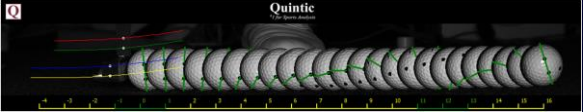


Sport Biomechanics & Human Movement



Quintic
The Sports Analysis

Dr Paul Hurrion
Olso, Norway 7th November 2025

QUINTIC

OVERVIEW

- Introduction
- What is Sports Biomechanics?
- Putting – My research and current beliefs...
- Develop a coherent technical model of the putting stroke
- Fit the putter to the stroke
- How to implement this into your teaching?

What is Sports Biomechanics? The science of human movement...



"Being able to synchronise different throws, current and best, proved invaluable in preparation for the games in Sydney 2000 & Athens 2004." "I can compare the timing of current training throws with my best 90m efforts from previous years. By synchronising current and best throws at release we could rewind in slow motion and analyse the differences."


Steve Backley OBE

QUINTIC

What is Sports Biomechanics? The science of human movement...



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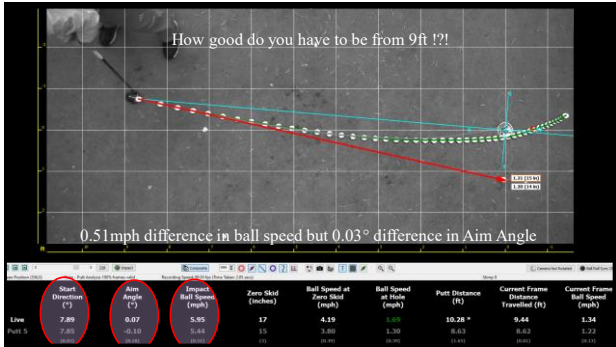
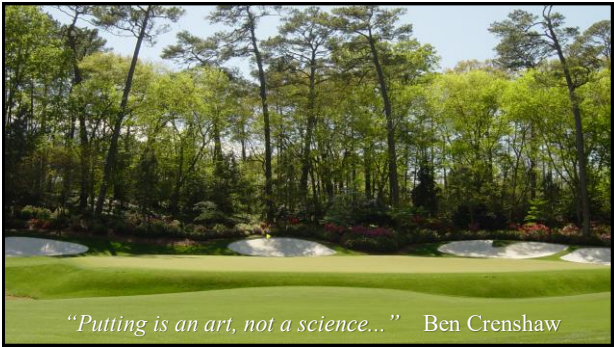


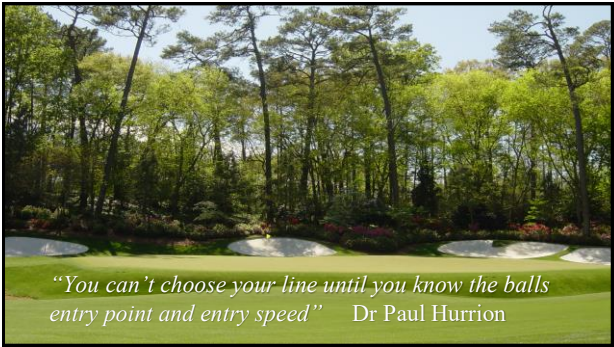
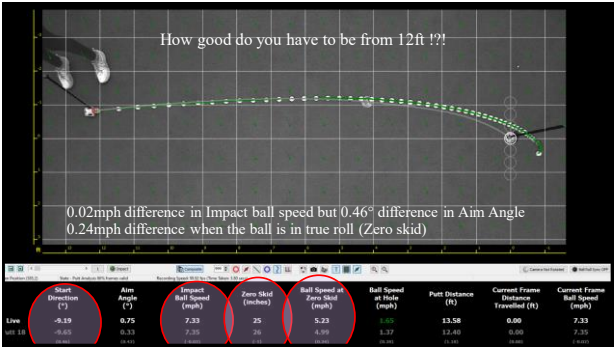
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Jessica Ennis-Hill 2012 Olympic Heptathlon Champion



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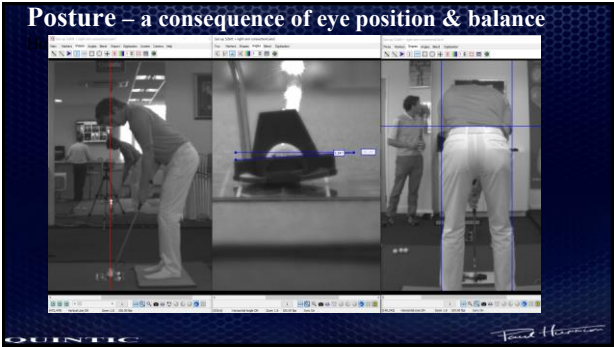
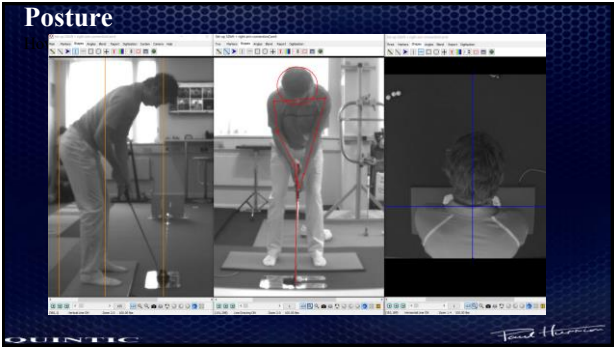
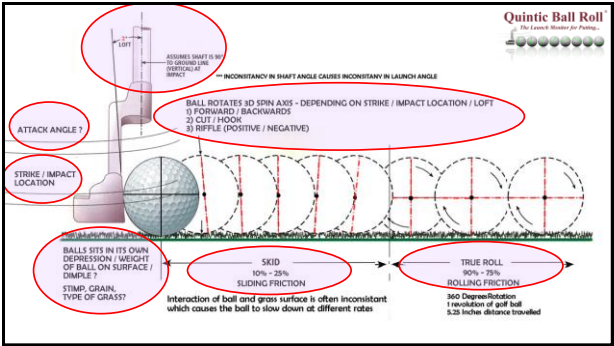


Biomechanical Fundamentals of the Putting Action

Quintic
The Science of Putting

Dr Paul Hurrion
7th November 2025

Quintic



Perception and Reality

Which position maintains the same angle (perspective) regardless of the focus point?

20ft
10ft
0ft

Line or No Line?

© Quintic

■ 95% of the top amateurs and PGA professional golfers display fundamental flaws in their alignment that demand some sort of compensation during the putting stroke...

© Quintic

Do you know your eye position ?

© Quintic

Check that a line drawn through your eyes passes through the center of the club head.

Let your eyes see the ball directly in front of you.

Let the head and neck be in line with the ball.

Let the head and neck be in line with the ball.

© Quintic

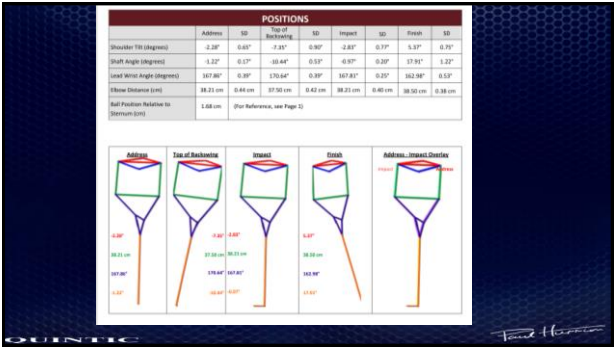
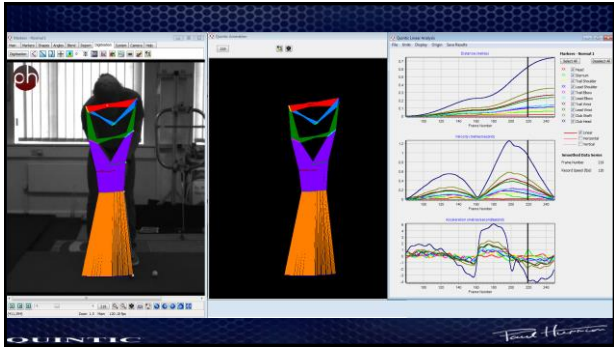
13 degrees = ARC?

© Quintic

Head
Trail Shoulder
Lead Shoulder
Trail Elbow
Lead Elbow
Trail Wrist
Lead Wrist
Club Head
Club Head

N.B. The above markers are for Right Handed Golfers. For Left Handeds, the Lead and Trail markers will be reversed for Shoulder, Elbow and Wrist.

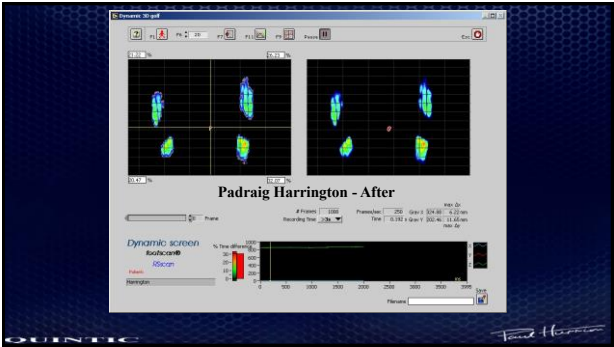
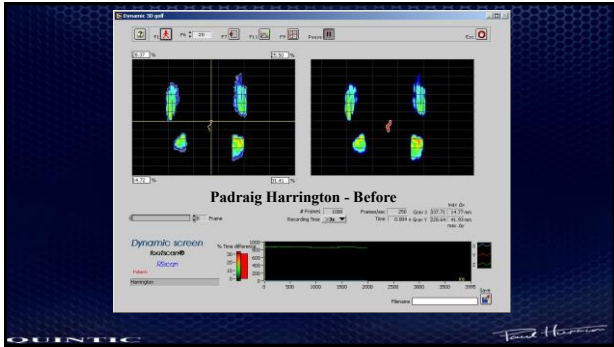
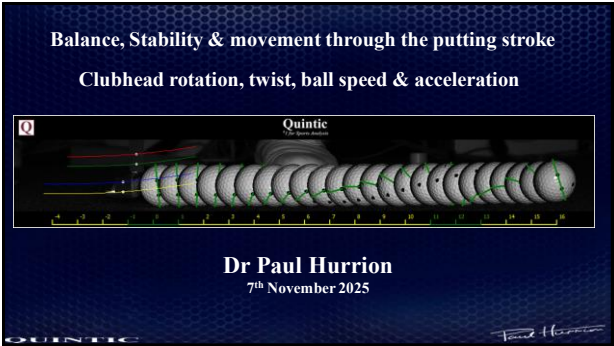
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Parameter	Units	Pros		Amateurs	
		Mean	SE	Mean	SE
Stance Width	cm	28.84	3.24	24.21	3.45
Height: Sternum – Floor	cm	136	4.10	135	3.39
Stance Width / Sternum Height	%	21.29	3.84	17.98	2.68
Ball Position / Stance Width	%	71.11	5.76	63.24	6.28
Ball Position: Sternum	cm	2.51	2.55	2.63	2.44
Ball Position: Left Eye	cm	-0.57	2.87	0.68	1.90
Ball Position: Bottom of Arc of Arc	cm	109	3	88	5

Table 4. Kinematic Parameters
SE = Standard Error

SCIENCE AND GOLF V Proceedings of the World Scientific Congress of Golf Edited by Debbie Crews, PhD and Rafer Lutz, PhD CHAPTER 31 Page 232-238 An investigation into Weight Distribution and Kinematic Parameters during the Putting Stroke Paul D Hurron & Robert D Hurron, Quintic Consultancy Ltd.





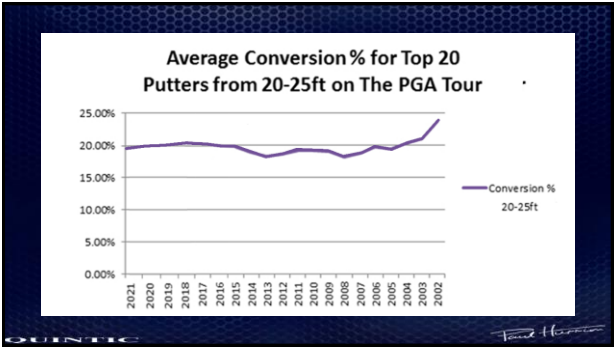
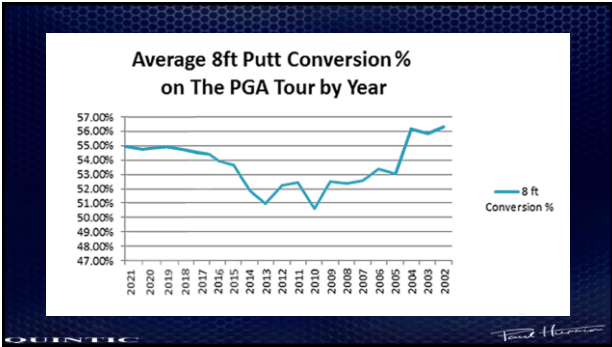
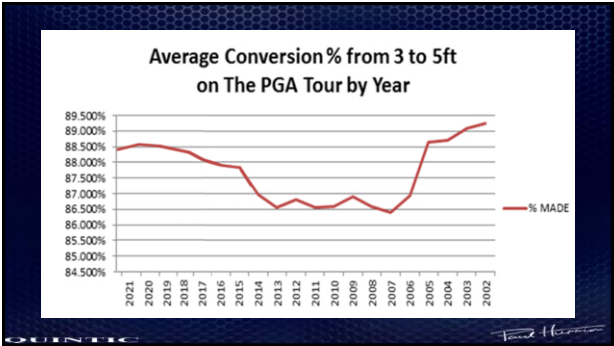
N=30 Amateur and Professional Golfers :
Centre of Pressure SWAY (mm) SE = Standard Error

	Mean Total Body Sway	Start – Top of Backswing	Top of Backswing - Impact	Impact - Finish
Amateur	83.10*	17.61*	12.23	53.26*
± S.E.	6	3	4	5
Professional	64.34	12.24	10.13	41.97
± S.E.	6	2	3	5

Significant difference $p < 0.05$
Centre of Pressure SWAY (mm)

SCIENCE AND GOLF V Proceedings of the World Scientific Congress of Golf Edited by Debbie Crews, PhD and Rafer Lutz, PhD CHAPTER 31 Page 232-238 An investigation into Weight Distribution and Kinematic Parameters during the Putting Stroke Paul D Hurron & Robert D Hurron, Quintic Consultancy Ltd.

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■ What year do we see a drop in percentage holed ? 2004



60 fewer dimples in 2003 Pro V1x 332 to the 2000 ProV1 392

Off Centre Strikes... Club Face twist

- Finding the centre of gravity of your putter?
- What impact does an off centre strike have on pace & direction?
- Gear effect? (Toe strike = Hook Spin / Heel Strike = Cut Spin)
- Potential change in horizontal start direction ? Up to 2 degrees!
- Quintic Ball Roll – Club face twist @360fps – WSCG Paper 2018 Vancouver



Off Centre Strikes... Club Face twist?



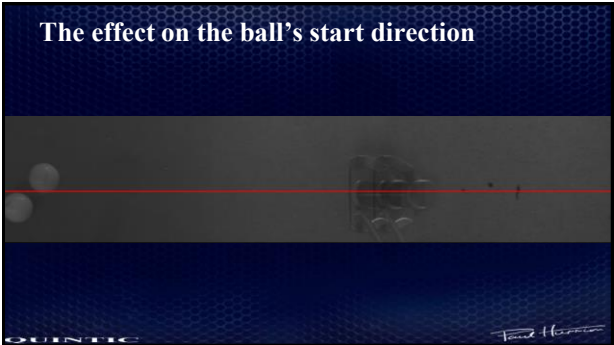
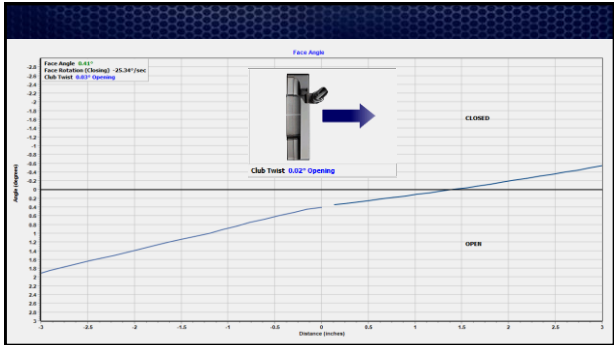
What is too much side spin?



The effect of a slope?

Point of Rotational Equilibrium (PRE) - Shaft Location / Weight / Speed of Rotation





What is more important, putter face or path?

- There are only three conditions that can occur at impact with the putter and ball. The face of the putter is either open, square or closed to the putter's path. The number of face angles and paths to make up these three conditions are however, infinite.
- Previous published research on the subject from Dave Pelz's Putting Bible (2000), reports :
"for a solidly struck putt that face angle determines 83 percent of the starting line while putter path direction determines 17 percent. Therefore, a square face angle is five times more important to starting putts on line than putter path"

Manufacturers have continued to make a harder cover ball that will fly 300 yards+ and spin on a wedge around the green. That's great for full shots and chipping – but, it turns out, not so good for putting. When you combine the harder cover with random, uneven patterns on the putter face (designed to create a rougher surface and improve overspin with a positive attack angle) you have a recipe for disaster

<https://www.paulhutton.com/tuition/putting-is-difficult/>

How do you measure the Putter Face ???

92% of the Ball's Start Direction

PGA Tour Stats 2022 Season

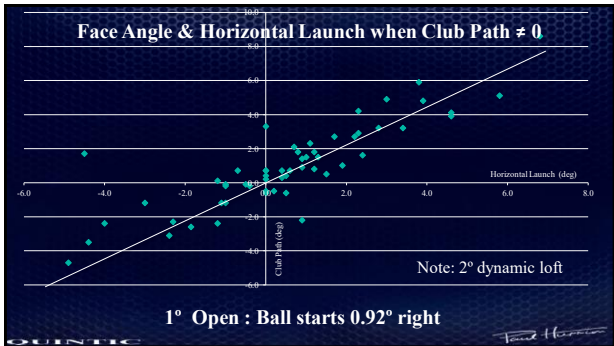
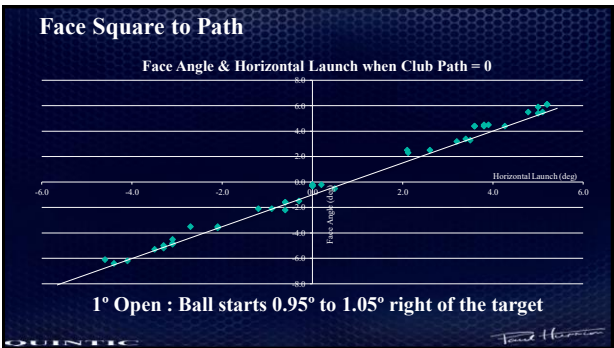
www.pgatour.com

Distance	1st	75th	150th	Difference 1st – 150th	PGA Tour Average
Inside 3 feet	100%	99.51%	99.22%	0.78%	99.44%
3-5 feet	96.30%	88.24%	84.82%	11.68%	87.44%
4-8 feet	78.07%	69.33%	64.75%	13.32%	68.21%
5-10 feet	67.66%	57.89%	52.45%	15.75%	55.99%
10-15 feet	40.85%	32.14%	26.95%	13.90%	30.30%
15-20 feet	31.08%	20.41%	16.00%	15.08%	18.84%
20-25 feet	22.50%	13.21%	9.86%	12.64%	12.54%
>25 feet	10.13%	5.86%	4.07%	6.06%	5.40%
Strokes Gained	0.988	0.118	-0.282	1.36	-

♣15 players 100% Inside 3ft for the year!
 ♣5-10ft biggest difference between 1st and 150th

□ During the PGA Tour 2021 season, 5 players made 100% (min 400) inside 3 feet ...
The putter face angle can be up to 2.60 degrees open or closed relative to the ball to target line and still hole the putt from 3 feet...

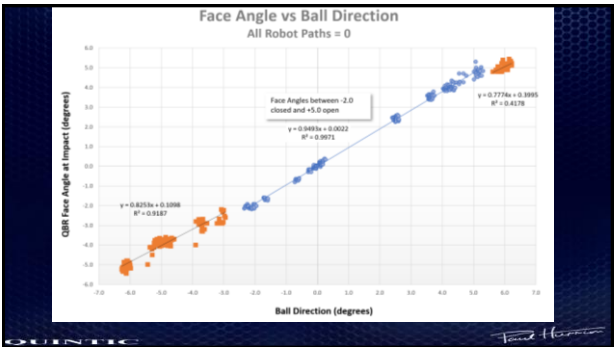
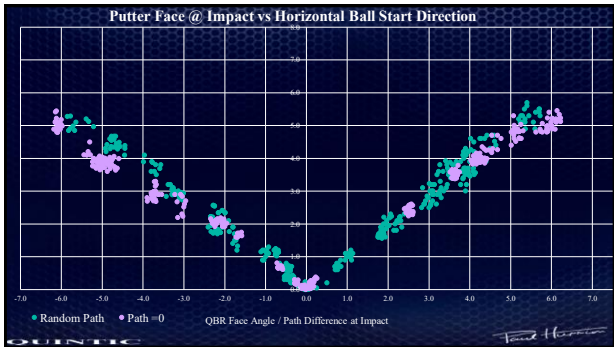
Distance	Angle of Ball	Putter Face Angle (92%)
3 feet	2.80°	2.60°
4 feet	2.20°	2.02°
5 feet	1.90°	1.75°
6 feet	1.60°	1.47°
7 feet	1.40°	1.29°
8 feet	1.20°	1.10°
9 feet	1.00°	0.92°
10 feet	0.90°	0.83°
12 feet	0.75°	0.69°
15 feet	0.60°	0.55°



The Importance of the Face Angle

- 1° closed or open at impact will cause the ball to miss the hole from 8 feet... Every wonder why the percentage putts on the PGA Tour drop off so quickly after 8 feet?
- The angle of the putter face at impact is by far the MOST IMPORTANT factor in terms of the ball's start direction.

Is it possible for a human to align a putter with a 1° accuracy?



Impact Ratio

- Is the kinetic energy (speed) transferred to the ball from the clubhead during contact.
- Normally the consistency of the impact ratio is more important than the average.
- However, a high impact ratio will cause greater variations in the impact clubhead speed.

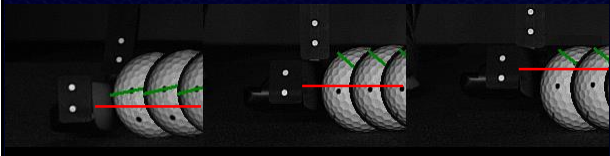
Clubhead Speed	Impact Ratio	Resultant Ball Speed	Difference
3.5 mph	1.6	5.6 mph	0.8 mph
4.0 mph	1.6	6.4 mph	

Clubhead Speed	Impact Ratio	Resultant Ball Speed	Difference
3.5 mph	1.9	6.6 mph	1 mph
4.0 mph	1.9	7.6 mph	

Impact Ratio

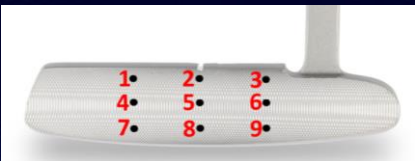
- Ratio will change depending on putter
- Impact location on the face
- Ratio will also vary depending on grip pressure
- Rate of acceleration of the putter at impact.
- An Investigation into Impact Ratio for Putter Club Design and Impact Location (2018 World Scientific Congress of Golf) July 2018 Abbotsford, BC Canada
- https://www.quinticballroll.com/Quintic_Ball_Roll_Research.html

Impact Ratio – Impact Location ?



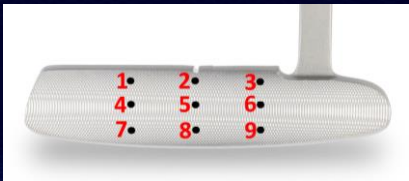
Impact Ratio

	Impact Ratio			% Drop Impact Ratio		
	Toe	Centre	Heel	Toe	Centre	Heel
High	1.58	1.66	1.56	8%	3%	9%
Centre	1.66	1.72	1.64	3%	0%	5%
Low	1.56	1.64	1.53	9%	5%	11%



Impact Ratio

The Quintic Ball Roll system uses a high speed camera (1080 fps) to measure a variety of factors including clubhead speed, ball speed, face angle, face rotation and putter twist as a result of impact. Nine different putter designs were used for the study (three blade, three mallet and three high MOI design putters). Nine impact locations were analysed per putter (see below).



Impact Ratio

Putter	Category	Face	Clubhead Speed (mph)	Ball Speed (mph)	Impact Ratio (IR)	Face Angle (Impact)	Face Twist (°)
Odyssey O Works #1Wide	Blade	Micro Hinges	3.70 ± 0.06	6.05 ± 0.09	1.64 ± 0.02	0.08 ± 0.03	0.13 ± 0.02
Bettinardi BB1F	Blade	Milled	3.70 ± 0.07	6.33 ± 0.12	1.71 ± 0.01	-0.03 ± 0.04	0.11 ± 0.04
Evrolf ER2	Blade	Grooves	3.66 ± 0.04	6.01 ± 0.07	1.64 ± 0.01	-0.10 ± 0.05	0.10 ± 0.04
Odyssey O Works R Line	Mallet	Micro Hinges	3.59 ± 0.03	5.86 ± 0.05	1.63 ± 0.01	0.04 ± 0.03	0.07 ± 0.02
Taylor Made TP-Berswick	Mallet	Grooves	3.72 ± 0.06	6.25 ± 0.05	1.68 ± 0.03	-0.02 ± 0.10	0.05 ± 0.04
PING Vault Oslo	Mallet	Grooves	3.62 ± 0.04	6.23 ± 0.08	1.72 ± 0.03	-0.07 ± 0.10	0.07 ± 0.03
Evrolf ER7	MOI	Grooves	3.71 ± 0.04	6.01 ± 0.07	1.62 ± 0.03	-0.08 ± 0.09	0.14 ± 0.08
Taylor Made Spider Red	MOI	Grooves	3.62 ± 0.05	5.90 ± 0.07	1.63 ± 0.03	-0.06 ± 0.12	0.18 ± 0.09
Ping Sigma G Wolverine T	MOI	Insert	3.59 ± 0.03	6.00 ± 0.05	1.67 ± 0.02	-0.08 ± 0.06	0.08 ± 0.06

Impact Ratio

Impact Location 5: The IR ranged from 1.62 to 1.72 for location 5 (impact centre / centre) for the nine putters.

This variation in ball speed, caused by a variation in IR, will cause the ball to travel different distances and therefore slow down at different rates, particularly relevant to the golfer on sloping putts.

A ball speed range of 0.47 mph was reported between the nine different putters for centre impact, despite the clubhead speed at impact having a range of 0.13 mph (3.59 to 3.72 mph). These differences are caused by the variance in material, head weight and design of the putter.

Impact Ratio

	Impact Ratio			% Drop Impact Ratio		
	Toe	Centre	Heel	Toe	Centre	Heel
High	1.58	1.66	1.56	8%	3%	9%
Centre	1.66	1.72	1.64	3%	0%	5%
Low	1.56	1.64	1.53	9%	0%	11%

Table 2: PING Vault Oslo - Mallet Impact Ratio (IR) and % drop for the 9 Impact locations
(0% = Centre, Centre impact location 5. % reduction in IR depending on impact location (1-9).

	Impact Ratio			% Drop Impact Ratio		
	Toe	Centre	Heel	Toe	Centre	Heel
High	1.53	1.60	1.50	6%	2%	8%
Centre	1.55	1.63	1.51	5%	0%	7%
Low	1.52	1.58	1.46	7%	3%	11%

Table 3: Taylor Made Spider Red - MOI Impact Ratio (IR) and % drop for the 9 Impact locations
(0% = Centre, Centre impact location 5. % reduction in IR depending on impact location (1-9).

Impact Ratio

If both putters had an average clubhead impact speed of 3.65mph, this would equate to a 0.95mph difference in ball speed

$3.65\text{mph} \times 1.72 \text{ (IR)} = 6.28\text{mph}$ PING Vault Oslo

$3.65\text{mph} \times 1.46 \text{ (IR)} = 5.33\text{mph}$ Taylor Made Spider Red

How does this equate to ball roll out distance on the actual putting green?

Ball Speed (ft/sec) (mph) total
roll out distance (feet) on a flat
green, no grain or wind) for the
respective Stimp readings. Data
provided courtesy of Aim Point.

Stimp	8	9	10	11	12	
ft/sec	mph					
1	0.68	0.6	0.8	1.0	1.1	1.2
2	1.36	1.1	1.3	1.4	1.7	1.9
3	2.05	2.2	2.5	2.7	3.0	3.2
4	2.73	4.1	4.4	4.8	5.2	5.6
5	3.41	5.9	6.6	7.2	8.0	8.7
6	4.09	8.0	9.0	10.0	11.0	12.0
7	4.77	10.5	11.9	13.2	14.5	15.8
8	5.45	13.2	14.9	16.5	18.2	19.9
9	6.14	16.1	18.1	20.1	22.1	24.1
10	6.82	19.0	21.4	23.8	26.2	28.6
11	7.50	22.1	24.9	27.8	30.4	33.1
12	8.18	25.1	28.3	31.4	34.6	37.7
13	8.86	28.2	31.7	35.2	38.8	42.3
14	9.55	31.2	35.2	39.1	43.0	46.9
15	10.23	34.3	38.6	42.8	47.1	51.4
16	10.91	37.3	42.0	46.8	51.3	55.9
17	11.59	40.2	45.3	50.3	55.3	60.3
18	12.27	43.1	48.4	53.6	59.2	64.7
19	12.95	45.9	51.7	57.4	63.2	68.9
20	13.64	48.7	54.8	60.9	67.0	73.1

Impact Ratio

Stimp reading of 8, there is a difference in ball roll out distance $(16.1 - 13.2) = 2.9\text{ft}$
Stimp reading of 9, there is a difference in ball roll out distance $(18.1 - 14.9) = 3.2\text{ft}$
Stimp reading of 10, there is a difference in ball roll out distance $(20.1 - 16.5) = 3.6\text{ft}$
Stimp reading of 11, there is a difference in ball roll out distance $(22.1 - 18.2) = 3.9\text{ft}$
Stimp reading of 12, there is a difference in ball roll out distance $(24.1 - 19.9) = 4.2\text{ft}$

A 4.2ft difference in roll out ball distance (Stimp 12) of a putt travelling 24.1ft highlights the importance of IR (and putter specific designs) along with the impact location on the actual face. These differences in roll out distance will only increase as the putt is hit harder...

Callaway Ball Testing for Impact Ratio

Putt	Clubhead Speed		Impact Ball Speed		Impact Ratio		Clubhead Tilt		Distance to 18	
	New	Old	New	Old	New	Old	New	Old	New	Old
1	2.94	2.87	4.42	4.61	1.05	1.01	-9.39	-9.01	19.00	20.00
2	2.79	2.87	4.47	4.63	1.05	1.01	-9.15	-9.06	19.00	20.00
3	2.86	2.86	4.63	4.63	1.06	1.03	-9.02	-9.18	20.00	21.00
4	2.95	2.84	4.61	4.60	1.07	1.02	-9.03	-9.19	20.00	20.00
5	2.87	2.83	4.71	4.62	1.06	1.03	-9.05	-9.09	19.00	21.00
6	2.76	2.78	4.48	4.63	1.06	1.03	-9.10	-9.22	19.00	20.00
7	2.63	2.81	4.33	4.56	1.05	1.02	-9.00	-9.20	18.00	20.00
8	2.84	2.75	4.61	4.49	1.03	1.03	-9.11	-9.16	21.00	19.00
9	2.88	2.81	4.67	4.58	1.04	1.03	-9.12	-9.11	22.00	20.00
10	2.83	2.86	4.61	4.79	1.03	1.03	-9.14	-9.12	20.00	21.00
11	2.91	2.72	4.60	4.44	1.04	1.03	-9.01	-9.23	21.00	19.00
12	2.72	2.74	4.50	4.49	1.04	1.04	-9.11	-9.19	19.00	20.00
13	2.74	2.81	4.52	4.60	1.05	1.04	-9.01	-9.06	19.00	20.00
14	2.78	2.75	4.57	4.62	1.04	1.04	-9.08	-9.16	21.00	20.00
15	2.76	2.80	4.56	4.62	1.04	1.01	-9.02	-9.02	20.00	20.00
16	2.84	2.74	4.62	4.61	1.03	1.04	-9.04	-9.17	20.00	20.00
17	2.77	2.75	4.65	4.45	1.04	1.02	-9.10	-9.22	20.00	19.00
18	2.86	2.83	4.69	4.69	1.04	1.02	-9.02	-9.07	21.00	21.00
19	2.77	2.84	4.66	4.63	1.05	1.03	-9.02	-9.00	20.00	21.00
20	2.84	2.79	4.60	4.54	1.05	1.03	-9.16	-9.09	20.00	20.00
Average	2.77	2.79	4.56	4.55	1.03	1.03	-9.03	-9.06	19.85	20.10
SD	0.07	0.05	0.30	0.07	0.04	0.04	-0.09	-0.24	1.06	0.46
min	2.68	2.75	4.51	4.44	1.00	0.91	-9.08	-9.23	18.00	19.00
max	2.88	2.87	4.69	4.70	1.07	1.04	-9.09	-9.01	22.00	21.00
range	0.25	0.15	0.38	0.25	0.05	0.04	-0.35	-0.45	4.00	2.00

An Investigation into Impact Ratio of current ball types

- Objective was to investigate the differences in Impact Ratio (IR) with 8 different (present day) ball types with putting. (Titleist, Taylor Made, Callaway, Srixon, Bridgestone),
- Robot (repeatable stroke)
- Putter – (2 degree static loft – shaft vertical). Plain face no milling or grooves. 4mph clubhead impact speed
- Quintic Ball Roll v4.4 (1080fps)
- Club parameters identical, only change was ball type.

An Investigation into Impact Ratio (Ball Types)

Ball Type	Face Angle (deg)	Pre-Impact Face Rotation (deg/sec)	Twist At Impact (deg)	Path Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Accel (mph/s)	Post-Impact Club Accel (mph/s)	Impact Ratio	Shaft Angle (deg)	Lie Angle (deg)	Attack Angle (deg)	Low Point (in)
A	0.03	1	-0.10	0.1	6.58	4.01	2.0	2.9	1.64	0.01	0.10	1.01	0.18
B	0.07	4	-0.11	0.1	6.50	4.04	2.0	3.0	1.61	0.03	0.10	1.04	0.17
C	-0.03	6	-0.11	0.1	6.60	4.00	1.9	3.3	1.65	-0.01	0.08	0.99	0.21
D	-0.01	3	-0.10	0.2	6.72	4.05	2.2	3.1	1.66	0.03	0.06	0.93	0.13
E	0.05	4	-0.12	0.1	6.46	3.99	2.0	3.1	1.62	-0.02	0.11	1.02	0.16
F	0.03	2	-0.11	0.2	6.68	3.98	2.1	3.1	1.68	-0.06	0.10	1.05	0.19
G	-0.04	-2	-0.10	0.1	6.68	4.05	2.0	3.2	1.65	0.10	0.08	0.93	0.18
H	0.04	5	-0.11	0.2	6.87	4.02	2.0	3.0	1.71	0.06	0.03	0.95	0.12

- Lowest 1.61 = 6.50 mph ball speed
- Highest 1.71 = 6.87 mph ball speed
- Difference 0.37 mph ball speed

Ball Speed

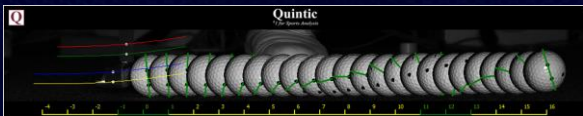
How consistent is the golfer? Minimum of 6 putts, ideal 10.



Ball Launch Angle

- Should be between positive 0.75-2.50 degrees.
- This is required to launch the ball from it's dimple / depression (Nest)
- Less than this will cause the ball to be struck into the surface (surface interaction)
- A higher launch than 2.50 degrees will cause the ball to be airborne for too long; causing inconsistencies in the way it pitches (Especially on longer putts)
- A Negative Ball Launch (and or Low Launch) can also cause inconsistencies in the way the ball launches, rolls and bounces (Especially on grain)
- These values may vary slightly depending on the quality of the putting surface.... Flight Angle / Surface Interaction?

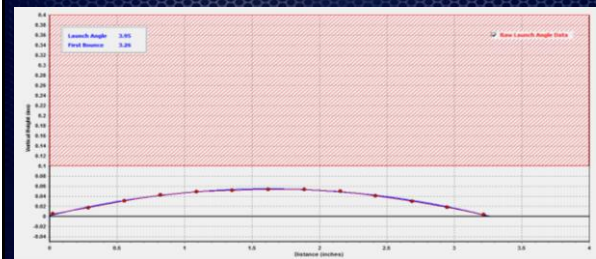
Ball Launch & Speed Control



Dr Paul Hurron
7th November 2025

What are the ideal launch conditions for a putter???





What is the optimum launch angle ?

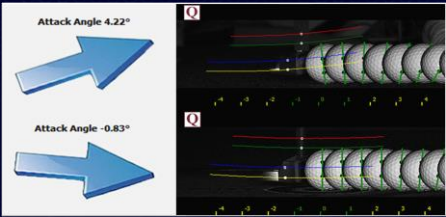


Club overtakes the hands – does the golf ball have backspin?

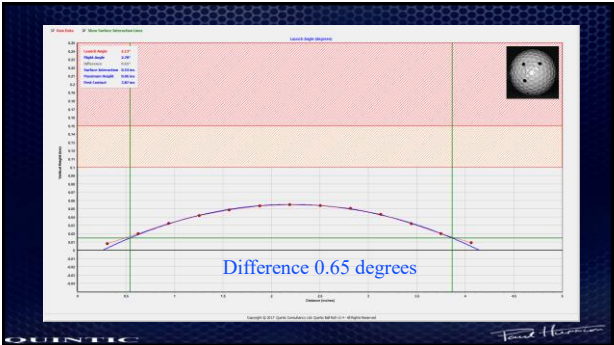
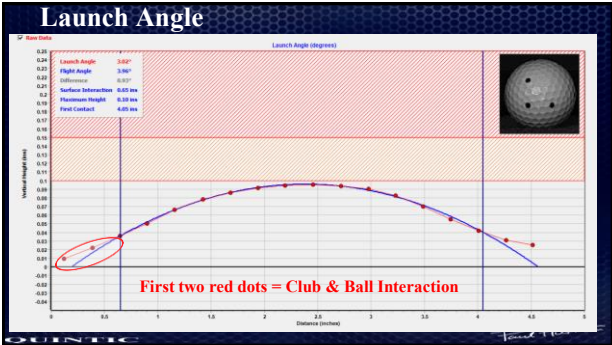


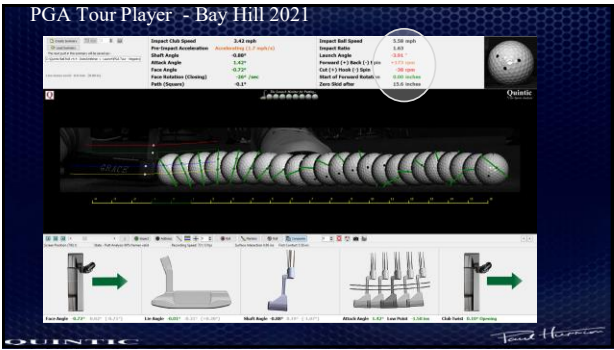
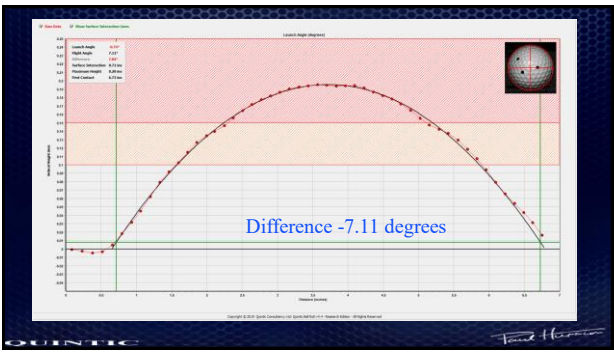
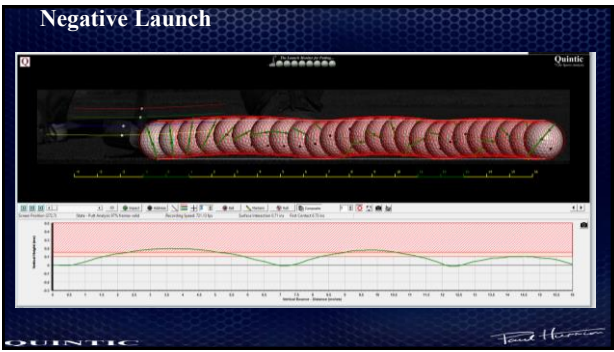
Hands lead the club through impact - does the golf ball have topspin?

Do you strike the ball with an upswing, downswing or level? – different low points...



What do you think the differences will be...





Factors affecting Launch

- Static Loft
- Shaft Angle
- Impact Location (top/bottom of the face)
- Surface...and how the ball's sitting on the surface
- Ball Club interaction = Ball Surface Interaction

An Investigation into Ball Launch

- Objective was to investigate the forward roll claims of various putter manufacturers and to ascertain whether forward roll was occurring due to reduced dynamic loft.
- Robot (repeatable stroke)
- Same Putter – Plain face putter, no grooves / inserts
- Quintic Ball Roll v4.4 (1080fps)
- Club parameters identical, only change was static loft.

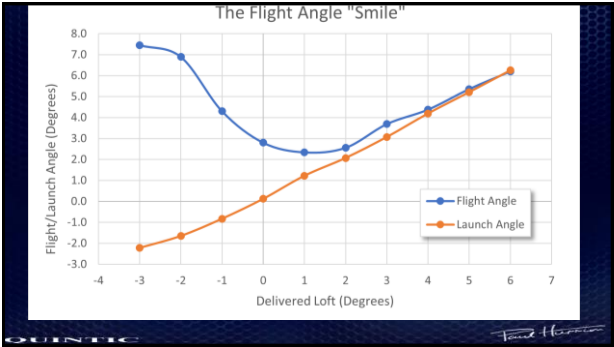
An Investigation into Ball Launch

Static Loft Putter	Face Angle	Pre-Impact Face Rotation	Twist At Impact	Path Impact	Impact Ball Speed	Impact Club Speed	Pre-Impact Club Speed	Post-Impact Club Speed	Impact Ratio	Shaft Angle	Lie Angle	Attack Angle	Low Point
20	0.02	5	-0.10	0.3	6.13	3.72	2.2	3.4	1.65	0.02	0.10	1.00	0.08
5	0.08	3	-0.19	0.2	6.03	3.65	2.1	3.2	1.65	0.06	0.11	1.06	0.15
4	-0.05	7	-0.13	0.4	6.07	3.70	1.9	3.6	1.64	-0.03	0.03	0.96	0.20
3	0.1	3	-0.17	0.2	5.99	3.74	2.2	3.1	1.60	0.07	0.06	0.91	0.15
2	0.07	5	-0.12	0.1	5.93	3.59	2.0	3.2	1.65	-0.06	0.01	1.03	0.12
1	0.04	1	-0.13	0.7	6.05	3.67	2.1	3.4	1.65	-0.09	0.13	1.05	0.19
0	-0.02	-3	-0.03	0.3	6.10	3.70	2.0	3.2	1.65	0.10	0.18	0.89	0.08
-1	-0.02	6	-0.14	0.2	5.86	3.55	1.9	3.1	1.65	0.09	0.04	0.99	0.12
-2	0.08	4	-0.09	0.6	6.01	3.64	1.9	3.4	1.65	0.11	0.07	1.12	0.09
-3	0.03	2	-0.18	0.2	6.11	3.70	2.0	3.0	1.65	0.05	0.10	1.03	0.15

- Club parameters identical, only change was static loft.
- Shaft vertical in the robot
- Static Loft = Dynamic Loft of the Putter

An Investigation into Ball Launch

Static Loft Putter n=20	Zero Skid (ins)	Forward Rotation (ins)	Forward/ Back Spin (rpm)	Side Spin (rpm)	Launch Angle (deg)	Flight Angle (deg)	Difference
6	40	3.59	-43	-9	6.25	6.20	-0.05
5	35	3.35	-40	-10	5.21	5.36	0.15
4	32	3.02	-30	-6	4.19	4.38	0.19
3	28	2.89	-38	-9	3.07	3.69	0.62
2	26	2.45	-39	-10	2.07	2.56	0.49
1	24	1.67	-29	-12	1.22	2.34	1.12
0	21	0	2	-20	0.12	2.80	2.68
-1	20	0	34	-26	-0.83	4.30	5.13
-2	24*	0	88	-22	-1.65	6.89	8.54
-3	28*	0	145	-19	-2.22	7.45	9.67



Static Loft + Shaft Angle = Effective Loft

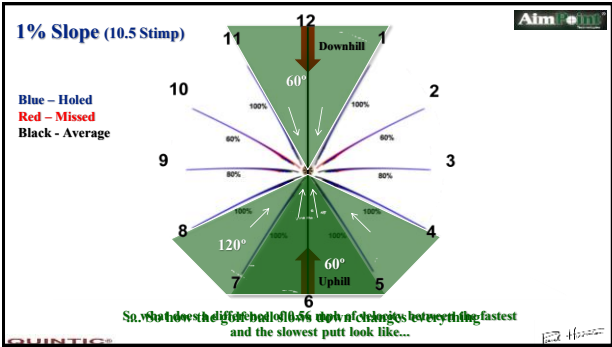
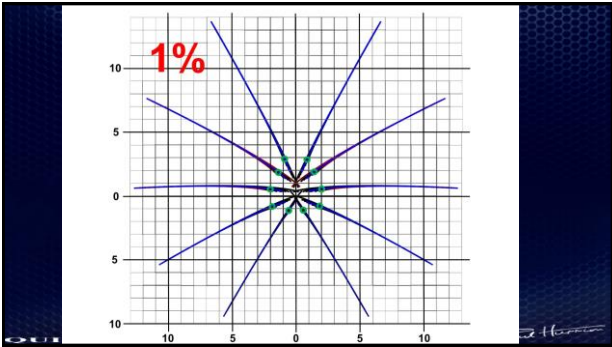
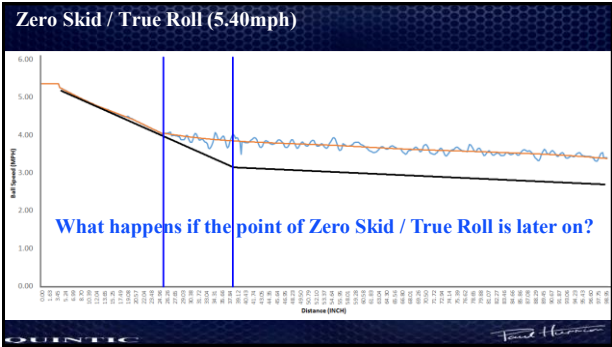
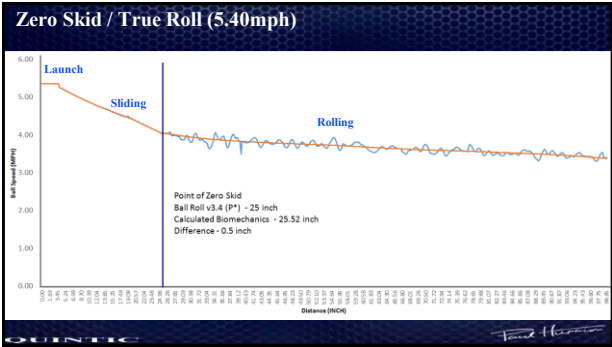
	2° Shaft Angle	0° (Vertical) Shaft Angle	-2° Shaft Angle	-4° Shaft Angle
-2° Static Loft	Effective Loft 0°	Effective Loft -2°	Effective Loft -4°	Effective Loft -6°
0° Static Loft	Effective Loft 2°	Effective Loft 0°	Effective Loft -2°	Effective Loft -4°
2° Static Loft	Effective Loft 4°	Effective Loft 2°	Effective Loft 0°	Effective Loft -2°
4° Static Loft	Effective Loft 6°	Effective Loft 4°	Effective Loft 2°	Effective Loft 0°

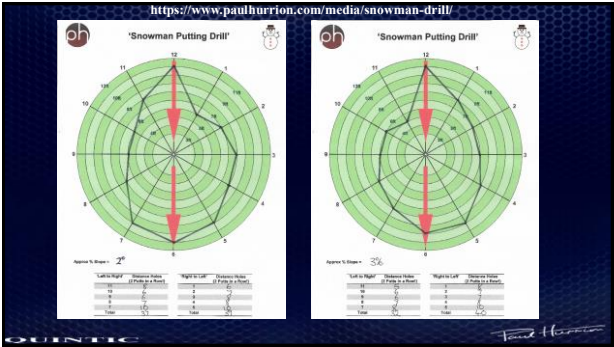
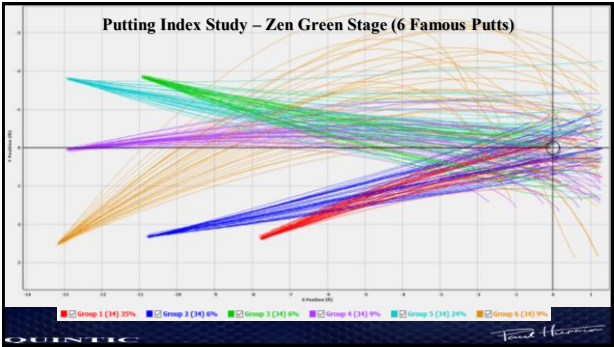
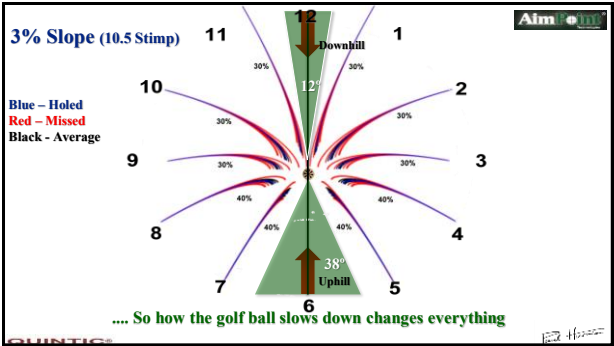
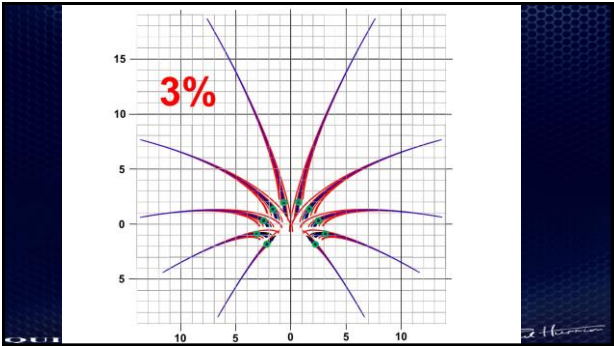
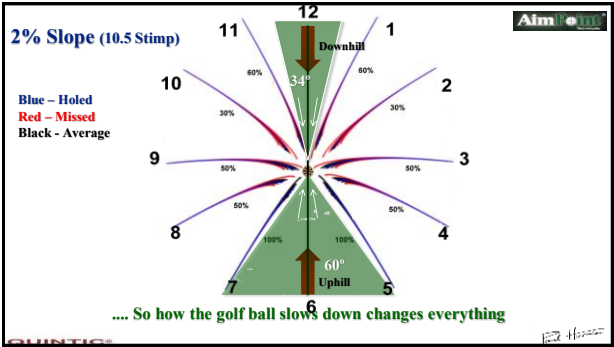
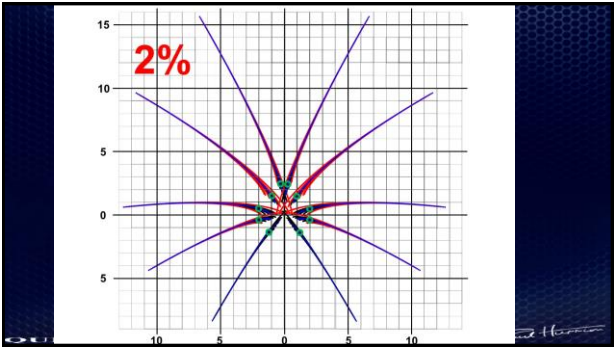
However, does effective loft at impact equal the ball's launch angle ?

"Most three putts aren't caused by bad green reading, but by bad judgement of speed"

Ben D. Crenshaw









Same Start Line, Different pace!

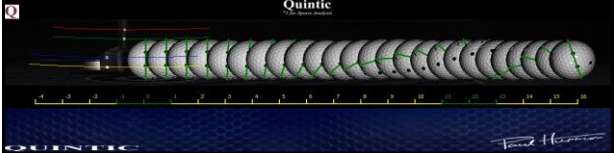
PH String Line, PH Outdoor Gate and 3 PH Ghost Holes

Set up the PH String line on a sloping section of the green of approximately 15-25ft. Then place the PH Outdoor gate ranging from 45-60cm in front of the ball (the further away, the more difficult). Can you start the golf ball on line consistently through the PH gate? Once you have mastered start line, then work on pace control. Hopefully you would have noticed how pace influences the point at which the ball breaks once it has passed through the gate. Next, place the 3 ghost holes at various distances locations, ranging from 10ft – 30ft such that the ball rolls over them. How many attempts does it take you to put the discs in the correct location? How many can you hole in a row? You will soon start to appreciate how important pace control is for this drill.

Paul Harrison

Different Club Dynamics

Surface (Wall Putt Mat)	Ball Speed (mph)	Launch Angle (degrees)	Point of Zero Skid (inches)	Time to Zero Skid (seconds)
1 degree - Negative Angle of Attack - Shaft 2° forward lean - (4 degree static loft)	5.09	2.04	18.70	0.21
1 degree - Positive Angle of Attack - Shaft 2° forward lean - (4 degree static loft)	5.02	3.49	21.00	0.23
1 degree Positive Angle of Attack - Shaft vertical - (1 degree static loft)	5.04	1.00	16.00	0.18



Fit the putter to the golfer!

- The 3 L's : Length, Lie & Loft
- The weight of the putter head & shaft, specific to the individual
- Putter Alignment and perception of square
- Measuring the ball's performance is key
- The 'Quintic Ball Roll System' measures the performance of the golf ball & putter impact dynamics, which at the end of the day, is what truly matters...

Paul Harrison

Always remember, the time the putter is in contact
with the ball = 0.000325 seconds
Please make it count!



Thank you for listening...

Paul Harrison