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TRACKMAN CLUB DELIVERY MEASUREMENTS

RELEVANCE, DEFINITION, ACCURACY, VERIFICATION

TrackMan takes accuracy very seriously and aims to always provide the best product and information possible. TrackMan has spent many hours, resources, and dollars to make sure that the information our customers receive is precise. The following will give the reader some insight into the importance of accurate measurements and how TrackMan verifies the integrity of our data.

REQUEST FOR ACCURACY

TrackMan provides measurements such as Swing Plane and Swing Direction, which relate to a longer duration of the golf swing, but it is the data collected at impact that creates the greatest amount of questions. First, it is critical to understand impact. "The amount of time that the golf club and golf ball are in contact during a given shot is less than 1/2000th of a second. That is less than 0.0005 seconds. To help appreciate how short this is - grab a stopwatch. Generally, stopwatches only show two decimal places after the zero. Now, try to stop and start the clock as quickly as possible. Let's say you are fast enough to stop it in 0.06 seconds. That's still more than 100 times longer than the impact interval of a golf shot," explains TrackMan inventor, Fredrik Tuxen. Of course, such an understanding raises questions about the potential accuracy of measuring data that is so time sensitive. The potential accuracy and the need for limits on what accuracy is acceptable were discussed in the January 2009 TrackMan Newsletter.

The following tables come from the 2009 newsletter article which spoke about defining industry standards for accuracy and why accuracy matters.

| | |
|----------------|---|
| Actionable | Data accurate enough to make an objective recommendation that will have an impact on player's performance. |
| Marginal | Trained operator may be able to use judgement to make recommendation based on general trends. |
| Not Actionable | Data not accurate or consistent enough to make a reliable recommendation that will impact player's performance. |

Table 1. Definition of accuracy categories (From January 2009 Newsletter)

| Parameter | Actionable | Marginal | Not Actionable |
|--------------|------------|-------------|----------------|
| Club Speed | < 2 mph | 2-3 mph | > 3mph |
| Attack Angle | < 1 degree | 1-2 degrees | > 2 degrees |
| Club Path | < 1 degree | 1-2 degrees | > 2 degrees |
| Dynamic Loft | < 1 degree | 1-2 degrees | > 2 degrees |
| Face Angle | < 1 degree | 1-2 degrees | > 2 degrees |

Table 2. Accuracy requirements

"Because of club delivery's significant impact on ball flight, it is imperative to require accuracy of Club Path and Attack Angle to be within ± 1 degree with a 95% confidence" stated Tuxen. "What is meant by 95% confidence? That means that 95% of the time the measurement will be within the stated tolerance." Tuxen continued, "One degree of accuracy might seem a bit strict, but the Attack Angle changes approximately 1 degree during the extremely short time that the club face and golf ball are in contact. Achieving a ± 1 degree accuracy on these data points 95% of the time is extremely difficult. Especially when the player is allowed to hit the ball within a relatively large area, use any club, and have a variety of golf swing flaws or traits." In order to provide this level of accuracy in all situations, TrackMan introduced the TrackMan III system at the end of 2011.

The TrackMan III and IIIe systems have additional hardware, in order to guarantee the high level of accuracy for the club delivery measurements. "Incorrect data or inconsistent data lead to bad conclusions, which lead to bad information being given to the student. The trust between the student and teacher is a critical part of the learning process and is critical to the instructor's brand," concluded Tuxen.

DEFINITION OF CLUB DELIVERY DATA

Equally important as the accuracy discussion is a clear understanding of the definitions being used for club delivery measurements. At first glance, it may seem like a trivial discussion, but experience has shown this understanding is far from trivial. Many poor conclusions have been made simply due to a difference in the definition of what is really being measured. To help improve the understanding of club delivery data, the following definitions are provided.

| | |
|--------------|---|
| Attack Angle | The vertical direction of the club head's center of gravity movement, relative to flat ground level, at the point in time of maximum compression of the golf ball*. |
| Club Path | The horizontal direction of the club head's center of gravity movement, relative to the target line, at the point in time of maximum compression of the golf ball*. |
| Dynamic Loft | The vertical club face orientation at the impact point on the club face, relative to flat ground level, at the point in time of maximum compression of the golf ball**. |
| Face Angle | The horizontal club face orientation at the impact point on the club face, relative to the target line, at the point in time of maximum compression of the golf ball**. |

Table 3. Definition of club delivery measurements by TrackMan

* Due to changes in the direction of movement of the club head's center of gravity during the impact interval, TrackMan uses the time averaged value which relates closely to the value at maximum compression of the golf ball.

** Due to changes in the impact point and orientation of the club face during the impact interval, the calculated value by TrackMan will relate closely to the value at maximum compression of the golf ball.

It is very important to note that both Club Path and Attack Angle are defined relative to the center of gravity of the club head. This point of measurement is based on the simple fact that the golf ball's movement is a reaction to the club head's mass at the collision. TrackMan measures the movement of the geometric center of the club head and not directly the center of gravity of the club head. However, the difference between the location of the geometric center of a club head and the center of gravity is typically very small (less than 6mm).

Another common misconception regarding TrackMan definitions is the description of Face Angle. Face Angle is not the leading edge (score lines) of the golf club. Also, Face Angle is not the orientation at the center of the club face (unless impact happens at this point). On the contrary, Face Angle is the direction the club face is pointing at the point of impact on the club face at a moment in time near maximum compression of the golf ball.

VERIFICATION OF ACCURACY

Club delivery data is much more difficult to verify compared to other TrackMan data such as Carry and Side measurements. In the case of Carry and Side, a series of measurements including multiple spotters combined with professional survey equipment is generally sufficient in testing and verifying these measurements.

On the other hand, verifying measurements that happen in such an extremely short amount of time as the impact between a club

and a ball is much more complicated. As we discuss accuracy further, note that there are, in general, two types of accuracies: absolute accuracy and consistency.

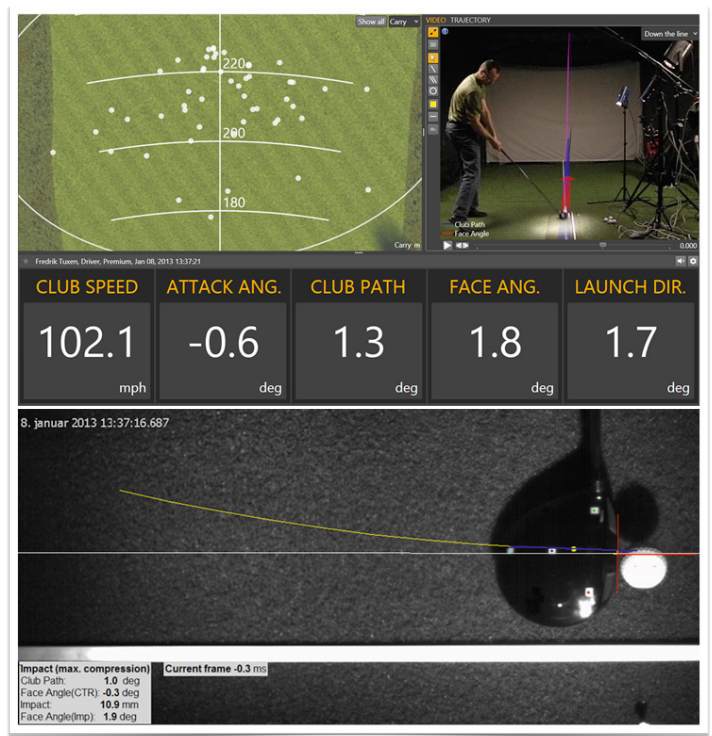
Absolute accuracy deals with comparing a measured value to the true measurement. For instance, if the real Club Path is zero, then how far away from zero is the measured value. Determining the "true measurement" is very difficult for club delivery data, but it definitely involves comparing to other technologies, such as high speed video tracking systems or similar.

Consistency means that if the same shot is repeated with the same club, setup, and everything else, then the measurements among multiple shots will be identical. Verifying consistency does not require testing against other technologies.

In golf, where it is important to know if a player has an "in-to-out" or "out-to-in" club path, it is not enough to have high consistency. You must also have high absolute accuracy.

TrackMan verifies its club delivery measurements in a number of ways. Among these are comparing the results with other trusted technologies (primarily multiple high speed video cameras), as well as collaborating with the R&A, equipment manufacturers, and research laboratories that possess the equipment and know-how to conduct such testing.

The following is an example of a shot simultaneously recorded by a TrackMan Ille, including swing video, and an external ultra-high speed video camera.



A driver shot from TM Ille captured with TPS (top); Ultra-high speed video processed by TrackMan's internal R&D system (bottom).

Notice that the Face Angle (CTR) listed on the ultra-high speed image has a value of -0.3 degrees. This value represents the physical center of the club face. However, when the Face Angle value is adjusted to represent the point of impact, which is 10.9 mm towards the toe, a value of +1.9 degrees is returned. As described above in the TrackMan club delivery definitions, the Face Angle reported by TrackMan is relative to the point of impact and not the center of the club face. By using an apple to apple comparison, you see that the TrackMan value of +1.8 degrees matches up extremely well with the ultra-high speed camera measurement of +1.9 degrees. If an incorrect conclusion was made about the Face Angle that TrackMan was reporting, someone may come to their own conclusion that the value is wrong because they would be comparing the value from the center of the club face (-0.3 degrees) versus TrackMan's value of +1.8 degrees. All of a sudden, this apple to orange comparison becomes a 2.1 degree discrepancy.

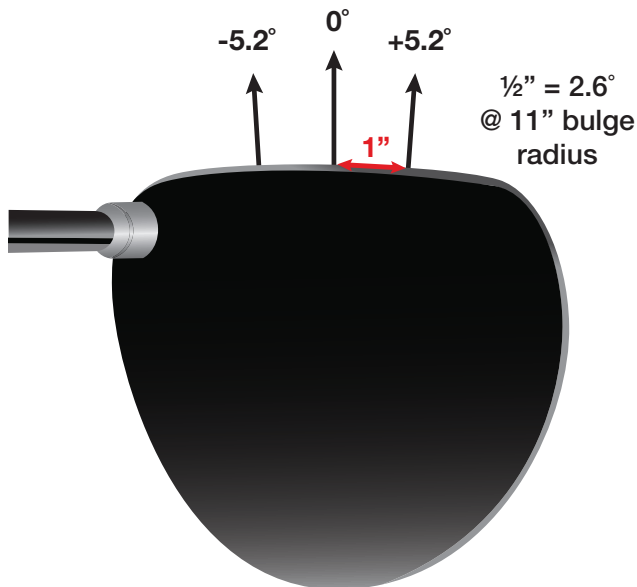


Figure 1. The above picture depicts how the Face Angle at different points on the club face can be dramatically different.

Also, consider the differences between using the center of gravity of the club head versus a point on the club face when reporting the Club Path value. In the above example, the ultra-high speed video returns a Club Path of +1.0 degrees. TrackMan returns a value of +1.3 degrees. Both of these values represent the movement of the center of gravity at impact. If the movement at a point on the club face was mistakenly chosen as the point of reference for the ultra-high speed video analysis, a Club Path value of -1.8 degrees would have been returned. Comparing -1.8 degrees versus +1.3 degrees would have led to a completely different conclusion about the perceived accuracy of the TrackMan measurement(s).

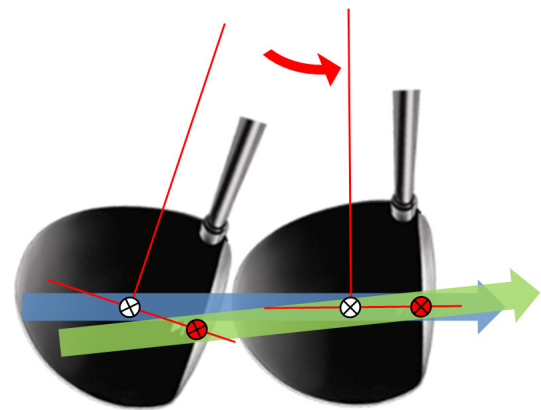


Figure 2. Notice that the center of gravity for the club head (white mark) is moving straight towards the target, while the club face (red mark) is moving out-to-in. This demonstrates how two points on the same object can be travelling in different directions.

Verifying the consistency of the data can be analyzed when shots are hit by an elite level player or a golf robot. The variation of a golf robot from swing to swing is very small. Therefore, it can be assumed that the data output from shot to shot (from a golf robot) should reflect little to no change in the club delivery measurements.

Alternatively, the consistency of the data can be done by having multiple TrackMan systems collect data on the same golf shot at the same time. Please note that this can only be performed with TrackMan III and IIIe systems. A TrackMan II radar can be negatively affected by another radar (all types) positioned directly next to it due to interference.

CHALLENGES WHEN DETERMINING CLUB DELIVERY

Generally speaking, making 3D club delivery measurements using high speed video is not an easy task. Even professionals find it quite challenging. Before you jump in to doing your own high speed camera recordings and try to extract club delivery measurements, here are some precautions:

- Without knowing (the precise) 3D position, orientation, and zoom of the camera relative to the measurement coordinate system, your measurement data will be flawed. A full 3D calibration is required for this, which includes accurate target line adjustment
- The cameras must be so-called 'global shutter' type, which means that all pixels are taken at the same point in time. Cheaper cameras have 'rolling shutter', which is not useful
- Even though it is possible, be very cautious on deriving any club measurements from a single camera. Club delivery is a three-dimensional movement and a camera image is a 2D projection of the 3D event. Consider, for example, the variation of face angle of a 6 iron at different lie angles while keeping the score lines (leading edge) constantly towards the target. From an overhead camera, the lie angle is almost impossible to determine, leading to errors in the face angle determination

- Camera lenses are not perfect, straight lines will not look straight in the captured images – in particular close to the edges of the images distortion is visible. Consequently, the camera(s) need to be lens-corrected. If you change the zoom of the camera, this will in general also change the distortion
- Using markers on the club head, a must to achieving a high level of accuracy, require the exact 3D position of each marker relative to a club head coordinate system to be known. In addition, the marker tracking algorithm needs to be able to precisely track the center of the markers
- Non-uniform light causes objects to appear differently in the images, creating issues for marker tracking
- Once the markers have been tracked, the markers are used to determine the club head 3D position and orientation on a frame by frame basis by matching a rigid model of the club head, which involves fairly complex 3D trigonometry
- Determining the exact time of impact is critical for accuracy of the club data parameters. This should typically involve sub-frame accuracy in the order of 1/5,000 second
- When using multiple cameras, each camera needs to be hardware synchronized so the images are captured at exactly the same point in time

TrackMan detects the club head from the microwave reflection that occurs from the club head. Since the reflection from a club head depends on the shape, material, and orientation of the club head, there are some critical factors when using radar technology for club delivery measurements:

- Variable club heads
- Variable swings (club speed, attack angle, club path, swing plane and/or swing direction)
- Various launch positions of the ball relative to the radar (both side and forward/backwards)

TrackMan has spent a lot of time and effort in making TrackMan club delivery measurements robust for the above variables. The TrackMan III and IIIe has additional, unique hardware added specifically for producing even more robust and accurate club delivery measurements.

ACCURACY OF TRACKMAN

Having carried out multiple tests as described above, TrackMan has determined the accuracy of the club delivery to be as below for TrackMan III and IIIe. Note: the accuracies are at 95% confidence intervals, which are twice as high as compared to the standard deviation (67% confidence interval).

| Parameter | Absolute Accuracy (95% confidence) | Repeatability (95% confidence) |
|----------------|------------------------------------|--------------------------------|
| Club Speed | ±1.5 mph | ±0.4 mph |
| Attack Angle* | ±1.0 degrees | ±0.6 degrees |
| Club Path* | ±1.0 degrees | ±0.6 degrees |
| Dynamic Loft** | ±0.8 degrees | ±0.6 degrees |
| Face Angle** | ±0.6 degrees | ±0.5 degrees |

Table 4. Accuracy of TrackMan III and IIIe.

*The Attack Angle and Club Path assumes that the center of gravity is not located more than 10 mm away from the geometric center of the club head.

**Both the Dynamic Loft and Face Angle refers to the impact location on the club face and assumes that ball impact occurs entirely on the club face. The listed accuracy assumes that the club direction (club speed, attack angle, and club path), ball direction (ball speed, launch angle, and launch direction), and spin rate of the ball are all measured.

NEW TRACKMAN RESEARCH – BALL FLIGHT CURVATURE

D-PLANE, OFF CENTER IMPACT, CLUB FACE ROTATION

Since the introduction of club delivery measurements by TrackMan, significant research has been completed to understand the connection between club delivery and the resulting ball flight.

Because of TrackMan's measurement of the entire ball flight and club delivery, TrackMan has been used intensively to understand what is causing a given ball flight. TrackMan has, from its own research, pioneered this deeper-level understanding in many ways.

In particular, understanding what causes the ball to curve in the air has been a key point of interest for golf instructors and players.

Ball flight curvature is directly related to the orientation of the spin axis. A positive spin axis will curve the ball to the right, while a negative spin axis will curve the ball left. As a rule of thumb, a spin axis of 10° will curve the ball 7% to the side relative to the initial starting direction and based on the Carry distance. For example, a 200 yard carry with a 0.0° launch direction and a +10° spin axis will curve 14 yards to the right of the target line.

When used outdoors, TrackMan makes no assumption on how the spin axis is generated from the club delivery. The ball data, including spin axis, is measured completely independent of the club delivery data.

TrackMan has analyzed hundreds of thousands of shots with full ball flight measurements and club delivery data to determine the relationship and explanations between spin axis and club delivery. We have found, to a very high degree, this relationship can be explained by two things: D-Plane and off-center impact.

D-PLANE

The primary source of generating the spin axis is explained by the D-Plane. Because of the oblique impact between the club face and the ball, the ball will start rolling up the club face, hereby creating a spin axis 90 degrees to the D-Plane. If there is any difference between the club path and the face angle, the D-Plane is tilted and consequently, spin axis is tilted.

Note it requires friction between the club and the ball before the ball will spin and thereby establish a spin axis.

OFF CENTER IMPACT (HORIZONTAL GEAR EFFECT)

If the ball is impacted anywhere but in front of the center of gravity of the club head, the club head will rotate during impact. The counter action of the ball is to rotate the other way – like a gear. This added component of spin will add to (or subtract from) the D-Plane spin axis, tilting the spin axis away from 90 degrees relative to the D-Plane.

Again, it requires friction between the club and the ball for the gear effect to happen. If no friction, there is no 'gear'.

CLUB FACE ROTATION (GEAR EFFECT)

However, in the search for explaining every degree of spin axis, we have more recently found that D-Plane and horizontal impact location is not always enough to fully explain the resulting spin axis tilt (and as a result the ball flight curvature).

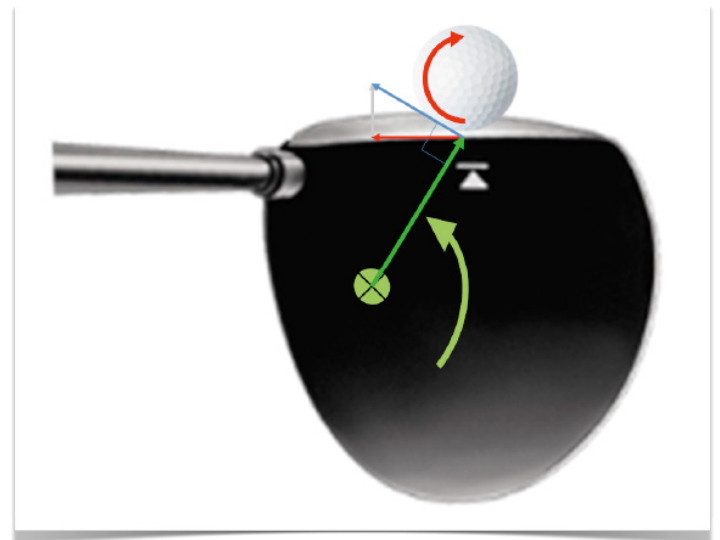


Figure 1. A club face rotation around an axis located behind the club face will create a rotation in the opposite direction (gear effect) of the ball due to friction between club and ball.

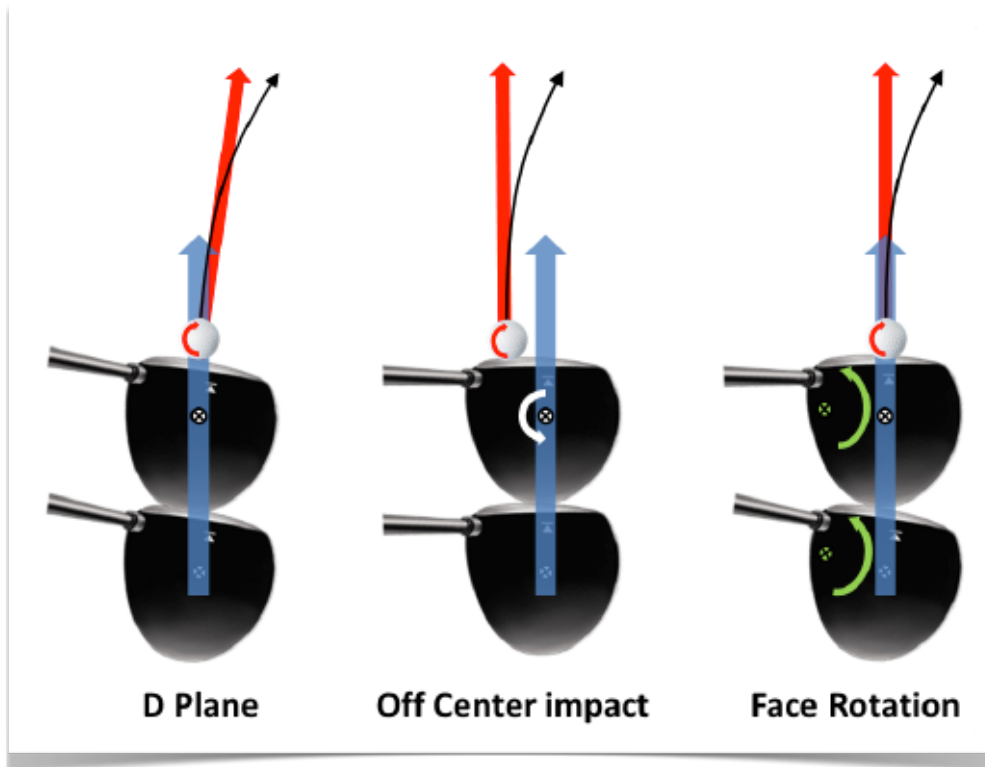


Figure 2. Three different fade components: an open (positive) face to path, a heel impact creating gear effect, and a face rotation (closure rate) creating a slight positive tilt of the Spin Axis.

The first step in this analysis was to double check the accuracy of TrackMan measurements. The common reaction for any human is to question things that do not make sense. When the TrackMan numbers do not match the user's expectations (or explanation for ball flight curvature), the data is assumed to be incorrect. However, the TrackMan data has been rechecked and verified to be accurate.

While we are not talking about big differences in spin axis that fail explanation, sometimes as much as 6 degrees of spin axis tilt cannot be explained from the D-Plane and off center impact alone. Deeper research has shown the shortcoming in accounting for the spin axis generally resulted in a fade ball flight. Interestingly, the missing element seems to be correlated with swing style, or more precisely, how fast the club face is rotating through impact - correlated with the player, not the club!

What we are finding is a rotating club face through impact can create the counter action of the ball to rotate the other way – like

a gear – exactly as explained above for off center impact. So it seems highly plausible that club face rotation can have an effect on spin axis. Important for quantifying the effect of the rotating club face through impact is to determine the location of the axis of rotation for the club face. Initial analysis shows that the rotation typically happens around an axis located behind the club face, with the net effect that the ball will have a fade component added to its spin axis.

This means that there are three components that have to be considered when trying to explain ball curvature: 1) The face to path relationship (D-Plane), 2) Off center impact, and 3) club face rotation rate through impact.

TrackMan's future research hopes to quantify the significance of club face rotation on the spin axis, to see if club face rotation (closure rate) together with D-Plane and off center impact can fully explain the spin axis.

2013 TRACKMAN PRODUCTS AND SERVICES

ALL NEW INCLUDING IIIe, TPS V2.3, AND MYTRACKMAN

TRACKMAN BEGINS 2013 WITH AN EXCITING AND ALL NEW PRODUCT LINEUP!

TrackMan Pro has taken an exciting leap forward for 2013. Building on the accomplishment of our TrackMan III hardware (introduced in late 2011), we have integrated a powerful embedded computer and now deliver full wireless functionality in the TrackMan Pro system. The new system is TrackMan IIIe and the first units were delivered to customers throughout the world in early December 2012.

TRACKMAN IIIe WITH IPHONE/IPAD APP

As mentioned above, TrackMan IIIe's wireless capability allows for full functionality of all the features our customers have grown to love in previous TrackMan hardware versions. These wireless features include:

- Using the integrated camera to select the target (patented process) wirelessly through an iPhone, iPad, or computer
- Capturing and transmitting swing and ball flight data wirelessly to an iPhone, iPad, or computer
- Recording and transferring high speed video from the internal camera wirelessly to an iPad or computer
- Uploading reports, data, and videos directly to mytrackman.com from the computer being used during the session

TrackMan IIIe also features an embedded battery, providing +5 hours of TrackMan operation on a single charge. Recharge the battery from empty to full in a quick two hours!

With dimensions of a standard laptop (12 inches X 12 inches X 2 inches thick) and weighing under 8 pounds including the built in battery, TrackMan IIIe takes portability to an unprecedented level. The IIIe radar and an iPad fit into TrackMan IIIe's neoprene carrying case, allowing anyone to transport a complete TrackMan Pro system with display unit (iPad) using only a single finger. Set up time (to hitting first shot), including auto leveling, target selection, and customer/club data entry, remains less than 2 minutes.



Hold the camera on your iPhone (with a free-to-download QR code reader) over this code to download the app.



Furthering the tradition of TrackMan's ease of use and system reliability, TrackMan IIIe also continues to raise the bar for industry standard accuracy across all club delivery, launch, and ball flight measurements – from 6 foot chip shots to 400 yard drives.

The TrackMan IIIe (along with the III model) has been improved to allow for improved accuracy and consistency along all data points. Additional hardware was added to allow the tracking of short chip shots and refine all ball flight and club delivery measurements. Also, the IIIe has an improved camera and lens for better images of the target selection and high speed video of the golf swing.

TRACKMAN PERFORMANCE STUDIO

The TrackMan Performance Studio (TPS) software has been upgraded with significant feature improvements for 2013. Released in late December 2012, TPS v2.3 adds HD Screenshot and one-touch auto-uploading for screenshots, videos, and data to mytrackman.com. Other existing TPS features include:

- A flexible UI (graphics and data layout are customizable)
- 3-D graphics overlay and spatially coherent video
- Multi-camera recording to the TPS Video Analysis software
- Merging TrackMan data and video together on the same screen/file
- Intelligent ellipses for comparing shot groups.
- TrackMan Combine benchmarking and analysis tool
- Support for wireless connection to TrackMan IIIe



The HD Screencast feature gives industry professionals the ability to easily record audio and video of their screen to produce internet lessons, presentations, and marketing/corporate event videos. The screencast videos can be saved to a file and/or automatically uploaded to mytrackman.com. When screencasts are uploaded, mytrackman.com immediately formats the video to optimize viewing on different devices (phone, tablet or laptop) and automatically sends an email to clients including a link for easy viewing.



TPS's cloud icon engages the auto-upload/auto-share feature with mytrackman.com. Now, students, instructors, coaches, and industry professionals can instantly share any data, videos, or screencasts with the touch of a button. For example, a traveling junior can use the TPS software to capture some swings, one-click upload the data and video to mytrackman.com for his instructor to import into TPS.

The instructor can then review the swings and data and create an HD Screencast that can be sent to the junior player to review from any internet ready device (phone, tablet, computer, etc). Another example is industry professionals can easily upload all client data to the cloud, for easy review and retrieval – no more worries about losing all your model swings and client data!

More new and exciting features to the TrackMan Performance Studio software and mytrackman.com are scheduled for release in May 2013. Stay tuned!

BIG CHANGES TO MYTRACKMAN.COM AND TRACKMAN PERFORMANCE STUDIO

MyTrackMan.com is your hub for all things TrackMan. Major changes and improvements were made to the MyTrackMan website in 2012. One of the most beneficial changes was building it on a responsive layout platform which allows the website and its contents to be viewed on any device whether it is a laptop, phone, or tablet. This functionality makes it easy for you or your students to view reports, lessons, combine results, and more from any internet ready device.

Another milestone improvement was integrating TrackMan Performance Studio (TPS) features with MyTrackMan (MTM). Using the 'Share' features built into the TPS software, the coach/instructor/fitter can easily share PDF reports and video recaps via

the HD Screencast feature released in TPS v2.3. Once the report or screencast is uploaded to MTM, the student/customer will automatically receive an email letting them know it is available. The student/customer can login to their free mytrackman.com account to view what they have received as well as any accompanying messages. These items are permanently stored in the user's MTM account where they can reply with a message to the sender, forward to someone else, or keep so that they can review the information at any time in the future. Beyond storing reports, data, and videos, MyTrackMan is also where you can find new content and information from TrackMan.

OVERVIEW OF SELECTED MYTRACKMAN.COM AND TPS FEATURES



HD SCREENCASTS

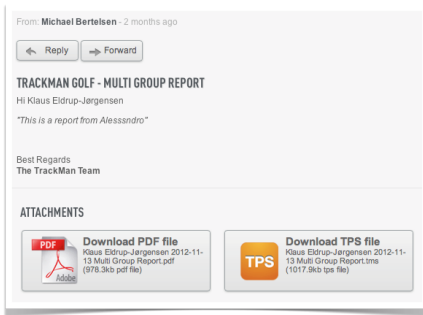
HD SCREENCASTS

Create an HD Screencast with voiceover for your customers. Use the record button at the top, middle of the TPS software to start. You can pause and restart the screencast at any time allowing you to record during a lesson. You can also Alt+Tab to include information from other programs or documents. Once completed, click Share and the HD Screencast will be uploaded to your customer's MyTrackMan account.



TRACKMAN COMBINE

Watch TrackMan Combine videos, view TrackMan Combine leaderboards, and download TrackMan Combine results on mytrackman.com. See which Tour Professionals are posting the highest scores or compare your results to your own peer group using the live leaderboards. You can also download the PDF reports of TrackMan Combine leaders to see how they achieved their score.



MTM MESSAGE BOARD

Communicate with your students through the MyTrackMan Message Board. The coach or student can reply to a message or forward their report and data to another MyTrackMan user. All reports, data, and videos are permanently stored in the MyTrackMan account and can be viewed at any time from any internet ready device. The storing of this information allows coaches to keep a backup of all their data in the cloud in case something were to happen to his or her computer.



SHARE TO MTM

Use the Share button in the TrackMan Performance Studio software to create a Single Shot, Single Group, Multi Group, or Compare Report. Include data along with video within the PDF report. Add a specialized message for your student to review and automatically upload the information to the student's MyTrackMan account. Create a backup of all data and videos by using the Share feature.



TRACKMAN LOCATOR

Make sure your business can be found on the TrackMan Locator. The locator allows golfers interested in using TrackMan technology to find coaches, instructors, and club fitters in their area. The golfer can see a brief description of the business, contact information, and a link to your website on the TrackMan Locator. TrackMan University certified instructors receive priority ranking on the facility list based on his or her certification level.



TRACKMAN UNIVERSITY

View eLearning Tools, see information from our certified TrackMan Masters, and take a free TrackMan University test at mytrackman.com. Want to learn more about TrackMan University? Check back frequently to the Event Calendar to find a TMU Workshop in your area. Or...interested in hosting a TMU Workshop? Contact your local representative for more information.



TRACKMAN VIDEOS

Watch tutorial, golf instruction, and Tour Pro videos at mytrackman.com. You can also visit our Vimeo website at www.vimeo.com/trackman for a full list of content. These videos can be linked and embedded into your website to help promote TrackMan at your location.

All of these features and more are available through the new mytrackman.com website and TrackMan Performance Studio v2.3. And best of all - it is free!

TRACKMAN COMBINE

TOTAL SCORE ANALYSIS

The TrackMan Combine continues to gain momentum as an accurate way to benchmark ball striking ability and assess potential. As more and more golfers of all levels have taken the TrackMan Combine, we are able to look at the results and make a further analysis of the TrackMan Combine Total Score.

The current highest score on the TrackMan Combine comes from European PGA Tour Rookie, Chris Paisley. Just over a month prior to receiving his own TrackMan he posted a score of 90.4 during November 2012.

“ I love the TrackMan Combine because it is as close as you can get to emulating the pressure you feel in a tournament.”

– Chris Paisley, TrackMan owner

“ I like using the TrackMan Combine because it keeps my practice competitive and gives instant feedback.”

– Jason Dufner, TrackMan owner

Earlier the same month, former Ryder Cup member, Edoardo Molinari was the first person to break the 90 point barrier with a score of 90.1.



“ I really like taking the TrackMan Combine as it is a really helpful way for maintaining an intense focus while you practice.”

– Edoardo Molinari, TrackMan owner

How do LPGA players fare at the TrackMan Combine? Well, the average score for the ladies is 80.2 with a standard deviation of 4.1. As written about in a previous article on the TrackMan Combine, the highest female score is still Sun Young Yoo with an 88.6. Note that females are scored the same as males which includes a Driver score based on accuracy but also distance. It is no surprise that Yoo won the LPGA Sybase Match Play event less than two weeks after achieving this score.

We've seen a lot of competitive spirit come out of taking the TrackMan Combine. Whether it was Ian Poulter taking a jab at Luke Donald on Twitter about beating his TrackMan Combine score or three time European Tour winner, Soren Kjeldsen, telling our CEO that he was out on the last day of October trying to beat his own score of 89.8 so that he could make sure he was the top player that month and take over the overall lead.

“ I'm not the longest guy out there, but where I can make up some ground is with my distance control and wedges. The TrackMan Combine provides a great practice session for me that makes me focus on every shot”

– Soren Kjeldsen, European PGA Tour

The following table shows a list of the last six months and the top score for each month.

| Month | Name | Score | Bio |
|-----------|-----------------|-------|-------------------------|
| July | Alexander Noren | 89.8 | European PGA Tour |
| August | Michael Smith | 88.4 | Played in 2011 US Open |
| September | Stephen Behr | 86.4 | 28th NCAA Men's |
| October | Soren Kjeldsen | 89.8 | European PGA Tour |
| November | Chris Paisley | 90.4 | European PGA Tour |
| December | Ignacio Elvira | 88.2 | European Challenge Tour |

Stephen Behr, a young unknown, took the top spot during September with a score of 86.4. Well, you may know him better in a couple years because he is currently a redshirt freshman at Clemson University. With a 4th, 7th, and 26th place finish in his first and only three starts of his first semester of collegiate golf, Behr has climbed to 28th in the Golfweek/Sagarin Rankings. We asked the Associate Head Coach, Jordan Byrd, his take on the TrackMan Combine.

"I think the TrackMan Combine will become a big part of the college recruiting process. It is a great way to measure the golfer's potential. I see it in my own players. We see a very strong correlation between how well they are playing and their TrackMan Combine scores. We have had several players who have scored in the mid to high 80's and then went on to finish in the top 10 of a collegiate event the next week."

We all cannot be Tour Pros, so what about the rest of us? The TrackMan Combine has proven to be a very strong assessment of any golfer's ability. When a golfer takes the TrackMan Combine, information about their gender, handicap, player category, date of birth, and nationality are collected and stored in the database. From this information along with the golfer's scores, club delivery data, and ball flight data, we will be able to create a full analysis of a golfer's ability. It also allows the golfer to receive the comparative feedback they need in order to assess their strengths and weaknesses.

“ *What the TrackMan Combine allows you to do is have actual targets involved, distances that you are trying to hit, and the ability to score it. What does that sound like? It sounds like real golf.* ”

– Kevin Strelman, PGA TOUR

First, let us look at scores by player category. The results have been classified into the following groups.

- Tour Professional – professionals playing on the top tours all around the world
- Developmental Tour – members of the next level tours such as Web.com and Futures
- Mini Tour – remaining golfers that play professionally
- Collegiate Golfer – collegiate golfers as well as national team members (top level amateurs)
- AJGA – junior golfers playing in top tier tournaments
- Amateur – golfers with amateur status not belonging to an above group

Male Golfers

| Player Category | Average Score |
|--------------------|---------------|
| Tour Professional | 82.9 |
| Developmental Tour | 80.6 |
| Mini Tour | 77.8 |
| Collegiate Golfer | 75.2 |
| AJGA | 68.1 |
| Amateur | 63.9 |

Female Golfers

| Player Category | Average Score |
|--------------------|---------------|
| Tour Professional | 77.5 |
| Developmental Tour | 74.3 |
| Mini Tour | 72.3 |
| Collegiate Golfer | 69.3 |
| AJGA | 65.3 |
| Amateur | 53.9 |

It should be noted when looking at these averages and the averages listed in the tables below that all submitted results are included in the calculations regardless of wind, rain, or temperature. Wind, rain, and temperature have an effect on a golfer's ability to score well on the TrackMan Combine just like they have an effect on a normal round of golf. If tests taken under harsh conditions are removed, then on average you will see the scores go up by about 2-4 points.

When looking at the two tables you will notice that the female golfers score consistently less than the male golfers. Again, both groups take the same test with the same scoring system. It is tough for females to carry the ball 180 yards and it is very unlikely that they can drive as far as male golfers. TrackMan has seen from measuring drives during PGA and LPGA events that the highest club speeds on the LPGA Tour are the lowest club speeds on the PGA TOUR. However, this consistency in scoring was purposefully done when TrackMan Combine was created. TrackMan wanted a universal scoring system to help analyze a golfer's ability and/or potential. Gender based scores can always be filtered to look at peer specific comparisons such as the above tables.

Now let us break the Amateur category down by handicap. Again, the TrackMan Combine shows a very high correlation between skill level and score. The groupings of the handicaps were chosen based on how amateur golfers see themselves: a scratch golfer, average golfer, bogey golfer, etc. These qualitative terms that are used so frequently in golf were the basis of the following table. Keep in mind that all golfers used for the following analysis were listed as amateur golfers.

| Male Golfers | |
|-----------------------|----------------------|
| <i>Handicap Group</i> | <i>Average Score</i> |
| +5 to 0 | 74.4 |
| 1 to 4 | 69.6 |
| 5 to 9 | 63.4 |
| 10 to 12 | 57.9 |
| 13 to 16 | 54.2 |
| 17 to 20 | 49.7 |
| 20+ | 45.1 |

| Women Golfers | |
|-----------------------|----------------------|
| <i>Handicap Group</i> | <i>Average Score</i> |
| +5 to 0 | 67.7 |
| 1 to 4 | 62.6 |
| 5 to 9 | 55.5 |
| 10 to 12 | 46.7 |
| 13 to 16 | 44.2 |
| 17 to 20 | 41.2 |
| 20+ | 29.7 |

These two tables in conjunction with the two player category tables above start to paint a very interesting picture of how skill level, handicap, and ball striking are linked. It is quite evident that TrackMan Combine scores can be used to analyze and assess a golfer's ability. If you would like to take a TrackMan Combine, find a TrackMan near you using the TrackMan Locator at www.mytrackman.com.

2012 TRACKMAN COMBINE TOP RESULT

EUROPEAN TOUR ROOKIE, CHRIS PAISLEY

European Tour Rookie, Chris Paisley, submitted the highest TrackMan Combine score in 2012. With a total score of 90.4 (out of 100), Paisley beat other Tour Professionals such as Edoardo Molinari, Soren Kjeldsen, Justin Rose, and more. To see a list of TrackMan Combine leaders and their individual results visit www.mytrackman.com. Also, click on 'Full Leaderboard' located at the bottom of the Combine Leaderboard widget to see the top 50 leaders and filters that allow the user to look at results from his or her peer group.



Coach Jim Kelson with player

Paisley is originally from Newcastle, England and was recruited to play collegiate golf at the University of Tennessee by Coach Jim Kelson. Coach Kelson started working with TrackMan back in 2006, making Tennessee one of the first universities to add TrackMan to their golf program. When Coach Kelson was asked about Paisley as a junior player Kelson responded, "He wasn't super highly recruited as a junior player. I had recruited his brother, Andrew, when I first got the job at UT so I knew he came from good stock and he was known to be a very accurate player. At the time, Chris's

overall strength and length were a concern, but he worked hard on improving those things during his time at Tennessee." Paisley's average club speed during the TrackMan Combine was 108 mph and his average total distance was 281 yards. Although these numbers are a little below the PGA TOUR average of 113 mph and 289 yards, Paisley made up for it with his accuracy. With an absolute average offline of only 19.6 feet, Paisley still managed to score an 85.5 on the driver portion of the TrackMan Combine.

| Shot | Club Speed (mph) | Distance (yds) | Side (ft) |
|------|------------------|----------------|-----------|
| 1 | 109.1 | 287 | 14,4L |
| 2 | 108,4 | 284 | 28,5R |
| 3 | 109,0 | 274 | 9,1R |
| 4 | 107,5 | 278 | 62,6L |
| 5 | 108,5 | 283 | 2,8L |
| 6 | 108,2 | 278 | 21,0R |

When Kelson was asked about Paisley's time at Tennessee Coach noted, "Chris was a very solid player during his career at UT. He was instrumental in helping us capture the SEC Championship in 2007. He won two individual events, the Bank of Tennessee Intercollegiate during the 2007-08 season, and the Arizona Invitational during the 2008-09 season. He was also selected as an honorable mention All-American in 2009." So when Kelson was asked about Paisley's chances to make the European Tour the coach quickly said, "I would have given Chris very good odds on becoming a successful Tour player. His game is solid in all areas. He is also very bright and a hard worker. Perhaps most importantly is he performs well under pressure."

Paisley commented about the pressure he felt during his final shots, "I felt a bit of pressure because I knew I was on for a pretty good score, but I didn't realise that I was about to break the record! I thought the 140 yard target had messed it up for me! It goes to show you that no matter how well you perform, there is always room for improvement." Paisley went on to say, "I love the TrackMan Combine because it is as close as you can get to emulating the pressure you feel in a tournament. Every shot counts so you need to focus the whole time, and if you hit a bad shot you need to mentally recover from it rather than shrug it off as you do when shelling balls. The main benefits for me are that it highlights areas I need to improve and sharpens my game up as I'm gearing up for a tournament. The sheer depth of feedback it gives you is invaluable, especially when you share it with your coach."

COMBINE LEADERBOARD

| EVER | YEAR | MONTH | |
|------|------|------------------|------|
| 1 | UK | CHRIS PAISLEY | 90.4 |
| 2 | IT | EDOARDO MOLINARI | 90.1 |
| 3 | DK | SOREN KJELDSEN | 89.8 |
| 3 | SE | ALEX NOREN | 89.8 |
| 5 | UK | DAVID HORSEY | 89.3 |
| 6 | US | CORBIN MILLS | 89.0 |
| 7 | FR | BENJAMIN HEBERT | 88.8 |
| 7 | FR | KENNY SUBREGIS | 88.8 |
| 7 | UK | JUSTIN ROSE | 88.8 |

11/26/2012 Chris Paisley
COMBINE TEST
TRACKMAN

TEST INFO

Date: 11/26/2012
 Name: Chris Paisley
 DOB: 3/24/1985
 Hcp: 0
 Mode: Outdoor
 Location: Knoxville
 Temp: 50 °F
 Wind: 0-5 mph switching
 Notes:

TOTAL SCORE

90.3

hp 18 16 14 12 10 8 6 4 2 0

Driver Statistics (avg.)

| | |
|--------------|----------|
| Club Speed | 108 mph |
| Ball Speed | 161 mph |
| Attack Angle | -3 deg |
| Launch Angle | 10 deg |
| Spin Rate | 3958 rpm |

See www.MyTrackMan.com for more statistics

| Target | Score | From Pin in ft | Avg. | Shot 1 | Shot 2 | Shot 3 | Shot 4 | Shot 5 | Shot 6 |
|--------|-------|----------------|------|--------|--------|--------|--------|--------|--------|
| 60 | 92.1 | From Pin in ft | 5.3 | 4.2 | 1.3 | 1.7 | 11.4 | 7.6 | 5.2 |
| 70 | 91.1 | From Pin in ft | 6.5 | 3.3 | 5.0 | 4.9 | 1.5 | 13.3 | 11.4 |
| 80 | 86.1 | From Pin in ft | 10.5 | 10.3 | 9.9 | 17.6 | 11.0 | 5.9 | 8.5 |
| 90 | 94.1 | From Pin in ft | 6.3 | 1.4 | 6.2 | 7.3 | 0.9 | 13.2 | 8.5 |
| 100 | 94.1 | From Pin in ft | 7.4 | 6.1 | 8.7 | 9.3 | 9.6 | 5.6 | 5.3 |
| 120 | 94.1 | From Pin in ft | 8.5 | 13.7 | 5.3 | 8.2 | 2.5 | 15.8 | 5.6 |
| 140 | 80.1 | From Pin in ft | 24.2 | 18.1 | 25.7 | 23.7 | 24.8 | 26.0 | 26.8 |
| 160 | 93.1 | From Pin in ft | 13.8 | 9.5 | 8.2 | 5.3 | 15.1 | 17.7 | 26.9 |
| 180 | 90.5 | From Pin in ft | 18.4 | 22.8 | 29.2 | 11.9 | 25.8 | 5.5 | 14.9 |
| Drive | 85.5 | Total in yds | 281 | 287 | 284 | 274 | 278 | 283 | 278 |
| | | Side in ft | 3.5L | 14.4L | 28.5R | 9.1R | 62.6L | 2.8L | 21.0R |

1 | TrackMan™
www.trackman.dk

Paisley recently purchased his own TrackMan Pro IIIe system so that he can practice with it at any time and travel with it to tournaments. You can follow him as he completes his first full year on the European Tour in 2013. We wish Chris and the rest of the TrackMan Tour Professionals great success. For a list of TrackMan Tour Professionals, you can visit the customers section at www.trackmangolf.com

Chris Paisley @ChrisPaisley86
 Just finished up my first practice session whit the @TrackManGolf surpassed my expectations.

Twitter

As the TrackMan Combine looks forward to 2013, we will leave you with a comment made by the only other person to have broken 90 points on their total score, Edoardo Molinari. When Molinari was told about Paisley's accomplishment he responded, "Wow! That's good but I am confident that soon I'll post a higher score again. I think that 92 is achievable, anything more than that will be insane!"

Challenge accepted?! To find a location to take the TrackMan Combine, visit the TrackMan Locator found at www.mytrackman.com

OWNED BY MORE THAN 80 TOUR PROS



Jason Dufner, TrackMan owner



Dustin Johnson, TrackMan owner



Rory McIlroy, TrackMan owner



Ian Poulter, TrackMan owner



Justin Rose, TrackMan owner

| | | |
|-----------------------|--------------------|------------------------|
| Blake Adams | Søren Hansen | Kenny Perry |
| Fredrik Andersson Hed | Peter Hanson | Panuphol Pittayarat |
| Jason Allred | Mark Hoffman | Ian Poulter |
| Markus Brier | J.B. Holmes | Michael Putnam |
| Danah Bordner | David Horsey | Jeff Quinney |
| James Byrne | Charles Howell III | Robert Rock |
| Paul Casey | David Howell | Alexandre Rocha |
| Darren Clarke | Mikko Ilonen | Justin Rose |
| Will Claxton | Ryuji Imada | Brett Rumford |
| Ben Curtis | Tongchai Jaidee | Lizette Salas |
| Daniel Chopra | Dustin Johnson | Jarmo Sandelin |
| Ben Crane | Martin Kaymer | Marcel Siem |
| Robert-Jan Derksen | Simon Khan | Sujjan Singh |
| Stephen Dodd | Søren Kjeldsen | Karin Sjödin |
| Jason Dufner | Seon Hwa Lee | Bob Tway |
| Meredith Duncan | Doug Labelle | Heath Slocum |
| Rafa Echenique | Steve Lowery | Kang Tae Suk |
| Johan Edfors | Rory McIlroy | Kevin Streelman |
| Niclas Fasth | Graeme McDowell | Mariajo Uribe |
| Brad Faxon | Paul McGinley | Grant Waite |
| Richard Finch | Edoardo Molinari | Marc Warren |
| Sean Fister | Francesco Molinari | Mike Weir |
| Marcus Fraser | James Morrison | Michelle Wie |
| Lucas Glover | Kevin Na | Martin Wiegele |
| Julieta Granada | Christian Nilsson | Bernd Weisberger |
| Peter Gustafsson | Alex Noren | Charlie Wi |
| Jason Gore | Chris Paisley | Mark Wilson |
| Jonathan Grover | Brenden Pappas | <i>(Selected list)</i> |
| Anders Hansen | John Parry | |