

Compare and  
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The area of biomechanics is a mammoth field, with many millions of pounds invested into research and development. Possibly its main use, is for the design of non-living things such as buildings, bridges, cars, boats and planes, but biomechanics can be applied to sport and different sporting situations, and has had a great impact in sports research. This is because gravity, friction and air resistance make no distinction between sporting and non sporting activities. The same mechanical principles which are used in the everyday world can easily be applied to sporting examples as this study aims to prove.

The aims of this experiment were two fold:

- 1) To compare and contrast using biomechanical techniques the two different styles of throw in used in football.
- 2) In comparing the two techniques draw conclusions as to the optimum release trajectories and velocities for each of the techniques concluding with an informed decision as to which is the ideal method in a range of game situations

Biomechanical techniques can be used within any sport, and soccer in particular, to define the characteristics of skills, to gain an understanding of the mechanical effectiveness of their execution and to identify the factors underlying their successful performance. This knowledge and understanding can help to enhance the learning and performance of those skills.

Until recently most practical coaches have been reluctant to use biomechanics. Carr (1997) reported “ most people involved in coaching are <https://assignbuster.com/compare-and-contrast-using-biomechanical-techniques-the-two-different-styles-of-throw-in-used-in-football-essay-sample/>

reluctant to study sport mechanics because from past experience they know it has meant tackling text loaded with formulas, calculations and scientific technology." This is very much true, but with the advent of more technical kicking and throwing in games, studies involving biomechanics are becoming increasingly popular.

Throw-ins are very important and each team will take 25 or more of them during a game. A study by Lees (1993) concluded that the throw in is the most common way of restarting a game, and when performed correctly has great tactical significance.

The throw in has evolved from only ever being used for short passes to launching a full on attack into the opponents goal area. A throw in is awarded when the whole ball crosses the touchline, either in the air or along the ground.

For the throw in to be legal

- (a) the ball must be thrown from behind & over the head
- (b) it must be thrown using both hands
- (c) the thrower must face the field
- (d) at the instant the ball leaves the thrower's hands, some part of both feet must be on the ground, either on or outside the side line.

The important points from a biomechanical aspect are;

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(1) The soccer throw-in can only be performed with both hands on the ball; therefore there is no trunk rotation to increase ball velocity.

(2) Part of each foot must be in contact with the ground

(3) Both hands must be used equally

(4) The ball is to be delivered from behind and over the thrower's head

More direct to this experiment, Matser, et al (1998) confirmed that the movements of the throw-in all occurs in the sagittal plane, around left-right axes, so the force-producing rotations are all in a forward directions.

The long throw-in has become a real offensive weapon in the game of soccer; especially when taken near the opponent's goal because it is more accurate than a corner kick. Many football teams now have a player with an exceptionally long throw-in, who has the potential to initiate scoring.

Two types of throw-in have been described in existing biomechanical studies: the short distance throw to pass to a teammate and get the ball under control, and the long throw which covers thirty or forty meters before being touched by a receiving player. The short throw-in can be performed by placing the feet in a side by side position, or by placing the feet with one foot in advance of another. The long throw-in is performed with the run up consisting of several steps; or it may be performed as a handspring throw-in. Luhtanen (1994)

In a comparative study Luhtanen compared the three different techniques of the throw, performed by one subject and revealed that the handspring <https://assignbuster.com/compare-and-contrast-using-biomechanical-techniques-the-two-different-styles-of-throw-in-used-in-football-essay-sample/>

throw-in was far superior in producing the greatest distance of the resulting throw-in. This was likely due to the greater approach velocity and the velocity of the ball of release. This study disregards the hand spring method of throw in, as Broglio (2001) pronounced that the widespread practice of the technique is non-existent in professional football.

The range of throwing depends on the initial velocity of the ball. Isocawa (1994) has proved that for initial velocity angles of 35 to 45 the velocity of the ball seems to be the most important factor.

The run-up has proved to be an important aspect of a long throw-in, as the velocity and momentum gained during the run-up are transferred to the ball. The momentum attained in a running approach can be combined with other forces in the throw-in pattern, giving greater velocity at the ball release confirmed by Levendusky, et al (1985).

Nigg & Yeadon (1987) reported that a skilled thrower covered 2.7 m in the run up, consisting of a step, hop and stride. A running approach of 2-4 steps is not uncommon. The traditional standing or running throw appears to be favored by most players, as the thrower can see the target area through the entire motion and make last second adjustments in direction, height, and speed, as reported by Levendusky et al (1988)

The release velocity is further increased through the run up suggested Lohnes, et al (2001). If the throw were to be taken while the player is still in transition then the total of both velocities would be added. In the case of the

throw in, the velocity from the run up is consequently lost when the subject plants their leg on the ground, effectively to stop the forwards motion.

The traditional running throw-in also permits release from maximum height, which will give greater distance for any release velocity confirmed again by Luthanen (2000)

The traditional throw-in relies on rapid trunk flexion, and shoulder extension, elbow extension and wrist flexion to provide force for ball release. The backswing movements consist of trunk hyperextension, hip extension and knee flexion, as well as elbow flexion and wrist hyperextension a study by Armstrong, et al (1994) found. The player leans well back, and brings the ball back as far as possible behind the body. As the trunk begins to flex forward, the arms and ball continue to move backward in relation to the trunk, similar to the movements seen in baseball pitching. As the trunk reaches its range of forward flexion, the trunk stops its forward rotation, and the arms and the ball accelerate forward. Luthanen (2000) showed the maximum velocity of the elbows (24 rad/s) and wrists (7.7 rad/s) reach their peak angular velocity at the instant of release of the ball.

The velocity, and therefore effective distance of the throw can be increased by increasing the length of the limbs involved. The body acts as a whip about the points of rotation. Starting at the hips, then the shoulder, elbow, then wrist., these all rotate about a fixed point in a sequential order.

In analysis of the physical action, there are similar characteristics that can be observed irrespective of the individual throwing style.

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The body hyper extends about the wrists, elbows, shoulder and hips. This is followed by a powerful burst sequentially up the body to the wrists, culminating in the release of the ball. Figure 1

This facilitates the whip motion, as suddenly stopping the lower body in this way, causes the upper body to continue its momentum, allowing the upper body to rapidly accelerate forwards.

The last factor considered which have an impact on overall distance achieved is angle of release. There are conflicting views on angle of release, Lees (1988) argue there is a significant difference in angle between running and standing throws as opposed to Luthanen (2000) who reveals " The traditional running throw in also permits release from maximum height" contradicting the earlier study.

In terms of the effect angles of the body have on total distance achieved, Levendusky (1994) points out the lack of correlation between the body angles and throw in length.

Numerous studies do however, point out that the coordination of the throw in is more important than the angles of the body. When using the whip ideology, its been proved Isokawa (1994) that the shorter the defined intervals between each stage, the higher were the corresponding changes in ball velocity. This is backed with work done by Levendusky (1994) suggesting " another variable which requires careful thought and consideration is the role of coordination in generating throw-in velocity"

Taking the for mentioned variables (angle of release, initial ball velocity, coordination aspects) alone, will not prove which of the two techniques is the more favorable, the key variable must in the end be the distance the ball has traveled.

The experimental hypothesis: Style of throw used (standing; run-up) will influence the distance covered by the ball.

Null hypothesis: Style of throw used will have no effect on the distance covered.

## Method

The method for this experiment is encapsulated into two precise elements; the capture of the video data; and the analysis of the video.

Capture: The video was filmed at The Nottingham Trent University. A standard digital video camera was used to film the action, and was placed on a tri pod 8 metres from the subject, directly inline and at right angles to the subject. This helped to minimize angular distortions and played a major factor in sustaining data integrity in the later analysis stage of experiment.

The action was filmed against a white background with a yellow indoor type football. A white against yellow background was chosen to help in the accurate marking of the video in the analysis stage.

The camera was set to a high (1/500) shutter speed, which meant that a new frame was taken every 500th of a second. Several practice runs were carried



out, which confirmed that all important aspects were in shot (part of the run up, the full extension and flexion and the follow through)

The subject was required to stick markers to the wrist, elbow and shoulder of the right arm. The markers consisted of white paper stuck onto the skin, and distances between the shoulder and elbow was used for later analysis.

The football was weighed, using the standard lab scales and is accurate to 1 KG -2

The subject was asked to throw the ball as far as they could using the run up and the standing method.

Digitization: The footage was then transferred onto a host pc for manipulation and analysis. The software used formed part of the World in Motion suite. Real life data concerning distances and weights were input at the analysis stage, which the software uses to scale the video and deduce accurate distances and velocities at a later stage.

Using the mouse and pointer a spot is made at each of the markers previously placed on the subject, and the video is moved to the next frame and the process repeated. This goes on until the full action of the throw in has been completed and marked.

Graphs were then produced, the ones of main significance for this study being; Displacement v Time; Velocity v Time; Angle v Time

## Results

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Figure 2: Shows the relationship between distance covered and time when the subject used a run up. The final distance covered was

Figure 3: Shows the relationship between distance covered and time when the subject used a standing throw. The final distance covered was

Figure 4: Shows the relationship between velocity and time when the subject threw using a run up. Note the sharp initial velocity levelling off as the ball slows down

Figure 5: Shows the relationship between velocity and time when the subject threw from a standing position. A line of best fit has been plotted, proving the statement that velocity should remain constant throughout the action.

Figure 6: Shows the relationship between acceleration and time when the subject threw from a standing position. This graph is very inaccurate due to the great a fluctuations in the force.

Figure 7: Shows the relationship between acceleration and time when the subject threw from a standing position. Note the inaccuracies in approx the same place as the twin graph for the standing position.

## Discussion

Video analysis turned up some very questionable results. In the process of conducting biomechanics many things can happen to reduce the reliability and validity of the results. Problems can occur during data collection, reduction and analysis (Unsure)

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Some of the sources of error in this study are closely related to the cinematography, explicitly failure to control for errors in parallax and perspective including. This included distortion introduced by the optical system of the camera, and maintaining the optical axis of the camera perpendicular to the plane of motion.

The physical results from my experiment don't show a very high level of validity, but theoretical ideas and theories can still be applied to differentiate between the two different types of throw in.

The range of throwing depends on the initial velocity and release angle of the ball. The initial velocity of the ball will be produced by the consecutive rotational movements of body segments as Luhtanen (1994) showed. The maximization of the release velocity can be reached by achieved by lengthening the radius of motion and/or increasing the angular velocity in the rotation of the throwing movement. In the successful throw the pattern works like whip from the center of action (hip) to the distal segments (hands).

Many biomechanical principles can be applied to a football throw. Some principles apply more towards the muscles needed to perform a football throw, and some apply to the projection and aerodynamics of the football. Newton's 2nd Law of Motion, the Law of Acceleration, states that the angular acceleration is produced by the net torque on a body is proportional to the net torque and inversely proportional to the moment of inertia. The moment of inertia is going to be constant because the ball is not going to change, this has been proved by Matser, et al (1998)

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From the results (fig 4) it can be seen that using the running technique creates much higher velocities. These results are supported by Luhtanen (1994) who found that initial velocity was always higher when throwing using a run up. Results from this study closely match Luhtanens in aspects of initial acceleration (15.94 m/s and 15.21 m/s) respectively. This is very unusual as the acceleration is really down to the individual athletes skill and practiced technique, results from similar studies are usually compared from a systematic viewpoint i. e. throws with a run up will be longer than throws from standing position and don't usually compare individual techniques against each other.

The momentum attained in a running approach can be combined with other forces in the throw-in pattern, giving greater velocity at the ball release Levendusky, et al, (1985). Nigg and Yeadon (1987) reported that a skilled thrower covered 2.7 m in the run up, consisting of a step, hop and stride. This parallels with my subject who utilized a run up of approx 2 m.

To further increase momentum, if the subject applies a torque at the shoulder joint to perform a throw, the football will travel at certain acceleration. If the subject applies a greater torque with the deltoid, pectorals, and rotator cuff muscles, the acceleration of the football will be greater. Newton's Law of Acceleration states; if the torque of the shoulder is increased, the acceleration of the football will also be increased. In simple terms the faster the initial acceleration the longer the distance covered.

Referring to fig 7 the throw with the largest initial acceleration covered more distance than the lesser. The standing throw began its flight at 15.95 m/s

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and covered 7.492 m while the running throw began at 20.54 m/s covering 9.5m.

Overall velocity is another contributing factor in differences between the two throws. A study by Levendusky, et al (1985) showed an overall 22% increase in the initial velocity of his throws with a run up, as compared to throws from standing. The results agree with this finding to an extent, with an overall 31% increase in velocity in the running throw. Although these results are greater than Levenduskys, they do show the expected systematic increase in velocity, hence distance.

Interpreting the results from the velocity/time graph, for both throws the velocity peaks to maximum values in the first 0.2 sec then shows a consistent levelling off until minimum speed is achieved. This is consistent with all biomechanical literature which explains the trajectory of a moving object. This is concurrent with another principle that can be applied to both football throws - Theoretical Square Law.

Theoretical square law states that if the coefficient of drag, the fluid density, and the projected area of the body remains constant, drag increases with the square of the relative velocity of the motion. Armstrong et al, (1994) showed that if the velocity of the football increases, the drag on the football will also increase. Using the same formula as used to find the force of drag; if the frontal area also increases this would result in even a greater drag. As a football is totally spherical than this is less of an effect than if throwing a spherical shaped ball

A key factor in determining the trajectory and subsequent distance the ball will travel is release angle. There had hoped to be data concerning release angle available to discuss, but as this is non evident a theoretical argument is raised.

Matser, et al (1998) describes that if you wish to maximize the range of a projectile you must launch it at an angle of 45. However, this is only true if the launch and landing are on the same level. An equation was formulated by Isokawa and Lees (1988) that relates the range of a projectile to its projection speed, projection angle, the height difference between the launch and the landing and the acceleration due to gravity.

As the projection angle is raised, the projection speed that the athlete is able to generate decreases, and so the range achieved (solid line) is lower than if the athlete were able to maintain a constant projection speed. As both types of throw are thrown from behind the head, there isn't much distinction between projection angles; however with the running throw the ball starts its trajectory with a smaller angle of incidence. This is due to the spine shape whip (fig 1) the body makes as the ball is brought far behind the head to generate the explosive force used to thrust it over the head.

Each athlete has a unique speed versus angle curve that depends on their strength, stature and throwing technique. This means that the optimum projection angle is different for each athlete. An athlete whose projection speed decreases much less rapidly will have a higher optimum projection angle; an athlete whose projection speed decreases more rapidly will have a

lower optimum projection angle. Armstrong et al, (1988) proved that for elite footballers the optimum projection angle usually lies between 30 and 40.

Projecting the shot at the optimum angle is not crucial to successful throw in delivery. Relatively large errors in projection angle are tolerable. A biomechanical study by Armstrong et al (1994) showed that if a player produces a projection angle that deviates by 3 from the optimum angle, his performance will be only 10 cm less than the maximum possible distance (16.6 m). Therefore, getting the projection angle right is not really that important. It is much more important for the athlete to generate a high projection speed than it is to project the shot at the optimum angle. This idea is backed up in studies by Armstrong et al, (1998) and Luhtanen (1994); who both found that if an athlete is already throwing at close to their optimum projection angle, performance can only be improved by increasing their projection speed.