Institution: Swansea University
Unit of Assessment: 26 - Sport and Exercise Sciences, Leisure and Tourism
a. Overview

The **Applied Sports Technology Exercise and Medicine (A-STEM) Research Centre** is part of a well-resourced research environment within the College of Engineering. A-STEM is strategically positioned within the College of Engineering's Sport and Health Research Theme within which integrated engineering and sports and exercise research occurs. A-STEM staff conduct distinctive, cutting-edge research that is both multidisciplinary and inter-collegiate. Academic staff contribute disciplinary and methodological expertise to one or both research groups: (1) **Elite and Professional Sport**; and (2) **Exercise Medicine and Health.** Their constituents and lead professors are as below.

Elite and Professional Sport	Exercise Medicine and Health
Professor Mike McNamee (Lead), Dr Andrew Bloodworth, Dr Iwan Griffiths, Dr Liam Kilduff, Dr Camilla Knight, Dr Tom Love, Dr Melitta McNarry, Dr Stephen Mellalieu, Mr Nick Owen, Professor Gareth Stratton. 27 Research students (PGRs)	Professor Gareth Stratton (Lead), Dr Richard Bracken, Dr Michael Lewis, Dr Melitta McNarry, Dr Kelly Mackintosh, Dr Stephen Mellalieu. 14 Research students (PGRs)

b. Research strategy

Strategy for the 2008-2013 period: During its reorganisation in 2008 the University recognised that potential for research synergies and funding opportunities with STEM subjects would be better realised by relocating the Sports and Exercise Sciences Research Group into the College of Engineering. The relocation occurred in 2010 and, following the initial period of integration, the College appointed a research Professor in February 2012 to: (i) provide discipline expertise; (ii) review the unit's research quality; and (iii) further develop international quality research in the group. This review resulted in the RAE2008 research themes – (i) functional assessment and exercise intervention in clinical and older populations; and (ii) performance analysis and enhancement in sport with an emphasis on using modern technologies to improve training and performance – being refined and embedded within the two current research groups, which focus on: (1) **Elite and Professional Sport**; and (2) **Exercise Medicine and Health**. Research in the *Elite and Professional Sport* group almost exclusively involves Olympic, elite or professional sports men and women or top-level junior athletes, and includes sport philosophy and ethics, applied physiology, applied sports psychology, and computer science applications. Research in the *Exercise Medicine and Health* group has a focus on medical engineering, diabetes and children's physical activity, fitness and health.

The A-STEM Research Centre was established in May 2012, with the Centre's name reflecting both continuity for existing lines of research and a strategic alignment of its future direction to the Government, and the RCUK policy of increasing funding for STEM subjects and the increasing internationalisation of the Centre's research. A-STEM will play a significant role in delivering the University's ambition of becoming a research-intensive UK Top 30 University by 2017.

The Centre has six strategic drivers to achieve its mission:

1. Exploit significant inter-collegiate opportunities offered by research facilities and expertise in medicine, health and human sciences and engineering with a specific focus on the prospects arising from facilities at the new Science and Innovation Campus (SD1).
2. Attract significant research funding, particularly external and competitive grant income (SD2).
3. Maintain a culture of international excellence that inspires, connects and supports research staff and students (SD3).

4. Invest in novel and significant areas of research that have a direct impact on junior athletes, elite and professional sports men and women, clinical, sub clinical and vulnerable populations and their respective policy making organisations and governing bodies (SD4).
5. Increase research capacity by recruiting established academics and early career researchers who are, or have the potential to be, internationally renowned scholars (SD5).
6. Promote international research collaboration with world-leading scholars and networks through joint projects and activities (SD6).

Strategic Driver 1 – This driver has resulted in projects with shared infrastructures and facilities and produced outputs in leading sports and exercise science journals. For example, work involving Engineering, Medicine and A-STEM has integrated medical engineering and exercise science, using novel analytics to develop clinical devices such as an artificial lung. Experts in A-STEM have worked with Computer Sciences to develop "Match-Pad" software analytics for sports performance and behaviour, and with Materials Engineering to explore the effects of thermoregulatory clothing on heat maintenance during preparation routines in Olympic and professional athletes. Unique and unparalleled access to professional sports participants and clinical and vulnerable populations, combined with engineering, clinical and sports and exercise science expertise has created a rich environment for novel and significant research to develop.

Strategic Driver 2 – Provides direction and support for increasing competitive grant income (Section D). The significant increase in income during this cycle has been aided by the relocation to the College of Engineering (a strategic partner to the EPSRC) and through partnerships with STEM subjects, in particular through Welsh Assembly Government (WAG) funded Knowledge Exchange and the EPSRC-funded Bridging the Gap (BTG) programmes.

Strategic Driver 3 – Works to enable academics to develop international connections with professional, industrial and academic partners, and to take on roles such as: editorships of international peer-review journals, chairs of scientific societies, visiting professorships, membership of scientific congress committees, consultants to industries, and advisors on international policies and practices.

Strategic Driver 4 – Is focussed on delivering direct impact to industries, people, policies and practices through the applied nature of A-STEM research and consultancies. It has enabled academics to strengthen relationships and deliver productive research collaborations with the national and international organisations including: World Anti-Doping Association (WADA), International Cycling Union (UCI), International Rugby Board (IRB), British Cycling and Gymnastics, UK Sport, Scarlets and Ospreys Rugby, Welsh Rugby Union (WRU), Lawn Tennis Association (LTA), UK Anti-Doping (UKAD), National Institute of Health and Clinical Excellence (NICE), and the Department of Health (DoH).

Strategic Driver 5 – gives the Centre its direction for growing research capacity (Section C). More growth will result from the move to the £250 million Science and Innovation Campus in 2015.

Strategic Driver 6 – Aims to promote international research collaboration. The growing vibrancy of A-STEM's research culture over the period is reflected in the increasing number of publications and presentations with international collaborators and success in attracting significant FP7 funding. The connection of early career researchers (ECRs) and research students to international projects also serves to inspire the next generation of researchers and develops international links and networks. Links with the EPSRC-funded Building Global Engagements in Research programme (Section E) have also been developed.

Sustainability and future plans: A-STEM's aims are to increase the quality and quantity of novel and rigorous applied research that has international reach and significance. In **Elite and Professional Sport,** Objectives include refining multidisciplinary research designs that identify the marginal performance gains required to maintain a competitive edge in elite and professional sports; integration of technology and engineering solutions to improve understanding of

preparation, performance and recovery from participation; deepen scientific understanding of youth sports performance; and development of new critical thinking in sports ethics, both empirical and theoretical, in relation to sports medicine, policy and engineering. In **Exercise Medicine and Health,** objectives include the integration of technology and engineering solutions to provide new approaches to quantifying the dose and response of physical activity and exercise on health outcomes; the further development of exercise and physical activity solutions for the management of clinical conditions, in particular diabetes. The production of medical devices and systems that require exercise physiology expertise in their engineering design. From a public health perspective challenging current literature on the design of physical activity programmes and interventions with young populations to improve fitness, health and wellbeing. New areas of research are also being developed. In particular a unique project that integrates biomechanics, engineering, archaeology and genetics in examining artefacts from long bowmen recovered from the Mary Rose; commenced in Swansea in 2011 is gaining momentum and is supported by the Mary Rose Trust.

The 6 Strategic Drivers have been refined to provide the focus for the 2013–2018 period:

1. Develop novel and rigorous sports-related research of international significance that improves athletic performance, development pathways, and ethically sound sports practices in adult and youth elite and professional athletes.
2. Develop innovative research technologies and methodologies that quantify the dose response, in elite and professional sport and exercise medicine and health.
3. Increase impact by targetting the development of industrial and public partnerships and collaborations at local, national, and international level.
4. Provide specific opportunities for developing international excellence in postgraduate students and early career researchers, and connect to and help connect them to world-leading academics and projects.
5. Increase competitive grant capture for multidisciplinary STEM related research and seek to further develop significant international projects.
6. Exploit opportunities for world-class research through state-of-the-art, purpose-built facilities, laboratories and infrastructure after relocation in 2015 to the University's new, £250 million, 64-acre, Science and Innovation Campus.

A-STEM's expansion will be informed by each of the 6 drivers. Research will continue to be applied in nature and entail scientific and critical enquiry, have policy relevance and be valuable to industry and society. Research will be aligned with national, EU and global funding priorities and policies.

c. People, including:

I. Staffing strategy and staff development

Swansea University's Academic Career Pathways (ACP) scheme has been designed to ensure that academic strengths, whether in research, teaching, the wider student experience, leadership or innovation and engagement, are all appropriately recognised, developed, valued, and rewarded. Since RAE2008, A-STEM has ensured that appointments have been made to sustain research centre aims. Over the cycle, three lecturers and one senior lecturer moved to new posts. In response, we have appointed established academic staff or ECRs aligned with the research centre's strategy and with potential to develop into international leaders. Two Professors in sport and exercise sciences (Stratton, McNamee) and four new tenured early career academics, all with a paediatric focus, have been appointed since February 2012. Four postdoctoral research appointments have supported the research environment; two have since been appointed as full-time members of staff and ECRs in 2012 (Mackintosh, McNarry). Bloodworth was also appointed as a full-time member of staff and ECR in 2010, to build capacity in anti-doping and sports ethics research. McNamee recently (2013) transferred Colleges from Health and Human Sciences to Engineering to accelerate philosophy and ethics research in sports and exercise engineering.

The University's **Performance Enabling Process** provides clarity on the support and training available to staff to enable them to perform to their optimum level. The process incorporates

individual staff KPIs, related directly to measures of organisational success, into an on-line Professional Development Review process. In 2012 the University won a Times Higher Leadership and Management Award and a UHR Excellence award for this initiative. Through this process, four A-STEM staff progressed from Lecturer to Associate Professor between 2009 and 2012. At a College level, a "Staff Working Load" model allocates teaching and administration duties in a manner that recognises an enables research contribution. College time-allocation surveys show that 60% of time was spent on research over the REF cycle. As part of probation, ECRs are allocated a mentor and a probation supervisor to assist them in developing and implementing a successful research strategy. A-STEM strategic driver 5 aims to link ECRs to established senior academics and to develop their experience. For example: Mackintosh and McNarry are co-investigators on a €9 million diabetes prevention project with Professor Stratton; McNarry is a co-investigator on a project developing an artificial lung led by Dr Lewis; Knight; Mackintosh and McNarry have been allocated fully funded PG students to accelerate their work. Dr Mellalieu has also assisted Dr Knight in acquiring an industry bursary for a second PG student in 2013-14.

Researchers' professional and career development is supported by a Development Officer in the Academic and Professional Enhancement Centre, which also provides generic skills training. Recruitment practices have been enhanced over the period to strengthen induction and probation, introduce a redeployment policy and minimise use of fixed-term contracts. Since 2011, the Researcher Development Framework (RDF) has been used to shape training provision and all workshops are now mapped onto it. The RDF has been included in Professional Development Reviews from 2012, with a link to the Vitae RDF planner.

Concordat to support career development of researchers: The University is fully committed to the implementation of the 2008 Concordat and has been awarded the European HR Excellence in Research badge. The University is actively involved in its Vitae network and was represented on the regional steering group until 2012. The 2009 and 2011 results of CROS (National Careers in Research Online Survey) and PIRLS (Principal Investigators and Research Leaders Survey) show that our researchers felt better supported, more valued and more engaged than the national trend.

Equality: The University works to provide a research environment that enables all staff to fulfil their potential, and has a Strategic Equality Plan to promote equality regardless of race and gender. Promotions data for academic staff is monitored annually and trends are highlighted for action. The University renewed its Athena Swan Bronze Award to 2016, recognising excellence in the areas of Science, Technology, Engineering, Mathematics and Medicine for Women in the HE Sector. A-STEM has addressed its gender imbalance by recruiting 3 female ECRs over the period. The University is a member of Stonewall's Diversity Champions Programme.

c. II. Research students

Research students: There are 41 PGRs in A-STEM, equating to 4.1 students per academic staff member with ECRs included (7.0 with ECRs excluded). 22 PGRs are registered for MSc by Research or MPhil, 18 of whom are studying elite and professional sport. Currently 8.1 students are reading for PhD/MD, with the headcount equally split between research groups. Table 1 illustrates the number of PGRs that were enrolled in each academic year of the REF cycle.

Table 1: FTE of postgraduate research students enrolled on doctoral programmes

08/09 FTE	09/10 FTE	10/11 FTE	11/12 FTE	12/13 FTE
3.2	6.8	8.6	9.6	8.1

Five Exercise Medicine and Health PhDs are jointly supervised with the College of Medicine and two with the College of Health and Human Sciences (CHHS). Two Elite and Professional Sport PhDs are led by CHHS, two are shared with Computer Science and one with Biosciences. In 2013, two research students were recipients of College studentships, one of which is part-funded through Swansea's EPSRC Doctoral Training Centre (DTC). The structures in place to support doctoral

students funded by the DTC are also used to support all research students in A-STEM. PG students are the engine room of A-STEM and in sum they have presented 44 papers at national and international conferences, and published 36 papers in international peer-reviewed journals.

In the 2008-2011 period, the University made strategic use of Roberts Funding to develop a robust research student training strategy. This included the appointment of a full-time Skills Officer and adoption of the RCUK recommendation to introduce an uplift of £200 to fees for all research students. The Academic and Professional Enhancement Centre coordinates a comprehensive skills development programme aligned to the Vitae Research Development Framework. The programme is free to all students enrolled on postgraduate research degrees. Research students in A-STEM are further encouraged to improve their employment prospects through the acquisition of high-level skills developed during collaborative research within elite sporting (British Cycling, English Cricket Board, Ospreys Rugby, British Gymnastics) and health (Diabetes UK, Regional Health Boards – ABM, Hywel Dda) organisations.

Training and support: In addition to specific A-STEM induction, progress of research students is supported and monitored by the Academic Board for Research. Students are allocated two supervisors and a "confirmation of candidature" procedure ensures a clear and agreed research and personal development plan for each student. For students on PhD programmes attendance at technical and professional development modules is individually agreed during confirmation of candidature. Research students in A-STEM also integrate as a body, and broaden their knowledge and skills, through engagement with peers and their respective research programmes. Research students are expected to help organise and contribute to A-STEM research seminars that provide valuable training and practice for presentations at national and international conferences. Student representatives from A-STEM are elected by their peers to facilitate communication and regularly attend the University-wide 'Student Engagement Window' meetings in which research students engage in and contribute to the discussions affecting research student issues.

Progress monitoring: The progress of research students is formally monitored, at least annually, through reports prepared by supervisors, which are discussed in the Postgraduate Progress Committee of the College and then sent for final consideration by the Academic Board for Research. At this stage, students are expected to write a summary report and to deliver a presentation before a progress report is completed. The College has agreed detailed probation and progression criteria that are contained in student handbooks.

d. Income, infrastructure and facilities

Income: The second strategic driver (SD2) aimed to increase research income. Over the current cycle A-STEM academics have spent £1,421,200 on research related activities. Income in 2008 was £104 k increasing to £487k in 2010 before flattening to an average of £350k over the past 2 years. This represents an approximate £1,300,000 increase in income over the REF cycle compared to RAE2008. The majority of research income (£1.43 million) is spread across 6 grants: (i) ESRC-funded sports ethics project on eating disorders in elite gymnasts (£100k); (ii) EPSRC-funded project on sports technology and engineering (£149k); (iii) EU FP7 project involving 16 countries that aims to deliver a global intervention to prevent diabetes (PREVIEW-€9 million, £352k for A-STEM); two Welsh Government-funded Collaborative Industrial Research Projects (CIRP) to develop (iv) the exercise and respiratory aspects of an artificial lung (£225k), (v) the integration of sports visualisation using computer science and sports performance data (£290k), and (vi) the formation of the Welsh Elite Performance Sport Innovation Network (WEPSIN) a knowledge exchange programme (KEP) to support and develop knowledge-transfer activity to support elite and professional athletes in Wales (£285k). In addition £500k of auditable in-kind industry funding was also levered from the two CIRPs.

Supporting researchers to apply for funding: Research advice, support and guidance is provided by the Department of Research and Innovation (DRI). DRI's External Funding Officers have College-specific responsibilities and advise on all aspects of research funding and provide training and advice on funding availability and grant capture. The Funding Officer sits on the College's Research Committee to provide guidance on and input into funding applications, support

researchers to attract research income, expand the College's research portfolio, and help to identify strategically important funding opportunities for individuals, Colleges and interdisciplinary research that meet University objectives. Funding officers also attend A-STEM seminars to update on lines of research and regularly communicate with the Director of A-STEM to support SD5. **Infrastructure and facilities:** A-STEM has well resourced biomechanics, physiology and cognition and behavior laboratories. These laboratories enable kinematics, force assessment, isokinetic dynamometry, ergometry, whole body imaging, detailed biochemistry and brain and behaviour experiments to be undertaken. These resources are complemented by the use of other specialist laboratories in Computer Sciences, Engineering and the Institute of Life Science (ILS). New facilities will be made available through A-STEM's relocation to the £250 million Science and Innovation Campus in 2015. The Centre has also procured sensor technologies from the EPSRC infrastructure funds and purchased a DEXA machine to complement MRI imaging facilities in ILS. The Elite Performance group benefits from ready access to the University's international quality sports facilities, which include the 50m Wales National Pool.

A-STEM management. The research centre adheres to the College's risk management, performance monitoring, and enablement processes and is guided by an A-STEM management group. This group includes a PGR, research assistant, an ECR, the lead of the innovation and engagement group and senior staff representative of each research group. The management group meets four times a year with changes in strategy and updates shared with colleagues at staff away day workshops organised thrice a year. Monthly reports are presented to the College's Research Committee, and metrics such as research income, publications, impact and presentations are monitored on a monthly basis. Staff performance is monitored through a Personal Development Review process (Section C).

e. Collaboration and contribution to the discipline or research base

A-STEM academics make a significant contribution to the Sports and Exercise Science discipline. Scientific studies in the Centre are a major hub for interdisciplinary collaborative activity promoted by *a culture that recognises the value of timeliness and relevance of A-STEM research.* Members from collaborating partners also sit on the independently chaired A-STEM innovation and engagement group, which considers the significance and reach of our research impact and provides sustained access to participants. Key examples of our collaborations are detailed in relation to: (1) international and national research networks; (2) engagement with research users and the public; (3) service given to the discipline and beyond; and (4) indicators of recognition of our contribution.

International and national research networks: *McNamee* is a key scientific advisor for UK, European and World Anti-doping agencies. *Mellalieu* is the founder and Network Editor of the International Rugby Board's rugby science research network. *Kilduff* is a member of the International Rugby and Genetics group. *Kilduff* also founded and leads WEPSIN, was a member of British Cycling Marginal Gains Group (2008-2012), convenor of BASES Strength and Conditioning Special Interest Group and a member of UK Sports Winter Sport Test and Challenge Group. *Griffiths* is founding chair of the British Association of Computer Sciences in Sports and Exercise. *Stratton* founded and chairs the Research into Exercise Activity and Children's Health research group. *Stratton* also chaired both the National Institute for Health and Clinical Excellence (NICE) group and the Chief Medial Officers (CMO) sub-group that produced national guidance for children's physical activity. *Lewis* is part funded by Texas A&M University, and the US Department of Commerce, National Institute of Standards and Technology programme in medical engineering. *Bracken* is national research coordinator for the Diabetes Physical Activity Network Wales.

Engagement with research users (SD4): A-STEM undertakes collaborative in-situ integrated, research and consultancy, scientific programmes that engage with a number of elite and professional UK sports who compete on the world stage. These sports require world-leading scientists to help maximise athletic performance. A-STEM academics provide psychological, pre-conditioning and recovery strategies and match and performance analysis research-informed support to: Swansea City AFC, West Ham United AFC, Bath Rugby Union, Biarritz Olympique (Rugby Union), Ospreys and Scarlets Rugby, the Welsh Rugby Union, the Rugby Football Union,

UK Sport, GB Bobsleigh and Skeleton Bobsleigh, GB Cycling and Canoeing and Sport Wales. Junior elite R&D activities are undertaken player development pathways with the Lawn Tennis Association, Football Premiership, Sport Wales and Welsh Rugby Union. Similar in-field relationships exist for Exercise Medicine and Health academics. A-STEM academics in Exercise Medicine and Health hold honorary NHS clinical and public health contracts with ABM and Hywel Dda health boards. Collectively, these sustained and fruitful relationships are an essential aspect of a vibrant applied research environment that allows open access to professional athletes, patients and participants of all ages.

Service given to the discipline: *McNamee* is founding Editor of *Sport, Ethics and Philosophy* and has been guest editor of *International Journal of Sport Policy and Politics* (2011) and *Ethical Theory and Moral Practice* (2011). He is a member of the Scientific Committee of the ECSS (2005-13) and gave Keynotes at ICSEMIS (2012), FIMS World Congress (2012), International Paralympic Committee Scientific Congress (2010). *Kilduff* is section editor of the IRB Rugby Science Network and editorial board member for *International Journal of Sports Physiology and Performance* and *Journal of the International Society of Sports Nutrition*. *Stratton* is an editorial board member of *Archives of Exercise in Heath and Disease* and the *Open Access Journal of Sports Medicine*, and has been a member of the management board of the Paediatric Work Physiology group since 2003. *Stratton* has given keynotes at the Sports Medicine and Sports Science Conference (Newcastle, 2010) Youth Technology and Health Conference (Hong Kong, 2012), the 20:20 vision Summary for Children's Health and Exercise at the International Congress on Physical Activity and Health (Sydney 2012) and the International Union of Nutritional Sciences (Granada 2013). He has organised Pre Congress Satellite meetings to ECSS in Liverpool 2011 and run numerous workshops at international conferences: Paediatric Work Physiology (Exeter 2011), European College of Sports Sciences (2011 Liverpool and 2012 Bruges), International Conference on Science Exercise and Medicine in Sport (2012), and International Conference of Electronic and Electrical Engineering (Ottawa 2012). *Mellalieu* is an associate editor and has acted as Guest Editor of the *Journal of Applied Sports Psychology*, along with the *Journal of Sports Sciences*. *Mellalieu* has also led symposia at conferences of the Association for Applied Sport Psychology in North America (2009, 2011, 2012), and is co-founder and Network Editor of IRB Rugby Science Network. *Lewis* is an Elected Fellow of the European Society of Cardiology (FESC). Academics from A-STEM also act as reviewers for competitive grants at national and international level such as the Wellcome Foundation (*Lewis. McNamee, Stratton*), BBSRC (*Kilduff, Watkins*), British Council (*Lewis*), British Heart Foundation (*Stratton*, *Bracken*), BUPA (*Stratton*), MRC (*Stratton*) and Diabetes UK (*Bracken*), ESRC (*McNamee, Mellalieu*), AHRC (*Mcnamee*), the Canadian Social Sciences and Humanities Research Council (*Mellalieu*).

Indicators of recognition of our contribution. International status is also evidenced through accolades awarded to staff. Staff have taken up international fellowships and research visits, for example, *McNamee* received the Erskine Fellowship as Visiting Professor at the University of Canterbury, New Zealand (2012). *Stratton* received the Healthway Visiting Research Fellowship Perth, Western Australia (2011) and is adjunct Professor at the University of Western Australia. *McNamee* is Visiting Professor in Sport Philosophy, at Hunan Normal University, China (2013-16) and at the Universities of Ghent and Louvain Le Neuve, Belgium (2013-14). He received the International Association for the Philosophy of Sport Distinguished Scholar Award (2008), Philip Noel Baker Award for Research (2012), was elected Fellow of the European College of Sport Science (2008), and was founding Vice President of the European Association for the Philosophy of Sport (2008). *Lewis* is an Elected Fellow of European Society of Cardiology (FESC) and *Stratton* was awarded Fellow of the British Association of Sports and Exercise Sciences (2011) and Fellow of the European College of Sport Science (2013). Two early career researchers have secured prestigious international awards, *McNarry* received 3rd prize at the European College of Sports Sciences meeting in (2010) whilst *Mackintosh* won first prize in the YIA at the pre-Olympic ICSEMIS conference in Glasgow in 2012. *Stratton* won the European Childhood Obesity Group award from the Louis Bonduelle Foundation in 2011.