Institution: University of Central Lancashire

Unit of Assessment: UoA 24 - Sport and Exercise Sciences, Leisure and Tourism

Title of case study: ***Improving horse health, welfare and performance***

Period when the underpinning research was undertaken: 2006 - ongoing

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Sarah Jane Hobbs	Reader	August 2000 to present
Dr Lindsay St George	Research Associate	May 2015 to present
Dr Robert Graydon	Lecturer	December 2016 to present

Period when the claimed impact occurred: 2011-ongoing

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Our research has had a substantial impact on developing and implementing equine surface testing protocols and terminology for the Fédération Equestre Internationale (FEI). These testing protocols have been used to certify Olympic Games surfaces at Rio de Janeiro and Tokyo and are currently being developed into international standards. Our work is being disseminated globally via media outlets, professional governing bodies, pro-riders and fellow equine educators, which is transforming awareness of equine surfaces and their underlying research evidence base. The impact of our research with multiple collaborators is far reaching, from using Hobbs' methods to investigate 'Usan telmen' gait in Mongolia, through enhancing the breeding industry in Sweden, to educating dressage judges in the USA.

2. Underpinning research (indicative maximum 500 words)

Equestrian sports research at the University of Central Lancashire was initiated in 2001 by Hobbs, who continues to lead this area of research today with support from a Research Associate, a number of other non-equine staff who have complementary skills and many external collaborators. The team have led 12 bids and supported one funded bid and consultancy projects. The focus of the University of Central Lancashire's equine research has been in three key areas: advancing knowledge of equestrian surface function and dysfunction, developing robust methods of equine locomotion analysis, and quantifying the functional demands of equine sports' performance for the horse and rider.

Assessment of equestrian sports' surface performance began at the University of Central Lancashire with studies involving the hoof-surface interaction. Initial findings suggested that: moisture substitutes, such as wax, alter grip characteristics, surface preparation can alter locomotion patterns, and banking a turn allows the horse to remain more perpendicular to the surface, which reduces the asymmetry between inside and outside limbs at faster gaits [1]. Surface functional properties influence gait, but appropriate standard methods of measurement were not available for equestrian arenas in 2010. With this in mind, Hobbs directed a number of projects to validate equipment and procedures for measuring and monitoring equestrian competition surfaces, from initial design through to installation and maintenance [2, 3]. Following on from this, Hobbs developed some of the complex objective measures that were compared to existing subjective evaluations [4]. This study formed the foundation for the development of appropriate measurements and measurement thresholds for show jumping competition surfaces.

In order to quantify the functional demands of equine sports performance for the horse and rider, Hobbs developed a long-standing collaborative relationship with Prof. Hilary Clayton (Michigan State University). Together they have developed three-dimensional full-body models of the horse that have allowed them to investigate aspects of locomotion and balance when performing different gaits and movements [5]. They have also developed advanced methods of studying multi-dimensional time continuous data to improve knowledge and understanding of the nuances of equine conformation and motion [6]. The methods developed in [6] aimed to create simplified

visual images of limb function from complex numerical data that veterinarians, farriers and other practitioners could easily interpret. The focus of this body of work has been firstly to quantify the demands of high-level movements for elite dressage horses [5] with complex movement, including *piaffe* which is currently under investigation. Secondly, to observe and measure asymmetric hoof growth and quantify the extent of locomotor asymmetry [6]. Asymmetric sports horses and racehorses are commonly found in the population and horses with asymmetric feet are associated with shortened competition careers. Quantifying the consequences of morphological and/or physiological differences, alongside discipline-specific demands for competitive horses, will likely reduce injury risks as the evidence is more widely disseminated. It will also improve selection criteria for equine athletes, leading to increased welfare and career longevity.

3. References to the research (indicative maximum of six references)

1. Hobbs, S.J., Licka, T. And Polman, R.J.C. (2011). The difference in kinematics of horses walking, trotting and cantering on a flat and banked 10 m circle. *Equine Veterinary Journal*. 43: 6: 686-694. DOI: 10.1111/j.2042-3306.2010.00334.x
2. Holt, D., Northrop, A., Owen, A., Martin, J. and Hobbs, S.J. (2014). Use of surface testing devices to identify potential risk factors for synthetic equestrian surfaces. *Procedia Engineering*. DOI: 10.1016/j.proeng.2014.06.160.
3. Lewis, K., Northrop, A., Crook, G., Mather, J., Martin, J., Clayton, H.M., Roepstorff, L., Peterson, M. and Hobbs, S.J. (2015). Validation of an original piece of equipment for the measurement of rotational shear properties in equine arena surfaces. *Biosystems Engineering*. DOI: 10.1016/j.biosystemseng.2015.07.006.
4. Hernlund, E., Egenvall, A., Hobbs, S.J., Peterson, M.L., Northrop, A.J., Bergh, A., Martin, J.H. and Roepstorff, L. (2017) Comparing subjective and objective evaluation of show jumping competition and warm-up arena surfaces. *The Veterinary Journal*, 227: 49-57. ISSN 1090-023.
5. Clayton, H.M. and Hobbs, S.J. (2017). An exploration of strategies used by dressage horses to control moments around the center of mass when performing passage. *PeerJ*, 5. e3866.
6. Hobbs, S.J., Nauwelaerts, S., Sinclair, J., Clayton, H.M., Back, W. (2018). Sagittal plane fore hoof unevenness is associated with fore and hindlimb asymmetrical force vectors in the sagittal and frontal planes. *PLOS ONE*, 13 (8). e0203134.

*all peer-reviewed journals

4. Details of the impact (indicative maximum 750 words)

Development of a framework for FEI certification

Following the London 2012 Olympics, the Fédération Equestre Internationale (FEI), the world governing body for equestrian sports, initiated a footing project to continue the scientific work on surfaces that evolved from the games. Soon after, Hobbs was asked to take the lead in writing a white paper [A], based on her research [1]. For Hobbs this became a two-year project, as her vision for the paper was to provide a comprehensive resource for the equestrian community by combining current scientific knowledge with a framework from which surface standards could be developed. Together with an extensive review of intrinsic and extrinsic factors that influence welfare and performance [1], the white paper also included a review of existing and new surface testing methods [2], engineering definitions applied to surface testing, a certification framework and layman's surface terminology for a new industry standard. The development of layman's terms to describe the functional properties of surfaces was an important step towards certification, as scientific (objective) measurements could then be directly applied to layman's terms, which provided a universal language of communication [B]. In 2014, the FEI made the white paper freely available to the worldwide equestrian community as a reference and educational source. Examples of its reach and influence can be found globally (i.e. Canada, USA, Australia) to include over 40 independent articles that discuss and critique the information, concepts and proposed framework. For example, Norton (2015) concluded for *Horse Sport* magazine that:

'The Equine Surfaces White Paper discussed a great number of aspects that must be considered when discussing optimal footing. However, there are such large gaps in our knowledge that specific recommendations for each discipline can't be made at this time.

The authors hope by educating trainers and riders as to how surface conditions affect the biomechanical performance of our horses, injuries can be prevented.' *[C]*

Producing protocols for the certification process

The FEI began a consultation process with industry following the launch of the white paper, with Hobbs as one of the main scientific advisors [D]. To progress the development of protocols, one study focused on defining acceptable thresholds for field based, objective measurements of show jumping competition surfaces [4], whilst other studies [2, 3] were used to inform the inclusion of laboratory-based tests and the development of surface maintenance procedures. The scientific work in [4] also raised awareness of surface terminology and function in the 198 riders taking part in nine elite competitions at six European venues. In 2016-17 Hobbs and St George were commissioned by the FEI to develop a complete set of protocols for surface certification. The protocols were underpinned by the scientific work and comprised of 38 separate documents in total. The in-situ protocols were piloted at the Olympic Games and the World Equestrian Games (WEG) (France, Brazil and USA). The materials and track-in-a-box protocols that were developed were used in the selection process for the tenders submitted for the Tokyo Olympic surface. The in-situ protocols were used at the Tokyo test event and will be used at the Olympic Games in 2021 [D]. The in-situ protocol has recently been adapted for an American Society for Testing and Materials (ASTM) standard (F3400-19) and the suite of materials, track-in-a-box and certification protocols are currently under consideration by voting members of the ASTM. The benefits of measuring surfaces to a defined standard for events, horses and riders was highlighted at Tryon, USA (WEG 2018). Prior to the WEG, three horses fell during competition in the main arena [E]. After extensive testing, a new main arena and surface were proposed and used for the games, which was hailed as a huge success. Implementation of the certification process on a wider scale was agreed by the Footing Standards Working Group in April 2019 [D]. They proposed that all 5* competitions (Approximately 90 worldwide/year) should have in-situ surface certification at the start of each competition. This recommendation is awaiting FEI approval by the Jumping Committee and the General Assembly and will result in a rule change if approved. In addition, the Working Group recommended that surface providers are given the opportunity to have their products FEI certified using the materials testing and track-in-a-box testing protocols. Surface evaluation using functional properties terminology is also embedded into the new FEI Event Classification system [D] that is designed to ensure that standards are maintained at all FEI competitions. Test results and surface evaluations are already influencing perception of acceptable surfaces and of maintenance practices, with practitioners more commonly favouring softer, well cushioned surfaces. Ultimately, this will reduce injury risk for the horse, as hard surfaces are a contributory factor in the development of overuse injuries (2).

Increasing awareness of factors that influence horse health, welfare and performance

Increasing awareness of intrinsic and extrinsic factors beyond the white paper that can impact on the health and performance of horses is also a key driver for the University of Central Lancashire's equine research team. In order to increase the reach of our work, a day of workshops were produced so that the footage and presentations could be used as part of the launch of the FEI Campus, a free educational website, targeted towards the international equestrian community [F]. The FEI Campus was launched in 2017 and by March 2018 it had already attracted 15,541 visitors (3,117 registered members) worldwide who had engaged with the learning materials which included all four presentations from the workshops [F]. The University of Central Lancashire's contribution included research work on asymmetry [6] and balance [5] in horses and further dissemination of the proposed equipment and techniques to be used for equestrian surface certification [A][2]. A key element of embedding new knowledge that will benefit horse welfare is through our work with scientific practitioners. Hobbs supervised the doctoral research of Dr Simon Curtis, Fellow of the Worshipful Company of Farriers. Since successfully graduating, Curtis has visited 15 different countries in Europe, North and South America, Australasia and Asia to date, to present the work to over 2000 farriers, vets and breeders. The research includes techniques developed in [6] on asymmetric hoof growth, foot balance, loading patterns and hoof distortion.

In March 2018, Curtis was acknowledged for his efforts, receiving the Colin Spedding Award from HRH Princess Anne at the National Equine Forum. The impact of his work in influencing practice was captured in a survey in 2018 [G], showing that his dissemination of the research had reached practitioners from every continent. From the survey, 95.7% of 516 respondents reported that Curtis' research has positively influenced their knowledge, skills development and/ or practice within the equine industry. An example of the impact of his research is illustrated by this quote from the Programme Manager of BYS Farrier School in Sweden.
'Simon's study means a lot to our development work on hoof care, correction of foals and various working methods within the hoof care sector in Sweden. His thesis is also of great importance for our future breeding work.' [G].

Educating students and practitioners on aspects of equine locomotion and their demands on the musculoskeletal system of the horse from our research findings [1, 2, 5, 6] is a priority for the research team. Along with the workshops and seminars given by the research team, Hobbs' collaborator Hilary Clayton (Michigan State University), a scientist, vet, dressage trainer and Grand Prix rider also disseminates our collaborative research [5] to the equestrian community to aid improvements in training practice [H]. This includes an annual presentation to judges at the US Dressage Federation Convention and many workshops and training sessions worldwide. Our research is embedded in equine science course curriculums at a local, national and international level [I] providing enhanced knowledge and understanding to current and future equine practitioners. Our methods of calculating moments around the centre of mass and then using them to investigate balance and locomotion [5] also has reach beyond the gaits performed by sports horses. A member of the Mongolian ambling horse federation remarked on using these techniques to investigate the 'Usan telmen' gait:
'I truly inspired by your work which the techniques that used in these studies and logic explanations, result are sufficient to understand and explore the behavior of other gaits too.' [I]

One of the keys to reaching stakeholders globally is using gold open access journals, which Hobbs and Clayton have prioritised wherever possible [5, 6]. This allows further dissemination to occur through lay article reviews and helps to spread important messages originating from the scientific work as widely as possible, such as the messages in [5] highlighted by *HorseTalk*, New Zealand:
'Given the complexities involved, it is not surprising that some horses fail to learn the biomechanical skills necessary for passage….Researchers Hilary Clayton and Sarah Jane Hobbs… writing in the journal PeerJ, said the slow speed of passage challenged the horse's ability to control the sagittal-plane moments around the center of mass.' [H].

Awareness of equine surface testing and surface standards for show jumping competitions has already made an impression on equestrian practitioners within the sport of eventing. Eventing is primarily performed on turf surfaces, which can vary considerably in their functional properties. Course designers, organisers, riders and other practitioners within eventing have recognised the benefits in having a quantifiable description of the 'going' prior to an event, particularly for the cross-country phase [J]. Cross-country courses are undulating and up to approximately 6.8 km in length, which limits the possibility of using identical equipment and methods to those used in show jumping competitions at all but the highest level. As such, Hobbs and Graydon, together with ex-junior team British Eventing (BE) veterinarian Mark Lucey, and colleagues from Nottingham Trent University, tested 26 affiliated BE courses with a range of surface measuring devices over the 2019 eventing season in the UK. The results from this initial work are driving the establishment of standard methods and equipment for measuring cross country turf surfaces in the future. This work has already been highly praised by stakeholders, such as Philip Herbert (accredited BE course designer):
'Thank you and all of your team for this most comprehensive report. I am most impressed with the trouble you have gone to and the amount of data you have recorded. You will be most welcome to come to Burghley, at any time in the future and if you require any assistance from me, in my capacity as BE Ground Condition Adviser, do please get in

touch. I wish you every success with this process in the future, I am sure it will be a valuable asset to equestrian sport.' [J]

5. Sources to corroborate the impact (indicative maximum of 10 references)

A. Hobbs, S.J., Northrop, A., Mahaffey, C., Martin, J., Clayton, H.M., Murray, R., Roepstorff, L. and Peterson, M. (2014). Equine Surfaces White Paper. FEI Publications. http://www.fei.org/fei/about-fei/publications/fei-books.
B. Footing Project History. Discussion of definitions and terminology.
C. Results from Google internet search for Equine Surfaces White paper.
D. Examples of FEI Correspondence. 1) Meeting minutes FEI Footing Standards Meeting, 28-29th July 2015, 2) E-mail from Tim Hadaway, FEI with regarding Tokyo tender process, 24th Oct 2017, 3) Letter of support from Harald Muller, FEI, 1st Feb 2018, 4) E-mail from Somesh Dutt with video link to promote surface standards,16th Oct 2019
E. Glavan, A. (2017). Footing Concerns Addressed During Tryon International Equestrian Center CSI***. Chronofhorse.com magazine article
F. Improving Sports Horse Performance: Bridging the gap between science and practice (2015-18). 1) Evidence of workshop on Eventbrite, 2) Workshop attendee numbers, 3) FEI Campus website. Online resources (video/learning tools) for all four presentations from Improving Sports Horse Performance: Bridging the gap between science and practice, 4) FEI Campus – Enrolment March 2018. E-mail from Clio Tettoni (FEI).
G. Hobbs, S.J., St George, L. and Curtis, S. (2019). Evaluation of the impact and reach of Dr. Simon Curtis' research on the equine industry: A survey of practitioners. Updated with e-mails
H. HorseTalk. (2017). Challenges in dressage: Complexities of passage identified by researchers. www.horsetalk.co.nz magazine article.
I. E-mail and online evidence of use of scientific work within curriculum from colleges, institutions and members of Researchgate. (2020).
J. Selection of e-mails from British Eventing testing. (2019).