foam padded disk. It is easy to go right through the fiberglass with the sander, so be careful.

Hand sanding is safer and just as good, even though it takes a little longer. When doing it by hand, start out with #36 grit on a sanding block to get the surface uniform. Then switch to #60 grit and take off the tops of the scratches left by coarser grit sandpaper. Keep changing to finer and finer sandpaper, ie #100, #200 wet or dry, and last #400 wet or dry. Put water on the surfboard when using the wet or dry sandpaper, because it will turn out better.

As far as I am concerned, that is good enough for surfing. But, most surfboard builders like to go all the way and put another thin coat of resin, called a gloss coat, on this fine sanded surface. Because the surface is smoother, a much thinner coat can be applied. The gloss coat is not sanded except to maybe smooth the edge around the board along the rail center.

This completes the construction of the surfboard. Put some new wax in your surfbag and head for the best waves you can find.