

The State of Golf and Science, 16 years into the 21st Century - A White Paper

The first sixteen years of the 21st Century have shown an exponential growth in how mankind uses science and technology in every field of human endeavor. How about in sport, specifically in golf? Has science and technology been utilized sufficiently to improve the quality of golf of all golfers, from the weekend enthusiast to the best players in the world? We must, of course, first define which aspect of 'quality of golf' we wish to assess, so that such a question can be answered in scientific terms.

Perhaps the most important quality all golfers look for is 'consistency'. On 30th December 2015, Tiger Woods' 40th birthday, ESPN stated that, "Tiger Woods is getting older, but golf is getting younger" and went on to add that ".....beginning at age 32, Nicklaus won nine majors. Woods has won only one. The difference between the two is consistency and durability." A few weeks prior, Bubba Watson, upon winning the last big PGA Tour event of 2015 said, "I think every year we're getting better at consistency. I believe consistency's the biggest thing about this game." Is it a fact that golfers are getting 'better at consistency'? Jordan Spieth won the US Masters in 2015, then missed the cut a few weeks later. Troy Merritt won a PGA Tour event, then finished dead last the very next week. What is consistency and how can science be used to improve it, especially for a Tour Pro who, these days, has access to the very best inputs possible?

While consistency can be about many things, overcoming three big hurdles would be a good start, and they all involve the full-swing. The 'big three' are - hitting more fairways so as to make the next shot easier; reaching more greens for regulation so that a golfer might putt rather than chip; and placing approach shots closer to the hole, time after time so that more putts might be made. During the 16 years of this century, the best driving accuracy on the PGA Tour (from PGA Tour stats) has been over 80% only thrice, and the best number of greens for regulation always in the 70s (percent) only going over 75% once, in 2000. The best average 'proximity to hole' has been 28' 11" in 2002, the only time this result was better than 30'. Only on five occasions did the person with the closest average proximity to hole also have a rank of 15 or better in greens for regulation. All of the above 'big three' records incidentally, have been held by different golfers, not the same one. Surely the use of science can bump these numbers up just enough for each golfer to have better overall consistency of golf swing?

How do Tour Players attempt to improve consistency?

Most Tour Players typically hire a 'swing coach', often a 'top 100' or 'top 50' instructor, whom they rely on completely for their understanding of the golf swing. Thus, what a player needs to do to improve distance, direction, trajectory, reduce the scope for injury and increase consistency is usually fully the purview of the golf coach/instructor. So, where does the coach come by his/her knowledge of what information to utilize? Details of knowledge acquisition by the teachers, and the science involved, is discussed below.

The first big chunk of information a typical golf instructor acquires is through whichever PGA he/she gets a teaching certification from. The PGA of America, working with several Universities, facilitates the acquisition of the following information:

PGA of America Requirements/Curriculum

There are essentially 4 Levels of coursework to be completed in the PGA side of this major. Beyond the Qualifying Level, each level contains 3 industry aspects: The people, game, and business of golf. These 4 Levels comprise the core of the material taught by the PGA Golf Management Staff in the PGAM Classes. The Qualifying Level This Level serves as an introduction to the program and also covers The History, Constitution of the PGA and the Rules of Golf. The first half of the first semester on campus is spent covering this material.

Level 1 Topics

- Business Planning
- Tournament Operations
- Customer Relations
- Golf Car Fleet Management
- Introduction to Teaching and Golf Club Performance

Level 1 takes the student through Fall semester of their Sophomore Year.

Level 2 Topics

- Golf Operations
- Turfgrass Management
- Merchandising and Inventory Management
- Intermediate Teaching and Golf Club Alterations

Level 2 takes the student through Fall semester of their Junior Year.

Level 3 Topics

- Human Resources/Supervising and Delegating
- Food and Beverage Control
- Career Enhancement
- Player Development Programs/Teaching as a Business
- Advanced Teaching and Golf Club Fitting
- Final Experience

Students will typically finish Level 3 in the Spring of their Senior Year.

As can clearly be seen, there is not much useful golf swing knowledge that a wannabe golf instructor can use, from within such a curriculum. Perhaps the biggest weapon in the newbie's arsenal is information from Gary Wren's Laws, Principles and Preferences. This document states that the golf ball, upon impact with the club, will move according to 5 Laws (clubhead speed, club path, clubface position both horizontal and vertical, club angle of approach and centeredness of contact). The 'Laws' which determine what the club is doing at impact are, in turn, influenced by 14 'Principles' which refer to a combination of golfer and club factors. The golfer factors include grip, aim, alignment, set-up, width of arc, position of lead arm and hand, timing/sequencing of body parts, dynamic balance/weight transfer, swing center and connection. The club factors include swing plane, length of swing arc and impact. The 'Preferences' are infinite, and can include such items as early wrist cock, open stance, two-knuckle grip, lateral slide, outside takeaway, light pressure, flat backswing, bent left knee, cupped left wrist, extended arms, left toe out, chin behind, fixed center, weight forward, high hands, shoulders closed, slow backswing, ball position.....

In other words, in the hands of a beginner instructor, the vast and bewildering number of options can be a lethal weapon, practically a 'license to kill'. Most importantly, the Principles and Preferences have never been researched for their efficacy, so WHERE is the SCIENCE?

The savvy instructor tries to gain more knowledge. The next step is probably acquiring experience. While this phase may not be beneficial to the students that a golf pro will work with during his/her first few years of disseminating golf swing information, it is of immeasurable use to the teacher, who will begin to see patterns of what a golfer can and cannot do. However, all the experience acquired is merely subjective - WHERE is the SCIENCE?

Next come the 'certifications', which a golf instructor, by now well-established, uses to differentiate himself or herself from the herd. There are many such to choose from, and a certification can be acquired, usually in just a weekend, on any subject from fitness to mental golf to, of all things, biomechanics. Each of these certifications gives a golf instructor a few tidbits of useful information, which is merely a distillation of the knowledge of the certifying body. Certifications do not impart enough knowledge to enable extrapolation of something specific for the needs of a particular golfer. Moreover, certifications do not give the instructor enough information to manipulate important concepts in a scientific manner. Certifications cannot by any means replace a relevant sports-science based academic education. One study titled "Education Levels of Hospital Nurses and Surgical Patient Mortality" (Aiken et al. 2003) showed, "... a 10% increase in the proportion of nurses holding a bachelor's degree was associated with a 5% decrease in both the likelihood of patients dying within 30 days of admission and the odds of failure to rescue (odds ratio, 0.95; 95% confidence interval, 0.91-0.99 in both cases). The conclusion reached was that, "In hospitals with higher proportions of nurses educated at the baccalaureate level or higher, surgical patients experienced lower mortality and failure-to-rescue rates."

A good example of a certification which has perhaps not been subjected to sufficient scientific rigor is the very popular Titleist Performance Institute (TPI) Level 1 Certification, marketed using the catch-phrase "Today's golfers need to be convinced that their instructors are up to date with the latest information on the sport. Golfers want to trust their coach, instructor or practitioner. TPI Certification gives golfers that trust!" The Level 1 certification then goes on to exhort the interested golf coach to "Learn about the most common swing characteristics that can lead to mechanical inefficiencies in your golf swing, and put you at greater risk for injury." (<http://www.mytpi.com/improvemy-game/swing-characteristics>). These most common swing characteristics include things such as loss of posture, flat shoulder plane, flying elbow, early extension, over the top, slide, sway, late buckle, reverse spine angle, forward lunge, hanging back, casting, scooping and chicken wing. Many of these 'faults' have been merely been passed along through the generations as 'faults' and have never been proven to be such. In fact the fault that TPI has found to be the most common one of all is 'early extension'. This extension or early straightening out from spinal/hip flexion might often be the clever human brain's 'fix' for a less efficient backswing, in which the trail shoulder is in internal rotation and the trail hip higher than

the lead one. The golfer's brain forces the body to 'early extend' rather than stay in posture and risk injury! All the causes of the 'faults', according to TPI, are based on some physical limitations.

"Research Design" is a topic which tells us that when establishing a cause and effect relationship between any two variables, it is very important to rule out any extraneous causative variables which might also lead to the same effect. To give a simple, no-brainer example, 'sway' is defined by TPI as, "An excessive lower body lateral movement away from the target during the backswing". Could this not merely be the result of a golfer having been told to shift weight yet not being able to feel how much to shift and thus over-doing that shift? A single scientific study on TPI 'faults' and their fixes, titled "Correlation of Titleist Performance Institute (TPI) Level 1 Movement Screens and Golf Swing Faults" (Gulgin et al., 2014) found only 3 significant correlations between physical limitations and swing 'faults'. A correlation does not imply a causation, which could involve many other variables, as explained above. Too, the study used only four swings of a 5 iron for all participants, not readily generalizable to other clubs and other situations. As already mentioned, many 'faults' can be addressed by swing fixes alone, and, in fact, a great scientific research project would be physical 'limitation' fix versus swing fix for reducing the 'faults' that TPI claims are common. WHERE is the SCIENCE?

So, the instructor in his/her search for knowledge goes on to 'The PhDs' to source what must surely be slightly more scientific, research-based information. Naturally, biomechanics research (by which is typically meant a study in a laboratory which has cameras, force plates and sometimes electromyographic equipment) can give one very specific numbers on any particular topic. All sports biomechanics research has two problems - it is based on what "skilled" sportspersons do, with no specific definition of what that term means, and is very piecemeal, giving information on small areas of information that a particular scientist specializes in. The "skill" of even the best in the world varies from week to week (hence the "skilled" golfers' search for consistency!) and varies dramatically from sanitized laboratory conditions to what actually takes place in the field. Studying skilled golfers is a useful starting point, as they obviously somehow often manage to make good impact. However, it should not be what all instruction is based on. No ball-impact or ball-release sports (golf, tennis, baseball batting; or cricket bowling and baseball pitching; to name a few) researchers have ever thought to ask, "what is the ball required to do" (how high, how far and with what spin does it need to travel to achieve a particular result) followed by "where must the hand or implement be at the time of release or impact" and finally by "which body positions during the backward motion can best facilitate the desired release/impact". Scientific research for all such sports should begin from first principles, not from what some randomly defined skilled sportspersons can occasionally pull off. WHERE is the SCIENCE?

It is also important when researching the golf swing to design studies that are not merely descriptive but actually experimental. Unless a study is experimental, in which a researcher actually manipulates one variable to study its effect on another, the only conclusion that can be

drawn is of a correlation, not of causation. So, when researchers look at, and describe, “skilled” golfers, all they are performing is an observational study. Sometimes they will compare swings using different clubs, but that only makes the “club” variable an attribute variable, not one which is being actively manipulated. Many studies have a small sample size yet make sweeping extrapolations based on small numbers. Besides not being truly random in the selection of participants, “convenience” sampling or using participants who are easily available in golf means that they may have similar swing styles because of being taught by the same local golf instructor. WHERE is the SCIENCE?

Another source of information golf instructors favor is what is referred to here as “miscellaneous”. It comprises a combination of books and DVD/videos by famous players and teachers, TV channel tips and, of course, latterly, the ubiquitous youtube, a free-for-all for those who feel they have some golf knowledge they wish to impart. Ironically it is the same ‘top 100 instructors’ whose tips are proliferated everywhere, so that there is much copying and mimicking in golf, often leading to any scientific research on leading golfers showing patterns which are common by coincidence, and anyway only show ‘what is’ not ‘how to’. WHERE is the SCIENCE?

As a result of all the glut of knowledge now available, the golf instructor of a leading Tour player farms out responsibilities to various other ‘players’ in the field such as the fitness coach, the physiotherapist, the chiropractor, the mental coach and even the nutritionist. None of these highly specialized individuals ever question the knowledge-base of the golf instructor, and, in fact defer to him/her with respect to what the golf swing MUST do, and then devise their ‘treatment’ based on what the golf pro advises. Actually, the golf pro is probably the weak link in the knowledge-chain.

The need of the hour, especially in the 21st century, in order to avail of all the scientific resources available with which to improve a golfer’s consistency, is for a golf instructor with the educational credentials and a vast breadth of sports science knowledge to be able to act as a ‘primary care physician’. One who is able to co-ordinate the ‘team’ of specialists that form a leading player’s entourage into a cohesive whole, so as to deliver the best possible service to the ‘patient’ - the golfer. One research study, “Leadership Clarity and Team Innovation in Health Care” (Shapiro et al. 2003) found that, “For health care teams in particular, and teams in general, the results suggest a need to ensure leadership is clear in teams when innovation is a desirable team performance outcome.”

The 21st century golf instructor should be able to do all of the following:

1. Understand the constraints of the human body and thus know what will and will not work optimally in a golf swing in anatomical terms
2. Be able to drive suitable, statistically meaningful, research which asks relevant questions in all the important sports sciences

3. Guide the fitness, mental and nutritional coaches so they can better support the swing movements the coach is able to devise

Imagine a scenario in which the golf instructor understands biomechanics sufficiently to devise alternate movements to harness ground reaction force or to better utilize the principle of conservation of angular momentum. Knows the body's design and how joints, muscles and ligaments can or cannot be used. Has enough of a background in exercise physiology, exercise testing and prescription and nutrition to understand human energy systems and how to enhance the mechanisms that drive them in golf. Knows enough about injury to develop movements which might avoid excessive loads on the joints. And has the years of sheer 'in the dirt' teaching experience to be able to deliver a highly scientific experience for any golfer, which is sure to improve, among other things, his/her consistency.

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