‘Experiment 1’ – Quintic Ball Roll

• The PH Putter shaft was compared with a putter shaft from a leading manufacturer (the control shaft) – data was collected using the Quintic Roll System (360fps) whilst using a putting robot.

• The two shafts were attached to two identical mallet putter heads (weight 355 gm); the loft, lie and length were identical for both putters (2^0, 71^0, 35” respectively).
• The putter shaft was clamped directly into the putting robot. (no putter grip)
• The putting robot was used to ensure that rate of rotation, contact location, shaft, lie and loft angle remained constant.

• The putter was released manually from the putting robot in order to create an impact club head velocity of 2.85 ± 0.1 mph (The club was gently pulled to the top of the back swing and released just prior to the putter reaching the top of the backswing. This was deemed the best way to reduce any oscillation of the putter shaft caused by the release of the putter).

Paul Hurrion

‘Experiment 1’ – Quintic Ball Roll

Quintic Ball Roll – Results (n=20 Putts per condition)

Key parameters recorded by Quintic Ball Roll:

Face Angle,
Face Rotation,
Face Twist,
Launch Angle,
Shaft Angle,
Attack Angle,
Zero Skid Distance,

Three different impact locations were measured, centre (white line on the back of the putter), 1” toe and 1” towards the heel. (During all three conditions, the height of impact location was constant, the middle of the putter head)

Paul Harrison

'Experiment 1' – Quintic Ball Roll

Control Shaft – **Centre Strike** : 0.17^0 Twist Open

	Face Angle (deg)	Face Rotation (deg/sec)	Twist @ Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Speed	Impact Ratio	Launch Angle (deg)	Shaft Angle (deg)	Attack Angle (deg)	Lie Angle (deg)	Zero Skid (ins)	Zero Skid (seconds)	Initial Ball Roll (rpm)
Minimum	-0.70	-3.90	0.04	4.64	2.65		1.72	-0.17	-0.44	-0.36	-0.01	22.00	0.27	-11.22
Maximum	0.04	3.70	0.21	5.39	3.00		1.81	1.79	0.82	0.19	0.09	28.00	0.29	17.11
Average	-0.17	-0.23	0.15	5.02	2.85	Constant	1.76	0.87	0.20	-0.04	0.04	24.50	0.28	4.15
Std. Dev.	0.18	2.27	0.04	0.21	0.10		0.02	0.48	0.39	0.13	0.03	1.67	0.01	6.82
Range	0.75	7.60	0.17	0.75	0.34		0.08	1.96	1.27	0.55	0.11	6.00	0.03	28.33

PH Shaft – **Centre Strike** : 0.17^0 Twist Open

	Face Angle (deg)	Face Rotation (deg/sec)	Twist @ Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Speed	Impact Ratio	Launch Angle (deg)	Shaft Angle (deg)	Attack Angle (deg)	Lie Angle (deg)	Zero Skid (ins)	Zero Skid (seconds)	Initial Ball Roll (rpm)
Minimum	-0.25	-5.44	0.10	4.66	2.67		1.73	0.42	-0.27	-0.51	-0.17	22.00	0.27	-24.67
Maximum	0.12	4.23	0.27	5.28	3.01		1.78	2.04	0.70	0.11	0.03	27.00	0.29	6.73
Average	-0.11	-1.21	0.19	5.01	2.86	Constant	1.75	1.34	0.13	-0.24	-0.07	24.70	0.28	-12.37
Std. Dev.	0.10	2.26	0.05	0.19	0.11		0.01	0.41	0.30	0.19	0.05	1.53	0.01	7.37
Range	0.37	9.68	0.17	0.61	0.34		0.05	1.63	0.97	0.62	0.20	5.00	0.02	31.40

Paul Harrison

'Experiment 1' – Quintic Ball Roll

Control Shaft – **Toe Strike** : 0.42^0 Twist Open

	Face Angle (deg)	Face Rotation (deg/sec)	Twist @ Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Speed	Impact Ratio	Launch Angle (deg)	Shaft Angle (deg)	Attack Angle (deg)	Lie Angle (deg)	Zero Skid (ins)	Zero Skid (seconds)	Initial Ball Roll (rpm)
Minimum	-0.16	-4.73	0.28	4.64	2.68		1.70	-0.16	-0.28	-0.42	-0.17	8.00	0.10	-13.08
Maximum	0.21	3.26	0.57	5.44	3.10		1.78	1.72	1.03	0.35	0.04	31.00	0.34	38.96
Average	0.07	-0.90	0.42	5.01	2.89	Constant	1.73	0.52	0.21	-0.12	-0.06	17.30	0.20	16.71
Std. Dev.	0.10	1.90	0.09	0.27	0.13		0.02	0.49	0.38	0.24	0.06	8.34	0.09	12.25
Range	0.37	7.99	0.30	0.79	0.42		0.07	1.88	1.31	0.77	0.21	23.00	0.24	52.04

PH Shaft – **Toe Strike** : 0.36^0 Twist Open

	Face Angle (deg)	Face Rotation (deg/sec)	Twist @ Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Speed	Impact Ratio	Launch Angle (deg)	Shaft Angle (deg)	Attack Angle (deg)	Lie Angle (deg)	Zero Skid (ins)	Zero Skid (seconds)	Initial Ball Roll (rpm)
Minimum	-0.24	-7.37	0.24	4.59	2.62		1.73	0.85	0.02	-0.39	-0.16	10.00	0.12	-30.66
Maximum	-0.09	4.10	0.50	5.21	2.99		1.79	2.43	0.84	0.35	0.01	26.00	0.29	16.45
Average	-0.18	-1.51	0.36	4.99	2.85	Constant	1.75	1.71	0.35	-0.05	-0.07	23.20	0.27	-10.14
Std. Dev.	0.05	2.76	0.07	0.16	0.10		0.01	0.48	0.25	0.17	0.04	3.38	0.04	9.99
Range	0.16	11.46	0.26	0.62	0.37		0.05	1.58	0.82	0.74	0.17	16.00	0.17	47.11

Paul Harrison

'Experiment 1' – Quintic Ball Roll

Control Shaft – **Heel Strike** : -0.11^0 Twist Closed

	Face Angle (deg)	Face Rotation (deg/sec)	Twist @ Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Speed	Impact Ratio	Launch Angle (deg)	Shaft Angle (deg)	Attack Angle (deg)	Lie Angle (deg)	Zero Skid (ins)	Zero Skid (seconds)	Initial Ball Roll (rpm)
Minimum	-0.16	-5.43	-0.21	4.70	2.74		1.69	-1.18	-0.33	-0.45	-0.04	16.00	0.23	2.21
Maximum	0.22	3.63	0.04	5.38	3.12		1.78	1.35	1.03	0.12	0.10	27.00	0.29	33.32
Average	0.06	-1.56	-0.11	5.00	2.91	Constant	1.72	0.08	0.24	-0.23	0.03	23.70	0.27	13.74
Std. Dev.	0.09	2.26	0.07	0.20	0.10		0.02	0.64	0.41	0.15	0.04	2.27	0.01	8.70
Range	0.38	9.06	0.25	0.68	0.38		0.09	2.53	1.37	0.57	0.15	11.00	0.06	31.10

PH Shaft – **Heel Strike** : -0.09^0 Twist Closed

	Face Angle (deg)	Face Rotation (deg/sec)	Twist @ Impact (deg)	Impact Ball Speed (mph)	Impact Club Speed (mph)	Pre-Impact Club Speed	Impact Ratio	Launch Angle (deg)	Shaft Angle (deg)	Attack Angle (deg)	Lie Angle (deg)	Zero Skid (ins)	Zero Skid (seconds)	Initial Ball Roll (rpm)
Minimum	-0.23	-6.45	-0.21	4.77	2.78		1.71	0.38	-0.38	-0.47	-0.07	23.00	0.27	-29.54
Maximum	0.21	4.12	0.01	5.19	3.01		1.75	1.91	0.83	-0.15	0.09	27.00	0.29	4.85
Average	0.02	-0.91	-0.09	5.00	2.90	Constant	1.72	1.10	0.08	-0.30	0.00	24.79	0.28	-15.45
Std. Dev.	0.10	2.89	0.07	0.10	0.06		0.01	0.39	0.28	0.10	0.05	1.03	0.01	8.36
Range	0.43	10.57	0.22	0.41	0.24		0.04	1.53	1.20	0.32	0.17	4.00	0.02	34.39

Paul Harrison

‘Experiment 1’ – Quintic Ball Roll Summary

• It is interesting to note that in all conditions: Centre, Toe and Heel strike, the PH Balanced Putter Shaft had a reduced range in ‘Shaft Angle’ at Impact.
• A reduced range in the ‘Shaft Angle’, resulted in a reduced range in the ‘Ball Launch Angle’, which in turn caused the time to ‘Zero Skid’ to be more consistent.
• Subsequently, the more consistent a golf ball reacts on first contact with the surface the greater consistency for the ball speed at ‘true roll’.
• The distance to ‘true roll’ is an important factor for determining pace control. How a ball slows down, will determine where the ball takes the break!
• For more information on this please see the research paper presented at the World Scientific Congress of Golf VII : July 18-22 July 2016 (*Hurrion, MacKay, Sweeney & Collinson., 2016*)