

The 2012 World Congress on Performance Analysis in Sport

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This biennial boutique conference at the University of Worcester in England was outstanding value for the growing cadre of sport-performance analysts, although there were few definitive experimental studies. [Keynotes](#): media channels; top soccer analysts; movement patterns in AFL; 400-m hurdles. [Noteworthy Methodologies](#): automatic tracking and analysis; barcode scanning for real-time analysis; luck- and error-free performance measure; summing performance indicators. [Basketball](#): performance rates; space creation; defensive plays; automatic tracking; iPad app; critical episodes; entropy in game scores. [Combat Sports](#): trunk protector in taekwondo; real-time coding in judo; punches and judging errors in boxing; movements in fencing. [Equestrian](#): body build and fitness; split times; motivation; saddle design; Pilates. [Handball](#): timeouts; game stats; movements; actions; fitness; skills; referees' accuracy and movements. [Racket Sports](#): serves, groundstrokes, set victories and intensity in tennis; affect in badminton; strokes and footwork in table tennis; movements in Padel; intensity and rule changes in squash; analysis in "real" tennis. [Rugby](#): movements; turnovers; tackling; positional profiles; rucks; actions; kicks; scrums; tries. [Soccer](#): environmental effects; home advantage; normative profiles; spatial-temporal relationships; offensive actions and plays; releasing players; goals; kicks; small-sided games; barcode scanning; goal keepers' actions and training; coach behaviors and effectiveness; role of analysis; career achievements; plays causing injuries. [Volleyball](#): setters' actions; defensive actions; attack tempo; serves; attack areas and winning teams in beach volleyball; training. [Other Individual Sports](#): strength in shot-put; movements in rhythmic gymnastics; pack size in triathlon; body sway in biathlon; environment in rowing; neural-net modeling of javelin; scoring system in trampoline; a golf coach-analyst; shot difficulty in golf; helper riders in Tour de France; analysis needs in canoe/kayak. [Other Team Sports](#): actions, plays and efficacy of analysis in netball; movements and decision-making in AFL; skills in Gaelic football; actions and batting in cricket; intensities and actions in ice hockey; playing time in water polo. [Sports Medicine and Science](#): biomechanics of ACL injury; fatigue in biathletes; academic performance and sport. KEYWORDS: competition, information technology, elite athletes, kinematics, kinetics, talent identification, tests, training.

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The archetypal English country township of Worcester was the venue for [this biennial conference](#) of the International Society of Performance Analysis of Sport (ISPAS). The day before the conference started, three of us had the good fortune to wander into Worcester cathedral in time for choral evensong—a moving experience made even more poignant by the almost complete absence of a congregation. The zeitgeist moves on, the cathedral of sport is

where you now find many worshippers, and some of us make our lives meaningful by analyzing sport performance.

Derek Peters and his team from the [University of Worcester](#) provided a conference venue and logistics that were exceptional value for money, while two key members of ISPAS, Peter O'Donoghue and Nic James, organized and ran the scientific show with aplomb. We look forward to the next conference in 2014,

wherever it might be. Any sport scientist interested in performance analysis (aren't we all?) should join the society to keep up with developments. Visit the [ISPAS website](#) for more.

In the summaries below, we have included presentations only if there was a measure of performance or other data or insights relevant to the science or practice of performance analysis. We have used the word **movements** to mean distances covered or speeds of athletes that can be quantified from videos, accelerometers or global-positioning satellite (GPS) devices, while **actions** and **plays** refer to events or strategies that require coding of a live or recorded video data stream by an analyst.

Alas, the keynote presentations did not have abstracts, so we have summarized only those we could attend. We have also provided paragraph summaries of a few noteworthy generic methodological developments, but otherwise only the **sport** and the relevant **aspect** of performance are listed under relevant headings—you will have to read the abstracts to get the findings. Download the [book of abstracts](#) and use the advanced search form in Acrobat (Ctrl-Shift-F) to find the abstract via the podium number (e.g., POD 1.1) or poster number (e.g., POST 1.1.1). The abstracts are sometimes in a foreign form of English that limits their utility.

Some research presentations at the conference could be described as "games I have coded". Up to a point that's acceptable: this conference is partly a professional workshop providing performance analysts with a valuable opportunity to share and reflect on their experiences. But it was disappointing that the designs of the original-research studies were almost all descriptive: we could find only a handful of studies involving an experimental manipulation in which a performance measure was a moderator, mediator or outcome variable (POD 15.2, 16.4, 16.5; POST 1.1.5, 2.1.5), and all but one was a time series rather than more definitive crossovers or parallel-groups controlled trials. Maybe such high-quality research is happening but is too valuable to present at conferences—see the end of the next section.

Keynotes

Accurate, meaningful content-rich data "anytime, anyplace, anywhere" (the Martini principle of marketing in the 1970s) via smartphones and other recent developments in information

technology was the main message in Tony Kirkbride's enthralling keynote on **media channels** for performance analysis. Real-time or near real-time competition data of some high-profile sports events are available free, but high-quality data feeds require subscriptions with providers such as Opta. At the level of your own athlete or team, real-time interactivity between analyst, coach and athlete is also becoming a reality in what Tony called Martini-II.

Barry Drust and Andy Scoulding provided insights into **performance analysis** in two top **soccer** teams of the English premier league. The role of performance analyst has evolved from that of simple match reporter to an indispensable source of information on monitoring of training, pre- and post-match analyses, and scouting for new players. The purpose of training monitoring is load management, providing useful information for coach and strength and conditioning staff. Pre- and post-match analyses rely on the quality of information and delivery. Piero, OPTA, Prozone, Amisco are some of the analysis tools in current use. Scouting for players has been made easier with players' profiling. Current challenges (and opportunities for upcoming analysts): how to extract relevant information from the deluge of data now available, and how to integrate it into day-to-day practice.

Brian Dawson's keynote on **movement patterns** in team sports drew on his experience with **Australian-rules football** (AFL). The data from GPS devices have established relationships between training/game loads and injury risk and have helped make training sessions more specific to demands of the game, but relationships between measures of movement and competition performance are at best poor.

Wynford Leyshon delivered a coach perspective for his keynote on the use of **performance analysis** in international **400-m hurdles**. He used a case study of a London Olympian to demonstrate how analysts can best present race analysis data in order to help and engage coaches. Parameters of most interest to him included touchdown times and differences in pacing due to changes in stride patterns, which he referred to as "differential at change-down".

Noteworthy Methodologies

Reports of **automated tracking and analysis** are always interesting, because hand coding of

videos consumes huge amounts of time and only rudimentary analyses can be done for real-time or near real-time feedback to coach and players. Recent improvements were presented in a system that tracks players with data from two overhead cameras, the Sport Performance Analyzer (POD 6.1, 6.3, 6.6). Plays in **basketball** were classified correctly only ~80% of the time, and only ~90% with post-game manual processing. This system is promising but still some way from routine implementation.

Monetary constraints often influence the level of performance analysis that is available to a team. An inexpensive option may be an inventive **real-time notational analysis** system where analysts use **barcode scanning** to code up to 15,000 different game events (POST 1.4.1). In initial trials analyzing **soccer** matches, scanners failed to read 0.9% of barcodes. An **iPad application** to configure, code and analyze live match performance also looks encouraging for the budget-conscious performance analyst, but the presenter failed to attend (POD 12.4).

A "**luck- and error-free**" measure of **team-sport** performance has been derived by assigning a score to every action on the basis of what happened before and after the action (POD 3.6). The approach has been [commercialized](#).

When you have all those so-called **performance indicators** for your team, do they really tell you anything about **team performance**? According to Ed Burt and Mike Hughes, "numerous studies have assessed performance using action variables but have largely failed to consistently identify a link between individual performance indicators and match outcome." So they tried adding up counts and scores of various actions with weightings they assigned on the basis of their own understanding of the importance of the actions in the game of **rugby union**. Reassuringly, performance scores in 26 national-level matches of a national-league team and in 12 Six Nations matches showed "a very strong correlation with match outcome" (POST 1.2.10). We presume the scoring system could be adapted easily to the rating of individual players. It's also very likely that linear or neural-net models derived with large data sets will be even more successful. It's even more likely that such scoring systems have already been worked out in rugby and other sports and that you will never see them in conference ab-

stracts or a journal! See for example [this article](#) about the role of analyst Ken Quarrie in the All Blacks' victory in the 2011 Rugby World Cup.

Basketball

Performance Indicators

- POD 1.3 **Performance rates** (sum of good minus bad actions) of 287 players in the male World Championships.
- POD 1.4 Little difference in **space-creation dynamics** between age groups in 46 semi-final matches of a state championship.
- POD 3.5 **Defensive plays** in 80 matches of a national league.
- POD 6.1, 6.3, 6.6 **Automated tracking** of players with two overhead cameras in 4 games of a national professional A league.
- POD 12.4 An **iPad application** for live match analysis (presenter absent).
- POST 2.2.12 **Defense-offense transitions** in nine regional under-14 matches.

Other

- POD 1.1 **Critical episodes** in 80 matches from a national league.
- POD 1.2 **Entropy** as a measure of uncertainty in game scores in "18 NBA and 14 ACB regular seasons".
- POST 2.2.11 **Time between scores** in five NBA seasons.

Combat Sports

Performance Indicators

- POD 11.2 Actions and scoring with introduction of **electronic trunk protector** in n=? **taekwondo** international bouts.
- POD 11.3 System for **real-time coding** of **judo** on palm-tops and smart-phones established n=? bouts.
- POD 11.5 Combinations of **punches** in 8 bouts from each of 3 weight divisions of **boxing**.
- POD 11.6 **Movements** of elite female **foil fencers** in 100 international bouts.

Other

- POD 11.1 **Errors in judging** in 10 Olympic **boxing** bouts.

Equestrian

Performance Indicators

- POD 16.2 **Body build and fitness** of 16 female riders at three competitive levels.
- POD 16.3 **Split times** and performance in 27 successful clearance rounds and 49 with

faults in a national (?) championship.

Other

- POD 16.1 "Large scale" survey of **motivation** in under-18 riders.
 POD 16.4 Effect of two **saddle designs** on posture in a crossover with nine experienced riders.
 POD 16.5 Effect of **Pilates training** on posture in an uncontrolled study of 10 riders.

Handball

Performance Indicators

- POD 8.1 Descriptive stats from 344 **team timeouts** in a national league.
 POD 8.3 **Game statistics** of winners and losers in five European men's handball championships.
 POD 8.5, POST 1.2.9 **Movements and actions** of 69 players in three women's qualifying games of the European championships.
 POST 2.2.5 **Actions** and **plays** in six games of Valencian handball.

Other

- POD 8.2 **Accuracy of referees** (10) and their examiners (3).
 POD 8.4 **Fitness and skills** of 108 players at college level.
 POD 8.6 **Movements of referees** in the nine finals of a national league.

Racket Sports

Performance Indicators

- POD 7.1 **First-serve success** and other indicators in 1929 Grand Slam **tennis** matches.
 POD 7.2 **Duration of groundstroke** as predictor of aggressive or defensive shot in 567 rallies in women's **tennis**.
 POD 7.4 **Gender and affect** (and implications for coaching) for eight mixed-pairs county **badminton** players.
 POD 7.5 **Strokes** and **footwork** in 10 male and five female top-30 **table tennis** matches.
 POD 14.3 **Movements** in two top-level matches of **Padel** tennis.
 POST 2.3.4 **Posture** in 2470 **ground strokes** in four matches of men's Masters Cup **tennis**.
 POST 2.3.5 **Set-victories** momentum in three years of Grand Slam **tennis**.
 POST 2.3.7 **Serve outcomes** in a Grand Slam vs national junior **tennis** tournament.

Other

- POD 7.3 **Physiological intensity** of shot types

- of 12 recreational male **squash** players.
 POST 2.3.6 **Movements** in one elite **tennis** match.
 POST 2.3.9 Changes in **rally length** and score with rule changes between a 2003 and 2010 **squash** championship
 POST 2.3.8, POD 6.2 **Analysis system** for **real tennis** (the peculiar progenitor of tennis).

Rugby

Performance Indicators

- POD 6.4 GPS for position-dependent **movements** in 98 players from eight premier clubs.
 POD 15.2 GPS for **movements** of 40 experienced vs novice players in small-sided games.
 POD 15.3 Network analysis for role of two-man tackles in producing **turnovers** in 20 matches of the World Cup.
 POD 15.4 **Tackling** in matches of a Super 15 rugby season.
 POD 15.5 **Positional profiles** in 28 home vs away games in the English championship.
 POD 15.6 **Rucks** in 15 Six-Nations matches.
 POST 1.2.10 Scores for **actions** predicting outcome in 26 national-level matches and in 12 Six-Nations matches.

Other

- POD 15.1 Kinematics of n=? **kicks** of 5 expert rugby and 5 expert Gaelic football players.
 POST 1.2.11 Clean and unclean **scrums** in 46 World-cup matches.
 POST 1.2.12 **Tries scored** per unit of possession time (or its inverse?) in 15 Six-Nations games.
 POST 1.2.12 **Scoring** and **actions** in the top and bottom nations of the World Cup.

Soccer

Performance Indicators–Player

- POD 4.4 Effects of **temperature, playing surface, travel, and recovery time** on performance indicators in four years of the US major league.
 POD 5.1, POD 5.5, POST 2.1.1 **Home advantage** in Brazilian, Norwegian and English national leagues.
 POD 5.2 **Normative profiling** of young footballers in 30 matches.
 POD 5.3 Players' **spatial-temporal relationships** in two national matches.
 POD 5.4, POD 9.1, POD 13.1 **Offensive plays**

of two international teams in 24 national games.

POD 9.2 Placing of the **corner kick** and **outcome** in 19 under-17 matches.

POD 9.3, POD 13.4, POST 1.1.4 **Movements** and **plays** in small-sided games at various levels.

POD 9.6 **Attacking actions** and **plays** in 60 matches of three national leagues.

POD 13.5 Analysis of **goals** in 41 matches of a youth academy team.

POD 12.6 Differences in **movements** of five semi-elite players between GPS, manual tracking, and video-based analysis systems.

POST 1.1.1 Effect of relative numbers of players in **attackers' and defenders' plays** in 10 international games and n=? lower-level practice games of futsal.

POST 1.1.3 Poor relationships between 22 **action variables** and outcomes in 277 national championship matches.

POST 1.1.5 Effect of zone vs man-to-man **defenses** on **plays** in a trial of 12 under-17 elite players in small-sided games.

POST 1.4.1 **Barcode scanning** for notational analysis validated with soccer matches.

POST 2.1.2 **Normative profiling** of 136 corner kicks in 12 matches in a professional league.

POST 2.1.4 **Time and pitch zone** of 439 goal scoring opportunities in semi-elite women's games.

POST 2.1.5 Effect of limiting **ball touches** on spatial interaction in a trial of 18 under-17 elite players in small-sided games.

POST 2.1.8 Network analysis to identify **attacking plays** in two teams of a premier league.

Performance Indicators—Goal Keeper

POD 2.5 **Analysis system** for the **goal keeper** developed from 15 interviews.

POD 9.4 Comparison between **training** (1 wk) and **match actions** (92 games) of goal keepers.

POST 2.1.3 **Network analysis** for role of goal-keeper in 61 passing sequences in three matches of premier league.

Coach

POD 2.2 **Behavior** of three head coaches toward 48 effective and non-effective players in 72 training sessions.

POD 2.3 **Observation effectiveness** and knowledge of players and the game in interviews of eight national-league coaches.

Other

POD 2.4 Perceived **role of performance analysis** from interviews of 8 players and three managers in one professional club.

POD 4.5 Effect of **environmental temperature** on home advantage in 346 international matches.

POD 9.5 **Release of players** to World Cup and ensuing clubs' performance.

POST 2.1.11 **Career achievements** of 154 international under-17 players.

POST 2.1.12 Quantification of **injuries** and identification of **high-risk plays** in 160 youth football matches.

Volleyball

Performance Indicators

POD 3.4 Successful **actions** of the **setter** in 24 championship games.

POD 10.5 **Defensive actions** in five national league games.

POST 1.2.2 Determinants of **attack tempo** in 19 high-level male games.

POST 1.2.3 Winning **serve**s in n=? championship games.

POST 1.2.4 Successful **areas of attack** in 10 games of men's professional **beach volleyball**.

POST 2.2.1, POST 2.2.4 **Actions** of winning teams in 31 sets of female **beach volleyball**.

Other

POST 1.2.5 Retrospective survey of **training** of 229 female and male adult players during earlier stages of development.

Other Individual Sports

Performance Indicators

POD 14.2 **IRM strength** and **shot-put** performance of 29 females and 24 males at national collegiate level.

POD 14.4 **Movement elements**, synchronicity and space utilization of **rhythmic gymnasts** in three international championships.

POST 2.3.2 **Pivots** and other movements of eight **rhythmic gymnasts** in a national final.

POD 14.6 **Pack size** and finishing position in 305 world-championship **triathlon** races.

POD 11.4 **Body sway** and shooting accuracy in 117 **biathletes**. of various ages.

POST 1.4.2 Effects of **environment** (wind and waves) on boat speed in an international **rowing** regatta (presenter absent).

POST 1.4.3 Predicting **javelin** performance

from 438 throws of 20 national-level athletes using **neural network modeling**.
 POST 1.4.10 Subjective marking vs objective **computerized scoring** of 13 national-level **trampolinists**.

Other

POD 2.1 Case study of experience of a **golf coach** as a **performance analyst**.
 POD 14.1 "**ISOPAR**" **method** to estimate difficulty of any position on a **golf** course.
 POD 14.5 "**Help intensity**" and incentives in Tour de France **cyclists** since 1947.
 POST 1.4.8 A **kinematic analysis** of the Yurchenko vault in 18 female **gymnasts**.
 POST 2.3.3 **Needs analysis** from n=? interviews of coaches and athletes in **canoe and kayak slalom**.
 POST 2.5.8 **EMG activity** during acrobatic back handspring performance in five **gymnasts**.

Other Team Sports

Performance Indicators

POD 3.2 Using small-sided games to increase exposure to **actions** and **plays** for development of young **netballers**.
 POD 3.3 Analysis of **movements** and **performance** in **Australian-rules football**.
 POST 1.2.7 Accuracy of **decision-making** in 13 games of **Australian-rules football**.
 POD 10.3 Analysis of **kicking** and **striking skills** in **Gaelic football**.
 POST 1.2.6 Sixty kinds of **actions** of 29 win-

ning and 30 losing teams in male (?) domestic 20-20 **cricket**.

POST 1.2.8 **Movement intensities** via heart rates in 15 **ice-hockey** players.
 POST 2.2.6 **Actions** in three under-18 national-level **ice-hockey** matches.
 POST 2.2.9 Players' **playing time** at the **water polo** World Championships.
 POST 2.2.10 Momentum in **shooting** during 20 national **netball** matches.

Other

POD 2.6 **Time constraints** and **efficacy** of performance analysis in n=? coaches and teams of National v International **netball**.
 POD 3.1 Development of a **test** simulating an innings of **cricket** batting.
 POD 10.1 Accuracy of **umpires' decisions** in **netball**.

Sports Medicine & Science

POD 4.3 A biomechanical model for movements causing **ACL injury**.
 POD 4.1 **Monitoring fatigue** in 11 trained **biathletes** with an orthostatic heart-rate test.
 POD 10.6 Retrospective survey of sporting and **academic performance** of 242 athletes of mainstream and elite **sport schools**.

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