

# Applied science and soccer: a personal perspective on the past, present and future of a discipline

Drust B<sup>1</sup>

<sup>1</sup>Research Institute of Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK

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## A background to this article

*Peer review is a crucial aspect of the publication process in my opinion. It's fundamentally important that the ideas that one generates are evaluated and verified in some way by experts. When you think about peer review in detail it's clear that it's a very challenging activity due its complexity. This complexity means that there will be some times when the process doesn't always work as you planned. The article below is an example of when the outcome of the peer review process isn't quite as you expected it to be.*

*This manuscript was written in response to a request from a guest editor (guest editor 1) for a special issue. In the process of its production there was dialogue guest editor 1 around the contents and it's structure as well as an exchange of early drafts of the manuscript for feedback. All these things would normally point to the eventual acceptance of the paper. What wasn't anticipated in this case, however, was the dogmatic stance of a reviewer/additional guest editor on the publication. This particular individual failed to be convinced by both the approach of the manuscript and/or its worth to the journal despite representation from both myself and guest editor 1 across a number of revised drafts. As a function of both the origins of the article (an invited commentary) and the obvious philosophical disagreement about how it should look in its finished form I had no choice but to withdraw it from consideration by the journal. This is the first (and hopefully the last) time that I have had to do this.*

*Though pretty hardened by a large number of rejections across an academic career that has spanned 20 plus years this outcome was particularly frustrating due to its nature. While it would be easy to question the peer review process in this case I would rather see the positives and use this an opportunity to explore the potential of other approaches to the dissemination of ideas. Hopefully those that spend their time to read this will be interested in the ideas that are included. It would be nice to also show that rejection from journals is not always based on logic and is universal irrespective of experience. Such things shouldn't prevent those who are committed to sharing their ideas with others in the field as this communication would seem to me to be what the peer review process is ultimately founded on.*

## Introduction

Professional soccer teams no longer rely on just the influence of the team manager, his coaching staff, and a limited number of medical personal to influence the performance of the players in competitive matches. It is now common for clubs to operate with a more diverse range of support staff, who fulfil specialist roles related to the development of performance of both the individual, and the team. Though these people can complete relatively diverse roles, depending upon the club in question, they are frequently categorised broadly as “applied Soccer scientists”. Though the specific remit of these individuals can vary they have broadly come to exist to support managers and coaches in the development of the

complex framework of principles and practices that are applied to increase the likelihood of a positive performance outcome. This article will attempt to outline the historical development of applied Soccer science in professional Soccer in the UK as well as providing a perspective of the current status of sport science support in the wider game. An attempt to identify possible future developments in the area will also be included. While this article attempts to locate all of the content from a recognised evidence base, it is clear that such an article cannot be produced without a big contribution from the authors own subjective experience. The article may therefore simply provide a framework of relevant ideas on applied science and Soccer for those interested in the discipline rather than indicative content that progresses the knowledge base in the area.

## Looking back: Reflections on the past

The application of science to Soccer is not a new phenomena. Professional sports, such as Soccer, have always attempted to innovate to help facilitate successful performance outcomes. The scientific community is not immune to the widespread popularity of Soccer and has, for a large number of years, conducted scientific studies that look to understand and influence the factors that may determine the performance of players. This common interest in “performance solutions” would therefore seem to have provided the impetus for the interaction between these two “disciplines”.

## Origins of applied science and soccer

It is probably difficult to pinpoint the exact origin of the interaction between the Soccer industry and science (due to both the availability of relevant historical records and the unsystematic nature of the early interactions between the areas). Yet the academic publications that are available have the potential to be used as a guide for the development of the discipline. This is because this record may represent the tangible outcomes of collaborative projects between Soccer organisations and scientists. A comprehensive search of the academic literature in this context is difficult, due to the unavailability of electronic records for older publications. Notwithstanding this limitation, it would seem that the modern basis of science and Soccer research can be traced back to the early 1970's. The seminal work of authors such as Tom Reilly and Vaughan Thomas (1) and Bengt Saltin (2) provided the initial descriptions of the performance characteristics of the sport. The descriptive nature of this research was fundamental in “setting the scene” for the development of the discipline and the basis for the interaction between the academic community and the sport. The development of this literature base was also one of the factors that paved the way for the development of early Soccer-specific conferences (for example The First World Congress of Science and Football that was held in Liverpool 1987). These conferences are important in the development of the field as they represent some of the initial attempts to foster interaction between both practitioners within the sport and academics.

The systematic organisation, of science and Soccer as a recognised area within sport science (as a consequence of the developing literature base and associated activity) in the late 1980's and early 1990's was mirrored in the developments seen in the professional game in the UK at this time. The impetus for this change within the sport was probably more directly related to the influx of foreign coaches and players into the leagues in the UK. Early innovators in the application of sport science, at club and international level, were quickly followed by other competing teams/organisations. These later adopters commonly modelled performance strategies observed at other organisations, both nationally and internationally, rather than develop their own philosophies. This led to the proliferation of similar sports science related practices across the leagues, irrespective of need, if the required financial support was available.

### The early focus of applied science and soccer

These developments, within the professional clubs and national associations, resulted in the move away from the delivery of sport science related practices by allied professionals already employed within the organisation (such as physiotherapy). As a consequence performance support became linked to more specialist delivery models delivered by specialist staff. These specialist staff were essentially focussed on the fitness and conditioning of the players irrespective of the job title assigned to them in the early years. The responsibility of these staff was the delivery of a now traditional single focused performance model centred on athletic improvement. In this approach players were monitored using specific testing protocols (most commonly physiological in origin) to obtain baseline performance metrics. This assessment was then followed by an intervention period, often carried out in addition to the usual training requirements of the players aimed at improving a specific performance determinant (e.g. aerobic fitness, body composition). Re-tests at a suitable opportunity provided some measure of effectiveness of the intervention and a basis for the development of future intervention strategies. Such approaches were frequently generic in approach (based on ideas from traditional athletic preparation approaches) probably as a consequence of the experience and knowledge base of the practitioners in question rather than being sport specific in orientation. They were also almost exclusively field based as little attention was paid by most at this time to gym based strength and conditioning programmes for groups of players. These athletic conditioning strategies were also often applied to all populations within a soccer organisation (junior to elite players) irrespective of the relevance to each specific age groups over-riding performance philosophy (around the mid 1990's).

The publication of key landmark scientific research articles by individuals like Bangsbo (3, 4) and Hoff et al. (5) help transition both the testing protocols and training interventions used to ones that were more Soccer-specific in nature (in the late 1990's early 2000's). Changes in the education programmes of national associations and universities provided a platform for the dissemination of this and similar research to practitioners. This enabled the spread of these concepts to those working within the sport (around the early to mid 2000's). This Soccer-specificity was demonstrated by the inclusion of relevant exercise patterns (intermittent), movements (multi-directional), and the inclusion of the ball. The suitability of these type of activities, compared to more traditional approaches for performance improvements, was supported by the use of rudimentary field based monitoring systems. These systems were at this time restricted to equipment that evalu-

ated the heart rate responses to exercise (late 1990's to mid 2000's). This data, while limited by today's standards, provided useful proof of concept data for the more Soccer-specific testing and training strategies of the time. It also provided the rudimentary and fundamental proof of concept for now common strategies to track the training response of players from both an acute and chronic perspective.

An improvement in the understanding of the game was also a focus of the scientific support strategies used in Soccer at this time. In this period (early 1990's), approaches to collect data on match performance were limited due to the rules and regulations of the sport, access issues to stadia and the time consuming nature of both data collection and processing. The introduction of multi-camera systems around the late 1990's such as Prozone and Amisco revolutionised these processes and led to the provision of unrivalled levels of data in timescales that were impossible to match using traditional methods. While such data created a wealth of information for interested parties to support performance outcomes, a lack of systematic coverage across clubs did however lead to gaps in information available week on week. Data, generated in this way was also initially limited in the eyes of some due to a lack of any independent scientific validation of both the data collection and analysis procedures. The novel interactive style and the bold use of schematic representations of feedback were however relevant in off-setting these early considerations for the majority of practitioners. The availability of the data, also in time, influenced the academic research community and in turn the scientific literature providing data for insights into performance at both a team and individual player level.

The changing landscape associated with applied science and Soccer at this time was not something that was embraced uniformly across the sport. While published accounts of the culture of professional Soccer exist (6) little, if any, specifically deal with the representation of sport science support strategies of this time from the perspective of either applied sport scientists, players or coaches. It would be true to say that few conversations with experienced practitioners in the area would present a picture of complete compliance and acceptance of sport science protocols from coaches and players during this period. A more common situation for such activity in these years was for the support strategy to be accepted by a small number of informed individual players and coaches within the organisation while the majority generally disregarded it. These individuals frequently considered such procedures to be an inconvenience to their day-to-day activities and an irrelevance to the support of their performance. This perceived ineffectiveness was based around the dominant subjective opinion that experiential knowledge of the sport was more important to determining future success than novel scientifically orientated support strategies. The acceptance of these processes, such as the collection of objective data on players, was also frequently seen in a negative context due to it's perceived role in the "policing" of compliance to training and testing regimes as well as coach instruction by players. While not universal, such views did have some credibility in some organisations where adherence to principles such as hard work and effort out weighed other potentially important performance objectives such as technical accomplishment. The existence of such philosophical considerations within performance based-programmes is hard to fully explain. The failure of sport science practitioners to adequately inform and educate relevant stakeholders into the benefits and limitations of such strategies would however seem to have relevance in their occurrence.

## Key Points

- The drive to improve performance would seem to form the basis for an association between science and practice
- First applied roles for sports scientists within football organisations were focussed on fitness and conditioning (primarily on the field). These roles were based on improving players from an athletic and physiological standpoint
- Research publications and conferences at this time demonstrated the importance of specificity in training
- Strategies to understand the demands of the sport using observational systems such as Prozone and Amisco and simple monitoring tools (e.g. heart rate) were innovations to practice
- Adoption of sport science was often limited to a relatively small number of players and coaches

## Examining current trends in applied science and Soccer: A subjective evaluation of contemporary practice

The last 10-15 years have seen dramatic developments in applied science and Soccer from both an academic and sport science support perspective. Articles on Soccer are now a major contributor to the general sport science literature base. This research now supports theoretical and methodological advances in the wider discipline area of sport science as well as the practical delivery of performance solutions at Soccer clubs and organisations around the world. The development of the Soccer-specific knowledge base has also been important in supporting the drive for new strategic policy developments within the sport. One example of this is the role of the science of Soccer on the talent identification and development strategy recently produced by The Premier League in England for the development of young players; the Elite Player Performance Plan.

## Current practice in applied science and soccer

The expansion in the provision of applied science and Soccer services within professional clubs and Soccer associations has changed the make up of the support services accessible by managers, coaches and players compared to traditional models. These staff are now frequently seen to occupy specialist roles as opposed to the generic job descriptions they were once associated with. These roles commonly include strength and conditioning specialists (who may be predominantly gym based), fitness coaches (who may be field based), sport scientists, performance analysts and rehabilitation coaches who focus on the return to fitness of recently injured players. These types of positions are not just restricted to the elite first team squads at clubs as they are frequently available to support the needs of the developing young players within the team's youth academies. Other roles, commonly termed performance directors, now focus on the management of these Soccer science support teams and the interaction of them with players and coaches. This increase in staff and the diversification of responsibilities is a significant departure from the strategies of the past that used to rely on a single individual to provide support in all of these areas. These full time staff are now also regularly supplemented by expert input from consultants and other specialists often from the world of academia. This can include individuals such as statisticians who may offer very specific skill sets associated with the analysis of information that helps to evaluate and recruit potential players for the club or to inform key decision making processes for those players already signed. Another key human resource found in

the majority of Soccer clubs and organisations is the young trainee practitioner. "Applied science and Soccer interns" are often recently qualified individuals from sport science related degrees who are in the process of gaining experience of the work of sport science and medicine departments in a professional Soccer club. These individuals, though not officially employed, have proved crucial in supporting the applied science and Soccer expansion in organisations that are limited in their financial capabilities to employ specific staff.

The development in the staffing base, related to applied science and soccer, has provided a basis for the development of the scientific support services that are operated within clubs. The analysis of the performance of players in matches remain an important component of any club's support strategy though the broad approach to this activity has not markedly changed compared to approaches used in previous years. Technological advances (associated with cameras and both computer hardware and software), as well as the addition of emerging service providers, have resulted in an evolution of the processes associated with data collection and analysis in some cases though the general strategic direction of this activity remains consistent with past models of support. While the traditional model associated with performance improvement (that dominated early scientific support strategies observed in Soccer) still has relevance (especially for young players in clubs and organisations) there is generally a broader concept of applied science and Soccer, related player support in operation within the industry now. These modern strategies, irrespective of their specific focus, still have the provision of feedback at their core. This can involve the provision of specifically formulated reports, videos or combined electronic files that are supplied to individual hand held devices. A common focus of science and Soccer activity is the maximisation of player availability for competitive games. These approaches have injury prevention at their core. As a consequence of this aim there is a focus on aspects such as specific gym based programmes centred on pre-habilitation, muscle activation and strength, and the close monitoring of field based training load. The importance of monitoring training load to these strategies has resulted in this being the biggest consideration for performance teams within modern Soccer. Such strategies are based on the view that team success is heavily reliant on ensuring that the team's best players are able and adequately prepared to perform in competitive matches.

## Monitoring performance in soccer

The interest in tracking player "readiness" amongst applied Soccer scientists frequently leads to the implementation of monitoring strategies that are multi-dimensional in nature. The multi-dimensional nature of these strategies is a consequence of the awareness that Soccer training and match-play will stress multiple physiological systems (e.g. the cardiovascular, nervous, and musculoskeletal systems). As the relative importance of each of these systems, to determining Soccer performance is unknown, it is logical that practitioners attempt to measure potentially relevant indices of them all in an attempt to gain an understanding of the functional capacity of the player. The development of micro sensor technology over the last decade has revolutionised the provision of data associated with the physical output completed by players during training. The technology within these sensors enables accurate tracking of changes in position (through the use of global positioning systems), and by calculation, provides the distance and speed of movement of players. They also include complimentary technology such as accelerometers, gyroscopes and magnetometers. These additional sensors provide poten-

tially useful information on variables such as impact forces, accelerations, decelerations, angular motion, rotation and the direction and orientation of the player. The current scope of this article makes it impossible to provide a detailed evaluation of all of the practical and scientific concepts related to the use of these systems to monitor training load in sports such as soccer. The application of such systems has, however, clearly provided new insights into both the nature and the intensity of the actions that make up the activities in soccer training and match-play. This has enabled both practitioners and researchers to think about the “loads” associated with these actions in more sophisticated terms than ever before. As a consequence opportunities to understand and influence performance have been greatly increased for those working with players on a day to day basis. For those interested in such information the reader is referred to the excellent reviews of authors such as Cummins et al, (7) and Aughey (8). Other tracking solutions that use different technological approaches are also available (e.g. Inmotio) though these are currently less widely used by Soccer clubs predominately due to issues associated with the requirements for infrastructure and cost. Heart rate data, to give an indication of the physiological cost of the activity, frequently supplements the movement data collected by practitioners during training. Despite its limitations in providing an indication of the cardiovascular response to high-intensity intermittent exercise, it remains a valuable tool for the majority of practitioners.

Other common supplementary measurements associated with player readiness include biochemical markers of stress (e.g. creatine kinase, salivary IgA), relatively simple assessments of jump performance and subjective evaluations of training load such as session Rating of Perceived Exertion (RPE). Subjective evaluations of training are popular due to their ability to provide a “global” indicator of the player’s response to an exercise challenge as well as their low cost and perceived simplicity of delivery. Once collected, this data is usually incorporated into a detailed database that represents a player’s most recent “score” as well as the historical record of their data over time. The specific metrics that populate these databases are largely determined by the individual philosophy of each respective applied Soccer scientist. Statistical processing of varied levels of complexity is associated with this data in an attempt to give an insight into the current status of each specific player. This analysis frequently attempts to interpret the training balance for each player and hence the potential injury risk for any given individual. Determining such outcomes is clearly difficult due to the incredibly complex nature of the factors that are associated with injury predisposition and occurrence.

An associated aspect of player readiness is the optimal recovery of players following both training and games. It is therefore no surprise that the design, delivery and monitoring of recovery is also a key foundation of current applied science and Soccer programmes. This interest is mirrored in the academic research papers available in the literature that attempt to provide insight into both the theoretical and practical understanding of the recovery process (for useful reviews see Nedelec (9,10) and Thorpe et al.,(11). The basic principles of recovery focus on the return of the different physiological systems that support Soccer performance to pre-exercise levels. This need is facilitated practically by both the inclusion of specific recovery strategies into a player’s programme (e.g. supplementary nutritional provision, the completion of ice baths, remedial exercise interventions such as foam rolling etc) and adaptations to both the training schedule and the training loads completed (e.g. time off, additional training

sessions that are focussed on recovery and/or reductions in both the intensity and volume of activity). Such programmes are especially important when the competitive fixture calendar is intense and includes repeated games within short spaces of time. The effectiveness of these strategies is frequently evaluated by adapting the monitoring procedures that are associated with the analysis of training load. For example, the beat to beat variability of heart, or the heart rate recovery, to a standardised exercise test or recovery period is recorded to give data on the physiological status of an individual player. The delivery of such multi-dimensional programmes to support the training and regeneration of players are associated with significant investments both financially and in terms of time. The time demands associated with the collection, analysis and feedback of data linked to these strategies are probably partly responsible for the large increases in the staff associated with science and Soccer observed in the last 5-10 years.

### Evaluating the effectiveness of current practice

Increased activity is not in itself a marker by which the importance of applied science and Soccer activity should be judged. A critical analysis of the effectiveness of current strategies within the sport is required for an evaluation of the current influence of applied science and Soccer on practice. Such evaluations also have the potential to identify potential future developments in provision in the Soccer industry. It may be useful for such evaluations to include both practical and philosophical considerations. One of the main challenges, from a practical perspective, is the integration of the information in the available scientific literature base into pragmatic operational strategies that are suitable for delivery in a complex organisation. While the academic research base, from which to draw applied science and Soccer knowledge has dramatically increased, the available information that directly relates to pragmatic solutions to performance solutions is somewhat limited. This is a consequence of the knowledge within the literature been inherently descriptive and not always easily linked to the context of performance-based problems that are common within the industry. For example, research is commonly associated with evaluating the efficacy of interventions within rigidly controlled laboratory conditions as opposed to relevant situations in the “real world”. Little focus is therefore given to the translation of research findings into either the development of “real world” strategies or approaches to the implementation of applied Soccer science protocols into professional organisations.

### Evaluating the evidence base within applied science and soccer

As a consequence, the underpinning research evidence to support the specific activity in clubs may be weak with the strength of evidence for some procedures coming instead from practitioner experience and their subjective frameworks of “what works in the real world”. These issues can be illustrated by the recent research of Akenhead and Nassis (12) that examined the methods of analysis used to evaluate training in high-level Soccer. Their analysis of the data from 82 high-level Soccer clubs provides a novel insight into the most popular variables used to describe training load. A critical scientific evaluation of the most popular variables reported here would suggest that 40% of these are currently limited by methodological or theoretical considerations. These potential problems, from a scientific viewpoint, do not however, prevent their widespread application amongst practitioners. As a

**Table 1. Table showing number and type of “touch points” related to Soccer science for a player in the English Premier League in a typical week. NB: monitoring and assessment days may include multiple tests.**

Type of Contact	Game	Day +1	Day +2	Day +3	Day +4	Day +5	Day +6	Game
Readiness measurement		✓	✓	✓ ?				
Field based training monitoring			✓	✓	✓	✓	✓	
Gym based training monitoring			✓		✓			
Match Performance evaluation	✓							✓
Psychologist meeting				✓				
Physical test related to Soccer science (e.g. anthropometry)				✓				
Physical tests related to medical screening			✓	✓?				
Recovery protocols	✓		✓	✓	✓	✓	✓	✓
Nutritional supplements	✓	✓	✓	✓	✓	✓	✓	✓

NB1: ? denote potential additional test days depending on previous test outcome.

consequence, the practice would seem to be not driven by the principles of science, but by the subjective individual belief systems developed through experience. This may not inherently be problematic as science has yet to understand many well-practised strategies common in many fields. It does however call into question the fundamental importance of science in driving applied practice in the sport. In other areas, the academic debate around key issues within the research can lead to confusion amongst practitioners. This uncertainty can complicate the effectiveness of aspects of the processes used to support managers, coaches, and players associated with applied Soccer science. These ideas can be illustrated by the current discussion around the interpretation and the meaningfulness of applied data.

### The challenge of culture to applied science and soccer

The organisational culture and specific contexts that exist within a Soccer organisation also has the potential to impact the relevance of the applied Soccer science strategies used within the club and/or organisation. Research into high performance environments and other successful organisations highlight a number of concepts that seem important to successful interventions. These include culture, leadership, performance enablers and characteristics of individuals (13). Little knowledge is available that explicitly presents data on either the proficiency of individuals within applied science and Soccer programmes in such skills or how such concepts are actively strategically managed in teams of people in Soccer. Inefficiency in these areas of practice may be just as harmful to the overall outcomes of applied Soccer science support programmes as the inappropriate application of the theoretical content that is used to underpin performance solutions. It would therefore seem of relevance to incorporate approaches that attempt to evaluate the effectiveness of such things within Soccer organisations. Such evaluations would have the broad aim of attempting to ascertain if the “supporting infrastructure” around the Soccer science support programme was “effective” in its support of the general mission that was associated with the strategy. It may also include attempts to understand ways in which the separate “teams” within the overall staffing structure may modify behaviour characteristics to help facilitate effectiveness. These organisational and social aspects of support programmes are seldom included in today’s approaches within Soccer despite their clear association with successful practice.

The lack of clarity around the effectiveness of applied science and Soccer support programmes, from both a performance outcome and effectiveness of delivery standpoint, must lead to questions around the impact of these structures on the perfor-

mance models in Soccer. An inability of these programmes to provide meaningful insights for performance and/or to drive the decision making that influences performance decisions may render them little more than expensive job creation schemes. It may also suggest that such activity is merely a “folly” created to outwardly reflect the image that an organisation wishes to outwardly project about its approaches to its underpinning player support processes. These programmes may also be associated with challenging operational issues associated with the “data tsunamis” and the associated management, access and storage of data. Comprehensive evaluations of this nature are however inherently difficult to complete due to the complex nature of the network of factors that would need to be included if any appraisal of effectiveness was to be comprehensive. The de-limitation of these factors to performance orientated criteria such as the impact of interventions on match performance still make effectiveness incredibly difficult to determine due to the scientific problems associated with understanding performance in this context (e.g. the variability of an individuals performance and the very large range of factors that can influence the achievement of teams). These issues make effective evaluations of Soccer science support programmes almost impossible both from the organisational, logistical and performance outcome perspective. This is probably the reason that such evaluations are not frequently attempted by applied practitioners within the sport despite their obvious importance to the understanding of the impact of their strategies.

Any uncertainty over the effectiveness of applied interventions may impact the philosophical approach, and as a consequence the specific activities, that are included in the support programmes implemented with players. High performance Soccer organisations operate under significant pressure. While innovation in the practical strategies used may have the potential to improve performance, untested protocols in the “real world” are also accompanied by risk. The balance between risk and reward is probably an important driver in the determination of which performance questions practitioners attempt to address. It is understandable that in this context, the potential impact of high risk strategies, may reduce applied Soccer science support protocols to those which are relatively safe. Such low risk protocols are unlikely to impact things such as the availability of a player or an individuals short-term performance potential (both important considerations in today’s modern support programmes). While this may ensure that players can play in games such approaches may not be conducive to optimal preparation. This is because performance models that are inherently risk averse are unlikely to be associated with stimuli that may challenge a player physiologically and that may lead to athletic improvements (for example, training programmes that do not overload

athletes will not result in physiological adaptations and in the long term improved physiological function). Such approaches may in fact be counter-productive to athletic excellence in the long term by under preparing players for the demands of competition and as a consequence exposing them to higher risks of injury that may be associated with under conditioning.

Support programmes that do not challenge players with potentially useful, yet high risk strategies, may be one reason why applied Soccer science has gone along way to gaining acceptance in the current climate. Unchallenging programmes will be both coach and player friendly and so will, in theory, be supported by such stakeholders as they simply support the status quo that exists within the organisation. If such strategies are common in Soccer today it may not be surprising that Soccer science has expanded in such a way as it has over the preceding decade. This view may be unnecessarily pessimistic as it is feasible that the current state of Soccer science related support programmes are simply a reflection of the experience and real world learning of practitioners about what does and doesn't work within the organisational cultures that pervade such clubs and associations.

Questions against the professionalism of players and their limited desire to be challenged would also seem to be un-fair as this population have demonstrated great flexibility in responding to the changing demands of the sport in so many ways over the last decade or so. This willingness to change can be evidenced by their tolerance of the completion of the large number of sports science related activities/interventions that may support their performance in training and games commonly completed at top clubs. Table 2 provides a representation of the number of "touch points" that exist between Soccer science staff and players across a typical week in a Premier League club. These "touch points" are essentially "checks" and/or attempts at behaviour modification to support the performance process. It may not be unfair to suggest that a proportion of these may not directly relate to what may be an individuals "normal" or preferred approach to their daily activities. The high frequency of these touch points clearly illustrates the level of "surveillance" that accompanies being a top class player in today's elite Soccer organisations. While these strategies may help increase the performance potential of players and elongate their careers it is fair to say that few other professions will be subject to such close scrutiny and behaviour modification around specific actions as these individuals. This examination will also follow today's top class player in their personal lives away from the club as a consequence of media and fan interest in their day to day existence. It is therefore interesting to consider the long term consequences of such "intrusion" for the individual in addition to evaluating the ethical issues associated with the application of such strategies that are not fully evidence based by science.

**Key points**

- Generic roles have given way to increasingly more detailed specialisms in the roles and responsibilities of staff
- Frequent support from external experts for specific functions (e.g. statistical analysis) is common
- Large number of "intern" positions within clubs frequently used as the functional unit for delivery of lower level tasks
- Broader scope of practice for sport science departments than traditionally associated with athletic development model. Prevention of injuries and player availability now an important focus. More detailed approach to strength and conditioning practices and recovery also a feature.
- Monitoring now well accepted in general by players. More intensive approaches that are multi-dimensional often em-

ployed. Common approaches include micro-sensor technology, blood markers and subjective evaluations

- The effectiveness of sport science in football is still unclear. This may be a function of the appropriateness of evidence that exists in the scientific literature base for the strategies used.
- The culture within clubs still frequently provides a barrier for the effective implementation of sport science

**Future trends: What may the future hold for applied science and Soccer?**

The preceding sections show the transition that applied science in Soccer has experienced over the last 20 years or so. The level of practice that is common in today's professional game would indicate that the discipline has become a recognised component of the supporting infrastructure around the modern day player. This level of integration has occurred due to key stakeholders within the game perceiving the broad positives associated with its integration into their organisations. In the majority of cases these positives are likely to be both subjective and anecdotal though this should not detract from the impact these activities may have had. This is a consequence of the lack of published objective research in the scientific literature that outlines the effectiveness of intervention programmes within elite Soccer.

The current level of integration of applied science in Soccer, despite the lack of "hard" evidence for the "real world" impact of such programmes, provides a platform to deliberate on the developments of the support programmes used within clubs and organisations in the future. The dynamic nature at the current time in key factors that can influence support programmes provides a fertile environment for change in applied science and Soccer. Changes within key rules of governing bodies (i.e. the wearing of sensors within games), changes in the demands of the sport (i.e. increased game schedules), the general cultural acceptance of science related staff and rapid improvement in technology all provide opportunity for developments in practice. These opportunities may enable the acquisition of new data and the development of improved support strategies within Soccer. As a consequence of novel insights, more effective performance solutions may be provided that may provide a true competitive advantage.

The following suggestions may be relevant for the future development of applied science and Soccer practice. These suggestions are a result of one's personal views and are as a consequence representative of only a small proportion of those that may advance the applied science and Soccer field. One key area of evolution may be the use of data that is available from applied Soccer science support programmes. These

**Table 2. Table showing some important personal attributes for graduates interested in applied work in professional soccer**

Attribute
Theoretical Knowledge of the discipline
Good IT skills
Time management
Dedication
Good verbal and written communication skills
Awareness of confidentiality and data management issues
Willingness to learn
Proactive
Relevant practical skills and qualifications

developments likely occur through the more effective use of existing data streams in addition to the analysis and interpretation of new inputs. Such approaches may require more effective approaches to the data-basing of information to facilitate the broader use of data by individuals within the organisation. It may also mean the development of strategies to combine data from different areas of club operation to enable the cross interrogation of trends in the available information from a multi-disciplinary perspective.

Novel inputs may come from the inclusion of strategies from traditional sport science disciplines that are as yet relatively unsystematically adopted in terms of performance-based support in Soccer. For example, both biomechanics and psychology do not currently seem to have the level of integration into Soccer science support programmes that reflect their theoretical potential to influence performance. An additional benefit of the integration of additional expertise into support programmes may be the further refinement of collaborative arrangements between staff within Soccer organisations and those in specialist organisations such as universities. The facilitation of a closer understanding between these groups can only help to foster a better understanding of the philosophies and operational constraints within each paradigm. Such an understanding can only improve the levels of collaborations between individuals. This will undoubtedly support relevant activity and help to provide a solid foundation for creating improved applied practice and science.

The potential for the most significant advances in applied science and Soccer support are perhaps not linked to any of the types of factors highlighted above. The greatest potential may in fact come from the ability of those involved in relevant roles in the sport to reflect and evaluate on their own philosophical views and applied practices. Such personal evaluation, if completed in an honest way, undoubtedly leads to insights that have greater power to influence change than those associated with external environmental factors. A willingness to question any approach and to consider if it is impacting managers, coaches and players would create a situation in which new opportunities and new practices can be identified. This critically reflective approach to practice will prompt “insight” from “sight” as in “the emperors new clothes” (i.e. the removal of collective denial that something is not what it seems). The adoption of such a personal philosophy by those original pioneers, the next generation of practitioners in the area and their modern contemporaries is probably the single most important thing in the development of the current landscape and how things will look in the future.

### Key points

- Future strategies may focus on more integrated multi-disciplinary approaches to support players and coaches
- Professional training programmes that have at their heart an ethos of critical professional and personal reflection may support important future developments

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