

## CHAPTER THREE: The Use of Video in Notational Analysis

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### 0. Introduction

In this chapter, we discuss how video technology can be used in notational analysis. We are particularly interested in the process of video use and we do not intend to write in detail about the technical specifications of video. We make the assumption that there is an ever-changing product available for professional and domestic use that will offer increasing quality of picture and sound.

We have divided the chapter into the following sections:

1. The potential of video
2. Examples of its use
3. An evaluation of video in notational analysis

### 1. The Potential of Video in Sport

We anticipate that most readers of this chapter will have a range of experience of video technology. Television companies, for example, have made increasing use of video to give audiences multiple perspectives of key sporting events. Slow motion and freeze frame images are regularly used by TV producers to extend fleeting moments of sport.

We come to expect such video support of performance in sport. If we are passive consumers of TV sport then we can develop a visual dependency on the televised imagery. It is all too easy in such contexts to let others observe for us. On the other hand, television can encourage us to become visually literate by enabling us to actively observe what is taking place.

Our first basic point, therefore, is that when considering the potential of video we ought to reflect on how we consume professional broadcast material. Domestic video equipment significantly extends this potential. With a very basic video cassette recorder, we can record a sport programme and then replay it in our own time at some point after the event. This lapsed-time facility of video means that we can control the images made available to us by sport broadcasts. Video can become our tool.

Similarly, the development in domestic video cameras has made it increasingly possible (and easy) to make personal records of sporting performance. Lyons (1988) has given an overview of the potential use of domestic video cameras for teachers and coaches in physical education, dance and sport. In many schools and higher education institutions video is used regularly. We want to encourage the use of video by students of sport. We suggest that a video recording provides a relatively permanent, flexible resource for analysis.

These characteristics of video are particularly helpful for coaches. One of the main aims of coaching is to optimise performance. This is achieved, in part, by assessing and modifying performance. Hastie (1992), amongst others, has observed how video and notational analysis are becoming commonplace in this process.

Many coaches have to video and analyse performance with little or no help from outside agencies. This is particularly the case in so-called 'minor sports'. At elite levels of performance, it is likely that coaches will have available video and analysis support systems. At their best, such systems are defined by the coach for her/his needs. Notational analysts who work with coaches in these applied contexts should be sensitive to the coaches' needs. In this way they can exhibit characteristics of ecologically valid research noted by Davids (1988).

In their links with coaches, notational analysts have to consider the relationship between quantitative methodologies and qualitative concerns. Evidence about the process of observation indicates how important notational analysis can be in adding to a coach's knowledge of a specific sports performance.

5 Studies in applied psychology and sport psychology have shown that the observational skills of coaches are variable and inaccurate (Darst, 1983; Franks and Miller, 1986; Ellis, 1984). Factors that can influence observational accuracy include: observer state of arousal; perceived seriousness of competition; nature of observational medium (live event or videotape); the focus of attention; and the 'priming' for anticipated events (Franks et al, 1986). More research is needed in this area of 'eye witness testimony'. For an example of some of this work in notational analysis, see Sharp (1986), Hughes (1988) and Treadwell (1988). 1983, 1984, 1985 57 Franks and Miller (1986) remain an original and illuminating source of information about accuracy of observation.

Notational analysis has the potential to reduce problems related to observation. If video is used to offer a lapsed-time analysis then the coach's recall of a performance can be further augmented. All coaches make mental notes of what they see but the human brain has limited capacity for observation and accurate recall (Franks, Goodman, Miller, 1983).

Some sports place a greater demand on observation and accuracy of recall than others. In invasion games like association football and rugby, the coach is faced with a large number of parameters that define the sport action (Hughes, 1988). In team games there are large numbers of single events that can be quantified. These events are performed by different players, in varying playing positions and at different times during play. The sequencing of action leading up to a single event is also of importance (O'Shea, 1992). In such invasive games, notational analysis and a video record can deal with performance of individual players or with aspects of team play. Video can provide a permanent record of performance for repeated viewing and analysis.

Patrick and McKenna (1987) refer to these kinds of games as 'non-deterministic'. They comprise a large number of events with a

high degree of player choice of action in addition to a relatively high uncertainty of other players' actions.

In the next section we provide examples of the use of video and notational analysis in support of coaches.

## 2. Examples of Video Use in Notational Analysis

In the thirty five years since the invention of video recording, academic researchers and those involved directly in sport have made increasing use of video to record and analyse performance. Much of the published literature has focused on player performance rather than coach performance.

### 2.1 Studies of Playing Sport

In association football, Winterbottom (1959) and Wade (1967) pioneered analysis by recording the distance covered by players in competitive matches. The first 'classical' methodology for data collection in the game was specified by Reep and Benjamin (1968). Their work led to the identification of several key factors that are associated with successful soccer performance. As goal scoring was considered to be the main concern of football they proceeded to examine methods of scoring, patterns of build-up play that led to goals being scored and the areas of the pitch from where goals were scored. In essence, Reep and Benjamin (1968) sought to isolate the antecedents of goal-scoring.

Reep devised from his work a principle he termed the 'reacher theory'. He divided the soccer pitch into thirds and designated the critical scoring area the attacking third (the area between an imaginary line drawn 35 yards from goal and the goal line). A 'reacher' was defined as a single pass from the defensive third to the attacking third and was seen by Reep as the most probable way of creating a goal-scoring opportunity from a possession that started deep in defence.

Subsequent video and notational analysis of soccer was conducted by Charles Hughes (1984), the Coaching Director of the Football Association. His work confirmed that goals tend to be scored from passing sequences with a small number of passes. He has suggested that strategies for attack should be adopted that maximise the use of shorter possessions rather than those that emphasise maintaining possession over a period of time. This kind of research has been continued by Bate (1988) in his work with Notts County football club. Bate has noted that 98% of goals scored by the club were scored from four or less passes and that of these 33% were set-piece plays in the attacking third.

Michael Hughes and his co-workers at Liverpool Polytechnic have questioned the accuracy of this reacher theory in their own notational and video analysis of soccer. Hughes, Robertson and Nicholson (1987) compared patterns of play of successful and unsuccessful teams in the 1986 World Cup. They concluded that successful teams gained more territorial advantage and played more possession football than the less successful sides, and forced errors from their opponents by closing down space in all areas of the pitch.

The significant aspects of this study are its methodology and data gathering techniques. A computerised notational analysis was used by linking a BBC computer to a concept keyboard with data stored and accessed via a specially written computer programme. Video recordings were made of the 1986 World Cup games and analysis was carried out in lapsed-time some time after the games had ended. Each performance variable in the games was accommodated within a notational code and their incidence was stored for subsequent analysis. Robertson et al (1987) concluded that "for coaches ... to suggest that teams in the main aim to restrict their possession to three successive passes or less would be a simplistic approach to winning!". Hughes and Lewis (1987) have extended this work through an analysis of attacking plays to investigate whether or not successful teams use different attack plays to unsuccessful teams. They have concluded that winning teams passed the ball more when attacking, particularly out of defence, and in the final third of the pitch. Winning teams also seemed to control centre field much better than losing teams.

The value of computerised notational analysis in soccer is discussed by Church and Hughes (1987). They indicate that a computerised system can test hypotheses, provide detailed information about technical and tactical aspects, and in certain circumstances provide immediate feedback to players and or coaches.

1983, 1986 Video recordings of soccer games can also inform other forms of analysis. Russell (1987) has studied passing movements in relation to strikes on goal in international matches. Taylor (1988) and Herborn (1989) used a hand notation sytem to investigate goal attempts and reacher tactics in professional soccer. Herborn (1989), for example, compared and contrasted English first division and European international football and found that the most successful teams mix tactics during their games. Ali (1987) and Reilly and Harris (1987) used video recordings of soccer games to look at the utilisation of space, team work and the tactical configurations most likely to produce success. Pollard (1987) provided a quantitative comparison of playing styles in soccer by using a shorthand system of recording. He used this data for computer analysis purposes and compared similarity of style between pairs of soccer teams.

Some researchers focus on the physiological demands imposed in soccer. Their work makes use of time and motion analysis with the aim to "obtain detailed and objective data on the movement patterns of game play and to indicate how this information can be applied to fitness training" (Mayhew and Wenger, 1985). Some of the early examples of this kind of work can be found in Brooke and Knowles (1974) and Thomas and Reilly (1976). The latter, for example, deduced from their analysis that movement patterns in soccer were predominantly aerobic in nature and that a "high aerobic capacity is desirable for



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outfield soccer players". Withers et al (1978), Mayhew and Wenger (1985), Dufour (1988) and Patrick and McKenna (1988) have added to this kind of research.

Video is an important resource in such research since the ability to accurately measure distance and time is critical. Some higher educational institutions like Liverpool Polytechnic and Cardiff Institute of Higher Education have encouraged undergraduate students to develop small-scale time and motion analyses of soccer performance. Balsom (1986), Treadwell (1988) and Van de Vliet (1987), for example, developed a research cluster that aimed to produce an analysis system that could provide immediate feedback to players and coach concurrent with and immediately after the game. Researchers in Japan have made considerable use of video to develop this kind of analysis. Ohashi et al (1988) have looked at movement speeds and distances covered by players. Yamanaka et al (1988) have extended this work to referees. Ohashi et al's (1988) work is noteworthy for the way in which video cameras were used to capture data. Player movement was digitised by linking this video material to potentiometers.

The practical objective of coaches utilising data from such studies is for fitness training to replicate the demands of the game. The early work of Winterbottom (1959) and Wade (1967) established a tradition of analysis in soccer. They wanted to have a 'scientific' input in their everyday training and coaching so that they could give specificity to the preparation of soccer players for competition. The development of video technology has meant that their innovative work can become even more 'scientific'. Winkler (1991), for example, has developed a sophisticated data capture system called Computer Controlled Dual Video System (CCDVS) to evaluate individual and team performance in soccer. The potential of such systems for notational analysis is enormous.

Researchers in other sports have added to the stock of analysis material in soccer. In rugby union, for example, there is a growing 'invisible community' of workers who are linked with senior rugby teams. At the Centre for Notational Analysis at the Cardiff Institute of Higher Education, video recordings have been used to enable accurate hand notation of performance over ten home international seasons and two World Cup cycles. Other researchers have developed systems to analyse elite rugby union performance and these include Doherty et al (1988) and Maclean (1992).

In rugby league, Larder (1988) has developed a sophisticated hand notation system for use with video recordings. He concentrates on key variables linked to defence and possession. Data collected is used to give a comprehensive individual player and team report. Larder developed his system whilst the Director of Coaching for

the British Amateur Rugby League Association and offers a prime example of a coach using objective analysis of player performance for the common good of player, team and coach.

Netball is another sport that has experience of notational analysis. Although there are limited live broadcasts of netball and therefore few opportunities to record 'off-air', a small number of researchers have used video for analysis purposes. Brown (1978) noted that the coaching of netball needed to change from a reliance on subjective observations to a much more objective process. According to Embrey (1978), match analysis was adopted in netball in order to make the most of each player's potential. Some of the earliest analysis in netball produced data specific to game skills, game structure and team play. Otago (1983) analysed activity patterns of netball players. Potter (1985) developed a hand notation system to analyse live and video-recorded games. Her analysis compared the path of the ball towards the goal after the centre pass in games with that advocated in coaching textbooks. Fuller (1988) analysed the games played in the 1987 world championships in an attempt to identify performance trends capable of differentiating between winning, losing and drawing teams. More recently, Steele and Chad (1991) have added to this interest in analysis in netball by comparing movement patterns in training with those in game play.

Dagget and Davies (1982) noted that there was a distinct lack of match analysis data relating to (field) hockey. In an early study, Miller and Edwards (1982) used video to analyse the workloads of a full-back in one game of hockey. Morris and Bell (1985) recorded games on video and performed a lapsed-time computer analysis in order to establish the effectiveness of players' passing skills. Andrews (1985) used videotape recordings of men's international hockey games to analyse attacking play in the goal circle. Hughes and Billingham (1986) conducted a detailed computer analysis of women's hockey to investigate the hypothesis that the right side of the field is used more frequently for attacking build ups. Wilson (1987) conducted a detailed analysis of women's hockey in Canada and McNamara (1989) has analysed women's hockey in Wales.

Lyons (1988) has provided examples of how other sports have used video for analysis purposes. The growth of interest in video since that time has meant that more and more journals are publishing articles about notation and extending the number of models available to students and those involved in sports performance. We are conscious that our examples of video use have been selective and have focused on a small number of sports. We are also aware of the insight to be gained from an early article by Underwood and McHeath (1977):

From video, facts are provided and it is then up

to the skill and judgement of the coach to interpret this information in the light of the playing ability of the players. This type of analysis does not replicate the coach. It merely shows how some of the sophisticated equipment which is becoming more readily available can be used to augment coaching methods.

We have tried to alert you to some examples that have added to our stock of knowledge about sports performance. We make a very brief comment about coaching in the next section.

## **2.2 Studies in Coaching Sport**

Research carried out to investigate the accuracy of coach observation and recall is limited (Franks and Goodman, 1986; Hughes, 1985). The work that has been done indicates that the accuracy of recall of game information is low. Hughes (1985) found soccer coaches to be only 12% correct in post-game assessments from video of events leading to the creation of scoring chances. Franks and Goodman (1986) tested forty of Canada's top soccer coaches in conjunction with a group of forty physical education students on the accurate observation of soccer videotapes. Their results suggested that the coaches were only marginally better at accurately recalling events than were the students.

With this extremely limited report of work on video and coaching behaviour we move in the next section to an evaluation of the use of video in notational analysis.

## **3. Evaluation of Video in Notational Analysis**

Earlier in this chapter we mentioned some of the evidence relating to eye-witness testimony and the recall we have of events. Sport by its nature is fleeting and without a permanent record is consigned to personal memory and an oral tradition. Composers and choreographers make their performances amenable to repetition over time by establishing notation conventions. In sport we face a similar challenge.

A notational analyst in the 1990s has a range of choices about the form analysis can take. It may be, for example, that in the best applied sports science tradition an analyst is working with players and coaches at sporting events and providing immediate feedback with basic pen and paper techniques. Alternatively, as we noted earlier, it is possible to conduct 'pure' research in the sports science laboratory with the kind of technology used by Winkler (1991). Video technology provides a safety net for analysis and we regard it as an important tool. Lyons (1988) has discussed some of the issues surrounding video use and we want to emphasise here that considered use of

video in notational analysis should recognise its potential as an educational technology.

Fundamental to the whole process of notational analysis is the question of the audience for such material. British television viewers are now experiencing a range of information as they watch sport. Just as we became consumers of action replay, we now are becoming consumers of match facts. What decisions have television producers made about the information needs of viewers? We want to suggest that researchers have to make clear their audiences for analysis. We are engaged at Cardiff Institute in a range of projects with coaches and with students. At each stage we try to clarify the relationship between the so-called advancement of knowledge and the needs identified by a coach or governing body of sport. We firmly believe that it is our task to make notational analysis comprehensible and non-threatening. We think video is a means of doing this.

As a learning tool, video and notational analysis offer tremendous feedback potential. We are conscious, of course, of the equivocal nature of research relating to video and motor skill acquisition (Lyons, 1988) but recognise too the usefulness of video as motivational support for players and coaches (Hastie, 1992). Particularly important are those analysis systems that allow for positive focusing on performance excellence and constructive criticism linked to error detection. These systems allow for a macro analysis of performance and the micro analysis of game elements or actions. Such systems are amenable to both pure and applied research.

Video enables researcher and sports performer to triangulate understanding of performance. We think it takes a considerable amount of patience and skill to empower researchers, players and coaches to use the fruits of notational analysis. Video recordings embody the analysis so that repeated viewing can encourage dialogue about quantitative information and qualitative analysis.

In conclusion, we want to suggest that video is an integral tool for analysis. High quality video images are making fine grain analysis increasingly possible. By capturing sporting moments, video gives us chance to observe, reflect, check and accurately record performance. Developments in interactive video offer a fascinating challenge to notational analysts and educational technologists. Although some notational analysts might prefer ultimately to work closely with players and coaches and provide an immediate feedback on performance, it is likely that video will continue to enhance the quality of reflective practice in the art of notational analysis.



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