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CHAPTER 1

1.1 INTRODUCTION

There are pertinent factors that play a part in attacking play, in particular the collision site where the ball carrier and defender meet. In all aspects of the game, the players or teams that are able to manage and dominate this facet of play to their advantage should be more adept at moving up the field in order to get into a scoring position (Meyer, 2005).

This study will primarily be empirical in nature making use of analytical research methods. According to Thomas and Nelson (1996), a danger of such a study is that relying too much on personal experience may be a pitfall as one's own experience may be limited, furthermore, one's retention depends substantially on how the events agree with ones past experiences and beliefs, on whether things "make sense", and on the state of one's motivation to remember.

In order to guard against this possible danger, notational analysis will be done in order to attempt to analyse these collisions in the sport. This will be done using a specifically defined analysis process so that a biomechanical explanation is able to be made thus making it possible to use this information in a coaching environment (James & Bates, 1997; Mullineaux, Bartlett & Bennett, 2001; Bracewell, 2002).

Biomechanics and notational analysis both involve the analysis and improvement of sport performance. They make extensive use of video analysis and technology. They require careful information management for good feedback to coaches and performers and systematic techniques of observation. They do differ however in that biomechanists analyse, in fine detail, individual sports techniques and their science is grounded in mechanics and anatomy. Notational analysis studies gross movements or movement patterns in team sports and is primarily concerned with strategy and tactics (James & Bates, 1997; Bartlett, 2001; Mullineaux et al., 2001, Bracewell, 2002).

Traditionally, coaching intervention has been based upon subjective observations of athletes. However, several recent studies have shown that such observations are not only unreliable but also inaccurate. Franks and Miller (1986) compared coaching observations to eyewitness testimony of a criminal event. Using methodology gained from applied memory research, they showed that international-level soccer coaches could only recollect 42% of the key factors that determined successful soccer performance during one match.

In another study, a forced choice recognition paradigm was used by Franks (1993), who found that experienced gymnastic coaches were not significantly better than novice coaches in detecting differences in two, sequentially presented, front hand-spring performances (Hughes & Franks, 1997).

The evidence from these studies leads one to believe that the processing of visual information through the human information processing system is extremely problematic, if one requires an objective, unbiased accounting of past events. Hence, the solution is to collect relevant details at the termination of that event, analyse them in order to give the most accurate evaluation of movements or play possible, and to make this information available to the players as feedback for optimal performance improvement (Magill, 1993; Hughes & Franks, 1997).

1.2. MOTIVATION AND BACKGROUND

> *"Know your enemy, and know yourself, and you will win a 1000 battles"*
>
> Ancient Chinese proverb

As a professional rugby coach, it has always been a passion to always try and stay ahead of the opposition. This, with having been employed as Technical Advisor of The Bulls Super 12 team in 2004 has further fuelled this ambition to get ahead. This passion and opportunity to hone one's analysis skills has resulted in the desire to pursue the exploration of this topic of collisions in rugby.

During post graduate studies, two dissertations where completed where an analysis of the components of rugby has taken place. The two dissertations being firstly; “The significance of the level of attack and possession on the outcome of a rugby match” (Evert, 2000), and the second; “A Scientific Analysis of Running Lines in Rugby” (Evert, 2003), have both played a major role in the coaching techniques that have been employed since the completion of these two dissertations.

The information gained from these two studies has since been used in all aspects of the coaching that has taken place and have mostly definitely seen how it has positively influenced the success of the teams that have been worked with. The path of rugby is so dynamic and the cross pollination of information from various codes and sporting types has resulted in the game becoming an even closer contested spectacle.

It is for this reason that this study has been initiated. It is the authors view that if a player is able to dominate the collision site, the team as a whole will be able to be more successful, irrespective of the water tight defensive systems that are in place. This study will therefore form the basis of the methodology identified for coaching players in the “art” of how to approach a body on body collision in rugby.

1.3. FORMULATING THE RESEARCH PROBLEM

1.3.1 The unit of analysis

The research will follow a structure which will set the boundaries of the study. The discussion will take place in an ordered fashion beginning with a historical background of both rugby and notational analysis in sport followed by the necessity of notational analysis in the coaching of teams or players. It stands to reason that in order to know where you are going, you need to know where you have been.

Thereafter, a detailed look at attacking play will be made. In order to understand the concept of collisions in a rugby context, a complete understanding of how an attacking play will take place is needed. Each attack is based on the premise that an objective is sought to be achieved thus a full understanding of all the components involved is needed.

The next step will be to look at those aspects of defensive play that can be seen as a defensive error. The reason for this is that there could be either a breakdown in the defensive system or a fault made by player within the system which could lead to the defensive line being broken.

Thereafter, a detailed look at the principles of notational analysis which are specifically applicable to rugby will be analysed. The reason for this is that each sporting code has unique factors that affect the way their notational analysis takes place. It thus becomes important that the study shows how the detailed analysis of this aspect of play, i.e., collisions, is to be approached.

The analysis sheets will focus on the following key areas;

1. post contact evaluation;
2. in contact evaluation;
3. pre contact – attacking qualities;
4. pre contact – defensive qualities; and
5. velocity change evaluation.

1.4 THE RESEARCH GOAL

The research goal is to gain a better understanding of the factors that play a role in a dominant collision in rugby as well as the relative significance of dominant collisions as an indicator of success in rugby. The hypothesis stands to reason that if a team is aware of the factors that lead to a dominant collision, are able to execute them in a match situation, the team should thus be able to dominate collisions and be more adept at getting “go forward” resulting in more tries being scored. The final step will then be to analyse the collision making use of various biomechanical principles. This will be done making use of notational analysis sheets specially designed in order to evaluate the key concepts to be evaluated during the course of the study and that are important in order to explore the above mentioned factors (see CD Appendix).

Once the notational analysis process has been completed, links and reasons will be attempted to be explained as to the significance of successfully executed collisions in match situations. Key factors associated with collisions will also be evaluated in the light of, and in comparative ratios to the mentioned collisions. This will include the following;

1. The average number of collisions for the try to be scored. The collisions mentioned here, includes the number of rucks / phases, off-loads in the tackle and a forced missed tackle;
2. The ratio of dominant collisions versus the number of passes executed for the try to be scored. (number of collisions / number of passes);
3. The average number of forced missed tackles for the try to be scored;
4. The average positive velocity change of the dominant collisions for the try to be scored. (momentum of the ball carrier – momentum of the defender)
5. The comparison of whether a try is scored from a clean line break, or from extra players in support, versus the percentage of tries scored where a dominant collision took place by the try scorer before the try was in fact scored; and
6. The ratio of forced missed tackles per phase for the try to be scored. (forced missed tackles / number of phases).

If the study does in fact show that the above mentioned factors associated with successful dominating ball carrying collisions do positively influence the outcome of a match, reasons will be researched as to why this in fact does occur.

1.4.1 The research strategy

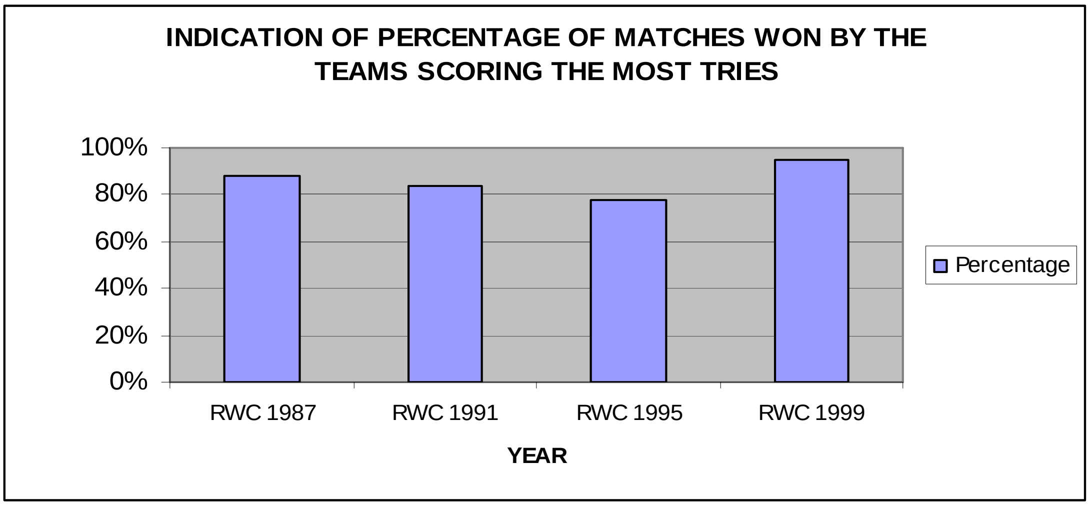
The research strategy will take the form of an in-depth analysis of specific factors that occur in real-life match situations. A notational analysis sheet will be developed which will identify pertinent factors to be looked for during a collision, (See Appendix A, B and C found on the accompanied CD). The research will be primarily statistical in nature and the author will make use of this statistical information in order to make deductions as to why or why not the identified contributing factors played a role in the dominant collision.

A quasi-experimental design will be used where a multiple regression analysis will be done identifying the correlation between log position and the four key measurements. Although no intervention will be possible from the researcher, the change will be measured between teams within a competition, and from a competition to competition basis. The number of tries scored will be seen as the indication of success. This assumption can be made due to the research done by Thomas (2003) when comparisons were made between the 1987 and 1999 IRB Rugby World Cup's as can be seen in Table 1.1 and Chart 1.1.

Table 1.1: Table indicating the percentage of teams winning matches by scoring more tries than the opposition

Year	Number of matches	Won by team scoring the most tries	Percentage
RWC 1987	32	28	88%
RWC 1991	32	27	84%
RWC 1995	32	25	78%
RWC 1999	41	39	95%

(Adapted from: Thomas, 2003)



(Adapted from: Thomas, 2003)

Figure 1.1: Graph showing the relative percentages of teams winning matches by scoring more tries than the opposition

As can be seen from the respective Table 1.1 and Graph 1.1, a summary of the above shows that of the 137 matches played in the four Rugby World Cups, 119 or 87% were won by the team scoring the most tries, and only two were won by the team that scored the fewest number of tries but kicked more penalties (Thomas, 2003).

The three competitions in question are the Super 12 of 2003, Super 12 of 2004 and Super 12 of 2005. The reason that these competitions have been identified is that they are firstly the most recent, and are recognised as the pace setting competitions in world rugby due to these Super 12 players making up the National teams that have won four of the last five Rugby World Cups. It would also be foolish to try and go too far back in history as, as previously mentioned, the game evolves from year to year and the information would be outdated.

The data that is collected will thus be compared in the following way:

- as ranked from winners, to position 12 on the log.

Once this comparison has been made, links will be attempted to be found so that a clear, correct deduction and prediction can be made. Finally, a philosophical comparison and discussion will take place.

1.5 METHODS OF RESEARCH

1.5.1 Data collection

The task is to obtain data which enables one to get an accurate and detailed description of the concepts that are specific to rugby, in particular the collision site. The data used will be collected from video footage of tries scored in the following competitions; the 2003, 2004 and 2005 Super 12 Competitions. All in all 784 tries were evaluated over the three years with 2003 Super 12 having 280 tries, 2004 Super 12 having 234 tries and 2005 Super 12 having 270 tries. During these three years 405 matches were played made up of each team playing eleven pool matches followed by a semi-final and a final. The discussion will be made by means of making use of scientific articles, relevant books on the subject, and interviews with coaches and the researcher's own deductions.

1.5.2 Data organisation

The data will be organised in such a way that when incorporated into the discussion it will add to the exploration of the research goal. The analysis will be done manually however the researcher will attempt to develop a computer program in order to be able to log and recall information that will be able to be used in the future as a notational analysis tool. A computer program called "Verusco Systems®" will also be used. This program will aid in the biomechanical analysis of the technical aspects of the study.

1.5.3 Analysis and interpretation of data

The analysis of this subject will rely heavily on statistical evaluations and descriptions of the relevant topics. The information will follow a systematic description of the concepts needed to understand the object of the study, namely collisions in rugby.

It will involve working with data, organising the data, systematically ordering the information into understandable, easy to read components, searching for patterns and links between concepts, discovering what is important and what can be learnt, and finally identifying key principles that are applicable to the concept.

CHAPTER 2

2.1 THE DEVELOPMENT OF RUGBY FOOTBALL

The early history of rugby football has been researched by a South African teacher, writer and rugby administrator and is described in two books which show the history of rugby in South Africa and at a Cape Town private school for boys (Noakes & Du Plessis, 1996).

According to Dobson (2003), the origin of all ball games, being played between two teams on a field with two goal posts for example rugby, soccer and hockey, can be traced back to the Middle Ages in England. In these "games" the inhabitants of two neighbouring villages would meet halfway between the two villages on an open piece of ground. The goal of the game was to get a ball or a similar like object through the poles of the house owned by the opposition's town "chief'.

There are many accounts of these games being very gruesome as the game Brigand was played with the heads of Danish Vikings, which was unceremoniously kicked through the streets by the local towns' people. The game began as soon as the "ball" was let loose in the middle of the two teams. Thereafter anything was acceptable as there were no rules concerning clothing, equipment, the number or the age of players taking part. These games were often so savage that Royal Proclamation banned them 30 times in three centuries (Gallaher & Stead, 1906; Noakes & Du Plessis, 1996).

Later in the 19th Century in the English Public Schools, especially Rugby, Westminster, Eton, Marlborough, Winchester, Charterhouse and Cheltenham a form of the game of rugby developed. The schools accepted these "manly" games as an opportunity for their pupils to relax and to prepare the "muscled Christians" physically, in order to take the British values to the far corners of the British Empire. The football games that developed in these famous schools each had different characteristics and there were no fixed rules. The reason for this was that each school developed their own particular rules based on the facilities available to them. The playing area at Rugby School was much larger than the others, therefore it allowed for the ball to be able to be carried. Eton school had a much smaller area available and they therefore developed a form of “dribbling” game (Noakes & Du Plessis, 1996).

When these pupils left school to attend the University of Cambridge, the first rugby club in 1839 was founded by an old boy from Rugby School. The old boys from Eton got upset when in the middle of games the players from Rugby School picked up the ball instead of kicking it. Thereafter a new set of rules was set up in 1846 at a meeting of the University of Cambridge. There were more old boys from Eton, therefore, the rules favoured the “dribbling’ game. In 1863 these Cambridge rules formed the basis of the rules developed for football (soccer) (Noakes & Du Plessis, 1996). It therefore happened that in 1863 the differences between rugby and soccer became more defined. Teams in these early days of rugby consisted of up to 300 players per side, obviously to ensure no goals were scored! The ball was kicked downfield towards the opposition’s goal posts and players then moved by means of dribbling and scrums, which were called *hots*. Lineouts were formed if the ball landed outside the field of play. Handling of the ball was first allowed at Rugby School and only if the ball was cleanly caught. Out of a historical perspective William Webb Ellis was the first person to take a clean catch and then ran forwards with the ball in possession. Rugby School then introduced a rule that a player could only run forwards if he was trying to score a goal himself. At this stage he still wasn’t able to pass the ball to another player (Noakes & Du Plessis, 1996).

On 26 January 1871, a meeting was ordered for the 21 rugby-playing clubs in London and the surrounding areas in the Pall Mall Restaurant. At this meeting the Rugby Football Union was founded and 59 laws were set out for the playing of the game rugby (Noakes & Du Plessis, 1996). In 1875 the number of players was limited to 15 a side for the match between Cambridge and Oxford and in 1877 international teams also had teams of 15 players. These 15 players consisted of 10 forwards, two attacking halves and three defending backline players. From here the play developed through changes in the scrum formations to what we see in modern day rugby, a 3-5-1 formation. The positions also became specialised and lately the laws have been adjusted in order to make the game more exciting so that viewer audiences can increase (Noakes & Du Plessis, 1996).

Although the first style of rugby played in South Africa at Bishops School in Cape Town conformed to the rules of Winchester School (the headmaster was a former pupil of the English School) by the time the first governing body of the sport - England's Rugby Football Union (RFU) - was founded in 1871, Rugby's rules held sway. That same year the first international match was played between England and Scotland. Wales and Ireland followed onto the international calendar shortly afterwards and by the end of the century South Africa, New Zealand and two Australian states were also part of the international community. Since that time the game has evolved slowly. The game's international governing body, the International Rugby Football Union (today the International Rugby Board) was founded in 1886 although England declined to take part in a dispute over the number of representatives they would be permitted to supply. It was agreed that games would be played according to the rules of the Rugby Football Union but it was not until 1930 that the way the game was played was standardised across the world.

The first match in South Africa took place between the "Officers of the Army" and the "Gentlemen of the Civil Service" at Green Point in Cape Town on 23 August 1862 and ended as a 0-0 draw (van der Merwe, 2001). The game spread with British colonisers through the Eastern Cape, Natal and along the gold and diamond routes to Kimberley and Johannesburg. The first union to be formed in South Africa was Western Province, which came into being in 1883; Griqualand West followed in 1886 and Eastern Province in 1888 (Dobson, 2003).

South Africa played its first international in 1891 against a touring side from Britain although it was not until the side toured Britain in 1906 that they became known as the Springboks. The sport quickly gripped the imagination of many South Africans and the country's success fuelled the enthusiasm (Dobson, 2003; Unknown Author, 2005a). South Africa won their third series in 1903 and it was not until the 1956 tour of New Zealand that they were to be defeated in a series as they established themselves as arguably the world's leading rugby nation. Their most dangerous rival was invariably New Zealand whom they met for the first time in 1921 to establish what is regarded as rugby's most bitter rivalry (Dobson, 2003; Unknown Author, 2005a).

The game remained strictly amateur until 1995 when the inevitable decision to allow players to be paid was made. Up until then anyone caught taking money for playing the game was banned for life. In the years since that decision the game has changed more rapidly than in the previous century and a half. New competitions such as the Vodacom Super 12, Vodacom Tri-Nations and the Heineken Championship in Europe have hugely increased the game's revenues and spectator interest (Dobson, 2003; Unknown Author, 2005a).

2.2 Background to The South African Rugby Football Union (SARFU) and SA Rugby (Pty) Limited

The South African Rugby Football Union (SARFU) is the custodian of the Game of rugby in South Africa. SARFU was established in 1992 following the unification of the former SA Rugby Board (SARB) and SA Rugby Union (SARU), paving the way for South Africa's readmission to the international arena after eight years of isolation (Dobson, 2003; Unknown Author, 2005b).

SARFU has as its members the 14 Provincial Unions - the Blue Bulls (Pretoria), Boland (Wellington), Border (East London), Eastern Province (Port Elizabeth), Falcons (Springs), Free State (Bloemfontein), Golden Lions (Gauteng), Griffons (Welkom), Griqualand West (Kimberley), Leopards (Potchefstroom), Mpumalanga (Witbank), Natal (Durban), South Western Districts (George) and Western Province (Cape Town) (Unknown Author, 2005b).

The unified SARFU was founded on three core principles:

1. The establishment of a non-racial, non-political and democratic rugby community, both on and off the field to ensure the levelling of the playing fields at all levels;
2. The development of infrastructure and human resources potential in order to uplift the game in disadvantaged areas and establish it in areas where it was not being played;
3. To ensure that South Africa reclaimed its place amongst the world's top rugby playing Nations (Unknown Author, 2005b).

Over the past decade much progress has been made in growing and transforming the game in South Africa and there have been many notable achievements. The SARFU Game Development Programme was successfully launched in 1993 with the aim of creating opportunities for all South Africans to play the game and ensuring that the sport is representative of the population at all levels. Over the last nine years the programme has ensured the on-going growth of the game, especially in local communities through the schools and clubs network. The SARFU investment in community rugby over the past 10 years has been extensive and has provided much needed financial assistance to the 14 Provincial Unions, allowing the growth and transformation of the game at grassroots level on a National scale. Community rugby and the support of the 14 Provinces rely heavily on income generated through the sale of broadcast rights, as well as sponsorship income. This is enabling the continuance of a host of activities annually at all levels, including Youth Weeks, talent identification programmes, elite squads, fast-tracking and excellence programmes, rugby academies, coaching and referee development, club assistance programmes, school and club tournaments and the establishment of women's rugby. It is obvious that rugby has had to adapt to the needs of players and in so doing has developed into the spectacle that we are able to experience now two centuries later (Unknown Author, 2005b). Today's Rugby Coaches are thus better prepared, better organised and more understanding of the needs of their athletes in their care. They are skilful, resourceful, confident and caring in their role as responsible coaches (Levy & Ponissi, 1993).

As is evident South African rugby has undergone many changes from isolated governing bodies to a now unified South African Rugby Union. This path has allowed for a successful transition and as long as dialogue and unity prevail, South African rugby can again become the world force it was in the last century.

CHAPTER 3

3.1 THE NECESSITY OF FEEDBACK FROM NOTATIONAL ANALYSIS

Information that is provided to the athlete about action is one of the most important variables affecting the learning and subsequent performance of a skill (Mento *et al.*, 1987; Alexander *et al.*, 1988; Hughes *et al.,* 1989; Young & Schmidt, 1992; Bouthier *et al.,* 1996; Franks, 1996; Partridge & Franks, 1996; Mosteller, 1997; McGarry *et al.*, 2002; Hughes *et al.*, 2003).

The term feedback should thus be viewed as a general term that refers to information that comes from a source and goes to a mechanism that uses the information to make error corrections (Alexander *et al.*, 1988; Alderson *et al.*, 1990; Young & Schmidt, 1992; Magill, 1993; Partridge & Franks, 1996; Bracewell, 2002; Glazier *et al.*, 2003).

The practical value of performance analysis is that well-chosen performance indicators highlight good and bad techniques or team performances. They help coaches to identify good and bad performances of an individual or a team member and facilitate comparative analysis of individuals, teams and players (Alexander *et al.*, 1988; Sprigings, 1988, Hughes *et al.*, 1989; Alderson *et al.*, 1990; Young & Schmidt, 1992; Partridge & Franks, 1996; Mosteller, 1997; Bartlett, 2001; Bracewell, 2002; McGarry *et al.*, 2002; Glazier *et al.*, 2003; Hughes *et al.*, 2003; Hughes & Franks, 2004).

Knowledge about the proficiency with which athletes perform a skill is critical to the learning process and in certain circumstances a failure to provide such knowledge may even prevent learning from taking place (Sprigings, 1988; Hughes *et al.*, 1989; Alderson *et al.*, 1990; Young & Schmidt, 1992; Bouthier *et al.*, 1996; Partridge & Franks, 1996; Potgieter, 1997; McGarry *et al.*, 2002; Glazier *et al.*, 2003).

In addition, the nature of the information that is provided has been shown to be a strong determinant of skilful performance, i.e., precise information about the produced action will yield significantly more benefits for the athletes than feedback that is imprecise (Hughes et al., 1989; Young & Schmidt, 1992; Bracewell, 2002; Glazier *et al*., 2003).

3.2 TYPES OF FEEDBACK

The question now arises as to how does the athlete acquire this vital information?

First, a major contributor to the athlete's knowledge base about the performance of a skill is that of intrinsic or sensory feedback. Intrinsic feedback can be defined as information that is gained from the body's own proprioceptors, such as muscle spindles, joint receptors, etc. (Alexander *et al*., 1988; Sprigings, 1988; Hughes *et al*., 1989; Alderson *et al*., 1990; Young & Schmidt, 1992; Magill, 1993; Bouthier *et al*., 1996; Partridge & Franks, 1996; Hughes & Franks, 1997; Mosteller, 1997; Hughes & Franks, 2004).

A second source of feedback is that which augments the feedback from within the individual. This can be thought of as extrinsic information or Knowledge of Results (KR). The term Knowledge of Performance (KP) has also been used to differentiate between information about the outcome of the action (KR) and information about the patterns of actions used to complete the skill (KP) (Alexander *et al*., 1988; Sprigings, 1988; Alderson *et al*., 1990; Young & Schmidt, 1992; Magill, 1993; Partridge & Franks, 1996; Bracewell, 2002).

Perhaps the best global definition of KR would be, "… *information provided to an individual after the completion of a response that is related to either the outcome of the response or what performance characteristics produced that outcome*" (Magill, 1993).

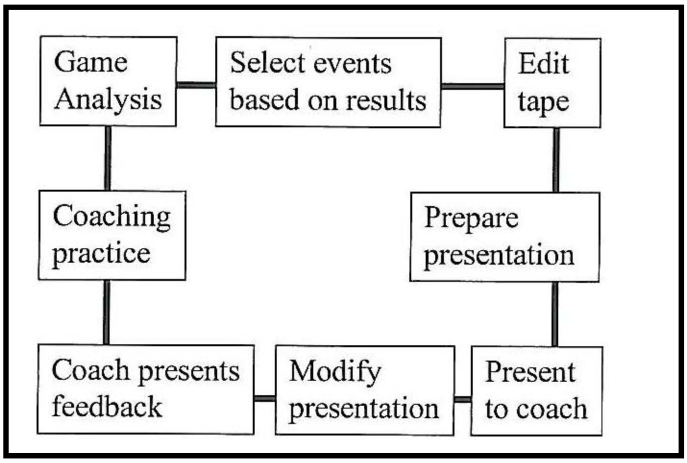
3.3 THE ROLE OF THE COACH IN USING FEEDBACK

Although intrinsic feedback is of vital importance to the performance of a skill, there is very little that coaches can do to improve upon this "hardwired" system (Zatsiorski, 1995).

It thus remains the responsibility of the coach to offer the best possible extrinsic feedback that will enable the athlete to accurately compare "*what was done*" with "*what was intended*" (Alexander *et al*., 1988; Bouthier *et al*., 1996; Partridge & Franks, 1996; Bracewell, 2002).

Clearly, the use of video footage as a medium of feedback has irreplaceable potential in this regard. The benefits are intuitively obvious. In the case of video, the information can be played back on a TV screen only a few seconds after the event has taken place. There is no delay period that may hamper the comparison of performances being made by the athlete, the motivation to perform is enhanced by individuals wanting to see themselves on TV and, in addition, the whole performance can be stored in its entirety or edited for later analysis.

The following Figure 3.1, shows that the coach provides the information to the players based on the results of match analysis.



(Adapted from O' Donoghue et al., 2005)

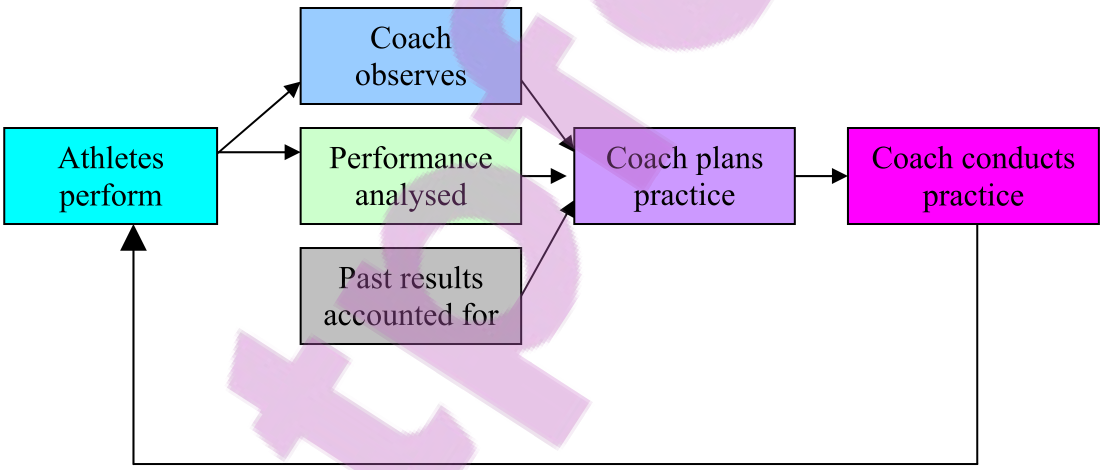
Figure 3.1: A schematic diagram representing how the coaching process can be improved by means of feedback

The videotape can therefore provide error information, can be a reinforcer when performance is correct and can be a strong motivating force (Sprigings, 1988; Young & Schmidt, 1992; Hughes & Franks, 1997; Mosteller, 1997; O' Donoghue *et al*., 2005).

3.4 THE NEED FOR OBJECTIVE INFORMATION

The essence of the coaching process is to instigate observable changes in behaviour. The coaching and teaching of skill depends heavily upon analysis in order to effect an improvement in athletic performance. It is clear that informed and accurate measures are necessary for effective feedback and hence improvement of performance. This feedback should include qualitative as well as quantitative analysis (Alexander *et al*, 1988; Sprigings, 1988; Hughes *et al*., 1989; Alderson *et al*., 1990; Young & Schmidt, 1992; Bouthier *et al*., 1996; Partridge & Franks, 1996; Hughes & Franks, 1997; Mosteller, 1997; Bracewell, 2002; McGarry *et al*., 2002; Glazier *et al*., 2003; Hughes *et al*., 2003; Hughes & Franks, 2004; O' Donoghue *et al*., 2005).

In most athletic events analysis of the performance is guided by a series of qualitative assessments made by the coach. Franks *et al*. (1983a, b) defined a simple flowchart of the coaching process (see Figure 3.2).



(Adapted from: Franks et al., 1983a, b)

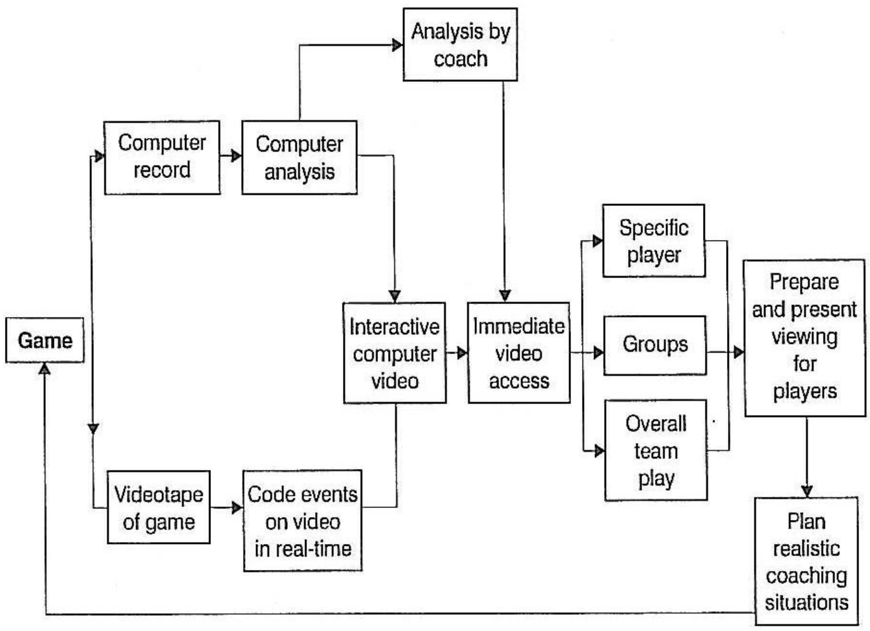
Figure 3.2: A schematic diagram representing the coaching process

The schema in Figure 3.2 outlines the coaching process in its observational, analytical and planning phase. The game is watched and the coach will form a conception of positive and negative aspects of the performance. Often the results from previous games, as well as performances in practice, are considered before planning in preparation of the next match (Alexander *et al*., 1988; Hughes *et al*., 1989; Alderson *et al*., 1990; Young & Schmidt, 1992; Partridge & Franks, 1996; Hughes & Franks, 1997; Mosteller, 1997; Lynch, 2001; Bracewell, 2002; McGarry *et al.*, 2002; Glazier *et al*., 2003; Hughes *et al*., 2003; Hughes & Franks, 2004; O' Donoghue *et al*., 2005).

The next game is played and the process repeats itself. There are, however, problems associated with a coaching process that relies heavily upon the subjective assessment of game action. During a game many occurrences stand out as distinctive features of action. These range from controversial decisions given by officials to exceptional technical achievements by individual players. While these types of occurrences are easily remembered, they tend to distort the coaches' assessment of the game in total. Human memory systems have limitations and it is almost impossible to accurately remember all the events that take place during an entire competition. Studies by Franks and Miller (1986) have shown that soccer coaches are less than 45% correct in their post-game assessment of what occurred during 45 min of a soccer game. While there is considerable individual variability, this rapid forgetting is not surprising, given the complicated process of committing data to memory and subsequently retrieving it. Events that occur only once in the game are not easily remembered and forgetting is rapid. Furthermore, emotions and personal biases are significant factors which affect storage and retrieval processes of memory. In most team sports an observer is unable to view, and assimilate, all the action taking place on all the playing area. Since the coach can only view parts of game action at any one time (usually the critical areas), most of the peripheral play action is lost. Consequently, the coach must then base post-match feedback on only partial information about a team's, unit's or individual's performance during the game. This feedback is often inadequate and, as such, the opportunity is missed to fully aid the possible improvement of players and teams (Young & Schmidt, 1992; Bouthier *et al*., 1996; Partridge & Franks, 1996; Hughes & Franks, 1997; Bracewell, 2002; McGarry *et al*., 2002; Hughes & Franks, 2004; O' Donoghue *et al*., 2005).

Problems that are associated with subjective assessments would seem to present the coach with virtually insurmountable difficulties. The whole process of coaching, i.e., gaining improvement of performance of the athlete, hinges on the observational abilities of the coach (Partridge & Franks, 1996; Hughes & Franks, 1997; O'

Donoghue *et al*., 2005). Despite the importance of observation within the coaching process, very little research has been completed in the specific area of observational accuracy. Despite this dearth in the literature of the sport science discipline, there has been a considerable body of applied research that quantitatively measured the accuracy of observers in criminal eyewitness situations. There are a number of similarities between the situation of the coach observing an athletic performance and that of the eyewitness to the criminal event. Testimony by an eyewitness can be an event of profound importance; this is equally true for both criminal and sporting situations. The accurate analysis of competition is thus fundamental to the entire coaching process and underlies improvement in performance; see Figure 3.3 (Alderson *et al*., 1990; Bouthier *et al*., 1996; Hughes & Franks, 1997; Lynch, 2001; O' Donoghue *et al*., 2005).



(Adapted from Hughes & Franks, 1997)

Figure 3.3: A schematic diagram representing the coaching process, utilising some of the computer-aided analysis and feedback technology

3.5 NOTATIONAL ANALYSIS – A REVIEW OF THE LITERATURE

Notational analysis is the systematic gathering, analysis and communication of detailed information relating to competitive sport. Notational analysis provides accurate information in quantifiable terms that allows misperceptions by coaches to be avoided. Notational analysis allows progress to be monitored and accurate feedback to be provided to players. This assists decisions about training and tactics and improves the coaching process by directing the coach to those facets of the game that require attention.

General, rudimentary and unsophisticated forms of notation have existed for centuries. Hutchinson (1970) cited evidence indicative of the fact that for at least five centuries attempts had been made to devise and develop a system of movement notation. Further, the Egyptians, thousands of years ago, made use of hieroglyphs to read dance, and the Romans employed a primitive method of notation for recording salutary gestures. Research shows that the earliest recorded form of music notation was conceived in the 11th century (Hutchinson, 1970; Thornton, 1971), although it did not become established as a uniform system until the 18th century. Historical texts give substantial evidence pointing to the emergence of a crude form of dance notation much later, in about the 15th century. Thornton (1971) stated that the early attempts at movement notation may well have "*kept step*" with the development of dance in society and as a consequence the early systems were essentially designed to record particular movement patterns as opposed to movement in general. It becomes apparent, then, that dance notation actually constituted the "*starting base*" for the development of a general movement notation system. Arguably the greatest development in dance notation was the emergence of the system referred to as "*Labanotation*" or "*Kinetography-Laban*", so called after its creator Rudolph Laban, in 1948 (Hughes & Franks, 1997).

Laban highlighted three fundamental problems encountered in the formulation of any movement notation system:

1. recording complicated movement accurately;
2. recording this movement in economical and legible form; and

3. keeping abreast with continual innovations in movement (Hughes & Franks, 1997).

It was these three fundamental problems that left dance in a state of flux incapable of steady growth, for centuries (Hutchinson, 1970). The next "*step*" in the development of movement notation came in 1947 with the conception of another form of dance notation, Choreology, published in 1956, by Jean and Rudolph Benesh (Hughes & Franks, 1997).

In this form of notation five staves formed the base or matrix for the human figure, i.e.,

________________	Top of head
________________	Top of shoulder
________________	Waist
________________	Knees
________________	Floor

All notation was completed on a series of these five-line grids with a complex vocabulary of lines and symbols (Hughes & Franks, 1997).

The major underlying disadvantage of both Benesh and Laban methods of notation in terms of sport is that they are both primarily utilised for the recording of patterns of movement rather than its quantification (Hughes & Franks, 1997). There were numerous attempts to develop a system of movement notation based entirely on the mathematical description of movement in terms of the degrees of a circle in a positive or negative direction. However, as with the systems of Labanotation and Choreology, these systems did not allow the description of movement in terms familiar to sport or everyday life. As Brooke and Knowles (1974) stated:

> "*The Benesh and Laban methods of notation are more suitable for recording expressive movement and articulate skills than for gross motor activity of major team games*".

Movement notation systems, developed primarily in the field of expressive movement, gradually diversified into game analysis, specifically sport. However, ensuing research proved severely limited both in variety and detail, as reported by Sanderson & Way (1977):

> *"The majority of little-published research that there is in game analysis is concerned with basketball and soccer – and at a fairly global and unsophisticated level".*

There are a number of texts that contain sections devoted to research in notational analysis. The best of these are copies of proceedings of conferences on football (two) and racquet sports respectively (Reilly *et al.*, 1988, Reilly *et al.*,1993; Reilly *et al.*, 1995).

Finally, there are the proceedings of the three world conferences on notational analysis of sport. The presentations of the first two conferences are compiled in one book, Notational Analysis of Sport I & II (Hughes, 1996), and the first section has a number of keynote speakers who present a varied but enlightened overview of different aspects of notational analysis. Croucher (1996) presents a lucid and clear analysis of the way in which notational analysis can be used in a practical and real setting. To complement this practical presentation, Winkler (1996a, b) introduces all the problems associated with computer analysis of a sport, using his experiences with German soccer as a source of practical examples. From a philosophical point of view, Treadwell (1996) presents an educational aspect to the potential uses of notational analysis. Lyons (1996) completed what must be the first historical piece of research in notational analysis highlighting the work and life of Lloyd Messersmith, one of the earliest pioneers of notation in sport, also clearing up some of the misconceptions about his research (Hughes & Franks, 1997).

3.6 THE DEVELOPMENT OF SPORT – SPECIFIC NOTATION SYSTEMS (HAND NOTATION)

Probably one of the first attempts to devise a notation system specifically for sport analysis was that of Messersmith and Corey (1931), who attempted to notate distance covered by specific basketball players during a match (Hughes & Franks, 1997). Notation systems were commercially available for American football play-analysis as early as 1966 (Purdy, 1977), and the Washington Redskins were using one of the first in 1968 (Witzel, cited by Purdy, 1977).

Interestingly, American football is the only sport that has as part of its rules a ban on the use of computerised notation systems in the stadium. How this could be enforced is not clear; however, all clubs that have been contacted have been helpful. All claim to use a similar hand notation system, the results of which are transferred to computer after the match (Hughes & Franks, 1997).

3.7 A HISTORICAL REVIEW OF HAND NOTATION SYSTEMS FOR RUGBY UNION

Rugby union presents unique problems for analysis with its primary phase facets, i.e., scrums, lineouts and restarts, and the activity ensuing from a tackle in either rucks or mauls. Lyons (1988) has gathered data by hand on the Home International Championship for a period of ten years and has created a sound database. From this database he claimed to predict the actions, e.g., the number of scrums, lineouts, passes, kicks, penalties, etc., in the England – Wales match in the 1986-87 season to within three passes and two kicks (Hughes & Franks, 1997).

Treadwell (1992) presented a summary of work completed at Cardiff by the team working there, demonstrating that game models were clearly tenable for rugby union regardless of weather, selection, refereeing or even coaching style. Over 40 different action variables were defined and data collection was completed live using hand notation. This was validated using a computerised system to analyse matches from video, post-event. Data from the Five Nations championships over four years were presented to confirm the hypothesis that the game of rugby union provides a rhythm for prediction of certain variables (Hughes & Franks, 1997).

Du Toit (1989) made a time, movement and skill analysis for rugby union at senior level in South Africa in 1987. Three video cameras were used. One followed the match, one followed a forward and one followed a back in each of 12 matches. Their methodology provided the possibility to compare between positions and over a period of time and take into account the game situation (Hughes & Franks, 1997).

Their results included:

1. the length of an average match was 88 min 37 s;
2. 77% of each playing periods were below 20 s;
3. average play to rest ratio for forwards was 14:22 and backs was 12:24;
4. scrums lasted 5 s; lineouts 4 s, loose play situations 6 s;
5. forwards moved 3730 m; backs 3900 m;
6. average of 9 scrums, 45 lineouts, 49 loose-play situations; and
7. average of 35 tackles, 24 running skills, 169 handling skills, 82 hand kicks (Du Toit, 1989).

There is however a need when comparing time-and-motion studies to consider whether every researcher's definition of each activity is the same. For instance, Grehaigne *et al.* (1996) used the following measurements: stop (0 m/s), walk (0-2 m/s), jog (2-4 m/s), cruise (4-6 m/s) and sprint (greater than 6 m/s). Research into movement analysis and definition of fitness profiles is of value to rugby union coaches, players and others but it does have its limitations, and there is a need for some other important aspects to be considered (Hughes & Franks, 1997).

For any fitness or training norms to be taken from such studies there is a need to ensure that:

1. a specific player / position is tracked for the entire match and for a series of matches. This will then give a global figure which will also have accounted for environmental factors such as weather and pitch conditions, importance of the match and personal attitude of the player; and

2. the nature of the game is accounted for. The work-rates of the player may vary from position to position according to whether the game is fast and fluid or whether they are on the winning or losing side (Hughes & Franks, 1997).

Carter (1996) did combine quantitative and qualitative information in a time-and-motion analysis and heart rate monitoring of a back-row forward. The results showed that the requirements for playing in each of the three back-row positions did vary. The qualitative recording of game incidents and training methods did add another dimension to the research. A clear analysis of the performance of England (Potter, 1996), as an example of one of the international teams in the Five Nations championship (1992-1994), demonstrated the power of notational analysis in a team sport, but this type of research might benefit from a directed hypothesis rather than just reporting data (Alexander *et al*., 1988; Hughes & Franks, 1997).

Hand notation systems are in general very accurate but they do have some disadvantages. The more sophisticated systems involve considerable learning time. In addition, the amount of data that these systems produce involve many hours of work in processing them into forms of output that are meaningful to the coach, athlete or sports scientist (Alexander *et al*., 1988; Hughes & Franks, 1997; O' Donoghue *et al*., 2005).

The introduction of computerised notation systems has enabled these two problems, in particular the data processing, to be tackled in a positive way. Used in real-time analysis or in post-event analysis in conjunction with video recordings, they enable immediate, easy access to data (Alexander *et al*., 1988; Alderson *et al*., 1990; Maclean, 1992; Hughes & Franks, 1997; O' Donoghue *et al*., 2005).

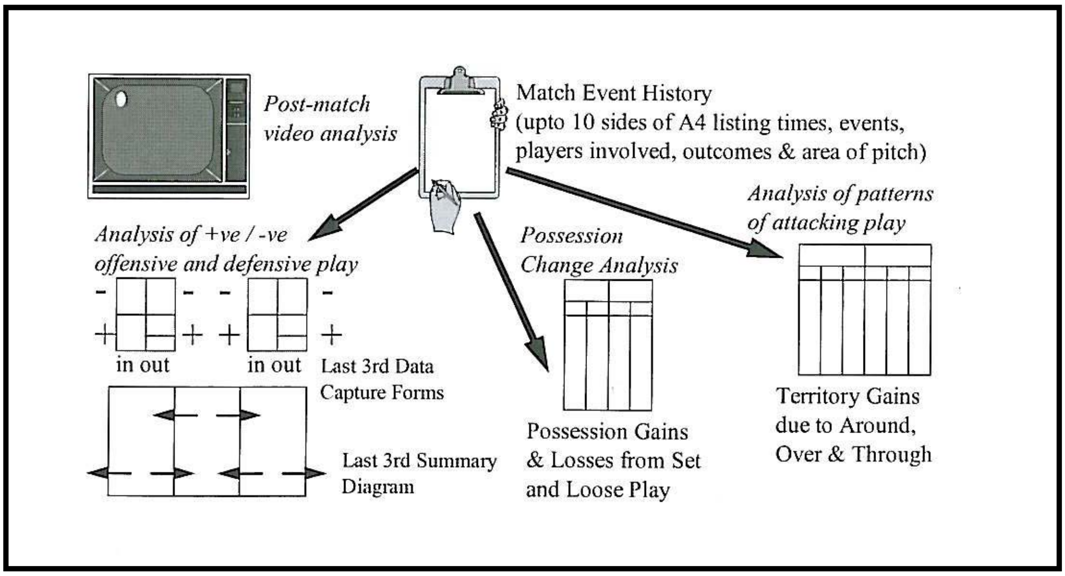
They also enable the sports scientist to present data in graphical forms more easily understood by the coach and athlete. The increasing sophistication and reducing cost of video systems has greatly enhanced the whole area of post-event feedback, from playback with subjective analysis by a coach to detailed objective analysis by means of notation systems (Maclean, 1992; Hughes & Franks, 1997; O' Donoghue *et al*., 2005).

A description follows of a manual method of notational analysis used during the 1995 Rugby Union World Cup, see Figure 3.4. The project studied the quarter-finals, semi-finals, 3rd and 4th place play off as well as the final of the 1995 World Cup for Rugby Union (O' Donoghue *et al*., 2005).

The methodology systematically reduced match information into a quantified form. Initially, the video-recording of each match was observed and a history of match events was recorded onto paper (up to 10 sides of A4) including the time of each event, the players involved, territorial position of the event and the outcome of the event (possession lost, touch found, penalty scored or missed, etc).

After consultation with academics and practitioners of rugby union, it was decided to concentrate on the following areas;

- offensive and defensive play;
- possession changes; and
- patterns of attacking play (O' Donoghue *et al*., 2005).



(Adapted from O' Donoghue et al., 2005)

Figure 3.4: A schematic diagram representing a hand notation system used during the 1995 Rugby World Cup.

To analyse offensive and defensive play, each team's last third of the pitch was considered. A last third capture form was used to note occurrences of various examples of good attacking or poor defensive play leading to the ball entering the last third. The form was also used to capture details of whether play in the last third resulted in a score or whether the ball left the last third as a result of good defensive play or poor offensive play. For each side, the occasions where possession of the ball was gained were identified by examining the match history. These possession changes were classified as coming from set play or loose play. Similarly, to analyse patterns of attacking play those occasions where a team gained territory were identified and classified into around (running and passing, etc), over (chipping, up and under, etc) and through the opposition (rucking, mauling and driving) (O' Donoghue *et al.*, 2005).

Four sides competed in three matches each during the knockout stages (South Africa, New Zealand, France and England). The performances of these teams were analysed. Of these, the Possession Gain to Loss Ratio turned out to be the most promising predictor of performance, reflecting the four team's rankings in the tournament (South Africa 1.24:1, New Zealand 1.19:1, France 1.03:1 and England 0.64:1) (Eaves & Hughes, 2003; O' Donoghue *et al.*, 2005).

3.8 THE USE OF COMPUTERISED NOTATION

Using computers does introduce extra problems of which systems users and programmers must be aware. Increases in error possibilities are enhanced by either operator errors or hardware and software errors.

The former type of error is when the system user unintentionally enters incorrect data, e.g., presses the wrong key on the keyboard. Any system is subject to perception error where the observer misunderstands an event or incorrectly fixes a position but the computer-operator interface can result in the operator thinking the correct data is being entered when it is not (Hughes & Williams, 1988; Hughes *et al.*, 1989; Alderson *et al.*, 1990; Maclean, 1992; Bouthier *et al.*, 1996; Partridge & Franks, 1996; Hughes & Franks, 1997; Glazier *et al.*, 2003; O' Donoghue *et al.*, 2005).

Hardware and software errors are introduced by the machinery itself, or the programs of instructions controlling the operation of the computer. To minimise both of these types of problems, careful validation of computerised notation systems must be carried out. Results from both the computerised system and a hand system should be compared, and the accuracy of the computerised system quantitatively assessed (Hughes *et al*., 1989; Alderson *et al*., 1990; Maclean, 1992; Bouthier *et al*., 1996; Partridge & Franks, 1996; Hughes & Franks, 1997; Hughes, 1999; Glazier *et al*., 2003; O' Donoghue *et al*., 2005).

Computers have only been recently impinged on the concept of notation analysis. Franks *et al*. (1983b) maintained that this form of technology is likely to enhance manipulation and presentation due to improved efficiency. This postulation is supported by the work of Hughes (1985).

Four major purposes of notation have been delineated:

1. analysis of movement – time motion analysis involves the collection of more information than match analysis as the movement activity of each competitor must be recorded for the full duration of the match. This is particularly challenging for team sports;
2. tactical evaluation – analysis of the moment to moment decisions made during the game and the cognitive which cannot be directly analysed but which must be inferred from the application of technical skills;
3. technical evaluation - is the quantification and assessment of technical skills. Technique refers to those psychomotor aspects of behaviour used by the individual players. These are often recorded independently of the playing context of the technical events;
4. development of databases for performance modelling, and
5. statistical compilation (Hughes & Franks, 1997; O' Donoghue *et al*., 2005).

Many of the traditional systems outlined above are concerned with the statistical analysis of events which previously had to be recorded by hand. The advent of on-line computer facilities overcame this problem, since the game could then be digitally represented, first via data collection directly onto the computer and then later documented via response to queries pertaining to the game. The major advantage of this method of data collection is that the game is represented in its entirety and stored in ROM or on disk. A database is therefore initiated and is a powerful tool once manipulated (Franks *et al*., 1983a; Alderson *et al*., 1990; Partridge & Franks, 1996; Hughes & Franks, 1997; Hughes, 1999; Glazier *et al*., 2003; O' Donoghue *et al*., 2005).

Team sports have the potential to benefit immensely from the development of computerised notation. The information derived from this type of computerised system can be used for several purposes as suggested by Franks *et al.* (1983a):

1. immediate feedback;
2. development of a database;
3. indication of areas requiring improvement;
4. evaluation; and
5. as a mechanism for selective searching through video recording of the game.

All the above functions are of paramount importance to the coaching process. The development of a database is a crucial element, since it is sometimes possible, if the database is large enough, to formulate predictive models as an aid to the analysis of different sports, subsequently enhancing future training and performance (Hughes & Franks, 1997).

3.9 THE USE OF COMPUTERISED NOTATION IN RUGBY UNION

Rugby union presents slightly different problems for analysis, with its set-piece moves, the scrum and the lineout, and also the ensuing action after a tackle: either rucks or mauls. Treadwell (1987) developed software that utilises the concept keyboard to analyse rugby union. Hughes and Williams (1987) developed software using a similar system of hardware. The system was designed to notate the matches' post-event using videotapes. Four computer programs were written. The data collection program was constructed with the help of an international coach, who helped define the most important variables to be recorded (Hughes & Franks, 1997; Hughes, 1999).

The other three programs analysed the data and provided the output. Once again the concept keyboard was used to help gather the data. The pressing of the sub-routine keys, i.e., “scrum”, “lineout”, “ruck”, or “maul”, caused the software to direct the input back to the QWERTY keyboard where additional data was entered, such as: the order in which the players arrived (ruck or maul), quality of ball (scrum, ruck or maul), etc (Bouthier *et al*., 1996; Hughes & Franks, 1997; Hughes, 1999).

The developed system was used to notate five matches from the Home International Series over the previous two years, involving all the participating nations. A comparison was made for each match between two playing sides and then the results were collated and analysed statistically for differences in the patterns of play between the French, Scottish and Irish compared to the English and Welsh sides. No significant differences were found between the patterns of play for successful and unsuccessful teams, although a number of differences were found between the patterns of play of the three nations compared to the other two ($\rho < 0.05$). France, Scotland and Ireland have played, for the previous two seasons, in different patterns to England and Wales (Hughes & Williams, 1987; Bouthier *et al*., 1996; Hughes & Franks, 1997).

Docherty *et al*. (1988) analysed 27 players during matches to assess the time spent in the various activities of the game. Computerised notation of the frequency and total, mean and percentage times of six activities was undertaken. The players selected were either centres or props; eight players were tracked by four cameras in 5 min intervals for a minimum of 40 min per match. The players spent:

1. 47% of the time walking and jogging;
2. 6% of the time running and sprinting;
3. 9% of the time tackling and competing for the ball;
4. 38% of the time standing;

5. centres sprinted for 3% of the time, the props for less than 1% of the time; and
6. players spend 85% of the match in low-intensity activity (Docherty et al., 1988).

The system of Hughes and Williams (1987) was upgraded and transferred to IBM software architecture and used to investigate the effects of the rule changes in rugby union in the 1991-92 seasons. It was found that the ball in play time actually decreased, and the only other significant changes were to the rucks and mauls (Maclean, 1992; Bouthier *et al.*, 1996; Hughes & Franks, 1997).

These systems were also used to investigate the 1991 World Cup (Hughes & White, 1996; Stanhope & Hughes, 1996); comprehensively analysing the way in which points were scored, the way the successful and unsuccessful teams used their respective three-quarters and forwards. The whole analysis of the tournament also placed all the data onto a database, which will be invaluable as it will enable longitudinal comparisons across tournaments to be made (Hughes & Franks, 1997).

Hughes et al., (1996) used some of this data as a comparative norm with which to compare similar analyses of women's international rugby matches taken from the Five Nations championship. This data showed clearly the result of the stark physiological differences between male and female rugby players in the comparative figures in distances gained from kicks and yardage gained, in all positions, in running with the ball. There were also indications that the women's game is still in the early stages of technical development and further studies should be repeated in years to come to help the coaches remain aware of shortcomings.

3.10 THE FUTURE OF NOTATIONAL ANALYSIS IN SPORT

In terms of technological development, notational analysis will undoubtedly move as rapidly as the developments in computer technology and video technology. There are two developments that will most certainly happen over the next few years. The first will be the development of "all-purpose", generic software. Work in some centres has almost reached this point now (Alderson *et al.*, 1990; Bouthier *et al.*, 1996; Hughes & Franks, 1997; Glazier *et al*., 2003; Hughes, 2004).

Another technological advance that will make computerised notation more easily handled by the non-specialist will be the introduction of "voice-over" methods of data entree. Taylor and Hughes (1988) have demonstrated that this is possible now, but relatively expensive at present day prices. These are expected to drop rapidly over the next couple of years and voice interaction should therefore be a natural extension of any computing hardware system (Hughes & Franks, 1997). The integration of both these technological developments with computerised video feedback will enable both detailed objective analysis of competition and the immediate presentation of the most important elements of play. Computerised systems now enable the analysis, selection, compilation and re-presentation of any game on video to be processed in a matter of seconds. The coach can then use this facility as a visual aid to support the detailed analysis (Alderson *et al.,* 1990; Partridge & Franks, 1996; Hughes & Franks, 1997; Bracewell, 2002; Glazier *et al.*, 2003; O' Donoghue *et al*., 2005).

As these systems are used more and more, and larger databases are created, a clearer understanding of each sport will follow. The mathematical approach, typified by Eom (1988) and McGarry and Franks (1994, 1995), will make these systems more and more accurate in their predictions (Hughes, 2004). At the moment the main functions of the systems are analysis, diagnosis and feedback; few sports have gathered enough data to allow prediction of optimum tactics in set situations. Where large databases have been collected (e.g., soccer and squash), models of the games have been created and this has enabled predictive assertions of winning tactics (Hughes & Franks, 1997; O' Donoghue *et al.*, 2005).

Technological advances aside, the real future of notational analysis lies in the growing awareness by coaches, athletes and sports scientists of its potential applications to sport. Whether the most sophisticated and expensive of systems is being used, or a simple pen and paper analysis, as long as either system produces accurate results that are easy to understand, then coaches, athletes and sport scientists will increase their insights into sport performance (Alderson *et al*., 1990; Bouthier *et al.,* 1996; Partridge & Franks, 1996; Hughes & Franks, 1997; Bracewell, 2002).

CHAPTER 4

4.1 DEFENSIVE SYSTEMS

Defence starts with the battle for possession – when you have the ball, you do not have to defend (Pool, 1997).

The object of this section is to discuss in detail the workings of defensive patterns and to identify shortcomings in their structure. In order for one to understand running lines and their effectiveness, it is important to first have a fuller understanding of defensive patterns and alignment so that weaknesses in the opposition's defensive systems can be identified and taken advantage of. For an attacking running line to be effective, it must manipulate the immediate defender as well as the opposition's defensive lines. This scrambling up of the defensive wall will result in a disruption of how the defenders will be able to reorganise their defence and be able to recreate the structure they had at the beginning of the opposition's attack on their defensive wall.

One must take cognisance of the fact that first phase set-up attack is extremely important as it disorganises the opposition's defensive wall. The attacking team wants to create attacking situations where after 2^{nd} and 3^{rd} phase, their backs strike on the opposition's forwards and their forwards attack on the opposition's backs. This will be referred to as a "mismatch". This "mismatch" is extremely important as it gives the attacking backs an opportunity to beat a forward on the outside or inside in a one-on-one confrontation by using their superior footwork skills. The forwards are also able to run onto the defending backs who, due to their defensive body positioning are mechanically weaker, thus the forwards momentum advantage can be made full use of.

With this in mind it is important to note that defence from first phase is slightly easier to manage, as the defenders know exactly who is defending next to them and this allows for better communication, nomination and execution (Marks, 1998). It is after first phase that the defence becomes more complex due to a greater number of variables being involved. The term "attacking without the ball" is an extremely apt definition for the mindset needed to be successful in defence as most teams spend about 50 per cent of their time attempting to regain the ball held by the opposition (Robilliard, 1997), and this regaining of possession can be achieved by either:

1. dominating the tackle i.e., the attacker loses the ball in contact, or it is turned over at the subsequent ruck through effective poaching skills by the defensive support players (Pool, 1997; Walker, 2000; Muggleton, 2001) or,
2. pressurising the defence by forcing them backwards or across the width of the field without getting over the advantage line, until the attacking team is forced into an error or tackled out over the touchline (Evert, 2001a).

With all these aspects as background, the finer intricacies of effective defensive play will be discussed in the light of the following factors.

4.2 THE PILLARS OF DEFENCE

The effectiveness of a team's defensive abilities is largely reliant on nine important factors namely:

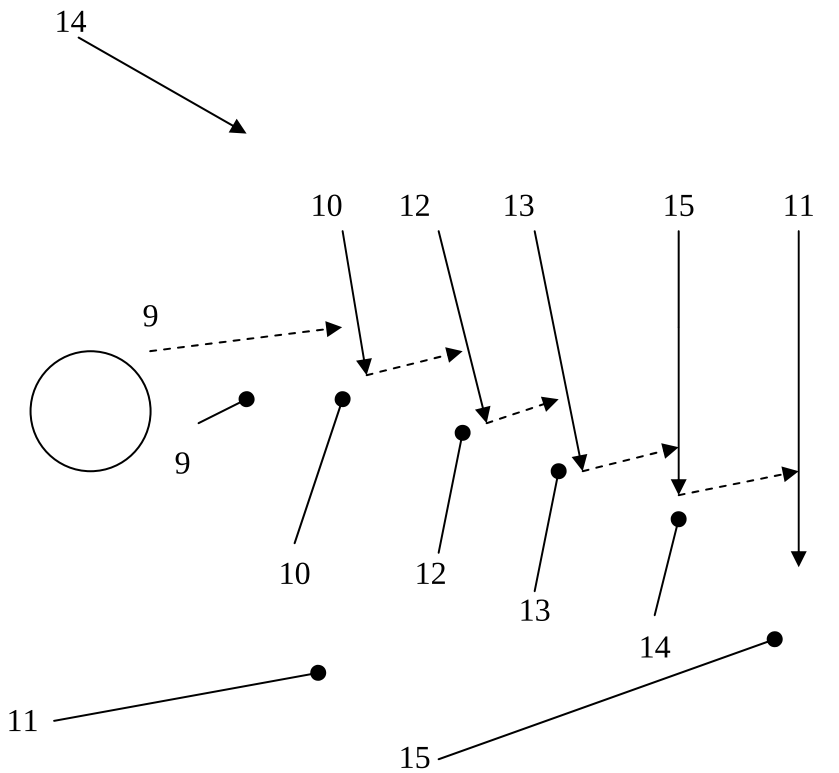
1. defensive organisation;
2. the defensive shape;
3. the defensive zones;
4. defensive spacing;
5. the execution line;
6. attitude (Kiss, 2002);
7. drift defence as a concept;
8. second phase defence; and
9. third and subsequent phase defence (McFarland, 2005a).

4.2.1 Defensive Organization

Defensive organisation will be discussed in the form of the three basic defensive "techniques" from primary phases of play, the first being:

4.2.1.1 Man-to-Man Overlap Defence

This system of defence identifies the ball carrier. When the attacking team brings in an extra attacking player into the backline it forces the defenders on the outside to adjust (i.e., move in one), allowing the overlap to be created on the wing. In this case the cover would be directed to the touchline and the job of taking the last runner would fall to the fullback. This is not such a difficult task if the extra man comes in outside the outside centre. It does however create problems if the overlap occurs through a run around, because to take the player with the ball, the outside defender then has to turn rather drastically. If they don't make that turn well enough and a linebreak occurs, it makes it difficult for the fullback who is basically set on reaching the touchline to be able to correct himself so to be able to make the tackle on the player coming through in the midfield (Greenwood, 2003). It is therefore important that in this situation the fullback as well as the blindside wing who is moving across has to be conscious of trying to stay inside the ball and then shift across as needed (Pool, 1992; Williams *et al.,* 1994; Robilliard, 1997; Pool, 1997; Marks, 1998; Walker, 2000).

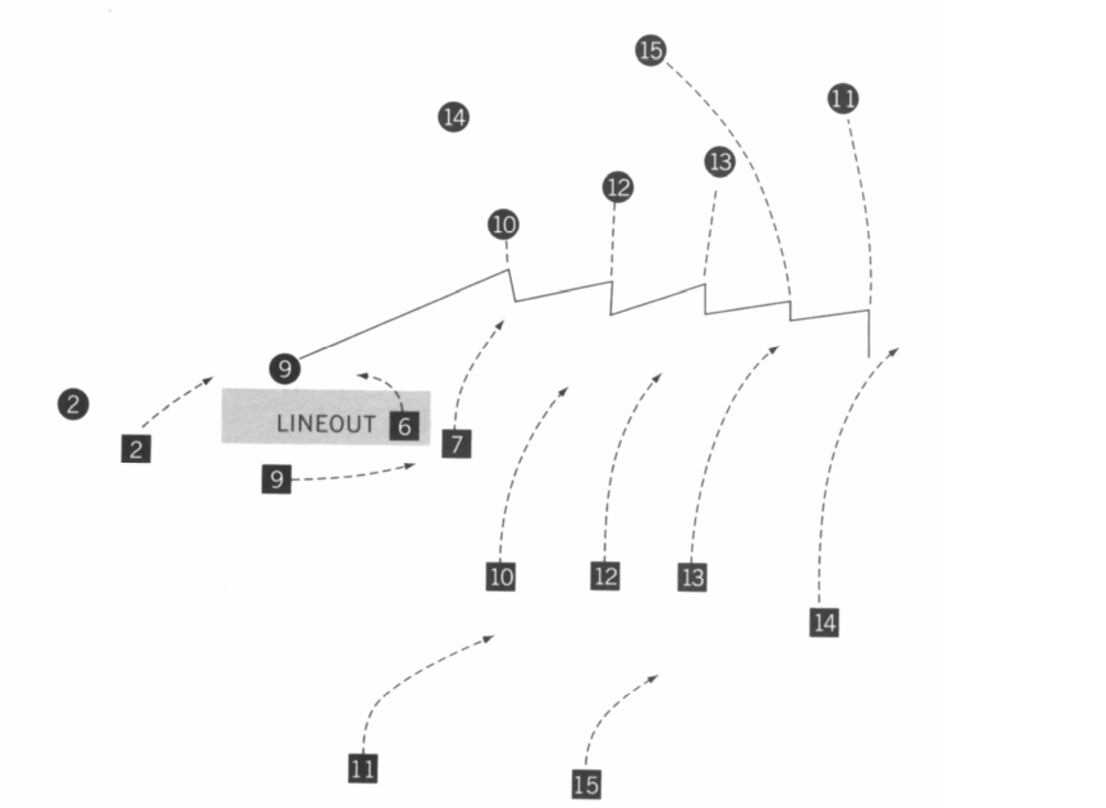


(Adapted from: Robilliard, 1997)

Figure 4.1: Man-to-Man overlap defense from a scrum

4.2.1.2 Man-to-Man Isolation Defence

This pattern identifies the target runner and the defence then isolates the “extra” man with the ball by having the defensive openside wing stay with this attacking player. The main objective is to isolate the ball carrier from his support, both on the inside and the outside (Pool, 1992; Johnson, 1993; Marks, 1998; Walker, 2000).



(Adapted from: Marks, 1998)

Figure 4.2: Man-to-Man isolation defence

It is the responsibility of the designated player (usually the blindside wing or fullback) to tackle any extra man who comes into the line from a lineout. The positioning of the blindside wing is extremely important when using this pattern. From a scrum the same winger or the fullback can accomplish the task. This defender should only be a few metres from the scrum, lineout, ruck and maul situation if it is to be effective (Johnson, 1993; Marks, 1994; Robilliard, 1997; Barker, 2003).

There are two important concerns when defending in such a manner:

- the defender must isolate and nullify his opposite number, and

- the defender must get between the ball carrier and the inside support which is the attacking teams most valuable weapon (Pool, 1997; Tranent, 2003).

When looking at these two concerns the first takes priority, however, where the ball is shifted quickly, the defenders have to shift quickly onto a lateral run. In this situation, the defenders should anticipate where the attackers should run in support and then try to beat them to that position. In other words, where a defensive line can anticipate where a space is going to open up, they should lead their opposite numbers to that position rather than following them to it (Marks, 1998; Walker, 2000; Greenwood, 2004).

Once this has been achieved, the attacking options will have been reduced fairly well in the midfield; however, the real danger is likely to occur wider out with the entry of an extra man between the outside centre and the openside wing. It is in this situation that the openside wing should be on his guard (Greenwood, 2003).

It was mentioned earlier that in this situation the defender should stick to his opposite number. The reason for this being that it makes certain that the opposition wing is shut out so that:

- the fastest opponent is not able to get out into the clear, thus resulting in the cover defence not having to stretch itself to the limit in order to stop this player (Robbiliard, 1997).

This defensive philosophy is effective as, by leaving the directly opposite attacker in that situation rarely results in having to make a tackle or stop a pass. A good defensive wing will however also be able to:

- position himself so that if the pass comes, his opposition winger can be tackled, and the opposition wing is given the impression that there is a threat that he will be caught which will require him to pass the ball. This is a secondary concern as, whether the pass is thrown or not, the support player has to be isolated and covered from being able to break the defensive wall (Kiss, 2002).

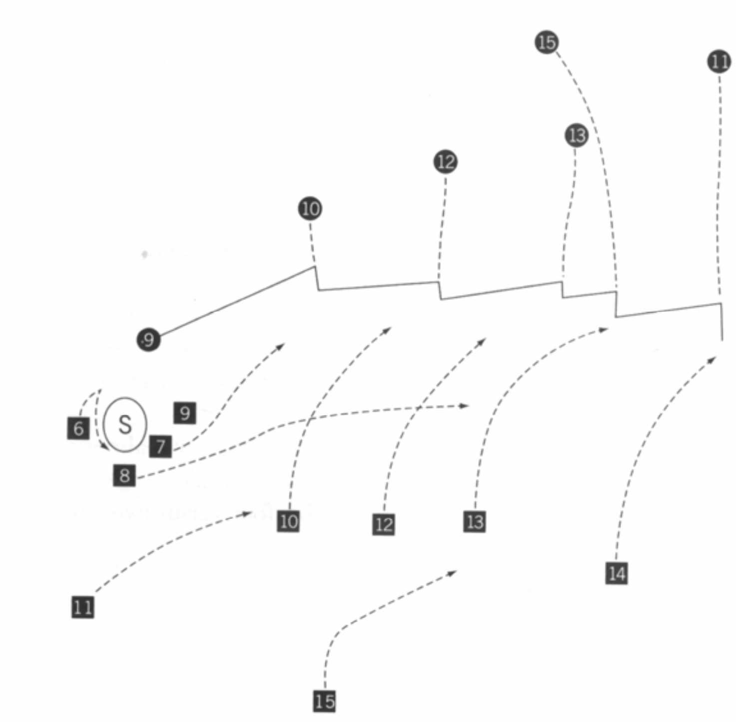
The most important factor in the defender's role is the running path. This can only be optimally executed by anticipating the two versus one situation. If this situation arises it can be managed in the following way:

a) the defenders must stand narrow in relation to the attackers;
b) the defender must turn and shift outwards as the inside player receives the pass;
c) the defender must run across the face of that player to encourage him to concentrate on the retention of the ball, i.e., put him under intense pressure, i.e., the possibility of being tackled by the defender; and
d) once this has been achieved the defender must aim to and concentrate on his own opposite number with a view to making contact with him just as his hands go out to take the ball (Marks, 1998).

4.2.1.3 One-Out Defense

This pattern requires excellent communication skills between players. It identifies the ball carrier so that the attacking flyhalf is tackled by the defending flank at the scrum or the last man in the lineout (Pool, 1997; Walker, 2000; Kiss, 2002).

The attacking inside centre is covered by the defensive flyhalf, the attacking outside centre is covered by the defensive inside centre, the attacking fullback is covered by the defensive outside centre, and the attacking wing is covered by the defensive wing (Johnson, 1993; Robilliard, 1997; Greenwood, 2004).



(Adapted from: Robilliard, 1997)

Figure 4.3: One-Out defence

The following points should be noted:

- One-out or drift defence is easier to employ from a lineout as the blindside wing is in a better position to be able to cover a break from that defensive position than from a scrum. This is because there is a bigger area to cover from a scrum than from the lineout.
- It is however most effective from a scrum on the left hand side of a field as:
  - a) from a scrum you are closer to the opposition, making it difficult for the defenders to detect the positioning of the wing; and
  - b) on the left hand side of the field it is easier to cover the attacking flyhalf by the open side flanker (Pool, 1997).
- If drift defence is used on the right hand side of the field, the openside flanker has the difficult job of watching both the scrumhalf and the flyhalf (Robilliard, 1992; Greenwood, 2003).

- The blindside wing still takes the "across, up and across" line to cover any break in that big box from their outside centre in. If no extra man comes in from there out, the openside wing takes his opposite attacker, leaving the outside centre free to capture possession after the tackle (Marks, 1998).

If the fullback does enter in this situation, the defending wing still stays with the attacking wing because the slide of the outside centre will cover this option. If the fullback should come in very wide, the centre will slide onto the wing and the wing will slide onto the fullback (Johnson, 1993; Robilliard, 1997).

With this defence it is better to line up inside your opposite number. Standing outside makes the slide easier but it also alerts the opposition. If, however, the attack is spread, this outside option is necessary so to be able to get to the striking attacking player (Marks, 1998). Once primary phase defensive play has taken place, the following key aspects play an important part in defensive play.

4.2.2 The Defensive Shape

A team's defensive shape is an important key in building a defensive wall that can absorb and nullify various attacking threats. What is important for a defensive line to concentrate on is a commitment to keeping this "shape". The key rule is that a defender must under no circumstances advance ahead of the man inside of him. Each defender should preferably position himself half a meter laterally behind his fellow defender inside of him (Muggleton, 2001; Kiss, 2002, McFarland, 2005a; McFarland, 2005b; Gold, 2005).

Once the ball passes the defenders "zone" he should continue to push forward into the space inside the ball. By maintaining this "shape" at least two "zones" inside the ball it is possible to guard against any attempted inside passes or switches which the attacking team may use to strike our defensive wall. The defenders must defend the spaces inside the ball. The defenders closest to the facet play an important role in leading and developing the "shape". Once they have addressed the immediate threat in front of them their next duty is to lead the defensive line forward in order to develop good "shape" early and to assist the midfield in edging the outside defenders into their specific role in defence (Anderson, 2000; McFarland, 2005a; Gold, 2005). Attacking systems are continually being developed to create situations that will lure defenders out of their line in order to disrupt and break their defensive "shape" and thus create the holes they then wish to exploit with their strike and support runners. This "lure" is aimed at the ball carrier and also inside and outside the ball carrier through decoys, deceptive plays and exploitive running lines. In order to prevent line breaks taking place in this fashion, the defensive line must be maintained and there has to be a commitment to keeping the "shape".

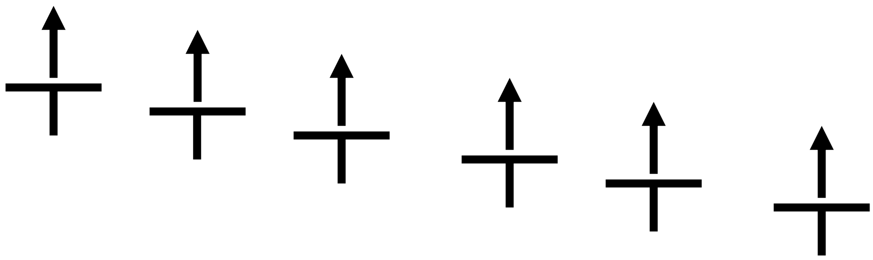


Figure 4.4: Defensive shape

4.2.3. The Defensive Zones

A "zone" can be described as the space or area a defender is responsible for. The key "zones" are the ball and the two spaces or "zones" on either side of the ball carrier (Marks, 1998; Kiss, 2002; McFarland, 2005a; Gold, 2005).

Defenders at the ball and the outside "zones" must stay strong and square in their "zones". The rule is that a defender should not slide or drift off their "zone" of responsibility before the ball has passed their defensive "zone". Only under certain circumstances will an inside defender be able to release the inside defender from his "zone" early, e.g., when the attack shifts the ball wider early, and when the defensive line are using a holding pattern due to the attack having a greater number of players available than the defence has. While discussing the aspect of defensive "zones", the concept of tracking needs to be understood. When tracking an attacker, the objective of the defender is to position himself for his own advantage and strength, i.e., this implies that the defender presents himself to the contest with a strong body positioning and a correct shoulder presentation (Muggleton, 2001; Kiss, 2002, McFarland, 2005a; Gold, 2005).

The defender's positioning should be a body width at least inside the attacking player in your "zone" or on the directly opposite attacker who is about to be tackled. By having this starting position as with the initial tracking position it reduces or prevents a possible opportunity for the ball carrier from being able to change his angle and then run at a weak shoulder of the defender. The defender also has good vision of his "zone" and of the defensive "zone" of the supporting defensive player on his outside. While the approach is taking place, it is important that the defender stays strong and square in his "zone" (Robilliard, 1992; Muggleton, 2001; Hedger, 2002; Kiss, 2002; McFarland, 2005a).

4.2.4. Defensive Spacing

"Spacing" refers to the appropriate distances between defenders in order to attain the ideal field coverage that:

1. will suit the defensive style and pattern of the team;
2. will suit the defensive abilities of the players in the team;
3. is appropriate to the field position; and
4. gives the best awareness and coverage of possible attacking threats and patterns possibly executed by the opposition (Muggleton, 2001; McFarland, 2005b; Gold, 2005).

Maintaining good equal "spacing" is vital particularly when the defensive line is in movement forwards and sideways. Equal "spacing" does not necessarily imply that every space between the defending players is the same. The players nearer to the facet will obviously have a closer more compressed "spacing". As one moves along the defensive line outwards towards the midfield defenders, the "spacing" will become gradually wider. It is important to note that the important "spacings" are the "zones" inside and outside of the ball carrier. The "spacings" inside the ball carrier should not be closed up too quickly or early, as those "zones" need to be defended. A vital component in effective "spacing" and maintaining good "spacing" is the defensive lines starting position. Being fully prepared in the line with scanning and awareness, talk and urgent "reload" will ensure that the defensive line begins with the appropriate "spacing". The most important aspect of "spacing" is communication and for the defenders to work effectively in "3's". This implies that a defender should be continually communicating with the defender on either side of him so to ensure the "spacing" is appropriate (Larder, 1992; Anderson, 2000; Kiss, 2002; Hedger, 2002, McFarland, 2005a; Gold, 2005).

4.2.5. The Execution Line

This refers to the "critical" point or line of pass of the attacking play. When discussing the "execution line" the most important component is awareness and judgement in the defence's line application. The art is to avoid being pulled out of "shape" while pressing forward and therefore being made redundant in the defensive line especially at the "critical" point where a defensive decision has to be made, e.g., a run-around or looping play. Awareness and judgement is required here to ensure that the key point of the defensive line does not overextend to the "critical" line. The defence line speed and tempo is determined at this stage, usually by the flyhalf and inside centre as well as the defender inside the flyhalf. It must be noted that the lines speed of advancement is also affected by the "shape" rule, i.e., no player should advance ahead of the defending player on his inside. In these "critical" points and situations a forward motion, "holding" pattern is to be applied with the intention of letting the play evolve without interference to the defensive structure and "shape" (Barnes & Swain, 2002; Kiss, 2002; Hedger, 2002; Gold, 2005; McFarland, 2005a).

By achieving this the defending team can "influence" the pass and play to their own terms rather than being dictated to by the attacking team. The defensive team is then able to:

a) observe;
b) orientate;
c) decide; and
d) act (OODA method) (Kiss, 2002).

This results in the defending team being able to defend the evolving attacking threat with the defensive lines "shape" and structure still in place. The control of the "execution line" and the application of this method effectively and consistently, can and will frustrate the attacking team and in particular the key ball players and supporters. This is because they are not able to do what they plan to do, i.e., to lure and pull a defender out of shape or make a key defender redundant and ineffective by committing him to a point resulting in him being unable to assist his outside defenders (Anderson, 2000, McFarland, 2005a; Gold, 2005).

This method is very useful when the opposition have more numbers in attack than what the defending team have defenders. By making use of good scanning any possible attacking threats can be overcome by means of thorough analysis of the opposition followed by communication between the defenders. This is essential for successful defence in these situations (Williams *et al.*, 1994; McFarland, 2005b).

4.2.6. Attitude

This is by far the most important aspect of defence as without commitment to these factors no amount of technique will be sufficient to stop any form of attacking play!

- There must be a commitment made to these principles irrespective of any interference within the defensive structure or fatigue among the defenders.
- There must be a commitment to maintaining the defensive shape despite possible interference within the defensive structure or fatigue among the defenders.
- There must be a commitment to stay strong and square in each defenders defensive zone irrespective of any interference within the defensive structure or fatigue among the defenders.
- There must be urgency on the "reload" irrespective of any possible situations that may arise or fatigue among the defenders.
- There must be exceptional off the ball work ethic and awareness by all the defenders.
- Any opportunity for presentation of oneself for a defensive contest must be taken advantage of irrespective of any possible circumstance or fatigue.

- Every defensive player must be prepared for / or alert of any possible quick taps, turnovers or any attacking kicks (Larder, 1992; Kiss, 2002; Weinberg & Gould 2003; Millard, 2005).

This explains the alignment and techniques necessary for a team defending and the attempt to turnover the opposition's possession by means of solid well-orchestrated defensive lines and tackling techniques. As mentioned earlier, the challenge presents itself when defensive lines are made up of a combination of forwards and backline players. The key to any backline attack is based on manipulation of the defence's organisation, and to "strike" in an area perceived as vulnerable in order to breach the defensive line. Alternatively to successfully defend lies in the ability to organise defensive lines from 2nd and subsequent phases. It must be noted that an attacking team will continue probing until either there is a line break or an extra man on the outside has been created.

4.2.7. Drift Defense as a Concept

"Drift defence" is not a pattern, but a concept and isn't specific to phases of defence. Drift defence does not identify a definite target for the tackler but works on shepherding the attacking backline across the field. One must note however that the words "drift" or "slide" indicate that something will occur later (Larder, 1992; Johnson, 1993; Williams *et al*., 1994; Marks, 1998).

Defence occurs now – not later, and this links up with the first rule regarding defence. The first basic rule regarding defence is to deny the opposition time and space, which subsequently reduces attacking options. This can only be achieved if the team not in possession advances forward quickly and pressurises the ball carrier (Robilliard, 1997).

The second basic idea of "drift" or "slide" defence is a concept of "wait and see" which is commonly used in rugby league. The idea is to organise the defensive lines to try and "herd" the attacking team towards the side of the field in order to force them to have to try and beat the defence around the outside. This tends to eliminate the possibility that the attacking team is able to break through the defensive line in the midfield, which would be disastrous (Muggleton, 2001).

In order to achieve these ideas it is important for the defender to align on the opponent's inside shoulder, thus pushing the attacker towards the sideline. It is important to move forward towards the target quickly, allowing the opponent only an outside opportunity. In moving forward, defensive players should not get ahead of team-mates inside them as this will create a crooked defensive shape (Anderson, 2000; Muggleton, 2001; Kiss, 2002; Hedger, 2002).

It is important that while approaching the attacker that the defender slows down slightly and balances himself so that if the player cuts inside, the defender can adjust his line according to what the ball carrier does. It is vital that the defensive line is kept, and that there is a slight "hockey stick" defensive line angled towards the touchline. Once each defender's attacker has passed the ball, he should move into a position between the ball carrier and his immediate opponent (Robilliard, 1997; McFarland, 2005b).

It will become evident that as the opposition are forced across the field, their options become limited and time is "bought" for the second line of defenders to move across the field in defensive support. It is also easier for the defender to tackle the opposition striker as it makes for an easier side-on tackle (Larder, 1992, Greenwood, 2003).

4.2.8. Second Phase Defense

The key to defence at 2nd phase is to get as many players as possible to the breakdown first. The reason for this is that there are two possible outcomes that may occur:

- either the ball can be turned over and won, or
- the ball can be slowed sufficiently (without giving away a penalty), so that the defensive lines can reorganise creating a situation where there are more defenders than what there are attackers (Anderson, 2000; McFarland, 2005b).

This is due to the attacking team having to commit more cleaners to a ruck so to ensure that they, the attacking team, recycle their possession. What is important to understand when defending after the first ruck or maul is that the principle of drift defence is still executed; it is merely the organisation around the contact area which is adapted. After a tackle has been made and the subsequent ruck or maul is formed, the players not committed to the ruck should align themselves on either side of the facet. The player closest to the facet is the "marker". This player must align half a body width overlapping the ruck and behind the last mans feet. The next player next to the "marker" is called "one" (Anderson, 2000; Muggleton, 2001; Kiss, 2002; McFarland, 2005a; McFarland, 2005b; Gold, 2005).

The "marker" and "one", known as "guards", cover the pick and drive around the ruck, a quick break by a fringe player, the inside pass from the flyhalf, the reverse pass from the scrumhalf or a pass with a run-around offloading to a striker in the inside channel. These two "guards" are defending the channel closest to the ruck. It is therefore important that they hold the position until the opposition flyhalf passes the ball outwards. The "marker" and "one" play an important role in the organisation of the defence. They firstly set the mark as to where the offside line is, and secondly set the position from where the supporting defenders begin their "hockey stick" defensive line shape. This results in the "drift" defensive lines being in place and ready to press forward onto the attackers. It is also important to note that the backline players marshal the forwards who are present in the backline inwards towards the ruck / maul if there is sufficient time to do so. The fanned players should aim to get the tight forwards nearest the facet, followed by the loose forwards as this will keep the line organised on the outside where possible "strikers" can begin their attacks. It is also necessary due to most of the probes (using the bigger forwards), will be played off the flyhalf. If however the attack is too highly pressured, the defenders should align as they reach the facet and concentrate on keeping their "hockey stick" shape (Marks, 1998; Anderson, 2000; Evert, 2001a; Muggleton, 2001; Kiss, 2002; Hedger, 2002; McFarland, 2005b).

The next stage in the defensive system begins as the ball is passed out towards the flyhalf. The term "shoot" and "shift" then becomes apparent. This is explained as where the rate of advance is set. The "marker" and "one" press hard from the inside i.e., they “shoot” forward cutting down the space available to the opposition before they reach the gain line so that the opposition forwards, or “striker” are caught behind the advantage line. This forces the support runners to move backwards in order to get in the clean that will arise from the tackle situation. The role of “captain” in defence is vital as he communicates with the rest of the defenders who is being covered and thus sets the rate of advance. This role is fulfilled by the player just out from the “marker” and “one” as he covers the flyhalf and is not focussed on the play on the inside which is being covered by the guards. For the defence to be successful it is important that no player gets in front of the next inside player as they advance, this will keep the “hockey stick” defensive line shape and thus the opposition will be shifted outwards. This formation makes it difficult for the attacking team to breach the line as the striking line is towards the defenders and any pass that can possibly send a runner back towards the forwards will be stopped by the 2nd wave of defenders who are moving across the field (Marks, 1998; Anderson, 2000; Muggleton, 2001; Kiss, 2002; McFarland, 2005a ; McFarland, 2005b).

4.2.9. Third and Subsequent Phase Defense

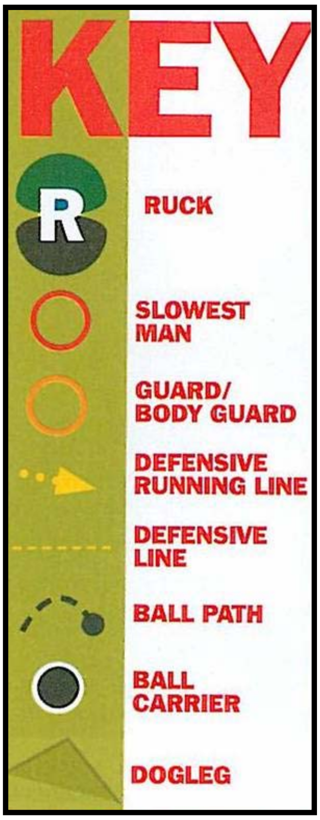
When 3rd phase is set up, the next important aspect of defence becomes apparent. If a team continually attacks in the same direction, a situation will arise where there will be a “pooling” of players on the side from which the attack originally came, and therefore too few defenders on the side where the next wave of attack is to be launched. In order to guard against such a situation, the term “far side” is brought into the defensive communication. The term refers to a situation where when a ruck or maul is created; two defenders automatically move over to the far side of the facet and fulfil the role of “marker” and “one”. What this does is that it prevents the defenders on the outside from having to commit to the area next to the facet. This allows them to be able to optimally protect the outside space, which would invariably be exposed if they had to move inwards towards the facet area. Another important reason for the “far side” is that if the players on the outside were forced to maintain there defensive width, and did not move in towards the ruck or maul, a short pass to a forward striking in the channel next to the facet would lead to a linebreak which would be a difficult situation to salvage (Anderson, 2000; Kiss, 2002, Greenwood, 2004, McFarland, 2005a).

4.2.10 Rush defence as a concept

Rush defence has been christened “four up”, “rush”, “umbrella”, “press”, “banana”, as well as “up and in” defensive system. Rush defence is an aggressive system, with the whole point being to get the defensive player into a more offensive position than the attacking player. There are four fundamental principles of this defensive system, namely;

1. speed off the line;
2. the alignment of each defender;
3. focus on the ball; and
4. maintenance of effective width. (Gold, 2005, McFarland, 2005a)

The following key will be used for the following diagrams:



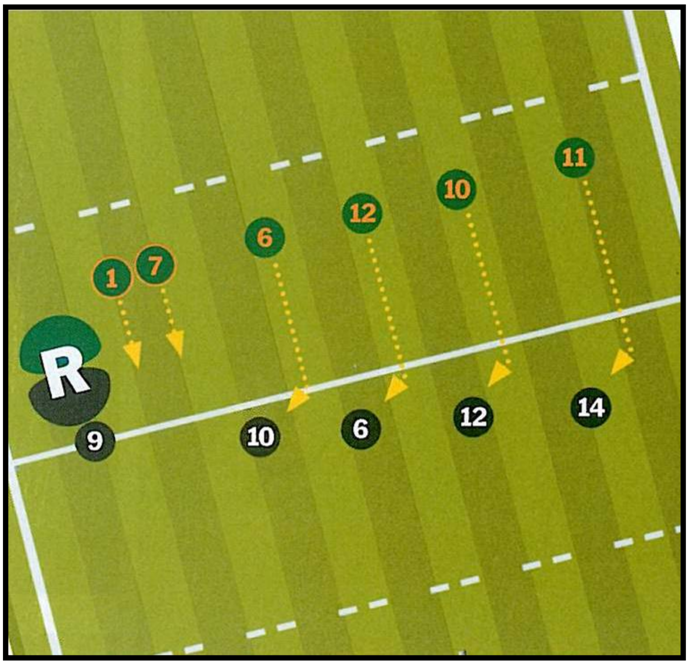
(Adapted from Gold, 2005)

Figure 4.5: Key for Drift defence diagrams

4.2.10.1 Speed off the line

Not everyone is familiar with this aspect of defence. The Springboks are very good at this, so much so that many Australian and New Zealand commentators, as well as the coaches, think they are offside. Gold (2005) does not believe this is so, as in his opinion they are just anxious and enthusiastic to make the hit, and work very hard at getting off the line quickly. Their aim is to burst forward at the call of 'press' which indicates that the defenders are moving towards the attacking teams ball carriers.

Refer to Figure 4.6 for a basic annotation of the defensive system.



(Adapted from Gold, 2005)

Figure 4.6: Basic annotation of the "Rush" defensive system

4.2.10.2 The alignment of each defender

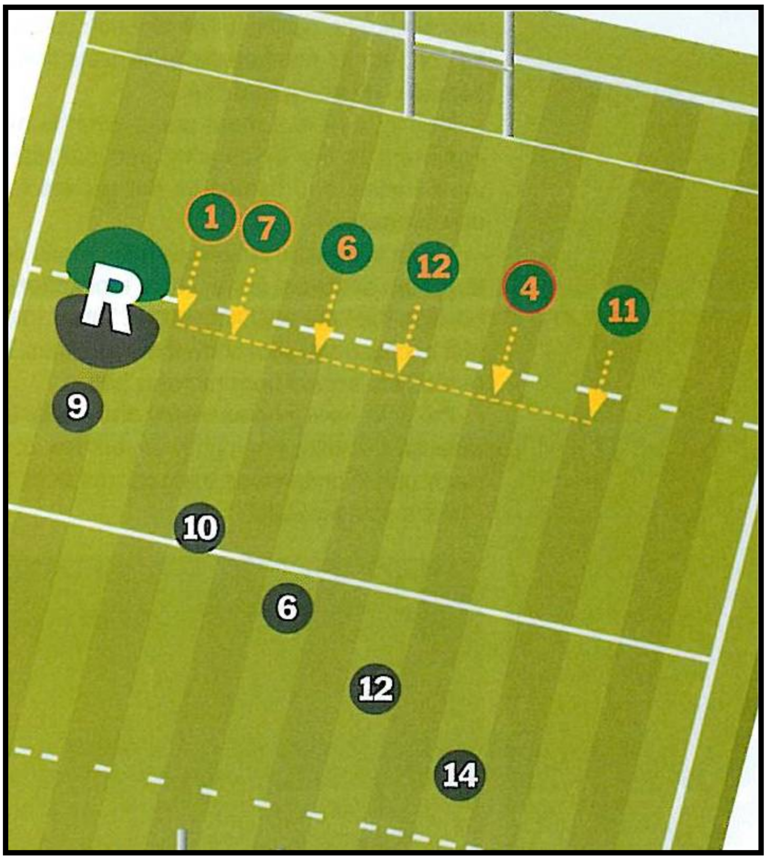
This principle demands that all the defenders keep their alignment when they begin to press off the line as described above. The key here is that the whole defensive line needs to move up in a line, i.e., at the speed of the slowest man see, Figure 4.7. After a number of phases, it is perfectly feasible for; say a prop or a lock to be in the line, and thus an awareness of who the slowest man is, is crucial (Gold, 2005; McFarland, 2005a).

It is completely useless if a defender or a few defenders are ahead in their eagerness to make the tackle, because that creates holes that the attacking team can exploit. All the defenders have to concentrate intensely, because going up slightly out of alignment due to carelessness or fatigue late in the game can undo 70 or 75 minutes of good defensive work.

A player shooting up out of alignment creates a dogleg-type effect, illustrated in Figure 4.7, which can be exploited by an attacker running the correct line. In this scenario, the right wing (14) can take a simple inside ball from the attacking flyhalf (10) and the defending flank (7) cannot reach him because the defending flyhalf (10) has shot out of line and left too big a space for him to cover.

Refer again to Figure 4.6. Note that the defenders (with the exception of the defenders close to the ruck, who can be called guard all position themselves outside of the attacker opposite. This is crucial and is why the defence is sometimes referred to as ‘up and in’. It’s not an entirely accurate description, because the players are not unthinking robots (Gold, 2005, McFarland, 2005a).

When the situation calls for it, see Figure 4.12, the inside defenders drift once the danger to their channel has been eliminated by a pass. On the whole, however, the defenders press up and then in on the attacker opposite. The determining factor as to whether you drift or ‘hit in’ is the depth that the attacking team keep (Gold, 2005, McFarland, 2005a).



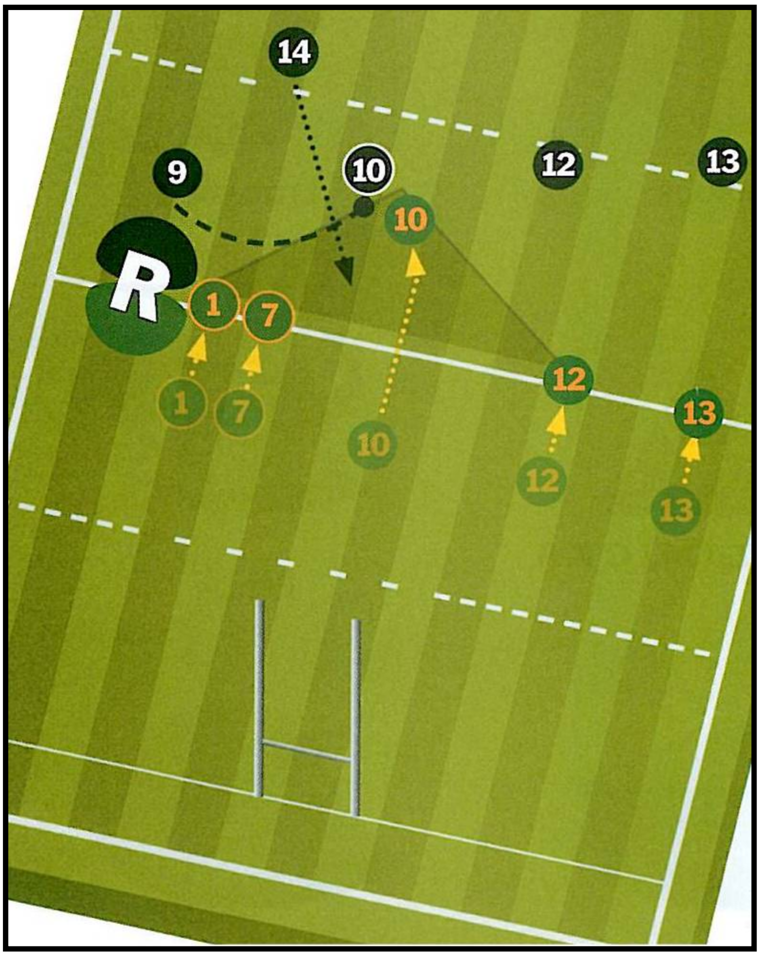
(Adapted from Gold, 2005)

Figure 4.7: Basic annotation of the "Rush" defensive system focussing on the effective alignment of each defender

4.2.10.3 Focus on the ball

The key to this defence is occupying space and cutting down options. This can be done only if the defence focuses on the ball and not the man. It is important to concentrate on the ball carrier as the key focus area (Gold, 2005, McFarland, 2005a).

Players, who are really adept at this, go in and take an option away from the ball carrier. The opposition looks to make a pass, say 13 to the wing, and often the players with a good "feel" for this type of defensive system will already occupied the space next to the wing to prevent that. Gold (2005) stresses here that the point is not to go for the intercept, but to occupy the space and deny the opponent the option (Gold, 2005, McFarland, 2005a).

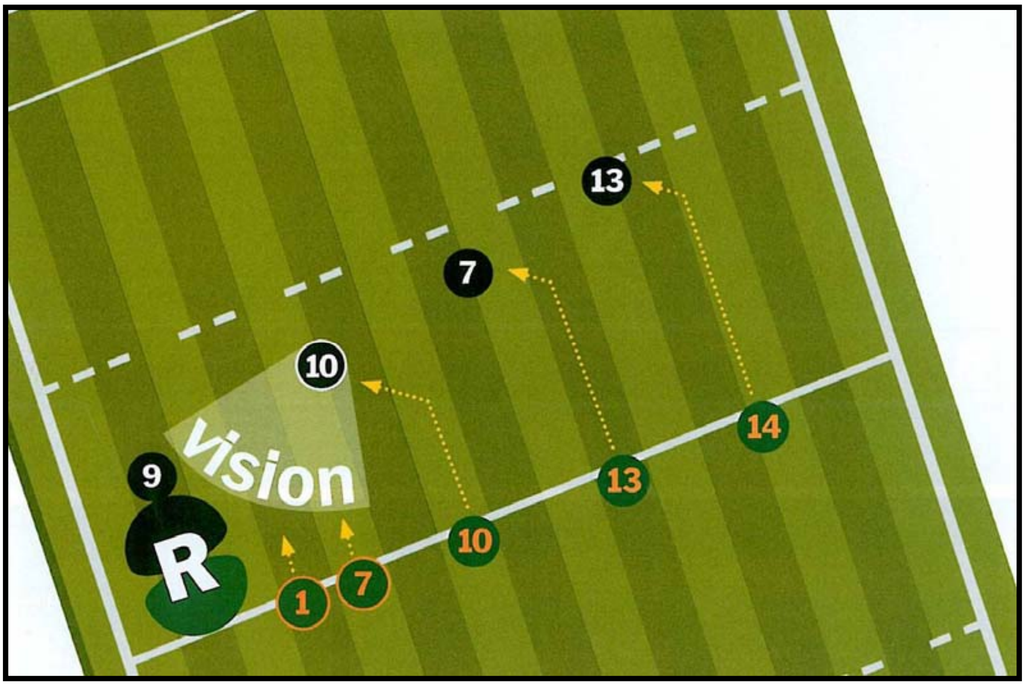


(Adapted from Gold, 2005)

Figure 4.8: Basic annotation of the “Rush” defensive system focussing on the ball

4.2.10.4 Maintenance of effective width

The fourth principle demands that each defender keeps his width. This means that he must ensure he remains on his opponent’s outside. If you are attacking the first receiver, for example the flyhalf, the focus is obviously on the ball. Therefore: your focus is on the ball, and your body and direction of sight is directed towards the passer (Gold, 2005, McFarland, 2005a), see Figure 4.9 above.



(Adapted from Gold, 2005)

Figure 4.9: Basic annotation of the “Rush” defensive system indicating effective width

The defender now has a blind spot on his outside, and if there is a defender aggressively communicating and the defender can’t be seen, it can be unbelievably intimidating for the ball carrier. That’s why this defensive system is so successful: the complete focus of the attacking player is on the ball, and when the defender comes from your blind side, you can’t play rugby (Gold, 2005).

CHAPTER 5

5.1 ATTACKING BACKLINE PLAY

An attack by the backline is the culmination of all the running and passing skills that have been developed in the many hours of training. It is what the crowds largely come to watch, and certainly they come alive when a line break is successful and a player is on his way towards the try line. The success of a backline attack is achieved by thorough planning, taking the right option at the right time, using decoy ploys and having players running the right lines from the appropriate depth (Craven, 1966; Craven, 1970; Williams *et al.*, 1994; Bond, 2000; Ross, 2001, Southwell, 2002; Greenwood, 2003).

If one were to ask what seems to be the enigma concerning attacking play, the term "breaking the wall" and "achieving a line break" would come up as the most highlighted topic of discussion (Townsend, 2000; Hale & Collins, 2002).

Since concentration of effort with the professional development of defensive patterns, coaches have been in search of that aspect of play, which, if mastered, would give their team the greatest edge over the opposition, and the ability to break the opposition's defensive line at will (Bird, 1998; Hill, 2002).

Coaches have looked at aspects such as individual brilliance, physiological development, strength and conditioning, postural and biomechanical development, nutrition, psychology, game analysis and play networking, vision development and communication skills, decision-making, and stress management, (on and off the field) as a means of individual and team development (Hale & Collins, 2002).

What has however become obviously clear is that none of these factors can be seen as individual units. For success each aspect needs to be combined within the "team mix" in order for optimal performance on the rugby field to take place.

The object of this study is to look at newer aspects of coaching and alternative ways of breaking down the defensive wall. This could be viewed as an attempt at stimulating creativity in coaching so to achieve new heights in rugby performance.

> *"Creative rugby is not a vague concept; it is a concrete concept that is available to every player and coach. Without creativity outstanding success is just no longer possible"*
>
> (Neethling & Botha, 1999:10).

There are various schools of thought on this specific subject each having merits, with the common question being, how does the number of phase balls recycled affect the possibility of breaking down the "wall" and the importance of running lines and angles on the quality of attack? In order to attempt to answer this and many other questions, a study will be made of those aspects that play a part in attacking play so to establish some form of idea of how to achieve optimal attacking backline play.

Running lines are found in three main aspects of the game of rugby namely:

1. attacking play;
2. defensive play; and
3. support play.

5.1.1 Attacking Teams Running Lines

In order for a full and complete understanding of running lines and their workings to be understood, an in depth look at the following aspects is required. This specific section will be looking at all the aspects involved in the build-up and finally the execution of these lines in their entirety.

Later in this section, the different running lines will be evaluated according to these principles ultimately to establish for what reason and in which circumstances they will be most effective.

5.1.2 The Aim of Backline Play

The aim of backline play is:

a) to create enough space for one of the attacking players to beat his individual opponent (Craven, 1966, Craven, 1970; Johnson, 1993; Bayly, 2001, Greenwood, 2004); and
b) to produce superior numbers in attack so that a ball carrier can break the line as an unmarked player (Marks, 1998; Hedger, 2002, Greenwood, 2004).

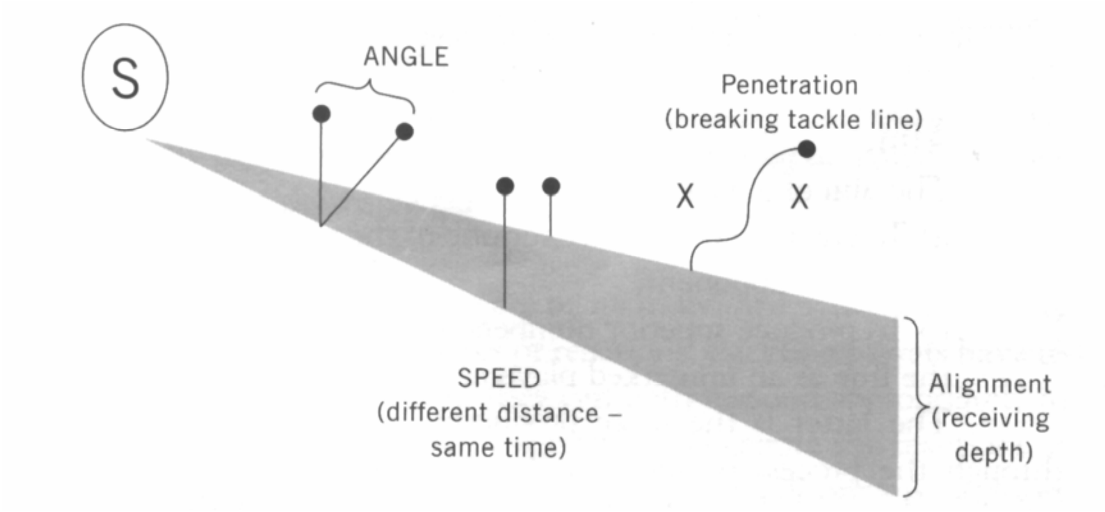
5.1.3 The Key Factors associated with Backline Play

In order for backline play to be effective, it is important for a backline to have some common aim. If individual backline players have different objectives, it makes synchronisation of attack difficult. There is however one universal concept that is imperative for any form of backline attack to be successful and that is that the first priority is to get over the gain line (Macintosh, 1997; Bird, 1998; Shaw, 1998; Townsend, 2000, Greenwood, 2003).

With this in mind the next step is to examine the factors that influence our ability to attack with precision and success in order to get over the gain line. The following factors all play an important role in achieving this goal:

a. distance. This will vary according to both the attacking backline's receiving position and the angle at which the players choose to run;
b. speed. This is determined by the player's forward running speed, and ball handling speed across the field; and
c. obstacles. This will occur when the opposition's tackle line gets between the attacking backline and the gain line through the defenders pressing forward towards the attacking backline. To reach the target in this case will require a "strike" on an individual player by our attacking unit (Marks, 1998; Hedger, 2002; Hunter, 2003).

The four key factors of backline play can thus be shown as follows:



(Adapted from: Marks, 1998)

Figure 5.1: Alignment, angle, speed and penetration in attack

None of these factors can be discussed in isolation. Different alignment will allow for different speeds of running and an earlier or later penetration. What needs to be emphasised is that the ability to create time and space are the qualities we are endeavouring to achieve and it is imperative that all backs are aware of the need to think and act quickly.

5.1.4 Attacking Backline Play Philosophy

When one looks further at important aspects of attacking play the following principles come to the fore:

1. The attacking team's creators;
2. the alignment of the attacking backline from the facet;
3. the attacking backline's attacking width;
4. the attacking backline's change in initial starting position;
5. the attacking backline's angles of running;
6. the attacking backline's decoy runners;

7. the attacking backline's manipulation of the opposition through numbers;
8. the attacking backline's manipulation of the opposition through addition;
9. the attacking backline's manipulation of the opposition through subtraction;
10. the attacking backline's striker;
11. the attacking backline's timing of the movement of the attack;
12. the attacking backline's strike on the defensive line;
13. the striker's speed versus quickness;
14. speed concepts specific to rugby;
15. the striker's running speed;
16. the attacking backline's passing speed;
17. the attacking backline's thought speed;
18. the attacking backline's strike area;
19. the attacking backline's trailing support runners;
20. the attacking backline's first wave of support runners;
21. the attacking backline's second wave of support runners;
22. the striker's angle of run after a successful strike has been made;
23. the attacking team's cleaning units;
24. the attacking team's communication; and
25. the attacking team's decision-making (Greenwood, 1993; Bayly, 2001; Hedger, 2002; White, 2003; Greenwood, 2004).

In order for these aspects to have value, a description is necessary in order to highlight the key aspects involved, which will ultimately influence the attacking capabilities of the team.

5.2 THE ATTACKING BACKLINE'S CREATORS

These are the ball carriers who distribute the ball to the strikers and can be seen as the initiators of any backline attack thus their importance is highlighted (Pool, 1997; Nucifora, 1999; Greenwood, 2003).

5.3 THE ALIGNMENT OF THE ATTACKING BACKLINE FROM THE FACET

With defence becoming more organised on set and phase play, it often occurs that a defending team will commit limited numbers to the ruck or maul and stack a straight line defence across the field, which often results in the defenders outnumbering the attackers (Townsend, 2000). This makes the transference of the ball very difficult.

As an attacking strategy against an opposition using such a defensive system, the alignment should be set so that the advantage line can be crossed and thus the attack can move up the field longitudinally, i.e., up the channel. This should be done until the lateral defence has been drawn in and has lost its defensive alignment (Hunter, 2003).

Once this has been done then the option can be taken to move the ball laterally to space where the attackers have numbers or continue up the channel if it is not well defended (Bird, 1998; Emtage, 2001).

It is important to note that the channel to strike into may vary and should be directed to areas where the defence is weakest and this is not necessarily close to the ruck or maul. According to where the strike is planned will influence the alignment of the attacking team. For explanation, the attacking channels in which the strike is likely to take place will be defined as follows, thus making further discussion easier:

i. channel 1 - Between the flyhalf and the facet on the inside;
ii. channel 2 - Between the inside centre and the flyhalf;
iii. channel 3 - Between the outside centre and the inside centre; and
iv. channel 4 - The area outside the outside centre.

The question of whether a backline should be aligned “flat or steep” and “shallow or deep” is dependant on the channel the strike is to be executed in. If the strike is to take place in channel 1 or 2, the backline can take the ball flat as the strike is to take place on the contact line and the ball does not need to be passed a long way before the strike will be made (Southwell, 2002).

If an attacking unit attacks a "flat-line" defensive team, it can be assumed that the strike is going to take place in these two channels. When faced with this there are certain options available to the attacking team in order to "outsmart" the defenders. The concept of "overloading the defenders with attackers" is the key to a successful attack when confronted with a "flat-line" defensive line (Hill, 2002).

This is achieved by using the ball carrier and multiple runners to attack a defender one or two out from the ball's current position. The ball carrier and runner needs to put the defender in two minds covering two or three runners. This is done by running at the gap to draw the defender out of position, overloading the situation with two additional runners holding their line or angling in towards another gap (Parore, 1997; Emtage, 2001; Greenwood, 2004).

The key to this approach being successful is the need for the ball carrier to have two optional off-load options and having the ability to decide at or after the point of impact which option is to be taken. The following can be seen as possible examples:

Option 1:

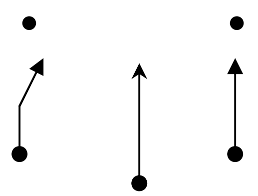


Figure 5.2: Attacker pulling the first defender out of alignment while the second defender marks his opposite attacker running at him

In this example the attacker is pulling the first defender out of alignment while the second defender is being fixed by his opposite attacker who is running straight at him. The second defender is therefore being "attacked" because he has two players to cover, i.e., his own attacker, or the striker who is running in the centre. The ball carrier has thus various offload options available to him depending on the reactions of the defender.

Option 2:

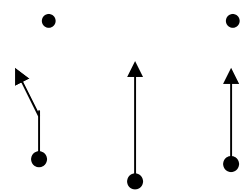


Figure 5.3: Attacker being pulled away from his defensive channel

In this example the attacker is pulling the defender away from his channel. The outside player holds his line to fix the second defender. The ball carrier squares up his defender then goes on the inside path using advantageous foot speed and tempo, executes a hit and spin off, or drive through into the defender before offloading to the striker or the second attacker depending on how the defenders react. There are two further variations, which can be used in order to further "overload" the defenders:

1. the attacking unit can either execute a "block" or "one-out" striker to move the second defender out of their alignment; or
2. the third man out can run at the gap with the striker holding back and striking through a stream.

These two variations give the ball carrier two or three offload options, which make defending an arduous task.

The final option is that of attacking the third man out. This is slightly more complex when viewed in the line of the flat-line defence of the opposition. What is attempted to be achieved is the ball carrier fixing his defender then running hard at the inside shoulder of the next defender out. The two outside attackers hold their line but adjust their rate of attack to change their alignment, e.g., the third receiver comes in faster than the second receiver.

Option 3:

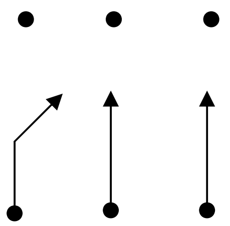


Figure 5.4: Outside attackers hold their line but adjust their rate of advance

The third defender is faced with the decision of which of the two attackers he is going to take which makes his defensive ability extremely difficult. The ball carrier has offload options to either the second or third attackers who are both approaching at different rates. Depending on whether the offload occurs before or after impact, or on how the defender reacts to what is taking place ahead of him, will determine which offload option will be taken. This type of attack close to the facet brings forth the next concept to be explained which is a strike near to the facet. The key to attacks close in is to "overload" the defenders with attacking options. For this to be achieved the attack has to be "compressed". A "compressed attack" implies that there is a concentration of attackers in a condensed area. What this achieves is that the attacking team knows where the strike is to take place and therefore throws all possible attackers into that strike area so to "force" the line break (Muggleton, 2001).

The second aspect of alignment is that of an "expanded attack". This form of attack occurs when strikes take place further down the attacking line. The key to its success is the opening up of a space through which a strike can occur. This is achieved by keeping defenders busy on the inside of the strike zone, and on the outside of the strike zone. The concepts of "one-out" strikers, "one-out" decoys and "one-out" trailers all work together to make this possible. The way that these "attackers" all interlink added to the organised width to create the necessary illusion that will make the line break possible, all play a part in the success of an expanded attacking method.

If the strike is to take place further out in channel 3 or 4, a steeper alignment will be needed as the ball will need more time to reach its destination. The advantage that can be created by an attacking backline aligning in a "crocodile teeth" manner holds even more advantages when the attack is executed. The reason for this is that it makes nomination of the attacking player to be defended difficult. Added to this, the fact that a backline that is viewed as marked with defenders allocated is all of a sudden different after the defender's attention has been drawn away by the focus being on the preceding facet accompanied by the change in the initial starting position makes the defensive situation difficult to evaluate. We will attempt to incorporate the concepts of "compressed" and "expanded" attacking alignment to our attacking organisation and thereafter evaluate its influence. When discussing the major determining factor in deciding how deep an attacking backline should lie, be it at first, second, third or even fourth phase is the level of skill the players possess (Shaw, 1998).

The core skills needed in order to penetrate with the ball in hand and that need to be automatic behaviours are:

- catching the ball at pace;
- passing a variety of passes at pace;
- reading the defence in front; and
- making the appropriate decision (Hedger, 2002).

These key core skill concepts have been widely researched however specifically orientated skill acquisition research in rugby has been lacklustre to say the least. When one observes the development research regarding skill acquisition by (Gabbard, 1992), it seems that there is a large scope for future research in this area. He states the following: "the dynamical systems perspective seeks to provide an understanding of "how" movement and control emerges or unfolds developmentally". Based upon highly complex principles from theoretical physics, theoretical mathematics, and ecological psychology. The theory of Bernstein (1967) proposes that qualitative changes in motor behaviour emerge out of the naturally developing dynamic properties of the motor system and coordinative structures (Kugler *et al*., 1982).

Using the dynamical systems perspective on motor behaviour, recent enquiries have begun to unfold the developmental picture of "how" interlimb coordination emerges in such early motor tasks as kicking (Thelen, 1985), stepping patterns (Ulrich, 1989), hopping (Roberton & Halverson, 1998), and independent walking (Clark *et al.*, 1988).

> *"This line of developmental research, which uses biomechanical principles and tools to study the dynamics of motor development, shows great promise for providing a more comprehensive understanding of motor control and performance across the life span"*
>
> (Gabbard, 1992).

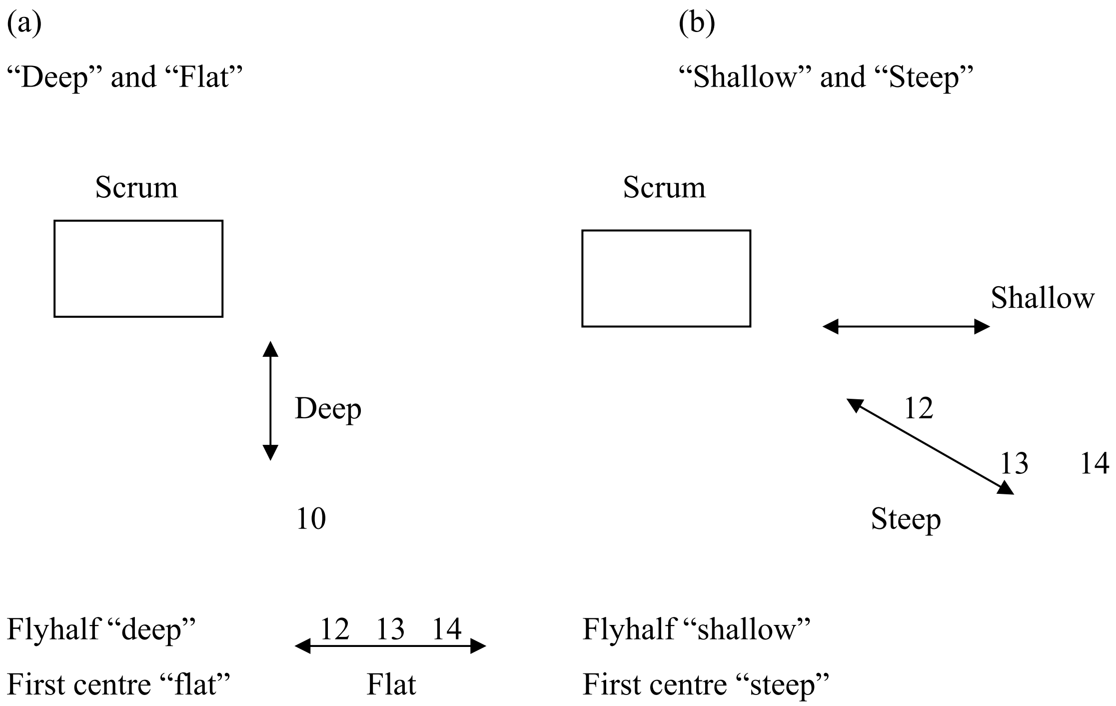
With this in mind the development of the necessary skills required in attacking backline play can be nurtured and developed so to give the backline every opportunity to break the defence's wall at will. If one was to give a very basic definition of what a backline will try to achieve when attacking this defensive wall it could be summarized as follows.

- An attacking backline will aim to make use of a flat or steep, / shallow or deep line of alignment concept, using angles of running lines with trailers, in order to create gaps in the defensive line, or to force the opposition into making side on tackles, from which the team in possession can offload the ball to a support runner (Bayly, 2001).

When looking at this definition it is important that one is able to distinguish between the following types of alignment:

- "flat versus steep alignment" ; and
- "shallow versus deep alignment" (Honan, 1999).

Honan (1999), widely regarded backline specialist, has been instrumental in his research into the finer intricacies of specialist backline play. In his dissertation "10 Commandments of Attacking Back play", he paid close attention to the critical principles and definitions for successful backline play. Although the emphasis of the study was on how to get over the advantage line as quickly as possible and to have sufficient time and space on the outside so to be able to make use of the extra man, the importance of the two concepts mentioned above also have an influence on the quality of attack and is explained and shown diagrammatically as follows (Honan, 1999):



(Adapted from: Giles, 2000)

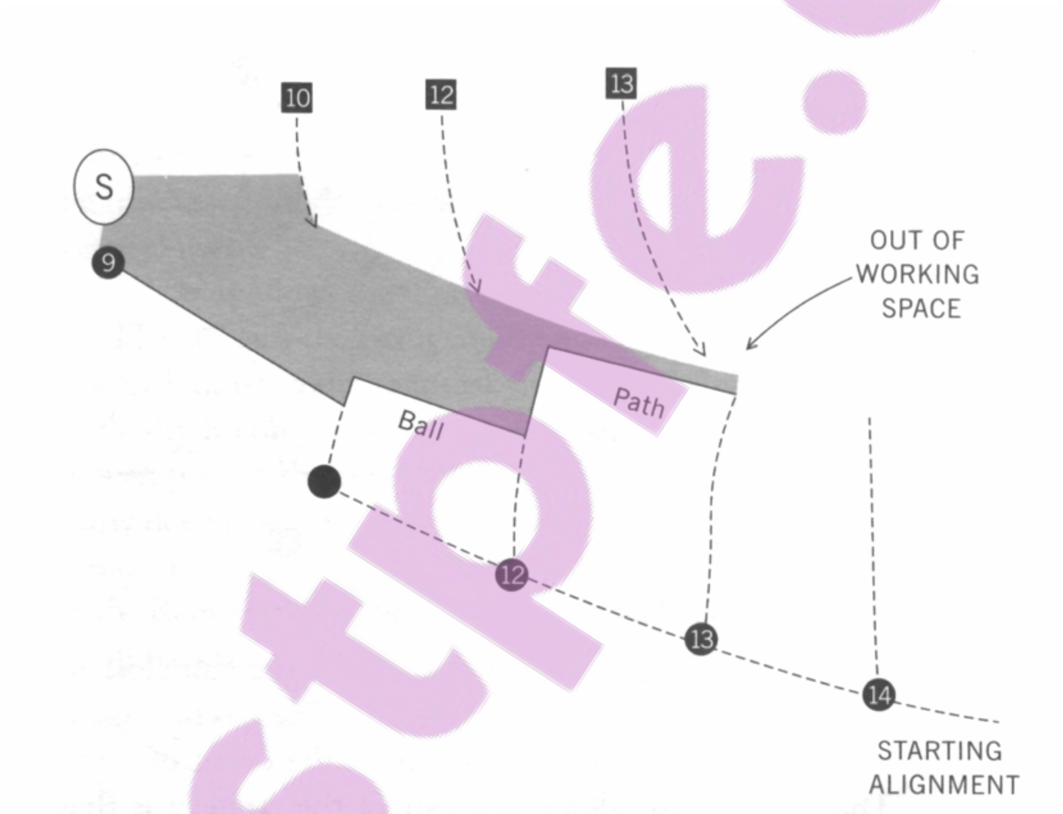
Figure 5.5: "Deep" and "Flat" alignment versus "Shallow" and "Steep" alignment

A "steep" alignment will not often be successful due to the attacking backline being further away from the advantage line and that with each pass the attacking team moves further away. There is also the danger that when contact is made it takes place behind the advantage line thereby making it difficult for the forwards of the team in possession to get to the point of breakdown as they will have to run backwards in order to do so (Honan, 1999).

What will also play an important part in the alignment of the attacking backline is where the striker is going to attack. This responsibility will lie in the hands of the flyhalf who will align in the appropriate position according to the nominated set-up move, this implies that the further out the strike takes place, the steeper the alignment will be, i.e., an attack can take place in zone 1, 2, 3 or wide off the facet. It is also important to realise that this alignment will vary according to whether it is taking place from 1st phase possession or after 2nd or consequent phase possession. There are two distinct components of alignment:

a) working space; and
b) angle of the ball, transfer line (Marks, 1998).

Working space is the decision made by the backline as to how far away it wants to operate from the opposition. This distance is that between the ball path and the defence line. This space will reduce as the ball is transferred along the line, as both backlines will be moving towards each other.



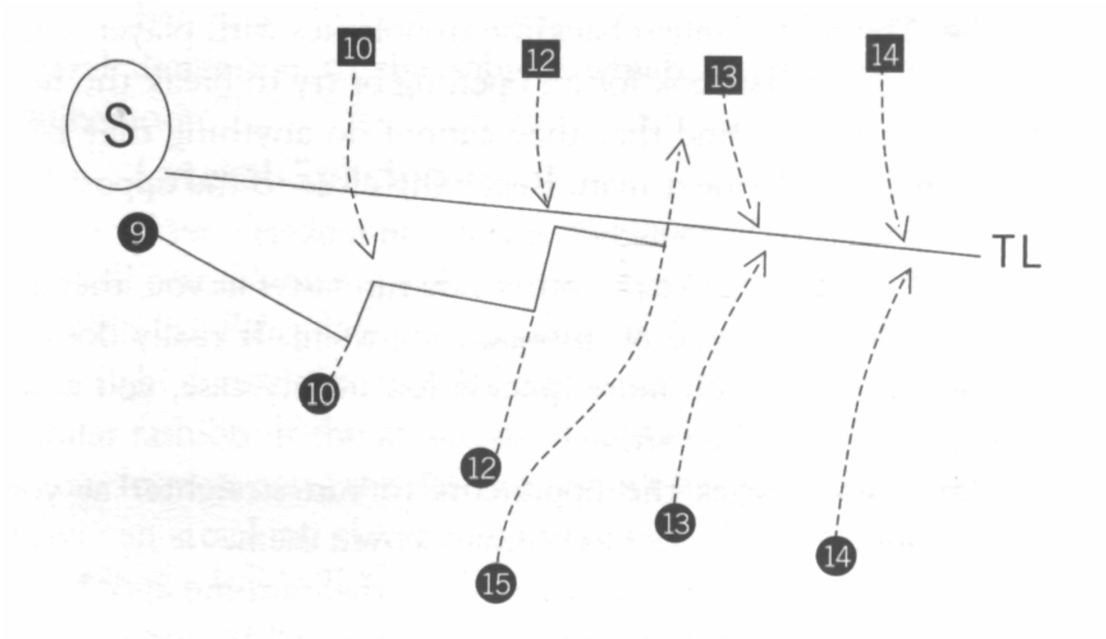
(Adapted from: Marks, 1998)

Figure 5.6: Working space in attacking play

The ideal distance is largely dependant on the following:

a) where the attacking backline wants to attack the defensive line; and
b) what level of skill the players have (Jevon, 1997).

The more skill the players have and the closer in you want to plan your “strike”, the closer you can stand to the opposition (Levy & Palin, 1993).



(Adapted from: Marks, 1998)

Figure 5.7: The way to hit a space in attacking play

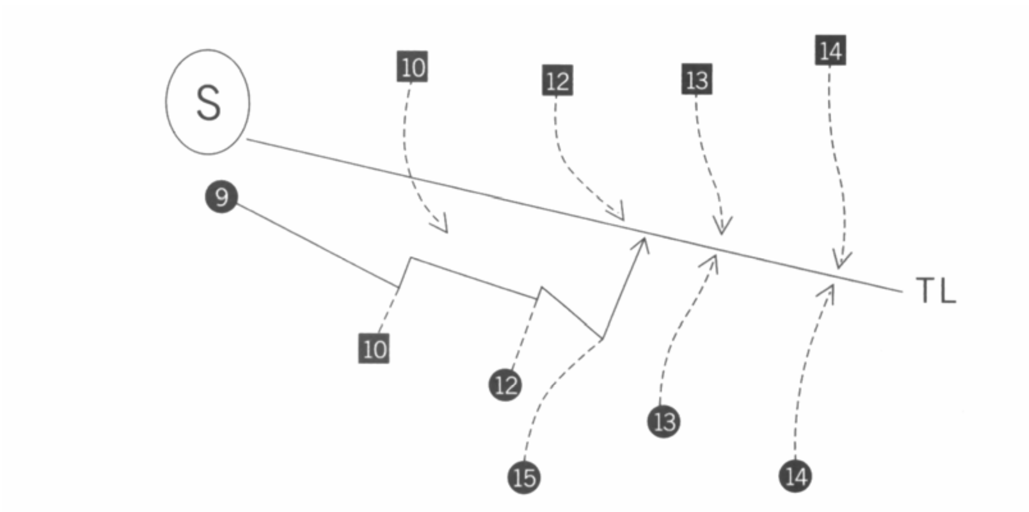
A simple way to determine the working space required and the angle of the ball transference can be to determine the number of passes involved in transferring the ball to the “striking” player in any pre-planned sequence, and then adjust the depth so this can be achieved with the striker receiving the ball almost on the tackle line. If the attack is structured that the receiver receives the pass too far back, any gap that might have existed will disappear (Evert, 2001a).

If the attack is planned close in, the team will need only two or three passes. The attacking line can then confront the opposition by standing up on the defence. If the attack is more complicated and wider out, the final transfer might be the fifth pass; therefore, the backline will require greater working space. Three facts are vital to understand:

1. you can’t pass a defensive line until you meet it;

2. the closer you are to a defender when you receive the ball the quicker and more definite the opposition's response will be (Marks, 1998); and
3. a team must first put themselves under pressure in order to put the opposition under pressure (Dwyer, 1992; Unknown Author, 2005c).

The result of these factors is that it is useless doing switches or bringing in an extra player metres away from the tackle line because the defence will adjust accordingly. These ploys have to be carried out on the tackle line and the flatter the passing alignment is the further forward the tackle line becomes, which will be to the advantage of the attacking backline (Marks, 1998).



(Adapted from: Marks, 1998)

Figure 5.8: Pass to an extra player too early and too far back

It can also be observed that if you receive the ball close to an opponent, that player can only do one thing. There is no second chance of recovery in the event of a bad decision. The crux of the matter is that if you receive the ball close to an opponent you absorb, involve and commit his defensive attention. If you are not successful in committing him then the tackler is released from his duty and he can become an extra defender further along the line. Because backline play is very much a numbers game where you are trying to preserve and improve the ratio of attackers against defenders, a too large a working space will make defence by the opposition easier (Honan, 1992; Marks, 1998; McFarland, 2005a).

Here follows a few further advantages that occur if the close attacking policy is followed:

- if a line break occurs, it will tend to put you in behind the opposition before their cover defence has had time to make their way across the field and therefore come into play;
- the biggest mistake attacking players make is that they run too far. They first look for an opening or try to break the line and then when they find they cannot do anything they pass the ball on to the next man. By receiving the pass close to the opposition it forces the players to become better decision makers; and
- it tends to induce the defenders to rush onto you thereby disorganising their defensive lines and therefore making them more vulnerable to line breaks (Smith, 2001; Hill, 2002; Greenwood, 2004).

Finally, it is important to note that alignment is only a starting point; it's where the backs run from, not where they actually get to. It is only important in so far as it enables the backs to carry through their projected manoeuvre successfully. The alignment must enable the attacking backs to make the "telling" pass to the striker runner as he cuts through and beyond the tackle line (Ashton & Meier, 2002).

5.4 THE ATTACKING BACKLINE'S ATTACKING WIDTH

The preservation and creation of space also has a lot to do with the ball carrier's own spacing i.e., if the attackers line up or run in a tight formation, the defenders will tend to mark them in a similar fashion. If the attack spreads, then so will the defence and so on. In most cases the defence doesn't have a choice because if they leave an attacking player open who can receive the ball unmarked, then the defensive line will be broken (Marks, 1998; Smith, 2001; Southwell, 2002; Unknown Author, 2005c).

When one speaks of width on the attack, Garth Giles, Director of Coaching for the Natal Sharks makes an interesting comment. "If one considers that a rugby field is 70 metres wide and that at a scrum there are 18 players (two packs of forwards and two scrumhalves) that are fixed in a small rectangle, possibly 3m x 5m, there would appear to be acres of width space for four three quarters (flyhalf, two centres and a wing) in which to manoeuvre!". His belief is that South African teams in general are good at using the length of the field (i.e., "length space") but are not good at using "width space", and this is the essence of the "expansive" game (Giles, 2000).

Ashton and Meier (2002) agree and further expand on this idea of players committed in a confined space when they state that a similar situation to the scrum exists at a lineout situation with up to 18 players confined within 15m of the touchline, allowing 55m of lateral space that can be exploited. Added to this the enforced 20m space between the two backlines and one can see the attacking possibilities available. As mentioned earlier, it remains the flyhalves responsibility to be either "shallow" or "deep" and the first centre to be "steep" or "flat". The advantage that these alignment systems bring is that depth is created in the midfield and "space" on the outside. The "roving" unmarked players, i.e., the uninvolved wing and the fullback can be brought into play in any area. The vital aspect of playing in expansive channels is that the objective of manipulating the defence as much as possible, in order to create "holes" in the required "strike channels" and thus being able to put players into these spaces becomes possible (Giles, 2000).

The important aspect in terms of success from attacking play is largely reliant on how the space on the field is used. The gaps will become more apparent and the optimal use of them should result in a more successful attack.

Gary Nucifora makes an interesting comment.

> *"…Most of the space on the field is to be found outside the open winger, why not place the attackers at the phase at varying distances and depths prior to the balls emergence from the ruck or maul. Defenders will still mark up on their opposing man, but now natural gaps in the defensive wall will occur because of the spacing of the attackers. It could be argued that this will make it less necessary to run intricate angle-changing plays as the gaps will test the defences confidence and allow individual skills of*

attackers to shine through; either by running and attacking these gaps or there being "areas of concern" for the defenders on which the attackers can capitalise on, if their attack is good enough. Defenders will now position themselves on attackers with less confidence because they cannot adequately cover a defender as well as a 10m space in the line"

(Nucifora, 1999)

Chris Hickman, New South Wales U21 Assistant Coach has some interesting views on wide alignment attack. In his view the flyhalf must be wide and flat, the reason for this is that by aligning in such a position the following is achieved:

- by aligning wider the flyhalf prevents players who were committed at a ruck or scrum from being able to tackle him on his inside shoulder, this results in him only being able to be tackled by a player in the defensive line; and
- by taking the ball flatter the flyhalf is able to draw a defender so that the defender cannot leave him to drift outwards on his preferred defensive line (Hickman, 1999; Hill, 2002).

The inside centre must be deeper and wider:

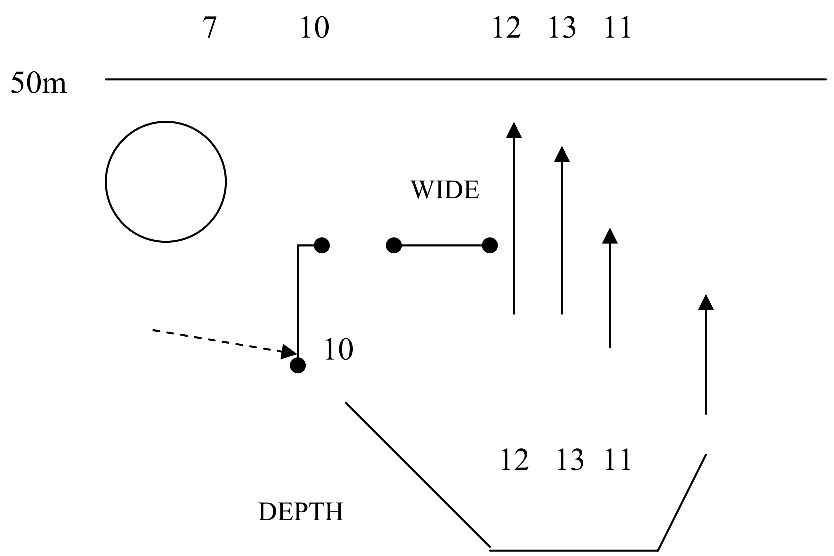
- by being deeper the centre gives himself greater space to work in; and
- with the extra width he is able to take away the inside pressure of players attempting to drift across in defence (Hickman, 1999).

The players outside these two should be able to run straight at the defence in a normal pass position. This alignment can be used in the following situations:

- from rucks and scrums when the defence is close and each defender can be committed, this prevents the defenders from being able to initiate their drift defence option, as they have to assess that which is taking place near to them;
- when you have an overlap. Defenders can be committed man-to-man and running straight at them gives the overlap player on the outside maximum

space to work in. It also creates space on either side of the ball carrier – which is an optimal situation; and

- the attacking team are able to achieve quick ruck ball going forward. The defenders are on the back foot and attackers can organise a one-on-one confrontation where they hold the maximum advantage (Hickman, 1999).



(Adapted from: Hickman, 1999)

Figure 5.9: Wide alignment attack

It is important to note that this alignment is not suitable for all situations. It will have advantages in certain situations; however it does have certain limitations. One of the dangers is that if running and passing is too far apart it may encourage across the field movement, i.e., because the passers feel that the pass may just be out of his range, he moves laterally so to shorten the distance he may have to pass. Another danger is that because the time travel of the ball increases with the width of the pass, the receiver may have to either:

1. start the run on to the ball later;
2. approach it more slowly; and
3. stand further behind the receiving point (Marks, 1998).

This is why wide spacing usually produces a steeper starting alignment. The key for successful attack is that spacing is varied and adjusted according to the situation, i.e., if the attacking formation remains close all the time, it can expect the defence to follow, this will result in the holes in the defence to be more difficult to attack and the attacking team will find it more difficult to stretch the cover defence. The last important aspect of this section is the importance of ensuring that players in the line maintain and use their position's space responsibly, and as such, respects and preserves the space of the players on the outside. This ability to maintain the width in attack is ultimately related to the player's ability to make very long accurate spin passes off both the right and left hands equally well. These passes should be at least 12m preferably between 15m and 18m, travelling as near to horizontal as possible. The accuracy of the pass should be flat, at right angles to the touchline, so that the receiver, running parallel to the touchline does not break pace at all on the receiving of the pass (Ashton & Meier, 2002).

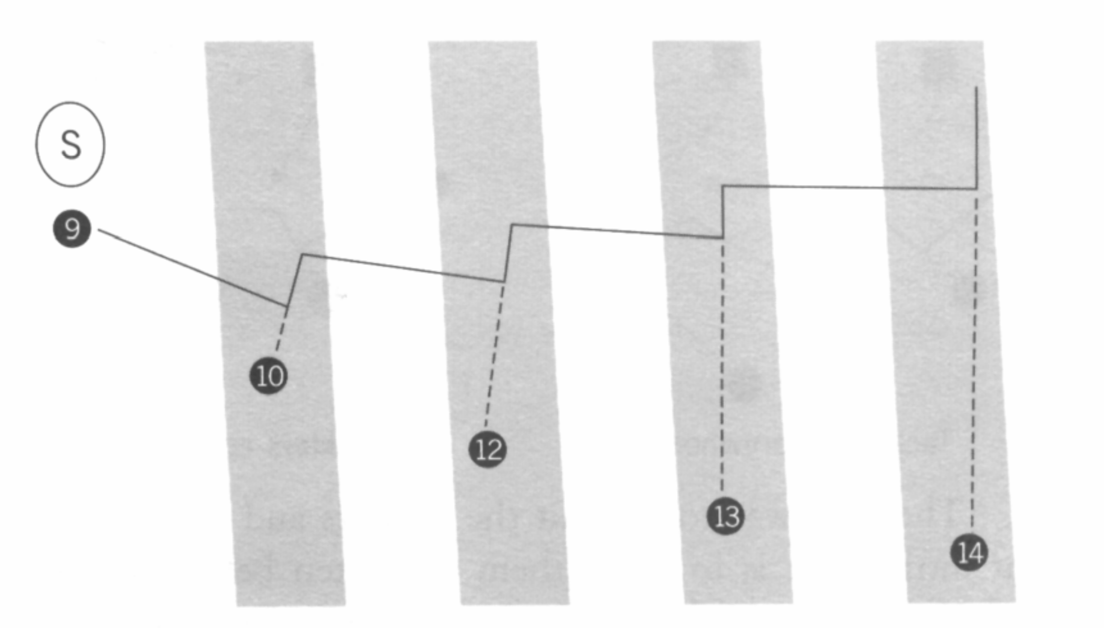
(a) (b)

(Adapted from: Ashton & Meier, 2002)

Figure 5.10: (a) Necessary accuracy for a wide pass, (b) poor accuracy of a wide pass

This can be explained as a form of channel running i.e., each runner remains in his own territory until he has transferred the ball. After this, that player is responsible to follow play and "resurface" and enter the line in one of the "space" channels on the outside or further along in play. If this ball carrier leaves his channel and starts running towards his outside players, then it should be a signal for a special action such as a switch pass in order to straighten up the attacking line again (Jevon, 1997; Marks, 1998).

It is important that running serves a purpose and is not merely instinctive. These running channels are not very wide and are fairly straight. This ensures that the defence is committed and creates areas through which the trailers can run.



(Adapted from: Marks, 1998)

Figure 5.11: Channel running in attacking play

5.5 THE ATTACKING BACKLINE'S CHANGE IN INITIAL STARTING POSITION

The key to catching the opposition unaware so that advantage can be taken of their lack of attention on the field can be achieved by the whole attacking backline positioning quickly, and then, as the ball is entered into play, the whole attacking backline positions as a unit in a new position, i.e., either

a. two steps backwards – for a strike in a wider channel
b. two steps forwards – for a strike close to the facet
c. two steps to the left
d. two steps to the right.

for an expanded or compressed attack

This change in initial starting position creates the following situation for the defending team if they are not at full wit and aware of what is happening in front of them. The opposition's defensive lines align themselves according to what they see in front of them. When the ball is entered into play, their attention focuses on the play that is taking place inside of them at that facet of play, i.e., the defenders attention is drawn to the result of the facet, this implies that if the ball is won by the attacking team, the defenders have to defend, however if the possession is won by the defending team through a turn-over at that facet, then the defenders will change to an attacking mode and react accordingly. The net result is therefore that if the attacking team can take advantage of the opposition's split second lack of concentration, and in this time align differently from their initial position, the opposition's defensive "zones" will be slightly out of sync and the defenders will be faced with an attacking backline that looks "different" to what it did a split second earlier. The following will be achieved:

5.5.1 By moving sideways before receiving the ball, it creates a situation where the defence's alignment is out of sync, due to them being too far inside their immediate defenders.

5.5.2 By being out of sync, there is extra space on the outside and it makes the preservation of this space easier if the attacking backline moves forward and "fixes" their immediate defenders.

5.5.3 Finally, the responsibility of the attacking team is limited to merely preserving and then making use of this space on the outside through optimal transference of the ball along the backline.

5.5.4 Defensively, it makes it increasingly difficult for the defenders, especially further out along the line. The reason for this is that because they are "caught" to close inside, when they press and move towards the attacking players, it is difficult for them to keep their shoulders square to the touchline in order to be in a good position to be able to execute the tackle.

5.5.5 Because the defenders suddenly feel "out of touch" of the attackers due to the extra space that is inside of them, it makes it difficult for the defenders to press, and then shift. He is forced to shift immediately as there is too much ground for him to make up and thus if he does press first, the attackers will move even more out of reach and there will be even more space on the outside. The defender thus becomes a chaser instead of being the one who attacks the opposition's possession front on which is the optimal mindset of a defender.

5.5.6 This gives the attacking players the following advantages:

5.5.6.1 The defender's shift from the outset of the play, thus if the attacker runs forward "at" the defenders and attacks their defensive line, it is highly likely that the attacking unit will get over the advantage line.

5.5.6.2 It forces the defenders to turn their shoulders towards the touchline thus making them defensively vulnerable behind their back from any attacking scissors, or inside passes.

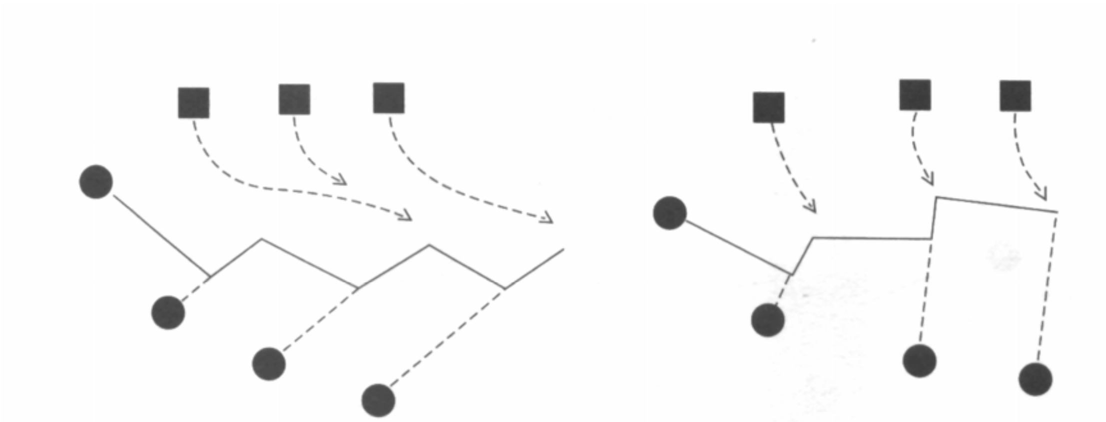
When defending they are not able to contest at the strike zone by making big hits or out muscling the attackers but are merely able to try and nullify it. The possibility of gaining a turnover or contesting at the resultant ruck is minimal thus the attackers are able to recycle quick possession which will put the defenders under further pressure at later phase play.

5.6 THE ATTACKING BACKLINE'S ANGLES OF RUNNING

At this stage of the discussion, emphasis has been on the work done before the receiving of the ball. Factors such as working space and lateral spacing are both key factors in "setting up" the defenders so that when the attack is launched, that they are manipulated into a mechanically weak defensive position. The angle with which a line approaches the defence, followed by the sudden veering off in different directions, (with a multitude of offloading options), and finally the pass made to a player attacking space, is the ultimate objective of an attacking backline. Running and passing angles have the largest influence on the preservation and creation of space (Southwell, 2002; Unknown Authors, 2004a).

A simple explanation of running angles is that if players with the ball run across the field, the inside defenders can run up to the ball carrier on such a complimentary angle, that they can move onto a good tackling line further out which will result in the backline attack being stopped. The only way to commit the tacklers and to prevent this threat further out is to make them straighten before the ball is passed. Running straight or veering in before the pass is made can achieve this. This straight run will not only "fix" the immediate defender but also to a certain extent those defenders who are moving across the field on their drift as cover (Marks, 1998; Nucifora, 1999; Evert, 2001a, Greenwood, 2003; Greenwood, 2004).

(a) (b)

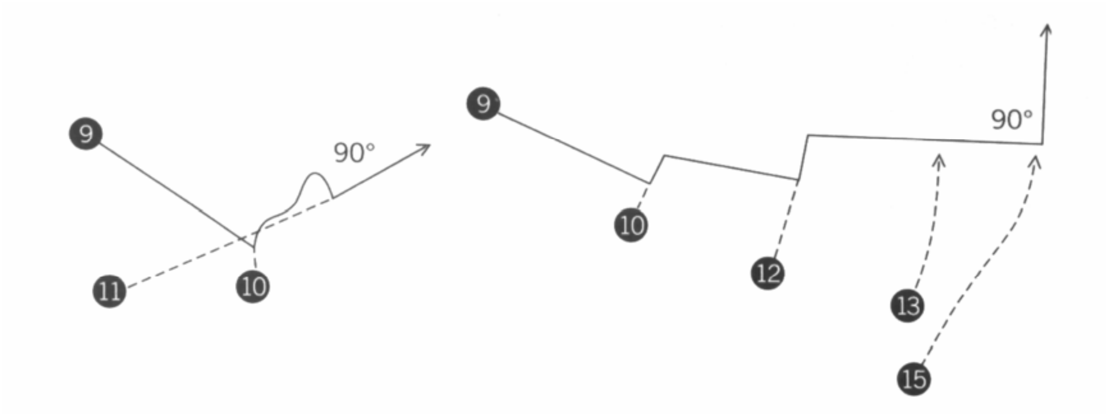


(Adapted from: Marks, 1998)

Figure 5.12: (a) Tacklers everywhere and (b) tacklers contained

When discussing the angle of the pass it is important to note the natural 90º angles that exist between the ball path and the receiving line. This relationship helps reduce the pressure on the transfer. In terms of its ability to "fix" the opposition, a deep pass will tend to produce a "following across the field" pass, while a flat pass will require the receiver to take it on a straight run (Honan, 1992; Ashton & Meier, 2002).

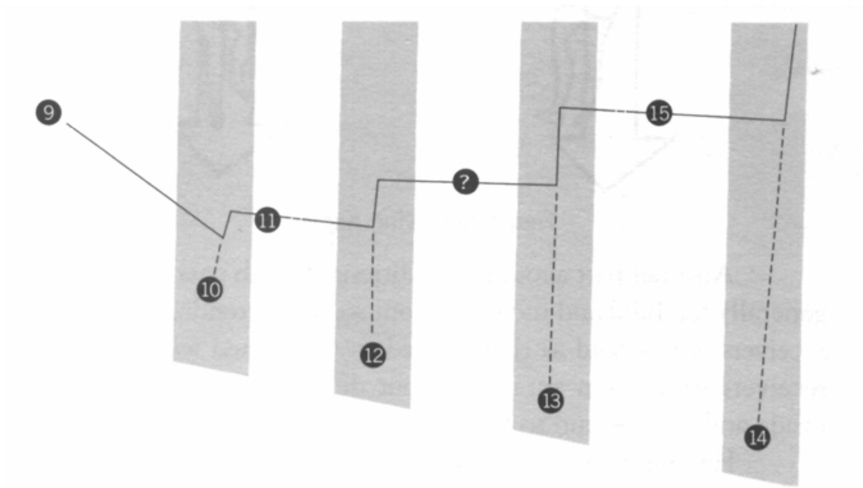
There are two examples of these two options. If a player is entering on a strike from the side of the field, (a blindside wing), he will usually need to receive the ball on a diagonal run. If the entry is more from behind then the player will want to run straight on to the pass to receive the ball and enter the space simultaneously, (i.e., a full back coming in on a cut pass from the inside centre) (Marks, 1998; Robilliard, 1998).



(Adapted from: Marks, 1998)

Figure 5.13: The 90˚ passing rule

It is important to understand the link between the angle of run and the peripheral vision "available" to the ball carrier. If the ball carrier runs across the field in search of space, he diminishes his available options due to him not being able to see them. If however the ball carrier moves in his channel he is able to open up the full 180º of vision of what is in front of him. He is thus able to pass the ball in various directions even back inwards, if necessary, to a support player in depth as a second line of attack (Jevon, 1997; Harrow, 2002).



(Adapted from: Marks, 1998)

Figure 5.14: Stair passing showing the full peripheral vision for all the attackers

If one looks at the diagrammatical representation, there is great emphasis on a flat transfer as well as the action of advancing the ball beyond the receiving point. The important aspect of the pass is that the ball doesn't travel backwards to any degree other than to avoid making a forward pass. The reason for this is that it is pointless to pass a ball back in depth to a player who then has to carry the ball forward some distance before he makes any net gain on the initial position (Marks, 1998; Ashton & Meier, 2002).

There are two important benefits from this means of attack. By following this form of running line, the team maintains forward momentum. This results in supporting players being in a better position to support the ball carrier. This aspect of play, namely support will be discussed in depth at a later stage, however in order to understand the reason for its importance, it will be briefly touched upon.

By advancing the ball forward, it makes the supporting players more effective as their path of run is forward. It is very difficult to re-enter play if you're chasing a ball that's going backwards. If a supporter can follow a ball forward and across, you can reach it on a suitable receiving line and thus a re-entry into play becomes easier (Royall, 2000; Harrow, 2002).

As we near the crux of this paper it is necessary to touch on a few elementary aspects concerned with running lines. If the attacking team are going to be successful in confusing the opposition, then they are not going to merely pass the ball up and down the line, but are going to bring in variations such as having the ball travel back in the opposite direction, around and diagonally along the attacking line.

5.7 THE ATTACKING BACKLINE'S DECOY RUNNERS

The role of the decoy runners is to create imaginary forces that manipulate the defenders into mechanically weak defensive positions. For this to be possible they should draw attention to themselves as impending "pressure" or "danger" players in order to be effective in committing opponents (Evert, 2001a).

There are two decoy ploys necessary if the play is to take place in the midfield channels. These decoy ploys take place inside and outside the strike zone. The decoy runner who needs to come in on the inside whose responsibility it is to "check" the inside defenders from the preceding facet have to decoy "strike" with absolute conviction. His responsibility is to "fix" the inside defenders and to delay their movement across the field so to "buy" attacking time and space in the midfield where the strike is to take place (Evert, 2001a).

This also fulfils the function of nullifying the defensive system of "one-out" defence which is executed by using a forward at the facet to mark and defend against the flyhalf thus allowing the flyhalf to defend the inside centre and so on.

If this is not achieved then there will be no possible overlap on the outside thus the attack will be difficult due to the attackers equalling the defenders. If the "striking" decoy is convincing enough so to commit the inside defender thus forcing the flyhalf to have to defend against flyhalf then there will be extra attackers on the outside.

The second decoy ploy takes place on the outside of the strike zone and has the following two advantages. The first is that it keeps the hole through which the strike is to go through open by committing the outside defenders in their defensive zones as there always remains the possibility that these decoy runners can receive the ball on an "overs" line thus their immediate defenders cannot afford to tackle in.

Secondly, it facilitates easier supporting running lines. Three situations can result from a strike with decoy ploys on the inside and the outside:

(i) There can be a successful and clean strike. If this occurs, then the supporting running line will create two supporters who are in a position to receive "finishing off" return passes to score the try.

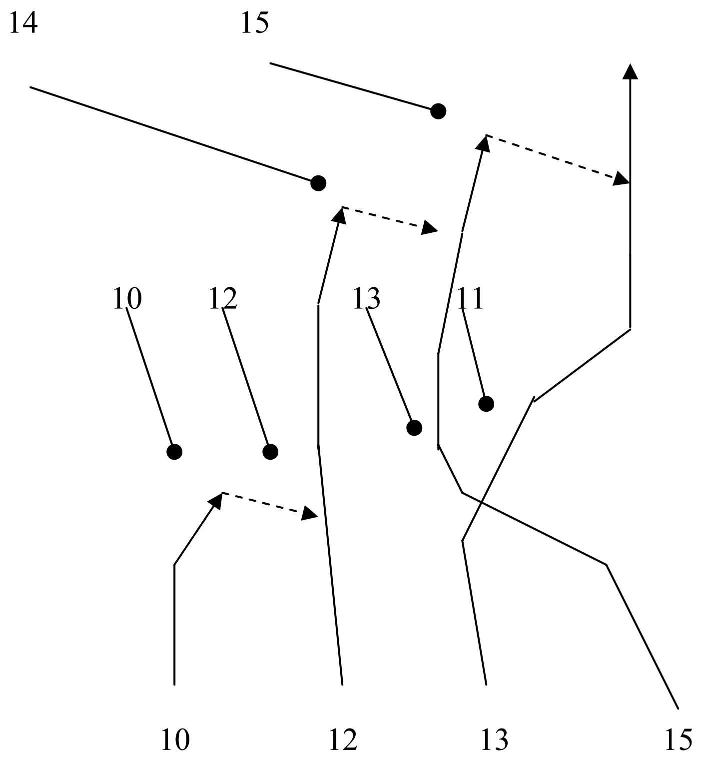


Figure 5.15: Indicating the use of an "O,I" decoy line and the support lines created through its use after a clean break has been achieved

(ii) If the strike takes place and the striker is momentarily stopped in the tackle, the supporting running lines of the decoy runners will result in there being a trailer who will be able to receive an offload and thus be able to continue the play that has been created.

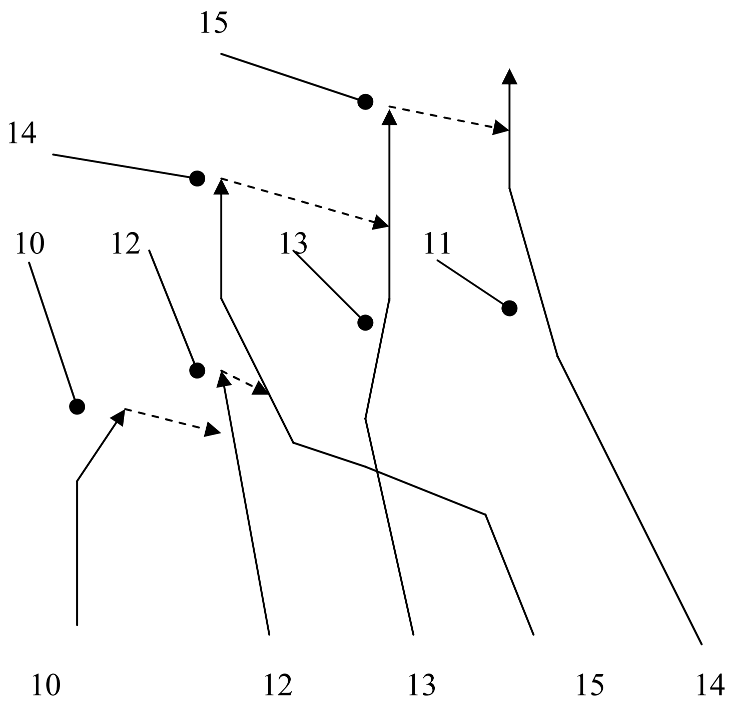


Figure 5.16: Indicating an "O,I" decoy line where the striker offloads to a trailer coming in, and the support lines created after the line break has been achieved.

(iii) There will also be one extra support runner on the outside that will be able to link up with the player who received the offload and be in a position to receive the "finishing off" return pass to score the try. If the attack is smothered and the play is halted, the support runner will be in a position to be the first cleaner, thus recycling the possession and creating another opportunity to launch a further attack on the oppositions defence is created.

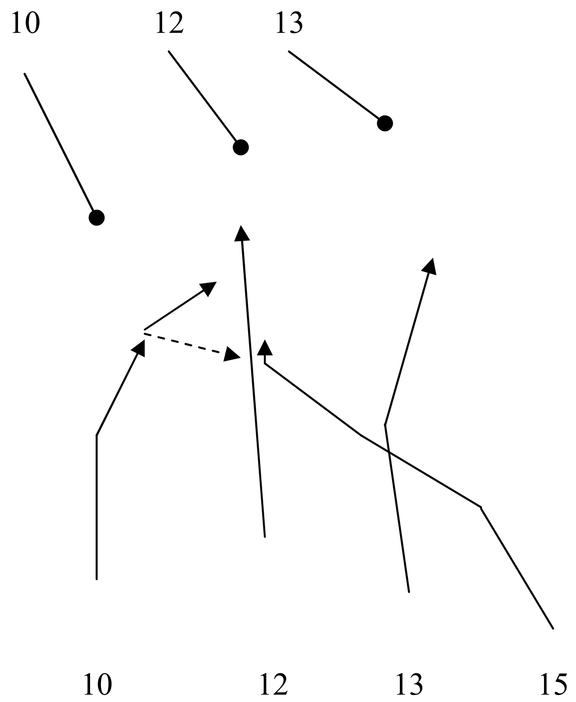


Figure 5.17: Indicating an "O,I" decoy line where the trailer becomes the primary cleaner with the previous ball carrier on the inside after an attempted line break has been unsuccessful**.**

With these examples in mind the fundamental role of force can be defined as the ability to change the state of motion of a body on which the force acts (Young, 1992).

If one was to look at Newton's first law of motion which states that: Every body continues in its own state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed on it, then it could be implied that if no net force acts on a body, the body either remains at rest or moves with constant velocity in a straight line (Cajori, 1934; Young, 1992).

In order to understand this link between Newton's first law and rugby, it is necessary to look at contact situations during play. In order for contact to take place, the striker and defender need to meet at the contact area. However, before this contact area develops, the players move towards each other with different velocities and from different angles. The situation preceding contact involves many forces acting on the players before, during and after contact. The use of these varying velocities and running lines creates imaginary forces that are exerted on the defenders in order to manipulate them. It is therefore the decoy runner's responsibility to create these forces, which can be achieved in the following way:

1. when these forces act on the defenders, it changes their state of motion. A player who is initially at rest will start to move. If the player is moving, a force in the opposite direction to the motion will cause the player to slow down or stop; and
2. if the decoy runner and ball carrier are able to exert a force on the defenders and manipulate them accordingly, their defensive line can be changed, thus creating conditions that could be conducive to a line break (Evert, 2001a; White, 2003).

The result is that if a defender has his line of defence, and a decoy runner together with the ball carrier's running line does not manipulate the defender, the defender will not be taken out of his defensive alignment and will be able to maintain his defensive line and will stop the attack. With the understanding that the use of decoy runners is vital to a successful line break the finer details of decoy runners can be explained. The first key aspect for decoy runners is the need to run angles that create an advantage (Honan, 1999). In order to create an advantage it implies that the attacking team is split up into attacking units. These units are:

- the ball carrier;
- the decoy runners accompanied by the trailers;
- the striker; and

- the trailers who become the support runners (Marks, 1998; Evert, 2001a; Hedger, 2002; Greenwood, 2004).

With the importance of the first receiver keeping his immediate defender and the sliding defenders coming across from the inside “fixed” already having been established, the next part of the attacking unit are the decoy runners working in tandem with the ball carrier and the striker. The decoy runner’s objective is to keep defenders busy and focussed on them so that advantage can be taken of the space that can be opened up. The ideal is to keep more defenders busy with fewer attackers thus opening up spaces in the channel opposite to where their attention is. This contest of trying to keep more defenders busy with fewer attackers will result in the strikers having more trailers available behind them when they attack. The decoy runner should ensure that his movement is synchronised with the players on his inside (White, 2003).

If the strike is going to take place inside of them, then their aim should be to push and manipulate the defenders to keep their defensive width, i.e., they should stay wide. This together with sufficient lateral space between the first receiver and the distributor will open up a space behind the distributors back in the second or third channel. The term “one-out decoy” is as appropriate as what “one-out striker” is and implies that the first receiver out from the distributor i.e., the second receiver, runs the line that should take the defenders on the outside of the distributor outwards, while the person outside of him, i.e., the third receiver runs an “unders” line which crosses with the second receiver and becomes the automatic trailer.

What this does is that it pools the defenders on the outside and then the strike takes place where they are not. If the strike is going to be wide in the fourth channel, then the aim of the decoy runners should be manipulate the defenders to “tackle in” so that the striker out wide comes into the strike “against the grain” and behind the defender’s back.

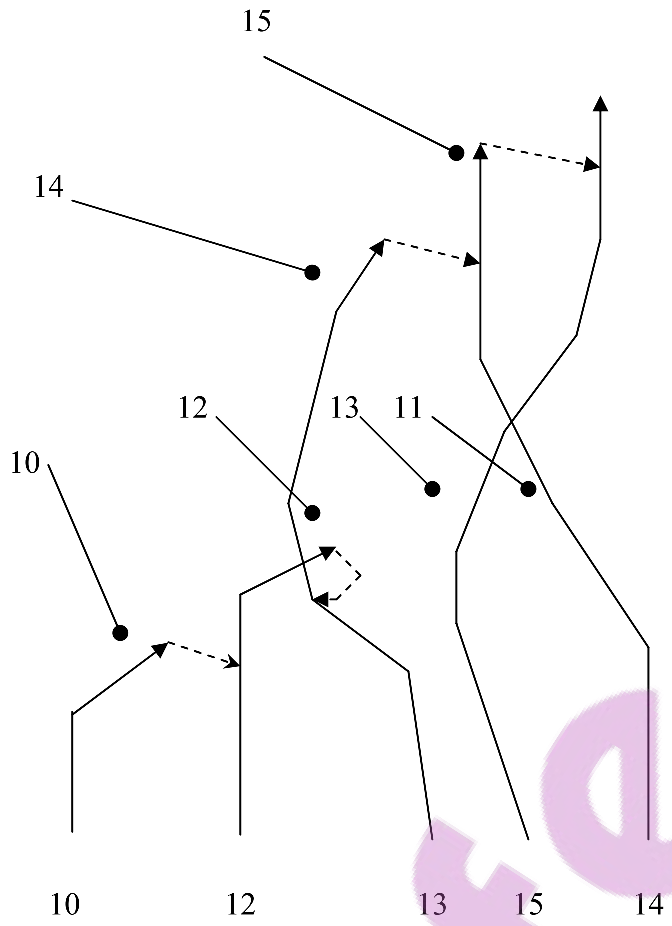


Figure 5.18: Indicating the concept of a "One-out" decoy line ending in a score

The success of the decoy runners is thus dependant on the following:

- the speed of movement of the defender and how this affects the speed of movement of the attackers;
- there has to be a marked acceleration on the part of the decoy runner in order to force the defender to speed up his movement. This must take place just as the striker is to come in on the strike. If this is achieved, the strike is more likely to be successful. If it is not achieved the defender may be able to realign himself and get himself into a position to make the tackle; and
- the centre of mass of the defender, which should be manipulated by the decoy runners to have a mechanical advantage for the striker. This can be achieved by the optimal use of the angle from which the decoy enters the strike zone. The

defender must be taken past the point of no return for the striker to be able to play into an area that is defensively weak (Evert, 2001a, White, 2003).

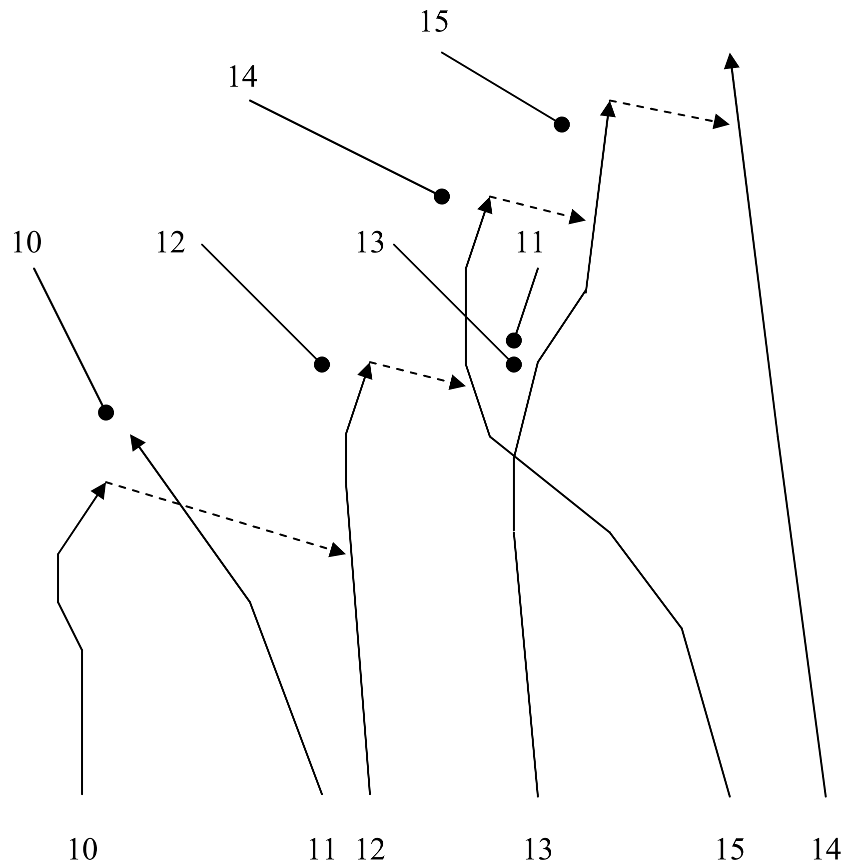


Figure 5.19: Indicating a decoy runner on the inside accompanied by a "One-out" decoy on the outside with the resultant trailing lines that are created

These are support players who are aligned either laterally or behind the creator. They are not intended to receive the pass however are in a position to do so if an open space was to present itself in their line of run. Their objective is to manipulate the defenders and commit or "fix" a defender / or defenders (Robilliard, 1998; Evert, 2001a, White, 2003).

5.8 THE ATTACKING BACKLINE'S MANIPULATION OF THE OPPOSITION THROUGH NUMBERS

To breach a defensive line requires both individual and collective skill. Individual breaks depend very much on running skills. Collective skills are directed towards putting a player away who is unmarked. In order to achieve this, a team must either add to their own numbers or subtract from the oppositions numbers. This can be achieved by means of two basic methods:

- addition. This comes from support play or bringing in extra runners onto committed defenders; and
- subtraction. This comes from involving or distracting the opposition, thereby taking them out of their defensive shape (Marks, 1998; Evert, 2001a, Greenwood, 2003).

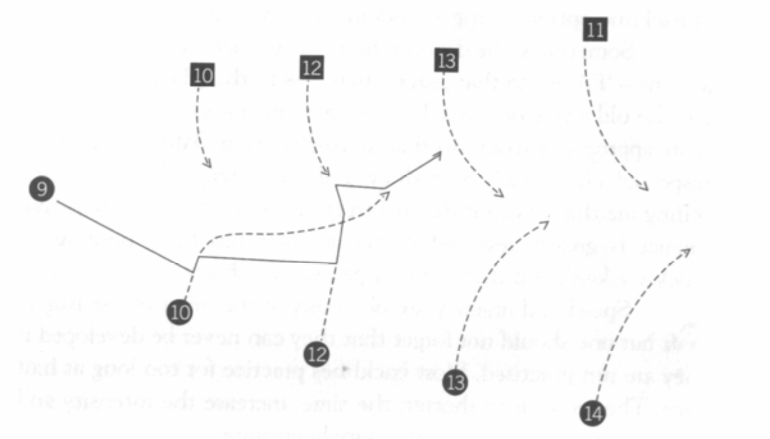
5.9 THE ATTACKING BACKLINE'S MANIPULATION OF THE OPPOSITION THROUGH ADDITION

For the principle of addition to be successful the following aspects have to be optimally executed:

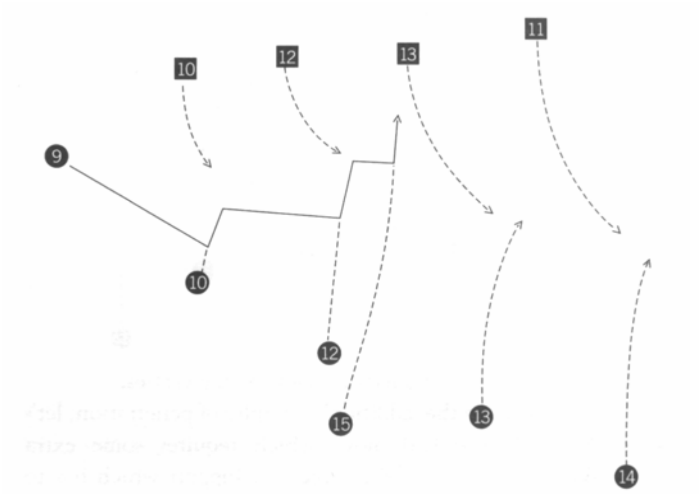
1. ball movement: The ball carriers need to be able to move the ball to the possible "space" and in some cases even create the hole with the path of the ball (Honan, 1999);
2. "fixing" the opposition: If the backline can get the opposition to hold its approach lines and stick to their immediate defender, it can preserve the space between the players, the one on the inside of the ball carrier and the two on the outside being the most effective channels (Robbilliard, 1992; Marks, 1998);
3. first support entry: If the front line backs are committing their opponents, it becomes the responsibility of the support players to put themselves into unmarked spaces. The supporter's presence or intended presence needs to be communicated to the ball carriers; and
4. final transfer: The passing of the ball to the entering support player is a vital part of the operation and the more accurately and deceptively it is done the more

effective the outcome will be. The angle, speed and the timing of this pass are all crucial factors to the success of the attack (Marks, 1998).

(a)



(b)



(Adapted from: Marks, 1998)

Figure 5.20: (a) Addition through a circle ball.

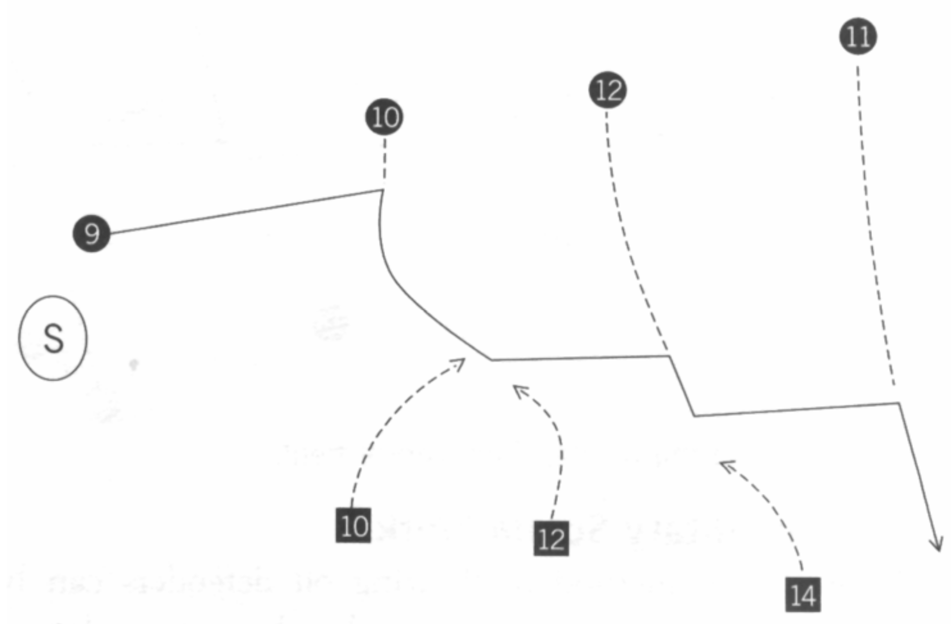
(b) Addition through an extra player entering the line

5.10 THE ATTACKING BACKLINE'S MANIPULATION OF THE OPPOSITION THROUGH SUBTRACTION

Subtraction is achieved by putting defenders into a position of disadvantage, i.e., they are either taken out of the game or left where they cannot take part in their defensive role any further (Johnson, 1993; Marks, 1998; Evert, 2001a).

To accomplish this, the following needs to be achieved:

- the attacking backline must know how to position a key opponent to involve him or isolate him. This is usually achieved on the basis that an opponent will usually mark his opposite opponent directly, i.e., if the inside player wants to involve the outside defender, you need to drag that defender in by standing tight. If you want to keep the defender away from an inside striking area, it helps to stand wide and have the player come across to mark you;
- it is important to run at a defending player with the aim to commit him onto his inside or outside shoulder (Marks, 1998; Hickman, 1999);
- if you want to commit two tacklers, the ball carrier has to run at the defender one out. If the opposition are standing narrow you run at the outside shoulder to shut that defender off. If they are standing wide you run at the "one-out" player's inside shoulder thereby bringing the defender onto you (Evert, 2001a); and
- it is vital to be able to get tacklers to change their direction drastically, thereby momentarily stopping them in their tracks. When confronting your direct opposition, this becomes possible by slowing down and straightening or by stepping inside and then outside (Marks, 1998; Hickman, 1999).



(Adapted from: Marks, 1998)

Figure 5.21: Subtraction through committing two tacklers

5.11 THE ATTACKING BACKLINE'S STRIKER

This player receives the ball from the creator. The decoy runners have "fixed" the opposition in a specific area and the striker thus attempts to break the line where the defensive line is weakest. It is important to note that with each organised strike there must be more than one option to off-load to, i.e., a decoy runner and striker function as a unit where any of the players involved are able to receive the pass on the strike. This means that decision making by the creator is important, as a change in plan at the last second may be necessary if full advantage is to be taken during a specific attack (Burkett, 1998; Evert, 2001a).

All these aspects are vital in the attacking team's armoury to break or slow down the defender's drifting defence. The most important contributing factor however is how the attackers change the angle of run during the attack. This is a major weapon for the attackers as the later the change of angle takes place the better, as the defender has less time to take in the information and thus has less time to react accordingly. For this change in angle at the last minute to be of maximum effectiveness the following factors could of value:

- the striker must come from a position outside of the defenders range of vision; and
- the striker must come in at pace and cut the angle as late as possible

5.12 THE ATTACKING BACKLINE'S TIMING OF THE MOVEMENT OF THE ATTACK

The success of any attacking play is dependant on variations in speed and movement through the different phases of the execution of the attacking strike. With the previous aspects in place, the key aspect is that the attacking backline should start moving as the scrumhalf touches the ball (Honan, 1999, Bond, 2000; Greenwood, 2004).

It is not necessary that this movement should be fast, the key is to move comfortably with the ability to be able to accelerate rapidly or decelerate as appropriate when required. This movement before the ball is passed makes the nomination and execution of the tackle by the defenders difficult (Robilliard, 1992) and begins the process of overloading the defenders with defensive options (Evert, 2001a).

It also gives the attacking players the necessary initial forward movement which will keep the defensive team on their toes as they cannot afford to just rush in on the attackers and will need to hold back to see what will transpire in the attack before executing their defensive action. There is the also the added advantage that the attacking team will be able to get over the advantage line with greater ease as the initial movement is always forward (Honan, 1999; Evert, 2001a; Hedger, 2002; Barker, 2003).

The second aspect of the timing of the movement in the attack is the change of pace during the execution of the attacking play. Each player within the unit has the responsibility to vary and adjust his speed of movement during the whole development of the attack as is appropriate in order to either catch the defenders unaware, or to surprise the defenders with unanticipated variations in pace and movement (Evert, 2001a). These variations of movement take place in the following stages of the attack:

5.12.1 The initial starting position of the first receiver.

This involves the sideways movement which needs to be made subtly so as not to draw attention to this movement and thus to catch the defenders unaware (Evert, 2001a).

5.12.2 The alignment of the attacking unit from the facet.

The key to effectively catching the defenders unaware so that they do not know what to expect from the attacking unit can also be instituted in the alignment of the attacking players. This involves the concepts of "compressed" and "expanded" attacking structures. Again the movement needs to be subtle so as not to draw attention to the movement (Evert, 2001a).

5.12.3 The timing of the movement of the attack.

This concept involves the movement and changes in pace and timing prior to the strike being executed. The ball is in play and the execution of the strike is imminent. The reason for these changes in pace is the need to lure the defenders into a sense of comfort and belief that they have the attack covered. While the defenders may feel secure in their defensive abilities at that specific moment if the attackers are able to rapidly explode and totally overpower them by increasing the pace and intensity of the strike then it will result in an increase in the defender's defensive options in such a way that they are not able to cope with nullifying the attack (Evert, 2001a).

The ball carrier who is to transfer the ball to the striker should move with ease and in such a way that he keeps his immediate defender on his inside shoulder if the strike is to take place on the outside. This ensures that the space on the outside is preserved. The first and primary responsibility of the first receiver is to ensure that he commits and "fixes" both his immediate defender, as well as the defenders moving across from the inside facet. The reason for this is that if any advantage is to be taken when striking in the outer channels, it will require space and one-on-one confrontations between attackers and defenders. This can only be achieved if the "sliding" or "drifting" defence is halted as close as possible to the facet that preceded. The first means of achieving this is through the first receiver:

1. positioning himself quickly;
2. as the play is entered into he should realign himself two steps outwards; and
3. as the scrumhalf touches the ball, the first receiver starts moving forwards firstly on a very slight drift, and then as the ball touches his hands he increases his velocity rapidly and steps inside onto his immediate defenders inside shoulder thus forcing him to straighten up his body positioning so that his shoulders are facing inwards.

As soon as his immediate defender's shoulders have been slightly turned, he slackens off on his acceleration and moves outwards with his body positioning being optimal to be able to give a precise pass to his fellow attackers who are outside of him. By shifting his initial alignment outside his defender and running outwards then inwards he forces his immediate defender to change direction twice, first outwards, then inwards to cover his movement inwards. It also makes the inside defenders coming from the preceding facet have to make two alterations to their defensive running lines.

Firstly, they can immediately move across as the first receiver takes the ball on a drift; secondly, they are faced with the next decision as the first receiver immediately steps inside thus opening up the option of an attack in channel 1. They thus have to slow down to ensure that any possible play in that channel is checked before again being able to move across the field to the outside once the first receiver passes the ball outwards. Although the players may not always react in this way, it seems to be a possible way of manipulating the immediate defender as well as the sliding inside defenders as long as possible so to be able to maintain the attacking space on the outside. What is also achieved is that if the opposition team are using the one-out defensive system, which implies that the openside flanker must take the first receiver, then, if the attacking first receiver can by means of his initial run at that specific point commit his immediate defender, i.e., the first receiver as well as the sliding defender from the inside, then the attacking team will have an extra attacker out wide who will be able to play havoc in the outfield when he is able to be unleashed (Evert, 2001a).

Secondly, a 15 vs 7 attack develops i.e., by running at the defender you force him to wait for the attack, as a defensive decision has to be made. This allows the attackers to get in ahead of their own forwards and the supporting running lines that the forwards run to the next phase of play is forward and not backwards as for the defending forwards (MaCintosh, 1997; MaCintosh, 2000).

If the strike is to take place behind his back, i.e., with an “X”, then the ball carrier should lure his immediate defender to follow him across the field so that the attempted strike can take place in optimal conditions. This can be achieved by the attacker suddenly accelerating forward at the last moment towards his immediate defender’s inside shoulder so to lure the defender into believing that he may be going for that gap. If the defender follows the ball carrier the space will open up (Evert, 2001a).

This aspect is vital as the timing of the pass to the “striker” largely determines whether the line will be broken or not. What is important to note is that even though the hole has been created through which should be played, if the timing of the pass is poor, the “striker” will be stopped by a defender who has been able to adjust his defensive line. The receiver should be receiving the ball at pace, running in a straight line and receive the ball at the right moment (Marks, 1994; Bayly, 2001; Greenwood, 2004; Serfontein, 2005).

The timing of the decoy runners is also an important part in determining the success of the attack. A very important aspect of timing has to do with kinaesthetic awareness. Kinaesthetic awareness refers to the “feel” associated with the body and its movements as well as the summing up of a situation which is achieved through visual acuity. It involves sensory input from muscles, joints and the inner ear, and includes our sense of the tension or relaxation in the muscles, joint actions, movement patterns and balance (DigiCricket, 2000), which are all important aspects of timing a strike (Evert, 2001a).

Proprioceptors in the muscles and tendons play a key role in providing the brain with sensory data on pressures, position and stretching within the body. Data passing to the brain from the kinaesthetic receptors is analysed and responded to largely at the subconscious level unless it is attended to consciously in order to enhance a player’s ability to perform, react and act on impulse and on “autopilot”. As a player’s kinaesthetic awareness develops so does his ability to “feel” where his body parts are in relation to each other and respond faster and more accurately in pre-contact situations. The key to optimal performance is how the brain interprets these sensory inputs and how they affect the decision-making on the field concerned with the strike taking place. This implies that although every effort is made to create an optimal striking situation, there exists a certain "feel" which is instrumental from rugby players in order to achieve success in rugby (DigiCricket, 2000).

5.13 THE ATTACKING BACKLINE'S STRIKE ON THE DEFENSIVE LINE

This is the most important aspect of a successful line break. Before the intricacies and final detail is discussed, the effect of forces and momentum will be explained in order to understand why strikes should be possible under conducive conditions. The first important aspect regarding the strike is that of the force exerted when it is executed. Force gives a quantitative description of the interaction between two bodies or between a body and its environment; therefore during contact situations there is a certain amount of force involved (Young, 1992).

The force of the striker takes place when he hits the tackle line in the attempt to break through the tackle. The key question is how a ball carrier and decoy runner can create a situation where the striker's force is sufficient in that the defensive wall is able to be broken. As the striker moves he has acceleration and it is important to understand the relation of the acceleration to the force and thus an understanding of Newton's 2nd law of motion is needed. It can be stated that the magnitude of the striker's acceleration is proportional to that of the force, and the direction of the acceleration is the same as that of the force, regardless of the direction of the velocity (Cajori, 1934; Young, 1992).

Therefore, when a force involves direct contact between two bodies such as in a striking area, it is equivalent to a contact force. Force is a vector quantity, thus to describe it we need to know the direction in which it acts, as well as its magnitude (Hamill & Knutzen, 1995). The direction of the force applies to:

a) the angle at which the striker comes into the strike at the attempted line break; and
b) the angle with which the defenders enter the contact area i.e., in which direction the defender's shoulders are facing (Evert, 2001a).

The magnitude of the force is determined by:

a) the acceleration of the striker before the ball is received;
b) the acceleration of the striker after the ball is received;
c) the velocity with which the striker enters the striking area together with the ability of the striker to change direction optimally if required;
d) the effect of the decoy ploy to manipulate the defenders, such that their centre of mass is not optimal when attempting to make the tackle; and
e) the mass of the striker (Evert, 2001a).

It is for this reason that running lines and changes in velocity are important in order to give the striker the momentum advantage at the contact area. The result of a collision between two bodies depends on their momentum, which can be described as the product of a body's mass and velocity. When two bodies collide and make contact, their resulting combined motion is in the direction of the body with the larger initial magnitude of momentum. Momentum is determined by speed **x** mass (Young, 1992; Hamill & Knutzen, 1995).

Unfortunately it is highly unlikely that a player's mass can be increased substantially in the course of a rugby season so to give him increased momentum in striking situations. What can however be achieved is that the player's speed or acceleration into a striking situation can be adapted to create a mechanical or momentum advantage for the striker. This can be achieved by manipulating a defender so that they are mechanically weak and cannot re-align to be able to be in a position to make the tackle, i.e., the defender is manipulated into moving in the wrong direction and can't reverse his momentum. If there is a marked increase in acceleration into a strike, if this has been achieved, then the strike is likely to be successful. Secondly, if a situation can be created where the defender is momentarily forced to stand still when the tackle is to be executed then the striker will have superior momentum as he is moving and attacking spaces, while the defender is stationary and trying to stop the attacking player.

Thirdly, if the defenders are drawn away from the strike zone so that there is a hole through which the striker can move. This can only be achieved if the defenders are overloaded with defensive options

In conclusion, the key to a successful line break is the culmination of all the preceding factors and it is the responsibility of the striker to "finish off" all the hard work that has been done by his fellow attacking players. This "finishing off" is achieved by creating a situation where the striker comes out of a position which is difficult to evaluate and defend against by the defenders.

The concept that will make this possible is called a "one-out" striker. What this implies that the striker will not be the first person out to receive the ball from the distributor. This could mean that he could either coming into the line from:

1. outside the decoy runners; or
2. out of a stream, i.e., the player strikes suddenly coming in on a "blind spot" for the defenders.

All these factors are achieved by the optimal use of advantageous running lines. The strike can be executed using the following types of "running lines":

1. an "angle" running line;
2. an "arc" running line;
3. a "L" running line; and
4. a "stream" running line (Evert, 2001a).

Although these running lines could result in a line break, they often work better as a combination. A backline with superior speed has an enormous advantage over its opponents. It can more easily outflank them, outrun them, out-chase them and out-support them. The faster players can also make changes in pace and in direction and are therefore more equipped for making individual breaks (Hedger, 2002).

In this section the emphasis will be on those aspects of speed, which have a direct influence on the attacking team's ability to break the defence's wall.

5.14 THE STRIKER'S SPEED VERSUS QUICKNESS

Speed is the measure of how fast an athlete can sprint short distances. A high maximum speed by itself doesn't guarantee athletic success as coaches and athletes are aware that an athlete may be able to run fast however he may lack the explosive power to accelerate rapidly, change direction rapidly, or get the entire body or a body part moving rapidly (Zatsiorski, 1995; Dintiman *et al*., 1998; Hedger, 2002).

Quickness refers to the ability of an athlete to perform specific movements in the shortest possible time. It also involves the ability of the nervous system to process and produce rapid contractions and relaxations of the muscle fibres. Fast, explosive movements of the entire body, which occur in the starting and acceleration phases of sprinting, or in the adjusting of a body part to start a new movement or rapidly change direction demonstrates an athletes quickness. The object of this section is to discuss specific aspects of quickness, which is applicable to the backlines ability to make a strike on the defence. Firstly the ball carrier's ability to accelerate when receiving the ball combined with his ability to change direction just before off-loading the possession needs to be discussed. This soundness of speed, body positioning and control will aid ball carriers in attacking situations to be in a physical position that is mechanically stable, and able to distribute or transfer the ball to a receiver who is also in this optimal state or condition (Dintiman *et al.*, 1998; Evert, 2001a).

5.15 SPEED CONCEPTS SPECIFIC TO RUGBY

There are three broad aspects of speed:

- c1. running speed;
- c2. passing speed; and
- c3. thought speed (Marks, 1998; Hedger, 2002).

5.16 THE STRIKER'S RUNNING SPEED

There has long been the notion that backs should receive the ball at top speed. This may be appropriate if the receiver is taking advantage of a gap, however if the aim is to create a gap it is difficult if the ball carrier is at full speed. The key is to have two speeds available with which to manipulate the defence. The following advantages exist:

- If a player has a deceptive turn of speed it can nullify the defender's ability to stop the attack, as the defender is unable to cope with the reserve acceleration the ball carrier has to beat him. If the ball carrier runs at full pace his only strength lies in the momentum he has from that run.
- By slackening off in speed, strength returns to the legs and then accelerating into a tackle is far more likely to break an arm grip than what would be possible if he was approaching with a constant speed. If the ball carrier can swerve while accelerating just before the tackle line, it makes him extremely difficult to stop (Jenkins *et al*., 1998, Hedger, 2002).

A player's control of his running speed will aid his attacking ability in the following way:

- accurate passing and kicking is easier to achieve if you are running comfortably;
- when running at three-quarter pace, you have more of the balance and timing required to execute the appropriate line of run and deviation in course necessary for the nominated attack;
- if there is a difference in the pace of running between the ball carrier and supporters, there is always the option of blocking, or sending away the outside support on a burst. This is not possible if both backs are running at full speed; and
- by running fast towards the defence, tacklers are committed; however it also reduces the amount of space available. There are times when a slower approach is more likely to tempt one of the opposition tacklers to lose his alignment and leave a gap (Craven, 1966; Marks, 1998).

In summary, it is better for conservative running to the area where the break is attempted. Top speed is turned on in the following circumstances which all relate to the final strike at the defence:

- when you are attempting a break;
- when you have made a break;
- when you are supporting a break; and
- when you are about to make contact so that you can gain an extra metre at the contact area (Evert, 2001a).

5.17 THE ATTACKING BACKLINE'S PASSING SPEED

Passing is the greatest asset a team can have. In respect of attacking play it is more effective to move the ball quickly through the hands than it is to move it quickly through the air by using cut out or skip passes as this does not "fix" any defenders and it makes it easier for the defenders to drift outwards while still covering the attack (Honan, 1992).

According to Magill (1993:7), a skill can be defined, as "an action or a task that has a goal and that requires voluntary body and / or limb movement to achieve the goal." For this reason the execution of a well timed and sympathetic pass is vital in the success of any attacking back play. A sympathetic pass can be described as a pass that is appropriate to the situation. This implies that if a fast transfer of the ball is required, then it should be executed. If however, a slower looped pass is required then it should be passed in that fashion so that advantage can be taken of the attacking situation. When talking of passing speed, it is advantageous to be able to transfer the ball as quickly as possible, however in strategic phases the players are trying to deliver the ball into an unguarded hole just as one of their own strikers arrives out of "nowhere" to receive it. This requires a mix of speeds of running, handling and a balance, which is difficult to execute (Johnson, 1993; Marks, 1998; Smith, 2001).

5.18 THE ATTACKING BACKLINE'S THOUGHT SPEED

Visual awareness is the ability to see everything in the visual field (Greenwood, 1993). A flyhalf who sees all the defensive players as they are positioned and transfers the ball to a striker who receives the ball on the contact line and in the gap is a technique called open focus. This technique is similar to a camera that is able to take a clear picture; the player is then able to process all incoming information and automatically sorts out what he needs at any moment during the game. This technique can be developed by means of skill training with the incorporation of techniques that increase the area of visual recognition, and, be able to manage other sensory input with improving ability. Much of backline play is based on decision-making, particularly in the backs where there is a lot of traffic and a lot of options available that can be taken. Almost every time a player receives the ball there is a decision to be made in relation to the action he takes as well as to the subsequent support line he should follow (Marks, 1998). In conclusion, the following guidelines can be given concerning decisions that players may face during play: (Greenwood, 1993; Levy & Ponissi, 1993; Ross, 2001; Greenwood, 2004).

- If a gap opens up, accelerate and go for it.
- If it is to be a straight transfer of the ball, pull the ball across your body quickly towards its target (Honan, 1992; Harrow, 2002).
- If you are to kick, balance and position yourself quickly.
- If there is to be a change in pace, make it dramatic.
- If you are going to take the ball up, set your body position correctly and build up momentum early (Evert, 2001a).

A team can live with decision-making mistakes provided that they are made positively and with urgency. Self-assurance, confidence and assertiveness are the primary requirements of backline option taking – wisdom can come later.

5.19 THE ATTACKING BACKLINE'S STRIKE AREA

If the tackle is made, then a collision area develops. At the collision area the following should be attempted to be achieved:

- the angle of run and velocity of the ball carrier combined with the angle of run and velocity of the striker should be that the attacking players are at mechanical advantage and have a high kinetic energy while the defenders should be at a momentum disadvantage (Evert, 2001a).

This can be achieved by manipulating the defenders that they:

- are forced into entering the collision area in a stationary body position; and
- their body positioning / centre of mass is such that they are unable to re-check in order to get into position to make the tackle on a striker coming in on an attempted line break (Evert, 2001a).

In collision situations that result from a strike, the following situations can possibly arise. They are primarily determined by the angle at which the striker and defender meet in contact, which can be as follows:

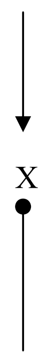


Figure 5.22: A front on tackle situation

This type of collision arises due to the striker coming in on a strike from the same channel in which the defender is. It is very difficult to give an offload in this tackle situation and it will usually result in a ruck. Often a tackle in this type of scenario comes in the form of a double hit tackle from the opposition. This holds the danger of the striker losing the ball in the tackle or the possibility that the attacking team's striker is tackled backwards which could result in serious negative implications for the supporting players of the striker.

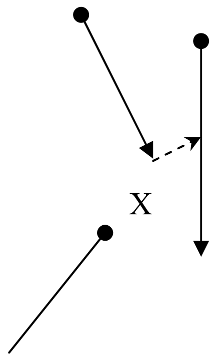


Figure 5.23: From the side tackle situation

There are two reasons why a side on contact situation is preferable:

1. the possibility of a line break is increased as the side on tackle can be stopped or be made more difficult due to:

   1.1 the striker being able to hand off the tackler due to the free arm being available; and

   1.2 the striker has the advantage that his hard body parts, i.e., elbows, hips and knees are the first body parts that make contact with the tackler making the tackler's "tackle strike area" smaller and less comfortable.

   the striker is in a better position to be able to give an off-load to a trailer coming in from behind.

   This will only be possible if the striker can hand-off the tackler and safely keep the ball secure until the off-load option presents itself and then the pass can be given or be able to keep his arms free while he is being tackled thus making an offload possible.

5.20 THE ATTACKING BACKLINE'S TRAILING SUPPORT RUNNERS

If the attack is efficiently planned the players who performed the role of decoy runners will be able to fulfil this secondary role of being a supporter or trailer. These player's objective is to receive an off-load in the tackle, or, if the ball carrier goes to ground, to make the clean at that specific facet. Another effective option as a supporter is to make use of the second player outside the decoy runner. This creates a situation where he comes in on an inside run and is best able to support, receive an off-load or clean (Evert, 2001a).

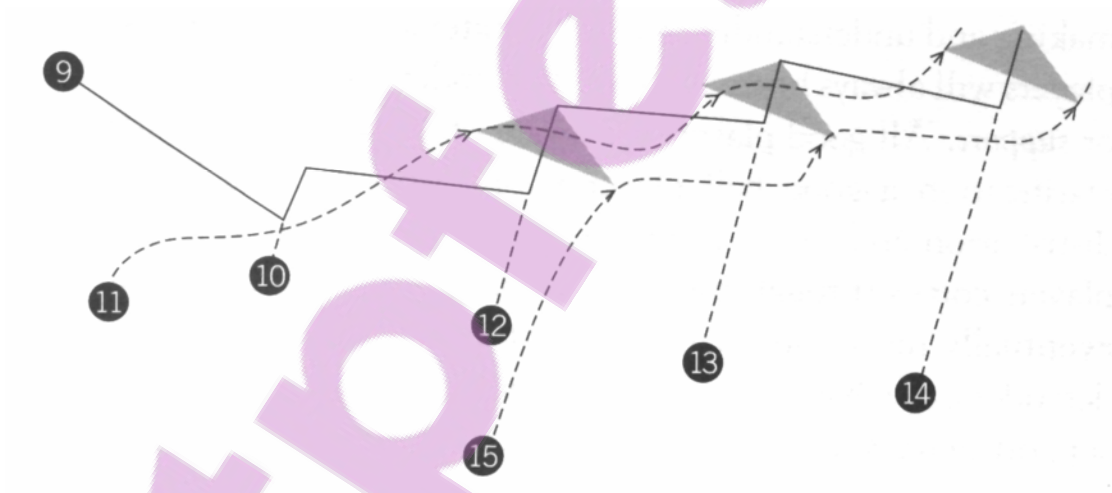
It is important to note that for an attack to be successful, the process must be completed through efficient and sufficient support play from the trailers. A trailer can be described as the players that are the 2nd line of support behind the ball carrier. These players are normally the blindside wing, fullback or 2nd phase forwards. Effective support is based on an awareness that the player should be as committed to work off the ball as to any work that can be done with the ball (Marks, 1998; Tranent, 2003). The emphasis for the trailer is that he is able to run to an unguarded spot and receive the ball before a defender can cover it. The term "ten man rugby" in backline attack means that there is a secondary use of players in attack, however to organise this properly the team really requires the support in a two wave situation involving starting and finishing trailers, the primary strikers going through the line and secondary supporters beating the cover defence. This implies that all players should have the awareness of mind to search for any opportunity to run a trailing line. In attacking play there needs to be emphasis on two specific areas of support or trailer running lines:

1. pre-possession; and
2. post-possession (Johnson, 1993; Robilliard, 1997; Shaw, 1998; Hickey, 1998; Marks, 1998; Evert, 2001a).

If this is optimally achieved it implies that there are two wave trailing situations involving starting and finishing trailers. Therefore the primary attackers attack through the line in search of a line break, and the secondary supporters work through to support the strike and to be in a position to be able to beat the cover defence.

5.21 THE ATTACKING BACKLINE'S FIRST WAVE OF SUPPORT RUNNERS

The first important factor is to realise that this support takes place off a ball carrier giving offload options to an extra player on the inside or on the outside. It can be easily organised from structured play however it does run the risk that because the blindside wing and fullback are directly involved, a player from the forwards needs to be dropped back to cover for the involved fullback. The next step would be the use of "step running" (up and across) around the two centres and the openside wing by the blindside wing and fullback (Marks, 1998).



(Adapted from: Marks, 1998)

Figure 5.24: Inside and outside first wave supporting running lines

By making use of this supporting system, the blindside wing and fullback are more than support players, they are trailers. Even without them the ball carrier in the middle of the line has a player inside and a player outside but it's the option that puts doubt into the defensive lines made (Marks, 1998; Royall, 2000).

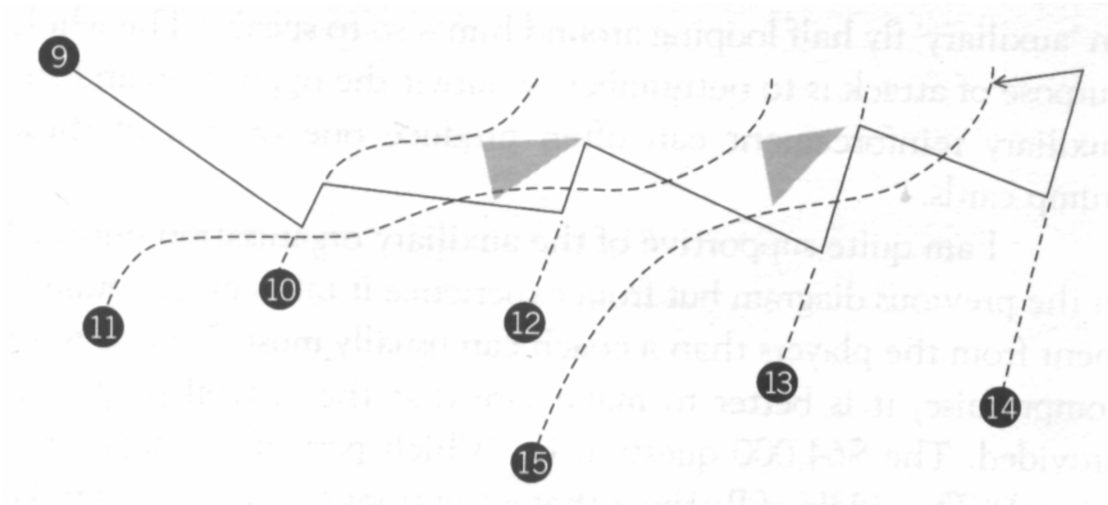
For definitional purposes support players are regarded as auxiliary supporters reinforcing the regular supporters, i.e., an inside centre can pass to his outside centre or to an “auxiliary” flyhalf looping around him. The use of these auxiliary supporters can possibly help to outnumber or outwit the opposition thus making the attack more successful. The key to supporting lines is that they need not be stereotyped which implies that players should understand the concept and be able to adapt to situations and thus ensure that there is always inside and outside supporters. Another key aspect of this form of support is that these players often fulfil the role of primary cleaners if a breakdown occurs. This responsibility cannot be overemphasised and needs to be ingrained in the supporting runner’s minds as an integral part of their job. If a breakdown occurs and the opposition turnover the possession, all the hard work done in previous phases will be undone and the attacking possibilities will immediately become opportunities to defend (Robilliard, 1992; Marks, 1998; McFarland, 2002).

5.22 THE ATTACKING BACKLINE’S SECOND WAVE OF SUPPORT RUNNERS

This phase of backing up is often neglected even though the possible returns for players who place it as an important part of their play is extremely high. It is for this reason that it is those players who support the breaks that score the tries, however most often a try goes begging because the ball carrier has no one to whom he can pass (Marks, 1998; Honan, 1999a; Evert, 2001a).

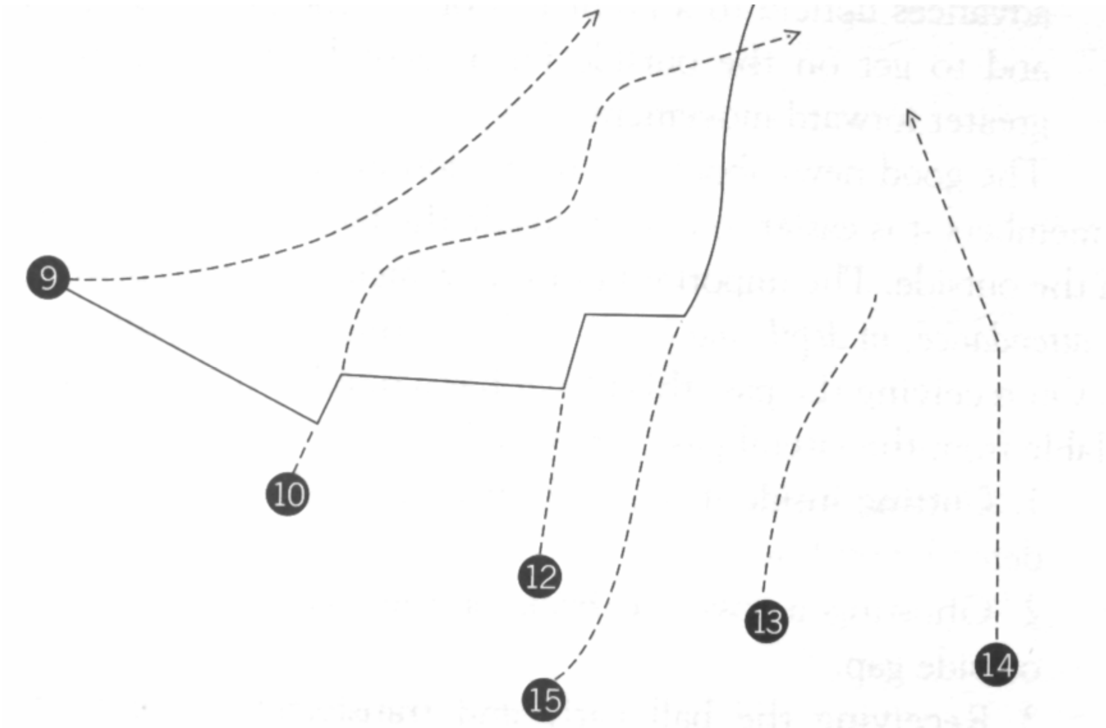
If one looks at any attacking play, there is no reason why the scrumhalf or flank can’t be on the inside shoulder as a supporter, the flyhalf in behind and the openside wing up on the outside as supporter. The player in behind would eventually slip into the lateral line on the side that showed the most potential. If a situation arises where there is only one supporter, then his initial run should be aimed at positioning himself behind the ball carrier because this keeps the options on either side open until an opportunity presents itself. It must be noted that it is not feasible for the players on either side of the line breaker to support as surprising extra players as they are needed as decoys to involve key defenders. All the other players involved in the primary line of attack are able to be involved and should continue to move forward even after they have passed the ball (Bird, 1998; Marks, 1998; Honan, 1999).

They might have to move across to find the ball carrier, but their first movement should always be forward. It must be noted that the success of supporting running lines is dependant on a supporting player wanting to involve or reinvolve himself in play some two or three positions away. Often players either pull back during or after a pass or they run across the field behind the backline as they chase the ball. It's because they start doing the secondary thing before completing the primary action that they don't find themselves in a position to receive the try-scoring pass. The only way for this vital link of secondary supporter to operate is to pass while moving forward and to keep moving forward before shifting the line across. Another important aspect to understand is that supporting the receiver is only really possible if that person takes the ball past the passer. From a fairly flat pass that means the receiver only has to carry the ball two or possibly three steps up-field before any transfer to the previous passer can take place. If there is sufficient working space available, this is an option, however if not it may be better to leave it to the trailers coming from behind and to concentrate on either assisting a break or on realigning in support further on in the attack (Marks, 1998).



(Adapted from: Marks, 1998)

Figure 5.25: Concentration on inside supporting running lines



(Adapted from: Marks, 1998)

Figure 5.26: Second wave supporting running lines after a line break

5.23 THE STRIKER'S ANGLE OF RUN AFTER A SUCCESFUL STRIKE HAS BEEN MADE

When a strike is made, there must be a sudden and immediate change in direction away from the inside defenders. This change of direction can be better explained by understanding that the striker always wants to play in behind the person who was originally entrusted to defend him. Because no cover lines are run intentionally, there will be a big space behind the beaten player where-after the successful striker is able to link up with the decoy runner who was moving away from the strike zone but who is able to reappear to support the striker on the outside (Evert, 2001a). It also results in the players coming across having to work harder to reach the successful striker. The common error players make is that they tend to run back towards the defenders thus making the defender's job easier. By running away however, the players coming across will only be able to make a side on tackle, thus off-load options are easier to execute.

5.24 THE ATTACKING TEAM'S CLEANING UNITS

If an attack is stopped and a ruck or maul results, then the players in lateral support need to be committed to clean at the resultant ruck or maul. This is an important aspect of play as if this possession is not quickly and efficiently recycled, the advantages of quick recycled ball and disorganised defensive lines cannot be taken advantage of (Hickey, 1998).

5.25 THE ATTACKING TEAM'S COMMUNICATION

When looking at the principles of attack, this aspect, which surely rates as one of the most important, seems to be the most neglected. The information, which needs to be communicated, is firstly, where the opposition's weak area in defence is, and therefore, where the backline would like to attack and penetrate (Evert, 2001a)?

Secondly, where the receiver is positioned and who will be the striker at the pre-determined defensively weak area (Evert, 2001a)?

Thirdly, who are the first wave supporters? (i.e., the support players on the inside as well as the outside) The key aspect regarding the first wave supporters is that if there is a breakdown in the "striking area" they automatically become the nominated cleaners at that contact point where-after the second wave supporters will follow and come into play (Evert, 2001a).

Fourthly, who are the second wave of supporters who keep the momentum and who will take advantage of the line break (Evert, 2001a)?

There also needs to be distinguished between "man on" and "plus one" situations:

1. "Man on" situations occur when the defence and attack have equal numbers. This is the situation where an attacking team will nominate the identified weak area in defence and apply full striking action in that area. The blindside wing and fullback are vital in communicating this information to the flyhalf and inside centre so that better decision making by them is possible.

2. “Plus one” situations occur when there are more attackers than what there are defenders. In this situation it is not desirable to strike but to rather fix the defenders and to transfer the ball to where the space is on the outside and thus break the line by beating the opposition with speed on the outside (Evert, 2001a).

Communication must take place from the outside in, i.e., fullback and wing to outside centre, to inside centre and finally to the flyhalf. Due to the nature of the game and the intense mental and physical pressure on the players, it is important that these communication skills are ingrained in the players development so that when they find themselves under pressure in match situations, they are still able to maintain their communication channels and thus be able to take full advantage of possible opportunities that may arise during the game (Bracewell, 2001; Evert, 2001a).

5.26 THE ATTACKING TEAM’S DECISION-MAKING

The dictionary defines decisions as “resolutions reached after consideration” (Greenwood, 1993). Consideration of a multitude of factors in an open-skilled game makes this a hugely difficult part of the game to develop. Coaches spend hours improving their player’s physical condition and skills. All this will be to no avail if those players do not understand the game and lack the vision to make the correct decisions in ever changing situations (Askew, 2001; Weinberg & Gould 2003; Greenwood, 2004).

Top–level rugby players are, more or less, as fit and skilful as the other; what is likely to separate them is their ability to focus their attention at precisely the right moment and on the most relevant stimuli to allow them to make the correct decisions for themselves and the team (Hodge, 1994; Bracewell, 2001; Weinberg & Gould 2003; Greenwood, 2004).

In the professional game the biggest progress has been in defence; opportunities therefore are fewer and decision-making becomes increasingly more crucial.

A player must consider his own skills, physique, pace as well as other factors in his own decision-making process. Other factors emerge at the same time i.e.,

1. the strengths and weakness of the immediate opponent;
2. the strengths and weaknesses of the opposition as a whole;
3. the conditions at that specific moment; and
4. the strengths of his own team and the immediate support available to him (Evert, 2001a).

The player then has to weigh up the effects of his decision and how it interfaces with his team-mates. The decision making process is taken further when the player is faced with the following multitude of options i.e.,

1. the decision of whether to pass and how to do it, (before or in of contact?);
2. should the contact be evaded or taken (should he stay on his feet or go to ground?); and
3. is a kick an option (if so, what type?) (Marks, 1998).

When so many variations and different decisions are potentially available, this area of skill must have a great deal of time devoted to it. In the first weekend of the Six Nations in 2001 there were a total of 19 tries scored, 17 of which came directly from turnover ball. Does this mean that on 17 occasions the wrong decision was made or did the errors occur in execution?

It probably was both, however, had several players used brain rather than brawn, the total number of turnovers might well have been significantly decreased (Askew, 2001). The art of decision-making ultimately lies in the hands of the quality of communication that takes place within a team. Thinking and decision-making is a split-second process, which usually takes place before the player gets the ball, and communication is a vital part of the process (Bracewell, 2001).

Communication comes from the eyes, ears, voice and body language. The supporting players should consciously hold depth, which allows him to have a wider vision of the action in front of him. With what his eyes tell him he can then use his voice to inform the ball carrier what he wants from him if the defence is in place (Hodge & McKenzie, 1999). The ball carrier then communicates by listening and this co-operation is crucial in decision-making, which leads to ball retention and more successful rugby. The wider vision of actions in the game is improved with depth and width of support, which will eventually assist the process of better decisions being able to be made (Askew, 2001).

Educating players and developing their rugby intellect are crucial if they are to make better decisions. Coaches should strive to get intelligent players in all positions, as all players on the pitch are decision-makers. All these players, wherever they play, have to make swift judgements then act on them with decisions, it is through these decisions that a team functions or fails (Neethling & Botha 1999).

The higher the level of the game the more subtle the process, so the intelligence factor becomes hugely important. For some players this ability may be innate making them crucial as they can make a team click. The majority however, require education and development through practice. This will allow them to recognise cues and select the best option for their team. To achieve improvement, coaches must ensure that the players work constantly against opposition to replicate the changes in time and space they will face in matches (Askew, 2001).

When play is analysed in general, the following characteristics will come to the fore. Each attack is based on a planned move, which aims to disorganise the opposition's defensive lines. Invariably each set-up move will have various options or variations. The attacking team will have a reasonable idea of where the weaknesses are in the opposition's defence and will aim to take advantage of this. The situation may however arise that that which may have been perceived as a weak area is no longer one, and that is where optimal decision-making in this part of play becomes important. Optimal communication in such a situation will allow the attacking team to adapt and concentrate on other attacking zones.

At this stage decision-making is reasonably simple as the players are organised and there are no disruptions in the make up of the attacking team's backline or in the defending team's defensive lines. Once a contact situation has occurred there becomes a marked disruption in the make up of the attacking team's backline as well as in the defending team's defensive lines. This situation presents opportunities for backline players to run at and strike on forward defenders, as well as for attacking forwards running at backline defenders. The opportunities for line breaks and yardage are better here and possible opportunities are presented (Evert, 2001a).

Many teams network their play in such a way that players are "programmed" into knowing where play will be "taken" to up to three, four or possibly five phases where they have nominated cleaners and strikers at each phase. The importance of decision-making becomes evident when there comes a breakdown in the networking or where fifth phase has been reached and the team still finds themselves in possession.

This is where communication structures need to be in place so that advantage can be taken of the opportunities that were created from the networked play and from that point the attacking team should maintain their discipline and persistence in order to attack the opposition's weaknesses until a line break occurs or there are extra players on the outside that can be used to finish off the attack by scoring a try (Evert, 2001a).

5.27 THE ATTACKING TEAM'S USE OF FORWARDS AS BALL CARRIERS

As previously mentioned a successful attack is often based on the premise of mismatches. There are various situations where mismatches, in specific forward runners running at backs, can be creatively created. This would be for the reason of gaining greater forward momentum on attack. These forward ball carries do not necessarily need to be against backline players only in order for them to be of value. Often slow ball needs to be taken up by forwards in order to try and "turn" it into quick ball and often teams that play structured patterns have dedicated 2nd phase target runners who try and get to run at the flyhalf on a wide arc in order to get over the advantage line (Meyer, 2005; Du Toit, 2006; Human, 2006; Mitchell, 2006; Van Graan, 2006).

The following forward ball carrying collisions can be identified:

1. Pick and drive forward carries near the fringes of a ruck;
2. "one off runners" one pass off the ruck;
3. forwards running off shortened lineouts or any open phase play situations (similar characteristics to backline attacking play) (Meyer, 2005; Du Toit, 2006; Human, 2006; Mitchell, 2006; Van Graan, 2006).

5.27.1 Pick and drive forward ball carries near the fringes of the ruck

All play is started either from a restart, lineout, scrum, penalty or free kick. It is however between these facets of play that ball carrying collisions take place. Very often during open play, forwards are required to re-enter general play and often carry the ball in order to maintain the continuity that is trying to be created by the team. If however the ball is slowed significantly to such an extent that it is stationery, a method of regenerating the momentum is required. In order to achieve this, is to make use of forwards to pick and drive the ball into the opposition players that are defending around the fringes of the ruck. If this is done and the ball is recycled quicker than what the defenders can fold into the openside, extra attacking numbers can be achieved thus the momentum can be regenerated (Meyer, 2005; Du Toit, 2006; Human, 2006; Mitchell, 2006; Van Graan, 2006).

5.27.2 "One off runner" one pass off the ruck

Very often teams that make use of target runners off scrums and lineouts will make use of a forward to carry the ball a further phase after the 1st phase ruck ball has been recycled. This pass is most often made by the scrumhalf who attempts to give a flat pass on the advantage line to a forward runner who attempts to run at the opposition flyhalf in order to force him to make the difficult tackle. This is a very effective way of getting a team's best ball carriers to take the ball up on their natural running path and to hit either the space with great momentum or to manipulate the flyhalf to make tackles (Meyer, 2005; Du Toit, 2006; Human, 2006; Mitchell, 2006; Van Graan, 2006).

5.27.3 Forwards running off shortened lineouts or any open phase play situations

Because most forwards are bigger and heavier than the more agile backline players and teams often make use of target runners, forwards can be used to run off backline players into spaces that have been created. This is done in order to gain that much sought after momentum. Another factor is the fact that forwards being bigger and more powerful are able to off-load the ball to supporting players more effectively thus resulting in the play being more effective in moving down the length of the field. Most teams identify key ball carriers to run off the distributing playmaker in the backline thus resulting in the specific players playing to their respective strengths and thus helping the team to achieve their attacking play goals (Meyer, 2005; Du Toit, 2006; Human, 2006; Mitchell, 2006; Van Graan, 2006).

5.28 CONCLUSION

As is evident from the various discussions above, ball carries can be executed by both forwards and backs however as is evident, forward players ball carries tend to be more one dimensional in that it takes place with very little space between the attacking team and defending team and opportunities for the use of decoy runners and complex running lines are limited. It is however important to realise that neither backline or forward ball carrying collisions can take place in isolation, and neither can be deemed as more important than the other. Thus the integration and successful execution of the ball carries will ultimately determine the success of the attacking play.

CHAPTER 6

6.1 INTRODUCTION TO BIOMECHANICAL ASPECTS

> *"How do you steal the ball away from opponents who are dead set on making sure you don't? One is speed with which you do it...The other... is the art... of changing the angle of attack on the player's grip of the ball...The same methods apply when you have the ball. Some guys are far superior to me in strength, so I try to keep changing the balls position or angle so they can't get a good grip on it... It's all about getting the right angle of purchase. You need to know a bit about how levers and fulcrums work, a bit about torque."*
>
> (Kronfeld & Turner, 1999)

When William Webb Ellis first picked up the ball and ran with it in 1823, he probably didn't think too much about the physics behind the movements he was making at the time. However, all the movements involved in rugby rely heavily on the laws of physics, and by understanding them you can learn how to perform them more effectively (McKenzie *et al*., 2000).

Almost every aspect that takes place in rugby from how fast a wing runs down a field to score a try to how far a flyhalf can kick a ball downfield is bound by the laws of physics. In this study the author will look in detail at the isolated aspect of ball carrying collisions and identify this bond in order to maximise a team's ability to dominate the aspect of collisions in a rugby context.

6.2 KINEMATICS

Kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations (Kreighbaum & Barthels, 1996). The goal of any study of kinematics is to develop sophisticated mental models which serve to describe (and ultimately, explain) the motion of real-world objects (Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; Bartlett, 1999).

6.3 SCALARS AND VECTORS

Physics is a mathematical science – that is, the underlying concepts and principles have a mathematical basis. The motion of objects can be described by words – words such as distance, displacement, speed, velocity, and acceleration (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; Elliot, 1999***).***

These mathematical quantities which are used to describe the motion of objects can be divided into two categories. The quantity is either a vector or a scalar. These two categories can be distinguished from one another by their distinct definitions:

1. Scalars are quantities which are fully described by a magnitude alone.
2. Vectors are quantities which are fully described by both a magnitude and a direction (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996).

Anytime a player is moving up the field, whether carrying the ball or not, factors such as the magnitude and direction of the moving player come into play. For this reason the measurement of player's actions is possible by means of applying scientific laws of movement.

6.4 DISTANCE AND DISPLACEMENT

Distance and displacement are two quantities which may seem to mean the same thing, yet they have distinctly different meanings and definitions.

1. Distance is a scalar quantity which refers to "how much ground an object has covered" during its motion.
2. Displacement is a vector quantity which refers to "how far out of place an object is"; it is the object's change in position (Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996).

For example, if a player in possession of a rugby ball runs 5m from position A to position B, the distance the player has moved would be 5m. During the course of the player's motion, the player "covered a distance of 5m of ground".

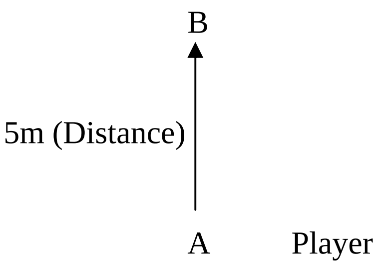


Figure 6.1: Diagram indicating the distance covered by a player moving from A to B

However, if the ball carrying player ran 5m forwards from position A to position B and was then tackled backwards by an oncoming defender and landed on the ground in the same position he started (position A). The player would thus not be "out of place" – i.e., there would be no displacement of his motion (displacement = 0m).

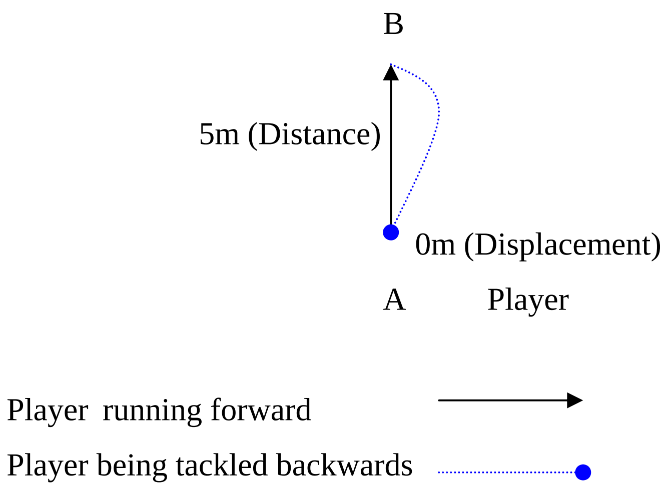


Figure 6.2: Diagram indicating a player moving forwards from position A towards position B, then being tackled backwards to the initial starting position

Thus displacement, being a vector, must give attention to direction. The 5m forward is cancelled by the 5m backwards after the tackle resulting in the 0m displacement.

6.5 NEWTON'S LAWS OF UNIFORM MOTION IN A RUGBY CONTEXT

Most everyday movements, including those in rugby, are based on three basic laws that are known as Newton's Laws of Uniform Motion (McKenzie *et al.*, 2000).

6.5.1 NEWTON'S FIRST LAW

> *"Any object that is either moving or stationary will tend to stay that way unless a force acts upon it."* (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Quarrie & Wilson, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

This law says simply that mass wants to continue doing what it is doing, whether it's at rest or in motion. While this law seems pretty straightforward, the First Law is actually counterintuitive. When considered, it becomes obvious our everyday experiences suggest that objects want to come to a stop. If one is driving along on a level street and the foot is taken off the accelerator and put the car in neutral, the driver will slowly coast to a halt. This everyday physics experiment seems to tell us that the natural state of matter is to be at rest. However, this naïve analysis fails to factor in the braking effects of frictional forces. The slowing and stopping of the moving objects can be attributed to a natural tendency on their part, but in fact the friction generated by the car's tyres making contact with the road causes this action. Newton however saw through the apparent reality to the underlying truth: Unless acted on by an external force, the natural state of matter is to continue on its initial, straight-line path indefinitely. The First Law also says that the more massive an object is, the more it wants to continue doing what its doing and the less likely it is to be deflected, slowed down, or sped up by an outside force. This law can also be applied to rugby by looking at a kick or pass (East, 1994). In the absence of air resistance and gravity, once the ball has left the players foot or hands it would tend to move in the same direction forever. But with air resistance and gravity, both of which are forces acting on the ball the ball will come to rest after a few seconds (Beer &

Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

6.5.2 NEWTON'S SECOND LAW

> *"The force applied to an object is equal to the acceleration of the objects involved multiplied by their mass."* (Beer & Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Quarrie & Wilson, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

This law can be explained in the following equation: **F = ma**, where **F** is force, **m** is mass and **a** is acceleration. One can also use this formula to appreciate just how much force is expended when one player hits another, and how much force exerted over a given time would have been needed to stop a huge bollocking forward hurtling toward a defender. The mass (m) of an object is basically the amount of matter – the number of atoms it has in it. Mass and weight are connected, but they are not the same thing. While mass is a measure of how much matter an object has, weight is a measure of how strongly this mass is attracted by gravity. This equation can be applied to a player starting off running from stationary and accelerating up to speed of 4 metres per second in about 1 second. For the purpose of this example the player weighs 100 kg. Based on this information it becomes evident that the acceleration (or change in velocity) is 4 metres per second, and the mass is 100 kg. If these values are placed into the equation it becomes possible to establish the force the player needs to generate with his or her legs in order to attain that kind of acceleration. In this case the player needs to apply +/- 40 kg of force in the direction he or she wants to run in order to attain the required acceleration (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Quarrie & Wilson, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

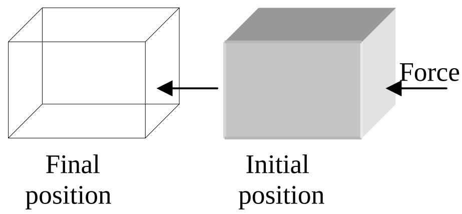
6.5.2.1 Acceleration, Speed, and Position: Kinematics

After mass (m), the next variable in the equation F = ma is acceleration (a). Acceleration should not be confused with speed. Speed indicates how rapidly an object is changing its position, while acceleration indicates how rapidly this speed is changing in time. In rugby, speed is used to measure the time a player needs to travel a certain distance: i.e., the player can run 40 yards in 4.7 seconds from a standing start. The player's average speed is thus 40 yards divided by 4.7 seconds, or 8.5 yards per second. (This is equivalent to 25.5 feet per second.) The reason that one talks about a player's "average" speed" is because over the course of a run he is likely to speed up or slow down. The next term related to speed is velocity. Velocity is a speed specified in connection with a direction. The units of both speed and velocity are meters per second or yards per second, abbreviated "m/s or yards/s". The units of acceleration are meters per second per second or yards per second per second (Gay, 2004).

6.5.2.2 Figuring out the force of a "Big Hit"

What is force? Simply put, according to Newton's Second Law, force is the thing that speeds mass up or slows it down – in other words, gives it an acceleration or deceleration. This is strictly true only for one-dimensional motion, see Figure 6.3. In two-dimensional motion, it is possible for forces to change an object's direction but not its speed. For example, when a ball carrier is given a sharp, impulsive blow from the side by a defensive tackle, the hit doesn't necessarily slow him down, but it will deflect his path. For example, the force that a ball carrier "hits" a defender is proportional to the ball carrier's mass times his acceleration: F = (1/32)ma. If two players face each other with similar weight 245 pounds (lbm). The ball carrier hits a gap opened up by the attacking backline and he is running hard, so the ball carrier's initial speed is about 10 yards per second, or 30 feet per second. The defender enters the collision area, and "hits" the ball carrier and the play comes to a screeching halt. The ball carrier's final speed, immediately after the hit is thus zero. The duration of the hit, from the first contact of bodies to the point when the ball carrier's forward motion stops, is about two-tenths of a second. Dividing the speed change by the time interval over which it occurred gives the acceleration of the ball carrier – or, rather, the deceleration, as his forward motion is stopped cold: a = (0 ft/s – 30 ft/s)/0.2 = -

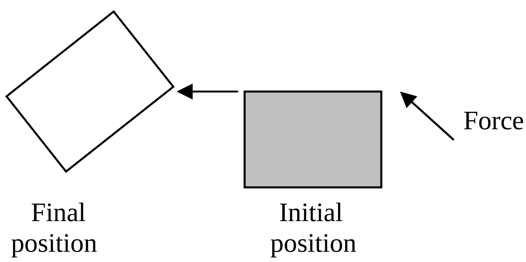
150 feet per second squared. (The minus sign indicates that *a* is actually a deceleration.) Following, the next step is to multiply by the ball carrier's mass (lbm) to find the force acting on him: (1/32) x (-150 ft/s²) x (245 lbm) = -1,150 pounds of force in a backward (negative) direction (Gay, 2004).



(Adapted from McKenzie *et al.*, 2000)

Figure 6.3: The effect of a force

Torque is similar to force with the exception that it tries to cause motion about an axis of rotation instead of motion in a straight line as in force, see Figure 6.4. One can think of rotation as the axle of a wheel, and a hand that spins the wheel around the axle as generating torque. While a force acts through the centre of mass of an object, a torque is created any time the line of action of a force doesn't pass through the centre of mass of an object (straight on collision where the ball carrier uses footwork/hit & spin, in order to "slide out" of the collision) (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Tripi, 2001; McCllymont & Cron, 2002; Unknown author, 2003).



(Adapted from McKenzie *et al.*, 2000)

Figure 6.4: The effect of a torque

6.5.2.3 A Force to be reckoned with

In order to create a perspective, it's important to consider how big a deceleration of -150 feet per second squared is by comparing it with the acceleration that an object of the same mass would experience falling out of a fifth-story window. In this case, the object is acted on by the force of gravity alone and accelerates under its influence. The interesting thing about the force of gravity is that it is proportional to an object's mass: $F_{gravity} = (1/32)$ mg. This is a direct result of Newton's Universal Law of Gravitation, developed to describe the motion of planets. If a 245-pound object were to fall out of a fifth-floor window, it would accelerate downward with a value of a = g 32 feet per second squared. This is true for any object with any mass – *all* falling bodies experience the same acceleration under the pull of a gravitational field (Gay, 2004).

In the collision between the ball carrier and the defender, the unfortunate ball carrier experience a force causing his body to have more than *five times* this acceleration – a force greater than 5 g's. Still, such collisions don't leave the defender unscathed. In the quick burst forward the ball carrier has built up quite a head of steam and exerts some force of his own onto the defender. The defenders speed, also about 10 yards per second, is reduced to zero at the point of contact. Here, though, the defender's initial speed will be assigned a minus sign because he is moving in a direction opposite that of the ball carrier of his initial velocity, his acceleration actually turns out to be a positive: a = (0ft/s – [-30ft/s])/0.2s = 150 feet per second squared. The defender has a mass of about 245 pounds (lbm), so the Second Law states that the force on him is 1,150 pounds (Lbf). It becomes evident that the collision in question is relatively symmetric, meaning that the ball carrier and defender have roughly the same initial magnitude of speed, albeit in different directions. They also have the same final speed: zero. The opposite signs on the forces correspond to the differences in their respective accelerations – minus 1,150 pounds of force for the ball carrier, plus 1,150 pounds for the defender – and so the magnitude of the force each one feels from the collision is the same (Gay, 2004).

6.5.3 NEWTON'S THIRD LAW

> *"For every action there is an equal and opposite reaction"* (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Quarrie & Wilson, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

Newton's Third Law says that whenever two objects collide, no matter what their individual masses, no matter how fast they're going, they always exert the same amount of force on each other, but in opposite directions. Mathematically, this can be written as $F_{12} = -F_{21}$, where F_{12} is read as "the force that the body 1 exerts on body 2." The minus sign means, again, that the forces have opposite directions (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; McNitt Gray *et al.*, 1993; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Zatsiorski, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; Kent, 2000; McKenzie *et al.*, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

6.5.3.1 Momentum and Impulse

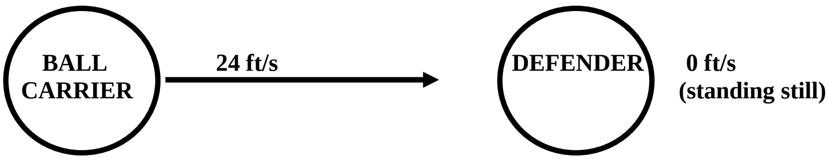
The word momentum is often used, and usually imprecisely. In physics, momentum is defined to be the mass times the velocity (or speed): p = mv. (Momentum is designated with the letter *p* to conform to tradition and to avoid confusing it with mass.) Momentum is what Newton called "the quantity of motion". In any collision on the rugby field, momentum is always conserved – a principle that is extremely useful in analysing collisions. In addition to momentum, one also needs to consider impulse, which is really just the change in an object's momentum. If one object strikes another, it is said to have delivered an impulse to that body that is equal to the change in the second body's momentum as a result of the collision. The impulse is equal to the product of the time over which the collision occurs multiplied by the average force exerted on the body. Therefore, since both objects (players) exert the same force on each other but in opposite directions ($F_{12} = -F_{21}$) during the collision, and they do so over the same interval, they must deliver equal but oppositely directed impulses to each other. This means that one player gains exactly the same momentum that the other loses, so the net change in the momentum of the two players is zero (Beer & Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; McNitt Gray *et al.*, 1993; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Zatsiorski, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Tripi, 2001; McCllymont & Cron, 2002; Unknown author, 2003; Gay, 2004).

This is referred to as the principle of Conservation of Momentum, and it is one of the most important rules in physics. Alternately it says that when any two objects interact with each other (and forces due to other external objects, such as a third player or friction from the ground, are negligible), the sum of their momenta will not change over the course of the interaction. In determining the change in momentum of an object, one must be careful to remember the directions of the motion involved. This is done by plus and minus signs (Beer & Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; McNitt Gray *et al.*, 1993; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Zatsiorski, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; Kent, 2000; McKenzie *et al*., 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

A practical example could look as follows, see Figure 6.5. If a ball carrier and defender were to meet in a collision, and the ball carrier runs directly towards a defender with a speed of 24 feet per second. The defender prepares for the tackle in a stationary position. The defender's velocity is zero and he has a mass of 180 pounds (lbms). The ball carrier, weighing in at 310 lbms, is storming towards the defender. The ball carrier hurtles into the defender so hard that the defender falls to the ground after contact has been made, rolling on the ground at perhaps 3 feet per second. The ball carrier is knocked in the same direction as the defender was moving before the collision. How quickly is he moving?

The initial momentum of the two players is due entirely to the ball carrier and equals his mass times his velocity: 7,440 lbm*ft/s (in math nomenclature, an asterisk means "times"). It is important to note that momentum is never lost, it's conserved, so the momentum of the ball carrier and that of the defender combined after the collision must also be 7,440 lbm*ft/s. Knowing the ball carrier's final velocity, the defenders final speed can be calculated: 31 feet per second. The defender really does go flying! (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; McNitt Gray *et al.*, 1993; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Zatsiorski, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Tripi, 2001; McCllymont & Cron, 2002; Unknown author, 2003; Gay, 2004).

BEFORE COLLISION



AFTER COLLISION

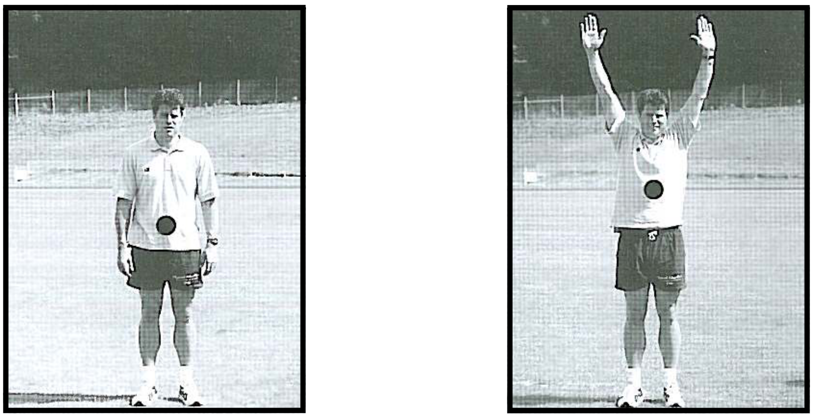
(Adapted from Gay, 2004)

Figure 6.5: The velocities of both players are indicated for before and after the collision. Momentum is conserved in the collision.

6.6 BASIC TERMS ASSOCIATED WITH BIOMECHANICAL ANALYSIS OF RUGBY SITUATIONS

Before actual specific rugby movements are analysed further, some additional basic terms need to be defined. In conjunction with mass there is also the term **centre of mass**. Centre of mass is also known as centre of gravity, and is a single point that can be used to represent an entire object (See Figure 6.6). This is very handy when one is dealing with an unusually shaped object like the human body. When a person is standing upright their centre of mass lies just around the area of the navel.

Because the centre of mass represents all different parts of the body at once it moves according to the movement of various parts of the body. For example, if a person who is standing up straight with their hands at their sides (centre of mass around the navel) lifts both arms over their head, the centre of mass will rise slightly because part of the body's mass (the arms) has risen, see Figure 6.5 (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Adrian & Cooper, 1995; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Tripi, 2001; Unknown author, 2003).



(Adapted from McKenzie et al., 2000)

Figure 6.6: Indication of centre of mass in various positions

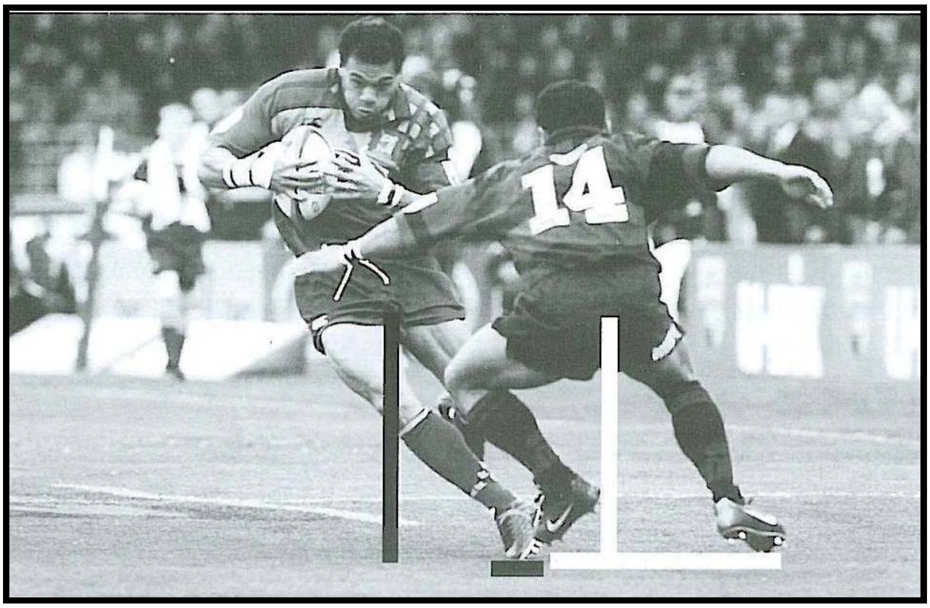
Another characteristic that is vital to all movements, whether a player is running, kicking, passing tackling or scrumming, is **stability**. If a player is not in a stable position while executing a skill, the success of that skill is usually compromised. Some of the characteristics of a stable position are described in the following principles.

6.6.1 PRINCIPLE 1 - STABILITY

> *"In order to maintain stability, establish a wide base of support when possible, maintain the centre of mass over the base of support, lower the centre of mass towards the base of support, and shift the centre of mass towards any expected force which may cause instability."*
>
> (Bauman, 1991; Grabiner *et al*., 1993; MacKinnon & Winter, 1993; McKenzie *et al*., 2000)

The most important of these factors is to keep the centre of mass over the base of support (Kronfeld & Turner, 1999). If one looks at Figure 6.7 below one can see that if a vertical line is drawn from the defenders centre of mass to the ground, the line falls within his base of support, indicated by the horizontal line For the moment assume that the ball carrier is not moving but is in a stationary position. If one looks at the ball carrier and do the same thing as with the tackler, you see that the vertical line is well away from his base of support, shown by the short horizontal line.

This means that the defender is very stable in his position while the ball carrier, if he were not running, would fall over, making him ineffective at dominating a collision if he were to meet the force from the defender. Therefore, one can see that aligning the centre of mass over the base of support will keep a player on his or her feet and better be able to perform the skill of dominating a collision as indicated in Figure 6.6 (Bauman, 1991; Grabiner *et al.*, 1993; MacKinnon & Winter, 1993; McKenzie *et al.*, 2000).



(Adapted from McKenzie *et al.*, 2000)

Figure 6.7: Stable and unstable positions when the ball carrier and defender meet

6.6.2 PRINCIPLE 2 – GROUND REACTION FORCES

> *"The amount of momentum a player generates depends on the size of the force applied and the amount of time for which that force is applied."*
>
> (Bauman, 1991; Elliot, 1999; McKenzie *et al.*, 2000)

In terms of running, the force referred to is the **ground reaction force** described above with regard to Newton's third law. This ground reaction force is responsible for generating almost all human motion and will be discussed throughout this chapter.

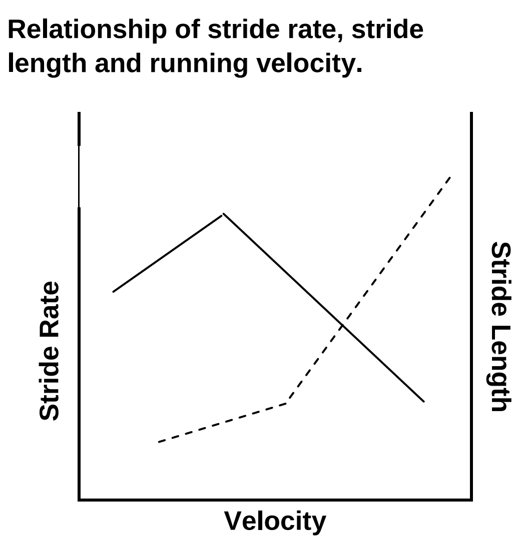
6.6.3 PRINCIPLE 3 – DIRECTION OF THE GROUND REACTION FORCES

"Forces (i.e. ground reaction forces) must be applied in the direction of the desired change of motion (forward, sideways, up, down etc."

(Bauman, 1991; Elliot, 1999; McKenzie *et al*., 2000)

In order to maximise straight-line running speed and give a player maximum amount of momentum, the player needs to generate large ground reaction forces for a relatively long time.

This is achieved by determining the optimal combination of stride rate (how fast the player's legs are turning over) and stride length (how far the player travels for every complete stride). This relationship looks something like that indicated in figure 6.8 (McKenzie *et al*., 2000).



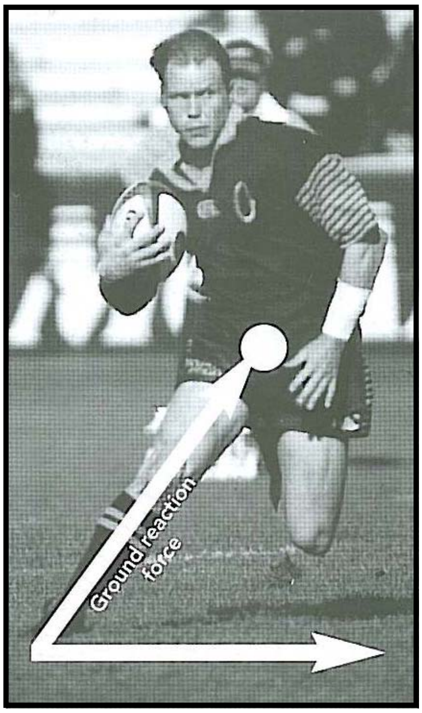
(Adapted from McKenzie *et al*., 2000)

Figure 6.8: Relationship of stride rate, stride length and running velocity

It is evident that as velocity increases the player is able to increase both stride rate (dashed line) and stride length (solid line) to a point, but then stride length begins to fall off and stride rate begins to climb rapidly. Most players will use a stride rate that is rapid but not so rapid that there is a significant drop off in stride length. If one observes track sprinters one will notice that during the middle part of a race they travel a fairly large distance during every stride they take, while still having quite a rapid stride rate (Unknown Author, 2005d).

They have learned through practice what stride rate they need to use in order to maximise their performance. The problem when applying this to rugby is that with a long stride length, and therefore a relatively low stride rate (or turnover), the player is not able to reposition their foot back on the ground in order to change direction as quickly as if the player had a quicker stride and shorter stride length. If a player is not trying to change direction, but simply trying to get from one side of the field to the other as quickly as possible, then a longer stride is appropriate. However, when players like Christian Cullen or Jeff Wilson are watched running a weaving pattern through defenders they tend to shorten their stride (Bauman, 1991; Elliot, 1999; McKenzie *et al*., 2000; Unknown Author, 2005d).

By quickening their stride they can get their feet back on the ground faster, and into positions that will generate sideways ground reaction forces which causes them to move sideways. It is this lateral force that provides the cutting motion characteristic of much of the running involved in rugby. In figure 6.9 one can observe how the ground reaction force acting on the players body passes right through his centre of mass, indicated by the white dot. The horizontal white line indicates the proportion of the ground reaction force that is moving him sideways and allowing him to change direction (Bauman, 1991; McKenzie *et al.,* 2000; Unknown Author, 2005d).



(Adapted from McKenzie *et al.*, 2000)

Figure 6.9: Use of ground reaction force to cause lateral motion

Another aspect of this type of movement involves the stability of the player, or their balance. It is important for the player who is about to execute a change in direction that they position themselves so that the ground reaction forces are moving them sideways rather than tipping them over (Grabiner *et al.*, 1993; MacKinnon & Winter, 1993; Elliot, 1999).

When observing Figure 6.9 above, one can imagine that if the line of the ground reaction force did not pass through the player's centre of mass, a torque would be created. As previously mentioned, objects tend to rotate about their centre of mass, a torque is applied – the player would start to rotate, which could cause him to fall over. Therefore the best position when changing direction is to lower your body slightly or to lean it in the direction the player wants to go, so that the ground reaction force will push the player sideways rather than tip him or her over (Bauman, 1991; Grabiner *et al.*, 1993; MacKinnon & Winter, 1993; McKenzie *et al.*, 2000).

6.6.4 PRINCIPLE 4 – EFFICIENT USE OF GROUND REACTION FORCES

> *"Players should position their body in such a way as to use ground reaction forces efficiently"*
>
> (Bauman, 1991; Grabiner *et al*., 1993; McKenzie *et al.*, 2000)

Another important characteristic of high-speed running which is often overlooked is the role of the upper body. When the concept of torque was discussed it became evident that running is a prime example of torque generation in that the legs generate a large torque about the vertical axis of the player's body (i.e., think of this as a line travelling from the player's head to their feet) when they are driving their knees during the running stride. Therefore, since a torque tends to cause rotation, one would expect that the body would turn in the direction in which the player's legs were driving (i.e., left leg driving forward causing the player to turn to the right) because of the torque the leg was generating. However, running players continue to move in a straight line rather than turning from side to side. This is due to the contribution of the upper body (Bauman, 1991; Grabiner *et al*., 1993; MacKinnon & Winter, 1993; McKenzie *et al.*, 2000).

When observing track sprinters it becomes evident that they have extremely big arms and shoulders rather than just the legs. They need to have strong muscles in the upper body in order to generate a torque in the opposite direction to the legs, in order to create a balance between the two halves of the body to keep it moving straight. With all the different situations involved in a rugby game, it's important to understand how to modify a player's running technique to maximise his or her performance in any given situation, whether it calls for a high-speed sprint or a dramatic change of direction (Bauman, 1991; Grabiner *et al*., 1993; MacKinnon & Winter, 1993; McKenzie *et al.*, 2000).

6.7 THE ANALYSIS AND INTERPRETATION OF THE OBSERVED COLLISIONS

6.7.1 THE SCIENCE OF BALL CARRYING COLLISIONS

A collision in rugby is highly variable in nature due to the wide variety of situations in which a collision can occur. In order for a ball carrier to be most effective the player needs to be able to generate sufficient momentum in his or her own body to counteract the momentum of the defender when a tackle situation arises. Probably the most important principle applicable to a collision is as follows and which has been previously dealt with:

6.7.2 PRINCIPLE 5 – COLLISION STABILITY

> *"In order to maintain stability, establish a wide base of support when possible, maintain the centre of mass over the base of support, lower the centre of mass towards the base of support, and shift the centre of mass towards any expected force which may cause instability."*

(Bauman, 1991; Grabiner *et al*., 1993; MacKinnon & Winter, 1993; McKenzie *et al.*, 2000)

This principle can influence a collision in the following two ways:

1. If the tackler is starting from a stable position, the tackler is thus able to adjust to any changes in direction by the ball carrier. If the tackler is not in a stable position, such as when the ball carrier has used footwork or has come in on an effective running line, the tackler will not be able to change direction and the ball carrier can more easily avoid the tackle or dominate the collision when it takes place (Bauman, 1991; McKenzie *et al*., 2000; Unknown Author, 2005d).

2. If a player is not in a relatively stable position when going into the collision, the player will not be able to utilise the ground reaction forces effectively in order to

be able to generate sufficient momentum into the collision. In order for the ball carrier to achieve this stability it is important for the player to keep his or her centre of gravity low to the ground and to lean towards the oncoming defender (Bauman, 1991; Elliot, 2000; McKenzie *et al.*, 2000).

6.7.3 THE EFFECTIVE BODY POSITIONING REQUIRED FOR ENTERING THE COLLISION SITE

The reason for leaning into the collision is that it gives more time for the ball carrier to apply force from a stable position because, even if they are driven back by the defender, the ball carriers centre of gravity is still over their base of support. This allows for a decrease in the force required at any given instant in time. If the ball carrier doesn't lean into the collision then in order to get the same result, they will need to apply a much greater force over a shorter period of time, which can result in a high velocity jarring impact at the collision site (Elliot, 2000; McKenzie *et al.*, 2000; Unknown Author, 2004a).

This situation is primarily explained by the following principle which has been previously dealt with:

6.7.4 PRINCIPLE 6 – EFFECTIVE MOMENTUM GENERATION

> *"The amount of momentum you generate depends on the size of the force applied and the amount of time for which that force is applied."*
>
> (McKenzie *et al.*, 2000)

The generation of these very high forces is not only harder to achieve but it also greatly increases the impact forces for both the ball carrier as well as the defender. The player who is able to absorb and apply these collision forces well will dominate this area of play (Millburn, 1995; Unknown Author, 2004a; Unknown Author, 2004b).

6.7.5 PRINCIPLE 7 – EFFECTIVE BODY TECHNIQUE USAGE

> *"When involved in an impact situation, use proper techniques and equipment in order to absorb, minimise and be able to apply the forces involved"*
>
> (McKenzie *et al*., 2000)

This principle implies the following: there must be a middle ground, where the impact forces experienced by the body are lower but are still at a level where the ball carrier is able to dominate the defender (Hay, 1993; Unknown Author, 2004a; Unknown Author, 2004b).

The same principles in terms of collisions apply with the ball carrier's goal being to get the defender into an unstable position where they are less effective (Millburn, 1990). The ball carrier also wants to have as little force acting on his or her body as possible. This is where a side-step or swerve away from the defender can be used.

By moving away from the defender the ball carrier is able to draw them into an unstable position. It is also imperative that the ball carrier maintains a stable position by keeping his or her centre of gravity low and over their base of support (Millburn, 1987; Gerrard, 1998; McKenzie *et al*., 2000; Unknown Author, 2004a; Unknown Author, 2004b).

When a ball carrier runs into a tackle situation it becomes noticeable that the ball carrier has the tendency to lean towards the defender just before impact. This enables the ball carrier to remain in a relatively stable position for longer; this will give the ball carrier more control when he or she enters the collision site (Alexander, 1992; McKenzie *et al*., 2000; Unknown Author, 2004a; Unknown Author, 2004b).

CHAPTER 7

METHODS, THE EXPERIMENTAL DESIGN AND THE RELEVANT PROCEDURES

7.1 METHOD

At this stage of the discussion the purpose of this section is to identify and explain the concepts that are to be incorporated into the experimental design of this study. The study will take the form of a quasi–time series experiment. The following key components that are to be extracted from the analysis sheets will be used in order to evaluate whether the concept of collisions in rugby can be used as a determining factor in success in rugby.

1. The average number of collisions for the try to be scored. The collisions mentioned here, includes the number of rucks / phases, off-loads in the tackle and a forced missed tackle;
2. The ratio of dominant collisions versus the number of passes executed for the try to be scored. (number of collisions / number of passes);
3. The average number of forced missed tackles for the try to be scored;
4. The average velocity change of the dominant collisions for the try to be scored. (momentum of the ball carrier – momentum of the defender)

The following factors will be used as a further possible indication of the effectiveness of determining factors for success in rugby (see APPENDICES 4 – 9).

5. The comparison of whether a try is scored from a clean line break, or from extra players in support, versus the percentage of tries scored where a dominant collision took place by the try scorer before the try was in fact scored;
6. The ratio of forced missed tackles per phase for the try to be scored. (forced missed tackles / number of phases); and

Once an increase or decrease in the various forms of collisions as well as these specific observations as mentioned above has been established, an in-depth study of the reasons why the collisions were successful or not will be evaluated. The concepts explained in this section will be evaluated in relation to footage obtained from the following rugby competitions;

1. The Super 12 of 2003,
2. The Super 12 of 2004, and
3. The Super 12 of 2005.

Video Analysis will be done according to prescribed Notational Analysis sheets that have been developed in order to identify and isolate the pertinent factors which will be used in the appropriate discussion regarding the concept of “Dominant Collisions”. During the course of these competitions these identified aspects regarding the execution and implementation of the concepts that form the integral part of collisions will be focussed on with the objective of attempting to identify for what reasons there was an increase in the success rate of dominant collisions during match situations. By means of statistical information gathered during the 2003 Super 12, 2004 Super 12 and the 2005 Super 12 rugby competitions a comparison is to be made in order to evaluate whether there was a significant change in success when compared to the results of the other competitions. The concepts identified as imperative to achieving successful dominant collisions and to be concentrated on during the rugby situations are as follows:

7.2 PRE - CONTACT SITUATIONS BEFORE THE COLLISION TOOK PLACE – BALL CARRIER/S

1. The initial attacking base from which the try was scored.

Once it can be established which of the following starter facets resulted in the most try’s being scored, coaches will inevitably adjust their focus areas in training in order to emphasise training in that specific area of play.

1.1 Restarts

This will include phases of play including the following;

1.1.1 Kick off receives,

1.1.2 Kick off on the team's own ball,

1.1.3 22m Kick in receives, and

1.1.4 22m kick in on the team's own ball.

1.2 Scrums

The position on the field of play will be notated in order to identify from which position teams can most effectively attacked from in order to be most effective in an attacking play. The field area will be divided into the following sections;

1.2.1 The left hand side of the field (20 meters in from the touchline);

1.2.2 The middle of the field ; and

1.2.3 The right hand side of the field (20 meters in from the touchline).

1.3 Lineouts

The greater space forced onto teams due to the laws of the game has often be used as the reason why teams are possibly more effective in attacking play from this facet of play. The study will aim to show that this is in fact so and possibly identify reason why it is or is not so.

The side of the field will also be notated in order to identify if there is a significant difference in terms of from which side of the field the lineout takes place from.

1.3.1 The left hand side of the field; or

1.3.2 The right hand side of the field.

1.4 Turnovers

The emphasis of teams being able to recycle and maintain possession has been conditioned into teams with the belief that attacking teams are the most vulnerable when they have applied all their attacking players in an attack and while in the execution of the play turn the ball over to the opposition. The defending team are thus able to use the turnover possession and run at a team that has no defensive organisation which is the most vulnerable defence to run at. The study will measure if there is in fact a significant indication of the level of success of attack from turnover possession.

2. The predominant type of running line used into the collision

The type of possible running lines used in attacking plays has been confined into two basic angles of entrance into the collision. These lines are categorised into either a running line that comes in back towards where the ball has been received, i.e., "against the grain", or a running line that moves away from where the ball has been received, i.e., "working with the grain". The lines have been categorised as follows;

2.1 An under's running line; or
2.2 An over's running line

3. Was the collision a mismatch?

The term "mismatch" is used to describe the situation when a forward runner carries the ball into a collision with a backline player having to defend against the ball carrier. This type of collision will invariably result in a more dramatic collision as a forward will tend to try to run "over" the backline player. The opposite is also true. A backline player will tend to back his or her ability to beat the forward with footwork and try to evade the collision and attempt to break the line with as little contact as possible. The coach will thus try to manipulate attacking play to possibly be able to take advantage of these types of situation so to be most effective when in possession of the ball. As previously mentioned the mismatches or lack thereof will be evaluated as follows;

3.1 A forward ball carrier running at a back (defender);
3.2 A situation where no mismatch occurred, i.e., a forward running at a forward or a back running at a back; or

3.3 A back ball carrier running at a forward (defender).

4. Was there footwork involved before the collision took place?

In all collisions or attacking plays, there has to be a certain amount of footwork applied by the ball carrier in order to manipulate the defender so as to attempt to try and minimise the level of impact at the collision site. The opposite is also true if in fact the ball carrier wishes to use the footwork in order try and maximise the impact at the collision site. This aspect of the collision will be evaluated according to the following factors;

4.1 The use of a pre-step before the collision takes place;
4.2 The use of a side-step before the collision takes place;
4.3 The use of a deceleration step before the collision takes place;
4.4 The use of an acceleration step before the collision takes place; or
4.5 A situation where the ball carrier makes use of no step before the collision takes place.

5. The yardage the ball was carried before the collision took place

This figure is imperative in that it is required to work out the velocity that the ball carrier is able to “build up” into the collision. It also becomes an indication of how much time the defender has to position his or herself to be able to get into a strong defensive situation.

6. The amount of time that the ball carrier/s was in possession of the ball before the collision took place

This figure also forms part of the equation to work out the velocity of the ball carrier into the collision.

7. The velocity of the striker/s into the collision

This is a vital figure that plays a marked role in regards to the amount of momentum that the ball carrier/s can take into the collision. This will influence with what kind of “force” the ball carrier/s can impart onto the defender when they meet at the collision area.

8. The mass of the striker/s into the collision

This figure will also be used in the equation to establish the amount of momentum of the ball carrier/s into the collision.

9. The amount of momentum the striker/s takes into the collision

This value will be used in the discussion in order determine the velocity change when comparing the ball carrier s momentum to the defenders momentum. It represents the amount of velocity either the ball carrier or the defender takes into collisions.

7.3 PRE - CONTACT SITUATIONS BEFORE THE COLLISION TOOK PLACE – THE DEFENDER/S

This section will focus on the defenders who are involved in the collision. It will take a detailed look at the following factors:

1. Was there a defensive error that may have influenced the defenders ability to dominate the defensive situation?

If it is possible to identify situations where the defence can be beaten or forced into weaker defensive situations, and a team can manipulate the opposition into these situations, then collisions could be made easier to dominate.

The following defensive errors have been identified;

1.1 Slow reload

This is described as the ability of a defender/s to get into an organised and well positioned defensive position so to be able to move up onto the ball carrier in a stable, strong defensive body position.

1.2 Poor defensive spacing

This aspect of defensive error s indicates the ability of the opposition's defensive line to organise the spacing between the players who form the defensive line. An inability to have appropriate spacing between players will have a marked influence on each player's ability to effectively enter the collision site and to dominate the defensive collision.

1.3 A defensive line that has an uneven line of press

If a defensive line does not move forward towards the ball carrier in an even line, it will create "gaps" through which the ball carrier can move which will give the ball carrier an edge when the collision takes place. The defenders will thus be less effective in their ability to execute a dominant tackle.

1.4 A defender who overtracks the ball carrier and moves out of his or her defensive line

This situation often happens when defenders do not work together in an organised defensive line and rush onto the ball carrier. When a defender overtracks, he moves outside the line of the ball carrier and finds him or herself unable to execute a dominant tackle. The defender's centre of mass falls outside his or her level of stability and is thus not adequately balanced into the collision.

1.5 A missed tackle

It can often happen in a collision that the defender falls off the tackle. It can occur for many reasons but most often occurs due to poor technique or lack of commitment into the collision.

2. The distance the defender/s moved until entering the collision site

This aspect of the equation plays a vital role in the ability of the defender to have sufficient momentum to be able to dominate the tackle situation.

3. The time transpired till defender/s entered the collision site

This figure will also play a part in the determining of the defender/s velocity into the tackle situation.

4. The velocity of the defenders/s into the collision

The amount of velocity plays an important role in regards to the amount of momentum that the defender/s can impart to the collision. This will influence the amount of impact that occurs at the collision area.

5. The mass of the defender/s into the collision

The defender/s amount of mass will determine the defender/s ability to stand strong in the tackle situation and not "slide off" the tackle situation. A one-on-one situation is easier to calculate, however if the ball carrier runs into a "double hit" the extra mass of the defenders will make it extremely difficult for the ball carrier to dominate the collision.

6. The momentum of the defender/s into the collision

This value will be used in the discussion in order determine the velocity change when comparing the ball carrier s momentum to the defenders momentum. It represents the amount of velocity either the ball carrier or the defender takes into collisions.

7.4 KEY FACTORS PRESENT AT THE IN CONTACT SITUATION AS THE COLLISION TAKES PLACE

This section of the discussion focuses on the actual collision site where the ball carrier/s and defender/s meet.

1. In which collision channel did the collision takes place

The channel area where the specific collision takes will be notated in order to identify in which channel most collisions takes place. Once this has been established, coaches can make use of this information to attack this channel.

1.1 Channel 1 (1st Pillar)

This collision takes place when the ball carrier runs at the defender who is positioned directly next to the ruck.

1.2 Channel 2 (2^{nd} Pillar)

This collision takes place when the ball carrier runs at the defender who is positioned next to the player who is at 1^{st} pillar.

1.3 Channel 3 (3^{rd} Pillar)

This collision takes place when the ball carrier runs at the defender who is aligned on the flyhalf position who is at 3^{rd} pillar.

1.4 Channel 4 (4^{th} Pillar)

This collision takes place when the ball carrier runs at the defender who is aligned on the inside centre position who is at 4^{th} pillar.

1.5 Channel 5 (5^{th} Pillar)

This collision takes place when the ball carrier runs at the defender who is aligned on the outside centre position who is at 5^{th} pillar.

1.6 Channel 6+ (6^{th} Pillar)

This collision takes place when the ball carrier runs at the defender who is aligned out wide at the 6^{th} + pillar.

2. Was the defender/s stationary when the collision took place?

This aspect will have a significant impact on the ability of the defender/s to generate sufficient momentum in order to be able to significantly dominate the tackle situation.

3. Where was contact made with the defender/s?

This will be an indication of where collisions predominantly took place. The reason why this can be of importance is that the most effective area on the defender's body will be able to be identified so that ball carriers will be able to run at them aiming for that specific zone of the defender's body. The following zones on the defenders body will be identified as target areas and will be used as the indication of the optimal area of the body to run at:

3.1 Non dominant collision, insufficient mass into the collision (Side of body - Forearms)

3.2 Dominant collision, sufficient mass into the collision (Side of body – shoulder to elbow)

3.3 Dominant collision, maximum mass into the collision (Centre of the body)

4. Was the tackler beaten?

This is a vital indication of the yardage the ball carrier makes after the collision takes place. This is important in that it shows the level of significance of the collision and if it was dominant or not. This will be evaluated by evaluating the collisions using the following parameters:

4.1 The ball carrier dominated the collision by achieving greater than 1metre forward momentum

4.2 The ball carrier dominated the collision by achieving less than 1 meter forward momentum

5. The body action of the ball carrier through or out of the collision

This specific indicator will make a comparison between linear and angular momentum out of the collision. This will be achieved by identifying the type of body action out of the collision. It will be achieved by evaluating the situation according to the following factors:

5.1 An inward spin by the ball carrier out of the collision;

5.2 The ball carrier comes straight out of the collision; or

5.3 An outward spin by the ball carrier out of the collision.

6. The yardage of the ball carrier after the collision has taken place

This will be an indication of the relative go forward momentum of the ball carrier after the collision has taken place.

7.5 THE VELOCITY CHANGE COMPARISON BETWEEN BALL CARRIER/S AND THE DEFENDER/S, AND THE RELEVANT COLLISION ANGLES

This section will focus on the comparison between the ball carrier and the defender at the specific collision. It will indicate the level of difference between the two both players.

1. What was the ball carrier's momentum into the collision?

This value has been determined from previous notation sheets and is imperative for the success of this study.

2. Was it a leached ball carry into the collision?

This factor will play an important role in the evaluating of the collision. The leached ball carry implies that two players are bound onto each other to drive the ball carrier through the tackle of the defender.

3. What was the defender's momentum?

This value will be used in order to compare it with the ball carrier's momentum. The player with the greater value should be more adept to dominating the collision.

4. Was it a double hit by the defenders?

This factor will affect the defenders momentum into the collision and if the tackle is executed effectively will result in the defenders dominating the collision. The defenders will thus be able to drive the ball carrier backwards.

5. What was the velocity change?

This value will indicate which player, ball carrier or defender, dominated the collision?

6. Which player executed the dominant force?

This will indicated which player was dominant at the impact and thus dominated the collision?

7. The collision angle of the ball carrier onto the defender

This will indicate the predominant collision angles that took place between the ball carriers and the defenders. Such an observation can greatly influence the type of running lines implemented by ball carriers in order to be more efficient during impact at collision situations. The following collision angles will be used as references:

7.1 A 180' collision (i.e., a front on collision);
7.2 A 157, 5' collision;
7.3 A 135' collision;
7.4 A 112, 5' collision;
7.5 A 90' collision; or
7.6 A 67, 5' collision (i.e., a from behind collision.)

7.6 THE POST - CONTACT EVALUATION OF THE TRY SCORED

This final section will evaluate the final pertinent factors that played a major role in the successful scoring of the try that has been evaluated. The following observations are to be made:

1. In which channel did the final line break or where the defender was beaten take place?

This observation will be able to show which areas of the field are the most vulnerable and through which area most line breaks or dominant collisions took place. The following channels have been identified for evaluation:

1.1 Channel 1 (2m)
1.2 Channel 2 (5m)

1.3 Channel 3 (10m)
1.4 Channel 4 (20m)
1.5 Channel 5 (30m)
1.6 Channel 6+ (40+m)

2. The number of passes between the last collision and the try being scored

This will indicate the average number of passes required in order to ultimately score a try.

3. The total number of passes for the try to be scored

The emphasis of a teams need to pass will be observed by notating the average number of passes required for a try to be scored.

4. The total number of phases before the try is scored

This value will show the value of phase play to be able to score tries. The average number of phases will be established, and show how defences can be broken through the scrambling of defences.

5. The total field distance covered by the attacking team for the try to be scored

It will show the average distance from which most tries are scored. It can be an indication of from which zone on the field a team should apply attack, and possibly in which zones teams should play for field position.

CHAPTER 8

8.1 ANALYSIS AND INTERPRETATION

As mentioned in the previous chapter, four key components have been identified as indicators of the level of significance of dominant collisions when evaluating how tries are scored.

The following key performance measurements were evaluated and the relevant trend lines shown in order to indicate how each factor affected the level of success:

8.1.1 Average total number of collisions for a try to be scored

This statistic is determined during the notational analysis stage as the sum of the total number of ruck situations or phases forced, the number of forced missed tackles and the number of off-loads out of a tackle during play when a try is scored. This statistic shows the team's ability to recycle possession effectively as well as the ability to "punch away" at the opposition's defensive structure. With defensive systems being so effective, opportunities to score tries are scarce and the successful teams are better able to keep the ball for longer periods in so doing force mistakes from the opposition which can then be taken advantage of.

8.1.2 Average total number of forced missed tackles for a try to be scored

This indicates the relative strength and ability of the team when carrying the ball into a collision. The teams that are able to knock-over the opposition defenders with more regularity will in effect gain better yardage and "go-forward" possession. It also creates the situation where other defenders that form part of the system have to step in to cover for the player who missed the tackle; this creates holes in the defensive line which makes them more susceptible to having tries scored against them.

8.1.3 Ratio of dominant collisions versus passes executed when a try is scored

This statistic indicates the teams playing structure, i.e., does the team focus on carrying the ball forward, running at the opposition and being confrontational or do they tend to pass the ball around more in an effort to move the opposition around. A value below 1 (zero) indicates that the team passes more than what they force collisions when they score tries, and a value above 1 (zero) indicates that the team forces more collisions than what they pass the ball when they score a try.

8.1.4 Average positive velocity change of dominant collisions resulting in a try being scored

This is an indication of the relative difference between the ball carrier's momentum and the defender's momentum when they meet in a collision. The higher the value the greater the difference and the more ability the ball carrier has when the two players meet to "knock-over" the defender. This is a very good indicator of the team's strength into the collision and the force with which they are able to run into the opposition.

These four factors have been identified as the key factors required in order to prove the hypotheses that the teams that dominate the collision situation best are more likely to be successful in a rugby match and thus should win more matches than what they should lose. In order to evaluate the reliability and validity of these statistics the statistical significance has to be established.

8.2 The statistical significance of the data

Inductive reasoning moves from specific facts to general, but tentative conclusions. We can never be absolutely sure that inductive conclusions are flawless. With the aid of probability estimates, we can qualify our results and state the degree of confidence we have in them. Statistical inference is an application of inductive reasoning. It allows us to reason from evidence found in the sample to conclusions we wish to make about the population. The process of getting probability estimates and calculating the degree of confidence we have in our data is called hypotheses testing. The purpose of hypotheses testing is to determine the accuracy of the hypotheses and the validity of the statistics in order to prove or disprove the hypotheses. The accuracy of the hypotheses is evaluated by determining the statistical likelihood that the data reveals true differences – and that there is not random sample error. We evaluate the importance of a statistical significance difference by weighing the practical significance of any change that is measured (Cooper & Emory, 1995; Cooper & Schindler, 2001).

The Null hypothesis is used for testing. It is a statement that there is no difference between the parameter and the statistics being compared to it. In this case a one-tailed approach to the Null hypothesis will be used (Cooper & Emory, 1995; Cooper & Schindler, 2001).

8.3 The statistical testing procedure

Testing for statistical significance follows a relatively well-defined pattern; the six-stage sequence is as follows:

1. state the null hypothesis;
2. choose the statistical test;
3. select the desired level of significance;
4. compute the calculated difference value;
5. obtain the critical test value; and
6. interpretation of the test (Cooper & Emory, 1995; Cooper & Schindler, 2001).

8.4 The tests of significance

There are two general classes of significance tests: parametric and nonparametric. Parametric tests are more powerful because their data are derived from interval and ratio measurements.

Nonparametric tests are used to test the hypotheses with nominal and ordinal data. In this study parametric tests will be used, as the data is interval and ratio data. Parametric techniques are the tests of choice if their assumptions are met. Assumptions for parametric tests include the following:

- The observations must be independent – that is, the selection of any one case should not affect the chances for any other case to be included in the sample;
- The observations should be drawn from normally distributed populations;
- These populations should have equal variances; and
- The measurement scales should be at least interval so that arithmetic operations can be used on them (Cooper & Emory, 1995; Cooper & Schindler, 2001).

8.5 The selection of a statistical test

In attempting to choose a particular significance test, the following three questions should be asked:

- Does the test involve one sample, two samples or *k* samples?
- If two samples or *k* samples are involved, are the individual cases independent or related?
- Is the scale of measurement nominal, ordinal, interval or ratio?

For this research the *k*-sample case is used. The samples are related and the data used is interval and ratio. Therefore the test that will be used would be the repeated measures ANOVA test. See Table 8.1 below detailing the criteria when deciding on a relevant test to use as discussed above.

Table 8.1: Criteria for relevant hypotheses testing

Measurement Level	One-Sample Case	Two-Sample Case Related Samples	Two-Sample Case Independent Samples	*k*-Sample Case Related Samples	*k*-Sample Case Independent Samples
Nominal	Binomial X-Square One Sample	McNemar	Fisher exact X-Square Two Sample	Cochran Q	X-Square for k Samples
Ordinal	Kolmogorov-Smirnov one - Sample test Runs Test	Sign Test Wilcoxon matched Pairs.	Median test Mann-Whitney U Kolmogorov-Smirnov Wald - Wolfowitz	Friedman two-way ANOVA	Median extension Kruskal-Wallis One-Way ANOVA
Interval / Ratio	t - test Z - test	t - test for paired samples	t - test Z - test	**Repeated measures ANOVA**	One-Way ANOVA n-way ANOVA

(Adapted from: Cooper & Schindler, 2001)

8.6 *k* - Sample related case for interval / ratio data

The repeated-measures ANOVA is a special form of n-way analysis of variance and will be used in this case.

During the following testing procedure, the following is stated:

1. Null hypotheses

(1) Key Measurement: H*o:* $\mu_{K1} = \mu_{K2} = \mu_{K3} = \mu_{K4}$

(2) Year Rating: H*o:* $\mu_{Y1} = \mu_{Y2} = \mu_{Y3}$

(3) Year Rating × Key Measurement: $(\mu_{Y3K1} - \mu_{Y3K2} - \mu_{Y3K3}) =$
$(\mu_{Y2K1} - \mu_{Y2K2} - \mu_{Y2K3}) =$
$(\mu_{Y1K1} - \mu_{Y1K2} - \mu_{Y1K3})$.

(K = Key measurement and Y = Year)

For the alternative hypotheses, the statement will be generalized so that not all the groups have equal means for each of the hypotheses.

2. The statistical F-test for repeated measure is chosen because there are related trials on the dependant variable for *k* samples, accept the assumptions of analysis of variance, and have interval data.

3. Significance level. Let $\alpha = 0.05$ and
   - Key measurement d.f. = [numerator (key measurement) (k-1) = (4-1) = 3], [denominator (n-k) = (12 – 4) = 8] = Key Measurement (3,8)
   - Year rating d.f. = [numerator (Year Rating) (k-1) = (3-1) = 2], [denominator (n-k) = (12 – 4) = 8] = Year Rating (2,8)
   - Year rating by Key measurement d.f. = [numerator (Year Rating by Key Measurement) (k-1) = (3-1) = 2], [denominator (n-k) = (12 – 4) = 8] = Year Rating by Key Measurement (3,8)

This shows that: Key Measurement (3,8), Year Rating (2,8),Year Rating by Key Measurement (3,8)

4. The calculated values are shown in Table 8.2 as seen below.

Table 8.2: Data table for the key performance measurements

1: AVERAGE NUMBER OF FORCED MISSED TACKLES FOR THE TRY TO BE SCORED												
Log Position	1	2	3	4	5	6	7	8	9	10	11	12
2003	2.58	2.24	2.26	2.26	2.2	1.87	2.83	2.00	1.82	2.61	1.89	1.47
2004	2.36	2.64	1.45	2.25	2.58	2.17	2.29	1.43	2.05	1.59	2.00	1.23
2005	4.13	3.84	4.04	3.73	3.30	3.80	3.69	3.11	1.42	2.77	1.86	1.56
Total 2003 - 2005	9.07	8.72	7.75	8.24	8.08	7.84	8.81	6.54	5.29	6.97	5.75	4.26
2: AVERAGE TOTAL NUMBER OF COLLISIONS FOR A TRY TO BE SCORED												
Log Position	1	2	3	4	5	6	7	8	9	10	11	12
2003	7.12	5.24	5.53	5.23	5.40	4.23	6.11	4.60	4.71	5.61	4.78	3.53
2004	5.53	6.50	3.95	5.19	5.42	4.33	5.08	3.86	5.95	3.71	5.47	4.31
2005	7.38	7.23	7.12	7.09	6.74	7.25	6.81	6.00	3.16	5.46	4.00	3.44
Total 2003 - 2005	20.03	18.97	16.6	17.51	17.56	15.81	18.00	14.46	13.82	14.78	14.25	11.28
3: RATIO OF DOMINANT COLLISIONS versus PASSES EXECUTED WHEN A TRY IS SCORED												
Log Position	1	2	3	4	5	6	7	8	9	10	11	12
2003	1.65	1.31	1.14	1.02	1.19	1.28	1.05	0.97	1.08	1.01	0.92	0.9
2004	0.95	1.26	0.93	0.91	0.99	1.01	1.16	0.82	1.09	0.94	1.01	0.75
2005	1.95	1.48	2.05	1.70	1.16	1.42	1.50	1.50	0.87	1.14	0.77	0.92
Total 2003 - 2005	4.55	4.05	4.12	3.63	3.34	3.71	3.71	3.29	3.04	3.09	2.70	2.57
4: AVERAGE POSITIVE VELOCITY CHANGE OF DOMINANT COLLISIONS RESULTING IN A TRY BEING SCORED												
Log Position	1	2	3	4	5	6	7	8	9	10	11	12
2003	596.02	509.05	407.67	407.80	300.65	491.35	285.65	392.02	376.33	489.02	303.05	283.19
2004	504.73	538.47	499.13	483.54	448.85	572.16	448.15	428.58	461.12	397.34	414.00	451.09
2005	818.46	691.21	687.25	694.39	662.78	595.49	610.24	573.83	524.45	531.44	577.45	526.12
Total 2003 - 2005	639.73	579.57	531.35	528.58	470.76	553.00	448.01	464.81	453.96	472.60	431.50	420.13

Table 8.3: Data table summary for the key performance measurements

Log Position	Rating 2003	Rating 2004	Rating 2005	Key Figure	Log Position	Rating 2003	Rating 2004	Rating 2005	Key Figure
1	2.58	2.36	4.13	1	1	1.65	0.95	1.95	3
2	2.24	2.64	3.84	1	2	1.31	1.26	1.48	3
3	2.26	1.45	4.04	1	3	1.14	0.93	2.05	3
4	2.26	2.25	3.73	1	4	1.02	0.91	1.70	3
5	2.20	2.58	3.30	1	5	1.19	0.99	1.16	3
6	1.87	2.17	3.80	1	6	1.28	1.01	1.42	3
7	2.83	2.29	3.69	1	7	1.05	1.16	1.50	3
8	2.00	1.43	3.11	1	8	0.97	0.82	1.50	3
9	1.82	2.05	1.42	1	9	1.08	1.09	0.87	3
10	2.61	1.59	2.77	1	10	1.01	0.94	1.14	3
11	1.89	2.00	1.86	1	11	0.92	1.01	0.77	3
12	1.47	1.23	1.56	1	12	0.90	0.75	0.92	3
1	7.12	5.53	7.38	2	1	596.02	504.73	818.46	4
2	5.24	6.50	7.23	2	2	509.05	538.47	691.21	4
3	5.53	3.95	7.12	2	3	407.67	499.13	687.25	4
4	5.23	5.19	7.09	2	4	407.80	483.54	694.39	4
5	5.40	5.42	6.74	2	5	300.65	448.85	662.78	4
6	4.23	4.33	7.25	2	6	491.35	572.16	595.49	4
7	6.11	5.08	6.81	2	7	285.65	448.15	610.24	4
8	4.60	3.86	6.00	2	8	392.02	428.58	573.83	4
9	4.71	5.95	3.16	2	9	376.33	461.12	524.45	4
10	5.61	3.71	5.46	2	10	489.02	397.34	531.44	4
11	4.78	5.47	4.00	2	11	303.05	414.00	577.45	4
12	3.53	4.31	3.44	2	12	283.19	451.09	526.12	4

The statistical F = Between Group Variance / Within Group Variance = Mean square between / Mean square within

where,

Mean square between = Sum of Squares between / Degrees of freedom between

Mean square within = Sum of Squares within / Degrees of freedom within

$F = MS_b/MS_w$: Table 8.4 below shows the F - values that have been calculated for each null hypothesis.

Table 8.4: Model summary

Model Summary					
Hypotheses to test	d.f.	F value between 2003 and 2004	F value between 2004 and 2005	F value between 2003 and 2005	Measure of spread
Key Measurement	3	0.805	0.654	0.491	(3,8)
Year Rating	2	0.377	0.044	0.004	(2,8)
Year Rating by Key Measurement	3	0.035	0.074	0.803	(3,8)

5. Critical test value

   The d.f values are as following:

   Key Measurement (3,8), Year Rating (2,8),Year Rating by Key Measurement (3,8)

   Comparing these with a statistical table for critical values of the F distribution for $\alpha = 0.05$ the critical values are as following:

   - (3,8): 4.07
   - (2,8): 4.46
   - (3,8): 4.07

6. Interpretation

   The statistical results are grounds for accepting all three null hypotheses and concluding that there is a statistical significance of at least 95% with an alpha of 0.05 between the means in all three instances. This shows that the data that was captured for the twelve teams for all tries scored by these teams over a period of three years and for the four key measurements, have a statistical significance of 95% for the readings respectively. Figure 8.1 below shows the mean average differences for all three key measurements over the three-year period.

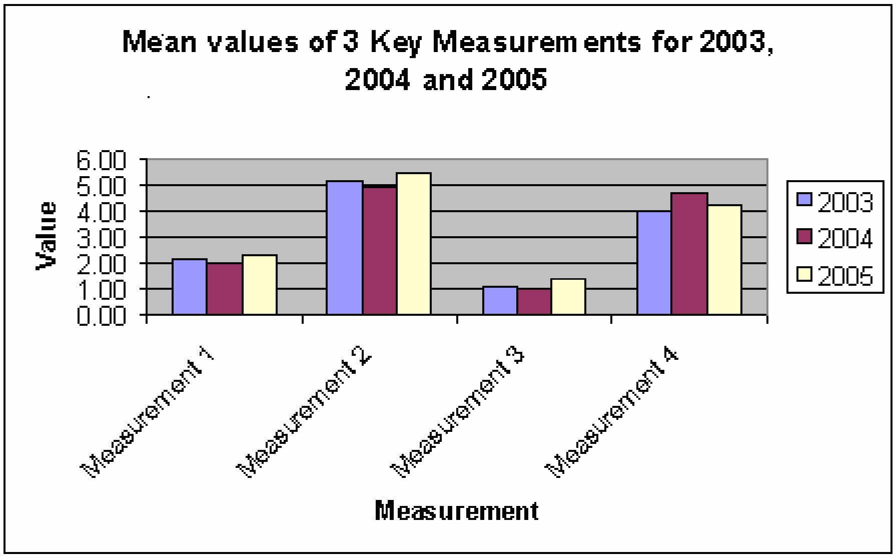


Figure 8.1: Mean values of the four key performance measurements for 2003, 2004 and 2005

8.7 Multivariate analysis

As the reliability and validity of the statistics has been established, the following step in the process is to interpret the information so that reasons and recommendations can be made concerning the statistics shown.

Making use of regression analysis and multiple regressions the correlation between log position and the four key measurements as well as the relation between these key measurements can clearly be seen in the tables and Figures that are to be shown.

Table 8.5: Total number of forced missed tackles vs total average number of collisions

AVERAGE NUMBER OF FORCED MISSED TACKLES vs TOTAL AVERAGE NUMBER OF COLLISIONS													
	LOG POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	Average number of forced missed tackles – 2003	2.58	2.24	2.26	2.26	2.20	1.87	2.83	2.00	1.82	2.61	1.89	1.47
1	Average number of forced missed tackles – 2004	2.36	2.64	1.45	2.25	2.58	2.17	2.29	1.43	2.05	1.59	2.00	1.23
1	Average number of forced missed tackles – 2005	4.13	3.84	4.04	3.73	3.30	3.80	3.69	3.11	1.42	2.77	1.86	1.56
1	Average number of forced missed tackles – Total	9.07	8.72	7.75	8.24	8.08	7.84	8.81	6.54	5.29	6.97	5.75	4.26
	vs												
2	Average total number of collisions - 2003	7.12	5.24	5.53	5.23	5.40	4.23	6.11	4.60	4.71	5.61	4.78	3.53
2	Average total number of collisions – 2004	5.53	6.50	3.95	5.19	5.42	4.33	5.08	3.86	5.95	3.71	5.47	4.31
2	Average total number of collisions – 2005	7.38	7.23	7.12	7.09	6.74	7.25	6.81	6.00	3.16	5.46	4.00	3.44
2	Average total number of collisions – Total	20.03	18.97	16.6	17.51	17.56	15.81	18	14.46	13.82	14.78	14.25	11.28
	1: 2003 / 2: 2003	0.36236	0.42748	0.40868	0.43212	0.40741	0.44208	0.46318	0.43478	0.38641	0.46524	0.3954	0.41643
	1: 2004 / 2: 2004	0.42676	0.40615	0.36709	0.43353	0.47601	0.50115	0.45079	0.37047	0.34454	0.42857	0.36563	0.28538
	1: 2005 / 2: 2005	0.55962	0.53112	0.56742	0.52609	0.48961	0.52414	0.54185	0.51833	0.44937	0.50733	0.465	0.45349
	1: TOTAL / 2: TOTAL	0.45282	0.45967	0.46687	0.47059	0.46014	0.49589	0.48944	0.45228	0.38278	0.47158	0.40351	0.37766

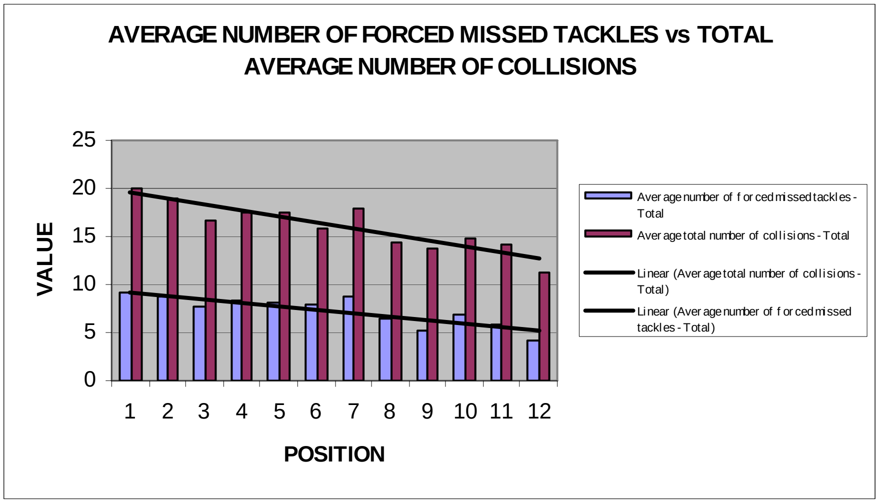


Figure 8.2: Average number of forced missed tackles vs total average number of collisions

As is evident from Table 8.5 and Figure 8.2, teams that are more successful and that finish higher on the log have a higher rate of forced missed tackles as well as a higher rate of total average number of collisions. A reason for this could be attributed to the fact that a team that executes more collisions while scoring a try will have more opportunities to force more missed tackles. The fact that more collisions take place also indicates that the team is able to dominate the opposition in terms of their ability to run at defensive lines that have been constantly tested thus making them vulnerable and more likely to make defensive errors. These two factors are interrelated as they both become lower as the teams are lower on the log.

Table 8.6: Total number of forced missed tackles vs average positive velocity change of dominant collisions

AVERAGE NUMBER OF FORCED MISSED TACKLES vs AVERAGE POSITIVE VELOCITY CHANGE OF DOMINANT COLLISIONS													
	LOG POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	Average number of forced missed tackles - 2003	2.58	2.24	2.26	2.26	2.2	1.87	2.83	2.00	1.82	2.61	1.89	1.47
1	Average number of forced missed tackles - 2004	2.36	2.64	1.45	2.25	2.58	2.17	2.29	1.43	2.05	1.59	2.00	1.23
1	Average number of forced missed tackles - 2005	4.13	3.84	4.04	3.73	3.30	3.80	3.69	3.11	1.42	2.77	1.86	1.56
1	Average number of forced missed tackles - Total	9.07	8.72	7.75	8.24	8.08	7.84	8.81	6.54	5.29	6.97	5.75	4.26
	vs												
2	Average positive velocity change of dominant collisions - 2003	596	509.1	407.7	407.8	300.7	491.4	285.7	392.02	376.3	489	303.1	283.2
2	Average positive velocity change of dominant collisions - 2004	504.7	538.47	499.13	483.54	448.85	572.16	448.2	428.6	461.1	397.3	414.00	451.1
2	Average positive velocity change of dominant collisions - 2005	818.5	691.2	687.3	694.4	662.78	595.49	610.24	573.83	524.45	531.44	577.45	526.1
2	Average positive velocity change of dominant collisions - Total	639.7	579.6	531.4	528.6	470.8	553	448	464.8	454	472.6	431.5	420.1
2	Average positive velocity change of dominant collisions / 100	6.397	5.796	5.314	5.286	4.708	5.53	4.48	4.648	4.54	4.726	4.315	4.201
	1: 2003 / 2: 2003	0.00433	0.0044	0.00554	0.00554	0.00732	0.00381	0.00991	0.0051	0.00484	0.00534	0.00624	0.00519
	1: 2004 / 2: 2004	0.00468	0.0049	0.00291	0.00465	0.00575	0.00379	0.00511	0.00334	0.00445	0.004	0.00483	0.00273
	1: 2005 / 2: 2005	0.00505	0.00556	0.00588	0.00537	0.00498	0.00638	0.00605	0.00542	0.00271	0.00521	0.00322	0.00297
	1: TOTAL / 2: TOTAL	0.01418	0.01505	0.01459	0.01559	0.01716	0.01418	0.01966	0.01407	0.01165	0.01475	0.01333	0.01014

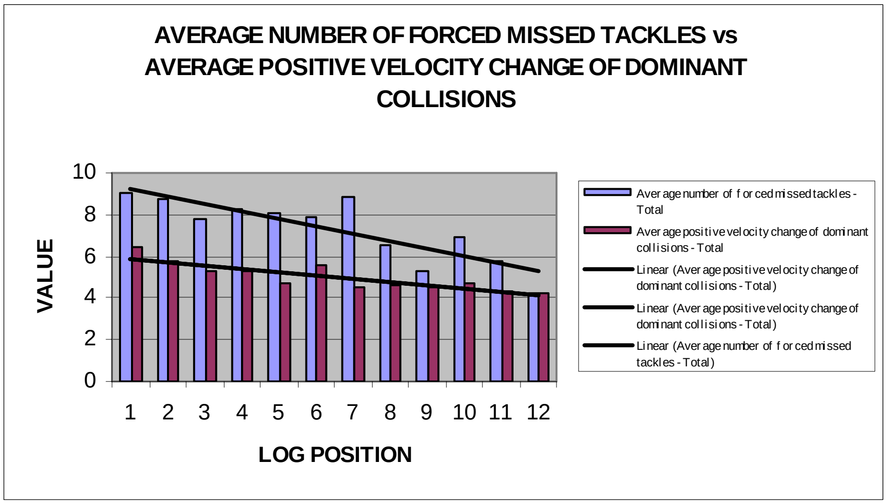


Figure 8.3: Average number of forced missed tackles vs average positive velocity change of dominant collisions

As is evident from Table 8.6 and Figure 8.3, teams that are more successful and that finish higher on the log have a higher rate of forced missed tackles as well as a higher rate of average positive velocity change of dominant collisions.

The higher average positive velocity change of dominant collisions is an indicator of a team's ability to dominate the defender in terms of running into the defender with a greater average momentum than what the defender can bring into the collision situation. This greater momentum into the collision by the ball carrier will most definitely impact on the number of missed tackles made by the defenders as they are not able to impact effectively when executing the tackle. The defender is thus more likely to be knocked over when trying to make the tackle. These two factors are interrelated as they both become lower as the teams are lower on the log.

Table 8.7: Average number of forced missed tackles vs ratio of dominant collision versus passes executed

AVERAGE NUMBER OF FORCED MISSED TACKLES vs RATIO OF DOMINANT COLLISIONS VERSUS PASSES EXECUTED													
	LOG POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	Average number of forced missed tackles - 2003	2.58	2.24	2.26	2.26	2.2	1.87	2.83	2.00	1.82	2.61	1.89	1.47
1	Average number of forced missed tackles - 2004	2.36	2.64	1.45	2.25	2.58	2.17	2.29	1.43	2.05	1.59	2.00	1.23
1	Average number of forced missed tackles - 2005	4.13	3.84	4.04	3.73	3.30	3.80	3.69	3.11	1.42	2.77	1.86	1.56
1	Average number of forced missed tackles - Total	9.07	8.72	7.75	8.24	8.08	7.84	8.81	6.54	5.29	6.97	5.75	4.26
	vs												
2	Ratio of dominant collisions vs passes executed - 2003	1.65	1.31	1.14	1.02	1.19	1.28	1.05	0.97	1.08	1.01	0.92	0.9
2	Ratio of dominant collisions vs passes executed - 2004	0.95	1.26	0.93	0.91	0.99	1.01	1.16	0.82	1.09	0.94	1.01	0.75
2	Ratio of dominant collisions vs passes executed - 2005	1.95	1.48	2.05	1.7	1.16	1.42	1.50	1.50	0.87	1.14	0.77	0.92
2	Ratio of dominant collisions vs passes executed - Total	4.55	4.05	4.12	3.63	3.34	3.71	3.71	3.29	3.04	3.09	2.7	2.57
	1: 2003 / 2: 2003	1.563636	1.709924	1.982456	2.215686	1.848739	1.460938	2.695238	2.061856	1.685185	2.584158	2.054348	1.633333
	1: 2004 / 2: 2004	2.484211	2.095238	1.55914	2.472527	2.606061	2.148515	1.974138	1.743902	1.880734	1.691489	1.980198	1.64
	1: 2005 / 2: 2005	2.117949	2.594595	1.970732	2.194118	2.844828	2.676056	2.46	2.073333	1.632184	2.429825	2.415584	1.695652
	1: TOTAL / 2: TOTAL	1.993407	2.153086	1.881068	2.269972	2.419162	2.113208	2.374663	1.987842	1.740132	2.255663	2.12963	1.657588

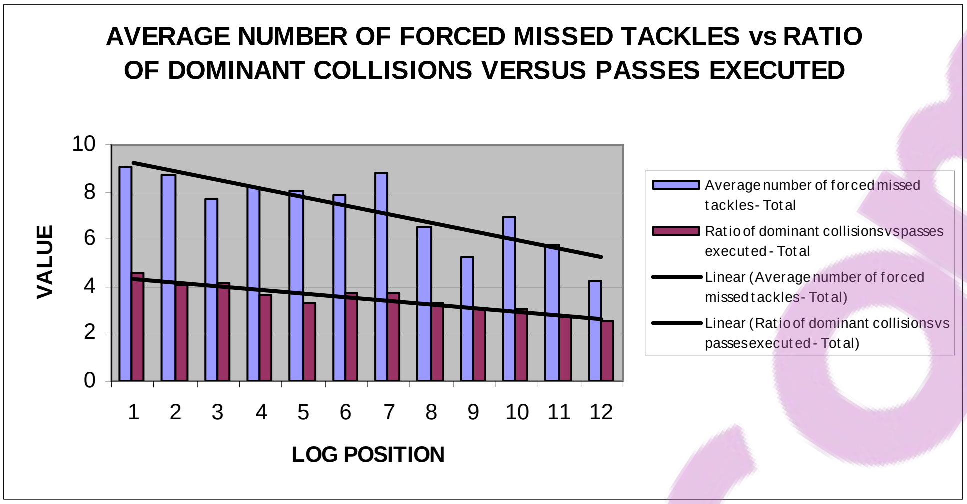


Figure 8.4: Average number of forced missed tackles vs ratio of dominant collisions versus passes executed

As is evident from Table 8.7 and Figure 8.4, teams that are more successful and that finish higher on the log have a higher rate of forced missed tackles as well as a higher ratio of dominant collisions versus passes executed. The ratio of dominant collisions versus passes executed is an indicator of a team's ability to move upwards down the filed of play towards the opposition's try line compared to the team's willingness to move the ball around making use of passes along the field in order to try and do so.

This implies that a team with a higher ratio of dominant collisions versus passes executed is more likely to be confrontational and tends to move forward and run at the opposition than what a team would do that passes the ball more often. The teams that have a lower ratio of dominant collisions versus passes executed attempts to score tries by passing the ball more often in their attempt to shy away from collisions.

Teams that are inclined to run more at the opposition also thus tend to be able to force more missed tackles onto the opposition thus making it more difficult for the defenders to consistently make their tackles. These two factors are interrelated as they both become lower as the teams are lower on the log.

Table 8.8: Total average number of collisions vs average positive velocity change of dominant collisions

	TOTAL AVERAGE NUMBER OF COLLISIONS vs AVERAGE POSITIVE VELOCITY CHANGE OF DOMINANT COLLISIONS												
	LOG POSITION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Average number of collisions – 2003	7.12	5.24	5.53	5.23	5.4	4.23	6.11	4.60	4.71	5.61	4.78	3.53
1	Average number of collisions – 2004	5.53	6.50	3.95	5.19	5.42	4.33	5.08	3.86	5.95	3.71	5.47	4.31
1	Average number of collisions – 2005	7.38	7.23	7.12	7.09	6.74	7.25	6.81	6.00	3.16	5.46	4.00	3.44
1	Average number of collisions – Total	20.03	18.97	16.6	17.51	17.56	15.81	18	14.46	13.82	14.78	14.25	11.28
	vs												
2	Average positive velocity change of dominant collisions - 2003	596	509.1	407.7	407.8	300.7	491.4	285.7	392.02	376.3	489	303.1	283.2
2	Average positive velocity change of dominant collisions - 2004	504.7	538.47	499.13	483.54	448.85	572.16	448.2	428.6	461.1	397.3	414.00	451.1
2	Average positive velocity change of dominant collisions - 2005	818.5	691.2	687.3	694.4	662.78	595.49	610.24	573.83	524.45	531.44	577.45	526.1
2	Average positive velocity change of dominant collisions - Total	639.7	579.6	531.4	528.6	470.8	553	448	464.8	454	472.6	431.5	420.1
2	Average positive velocity change of dominant collisions / 100	6.397	5.796	5.314	5.286	4.708	5.53	4.48	4.648	4.54	4.726	4.315	4.201
	1: 2003 / 2: 2003	0.01195	0.01029	0.01356	0.01282	0.01796	0.00861	0.02139	0.01173	0.01252	0.01147	0.01577	0.01247
	1: 2004 / 2: 2004	0.01096	0.01207	0.00791	0.01073	0.01208	0.00757	0.01134	0.00901	0.0129	0.00934	0.01321	0.00955
	1: 2005 / 2: 2005	0.00902	0.01046	0.01036	0.01021	0.01017	0.01217	0.01116	0.01046	0.00603	0.01027	0.00693	0.00654
	1: TOTAL / 2: TOTAL	0.03131	0.03273	0.03124	0.03313	0.0373	0.02859	0.04018	0.03111	0.03044	0.03127	0.03302	0.02685

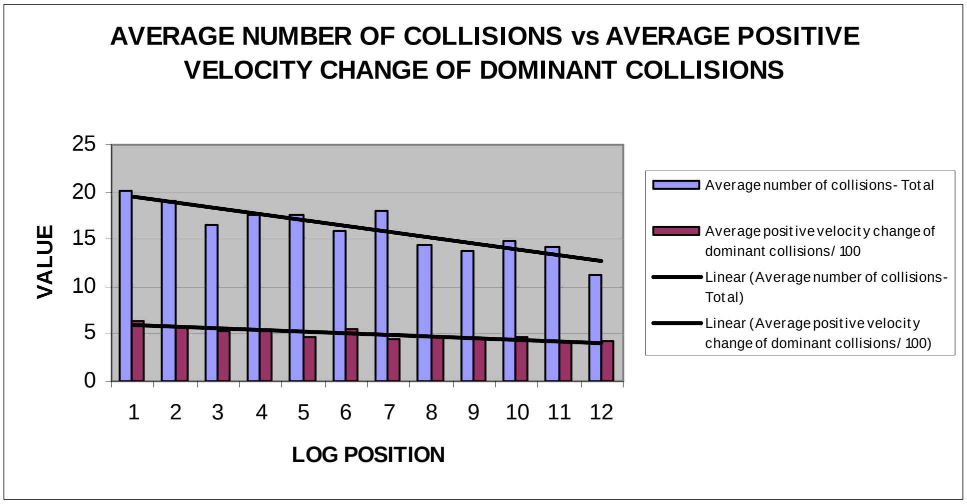


Figure 8.5: Average number of collisions vs average positive velocity change of dominant collisions

As is evident from Table 8.8 and Figure 8.5, teams that are more successful and that finish higher on the log have a higher rate of average number of collisions versus average positive velocity change of dominant collisions. In order for a team to be able to optimally dominate collisions, a crucial component is the team's ability to run hard into the collision site with a higher average positive velocity change. If this is done with repeated regularity, as is indicated by the higher average number of collisions, it thus becomes obvious that these two factors in combination positively affect a team's ability to score a try. As indicated in Figure 8.5, there is a strong correlation between the two factors which indicates that the teams with higher values are most definitely more likely to be successful in their matches that they play. These two factors are interrelated as they both become lower as the teams are lower on the log.

Table 8.9: Total average number of collisions vs ratio of dominant collisions versus passes executed

	TOTAL AVERAGE NUMBER OF COLLISIONS vs RATIO OF DOMINANT COLLISIONS VERSUS PASSES EXECUTED												
	LOG POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	Average number of collisions – 2003	7.12	5.24	5.53	5.23	5.40	4.23	6.11	4.60	4.71	5.61	4.78	3.53
1	Average number of collisions – 2004	5.53	6.50	3.95	5.19	5.42	4.33	5.08	3.86	5.95	3.71	5.47	4.31
1	Average number of collisions – 2005	7.38	7.23	7.12	7.09	6.74	7.25	6.81	6.00	3.16	5.46	4.00	3.44
1	Average number of collisions – Total	20.03	18.97	16.60	17.51	17.56	15.81	18.00	14.46	13.82	14.78	14.25	11.28
	vs												
2	Ratio of dominant collisions vs passes executed - 2003	1.65	1.31	1.14	1.02	1.19	1.28	1.05	0.97	1.08	1.01	0.92	0.90
2	Ratio of dominant collisions vs passes executed - 2004	0.95	1.26	0.93	0.91	0.99	1.01	1.16	0.82	1.09	0.94	1.01	0.75
2	Ratio of dominant collisions vs passes executed - 2005	1.95	1.48	2.05	1.7	1.16	1.42	1.50	1.50	0.87	1.14	0.77	0.92
2	Ratio of dominant collisions vs passes executed - Total	4.55	4.05	4.12	3.63	3.34	3.71	3.71	3.29	3.04	3.09	2.70	2.57
	1: 2003 / 2: 2003	4.31515	4.00000	4.85088	5.12745	4.53782	3.30469	5.81905	4.74227	4.36111	5.55446	5.19565	3.92222
	1: 2004 / 2: 2004	5.82105	5.15873	4.24731	5.7033	5.47475	4.28713	4.37931	4.70732	5.45872	3.94681	5.41584	5.74667
	1: 2005 / 2: 2005	3.78462	4.88514	3.47317	4.17059	5.81034	5.10563	4.54000	4.00000	3.63218	4.78947	5.19481	3.73913
	1: TOTAL / 2: TOTAL	4.4022	4.68395	4.02913	4.82369	5.25749	4.26146	4.85175	4.39514	4.54605	4.78317	5.27778	4.38911

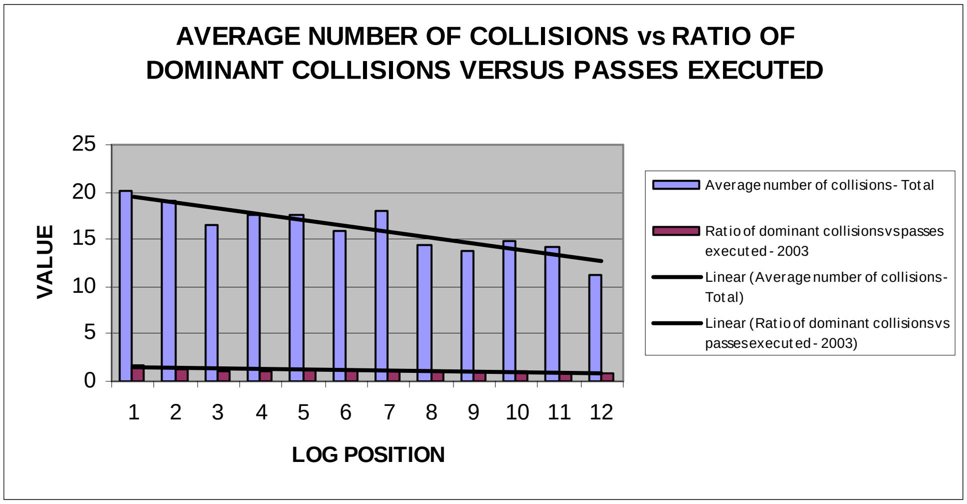


Figure 8.6: Average number of collisions vs ratio of dominant collisions versus passes executed

As is evident from Table 8.9 and Figure 8.6, teams that are more successful and that finish higher on the log have a higher average number of collisions versus ratio of dominant collisions versus passes executed.

The correlation between these two factors indicates that teams that focus more on running hard and effectively at the opposition are more likely to dominate collisions and thus be more successful in the matches that they have played. The number of collisions taking place is higher thus the team is more physically dominant at the collision site and is thus more successful.

These two factors are interrelated as they both become lower as the teams are lower on the log.

Table 8.10: Ratio of dominant collisions versus passes executed vs average positive velocity change

	RATIO OF DOMINANT COLLISIONS VERSUS PASSES EXECUTED vs AVERAGE POSITIVE VELOCITY CHANGE												
	LOG POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	Ratio of dominant collisions vs passes executed - 2003	1.65	1.31	1.14	1.02	1.19	1.28	1.05	0.97	1.08	1.01	0.92	0.9
1	Ratio of dominant collisions vs passes executed - 2004	0.95	1.26	0.93	0.91	0.99	1.01	1.16	0.82	1.09	0.94	1.01	0.75
1	Ratio of dominant collisions vs passes executed - 2005	1.95	1.48	2.05	1.7	1.16	1.42	1.50	1.50	0.87	1.14	0.77	0.92
1	Ratio of dominant collisions vs passes executed - Total	4.55	4.05	4.12	3.63	3.34	3.71	3.71	3.29	3.04	3.09	2.70	2.57
	vs												
2	Average positive velocity change of dominant collisions - 2003	596.0	509.1	407.7	407.8	300.7	491.4	285.7	392.02	376.3	489.0	303.1	283.2
2	Average positive velocity change of dominant collisions - 2004	504.7	538.47	499.13	483.54	448.85	572.16	448.2	428.6	461.1	397.3	414.00	451.1
2	Average positive velocity change of dominant collisions - 2005	818.5	691.2	687.3	694.4	662.78	595.49	610.24	573.83	524.45	531.44	577.45	526.1
2	Average positive velocity change of dominant collisions - Total	639.7	579.6	531.4	528.6	470.8	553	448	464.8	454	472.6	431.5	420.1
2	Average positive velocity change of dominant collisions / 100	6.397	5.796	5.314	5.286	4.708	5.53	4.48	4.648	4.54	4.726	4.315	4.201
	1: 2003 / 2: 2003	0.00277	0.00257	0.0028	0.0025	0.00396	0.00261	0.00368	0.00247	0.00287	0.00207	0.00304	0.00318
	1: 2004 / 2: 2004	0.00188	0.00234	0.00186	0.00188	0.00221	0.00177	0.00259	0.00191	0.00236	0.00237	0.00244	0.00166
	1: 2005 / 2: 2005	0.00238	0.00214	0.00298	0.00245	0.00175	0.00238	0.00246	0.00261	0.00166	0.00215	0.00133	0.00175
	1: TOTAL / 2: TOTAL	0.00711	0.00699	0.00775	0.00687	0.00709	0.00671	0.00828	0.00708	0.0067	0.00654	0.00626	0.00612

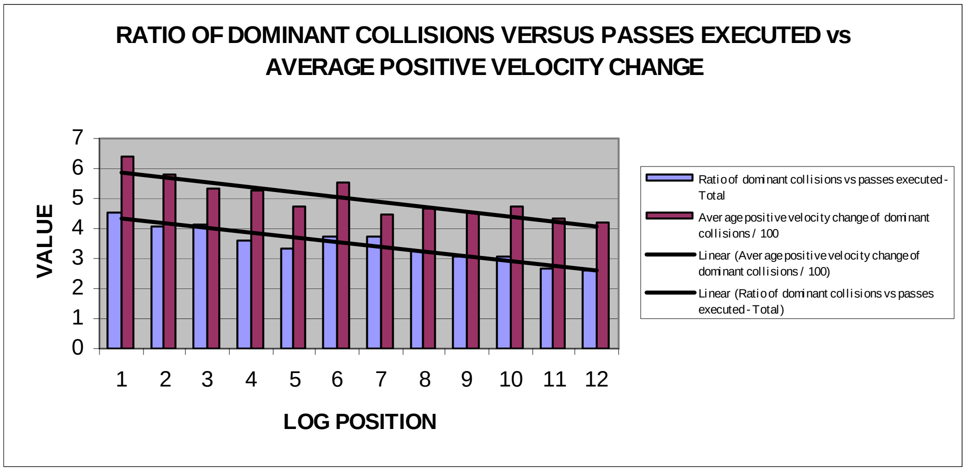


Figure 8.7: Ratio of dominant collisions versus passes executed vs average positive velocity change of dominant collisions

As is evident from Table 8.10 and Figure 8.7, teams that are more successful and that finish higher on the log have a higher ratio of dominant collisions versus passes executed versus average positive velocity change.

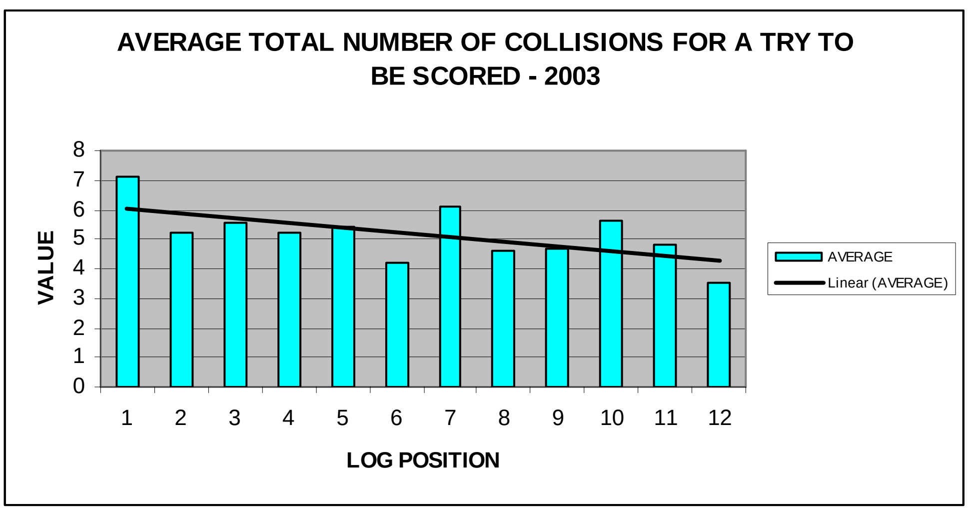
These two factors show a correlation that the teams that are able to dominate collisions better in terms of their ability to carry a higher average momentum into the collision as well as their focus on moving forward at the defenders, most definitely results in a more successful team. They are more able to physically confront the defensive opposition and thus dominate the defenders.

These two factors are interrelated as they both become lower as the teams are lower on the log.

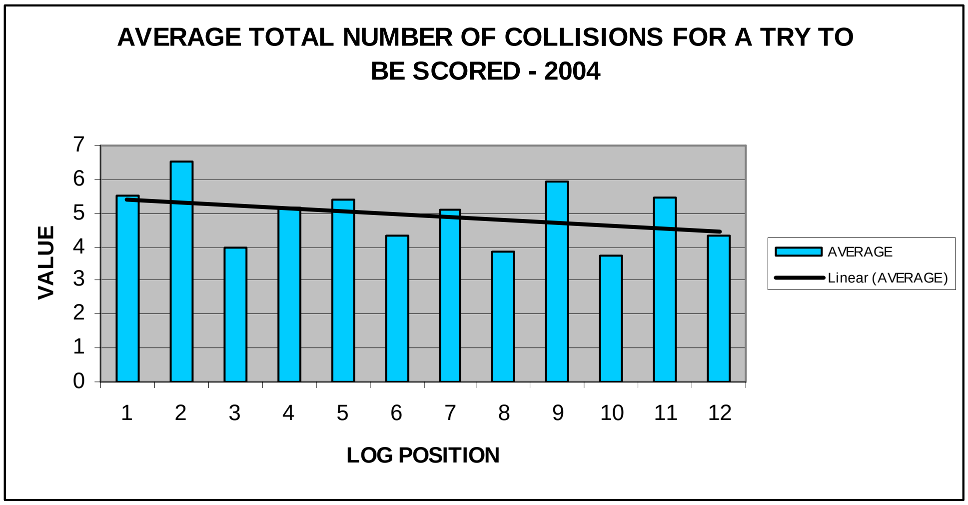
Table 8.11: Average total number of collisions for a try to be scored

AVERAGE TOTAL NUMBER OF COLLISIONS FOR A TRY TO BE SCORED												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
AVERAGE	7.12	5.24	5.53	5.23	5.40	4.23	6.11	4.60	4.71	5.61	4.78	3.53
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
AVERAGE	5.53	6.50	3.95	5.19	5.42	4.33	5.08	3.86	5.95	3.71	5.47	4.31
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLUES	HIGH	STO	REDS	CATS	SHA
AVERAGE	7.38	7.23	7.12	7.09	6.74	7.25	6.81	6.00	3.16	5.46	4.00	3.44

(a)



(b)



(c)

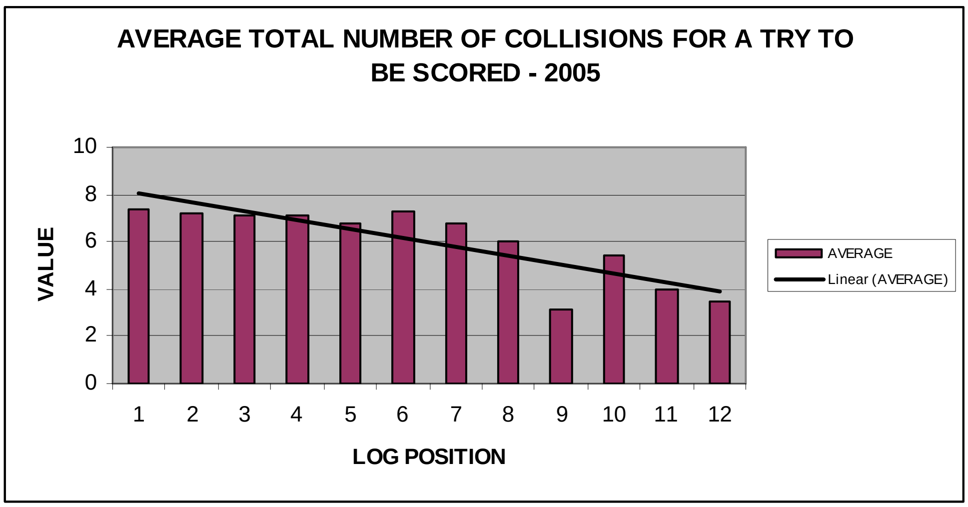


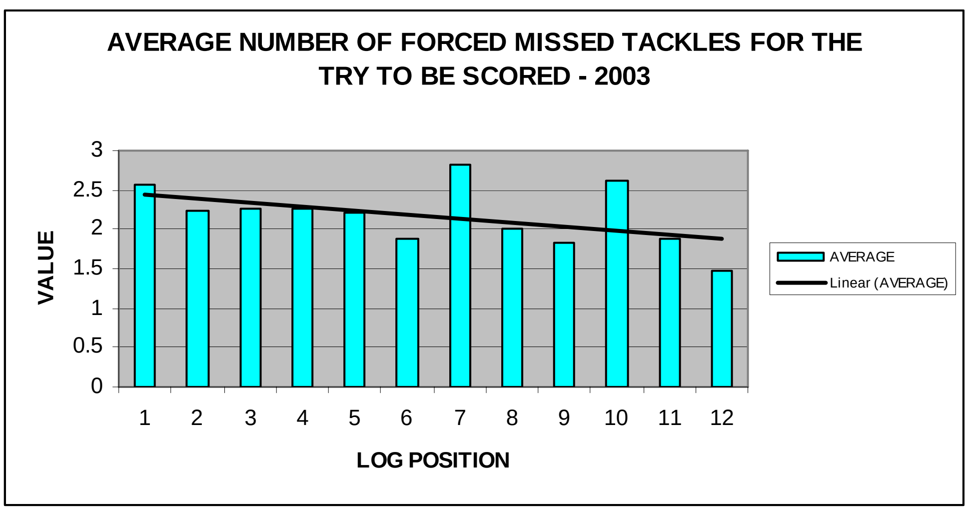
Figure 8.8 (a,b,c): Average total number of collisions for a try to be scored (2003, 2004 and 2005)

When Table 8.11 and Figures 8.8 (a,b,c) were evaluated it indicated that teams that are placed higher on the log statistically, made more dominant collisions in their attacking play before a try was scored. This could be due to various reasons, for example, with more dominant collisions, the attacking team was able to get more effective forward momentum, this in turn makes it difficult for the defending team to be able to fold effectively in term the attacking team was able to run hard at the opposition and be more effective at "hitting" the defender.

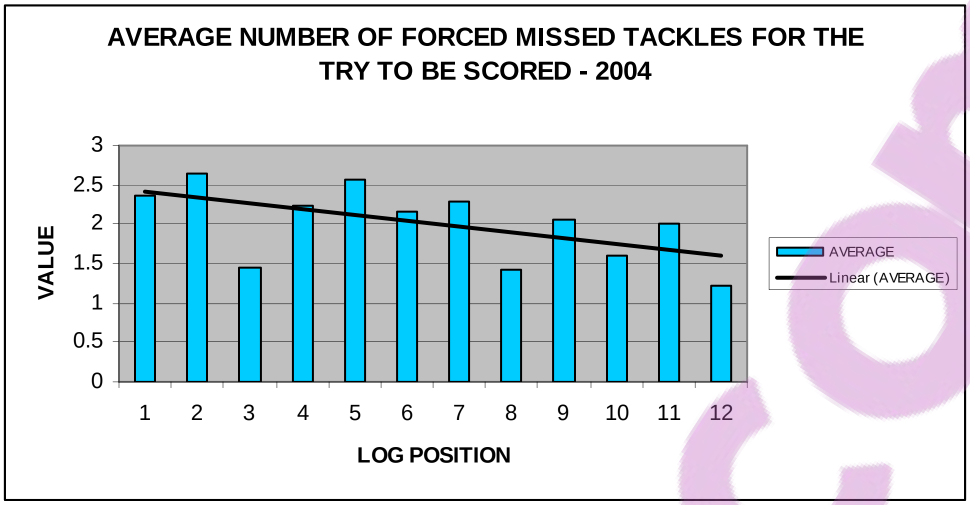
Table 8.12: Average number of forced missed tackles for the try to be scored

AVERAGE NUMBER OF FORCED MISSED TACKLES FOR THE TRY TO BE SCORED												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
AVERAGE	2.58	2.24	2.26	2.26	2.20	1.87	2.83	2.00	1.82	2.61	1.89	1.47
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
AVERAGE	2.36	2.64	1.45	2.25	2.58	2.17	2.29	1.43	2.05	1.59	2.00	1.23
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLUES	HIGH	STO	REDS	CATS	SHA
AVERAGE	4.13	3.84	4.04	3.73	3.30	3.80	3.69	3.11	1.42	2.77	1.86	1.56

(a)



(b)



(c)

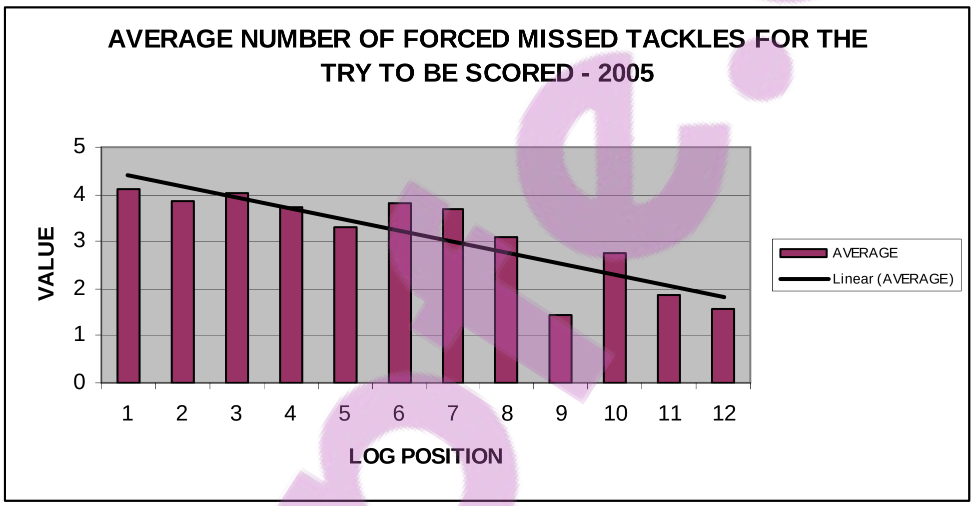


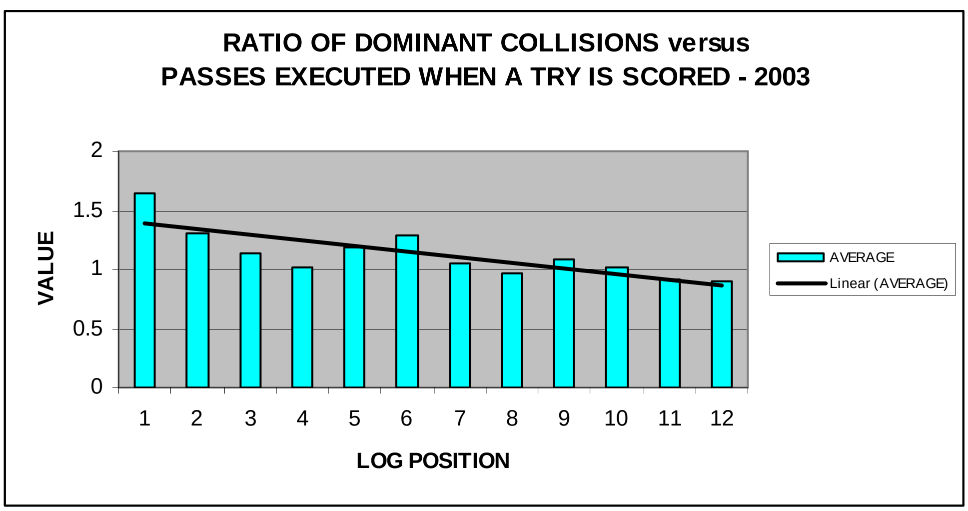
Figure 8.9 (a,b,c): Average number of forced missed tackles for the try to be scored (2003, 2004 and 2005)

After evaluation of Table 8.12 and Figures 8.9 (a,b,c), it becomes evident that those teams that were placed higher up on the log, forced more missed tackles onto the opposition during attacking play when scoring the try.

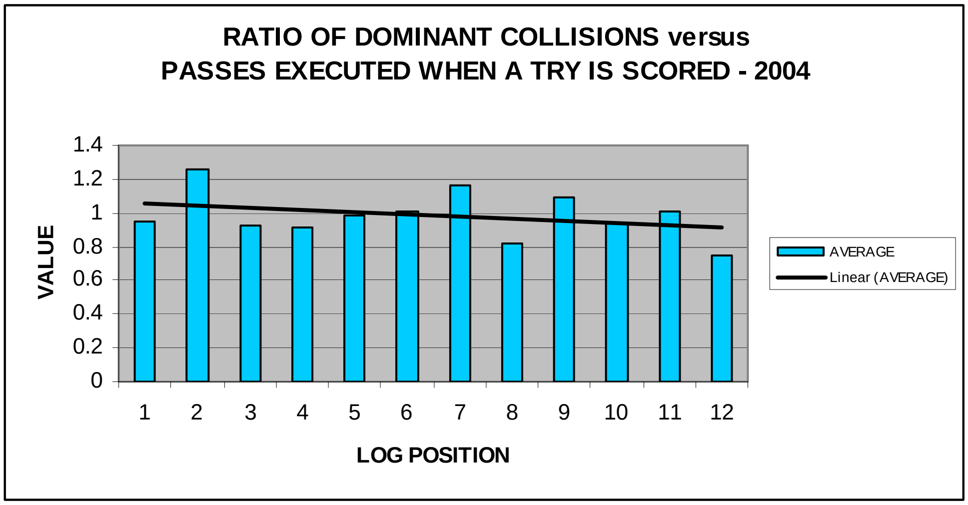
Table 8.13: Ratio of dominant collisions versus passes executed when a try is scored

RATIO OF DOMINANT COLLISIONS versus PASSES EXECUTED WHEN A TRY IS SCORED												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHIEFS	SHA	CATS
AVERAGE	1.65	1.31	1.14	1.02	1.19	1.28	1.05	0.97	1.08	1.01	0.92	0.9
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHIEFS	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
AVERAGE	0.95	1.26	0.93	0.91	0.99	1.01	1.16	0.82	1.09	0.94	1.01	0.75
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHIEFS	BLUES	HIGH	STO	REDS	CATS	SHA
AVERAGE	1.95	1.48	2.05	1.70	1.16	1.42	1.50	1.50	0.87	1.14	0.77	0.92

(a)



(b)



(c)

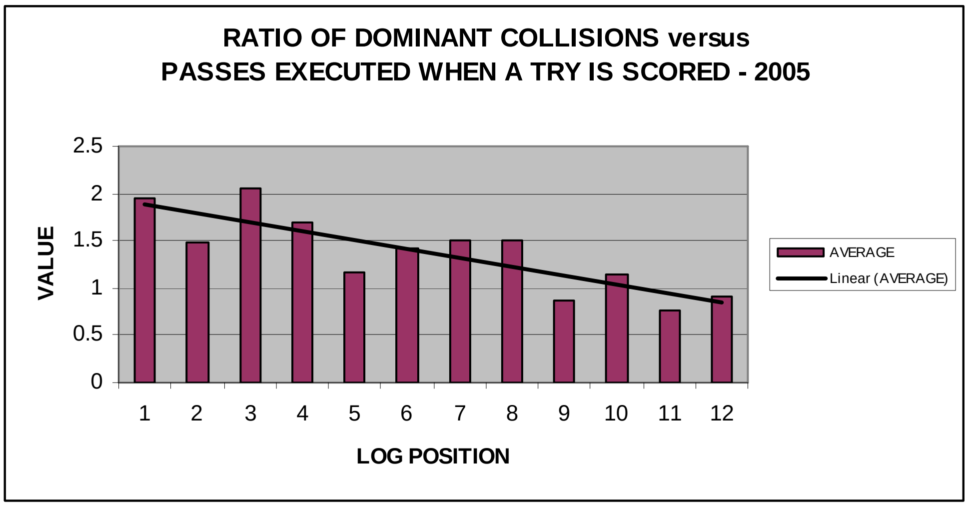


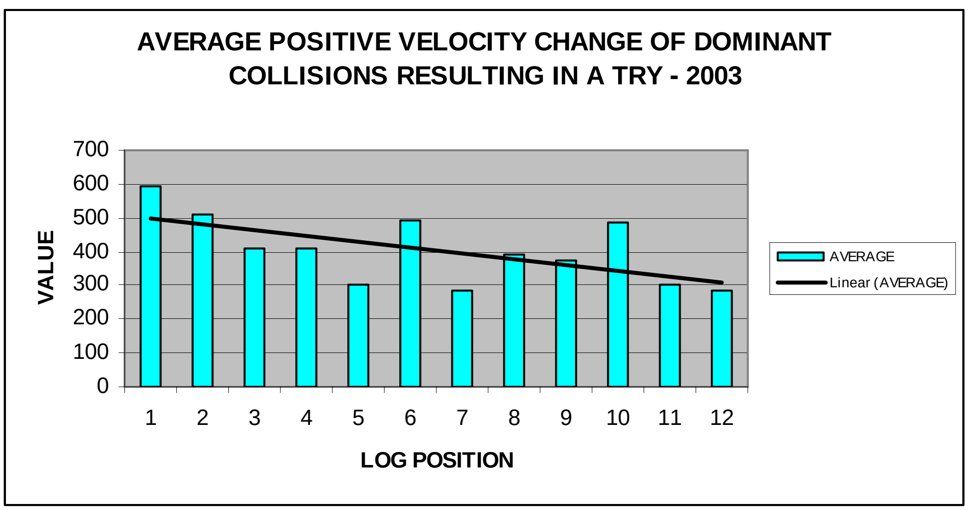
Figure 8.10 (a,b,c): Ratio of dominant collisions versus passes executed when a try is scored (2003, 2004 and 2005)

After evaluation of Table 8.13 and Figures 8.10 (a,b,c), the following tendency was identified. The teams that finished higher on the log had a higher ratio of collisions when compared with the number of passes that were executed. When the team had a ratio of above one, this was an indication that those teams made more dominant collisions than passes for their tries to be scored. It becomes obvious that those teams that placed higher on the log had a markedly higher value above 1 and those teams that were under 0 were markedly lower on the log.

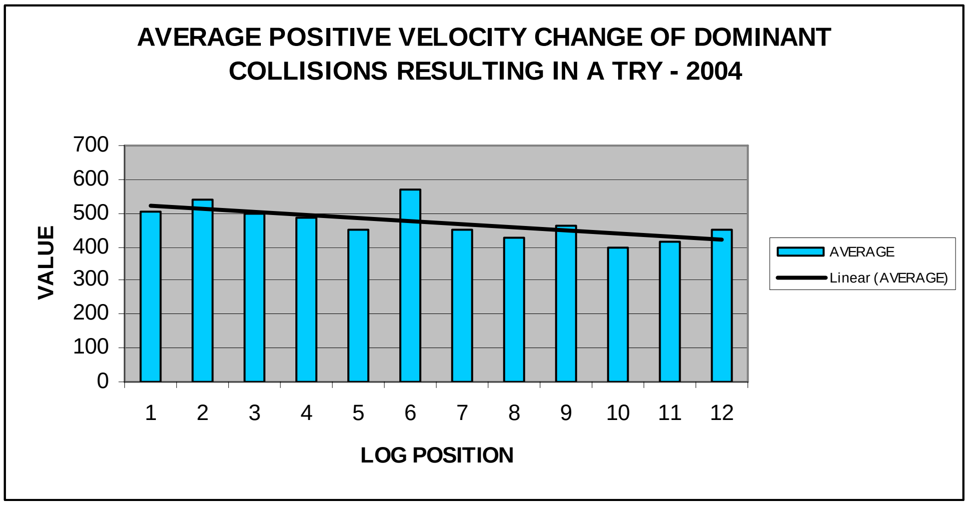
Table 8.14: Average positive velocity change of dominant collisions resulting in a try being scored

AVERAGE POSITIVE VELOCITY CHANGE OF DOMINANT COLLISIONS RESULTING IN A TRY												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHIEFS	SHA	CATS
AVERAGE	596.02	509.05	407.67	407.80	300.65	491.35	285.65	392.02	376.33	489.02	303.05	283.19
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHIEFS	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
AVERAGE	504.73	538.47	499.13	483.54	448.85	572.16	448.15	428.58	461.12	397.34	414.00	451.09
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHIEFS	BLUES	HIGH	STO	REDS	CATS	SHA
AVERAGE	818.46	691.21	687.25	694.39	662.78	595.49	610.24	573.83	524.45	531.44	577.45	526.12

(a)



(b)



(c)

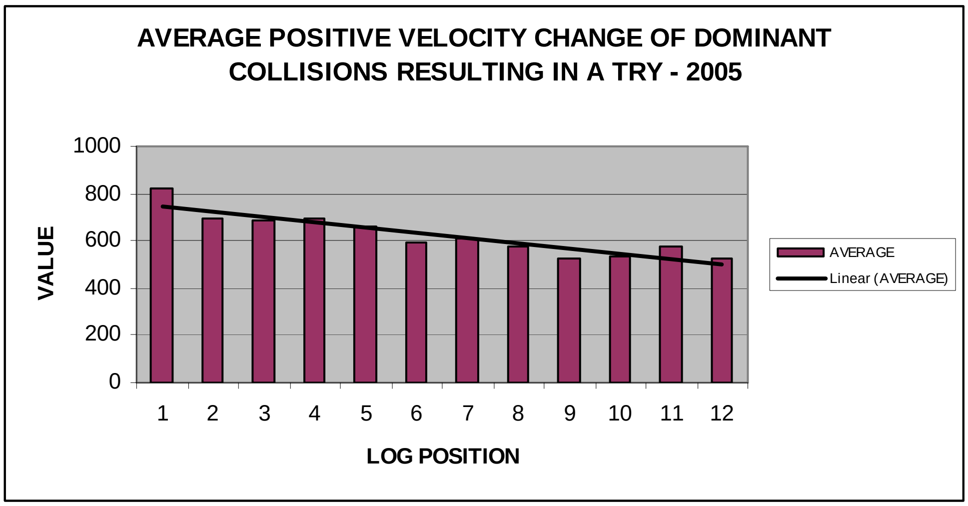


Figure 8.11 (a,b,c): Average positive velocity change of dominant collisions resulting in a try being scored (2003, 2004 and 2005)

After evaluating Table 8.14 and Figure 8.11 (a,b,c), it is noticeable that those teams that finished higher on the log statistically have a higher average positive velocity change than those teams that finished lower on the log when a try was scored. This indicates that those teams that dominated the collision site with a greater force were more successful on the log.

8.8 Cross tabulation of the data

The final stage of the statistical analysis is a cross tabulation of the respective data. The data is compared from the year 2003 to 2005 and indicates the relative percentage changes of the key performance measurements.

As can be seen from Tables 8.15(a), 8.15(b), and 8.16 there is without doubt a strong correlation between the increases in percentage change of teams that are higher on the log than those teams that are placed lower down on the log.

The teams that showed a greater increased change in the key performance measurements were more inclined to improve their success and thus performed better in the relevant competitions.

Table 8.15 (a): Rate of change in collisions between teams ranked from position 1 through to 6; 2003-2005

RATE OF CHANGE 2003 - 2005 POSITION 1 - 6																		
2003	CRUSADERS			BLUES			HURRICANES			ACT			NSW			BULLS		
Average forced missed tackles	2.58			2.2			2.26			2.3			2.2			1.9		
Average number of collisions	7.12			5.2			5.53			5.2			5.4			4.2		
Ratio of collisions vs passes	1.65			1.3			1.14			1			1.19			1.3		
Average positive velocity change/100	5.96			5.1			4.08			4.1			3.01			4.9		
2004	CRUSADERS			BLUES			HURRICANES			ACT			NSW			BULLS		
Average forced missed tackles	2.64	2.3%		2.6	15.2%		2	-11.5%		2.4	4.4%		2.29	4.1%		2.2	16.0%	
Average number of collisions	6.5	-8.7%		5.4	3.4%		5.47	-1.1%		5.5	5.7%		5.08	-5.9%		4.3	2.4%	
Ratio of collisions vs passes	1.26	-23.6%		1	-24.4%		1.01	-11.4%		1	-6.9%		1.16	-2.5%		1	-21.1%	
Average positive velocity change/100	5.38	-9.7%		4.5	-11.8%		4.14	1.6%		5	23.8%		4.48	49.1%		5.7	16.4%	
2005	CRUSADERS			BLUES			HURRICANES			ACT			NSW			BULLS		
Average forced missed tackles	4.13	56.4%	60.1%	3.7	43.0%	64.7%	3.73	86.5%	65.0%	3.3	39.8%	46.0%	3.84	67.7%	74.5%	4	86.2%	116.0%
Average number of collisions	7.38	13.5%	3.7%	6.8	25.6%	30.0%	7.09	29.6%	28.2%	6.7	21.9%	28.9%	7.23	42.3%	33.9%	7.1	64.4%	68.3%
Ratio of collisions vs passes	1.95	54.8%	18.2%	1.5	51.5%	14.5%	1.7	68.3%	49.1%	1.2	22.1%	13.7%	1.48	27.6%	24.4%	2.1	103.0%	60.2%
Average positive velocity change/100	8.18	52.0%	37.3%	6.1	36.0%	19.9%	6.94	67.7%	70.3%	6.6	31.3%	62.5%	6.91	54.2%	129.9%	6.9	20.1%	39.9%

	CRUSADERS	BLUES	HURRICANES	ACT	NSW	BULLS
Position 2003	1	2	3	4	5	6
Position 2004	2	5	11	1	7	6
Position 2005	1	7	4	5	2	3
Position - Average	1	5	6	3	5	5
Class A changes 2003 - 2004	0	0	0	0	1	0
Class B changes 2003 - 2004	0	0	0	0	0	0
Class A changes 2004 - 2005	3	3	1	2	1	1
Class B changes 2004 - 2005	0	0	2	0	1	2
Class A changes 2003 - 2005	1	1	1	1	1	1
Class B changes 2003 - 2005	1	1	2	1	2	3
Total Class A changes	4	4	2	3	3	2
Total Class B changes	1	1	4	1	3	5
Total Changes	5	5	6	4	6	7

Table 8.15 (b): Rate of change in collisions between teams ranked from position 7 through to 12; 2003-2005

RATE OF CHANGE 2003 - 2005 POSITION 7 - 12

2003	HIGHLANDERS			REDS			STORMERS			CHIEFS			SHARKS			CATS		
Average forced missed tackles	2.83			2			1.82			2.6			1.89			1.5		
Average number of collisions	6.11			4.6			4.71			5.6			4.78			3.5		
Ratio of collisions vs passes	1.05			1			1.08			1			0.92			0.9		
Average positive velocity change/100	2.86			3.9			3.76			4.9			3.03			2.8		

2004	HIGHLANDERS			REDS			STORMERS			CHIEFS			SHARKS			CATS		
Average forced missed tackles	2.05	-27.6%		1.6	-20.5%		1.45	-20.3%		2.3	-13.8%		1.43	-24.3%		1.2	-16.3%	
Average number of collisions	5.95	-2.6%		3.7	-19.3%		3.95	-16.1%		5.2	-7.5%		3.86	-19.2%		4.3	22.1%	
Ratio of collisions vs passes	1.09	3.8%		0.9	-3.1%		0.93	-13.9%		0.9	-9.9%		0.82	-10.9%		0.8	-16.7%	
Average positive velocity change/100	4.61	61.4%		4	1.4%		4.99	32.6%		4.8	-1.1%		4.29	41.4%		4.5	59.3%	

2005	HIGHLANDERS			REDS			STORMERS			CHIEFS			SHARKS			CATS		
Average forced missed tackles	3.11	51.7%	9.9%	2.8	74.2%	38.5%	1.42	-2.1%	-22.0%	3.8	68.9%	45.6%	1.56	9.1%	-17.5%	1.9	51.2%	26.5%
Average number of collisions	6	0.8%	-1.8%	5.5	47.2%	18.7%	3.16	-20.0%	-32.9%	7.3	39.7%	29.2%	3.44	-10.9%	-28.0%	4	-7.2%	13.3%
Ratio of collisions vs passes	1.5	37.6%	42.9%	1.1	21.3%	17.5%	0.87	-6.5%	-19.4%	1.4	56.0%	40.6%	0.92	12.2%	0.0%	0.8	2.7%	-14.4%
Average positive velocity change/100	5.74	24.4%	100.9%	5.3	33.7%	35.6%	5.24	5.1%	39.4%	6	23.2%	21.8%	5.26	22.8%	73.6%	5.8	28.0%	103.9%

	HIGHLANDERS	REDS	STORMERS	CHIEFS	SHARKS	CATS
Position 2003	7	8	9	10	11	12
Position 2004	9	10	3	4	8	12
Position 2005	8	10	9	6	12	11
Position - Average	8	9	7	7	10	12
Class A changes 2003 - 2004	0	0	1	0	1	1
Class B changes 2003 - 2004	1	0	0	0	0	0
Class A changes 2004 - 2005	1	2	0	2	0	1
Class B changes 2004 - 2005	0	1	0	1	0	0
Class A changes 2003 - 2005	1	2	2	2	0	0
Class B changes 2003 - 2005	1	0	0	0	1	1
Total Class A changes	2	4	3	4	1	2
Total Class B changes	2	1	0	1	1	1
Total Changes	4	5	3	5	2	3

Table 8.16: Changes in collisions 2003 – 2005 between nations

CHANGES IN COLLISIONS 2003 - 2005 BETWEEN NATIONS									
2003	NZ			SA			AUS		
Average forced missed tackles	2.5			1.8			2.15		
Average number of collisions	5.92			4.3			5.08		
Ratio of collisions vs passes	1.23			1			1.06		
Average positive velocity change / 100	4.57			3.6			3.67		
2004	NZ			SA			AUS		
Average forced missed tackles	2.3	-8.0%		1.6	-10.9%		2.08	-3.4%	
Average number of collisions	5.71	-3.6%		4.1	-4.6%		4.77	-6.0%	
Ratio of collisions vs passes	1.05	-14.6%		0.9	-16.0%		1.02	-4.1%	
Average positive velocity change / 100	4.69	2.6%		4.9	34.2%		4.5	22.7%	
2005	NZ			SA			AUS		
Average forced missed tackles	3.69	60.2%	47.4%	2.2	41.4%	26.0%	3.3	58.8%	53.4%
Average number of collisions	6.91	21.0%	16.6%	4.4	7.7%	2.7%	6.48	35.7%	27.6%
Ratio of collisions vs passes	1.61	53.4%	31.0%	1.2	31.3%	10.3%	1.26	23.9%	18.9%
Average positive velocity change / 100	6.58	40.3%	43.9%	5.8	18.7%	59.2%	6.28	39.6%	71.3%

	NZ	SA	Aus
Class A changes from 2003 - 2004	0	1	0
Class B changes from 2003 - 2004	0	0	0
Class A changes from 2004 - 2005	2	2	3
Class B changes from 2004 - 2005	1	0	0
Class A changes from 2003 - 2005	3	1	2
Class B changes from 2003 - 2005	0	0	1
Total Class A changes	5	4	1
Total Class B changes	1	0	1
Total Changes	6	4	2

The major reason for the South African team's higher value regarding change in regard to the four key performance factors is most definitely due to the Bulls markedly higher values attained during the competitions participated in during the 2004 and 2005 seasons. This is also shown by the Bulls high log finishing positions in 2004 and 2005. If the Bulls team performed at the same level as the other South African teams, the total changes would most definitely be significantly lower. It becomes evident that those teams that endeavoured to improve their collision statistics in the four key performance areas, were more successful than those teams that did not.

CHAPTER 9

RECOMMENDATIONS

Although there were numerous observations made, recommendations will be isolated to those factors where dominant collisions affecting the scoring of a try will be discussed.

9.1 INTERPRETATION OF THE DATA

In rugby, there is a name for teams that fail to execute the fundamentals: losers. And there is nothing more fundamental in rugby than ball carrying collisions and non ball carrying collisions (rucking and tackling). Incredible moves, and exceptional incisive runs are fun to watch and can make the difference in a game or two over the course of a season, but they ultimately mean little if the team is failing at the basics. A superb athlete who has been well coached and has the aggressive desire to make an impact on the game will consistently make solid tackles and ball carrying collisions – the kind that make the team's plays work and force those of his opponents to fail.

The ultimate collision athlete has to have the work ethic and technical skills of a consummate professional along with the heart of a warrior, the ability to read the play of the opposition, and the ability to close with ferocious speed on a ball carrier or defender. Looming in the runner's or defender's path with his head up and shoulders squared, driving through the ball carrier or defender with an incredibly beautiful, fluid motion that results in the defender being smashed in the ensuing collision and brushed away at will, the ball being dislodged from the ball carriers grasp or the ball carrier lying flat on his back and being driven into the ground.

In order to begin the necessary recommendations a broad overview is important to know from which facet of play the tries that were evaluated were scored from. This sets the beginning point of the play as well as the necessary discussions.

Table 9.1: Distribution of tries scored as a percentage – 2003

DISTRIBUTION OF TRIES SCORED AS A PERCENTAGE - 2003								
Log Position	Team	Restarts	Left Scrum	Middle Scrum	Right Scrum	Left Lineout	Right Lineout	T/O or Pen
1	CRUSADERS	0%	10%	6%	10%	13%	13%	48%
2	BLUES	6%	4%	6%	9%	18%	9%	48%
3	HURRICANES	12%	6%	3%	9%	29%	6%	35%
4	ACT	7%	13%	7%	0%	27%	7%	39%
5	NSW	4%	10%	0%	4%	40%	8%	34%
6	BULLS	4%	4%	0%	13%	14%	17%	48%
7	HIGHLANDERS	11%	11%	6%	0%	28%	11%	33%
8	REDS	7%	7%	0%	2%	40%	13%	31%
9	STORMERS	0%	0%	12%	11%	0%	12%	65%
10	CHIEFS	5%	10%	5%	0%	19%	9%	52%
11	SHARKS	11%	11%	17%	11%	0%	6%	44%
12	CATS	0%	6%	0%	0%	7%	0%	87%

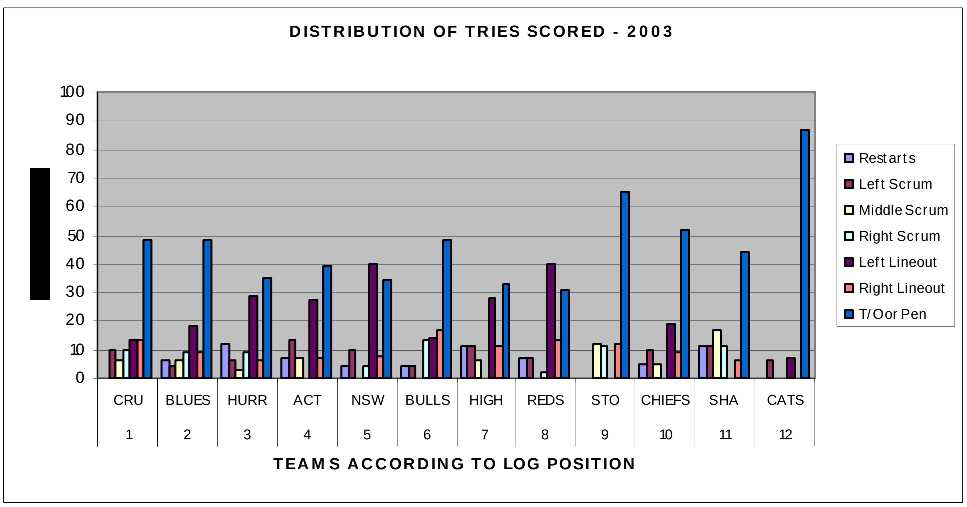


Figure 9.1: Distribution of tries scored – 2003

As is evident from Table 9.1 and Figure 9.1, it indicates that most tries scored during the 2003 Super 12 season were in fact scored from turnover possession. The second most tries from left hand lineouts and third most tries from left hand scrums.

Table 9.2: Distribution of tries scored as a percentage – 2004

DISTRIBUTION OF TRIES SCORED AS A PERCENTAGE - 2004								
LOG POSITION	TEAM	RESTARTS	LEFT SCRUM	MIDDLE SCRUM	RIGHT SCRUM	LEFT LINEOUT	RIGHT LINEOUT	T/O or PEN
1	ACT	0%	13%	0%	6%	26%	8%	47%
2	CRUSADERS	5%	14%	4%	0%	23%	15%	39%
3	STORMERS	0%	5%	0%	0%	36%	14%	45%
4	CHIEFS	0%	40%	0%	0%	20%	7%	33%
5	BLUES	4%	21%	1%	8%	33%	8%	25%
6	BULLS	0%	3%	2%	8%	16%	21%	50%
7	NSW	0%	4%	1%	4%	26%	21%	44%
8	SHARKS	0%	9%	7%	0%	29%	7%	48%
9	HIGHLANDERS	5%	0%	0%	16%	21%	5%	53%
10	REDS	0%	7%	1%	6%	33%	9%	44%
11	HURRICANES	0%	7%	1%	0%	27%	4%	61%
12	CATS	8%	15%	0%	3%	8%	2%	64%

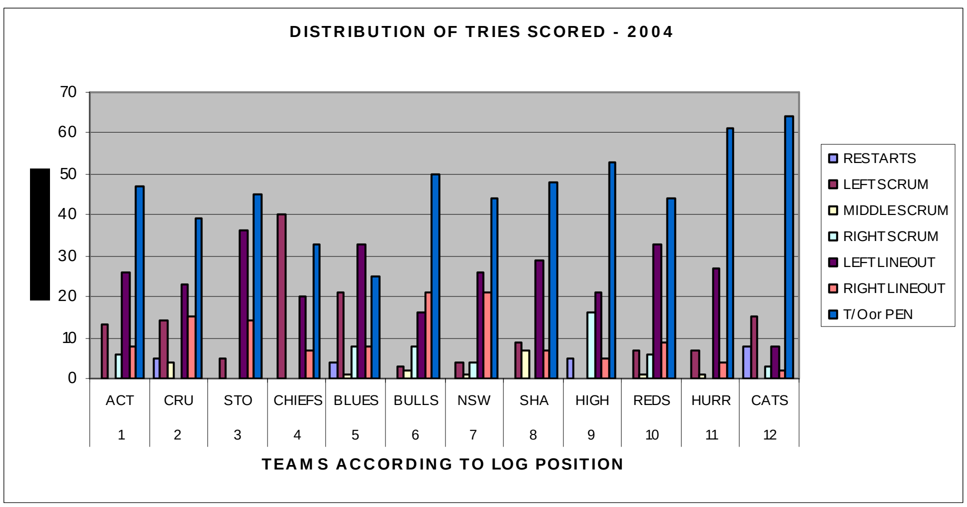


Figure 9.2: Distribution of tries scored – 2004

As is evident from Table 9.2 and Figure 9.2, it indicates that most tries scored during the 2004 Super 12 season were in fact scored from turnover possession. The second most tries from left hand lineouts and third most tries from left hand scrums.

Table 9.3: Distribution of tries scored as a percentage – 2005

DISTRIBUTION OF TRIES SCORED AS A PERCENTAGE - 2005								
LOG POSITION	TEAM	RESTARTS	LEFT SCRUM	MIDDLE SCRUM	RIGHT SCRUM	LEFT LINEOUT	RIGHT LINEOUT	T/O or PEN
1	CRUSADERS	3%	5%	0%	4%	18%	8%	62%
2	NSW	0%	10%	1%	6%	29%	6%	48%
3	BULLS	5%	7%	8%	0%	8%	4%	68%
4	HURRICANES	0%	5%	1%	4%	36%	9%	45%
5	ACT	0%	7%	0%	4%	63%	15%	11%
6	CHIEFS	0%	11%	0%	0%	26%	10%	53%
7	BLUES	0%	15%	0%	4%	15%	8%	58%
8	HIGHLANDERS	0%	6%	5%	0%	28%	0%	61%
9	STORMERS	0%	26%	5%	0%	16%	16%	37%
10	REDS	0%	16%	0%	15%	23%	15%	31%
11	CATS	0%	14%	0%	0%	14%	21%	51%
12	SHARKS	0%	7%	6%	0%	25%	6%	56%

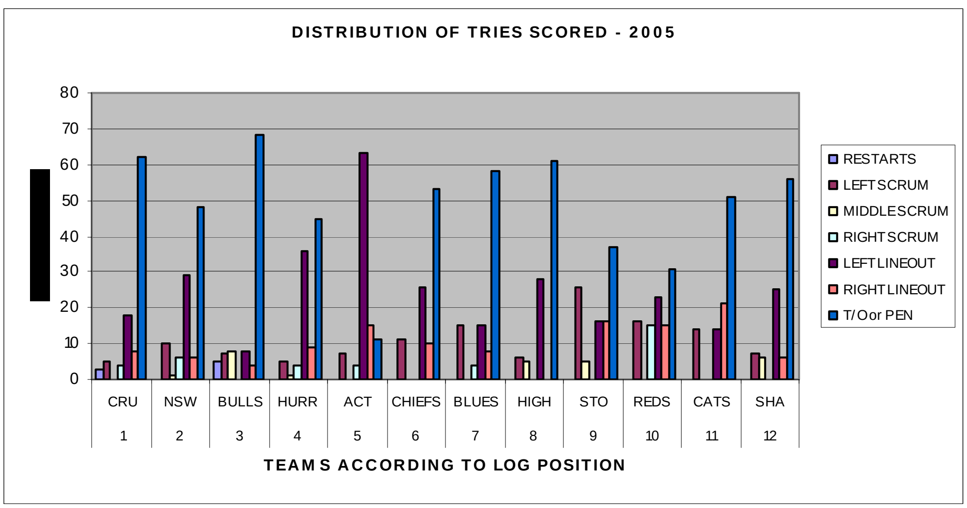


Figure 9.3: Distribution of tries scored - 2005

As is evident from Table 9.3 and Figure 9.3, it indicates that most tries scored during the 2005 Super 12 season were in fact scored from turnover possession. The second most tries from left hand lineouts and third most tries from left hand scrums.

9.2 PHYSICS versus ABILITY: WHAT IS THE LINK?

Physical law places absolute limits on what players can and can't do. Physics can be used to understand why the tried-and-true, basic advice that coaches give to their players about technique works so well in rugby. It is possible to use physics to reveal just how incredibly talented rugby union players have to be to do what they do, and in such spectacular fashion. But when one gets into the detailed differences between the running ability of two players, for example, or try to analyse why a poorer team beats a good one, it becomes increasingly difficult to make definitive statements. Part of the problem is that human beings are extremely complicated biomechanical machines.

The attempt to make a detailed analysis of how humans move, especially with regard to sports activities is the area of kinesiology. One of the main goals of kinesiology is to develop guidelines for what is and isn't good technique in a given sports activity. What becomes increasingly obvious is that although trends can be identified when evaluating performance, the real art is the coach's ability to make the tough calls on players based on the feedback from player performance and then the "X" factor that the coach needs to posses in order to create a top quality team.

9.3 WHERE COACHING COMES IN: THE EFFECTIVE USE OF CENTRE OF MASS AND TORQUE

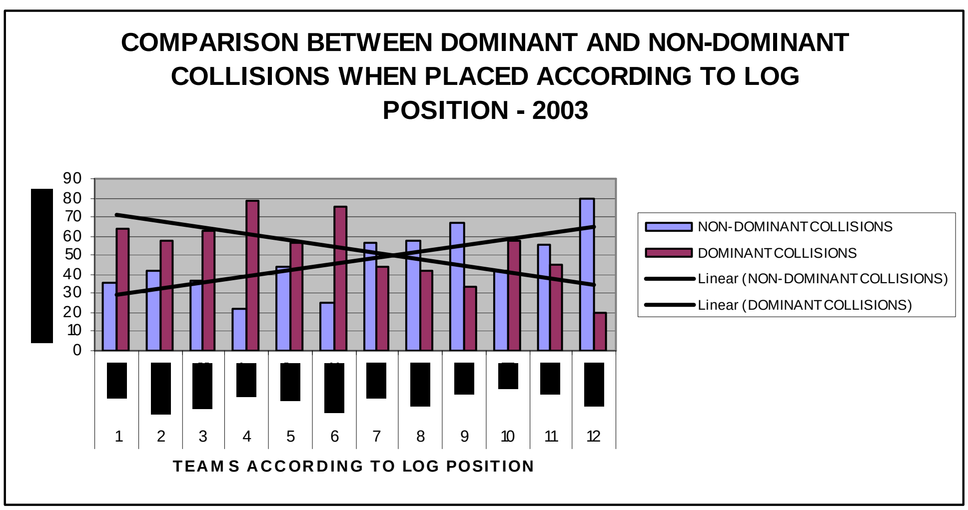
As has been shown throughout the study, the physics ideas presented are as applicable to ricocheting billiard balls as they are to colliding ball carriers and defenders. But it is obvious that there is more to a rugby match than inanimate masses colliding with each other. The question arises as to what is it about the fundamentals of ball carriers and defenders colliding with each other that can be taught by coaches?

The following statistics were obtained and give an indication of the importance of how and where the collision takes place, and the impact it has on the log position eventually obtained.

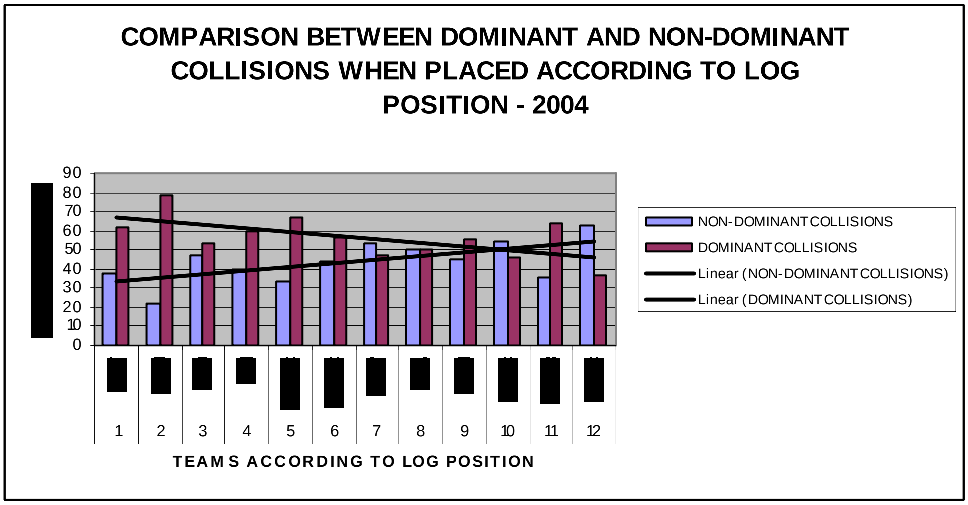
Table 9.4: Comparison between dominant and non-dominant collisions when placed according to log positions

COMPARISON BETWEEN DOMINANT AND NON-DOMINANT COLLISIONS WHEN PLACED ACCORDING TO LOG POSITION												
LOG POSITION - 2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLU	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
NON-DOMINANT COLLISIONS	36%	42%	37%	22%	44%	25%	56%	58%	67%	42%	55%	80%
DOMINANT COLLISIONS	64%	58%	63%	78%	56%	75%	44%	42%	33%	58%	45%	20%
LOG POSITION - 2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLU	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
NON-DOMINANT COLLISIONS	38%	22%	47%	40%	33%	44%	53%	50%	45%	54%	36%	63%
DOMINANT COLLISIONS	62%	78%	53%	60%	67%	56%	47%	50%	55%	46%	64%	37%
LOG POSITION - 2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLU	HIGH	STO	REDS	CATS	SHA
NON-DOMINANT COLLISIONS	29%	25%	30%	35%	45%	35%	55%	54%	47%	30%	73%	58%
DOMINANT COLLISIONS	71%	75%	70%	65%	55%	65%	45%	46%	53%	70%	27%	42%

(a)



(b)



(c)

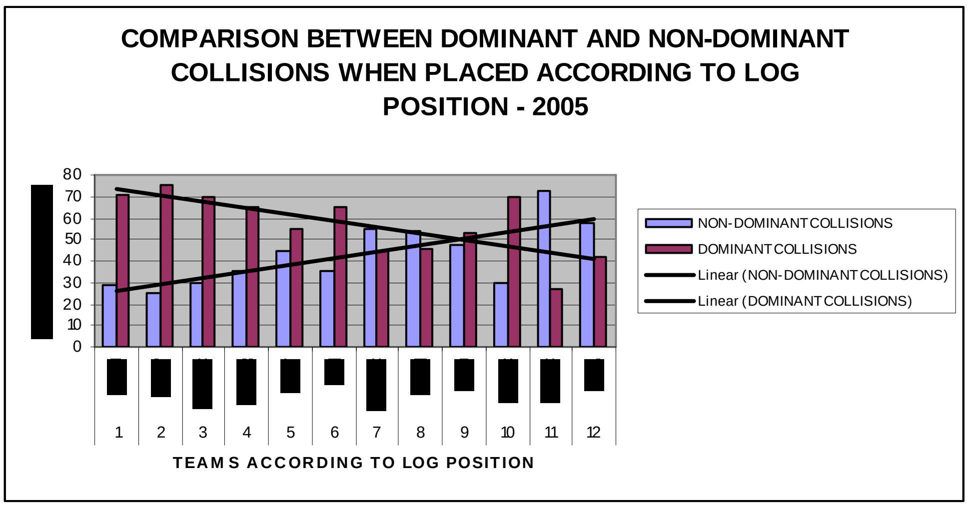
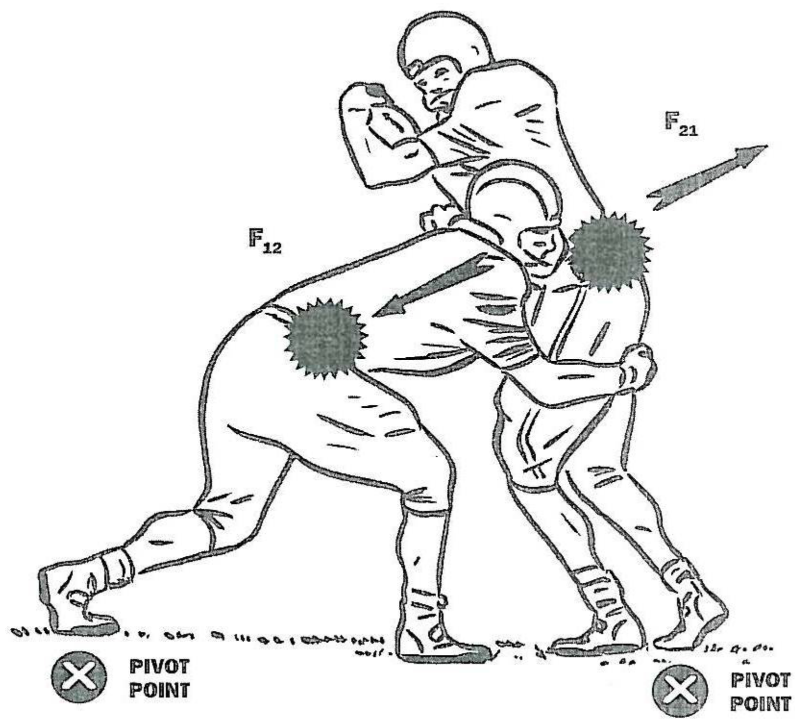


Figure 9.4 (a,b,c): Comparison between dominant and non-dominant collisions when placed according to log position 2003, 2004 and 2005

As is evident from Table 9.4 and Figures 9.4 (a,b,c), it is clear that those teams that had a higher percentage of dominant collisions when compared to non-dominant collision were more likely to finish higher on the respective season log ad thus be more successful. These statistics clearly show that teams that are more successful are better able to dominate collisions and have a higher percentage of dominant collisions when compared to non-dominant collisions. These statistics were obtained from the appropriate statistics sheets and are described in chapter 7 under the heading of key factors present at the in contact situation as the collision takes place. A discussion of possible reasons why and how this can be achieved follows. The further question as to why when executed correctly, can small, quick defensive players sometimes demolish big forwards that are hurtling down on them? The first most basic instruction that coaches should give players about tackling an opponent and when driving into a defensive opponent should be that they: " Keep their feet apart, stay low with their head up, and to drive upward and through the opposing player." In order to understand why this technique is so effective, the following physics ideas need to be explored: the centre of mass and torque. Torque is the rotational equivalent of force. In the same way that force causes a mass to accelerate along a straight line, torque causes objects to rotate about a pivot line, sometimes called the axis of rotation. The bigger the torque, the more effective it is at causing the object to which it is applied to rotate about its pivot line (Beer & Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al*., 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

Torque by itself doesn't tell one much about tackling or driving into a defender unless it is combined with an understanding of a player's center of mass. An object's center of mass is essentially the point through which one would consider the pull of gravity on that object to act. This is why the center of mass is also referred to as the centre of gravity. Most people have a basic concept of where the center of mass of an object lies – roughly at the objects center. A player's center of mass is roughly just below his rib cage, on his vertical center line.

When a player assumes a wide stance and crouches down to make a hit, his center of mass lowers (but remains in his torso area). Therefore, when tackling or driving into an opponent, the reason to stay low and drive upward through the opposing player is so that the player can control his motion by exerting far more torque on him than he does on the opposition player. As shown by Newton's Third Law, the player exerts the same force on the defender or ball carrier as he does on himself, however by using his knowledge of centers of mass, he can completely dominate him in terms of torque. This gives the ball carrier the biomechanical advantage at the collision site and this enables the player to dominate the collision and thus be more successful when running at the opposition (Beer & Johnston, 1990; Young, 1992; Van Staden *et al.*, 1992; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al.*, 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).



(Adapted from Gay, 2004)

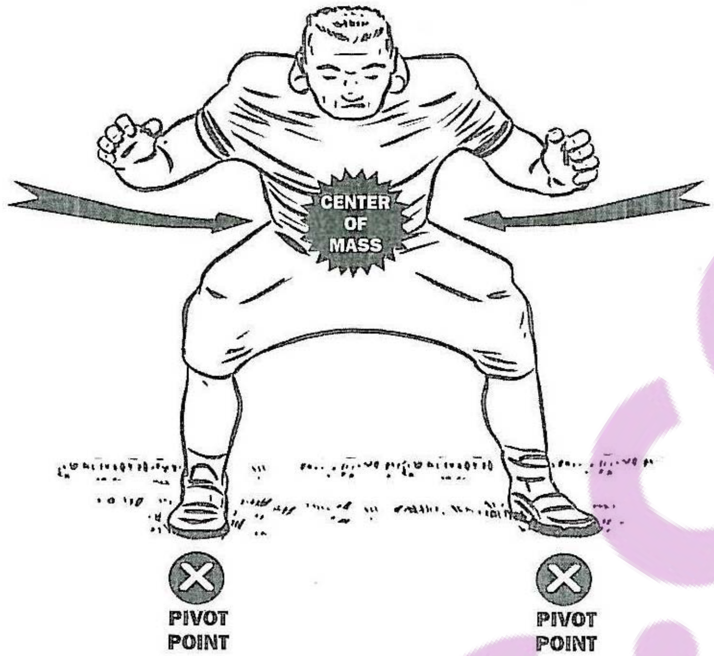
Figure 9.5: Player on the left lowers his center of mass and drives up and through the ball carrier at the right. The two player's centers of gravity are indicated with solid black bursts. Pivot points occur where the player's feet contact the ground, indicated with an X.

When observing Figure 9.5, the two players meeting in the collision initially exert equal magnitudes of force on each other as soon as they make contact. The force the defender exerts runs roughly along the line of his body and up through the ball carrier's torso. The ball carrier exerts a force equal in magnitude but opposed in direction ($F_{12} = -F_{21}$). The equal forces that they exert on each other, however, do not result in equal torques.

The ball carrier exerts a force on the defender that extends along the line connecting the defenders centre of mass and his effective pivot point – the point of contact between his back foot and the ground. The defender is thus very stable under the force from the ball carrier. On the other hand, he has a large lever arm – a large amount of leverage – with the force that he exerts on the ball carrier, who rotates rapidly about his point of contact with the ground as a result of this torque, becoming unstable under the unexpected rotational motion. At the least, the defender will stop the ball carrier, effectively halting his forward motion. Ideally the ball carrier will be completely bowled over and lose the ball in the process. In this kind of hit, the coach's focus on "keeping the head up" doesn't affect the amount of torque delivered directly, but it does help the defender to follow through with the motion that delivers the torque. As for how far apart to keep one's feet as the player sets himself up to make the tackle, a good rule of thumb is to plant them slightly wider than shoulder width (Beer & Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al*., 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

This again relates to stability, but now the focus is on stability in the lateral, side-to-side sense. When looking at Figure 9.1, anytime a ball carrier and a defender meet in a collision and it does not take place in a straight plane, i.e., not head on, the player's body will experience lateral forces upon contact (Beer & Johnston, 1990; Young, 1992; Van Staden *et al*., 1992; Hamill & Knutzen, 1995; Kreighbaum & Barthels, 1996; McAleer, 1998; Brister, 2000; McKenzie *et al*., 2000; Tripi, 2001; Unknown author, 2003; Gay, 2004).

The reason why this information is relevant is the fact that these physics principles are as applicable to the defender as they are to the ball carrier when he enters the collision site and is forced to deal with a defender looking to tackle him aggressively backwards. It is thus important to be aware of these aspects and to apply these principles to attacking play.



(Adapted from Gay, 2004)

Figure 9.6: Lateral forces are less effective at destabilising a player whose stance is low to the ground. The player's feet act as pivot points for his body – and come into play depending on the direction of the force applied by the opposing player. His centre of mass is indicated.

As is evident from Figure 9.6, if the player's feet were close together at this time, there would be significant leverage for these lateral forces about the point of contact between the feet and the ground. With the feet spread, however, the pivotal point is whichever foot is opposite to the point of contact between the lateral force and the body. Because the body is low, below this point of contact the leverage for the lateral torque is small, and the tendency for your body to rotate off the tackle is minimised. Again, the crucial point here is that the tackler must keep his centre of mass as low as possible. The physics of driving into the opposition and tackling must be seen as the basics of dominating collisions. All the complex science discussed wont do a team much good if the players don't execute efficiently (Gay, 2004).

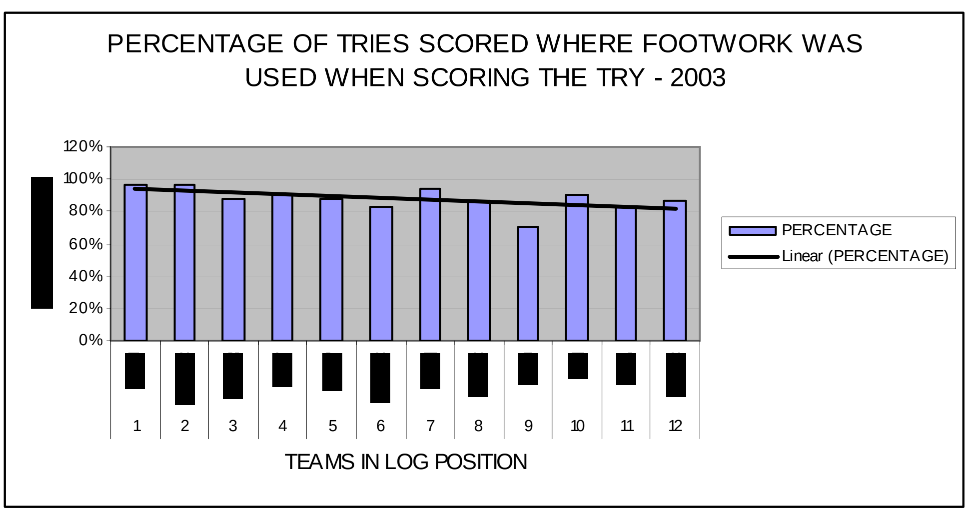
9.4 SPEED, AGILITY, QUICKNESS AND THE ABILITY TO BEAT THE DEFENDER WITH FOOTWORK

On of the most effective means of wrong-footing a defender and making the ball carrier's job of dominating the collision site is the use of effective, dynamic footwork before the collision takes place. When this is viewed in respect to the statistics obtained from the various Super 12 competitions the following comes to the fore.

Table 9.5: Percentage of tries where footwork was used when scoring the try

PERCENTAGE OF TRIES SCORED WHERE FOOTWORK WAS USED WHEN SCORING THE TRY												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
PERCENTAGE	97%	97%	88%	90%	88%	83%	94%	87%	71%	90%	83%	87%
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
PERCENTAGE	97%	100%	77%	88%	100%	100%	96%	71%	84%	82%	100%	85%
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLUES	HIGH	STO	REDS	CATS	SHA
PERCENTAGE	97%	97%	84%	100%	100%	90%	79%	89%	89%	77%	71%	69%

(a)



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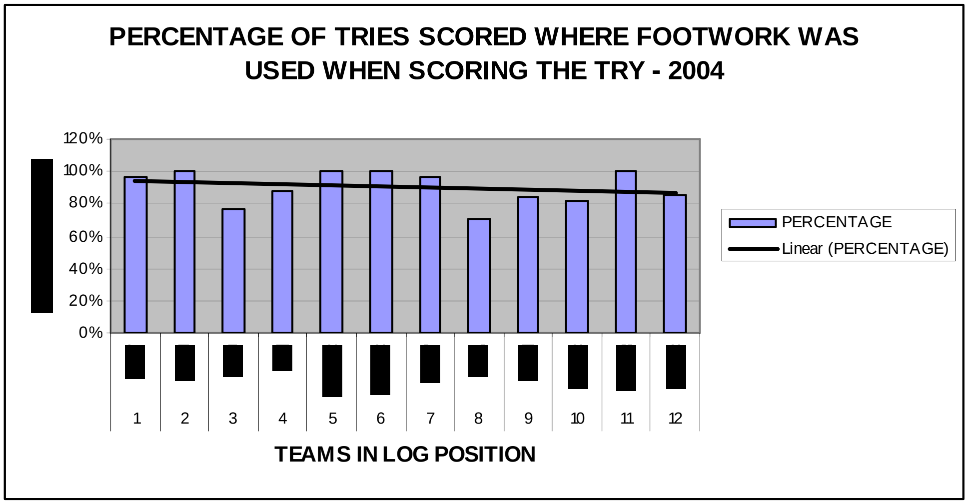

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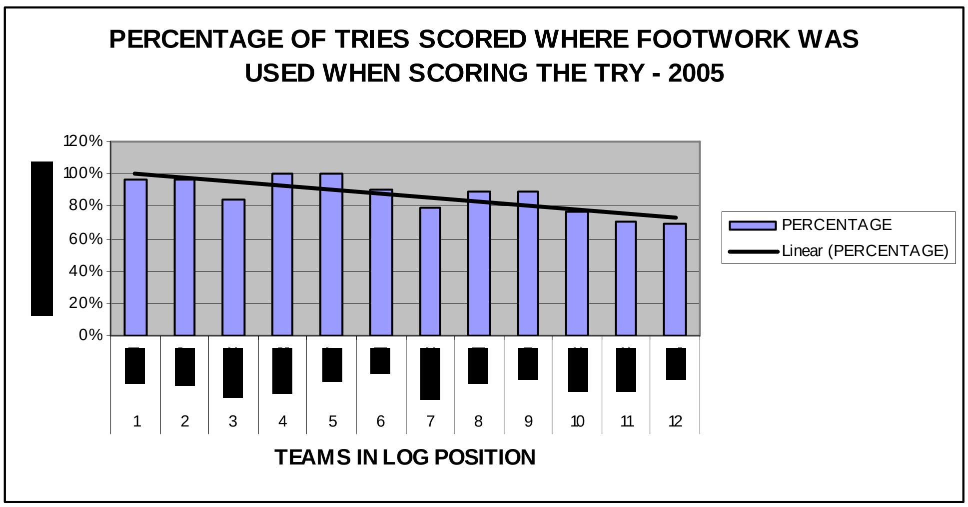
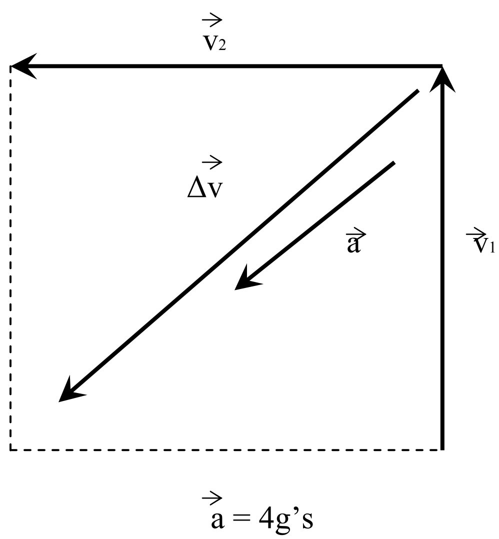


Figure 9.7 (a,b,c): Percentage of tries scored where footwork was used when scoring the try

As is evident from the above data Table 9.5 and Figures 9.7 (a,b,c) it becomes evident that the teams that make use of a higher percentage of footwork before the collision takes place when tries were scored finished higher on the respective log than those that did not.

The reason for this in fact occurring can be explained in the following explanations. Footwork can be defined as a rapid change of course direction, possibly involving a change in speed, possibly repeated several times in quick succession. Naturally both defenders and ball carriers will make use of footwork respective to their role; however the ability to be outstanding in this skill is a much valued characteristic. As a rugby physicist, one knows that you are dealing with changes of speed and direction in short amounts of time: big accelerations. If one looks at the following example, this skill and its ability to aid in a successful dominant collision becomes evident. Consider the common scenario of an attacking backline player running hard at a lone defender attempting to wrong foot him and hopefully leave the defender in his tracks. This ball carrier's velocity vector through the line is roughly straight ahead, with a magnitude (length) of 18 feet per second (V_1) → (see Figure 9.7) (Gay, 2004).



(Adapted from Gay, 2004)

Figure 9.8: Velocity vectors before (V_1→) and after (V_2→) the player moves, connected by the change in his velocity (ΔV→), yield his acceleration (a→): 4g's

The ball carrier plants his right foot hard just as a head-on collision with the defender seems to be inevitable, and, literally in the blink of an eye, he is now moving at 18 feet per second at right angles to his initial velocity (V_2→). The defender's reaction to this footwork is typical of defensive players who encounter such fleet footed ball carriers in the open field: they are left standing and cannot adjust to even come close to the ball carrier let alone tackle him. If the tackle is made the defender is in no way able to execute a dominant tackle of any sort.

Using vectors and Pythagorean Theorem, it can be shown that the acceleration vector (a→) related to (V_2→) and (V_1→) has a magnitude of 127 feet per second squared. Using Newton's Second Law, it can also be calculated what the force is of the ball carrier has to exert on the ground to produce an acceleration of this magnitude: 2,300 pounds. Since all this force is essentially acting through his right knee and ankle as he makes the cut, one can appreciate where ankle and knee injuries come from.

Notice that this amount of force gives the ball carrier an acceleration of about 4 g's. If the ball carrier could continue accelerating at this rate for 10 seconds, he would be moving faster than the speed of sound (Gay, 2004).

9.5 THE ABILITY TO RUN OVER THE DEFENDER

There are two specific ways that a ball carrier can dominate the collision and totally demolish the defender:

1. a full-on defender beating collision where the defender is blown off and merely temporarily halts the ball carriers forward momentum, with the ball carrier continuing his forward motion: and
2. repeated execution of collisions that in effect soften up the opposition before the final knock-out blow is issued.

9.5.1 A full-on defender beating collision

This collision is one where the ball carrier is at a total advantage in terms of:

1. attacking from quick ball,
2. being at full speed when running onto the ball,
3. the level of effective footwork ahead of the collision so that the ball carrier dominates the collision site;

4. the defender is flat footed;
5. the defender is forced to tackle making use of his weaker shoulder,
6. the defender has been manipulated into over tracking by the probe used by the attacking backline and the ball carrier hits the line using the effective running line,
7. the ball carrier enters the collision site with his full mass moving through the line of application of the defender;
8. the ball carrier is physically bigger and more powerful than the defender; and
9. the ball carrier has a player/s leached to him thus doubling the mass of the ball carrier into the collision.

Although only one of these factors is required to create this type of collision, if all these factors are present it stands to reason that the execution becomes easier.

9.5.1.1 Attacking from quick ball or slow ball

This aspect of the collision is crucial. The ball carrier as well as his team must dominate the collision site, i.e., must only send the players in if they know they can dominate the situation. This is done by distinguishing between slow and quick ball. This entails decision-making and communication from the player in the flyhalf position. If it is slow ball, the defensive line will be organised and they will be charged up to rush up hard onto the ball carrier. If the ball is passed backwards from slow ball, the ball carrier will be caught behind the advantage line and he will be attempting to run hard at the defensive line but will however be coming from a standing start. In this situation, it becomes obvious that the ball carrying team is not dominating the situation. In order to bring the advantage back to the attacking team, this slow ball has to be recreated into quick recycled possession. This can be done by either setting up a mini-maul, or setting up a pick and drive situation. If this is done effectively and the ball can be recycled before the defenders can fold extra defenders on the openside of the ruck, then the advantage is back with the attacking team. The reason this occurs is because the defenders that are folding towards the openside are not in an optimal body position to be able to chase the press or to execute a dominant tackle. In effect, the team that can run more often at the defenders from quick recycled possession will inadvertently dominate the collision site more often.

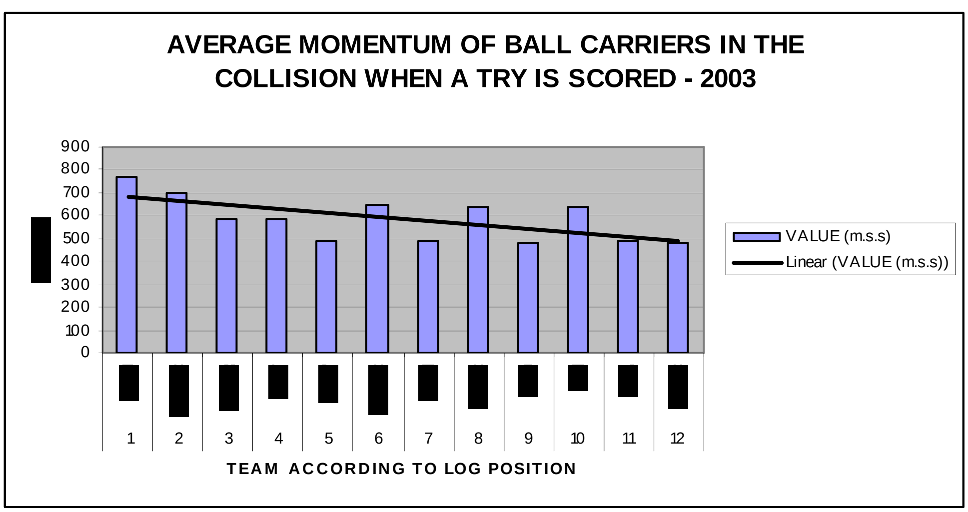
9.5.1.2 The ball carrier's ability to hit the collision line at maximum speed when running onto the ball

After evaluation of the following data the importance of a player being able to hit the tackle line with force was clearly highlighted.

Table 9.6: Average momentum of ball carriers in the collision when a try is scored

AVERAGE MOMENTUM OF BALL CARRIERS IN THE COLLISION WHEN A TRY IS SCORED												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
VALUE (m.s.s)	771.13	703.01	588.07	582.18	489.35	642.77	488.32	636.27	480.39	642.01	493.34	481.37
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
VALUE (m.s.s)	646.6	700.4	635.61	604.92	624.08	700.68	595.25	561.43	623.89	508.95	597.87	565.66
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLUES	HIGH	STO	REDS	CATS	SHA
VALUE (m.s.s)	1003.41	895.4	865.18	881.00	828.37	812.78	797.52	733.58	701.72	687.91	793.63	742.44

(a)



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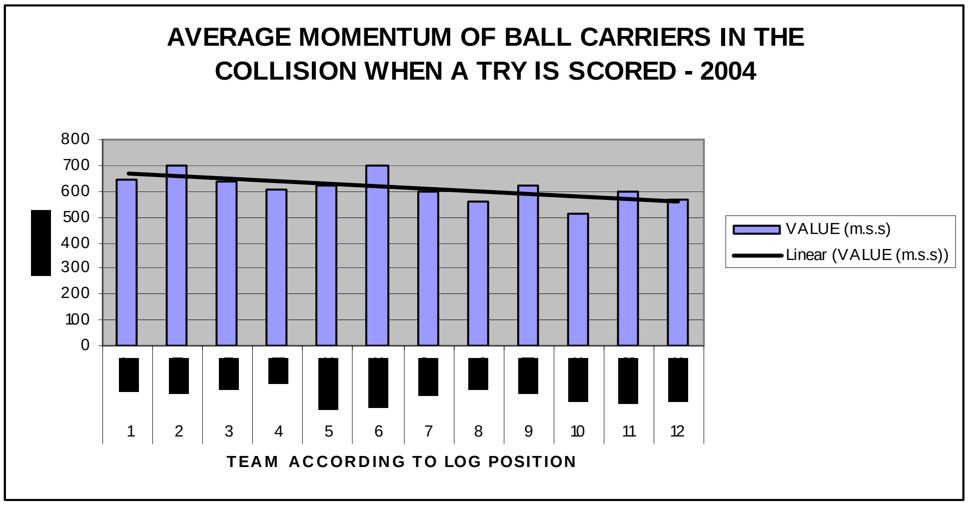

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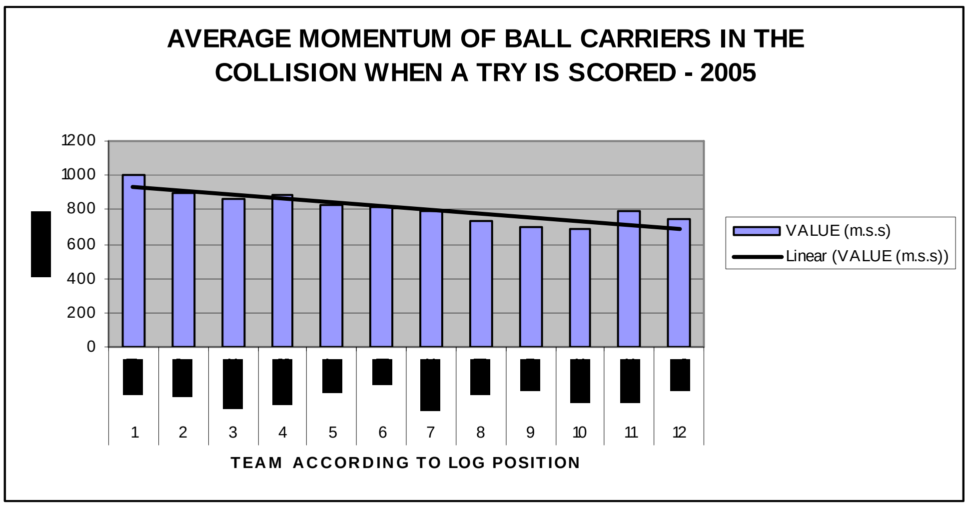


Figure 9.9 (a,b,c): Average momentum of ball carriers in the collision when a try is scored – 2003, 2004 and 2005

These statistics from Table 9.6 and Figure 9.9 (a,b,c) clearly show the importance of players being able to run hard at the opposition and dominate the collision site. Teams that were most successful have a markedly higher value when compared with those teams placed lower on the respective logs.

The following factors could be reasons why this in fact did occur. In order for the ball carrier to be able to hit the collision line at maximum speed, the timing of his approach and his ability to run off the player who is feeding him with the possession is crucial. If there is any deceleration on the ball carriers part due to either a poor pass, poor realignment by the ball carrier off the passer, or poor judgment on the part of the ball carrier concerning the target set for the collision, the ball carrier will not be able to really "throw" himself into the collision. With defensive lines, organization and field coverage being as effective and dominating as they are, this form of full on collision attack has become necessary. It is no longer possible to merely fling the ball around the park in the hope that an opportunity will pop up. It has become increasingly necessary for attacking teams to earn their yardage that is gained from this form of attacking ploy. Attacking teams will therefore aim to bring their best ball carriers into play as often as possible. This means that their play is structured in such a way that:

1. the best passes are used to get the ball into the ball carrier's hands,
2. the best carriers carry the ball into the collisions,
3. the best running off the ball supporters run off the ball carrier at the collision site in anticipation of a quality off-load,
4. the best cleaners are put onto the ball carriers behind so that effective clean can be executed thus resulting in quick ball being recycled; and finally that
5. the best distributing backs are aligned off the recycled possession so that advantage can be taken of the quality attacking ball that has been created.

All effort must be placed on the fact that the ball carrier must never receive the ball while being stationary thus forcing him to enter the collision site from a standing start. It thus stands to reason that the teams that are able to create such a situation the most often has a greater chance of success in attempting to increase their execution of full-on defender beating collisions.

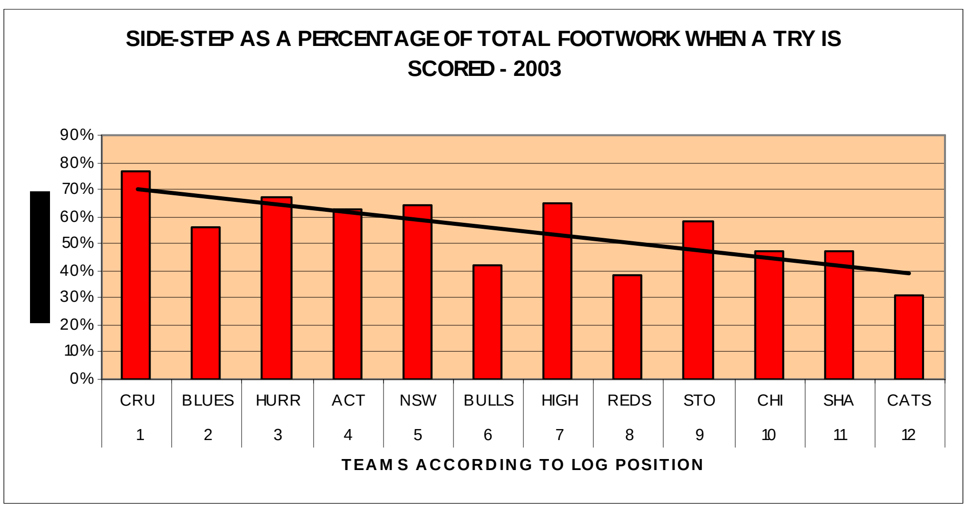
9.5.1.3 The level of effective footwork ahead of the collision so that the ball carrier dominates the collision site

When evaluating the following statistics the importance of effective footwork and specifically the side-step before the collision came to the fore.

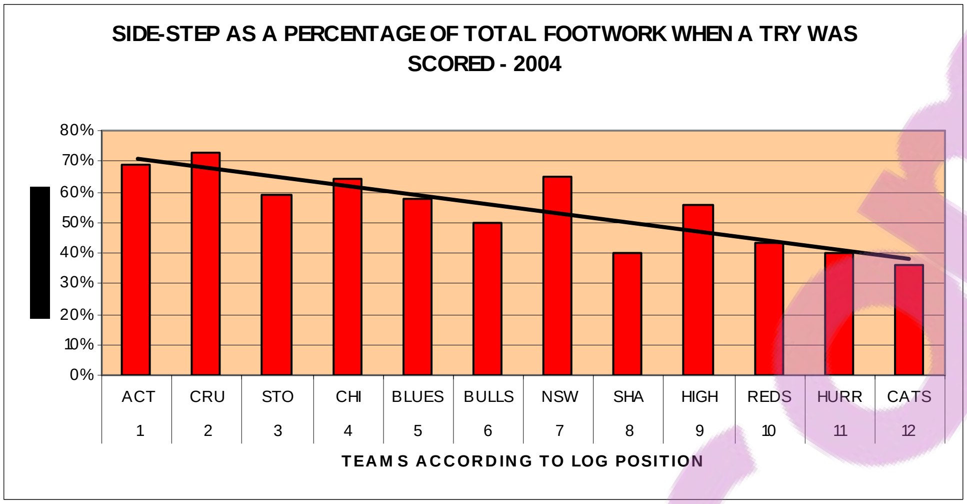
Table 9.7: Side-step as a percentage of total footwork when a try is scored

SIDE-STEP AS A PERCENTAGE OF TOTAL FOOTWORK WHEN A TRY WAS SCORED												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
PERCENTAGE	77%	56%	67%	63%	64%	42%	65%	38%	58%	47%	47%	31%
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
PERCENTAGE	69%	73%	59%	64%	58%	50%	65%	40%	56%	43%	40%	36%
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLUES	HIGH	STO	REDS	CATS	SHA
PERCENTAGE	74%	67%	48%	77%	63%	61%	43%	44%	47%	50%	40%	36%

(a)



(b)



(c)

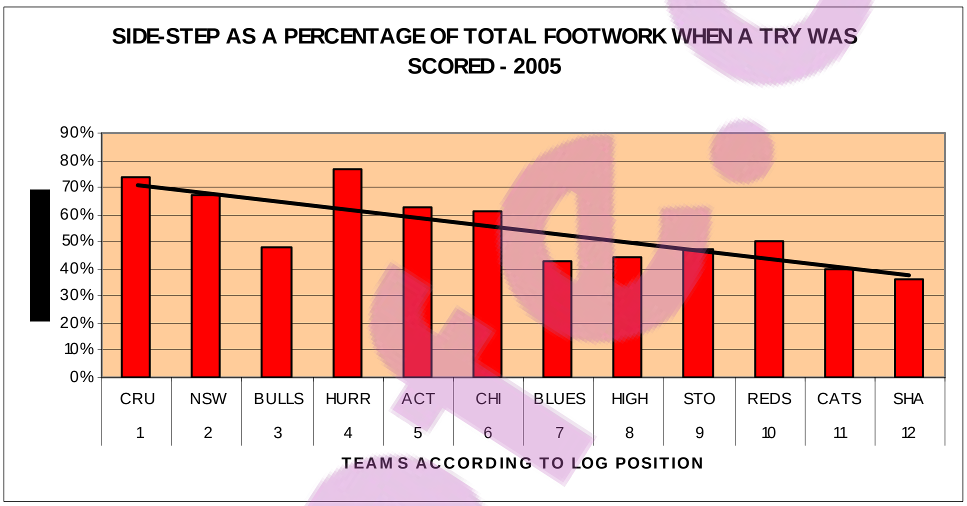


Figure 9.10 (a,b,c): Side-step as a percentage of total footwork when a try was scored – 2003, 2004 and 2005

The data from Table 9.7 and Figure 9.10 (a,b,c) clearly indicates that teams that made clear use of the relevant footwork i.e., the side-step, were more likely to execute a successful strike on the opposition defender and more importantly dominate the collision and thus aid their team to be more successful in their respective competitions. The teams that executed a higher percentage of side-step footwork were more successful in all three Super 12 competitions. As mentioned earlier it is crucial that the ball carrier dominates the collision area even before the collision takes place. This can be done by the ball carrier making use of effective footwork while approaching the collision site. The ball carrier thus attempts to off-foot the defender by destabilizing him thus allowing the ball carrier to run at maximum speed at a destabilized defender. This results in the ball carrier hitting the defender with maximum mass and speed, and the defender being stationary and not being able to execute a dominant tackle due to being wrong footed and thus not being able to take maximum mass intro the tackle. It is vital that while effective footwork can aid in the execution of a ball carrying collision, it must never take place at the cost of taking maximum speed into the collision. Often fleet footed players side-step or “triple” but often they move more sideways than what they move forwards. In effect, if a ball carrier has to choose between footwork and maximum speed, maximum speed must never be compromised.

9.5.1.4 Manipulation of the defender so that he is flat footed

In a rugby context, any time that a player is moving, he will almost always be able to dominate the situation, whether it be defending or carrying a ball into a collision. As mentioned earlier, if a ball carrier can run hard at a defender who is flat footed, the ball carrier will most definitely be more likely to dominate the collision. Apart from the fact of the velocity advantage, any slight directional change at the last minute that does not negatively impact on the velocity of the ball carrier will allow the ball carrier to either attack the weaker shoulder of the defender, or destabilize the defender in such a fashion that the defender is not able to apply his maximum mass into the tackle. The body positioning of the flat footed defender also plays a part in the ability of the defender to execute an effective tackle. If the flat footed defender’s center of gravity is not in front of their body, the defender will be inefficient in applying his mass and power into the tackle. If the defender’s center of gravity is behind his body (i.e., sitting on a chair defensive position), the defender will most definitely be in defensive trouble. A key component of this situation is to create situations where when a ball carrier runs hard at a defender that the defender’s centre of gravity is behind him thus making the defender unstable and thus the collision for the ball carrier more effective. Alternatively, defenders must concentrate on keeping their centre of gravity in front of their body so that they can attempt to make an effective tackle otherwise the physics of the situation will result in the downfall of the defender.

9.5.1.5 The defender is forced to tackle making use of his weaker shoulder

The premise used is that most of the rugby playing population are predominantly right handed. This would result in that if the ball carriers were executing their play from the left hand side of the field, that the defenders would be forced to make the defensive tackle making use of their left (i.e., weaker) shoulder.

Table 9.8: Distribution of tries scored as a percentage: 2003 - scrums

DISTRIBUTION OF TRIES SCORED AS A PERCENTAGE: 2003 - SCRUMS				
Log Position	Team	Left Scrum	Middle Scrum	Right Scrum
1	CRUSADERS	10%	6%	10%
2	BLUES	4%	6%	9%
3	HURRICANES	6%	3%	9%
4	ACT	13%	7%	0%
5	NSW	10%	0%	4%
6	BULLS	4%	0%	13%
7	HIGHLANDERS	11%	6%	0%
8	REDS	7%	0%	2%
9	STORMERS	0%	12%	11%
10	CHIEFS	10%	5%	0%
11	SHARKS	11%	17%	11%
12	CATS	6%	0%	0%

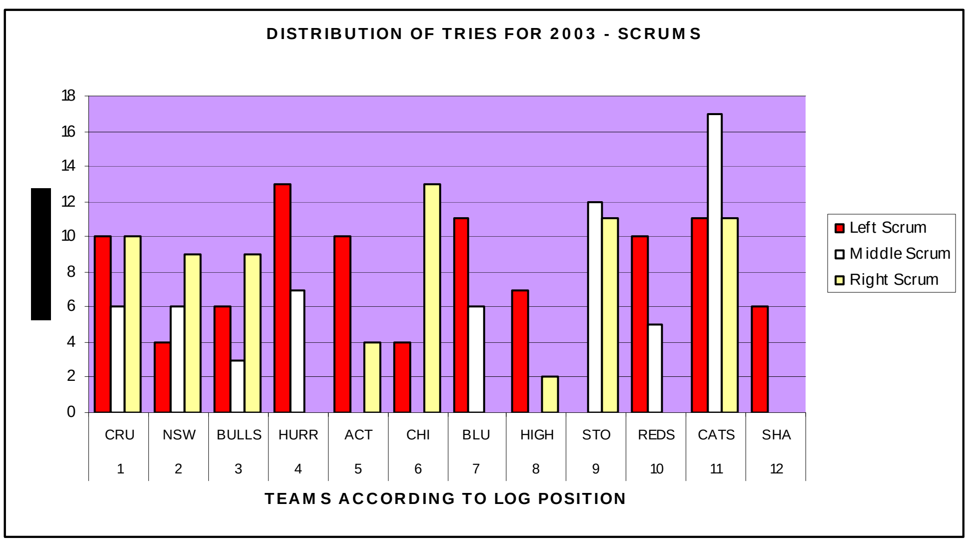


Figure 9.11: Distribution of tries scored for 2003 - scrums

As is evident from Table 9.8 and Figure 9.11, a greater percentage of tries evaluated were scored from left hand scrums.

Table 9.9: Distribution of tries scored as a percentage: 2004 – scrums

DISTRIBUTION OF TRIES SCORED AS A PERCENTAGE: 2004 - SCRUMS				
LOG POSITION	TEAM	LEFT SCRUM	MIDDLE SCRUM	RIGHT SCRUM
1	ACT	13%	0%	6%
2	CRUSADERS	14%	4%	0%
3	STORMERS	5%	0%	0%
4	CHIEFS	40%	0%	0%
5	BLUES	21%	1%	8%
6	BULLS	3%	2%	8%
7	NSW	4%	1%	4%
8	SHARKS	9%	7%	0%
9	HIGHLANDERS	0%	0%	16%
10	REDS	7%	1%	6%
11	HURRICANES	7%	1%	0%
12	CATS	15%	0%	3%

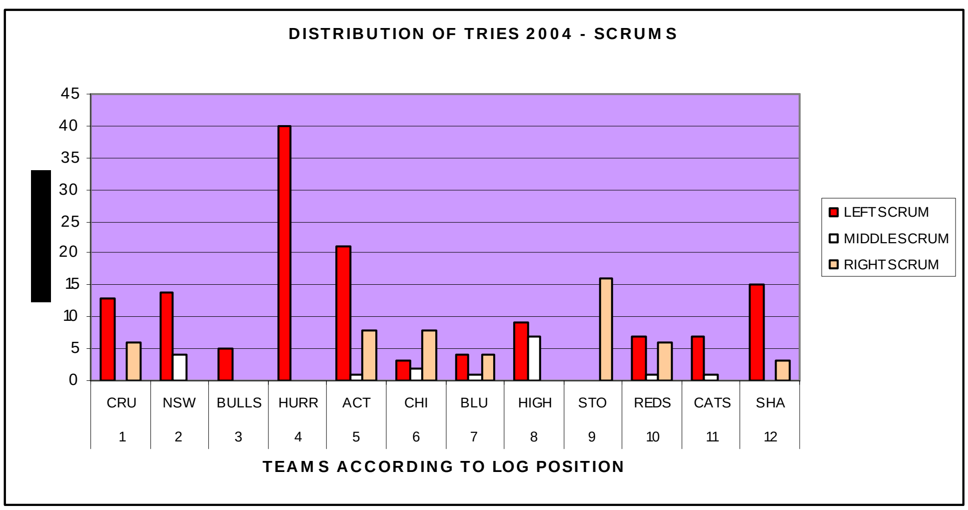


Figure 9.12: Distribution of tries scored for 2004 - scrums

As is evident from Table 9.9 and Figure 9.12, a greater percentage of tries evaluated were scored from left hand scrums.

Table 9.10: Distribution of tries scored as a percentage: 2005 – scrums

DISTRIBUTION OF TRIES SCORED AS A PERCENTAGE: 2005 - SCRUMS				
LOG POSITION	TEAM	LEFT SCRUM	MIDDLE SCRUM	RIGHT SCRUM
1	CRUSADERS	5%	0%	4%
2	NSW	10%	1%	6%
3	BULLS	7%	8%	0%
4	HURRICANES	5%	1%	4%
5	ACT	7%	0%	4%
6	CHIEFS	11%	0%	0%
7	BLUES	15%	0%	4%
8	HIGHLANDERS	6%	5%	0%
9	STORMERS	26%	5%	0%
10	REDS	16%	0%	15%
11	CATS	14%	0%	0%
12	SHARKS	7%	6%	0%

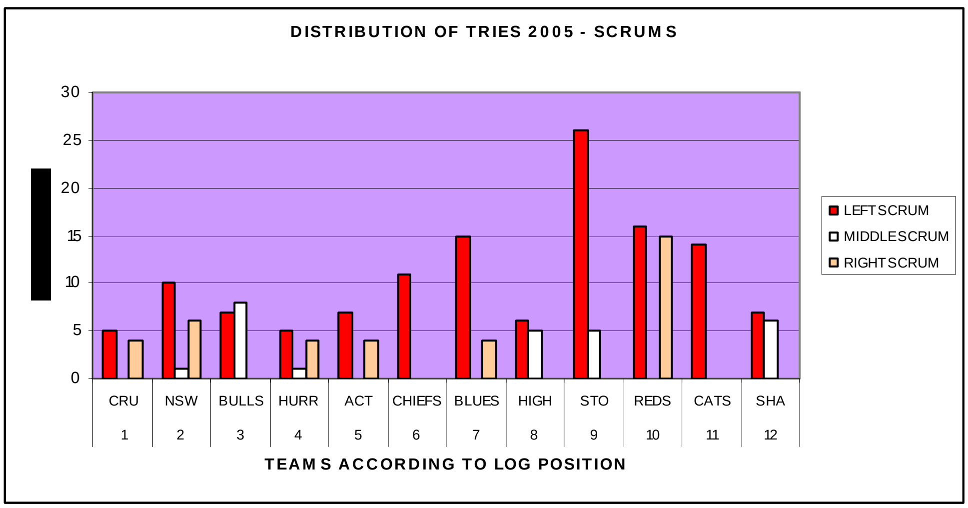


Figure 9.13: Distribution of tries scored for 2005 - scrums

As is evident from Table 9.10 and Figure 9.13, a greater percentage of tries that were evaluated were scored from left hand scrums.

Table 9.11: Tries scored as a percentage; 2003 – lineouts

TRIES SCORED AS A PERCENTAGE; 2003 - LINEOUTS			
Log Position	Team	Left Lineout	Right Lineout
1	CRUSADERS	13%	13%
2	BLUES	18%	9%
3	HURRICANES	29%	6%
4	ACT	27%	7%
5	NSW	40%	8%
6	BULLS	14%	17%
7	HIGHLANDERS	28%	11%
8	REDS	40%	13%
9	STORMERS	0%	12%
10	CHIEFS	19%	9%
11	SHARKS	0%	6%
12	CATS	7%	0%

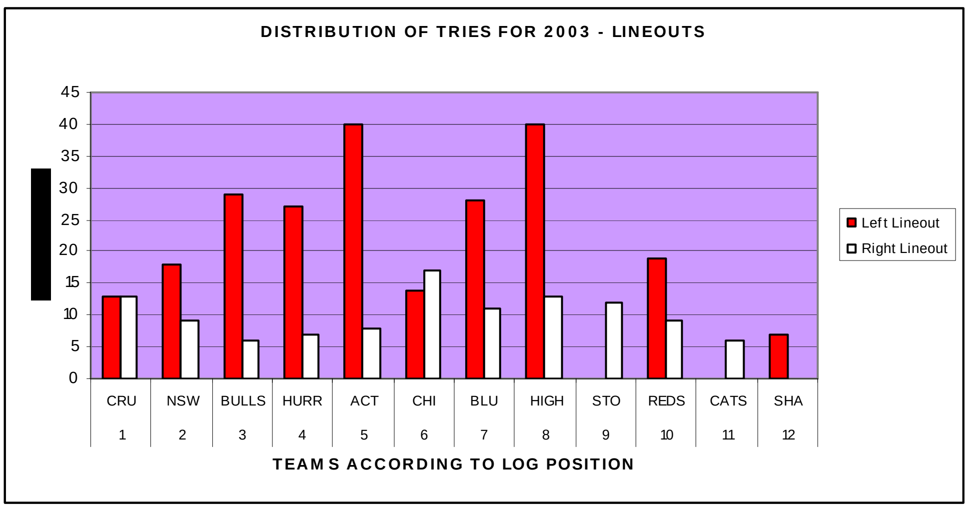


Figure 9.14: Distribution of tries scored for 2003 – lineouts

As is evident from Table 9.11 and Figure 9.14, a greater percentage of tries that were evaluated were scored from left hand lineouts.

Table 9.12: Tries scored as a percentage; 2004 – lineouts

TRIES SCORED AS A PERCENTAGE; 2004 - LINEOUTS			
LOG POSITION	TEAM	LEFT LINEOUT	RIGHT LINEOUT
1	ACT	26%	8%
2	CRUSADERS	23%	15%
3	STORMERS	36%	14%
4	CHIEFS	20%	7%
5	BLUES	33%	8%
6	BULLS	16%	21%
7	NSW	26%	21%
8	SHARKS	29%	7%
9	HIGHLANDERS	21%	5%
10	REDS	33%	9%
11	HURRICANES	27%	4%
12	CATS	8%	2%

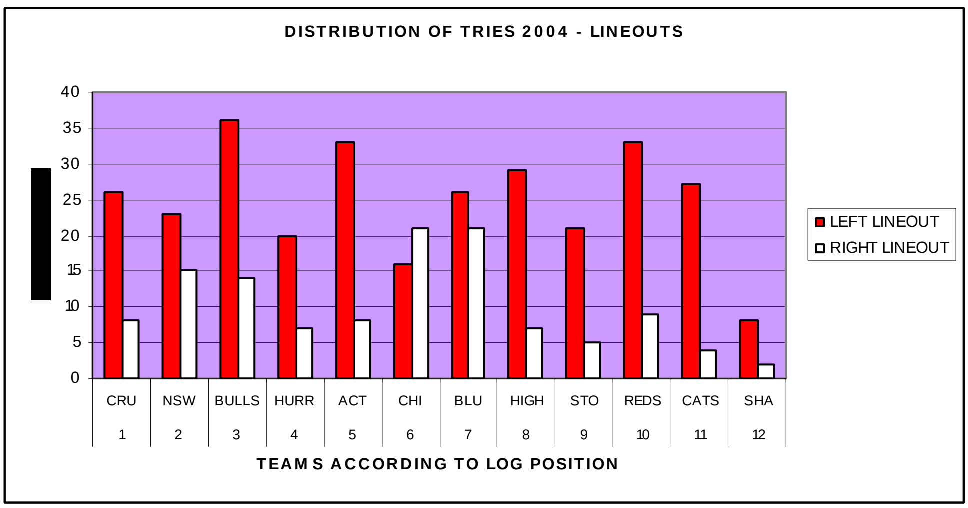


Figure 9.15: Distribution of tries scored for 2004 – lineouts

As is evident from Table 9.12 and Figure 9.15, a greater percentage of tries that were evaluated were scored from left hand lineouts.

Table 9.13: Tries scored as a percentage; 2005 – lineouts

TRIES SCORED AS A PERCENTAGE; 2005 - LINEOUTS			
LOG POSITION	TEAM	LEFT LINEOUT	RIGHT LINEOUT
1	CRUSADERS	18%	8%
2	NSW	29%	6%
3	BULLS	8%	4%
4	HURRICANES	36%	9%
5	ACT	63%	15%
6	CHIEFS	26%	10%
7	BLUES	15%	8%
8	HIGHLANDERS	28%	0%
9	STORMERS	16%	16%
10	REDS	23%	15%
11	CATS	14%	21%
12	SHARKS	25%	6%

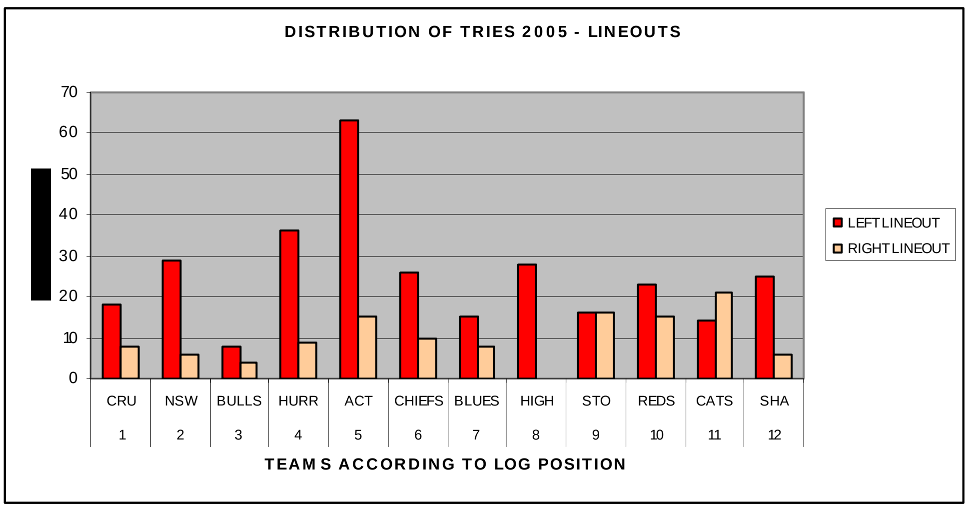


Figure 9.16: Distribution of tries scored for 2005 – lineouts

As is evident from Table 9.13 Figure 9.16, a greater percentage of tries that were evaluated were scored from left hand lineouts.

During this study, it became increasingly obvious that when defenders were forced to make tackles off their weaker shoulder, the ball carrier had a distinct advantage at the collision site. The premise is that a predominant number of players are primarily stronger and more powerful on their right shoulders when compared to their left shoulders. This situation most often took place when the ball was moved from the left hand side of the field towards the right hand side of the field, and the ball carrier came in on either an "unders" line or "overs" line. If the "unders" line is used by the ball carrier during the collision, it results in little need for the ball carrier to adjust his running line thus he can throw his maximum mass and speed into the collision. The ball carrier will also definitely run extremely hard onto the defender's weaker shoulder giving the ball carrier a distinct advantage. If the ball carrier keeps the ball tight to his chest during the collision, the balls elasticity will also aid in "bouncing" the defender off the collision. Although the defender should be able to adjust off his right leg to get into a position to make the tackle, the force and momentum exerted by the ball carrier should override and sway the advantage of the collision towards the ball carrier. If the "overs" line is used, another component applicable to collisions comes to the fore. Again the factor that the defender will be exposing his weaker shoulder to the tackle becomes evident. The tackle will however be more side-on in nature, thus the effect of mass into the collision becomes less, and the need for greater acceleration and speed in order to get away from the defender's tackling shoulder becomes necessary. The use of a hand-off from the ball carrier now becomes an effective means of keeping the defender away from the ball carrier's body and can be used as a forceful legal "punch" in order to destabilize the defender attempting to make the tackle. When the "overs" line is executed the defender will again be more agile and be better able to adjust onto the ball carrier in order to make the tackle. However, with the defender having to move sideways in order to get to the ball carrier, it becomes difficult for the defender to maintain the optimal center of gravity required to execute the successful tackle. In this specific case, the hand-off becomes an effective evasive measure.

9.5.1.6 The defender has been manipulated into over tracking by the probe used by the attacking backline and the ball carrier hits the line using the effective running line

As mentioned in the previous discussion concerning the effectiveness of a defender's tackle based on the use of his predominant or non-dominant shoulder, the concept of taking advantage of a defender over tracking on the approach to a tackle is a factor that can greatly influence the success of a collision. When the play comes from the right hand side of the field towards the left hand side of the field, results in the defender being able to make the tackle on is dominant shoulder ultimately swaying the advantage towards the defending team.

This advantage can be swayed back towards the ball carrier if they make use of attacking running and strike lines that come back onto the defenders weaker shoulders. For example, a simple switch or inside pass will result in the ball carrier running back onto the defender's weaker shoulder. If the execution is precise the added advantage of wrong-footing the defender and causing him to over-track thus manipulating his center of gravity and i.e., his stability, thus making the execution of an effective tackle by the defender all the more difficult.

An attacking backline and those players used to carry the ball into the various collisions must be aware of these factors in order to make each attack and collision as successful as possible. By this awareness, the ball carriers can nominate and execute the most appropriate running line in order to get the best result from the collision.

9.5.1.7 The ball carrier entering the collision site with his full mass moving through the line of application of the defender

The key to dominating a head-on collision is to ensure that the ball carrier ensures that his full body mass is forced upon the defender. By doing this, the defender has to execute the tackle perfectly in terms of his maximum mass in line with the ball carrier, his center of gravity perfectly in line and in front of his body, able to move into the tackle and isn't flat footed, able to manipulate the tackle situation in such a way that he can tackle with his dominant shoulder and to top it all off, that he is physically up to it to make the tackle! If all of these factors are not in place, it becomes increasingly difficult for any defender irrespective of how effective he is in executing a tackle to actually pull off a collision stopping collision.

The ability of the ball carrier to manipulate his body so that he can compact himself in order to manipulate his bodies surface area to be smaller, thus making the execution and driving of his mass "through" the defender more effective. The ball carrier also needs to be adept at setting his collision target through and behind the defender. What this implies is that the execution line of the ball carrying collision must be through and up the defenders body, maintaining maximum momentum, as well as maintaining an explosive continued leg drive so that after the initial impact at the collision site, that the ball carrier maintains forward momentum through the defender.

The initial impact will destabilize the defender, and the continued leg drive will then take advantage of the destabilized defender's body positioning and thus drive home the forward momentum. This is achieved by planting the ball carrier's driving foot as close as possible to the tackler's body. By achieving this, the ball carrier will maintain a maximum stable body positioning throughout the whole course of the collision.

9.5.1.8 The ball carrier is physically bigger and more powerful than the defender

Although the contracting of players will ultimately determine the quality, size, strength, speed and explosiveness of the players, this aspect can also be improved through the continued use of effective strength and conditioning programs.

If one considers that the game is ultimately one where the strongest and most powerful teams tend to be the most successful, it becomes increasingly obvious that the aspect of creating a unique breed of rugby player is crucial in the continued success of any team that wishes to dominate world rugby. The key however is the effective coaching of the players so that they are able to apply this strength in a rugby situation. Often teams are filled with huge players but they either don't know how to apply this strength or they do not possess the inherent desire required to be aggressive and determined to dominate the opposition in all the physical aspects of the game. Rugby is a physical game, and no amount of strength or speed can factor out desire. Even the smallest player with the necessary desire will stop a bigger player with any means at his disposal, even if it means allowing the huge ball carrier to fall over him. Stopping the opposition is key, whichever way you choose. The same desire is applicable for the ball carrier.

A decision has to be made that irrespective of how many defenders are in front of him, how many defenders are clinging to him or how big or powerful the defender is, if the ball carrier wants to dominate the collision and press forward he can and he must.

9.5.1.9 The ball carrier has a player/s leached to him thus doubling the mass of the ball carrier into the collision

As mentioned earlier, the ball carrier's ability to force his maximum mass into the collision plays a huge part in successfully dominating a collision. This type of "leaching" can be used from both quick and slow ball, and if it is effectively exploited, can be very rewarding.

In this situation if a ball carrier has a supporting player bound behind him helping him drive up and through the defender, the increase in mass makes it even more difficult for the defender to stop the forward momentum. The forward drive is aided even more if the ball carrier and the player driving behind him maintain an effective leg drive; the increase in forward force is dramatically increased.

It is also vital that the ball carrier maintains effective ball control, maintaining an effective arm driving action as the defenders will aim to wrap up the ball and thus slow the ball down when the mini-maul is taken to ground. In addition to the increase in mass and thus momentum, the ability to recycle the possession quickly and effectively becomes apparent if the carrier keeps working with his arms and the leached players drive any excess opposition players away from the collision area. The reason for this is that the cleaners are on the ball carrier's behind, and thus the opposition players wishing to slow down and steal the ball are not given an opportunity to even come close to the ruck situation.

9.5.1.2 The repeated execution of collisions that in effect soften up the opposition before the final knock-out blow is issued

When Table 8.1 and Figures 8.8 (a,b,c) (Chapter 8), were evaluated the importance of continued pressure on the defense in regards to maintaining possession became obvious. The following discussion spreads more light on the topic.

As is evident in most sports where body contact and collisions take place, the team or players that can effectively and consistently make "hits" on the opposition in such a fashion that the opposition feels the continued force and "pain", will be the most successful. The reason for this is that the energy used to absorb the collision takes more out of the player than the energy used to apply the force and collision. As shown in the study, the teams that can apply the most collisions are the ones that tend to be the most successful. Collisions in this sense are the following:

1. dominating ball carrying collisions that lead to a ruck being formed;
2. dominating ball carrying collisions that lead to the defender being bumped off; and
3. dominating ball carrying collisions where the ball carrier is able to give an effective off-load to a support player.

9.5.2.1 Dominating ball carrying collisions that lead to a ruck being formed

The ability to effectively recycle possession after a bone crushing ball carrying collision has take place is one of the great spectacles of a match for the collision connoisseur. Seeing the cleaners flying in through the imaginary gates enforced by the referee cleaning away anyone trying to get their hands on their possession really does set the tone of a match. It is one of the few legal situations where a player without the ball can be driven into in order to make your physical presence felt. Rugby is about dominance! Whether it be physical, or from the sheer speed shown by a team, the weaker team must know that they are no match for the team whose sheer purpose is dominance.

The problem arises most often in that the most teams attempt to make use of speed dominance before the physical standard has been set. A team's ability to keep on driving into the opposition being supported by hungry players wanting to clean-up any lurking players around the fringes effectively softens up the opposition. When the ball is eventually moved around, the defending team's legs start to feel like jelly, and the effectiveness of the attack becomes even more apparent. This aspect of play if the teams are conditioned to do it effectively, and if discipline is maintained is a huge part of a successful team's armory.

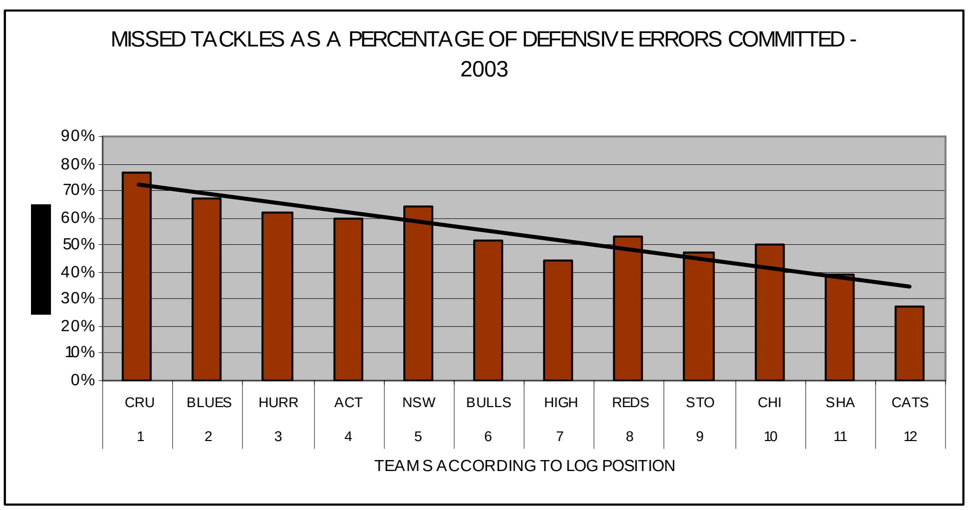
9.5.2.2 Dominating ball carrying collisions that lead to the defender being bumped off

After evaluation of the following data statistics that were compiled during the three years of Super 12 competitions, missed tackles as a percentage of defensive errors made by the defending team indicated the importance of being able to knock over defenders during attacking play.

Table 9.14: Missed tackles as a percentage of defensive errors committed

MISSED TACKLES AS A PERCENTAGE OF DEFENSIVE ERRORS COMMITTED												
2003	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	BLUES	HURR	ACT	NSW	BULLS	HIGH	REDS	STO	CHI	SHA	CATS
PERCENTAGE	77%	67%	62%	60%	64%	52%	44%	53%	47%	50%	39%	27%
2004	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	ACT	CRU	STO	CHI	BLUES	BULLS	NSW	SHA	HIGH	REDS	HURR	CATS
PERCENTAGE	81%	82%	64%	63%	58%	50%	54%	50%	50%	47%	47%	31%
2005	1	2	3	4	5	6	7	8	9	10	11	12
TEAM	CRU	NSW	BULLS	HURR	ACT	CHI	BLUES	HIGH	STO	REDS	CATS	SHA
PERCENTAGE	90%	81%	76%	77%	67%	65%	50%	44%	53%	54%	43%	44%

(a)



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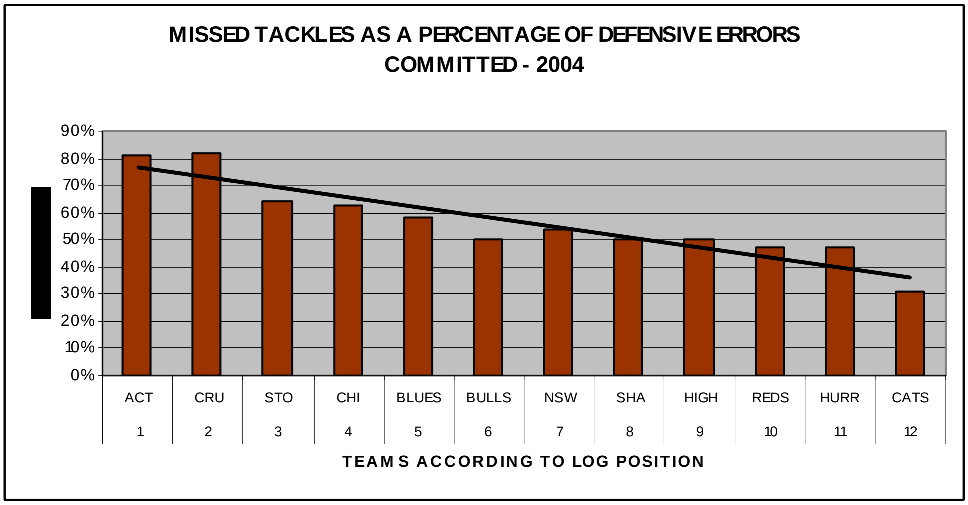

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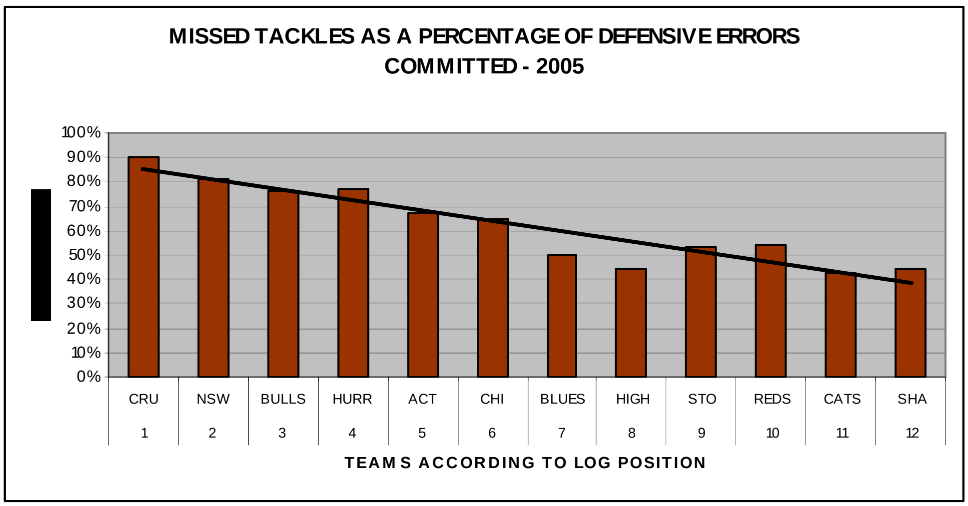

Figure 9.17 (a,b,c): Missed tackles as a percentage of defensive errors committed – 2003, 2004 and 2005

As is evident from Table 9.14 and Figure 9.17 (a,b,c) the teams ability to dominate collisions by knocking over defenders certainly influenced the final log position attained during the three Super 12 competitions.

A defensive team finds itself under extreme pressure when their defenders start falling off tackles. The reason for this is that the defenders start shirking their duties which results in extra pressure being applied to the other defenders who have to in turn make the tackle which should have been made earlier. This ultimately results in insufficient resources to cover the field defensively and defensive holes start to present themselves all over the field. Apart from defenders whose system gets shuffled due to the missed tackles, the mental dominance that is experienced by the defenders is huge. The defenders start becoming jittery and there is constant doubt in each player's mind as to can they "trust" their teammate to make their tackle, or will they have to adjust in order to cover up for fellow teammates? This mental barrage that teams experience starts to impact on almost all aspects of their play, whether it be primary phases, decision-making, execution or merely concentration during the match. Again, the team that dominates the opposition can absorb the pressure without losing their shape and concentration, and who can apply pressure constantly will ultimately breakdown the opposition. This is the key determinant of success!

9.5.2.3 Dominating ball carrying collisions where the ball carrier is able to give an effective off-load to a support player

The most disorganized defensive lines and the greatest opportunities to punish the defense occur around the ruck. The reason for this is that the defenders need to realign and fold as appropriate which, if it occurs slower than what the attacking supporters can get to the area will result in holes through which the attacking team can punch. It does however also present the most amount of "traffic" in a very confined space, which means that the execution is crucial in order to get the ball to the appropriate player.

Support from depth is crucial in such situations; this implies that the supporters must come in directly from behind so that the small space can be truly exploited. If the attacking team can maintain their forward momentum through this channel, with there supporters and cleaners working hard to maintain quick and efficient possession, the defensive wall most certainly burst open. In conclusion, if a team keeps punching away at the opposition, getting in effective physical hits, (in an appropriate and legal manner), and no opposition can maintain their defensive qualities for such a prolonged period of time. Ultimately, the teams that can execute this strategy will be the ones that are successful.

9.6 CONCLUSION

When all is said and done, it remains the team and coaching staff's responsibility to identify and incorporate what is their attacking strategy and how that strategy is to be incorporated into their playing structure. Collisions in rugby cannot be avoided, what also becomes evident that there are far more collisions taking place in a match that any other skill. For this reason, it is of vital importance that this skill is acknowledged as vital to the success of rugby and the training of this skill become more prevalent in rugby sessions.

In concluding the study the following key factors have come to the fore during the evaluation of the available data and been identified by the author as important key coaching areas for coaches to focus on during training sessions and matches.

- Have a clear understanding of where tries originate from and empower the players to dominate that aspect of the play, this implies that as most tries were scored from turnover possession, players should be coached as how to effectively attack from this turnover possession gained and in turn when attacking to be very accomplished at maintaining and recycling their possession so that it is not turned over thus giving the opposition exceptional possession from which to attack;
- Become a student of the game identifying those scientific aspects that, if implemented could make a difference to the improved performance of the player and the team;
- Have the ability to make use of the "art" of conveying information to the player or team in such a way that it can be implemented and executed successfully;
- Empower the player and team to be able to perform in a structured environment that does not overbear the players creativity but in fact gives the player or team the parameters within which this creativity can be effectively displayed;
- Empower players to be able to use effective footwork while entering the collision site in order to be able to manipulate defenders and thus be more adept at dominating the collision;
- Empower players to be able create attacking "quick" ball and be able to regenerate slow ball if required;

- Empower players to be able to take maximum velocity into a collision if the situation requires it;
- Create attacking situations where defenders are forced to make tackles with their “weaker” tackling shoulders;
- Empower players and teams to be able to use optimal running lines in order to weaken defensive lines and manipulate defenders to such an extent that their tackle technique is compromised;
- Empower players and teams to be able to maintain and recycle possession effectively while attacking;
- Empower players to be able to maintain the attacking momentum by being able to make knowledgeable off-loads at appropriate times with the necessary precise execution; and
- Ensure exceptional recruiting skills by identifying the biggest, strongest, most athletically powerful, mentally durable and skillful players in order to put together a successful team.

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APPENDIX 1

TEAM	W	D	L	PF	PA	BP	PTS
BLUES	10	0	1	393	185	9	49
CRUSADERS	8	0	3	358	263	8	40
HURRICANES	7	0	4	324	284	7	35
ACT BRUMBIES	6	0	5	358	314	8	31
NSW WARATAHS	6	0	5	320	344	7	31
BULLS	6	0	5	319	354	6	30
HIGHLANDERS	6	0	5	287	246	5	29
QUEENSLAND REDS	5	0	6	279	318	6	26
STORMERS	5	0	6	258	353	3	23
CHIEFS	3	0	8	289	306	10	18
SHARKS	3	0	8	241	306	5	17
CATS	3	0	9	259	398	5	13

Note: 4 points for a win; 2 points for a draw; 1 point for losing by 7 points or less; 1 point for scoring 4 or more tries.

SEMI FINALS

16 May	CRUSADERS	39	HURRICANES	16
17 May	BLUES	42	BRUMBIES	21

FINALS

24 May	BLUES	21	CRUSADERS	38

(Various Authors, 2003)

APPENDIX 2

TEAM	W	D	L	PF	PA	BP	PTS
ACT BRUMBIES	8	0	3	408	269	8	40
CRUSADERS	7	0	4	345	303	6	34
STORMERS	7	0	4	286	260	5	33
CHIEFS	7	0	4	274	251	5	33
BLUES	6	1	4	337	309	6	32
BULLS	5	1	5	302	320	6	28
NSW WARATAHS	5	0	6	342	274	7	27
SHARKS	5	0	6	267	305	7	27
HIGHLANDERS	4	1	6	299	347	8	26
QUEENSLAND REDS	5	0	6	217	246	5	25
HURRICANES	4	1	6	275	303	5	23
CATS	1	0	10	294	459	7	11

Note: 4 points for a win; 2 points for a draw; 1 point for losing by 7 points or less; 1 point for scoring 4 or more tries.

SEMI FINALS

15 May	CRUSADERS	27	STORMERS	16
15 May	BRUMBIES	32	CHIEFS	17

FINALS

24 May	BRUMBIES	47	CRUSADERS	38

(Various Authors, 2004)

APPENDIX 3

TEAM	W	D	L	PF	PA	BP	PTS
CRUSADERS	9	0	2	459	281	8	44
NSW WARATAHS	9	0	2	322	174	8	44
VODACOM BULLS	7	0	4	301	229	6	34
HURRICANES	8	0	3	283	248	2	34
ACT BRUMBIES	5	1	5	260	268	7	29
CHIEFS	5	1	5	272	250	6	28
BLUES	6	0	5	243	216	3	27
HIGHLANDERS	6	1	4	221	214	1	27
STORMERS	3	1	7	215	320	4	18
QUEENSLAND REDS	3	0	8	185	282	5	17
CATS	1	1	9	226	326	7	13
SHARKS	1	1	9	205	384	5	11

Note: 4 points for a win; 2 points for a draw; 1 point for losing by 7 points or less; 1 point for scoring 4 or more tries.

SEMI FINALS

16 May	CRUSADERS	47	HURRICANES	7
17 May	WARATAHS	23	BULLS	13

FINALS

24 May	CRUSADERS	35	WARATAHS	25

(Various Authors, 2005)

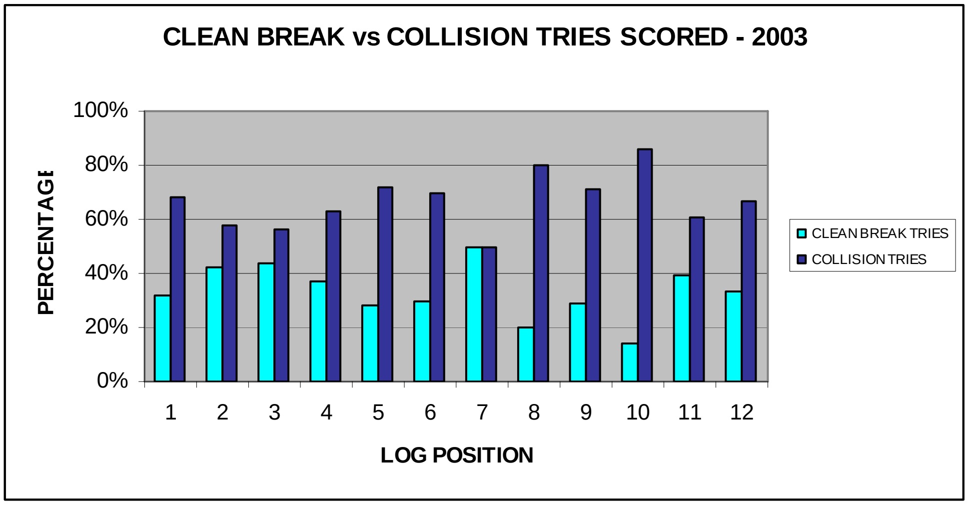
APPENDIX 4

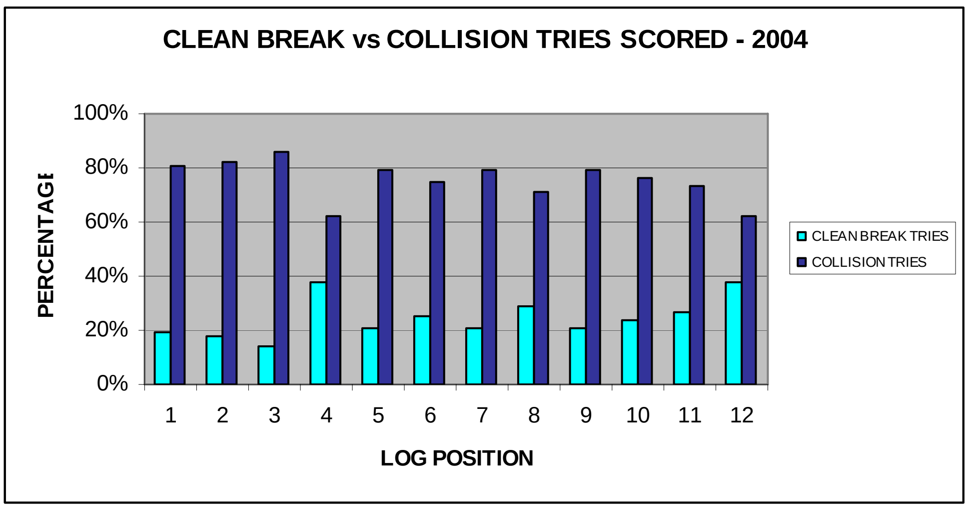
AUSTRALIA			
COACHES	ACT	NSW	REDS
2003	DAVID NUCIFORA	BOB DWYER	ANDREW SLACK
2004	DAVID NUCIFORA	EWAN McKENZIE	JEFF MILLER
2005	LAURIE FISHER	EWAN McKENZIE	JEFF MILLER

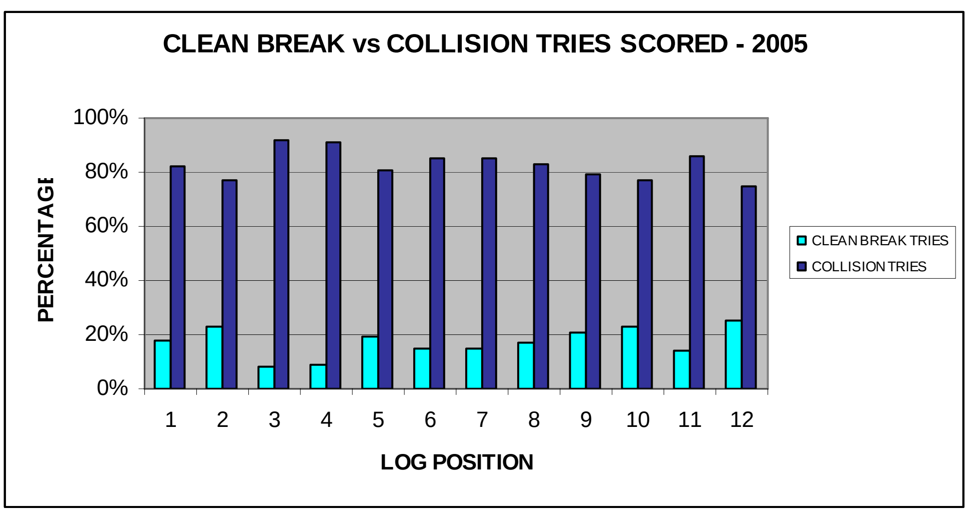
NEW ZEALAND					
COACHES	BLUES	CHIEFS	CRUSADERS	HIGHLANDERS	HURRICANES
2003	PETER SLOANE	KEVIN GREENE	ROBBIE DEANS	LAURIE MAINS	COLIN COOPER
2004	PETER SLOANE	IAN FOSTER	ROBBIE DEANS	GREG COOPER	COLIN COOPER
2005	PETER SLOANE	IAN FOSTER	ROBBIE DEANS	GREG COOPER	COLIN COOPER

SOUTH AFRICA				
COACHES	BULLS	CATS	SHARKS	STORMERS
2003	RUDY JOUBERT	TIM LANE	KEVIN PUTT	GERT SMAL
2004	RUDY JOUBERT	TIM LANE	KEVIN PUTT	GERT SMAL
2005	HEYNEKE MEYER	CHESTER WILLIAMS	KEVIN PUTT / DICK MUIR	GERT SMAL

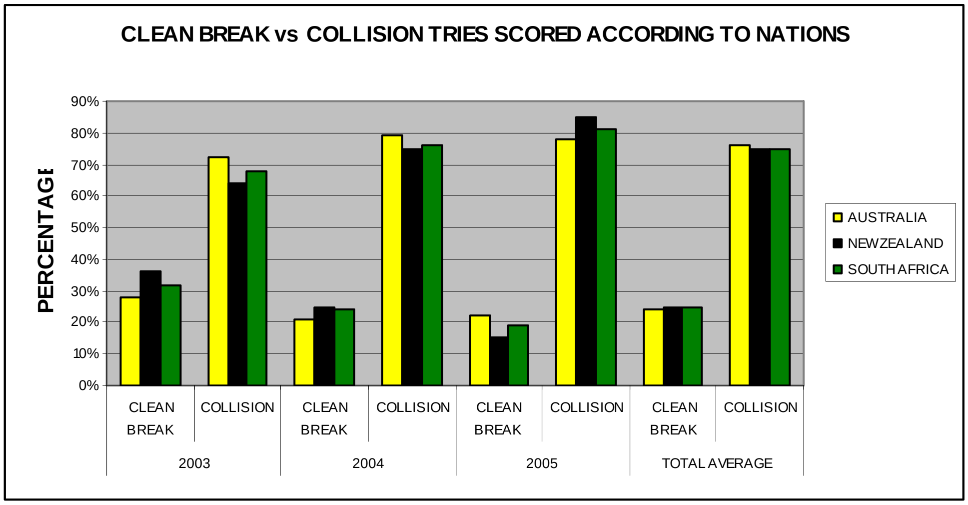
APPENDIX 5

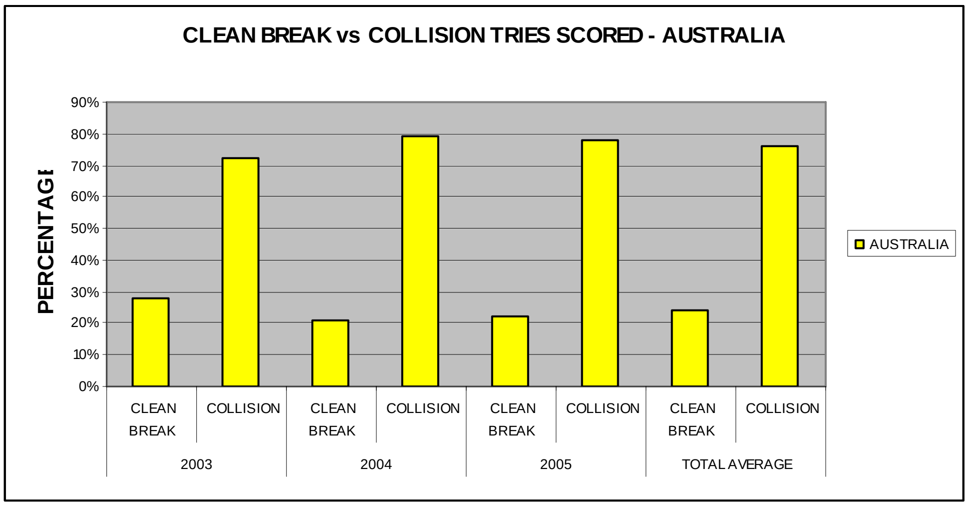

CLEAN BREAK vs COLLISION TRIES SCORED - 2003
PERCENTAGE
100%
80%
60%
40%
20%
0%
1
2
3
4
5
6
7
8
9
10
11
12
LOG POSITION
CLEAN BREAK TRIES
COLLISION TRIES

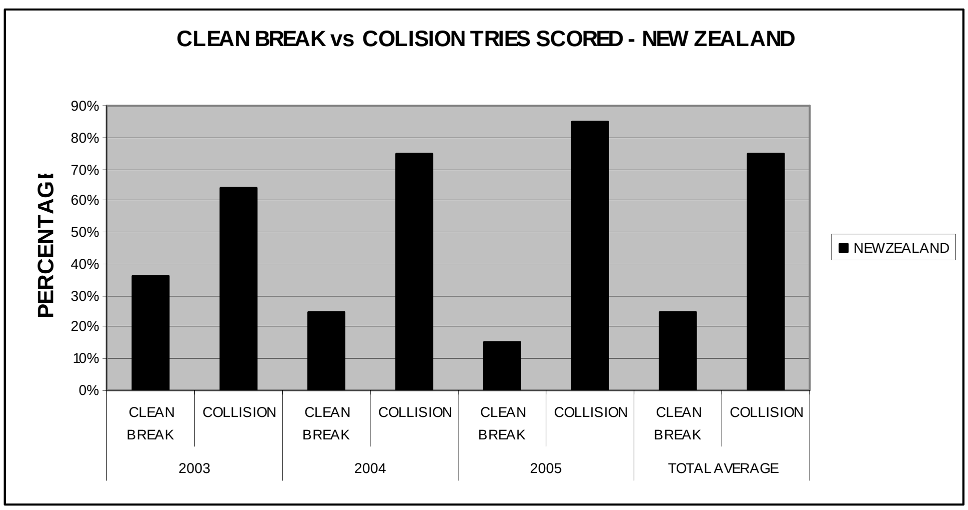

CLEAN BREAK vs COLLISION TRIES SCORED - 2004
PERCENTAGE
100%
80%
60%
40%
20%
0%
1
2
3
4
5
6
7
8
9
10
11
12
LOG POSITION
CLEAN BREAK TRIES
COLLISION TRIES

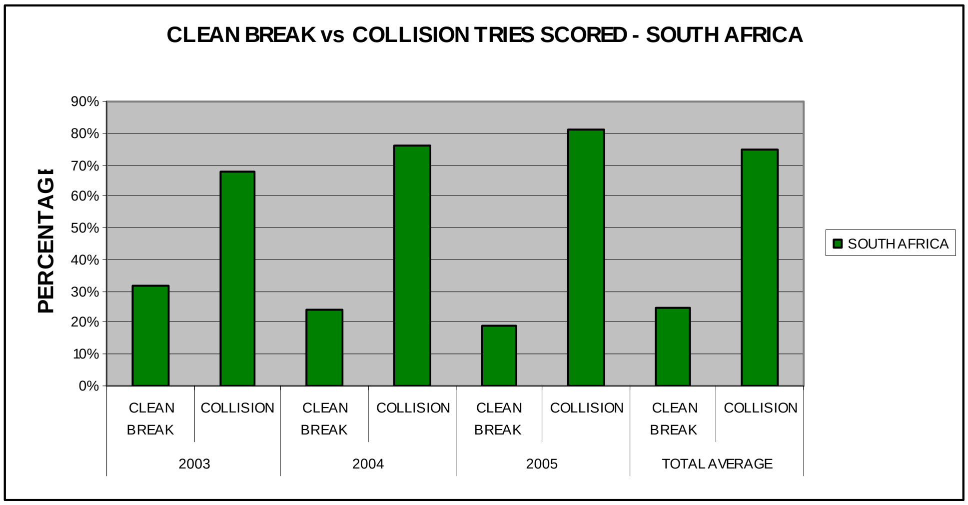

CLEAN BREAK vs COLLISION TRIES SCORED - 2005
PERCENTAGE
100%
80%
60%
40%
20%
0%
1
2
3
4
5
6
7
8
9
10
11
12
LOG POSITION
CLEAN BREAK TRIES
COLLISION TRIES

APPENDIX 6

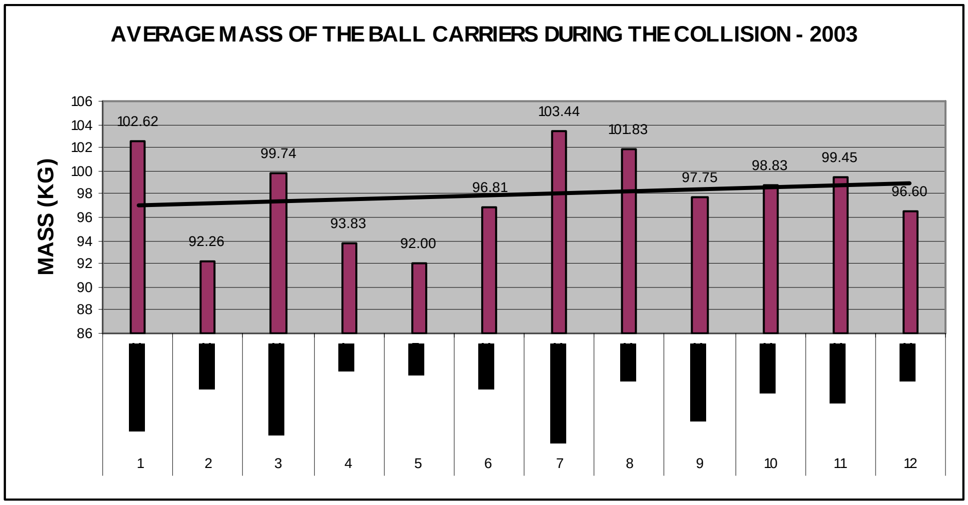

CLEAN BREAK vs COLLISION TRIES SCORED ACCORDING TO NATIONS
PERCENTAGE
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CLEAN BREAK
COLLISION
2003
2004
2005
TOTAL AVERAGE
AUSTRALIA
NEWZEALAND
SOUTH AFRICA

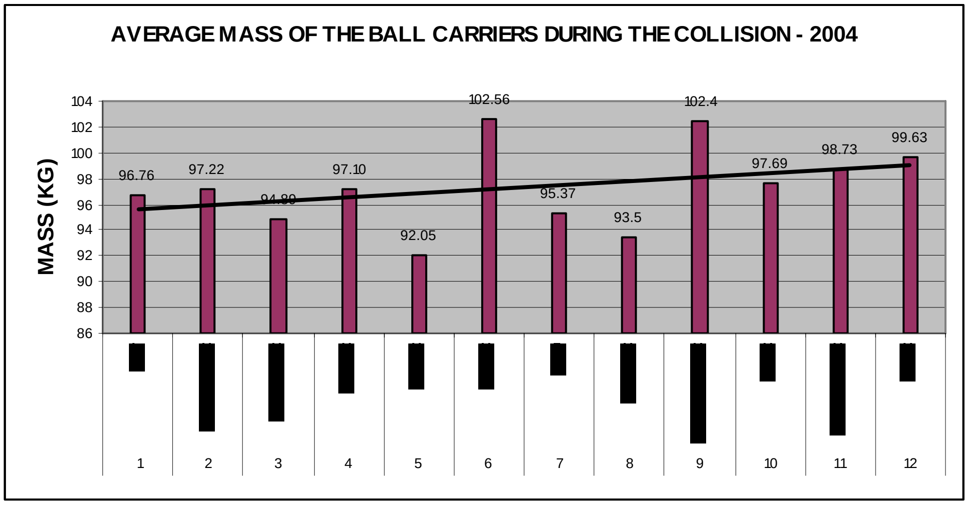

CLEAN BREAK vs COLLISION TRIES SCORED - AUSTRALIA
PERCENTAGE
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CLEAN BREAK
COLLISION
2003
2004
2005
TOTAL AVERAGE
AUSTRALIA

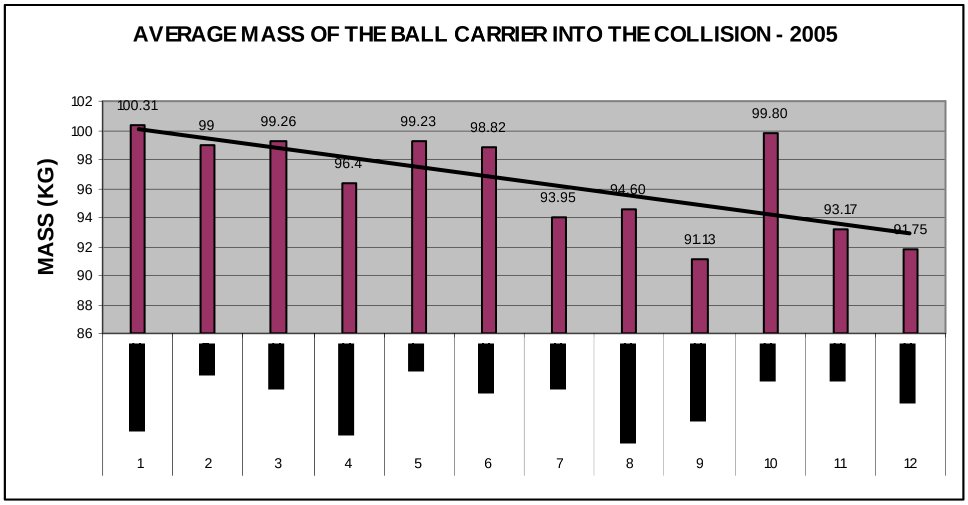

CLEAN BREAK vs COLISION TRIES SCORED - NEW ZEALAND
PERCENTAGE
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CLEAN BREAK
COLLISION
2003
2004
2005
TOTAL AVERAGE
NEWZEALAND


CLEAN BREAK vs COLLISION TRIES SCORED - SOUTH AFRICA
PERCENTAGE
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CLEAN BREAK
COLLISION
CLEAN BREAK
COLLISION
CLEAN BREAK
COLLISION
CLEAN BREAK
COLLISION
2003
2004
2005
TOTAL AVERAGE
SOUTH AFRICA

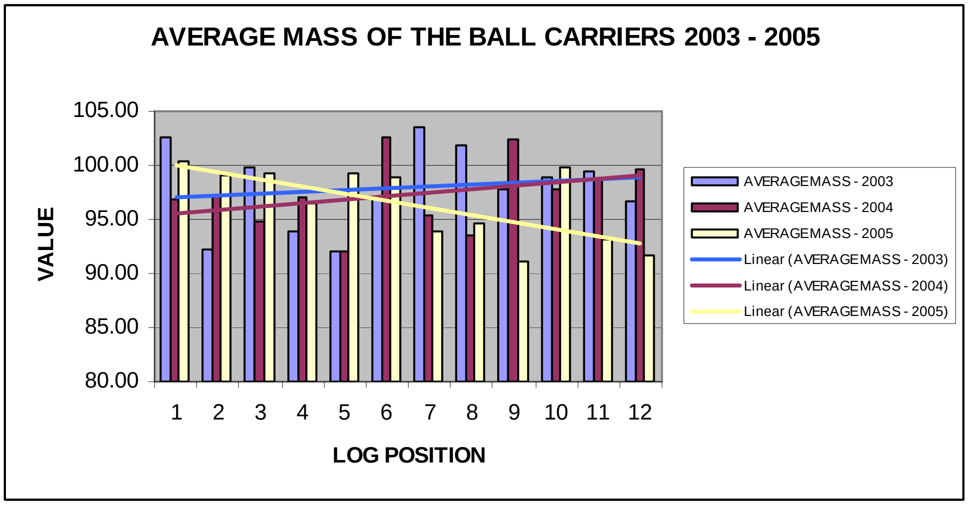
APPENDIX 7

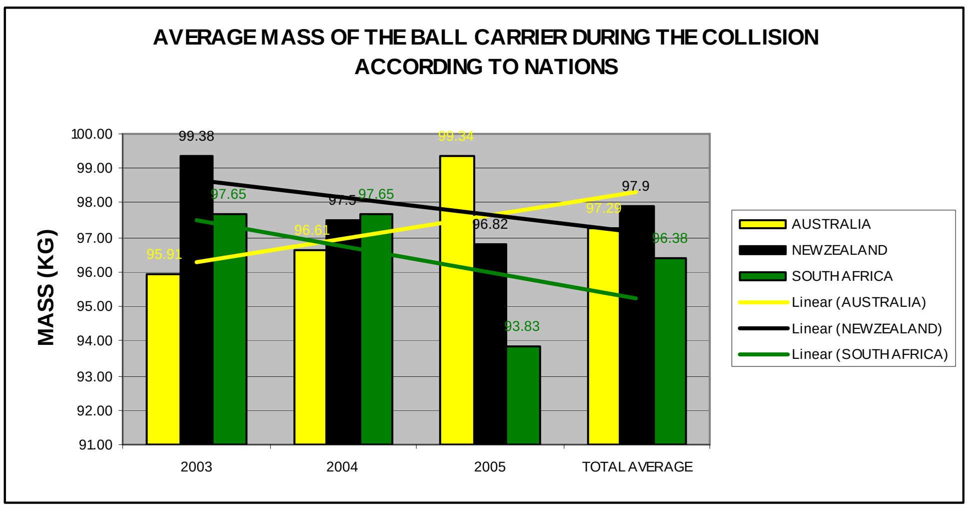

AVERAGE MASS OF THE BALL CARRIERS DURING THE COLLISION - 2003
MASS (KG)
106
104
102
100
98
96
94
92
90
88
86
102.62
92.26
99.74
93.83
92.00
96.81
103.44
101.83
97.75
98.83
99.45
96.60
1
2
3
4
5
6
7
8
9
10
11
12


AVERAGE MASS OF THE BALL CARRIERS DURING THE COLLISION - 2004
MASS (KG)
104
102
100
98
96
94
92
90
88
86
96.76
97.22
94.89
97.10
92.05
102.56
95.37
93.5
102.4
97.69
98.73
99.63
1
2
3
4
5
6
7
8
9
10
11
12

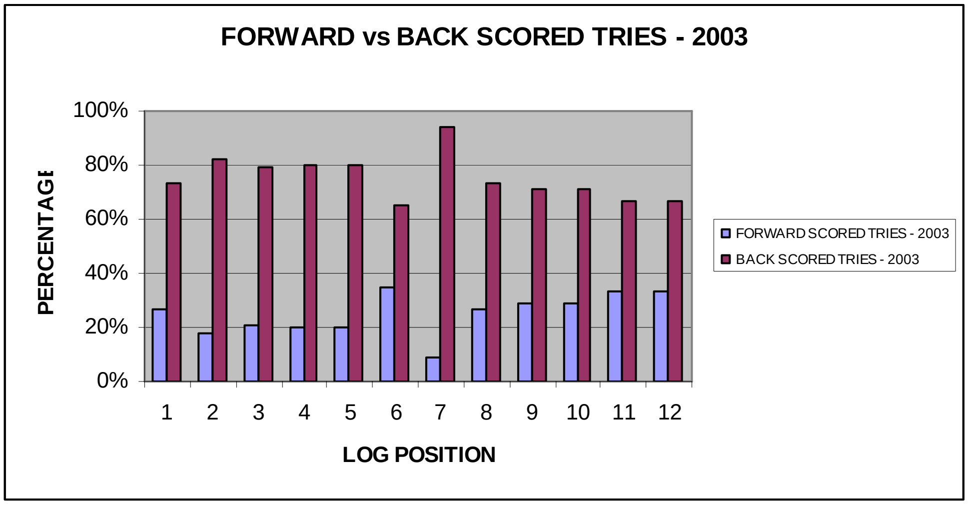

AVERAGE MASS OF THE BALL CARRIER INTO THE COLLISION - 2005
MASS (KG)
102
100
98
96
94
92
90
88
86
100.31
99
99.26
96.4
99.23
98.82
93.95
94.60
91.13
99.80
93.17
91.75
1
2
3
4
5
6
7
8
9
10
11
12

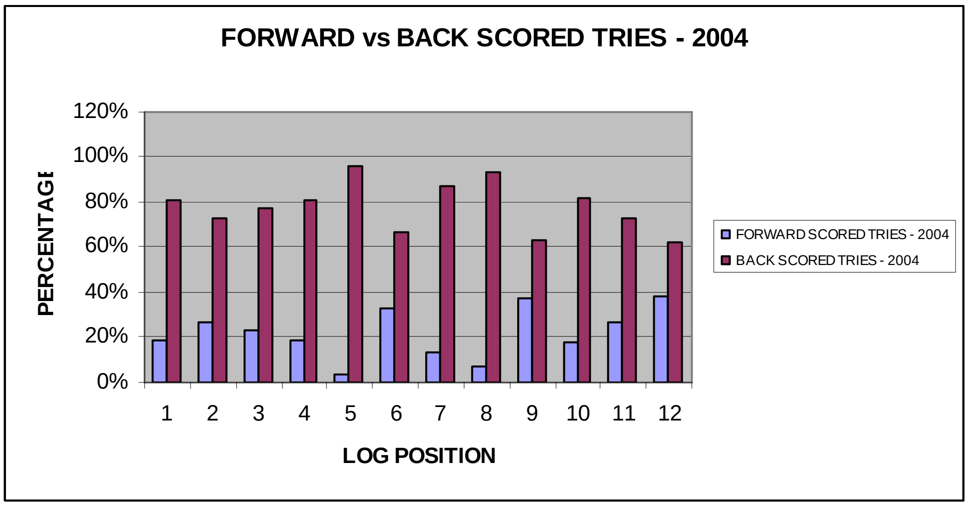
APPENDIX 8

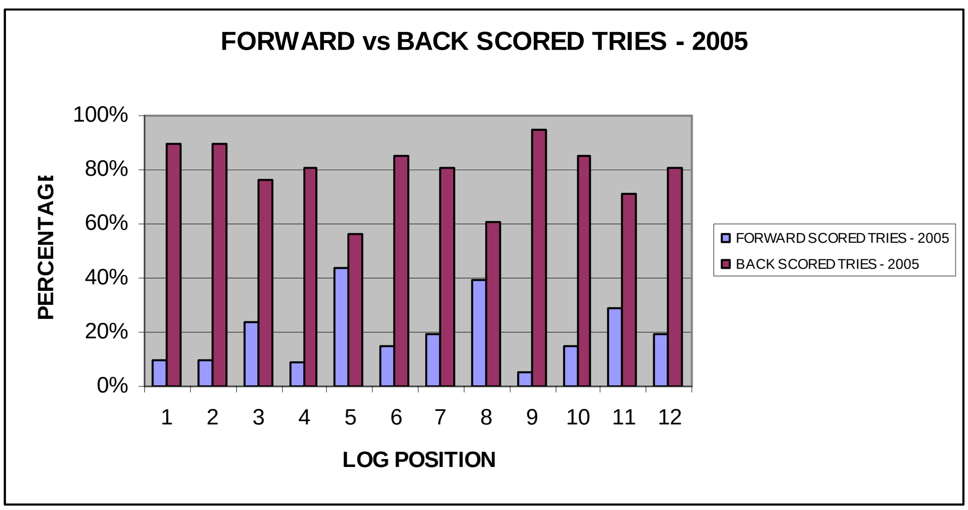

AVERAGE MASS OF THE BALL CARRIERS 2003 - 2005
VALUE
LOG POSITION
105.00
100.00
95.00
90.00
85.00
80.00
1 2 3 4 5 6 7 8 9 10 11 12
AVERAGEMASS - 2003
AVERAGEMASS - 2004
AVERAGEMASS - 2005
Linear (AVERAGEMASS - 2003)
Linear (AVERAGEMASS - 2004)
Linear (AVERAGEMASS - 2005)


AVERAGE MASS OF THE BALL CARRIER DURING THE COLLISION ACCORDING TO NATIONS
MASS (KG)
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
99.38
97.65
95.91
96.61
97.5
97.65
99.34
96.82
93.83
97.29
97.9
96.38
2003
2004
2005
TOTAL AVERAGE
AUSTRALIA
NEWZEALAND
SOUTHAFRICA
Linear (AUSTRALIA)
Linear (NEWZEALAND)
Linear (SOUTHAFRICA)

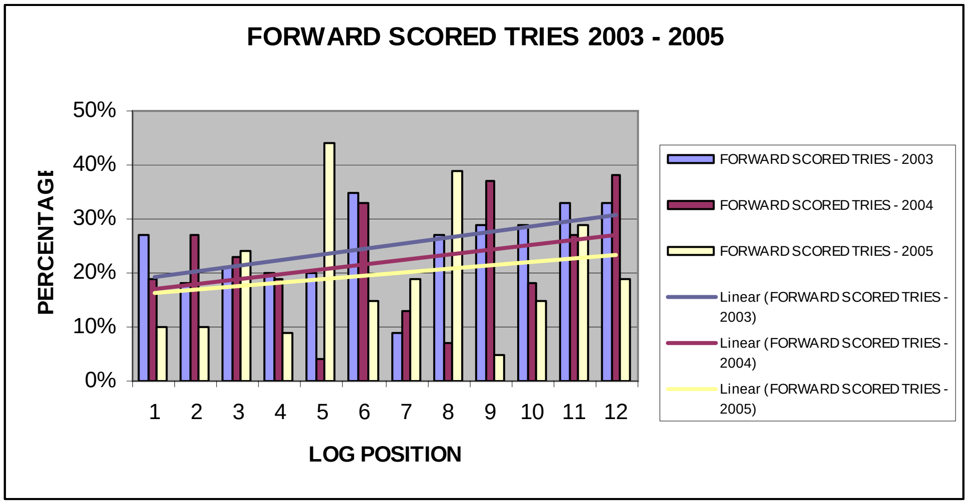
APPENDIX 9

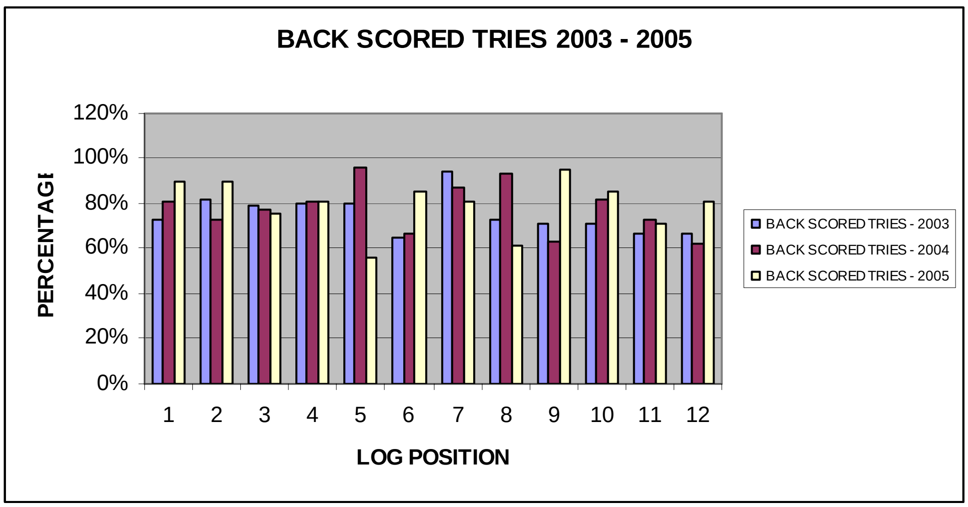

FORWARD vs BACK SCORED TRIES - 2003
PERCENTAGE
100%
80%
60%
40%
20%
0%
1
2
3
4
5
6
7
8
9
10
11
12
LOG POSITION
FORWARD SCORED TRIES - 2003
BACK SCORED TRIES - 2003


FORWARD vs BACK SCORED TRIES - 2004
PERCENTAGE
120%
100%
80%
60%
40%
20%
0%
1
2
3
4
5
6
7
8
9
10
11
12
LOG POSITION
FORWARD SCORED TRIES - 2004
BACK SCORED TRIES - 2004

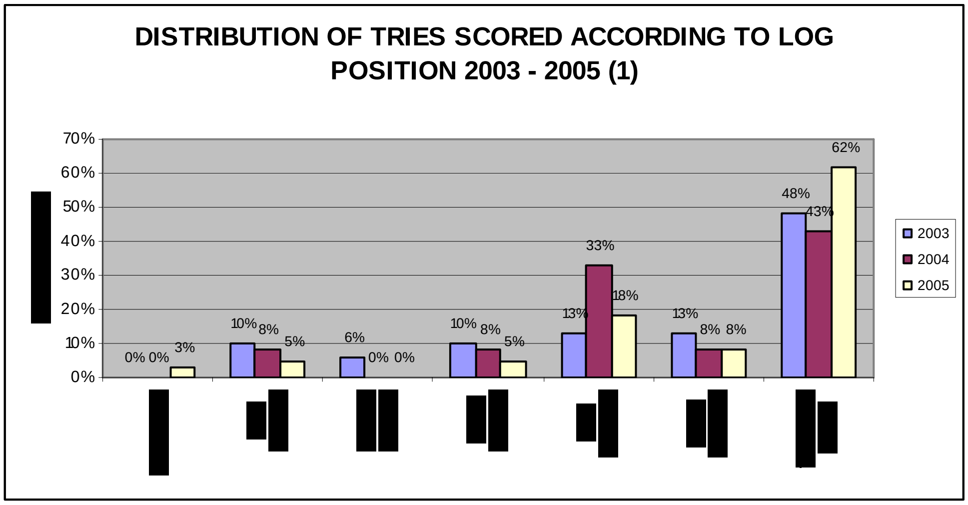

FORWARD vs BACK SCORED TRIES - 2005
PERCENTAGE
100%
80%
60%
40%
20%
0%
1
2
3
4
5
6
7
8
9
10
11
12
LOG POSITION
FORWARD SCORED TRIES - 2005
BACK SCORED TRIES - 2005

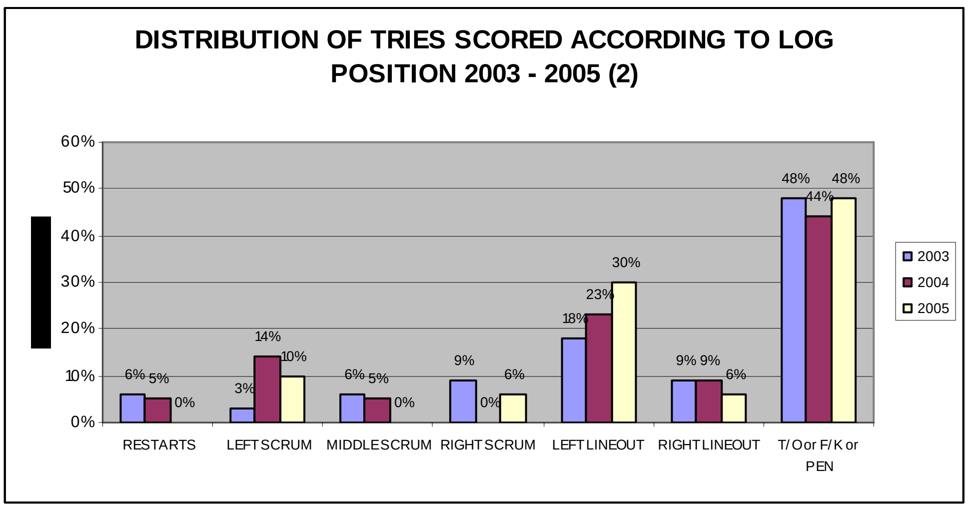
APPENDIX 10

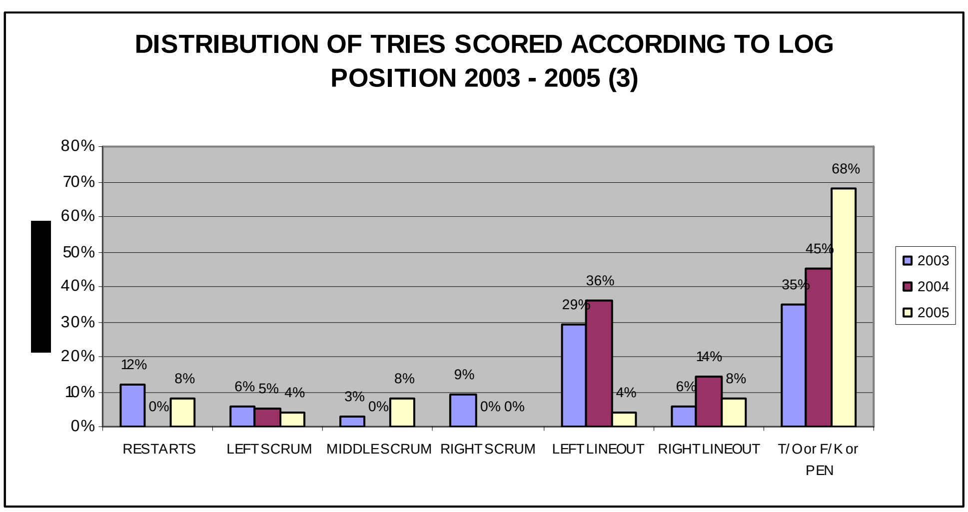

FORWARD SCORED TRIES 2003 - 2005
PERCENTAGE
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12
LOG POSITION
FORWARD SCORED TRIES - 2003
FORWARD SCORED TRIES - 2004
FORWARD SCORED TRIES - 2005
Linear (FORWARD SCORED TRIES - 2003)
Linear (FORWARD SCORED TRIES - 2004)
Linear (FORWARD SCORED TRIES - 2005)

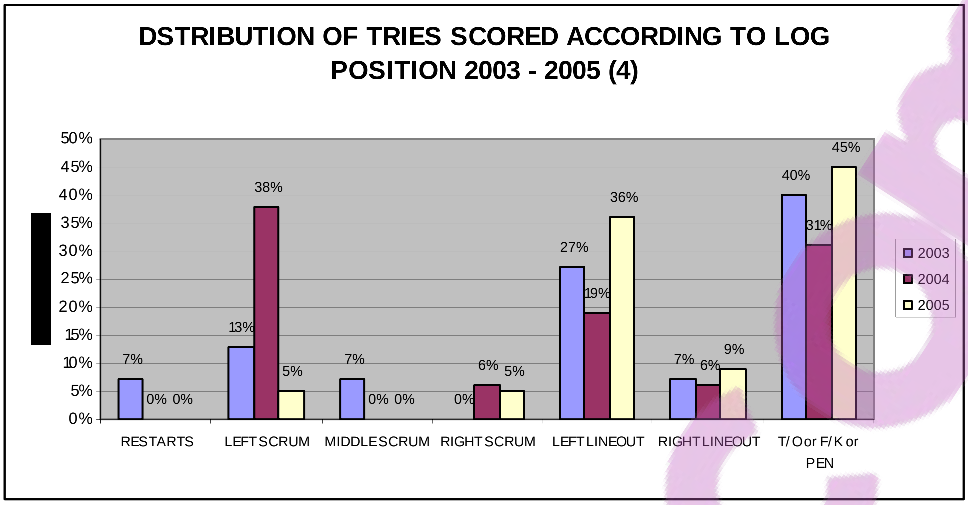

BACK SCORED TRIES 2003 - 2005
PERCENTAGE
120%
100%
80%
60%
40%
20%
0%
1 2 3 4 5 6 7 8 9 10 11 12
LOG POSITION
BACK SCORED TRIES - 2003
BACK SCORED TRIES - 2004
BACK SCORED TRIES - 2005

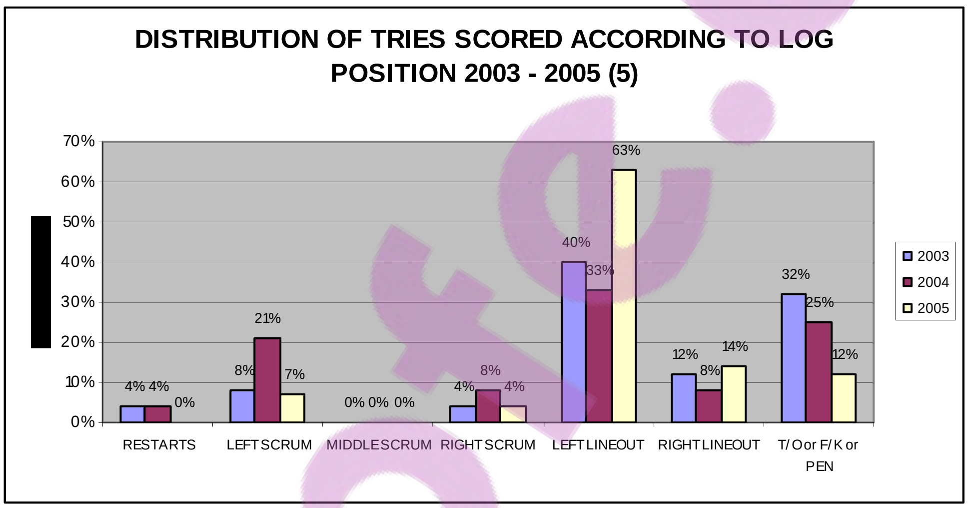
APPENDIX 11

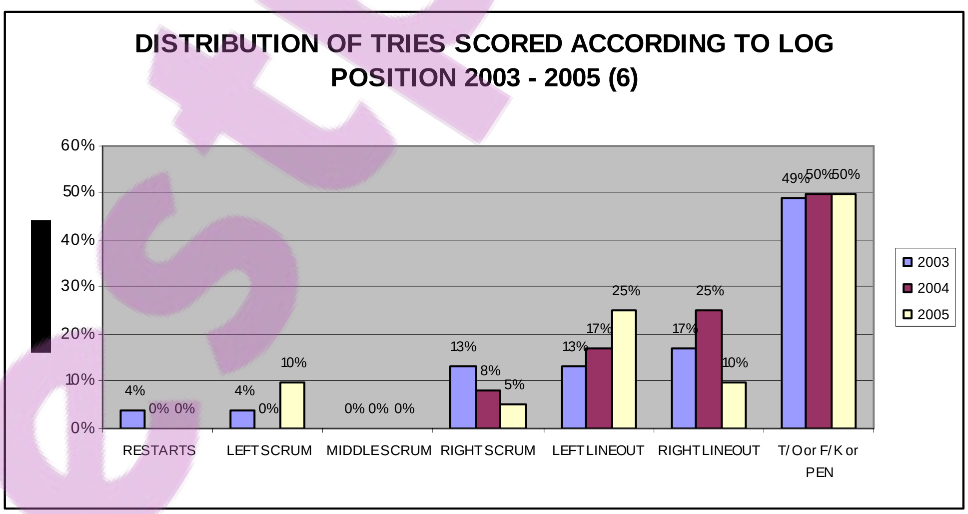

DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (1)
70%
60%
50%
40%
30%
20%
10%
0%
2003
2004
2005

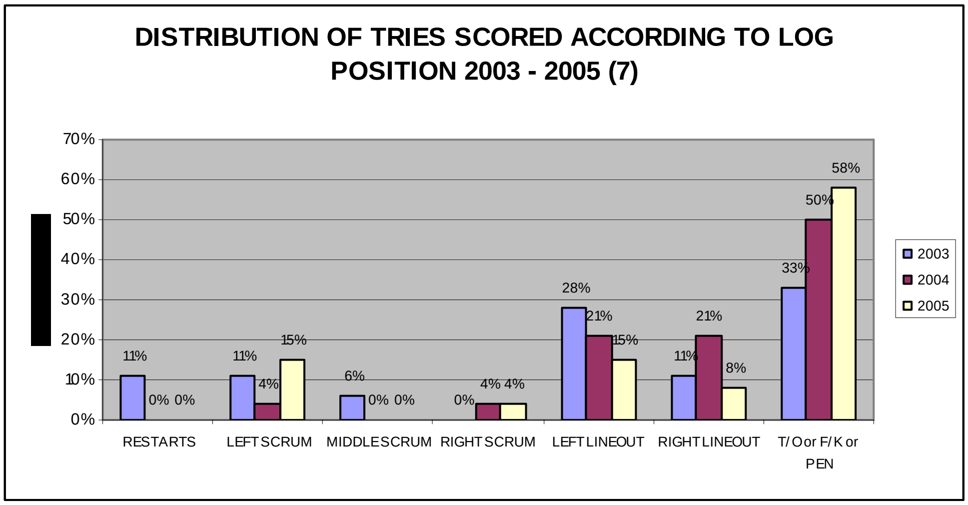

DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (2)
60%
50%
40%
30%
20%
10%
0%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005

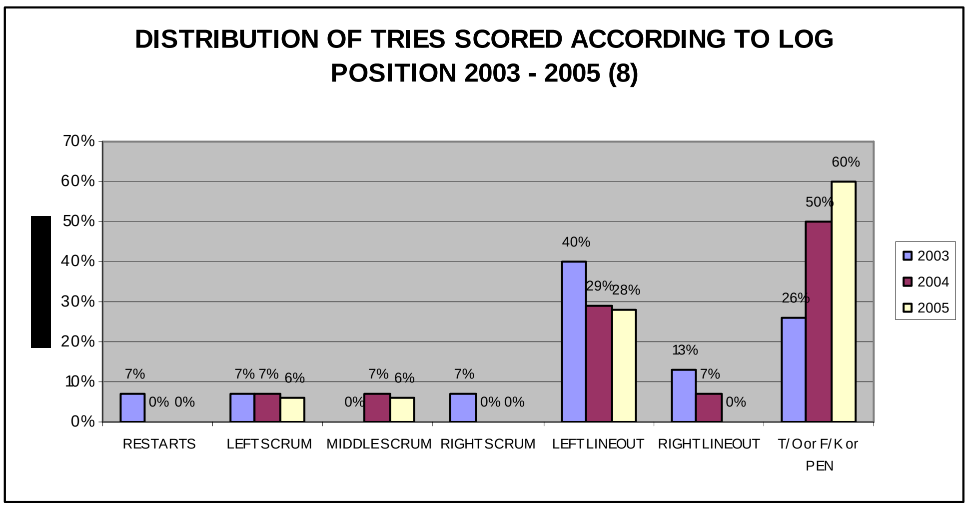

DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (3)
80%
70%
60%
50%
40%
30%
20%
10%
0%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005

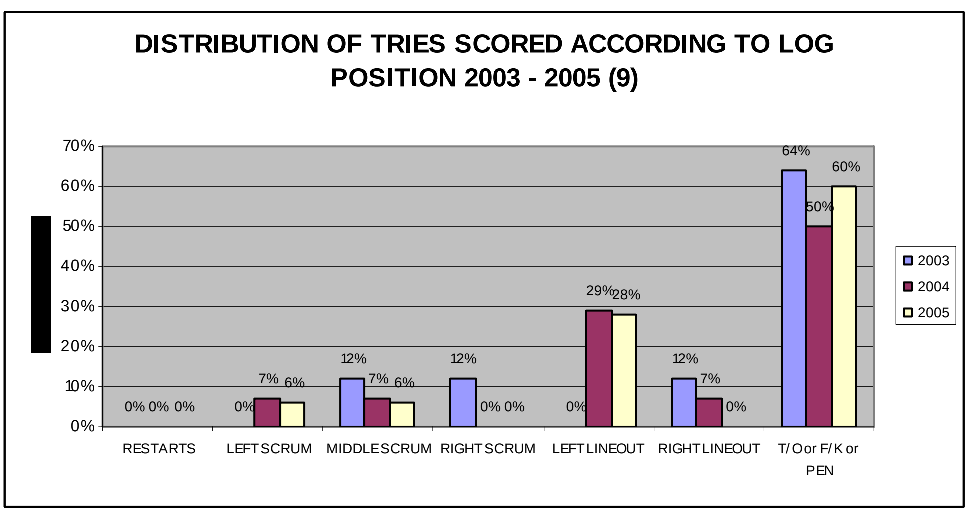

DSTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (4)
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
7% 0% 0%
13% 38% 5%
7% 0% 0%
0% 6% 5%
27% 19% 36%
7% 6% 9%
40% 31% 45%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005


DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (5)
70%
60%
50%
40%
30%
20%
10%
0%
4% 4% 0%
8% 21% 7%
0% 0% 0%
4% 8% 4%
40% 33% 63%
12% 8% 14%
32% 25% 12%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005

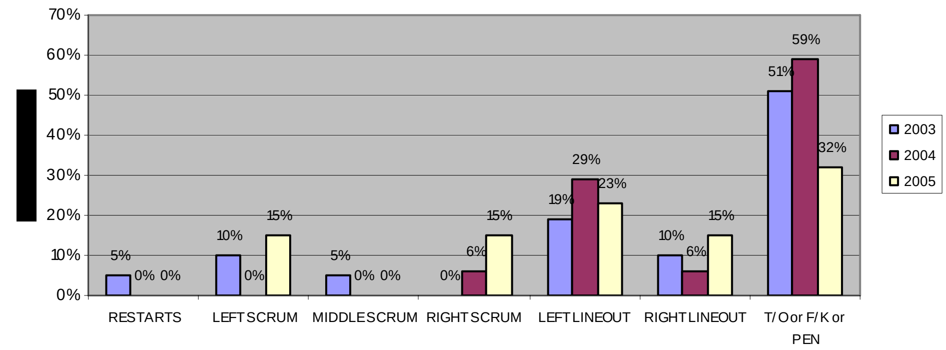

DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (6)
60%
50%
40%
30%
20%
10%
0%
4% 0% 0%
4% 0% 10%
0% 0% 0%
13% 8% 5%
13% 17% 25%
17% 25% 10%
49% 50% 50%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005


DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (7)
70%
60%
50%
40%
30%
20%
10%
0%
11% 0% 0%
11% 4% 15%
6% 0% 0%
0% 4% 4%
28% 21% 15%
11% 21% 8%
33% 50% 58%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005

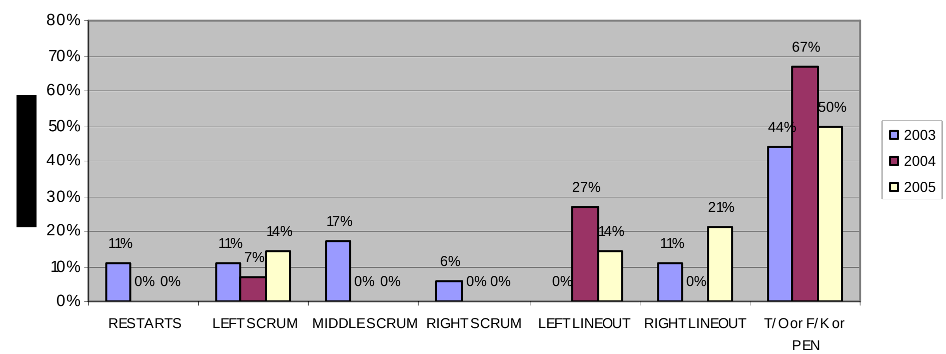

DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (8)
70%
60%
50%
40%
30%
20%
10%
0%
7% 0% 0%
7% 7% 6%
0% 7% 6%
7% 0% 0%
40% 29% 28%
13% 7% 0%
26% 50% 60%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005


DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (9)
70%
60%
50%
40%
30%
20%
10%
0%
0% 0% 0%
0% 7% 6%
12% 7% 6%
12% 0% 0%
0% 29% 28%
12% 7% 0%
64% 50% 60%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005

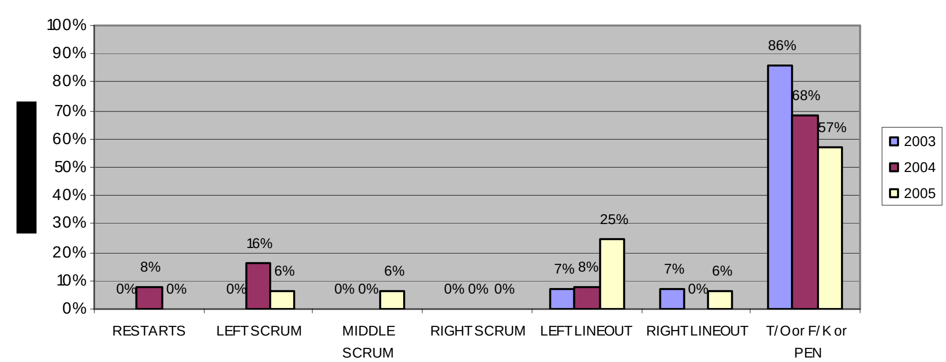
DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (10)

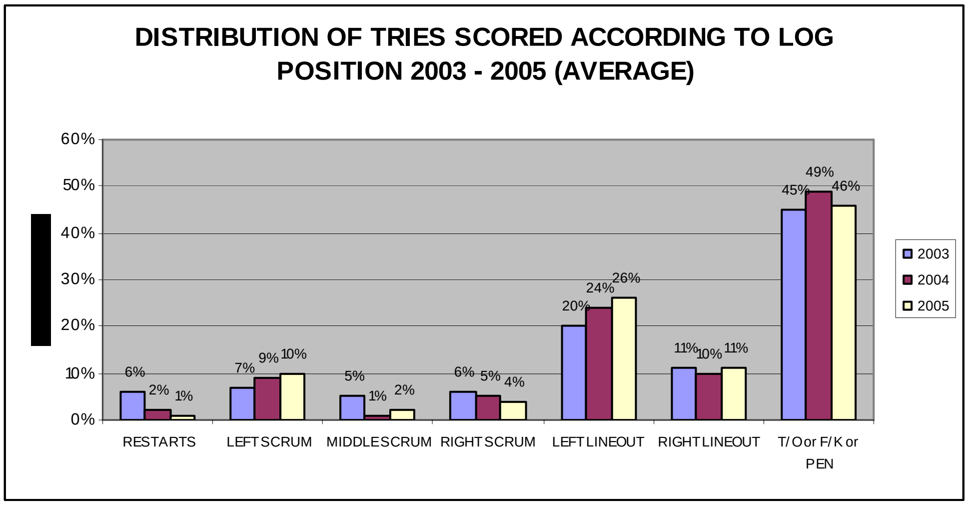


DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (11)



DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (12)




DISTRIBUTION OF TRIES SCORED ACCORDING TO LOG POSITION 2003 - 2005 (AVERAGE)
60%
50%
40%
30%
20%
10%
0%
6%
2%
1%
7%
9%
10%
5%
1%
2%
6%
5%
4%
20%
24%
26%
11%
10%
11%
45%
49%
46%
RESTARTS
LEFT SCRUM
MIDDLE SCRUM
RIGHT SCRUM
LEFT LINEOUT
RIGHT LINEOUT
T/O or F/K or PEN
2003
2004
2005