Batting is a side-on game – or at least it used to be…

The demands for International cricket batsmen have changed considerably over the past ten years, the increased run rates in both test matches and one day internationals is testament to this. There is no doubt in my mind that 20 – 20 cricket has also had a part to play in increasing the range of flamboyant strokes we see today, the reverse sweep or flick over fine leg whilst walking down the wicket to the quick bowler. Nobody seems to play with a straight bat anymore? Batsmen are intent on working the ball off middle stump into the leg side, trying to pick up a quick single with a bat path that only coincides with the ball for a split second… effective when it comes off, however do the actions justify the risks taken?

Given that batting is such an important part of the game, it is surprising that little biomechanics research has been undertaken in this area of the sport. The biomechanics of the off-drive and on-drive have been found to be very similar, with only minor differences occurring in their execution. Grip force patterns of top & bottom hands along with kinematic analysis of selected strokes are areas that have been researched; however, the underlying theme from the biomechanics literature is that batting has many different styles and techniques. You only have to compare the flowing and rhythmical drives of Sachin Tendulkar, Brian Lara & Sunil Gavaskar, the brut force of Inzamam Ul-Haq, Matthew Hayden & Adam Gilchrist, or the skill and determination of an Aravinda de Silva, Ricky Ponting or even Sir Garfield Sobers. Indeed what is also becoming more apparent from the research is the degree of variation the same individual has when playing the same shot… You only have to look at players when they first arrive at the crease and then after scoring 50+ runs, why is this the case?

A question which I have been asked on many occasions, most notably by the late Bob Woolmer, is "Are great batsmen born or made?" He was very much of the opinion that, apart from teaching a few basic fundamentals, ones batting ability is determined early on in life and governed primarily by the players natural flare, athletic instinct and desire to succeed. In Bob's opinion, any technical problem of a player could always be related back to one or more of his key fundamentals. After numerous debates with Bob on this topic, we both agreed that the key fundamentals must be consistent throughout all batsmen: and in coaching terminology, we must not over complicate the act of striking a cricket ball. So, what are these key fundamentals? Well put simply, they are made up of *Dynamic Balance & Stability*, *Angular Momentum of the Bat* and most importantly the *Path of the Bat* during the stroke…

Some aspects of batting cannot be supported biomechanically, however many elite players are very successful despite their individual techniques. The objective of this article is for all coaches to ask themselves 'How do you optimise the art and science of batting whilst keeping the act of striking a cricket ball as simple as possible for the player?'. I strongly believe that biomechanical analysis can improve the technique of every batsmen, it is the responsibility of coaches to ensure that the biomechanical information is deciphered correctly and put into practice within an appropriate time frame...

The key fundamentals are discussed below;

'Path of the Bat & Angular Momentum'

Many of today's players utilize their bottom hand as a fulcrum to lever the bat into position during the backswing. This is a minor modification on the traditional method when batsmen will raise their bat back towards the stumps and at the top of the backlift, the face being slightly open towards second slip.

By utilizing the bottom hand as a lever, the wrists will remain close to the centre of mass, thus allowing the mass of the bat to remain close to the base of support (effectively making the bat lighter). If the centre of mass of the bat can be positioned over the wrists, the torque generated is minimal, therefore, the force required by the muscles in the forearms is reduced and subtle movements are made far easier. This action will also decrease the *rotational inertia* of the system**.** As a result the bat will travel in a smaller arc on the backswing, thus is more dynamic and executed faster.

The definition for 'Rotational Inertia' is as follows:

> *A rotating rigid body (for example the bat) maintains its state of uniform rotation – its ANGULAR MOMENTUM is unchanged, unless an external TORQUE is applied or otherwise the conservation of angular momentum remains constant.*
>
> *The amount of momentum that an object has depends on two physical quantities: the MASS and the VELOCITY of the moving object.*

Consequently, when translated into coaching terminology, this means that the cricket bat will be easier to manoeuvre if it is close to the cricketer's centre of mass. The path of the bat on the backswing and position at the top of the backswing is crucial for consistency. Every action has a chain reaction in kinematics, if the arms leave the body on the backswing, this will create additional rotational forces that will counteract this action. The correct position of the hands and bat at the top of the backswing will not only allow the subsequent downswing movement to be produced with a greater angular acceleration, it will also enable the path to be more 'down the line' – therefore play with a straight bat!

Many batsmen have a distinct loop in their backswing & downswing. As a result the bat must undergo subtle compensations, (applied force from the forearms) in order to set it onto the required plane to make contact with a straight ball. With a loop in the backswing, continual compensations may go unnoticed on a good wicket, what happens if the ball nips back off the seam? In this instance, the path of the ball and bat are at complete odds with each other, with only a small 'contact zone' where the two can collide... Players with a distinct loop in the bat path, have to wait until after the commencement of their downswing to begin to try and redirect the path of the bat to meet the ball. If we are looking to increase stroke accuracy the longer the path of the bat is in line with the ball, the more chance we have of hitting it.

Figure 1 is a six-image photo sequence of Michael Vaughan (MV), Mark Ramprakash (MR), Matthew Prior (MP) & Andrew Flower (AF). The match footage is taken from the Second test, West Indies vs. England – Headingley, Leeds 25th May '07. The net footage is taken at the National Cricket Academy at Loughbrough, March 06. The red line highlights the path of the toe of the bat during each shot. All deliveries are approximately 80mph in release speed.

Each of the six-image sequences is made up of the following events:

- Frame 1: The bowler is in the pre-delivery position. *Note:* All four of the players' hands hang directly under their shoulders.
- Frame 2: Trigger Movement, un-weighting of the front foot - Back foot landing of the bowler.
- Frame 3: Bowler – Front Foot Contact
- Frame 4: Point of Release (POR)
- Frame 5: Ball – approximately half way down the wicket - Top of Backswing
- Frame 6: Ball Impact.

Traditional coaching principles generally suggest that the bat should not be taken back outside the line of a fielding position equivalent to second slip. The first 2 players in the sequence (MV & MR) illustrate during frames 1-5, how their wrists remain close to their centre of mass throughout the stroke. The position of the hands directly under their shoulders enables their wrists to remain close to their body. As a result the mass of the bat remains close to the base of support. This will decrease the '*ROTATIONAL Inertia'* of the system**.** In addition, the toe of the bat also remains close to the body, allowing the mass of the bat to remain close to the base of support and effectively makes the bat feel lighter.

It can be seen from the trace of the toe of the bat, that the backswing & downswing are very similar in trajectory. There is no loop at the top of the backswing, thus no need to re-align the bath at the start of the downswing. This also has the additional advantage of ensuring the bat swing is based on the most current ball flight information available. A controlled bat path at the point of impact is more important than bat velocity alone.

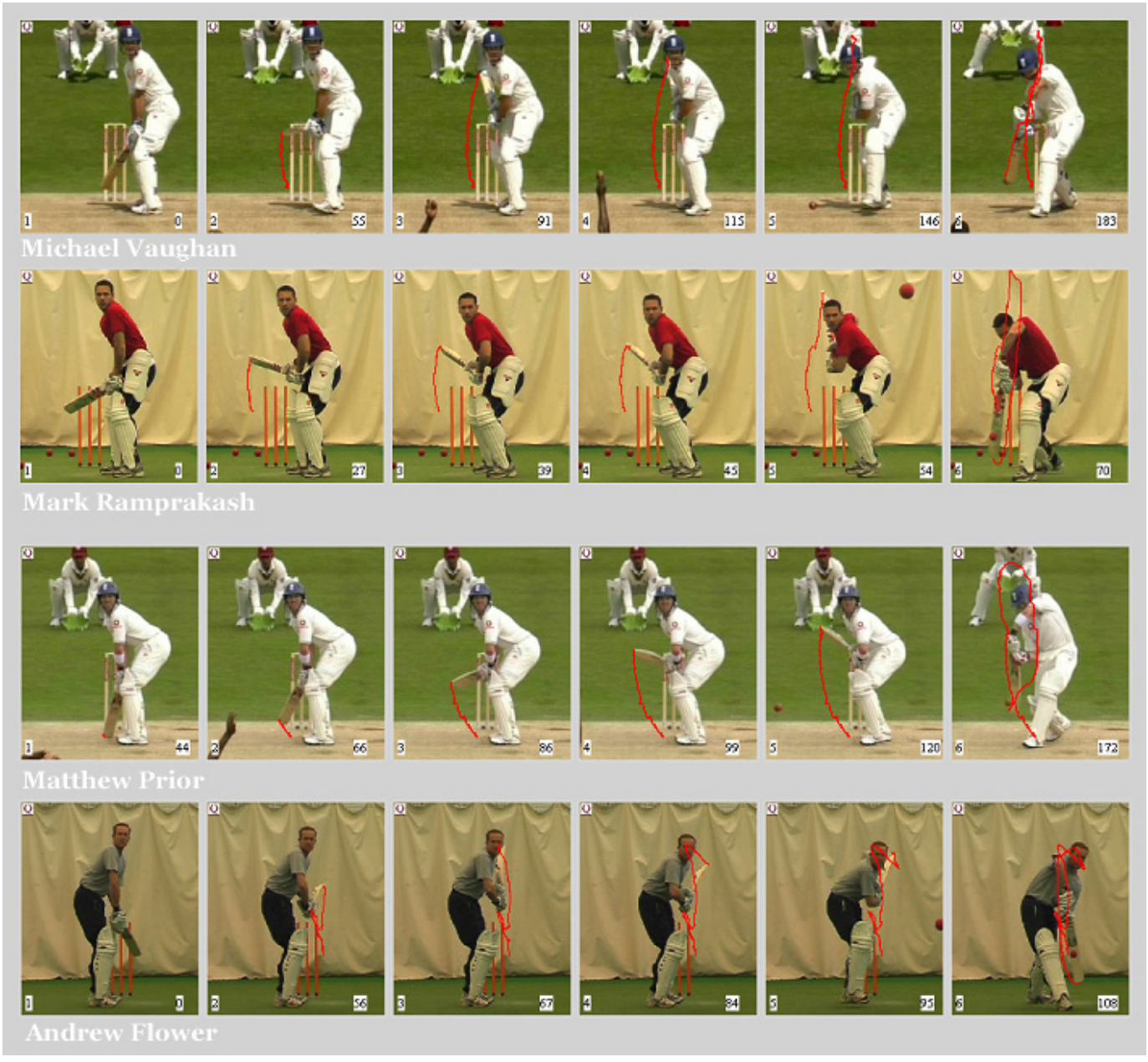

Figure 1: Six-image photo sequence – Quintic v14 video analysis software

The image sequences of MP & AF also highlight in frames 1-5, their wrists remaining close to their centre of mass throughout the stroke. Although the positions of their hands are directly under their shoulders, the position and path of the toe of the bat goes away from the body, out towards second slip. As a result the mass of the bat goes towards the OFF-side (Frames 2, 3 & 4) and away from the base of support. This will increase the 'Rotational Inertia' of the system. This will have the effect of making the bat feel heavier. It can be seen from the trace of the toe of the bat, that the backswing & downswing are two distinct traces. Both players have a loop at the top of the backswing in order to re-align the bat & shoulders at the start of the downswing. In each case their shoulders re-align to become more side-on. The bat, despite moving in a continuous rhythmical manner, as in the example of Matthew Prior, demonstrates a very limited 'contact zone'. This may be more commonly described as hitting 'in to out'… The additional forces required in the forearms, upper arms and torso to overcome the rotational inertia and re-align the bat with the path of the ball are significant, especially with today's heavy equipment. To Andrew's credit, he does re-align early in the downswing and bring the bat down on a good plane; however, there still is an unnecessary movement here that could over-complicate matters on a seaming wicket.

Golf is another sport where similar mechanics applies; think of the path of the club on the backswing, during the transition and downswing. I can only think of two exceptions, Jim Furyk and Eamonn Darcy, that have a considerable loop and re-alignment of the club head during the transition. At least with golf, the ball is stationary and the path of the club through impact area is directed towards the target. There are however (as with Andrew Flower & Matthew Prior) unnecessary movements of the clubhead during the swing that may not stand up to pressure and as a result be inconsistent... Figure 2 highlights the trajectory of the clubhead driver of Padraig Harrington. It is interesting to note the backswing & downswing are on a very similar path. The slight changes at the top of the backswing are due to the weight transition during the swing.

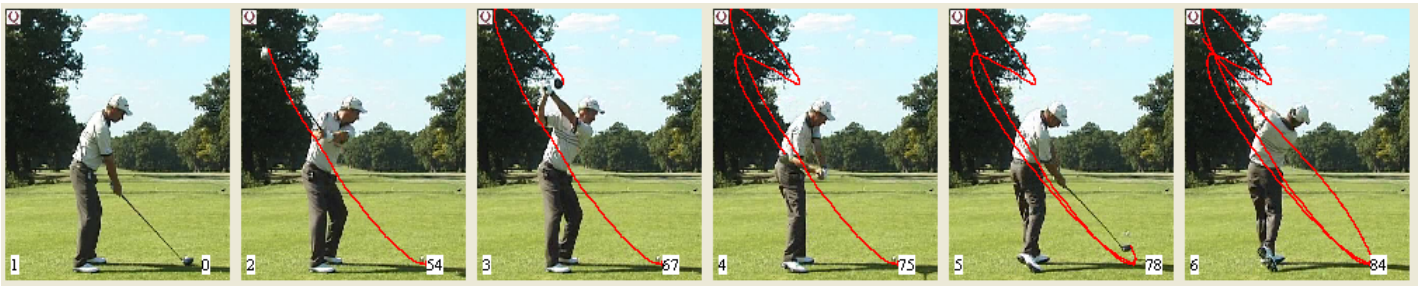

Figure 2: Padraig Harrington x6 image photo sequence
Quintic v14 video analysis software

Dynamic Balance – Position of Readiness?

For every action there is a reaction. If the fundamentals of a good set up are not present, so the required chaining effects of movement will not occur efficiently and effectively. The stance is the "ready" position when the batsman is about to face a delivery. It is the base to play all your shots, as the majority of coaching material state, "you need to be comfortable and relaxed at stance".

What is the correct stance & optimal width?
Coaching textbooks would recommend the feet approximately a foot length apart either side or on the popping crease as the correct technique. A wider base may indicate a desire to optimise stability by increasing the base of support. The down side to adopting a wide stance is the potential decline in mobility so a trade-off situation exists. In my opinion, the centre of mass of the body should be positioned over the midpoint between the feet indicating that the weight is evenly distributed on both

the left & right foot, with an individual's weight also being evenly distributed on their heels & toes. The weight should be through your instep, or arches in your feet. At 'stance' you should be able to wiggle your toes, without having to change your balance. Batting is an athletic, explosive movement, so it is imperative that the batsman has the best possible starting position – that of dynamic balance...

Where should the weight be positioned?
This is a great question to ask every batsman – they should be able to answer. However what they think they are doing must match with what they do! Technology is needed here to give you the correct answer, force or pressure platforms or even special shoe inserts can give you very accurate measurements. Traditional coaching literature would suggest the weight on the balls of the feet, with the knees slightly flexed. The reason being, that you can transfer quickly to either front or back foot depending on the length of the ball. However, by having the weight on the toes, this does in fact limit movement to the leg side; a classic example is people falling over to the off-side when they play such deliveries...

As long as the batsmen is comfortable in their preferred starting position and any pre delivery trigger movements are consistent, then so am I. The most critical point during batting in terms of stability & balance is the position at which the ball is released (POR). I refer to position as the 'Position of Readiness'.

The batsmen does not know where the ball is going at POR, short, full, off side, straight or down the leg side… Yes there are clues in the bowlers' delivery action and even previous deliveries may influence the final outcome, yet until that ball is released, you can't be 100% sure. With this in mind the batsmen needs to be in the optimal position to move and react to where the ball is ultimately directed. Their head must be still & eyes level at this point, but their posture needs to be alive and athletic. The easiest way to achieve this is to ensure their weight is equal, both: 50% Right & 50% Left, and equally distributed by heels & toes - 50% Balls & 50% Heels. If the weight is all on the back foot at POR, it is easy for the player to come forward, but you would require a double movement to go back to a short pitched ball… vice versa if the weight is predominately on the front foot at POR – it's hard to come further forward, a double movement is needed once again.

A simple yet extremely affective way of ascertaining where a player's weight is at POR is to do simple 'throw downs'. Allow the player to first get comfortable by playing a number of different shots at various line & length, then simply on the next occasion don't let go of the ball… watch carefully where is their body weight, are they moving forward, backwards, or falling to the off side? The batsmen must be static, but dynamically balanced at the point you fake to release the ball, they must be ready to react to wherever you throw the ball, if not they are putting themselves at a distinct disadvantage.

A recent football study undertaken by Quintic involved analysing English Premiership goalkeepers' weight distribution during the penalty kick. The outcome has very similar connotations with batting. The goalkeepers, when saving a penalty, need to be perfectly balance at the moment the ball is struck, as they don't know where the ball will be targeted… If, for example, the goalkeeper favoured their right side at address (most right-handed people do!) then, they were fine when diving to the right, but if they needed to dive left, then they must first un-weight their right leg, move their centre of gravity over to the left before finally pushing off the left leg… by this time the ball is in the back of the net, effectively the distance they could cover on the left in the same time frame was significantly reduced.

Figure 3 highlights the position of the four batsmen at the point of release. (Andrew Flower is right-handed here for comparison purposes.) Where do you think the weight is distributed for each of them? Are they balanced at the point of release? Can they go forward or back, left and right with the same amount of effort, or do they favour one particular movement? Are they in a state of dynamic balance?

Figure 3: Point of Release

In two of the above examples (MP & MV) the weight distribution is predominately on the back foot (right foot), the left foot is floating… MR is the opposite having the majority of weight on the front foot, only Andrew Flower has an even distribution at the point of release. In both MP & MV the next frame on the video has the left foot airborne. From looking at the above example, MP's weight distribution would appear to be in the heels at POR, a reaction to the toe of the bat going away from the body? Chicken or egg, what causes this to happen?

If a player has a pre delivery trigger movement there is an opportunity to move into a more dynamic and balanced position as the bowler releases the ball. This increase in momentum can be later utilised during the stroke. You are more likely to get into a balanced position if you start in a balanced position. However, the movement must enable the batsmen to arrive at a balanced position at POR in order to benefit from the trigger movements. Too many players are in a poor position at POR as a result of poor timing with the trigger movements, inconsistent trigger movements (they do differ during the stages of an innings), different movements to different bowlers… there is a lot of room for inconsistency. Have a pre-delivery movement by all means, but ensure it is consistent and your timing is spot on!

A stable base or a position of dynamic balance at POR would ensure:

- Increased resistance to work the body levers against other body parts – summation of force – heavy parts move first, transferring momentum to the lighter, faster moving body parts…
- Body energy transferred efficiently to the bat
- Full force generation

Finally food for thought, if you increase your stability during the position of readiness, what effect would this have on perception, accuracy and consistency?

In summary, some aspects of elite player's technique can not be supported biomechanically. The primary objective of this article is for all coaches to ask themselves 'How do you optimise the art and science of batting whilst keeping the act of striking a cricket ball as simple as possible for the player?'

Biomechanical analysis is the 'why' something happens, it is down to the skill of the coach and relationship with the player to decipher correctly the 'cause and effect' of the any movement they observe...

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ECB Level IV – Biomechanics Tutor
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