

## Rate of Recoil in the Golf Swing

Robert J Neal, PhD

Whilst many golf professionals will be familiar with the concept of “Recoil” during the downswing, they will not have had the knowledge or insight into the idea that is possible using the measurement capabilities of an accurate 3D motion tracking system and a sound understanding of muscle mechanics. One cannot examine the subject in any depth when observations are based solely on qualitative information (i.e. video). In other words, you need to “numbers” to make logical arguments and draw sound conclusions.

The Recoil factor can be explained as follows. Our *operational* definition of recoil is the process that the golfer uses to close the gap between the hips and the shoulders as the body moves towards impact. In a quality golf swing the hips lead out at the start of the downswing and as they accelerate increasing the differential between the hips and shoulders. In the golfing vernacular, the X-Factor (difference between hip and upper torso rotations at the top of the backswing) is created at the top of the backswing and then increased (X-Factor Stretch) in transition. Thus, the hips have a head-start on the upper torso as the tissues across the torso are stretched. However, as the oblique abdominal muscles as well as those in the back and pelvis contract, the upper body rapidly “recoils” and almost catches up to the pelvis at impact. This catching up phase is the **Recoil**. There are many characteristics that govern how this recoil takes place and it is also important to realize that the rate of recoil (speed of recoil) is not constant during the movement.

**Rate of Recoil** (ROR) is defined as the speed with which the upper torso (UT) catches up to the lower body (hips/pelvis) on the downswing. Ideally, in the golf swing we want to see the upper and lower body of the golfer reasonably well matched (with respect to axial rotation) by impact. That is, both the UT and pelvis should be well “cleared” or open to

the target line at impact. In the 3D world the hips and UT should be approximately 30-45 deg. open in a better player with the hips just slightly more open than the UT.

We believe that examination of this Recoil factor can give us tremendous insights into the physical make-up of our gofer. As a consequence, there are important technical as well as training implications for our golf athletes.

This new term is closely linked with the X-factor story. So let's take a moment to recap.

The X-Factor (McLean, 1992) – is the notion that getting a large “gap” or “differential” between the rotation of the hips and the upper torso on the backswing was correlated with driving distance. This concept became a cornerstone of McLean’s teaching system as he advocated that the lower body needed to be stable so that it could resist the turn of the upper body and “coil” was developed in the torso. One can liken the coil to the winding up of a spring in which potential strain energy is stored in the spring and then liberated when one end of the spring is released. The analogy is very appealing since the golfer has structures in the body such as tendons and parts of the muscles that have spring-like properties.

In 2000, Cheetham et al. published a paper in which an extension of the X-Factor was presented. Their idea was that during the backswing a certain amount of “coil” or X-Factor was developed in the body but that this difference was increased during the transition and early downswing phases of the swing where, in good players, the hips bump laterally toward the target and rotate rapidly (faster than the upper body). This movement serves to *stretch* the X-Factor, increasing it by sometimes as much as 60%! Their research showed a strong correlation between those players who launched the ball prodigious distances and the size of the ‘stretch’. The common term to refer to this increase of the X-Factor during the transition between backswing and downswing has become known as the X-Factor Stretch.

Our own research (GBD Inc.) has supported the concept that there is an ideal X-Factor range of values for the top of the backswing<sup>1</sup>. A corridor of 40-50 degrees allows for the variation in the golfing population, from the young adult to the older golfer. Significant deviations from the corridors can they provide us with additional information about their technical ability and physical limitations mostly from a flexibility or motor control stand point.

Most people thought that this was the end of the X-Factor story but that is far from the case! Like any simple theory, it helps us to understand the movement but does not account for many individual variations. Our recent work adds an extremely important piece to the puzzle. The really interesting aspect about this idea is that it not only “gels” very well with coaching ideas but is built on sound principles of human muscle physiology. Put simply, positional variables (e.g., X-Factor or X-Factor Stretch) are important but they do not tell the whole story! Higher order kinematic variables (e.g., Rate of Stretch [ROS] and Rate of Recoil [ROR] - the speeds of movement) are equally important.

Some very simple mechanics will help explain these ideas we are about to present to you. For most of us it is very easy for us to picture positions in the swing. Thus we can develop a picture in our heads that, for example, if a player, on her backswing, turned her hips 50 deg and her shoulders 100 deg that the “gap” between them at the top of the backswing was 50 deg. What is much harder to picture is the way in which these angles change during the backswing and downswing. Perhaps the image of a see-saw or a pendulum will help to make the point here.

If you watch two people on a see-saw you know that when they reach either the zenith (top) or bottom of the “movement”, their speed is zero (i.e., they stop at the top and the bottom for an instant and then change the direction of movement). In the middle of the cycle, when the see-saw is horizontal, both people are moving at their greatest speeds (in opposite directions of course; one person would be moving up but the other person is moving down). In summary, during one upward cycle the person’s speed starts from zero and increases (i.e., an acceleration

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<sup>1</sup> We define the top of the backswing as the maximum hip turn. This point demarcates the wind-up movements of the body and the transition phase where the body segments change direction. In skilled golfers, this change of direction for each segment occurs in sequence, beginning with the lower body and ending with the club.

is experienced) until the halfway point is reached. At that instant, speed is at a maximum. During the next part of the journey up, speed decreases (i.e., a deceleration is experienced) until the high point of the cycle is reached. At this point, speed is zero. After reaching the zenith, the downward phase of a complete cycle begins. Initially speed increases (in the downward direction), reaches a maximum at the horizontal and then decreases to reach zero at the bottom.

A simple pendulum also serves as a good model. If you imagine the movement of the mass at the end of the pendulum, when it reaches the high points of its motion, its speed is zero. As it falls down during the swing, it speeds up until it reaches its maximum speed at the bottom of the arc. During the next part of the cycle, it slows down (decelerates) such that by the time it reaches its highest point on the “other” side, its speed is zero once again. This pattern of acceleration-deceleration continues as the pendulum oscillates. What is the connection with the Rate of Recoil?

The reason for this analogy is to point out that the speed of the see-saw or pendulum is **NOT** constant throughout the motion. It changes (continuously) reaching maxima and minima at certain times in the cycle. The same idea applies to the ROS and ROR. The stretch and recoil do **NOT** take place at a constant speed and muscle physiology and mechanics research has shown that the speed of stretch of a muscle has a dramatic effect on its ability to produce force!

Returning to the golf swing! If one carefully studies the angle between the hips and shoulders during both the backswing and downswing we see some similar patterns. During the backswing the gap opens but it does so at different rates. Initially, the gap does not increase much as the club, UT and hips begin the backswing (one-piece takeaway). During the next part of the backswing, the gap opens quickly as the UT winds past the pelvis. Interestingly, as the top of the backswing position is approached, the gap opens slowly as the UT approaches its maximum turn. The speed that the gap opens on the backswing is not too critical (although it is important) however, the speed that the gap opens during transition (when the X-Factor Stretch is experienced), is crucial. Following that *stretch*, the “gap” between the hips and UT decreases so



that by the time impact occurs, the UT has just about “caught” up to the hips. The rates at which these two events (the stretching and recoiling) occur gives tremendous insight into the body’s strengths and weaknesses!

Need to include some of the data that I discussed at the SFPGA seminar on different rates etc.

To summarize, it is important from a technical perspective that the golfer is in a good position at impact with their body in order to maximize power and consistency. It is a fundamental of all the top golfers. We can use the instructor’s vernacular in saying the golfer should be “stacked” or over the top of it.... The Recoil measurement gives us fantastic insights into the golfer’s rotational power. It is a measure that also helps us understand the emphasis we can place of a golfer’s flexibility in rotation and how important the X-Factor and Stretch combination are in terms of developing power and ultimately speed of the clubhead at impact.