

Assigning numbers to feel.

Breit Olsson, Tony Björkman, Richard Dovrell. Smart Balance Golf June 2013

We can travel to the moon, build nuclear power plants and manipulate DNA, but we cannot exactly reproduce a golf club or make two identical golf sets. Even though a golf club consists of just three parts. Can this really be true?

There has been much talk recently about Rory's change of equipment from Titleist to Nike. Nick Faldo said a short time ago on Golf Channel's "Morning Drive", "I've changed clubs and changed equipment, and every manufacturer will say, 'We can copy your clubs: we can tweak the golf ball so it fits you.' But there's feel and sound as well, and there's confidence". Johnny Miller agreed, pointing to his own experience with new clubs. "I was like a fish out of water, I was gasping for air..."

Phil Mickelson said, after he won the Northern Trust Open in 2009, "I ended up going back to my old irons trying to eliminate some variables."

There have been many cases where tour players, over the years, have had problems changing clubs, despite the full backing of manufacturers and the fact that tour players are very good at adapting to their equipment and training continuously, very often injuring themselves in the process. We can definitively dispose of the old idea that great players can win a championship even if they play with a broomstick.

The manufacturers of golfing equipment have made great strides over the years in the use of new materials and more forgiving clubs, adjustable drivers and amazing new balls, but there has still only been a slight reduction in the average handicap. There is one area where development has stood completely still, and that is in the improvement of the interface between the human body and the golf club. In most other fields there have been great advances in ergonomic adaptation to the

human body, such as smart running shoes, keyboards, computer mice, clothes, cars, and so forth. In golf, however, this development has scarcely started yet. We still use the same standard method to match and specify the golf clubs that we have used for almost a hundred years. Swing weight is an arbitrary figure based on the balance of the club in a resting state and it is assigned with no consideration of the actual use of golf clubs. You cannot ergonomically match, provide a detailed specification of or copy golf clubs by using only their swing weight. When I talked to Frank Thomas, the former technical director of USGA, he said "It is unfortunate that the industry got stuck in swing weight".

We need to get more people to play golf but in particular need to get people who start playing to come more quickly over the threshold of enjoyable golf that they cross when they can hit the ball correctly. What we want to achieve is the conversion of bad shots into good misses.

Today we have a large percentage of beginners who will give up on golf not long after they start to play it.

The National Golf Foundation reported that more than 150 golf courses in the U.S.A. closed during 2012.

Feel and interference

The word "feel" is constantly heard when you talk with talented golfers: the feeling of effortlessly swinging the club without thinking about it, and then the wonderful feedback from the beautiful sound of the club face hitting the sweet spot and seeing the ball fly just like you intended. This increases a player's stock of confidence. When you can do the same thing with every club in your bag, you suddenly enter the zone where everything just works. Some days it works great, on other days things are not so good. What is this feel and how can we help it grow? We can certainly succeed in doing so, this great feeling is achieved when we manage to reprogram the complexities of our body. With our muscles attached to 14 joints (ankles, knees, hips, back, chest, shoulders, elbows and wrists), we initiate an elaborate motoric process in a very exact sequence to accelerate a club from standstill to 100 mph in a fraction of a second and with enormous precision. The work that the body performs is well described in a research report from **Steven Nesbit and Monika Serrano (1)**. They mention about 1000-1500 Nm for a swing, and this is the equivalent of a force that would lift 150kg one meter. The motor system of the body is challenged when we change our clubs, because it must then be adjusted to the kinetic qualities of the new club. This reprogramming of our motor control as we change from one club to another is difficult without taking some swings with the club. A perceptual reprogramming is a real challenge. We can test-swing the club, but if we fail to adjust the body to the demands of the new club we will probably miss the sweet spot, and this results in shorter shots with less control of their direction.

We asked several PGA instructors the following question: If we get an amateur to first hit five to ten practice shots and then test five shots to check their dispersion with the 9 iron, 7 iron and 5 iron, and the amateur then strikes with the three clubs, switching clubs every other swing, how much less precise will the shots be when the clubs are changed. The answers we received lay in the range between 20% and 40% less precision. Do this exercise yourself at the range and feel free to use impact tape or spray, and you will discover that the spread increases markedly in the club head when you have to adjust the

body from club to club. "Interference" is the word we use for the situation when the last used club disrupts the reprogramming of the body to the kinetic properties of the new club.

Logically you should be able to hit correctly with every club in your bag if you can hit one of them, provided that all the clubs are ergonomically matched. But what happens in the real world? With golfing equipment today the player's body must adjust itself to the new club, which requires a lot of training and presumably some innate ability.

The club affects the body and the body affects the club, which has both been demonstrated in our tests, and is also further described in the research of **GB Shan, N. Betzler & Dunn (2)**. These researchers have examined a number of talented golfers who were tested with six irons which all had slightly different mechanical properties. The results showed that we adapt our swings as we move between clubs that have different kinetic load. This shows that an uneven swing is mostly a result of our clubs. You affect the club as it affects you, "It takes two to tango." No wonder that you come close to mental collapse when you have to learn to dance with thirteen different partners. Many decent golfers have problems with their swing after changing clubs. But if you look for the answer in the swing, it might lie a long way off. Feel and hitting the sweet spot is largely a question of equipment.

Our feel gets up to a lot of monkey business. **Dr. Greg Rose and Dave Phillips from Titleist Performance Institute participated in the program Sports Science (3)**. Dave warmed up first and then hit ten strokes with his driver. Then he warmed up with two clubs (a driver and an iron) before taking ten shots with the driver. Dave felt that the driver was lighter and that he struck at a higher speed. The results of the test showed that warming up with a heavier driver was not a good idea. The average length of ten strikes was thirty yards less. Swing speed was not affected but to switch between different clubs requires much training in order to swing precisely even if the golfer is very skilled. Missing the sweet spot by a few millimeters reduces the transference of energy to the ball. Greg Rose observes that "feel and real is not always the same" (in a video available on Youtube).

In the research report **Switching tools by Sandee Scott and Rob Gray, (4)** a number of baseball players were asked to use differently weighted bats and the result was identical, switching between differently weighted bats led to a deterioration in performance.

Feeling is not related to performance, but an internal comparison with previous experiences. **Jon Karlsen found in his research on putting (5)** that many tour players choose the wrong form of the putter head for best aiming easiness and a wrong weight for the putter if they base their choice on feel. Nor can feel be used to answer the following question: If you have two clubs, each of which works perfectly on its own, though when you switch between them the dispersion increases on one of the clubs, which club do you need to change?

Feel fools players regularly, and we may dislike our favorite clubs, depending on what other clubs we mix them with in our bags. How can this happen?

Interference is a well known phenomenon that we face in many everyday situations. During the Middle Ages it was also known. In medieval castles stairs were built with steps of different heights and depths, which resulted in enemy who stormed the castle stumbling on the uneven stairs and being killed, while the castle's residents learned to use the stairs in the course of their daily life. Those who are well-disposed to order will protest at this and feel that this example is not analogous to a switch between golf clubs. And the objector is quite right. Switching golf clubs is much more difficult than lifting one leg before the other on an uneven flight of stairs. But let's nevertheless use the stairs as a comparison since all the old myths about golf and antiquated prejudices about equipment can easily cloud our minds. We humans are very proficient at repeating a movement in identical circumstances. The body can automatically progress up a whole flight of stairs after we have taken the first step, we can close our eyes and talk on our cell phone as we go up. However, if the depth or height of the steps varies we can easily trip. On the driving range amateurs stand and hit many great shots with the same club, but on the course, with one shot at a time from every club, the bad shots appear.

Ergonomics and golf clubs

We illustrate with the real "load" of some golf clubs from a couple of golfers. "Steps" refers to the relative loads to which the player must adjust before executing the swing. First, a scratch player who has competed at the Swedish national level. Below we see one of the four torsional moments that act on the human body when we swing the club. All four moments need to be controlled in order to specify a golf club and copy it. The torsional moment is in Nm but the absolute value is irrelevant here, since it is the intervals between the golf clubs that are most interesting in this context. Without going any deeper into technical mathematical details we can mention that the models used to derive the values are the double pendulum and Newton's laws of motion. In this "staircase" one must practice a great deal in order not to "trip" somewhere halfway up.

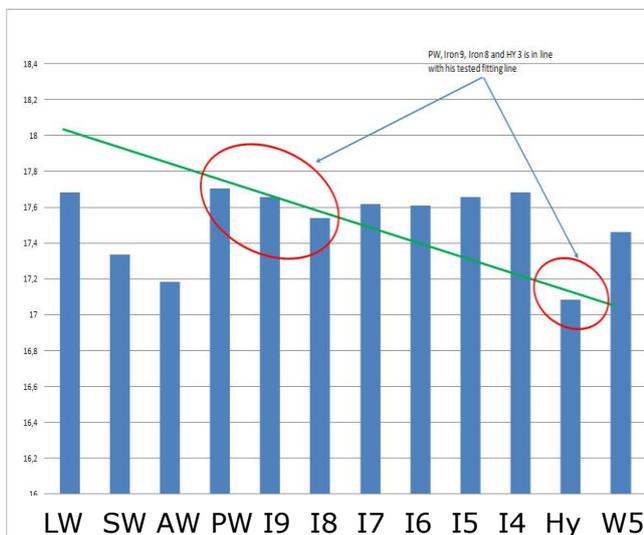


Apparently the 9 iron, 8 iron and 7 iron have the widest dispersion from the club face, while the pitching wedge (PW) and 6 iron have a low dispersion.

The PW is on the left hand side. The player has obvious problems finding the "feel" - this means that it is difficult to reprogram his body for these clubs. His problem coincides with the deviation in load compared to the tested alignment.



The next example is an 9 handicapper with weak wedge play and an 8 iron that he uses infrequently since he said that he had a mental problem with using it. As we can see, there is a dip in the 8 iron and the wedges are totally wrong compared with his tested alignment. This example shows yet again that you cannot rely on feel. In the new set of tested clubs the hated 8 iron becomes one of four clubs of the old set that now suddenly fit. The 8 iron becomes one of his thirteen new favorites with his new alignment (green line).



This shows that in order to provide players with ergonomic clubs we need to match all the clubs in their bags, something which is simply not done nowadays. As can be seen from the actual curve from the player's old set, all of the clubs that are not irons live their own independent lives. The set of irons is swing weighted though, and with the relation between the weights of the heads there will be roughly the same torsional moment on the wrists with each iron in the set at release. Our measurements show that over 95% of all amateurs require decreased moment with longer clubs. This is one reason why an amateur finds it harder to hit the ball well with a longer iron compared to a shorter iron. The usual explanation is that it is harder to hit the ball with a longer club, but most amateurs can easily hit the ball with a longer club like wood 7 without any problems. However, it is not certain that the ball will fly well if the speed of the club head is low and has less loft, but that is a separate consideration.

The challenge to manufacturers and to all golfers is whether we can change our pattern of purchases and thereby acquire clubs that are easier to play with. Are we prepared to buy a whole series, from wedge to woods, with a set of specifications that ensures that you, as a customer who wants to buy this year's model, will find sets of clubs with suitable specs in stock.

Breit Olsson has worked as a club-fitter for twenty years. For the last eight years he has documented the data about the four torsional moments needed to specify a golf club from studies of hundreds of amateur golfers. Today we have a good idea of how the masses of golf clubs should be distributed in order for the body to be able to switch easily and naturally from the use of one long golf club to another with as little interference as possible. With perfectly matched clubs, an amateur with a high handicap can switch from club to club and continue to hit the ball excellently. The secret being that the body does not then need to be reprogrammed between each swing. The picture shows how things usually look after a personal fitting, which obviously gives the best results. Then even a player with a high handicap can achieve this result when changing clubs without a practice swing. A typical spontaneous comment by golfers after this test is: "I felt like I was using the same club every time."



Summary

We can confirm that if you intend to try out a new club today, do it by switching between it and any of your old clubs so that you do not get an unpleasant surprise out on the course because of interference from the other clubs. It is also true that if you are trying out a new club buy the club that you have used to test it, the "same" club on the shelf will probably "feel" different, that is it will have a different specification. We have to concede the truth of Sir Nick Faldo's statement; because of the manner in which the industry specifies our clubs nowadays, we always have to learn to play with the new club. We can, however, with new experimental findings, draw help from

mathematics and the laws of physics in order to specify and copy sets of clubs that all play and feel the same. To build three identical sets for professional players, where one set might be for training, one for actual competition, and one as a spare set, is perfectly feasible. In the future, we believe that the use of ergonomically designed sets of clubs based on scientific knowledge and Newton's laws of motion will be common. Today, there are no such clubs on the market, as far as we are aware.

The golf world is conservative, but anything that might help the sport to increase in popularity should, in all fairness, be taken into consideration.

References:

- (1) "Work and Power Analysis of the Golf Swing", Steven M. Nesbit and Monika Serrano
- (2) "The Influences of Motor Control Adaptation and Human-Equipment Interaction on Issues Related to Golf Club Design and Optimization", G.B. Shan, N. Betzler and B. Dunn
- (3) "Warming up with a weighted bat or club", Sports Science video on Youtube, Dr. Greg Rose Titelist Performance Institute
- (4) "Switching tools: perceptual-motor recalibration to weight changes", Sandee Scott & Rob Gray
- (5) "Performance in golf putting", Jon Karlsen