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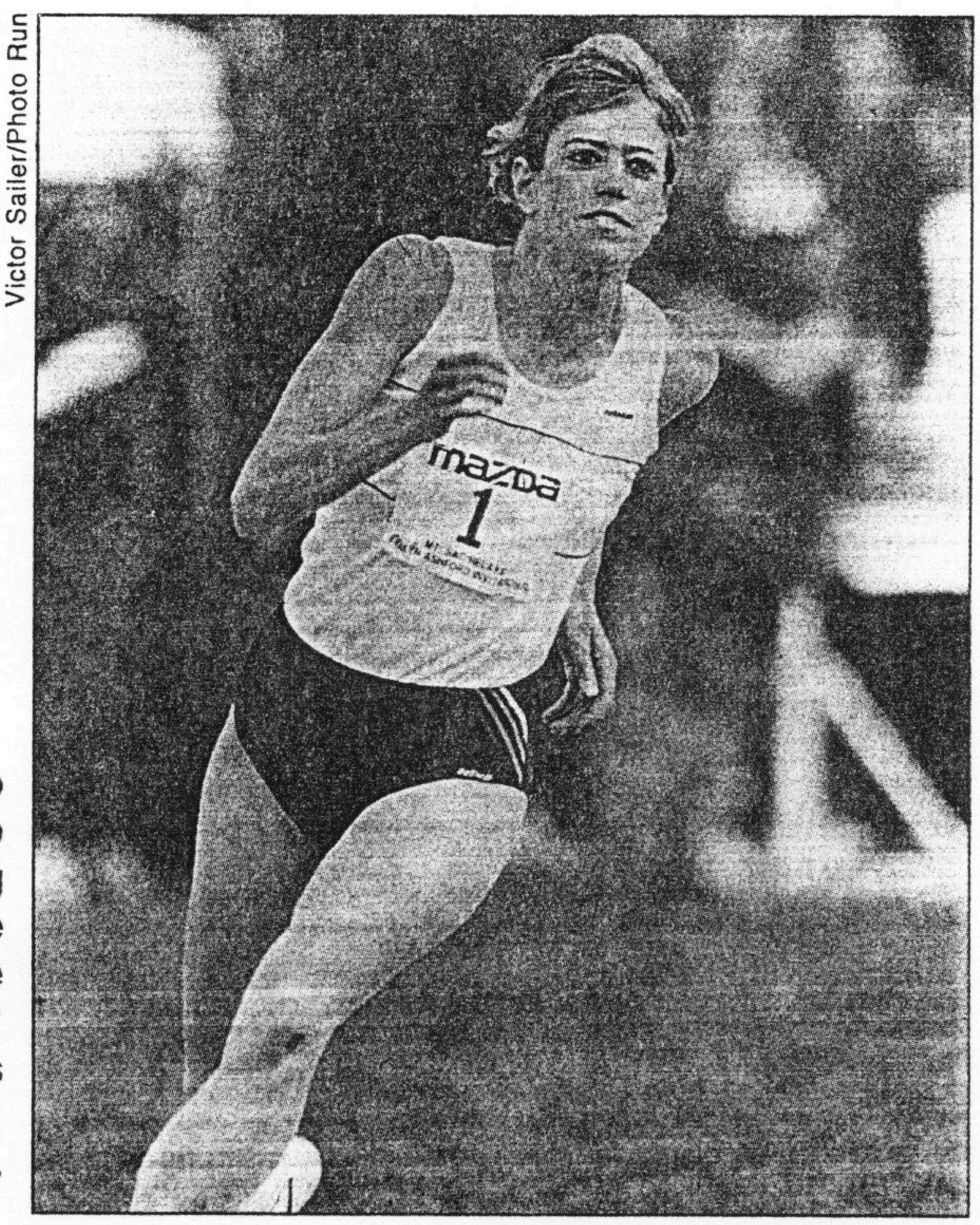
Plotting Your Approach For Better Consistency

How To Design The Shape Of A High Jump Run-Up

Dr. Dapena, a leader in biomechanics research, has given us another valuable piece, this time on the high jump. Actually, this is the first of two articles. It seems that USOC/USATF wanted to find out why some high jumpers are tilted on top of the bar, with one hip higher than the other. Dr. Dapena tackled the problem, and found the answer. This article will be referred to in the second piece, Rotation Over the Bar in the Fosbury Flop High Jump. *Don't touch that dial.*

Victor Sailer/Photo Run



"The curved run-up of the Fosbury-flop style of high jumping makes the athlete lean toward the center of the curve." Vicki Borsheim is seen here at *the* 1991 Mt. SAC Relays.

The curved run-up of the Fosbury-flop style of high jumping makes the athlete lean toward the center of the curve. This helps the jumper to lower the center of gravity (c.g.) in the last steps of the run-up. It also allows the athlete to rotate during the takeoff phase from an initial position in which the body is tilted toward the center of the curve to a final position in which the body is essentially vertical; therefore, it allows the athlete to generate rotation without having to lean excessively toward the bar at the end of the takeoff (Dapena, 1988).

The curved run-up has clear benefits over a straight run-up, and therefore all high jumpers should use it. However, it is also more complex than a straight run-up. Therefore, it is more difficult to learn, and it requires more attention from the athlete and the coach.

The curved run-up can also be a

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source of inconsistency: There are many different possible paths that the jumper can follow between the start of the run-up and the takeoff point. If the athlete does not always follow the same path, the distance between the takeoff point and the bar will vary from one jump to another. This inconsistency will make it difficult for the athlete to reach the peak of the jump directly over the bar.

To make it easier for a high jumper to follow a given run-up path consistently, it can be useful to have the desired path marked on the ground during training. But before drawing the run-up path on the ground, it will first be necessary to choose the values for the two main factors that determine the run-up path: (a) the final direction of the run-up and (b) the radius of the curve.

DECIDING THE FINAL DIRECTION OF THE RUN-UP PATH

The final direction of the run-up is defined as the angle between the bar and the direction of motion of the c.g. in the last airborne phase of the run-up immediately before the takeoff foot is planted on the ground. The angle of the final run-up direction should not be confused with the angle between the bar and the line joining the last two footprints. This latter angle is generally 10-15 degrees smaller than the angle of the final run-up direction (Dapena, 1988).

Without a quantitative biomechanical analysis, it is difficult to know what would be the precise value of the optimum angle for the final run-up direction of an individual high jumper. However, for most high jumpers it will be somewhere between 35° and 45°. Therefore, in the absence of more precise information, a high jumper should make the initial assumption that a 40° angle will work satisfactorily. This is an average value that should fit most high jumpers reasonably well. If the athlete later feels uncomfortable with the run-up curve drawn based on that angle, he/she can experiment with other angle values to find one that feels better.

DECIDING THE RADIUS OF CURVATURE OF THE RUN-UP PATH

The run-up curve needs to have an optimum radius of curvature. If the radius is too small, the curve will be too tight, and the athlete will have difficulty running; if the radius is too large, the curve will be too straight, and the athlete will not lean enough toward the center of the curve. The optimum radius will depend on the speed of the jumper: The faster the run-up, the longer the radius should be. We can make a *rough* estimate of the optimum value of the radius of curvature for an individual high jumper using the equation $r=v^2/4.7$, where r is the approximate value of the radius of curvature (in meters), and v is the final speed of the run-up (in meters/second).

Jumpers who know their final run-up speed can make a rough initial estimate for their optimum radius of curvature by substituting into the above equation the value of their own final speed at the end of the run-up. However, most high jumpers do not know precisely how fast their run-up is, because that would normally require a quantitative biomechanical analysis.

In such cases, the following rough guidelines can be followed: The radius of the run-up curve for female high jumpers with personal records above 1.80m will be somewhere between 7m and 10m; for male jumpers with personal records above 2.20m, the optimum radius will be somewhere between 10m and 15m. The radius should generally be smaller for athletes with lower personal records (because they also tend to have slower run-up speeds).

In all cases, even for the jumpers who have been subjected to a quantitative biomechanical analysis, the *optimum* value of the radius of curvature for each individual athlete will ultimately have to be found through fine-tuning, using trial and error.

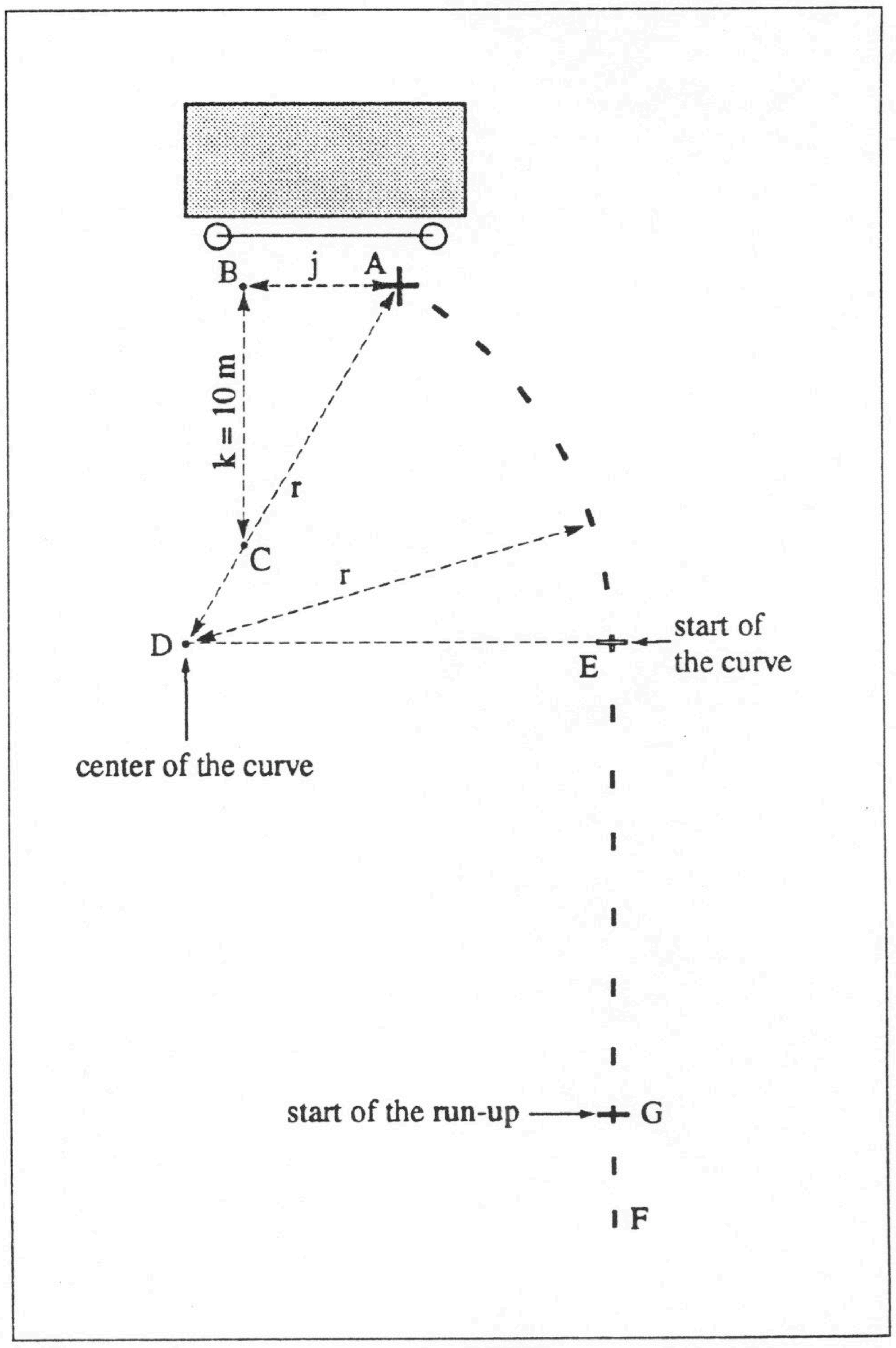

Figure 1

ACTUAL DRAWING OF THE RUN-UP

Materials needed: a measuring tape (10-20m long), a piece of chalk, and white adhesive tape.

Tell the athlete to make a few jumps at a challenging height, using his/her present run-up. Using adhesive tape, make a cross on the ground to mark the position of the takeoff point (point A in Figure 1).

Put one end of the measuring tape at point A, and measure a distance j parallel to the bar. The value of j depends on the desired final direction of the run-up:

final direction of the run-up	value of j
25°	0.50m
30°	1.40m
35°	2.30m
40°	3.25m
45°	4.25m
50°	5.30m

(General guidelines for the optimum value of the final direction of the run-up were given previously. If you want to try an angle intermediate between the ones given in this table, you can use a value of j intermediate between the ones given in the table.)

Mark the new point (B) with chalk. Put one end of the measuring tape at point B, and measure a distance k=10 meters in the direction perpendicular to the bar. Mark the new point (C) with chalk. The line joining point A and point C indicates the direction of the center of the curve relative to the takeoff point.

To find the center of the curve (point D), put one end of the tape at point A, and make the tape pass over point C. The center of the curve will be aligned with points A and C, and it will be at a distance r from point A. (General guidelines for the optimum value of r were given previously.) Mark point D with chalk.

With center in D and radius r, draw an arc from point A to point E. (Point E has to be at the same distance from the plane of the bar as point D.) Arc A-E is the run-up curve. Mark it with strips of adhesive tape. Put a transverse piece of tape at point E to mark the start of the curve.

Starting at point E, draw a straight line perpendicular to the bar (E-F), and mark it with strips of adhesive tape. Set the bar at a challenging height, and have the jumper take a few jumps. By trial and error, find the optimum position for the start of the run-up (point G), and mark it with a transverse piece of adhesive tape.

The run-up is now ready. The set-up just described can be left in place for training, and it will contribute to drill into the athlete the pattern that the run-up should follow.

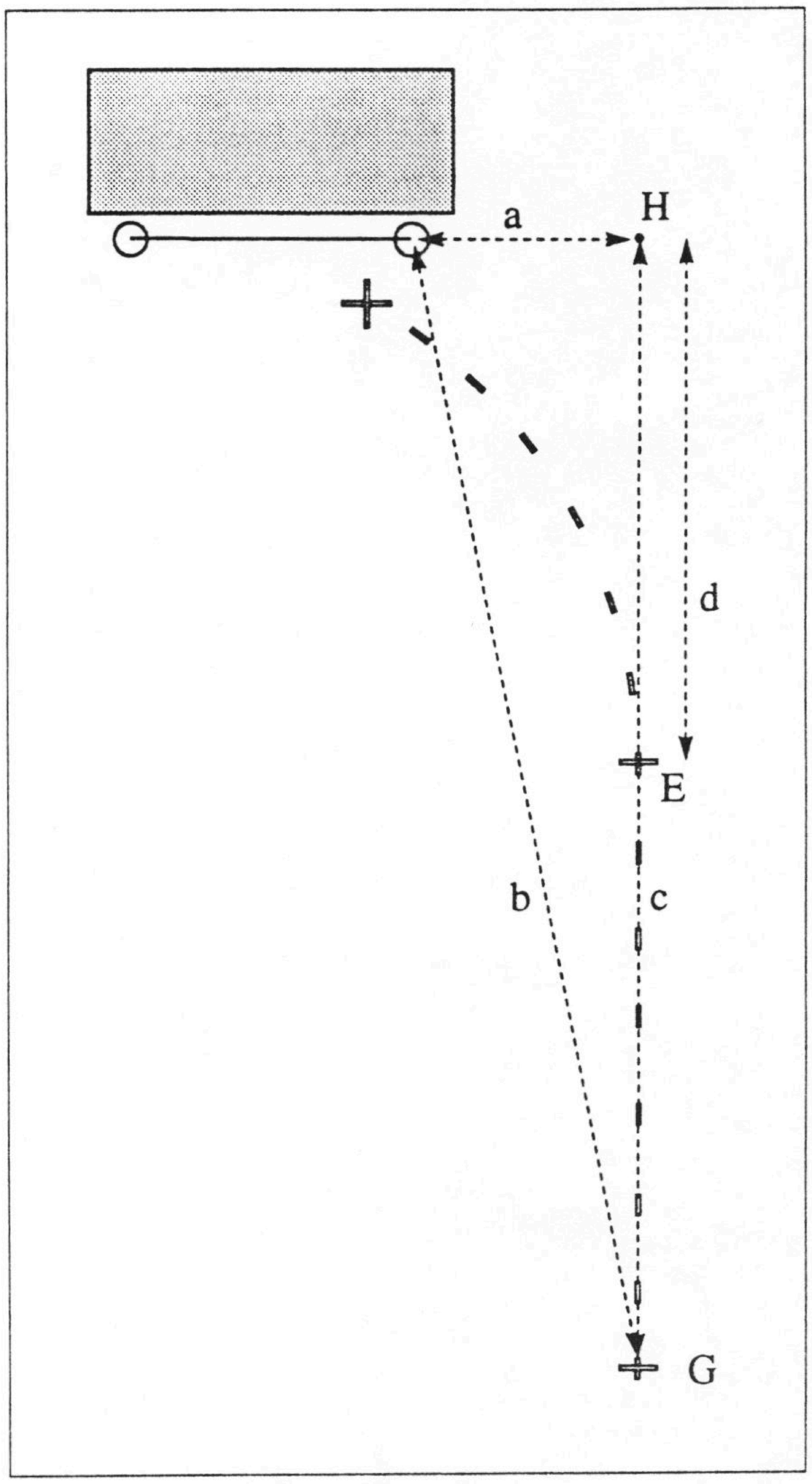

Figure 2

Items to remember:

- Point E indicates the place where the curve should start, but the athlete does not necessarily have to step on this point.
- Some jumpers may find it difficult to follow exactly the path marked by the adhesive tape in the transition from the straight to the curved part of the run-up. This should not be a problem: It is acceptable to deviate somewhat from the path marked by the adhesive tape in the area around point E. as long as the athlete deviates consistently in the same way in every jump.
- It is important to follow the tape very precisely in the middle and final parts of the curve.

As mentioned, the set-up described above can be left in place for training. However, one or two marks will have to suffice for competitions. Distances a, b, c and d should be measured in the training set-up (see Figure 2). In the competition, distance a will be used to reconstruct the position of point H. Distances b and c will then be used to reconstruct the triangle formed by the standard and points G and H. This will allow the athlete to locate the start of the run-up (point G). Distance d can be used to find the position of point E if the rules of the competition allow for a mark to be placed at that point.

REFERENCE

Dapena, J. Biomechanical analysis of the Fosbury flop. *Track Technique* 104:3307-3317;3333;105:3343-3350, 1988. ■