SURFACE HARDNESS
OF
BOWLING BALLS

Prepared for
American Bowling Congress

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Retyped by ABC

OBJECTIVE

During the past several years, various analyses and observations regarding the ability to score a strike on a set of bowling pins and the ability to apply a hook to the bowling ball have been made. The objective of this report is to capsulate these findings as pertaining to the soft surface bowling ball.

LAWRENCE THEORY

Using Newton's Second Law in the form of impulse and momentum equations, a simplified two dimensional model of a set of bowling pins being struck by a bowling ball has been developed. Figure 1 shows the impact between the ball and the head pin. Pin #1 collides with pin #2, which in turn collides with #4 which impacts #7 and the ball proceeds to impact pin #3, and so forth, until all pins have been hit. From this analysis, a range in the form of an arc on the head pin was determined whereby the ball hitting within the arc could score a strike, but hitting outside the arc would leave at least one pin without an impact.

The results of this analysis, called the Lawrence Theory, are graphed on Figure 2 and Figure 3. Generally, the greater the hook angle, the larger the arc on the head pin within which the bowler can bowl and still obtain a strike. In other words, when a bowler, within certain limits, throws a ball with a greater hook angle, there is a larger target to be hit.

BALL SURFACE DEFORMATION

Ball surface hardness data was taken on about twenty different models of bowling balls produced by some nine ball manufacturers. For each ball, three hardness readings in durometer D were taken and averaged. Ball track widths were obtained by rolling each ball over carbon paper placed on a glass plate. With the use of a microscope, the ball track width was measured in three places and averaged. Approximately eighty balls were so analyzed.

A graph of ball hardness in durometer D versus ball track width was obtained by plotting all the data. Figure 4 shows the relationship between ball hardness and ball track width. Ball track width decreases proportionally with the increase in hardness until reaching a hardness of about 78 durometer D. Track width then tends to level off with but a very small decrease with increased hardness. Therefore, a ball of hardness say 60 durometer D has a ball track width 50 per cent greater than a ball of hardness 85 durometer D. Since the area of contact is related to the square of the diameter, the 60 durometer D ball has a contact area 2.25 times as great as the contact area of the 85 durometer D ball.

It is of interest to note that the phenomena observed in Figure 4 is similar to that observed for a hard surface ball that has been soaked in acetone.

SOFT SURFACE BOWLING BALL

The action of the bowling ball between the foul line and the head pin can be described in terms of the phenomena observed in Figure 4. With more area of contact, the ball is more able to grip the lane, and this greater grip will maintain a higher lateral reaction force between the ball and the lane. Thus, the softer the ball surface, the higher the lateral reaction force and therefore the greater the ability of the bowler to impart a larger hook on the ball.

Combining the results of Figure 4 with that of Figure 2 leads to the conclusion that a soft surface ball gives the bowler a greater ability to place a larger hook on the ball and therefore increases the probability of scoring a strike.

The curve drawn through the data points and displayed in Figure 4 is a reasonable one. Given normal experimental variations, it can be concluded that setting the lower limit for hardness at 72 to 75 durometer D will result in a group of balls that should perform consistently with little surface grip variation at hardnesses above that level.

Signed/ W. Wayne Siesennop

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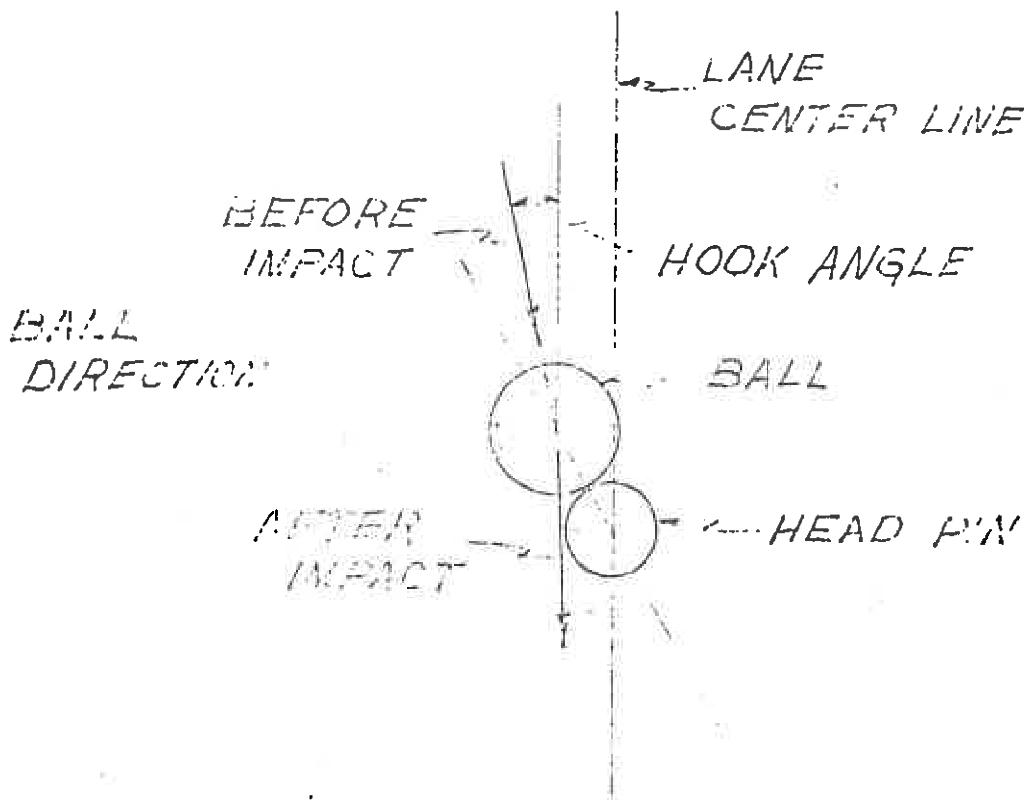

FIGURE 1

Pocket Width on #1 v Hook Angle
(e = .707)
ABC (by Wayne [illegible])
23 Dec '9[illegible]

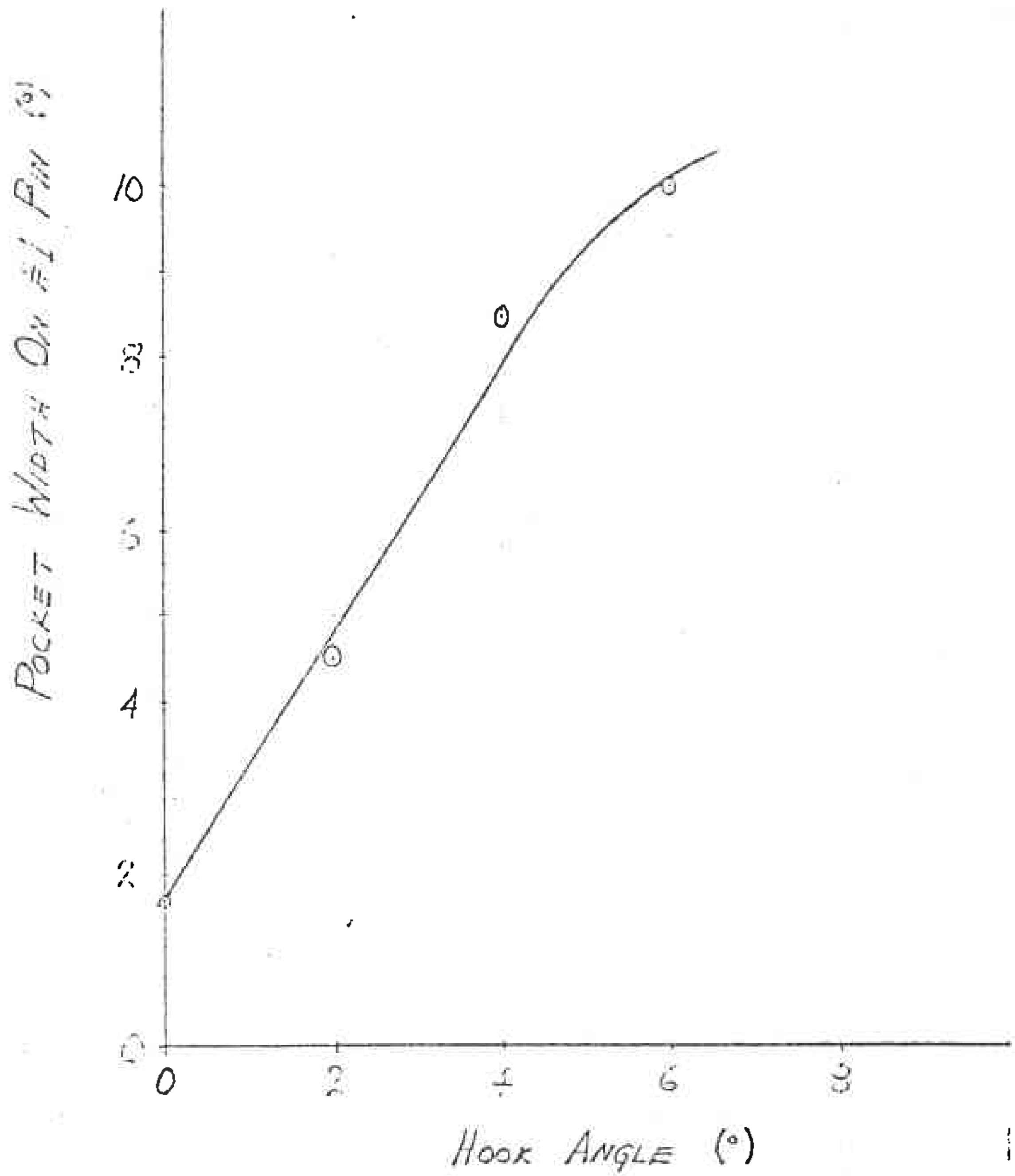

FIGURE 2

STRIKE POCKETS FOR
VARIOUS IMPACT ANGLES &
FOR e/d = .700 & e/d = .500.

2/15/75
J.C.R.

α = HOOK ANGLE OR ANGLE
OF BALL APPROACH TO LANE ℄.

IMPACT ANGLE = 30° - (α + θ)

e/d = .700

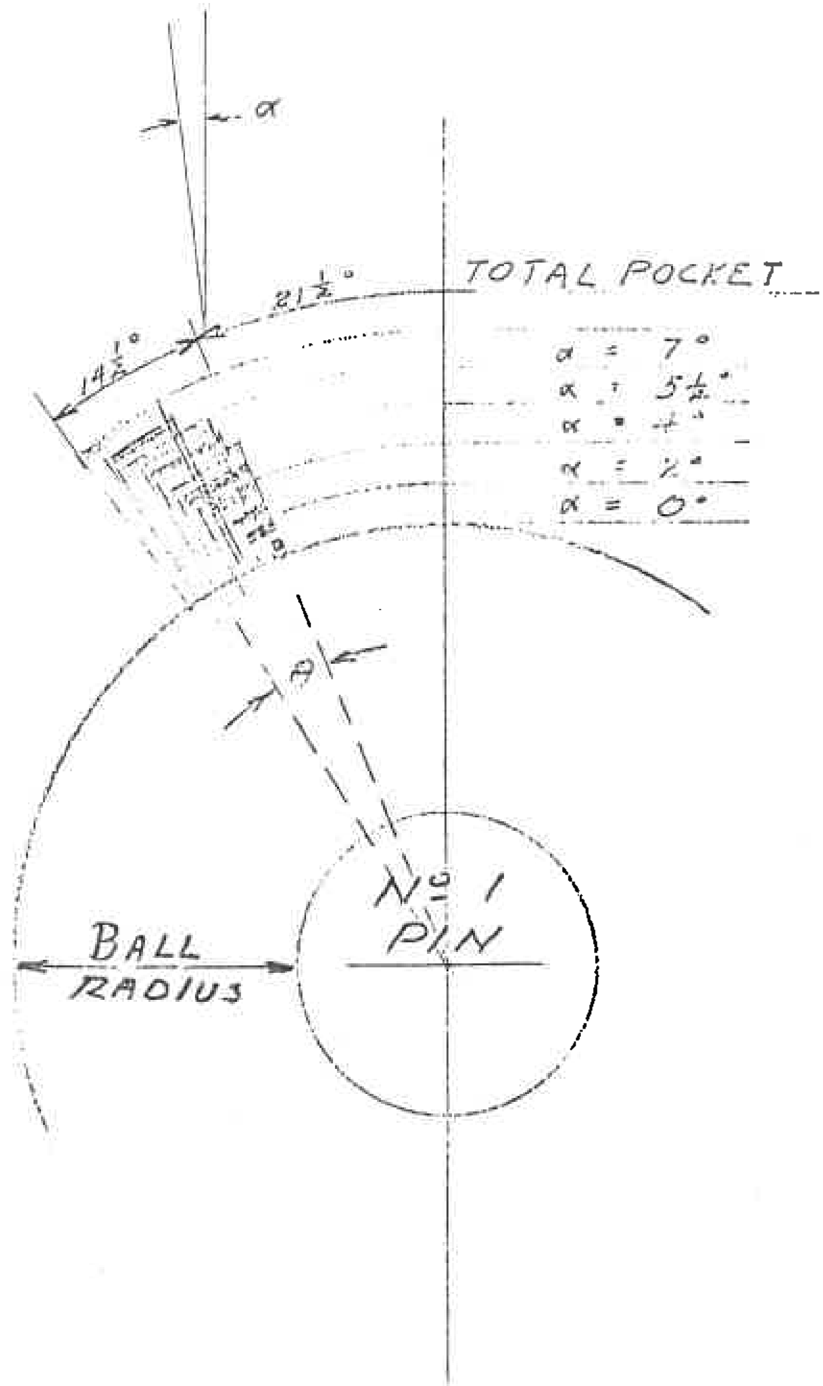

FIGURE 3

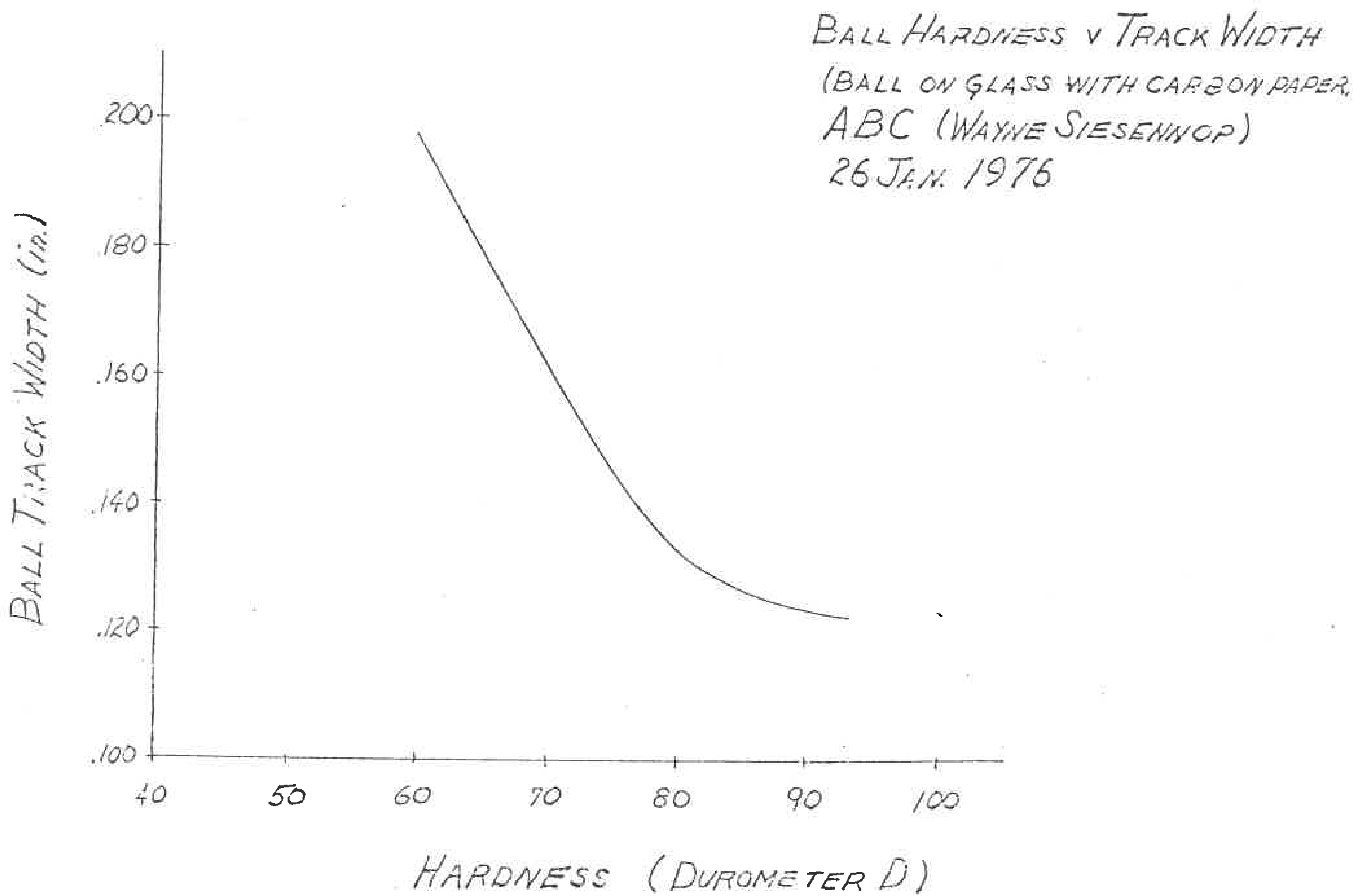
BALL HARDNESS v TRACK WIDTH
(BALL ON GLASS WITH CARBON PAPER,
ABC (WAYNE SIESENNOP)
26 JAN. 1976
BALL TRACK WIDTH (in.)
.200
.180
.160
.140
.120
.100
40
50
60
70
80
90
100
HARDNESS (DUROMETER D)

FIGURE 4