

Are You Inclined to Putt?

Background, Purpose, Hypothesis

I decided to do my science fair project on something related to golf because it is my favourite sport. I decided to study the putting aspect of golf because for many golfers it is the most challenging part of the game. Even professional golfers have difficulty judging the strength of hit required for uphill or downhill putts. From watching golf on television, it appeared to me that golfers had more trouble judging putting distance on fast, dry green surfaces. I wondered if there was some way I could investigate this with a science fair project.

The purpose of the project was to try to investigate the relationship between the strength of a putting stroke and the degree of inclination and the speed of the green. It was assumed that a typical putt could be studied from the physics standpoint. The ball would have an initial velocity (which could be measured with a motion sensor), a final velocity (which would be zero since a putt stops), and a displacement (which one could measure). Acceleration could be calculated using this data. The degree of inclination could be easily controlled and measured with a ramp system. Different green surfaces (fast or slow) could be simulated with different carpet remnants. Some preliminary research suggested that the primary frictional forces would be those of rolling friction, which is far less in magnitude than conventional sliding friction. It was hoped that this approach would allow a quantitative assessment of putting.

The hypothesis was that faster green surfaces would be more sensitive to variations in the inclination of a putt. This means that putting speed would have to be adjusted more for downhill and uphill putts on a faster green than on a slower green. This hypothesis was supported by a theoretical analysis of the physics of a rolling sphere.

Procedure

A putting machine was designed and built. It was divided into three parts: the putter swinger, a ramp, and an inclination adjuster. The putter swinger was a putting club mounted as a pendulum. The 8 foot (2.5 meter) ramp was double-sided and had a slow carpet surface on one side and a faster surface on the other. A stimpmeter (which measures green speed) was used to verify that the slow and fast carpets mimicked real green conditions (with readings of 8 feet and 14.5 feet, respectively). The inclination adjuster held the foot of the ramp and could be adjusted to give different slopes. Balls were hit on both surfaces with different inclinations. Varying velocities gave putts ranging from 0.5 to 2 metres. The initial velocity of the ball was measured with a motion sensor, and the distance of the putt was documented. The results were analyzed.

Results/Observations and Conclusions

A lot of interesting data was generated. The graphs of experimentally measured distance versus initial velocity gave relatively straight lines that shifted as inclination changed. The calculated acceleration (actually deceleration) versus initial velocity also gave largely linear relationships that again shifted as inclination was modified. Analysis of this experimental data allowed the determination of the initial velocity required on different inclinations (and different green speeds) to achieve putting distances of 1 and 2 metres.

From the physics standpoint, the results verified that deceleration of a golf putt depends on at least three factors: green surface, green inclination, and the initial velocity of the putt. Slower greens have a greater deceleration (when inclination and initial velocity are kept constant). Deceleration increases for uphill putts and decreases for downhill putts. Interestingly, deceleration is fairly uniform for all initial velocities on a faster green but deceleration increases as initial velocity increases on a slower green. This may be because the harder hit on the slower

green causes some initial bouncing and sliding which increases the friction. This effect is much less on a faster green where one does not need to hit the ball as hard.

The results seemed to prove the hypothesis in that it showed that more compensation was required for inclination on fast surfaces (with less friction) than for slow surfaces (with more friction). This means that a golfer putting on fast greens must hit downhill putts *really* softly and uphill putts much harder compared to a level putt. On a slower surface, there would be less of a variation on the strength needed to hit uphill or downhill putts compared to a level putt.

Acknowledgement

I would like to thank my mom and dad for financing the materials used in the project and also for advice during construction of the apparatus. Also thanks goes to my dad for operating the putter swing, as it was necessary for two people to be present at all the trials (one to operate motion sensor, one to swing the putter). Finally I would like to thank Victoria East Golf Club in Guelph for lending me the stimpmeter so that I could quantify the green speeds.

References

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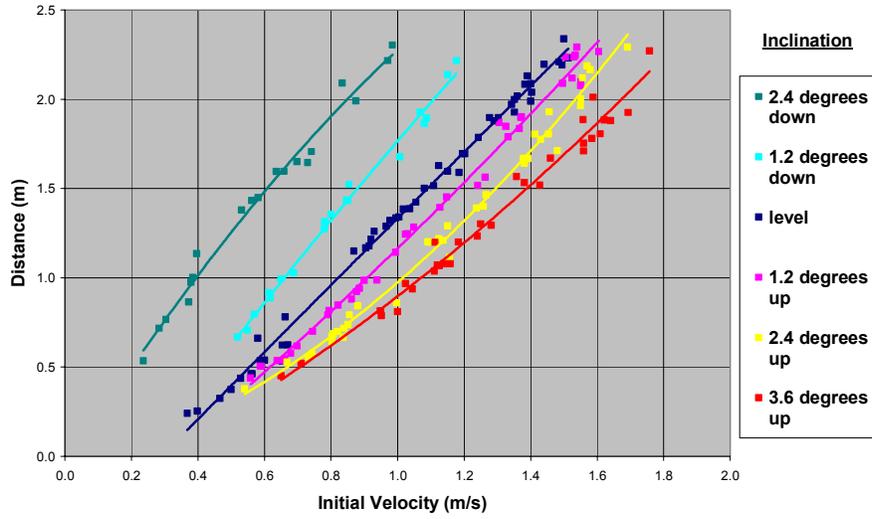
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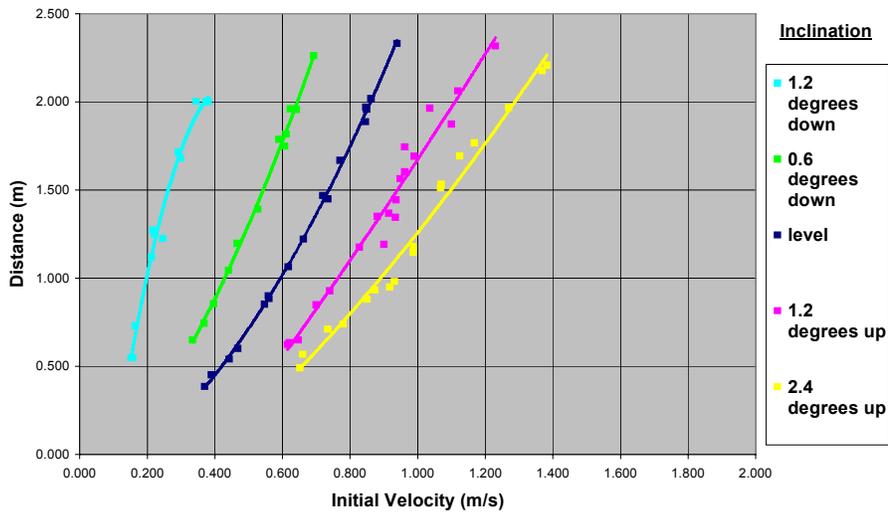
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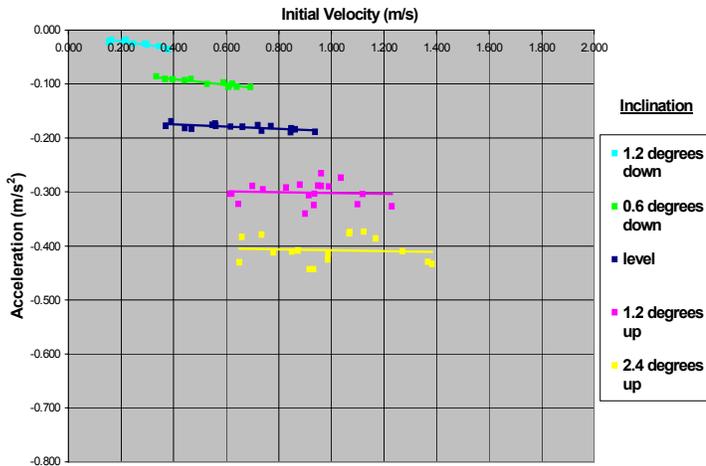
Distance vs. Initial Velocity for Putt on Slow Green



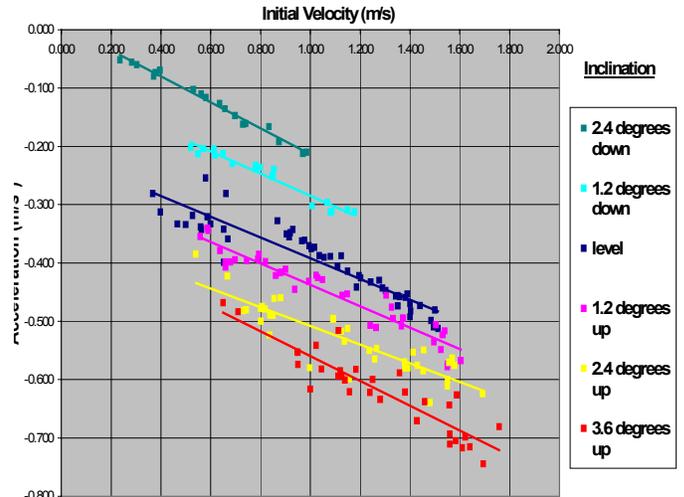
Distance vs. Initial Velocity for Putt on Fast Green



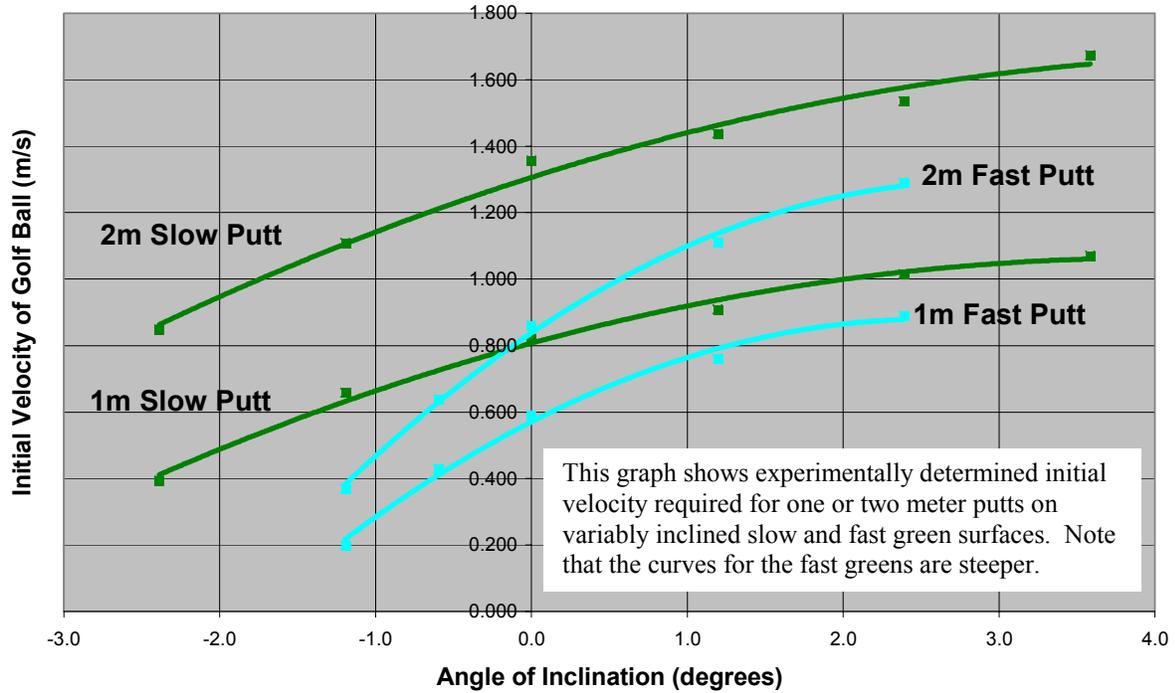
Acceleration vs. Initial Velocity for Putt on Fast Green



Acceleration vs. Initial Velocity for Putt on Slow Green



Effects of Inclination and Green Speed on Straight Putts



Compensation Required for Inclined Putts on Fast and Slow Greens

