

A ROLLING BRIEF

BEST OF BRITISH

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"Quantifying the relative and conflicting effects of putter path and face angle on the direction and motion of the golf ball" – that was our goal in producing a research document based on our own extensive testing

By Dr Paul Hurrion & Jim MacKay

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The putter: the most used club in the bag but the most overlooked part of the average golfer's practice. Golfers around the world are using the technology available in today's market to help analyse and improve their golf swing. Technology is transforming teaching and club-fitting, offering golfers three-dimensional, frame-by-frame swing analysis, high-speed video and precise spin rates and launch angles that apply to the golf ball after impact. However, when it comes to putting, rather than analysing what our putting stroke and the ball are doing in detail, we simply opt to buy another putter with little more than hope that it will truly improve our putting performance.

Factors such as alignment of the putter face, path of the putter, launch angle, speed, impact location, grip pressure, forward or backwards rotation, hook or cut spin, grain, spike marks, slope and even wind can play a significant part in the outcome of a putt.

The vital question we like to ask our players is simple: "Do you know the difference between a good putt and a poor putt?" Without feedback on the launch conditions of each putt, is it possible to begin to answer this question?

So let's look at feedback and understand the relative effects of putter face angle and putter path.

In the vertical plane, there are only three conditions that can occur at impact of putter on ball. The face of the putter is either open or square or closed to the putter's path. But how many variations of face angles and paths can make up these three conditions...countless. Yet, crucially, the putter's face angle and path at impact are the two factors that determine the direction in which the ball will start.

We explain which is the more influential and by how much?

Interestingly, our study proved that Face Angle at impact accounted for as much as 92-95% of the starting direction of putts (centre strike with a two degree dynamic loft at impact). The question, then, is how does this translate into making or missing putts? Our data below shows the angular margin for error within which a putt will still succeed.

Distance Angle of Ball Putter Face Angle (92%)
from target line

3 feet	2.80°	2.60°
4 feet	2.20°	2.02°
5 feet	1.90°	1.75°
6 feet	1.60°	1.47°
7 feet	1.40°	1.29°
8 feet	1.20°	1.10°
9 feet	1.00°	0.92°
10 feet	0.90°	0.83°
12 feet	0.75°	0.69°
15 feet	0.60°	0.55°

Note: Data produced by The Quintic Ball Roll System (as explained later)

During the PGA Tour 2011 season, five players made 100% (minimum 400 attempts) of putts inside three feet where the putter face angle can be up to 2.60 degrees open or closed relative to the target line and the putt still drops (Target line = 0 degrees). But note from more than 8 feet that only a single degree closed or open will cause the ball to miss – it is very difficult with the naked eye to see the difference between a putter that is square as opposed to one degree open or closed. No wonder the percentage of putts made on the PGA Tour drops off so quickly after 8 feet as can be seen from the following official table.

PGA Tour Stats 2011 Season

Distance	1st	75th	150th
Inside 3 feet	100%	99.40%	98.88%
3-5 feet	94.29%	87.57%	83.57%
4-8 feet	77.58%	68.80%	64.25%
5-10 feet	65.81%	56.80%	52.80%
10-15 feet	39.18%	30.81%	26.59%
15-20 feet	29.09%	19.84%	16.55%
20-25 feet	27.20%	12.86%	9.40%
>25 feet	10.55%	5.75%	4.33%

Looking at these stats from another perspective and based on 400

The importance of putter-face alignment is critical – and that's what top players like Rory work on week to week. Can you tell the difference between 1-degree open and 1-degree closed?

“Putting accounts for over 40% of the club golfer’s strokes and yet most players tend to buy a putter by taking a few off the rack and trying them in the shop or on the practice green – and often after a bad round. Until now, they could get a vague notion of the ball skidding and then rolling forward, but there was no actual way to quantify it and the thought of hook or cut spin on a putt rarely entered a player’s mind. Now with Quintic Ball Roll v2.4, the golfer can clearly appreciate their levels of consistency, speed, spin, launch angle... and not only find which putter suits them best but, with ‘a bit of work’, can measure how changes of technique can significantly affect their performance”.

DR PAUL HURRION

attempts, from the 4-8 ft range, the player in 150th position would have required an additional 82 attempts to hole the same number of putts as the leading player holed from this distance. This increased to 98 more attempts from the 5-10 foot range, or one in four. As we all know, PGA Tour veterans tell you that putting is the key to success both weekly and over the course of a career, and our study shows the relevance of understanding components of “the putt”.

Here is a great drill to focus the attention and hone putter face alignment at impact – we call it the 6 by 2 drill.

Find a straight putt on the practice green. Take six balls and put them in a straight line starting at two feet and every two feet to 12 feet. Start with the ball that is at two feet and work your way back to the ball that is at 12 feet. If you miss a putt you have to start over again at the first ball at two feet. You need to make all six balls in a row to finish the drill. Once you can complete all six balls on a straight putt, try it with an uphill, downhill or even a small breaking putt. Remember, from two feet your putter face can be up to 3+ degrees open or closed to the target and you can still hole the putt! But once you get to 12 feet, it can be no more than 0.69 degrees open or closed – a small margin indeed!

And here is another – the 2-tee drill.

Creating a ‘gate’ with a couple of tee pegs – and then running your putter between them – makes for a terrific practice drill. (Tiger is a master at it, holing out six-footers one after another). The challenge is to return the putter consistently through the gate so that you make solid square contact with the ball. Line up a six-foot putt and repeat the drill ten times. In order to control the pace of the putt it is vital that the ball is struck consistently out of the sweet spot – and this drill will help you to improve that element of your putting.

How we did the testing

Utilizing a fixed Putting Robot with varied optional settings, Quintic Biomechanics Analysis Software, and The Quintic Ball Roll System, our study was conducted to determine and hopefully answer the question: “The Face or The Path - which is more influential in determining the horizontal launch angle (direction) of the golf ball after impact with the putter face?”

Previous published research on the subject from Dave Pelz’s Putting Bible (2000), reports:

“(for a solidly struck putt) that face angle determines 83 per cent of the starting line while putter path direction determines 17 per cent.



SOMETHING FOR THE WEEKEND?

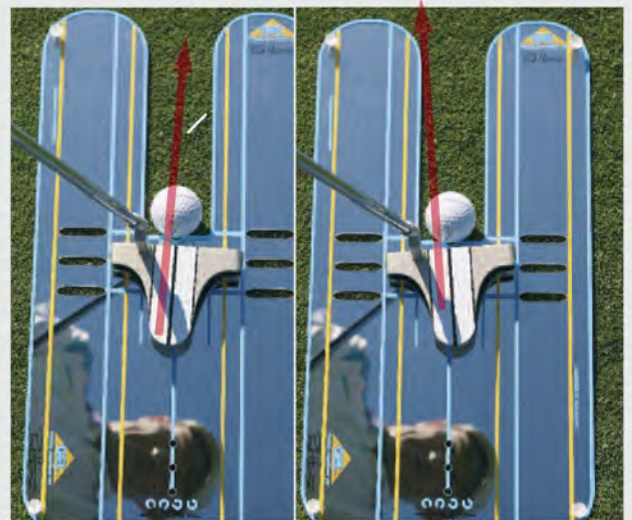
“Quantifying the relative and conflicting effects of putter path and face angle on the direction



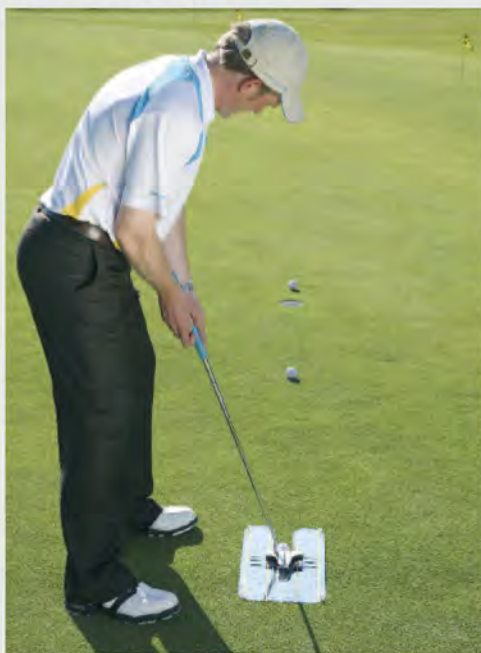
PUTTER FACE IS SQUARE: THIS IS 'NON-NEGOTIABLE'

Is the face of your putter square to your intended line at the set-up? You would be surprised at the number of golfers who fail to get this most fundamental of basics right. And if your putter face isn't aimed correctly you will (subconsciously) be forced into a series of manipulations in the stroke in an attempt to get it square for impact.

So it's key that you regard this as the first key detail. Use the blue and yellow transverse lines that you see located directly behind the ball location as your reference point to square the putter-face to the target line. You should be able to see the line directly in front of the putter blade, which is 90 degrees to the target. Laying the putter face open (right) or closed (far right) to the target line will necessitate some sort of manipulation in the stroke itself in order to square the blade for impact. And that will never be consistent.



EYE POSITION "PARALLEL" WHERE DO YOU SEE THE PUTT AS STRAIGHT?



What is your perception of reality? Here's the test: having lined up a straight row of balls into the centre of the hole, when you remove all but the middle ball and the one directly behind the hole, do you still see this as a straight putt? For the vast majority of golfers, some adjustment to posture and the position of the eye-line is necessary to see a perfectly straight line. Try it next time you play. Even the tiniest of adjustments to see a straight putt will have a dramatic effect on your ability to hole putts within this critical 10-12 foot range. For all the fancy gadgets in golf today, the putting mirror remains one of the most simple and effective. Secured with tee pegs, the mirror is a vital tool when it comes to grooving positive set-up habits. In this case, it will help you identify the correct alignment of the eyes in order to see the straight line to the hole

USE THE TEE HELP RESTRICT YOUR BACKSWING LENGTH



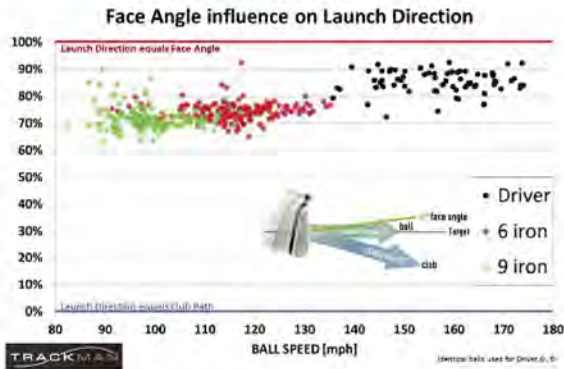
Use the back-stop to restrict length of backswing and then focus on matching it in the follow-through. Note, head remains still until the ball is in the hole



I am a big believer in the fact that making a stroke of equal distance back and through serves to optimise the acceleration of the putter into the back of the ball – and so helps you to impart a consistent 'roll' and control the pace of your putts. By utilising one of the four different holes along the blue centre line in the mirror (right), or even placing a tee directly behind that centre line in the putting green for a longer stroke (above), you restrict the length of your backswing and can easily monitor (and match) the length of your follow-through. Remember, equal distance back and through = good pace control.

Therefore, a square face angle is five times more important to starting putts on line than putter path".

Also relevant is research presented by TrackMan (PGA Conference Harrogate – September 2011) on irons and drivers. They report for a 9 iron the relationship is 70% face and 30% path and that this relationship changes as the loft on the club reduces; 6 iron 75% face and 25% path; and with a Driver, the relationship is as much as 80-85% face and only 20-15% path (see graph below)

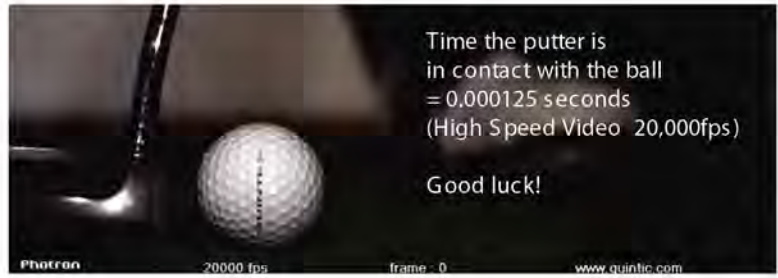


Our putting study goes further. For the first part the putter path was set to zero (straight back and through – i.e. no face rotation). Thirty-six different face angles were used for the study (random positions), ten putts were taken with each specific face angle (number of putts = 360). The average of each set of ten is displayed as a single mark in the graph below. The putter was clamped in the Putting Robot and released from the same point each time. Via a high-speed camera directly over the ball to target line, Quintic Biomechanics Software was used to calculate the horizontal launch angle of each putt. Simultaneously, The Quintic Ball Roll System calculated the launch characteristics of each putt. The putter was set to create a 1 degree rise angle through impact with two degrees of dynamic loft at the point of impact.

A: "Straight Club Path – no face rotation" (number of putts = 360)

For the second part of the study, the putter path was randomised by varying degrees, for example, 'in to square to in', 'out to in', 'out to square to out'. Fifty-four different face angles were used for the study (random positions), and the Putting Robot enabled ten identical putts at each specific face angle. The average of each set of ten is displayed as a single point in the following graph. Otherwise the methodology was identical to part one of the study.

B: "Variable Club Path – face square to path" (number of putts = 540)



Specifics of the Equipment

The Quintic Putting Robot is a fixed metal frame which clamps the putter firmly and allows variable and lockable angles to simulate shoulders, neck, arms, and hands angles. It swings freely on an 800 pound industrial bearing.

Quintic Biomechanics is well known and proven video analysis software, one function of which automatically or manually calculates angles from video footage.

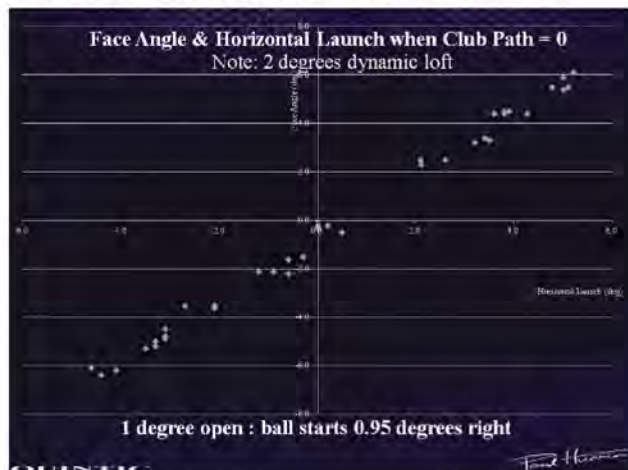
The Quintic Ball Roll System is a revolutionary new system and needs more explanation. It utilises a high-speed camera (up to 260 frames per second) tracking the golf ball for the first 12 inches (30cms) of the putt. The ball (Titleist ProV1x) has three specific markings. The proven software instantly (before the ball has reached the hole!) produces full graphical and numerical information about the putt (just as for full swing analysis using irons and woods with launch monitors). Quintic Ball Roll shows Skid, Backspin & Roll, Launch Angle & Bounce, Ball Speed, Angular Rotation & Revolutions, Hook or Slice Spin, Point of True Roll (zero skid), Push & Pull (estimated face angle at impact), the average of the current sequence of up to 20 putts, plus range & standard deviation for easy comparison of putters and putting technique. Following a simple calibration procedure (for right or left handed golfers – or robots), the software can be used indoors in a controlled putting studio or outdoors on the putting green with the same degree of accuracy. Averages, ranges and standard deviation of putts is automatically updated after each putt and saved into a session folder. This instant feedback is crucial when working live with a golfer. It leads into comparing: putting session results; different types of putter; before and after changes to loft/lie/length; and the effect before and after a putting lesson/technique changes.

One key feature is the Push/Pull screen showing the predicted position of where the golf ball would have finished (right or left of the hole) based on a 1-foot to 15-foot putt. The animation of the ball is to a distance of eight feet. The prediction is based on a flat putt, there is no accounting for slope, grain, speed of green, wind, moisture, launch angle, rotation or even hook or cut spin.

The example below demonstrates a predicted 45% chance of holing the putt, with a 55% probability of missing left and a 0% chance of missing right. The predicted position at 8 feet is 2.29 inches right of centre. The diameter of the hole is 4.25 inches. The predicted angle of the putt is 1.37 degrees left of the ball to target line. The predicted ball position at four feet



A. "Straight Club Path – no face rotation" (number of putts = 360)



B. "Variable Club Path – face square to path" (number of putts = 540)



THE QUINTIC BALL ROLL ANALYSIS TECHNOLOGY - PLUS THE ROBOT!



...you have to understand what is happening to the golf ball in order to teach putting!" DR PAUL HURRION

Quintic Ball Roll screen shot Push/Pull: predicted position from 8 feet is 2.29 inches left of centre-cup (software measures starting direction of the ball). in this example the player has effectively pulled the putt. There is 45% of the ball going in, assuming a perfect conditions. The premise of this article is that once you go more than 1 degree open or closed with putter alignment, the ball doesn't go in. Can you detect that sort of alignment accuracy at the set up? You will certainly find it easier with a putter that is properly 'fit' to your personal specifications, and one that suits your eye



Screenshot of Quintic Ball Roll – Push/Pull

is 1.14 inches left and at eight feet 2.29 inches left of the hole. Importantly to the overall study, this results in a 77% chance of the ball going in at four feet from the hole but only a 45% chance at eight feet. The central table highlights (green) where the success probability is above 55% (up to six feet in this example), Orange between 45 - 55%, and Red below 45%. The data shows the ball missing left on putts from nine feet onwards.

Based on the Angle of the Putt being shown at 1.37 degrees left, using the 92% value demonstrated in the previous table, we can calculate that the putter face was 1.26 degrees closed at the point of impact.

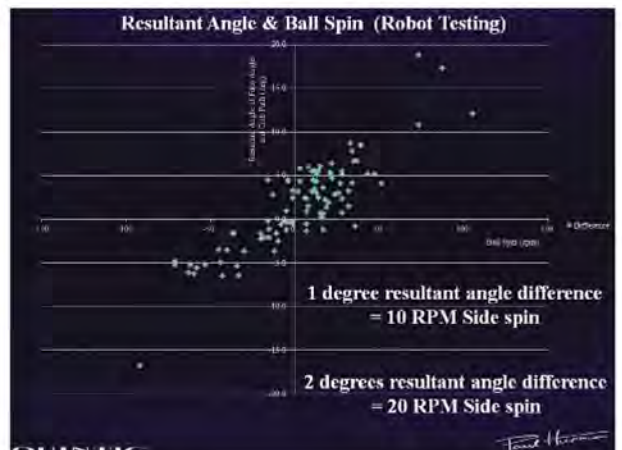
What happens when there is a mis-match between face and path with the putter?

The breakdown is that approximately 92% of the ball's initial direction is determined by putter face angle at impact and only 8% is the result of the putter path. The two together determine the horizontal direction of the ball and also if there is any hook or cut spin applied to the ball. Again using the Quintic Ball Roll System, the amount of hook or cut spin imparted on the ball can be shown.

During the third part of the study, the putter path was again randomized by varying degrees and patterns along with random face angles at impact. One hundred different face angles and path combinations were used. Again the Putting Robot allowed ten identical putts with each specific setting. The average of each set of ten is displayed as a single point below in the graph below. As previously, horizontal launch angle, putter path and face angle at impact were measured and Quintic Ball Roll was used to calculate the launch characteristics of each putt, in particular the hook or cut spin. All putts were struck in the centre of the putter face.

C: "Variable Club Path and face angle" (number of putts = 1000)
This scientific testing using a fixed robot and a high-speed camera (1000fps) has shown that up to 10 rpm of hook or cut spin imparted to the ball is acceptable as having negligible effect (5 temp rating 15). As soon as 'hook' or 'cut' spin increase above 20 rpm, it causes the ball to spin, bounce and /or stray from the intended line.

C: "Variable Club Path and face angle" (number of putts = 1000)



Here are common causes of too much hook spin:
inside to outside putting stroke
putter face closed at impact
striking the putt out of the 'toe'
putter with lie angle too high (toe high)

...and common causes of too much cut spin:
an outside to inside putting stroke
an open putter face at impact
striking the putt out of the 'heel'
putter with lie angle too low (heel high)

In practical terms, assuming a center strike, this study demonstrates that it only requires a two degree resultant angle between the club face angle and the putter path to impart 20 rpm of 'hook' or 'cut' spin onto the golf ball. So although with the putter face one degree open from eight feet, the ball will still go in the hole... if there is also one degree 'out to in' swing path then 20 rpm of cut spin will be imparted and the ball will miss right, and more so if it's a left to right putt.

Greater than 20 rpm of cut or hook spin is enough to cause the golf ball to move from its intended path and miss the hole even over a distance of 10 feet, especially if it is launched into the air at impact! If the imparted the RPM increases above 20 rpm then a change to the fitting of the putter may provide correction, for example lie angle or face balanced vs. toe heavy, without changing the technique of the golfer, but technique should also be considered.

However, with a spin rate of more than 40 rpm, attention to the putting stroke is definitely required.

These may be new concepts to many golfers but, as validated by this study, they are fundamental.