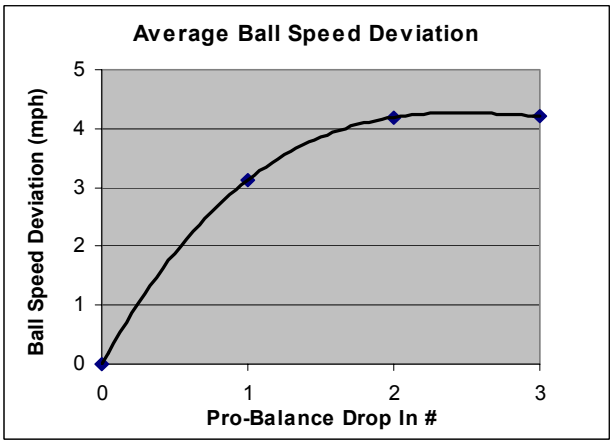
Balance-Certified Golf, Inc. Launch Monitor Test Results 9-25-04 Jeff Lindner

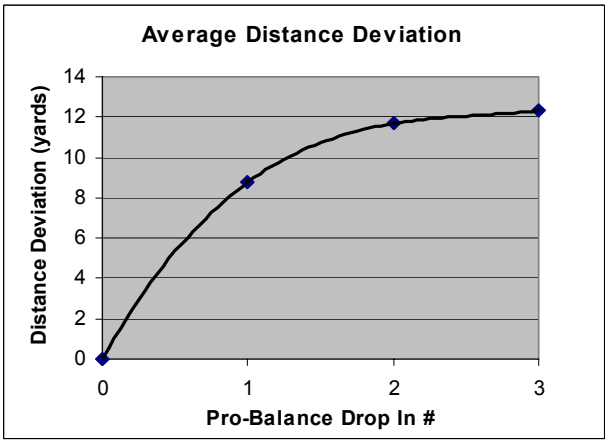
Preface: The introduction of relatively economical launch monitor systems is changing the way performance evaluation of golf equipment is accomplished. Advanced data acquisition systems can be found in many custom golf shops, thus consumers should become more savvy in their approach to the purchase of new equipment. This phenomenon should increase over time, as more golf shops join the computer age. Consumers will benefit in the long run since products that function as advertised will rise to the top.

Test Objective: The primary objective of this test series was to utilize a launch monitor to evaluate changes in ball flight characteristics resulting from the installation and optimization of Balance-Certified Golf, Inc.'s (BCG) Pro-Balance shaft weighting system in various manufacturers' drivers. BCG's proprietary "Motion Balancing™" procedure was used exclusively to determine the optimum weighting for each golfer tested.

Procedure: Data was acquired from fifteen golfers of various skill levels and swing types. Handicaps ranged from 2 to 24 while swing speed varied from 86 to 135 mph. A Vector launch monitor equipped with a laser club head speed meter was used to monitor ball trajectory and club velocity. Approximately 75% of the golfers used their own drivers during these tests while the remaining 25% were fitted with an appropriate flex and length club. Each golfer was allowed to thoroughly warm up prior to data acquisition. Measurements were first acquired without the Pro-Balance system installed. The Pro-Balance weights were subsequently installed and tested in random order. To increase accuracy and reduce random error effects, several swings were analyzed and averaged with the BCG system configured at 3 weight settings (#1, #2, and #3). The data was then reduced using Excel software.

Results: The following two plots characterize the average ball speed deviation and the average distance deviation for the fifteen golfers tested.





Three golfers optimized at the Pro-Balance #1 weight and five golfers optimized at the Pro-Balance #2 weight while the remaining seven golfers found maximum performance with the Pro-Balance #3 weight. It should be noted that the average gains shown in the previous charts were somewhat attenuated since all of the golfers peaked performance at an individual Pro-Balance weight value yet all of their respective data for each Pro-Balance insert weight was averaged together during data reduction. Even with the noted attenuation, the deviation in performance was large.

To date, eighteen golfers have been tested utilizing BCG's proprietary launch monitor based test procedure. Fifteen golfers observed significant improvements in distance while three golfers observed no measurable change. Statistically, 83.3% of the golfers increased driving distance. The launch monitor results reveal much about the mechanisms behind the increase in performance. The following table documents averaged data for each of the fifteen golfers tested in ascending swing speed order.

Golfer	Un-Balanced Distance (yards)	Pro-Balanced Distance (yards)	Distance Deviation (yards)	Un-Balanced Ball Velocity (mph)	Pro-Balanced Ball Velocity (mph)	Ball Velocity Deviation (mph)	Un-Balanced Swing Speed (mph)	Pro-Balanced Swing Speed (mph)	Un-Balanced Efficiency	Pro-Balanced Efficiency
1	163.80	183.83	20.03	107.70	112.25	4.55	83.37	81.38	1.29	1.38
10	178.90	189.65	10.75	116.23	121.60	5.37	84.85	86.50	1.37	1.41
14	199.00	220.00	21.00	119.30	128.20	8.90	92.90	92.10	1.28	1.39
2	197.50	216.97	19.47	121.22	128.40	7.18	94.44	95.45	1.28	1.35
4	224.00	229.00	5.00	134.30	136.33	2.03	94.90	95.97	1.42	1.42
15	221.70	245.50	23.80	135.20	143.10	7.90	97.20	98.10	1.39	1.46
3	235.10	238.50	3.40	134.60	137.10	2.50	99.20	99.00	1.36	1.38
12	237.33	253.77	16.43	138.77	145.57	6.80	99.56	101.63	1.39	1.43
9	225.83	243.73	17.90	135.27	138.07	2.80	99.83	99.40	1.36	1.39
11	240.90	260.40	19.50	140.90	146.50	5.60	103.90	105.60	1.36	1.39
13	228.05	241.20	13.15	145.25	150.77	5.52	107.10	106.25	1.36	1.42
8	244.00	257.00	13.00	142.20	148.80	6.60	108.04	107.60	1.32	1.38
7	236.00	266.00	30.00	152.00	159.20	7.20	111.20	111.90	1.37	1.42
6	328.00	341.00	13.00	184.00	182.40	-1.60	128.27	130.70	1.43	1.40
5	346.00	360.00	14.00	188.80	194.00	5.20	135.10	129.27	1.40	1.50
Aver	**233.74**	**249.77**	**16.03**	**139.72**	**144.82**	**5.10**	**102.27**	**102.37**	**1.358**	**1.408**

The average distance increase and ball speed increase (highlighted in the table above in green) were 16.03 yards and 5.10 mph respectively. These values are slightly higher than those shown in the previous plots due to the aforementioned averaging attenuation.

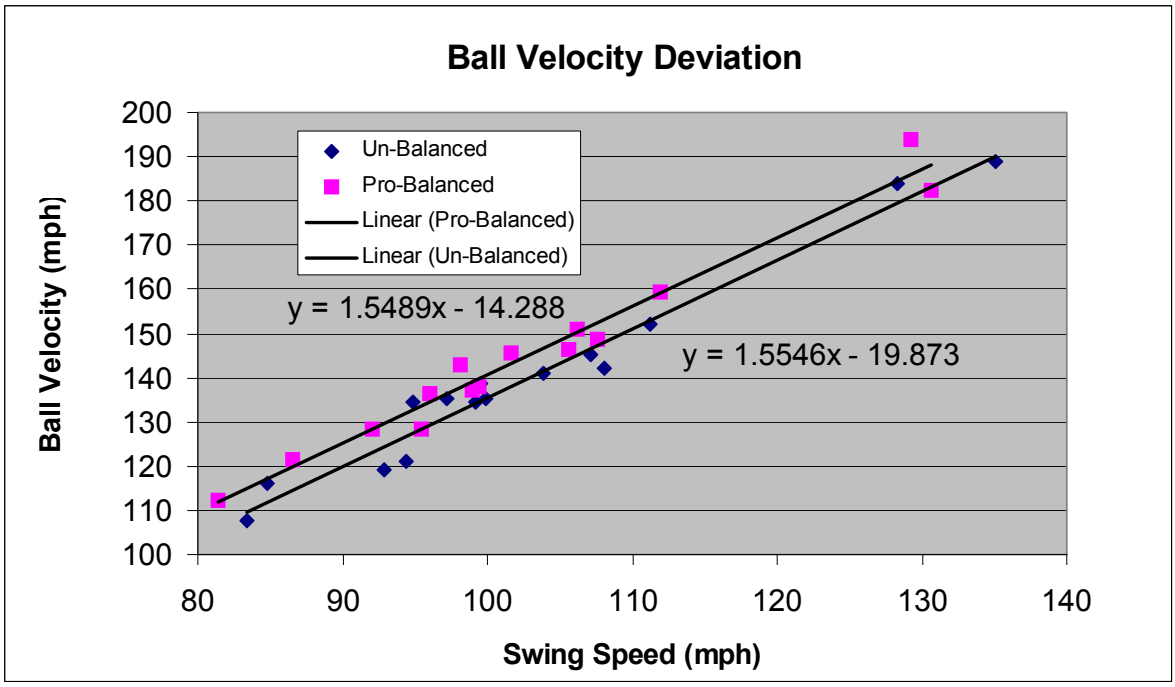
Efficiency numbers were calculated by dividing ball speed by swing speed. The average efficiency for the un-balanced club was 1.358 while the Pro-Balanced club's efficiency was 1.408. The average un-balanced swing speed was 102.27 mph while the Pro-Balanced club's swing speed 102.37 mph. A significant change in efficiency was observed along with a statistically **insignificant** change in swing speed. This indicates that the optimized club transferred momentum more effectively than the non-optimized club. Face tape data has

consistently confirmed that the optimized club impacted the ball with a tighter dispersion pattern than the non-optimized club. Videotape swing plane analysis has also confirmed this result with improved swing plane repeatability.

It should be clearly noted that these results were obtained by optimizing the Pro-Balanced club and the golfer together through the Motion Balancing™ process. Each golfer was fitted with the Pro-Balance system. Once fit to the user, the Pro-Balanced club was more efficient.

As stated, the primary parameter that was modulated was ball speed. However, launch angle, lead-lag, backspin, and sidespin were also modulated in relationship to the Pro-Balance insert weight. In fact, golfer #6 achieved a 13.00 yard distance increase even though his ball speed decreased by 1.60 mph. It is the combination of all launch parameters that produce shot distance.

The following plot graphically illustrates the relationship between distance and swing speed for all fifteen golfers with and without the Pro-Balance system.



Clearly, swing and ball speed were linearly proportional. It can also be concluded that the magnitude of the "improvement in ball velocity" is not linearly proportional to swing speed since the slopes of the Un-Balanced and the Pro-Balanced curve fits were nearly identical. Thus, golfers with slow swing speeds and golfers with high swing speeds had nearly the same opportunity for improvement.

For 15 out of 18 (83.3%) golfers a table can be generated from the data above to predict un-Balanced and Pro-Balanced results.

Swing Speed (mph)	Un-Balanced Distance (yards)	Pro-Balanced Distance (yards)	Distance Deviation (yards)	Un-Balanced Ball Velocity (mph)	Pro-Balanced Ball Velocity (mph)	Ball Velocity Deviation (mph)
85	175.82	190.02	14.20	112.27	117.37	5.10
90	192.22	206.88	14.65	120.04	125.11	5.07
95	208.63	223.73	15.11	127.81	132.86	5.04
100	225.03	240.59	15.56	135.59	140.60	5.01
105	241.43	257.45	16.01	143.36	148.35	4.99
110	257.83	274.30	16.47	151.13	156.09	4.96
115	274.24	291.16	16.92	158.91	163.84	4.93
120	290.64	308.02	17.38	166.68	171.58	4.90
		Aver	**15.79**		**Aver**	**5.00**

Conclusions:

The Pro-Balance system perturbed ball flight characteristics for 15 out of 18 (83.3%) golfers resulting in increased distance off the tee. While there were several factors that contributed to this positive distance change, it was primarily attributed to an improvement in clubhead and golf ball collision dynamics that generated increased ball speed. In lay terms, the golfers hit through the club's sweet spot more often with the Pro-Balanced club. Shaft loading, swing plane alignment, and clubhead path were also responsible for a portion of the improvement.

Acknowledgement: Balance-Certified Golf, Inc. would like to acknowledge the significant technical expertise that was provided by Gary Mayes of Equip2Golf, Inc. (www.equip2golf.com). Mr. Mayes was responsible for insuring that these tests were conducted with the highest engineering standards possible to insure that the results were accurate, repeatable, and would withstand the rigorous review required for refereed publication.

Follow-up Analysis Topics: Phase two of this study will address:
1) Swing plane modulation
2) Range ball issues...random error...short distances
3) Reasons why 3 out of 18 not realize improvements

Jeff Lindner, President
Balance-Certified Golf, Inc.