Performance Analysis in Sport

Abstract

This paper will seek to provide a comprehensive description of Performance Analysis, its purpose and its broad possible applications. The paper will summarise the similarities of approach of biomechanics and notational analysis, and will show how, through the application of motor control theories, these two different approaches to of objective feedback can combine to help the sports player, coach and manager. The review of relevant researches in Performance analysis of sport is given also. The main focus of this paper is how biomechanical and notational analyses have helped, and can help, coaches and athletes to analyse and improve sports performance. It has been also showed how data from these researches can be analysed and processed in a variety of ways to provide a descriptive profile that can be used for giving both the athlete and the coach feedback about their actions.

Key words: Performance Analysis, Sport, biomechanics, notational analysis, training process

Introduction

This paper will consider what performance analysis in sport is, what biomechanical and notational analysis has in common and how they differ. The main focus will be how they have helped, and can better help, coaches and athletes to analyse and improve sports performance. Biomechanics, notational analysis and motor control all involve the analysis and improvement of sport performance (Bartlet, 2001). 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 (Bartlet, 2001). They have theoretical models - based on performance indicators – amenable to artificial intelligence (AI) developments and strong theoretical links with other sport science and information technologies (IT) disciplines. They differ in that biomechanists analyse, in fine-detail, individual sports techniques and their science is grounded in mechanics and anatomy. A notational analyst study technical and tactical patterns in soccer, gross movements or movement patterns, and is primarily concerned with strategy and tactics and has a history in dance and music notation. Notational analysts are gradually establishing their own methodological processes and interlinking these with developing theories for the specific problems associated with their data analyses (Hughes and Franks, 1997).

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 a player and facilitate comparative analysis of teams and players. In addition, biomechanics helps to identify injurious techniques (Bartlet, 2001) while notational analysis helps to assess physiological and psychological demands of sports (Sporis et al., 2012). Drawing on a range of examples, it will be argued that performance analysts require a unified approach, examining interactions between players, and their individual skill elements. Of fundamental importance is the need for us to pay far greater attention to the principles of providing feedback - technique points that a coach can observe

from video and simple counts of events are unlikely to enhance individual or team performance. Notational analysis is an objective way of recording performance (Hughes and Franks, 1997), so that critical events in that performance can be quantified in a consistent and reliable manner. This enables quantitative and qualitative feedback that is accurate and objective. No change in performance of any kind will take place without feedback. The role of feedback is central in the performance improvement process, and by inference, so is the need for accuracy and precision of such feedback (Morya et al., 2003). The provision of this accurate and precise feedback can only be facilitated if performance and practice is subjected to a vigorous process of analysis. Augmented feedback has traditionally been provided by subjective observations, made during performance by the coaches, in the belief that they can accurately report on the critical elements of performance without any observation aids. Several studies (Hughes, 1980; Franks, 2000; Morya et al., 2003) not only contradict this belief, but also suggest that the recall abilities of experienced coaches are little better than those of novices, and that even with observational training, coaches' recall abilities improved only slightly.

Furthermore, research in applied psychology has suggested that these recall abilities are also influenced by factors that include the observer's motives and beliefs. The coach is not a passive perceiver of information, and as such his or her perception of events is selective and constructive, not simply a copying process. This importance of feedback to performance improvement, and the limitations of coaches' recall abilities alluded to above, implies a requirement for objective data upon which to base augmented feedback, and the main methods of "objectifying" these data involve the use of video / notational analysis (Hughes and Franks, 1997 p.11). Coaches have been aware, consciously or unconsciously, of these needs for accuracy of feedback and have been using simple data gathering systems for decades.

More recently, sports scientists have been using notational analysis systems to answer fundamental questions about game play and performance in sport. An early work, over some decades, on analysis of soccer (Reep and Benjamin, 1968) was picked up by the then Director of Coaching at the Football Association, and this had a profound effect on the patterns of play in British football – the adoption of the 'long ball' game. Generally, the first publications in Britain of the research process by notational analysis of sport were in the mid 1970's, so as a discipline it is one of the more recent to be embraced by sports science. The publication of a number of notation systems in racket sports provided a fund of ideas used by other analysts. Because of the growth and development of sports science as an academic discipline, a number of scientists began using and extending the simple hand notation techniques that had served for decades.

The applications of notational analysis in different sport activities

Movement analysis

Reilly and Thomas (1976) recorded and analysed the intensity and extent of discrete activities during match play in field soccer. With a combination of hand notation and the use of an audio tape recorder, they analysed in detail the movements of English first division soccer players. They were able to specify

work-rates of the different positions, distances covered in a game and the percentage time of each position in each of the different ambulatory classifications.

Reilly has continually added to this base of data enabling him to clearly define the specific physiological demands in not just soccer, but all the football codes. This piece of work by Reilly and Thomas (1976) has become a standard against which other similar research projects can compare their results and procedures, and it has been replicated by many other researchers in many different sports.

Modern tracking systems have taken the chore out of gathering movement data, which was the most time-consuming application of notational analysis, and advanced computer graphics make the data presentation very simple to understand (Nevill et al. 2002). Modelling movement has created a better understanding of the respective sports and has enabled specific training programmes to be developed to improve the movement patterns, and fitness, of the respective athletes.

Biomechanics - what is the biomechanical view of performance analysis?

Sports biomechanics is concerned with fine detail about individual sports techniques while notational analysts are more concerned with gross movements or movement patterns in games or teams (Bartlet 2001). Furthermore, notational analysts are more concerned with strategic and tactical issues in sport than with technique analysis and the two disciplines do not share a common historical background. However, the similarities between the two groups of performance analysts are far more marked than the differences. A crucial similarity is evident when we look at the other sport science disciplines: sports psychology and physiology (including nutrition) essentially focus on preparing the athlete for competition.

Performance analysts, in contrast, focus on the performance in competition to draw lessons for improving performance and this is true of both notational and biomechanical analysis (Franks and Goodman, 1986). Both are fundamentally concerned with the analysis and improvement of performance. Both are rooted in the analysis of human movement. Both make extensive use of video analysis and video-based technology. Although both evolved from manual systems, they now rely heavily on computerised analysis systems. Both have a strong focus on data collection and processing.

Produce vast amounts of information - this is sometimes claimed to be a strength of both sports biomechanics and notational analysis; however, it often requires careful attention in providing feedback to athletes and coaches. Many of these important topics were covered in a special issue of the Journal of Sports Sciences on Performance Analysis that appeared in the latter half of 2002.

In addition, biomechanists and notational analysts both emphasise the development of systematic techniques of observation. This is more obvious in notational analysis and, perhaps, in the somewhat-neglected ‘qualitative’ analysis approach of biomechanics than in fully quantitative ‘computerised biomechanical analysis’, which seems somewhat out of fashion with coaches at present. Both have a strong focus on the provision of feedback to the coach and performer to improve performance and each group is now learning and adopting best practice from the other.

Technical evaluation

To define quantitatively where technique fails or excels has very practical uses for coaches, in particular, and also for sports scientists aiming to analyse performance at different levels of development of athletes. A technical evaluation was achieved by Partridge et al., (1992). A specialised computer analysis system was developed, using 38 key events entered in real time by a trained analyst. The system was used to provide a comprehensive technical evaluation of performance by comparing the results of 2 distinct levels of performance, the 1990 FIFA World Cup and the 1990 World Collegiate Soccer Championships. From the results it can be inferred that collegiate coaches must be selective when presenting World Cup teams as an appropriate model of performance as many differences do occur, which makes any comparison invalid.

At International football level, where games are decided by small margins, the team that is superior in physiological and motor abilities will have the advantage (Reilly and Holmes, 1983). This places a high emphasis on a team at the elite level possessing high levels of technical ability. Although a team unit is comprised of 11 individuals, all 11 players must assume certain roles and functions in order to make such a team unit a success. Subconsciously, players and coaches alike have a universal knowledge of which technical components are required in order to play in each position within association football. There is however very little research to either reinforces or questions these concepts. Having an exact technical analysis of the precise playing requirements of each position would allow accurate training schedules and more accurate player profiles to be established. Many coaching publications state the necessary credentials to play in certain positions within soccer (Cook, 1982). These publications are however based upon opinion, as opposed to exact epidemiological research. Much ambiguity does exist between these opinions and the reported differences. Wiemeyer (2003) in interviewing 14 coaches, across varying participation levels in order to establish positional technical demands emphases this. In only one case did all coaches agree of the exact functions of a position? The tasks and functions of individuals within a team can differ according to whether a team has possession of the ball or not (Van Lingen, 1997). Despite the literature present in this field of notational analysis, there is an obvious opening for further research to be conducted. Reilly and Holmes (1983) identified that a further study could incorporate an analysis of skill performance within a competition context. As stated by Franks and McGarry (1999), the ability to provide information about individual's technical performance and the profiles of such players can significantly modify playing behaviour and promote successful performance.

Information about technical performance is also much preferable to cursory comments made by coaches following competition (Franks and Goodman, 1986). The recording of events in some coded form can help such coach observations to be formed, especially by defining each skill performed as successful or unsuccessful (Franks and Goodman, 1986).

Tactical evaluation

The definition of tactical patterns of play in sports has been a profitable source of work for a number of researchers (Hughes, 1980). The maturation of tactics can be analysed at different levels of development

of a specific sport, usually by means of a cross-sectional design. The different tactics used at each level of development within a sport will inevitably depend upon technical development, physical maturation and other variables. The 'maturation models' have very important implications for coaching methods and directions at the different stages of development in each of the racket sports (Hughes and Franks, 2008). These tactical 'norms' or 'models', based both upon technique and tactics, demonstrate how the different applications, defined above, can overlap.

Evaluation is an essential component of sport because it provides the coach with a means of establishing norms from the model based on the 'post mortem' in order to fulfil selection and scouting needs. One of the major conclusions related to previously noted observations (Hughes, 1980) concerning the number of passes leading to a goal. It was suggested as a result of the analysis, that it would be extremely beneficial to performance if coaches could advise players to keep the number of passes in sequence down to three or less. This application of the research could be improved upon by a more thorough analysis of the parameters required to enhance the result. Minimal consideration was given to the number of games to be notated prior to the establishment of a recognized system of play. This is an important point, since any fluctuation in the patterns and profile will affect the deduced consequences, particularly with reference to the match outcome. Teams may also vary their system and pattern of play according to opponents, although these factors are not considered. Furthermore, the existence of patterns of play peculiar to individual players was not illustrated. It is in this area that the study by Church and Hughes (1986) concentrated, in an attempt to investigate the presence of patterns of play in a soccer team and whether any reasons can be found to explain the results. Church and Hughes (1986) developed a computerised notation system for analysing soccer matches using an alternative type of keyboard, called a concept keyboard. This is a touch sensitive pad that can be programmed to accept input to the computer. It permitted pitch representation to be graphically accurate and action and player keys to be specific and labelled. It can considerably reduce the learning time of the system, and made the data input quicker and more accurate. The system enabled an analysis of patterns of play at a team and player level, and with respect to match outcome.

Development of a database and modelling

Teams and performers often demonstrate a stereotypical way of playing and these are idiosyncratic models, which include positive and negative aspects of performance. Patterns of play will begin to establish over a period of time but the greater the database then the more accurate the model. An established model provides for the opportunity to compare single performance against it (Nevill et al., 2002). The modelling of competitive sport is an informative analytic technique because it directs the attention of the modeller to the critical aspects of data that delineate successful performance.

The modeller searches for an underlying signature of sport performance, which is a reliable predictor of future sport behaviour. Stochastic models have not yet, to our knowledge, been used further to investigate sport at the behavioural level of analysis (Hughes and Franks, 2004). However, the modelling procedure is readily applicable to other sports and could lead to useful and interesting results. Once notational analysis systems are used to collect amounts of data that are sufficiently large enough to define

'norms' of behaviour, then all the ensuing outcomes of the work are based upon the principles of modelling. In 2004 Hughes wrote: "*It is an implicit assumption in notational analysis that in presenting a performance profile of a team or an individual that a "normative profile" has been achieved. Inherently this implies that all the variables that are to be analysed and compared have all stabilised. Most researchers assume that this will have happened if they analyse enough performances. But how many is enough?*" (Hughes, 2004) In the literature preview large differences in sample sizes can be found. These problems have very serious direct outcomes for the analyst working with coaches and athletes, both in practical and theoretical applications (Nevill et al., 2002). It is vital that when analysts are presenting profiles of performance that they are definitely stable otherwise any statement about that performance is spurious. The whole process of analysis and feedback of performance has many practical difficulties.

The performance analyst working in this applied environment will experience strict deadlines and acute time pressures defined by the date of the next tournament, the schedule and the draw. The need then is to provide coaches with accurate information on as many of the likely opposition players, or teams, in the amount of time available. This may be achieved by the instigation of a library of team and/or player analysis files, which can be extended over time and receive frequent updating. Player files must be regularly updated by adding analyses from recent matches to the database held on each player (Hughes and Franks, 2004). Finally, some scientists have considered the use of a number of sophisticated techniques, such as neural networks, chaos theory, fuzzy logic and catastrophe theory, for recognizing structures, or processes, within sports contests (Hughes and Franks, 2008).

Each of these system descriptions, while incomplete, may assist in our understanding of the behaviours that form sports contests. Furthermore, these descriptions for sports contests need not be exclusive of each other and a hybrid type of description (or model) may be appropriate in the future, a suggestion that remains only a point of conjecture at this time.

Educational applications

It is accepted that feedback, if presented at the correct time and in the correct quantity, plays a great part in the learning of new skills and the enhancement of performance. Recent research (Morya, Ranvaud, Pinheiro, 2003), however, has shown that the more objective or quantitative the feedback, the greater effect it has on performance. However, in order to gauge the exact effect of feedback alone, complete control conditions would be needed in order to minimise the effect of other external variables, which is by definition impossible in real competitive environments. This experimental design is also made more difficult because working with elite athletes precludes large numbers of subjects. Hughes and Robertson (1998) were using notation systems as an adjunct to a spectrum of tactical models that they created for squash. The hand notation systems are used by the Welsh national youth squads, the actual notation being completed by the players, for the players. It is believed that in this way the tactical awareness of the players, doing the notation, are heightened by their administration of these systems.

This type of practical educational use of notation systems has been used in a number of teams sports, soccer, rugby union, rugby league, basketball, cricket, and so on, by players in the squads, substitutes,

injured players, as a way of enhancing their understanding of their sport, as well as providing statistics on their team.

Conclusions

The use of systematic observation instruments provides researchers with a method of collecting behavioural data on both the coach and the athlete. These data can be analysed and processed in a variety of ways to provide a descriptive profile that can be used for giving both the athlete and the coach feedback about their actions. Advances in both computer and video technology can make this observation process more efficient and also provide the coach with audio-visual feedback about their interactions with athletes. The next phase of solving these problems in their entirety is translating the use of these objective observation systems into practice. The presentation here attempts to exemplify some of the better practical uses of analysis by elite coaches and athletes. The next step is to be able to describe in generic terms the whole process, of performance analyses and their applications to the coaching process, so that it can be applied to any type of sport.

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