Institution: Nottingham Trent University

Unit of Assessment: C26 Sport and Exercise Sciences, Leisure and Tourism

a. Overview

Since RAE2008, the Sport Academic Team's research power has increased significantly, aided by substantial development of the sport research environment and most notably through the development of the Sport, Health and Performance Enhancement Research Group (SHAPE). SHAPE has a defined remit within the Biomedical, Life and Health Sciences Research Centre (BLHS) within the School of Science and Technology (SST). SHAPE now provides an environment for researchers from across the University to interact, engage with and deliver research focused on sport, health and performance enhancement; with our research impacting upon sporting bodies, commercial companies, health providers and government agencies to change practice, formulate policy and inform training.

b. Research strategy

Context

Since 2008, the Unit made a strategic decision to consolidate our research activity under three sub-groups, namely **Sport**, **Health** and **Performance Enhancement**. As a direct result of the implementation of the SHAPE research strategy, significant improvements in the quantity and quality of our research environment have been realised.

SHAPE has a balanced profile of Readers (2 FTE), Principal Lecturers (3 FTE) and Lecturer/Senior Lecturers (17.4 FTE), of which 6 are Early Career Researchers. As a consequence of the research strategy since 2008, research activity in SHAPE has increased significantly. Examples include a more than 5-fold increase in journal publications from 22 to well over 100 during the assessment period; a research income increase of 2534%; a thirteen-fold increase in the number of international collaborations; an increase in the number of staff submitted from 8 to 12.8 FTE and an increase in the number of PhD completions from 1 to 12.

SHAPE has three strategic aims: (1) To establish an inclusive and sustainable research environment in Sport at NTU; (2) To support and develop excellent research and 3) To impact positively on performance and health through the delivery of high quality services and consultancy underpinned by the excellent research. The achievement of these strategic aims is realised through 3 enabling drivers: (1) The creation of a high-calibre physical environment to enable sport-related research; (2) Investment in people; and (3) A dissemination strategy to raise the profile of SHAPE emphasising its placement, prominence and eminence in its areas of expertise. The SHAPE Research Strategy supports and reflects the NTU mission (to deliver education and research that shapes lives and society) and its overarching research aims (to gain further recognition and support for our research, and grow our postgraduate student body). The strategy focuses on: staffing; publications; funding; resource development; research development and externality.

Achievements since RAE2008

Following the outcome of RAE2008, our strategic aim has involved the creation of a sustainable and vibrant research environment supported by the construction of a well-considered framework for research. Outlined below are examples of our key achievements following the implementation of our strategic plan.

Staffing:

SHAPE has grown through a targeted recruitment and development strategy. Experienced researchers (e.g., Dr's Sale and Elliott-Sale) were appointed, with Dr Sale becoming SHAPE's first Reader in 2011 and Dr Sunderland the second in 2013. This has been supported by the appointment of several early career academics (Drs Barnett, Lewis, Cooper, Bell, Evans and Hobson). By investing QR funding and strategically targeting specific end-users and grant awarding bodies, SHAPE has been able to increase the number of Research Assistants, Associates and Fellows from 0 during RAE2008 to 5 (4.2 FTE) in the current REF period. Through the introduction of academic associates (0.5 FTE teaching, 0.5 FTE PhD), investment of QR funds

and the development of strong collaborative links for joint studentships (e.g., Dr Sunderland's research examining the effect of altitude on appetite, energy intake and gut hormones [Sunderland 1] was a direct result of an East Midlands Universities Association collaborative studentship with Loughborough University), SHAPE has increased the number of PhD completions from 1 during RAE2008 to 12 between 2008 and 2013.

Publications:
The number and quality of SHAPE research outputs have increased from 22 in RAE2008 to well over 100 in the current REF period; this has been accompanied by a greater proportion of publications in higher ranked journals. Staff publications are supported through investment in PhD students, development of collaborative links, management of workloads to free time for writing and sabbaticals. The latter being via a competitive internal application process, strategically supported by SST. For example, during Dr Minshull's six month sabbatical period, 4 articles were published in high impact journals (two of which are included in our current submission; Minshull 2 and 4).

Funding:
Research income has increased from £7,575 during RAE2008, to £191,972.89 between 2008 and 2013. This was a result of the support provided to staff through: grant writing workshops and staff mentorship in the grant writing process. For example, Dr Barnett was a successful co-applicant on a £33,000 grant awarded by NHS Nottingham City to evaluate the effect of exercise on health and weight loss during pregnancy and following child birth.

Resource Development:
There has been over £600,000 of investment in SHAPE resources for research and teaching, with additional research facilities including a Biochemistry laboratory, a Performance Analysis suite, two Exercise Physiology laboratories and Sport Management and Sport Psychology suites. A further £307,000 has been spent on new equipment for SHAPE research, including a clinical chemistry analyser (which has supported several publications [*e.g.*, Johnson 1 and 4 and Sharpe 3] and collaborations [*e.g.*, sweat analysis for GlaxoSmithKline]), and a bespoke isometric dynamometer (which has resulted in several key outputs [*e.g.*, Minshull 1, 3 and 4).

Research Development:
The number of sabbaticals increased from 1 during RAE2008 to 4 in the period 2008 to 2013. Drs Minniti (February-August 2010), Sale (February-August 2011), Minshull (February-August 2012) and Hall (October 2012 – July 2013) have benefitted from focused time for research activity, funding development and dissemination of outputs. Staff were supported to develop their research profile through: workshops; individual mentoring and skill development sessions. The focus was on: writing grant and sabbatical applications; communication skills that enable the development of networks and end-user needs; journal and book writing; internal seminar presentations and attendance or presentations at National and International Research Conferences. Links with our visiting Research Fellows have also supported SHAPEs research in this regard. For example, Richard Davison (a four-time Olympian) was appointed as a Visiting Fellow at NTU in 2012 and has supported Dr Hall in recent publications and consideration of impact.

Externality:
The creation and implementation of SHAPE was pivotal in both promoting research externally and in helping to create essential networks. SHAPE enables impact internationally across a wide range of industries, organisations and environments. For example, Dr Sunderland produced a training manual for the International Hockey Federation that is now used globally by all international umpires; Drs Hunter and Cooper are undertaking research at the Michelin starred Le Manoir aux Quat'Saisons into cognitive function and physical wellbeing of staff and Dr Sale has started work with the English Institute of Sport investigating bone health in elite athletes. SHAPE research has been disseminated through social media, articles written in industry magazines, and academic and corporate presentations. The training and support provided in developing networks, understanding end-user's needs and presenting and sharing findings, underpins the above. The number of international collaborations has increased from 1 during RAE 2008 to 13 international and over 30 national collaborations in the period 2008 to 2013.

Research Vision

The vision for research over the next 5 years is to grow existing research excellence within each of the research sub-groups; sustain a stimulating research culture and infrastructure that meets the needs of our researchers, collaborators and end-users; develop a culture of collaboration between researchers both within SHAPE and externally; expand upon our recent successes in grant capture and maximise the exploitation of our research for the generation of impact. SHAPEs research vision will be achieved through the strategic objectives outlined below.

Staffing:

SHAPE will continue to develop the profile of staff through strategic appointments, including a Professorial research leadership post. Support will be provided to ensure that research activity and capacity is enhanced, with a target for two thirds of SHAPE researchers being 'research active'. This will be supported by formal and informal mentoring, continued investment in sabbaticals and teaching buy-out, and the management of teaching workloads. Growth in research active staff will be supported by the recruitment of technical resources to address specific areas of high impact research; such as muscle and bone physiology, molecular biology and neurophysiology. During the next 5 years, we will build on the recent growth in PGR numbers through expansion of the Academic Associates scheme, external funding, strategic targeting of international student funding schemes and development of matched funding collaborations (e.g., the current studentship with the English Institute of Sport).

Publications:

In line with the Institutional strategy to provide support for research outputs and publications, SHAPE will provide support to realise continued growth in the volume and quality of research outputs. Sabbaticals and careful management of teaching and research workloads to provide time for publications and grant writing will be provided.

Funding:

The development of research funding support will promote growth in income during the next 5 years, with a target (based on the success achieved during the current REF period) of a minimum growth of 300% on REF2014 income. An increase in the grant capture activity of SHAPE will be achieved through continued partnership with the NTU Research Grant Capture Team and resources for the identification of funding opportunities.

Resource Development:

In order to continue and develop research activity at the highest level, a critical element of the SHAPE research strategy is to consolidate and increase our available resource base. Primarily this will be achieved through the targeting of external funding opportunities specific to equipment procurement. In addition, SHAPE will continue to produce robust business cases to secure internal capital investment for the benefit of our research environment. Specific requirements are already identified and include a high resolution peripheral quantitative computed tomography scanner, a new multiple camera motion capture system; magnetic resonance imaging (sourced to hire); muscle biopsy and dynamometry equipment.

Research Development:

SHAPE will continue to support staff in the development of their research careers, primarily through sabbatical support, research buy-out and the management of academic workloads. Senior research staff will continue to mentor early career researchers and will be supported in this endeavor by the development, in collaboration with the NTU Research Grant Capture Team, of a guidance resource providing information on creating and managing networks, identifying end-user needs, building collaborations, writing grant applications, and recording reach, significance, impact and end-user feedback. Further development of our research environment will also be provided by an increase in the number of our visiting researchers, with a focus on expanding active research collaborations. The dissemination of research will be supported through funding of publication costs, where these apply to key target journals (e.g., open access publication costs), and for attendance at National and International conferences.

Externality:

SHAPE also plans to continue to embed the impact agenda within its research strategy, using the website (www.ntu.ac.uk/shape) and other appropriate media channels as a means to demonstrate the impact of our excellent research. SHAPE will also build sustained relationships with clients with whom consultancy work is undertaken to develop further activities that enable a range of end users to benefit from the research work. In order to ensure strategic and individual benefit and value,

meaningful collaborations will be defined as those that 'produce a measurable, joint output', such as a grant application, research paper or book. Each research active member of SHAPE will be actively developing an identifiable and strategically relevant network within and beyond NTU resulting in joint outputs. SHAPE researchers will engage the Press Office at the earliest possible stage of research that has the potential to deliver impact.

c. People:

This section is informed and framed by the University's commitment to promoting, developing and supporting equality and diversity. The University adheres to an Equality and Diversity Policy and a Dignity at Work Policy and Procedure, which are embedded through management practices including recruitment and learning and development. Individual circumstances are taken into account when conducting staff reviews and in management processes. NTU has an equality and diversity champion who participates as part of the Vitae Equality and Diversity Champion Network. A range of case studies informed by NTU's work in this area are available on the Vitae website.

i. Staffing strategy and staff development

The demographic of staff in 2008 was diverse, with a Reader, Senior Lecturers and Lecturers, several of whom were classified as early career researchers. These early career researchers have been supported to develop their research profiles towards inclusion in the current REF submission. For example, Dr Johnson was supported through staff mentorship (Dr Sharpe), QR funding to support teaching buyout, a lightened teaching load, conference attendance and PhD studentships. Our ability to deliver on our research strategy since RAE2008 has been strengthened by the appointment new staff, with expertise in sports nutrition, cognitive function and exercise and health. For example, Dr Sale investigates the exercise and nutritional triggers for adaptations in muscle and bone; whilst Dr Cooper provides links between diet and cognitive function in paediatric exercise physiology and Mr Bell investigates the optimisation of recovery for athletes and athletic individuals.

Two members of staff (Drs Sale and Sunderland) have been promoted to Reader through the Universities awards and titles process, demonstrating the support for staff through our rich research environment. Part-time staff are also supported in the research process. For example, Miss Redwood-Brown (0.6 FTE) is funded and supported by SHAPE for a PhD and Dr Elliott-Sale (0.8FTE) has been provided with an opportunity to engage in full-time research activity through buy-out from a grant from NHS Nottingham City.

SHAPE has also introduced an innovative approach to the development of young researchers by implementing Academic Associate appointments (0.5 FTE teaching and 0.5 FTE PhD; the first such appointments across the University). Similarly, the current REF period has seen a contribution to our research strategy provided by Research Assistants, Associates and Fellows. For example, Dr Ricci Hannah was employed to complete a project relating to the use of Transcranial Magnetic Stimulation, which provides the basis for future grant applications and high impact research in performance enhancement and health.

NTU has implemented the Concordat to Support the Career Development of Researchers, and holds the European HR Excellence in Research Award, in recognition of its commitment to enhancing working conditions and careers for research staff. Our implementation of the Concordat is evident through our commitment to recruiting, rewarding and developing Researchers as full members of our university staff community. For example, Dr Ruth Hobson, a former Research Fellow, has received a permanent Lecturing contract. All staff participate in annual performance development and contribution reviews (PDCRs), ensuring that individual development needs are ascertained and addressed. The University has developed a Researcher Continuing Professional Development Tool (RCPD: based on the Vitae Researcher Development Framework) to assess and enhance its support for the research-related career development of individuals at all stages of their career. SHAPE is supported by the NTU Ethical Review Committee (Humans) ensuring that our research adheres to an ethics policy that is regularly reviewed and updated.

ii. Research students

There has been a significant increase in the number of research students within SHAPE, with current PhD completions at 12 (compared with 1 in RAE2008), Table 1. Members of SHAPE also collaborate on several PhDs registered in other research groups at NTU (e.g., smart materials) and at other institutions across the UK (e.g., University of East Anglia; Loughborough University). SHAPE has focused on attracting high-quality research students to undertake PhDs by providing a collegiate research culture in which they can maximise their potential and by following robust procedures for monitoring progress and attainment. 100% of students starting in SHAPE in 2006/07, 2007/08 and 2008/09 completed to PhD, demonstrating the success of our postgraduate recruitment and support policies.

Table 1. PhD students (FTE) enrolled per year of Assessment.

2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	Total
7.50	6.50	5.23	5.16	6.01	30.40

The developments in SHAPEs postgraduate research community are underpinned by the NTU Graduate School, which has three main areas of responsibility: administration; quality management; and training. With regard to administrative processes, the graduate school is responsible for research students from initial enquiries and applications, where it manages and ensures an equitable process within and across the university. In terms of quality management and enhancement, the Graduate School, alongside the University Research Degrees Committee, has oversight of all progression points for research degrees including establishment and approval of supervisory teams, project approval, transfer from MPhil to PhD, management of the approval of examiners and the operations of *viva voce's*. In terms of training, the Graduate School, in conjunction with the Centre for Professional Learning and Development, organises and delivers training for supervisory teams, internal examiners and Independent Chairs of *viva voce*'s. The Graduate School now manages a single training programme for all research students across NTU offering a diploma level qualification in Professional Research Practice designed to meet RCUK and the Vitae Researcher Development Framework requirements for researchers.

Supervisory teams schedule regular meetings for subject specific training. Generic skills training includes compulsory attendance and presentations at the BLHS Seminar Series and the SST Research Conference. Training related to the writing of the transfer report is provided in the second year, with information relating to the completion of the PhD and the *viva voce* process being provided during the third year. There is a 6 monthly monitoring of student progress, signed off by the supervisory team and an independent assessor. Research students are supported financially and in the development of the professional skills needed to: design research studies; undertake and complete data collection; analyse data; and write and present findings. They are encouraged to participate in continued professional development activities, including topic specific workshops (e.g., BASES); lecturing; attainment of professional qualifications (e.g., phlebotomy and International Society for the Advancement of Kinanthropometry qualifications); and attendance at conferences. The effectiveness of this support and training is evidenced by the employability of our students within elite sport (e.g., English Institute of Sport), lectureships at higher-education institutions (e.g., University College London), post-doctoral training programmes with top research groups in the discipline (e.g., University College London, University of Sao Paolo, Brazil).

d. Income, infrastructure and facilities

NTU funding specific to non-capital support for research has totalled £75,500 per annum since 2009. This has been invested in staff sabbaticals and development (including teaching buy-out and payments for training courses; PhD students; conference attendance and research costs).

i. Income

One of SHAPEs key priorities since inception has been to increase external research funding, with direct support being provided by the NTU Research Grant Capture Team. By the end of RAE2008 we had secured £7,575 of research income, which has now increased to £191,972.89 for the current REF cycle. This considerable increase in income is testament to the strategic approach of SHAPE and also the significant efforts of the team and includes: £124,095 to the Health and Performance Enhancement sub-groups from UK central and local government institutions, £32,476

to the Sport, Health and Performance Enhancement sub-groups from overseas institutions, £16,038 to the Performance Enhancement sub-group from UK industry, and £1,440 to the Performance Enhancement sub-group from UK Charities. Importantly several of these grant awards will extend beyond the current REF cycle and into the following one, with research awards in the REF period totalling £270,800, providing a platform to realise significant further gains in research income necessary to support our future research plans.

ii. Physical infrastructure and facilities

The University has demonstrated its support to SHAPE through investment into the enhancement and development of the physical infrastructure. Over £5M of investment has been made in the sport environment across the University since 2008 and includes:

- £600,000 refurbishment of Sport Science facilities (2012), realising the development of: 4 sport and exercise physiology laboratories; 1 sport and exercise biochemistry laboratory; 1 sport and exercise psychology laboratory; 1 exercise and health laboratory; 1 sport and leisure management suite; 1 food preparation area and a 40-terminal performance analysis laboratory.
- £4.3m enhancement of the Lee Westwood Sport Centre and facilities (2012) including: high-performance physiology laboratory; sport psychology suite; nutrition centre with 8-bay kitchenette; strength and conditioning suite; and multi-purpose sport facilities including 3rd generation all-weather surface pitch.
- £820,000 development of the Equine Sport Science facilities on the Brackenhurst Campus (2011)

Further capital investment (in excess of £307,000 since 2009) has enhanced the capability within the SHAPE research base through procurement of research equipment, analytics and services; including: dual x-ray absorptiometry (2013); Pentra clinical chemistry analyser (2011); horse simulator (2011); magnetic stimulation system (2009); isometric dynamometer and arthrometry system (2009); and integration electronics (2009) . Performance analysis software including Sports Code (2009), Match Insight by Prozone (2008), ProSuite and TeamPro by Dartifsh (2010-2012) have also been provided.

e. Collaboration or contribution to the discipline or research base

i. Interdisciplinary and collaborative research

SHAPEs research is inherently interdisciplinary including, for example, elements of biology, medicine and nutrition. Evidence of this is provided by examples of our collaborative research, as highlighted below.

Examples of our strong international collaborations are: Drs Sharpe and Johnson with the University of Queensland (co-publications); Dr Sale with the University of Sao Paolo (successful in joint postdoctoral research [funded by FAPESP] and several publications) and Murdoch Children's Research Institute at The Royal Children's Hospital in Australia (on-going study on genetic influences on elite athlete performance); Dr Sunderland with Brock University (co-publications and research into the central effects of fatigue in the heat); Dr Barnett with Jönköping University (investigating balance assessment protocols and their ability to predict falls in lower limb amputees); Dr Hall with the University of Sydney, Australia (co-publications).

Notable national collaborations include: Prof. Fraser (Head of Department of Medicine, Norwich Medical School) on studies relating to exercise, nutrition and bone (Dr Sale); Prof. Montgomery (Professor of Intensive Care Medicine at University College London) on studies relating to genetic associations with stress fracture injury (Dr Sale); Drs Nevill, Morris, Stensel, James and Folland at Loughborough University on studies investigating talent ID in football and hockey, extreme environments and appetite and muscle function (Dr Sunderland, Dr Minshull) and Prof Gibson (University of Reading) on studies relating to the use of prebiotics to improve the performance and wellbeing of athletes (Dr Hunter).

ii. Relationship with public sector and other end users

SHAPE has built and maintains positive relationships with a growing network of national and international organisations and end users across a range of industry sectors. These include sporting bodies (e.g., English Institute of Sport, Australian Institute of Sport, High Performance Sport New Zealand, Antigua National Olympic Committee), commercial companies (e.g., Nestle,

EA Sports, Clasado ltd, Natural Alternatives Int), health providers (e.g., NHS Nottingham City) and government agencies (e.g., Department of Health, Ministry of Defence, UK Sport). This is achieved by proactively forwarding research work to appropriate end users using all available media (e.g., social media such as ResearchGate, twitter and LinkedIn; Dr Sunderland providing research findings to England Hockey performance staff; chairing and sitting on committees (e.g., Dr Hunter sits as the Nutrition Judge on the National Association of Care Catering National Care Cook of the Year), providing consultancy (e.g., Dr Lewis provided a workshop on the East Midlands Amateur Swimming Association Master Development Day on the Biomechanics of swimming); and networking (e.g., Mr Parker introduced Drs Hunter and Cooper to managers at Le Manoir aux Quat'Saisons to enable an additional research project). The SHAPE approach to building relationships with the public sector and other end users enables impact, increases research opportunities and informs best practice within the team.

iii. Contribution to the discipline

Editorial board membership and editing:

Dr Sale is an editorial board member for Amino Acids and was Principle Conference Editor for a Special Issue in Amino Acids (2012, 43(1)) on the International Congress on Carnosine in Exercise and Disease. Dr Minshull is an editorial board member for the International Journal of Sport Science. Dr Minniti edited a book section for the Routledge Companion to Sport and Exercise Psychology: Global Perspectives and Fundamental Concepts (International Perspectives on Key Issues in Sport and Exercise Psychology).

Grant reviewing:

Several staff are involved with reviewing grants for National and International awarding bodies, examples include: Dr Hall has reviewed grants for the BBSRC (2012). Dr Sale has reviewed 2 separate grants for the Research Foundation Flanders (FWO, Belgium, 2012) and another for the National Science Center (Poland, 2013). Dr Minshull has reviewed grants for UNESCO-L'Oreal (National and International) Women in Science Fellowship (2009-present).

Conference organisation and acting as conference session chair:

For example: Dr Sale – International Scientific Committee of the International Congress on Carnosine in Exercise and Disease (2012, Belgium) and International Scientific Committee for the International Congress on Carnosine and Anserine (2014, Japan). Dr Minniti – managing council for the International Society of Sport Psychology and organisation of their annual conference (Beijing 2013). Dr Hall – organising committee of the International Society for Equitation Science conference (Edinburgh 2012). Dr Elliott-Sale – organised a workshop on Antenatal Obesity Health and Wellbeing in Nottingham City and Nottinghamshire County. Dr Minshull – chaired at the Annual International Conference on Kinesiology and Exercise Sciences; Dr Sunderland – chaired at BASES; Dr Sale – chaired at the International Congress on Carnosine in Exercise and Disease and Dr Hall – chaired at the International Society for Equitation Science conference.

Invited talks and keynote speeches:

Examples include: Dr Hunter – The International Scientific Association for Probiotics and Prebiotics annual meeting; Dr Sunderland – Researching Youth Sport Conference (2013); Dr Sale - University of Sao Paulo (2012, 2013), continuing professional development seminar for Performance Nutritionists from the English Institute of Sport and Sport Wales (2012) and the International Congress on Carnosine in Exercise and Disease (2012); Dr Elliott-Sale - workshop on Antenatal Obesity Health and Wellbeing in Nottingham City and Nottinghamshire County.

Invited review articles, books and book chapters:

Staff are regularly invited to produce scholarly articles, which have included: Original articles by Drs Minshull and Lewis; review articles by Dr Sale; books by Mr Parker (x2) and book chapters by Mr Parker (x3) and Drs Sale (x2) and Minniti (x3).

External examining:

Staff from SHAPE have externally examined 7 PhDs and 1 MPhil within the REF period.

Accreditations and fellowships:

Dr Sunderland is a Chartered Scientist and a BASES accredited sport and exercise scientist (sports support and research). Drs Sharpe, Hall, Evans and Elliott-Sale are fellows of the Higher Education Academy.