CHAPTER - I
INTRODUCTION

HISTORY OF CRICKET

The name of cricket probably has originated from the Anglo-Saxon word "crice". The origin of cricket was expressed in many conflicting conclusions due to the measure. Like all bat and ball games, cricket evolved gradually from various sources. It is related to an early Scottish sport known as 'cat and dog' a 13th century past time called 'hand in and hand out'. To the very next of the game, while all the logical evidence proves to the Englishman as the investigator of the game. Some historians think that the name cricket derived from "croquet" as a game that was popular in France, before the beginning of cricket. In 13th century the word "creag" concerned with cricket came into the dictionary. In the 13th century "crosse" the French word meaning to play "crose" came which means playing cross.

It was pointed out that there was a word in French "conquet" pronounced "krickey" and that was the evidence that French created the game and named it. However the game of cricket was unknown in France through years when it was gaining such great popularity in England and further the word "conquet" did not make much its appearance in the French language until 1478 when obviously it was used to describe as sport which existed in England.
English historians while consisting that cricket originated and developed in England do not know the exact date when it as played first or how it gained its name. One authority thought that it came from “crice” which was a word in old English meaning staff.

A king’s library of London is drawing dated 1344 showing a cricket bowler and also a batter facing him. The batter has his bat upside down resting on the ground in waiting position. This established cricket as well organised and commanding sport at that time. Historians are quite certain that the game originated in between twelfth and thirteenth century.

The first recorded match was played between Kent and Surrey in the year 1710 at Cambridge university and in the year 1744 a match was played between Kent and England on the Artillery ground the complete score sheet has been prepared. In the year 1755 Star and Gallex club started forming laws. The members of “old white club” formed the Marylebone cricket club, which is the first governing body of this game, on thirty July 1787. During the 17th century under arm bowling was started, the round-arm bowling was in action during 1835 and the over arm bowling was started in 1874. There was no prepared pitch but the captain who won the toss used to select a particular space in the open area. In the year 1933 the width of stumps was changed to nine inches from its two feet wide and the height was increased to 28 inches.
The original weight of the ball was 5 ounces and in the 1774 the weight was increased to five and half ounces or five and three by four ounces and its circumference is fixed to a minimum of nine and half inches. In the year 1774 one over consists of four balls only but in the year 1889 it was increased to five balls and in the 19th century it was changed to six balls.

There was no fixed size of the bat but in the year 1840, the size was limited to thirty-eight inches length and half inches width. There was no rule regarding the side of the handle. In the year 1866 Marylebone cricket club purchased the famous lards’ cricket ground. The original I.C.C. was Imperial cricket conference later it was changed to International cricket conference. Their first meeting was held on 15th June 1909.

HISTORY OF INDIAN CRICKET

Cricket was played in India two hundred years ago. English people brought the game into our country. These English people were soldiers, officers of East India Company. They settled in four major cities of India namely Bombay, Madras, Calcutta and Delhi. English people have played the game in India for many years. In 1751 the match was played between English settlers and the representing British army. The first cricket club in India which is the second oldest club in the world was formed in Calcutta in 1792; in 1846 at Madras second club was formed. In 1848 oriental cricket club was formed by Hindus, Maharaja of Patiala has taken more interest in
the development of the game in India. In 1886 a Parsi team toured England. The presidency matches began in 1892-93 between Parsis and Europeans and the tournament became the Bombay triangular with the Hindus fielding a team in 1907 - 08. In 1905 Mohammedan formed the club and named it as Mohammeden Gymkhana. In 1928 a meeting was held by several princes, H.E. Grant-Govern and A S De Mellow who was an anchor for the cricket board. Maharaja of Patiala was the chairman of the meeting and a term was sent to England in the year 1932-33 under the banner of BCCI, Maharaja of Porbander has named as captain.

As the game became popular all over India some important tournaments like Ranji trophy, Irani trophy, C.K. Naidu under 19 and 22 Tournament and Inter Universities Tournament has come up. India played its first official test against England in 1932. Teat cricket is playing for 5 days. Another form of cricket is known as one day international. It is for 50 over a side match. World champions are decided by playing this type of cricket. India was the world champion in 1983.

FUNDAMENTAL SKILLS IN CRICKET

As in any other game, cricket also has got many fundamental skills. They are

1. Batting
2. Bowling
3. Fielding

4. Running between the wickets

**Types of bowling**

In the sport of cricket there are two broad categories of bowlers: pace bowlers and spin bowlers. Pace bowlers rely mostly on the speed of the ball to dismiss batsmen, whereas spin bowlers rely on the rotation of the ball.

**Pace bowlers**

Pace bowlers or fast bowlers or pace men, rely on speed to get a batsman out. The main aim of fast bowling is to bowl the hard cricket ball at high speed and to induce it to bounce off the pitch in an erratic fashion or move sideways through the air, factors which make it difficult for the batsman to hit the ball cleanly. A typical fast delivery has a speed in the range of 136 to 150 km/h (85 to 95 mph). In most cricketing countries, fast bowlers are considered to be the mainstay of a team's bowling attack, with slower bowlers in support roles. In the subcontinent, especially India and Sri Lanka, the reverse is often true, with fast bowlers serving mainly to soften the ball up for the spinners. This is largely due to the condition of the pitches used in those countries which gives more help to spinners than to fast bowlers, but at international level it is also a reflection of the outstanding skills of their spinners compared to their pace bowlers. This type of bowler can be further
classified according to the speed at which they bowl the ball on average. Most pace bowlers are medium-fast to fast in top level cricket. In general, bowlers of this type are described as right arm or left arm "fast", or right arm or left arm "fast-medium", and so on.

Swing bowlers

Swing bowlers are pace bowlers who, apart from being fast, also use the seam of the ball to make it travel in a curved path through the air. This is further encouraged by systematically polishing one side of the ball while allowing the other side to become roughened and worn. The differing airflow around the two sides will cause the ball to swing in the air, towards the roughened side. By changing the orientation of the ball in his hand, a bowler may therefore cause the ball to swing into or away from the batsman. In addition to a well-polished ball, other factors help the ball to swing, notably damp or humid weather conditions. However balls which have been in play for some time do not tend to swing so much due to the deterioration of the seam. In addition, bowlers of express pace do not tend to get as much swing as the fast-medium-to-medium pace bowlers.

Though younger pace bowlers tend to rely exclusively on speed, as bowlers age they tend to develop this more sophisticated art of swing bowling. Swing bowlers are more effective than sheer pace bowlers as the swing can confuse a batsman. Some bowlers were capable of causing an older,
misshapen ball to swing the opposite way from normal, i.e. toward the shiny side. This is known as reverse swing and has become an increasingly important skill in the last 10 to 15 years.

Pace bowlers frequently dismiss batsmen through variation and deception. A batter who has been "softened up" by a series of bouncers, which pitch nearer the bowler than normal and reach the batsman around head height, or even hit the batsman, may tend to play the next ball on the back foot, and thus be susceptible to a full length yorker delivery that bounces at his toes. Many bowlers also develop a "slower ball;" these are bowled with the same arm action as their normal delivery, but come slower from the hand, usually due the bowler gripping the ball differently or cocking his wrist at the last moment. With luck, the batsman will misread the pace, and will have finished his shot before the ball arrives. Other common variations include the leg cutter and off cutter, medium pace deliveries bowled with a spinner’s wrist action, which can sometimes "turn" just like deliveries from a spinner.

**Technique in fast bowling**

**Grip**

The first thing a fast bowler needs to do is to grip the ball correctly. The basic fast bowling grip to achieve maximum speed is to hold the ball with the seam upright and to place the index and middle fingers close together at the top of the seam with the thumb gripping the ball at the bottom of the seam.
The image to the right shows the correct grip. The first two fingers and the thumb should hold the ball forward of the rest of the hand, and the other two fingers should be tucked into the palm. The ball is held quite loosely so that it leaves the hand easily. Other grips are possible, and result in different balls - see swing and seam bowling below. The bowler usually holds their other hand over the hand gripping the ball until the latest possible moment so that the batsman cannot see what type of grip he or she is employing and prepare accordingly.

Run-up

A fast bowler needs to take a longer run-up toward the wicket than a spinner, due to the need to generate the momentum and rhythm required to bowl a fast delivery. Fast bowlers will measure their preferred run up in strides and mark the distance from the wicket. It is important for the bowler to know exactly how long his or her run-up is because it needs to terminate at the popping crease. If the bowler steps over this, he or she will have bowled a no ball.

Action

At the end of the run-up the bowler will bring his or her lead foot down on the pitch with the knee as straight as possible. These aids in generating speed but can be dangerous due to the pressure placed on the joint by this
action. Knee injuries are not uncommon amongst fast bowlers. The pressure
on the leading foot is such that some fast bowlers cut the front off their shoes
to stop their toes from being injured as they are repeatedly pressed against
the inside of the shoe. The bowler will then bring their bowling arm up over
their head and release the ball at the height appropriate to where they want
the ball to pitch. Again, the arm must be straight although this is a stipulation
of the laws of cricket rather than an aid to speed. Bending the elbow and
"chucking" the ball would make it too easy for the bowler to aim accurately at
the batsman's wicket and get them out.

Fast bowlers tend to have an action which leaves them either side-on
or chest-on at the end of the run up. A chest on bowler has chest and hips
aligned towards the batsman at the instant of back foot contact, while a side
on bowler has chest and hips aligned at ninety degrees to the batsman at the
instant of back foot contact. While a bowler's action does not affect the speed
at which they bowl, it can limit the style of balls that they can bowl. Although
not hard and fast rules, side on bowlers generally bowl out swingers, and front
on bowlers generally bowl in swingers.

A variant on the fast bowler's action is the sling (sometimes referred to
as the slingshot or javelin), where the bowler begins his delivery with his or
her arm fully extended behind their back. The slinging action generates extra
speed, but sacrifices control.
Follow through

After the ball has been released, the bowler "follows through" at the end of his or her action. This involves veering to the side so as not to tread on the pitch and taking a few more strides to slow down. Striding on to the pitch at the end of a delivery can damage the surface resulting in rough patches which spin bowlers can exploit to get extra turn on the ball; doing so is illegal according to the laws of the game. Bowlers who persistently run onto the pitch can be warned, with two warnings disqualifying a bowler from bowling again during the innings.

Line and length

An effective fast bowler needs to be able to hold a consistent line and length, or in common terms, to be accurate. In this context, line refers to the path of the ball towards the batsman, in the horizontal dimension running from the off to the leg side, while length describes the distance the ball travels toward the batsman before bouncing. Length is generally seen as the more important of the two for a fast bowler. The faster the bowler, the harder it is to achieve consistent line and length but sheer speed can make up for the shortfall. Fast bowlers who also manage to be accurate can be devastatingly effective.
Line

In modern cricket, the line usually aimed for by fast bowlers is the so-called corridor of uncertainty, the area just outside the batsman’s off stump. It is difficult for the batsman to tell whether or not such a ball is likely to strike their wicket, and thus to know whether to attack, defend or leave the ball. This technique was historically known as off theory (contrast leg theory), but it is now so routine that it is rarely given a name at all. Of course, variation in line is also important and deliveries aimed at the leg stump can also serve a purpose. Precise mastery of the line of the ball is best utilized when a batsman is known to have a weakness hitting a particular shot, because a bowler with an effective line can place the ball in the weak spot time after time. Failing to overcome a persistent inability to hit balls on a certain line has been enough to end the careers of innumerable batsmen once they had been found out by skilled line bowlers.

Length

Lengths of balls showing name & bounce height. A good length ball is one that arrives at the batsman at around waist height. There is no fixed distance to a good length, or indeed any other length of ball in cricket since the distance required will vary with the speed of the ball, the state of the pitch and the height of the bowler and batsman. It should be noted that bowling a
wicketkeeper will have trying to stop a high ball means that bouncers can be expensive in terms of runs against skilled batsmen.

Slower ball

A slower ball is a ball which is delivered exactly like a usual pace delivery in terms of action and run-up but where the grip is changed slightly in order to slow the ball down. This deceives the batsmen, who will likely attempt to play the ball as though it were at full speed, causing him or her to mistimed their shot. The result is usually that the ball strikes lower down the bat resulting in it leaving the bat at a slower speed (a cricket bat has a middle-hitting the ball at this point will result in the maximum possible energy being transferred to the ball; as the ball is hit away from the middle so the energy transferred, and hence the speed, will decrease). Also, the bat will generally have travelled further when it hits the ball and be in the upward part of its arc, causing the ball to leave the bat at a steeper angle. The combination of these can be a slow-moving, looping catch which is relatively easy to catch. In an extreme case, the batsman will play the shot so early as to completely play over the ball, and be clean-bowled.

One of a number of different grips is illustrated to the right. Essentially the only difference is that the middle and index fingers are split and come down on each side of the seam. This causes more drag on the ball as it leaves the hand, slowing down the delivery. Slower balls are also bowled by
using the off break grip and finger action used by off spinners. A slower delivery may also be achieved - less commonly - by using a leg spin grip and wrist action or by supporting the upper aspect of the ball with only one finger or with the knuckles.

The slower ball is particularly effective against a batsman seeking to score quickly. Consequently, its prominence has increased with the development of one-day cricket, and particularly at the end of an innings where batsman will attack with abandon. A more experienced batsman will be able to adjust his/her shot mid-stroke, momentarily pausing so as to middle the ball when it is hit.

Another version of the slower ball also known as the SLOB is released with the top fingers only. Aimed as a "beamer", the method of delivery causes the ball to drop dramatically in flight and arrive at a yorker length.

Yorker

A yorker is a ball which bounces off the pitch right in front of (or is aimed at the toes of) the batsman's feet, an area known as the block hole. Because of the usual stance of the batsman and the regulation length of the cricket bat the bat is not usually held near the ground while the batsman prepares to strike the ball, so playing a yorker requires the batsman to alter the height of his or her bat very quickly after detecting a yorker has been
bowled. This is difficult, and the yorker can often squeeze through the gap and break the wicket. Successfully playing this type of delivery is also known as digging out a yorker.

Bowling a yorker requires pinpoint accuracy since bowling it slightly too long will result in a full toss or full pitched delivery which is easy for the batsman to play because the ball has not deviated by bouncing off the pitch. It also has most of its value as a surprise ball. For these two reasons, yorkers are not common deliveries in most circumstances.

In the latter stages of an innings in one day cricket, batters seek to attack every ball bowled. In such circumstances, the yorker is a particularly effective delivery, both in taking wickets and preventing boundaries from being hit. Therefore, the yorker is very frequently bowled in these circumstances, and bowlers who can bowl yorkers accurately are prized in this form of cricket.

Swing bowling

Swing bowlers cause the ball to move laterally through the air, rather than off the pitch like seam bowlers. Normal or conventional swing bowling is encouraged by the raised seam of the ball, and conventional swing is usually greatest when the ball is new and therefore has a pronounced seam. As the ball gets older, the wear makes swing more difficult to achieve, but this can be
countered if the fielding team systematically polishes one side of the ball while allowing the other to become rough. When the ball has been polished highly on one side and not on the other and if the ball is bowled very fast (over 85 miles per hour), it produces a reverse swing such that the ball swings in the opposite direction as in conventional swing. Contrary to popular opinion, this swing is not produced by air flowing faster over the smooth or "shiny" side as compared to the rough side.

Swing is produced due to a net force acting on the ball from one side; that is, the side with the more turbulent boundary layer. For conventional swing bowling, the raised seam and the direction in which it is pointed governs the direction of swing. Due to the angled seam of the ball, air flowing over the seam produces turbulence on the side that the seam is angled toward. This causes the fluid boundary layer to separate from the surface of the ball later (farther toward the rear of the ball) than the other side where a laminar boundary layer separates earlier (farther forward on the surface). There is a net pressure differential (greater pressure on the side with the laminar boundary layer) and thus the net force moves or swings the ball in the direction of the angled seam. Conventional swing bowling is delivered with the seam angled such that the smooth or polished side of the ball faces forward to move the ball in the direction of the seam i.e. toward the rough side.

A swinging ball is classed as either an out swinger, which moves away from the batsman, or an in swinger, which moves in toward the batsman. In
most cases the out swinger is seen as the more dangerous ball because, if the batsman fails to recognize it, it will catch the outside edge of the bat instead of the middle and fly up to be caught in the slips. In swingers have their place too, especially combined with the yorker as the in swinger can catch the inside edge and break the wicket, or hit the batter on the pad rather than the bat, resulting in a possible LBW decision.

Swing bowling can also be roughly categorized as early swing or late swing, corresponding to when in the trajectory the ball will change direction - the later the ball swings, the less chance the batter has of adjusting his/her shot to account for the swing. Swing balls are bowled with the same grip and technique as fast balls although the seam is usually angled slightly rather than straight, and the slower ball grip may be used. For an out swinger the shiny side of the ball is nearest the batsman and the seam is angled away from him while for an in swinger, the rough side needs to be nearest the batsman and the seam angled toward them. It is difficult to achieve swing with a cutter grip since the ball will spin in flight, varying the orientation of the shiny and rough surfaces as it moves through the air. Many players, commentators on the game, and fans agree that swing is easier to achieve in humid or overcast conditions, and also that the red ball used in Test cricket swings more than the white ball used in the one-day game.
Reverse swing

Reverse swing is a phenomenon which causes the ball to swing in the opposite direction to that usually produced by the orientation of the shiny and rough sides of the ball. When the ball is reverse swinging, the ball will swing towards the shiny side. Balls which reverse swing move much later and much more sharply than those swinging conventionally, both factors increasing the difficulty the batsman will have in trying to hit the ball. Reverse swing is much more dependent on conditions than normal swing, and so it is nearly impossible to achieve consistently. Reverse swing does not usually happen until the ball is around 45 over's old, and requires the weather to be hot and dry. The technique of getting reverse swing was first invented and perfected by Pakistani bowlers in the 1980s but has since spread through all the cricketing nations.

In reverse swing, the rough side is placed forward. The seam is angled in the same way as in conventional swing (10-20 degrees to one side) BUT the boundary layer on both sides is turbulent. The net effect of the seam and rough side is that the ball actually swings in the direction opposite to where the seam is pointing to. Good reverse swing bowling requires the bowler to deliver the ball at a fairly high speed (80-85 miles per hour or greater), which is only achieved by a select few fast bowlers in the world. Now, in one-day cricket the compulsory change of ball after 35 over's has caused reverse
swing to reduce, thus, making it mandatory for the fielding team to take the new ball and therefore there is no reverse swing.

**Dippers**

A dipper is a swinging ball which is deliberately bowled as a yorker or a full toss, the latter not normally being a ball that a fast bowler would choose to bowl. The in dipper moves in to the right-handed batsman while the out dipper moves away. In order to be effective, a dipper has to generate a lot of swing to make up for the variation in movement lost because the ball is not bouncing on the pitch. However, because the batsman usually expects a full toss to be an easy ball to score off, dippers have huge surprise value and can be extremely difficult to play especially if the bowler is very accurate and manages the yorker rather than a genuine full toss.

**Intimidatory bowling**

Intimidatory or aggressive bowling refers to a legitimate tactic of bowling with the intent of hitting the batsman with the ball. This is somewhat restrained by some of the laws of cricket, including those which disallow excessive use of bouncers and any use of the "beamer", which is aimed directly at the head on the full. Successful intimidatory bowling usually employs a mixture of bouncers and short-pitched deliveries aimed at the batsman's head, chest, and rib cage. The intention is to disrupt a batsman's
focus, and ultimately induce a mistake that leads to the loss of the batsman’s wicket. Often the eventual wicket will not fall to a bouncer or short-pitched ball, but instead to a more standard delivery that the batsman is no longer expecting, or is rendered temporarily unable to play in his usual way (by fear, pain, surprise, or some combination of the three). One classic approach is to deliver several short balls into the batsman’s chest, forcing the batsman onto the back foot to defend with a high bat, and then fire in a fast yorker, aimed at the base of the stumps. If the batsman is expecting to play a high back foot defensive, the time it takes to shift their weight to play the ball at their feet may just be enough for the delivery to surprise the batsman and cause him or her to panic, and thus cause the loss of their wicket.

A fast bowler can also employ intimidatory tactics to anger (or frustrate) a batsman into playing a rash shot, by directing the ball to strike the batsman. Intimidatory bowling plays a part in every fast bowlers attack to varying degrees, and even the best batsmen sometimes sustain serious injuries that can force them off the field and out of the game. In almost all instances verbal ‘sledging’ accompanies the attack. The tactic was to bowl, very fast and very short, at the batsman’s body, intent on inflicting personal injury. After the Bodyline series, as it became known, several laws of cricket were altered to prevent such a tactic used again, such as a restriction on the number of fielders that can occupy the rear leg-side quadrant of the cricket to two (excluding the wicketkeeper).
RATING OF THE FAST BOWLERS

The top rated fast bowlers who peaked with at least 850 points in the ICC Player Rankings as of on June 2009 is presented in Table - 1.

**TABLE – I**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>Country</th>
<th>Highest rating</th>
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<tr>
<td>1</td>
<td>Sydney Barnes</td>
<td>England</td>
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<td>2</td>
<td>George Lohmann</td>
<td>England</td>
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<td>3</td>
<td>Imran Khan</td>
<td>Pakistan</td>
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<td>4</td>
<td>Glenn McGrath</td>
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<td>5</td>
<td>Curtly Ambrose</td>
<td>West Indies</td>
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<td>6</td>
<td>Ian Botham</td>
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<td>7</td>
<td>Malcolm Marshall</td>
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<td>Richard Hadlee</td>
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<td>Waqar Younis</td>
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<tr>
<td>10</td>
<td>Shaun Pollock</td>
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<td>34</td>
<td>Shoaib Akhtar</td>
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For the purpose of the study Classification of fast bowlers was done according to their speed as presented in Table - II

**TABLE - II**

Classification of fast bowlers

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<thead>
<tr>
<th>Type</th>
<th>mph</th>
<th>km/h</th>
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<tbody>
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<td>Fast</td>
<td>86 +</td>
<td>138 +</td>
</tr>
<tr>
<td>Fast-medium</td>
<td>80 to 85</td>
<td>130 to 137</td>
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<tr>
<td>Medium-fast</td>
<td>75 to 80</td>
<td>121 to 130</td>
</tr>
<tr>
<td>Medium</td>
<td>70 to 75</td>
<td>114 to 121</td>
</tr>
</tbody>
</table>

**BIOMECHANICS**

Biomechanics is the study of the structure and function of biological systems by means of the methods of "mechanics." – Which is the branch of physics involving analysis of the actions of forces. Within "mechanics" there are two sub-fields of study: (1) statics, which is the study of systems that are in a state of constant motion either at rest (with no motion) or moving with a constant velocity; and (2) dynamics, which is the study of systems in motion in which acceleration is present, which may involve kinematics (i.e., the study of the motion of bodies with respect to time, displacement, velocity, and speed of movement either in a straight line or in a rotary direction) and kinetics (the
study of the forces associated with motion, including forces causing motion and forces resulting from motion).

BIOMECHANICAL ANALYSIS

In general, there are two approaches used to study mechanical aspects of human movement. There is the quantitative approach that involves the use of numbers. This approach helps to eliminate subjective description and relies on data from the use of different instruments. It is a more scientific, publishable, and predictable analysis than the qualitative approach that implies that the movement is described without the use of numbers. This approach is used a lot in coaching and during the teaching of sports skills. Both quantitative and qualitative descriptions play important roles in the biomechanical analysis of human movement.

Biomechanical analyses can be divided into four areas.

Non-cinematographic analysis

Non-cinematographic analysis is the most common analytical technique used in sports by coaches, athletes, and others. No film or videotape is used in capturing the performance and/or component parts of the execution of the motor skill. It requires a disciplined approach to observing and, then, analyzing skills, but does not require intricate mathematical calculations. It does require a full understanding of biomechanical principles. Obviously, a qualitative analysis is subject to some error in interpretation.
Cinematographic analysis

Basic cinematographic analysis involves the use of film or videotape for improving performance. It does not involve any mathematical calculations. One advantage of non-cinematographic analysis is that you can see the movements in slow motion (frame by frame). The analysis allows for seeing what actually occurred versus what you may think took place. It is helpful in reducing the amount of guess work and, thus error in correcting motor skills since it is a qualitative analysis.

Intermediate cinematographic

Intermediate cinematographic analysis requires some mathematical computations to enhance the analysis. The use of film is necessary to capture the motor skill and subsequent analysis. It is a quantitative analysis, where velocity and force (along with other data) are calculated, thus allowing for a significant reduction in guess work in analysis of component parts of a given skill. As a result, the analysis increases the chances of teaching the skill correctly.

Biomechanics research

Biomechanics research involves highly sophisticated biomechanical equipment, such as high speed cameras, EMG for muscle involvement, force
plates, transducers, computers, and much more. The equipment allows for very accurate determination of factors that influence human performance. It is the method for publishing in scientific journals, and usually a doctorate in biomechanics is needed. As you might imagine, it takes a lot of time to reduce the data before treated with statistical procedures.

**Need and Importance of Biomechanics**

This study aims for the kinetic and kinematic analysis of bowling techniques in cricket. Kinetics is a branch of Biomechanics. Similarly kinematics is the study of motion is also a branch of Biomechanics. So it become necessary for the investigator to explain biomechanics and its importance in sports.

The science of biomechanics is concerned with the forces that act on human body and the effects these forces produce. Physical education teachers and coaches are like wise concerned with forces and effects. Their ability to teach the basic techniques of sports or physical activity depends very largely on their application on both the effects they are trying to produce and the forces that cause them. Scientific principle of coaching and teaching is to determine the proper application of the mechanics to physical activities in order to obtain the most effective and efficient performance. These approaches eliminate the hit or miss method that prevails so often. Competition in the field of sports has been developed to such a high degree
that no coach or player can afford to neglect the application of scientific principles that can give him an advantage over or at least keep him a space with his opponents. Biomechanics helps to understand the nature of sports movements on the basic of laws and the principles of mechanics. In short just as motor learning regarded as acquisition of skills the biomechanics as the service undertaking techniques.

Knowledge of physiology equips them to make sound judgment concerning the amount and type of training to prescribe in a given case. Knowledge of biomechanics equips them to choose appropriate techniques and to detect the root causes of faults that may rise in their use.

Biomechanics offers important scientific knowledge that can improve performance and the best coaches are taking advantage of this knowledge. Biomechanics is also concerned with motion of the objects. The study of mechanics includes the study of factors relating to non moving systems or characterized by study or motion. In turn dynamics can involve a kinematic or kinetic approach.

Biomechanical principles can be employed to analyze the individual movements and to determine the most effective timing of the sequence the one that leads to the greatest force or highest speed as the case may be. This information can be used to help an athlete to find the proper rhythm for his
performance or to locate the hitch in the sequence that has caused him to lose his rhythm.

Biomechanical research deals largely, with the anatomical, mechanical and physiological analysis of performance both in terms of local muscular action and gross body movements. No attempt has been made to resolve all questions raised by such a designation for the analysis of performance might take direction other than purely biomechanical studies. At present for the application biomechanics of the sports movements has become highly technical by using complex method of experimentations.

KINEMATICS

Kinematics is that branch of biomechanics that is concerned with describing the motion of bodies. It deals with such things as how far a body moves, how fast it moves and how consistently it moves. It is not at all concerned with what cause a body to move it the way it does.

1. Linear kinematics deals with the kinematics of translation or linear motion.
2. Angular kinematics deals with the kinematics of rotation or angular motion.
The study of how a body moves. This includes linear motion, angular motion, and rotational motion. Linear kinematics is applicable not only to the analysis of linear motions but also to the analysis of the linear aspects of general motion.

IMPORTANCE OF KINEMATICS

Kinematics is a necessary introduction to kinetics since ability to describe motion is prerequisite to an understanding of relation between force and motion.

Kinematics is one of the most basic areas of physics; in fact the definitions and methodology provide the foundation on which most of physics rest.

Kinematics is concerned with studies of time and space factors in motion such as velocity and acceleration whereas kinetics is involved with the force that act on a system, such as gravity and muscles. Kinematics can be useful to work out realistic values for products going through design stages, although the product may not be produced yet we can gain a fairly accurate idea as what to expect from it.

KINEMATIC PRINCIPLES INVOLVED IN BOWLING

Kinematics principles chosen for the study are
1. Speed
2. Acceleration
3. Power
4. Force

**Speed and its Importance**

The rate at which a body moves from one location to another is usually described with reference to its speed.

Speed of the bowler was measured by measuring the time of running in a fifty meter dash.

Speed = Distance covered / Time taken

That is

\[
\text{Speed} = \frac{d}{t}
\]

Where \(d\) = distance covered
\(t\) = time taken

Speed is the performance prerequisite to do motor action under given conditions (movement task, external factors, individual prerequisite) in minimum of time. In cricket the importance of speed is enormous. Every area in cricket requires speed for the perfect execution of techniques and skills.
Speed ability is very important because certain other abilities depend on it to a lesser extent and thus speed plays an important role in cricket.

**Force and its Importance**

Force is the function of mass and acceleration. A body’s state of being at rest or in motion can be changed by the force of some other body. A body at rest can be made to move when another body exerts a force on it. Similarly a body in motion can be slowed down, speeded up or have the direction of its motion altered if another body exerts a force on it.

In Cricket the kinematic principle force is very important. For the purpose of bowling the bowler has to apply more force to his last delivery stride and also to his shoulder at the time of delivery. He can also apply force of his wrist to guide the swing of the ball at the time of the delivery.

The force was measured by multiplying the mass of each bowler by his acceleration

Where

\[
F = ma
\]

\[
F = \text{Force}
\]

\[
M = \text{Mass}
\]

\[
A = \text{Acceleration}
\]

\[
M = \frac{W}{g}
\]

Where

\[
W = \text{weight of the batsmen}
\]

\[
g = \text{Gravity}
\]
Power and its Importance

Power is the product of force times the speed with which that force is applied. The power of the bowler was calculated by multiplying the force of the bowler with the final speed of the bowler which is calculated by dividing a small distance just before releasing the ball and the time taken to cover the distance.

\[ P = f V_f \]

Where
- \( P \) = power
- \( F \) = force
- \( V_f \) = Final velocity

Power is one of the most important factor in sports because the coordinative abilities are influenced to a lesser or greater extent by the power ability. Depending upon the magnitude and type of resistance to be tackled in various sports the sports men need different level of speed, endurance, technique, tactics and other coordinative abilities. This is impossible if the sportsmen lack the requisite amount of power.

In cricket the kinematic principle power is very important. For a bowler to bowl a ball he has to deliver the cricket ball with full power. The power for the ball should generate from the powerful running and on the final strides before the release of the ball.
Acceleration and its Importance

The rate at which the velocity changes with respect to time is called acceleration. Acceleration of the bowler was calculated by dividing the speed of the bowler with the time taken by the bowler to run the distance in between the start of his bowling and the delivery of the ball and using the formula.

\[
A = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{Time taken}}
\]

That is

\[
a = \frac{V_f - V_i}{t}
\]

where

\[
a = \text{the average acceleration}
\]

\[
V_f = \text{final velocity}
\]

\[
V_i = \text{initial velocity}
\]

\[
t = \text{elapsed time}
\]

The importance of acceleration in bowling cannot be neglected. The run-up and delivery of the cricket ball is greatly depends on a good rhythm. A proper acceleration at a proper time by a bowler can maintain a steady rhythm in his bowling run up. This leads a bowler to make his final stride to a great
effect and generate a good pace on his ball. Hence the kinematic principle of acceleration is regarded as an important variable.

With the introduction of shorter version of the game and the increased popularity of cricket the playing countries were forced to conduct more matches. To cope up the increased number of match schedules and competition, the involvement of the kinematic variables such as speed, force, power and acceleration has become very important for the development of the performance of the players.

There is inconsistency in the performance from the cricket players mainly from the bowlers. To overcome such factors lot of research work has to be done. Very little research has been done in cricket analyzing bowling techniques biomechanically. The investigator being a State level cricket player strongly believes the kinematic principles has got great relevance with bowling performance in cricket. Inadequate research work in this field motivated the researcher to take up this study.

**STATEMENT OF THE PROBLEM**

The main purpose of the study was to analyze the skill of bowling in cricket kinematically. The secondary purpose was to find out whether there is any relationship between the bowling in Cricket and the selected kinematic principles namely speed, displacement, acceleration of cricket players,
classified on their arm length, leg length, height, weight, upper body length.

The purpose of the study was the comparative analysis of selected body dimensions and kinematic variables of bowling performance in cricket.

DELIMITATIONS

The following were considered as the Delimitations of the study:

1. The subjects selected for the study was Thirty male cricketers (N=30).
2. The selected subjects were specialized bowlers who had represented the states of Kerala and Madhya Pradesh.
3. The pace of the selected bowlers ranged from medium fast to fast.
4. The age group of the subjects ranged from 22 years to 27 years.
5. The study was delimited to selected kinematic variables namely speed, power, force and acceleration.
6. The selected body dimensions for the study was height, weight, arm length, leg length and upper body length.
7. The videos of bowling performance were captured using SONY HDR-HC3E with SONY SUPER SG super VHS video cassettes.
8. The bowling analysis was done with the video analysis using the Windows XP based Dart fish motion analysis (version 4.5) software.
9. The ball speed was analyzed with the help of Platypus Canadian electronic bowling ball.

10. The study was delimited to the following independent variables:

1) Bowling arm angle at the time of delivery
2) Non Bowling arm angle at the time of delivery
3) Leading leg inner angle at the time of delivery
4) Back Leg angle at the time of delivery
5) Last stride length
6) Back leg ankles angle at front foot landing
7) Front leg ankles angle at front foot landing
8) Upper body angle at front foot landing
9) Bowling arm angle at front foot landing
10) Non bowling angle at front foot landing
11) Leading leg knee angle at front foot landing
12) Back leg knee angle at front foot landing
13) Upper body angle at back foot landing
14) Bowling arm angle at back foot landing
15) Non bowling angle at back foot landing
16) Leading leg knee angle at back foot landing
17) Back leg knee angle at back foot landing
18) Speed
19) Acceleration
20) Force
21) Power
22) Height
23) Weight
24) Upper Body Length
25) Leg Length
26) Arm Length
27) Palm Length

LIMITATIONS

The following were considered as the limitations of the study:

1. The atmospheric temperature was not taken into account while filming the bowlers.
2. The daily routine of the players.
3. The study was conducted without any reference or enquiry about the subject's methodology of training.
4. The bowlers were filmed during their net practice sessions.
5. The food habits of the subjects.
6. The nature of cricket pitch, its wear and tear was not taken into consideration.
HYPOTHESIS

1. It was hypothesized that the speed of ball in bowling in Cricket can be predicted from the selected anthropometrical, kinetic and kinematic variables.

2. There would be significant relationship between the selected anthropometrical, kinetic and kinematic variables involved in bowling.

SIGNIFICANCE OF STUDY

1. The competition at any level has become very quantitative to evaluate player performance. Even a small factor has its role to contribute to the total performance which needs careful attention and analysis. Through this study, the physical educationists, coaches and trainees can identify the right type of biomechanical variables to be taken into consideration in cricket bowling.

2. The results of the study may be of great value and importance in designing, suitable training programme for the improvement of bowling performance in cricket. For the proper coaching, a coach needs to identify the biomechanical characteristics of the players.
3. Appropriate qualification of various aspects of bowling performance in cricket and kinematics may lead to better understanding of the relationship between kinematic variables and anthropometric variables of cricket players with their performance in bowling.

4. This study may contribute to the body of knowledge in the specialized area of fast bowling.