

# THE 14 CLUB PERFORMANCE NUMBERS FOR GAME IMPROVEMENT



**Mitchell**<sup>®</sup>  
GOLF EQUIPMENT INSTITUTE

## Proem

The historical role of the American golf professional has come full circle back to the days of the developers of the game in America. Today offers a new opportunity for golf professionals to provide a service that golfers want. Golfers want to improve their game so they enjoy their golf more. They look to golf professionals to be complete equipment experts.

That means as expert golf instructors and club fitters, golf professionals have the opportunity to become club performance experts too. This single element of expertise will again make the golf professional's role a complete equipment expert just like those who served the game for centuries from it's beginning.

This new opportunity can be defined this way: Every lesson is a potential club performance alteration opportunity and every club fitting is a potential club performance alteration opportunity for all industry professionals; on course, off-course and practice ranges.

## **THE 14 CLUB PERFORMANCE NUMBERS**

# **MANUAL**

Written as a guide to show how club performance impacts golfers' ability to learn,  
to play and to enjoy the game of golf.

### **The Game Improvement Equation**

*Golf Instruction + Club Performance = Game Improvement*

## Preface

This manual is designed to offer new insight to golf instructors whose training has been to teach ball flight results solely through swing alterations. Such alterations “fix” certain swing characteristics for the moment as witnessed by ball flight, but does the “fix” last when the golfer goes to the golf course? Was the swing “fix” a compensating move for ill-fitting equipment?

Today’s technology of club evaluation and launch monitor data clearly suggests golf equipment performance contributes to ball flight. Therefore, when golf instructors use swing techniques to alter ball flight they are only employing one half of the equation for game improvement.

The simple equation; golf instruction + club performance = game improvement (ball flight) should be part of all golf instruction programs.

Golf instructors can use this manual as a guide for adding club performance evaluation to their lesson program and learn how to incorporate *The 14 Club Performance Numbers* into club performance alterations.

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## Forward

It is generally recognized that golf's early development came from the efforts of Scottish Golf Professionals. They routed holes for golf courses, hand-made golf clubs, taught people how to play and evaluated club performance to get those interested in the game to enjoy it to its fullest. Basically golf professionals did it all.

As the game increased in popularity throughout America, equipment quickly became commercialized by large manufacturing companies. American golf professionals quickly evolved into and were content to accept the duties of "instructor" as their primary role. The PGA of America even adopted a membership classification of "Instructor".

Herb Graffis stated in his historical book entitled *THE PGA*, that experienced professionals must go back to the method successfully employed by the founding professionals in America. They must have skills, knowledge and equipment to measure golf club specifications and make alterations if necessary to assist the pupil's playing ability when it is obvious that it is not just swing problems. He had great foresight. Custom fitted clubs became very popular 25 years after he published his book.

But make no mistake, club fitting using manufacturers' fitting carts is not what Herb Graffis had in mind. Golf professionals need to do more than rely on the fitting cart methods. They should be able to evaluate *The 14 Club Performance Numbers* of each of their students' clubs and make alterations when appropriate if they want their students to improve fully.

Golfers' want their golf professional to be a great instructor and equipment expert. But professionals must bring both instruction and club performance into the ball flight equation if they are to produce real game improvement for their students.

### **Ed Mitchell, PGA**

*Founder*

Mitchell® Golf Equipment Institute



# Part 1 - Introduction

## Purpose

This manual re-introduces golf professionals to the history of The PGA and their role to golf equipment as it relates to golf instruction, the foundation of which was established by their predecessors, the Scottish golf professionals who migrated to the United States at the beginning of the twentieth century. The discussion herein illustrates the understanding of ball flight laws and introduces *The 14 Club Performance Numbers* concept for golf equipment evaluation.

How to determine these performance numbers, learning what they represent, deciding how to integrate them into an existing lesson plan and when to make alterations to change ball flight is the documented purpose of this manual.

## History

***The PGA Of America*** - In the forming years of The PGA of America, golf professionals were divided into two groups, playing & working professionals. The club professionals that did not spend the winter months playing the tour took exception to paying dues so others could “play” all the time. At the 1930 annual PGA meeting, it was suggested by George Sargent to change the PGA name to ‘Golf Instructors and Players’ Association of America’. Sargent went on to state, “There are two distinct kinds of men in our organization: the instructor class who develop the players who make the game and business and which is the major class of our membership: then there is the group of high-class players who are the advertising fellows. They get the most publicity. The instructors should have more recognition”. This cemented the cornerstone that the primary role of the golf professional was as an instructor.

***American Equipment Manufacturers*** - As the game became popular in America golf equipment was commercialized by large manufacturers. It took several decades, but American golf professionals relented to market forces and completely abandoned the club making skills of their mentors and absolved any professional responsibility to equipment, other than to sell the commercialized brands. The American golf professional was content to accept the role of instructor. Thus, one half of the game improvement equation was lost.

***Evolution Into The Business Of Golf*** - As the role of the golf professional evolved into the business of golf, owning the merchandise and golf car concessions, the PGA professional has always championed his role as “instructor”.

Today, many professionals specialize in just teaching with no other duties at the club. A lot of professionals aspire to be one of the “top 100 instructors” in the country. Teaching professionals have developed their own niche in the golf business. Some have stand alone academies that offer instruction to its highest level with the latest technology, such as video, launch monitors and club alteration equipment.

With over 100 years of professional golfers conducting business in America, it can be said that instruction is their forte. But that is changing as many golf professionals are returning to the roots of their profession and are adding club performance to the game improvement equation.

## **Off Course Stores**

It is well known that discount golf stores over a period of 50 years became the place to purchase new clubs. It wasn't for the service golfers' got, but rather for the choice of inventory and price. Discount golf stores had all the latest brands to offer and sold them at a lower price than most professionals did.

Golf professionals, however argued golfers could only get the proper service from them because they knew the golfer's swing and could fit them properly. But that did not stop golfers from buying clubs at discount stores and taking lessons from golf professionals. Golf Professionals were happy to have the lesson income.

That has been changing in the last decade. Off course golf stores have become boutiques offering the latest and best fitting technology with large inventories of major brands of equipment. Price is no longer the attraction for purchasing golf clubs. It is back to the service that golf professionals have claimed all along that golfers' can only get from them because they know their golf swing.

It seems they may be right. Off course stores are now staffed with golf professionals who teach and fit in simulators or hitting nets and some retail chains even ask golf professionals to serve as repair technicians. It seems the role for some golf professionals has come full circle. They have returned to the historical beginnings of their profession.

## **Unparalleled Opportunity**

An opportunity exists today that has not been in the market place since 1961 when the first retail store opened and golf professionals began losing club sales. Golf professionals can reclaim golf club sales by providing the service that sets them apart from retailers. By simply adding club performance to their lesson programs they will again be giving the service golfers want. Golfers want an instructor who knows their swing to provide them with the best performing equipment. With the right knowledge and tools golf professionals can provide that service. By the way, that service is far more technical today than it was 50 years ago. That gives golf professionals an unparalleled opportunity.





## Part 2 - Club Fitting v. Club Performance

Today's technology of club fitting and launch monitor data clearly suggests that golf club performance contributes to ball flight. Technology has proven that swing mechanics are only half of the equation to consistent ball flight.

A large gap exists between golf instruction and club fitting. When each are performed separately, they serve different purposes and do not necessarily produce the same result. Technology has proven that swing mechanics are only half of the equation for game improvement and club fitting methods when used alone are just another way to sell equipment.

Golf instructors are on the front lines and positioned to bridge this gap between instruction and club fitting by adding club perform to their lesson programs. Evaluating *The 14 Club Performance Numbers* of a student's clubs should be the first action taken by a golf instructor.

The golf industry is embracing the philosophy: "Is it the swing, clubs or both"? Are you?



## Part 3 - Golf Instruction

There have been many theories on how to swing a golf club through out the history of the game. These theories have been supported by countless instructional books, magazine articles, videos and many instructors have their own idea of the infamous Hogan Secret. But through it all everyone recognizes that golf is a learned skill. As long as the game of golf prevails there will be a need for instruction.

But what if instruction alone is not the total answer for game improvement? What if golf instructors took into consideration the performance of the golfer's equipment. In the modern times that we now live, it is recognized that equipment does influence shot making, does influence swing characteristics and does influence ball flight.

It is fair to say golf instructors should have club performance knowledge and be willing to incorporate that knowledge into their lesson program so their students can develop to their fullest potential.

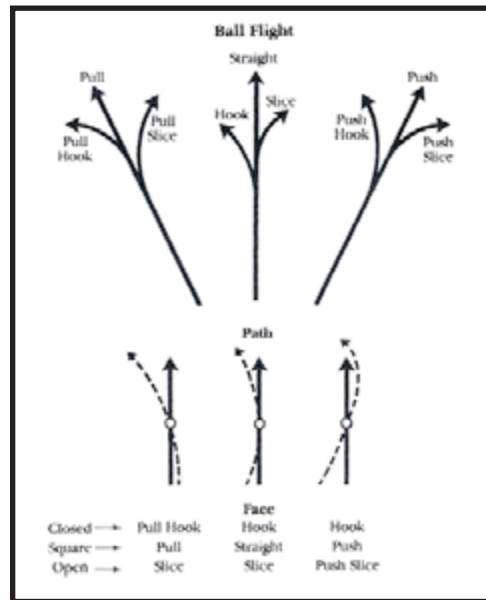
### Ball Flight

It is widely accepted that there are 5 ball flight laws as explained in the *PGA Teaching Manual* published in 1990 authored by Dr. Gary Wren, PGA Master Professional. These laws refer to the physical forces that produce ball flight, which are absolutes in influencing the flight of the ball. Dr. Wren explains there are no absolutes in the golf swing, only principles. Absolutes only pertain to ball flight, that's why he calls them laws.

Dr. Wren added "Impact" (The position of the body and club at the moment the club head delivers its full energy to the ball) to his Principles, which were first published in 1973 in his original model. He goes on to explain the effect of Impact: "There is only one moment of truth in the swing... Impact! The club face must be squared at this moment while the path is to the target if the ball is to travel there. It is the moment when the speed should be reached and the center of the club face is contacting the ball from the desired angle".

Today's technology shows a club's "face attitude" actually has more influence on direction than the leading edge as explained in Ball Flight Laws #4, "Face". Thus the club's lie angle proves to be very important to ball flight. Of course this also holds true for the principle "Impact". The club head must be delivered to the ball with a face attitude in a horizontal plane (square) to the target line.

## 9 Ball Flight Patterns



*Ball Flight Laws, Principles & Preferences*

By Dr. Gary Wiren, PGA

1973

### Laws

Law refers to the physical forces, which are absolutes in influencing the flight of the ball. There are no absolutes in the golf swing, only Principles. Absolutes are reserved for ball flight, that's why they are called Laws.

- 1. Speed** - The velocity with which the club head is traveling, Speed influences the distance the ball will be propelled, as well as the trajectory and shape of the resulting shot.
- 2. Centeredness** - The exactness with which the ball makes contact on the face of the club relative to the percussion point or "sweet spot". Contact could be either on the center, fore (toe), aft (heel), above or below that "sweet spot".
- 3. Path** - The direction of the arc described by the club head in its travel away from and then back toward the target. Its line of travel at impact is one of the primary factors influencing direction for a full shot.
- 4. Face** - The degree at which the leading edge of the club's face is at right angles to the swing path. It will determine the accuracy of the ball's flight along that line, or produce a left or right curve away from that line.
- 5. Angle of Approach** - The angle formed by the descending or ascending arc of the club head on the forward swing in relation to the slope of the ground. Due to its influence on the ball's spin rate, the trajectory and the distance the ball travels will be affected.

Ball Flight Laws rank as the first priority because they are absolute rather than arbitrary. They work every time without fail. All golf teachers must deal with them. Regardless of teaching method, the instructor must come to grips with the Ball Flight Laws. The ball is not concerned with swing style. It responds to being struck without any prejudice toward the striker. It doesn't ask what particular swing method is being used, nor does it care about one's handicap, club affiliation, sex, or age. The ball follows the basic Ball Flight Laws, whether the player uses an open or square stance, has a fast or slow backswing, an overlapping or ten-fingered grip, a firm or cupped wrist, emphasizes leverage or centrifugal force as the primary source of power. Yet, all these could have an important influence on the flight of the ball.

## Do You Teach Ball Flight Principles & Preferences?

**Do You Teach Ball Flight Principles?** - Most instructors generally measure the success of golf instruction through ball flight results. But what role does club performance play in achieving the desired ball flight? Should it be equally important as swing mechanics?

Golf instructors should know *The 14 Club Performance Numbers* of their students' clubs. This manual shows how to incorporate club performance evaluation and alteration into a lesson program. It explains what knowledge is required and why *The 14 Club Performance Numbers* are vital to golfers' improvement. It explains why equipment problems must be fixed just like a swing mechanic problem.

**What Is A Golf "Instructor"?** - This is the moment of truth for all golf instructors. Should they focus only on principles and preferences or should they also focus on Ball Flight Laws to improve their students' swing? Regardless of which principles and preferences they teach, if Ball Flight Laws are not satisfied game improvement results will not be permanent.

Golf instructors should know *The 14 Club Performance Numbers* of their students' clubs if they truly want them to improve to their greatest potential. After all, the real goal is to make golfers enjoy the game more, play more, take more instruction and play better.



## Part 4 - Defining Club Performance

**To The Golf Professional** - When Scottish golf professionals migrated to the United States and established the game of golf more than a century ago, they brought club making and repair skills with them, which they used to grow the game of golf.

Herb Graffis states in his 1975 historical book entitled *THE PGA*, "When the fully trained, experienced professional sees a pupil's problem that he suspects may be with clubs as well as technique, he has to go back to the method successfully employed by his astute predecessors who were golf pros in the building decades of the early 1900s".

Graffis is stating that golf professionals need to have skills like the old Scottish professionals. These skills include having the knowledge and equipment to measure golf club specifications and make alterations if necessary to assist the pupil's playing ability.

We are living the same era all over again: a time when it is important to grow the game, a time when golf professionals must incorporate club performance into the game improvement equation.

**To The Player** - The equipment side of the golf industry has evolved dramatically during the past 20 years, bringing the role of the PGA golf professional as an equipment expert back to the roots of his/her profession. Club fitting as presented by club manufacturers has been the main source of education and training for PGA golf professionals in this field. However, the golfing public now demands the same "tour van" services that tour professionals receive every week on tour. Golfers want angle adjustments to improve ball flight, the best performing shafts for more distance and control and the latest in grip technology.

The old Scottish pros had to make repairs and build clubs because of the limited amount of clubs they brought to this country when they settled here. That is the opposite of what we have today. The fact is, there is a proliferation of golf clubs available, thus making it even more important that golf professionals become equipment experts.

**To Ball Flight** - There are many theories on how to swing a golf club. Everyone recognizes golf is a learned skill and as long as the game prevails there will be a need for golf instruction. But what if instruction alone is not the total answer for game improvement? What if golf instructors took into consideration the performance of their golfer's equipment? It is recognized by the golf industry that equipment does influence shot making, does influence swing characteristics and does influence ball flight.

Instructors have influence on their students, but do not have complete control over their student's reaction to their experiences. Instructors can, however, influence their student's reactions by altering ball flight through instruction and/or by altering equipment performance.

It is important to the teaching and learning process that the instructor is confident the student is using the proper equipment for a positive learning experience. Improper equipment can be an inhibitor to learning how to produce a good golf swing that favors positive ball flight.

It is fair to say that golf instructors need to incorporate club performance into their lesson program for ideal ball flight results.

## The 14 Club Performance Numbers

**10 Static Club Performance Numbers** - There are 10 important static club performance numbers that need to be evaluated to determine the performance capability of a set of clubs. First, sets of clubs need to be consistent in progression of their performance numbers, e.g., lie angles. Second, the performance numbers must fit the golfer to achieve maximum game improvement, e.g., grip size, club length and swing weight.

1. Grip Size
2. Club Length
3. Shaft Flex
4. Shaft Weight
5. Swing Weight
6. Total Club Weight
7. Lie Angle
8. Loft Angle
9. Face Angle
10. Bounce Angle

**4 Dynamic Club Performance Numbers** - There are 4 dynamic club performance numbers that are the most important launch monitor data. These data are representative of the performance of both the golfer and the set of clubs and should be compared before and after alteration and with demo clubs of other specifications.

11. Ball Speed
12. Launch Angle
13. Spin Rate
14. Power Transfer Ratio

## Terms & Definitions

1. **Grip Size** - Measured in thousandths of inches at 2 inches down from butt cap. Grip size is a critical component of feel and timing of the golf club's release.
2. **Club Length** - The playing length of a club measured from the end of the grip to the intersecting point on the sole created by the linear extension of the shaft plane.
3. **Shaft Flex** - The designation of a shafts' resistance to bending or the flexural feel built into the design of the shaft. Shaft flex is important for direction of ball flight and tempo of swing.
4. **Shaft Weight** - The actual weight measured in grams. Shaft weight is mostly associated with feel.
5. **Swing Weight** - The measurement of comparing the distribution of the club's total weight defined as a swinging balance. Swing weight will affect feel and swing mechanics.
6. **Total Club Weight** - The total weight of the club measured on a gram scale in ounces and grams. Total weight affects the golfer's balance and tempo.
7. **Lie Angle** - The angle formed between the shaft plane and the horizontal face plane (attitude). Lie is the most important factor for ball direction.
8. **Loft Angle** - The angle formed by the vertical shaft plane and the pitch of the face. Loft is the most determining factor for distance.

9. **Face Angle** - When viewed in a playing position face angle is the angle formed by the club's face plane (open, square, closed) and the square vertical shaft plane when the club head is soled in its natural lie angle position.

When registered in a measuring device, face angle is the angle formed by the vertical shaft plane to the square face plane with no sole influence. Face angle is an important factor related to ball direction in woods and hybrids.

10. **Bounce Angle** - The angle formed by the bounce contact point on club's sole and the leading bounce edge on the club face. Bounce is critical on wedges for executing short game shots.

11. **Ball Speed** - The velocity at which the ball travels in miles per hour. Ball speed directly determines how far the ball travels.

12. **Launch Angle** - The initial angle in relation to the ground line that the ball leaves the club head measured in degrees. Launch angle will be affected by swing mechanics, loft/lie/face angles, ball speed, spin rate and shaft flex.

13. **Spin Rate** - The amount of back spin imparted to a ball when struck by a club measured in revolutions per minute (RPM). Spin rate is affected by swing mechanics, loft angle and shaft flex.

14. **Power Transfer Ratio (PTR)** - The ratio of ball speed divided by club head speed. Power Transfer Ratio is a measurement of how well the ball is being impacted by the club head.

### How The 14 Club Performance Numbers Affect Ball Flight

1. **Grip Size** - Grip size is a critical component of feel and timing of the golf club's release. An incorrect grip size will influence swing mechanics by increasing or decreasing the player's ability to release the club. A grip that is too large for the player will make it harder for a player to release the club. A grip that is too small for the player can make the player release the club too early. This fact can be utilized in conjunction with swing mechanics to achieve either result, earlier or later release.

2. **Club Length** - Club length greatly affects swing mechanics and ball flight. If a club's length is too long or too short for a player, it will affect the player's balance and spine angle. Club length also affects centeredness of impact and horizontal face attitude (Lie Angle) which affects ball direction.

The longer the club the greater the potential swing arc. A longer swing arc potentially means more distance, provided the ball is struck on center. Longer lengths offer the potential for faster club head speeds, but this potential is not the case for all players. Not all "long" drivers yield the longest distance.

Club length greatly influences a player's ability to return the club to a repeatable square position at impact. The longer the club the more potential for off center hits that result in both distance and directional problems.

Club length plays a role in both shot accuracy and distance. When finding the proper length for both of these factors, a given player has greater potential for good performance. Finding the club length that best matches a player is a key part of club performance.

3. **Shaft Flex** - Shaft flex is important for ball flight direction and swing tempo. If a shaft is too weak for a player the ball will tend to fly high left. The opposite is true if the shaft is too stiff. The ball will tend to fly low right. A shaft's flexural feel is important to the tempo of a golfer's swing.

Properly matched shafts will allow a player to consistently return the club to impact in an ideal square position for directional control. The shaft will feel good to the player, while at the same time optimizing the potential distance. If a shaft is too stiff or too flexible, too heavy or too light, or lacks the proper feel, performance will be compromised.

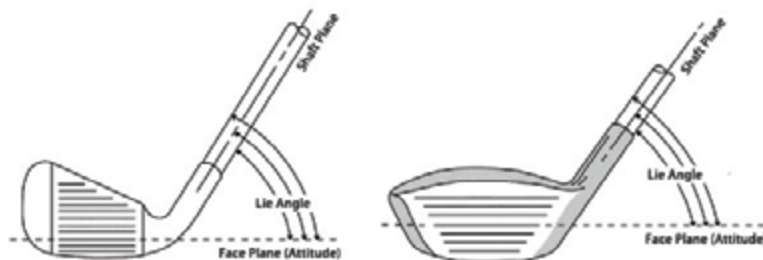
4. **Shaft Weight** - Shaft weight is mostly associated with feel. Shaft weight affects ball flight and player feel, as well as shaft flex. Generally the lighter the shaft the more the player can feel the club head and the heavier the shaft weight the player will feel less of the club head. Shaft weight tends to affect the consistency of the swing and shot dispersion (accuracy).

5. **Swing Weight** - Swing weight is the balance relationship between the club head and the grip end of the golf club and is dictated by the weights of the component parts of the golf club. Therefore, swing weight is related directly to the total weight of the club.

Swing weight will affect feel and swing mechanics. This in turn influences ball flight and human performance. For example, if a club is too light, (swing weight too low) it won't have a good feel and the player will generally be inconsistent returning the club's face squarely to the ball at impact. Therefore, the opposite will be true if a club is too heavy, (swing weight is too high) it will feel unwieldy and the player will probably have a jerky swing and become fatigued easily. The player may also tend to release too early or hit from the top. Feel is important in club performance.

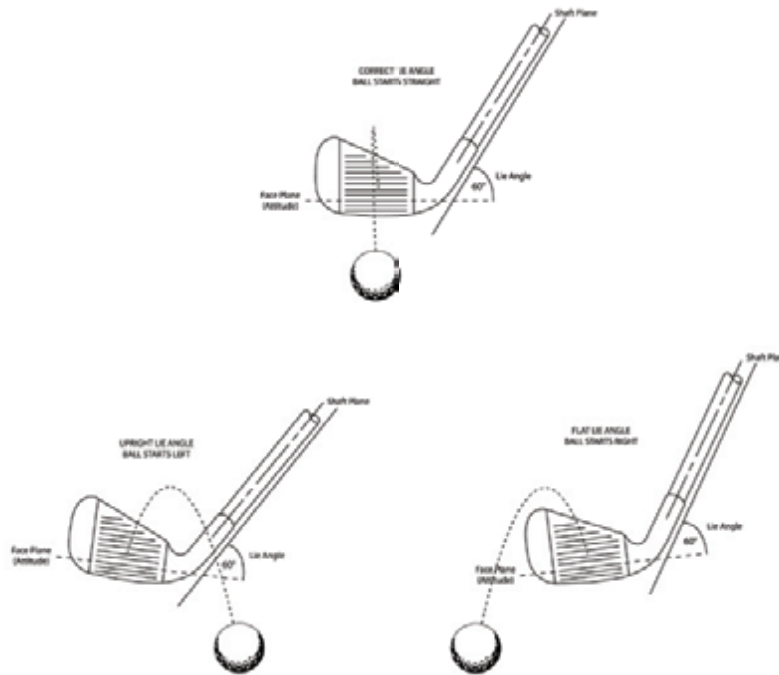
6. **Total Club Weight** - The total weight of the club affects the golfer's balance and tempo. The combination of shaft, head, and grip needs to be in the same weight classification, i.e., light, medium, or heavy when balancing a club. The relationship between shaft, head, and grip weight is an important parameter and relates to the club's swing weight. Players will tend to misinterpret total weight during a swing, confusing a lack of squareness of hit or lack of balance with the club being too heavy. When the ball is struck squarely, with a proper weight golf club and a balanced swing, you seldom hear about heavy clubs. For example, many golfers complain their drivers are too heavy, and their 9-iron is just fine. Since drivers are lighter, weight cannot actually be the offending specification.

7. **Lie Angle** - Lie is the primary influence on ball direction. Clubs with inaccurately set lie angles will be the root of many golf swing problems. The golfer learns to adjust or make swing compensations to overcome deficiencies built into the set of clubs.



Lie has the effect of positioning the face plane (attitude) of the golf club toward the target. If this positioning is "correct" the face plane (attitude) is aimed at the target and the resulting ball flight is straight (assuming an on-plane swing). If the lie angle is too upright, the face plane (attitude) will be positioned to the left of target for a right-hand player and the resulting ball flight will be to the left. If the lie is too flat, the face plane (attitude) will be aimed to the right and the ball will start to the right of target.



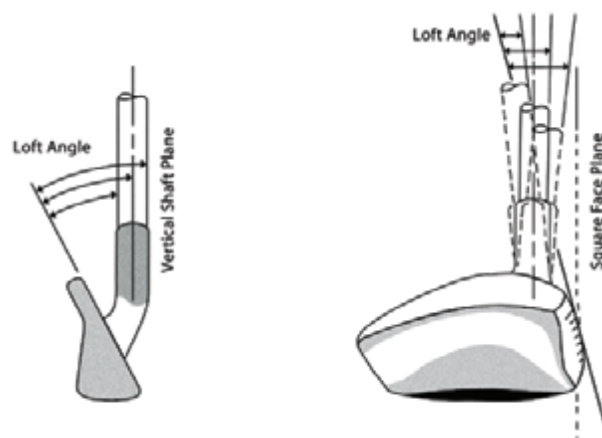


There are no industry standards for lie angles. Performance is best indicator of correct lie angles.

More loft = more errant shot if lie is incorrect because of more sidespin

The greater the loft of a club, the more influence lie angle has on ball direction. Incorrect lie angles will start the ball more offline in higher lofted clubs, such as wedges than it will in lower lofted clubs such as drivers. As a ball spins after being struck, any directional problems will be exaggerated due to this spin in the “wrong” direction. Thus, lie is a critical factor in ball direction.

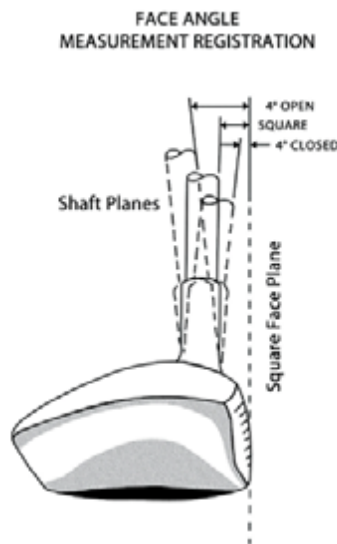
8. **Loft Angle** - Loft is the most determining factor for distance. The less loft or stronger a club is the farther the ball will fly, and conversely the more loft or weaker the shorter the ball will fly. Loft gapping between clubs is critical for distance control.



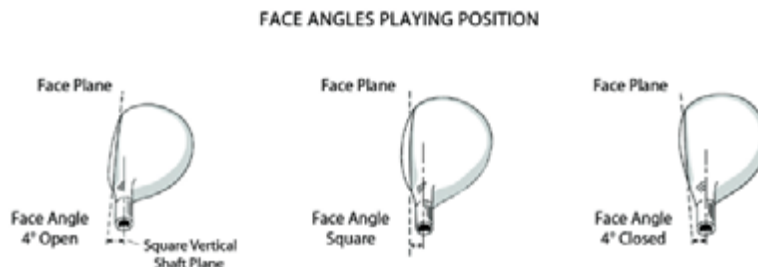
**Note:** On woods and hybrids the face pitch is the plane intersecting the center of the face. The vertical shaft plane on irons will always be square to the club's face. However, on metal woods and hybrids, when the shaft plane is not square to the face plane the playing loft will vary. See previous illustration: an open face angle will have less playing loft than a closed face angle.

Loft is also an important factor in getting the ball airborne. The more loft a club has the higher the resulting ball flight trajectory. In addition, loft imparts spin to a golf ball. The higher the loft of the driver (or any club), the greater the spin rate (backspin) will be, with all other factors being equal. The ball's spin rate also has an influence on the trajectory of a golf ball.

9. **Face Angle** - Face angles on woods and hybrids have a similar effect on ball flight and swing mechanics as lie angle. If the face angle is closed the ball will fly left with a higher playing loft. If the face angle is open the ball will fly right with a lower playing loft. The goal for every golfer is to return the club face squarely to the ball.



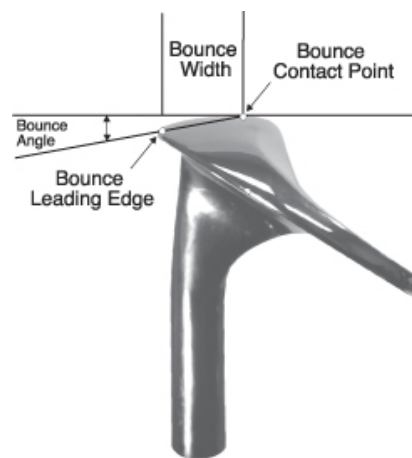
When registered in a measuring device, face angle is the angle formed by the vertical shaft plane to the square face plane with no sole influence.



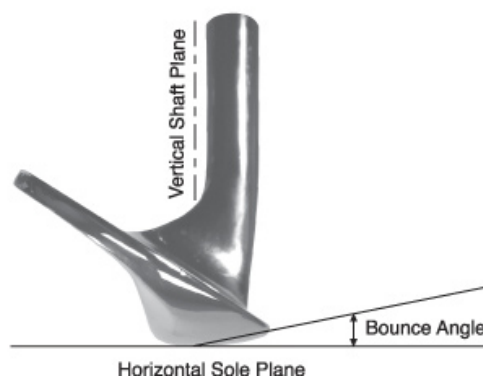
When viewed in a playing position, face angle is the angle formed by the club's face plane (open, square, closed) and the square vertical shaft plane when the club head is soled in its natural lie angle position.

As previously mentioned, face angle is an important factor related to ball direction in woods and hybrids. The angle of the face in relation to the target at impact has an obvious influence on ball direction. Assuming an on-plane swing, a square face driver will direct the ball straight toward the target, while an open face results in shots to the right and a closed face results in shots to the left. If the swing is not on plane, face angle influences ball direction as well.

10. **Bounce Angle** - Bounce is critical on wedges for executing short game shots. Bounce is an angle built into the club's sole with the purpose of creating a contact point with the ground that is lower than the leading bounce edge. The bounce angle is important to creating solid contact between club face and ball. Some bounce is needed in all iron clubs, but the sand wedge requires the most bounce due to the softness of the soil beneath the ball in bunkers. This prevents the club from digging into the sand.



Alteration of a club's loft angle will correspondingly change the club's bounce angle. The relationship is one-to-one. As the loft angle is decreased by one degree its bounce angle is decreased by a degree at the same time. Conversely, the bounce angle increases equal to the amount of any loft increase. A one or two degree change in loft will not cause a sole to dig when altering today's clubs.



11. **Ball Speed** - Ball speed directly determines how far the ball will travel. It is a direct result of club head speed. Ball speed is affected by the club head's Coefficient of Restitution (COR). The greater the COR the greater the ball speed on "on-center" hits. Ball speed is directly proportional to the quality of impact. The better the impact the more energy will be transferred from club head to the ball. In most cases the higher the ball speed the more distance the ball will travel and the lower the ball speed the less distance the ball will travel; as long as launch angle and spin rate are complimentary.

12. **Launch Angle** - Launch angle is the initial angle in relation to the ground line that the ball leaves the club head. It has a direct affect on the distance a golf ball will travel. Launch angle is especially important in longer shots and is influenced by swing mechanics and the player's physical abilities.

There are many factors that can affect launch angle. The best results with metal woods, especially a driver is achieved with an ascending angle of attack. When coupled with ideal spin rates, maximum distance is achieved.

13. **Spin Rate** - Spin rate affects ball flight distance and trajectory. Club head speed is important in determining the spin rate. Spin rate is affected by swing mechanics and loft angle. The angle of attack is a major determiner of spin rate. Additionally, it is important for the player to use a golf ball that provides the spin rate that is ideal for their game and ability. Many times a player will be able to see quantifiable spin rate differences with different balls. These differences will influence trajectory and distance.

14. **Power Transfer Ratio (PTR)** - Power Transfer Ratio or "Smash Factor" is a measurement of how well the ball is being impacted by the club head. It is important to assess the amount of energy that is transferred from the moving club head to the golf ball, obviously influenced by the angle of attack, club head path, and the face angle at impact and directly relates to the distance a golf ball will travel. The power transfer ratio correlates directly to the centeredness of hit on the horizontal face attitude and the club face's COR. A benchmark for good PTR is 1.50 or 150%, meaning the ball is traveling at 150% of the club head speed. If the club head is traveling 100 mph and the ball is traveling 150 mph you have a PTR of 1.50.

### Understanding The 3 Components Of A Golf Club

Club performance involves three distinct components of modern day golf clubs; grip, shaft and club head. These components individually and collectively contribute to the overall performance of shot making resulting in ideal ball flight.

The performance features of each club component must be evaluated and altered when necessary. It is important to understand these performance features and how they effectively make up a completed golf club. It is the sum of these performance features that produce ideal ball flight. In other words, the brand name on a particular club is less important than the performance features designed into the club. Club manufacturers engineer performance features into their club designs, which work best when they are in sync with the player's swing skills.

Component: **Grip**

**What They Are** - Grips can be made from rubber, leather or any number of polymers. What feels good to one player will not necessarily feel good to another. Grips are very much a matter of personal choice. This choice may

be influenced by the cost of certain grips, but grips are still the most personal choice specification when it comes to golf clubs.

**What They Do** - Grips are the only contact a player has with the golf club. Grips provide traction between a player's hands and the club. Worn grips are more likely to slip during the swing and produce inconsistent results. Improperly sized grips may not feel comfortable to a player, again leading to inconsistency.

**Why They're Important** - As they are the only contact a player has with the club, grips should be kept clean and should be replaced at the first signs of wear. Don't expect huge playability changes as a result of changing grips. Grips influence feel more than ball flight, but feel is a very important factor. Worn grips or improperly fitted grips lead to tight grip pressure, which brings tension into the golf swing. This makes the golf club grip a performance factor.

Grips are designed either round or ribbed and come in a variety of weights. Refer to the USGA Rules of Golf Appendix II – 3 for specifications regarding golf club grips.

Grip Size Chart:

When measuring grip size the Calipers should be placed 2" down from edge of grip cap to take the appropriate diameter measurement reading.

#### **GRIP SIZE - DIAMETER**

MENS 1/64" UNDERSIZE	0.885
MENS STANDARD	0.900
MENS 1/64" OVERSIZE	0.915
MENS 1/32" OVERSIZE	0.930
MENS 3/64" OVERSIZE	0.945
MENS 1/16" OVERSIZE	0.960
LADIES 1/64" UNDERSIZE	0.835
LADIES STANDARD	0.850
LADIES 1/64" OVERSIZE	0.865
LADIES 1/32" OVERSIZE	0.880

Component: **Shafts**

**What They Are** - Golf shafts have been labeled as "the engine of the golf club" by many in the industry while others contend the golfer is the engine and the shaft is what connects the club head to the golfer. It is also known that the mass and center of gravity of a club head will affect the performance of the shaft as the head squares itself. Shafts may be made of a variety and/or combination of materials and are designed to transfer energy from golfer to golf ball in the most efficient manner possible.

**What They Do** - Shafts are designed to provide the optimum combination of distance and accuracy for a golfer. They may be made from steel, graphite and other composite materials. They are available in a variety of distinctive colors and geometries. They may be very firm or very flexible. They can be light or heavy and can

possess a wide range of torques. Their balance and kick points can vary from shaft to shaft. They can be frequency matched, weight-sorted, flat-line oscillated or none of these.

Shafts are probably the most mysterious of all club components due to the sheer numbers of designs available and manufacturers who produce them. There are literally thousands of different shaft types produced during the past decades. With all of the different shafts on the market, it is important to quantify key playing characteristics of specific shafts so that we may analyze their effect on ball flight, launch angle and spin rate. Through the use of a launch monitor and specific shaft designs from a few manufacturers, a best-matched shaft for a player's driver can be identified. This shaft will work in concert with the club head to provide the highest launch angle with the lowest spin for the longest drives possible.

**Why They're Important** - Properly matched shafts will allow a player to consistently return the club to impact in the desired square club head position. The shaft will feel good to the player, while at the same time optimizing his distance potential. If a shaft is too stiff or too flexible, too heavy or too light, or lacks the proper feel, performance will be compromised.

#### SHAFT CHARACTERISTICS:

##### Steel Shafts

- Usually heavier than graphite
- Most popular for irons
- Thought to be more consistent for carry yardage
- Preferred by Tour Players and good amateurs
- Inexpensive when compared to graphite shafts

##### Parallel Tip

- Popular as hybrid and iron shaft with .370" diameter
- If a unitized shaft is tip trimmed for entire set, the shafts have descending weight
- Shaft diameter remains same for entire length of tip
- One shaft can be tip trimmed for use in any club in the set
- Offered in combination flexes so that one shaft can be used to install 2 or more flexes
- Inexpensive to inventory since one shaft can be used in many different combinations
- Preferred by smaller OEM's, club makers and repairmen due to lower inventory cost.

##### Taper Tip

- Popular for Steel iron shafts with .355" diameter
- Shaft diameter increases while traveling up shaft tip
- Constant weight in most popular brands
- Pre Tip-trimmed – No trimming from tip
- Preferred by OEM's due to ready to assemble feature

##### Graphite Shafts

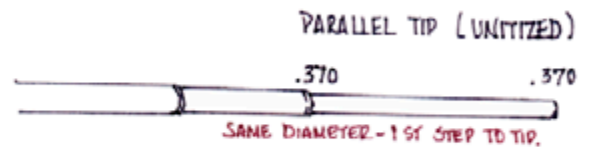
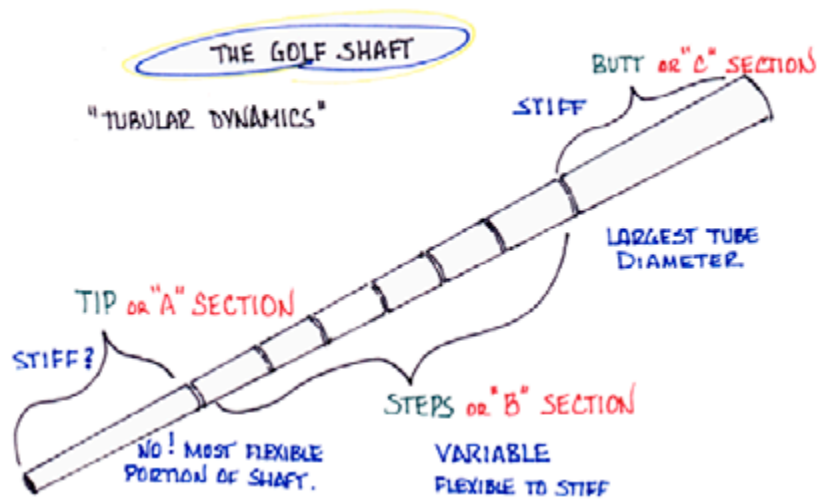
- Lighter than steel shafts
- Most popular for woods and hybrids
- Thought to provide longer shots due to lighter weight = faster club head speed
- Preferred by all types of players for woods
- Expensive when compared to steel shafts

Taper Tip

- Small percentage for irons
- Almost non-existent for woods

Parallel Tip

- Common for woods and irons
- Parallel Tip Section much shorter than steel shafts
- Limits the amount of tipping that can occur
- Very few combination flex models



TOURING PROS PREFER THE TAPER TIP DUE TO "SOFTER" TIP FEEL.

**Frequency Matching**

**What Is Frequency** - One of the key skills necessary for an equipment expert to possess is the measuring and comparing of a shaft's frequency. This information is valuable in matching shafts to a player's swing tempo. This process is referred to as "Frequency Matching." It is an absolute standard for selecting the correct shaft for a particular player's tempo - the elapsed time from the start of the down swing to ball contact. Since all clubs have different lengths, the shaft flexibility is different for each club. When plotting the shaft frequency on a graph it will provide a "Sloped Gradient."

Frequency Matching allows golf clubs to be easily duplicated for playability. Flex standards for parallel tip steel shafts have a tight range in the same flex among most models and manufacturers while taper tip shafts are different since all shafts in the set weigh the same or have "constant weight." In contrast graphite shafts have a wide range in the same flex among manufactures and within the same manufacturer. One company's senior flex may be another's stiff flex. This leads to much confusion when it comes to finding the correct shaft for an individual player, especially when it is related to the feel of the golf shot. Feel is "user defined" and varies among players but feel can be duplicated through Frequency Matching of the shaft's performance.

**Why Frequency Is Important** - Why is frequency matching so important? To answer this question we must first understand frequency. In respect to golf shafts, frequency can be defined as the number of times a shaft oscillates in a unit of time. Shaft frequency is measured in cycles per minute (CPM). What does the CPM reading of a golf shaft truly mean? It is an absolute measure of the shaft's flexural feel to a golfer. In essence it can be expressed as the flex of the shaft.

To explain how this is true, one must first understand the role of a golf shaft in relation to the sum of the three basic components that make up a golf club. When hitting a golf ball, it is the club head that delivers the blow to the ball. We know that distance is the result of mass times velocity squared ( $D=mv^2$ ). But how do we deliver the club head to the ball to produce a golf shot? That is where the golfer enters the equation. He swings the club in a way that generates club head speed to transfer energy to the golf ball. Due to the mass of the club head, the faster it is moving (velocity) the greater the distance.

So what is the purpose of the golf shaft? It has been defined as the engine of the club. But is it possible the golfer is really the engine? Actually the shaft is nothing more than what connects the club head to the golfer. If the golfer can deliver the club head to the ball in a perfect position at the greatest velocity he can generate, he will maximize the shot distance.

What if he doesn't? There are a lot of golf club specifications that may cause a bad shot, but in regard to the shaft, if it is not the correct flexural feel the golfer will have difficulty returning the club head perfectly to the ball. Trick shot artists prove this by hitting perfect shots with clubs that have rubber hose or chain shafts. Naturally, they do not generate a lot of club head speed so the distance is not that great, but the club head was delivered to the ball in a perfect hitting position.

Shaft manufacturers design shafts to produce certain ball flight results with specific profiles that relate to trajectory. They also design "feel" into their flexes. It is difficult to relate shaft profile measurements to golfers' feel. This is where frequency can be used as a measurement of flex. The golfer feels the club head through the shaft. When the shaft does not perform to the ideal feel for the golfer, the flex is not correct. Butt frequency is a direct correlation of that feel because the golfer relates that feel through the grip at the butt end of the shaft.

Frequency "feel" is interpreted to mean the relationship of the weights of each component of the club and how the golfer feels those weights are distributed when swinging the club. Frequency is used to produce a "matched set of clubs" by comparing each shaft's butt frequency to a gradient. The gradient will vary with different shaft designs and geometry. The advantage to a golfer of a "matched frequency set of clubs" is he can swing each club in the set with the same tempo to achieve consistent club head velocity at impact. This is the basis of the FM Precision frequency matching method developed by Dr. Joe Braley. This is not possible if frequency-flexes vary within the set.



Frequency is used to match a like shaft when replacing a broken shaft. It is used to determine the flex of a golfer's favorite club for building other clubs with similar shafts. It can be used to measure the symmetry of a shaft by comparing the CPM readings around the shaft's circumference in 6 equal 30° planes. When the CPM varies 3 cycles or less, the shaft is considered symmetrical. Obviously, frequency is a club performance-fitting variable for game improvement.

*FREQUENCY FACTS:*

**Frequency** - The measurement in cycles per minute of the shaft's flexural characteristics in relation to the club's length and head weight.

**Natural Frequency** - All rigid objects have a natural frequency.

**Frequency Rate** - The rate of frequency is not dependent on the amount of force required to create oscillation.

**CPM (Cycles per Minute)** - The number of shaft oscillations in a one-minute unit of time.

**Swing Weight** - Each swing weight increase is equal to one (1) CPM decrease and each swing weight decrease is equal to one (1) CPM increase.

**Club Head** - Each 2-gram club head weight change is equal to one (1) CPM change in frequency.

**Gradient/Slope** - The progression of cycles per minute between each club in a set. There is no one gradient/slope for all shafts of similar flex feel.

**Frequency Matching** - Building golf club sets to match the desired cycles per minute progression on a gradient/slope.

**Flex** - The designation of a shaft's resistance to bending. When comparing shafts of the same brand and model of equal length the higher the CPM reading the stiffer the flex.

**Flexible** - Easily bent, not rigid.

**Feel** - Term used to describe the playing characteristics of a golf club.

**Flex Feel** - The performance "feel" designed and built into a shaft's "flex" geometry.

**Flat Line/Single Frequency** - The same number of cycles per minute for each club in a set.

**Deflection Board** - Method used to measure a shaft's beam strength, not its flex.

**Circumferential Readings** - Measuring the cycles per minute of a shaft in 6-30° planes around the shaft's circumference to determine the shaft's symmetry.

**Shaft Profiling** - Measuring cycles per minute in multiple zones along a shaft's longitudinal axis.

**Shaft Beam Length** - The distance from the inside edge of the clamping device at the shaft's butt to the center of mass of a tip weight or club head.

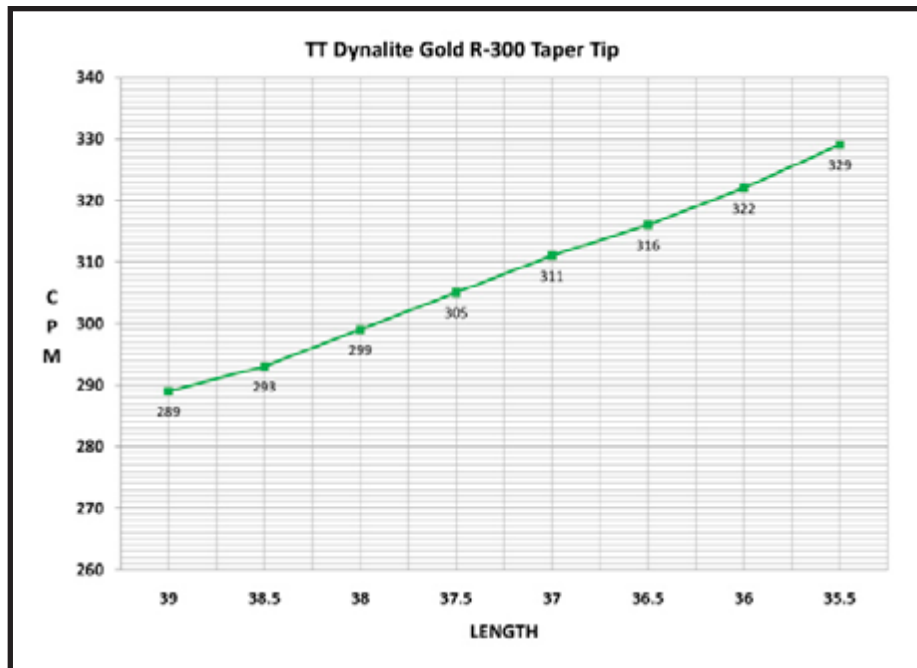
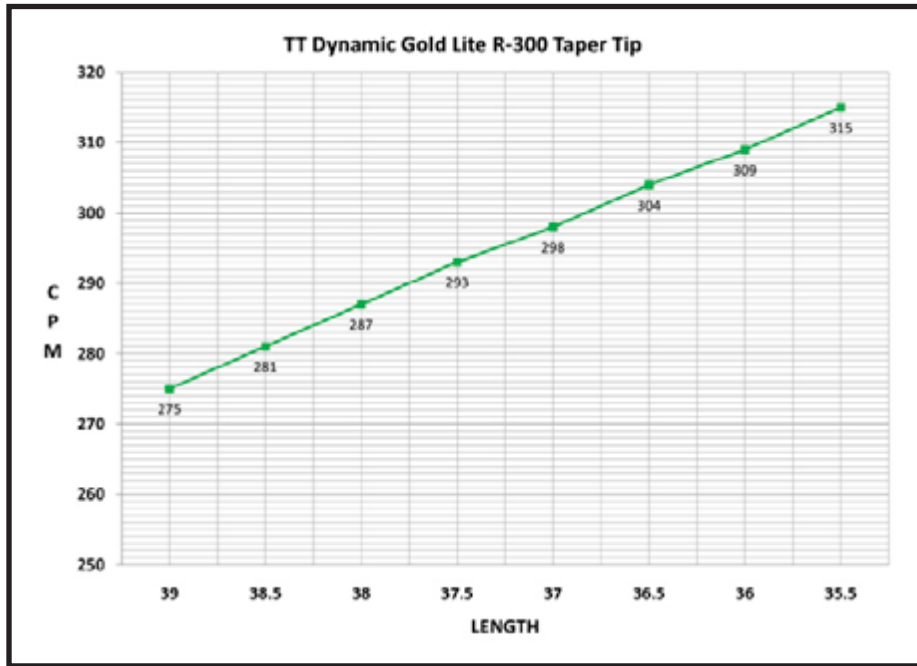
**Face Plane Oscillation** - Measuring cycles per minute in a shaft plane parallel to the club's face plane.

**Oval Oscillation** - Shaft oscillation in an oval or non-straight pattern.

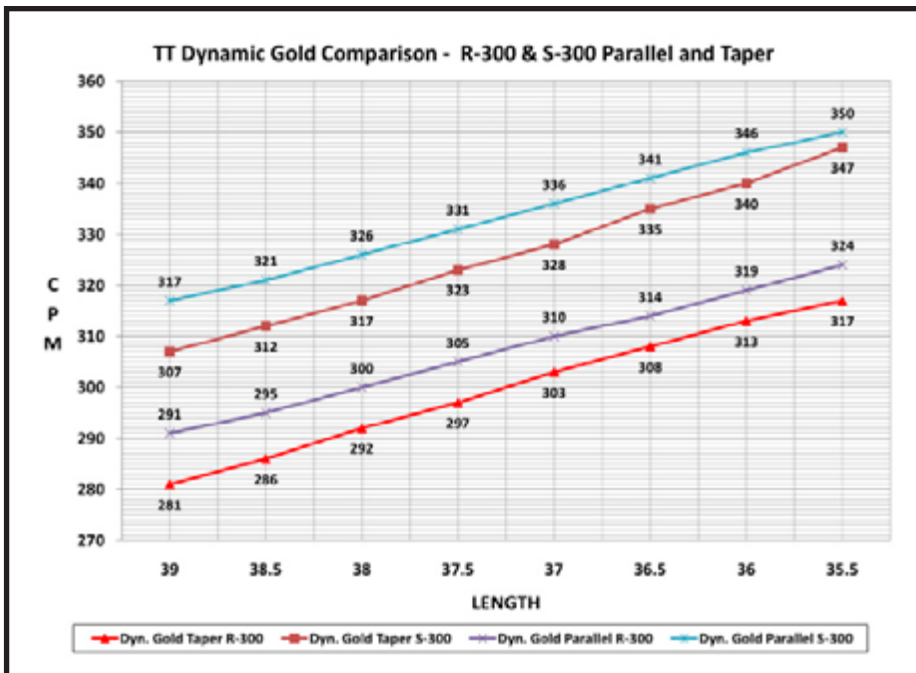
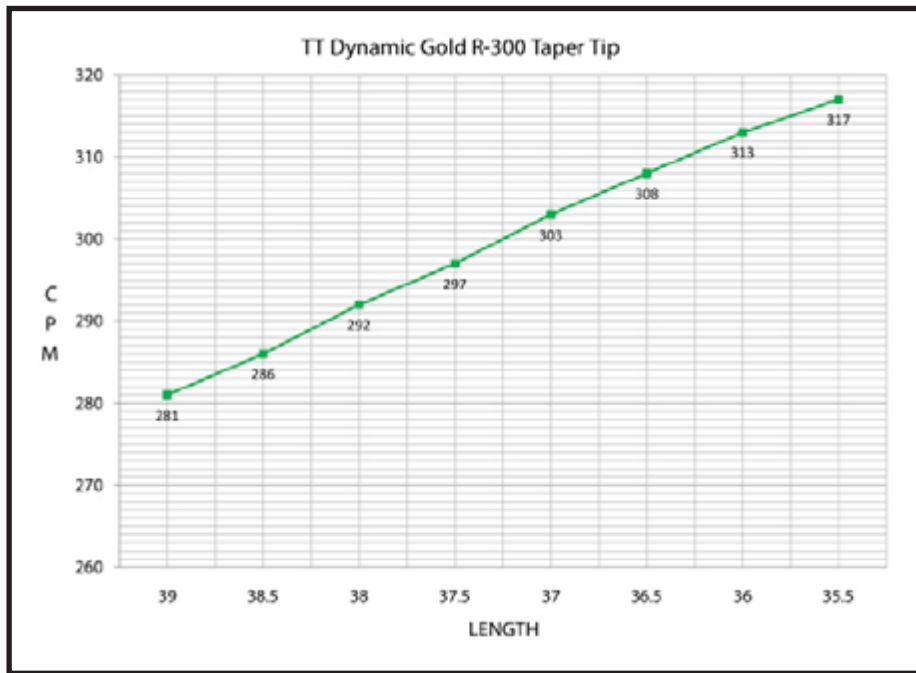
**Damping** - The effect on CPM readings caused by grips or clamping pressure variations.

**Spine/Seam** - Terms used to describe symmetry differences (stiffness) measured in planes along the longitudinal axis of a shaft.

Frequency Gradient Charts

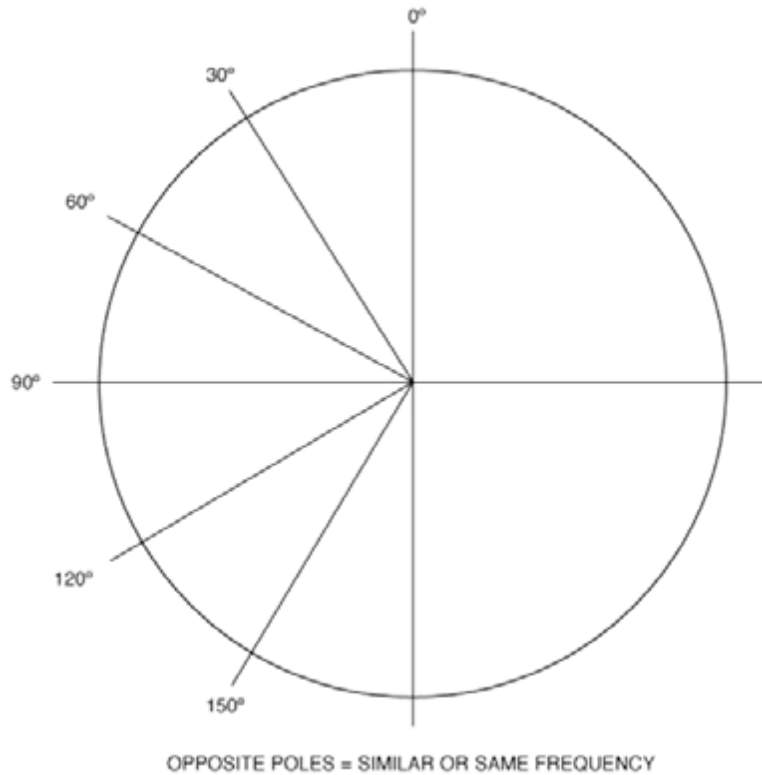


Frequency Gradient Charts (continued)



### Shaft Symmetry

It is important to determine the shaft symmetry and circumferential readings by measuring the shaft frequency in 6 planes of the shaft's circumference. These frequency measurements are taken and data recorded at 0°, 30°, 60°, 90°, 120°, and 150° to determine shaft symmetry. When the CPM variance is within 3 cycles at each of the 6 planes the shaft is considered symmetrical.



### Component: Club Head

The design of the club head and the material that it is constructed from may vary greatly. Heads may be forged, cast, have face inserts, or have bore through hosels. Clubs are designed with varying center of gravity and this has an effect on ball flight. Metal woods have built in bulge and roll to create gear effect and MOI specifications that affects ball flight. Finally metal woods have a specific COR (face spring-like effect) limits, MOI limits, dimension limits, volume limits, equivalent time requirements, and groove requirements set by the USGA Rules of Golf. Refer to the USGA Rules of Golf Book Appendix II, 1 a, and b, and 4 Clubs / General - Club Head.

Club heads are made of different materials such as carbon steel, stainless steel, and titanium. Their hosel designs are offset, non-offset, progressive-offset, and face progression. Also, club heads come in varying weights for the assembly of matched sets of golf clubs.

*STANDARD HEAD WEIGHTS:*

<b>CLUB</b>	<b>WEIGHT</b>
<b>Woods</b>	
Driver	205 gr.
3 Wood	211 gr.
5 Wood	219 gr.
<b>Hybrids</b>	
2I Hybrid	230 gr.
3I Hybrid	236 gr.
4I Hybrid	240 gr.
<b>Irons</b>	
2	229 gr.
3	236 gr.
4	243 gr.
5	250 gr.
6	257 gr.
7	264 gr.
8	272 gr.
9	280 gr.
PW	280 gr.
SW	300 gr.

**Driver Heads**

**What They Do** - The driver head imparts distance, loft and spin to the ball at impact. A properly fitted driver will optimize these three variables in combination with the shaft of the club to provide maximum distance and accuracy. The driver may be made of stainless steel, titanium, graphite or a combination of these materials that include other alloys, magnesium, and aluminum. Current models of drivers range from 400cc in volume to USGA-conforming maximum of 460cc. The heads may have unique weighting features to influence their centers of gravity. They may have unique hosel bore configurations to create stability and influence feel. They may have shallow or deep faces, square or closed face angles and different head weights to influence ball flight.

**Why They Are Important** - Golfers perceive the head of the club to be the most important component of the club. This is not exactly true; without the properly matched shaft and grip, the club will not perform to its optimum level. Matching a driver's loft, CG, feel and looks to a player will help ensure that the club performs as intended. Any compromise in any of these factors and the player will not perform to potential. The driver is the club that puts the ball into play on a majority of holes. Matching its launch characteristics to the player is of paramount importance in golf club performance.

*PERFORMANCE SPECIFICATIONS OF DRIVER HEADS:*

**Head Size** - The larger the head, the higher its MOI and the more forgiving it will be on off-center hits.

**Volume** - Head size is measured in cubic centimeters (cc's). Larger heads tend to have higher Moments of Inertia (MOI's). Material plays a role in driver volume due to weight of material.

**Head Breadth (from face to back)** - The greater this distance, the deeper the COG of the head and the higher the launch angle for a given loft.

**Face Height (from crown to sole)** - The deeper the face, the higher the COG of the head and the lower the launch angle. The shallower the face, the lower the COG and the higher the resulting launch angle.

**Face Angle** - The angle of the face plane in relation to the shaft plane. The larger the head, usually the more closed the face is to help square the face at impact.

**Bulge and Roll** - The radius from heel to toe and top to bottom of the club's face.

**COR** - The higher the COR, the more potential for higher ball speed. As most of today's drivers are designed with the highest COR possible, any ball speed difference as a result of COR are not quantifiable.

**Hosel Bore** - The deeper the bore, the stiffer the shaft will feel and the lower the launch angle for a given shaft.

**Head Material** - The head material itself will have no influence on distance. What head material allows are different types of face construction, which may have an influence on distance as well as on sound and feel.

**Weighting Additions** - Some of today's club head designs allow for the movement or removal of weight, either added to or taken away from certain areas of the club head. The addition of a heavier material somewhere on the head is designed to influence the center of gravity (COG) of the head. If the weight is placed low or rearward, the resulting launch angle will be higher; if weight is added toward the face or higher on the club head, the resulting launch will be lower. Weight placed toward the heel will have the effect of helping to close the club face; any weight toward the toe will tend to keep the face open. It is interesting to note the addition of lead tape will have an effect on swing weight and feel, but not on ball direction or trajectory due to the small amount of weight.

**Score Lines** - Score lines have no effect on ball flight. With the faces of many of today's drivers being made ultra-thin, the addition of score lines may compromise face strength. Thus many manufacturers eliminate score lines in the center of the face, while some eliminate them totally.

## Iron Heads

Iron heads are either forged from carbon steel or cast from a variety of steel alloys, but most popular is 431 and 17-4 stainless steel. The casting process includes annealing and heat treating the club heads. This makes the metal malleable by arranging the grain structure into a consistent pattern with a Rockwell hardness consistent with the type of alloy, which makes it bendable.

Iron heads are usually manufactured to certain standards (guidelines) for lie and loft angles. The following listing can be used as a guide when analyzing clubs from recent eras.

**STANDARD LIE/LOFT ANGLES IRONS GUIDE**

<b>Club</b>	<i>Old Standard</i>			<i>Modern Standard</i>			<i>New Modern Standard</i>		
	<b>Loft</b>	<b>Lie</b>	<b>Length</b>	<b>Loft</b>	<b>Lie</b>	<b>Length</b>	<b>Loft</b>	<b>Lie</b>	<b>Length</b>
1 Iron	12	56	39	16	56	39.5	15	58.5	40
2 Iron	20	57	38.5	18	57	39	17	59	39.5
3 Iron	23	58	38	21	58	38.5	20	60	39
4 Iron	26	59	37.5	24	59	38	23	60.5	38.5
5 Iron	30	60	37	28	60	37.5	26	61	38
6 Iron	34	61	36.5	32	61	37	30	61.5	37.5
7 Iron	38	62	36	36	62	36.5	34	62	37
8 Iron	42	63	35.5	40	63	36	38	62.5	36.5
9 Iron	46	64	36	44	64	35.5	42	63	36
PW	50	64	35	48	64	35.5	46	63.5	35.5
SW	56	64	35	56	64	35.5	56	64	35

This is only a guide and does not represent a “standard” for all brands of golf clubs.  
When clubs are “custom fitted” the specifications can vary.

**Hosel Configurations**

Iron heads are designed with different hosel configurations. It is important to identify these hosel designs for the purpose of understanding their bending characteristics when making lie angle adjustments.

Iron Hosel Terms:

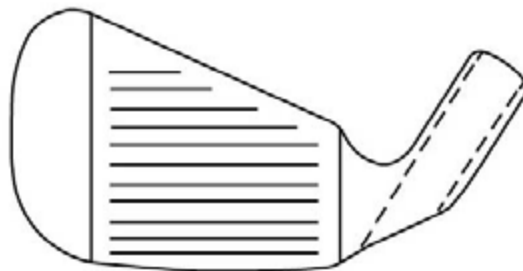
- Length
- Bore Depth
- Top Line Separation
- Outside Diameter
- Inside Diameter
- Wall Thickness
- Off Center Bore



Most friendly design  
Bends up to 4° depending on material and Rockwell hardness  
Little risk of cosmetic damage



Least friendly design  
Bends up to 3° depending on material and Rockwell hardness  
Bottom of bore at or below top line of club face  
Hosel can form a flat spot or indentation blemish



Friendly design  
Bends 3° without risking damage  
At 4° bend – Risk causing small cracks at the bottom of the bore-through  
May be necessary to blend the shaft tip to the sole using a buffing wheel.



**Metallurgy Of Club Heads**

Types of Metals

- 17-4 Stainless Steel
- 431 Stainless Steel
- 15-5 Stainless Steel
- 6-4 Titanium
- Forged Titanium
- 15-3-3-3 Titanium (Beta)
- Beryllium Copper
- Maraging
- Super Steel
- 1030 Carbon
- Aerospace Aluminum

Heat Treating Process

Annealing

Softening Process

Re-aligns molecular structure to make grain structure of the alloy more consistent

Heat Treating

Hardens club heads to specified hardness for strength and makes metal bendable

**ROCKWELL HARDNESS**

1030 Carbon Steel Forged Irons	B70-B80
431 Stainless Steel Cast Irons	C18-C22
17-4 Stainless Steel Cast Irons	C28-C32
17-4 Stainless Steel Cast Woods	C30-C35
6-4 Titanium Cast Woods	C45-C50

Bending Characteristics

Stretching

Physically moving the metal to a new position

Fatigue

Having changed the metal into a new permanent memory position

Memory

What the metal exhibits before it has been stretched or fatigued due to its grain structure

Golf clubs will not return to their old memory position after bending

Repetition

The useful life of a golf club allows it to be bent several times without damaging it



## Part 5 - Business Plan For Implementing Club Performance

### What It Takes To Be An Equipment Expert

An equipment expert understands ball flight laws, principals and preferences and is fully versed in new & old club designs and shaft characteristics.

An equipment expert understands the performance relationship of each component of a golf club and has the ability to observe and calculate equipment effects on ball flight.

An equipment expert has the ability to process technical data & recommend equipment specification numbers for fitted clubs.

An equipment expert understands the importance of properly fit clubs and knows how to conduct the dynamic fitting process to determine the proper:

- Grip Size
- Club Lengths
- Shaft Flex
- Shaft Weight
- Swing Weight
- Total Club Weight
- Lie Angles
- Loft Angles
- Face Angles
- Bounce Angles

An equipment expert works with a launch monitor and understands how to interpret and fit clubs from the following data:

- Ball Speed
- Launch Angle
- Spin Rate
- Power Transfer Ratio

An Equipment Expert is trained and experienced in club assembly, repair and alternation techniques.

An Equipment Expert possesses workbench skills to re-grip, re-shaft and adjust loft, lie and face angles.

An Equipment Expert knows how to use and maintain machines & tools for club alterations.

An Equipment Expert understands performance effects of all components of a golf club and performs upgrades of re-grip, re-shaft and angle adjustments for game improvement.

***What Tools Are Required For Club Performance Evaluation***

- Digital Grip Gauge
- Club Length Measure Tool
- Frequency Analyzer
- Swing Weight Scale
- Gram Scale
- Loft, Lie, Face Angle Machine
- Bounce Angle Gauge
- Launch Monitor

***What Training Is Required*** - Certified as a club repair performance technician, club performance fitting specialist and golf instructor.

***What Golf Instructors Add To Equipment Expert Definition*** - A golf instructor has knowledge of golf swing mechanics, knows ball flight laws, principles & preferences, can recognize swing faults and equipment induced bad shots, and has the ability to coach swing changes with equipment changes.

***Summary***

- How can a golfer learn from an instructor if their equipment induces bad swings?
- How can an instructor teach proper swing mechanics with ill-fitting equipment?
- Should instructors teach compensating swing moves allowing for faulty equipment performance?
- How can a club fitter fit clubs to poor swing mechanics?
- Should club performance upgrades be provided as the golfer's ability improves?

***CONCLUSION***

Industry professionals must do more than sell clubs from manufacturers' fitting carts. They must be able to fit, retrofit and ensure golf club specifications are a perfect match for their golfers. Being trained in one or more fitting system limits the fitting process and makes the golf professional solely dependent on the quality of the club making procedures of the club manufacturer. What are the club manufacturer's tolerances and how important are exact club specifications matched to the needs of golfers? How can industry professionals be sure that the club manufacturer's quality control will furnish exactly what was ordered?

As club fitters, when industry professionals do not know the exact specifications of the clubs they receive and deliver to their customers, they are putting their professional credibility on the line. They need to be the final quality control for every set of clubs they fit, sell and deliver to their golfers. Golf professionals must have the expertise and tools to perform this quality control task. All industry professionals must use the latest technology available to compete. Golfers are demanding the same tour van repair services tour players receive from tour vans every week on tour. A club repair shop is the vehicle to provide that same tour van service at golf courses, ranges and retail stores.

## How To Measure & Evaluate Club Performance Numbers

1. **Grip Size** - Measure grips using a caliper and record sizes in thousandths of an inch. You will probably find varying sizes in the set. Check your student's hands to see if their grips are the best fit. Re-grip if needed.
2. **Club Length** - Measure & record the lengths of all clubs including the putter. Check to see if the lengths create the desired spine angle that will ensure the proper balance throughout the swing. Do not accept the golf industries forced standards as best for your students. Re-shaft if needed.
3. **Shaft Flex** - Check the frequency of all clubs and graph out the flex gradient. Compare frequency of each club to confirm flex consistency throughout set. Determine if shaft type and flex is right for student based on ball flight performance. Re-shaft if needed.
4. **Shaft Weight** - Determine & record the shaft weights throughout the set. Refer to manufacturer's specification data sheets.
5. **Swing Weight** - Measure & record swing weights of all clubs.
6. **Total Club Weight** - Measure & record the total weight of each club in ounces/grams.
7. **Lie Angles** - Test student on dynamic lie angle board to determine ideal lie angle for a #6 iron. Measure and record lie angles of all clubs in set. Compare for a consistent progression within set and to the student's ideal dynamic lie angle. Make adjustments as needed.
8. **Loft Angles** - Measure and record all loft angles. Compare for a consistent progression within set and for distance gapping between each club. Make adjustments as needed.
9. **Face Angles** - Measure and record face angles of woods and hybrids. Compare consistency within set and determine if face angles are influencing ball flight positively or negatively. Make adjustments as needed.
10. **Bounce Angles** - Measure or determine bounce angles on wedges. Altering loft changes bounce angles as well.
11. **Ball Speed** - Measure and record ball speed of driver and #6 iron. Compare to industry average and performance of golfers' athleticism.
12. **Launch Angle** - Measure and record launch angle of driver and #6 iron. Compare to industry average and performance of golfers' athleticism.
13. **Spin Rate** - Measure and record spin rate of driver and #6 iron. Compare to industry average and performance of golfers' athleticism.
14. **Power Transfer Ratio (PTR)** - Measure and record PTR of driver and #6 iron. Determine if student is getting the most out of their ball speed to club head speed transfer ratio.

## Interpreting Launch Monitor Data For Club Performance

A launch monitor system will calculate and depict the flight of the ball as it moves downrange. This information includes the distance, dispersion (off line), roll and flight time. This information is obtained from a simulation that breaks the ball flight into 100 millisecond intervals. For each interval the speed, direction, spin rate, lift and drag values are computed. This information is then used to predict what the ball will do in the next 100 milliseconds. This methodology results in an accurate depiction of the ball's flight.

### TERMINOLOGY:

**Ball Speed** - Ball speed is the velocity of the ball as it leaves the club head. Ball speed is the key determinant to distance. If a player is able to increase his ball speed, his distance will correspondingly increase as a result, provided all other parameters remain the same.

**Swing Speed** - Also known as club head speed, the velocity of the golf club head at, or very near, impact. Typically a faster swing speed produces a faster ball speed and thus more distance.

**Vertical (Launch) Angle** - The angle of the ball from horizontal as it leaves the club head. The higher the initial launch angle, the farther the ball will travel, provided it has an optimum spin rate.

**Backspin** - Backspin is the spin that allows the ball to become airborne.

**Sidespin** - Sidespin is the spin deviation related to the specific target.

**Total Spin** - The combination of backspin and sidespin

**Carry Distance** - The distance the ball flies in the air, from the time it was struck with the club, until it lands.

**Total Distance** - The combination of carry distance and roll after the ball lands.

### EXAMPLES OF OPTIMAL LAUNCH CONDITIONS:

While launch fitting will vary from player to player, the following data provides a generalization of ideal launch conditions for a variety of players.

#### VERTICAL LAUNCH SPIN RATE CHART

Ball Speed	Vertical Launch	Backspin Low	Backspin High
130-140 mph	14.5	3600	4000
130-140 mph	15.5	3400	3800
140-150 mph	13.5	3200	3600
140-150 mph	14.5	3000	3400
150-160 mph	12.5	2800	3200
150-160 mph	13.2	2600	3000
160-170 mph	11.5	2500	2800
160-170 mph	12.2	2300	2500
170-180 mph	10.5	2300	2500
170-180 mph	11.2	2150	2300
180+ mph	9.5	2100	2300
180+ mph	10	1950	2150

**Is There An Ideal Launch Condition For Every Player** - Since most golfers want distance without a loss of accuracy, the answer becomes difficult because certain launch parameters for distance when the club head hits a ball are in opposition to what is optimal for accuracy. For maximum distance, the golfer wants to achieve a combination of launch parameters that yield the highest launch angle with the lowest amount of backspin with the highest ball velocity.

It is easy to increase launch angle by increasing loft, moving to a more rear-CG club head, or by using a shaft with a softer overall flex/softer flex tip section. But these changes on their own will also bring with them a decrease in the ball velocity and an increase in backspin at the same time. So the net result could be a loss of distance if the drop in ball velocity along with the backspin increase negates the increase in launch angle.

Launch Angle is the easiest parameter to change for a golfer. Backspin reduction is the hardest because so much of that parameter is tied directly to the swing characteristics of the golfer.

Ball velocity is the other parameter that directly affects launch and distance. We can increase ball velocity and launch angle together by using a driver head with a higher COR than what the golfer is currently using. Another way is to switch to a more flexible shaft or more tip flexible shaft, because a change in shaft that also changes trajectory will not normally lower the ball velocity at the same time. Do keep in mind that because most golfers have driver swing speeds under 90 mph, many times for these types of players a launch angle increase just from a higher loft driver will keep the ball in the air long enough to generate greater carry distance.

#### CHANGES IN LAUNCH CONDITIONS AND RESULTING BALL FLIGHT CHANGES:

1. Adjusting launch angles and spin rates can yield similar total distances for golfers who generate different swing speeds.

#### LAUNCH MONITOR TOTAL CARRY CHART

Total Carry	Swing Speed	Vertical Launch	Backspin
207	83.3	16.8	2199
207	95.8	14.9	5592
222	101.0	14.1	5801
222	85.3	21.3	2689
232	102.1	12.4	1735
232	92.1	13.8	3201
248	96.6	12.2	2506
248	103.9	10.5	3983

2. Even though two golfers have identical swing speeds, changing either the vertical launch angle or spin rate will yield completely different carry distances.

#### LAUNCH MONITOR SWING SPEED CHART

Swing Speed	Vertical Launch	Backspin	Distance
103	10.5	3983	248
103	15.2	3964	260
87	15	4918	189
87	15	4004	205



## Part 6 - Integrating Club Performance Into Lesson Program

A lesson plan with club performance evaluation and alterations can be structured like this:

- Explain club performance evaluation and lesson plan concept to student
- Offer series of lessons including club performance evaluation and alterations
- Offer individual lessons including club performance evaluation and alterations

Goals For Integrating Club Performance Into Lesson Plan

- Understanding how changing club characteristics will affect ball flight and the player by eliminating the maximum number of negative club performance numbers.
- Allowing the player to play their best while considering their physical attributes and personal preferences.
- Allowing the player to swing to balance with the least amount of effort considering their ability and swing style to attain maximum benefit.

Lesson Series

A Complete Game Improvement Approach

Series Of Six 1-Hour Sessions

Evaluating Swing Mechanics

Evaluating Club Performance

Making Alterations

Price: \$Equal to Regular Lesson Rates

*Lesson One*

Measure and record 10 static club performance numbers

Time: 20-30 minutes

Conduct swing analysis - work only on fundamentals

Time: 20-30 minutes

Check iron lie angles on impact board - #6 & 9-irons

Time: 10 minutes

Total Time: 1-hour

*Lesson Two*

Measure and record 4 dynamic club performance numbers

Time: 20-30 minutes

Use demo clubs with launch monitor to gather additional club performance data

Conduct swing analysis - work on swing mechanics

Time: 20-30 minutes

Discuss recommendations for club performance alterations

Time: 10 minutes

Total Time: 1-hour

PART 6 - Integrating Club Performance Into Lesson Program

*Lesson Three*

Make recommended club performance alterations before this lesson -  
charge for alterations and time in addition to lesson rates

Explain alterations and conduct swing analysis to verify performance changes

Time: 30 minutes

Conduct swing changes

Time: 30 minutes

Total Time: 1-hour

*Lesson Four*

Conduct swing analysis, make swing changes and

Alter clubs again if required to achieve desired ball flight results

Time: 60 minutes

Total Time: 1-hour

*Lesson Five*

conduct short game analysis

Verify lie angles for wedges using impact board – adjust angles as needed

Time: 15 minutes

Adjust wedge loft angles to gap distance

Time: 15 minutes

Measure, record and adjust putter lie and loft

Time: 15

Putter instruction

Time: 15 minutes

Total Time: 1-hour

*Lesson Six*

Conduct swing and club performance analysis to verify ball flight results

Time: 45 minutes

Make any final club performance alterations

Time: 15 minutes

Total Time: 1-hour

*Individual Lesson*

Request student bring clubs in for evaluation before scheduled lesson time

Charge for extra time as part of lesson fee at lesson rates

Observe student's swing mechanics

Recommend swing and club alterations

Charge market prices for club alterations





## Part 7 - Conclusion

Is it the swing, the clubs or could it be both? All aspects of the golf business are embracing the trend that golf instruction, club fitting and club performance alterations are intertwined to produce game improvement.

Golf instructors cannot teach a perfect swing with ill-fitted clubs. Club fitters cannot fit perfect clubs to poor swing mechanics. Altering and fine-tuning clubs produce the best results. Optimizing performance for any golfer must include head design, loft/lie & face angles, grip size and shaft characteristics.

Tour van repair services have become common practice in a lot of retail golf shops. Golfers want the same club performance service tour professionals receive every week on tour. They understand the gap between golf instruction and club fitting and want their instructors to evaluate their golf clubs.

With the few tools outlined earlier, golf instructors can implement *The 14 Club Performance Numbers* evaluation into their lesson program, become a complete equipment expert and provide greater game improvement to their students.

With the information in this manual golf instructors have the knowledge and understanding of how golf club performance influences learning and affects ball flight. The sample lesson plan shows golf instructors how to implement club performance alterations into a lesson series.

They can market club performance alterations with their lessons for the total learning experience. And it produces a new profit center.

As stated earlier, Herb Graffis suggested that instructors must return to the roots of the Scottish golf professional when it is evident that a golfer needs help with their equipment as well as their swing. Instructors must return their industry roots. It's a known fact club performance influences ball flight, which influences the player & swing regardless of the teacher's ability. Instructors can also influence the student's reaction by altering ball flight through instruction & equipment.

Most golf professionals consider themselves a golf equipment expert because of their expertise as an instructor and club fitter. They believe their training and experience in both areas is sufficient to qualify as an equipment expert. Their goal is to improve ball flight in either instance.

Golf professionals separate instruction and club fitting into two distinct functions.

Lets look at the way many professionals (including top 100 instructors) approach golf instruction.

They believe as recognized instructors their task is to teach golfers to play or improve with whatever golf equipment they bring to the lesson tee. Their instruction method is to achieve a result right then so the golfer sees improved ball flight. But what happens after the lesson when the golfer goes to the course? Does their equipment prohibit them from permanently re-training their swing mechanics? Or do they keep coming back for more instruction believing their physical limitations or inabilities are the total cause for not improving?

Now let's examine what most golf professionals consider as adequate training to be considered an equipment expert.

They generally use fitting carts from selected OEM club manufacturers. While it is true they possess expert knowledge shared with them by the club manufacturer's sales representative or when they made the trip to the manufacturer's factory to be trained, they are limited to the club performance features and the prescribed fitting process of each manufacturer. This process does not share with them the complete performance specification numbers of the fitted set they order for their customer.

Most professionals do not know when the custom fit clubs they ordered match the fitting specifications of the original order? What if the golfer does not like the custom fit clubs. What happens when the golfer does not improve?

Most professionals are not able to verify the performance numbers of the fitted clubs nor recommend changes for improvement? Compare this to purchasing a new car and when something goes wrong with its performance, you take it back to the dealer and ask their expert to make it perform as expected. What would you do if the dealer said they don't do that work and will have to send your car to someone else? Would you feel like they are not the experts after all?

Professionals should offer follow up service on the equipment they sell. They should not rely on someone who does not know the customer or what the problem might be? Should they send the clubs back to the manufacturer hoping for a fix? Who is the expert, the professional or someone else?

A truly complete equipment expert is capable of measuring and understanding the performance specifications of any golf club. There are only 14 club performance numbers that need to be known to be a complete equipment expert.

1. Grip Size
2. Club Lengths
3. Shaft Flex
4. Shaft Weight
5. Swing Weight
6. Total Club Weight
7. Lie Angles
8. Loft Angles
9. Face Angles
10. Bounce Angles
11. Ball Speed
12. Launch Angle
13. Spin Rate
14. Power Transfer Ratio (PTR)

Can you measure *The 14 Club Performance Numbers* of your students clubs before you give them instructions? Do you know *The 14 Club Performance Numbers* of the clubs you fit? What are *The 14 Club Performance Numbers* of the clubs you play?

# Appendix

## Supplemental Resources

*The PGA*

by Herb Graffis  
1975

*PGA Teaching Manual*

by Dr. Gary Wiren, PGA  
1990

*The PGA Manual of Golf*

by Dr. Gary Wiren, PGA  
1997

*Search For The Perfect Swing*

by Alastair Cochran & John Stubbs  
1986

*How Golf Clubs Really Work*

By Frank D. Werner & Richard C. Greig with Roger Ganem  
2000

*Better Golf from New Research*

By Richard C. Greig & Frank D. Werner  
2009

*How To Set Up And Operate A Club Repair Shop*

by Ed Mitchell, PGA  
2008

*Science and Golf*

Edited by A. J. Cochran  
1990

## Golf Industry Organizations

The Professional Golfers Association of America 100 Avenue of the Champions Box 109601 Palm Beach Gardens, FL 33410-9601 561-624-8400 - [www.pga.com](http://www.pga.com)

Ladies Professional Golfer Association 100 International Golf Drive Daytona Beach, Florida 32124-1092 386-274-6200 [tcpmembership@lpga.com](mailto:tcpmembership@lpga.com) - [www.lpga.com](http://www.lpga.com)

United States Golf Association P. O. Box 708 Far Hills, N.J. 07931 908-234-2300 [www.usga.org](http://www.usga.org)

Golf Coaches Association of America 1225 West Main Street Suite 110 Norman, OK 73069 405- 329-4222 [sharon@collegiategolf.com](mailto:sharon@collegiategolf.com)

### **Club Repair Training & Certification**

Mitchell Golf Equipment Institute 997 Senate Drive Dayton, Ohio 45459 800-437-1314 937-436-1314 [info@mitchellgolfschool.com](mailto:info@mitchellgolfschool.com) - [www.mitchellgolfschool.com](http://www.mitchellgolfschool.com)

### **Club Repair Equipment & Supplies**

Mitchell Golf Equipment Company 954 Senate Drive Dayton, Ohio 45459 800-437-1314 937-436-1314 [info@mitchellgolf.com](mailto:info@mitchellgolf.com) - [www.mitchellgolf.com](http://www.mitchellgolf.com)



**“In selecting clubs I always look for those which suit my swing. I’ve spent too long developing that swing to make any radical changes in it merely to fit a new club.” - Ben Hogan, 1948**