ROYAL ACADEMY OF ENGINEERING

Foreign & Commonwealth Office

BIS Department for Business Innovation & Skills

UK Science & Innovation Network

How can sport drive engineering innovation?

Tuesday 4 September 2012

CONFERENCE REPORT

EPSRC Engineering and Physical Sciences Research Council

Knowledge Transfer Network HealthTech and Medicines

UK TRADE & INVESTMENT

How can sport drive engineering innovation?

A conference held on 4 September 2012 at the Royal Academy of Engineering in London highlighting the links between sporting excellence and innovative engineering. It was organised by the Academy in conjunction with the FCO/BIS UK Science & Innovation Network, the Engineering and Physical Sciences Research Council, the HealthTech and Medicines Knowledge Transfer Network, and UK Trade & Investment.

Olympians and Paralympians in the UK's summer of sport have been breaking records and setting personal bests in event after event – and the focus in many cases has been on the engineering and science that has helped them to perform.

But does the technology used in sports engineering have wider application? Can it drive engineering innovation in areas such as public healthcare, for example? Or is it just there for the athletic elite?

Examples of broader benefits such as new measurement technologies, different construction techniques for stadia and improved prosthetics and wheelchairs were cited at the Royal Academy of Engineering's conference on sports engineering, held as part of a fortnight of Academy events that coincided with the Paralympic Games in London.

The benefits to engineering from sport are not just in terms of product innovations. Developments in sports equipment also encourage new processes and novel thinking, with sport often providing a fast route for all types of innovation due to the need for immediate success and the relative regulatory freedom that sport experiences compared to everyday living, such as in the healthcare sector.

Sport additionally generates huge public interest in science

Stuart Hughes, Senior World Affairs Producer, BBC, opens the conference with his personal perspective on rehabilitative technologies and his experiences of using his prosthetic leg, which he has had since stepping on a landmine while covering the Iraq War in 2003.

and engineering. The great feats of Britain's athletes, especially in the Paralympics, provide opportunities for engineers to tell positive stories of human interest about how their ideas have transformed lives and helped achievements.

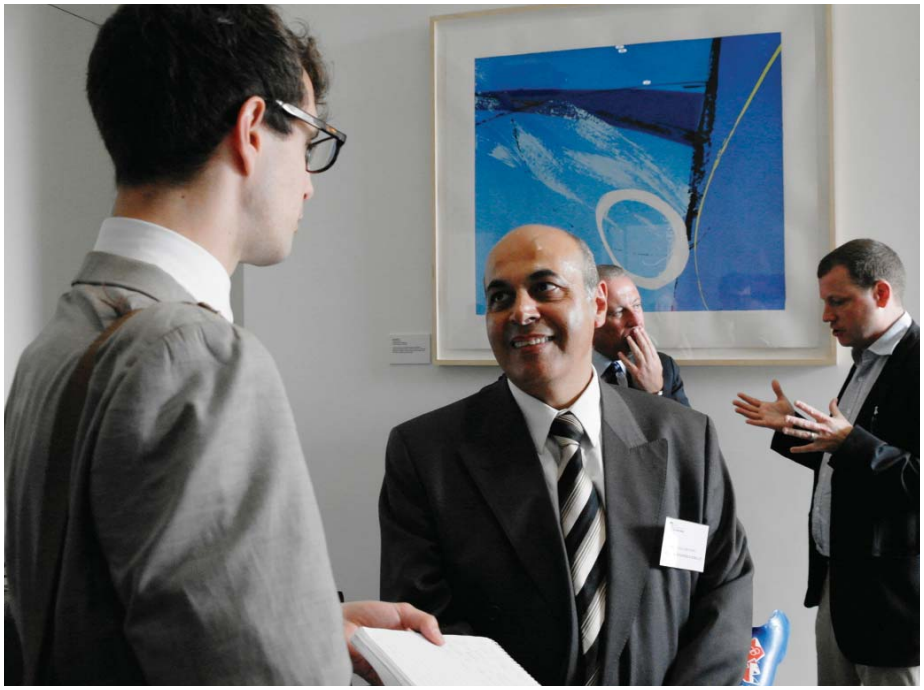
The conference attracted an international audience of sports engineers and scientists and related professionals, with innovators and practitioners represented among the speakers and the attendees. The conference divided its examination of innovation into three sessions: how sport helps the **Making** of equipment; how **Measuring** technology is enhanced through the needs of sport; and how the **Designing** of sports equipment leads to new thinking across engineering design as a whole.

Making

Prosthetic limbs of the kind used by the South African athlete Oscar Pistorius in both the Olympic and Paralympic Games are the clearest indicators from London 2012 of the engineering developments of recent years which were the main topic of discussion in the **Making** session of the conference.

Sport has provided the 'extreme' examples that have driven the investigation of innovative designs, structures and materials for replacement limbs. The key factors in prosthetics, said Professor Saeed Zahedi OBE FREng, Technical Director of the leading UK company in this business, Blatchford, are that amputees need the confidence that they can stand, walk and run – and athletes are the most demanding customers in terms of what they want their new limbs to do. So they encourage engineers to push the boundaries: to innovate.

Much of the work in this area, said Kevin Harney, President and CEO Asia Pacific of the prosthetics company Otto Bock, is about interfaces: between the body of the athlete and the device, and between the athlete and the external environment. The drive for performance from athletes has



Professor Saeed Zahedi OBE FREng of Blatchford, Chair of the 'Making' session, speaks to *The Engineer* publication during a networking session.

accelerated the testing of new materials and configurations to the benefit of non-athlete amputees.

A further trend identified by Dr Thorvaldur Ingvarsson, Executive Vice President for Research and Development at the Össur company, is towards personalisation and this, he said, had to be a benefit for wider healthcare, since every individual is different and their needs are different too. Work done to optimise devices for use in competitive sports may have particular relevance for the development of prosthetics for children, whose levels of activity are similar to those of athletes.

Extending the customisation of prosthetics is one of the challenges for the future which mirrors trends in other parts of engineering; but Kelvin Davies, who leads BAE Systems' technology partnership project with UK Sport, saw a lot of other crossover points between the engineering of sports devices and that of BAE's other businesses such as aerospace, defence and automotive. In particular, he noted that the optimisation of devices based on user experience questionnaires– now standard practice in the aeronautics industry– offered considerable scope for innovation in disability sports.

Measuring

Sport has been at the forefront of measurement technology for more than a century, and Dr Tom Shannon, Director of the motion capture company Vicon, showed the conference Eadweard Muybridge's pioneering freeze-frame camera work from the 1870s. Today's equivalent is the biomarker technology used to pinpoint athletes' techniques in detail as an aid to improving performance – and also used in films such as *Avatar* to generate computer images based on real movements.

A theme from the **Measuring** session was that sport has led many developments in measurement technology. Devices incorporating pressure sensors, accelerometers, gyroscopes and other equipment are now routinely used by athletes to record and analyse movements: these provide objectivity where previous methods tended to be based merely on observation, said Professor Kamiar Aminian from École Polytechnique Fédérale De Lausanne

Professor Mike Caine (far left) of Loughborough University, Chair of the 'Measuring' session, facilitates the Q&A session and is joined by the panel of speakers (L-R): Dr Tom Shannon of Vicon, Professor Kamiar Aminian of EPFL and Ludovic Giret of Phitech.

Rainer Küschall, a former Paralympian who designs bespoke wheelchairs, talks to Professor Wendy Tindale, Scientific Director at Sheffield Teaching Hospitals and Chair of the 'Designing' session.

(EPFL). However, there was still much work to be done to extend this kind of technology into sectors such as healthcare clinics, where the older methods were still the norm.

Professor Mike Caine from Loughborough University's Sports Technology Institute said that ideas such as these had radically increased the amount of data available, not just in sport, but more widely. Yet, he added, surveys of users of sports equipment and prosthetics indicated that 'qualitative' factors such as comfort and ease of use rated highly as concerns, and metrics for these were not always clear. There is a lot of data, but there needs to be more.

Designing

The contributors to the third session of the conference on Designing brought different viewpoints on the real driver for innovation: identifying what is really needed.

Professor Wendy Tindale, Scientific Director at Sheffield Teaching Hospitals, returned to the theme of personalisation and saw promise in technologies such as biomedical modelling, which spans both sport and healthcare. She noted, however, that engineering used to enhance sporting performance tended to be geared towards elite performers, where in healthcare a lack of suitable technology to meet individual needs can often frustrate those ground down by long-term conditions.

Two of the speakers presented a personal experience of needs from different ends of the span identified by Professor Tindale. Dr Amit Goffer of Argo Medical Technologies spoke of how identifying the needs of people with lower limb disabilities had led him to develop Re-Walk, an exoskeleton device that enables them to stand, walk and even climb stairs. Rainer Küschall, a former athlete who has won 21 Paralympic medals, has developed 'sports' wheelchairs and other specialised devices – not least because he himself wants to pursue an active sporting career at high level despite being in a wheelchair for almost 50 years.

The challenge identified by Professor Tindale to bring technologies used in sports into mainstream biomedical use in healthcare may be addressed,

at least in part, by Dr Jon Wheat's work at Sheffield Hallam University, on adapting the Kinect motion capture technology used in games simulators for clinical functions. But Dr Wheat had a wider engineering design point to make as well. Part of his work on motion capture has led him to challenge the assumption that there is a 'right' way to achieve top sports performance: common optimal movement patterns. Individual performance is more to do with the constraints of the task, the environment and the person doing it, he believes. Hence, if that applies in sport, then it can be used elsewhere too which could have implications across the whole of engineering design.

Discussion

In the concluding discussion to the conference, Dr David James of Sheffield Hallam University said that a fundamental question was whether sports generated innovations or merely borrowed from other areas.

Ben Vickery, Senior Principal of the sports facility design group Populous, said there was little doubt that sports arenas had had a big effect on the engineering of new buildings, whether it was the modification of existing structures such as the new roof that has been put into the centre court at Wimbledon or the design of temporary structures for the London Olympics. The driver for innovation, however, was often television coverage rather than the sports themselves.

Dr Kim Blair, Vice President of Cooper Perkins Inc. and President of the International Sports Engineering Association, said in the past a lot of technology had been proved through applications in defence and aerospace, and that sport now potentially offers a testing environment for new materials and designs.

Formula One motorsport, added Dr Scott Drawer, Head of Research and Innovation at UK Sport, had provided examples of many innovations that had gone on into the automotive mainstream. But he also cited 'non-sporting' developments such as wound dressings and even clothing fabrics where the needs of sport had provided the impetus for innovation that had been applied elsewhere.

Dr David James (far left) of Sheffield Hallam University chairs the concluding discussion session with an expert panel (L-R): Professor Veit Senner of the Technical University of Munich, Dr Scott Drawer of UK Sport, Ben Vickery of Populous and Dr Kim Blair of Cooper Perkins Inc.

Professor Veit Senner from the Technical University of Munich saw an overlap between sport and fashion, and also pointed to innovative sports that had become mainstream and were themselves generators of business opportunity and technology innovation, such as skateboarding. And the role of sport in pushing individuals towards higher performance applied to equipment as well, he said: sports engineering was instrumental in raising standards that contributed not just to better performance but to safety as well.

Conclusions

Several themes emerged consistently throughout the conference and in the discussions that it engendered. The sports engineering experts agreed that the pursuit of sporting excellence was often also a spur to excellence in innovation, often providing a rigorous testbed for products, systems and materials that could then be applied in other sectors.

Sport is itself the beneficiary of engineering innovation. The rules and regulations of many sports depend on engineering technologies in areas such as measurement, and individual athletes use innovative systems to monitor and benchmark their own performances. Sports and sportspeople are demanding customers: their requirements stimulate innovation and accelerate the deployment of new products and systems.

With much of sporting endeavour being about individual performance, many areas of sports engineering are geared to the needs of the individual. This can create challenges in terms of extrapolating from equipment or devices designed for elite sportspeople into techniques or products for wider use by the general public. However, in specialities such as prosthetics, the attention given to meeting individual needs has led to an emphasis on the customisation and personalisation of devices that has resulted in remarkable advances in replacement limbs for many people.

Sports are often high profile and can attract funding and attention for technical developments where other applications sometimes struggle. There is also huge potential for sport to make engineering and science accessible to the public at large and to attract young people towards courses and careers in engineering and other technical subjects.

Organisers

ROYAL ACADEMY OF ENGINEERING

As the UK's national academy for engineering, we bring together the most successful and talented engineers from across the engineering sectors for a shared purpose: to advance and promote excellence in engineering.

We provide analysis and policy support to promote the UK's role as a great place from which to do business. We take a lead on engineering education and we invest in the UK's world class research base to underpin innovation. We work to improve public awareness and understanding of engineering.

We are a national academy with a global outlook and use our international partnerships to ensure that the UK benefits from international networks, expertise and investment.

The Academy's work programmes are driven by four strategic challenges, each of which provides a key contribution to a strong and vibrant engineering sector and to the health and wealth of society:

- Drive faster and more balanced economic growth
- Foster better education and skills
- Lead the profession
- Promote engineering at the heart of society

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UK Science & Innovation Network

The UK Government's Science & Innovation Network (SIN) is a key delivery mechanism for strengthening the UK's science and innovation capacity through international collaboration in science and innovation. Based in Embassies, High Commissions and Consulates around the world, our Science Advisers understand both the UK and the local science and innovation landscapes.

Our main objectives are:

- Increase scientific collaboration of best with best
- Strengthen the UK's innovation capacity - R&D partnerships and technology transfer.
- Organise exchanges on science-related policy and best practice.
- Use science and innovation to influence international approaches to key global policy challenges such as climate change or stem cells.

We organise workshops and targeted missions offering experts the opportunity for discussions and visits on priority research challenges and solutions, aimed at facilitating new contacts and prompting new collaborative opportunities.

Organisers

EPSRC
Engineering and Physical Sciences Research Council

The Engineering and Physical Sciences Research Council (EPSRC) is the UK's main agency for funding research in engineering and physical sciences. EPSRC invests around £800m a year in research and postgraduate training, to help the nation handle the next generation of technological change.

The areas covered range from information technology to structural engineering, and mathematics to materials science. This research forms the basis for future economic development in the UK and improvements for everyone's health, lifestyle and culture. EPSRC works alongside other Research Councils with responsibility for other areas of research. The Research Councils work collectively on issues of common concern via research Councils UK.

Knowledge Transfer Network
HealthTech and Medicines

The HealthTech and Medicines KTN supports business innovation through partnerships, funding and knowledge transfer:

- Connecting partners: Bringing together and facilitating collaborations with a common goal
- Access to funding: Identify and influence new and existing sources of funding
- Knowledge transfer: Opening doors to wider networks of people, organisations

The HealthTech and Medicines KTN also help members to access funding from the Technology Strategy Board for prototype development and proof of concept work. Membership of the KTN provides access to a dynamic, UK wide knowledge transfer network covering all aspects of medical devices, diagnostics, and medicines. In addition, the KTN works with these communities, actively promoting sharing of knowledge, building value chains and suggesting possible collaborations and partnerships. It is also involved in developing international networks, supporting business engagement in the US, China, Japan, and Europe.

UK TRADE & INVESTMENT

UK Trade & Investment is the Government Department that helps UK-based companies succeed in the global economy. We also help overseas companies bring their high-quality investment to the UK's dynamic economy acknowledged as Europe's best place to succeed in global business.

UK Trade & Investment offers expertise and contacts through its extensive network of specialists in the UK, and in British embassies and other diplomatic offices around the world. We provide companies with the tools they require to be competitive on the world stage.