Dialogue concerning the Stimpmeter

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Dialogue concerning *the* Stimpmeter

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Abstract

The Stimpmeter is a device sanctioned by the United States Golf Association to measure the speed of putting greens. It is based upon the inclined plane. A calculation, more elaborate than is usual for inclined planes, shows that the Stimpmeter causes the ball to roll on the green at 1.83 m/s.

At the golf course last month, I fell in with three venerable golfers; together, we played as a foursome. After the round, I joined them in the clubhouse. Their fortunes had been such that they were glad to share the solace and refreshment provided by the companionship of kindred spirits; nor did they disdain the more traditional liquid spirits which abound in such a venue. Solaced in this manner, my three comrades disputed in a lively fashion the events of the day. Their names were Simplicio, Salviati, and Sagredo; and it was the latter, a greybeard with a handicap of 14, who spoke first.

Sagredo: The Pythagoreans held integers in high esteem; yet, I would be disappointed to learn that they held high integers in greater esteem than low ones. For I confess a preference for a lower score than the one which shames my scorecard.

Salviati: Pythagorean numerology explains the harmonies of the celestial spheres; yet, those spheres are perfect, whereas no perfection is detectable in the golf ball you employ. For, is not this sphere dimpled on its surface, and are not many of the dimples interconnected by long gashes, inflicted thereon by your niblick's errant swings? Where is the harmony of this sphere?

Simplicio: In addition, do you not lift your head in the middle of your swing, fixing your eye upon the perfections of the heavens, rather than keeping it on the ball?

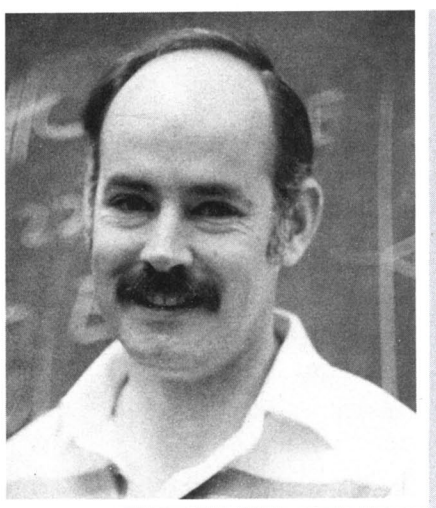
Sagredo: I confess that my equipment and technique may deviate from perfection; yet, I cannot help feeling that this golf course may contribute to the dismal events of the day. Were not all of us afflicted by great difficulties in sinking putts, even those of inconsiderable length?

Simplicio: Yes, indeed. I thought the greens were very fast.

Salviati: I must differ with Simplicio; for, though I suffered many difficulties in putting, even more than the estimable Sagredo, yet I repudiate the conclusion that the greens were fast.

Simplicio: How so? Did not many of your putts speed far past the holes, and is this not commonly held to indicate that greens are fast?

Salviati: I observed the greens all day, and I never saw them move. From this, I conclude that the greens



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cannot have been fast; rather, they were fixed, unmoving, and at rest. The speed of which you complain was to be found, not in the motion of the greens, but in the motion of the balls.

Sagredo: Then I must shift my complaints to the inadequate friction with which the grassy surfaces opposed the motion of my putts. Which among us can undertake to explain the mysteries of this friction?

Simplicio: Not I.

Salviati: Nor I. And yet, noble Sagredo, I see that you are reaching into your golf bag, pulling therefrom not a club, but a curious metal implement. What is it, and what bearing does it have on the present discussion?

Sagredo: I offer, for your consideration, a Stimpmeter. It was invented by Edward S. Stimpson, who was the Massachusetts Amateur Champion in 1935.

At the mention of this memorable achievement, they stood. The reader may use the ensuing lull in the conversation to consider Fig. 1.

Simplicio: I cannot understand what this device can reveal about the surface of a putting green, for it does not seem designed to roll easily.

Sagredo: Indeed not. This extruded aluminum bar, about one m long, has a V-shaped groove running its length. The groove subtends an angle of 145°. The tapered end is placed on the ground, and a golf ball is set in the notch, 30 in. (0.762 m) from the tapered end. The ball is released when the Stimpmeter is lifted to an angle of 20° with respect to the horizontal.[1] It then rolls down the groove and onto the green.

Salviati: I note the inscription USGA on one end, from which I infer that the United States Golf Association sanctions the use of this curious engine.

Sagredo: That is indeed the case, and, through the guidance of the Stimpmeter, greenskeepers may adjust, perfect, and render homogeneous the friction applied by every putting surface to the ball. In this matter, I suspect the local greenskeeper of egregious laxity.

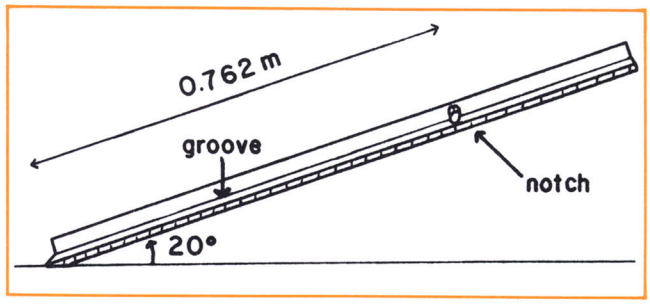
Salviati: Has the USGA set standards for the use of the Stimpmeter?

Sagredo: The USGA has decreed no universal standard. Instead, they allow local jurisdictions to set their own standards. However, a golf ball which rolls from a Stimpmeter may travel from 4 to 12 feet before coming to rest, provided that the surface is level.

Simplicio: How do you reckon that in meters?

Sagredo: About 1.2 to 3.7 meters. For tournament play, the speed (so-called) of a green is usually increased, so that the Stimpmeter value is around 3.5 meters; for ordinary play, by such duffers as ourselves, the wise greenskeeper usually adjusts the greens to a much lower value.

Simplicio: What methods avail for changing the speed of a green?



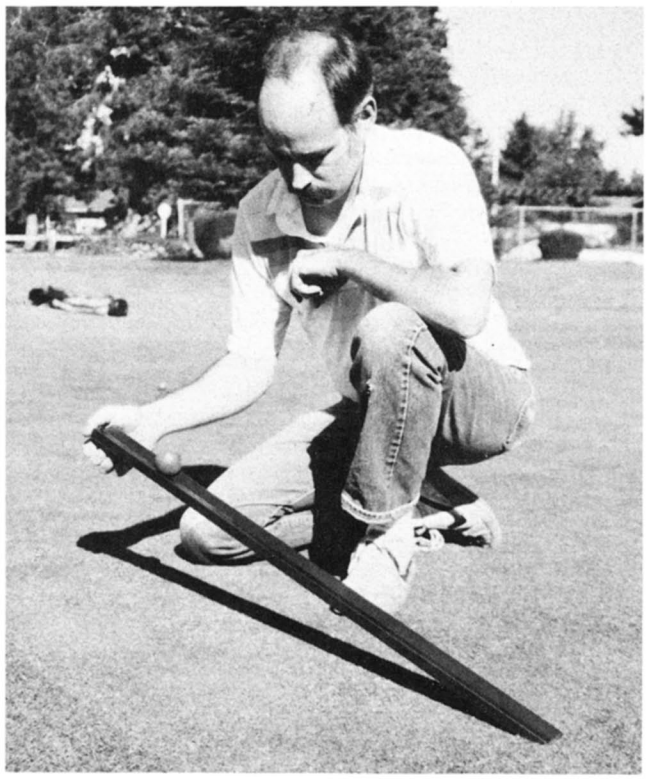


Fig. 1. The Stimpmeter.(*Top*) The ball is placed in the notch. The rod is raised with the tapered end in contact with the green. When the angle is 20°, the ball rolls 30 inches down the groove and onto the green.(*Bottom*) The author with a Stimpmeter in action. (Photo: Jolynda Tresner)

Sagredo: I should imagine that judicious mowing and watering of the surface, together with the application of fertilizer and sand, would have their effect. But these are matters bearing more on the science of agronomy, rather than on the natural philosophy of our noble sport. Let us consider instead a question which our analytical powers can more easily bring to resolution; that is, what is the speed of a golf ball just after rolling down the Stimpmeter?

Salviati: Have we enough information to solve this riddle? We know much about the dimensions of the Stimpmeter but little about the size of a golf ball; nor can we rely upon inspecting yours to enlighten us, seeing that it is as pocked and marred as the moon.

Sagredo: The USGA has pronounced that the diameter of the ball is 1.68 in., that is, 4.267 cm. In this,

they depart from the quaint customs of the British, who address themselves to a ball whose diameter is a mere 1.62 in., or 4.115 cm.

Simplicio: I would say that the problem is a simple one, and that its solution requires no knowledge of the ball's size. I will, however, need something to write on, in order to demonstrate the merits of my assertion.

The three demanded writing paper from the servitor, who returned with a supply of envelopes, as well as heady portions of brew to recharge their empty bumpers. Simplicio drew Fig. 2 on the back of his envelope as he continued.

Simplicio: The ball begins 0.762 m up the incline, which is at an angle of 20°. Thus, the initial height is h = 0.2606 m. The ball starts at rest. I neglect friction. If the final and initial energies are equal, then I have $1/2mv_f^2 = mgh$, for a final speed $v_f = 2.26$ m/sec. I note, sage Salviati, that you chafe at certain aspects of this explanation; the rolling of your eyes reminds me that I have omitted the rolling of the golf ball. Then the conservation of energy leads to $1/2I\omega_f^2 + 1/2mv_f^2 = mgh$. If the moment of inertia $I = (2/5)mR_b^2$, and the final angular velocity $\omega_f = v_f/R_b$, then I note that the radius of the ball R_b does not enter into the final result,

$$v_f = (10gh/7)^{1/2} = 1.91 \text{ m/sec.} \qquad (1)$$

Sagredo: This was neatly done, but I cannot believe that the moment of inertia of a golf ball is actually that of a uniform sphere, for the composition of a golf ball, though radially symmetric,[2] is not uniform.

Salviati: I applaud Simplicio for his belated inclusion of the ball's rotation. Yet, I fear that he has overlooked the following consideration.

Salviati displayed the back of his envelope, on which Fig. 3 appeared.

Salviati: He has assumed that the angular velocity of the ball is related to the linear velocity according to $\omega = v/R_b$. This cannot be true, since the ball rolls in a V-shaped groove. The actual distance between the axis of rotation and the points of contact with the surface is R_c, and no diligent student of Euclid will criticize me when I say that $R_c = R_b\sin(\alpha/2)$, where $\alpha = 145°$, the angle of the groove. Hence, $\omega_f = v_f/[R_b\sin(\alpha/2)]$ and,

$$v_f = (10gh)^{1/2}[5 + 2/\sin^2(\alpha)]^{-1/2} = 1.88 \text{ m/s} . \qquad (2)$$

So, I would say that the ball moves more slowly than 1.91 m/s. However, I note from Sagredo's earnest scribbling that he is not entirely content with my calculation.

Sagredo: Your contribution is satisfactory up to a point, but it does not tell us the speed of the ball when it begins to roll on the green after descending the incline. For, as you can see from this sketch...

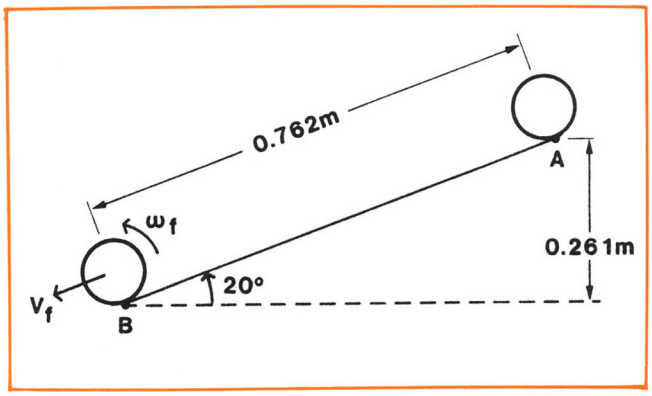


Fig. 2. Simplicio's envelope. The ball starts at rest at A. At the bottom (B), the velocity is v_f and the angular velocity is ω_f.

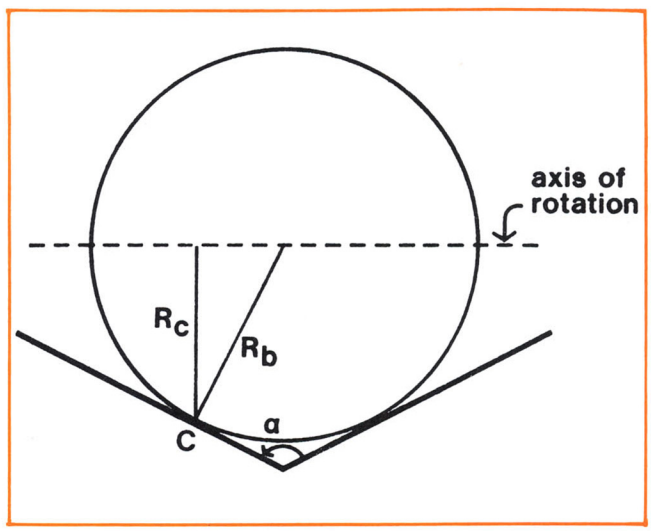


Fig. 3. Salviati's envelope. The ball is in the groove of the Stimpmeter. The angle α of the groove (145°) is exaggerated. R_b is the radius of the ball. R_c is the distance from the axis of rotation to the point of contact C.

[*Here Sagredo showed the back of his envelope, Fig. 4.*]

...the ball changes direction at the bottom of the incline when it starts to roll on the horizontal surface. Evidently, the ball will experience two forces when it first encounters the green: the vertical force F_1, whose impulse deprives the ball of vertical momentum; and the horizontal force F_2, which acts to prevent the ball from slipping as it rolls on the horizontal surface. If we say that the impulse of F_2 is $F_2\Delta t$, then this impulse acts to change the horizontal momentum and the angular momentum of the ball. So I write,

$(F_2\Delta t) = mv_2 - mv_f \cos 20°$,

$(F_2\Delta t)R_b = I\omega_f - I\omega_2$,

$\omega_f = v_f/R_c$, and $\omega_2 = v_2/R_b$,

where v_f is the speed just calculated by Salviati, and where v_2 is the actual final speed, for which I get

$$v_2 = (5/7)v_f(\cos 20° + 0.4/\sin(\alpha/2)) = 1.83 \text{ m/sec} \quad (3)$$

With a flourish, the learned Sagredo placed his much abused golf ball in the notch of the Stimpmeter and raised it slowly to the prescribed angle. The ball sped down the incline and rattled merrily across the table at 1.83 m/s, its progress checked only by Simplicio's glass.[3] The emptiness of this vessel preserved us from a soaking as it tumbled to the floor. As the ensuing discourse, though lively, did little to advance the previous discussion, I close my record at this point.□

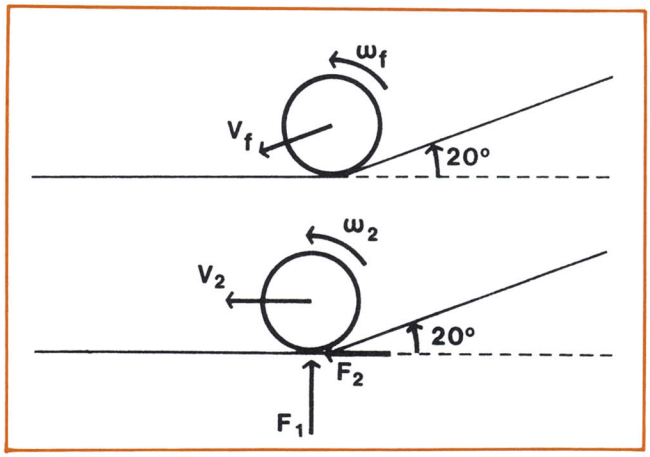


Fig. 4. Sagredo's envelope. The ball has velocity v_f and angular velocity ω_f at the bottom of the Stimpmeter. It is acted on by forces F_1 and F_2 when it contacts the green. It rolls away with velocity v_2 and angular velocity ω_2.

References

1. Stimpmeter Instruction Booklet, USGA, Far Hills, NJ 07931.
2. In this conjecture, Sagredo errs; golf balls, due to irregularities of manufacture, are frequently not radially symmetric. (F. Holmstrom, private communication.)
3. We have verified this speed experimentally.