SURFBOARD HYDRODYNAMICS PART IV: **SPEED**

BY TERRY HENDRICKS, Ph.D.

The emphasis today is on surfboard speed and refinement of the equipment to achieve this speed. But what is the maximum speed that a board can attain on a wave? **Clearly the answer depends on the size, speed and shape of the wave, as well as the characteristics of the board.** In order to be more specific, let us consider the following two questions:

1. What is the maximum speed that can be obtained when dropping in?
2. What is the maximum speed that a board attains when in trim across the face of the wave?

First consider question #1, which is the simplest. In the absence of any drag, the maximum speed is uniquely determined by the speed and height of the wave (assuming that the surfer drops in at the crest rather than at some lower point), and is given by the relation:

$$V = \tfrac{1}{3}\left(V_{wave} + \sqrt{V^2_{wave} + 256 \times \text{wave height (ft.)}}\right) \text{ m.p.h.}$$

For the purposes of this discussion, two wave speeds of 9.4 and 13.3 mph have been considered (these values probably roughly approximate California and Hawaii waves respectively). The dashed lines of Figure 1 show the corresponding speeds for waves of 10′, 20′, and 30′, for various positions on the wave (as shown on the inset). It should be pointed out that the speed at points 2 through 6 depend on the shape of the wave, but the maximum velocity (at point 7) does not.

A real surfboard, however, has drag, and this will tend to reduce the maximum speed obtained. Moreover, the maximum speed depends on the shape of the wave, as well as the drag of the board (although it will always be less than the corresponding dashed curve). For the sake of discussion, the shape of the face of the wave has been chosen to be the arc of a circle (as shown in the inset). Solutions to the resulting equation for a combined board and surfer weight of 160 pounds are given by the solid lines of Figure 1. Curves 1 and 2 are for a board with relatively large drag on 10′ waves of 9.4 and 13.3 mph respectively, and indicate that although there is a difference of about 4 mph at the time of dropping in, the maximum attained speeds of 16.6 and 18.3 mph differ by about 1½ mph. Curve 3 is a high drag board on a 20′ wave, and like curves 1 and 2, has its maximum value at a point before reaching the bottom of the wave (in contrast to the drag-free board). Curve 4 probably approximates an average board (on a 20′ wave) and indicates a maximum speed of about 23½ mph. If the combined weight of this board and the surfer were reduced to 80 pounds, however, the speed would be given by curve 3. This assumes that the wetted area remains constant — in actual practice, a lighter surfer has a smaller board, and if the area is also reduced by a factor of 2, the speed would be the same as curve 4. Curves 5 and 6 are optimistic speeds for a flat board with knife-sharp, dropped rails (and no fin) on 20′ and 30′ waves respectively. Even this board on a 30′ wave would not attain the same speed as a drag-free board on a 20′ wave.

The answer to question #2 is more difficult to obtain, and the shape of the wave and the characteristics of the board must be considered to arrive at any valid conclusions.

Proven equations point out that the maximum speed for two different weight surfers (on similar boards) will be the same if the wetted areas are proportional to the combined (surfer plus board) weights. The lateral velocity of the surfer (across the face of the wave) in terms of the wave velocity varies considerably for different combinations of weight, drag and distance. A typical value of D (weight of surfer and board)/(Drag of the board when starting to drop in) for a 160 pound surfer (plus board) and a wave velocity of 9.4 mph is about 7, so that at position 3 (approximately), he would be traveling laterally at:

$$1.38 \times v_{wave} = 1.38 \times 9.4 = 13 \text{ mph}$$

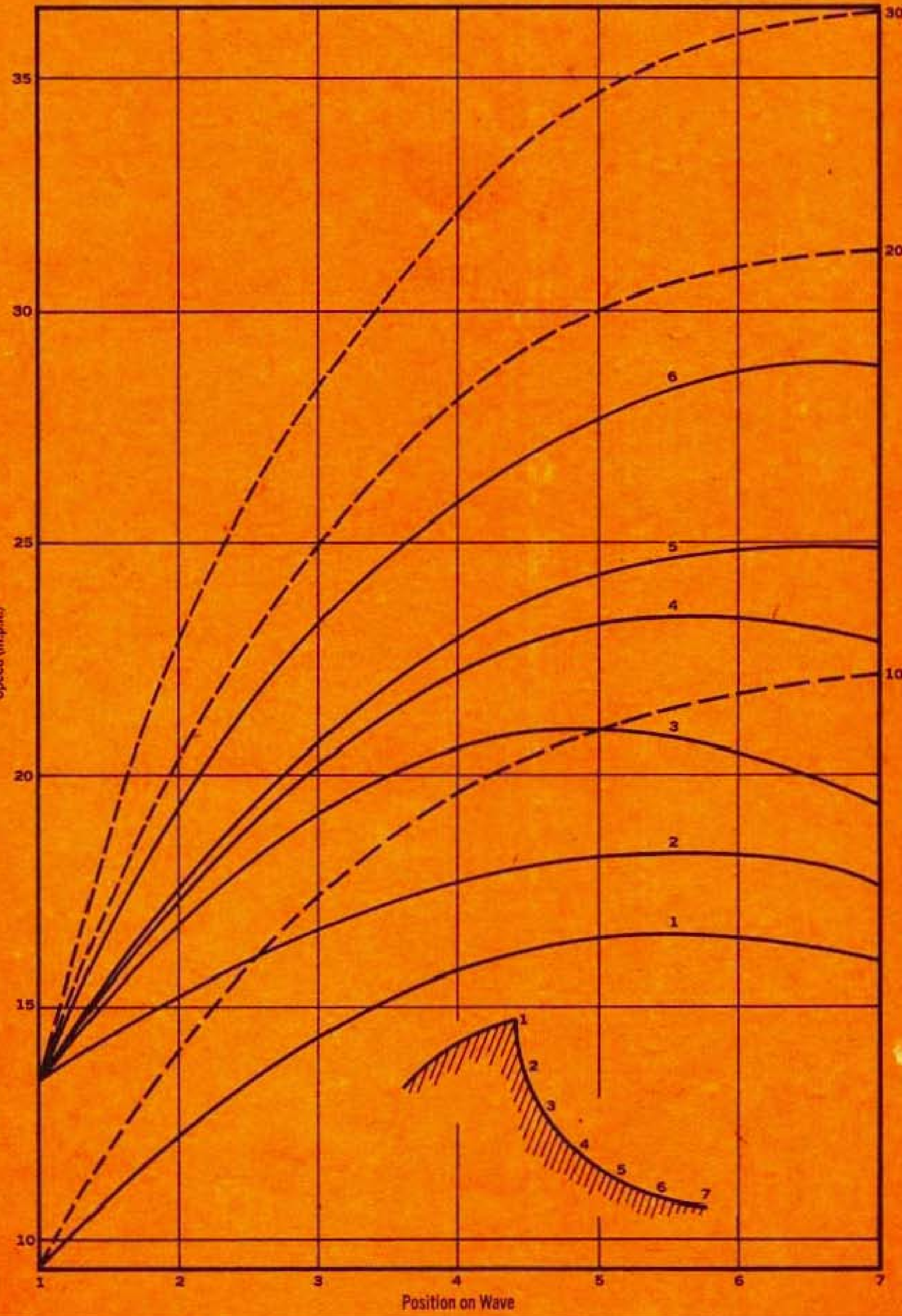
and his total speed would be:

$$\sqrt{(13)^2 + (9.4)^2} = 16 \text{ mph}$$

Suppose that by using a small board with gun rails and foiled fin, etc., D could be raised to 14. Then $v_{lateral} = 1.94 \times 9.4 =$ 18 mph, or an increase of about 50%. This speed would be reduced to approximately 16 mph, or a decrease of about 11% if the surfer changed his trim position from (approximately) position 3 to position 4. This same increase in speed (of 50%) would result if the drag coefficient were reduced to one-half of the original value (remember those scabs of wax). Since D is inversely proportional to the square of the wave speed (for constant wetted area), the lateral speed of the board (in relation to the wave speed) is drastically reduced for faster waves (although the overall speed may still be larger). This is best illustrated in surfing at Waimea (a high-speed wave spot) where it is necessary to drop almost straight down the wave in order to avoid being pulled over with the lip.

Although more accurate theoretical predictions of the speed on a wave can be (and have been) made, the uncertainties in the lift and drag coefficients, and wetted area of a board are so large that solving the resulting equations would probably be a waste of time. Accurate measurements of speed will probably only result when a recording type speedometer is installed on a board (at least on large waves where looking at a speedometer instead of the wave would be out of the question--unless maybe you're Nat Young).

Figure 1



Speed (m.p.h.)
10
15
20
25
30
35
Position on Wave
1
2
3
4
5
6
7
30'
20'
10'
1
2
3
4
5
6
1
2
3
4
5
6
7