A Comparison of Clubhead and Ball Speeds at the 1957 and 2005-8 US Amateur Championships

United States Golf Association

June 20, 2018

Summary

Clubhead speed, ball speed and carry distance data were collected for two elite amateur players at the US Amateur at Brookline in 1957. This data is compared to comprehensive launch condition data and simulated drive distances from the US Amateur Championships.

Data Collection at 1957 US Amateur at Brookline

In 1957 the USGA conducted a study to determine the clubhead speed of elite amateur golfers. They accomplished this using high-speed (stroboscopic) motion pictures of several golf drives of two accomplished amateur golfers; Tim Holland and Robert Kuntz. The data was collected at the US Amateur at Brookline and included clubhead speed, ball speed, carry distance, loft and contact time.

The first analysis of the high-speed motion picture data was problematic containing significant errors. However, a re-examination of this data in 1959 resolved the errors and the report documenting this re-examination is the source of the data for this comparison. The entire report is included as Appendix A.

Data Collection at the 2005-2008 US Amateurs

As part of their basic research during the mid-2000s, members of the USGA Equipment Standards Department would routinely collect launch condition data of elite amateurs and professionals at USGA events. The data was collected using launch monitors on the practice range. Competitors were each asked to hit 6 balls on the range in front of the launch monitor. The launch conditions; ball speed, ball spin, and launch angle were recorded for each shot and an average was determined for each golfer.

In addition, the USGA, through Darrell Survey, had comprehensive data about which makes and models of balls each competitor used. That knowledge, coupled with detailed aerodynamic data of the various balls obtained through conformance testing, allowed for a more complete picture of golfer performance, including distance.

Data Comparison

The 1957 data was very limited, only seven shots in total. Examining the data, the "corrected" high-speed motion picture record for Tim Holland (an elite amateur and Walker Cup veteran) demonstrated a peak clubhead speed of 168fps (114.5mph). The report also indicates that a similar analysis of Bobby Jones clubhead speed was measured at 166fps (113mph). Ball speed was also measured, as was carry distance. A graph of carry distance vs ball speed is shown in Figure 1.

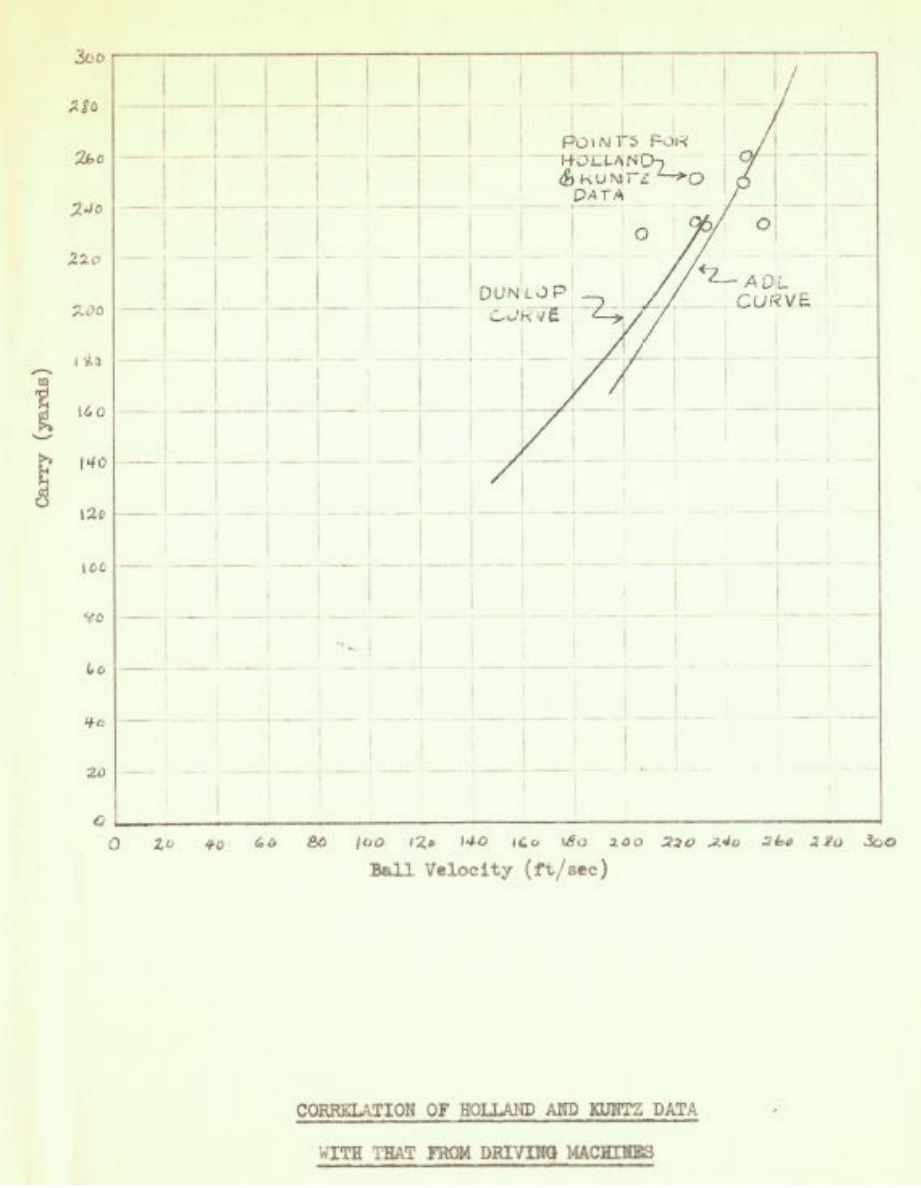


Figure 1: Carry distance vs. ball speed for Holland and Kuntz (as well as two analytical curves) .

The graph shows an average ball speed of ~240fps (163.6mph) and an average carry of ~242 yards for the two golfers; Holland and Kuntz.

Ball speeds from 2005-2008 US Amateur are given in Figure 2. Note that the average ball speeds of Holland and Kuntz fall in the in the center of this distribution.

Clubhead speeds were not measured at these events. However, the ratio of ball speed to clubhead speed (sometimes referred to as "smash factor") for modern balls and clubs is well established in the range of 1.47-1.49 for golfers of this caliber. Using these values of smash factor produce clubhead speeds of ~110-111mph. This is lower than Holland's peak clubhead of 114.5mph and Jones' of 113mph, but this is not unexpected given the differences in equipment of these two eras.

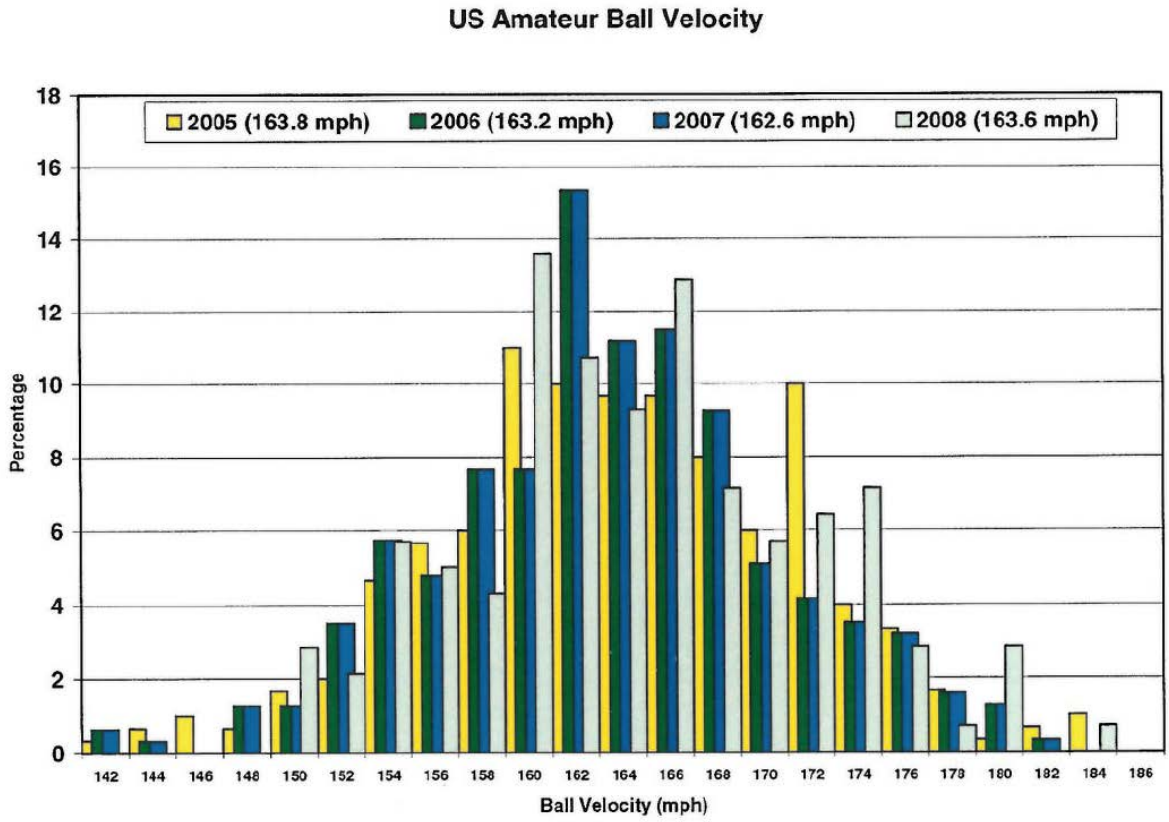


Figure 2: Ball Speed from the 2005-2008 US Amateurs.

Carry distances weren't measured during the range testing at the 2005-2008 US Amateurs. However, using the measured launch conditions (Figure 3) and aerodynamic data of the most popular balls used at these championships, we can simulate the "average" drive and calculate an average carry of 268 yards, Table 1.

Ball	Speed (mph)	Angle (°)	Spin (rpm)	Time (s)	Carry (yds)	Total (yds)
Tour Ball A	163.3	10.7	2788	6.69	268	286.5
Tour Ball B	163.3	10.7	2788	6.55	265.7	286
Tour Ball C	163.3	10.7	2788	6.63	266.9	287
Tour Ball D	163.3	10.7	2788	6.75	269.2	288.6
Tour Ball E	163.3	10.7	2788	6.56	269.6	290
					268	

Table 1: Calculated Carry Distances for Popular Tour Balls using 2005-2008 Amateur Launch Conditions

Like the calculated clubhead speed the calculated carry distance of 268 yards is very different from the carry distance of 242 yards in 1957. However, this 26 yard difference is not inconsistent with what one might expect given that driving distance (carry plus roll) on the PGA TOUR increased by 34 yards over that same time period, Figure 4.

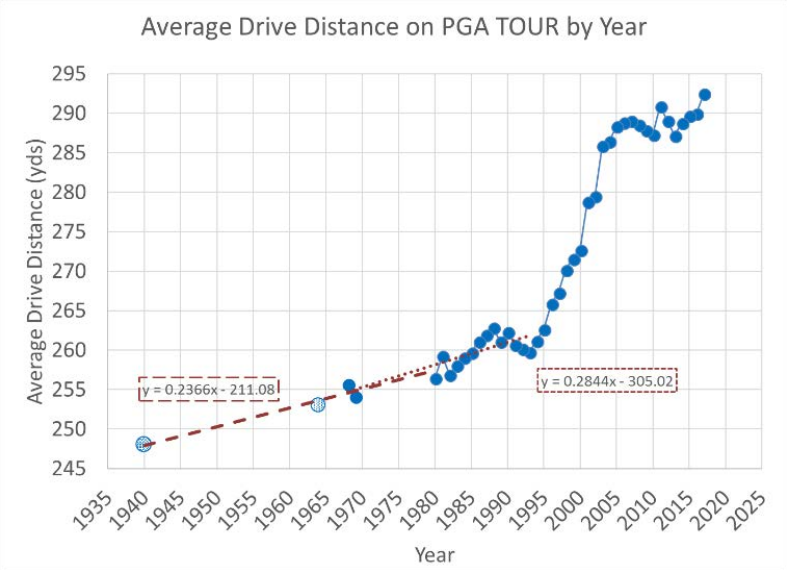


Figure 4: PGA TOUR Average Drive Distance (ref. "Historical Drive Distance on the PGA TOUR").

Furthermore, if you perform the same simulation over a range of ball speeds you obtain carry distance vs balls speed trends which are very similar (although higher in carry magnitude) to those listed in the 1959 report.

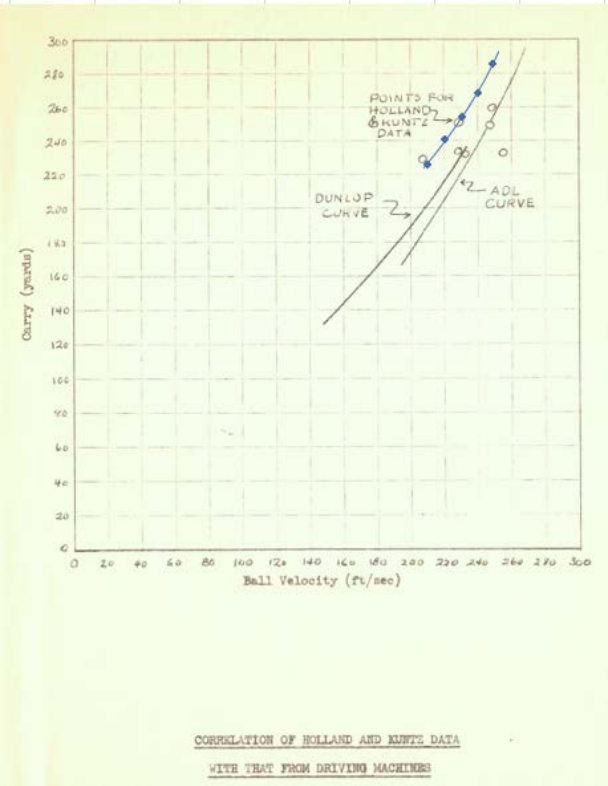


Figure 5: Calculated Carry Distances for Popular Tour Balls at Various Ball Speeds).

Conclusions

Given the extremely limited amount of data from 1957 it would be inappropriate to draw any quantitative conclusions from these comparisons other than that the data and analysis reported in the 1957 paper seem sound.

However, from a qualitative standpoint, it would appear that Messr's Holland and Kuntz had clubhead speeds that were not inconsistent with elite amateurs of 2005-2008 period. Furthermore, taking into account the significant advances in equipment over this 50+ year period, their measured carry distances also seemed reasonable when compared to the 2005-2008 data.

Appendix A

CLUB SPEED IN A GOLF SWING

Memorandum to

THE UNITED STATES GOLF ASSOCIATION

January 7, 1959
C-60585

Arthur D. Little, Inc.

CAMBRIDGE, MASS. NEW YORK CHICAGO WASHINGTON, D. C. SAN FRANCISCO SCOTLAND PUERTO RICO

CLUB SPEED IN A GOLF SWING

I. INTRODUCTION

In September 1957, during the Amateur Championship at Brookline, Mass., we made high-speed (stroboscopic) motion pictures of several golf drives. Measurements from these films were published in the USGA Journal by W. E. Gordon. The figures reported were club velocity, ball velocity, carry, loft and contact time. For Tim Holland, one of the performers, the average club speed was given as 212 ft/sec.

Mr. Len Elliott of the Newark News pointed out that Bobby Jones' club speed had been given by Professor Edgerton at about 166 ft/sec and Mr. Elliott questioned the accuracy of our values. He had also obtained figures of about this magnitude himself with a photo-electric timing device. Subsequently he employed the so-called Time-A-Swing of the Kay Electric Co., Pine Ridge, N. J. to make further measurements for several golfers, among them Holland. The hard hitters in the test group averaged in the 160's and Holland's peak was 168 ft/sec.

In order to resolve the discrepancy, Kay Electric very kindly sent Mr. Roy Huebner to Arthur D. Little Inc. on October 26, 1958, with the Time-A-Swing so that we could compare it with our equipment. This report describes the results of the tests and the resolution of the discrepancy.

II. TIME-A-SWING TESTS

Two different sets of tests of the Time-A-Swing were made to compare it with measurements by the multi-flash strobe technique. In the first set, golf balls were fired through the light beams of the Time-A-Swing by means of an air gun. Simultaneously, strobe photographs were taken. The two methods checked within about one percent, which was as close as could be expected.

In the second set of tests, golf club swings were measured simultaneously by the two methods. Here, the agreement was not as good, but only because of technical difficulties. (The club was hidden from view by the Time-A-Swing, so that the club speed had to be measured on the strobe photograph at a point ahead of and behind the Time-A-Swing itself.) There was no trend in these measurements to indicate a significant difference between the two methods, however.

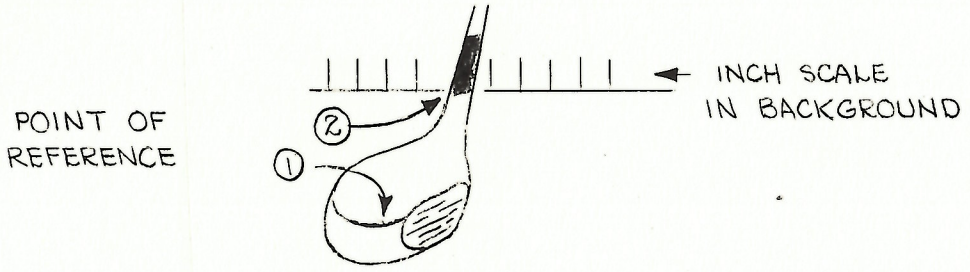
We therefore conclude that the Time-A-Swing and strobe multi-flash methods are in substantial agreement. Presumably, both are correct. The Club speeds on the Time-A-Swing were quite comparable with those that had previously been measured on it: top values in the 160's.

III. ERRORS IN THE BROOKLINE TESTS

We had previously discovered a serious error in our Brookline work due to parallax. We had failed to take account of the fact that the inch scale was some distance behind the ball on the opposite side to the camera and not coincident with the ball itself. For this reason our reported speeds were all too high. By comparing the diameter of the ball as measured in our photographs with the inch scale, we were able to fix this parallax error at 8.9%.

The parallax error, however, still failed by a wide margin to account for the error in our club speeds. Furthermore, the ball velocities, when corrected downwards by 8.9%, appeared consistent with the carry results, which, of course, were not in question. (See Section IV.) Hence, it appeared that, after correction for parallax, the club speeds were still in error by 12% even though the ball speeds were correct.

This situation called for a closer examination of the club speed measurement itself. Originally, we had used the toe of the hitting face as the point of reference on the clubhead, that marked (1) in the following diagram.



This was the only well-defined light mark on the otherwise dark clubhead. We repeated measurements of this point on the original photographs using a travelling miscroscope. (The original measurements were made with a fine scale.) These miscroscopic measurements tallied with the original ones.

We then measured with the miscroscope the point where the club shaft crossed the scale in the photograph (marked as point of reference (2) in the diagram). Club speed values for point of reference (2)--when corrected for parallax--were about 170 ft/sec; values measured from point of reference (1) were 194 ft/sec.

The explanation for the error caused by point of reference (1) we believe to be as follows. The face of the club is only lighted by reflection from the ball. In other words, there is a sort of image of the

ball reflected on the club face. This fact one gathers by inference; it is not at once apparent. The point that we had assumed to be the toe of the face was not in reality the toe, but simply the sharp edge of the spot of reflected light.

When this explanation occurred to us, a closer examination of the photographs gave it added credence. We now realized--as we had not before--why we had not been able to get good measurements of the clubhead after impact: the ball, being removed from near the club face, no longer reflected sufficient light on it to enable us to discern the sharp edge that we had used for the before-impact measurements. Our report remarks on this fact as follows: "A major improvement could be made in the experimental setup if a well-defined marker were located on the clubhead, close to the center of gravity.....little reliance can therefore be placed on the after-impact clubhead velocity figures from the Brookline tests."

In summary, the major error in the clubhead-speed measurements came about because--for want of a better marker--we had used a highlight in the photograph, which, instead of being an actual point on the club, was a reflected beam of light that shifted as the club approached the ball. Since we originally had no reason to suspect our results to be in error, we had not checked other reference points, such as (2). (Naturally, we wanted the speed measurements to be made at a point on the hitting surface if possible.)

IV. SUBSTANTIATION

In the accompanying graph we show the data points for the well-hit shots of Holland and Kuntz in comparison with driving machine curves as given in our 1958 report. The ball speeds here were corrected for parallax (8.9%). The carry figures were as given originally. The points scatter about the curves to a degree that might be expected as a result both of measurement errors and of inconsistency in the shots themselves. The agreement of the points with the curves is, of course, much better than it would be if the ball velocity values were not corrected for parallax.

In substantiation of the figure of about 170 ft/sec as a top clubhead speed, we can now--also as a result of recent work covered in our 1958 report--offer theoretical support. A top ball speed for Holland and Kuntz, as the figure shows, is about 250 ft/sec. The club speed can be calculated from the theoretical formula

$$\text{club speed} = \text{ball speed} \quad \frac{(1 + f)}{(1 + e)}$$

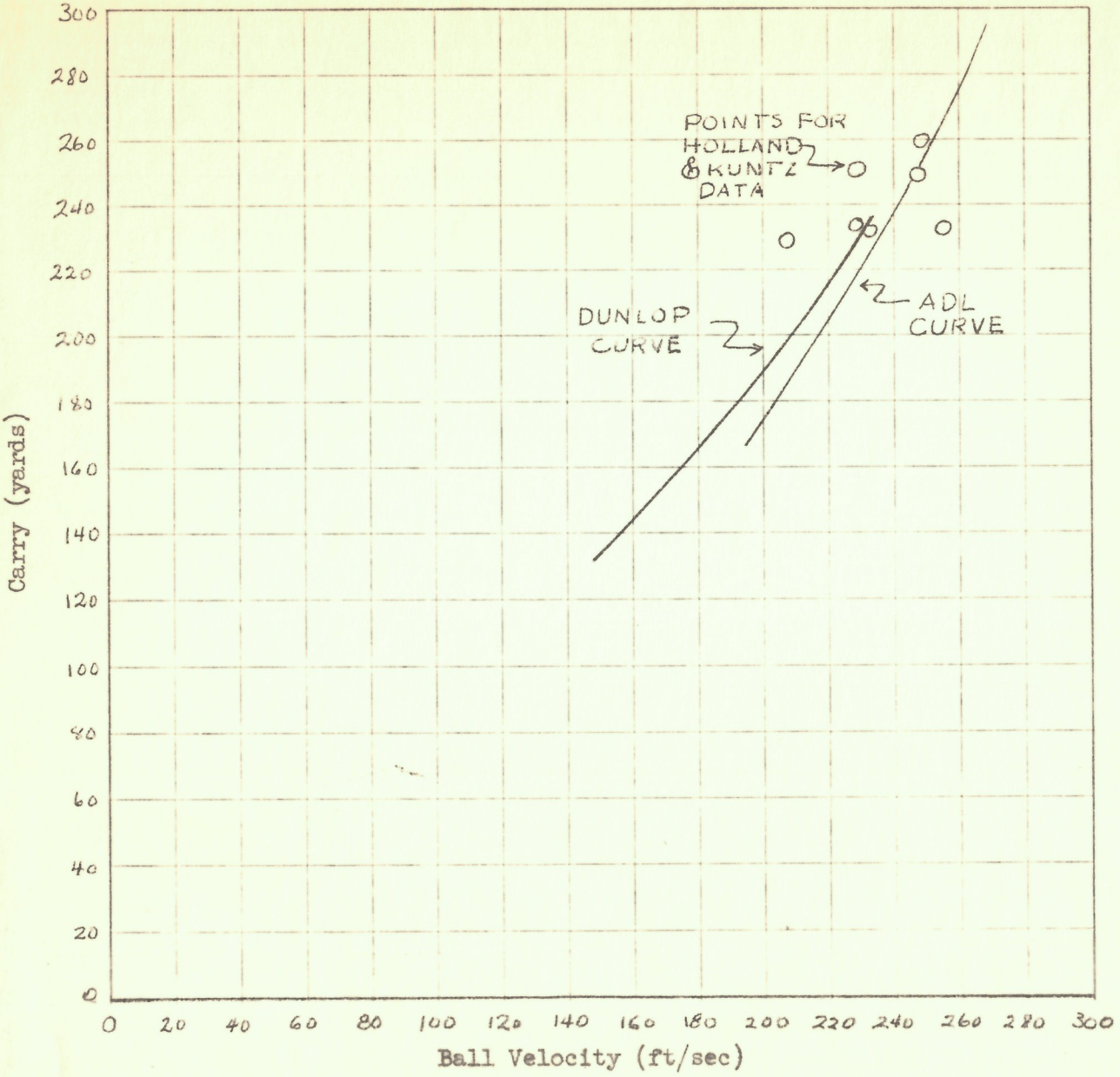
where f is (weight of ball)/weight of clubhead) and e is the coefficient of restitution. We know that f is commonly about 0.22 and e about 0.74. Therefore

$$\text{club speed} = 250 \text{ (ft/sec)} \times \frac{1.22}{1.74} = 175 \text{ ft/sec}$$

This club speed appears to be slightly higher than is commonly attained. Hence, in order to obtain 250 ft/sec with a smaller club speed, the golfer must use either a heavier club (hence smaller f) or a livlier ball (higher e). Let us suppose he uses a club with f = 0.20 (five times as heavy as the ball) and a ball with e : 0.76. Then

$$\text{club speed} = 250 \text{ (ft/sec)} \times \frac{1.20}{1.76} = 170 \text{ ft/sec}$$

It is possible that even heavier clubs are used, but this is about as high an e-value as it is possible to get in present balls.



CORRELATION OF HOLLAND AND KUNTZ DATA

WITH THAT FROM DRIVING MACHINES