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FOCUS: The Secret of the 'Straight Shot' II

In the January Newsletter #4, ISG CTO and TrackMan™ inventor Fredrik Tuxen talked about the straight shot and the new ball flight laws. For this in-depth interview, Tuxen expands upon the January article and reveals that horizontal swing planes must vary in order to accommodate the optimal Angles of Attack for different clubs (i.e. Driver vs. Irons).

Tuxen then continues by sharing newly discovered science about the implications of horizontal face impact position and how it relates to ball flight. These findings will shock any instructor who has built a teaching methodology around the mantra: "Ball Flight doesn't lie."

TrackMan™'s Club Delivery, launch, and ball flight data reveal many interesting things about the Ball Flight Laws.

First of all, the data reveal that a shot's Horizontal Launch Angle (HLA) is 85% determined by face angle and only 15% determined by club path. This means that starting a shot perfectly on line (0° HLA) not only can be accomplished if the club path is 0° and the face angle is 0°, but also if, for example, the club path is + 6.7° (inside-out) and the face angle is 1° closed (relative to the target line)! This is in direct contradiction to the 'old' Ball Flight Laws, which explained the starting direction of the ball (HLA) is determined by the club path.

This was the central focus of our in-depth interview with Fredrik Tuxen in the January Newsletter. But there are many other factors that combine to result in a straight shot.

What are the keys to achieving the optimal, straight shot?

In terms of club delivery, it is fairly simple since there are just three parameters in play. To hit a straight and effective shot at the target, you need:

1. Club Path ZERO
2. Face Angle ZERO
3. Impact in the center of the clubface.

Regardless if you are a weekend golfer or full status member on the PGA TOUR – this will work!

How close to 0 deg needs the club path and face angle be for achieving a 'straight shot'?

If your horizontal launch angle is within $\pm 1^\circ$ and your spin axis is within $\pm 2^\circ$, you will consider it being a straight shot.

Taking this one step further, the requirement this puts on your club path and face angle depends on what club you are hitting.

“For years we have heard the mantra ‘swing all clubs the same way’. But I would not agree to that”

Fredrik Tuxen
CTO at ISG

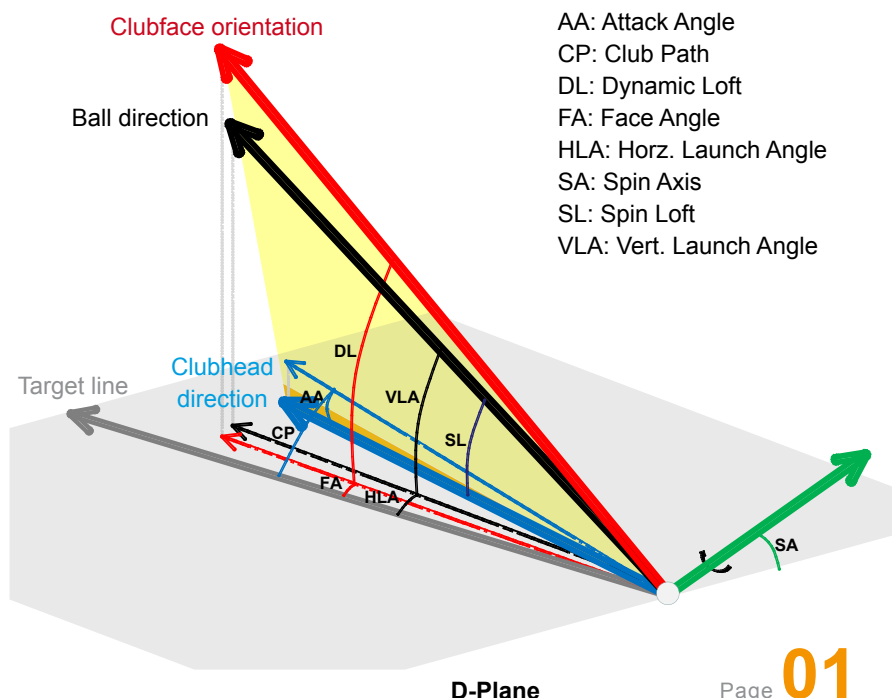
For a 6 iron, if the club path and face angle are both between $\pm 1^\circ$, this would, more or less, guarantee a straight shot (assuming center hit). But for the Driver, it is required that the club path and face angle are both between $\pm 0.5^\circ$ to achieve the straight shot (assuming center hit).

Why is it more sensitive for the Driver than for the 6 iron?

As a rule of thumb, for a 6 iron the ball's spin axis will be tilted two times the difference between the face angle and the club path, whereas for the Driver, the ball's spin axis will be tilted 4 times the difference between the club path and the face angle. So if face angle is 5° and club path is 3° , then for a driver the spin axis will be around 8° , whereas for a 6 iron the spin axis would be around 4° . To understand why, we have to look at the so-called D-plane.

The D-plane is the wedge-shaped plane between two 3-dimensional directions: 1) clubhead direction at impact which is described by attack angle and club path and 2) clubface orientation at impact which is described by dynamic loft and face angle. In the figure below, the yellow shaded wedge-shaped plane is the D-plane. Note that the angle of the D-plane is actually the spin loft.

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FOCUS: The Secret of the 'Straight Shot' II

The laws of physics tell us:

- the initial direction of the ball will always happen in the D-plane
- assuming center impact on the clubface, the spin axis will be 90 degrees relative to the D-plane.

For a Driver, the D-plane is a much more narrow 'wedge' than for a 6 iron. This is because the club loft is much less with a driver. The consequence is that for a certain difference between face angle and club path, the D-plane will be tilted more the lower the loft of the club. Since the spin loft of a driver shot is around half the spin loft of a 6 iron shot, the result is the spin axis of a 6 iron shot will only be half that of a Driver shot having the same delta between club path and face angle.

With club path being such an important factor, attack angle must be another key factor?

Yes it is. For years we have heard the mantra 'swing all clubs the same way'. But I would not agree to that. Golfers need different swings to be most effective with their shots. In order to take a divot after impacting the ball (irons), you need to hit down on the ball – negative Attack Angle. Conversely, hitting up on the ball – positive Attack Angle – with the driver enables you to maximize your distance for your club head speed.

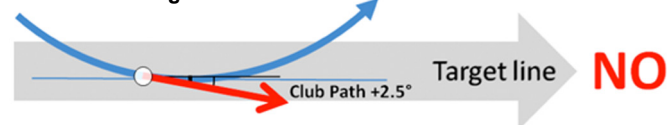
So, let's assume that your vertical swing plane with a 6 iron is 60° and your attack angle is -5°. In order to create a straight shot, your goal is a club path of 0°. How can this be achieved? The answer is a Horizontal Swing Plane of -2.5°, which means aim 2.5° left of the target line with your swing plane.

In summary, for a swing having a 60° vertical swing plane, an attack angle of -5°, and a horizontal swing plane of -2.5°, the result will be a club path of 0°.

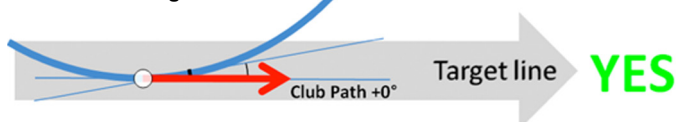
Clubhead Trajectory - TOP VIEW

(-5° Attack Angle, 60° Vertical Swing Plane)

Horizontal Swing Plane 0°



Horizontal Swing Plane -2.5°



The mark I indicates the bottom of the swing

With driver, the vertical swing plane is typically around 45°. Assuming a positive attack angle of 2° is desired, a horizontal swing plane of +2° is required to achieve the goal of club path 0°. With the driver, aim 2° right of the target with your swing plane. In summary, you need two different swings – or at least two different set-ups – to be most effective with the Driver and irons.

Does that apply throughout the set?

If you are hitting down -5° with every iron, the shorter the iron you hit the steeper your vertical swing plane will be and the lesser you'll have to compensate your horizontal swing plane to achieve a club path of 0°.

The shorter the iron with the same attack angle, the more direct at the target you should aim. In other words, it is more important to compensate – aim left – with the 3 iron than with the 8 iron.

CORRELATION BETWEEN HORIZONTAL SWING PLANE AND CLUB PATH

	ATTACK ANGLE [deg]	VERT. SW. PLANE [deg]	HORZ. SW. PLANE [deg]	CLUB PATH [deg]
DRIVER	+2	45	0	=> -2
DRIVER	+2	45	+2	=> 0 *
6 IRON	-5	60	0	=> +2.5
6 IRON	-5	60	-2.5	=> 0 *
	doesn't matter	90 **	0	=> 0

* Optimal combination

** In the hypothetical scenario of vertical swing plane equals 90 degrees, club path would always equal horizontal swing plane.

These charts and figures can be rather academic. Can you explain it in a very down to earth way?

I can try: We can say that with the driver you need the same value for attack angle and horizontal swing plane in order to obtain a 0° club path – for example if your attack angle is +3°, the horizontal swing plane needs to be +3° to obtain a club path of 0°. And for irons it is half effect – for example if attack angle is -4°, the horizontal swing plane needs to be -2° to obtain zero club path. In short, aim left when hitting down on the ball and aim right when hitting up upon the ball. And remember when I say 'aim left' I mean the swing plane, the face angle should always be aligned towards the target line.

Ball position is an issue here as well?

Absolutely. If you move the ball back towards your right foot for the same horizontal swing plane, the effect will be a steeper attack angle (more negative) and a more inside-out club path (more positive). So, in order to maintain a zero club path while moving the ball further back in your stance, you simply have to rotate your horizontal swing plane towards the left (more open stance).

Before we discussed that the shorter the club and the steeper the vertical swing plane, the less you had to compensate your horizontal swing plane away from the target line.

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FOCUS: The Secret of the 'Straight Shot' II

However, if you add the effect of moving the ball backwards in your stance progressively with the shorter club, it is possible to counter balance this so you can end up with the same horizontal swing plane (aiming) for all your irons! Other than that, ball position is very much a teaching philosophy in which I will not take a strong position - but I can analyze the data! Some teachers want to keep the same ball position throughout the set while others speak for moving the ball progressively towards the right foot. Analyzing the data I would probably tend towards the idea of moving the ball backwards, since this could enable your setup to be the same for all irons and hybrids.

We know that if club path is 0° and face angle is 0°, the ball will start on the target line. What makes the ball go offline?

Two things make the ball go offline. Launch conditions – i.e. horizontal launch angle, either a push or a pull, which is determined by face angle and club path, and secondly the spin axis which is responsible for the curving of the shot. Then, of course, other factors not related to the swing itself, such as wind.

There are two contributions to the tilting of the spin-axis.; The first is the tilting of the D-plane, which as discussed earlier, happens if club path does not equal face angle. The second contribution to the tilting of spin-axis is the result of horizontal gear effect. The horizontal gear effect occurs when the ball is impacted anywhere but the center of gravity of the club head in the heel-toe direction. If the ball is hit towards the toe, the club head will twist clockwise, and the gear effect causes the ball spin-axis to tilt anti clockwise i.e. a draw spin. If the ball is hit towards the heel, we'll get the opposite effect, or a fade spin-axis tilt.

How close to center impact do you need to be? How big is the effect of off-center hits?

Impact location and gear effect have a surprisingly significant effect on the curvature of a golf shot. If we start with the ideal situation with a face angle of 0° and a club path of 0° and impacting the ball in the center of gravity of the club face, then the ball will go straight. However, if you impact the ball just 1 dimple (0.14 inch) towards the heel of your driver, it creates a spin axis of +6° (fade spin) and the ball will end up 10 yards right of the target line on a 250 yards carry shot.

You will probably be on the fairway, but in a major with very narrow landing areas and firm turf conditions, the shot may be in jeopardy of missing the fairway. If you impact as much as half an inch towards the Toe, the dispersion will be 35 yards left of the target on a 250 yards carry!

Luckily the club manufactures have added a curvature to the club face (the bulge) on woods and drivers. This means that when you impact the ball on the heel your face angle at the impact point will most likely be closed, hereby starting the ball more left and tilting the D-plane towards a draw spin. The net effect will be a much straighter shot compared to the zero face angle situation.

“

However, if you impact the ball just 1 dimple (0.14 inch) towards the heel of your driver with face angle being zero at point of impact on the club face, it creates a spin axis of +6° (fade spin) and the ball will end up 10 yards right of the target line on a 250 yards carry shot.”

Fredrik Tuxen

Does horizontal gear effect have the same influence on an iron-shot as on a drive?

The spin created by the gear effect is a spin around a vertical axis (sidespin) that is added to the spin from the D-plane. The vertical spin from the horizontal gear effect tilts the spin axis. The contribution to the vertical spin is roughly the same in rpm's throughout the set for the same off-center distance, but because you get much less spin with the driver the effect of the added vertical spin is much more pronounced than with a wedge, for example. If we have a spin rate of 2500 rpm with the Driver and 10000 rpm with a wedge, the effect of 500 rpm of sidespin on the spin axis will be 11° for the driver and only a quarter of that, or 2.8°, for a wedge.

If we take an example of hitting a 6 iron with zero club path and face angle, and impacting the ball 1 dimple towards the toe of the club face, this will cause a spin axis of -2°, resulting in a shot being almost 2½ yards offline at 170 yards carry. A spin-axis of -2° is not a serious problem and often is what we refer to as a 'baby draw'. For comparison, a 2° spin axis could be originated from a center-impact 6-iron shot where the club path is 0° and the face angle is +1°; so a 1 dimple off-center impact has the same effect as 1° difference between club path and face angle on the spin axis for a 6 iron shot! For a driver shot, 1 dimple off-center corresponds to 1½° difference between club path and face angle.

DRIVER: EFFECT OF OFF-CENTER HITS

CLUB PATH [deg]	FACE ANGLE [deg]	FACE IMPACT	HORZ. LAUNCH [deg]	SPIN AXIS [deg]	SIDE OFFLINE [deg]
0	0	Center	0	0	On Target
0	0	1 dimple (0.14") towards heel	0	+6	10 yds R at 250 yds
0	0	½" towards heel	0	+20	35 yds R at 250 yds

6 IRON: EFFECT OF OFF-CENTER HITS

CLUB PATH [deg]	FACE ANGLE [deg]	FACE IMPACT	HORZ. LAUNCH [deg]	SPIN AXIS [deg]	SIDE OFFLINE [deg]
0	0	Center	0	0	On Target
0	0	1 dimple (0.14") towards toe	0	-2	2½ yds L at 170 yds
0	0	½" towards toe	0	-7	8 yds L at 170 yds

*Typical MOI and COG assumed

PGA of America Teacher of the Year Chooses TrackMan™

PGA of America's 2008 Teacher of the Year Martin Hall was not overwhelmed when he first experienced TrackMan™ during the summer of 2006.

This was before the system included Club Delivery measurements. At first glance, the renowned Florida-based PGA Professional from England liked the prospects of TrackMan™, mainly due to its ease of use and the accuracy of its ball launch and flight measurements. However, he wasn't convinced that it would fully support his teaching methods and he decided against buying one for his Academy.

Club Delivery measurements were added to TrackMan™ in 2008 with the release of version 3.0 (software), representing a milestone achievement in the industry and positioning TrackMan™ far ahead of any other device on the market. Now it was possible to see club path and face angle measurements, among other club delivery data, as well combine these data with the ball flight measurements TrackMan™ had always been recognized for. After having provided Martin the demonstration in 2006, Matt Frelich, TrackMan™'s US sales director, knew version 3.0 was the perfect opportunity to reengage Martin and called him to present the new features and measurement parameters.



Martin Hall

This was interesting news for the experienced Hall, who then ordered a TrackMan™, but on the condition of having a 14 days return option so he could evaluate the accuracy and usefulness of the club delivery data. After taking delivery of the system and training, and now nearing the end of the two weeks trial, Hall informed Matt he was not fully convinced of the system's club delivery measurements because he was seeing too many face and path measurements being reported by TrackMan™ that did not match ball flight. Martin returned the TrackMan™ system and ISG feared this might be a lost opportunity.

“Fredrik was able to tell us to within a quarter of an inch where Lisa was hitting the ball on the clubface. We sprayed the clubface and didn't show it to him, but he could tell us from the TrackMan™ data and ball flight the exact impact position. It was quite overwhelming, and I was turned over”

Martin Hall

PGA of America's 2008 Teacher of the Year

However, Fredrik Tuxen, CTO at ISG and the inventor of TrackMan™, understands the system's accuracy and limitations, and had trouble accepting the claim that TrackMan™'s club path and face measurements were wrong because they weren't matching ball flight! First hand, Fredrik spent an hour on the telephone trying to convince Martin of the fact that a ball hit with a Club Path of 0° and a Face Angle of 0° would not necessarily go straight as always believed in terms of the 'old' Ball Flight Laws.

Then Fredrik decided to go to Florida to visit Martin and give it a final chance, knowing that TrackMan™'s club path and face angle measurements are correct and that the days of the 'old' Ball Flight Laws are numbered.

During the late afternoon session that included Martin's wife, Ladies European Tour professional Lisa Hall, Fredrik Tuxen managed to convince Martin about the accuracy of TrackMan™'s club delivery measurements. And the session was a wake-up call for them both.

“Fredrik was able to tell us to within a quarter of an inch where Lisa was hitting the ball on the clubface. We sprayed the clubface and didn't show it to him, but he could tell us from the TrackMan™ data and ball flight the exact impact position. It was quite overwhelming, and I was turned over,” Martin Hall says.

“At first, Martin could not get the data to make sense in his understanding of the effects of 'a well hit shot',” Fredrik Tuxen recalls.

Tuxen refers to Lisa Hall as a 'human golf robot'. Her swing consistency is absolutely amazing, but from watching the club data on TrackMan™ and comparing to the ball flight (also measured by TrackMan™), he was able to tell her and Martin that she was hitting the ball as little as 'a dimple' towards the heel. And he was right. For quite some time Martin was speechless wondering what he was witnessing. Then he very quietly in his typical British manner said: “I think you just sold me a system.”

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PGA of America Teacher of the Year Chooses TrackMan™

For the past two months Martin Hall has used TrackMan™ as an integral part of his teaching and the results have been outstanding. He is still in a phase of learning all the benefits TrackMan™ has to offer, but he has changed his beliefs about the 'old' Ball Flight Laws, and is now studying the new Ball Flight Laws where the Horizontal Launch Angle is 85 % determined by the Face angle and only 15 % by the club path, which near fully contradicts the "traditional" ball flight laws.

"TrackMan™, to a great degree of certainty, is very helpful in determining whether club path or face angle is the villain (enemy) in the piece (golf swing)," he says admitting that TrackMan™ has caused him to rethink some fundamental teaching principles:

"First of all, don't always trust ball flight to give you the face and path relationship... And don't always trust what you see on video. While video shows what the eye can't see, TrackMan™ shows what video can't see."

“Previously I would have agreed to the fact that off-center hits influence the distance of the shot, but that horizontal impact position has such a significant influence on the curvature of ball flight was a complete surprise to me.”

Martin Hall

PGA of America Teacher of the Year 2008

Martin is glad he didn't just take the TrackMan™ system in November, when he did not trust the club delivery data. Surely this would have resulted in the system ending up in his closet not being used. The understanding of club delivery, as a result of the process with Fredrik Tuxen and TrackMan™, has been great.

Now, Martin Hall is a keen TrackMan™ user, not only for teaching his wife but also many young talented players.

"For student feedback, using TrackMan™ path and face, the information gets into their sensory system quicker than ever (before). TrackMan™ helps them learn how to control ball flight to an astonishing level." "TrackMan™ used in conjunction with video does a better job for students and TrackMan™ is very helpful to fix the swing," Martin Hall says.

Since the purchase of TrackMan™, recent accomplishments from Martin Hall students include:

- > Matt Cerabolo, a top Florida junior, after a TrackMan™ session with Martin, won Florida's #1 junior tournament.
- > Kailey Walsh worked with Martin and TrackMan™ for four weeks and subsequently won Florida's #1 junior tournament.
- > A 14-year old student used TrackMan™ to raise her club speed from 82 to 88 mph in one session; like a bar that she kept raising.

For these young players TrackMan™ also provides other useful information. It makes aspiring golfers realize just how good the pros really are... And why they are so good.

Martin Hall uses the cruel facts provided by TrackMan™ in working with the talents. "If someone thinks they are good, all it takes is a simple evaluation. Take some shots on TrackMan™ and let's take a look. TrackMan™ is a tremendous indicator whether players are good enough to play at the highest levels, including on tour. You can read it straight out of the data provided," he says.

In mid-May, Martin Hall left for Europe, travelling with his TrackMan™, to spend a few months on the Ladies European Tour, using TrackMan™ to work with his wife and other top players.

STUDY: Mind The Gaps

Dr. Jim Suttie, a Golf Digest top 20 instructor, has done significant research in golf - most recently on amateur golfer's gaps between clubs. The following is a report on that study and its findings.

"If professional golfers know how far each club in their bag carries and make sure that they have adequate gaps between each club, then shouldn't every golfer? In the past maybe it has been true that professional golfers had access to better technology and equipment, but that is not the case anymore. Amateur golfers now have access to the same technology and equipment that Tour Professionals do," states renowned teaching professional Dr. Jim Suttie.

In some cases it may come at a price, but it can still be accessed by any golfer who wishes to join in. TrackMan™ has brought club fitting to the forefront and allows any golfer to be privy to the same technology and data analysis that PGA TOUR, LPGA Tour, European PGA Tour and all other professional golfers use on a regular basis. "Since TrackMan™ measures the entire ball flight and gives actual carry distances, golfers of all levels can make sure that they have a set makeup specifically for them. Even though club fitting has come a long way, fitting for gaps is still something that is rarely done."

Club fitters talk about making sure that a golfer has the right length, lie and flex, but what about the correct gaps? Fitters will say that one length does not fit everyone, then why should one standard of lofts fit everyone? That is because until recently measuring how far a golfer hits a certain club was not very easy to do.

"With TrackMan™, a golfer can go through their entire set in less than an hour and know how far they hit each club in their bag. Again, this carry distance is not some kind of calculation based on club speed, ball speed, launch angle and/or spin rate. This carry distance is measured. Now that a golfer has gone through his or her bag and knows the distances of each club, he or she can get down to business and start adjusting the existing clubs or build a set that is truly specific for his or her swing.

Just as different swing speeds call for different flexes of shaft, different swing speeds also call for different set makeup to create proper spacing between each of the clubs. Only then can a golfer be fully fit."

With the help of TrackMan™, Dr. Jim Suttie, one of America's 50 greatest teachers, set out to test the gaps between amateur's clubs. It has long been known that most amateurs do not know how far they actually carry each club in their bag and also have serious gapping problems as the club gets longer and the loft decreases. As seen in the July 2009 issue of Golf Digest, the following is a deeper look into the test and results behind the article "Why you Miss Greens".



“With TrackMan™, a golfer can go through their entire set in less than an hour and know how far they hit each club in their bag.”

Dr. Jim Suttie

2000 PGA of America Teacher of the Year

"This study should open a lot of eyes of how golf clubs should be fit. Maybe a whole new set makeup of 14 clubs will enable the amateur golfer to become more aware of the gaps he has in his set and how far he actually carries each club," Jim Suttie says adding, "Only the use of the TrackMan™ made this study possible."

The study consisted of two tests, one for the lower lofted clubs (long iron) and one for the higher lofted clubs (wedge). For the long iron test, the study was based around the 4 iron or the participant's equivalent to a 4 iron. From there the two clubs on each side of the 4 iron were chosen for a total of five clubs (e.g. 2 iron, 3 iron, 4 iron, 5 iron, 6 iron or 5 wood, 3 hyb, 4 hyb, 5 iron, 6 iron). The participant then hit a total of 50 shots, 10 with each club, in random order. For the wedge test the three highest lofted clubs in the participant's bag were used (e.g. PW, SW, LW or 52°, 56°, 60°).

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STUDY: Mind The Gaps

The participant then hit 30 shots, 10 with each club, in random order. Out of each set of 10 shots for both the long iron and wedge test, only the most consistent eight shots were kept. The two shots from each set of 10 that affected the average the most were discarded to limit the effects of miss hits on the data.

Along with the shots that were hit by each participant, certain key demographic and club information was collected to use when analyzing the data. Some of the information collected was:

- >Age
- >Handicap
- >Years Playing Golf
- >Were Your Irons Fit
- >Lessons Last Year
- >Frequency of Time on Range
- >6 iron loft (measured)
- >6 iron flex (as listed on shaft)

This information was important in determining if there was a correlation or direct effect of one of these variables on the data from the long iron and wedge test.

RESULTS

After all of the data was collected and the shots were hit, the data was then compiled and analyzed to determine the results of the study. The following is a brief rundown of some of the key data regarding demographic and club information:

The ages ranged from 16 to 79. The average age was 47.2 with a median of 50. The standard deviation was 15.2.

The handicaps ranged from +2 to 40. The average handicap was 11.6 with a median of 10.1. The standard deviation was 8.4.

Nearly three-quarters (73%) of the participants said that their irons were fit for them to some extent. This would include clubs fit for length, lie, loft, flex and/or custom built.

The lofts of the 6 irons ranged from 27.5 to 34. The average 6 iron loft was 30.2 degrees with a median of 30. The standard deviation was 1.3.

For the shot data, averages were taken for each club, or each set of 10 shots. Using the averages, the gaps between each club was calculated for each participant. The following is a brief overview of some of the major findings with regards to the shot data. We will begin by looking at the long iron results.

44% of the gaps measured were reasonable (larger than 8 yards)
37% of the gaps measured were too small (less than 8 yards)
19% of the gaps were "reverse gaps" (the higher lofted club carried further)

That means out of the 160 gaps tested, less than half of them were separated by more than 8 yards on average. More than half of the gaps tested were too small or were reverse gaps! Then the data was sorted to see which demographical data has the biggest impact on the results. See the following percentages when compared to one demographic variable.

Handicap:

< 10.5

Reasonable – 48%
Too Small – 38%
Reverse – 14%

≥ 10.5

Reasonable – 40%
Too Small – 36%
Reverse – 24%

Fit for Irons:

Yes

Reasonable – 44%
Too Small – 39%
Reverse – 17%

No

Reasonable – 43%
Too Small – 32%
Reverse – 25%

Age:

< 50

Reasonable – 46%
Too Small – 36%
Reverse – 18%

≥ 50

Reasonable – 42%
Too Small – 38%
Reverse – 20%

Club Speed:

≥ 82.5 mph

Reasonable – 51%
Too Small – 38%
Reverse – 11%

< 82.5 mph

Reasonable – 36%
Too Small – 36%
Reverse – 28%

As can be seen from the percentages the variable that made the biggest impact is club speed. The higher the club speed, the more likely the person was to have better gaps between their clubs.

This relationship makes a lot of sense because most iron sets only have 3-4 degrees and a 1/2" length difference between each club. Lower club speeds make it much more difficult to create the energy and launch conditions necessary to create reasonable gaps.

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STUDY: Mind The Gaps

The shocking result is that being fit for the irons had no impact on the amount of reasonable gaps between the two groups. Participants were simply asked if their clubs were fit for them. They were not asked if the clubs had been fit for gaps. Most iron fittings revolve around head design, flex, length and lie. Although each of these things is very important, none of them guarantee that the golfer will have the correct gaps between their clubs.

Now let us look at the results from the wedge tests. The categories for the wedges were defined a little differently due to the fact that these clubs are considered a person's "scoring clubs".

43% of the gaps were too large (larger than 13 yards)
 28% of the gaps were reasonable (between 7 and 13 yards)
 23% of the gaps were too small (less than 7 yards)
 6% of the gaps were "reverse gaps" (the higher lofted club carried further)

Out of the 88 gaps tested with the wedges, only a little over one-fourth (28%) of gaps were considered reasonable. Nearly half (43%) fell into the category of too large. Out of the 38 gaps that fell into the too large category, 26 of the gaps were more than 15 yards and 14 of the gaps were more than 20 yards.



Dr. Suttie at his academy in Bonita Springs - Florida

The following percentages look at how the same demographic variables affected the wedge gaps. Only a very small percentage reported being fit for wedges, so this comparison was not taken into account.

Handicap:

< 10.5

Too Large – 43%
 Reasonable – 32%
 Too Small – 23%
 Reverse – 2%

≥ 10.5

Too Large – 43%
 Reasonable – 25%
 Too Small – 23%
 Reverse – 9%

Club Speed:

≥ 71 mph

Too Large – 43%
 Reasonable – 30%
 Too Small – 25%
 Reverse – 2%

< 71 mph

Too Large – 43%
 Reasonable – 27%
 Too Small – 21%
 Reverse – 9%

Age:

< 50

Too Large – 50%
 Reasonable – 26%
 Too Small – 22%
 Reverse – 2%

≥ 50

Too Large – 37%
 Reasonable – 30%
 Too Small – 24%
 Reverse – 9%

It is interesting that the lower handicap group had more people fall into the reasonable category and fewer in the reverse gap category. Club speed does not have the same impact with the wedges. This is likely due to the fact that most golfers' wedges have 5 or more degrees of separation between them. It is still noted that the slower club speed group did still have slightly more people with gaps that are too small or reverse gaps.

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STUDY: Mind The Gaps

CONCLUSIONS

From the results, it is obvious that amateurs of all skill levels have gapping issues. Less than half of the gaps measured in the long irons were more than 8 yards. Only one-quarter of the wedge gaps were between the recommended 8-13 yards. "It doesn't surprise me that most amateur golfers have larger gaps with their wedges and short irons than with their longer irons. The perfect fit of clubs in the future will take these gaps into consideration and tools such as the Trackman™ will make this process much easier," Dr. Jim Suttie says.

One question that may arise from the study and results is "are amateurs consistent enough to fit for gaps"?

"Most amateurs hit their short irons better than their longer clubs. The reason for this is they:

- 1) tend to have a steep angle of attack
- 2) tend to have a slow and less consistent club head speeds
- 3) tend not to consistently hit the ball in the center of the face.

For these reasons, amateurs need to have clubs that help minimize these inconsistencies. Clubs with more perimeter weighting, larger faces, more bounce, blunt leading edges and/or larger/wider soles can help amateur golfers immensely. Also, hybrid type clubs where the center of gravity is much lower helping to launch lower lofted clubs into the air can be a big advantage," Jim Suttie says.

Even in the face of these inconsistencies as stated at the beginning, only 2 out of the 10 shots for each club were rejected. That means that 8 out of 10 shots were counted towards the player's average with that club regardless of their handicap. Why weren't more shots kicked out to get a better "average" for each club? Because it did not seem necessary when looking at the data. A standard deviation was calculated for each group of shots to see how consistent the player was with that particular club. From this standard deviation number it could be determined how likely the average carry number is a repeatable distance for the player with that club. Could 5 out of 10 shots been taken for each club instead of 8? Yes, but the data did not suggest this was necessary and in the rules of golf there is no such thing as a mulligan. Next time a golfer says, "I'm not good enough to be fit." You can confidently answer, "Yes you are."

"Regardless of age, handicap, swing speed or other, every golfer should and needs to have the carry distances of his or her clubs checked. One of the keys to good golf is knowing how far you carry each club in your bag. If a golfer knew that his 3, 4 and 5 iron all went the same distance, would he or she really want to carry around the extra weight? The Rules of Golf state that a player can have a maximum of 14 clubs. Go have your yardages checked and make sure you actually have 14 "different" clubs." Suttie concludes.

TrackMan™'s Fredrik Tuxen Addresses the German PGA

During the last twelve months or so, Fredrik Tuxen, CTO at ISG and inventor of TrackMan™, has been a household name as a prominent speaker at several education seminars for national PGA organizations throughout Europe.

On April 6th he was invited to Bad Kissingen in Germany to deliver the TrackMan™ presentation "Optimal Club Delivery for All Golfers" to 180 members of PGA of Germany. Due to the time of the year and size of the anticipated audience, the presentation was held indoors.



PGA of Germany - seminar

Yet, a well engineered stage set up with two big screens for data projection and an indoor hitting area equipped with an on stage TrackMan™ radar made it possible to go through a lot of the Club Delivery data live.

Fredrik's provocative statement of "Ball Flight Lies" captured the audience's attention and the German pros were very open minded, showing a great understanding for the philosophy of 'true' Ball Flight Laws' as revealed through TrackMan™'s unique Club Delivery Data.

"It was a great day" Tuxen says

"I had the opportunity to talk about 'true' Ball Flight Laws and the Secret of the Straight Shot, as well how these data can be used in teaching golfers of all skills. This is fantastic for us because TrackMan™ is the only launch monitor system on the market that actually delivers these features."

"It is always a great honor and opportunity to stand up in front of a group of golf professionals and speak to them about the new knowledge TrackMan™ has made accessible to the golf industry.

Over the past twelve months, I've had the privilege to speak for the Swedish PGA, Scotland, Switzerland, the PGA of Denmark, and recently I was invited to speak at an education seminar for the PGA of England at The Belfry.

Photos courtesy of Golfphoto.de



Fredrik Tuxen - talking Club Data

TrackMan™'s philosophy is that the more PGA professionals throughout the world knowing what truly influences Ball Flight, the better. Of course they are all potential customers, but what I do as a speaker is not a sales speech nearly as much as sharing valuable knowledge about the golf swing and how to improve your skills," Tuxen says.



PGA TOUR Pro: Kevin Streelman

Club Fitting and Teaching Go Hand in Hand

Up and coming PGA TOUR professional Kevin Streelman had a fine rookie season in 2008, finishing 78th on the Money List while earning over 1.3 million dollars. He had 4 top 10 finishes, was in the top 25 eight times, and produced a stroke average of 70.63 per round.

At 30 years old, Streelman is the story of a young, talented, hard working professional who gained his way onto the PGA TOUR through six years on mini tours such as The Hooters Tour and The Gateway Tour. He earned his PGA TOUR card by finishing 14th in the 2007 PGA Tour Qualifying Tournament.

Thanks to his successful 2008 season and a solid start to the 2009 season, Streelman is now ranked in the World's top 135. Streelman is one of many players who methodically work on constantly improving his game by using the benefits of the TrackMan™. He doesn't own his own Trackman™ yet, but regularly works with his coach Alasdair Dyer and TrackMan™ Tour representative Justin Padjen at PGA TOUR events. Together they do intensive analysis of all parts of Kevin's game. Kevin began using Trackman™ at the Bear's Club in Jupiter, FL, last year during the 2008 Honda Classic. Darren May, Director of Instruction at the Bear's Club, worked with Kevin and Alasdair to analyze Kevin's swing and equipment. From there a game plan was established.



Streelman on the PGA TOUR

We talked to Kevin Streelman and Alasdair Dyer about what he and Kevin saw and learned during the first session and in the months that followed. Dyer is the Director of Instruction at Barefoot Resort in Myrtle Beach, SC, and has experience teaching tour professionals from most of the top tours around the world.

"When we met Darren (May) at the Bear's Club last year, we went with the purpose of getting Kevin the total package. We wanted to work with his swing and also make sure the equipment matched with the goals we had set for his technique. By making sure that



“ Making that trip to the Bear's Club to work with Darren May and their TrackMan™ was eye opening ”

Kevin Streelman
PGA TOUR Professional

Kevin had the correct equipment, we could not only help Kevin perform better on the course, but also to help in this transition of his swing mechanics. We had always seen Kevin's game didn't consistently perform through the entire bag on a day to day basis. No matter how hard we worked on technique to improve it, Kevin would not always get the result we were looking for. The use of TrackMan™ showed Kevin that what he was doing technically to make his iron game perform was different from what he did to make his woods, and especially his driver perform."

What was the goal following the visit to the Bear's Club?

"The main goal was to change Kevin's angle of attack with his driver. At the Bear's Club, Kevin's angle of attack was around -6 degrees. That is extremely steep (down) for any golfer, not to mention a PGA TOUR Professional.

The steep angle of attack was causing Kevin to spin the ball more than we would like and it also caused the amount of energy he was transferring (smash factor) to be lower than desired. The other issue was that Kevin's club path was around -6 degrees as well.

(continues)

PGA TOUR Pro: Kevin Streelman

This was in part due to the downward blow Kevin was creating. This combination of 6 deg. down and 6 deg. across meant that it was more than adjusting the angle of attack by ball position or spine angle.

Kevin was going to have to change his Horizontal Swing Plane and get the club moving more from the inside, or else the ball would end up starting even further left."

"Making that trip to the Bear's Club to work with Darren and their TrackMan™ was eye opening. The TrackMan™ is able to give us information that high speed video never could. I was immediately able to see my progress, establish my goals, and build my set of clubs accordingly throughout the set. Working with the TrackMan™ allows a level of freedom to be established throughout my game and gives me the confidence to know that I have the right equipment coupled with the right mechanics to take me to the top of my game!" Kevin said.

How did the goals change after the first few weeks?

"Goals were not changed after this time frame. We were not looking for this to be a quick fix. Kevin had a goal in mind and equipment that matched the specifics of the goal. Although it was going to be a process, things were made easier to achieve as Kevin was now going to be using a fully matched set of clubs, which up to that point he was not. So this made my job easier as we could clarify what we wanted Kevin to achieve technically and simplify his work."

How did you feel things went through the remainder of the 2008 campaign with him putting it together at the end of the season?

"Technically, as the season went on Kevin became a much more one plane swinger with the technology he had in his bag. This then made his release pattern far more constant through the bag and as such his ball flight became more stable. The big plus was his distance control became the best it had ever been. By concentrating on the angle of attack with his driver, it bled over into the rest of his bag creating more consistent blows for every club. These were keys that made Kevin able to perform in the greatest pressure and to the highest level," Dyer says.

During the offseason, Streelman continued his hard work to improve. What exactly did you do?

"We again over the off season went to see Darren to continue the work we had already started. Kevin worked extremely hard both during the '08 season but also during the offseason. One of the biggest points we focused on over the winter was to get all his clubs to fit his address position and not so much focus on impact position. One main feature we noticed with the driver was club length and we actually went to a driver 1/2 inch shorter than before.



“ Having the immediate feedback of the TrackMan™ data was a great help ”

Kevin Streelman
PGA TOUR Professional

Again, the data we got from TrackMan™ helped quantify the results and prove that this was the best decision. We were able to see immediately how both the angle of attack and club path changed with varying lengths of driver. When we went to a longer or more standard length, we found we could always get one set of numbers down, but at the cost to the other set. Having the immediate feedback of the TrackMan™ data was a great help."

(continues)

PGA TOUR Pro: Kevin Streelman

How did things continue to improve this season as well? Did you reach the goal of continually trying to get better by switching to the 8.5 driver?

"We have seen his swing become more of a motion that can perform with every club through the bag. Rather than being great with one area he is becoming world class with every club. This is because his use of TrackMan™ has made his understanding of his swing greater, thus his focus on his swing is sharper.

This has made him become a one-track-mind goal-setter now and not looking for the quick answer. He has the knowledge to identify what needs to be worked on and how and why. In roughly one year, Kevin has gone from needing more than 10.5 degrees of loft to get the ball in the air to recently putting an 8.5 degree head with a stiff tip shaft into play. It just shows you what hard work can do."

Streelman has no doubts:

"Hey, the numbers don't lie. I have gone from a steep, "hold on" player, attacking down and across the ball, to a "one plane" releaser with a positive attack angle. My impact position used to have a negative angle of attack of 6 to even 8 degrees. This used to force me to use a driver with lots of loft (10-11 degrees) and a very soft tip, to help get the ball in the air.

Now I use an 8.5 head with an extremely strong shaft that allows me to not only launch the ball higher, but launch it with close to 1000 RPM's less of spin. That has created a much stronger ball flight that is rarely affected by any wind. I don't know if I could've made these changes without the TrackMan™. TrackMan™ gives me the IMMEDIATE feedback necessary to make improvements in my swing, equipment and my game. I think it is the best technological advancement in the game of golf since the metal driver!"

DRIVER TIMELINE Honda Classic '08 to present:

Driver after Bear's Club:

> 10.5Hi Bore XL Diamana Blue Board 73X

Driver halfway through year: ('08)

> 9.5Hi Bore XL Diamana White Board 73X Tipped.

Driver beginning this year:

> 9.5Hi Bore XLS with Mitsubishi Fubuki 73X, ½ inch shorter Tipped.

Driver now:

> 8.5 Hi Bore XLS Miyazaki 72X (Srixon Shaft)

Any other comments, Alasdair?

"Just, that the use of TrackMan™ has made Kevin a complete player, and made my job as coach a lot easier. Video alone would have never done (the job). It is an advantage to have TrackMan™. Its use in coaching and day to day work is invaluable. It is so much more than just a club fitting tool."

Kevin Streelman Driver stats:

Event	Club Speed	Ball Speed	Smash Factor	Launch Angle	Spin Rate	Carry (yds)	Attack Angle	Club Path
08 Honda	116	166	1,43	8,9	2887	267	-5.6	-5,6
08 Byron Nelson	118	167	1,42	9,4	2811	268	-4.5	-5,4
08 Buick	116	167	1,44	9,1	2521	270	-4.0	-2,7
08 Deutsche Bank	116	169	1,46	7,9	2629	269	-2.4	-1,9
09 Quail Hollow	113	168	1,49	11,1	2858	282	-1.1	-2,2
09 Memorial	114	170	1,49	12,1	2399	290	-1.0	-1,3

Kevin Streelman is also a big supporter and fundraiser for Smile Train. Smile Train is a charity that provides free surgeries for cleft lip and palates. For more information on this great cause visit www.smiletrain.com

NEWS: Short Stories

TrackMan™ Users Conference

The first ever TrackMan™ Users Conference has been scheduled for November 6-7, 2009, at the PGA Center for Golf Learning and Performance in Port St. Lucie, FL. The objective of the conference is to increase the value of the TrackMan™ technology to users by presenting significant research and insights about TrackMan™ data, the relationships amongst club delivery, launch conditions, and the resulting ball flight, as well best practices for coaching, fitting, practice, and technique.

In a nutshell, the information presented is guaranteed to take attendees coaching and fitting knowledge to a new level. Matt Frelich, Director of US Operations states, "We hope that by offering this unique information in a special learning environment, we will provide TrackMan™ users the increased ability to take full advantage of TrackMan™ benefits, offering even more to their students and customers. A lot of industry professionals shut down when they hear words like gear effect, D-plane, collision properties, and other scientific terms, but all of these terms help explain how and why a golf ball goes where it does once contact is made.

Our goal is to provide an educational experience that takes the mystery and shock out of these terms and raises our customers' awareness of the true ball flight laws. With a solid understanding of these fundamentals, TrackMan™ users will be head and shoulders above others in the golf industry."

Memorial Clinic 2009

At the 2009 Memorial Tournament Clinic, TrackMan™ was invited to add a new twist to the experience. In recent years the clinic involved discussions about spin, distance and other measureable data between Jack Nicklaus and the participating TOUR Professionals. So this year it was determined that TrackMan™ should be involved to measure this information so that the crowd could see and understand what Jack and the others were speaking about. A 9' x 12' video board was placed on the range for the TrackMan™ data to be displayed for the spectators. Portions of the clinic were broadcast on the Golf Channel. The highlight of the Clinic was when Jack Nicklaus challenged TrackMan™ owner, Martin Kaymer, to hit his 7 iron 170 yards. Martin responded with a shot that carried 169.2 yards. TrackMan™ customer, Dustin Johnson, was also on hand to wow the crowd with drives that carried as much as 325 yards.

To see video highlights of the Memorial Clinic including TrackMan™ go to <http://www.trackman.dk/Media/Videos/Memorial.aspx>

US OPEN Champion Lucas Glover

ISG congratulates TrackMan™ customer and 2009 US OPEN champion Lucas Glover on an outstanding performance at Bethpage Black. Lucas was instrumental in the addition of TrackMan™ to his alma mater Clemson's golf program. With the addition of TrackMan™, Clemson joins an elite group of collegiate and national teams that use TrackMan™ as part of their player development programs.

Sea Island, where Lucas spends much of his time practicing and working with his instructor Mike Taylor, is also a valued TrackMan™ customer (Sea Island case story).

"TrackMan™ provides data helping me do my job. It reinforces and confirms what I am saying, enabling me to help players get better."
-Craig Allan, Golf Learning Center Manager at Sea Island.

Long Drivers of America

Long Drivers of America (LDA) announced that TrackMan™ will provide swing and ball flight data at the 2009 RE/MAX World Long Drive Championship. LDA chief executive officer Art Sellinger had the following to say, "To have TrackMan™ technology involved will not only enhance ESPN's telecast of the 2009 finals, it will provide spectators and competitors at Mesquite Regional Sports and Events Complex with immediate and meaningful data on competitors' swings and six-ball sets." The 2009 Championship will feature reigning World Champion Jamie Sadlowski, who last year broke the RE/MAX final's record with a drive of 418 yards. This year's event kicks off October 25 in Mesquite, NV, with the broadcast premier on ESPN December 20th.

Read the full press release at:
<http://trackman.dk/Media/News/remax.aspx>

Titans at the Tee Competition

TrackMan™ was recently used to capture data during the Titans at the Tee production at Foxwoods Casino in Connecticut. Titans at the Tee is a long drive competition in which a professional long drive competitor is teamed with a celebrity in a winner take all format. The long drive competitors included 3-time World Champion Sean "The Beast" Fister, 2008 European Long Drive Champion Brooks Baldwin and other top competitors in the world.

Some of history's greatest athletes such as Lawrence Taylor, Jim Rice, Bruce Jenner and others filled out the celebrity list competing at Foxwoods. The event will be televised nationally this September on Fox Sports.

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NEWS: Short Stories

PGA Fall Expo

On September 1, 2009, during the PGA Fall Expo, ISG's Matt Frelich will be on the show floor stage to present TrackMan™'s Optimal Club Delivery for All Golfers. The presentation is scheduled to start at 1:15PM.

For additional details, go to
www.pgaexpo.com/en/Conference/2009-Sessions/#optimal

Michigan Section PGA - Summit

In March 2009, the Michigan Section PGA held its first ever Teaching and Coaching Summit. Over 200 PGA Professionals attended the summit that included feature presentations from ISG's Matt Frelich, renowned instructor Jim Flick, TPI Instructor Corey Pu-year, and several of the Michigan Section's most successful teaching professionals. Frelich led off the summit with his presentation focused on TrackMan™'s new ball flight laws, practice and competition statistics for tour professionals, and driver optimization.

PGA Center Chooses TrackMan™

The PGA Center for Golf Learning and Performance (formerly the PGA Learning Center), in Port St. Lucie, Fla., has chosen TrackMan™ to support its player development and golf research initiatives. "We are excited about being able to offer TrackMan™ to PGA members and students alike, in order to enhance their golf instruction experience at the PGA Center for Golf Learning and Performance," said Joe Hallett, PGA General Manager. The partnership between the PGA and TrackMan™ will allow for great advancements in two key areas: 1) the development of educational programs for its more than 28,000 members and 2) a standard for benchmarking a player's skill level and improvement.

Read the full press release at:
<http://trackman.dk/Media/News/PGACenter.aspx>

2009 Under Armour College Golf Combine

The 2009 Under Armour College Golf Combines has announced that TrackMan™ will be the exclusive provider of swing and ball flight data at 6 nationwide events this year.

Read the full press release at:
<http://trackman.dk/Media/News/uagcc.aspx>

TaylorMade Center of Excellence

In late April, TaylorMade-Adidas Golf opened the TaylorMade Center of Excellence equipment fitting center based at Golf Club Herzogenaurach in Germany.

The TrackMan™ System plays an important role in this state-of-the-art equipment facility in which golfers of all skills can have their swings and equipment analyzed with the purpose of getting the best possible equipment fitting, tailored precisely to their individual swing.



TaylorMade Center of Excellence - Germany

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