Conference Report

THE FIRST ANNUAL OCEANIA PERFORMANCE ANALYSIS CONFERENCE

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BACKGROUND

The focus of this conference report is the inaugural Oceania Performance Analysis Symposium, held in Auckland in December 2017. Performance Analysis (PA) is a field of sport science which focuses on providing an objective way of recording performance so that key elements of performance can be quantified in a valid and consistent manner. While PA is a relatively new discipline of sport science, the field has grown rapidly in the past 20 years. ISPAS Oceania – the organising body behind the conference – is a subcommittee of *The International Society of Performance Analysis in Sport (ISPAS). ISPAS, and its predecessor the International Society of Notational Analysis of Sport (ISNAS, founded 1991), was founded:

to improve the international cooperation in the field of Analysis of Sport. Obviously, the internationalization of this discipline is of great importance for the exchange of views, the discussion and presentation of current research results as well as the realization of joint research projects. Until now the Society has existed quite informally – its main purpose was to ensure the continuing excellence in its World Conferences in Liverpool (1991), Cardiff (1993), Turkey (1995), Porto (1998), Cardiff (2001), Belfast (2004) and Szombathely, Hungary (2006). But now with the rapid growth of Performance Analysis as a discipline and career, there is a need for the Society to assume more formal responsibilities (www.ispas.org).

The rapid growth of performance analysis as a discipline has led to the need for a sub-branch of ISPAS to be organised in the Oceania region, principally covering Australia, New Zealand and the Pacific Islands. ISPAS International has supported the formation of the committee to encourage membership of ISPAS and to support the provision of accreditation through the ISPAS Pathways (www.ispas.org). ISPAS Oceania exists to provide an infrastructure for professionalisation, information and training opportunities for all performance analysts within Australia, New Zealand and Pasifika, whether they be interested amateurs, professional consultants or academics. One of the first activities agreed by a PA working group was the development of an annual Performance Analysis Symposium, mirroring, in a smaller way, the World Congress of Performance Analysis. This conference report will cover the first annual symposium, including an overview of keynote speakers, oral presentations and the AGM.

First, an overview of performance analysis is provided for those unfamiliar with this discipline of sport science.

Performance Analysis

PA has developed as a broad term that covers many areas of sports science. Although it has attracted research in many different sports and areas of sports science (Bampouras, Cronin, & Miller, 2012), it is commonly seen as a form of notational analysis (NA). NA can be defined as an objective way of recording information about a performance so that critical moments can be quantified in a consistent and reliable manner. NA allows for accurate and objective qualitative and quantitative feedback (Hughes et al., 2015). Five functions of notational analysis, identified by Hughes and Franks (2008), are: 1) to provide immediate feedback; 2) to assemble materials for database development; 3) to indicate areas that mandate improvement; 4) to evaluate specific aspects of performance; and 5) to operate as a selection mechanism in assisting coaches and athletes.

PA has also been significantly influenced by the field of biomechanics (Bartlett, 2001; Hughes & Bartlett, 2008). The commonalities that the fields of PA/NA and biomechanics share include the goal of enhancing performance, the analysis of player movement and reliance on information technology. Both of these fields involve the use of video analysis, video-based technology and computer software, while also providing important feedback to both the coach and performer to improve performance (Bartlett, 2012; Hughes and Bartlett, 2002). PA can be traced back to Charles Reep's notational analysis of information in English football matches beginning in 1950 (Pollard, 2002). Reep's analysis of passing sequences in football influenced how the game was played for many decades.

Equally, the field of sports biomechanics has its origins in the explanation of athletics technique pioneered around the same time as Charles Reep's work. The application of sports biomechanics to competition can be identified in Gideon Ariel's analysis of Bob Beamon's long jump world record during the 1968 Olympics (O'Donoghue, 2009). Ariel claimed to be the first to use cameras for capturing information which could then be analysed by a computer to identify faults in technique and performance.

More recently, Glazier (2010) has redefined performance analysis so as to give it a broader scope. He claims that all sport science disciplines look to enhance performance and produce and interpret data, as well as assess performance against parameters or indicators. These are the same criteria given by Hughes and Bartlett (2008) in explaining that performance analysis consists of notational analysis and biomechanics. Glazier further suggests that performance analysis should cover not just notational analysis and biomechanics, but also sports psychology and physiology (Glazier, 2010).

The professional terms that sports industry practitioners have adopted reflect this broader definition, and include various titles and roles such as data analyst, video analyst, coach analyst, sport scientist, biomechanist and technologist. In this article, performance analyst is adopted as an umbrella term for these different title and roles. Recent literature has enhanced our understanding of the diverse role that the performance analyst can play in the high-performance sport environment (e.g., Groom, Cushion, & Nelson, 2012; Middlemas & Harwood, 2017; Middlemas, Croft & Watson, 2017).

We envisage that this report will be of direct benefit to organisations supporting and developing analysis professionals within New Zealand, Australia and the Pacific Islands. An important focus of the new ISPAS Oceania committee involves providing guidance to organisations regarding accreditation and renumeration for performance analysts.

First Annual Oceania Performance Analysis Symposium

The inaugural Sport Performance Analysis Symposium and AGM was held on 15 November 2017 at Auckland University of Technology prior to the two-day Sports Performance Ressearch Institute (SPRINZ) conference. The symposium was organised by members of ISPAS Oceania, a newly formed subcommittee of the International Society of Performance Analysis in Sport (ISPAS; see AGM report below for further details). Performance analysis practitioners, academics, students and coaches from New Zealand, Australia and the Pacific Islands gathered for the one-day symposium.

ANNUAL GENERAL MEETING

A key purpose of the symposium was to host the first annual general meeting of the ISPAS Oceania Committee. The subcommittee assumed the following purposes and objectives, in line with the international body:

- dissemination of scientific knowledge concerning performance analysis of sport
- providing a forum for the exchange of ideas
- gathering and disseminating information, scientific knowledge and materials relating to the performance analysis of sport

The following people were elected to the ISPAS Oceania subcommittee as members:

- Kirsten Spencer, Auckland University of Technology (president)
- Hayden Croft, Otago Polytechnic (chairperson)
- Piet Van Hasselt, Canterbury University (secretary)
- Sam Robertson, Victoria University / Western Bulldogs
- Jamie Tout, VX Sports
- Matt Toulson, HUDL
- Peter Lamb, Otago University
- Paul Warren, New Zealand Cricket
- Simon Middlemas, Otago Polytechnic
- Stafford Murray, High Performance Sport New Zealand (HPSNZ)
- Jason Healy, New Zealand Rugby
- Simon Briscoe, HPSNZ

INVITED KEYNOTE SPEAKERS

The symposium featured a number of original research contributions in the form of featured speakers and peer-reviewed presentations. Dr Kirsten Spencer (senior lecturer at AUT) opened the symposium by discussing her research on netball. 'FutureFern to Fast5' is a research project she has conducted with Sophie Wolf for NZ Netball. This explores the impact of small-sided games (6v6) on game-specific factors such as player decision-making, game-specific learning, whistle stoppage, shooting opportunities and psychological factors such as player engagement and intrinsic motivation. These elements are contextualised around four main themes, described as fast, change, focus and motivation. The findings of this project underline the relevance of a constraint-led perspective for developing young netball players and the role of performance analysis as a data collection tool in applied research projects.

Dr Sam Robertson is an associate professor at Victoria University and head of Research & Innovation at Western Bulldogs AFL. He presented on the role of performance analysis in developing and delivering a successful culture within AFL, including improving decision-making and answering complex problems. He shared innovative examples of analysis work conducted with the Bulldogs, including player coupling, predicting ball and player movement, and attempts to define and measure pressure. He also spoke of the ongoing resistance to PA within sport, generated in part by inconsistent application and poor integration, lack of awareness and the need for continual reflection and innovation.

In a paper entitled "What Information is used by Coaches when Making Decisions During a Match?," Hayden Croft (principal lecturer at Otago Polytechnic) presented his research exploring coaches' use of performance analysis in rugby and netball. The aim of this project was to use qualitative methods (e.g., content analysis of rugby and netball coaches' audio during matches) to capture and analyse coaches' communication during competition. The aim was to provide a framework which practitioners can use to design coach-driven PA systems. His findings – broken down into tactical, technical, physical and psychological themes – also provide an insight into coaches' communication under pressure, including the use of robust language and emotional responses.

The day concluded with a series of presentations by experienced practitioners. Feature speakers included Jamie Tout (VX Sports) who spoke about the traps of sports analysis in his presentation "Don't be Baffled by the Bullsxxt." All Blacks analyst and Blues rugby coach, Alistair Rogers, presented reflections on his career and use of analysis in "Performance Analysis, A Game Changer? Absolutely!" while HPSNZ analysts Stafford Murray and Deborah Sides discussed the journey undergone by the PA service within The English Institute of Sport. They presented several case studies from UK elite sport and concluded that PA should be driven by gaps in performance rather than technology, and emphasised the importance of an analyst's interpersonal (soft) skills.

PEER-REVIEWED ORAL PRESENTATIONS

The symposium featured original research contributions. Submissions were reviewed by the conference organising committee and organised as ten-minute oral presentations, with five minutes for questions. These presentations reflected the broad focus and multi-disciplinary nature of performance analysis and attracted presenters from Australia and New Zealand.

The conference proceedings are reproduced in full below.

USING WEARABLE MICROTECHNOLOGY TO MEASURE PRECISION OF PRE-DETERMINED CHANGE-OF-DIRECTION INCIDENTS OF VARYING ANGLES

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INTRODUCTION

Cumulative change-of-direction incidents can elicit high levels of musculoskeletal and neuromuscular fatigue which may alter mechanical loading on lower-body joints and subsequently reduce mechanical efficiency, underpinning an increased risk of injury. Inertial sensors have previously shown the capability to accurately identify and differentiate between a variety of sports-specific movements. Therefore, the aim of this study was to determine whether an accurate and reliable algorithm could be developed to calculate the precise angle from a range of pre-determined change-of-direction incidents.

METHODS

Six recreationally active males (*Age*: 29 ± 0.5 years, *Height*: 181 ± 5.6 cm, *Weight*: 79.4 ± 5.3 kg) initially completed five consecutive individual change-of-direction trials at four pre-determined angles (45°, 90°, 135°, 180°), both left and right, for a total of 240 trials. Participants were fitted with a commercially available microtechnology unit (Optimeye, S5, Catapult Innovations, Melbourne, Australia) posteriorly trunk-mounted in a manufacturer-supplied vest. Tri-axial data from the accelerometer, gyroscope and magnetometer were extracted using manufacturer-supplied software prior to a series of data integration techniques combining each of the three inertial sensors before obtaining the final Yaw angle using a complementary filter. This data was then subject to a series of signal-processing techniques (Gaussian filter, edge detection, non-maximal suppression and threshold procedure) to precisely determine the angle of each change-of-direction incident, thus creating an algorithm. This algorithm was then tested on the same participants who completed five laps of a pre-marked change-of-direction course. Each lap consisted of three change-of-direction incidents in each direction (left and right) at identical angles (45°, 90°, 135°, 180°) for a total of 720 change-of direction-incidents. Reliability was assessed using a Coefficient of Variation (CV) expressed as a percentage error.

RESULTS

Descriptive statistics are reported as Mean ± Standard Deviation across all participants, for each angle, in each direction (Table 1). All angles in both directions displayed 'good' reliability (CV < 5%).

	45°		90°		135°		180°	
	Mean ± SD	CV (%)	Mean ± SD	CV (%)	Mean ± SD	CV (%)	Mean ± SD	CV (%)
Right	44.7 ± 2.0°	4.6	90.4 ± 3.4°	3.8	133.5 ± 3.3°	2.5	183.1 ± 3.5°	1.9
Left	43.6 ± 1.7°	3.9	89.0 ± 2.5°	2.8	135.3 ± 2.8°	2.1	180.3 ± 4.4°	2.5

Table 1. Reliablity and descriptive measures for all subjects between four pre-detemined change-of-direction angles.

CONCLUSIONS

Change-of-direction movement is highly prevalent in a range of team sports and, to our knowledge, is unable to be reliably distinguished from other running variables using a commercially available microtechnology unit. The development of a novel algorithm to accurately identify changes in mechanical loading (angle) during change-of-direction incidents may present a new perspective in athlete monitoring for performance enhancement and injury prevention purposes. While this novel algorithm appears to be reliable across a number of participants (and therefore different running styles), it is currently unknown whether the small amount of error present is a result of system error or human error. Therefore, additional reliability testing is currently in progress, with the implementation of drone video technology to calculate any error present within the system.

PROFILING THE MOVEMENT SEQUENCES OF ELITE AND JUNIOR-ELITE FEMALE NETBALL ATHLETES

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AIM

Quantifying the activity profile of team-sport athletes is useful for training design, specific to position or playing standard. Recently, the activity profiles of netballers was examined by position. The aim of the present study is to quantify activity profiles of the seven netball playing positions across two standards, elite and junior-elite.

METHODS

Fifteen junior-elite (age: 19.3 ± 0.9 years; height: 181.9 ± 8.0 cm, mean ± Standard Deviation (SD) and 12 elite (age: 24.8 ± 2.7 years; height: 179.5 ± 6.9 cm) female netballers participated. Spatiotemporal data was collected by radio-frequency (RF) tracking during seven matches. A movement sequencing technique was applied to spatiotemporal data. Athlete velocity, acceleration and angular velocity were clustered via *k*-means. Qualitative labels were assigned to each unique clustered combination of velocity, acceleration and angular velocity movement, forming sequences. Sequences were separated by moments of athlete inactivity. The similarity between each sequence was quantified via the Levenshtein distance. Similar movement sequences were grouped into 25 clusters using hierarchical clustering. The longest common subsequence (LCS) algorithm was used to discover the most common sequences within each of the 25 clusters. Similarities of the LCS results, between playing positions of differing standards, were quantified via the Minkowski distance.

RESULTS

A total of 11 frequently recurring movement sequences were discovered across both playing standards. The GS and GK are the most closely related positions across playing standards. The largest pairwise positional difference was the WA position.

CONCLUSIONS

The movement sequencing technique may distinguish between netball playing positions and standards, although more matches should be included in future comparisons. Examining the movement sequences performed, according to playing standard and position, may allow the design of specific training drills to assist transition from the junior-elite to the elite level.

PRODUCING SILHOUETTE-BASED AUGMENTED FEEDBACK: WHAT ELEMENTS OF PERFORMANCE CAN A GOLF COACH ANALYSE?

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INTRODUCTION

Video systems and technology supporting sport-specific or general sport science include various video sources, as well as software and architectures that are designed to work on a single device (e.g., a mobile or tablet) or in distributed processing off- and on-line scenarios (such as remote coaching and media-sharing cloud services). The challenges of this case study involve producing software utilities to support analytical common-sense feedback with an increased preservation of privacy levels, while minimising bias and diagnostics uncertainties associated with video analysis.

METHODS

Experimental evidence from collected data using a variety of video equipment (mobile, Kinect sensors, sport and DV cameras) on a shortened-size golf driving range has influenced various algorithm design approaches to eliminate redundant information, support swing analysis and enable visual feedback annotations. As a result of golf coaching-driven experimental software design on foreground/background separation from image and video, the produced silhouette-based algorithms allow the user to reduce or eliminate background information, obfuscate personal information from the golfer's body during on-line video streaming or select a video filtering method on collected videos from previous training sessions. One of the challenges with silhouette-based algorithm development was in moving and non-moving foreground/background pixel information, found on collected golf swing data.

RESULTS

The results achieved regarding silhouette filtering with edge-detection algorithms demonstrate their application in golf-swing analysis and potential for broader use in rehabilitation and general sport science. The examples of incorporated video analysis and diagnostic feedback for amateur-level golfers include correcting common errors associated with stance and swing-plane performance elements that are well established in golf literature.

CONCLUSIONS

Future work on silhouette-based video streaming solutions will include further algorithms advancements, and annotation automations combined with AI approaches for diverse contexts and disciplines. The benefits of on-line immediate motion analysis can be applied to healthcare, including post-surgery and elderly activity monitoring while preserving privacy.

VISUAL REPRESENTATIONS OF RUNNING PERFORMANCE IN HALF MARATHON COMPETITIONS

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BACKGROUND

Long-distance running is one of the most popular daily sports, through which participants can retain their health and take care of their bodies. Millions of people around the world run for different reasons such as recreation, professionalism, mental balance or fun. Analysing half marathon running events could further help us to understand the motivations of runners as well as identify the effects of the running environment on performance.

AIM

The main goal of this research is to design mathematical and information technological (IT) models and tools through which althletes' performance during long-distance running competitions can be realised using the advantages of visual data representation. It would be very useful if this model would allow us to compare different running competitions, even where running distances are different.

METHODS

For this research, a range of mathematical and statistical tools have been used, including classification, cluster and dispersion analysis, complemented by relevant sport science theorems and practical experience. A graphical desktop application was designed and implemented in C++ language using OpenGL (Open Graphics Library) and GLUT (OpenGL Utility Toolkit) graphical tools and libraries for realising the models. In the data processing phase, conventional Big Data techniques and concepts were applied, such as the identification and interpolation of missing or inaccurate data.

RESULTS

I created a desktop application through which a given half marathon can be visualised based on running time and distance. In addition, a second visual tool has been designed which is capable of characterising given competitions according to the age and speed parameters of the runners.

CONCLUSIONS

Using these models, different long-distance running competitions can be compared with each other in a variety of ways. This presentation will describe my research to date and present a real example of how we can use these tools according to the results of the Auckland Half Marathon and the Budapest Half Marathon in 2017.

ISO-LINE MAPPING OF SPORTS ACTIONS

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BACKGROUND

In recent years, sports performance and player tracking data have become more readily available to sports clubs, coaches and analysts. While seemingly endless supplies of data are available, reducing these data in meaningful ways that inform tactical and strategic planning and performance analysis still remains a challenge.

AIMS

This ongoing project is focussed on assigning representative performance outcomes to 2D field positions, which reflect the unique dynamics of the match.

METHODS

We developed a modelling approach based on measurements of performance (z), as a function of their respective spatial locations (x, y). First, a grid is applied to the pitch (mesh size varies by sport, but usually around 0.5 m); performance measures are then estimated at each grid node using exponential smoothing. Finally, *iso*-lines are calculated continuously across the pitch and plotted on a map of the pitch.

RESULTS

So far, the method has been applied to golf (2003–2017 PGA TOUR seasons), soccer (women›s FIFA World Cup 2007), and field hockey (2008 Olympic Games). In golf we have developed a new performance statistic, 'Shots Saved,' that is independent of other shots played on a hole; we also provide maps of each hole, visualising the difficulty inherent in different areas. Soccer applications have provided strategic insight into free-kick 'danger zones,' based on the *iso*-maps. In field hockey, certain pitch locations have been assigned likelihoods of leading to shot attempts on goal, regardless of the frequency of actions in those locations.

CONCLUSIONS

The *iso*-line method can readily be applied to other sports for which location-based performance information is available. By providing data visualisation and outcome information with respect to the specific dynamics of the match, performance data are meaningfully presented to be used directly in designing pre-match strategies and post-match performance analysis.

THE IMPORTANCE OF PLAYING GAMES EARLY IN AN AFL CAREER

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AIM

Young players entering the Australian Football League (AFL) are typically immature from both a physical and technical viewpoint. At the request of the senior coach of the Essendon Football Club, Melbourne, we set out to determine whether it was better to give top draft picks time to develop at the second level of football or play them in the AFL team as early as possible.

METHODS

The first 25 selections from each of the 2005 to 2014 national drafts (n=250) formed the sample evaluated. Logistic regression models were produced in R (R Foundation for Statistical Computing, Vienna, Austria) that determined the probability that a player would reach 50 games in eight seasons, 50 games in four seasons and 100 games in eight seasons following their first season. The mean number of games played by players who had played 15 to 19 games or 20+ games in their first season was also established following each season.

RESULTS

The findings report the probability of reaching the appropriate game milestone, given the number of games played in the first season. The probability of achieving 50 games in eight seasons was almost 50%, even if no games were played in the first season; however, that probability decreased considerably when the milestone difficulty was increased.

CONCLUSIONS

This research has implications for football coaches, strength and conditioning and recruiting practices. Practically, if team performance will not be overly affected, first-year players should be given opportunities to play AFL football as their probability of achieving significant milestones is improved. There is also no evidence to suggest that deliberately limiting first-year players makes any difference to the overall number of games played in the first eight seasons.

BEHIND CLOSED DOORS: THE ROLE OF DEBRIEFING AND FEEDBACK IN A PROFESSIONAL RUGBY TEAM

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BACKGROUND

Despite the popularity of performance analysis in high-performance rugby environments, limited attention has been paid to understanding how coaches and practitioners use this information to impact on performance.

AIM

The aim of this case study was to gain an in-depth understanding of how a professional rugby team – playing in New Zealand's ITM cup competition – uses post-match and pre-match meetings to debrief after performance and pre-brief prior to future performance.

METHODS

Multiple ethnographic techniques were employed to generate a comprehensive picture of the study phenomena, including participant observation, video recordings, formal and informal interviews, field notes, descriptive statistics and document analysis. Each meeting was transcribed separately and analysed using an inductive content analysis process, and themes were identified.

RESULTS

The case study explores how four key factors – the role of the coach-facilitator, player engagement, leadership, and the balance between reflection and preparation – impact on the debrief / pre-brief process. The findings reveal that while considerable emphasis was placed on the importance of player learning and engagement in team meetings, delivery was often ad hoc, coach-driven and results-focused.

CONCLUSIONS

This case study showed how debriefing can be a valuable tool for assessing, modifying or setting new short-term process goals, rather than long-term or seasonal goals. There are benefits from coaches and practitioners understanding athletes' preference for receiving feedback and providing opportunities for players to access feedback in a way that works for them. However, the study raised question marks over whether the players in the study team were able (or willing) to reflect honestly on their performance, and take responsibility for this during the debrief process. Coaches and practitioners may benefit from establishing consistent debriefing practices at all levels of their player pathway.

SUMMARY OF CONFERENCE REPORT

A reflection session was held at the end of the symposium. Three key messages stood out. Firstly, there is a high cross-over between performance analysis and coaching, and many coaches (including strength and conditioning coaches) attended the symposium. Secondly, as PA is a relatively new discipline of sport science and one which is rapidly growing, there is a need to better understand the employment conditions of neophyte practitioners working as performance analysts within sport. There is a perception that many neophyte practitioners work in low-paid positions, often under temporary contracts and limited supervision. Thirdly, it was recognised that there was a need for further research which can bridge the gap between research and practice within performance analysis. The second Sport Performance Analysis Symposium will be held on Wednesday 14 November 2018 at Auckland University of Technology (www.autmillennium.org.nz/special/sprinz2018).

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