Collective intelligence: An incursion into the tactical performance of football teams

Ricardo Duarte & Telmo Frias

Faculty of Human Kinetics, Portugal

Keywords: performance analysis, collective motion variables, collective behaviour of teams.

Abstract

The purpose of this paper is to present an alternative approach to teams' tactical performance based on principles of complexity sciences. In this view, the collective behaviour of a team is a process arising from the coordinated actions of individual players that work together to achieve the successive goals of the game (e.g., pressing collectively to close spaces and recover the ball and then, opening space to organise the attack). This kind of *collective intelligence* includes some critical features such as: i) players behaving as a unit, ii) teams showing a personal identity and structural organisation, and iii), players coordinating differentiated tasks between them. These principles are introduced using examples extracted from competitive matches and qualitative reports from players and coaches. Based on these fundaments, some innovative measures of teams' tactical performance are suggested, such as: i) the surface area occupied by the teams, ii) distance between teams' centre, iii) stretch index of the teams, iv) length and width of the "block", v) ratio length/width of a team, and so on. Using a specifically conceived software application (TeamSense 1.0), video animations and graphical data from competitive match-play of professional football teams are presented in order to demonstrate the utility of these tools to enhance tactical performance of teams. Finally, it is argued that football coaching and professional performance analysis departments can benefit from the adoption of this type of performance analysis.

Introduction

This paper presents an alternative approach to the analysis of teams' tactical performance. This perspective proposes that the collective behaviour of a team can be regarded as a kind of a highly distributed *collective intelligence* among the players. This proposal contrasts with the common view that the coach acts as a higher processor in a centralised control hierarchy. The idea of *collective intelligence* is analysed using qualitative data extracted from players and coaches' reports, and also discussing the notion of teams regarded as super-organisms. Technological developments and innovative measures are introduced as key issues to improve the analysis of teams' tactical performance.

Collective Intelligence: Teams as Superorganisms

How players decide during the game? Some studies developed in team sports have been demonstrated that individual movements of players during the game are highly coordinated, forming a coherent collective behaviour (Bourbousson, Sève, & McGarry,

2010a, 2010b; Passos et al., 2011). This relation between individual and team behaviours revealed that players' decisions and actions are very dependent of the whole behaviour of the team, as well as team's behaviour depends also on the individual behaviours of each player. This property of complex systems (as a football team, for instance) is called as interdependency (Bar-Yam, 2004). In this sense, the performance of a football team during the game can be viewed as a collective intelligent behaviour not centralised in any player (or coach) awareness, but distributed among all the players. This kind of intelligence is expressed by the collective behaviours of the teams, which emerge from the coordinated actions of the players.

But, what constrain players to coordinate their actions? It seems that the coherence in players' behaviour resulted from the fact that they share, not only the same general aims (e.g., score more goals than the opposite team), but particularly some specific momentary sub-goals (e.g., cooperating with a teammate to close a penetration space). Thus, the coherent behaviours of players create a relative stable structural organisation and a personal identity for the team. In socio-biology, animal groups with these features are called as superorganisms. The collective wisdom of these superorganisms (e.g., colonies of ants, swarms of honeybees, flocks of birds) seems also to arise from the simple complementary behaviours of each individual that typically perform different tasks (Seeley, 2002; Hölldobler, & Wilson, 2009). Due the cooperative nature of players' relations within a team, the concept of superorganism seems very suitable to explain the *collective intelligence* and decision making processes of the football teams as a whole (Duarte et al, 2011; Marsh et al, 2006). For example, André Villas-Boas (FC Porto's head coach) advocates that players have a crucial role in the collective decisions of the team. He said: "*we respect the unpredictability of the game. We believe that for the teams express all their quality, players need to have freedom to decide on the pitch. We don't act as dictator of the choices. The game is unpredictable and we need to respect this*" (in Alvarenga, 2011). These statements revealed that this coach seems to view the collective behaviour of its team as dependent of the changing conditions of the game.

Specifically, superorganismic entities as football teams also have some critical features such as: i) players behaving as a unit, ii) teams showing a personal identity and structural organisation, iii), players coordinating differentiated tasks between them, and iv), teams undergoing a clearly adaptive cycle of growth (Duarte et al., 2011). In this sense, the interdependence between team and player behaviours was at the core of Xavi Hernández's (central midfield of Barcelona) thoughts about its own performance: "*honestly, the team is the one who gives and takes me. My game needs teammates. I'm not anyone if nobody creates space ahead, and other opens a short passing line...without teammates my football doesn't make sense*" (in Cano, 2009, pp.91). Also, when Pep Guardiola (Barcelona's head coach) was asked about if Lionel Messi was the best player in the world, he answers "*I don't discuss things in this way. I don't analyse the player alone, I try to understand him within the general context of the team*" (in Cano, 2009, pp.79). These thoughts seem to demonstrate how players functionally behave as a unit and how they need to coordinate their individual actions to improve simultaneously team and individual performance effectiveness.

Considering team's behaviour as influenced by the features of the players and the interactions they tend to develop during the game, it is possible to argue that teams have

a kind of '*fingerprint'* (i.e. a personal identity of the team). This identity is based on a structural organisation defined by the positional distribution of the players in the field and the trends of relationship between players as a function of the game context. In this sense, José Mourinho (Real Madrid's head coach) seems to agree with the idea that a relative ordered structural organisation is the basis for players 'decide with freedom' during the game: "*it's important for a player to know that in certain position he has a teammate, and from a geometrical point of view they have something built on the field that allows them to decide and regulate their actions"* (in Cano, 2009, pp.137). He emphasises also the need to focus team's preparation in the improvement of structural organisation: "*for me, the most important is to have some behavioral principles that give organisation to the team. My first weeks of preparation systematically focus on tactical organisation, always to structure and improve the collective performance*" (Oliveira et al, 2006).

Another interesting point to briefly discuss is the idea that the collective behaviour of a team undergoes a clearly adaptive cycle of growth. That is, time seems to improve the effectiveness of teams' tactical performance. Xabi Alonso (Real Madrid's central midfield) referred this idea when he talks about its coming to the team: *"when I arrived, it was difficult for everyone to have an idea how to play together. When to press ahead, when retain the ball...we were very irregular. With time, we know each other better and now, we go on the pitch with an identity. The sensation is the team was growth"* (in Cano, 2009, pp.126). However, is it the team growth only dependent of time? It is arguably that an accurate diagnostic and monitoring of teams' behaviours seems to contribute to the enhancement of their tactical performance. In the next section, some concerns about the tactical performance of teams will be discussed.

Tactical Performance of Teams

Recent technological developments in tracking systems allow capturing the individual coordinated movements of all the players that together constrain the emergence of the collective behaviour of a team. These sophisticated commercial systems (e.g., ProZone, Amisco, GPSports) obtain time-series of positional data of the players from the pitch. Thus, it is possible to reconstruct the two-dimensional players' movements and the collective motion of the teams.

Based on this type of data, some innovative measures of tactical performance have been proposed in the last years. For example, abrupt changes in *surface area* occupied by the teams can reveal adjustments of their structural organisation (e.g., decreasing the covered area to close spaces and increase density of players when a team loses the ball, Figure 1).

Other measures of teams' collective performance suggested in literature are the displacement and distance between teams' centre, stretch index of the teams, length and width of the "block", ratio length/width of a team, predominant regions of players' action (Schölhorn, 2003; Frencken, & Lemmink, 2008; Folgado, 2010; Bourbousson et al., 2010b; Lames, Ertmer, & Walter, 2010; Duarte et al., 2011).

In order to improve the time consuming of the computation procedures, a specifically conceived software application (TeamSense 1.0) was developed in Matlab environment (The MathWorks Inc., Natick, MA, USA).

Figure 1. The surface area of the defensive team is lower than the offensive team. Changes in ball possession seem to influence the areas covered by teams (Source: Ribot, 2006).

This application uses positional data as input files to perform the analyses of collective/tactical motion variables, as well as graphical displays (time plots) and 2D video animations. Figure 2 presents a single photogram from the 2D video animation of a match.

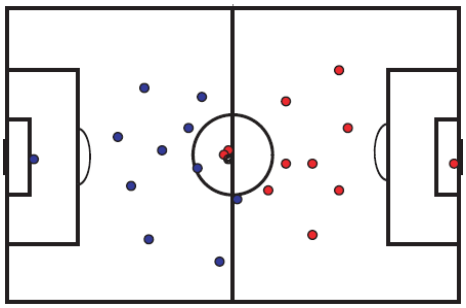

Figure 2. Photogram of the teams' initial formation in the start of the match.

Performance analysis studies using this type of collective variables during the match are still starting. Figure 3 shows exemplar data from a single match of two professional football teams (Duarte et al., 2011).

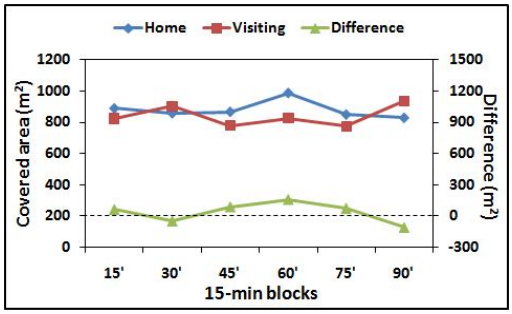

Figure 3. Variations in the area covered by each team along the 15-min periods of the match.

After some initial stability, the home team displayed higher surface area values than the visiting team in the third, fourth and fifth periods. However, in the last 15-mins period, the visiting team overpasses the home team, maybe due to the instability created by a goal suffered at minute 75, which created a disadvantage in match-score (Duarte et al., 2011).

Concluding remarks and applications

The proposed alternative approach identified some features that allowed regarding teams as complex collective entities or superorganisms, in which the collective functioning expresses the emergent *collective intelligence* of each team (a kind of '*team fingerprint*'). These ideas were strengthened using qualitative reports from top players and coaches. Based on these fundaments, some innovative measures of tactical performance were proposed, as well as presented some exemplar data from professional football teams.

The use of this emerging type of performance analysis seems to be promising in the improvement of accurate diagnostics and monitoring of teams' tactical performance in competition and training settings. It seems also to be clear that this type of performance analysis provide information to which players and coaches are very sensitive. Thus, professional performance analysis departments, and football coaching in general, may use this approach to enhance teams' performance.

References

Alvarenga, V. H. (2011, January 21). Villas-Boas grato a Robson e Mourinho: «Eu ia para jornalista desportivo» [Villas-Boas grateful to Robson and Mourinho]. Retrieved January 21, 2011, from http://www.maisfutebol.iol.pt/fcporto/fc-porto-villas-boas-porto-liga-mourinho/1227565-1304.html.

Bar-Yam, Y. (2004). Making things work. Cambridge, MA: NECSI Knowledge Press.

Bourbousson, J., Sève, C., McGarry, T. (2010). Space-time coordination patterns in basketball: Part 1. Intra- and inter-couplings among player dyads. Journal of Sports Sciences, 28(3), 339-347.

Bourbousson, J., Sève, C., McGarry, T. (2010). Space-time coordination patterns in basketball: Part 2. The interaction between the two teams. Journal of Sports Sciences, 28(3), 349-358.

Cano, O. (2009). El modelo de juego del FC Barcelona. Una red de significado interpretada desde el paradigma de la complejidad [The game model of FC Barcelona. A network of meaning understood from the paradigm of complexity]. España: MCSports.

Duarte, R., Araújo, D., Davids, K., Folgado, H., & Marques, P. (2011). Do professional football teams behave like superorganisms? Paper presented at the 13th European Congress of Sport Psychology, 12-17 July, Funchal, Portugal.

Duarte, R., Araújo, D., Davids, K., Folgado, H., Marques, P., & Ferreira, A. (2011). In search for dynamical patterns of teams' tactical behaviours during the match. Paper presented at the 7th World Congress on Science & Football, 26-30 May, Nagoya, Japan.

Folgado, H. (2010). Towards an understanding of youth football teams tactical performance by analysis of collective positional variables during small-sided games [Unpublished master thesis]. Vila Real, Portugal: UTAD.

Frencken, W.G.P. & Lemmink, K.A.P.M. (2008) Team kinematics of small-sided soccer games; a systematic approach. In T. Reilly, & F. Korkusuz (Eds.), Science and Football VI (pp 161-170). New York: Routledge

Hölldobler, B., Wilson, E. O. (2009). The Superorganism: the beauty, elegance, and strangeness of insect

societies. New York: W.W. Norton & Company, Inc.
Lames, M., Ertmer, J., & Walter, F. (2010). Oscillations in football - order and disorder in spatial interactions between the two teams. International Journal of Sport Psychology, 41, 85-86.
Marsh, K. L., Richardson, M. J., Baron, R. M., & Schmidt, R. C. (2006). Contrasting approaches to perceiving and acting with others. Ecological Psychology, 18, 1-37.
Oliveira, B., Amieiro, N., Resende, N., Barreto, R. (2006). Mourinho. Porquê tantas vitórias? [Mourinho. Why so many triumphs?]. Lisboa: Gradiva.
Passos, P., Milho, J., Fonseca, S., Borges, J., Araújo, D., Davids, K. (2011). Interpersonal Distance Regulates Functional Grouping Tendencies of Agents in Team Sports. Journal of Motor Behavior, 43(2), 155-163.
Ribot, J. C. (Producer). (2006). Football, l'intelligence collectif [Football, collective intelligence]. [TV documentary]. France: Mosaïque Films.
Schöllhorn, W. I. (2003). Coordination dynamics and its consequences on sport. International Journal of Computer Science in Sport, 2, 40 – 46.
Seeley, T. D. (2001). Decision making in superorganisms: how collective wisdom arises from the poorly informed masses. In G. Gigerenzer & R. Selten (Eds), Bounded rationality: the adaptive toolbox (pp249-261), Cambridge, MA: MIT Press.