A sporting chance

The London Olympic and Paralympic Games are just around the corner and Team GB is calling on the expertise of UK industry to help its athletes achieve record levels of speed, strength and endurance.

With the difference between first and second place often measured in fractions of a second, a hi-tech arsenal spanning mathematical modeling software, nanotechnology and materials science could play as important a role as fitness and conditioning.

It is with this in mind that government body UK Sport has been overseeing a research and innovation project since 2008 with the country's leading engineering firms and universities.

One of the partners involved in the initiative is BAE Systems, which is providing £1.5 million of its engineering time and access to more than 18,000 of its UK-based engineers.

BAE's Technology Partnership project manager, Kelvin Davies, explains: "In their normal day jobs, our engineers would spend their time developing submarines, aircraft carriers or jet fighters. Under this partnership, they can turn their hands to leveraging technology and expertise from the defence sector and transfering it to the sports industry. The goal is to create performance enhancing equipment which will make people go faster and win medals."

One such device is a performance monitoring system installed by BAE at the Manchester Velodrome to give the likes of Sir Chris Hoy an edge in training. The laser timing technology, derived from a battle space identification system, brings a new approach to monitoring cyclists.

According to Davies, it improves on traditional photoelectric break beam systems, which are unable to differentiate between individual athletes. Now, up to 30 cyclists can train simultaneously as the laser can read a personalised code from a retro-reflective tag attached to each bike. Installed at multiple points around the track, the system gives individual recordings for each cyclist with 'millisecond accuracy'.

"We've also been working with McLaren on a data logging system which is helping the cyclists establish not only how fast they're going, but how much power they're using," says Dr Scott Drawer, head of research and innovation at UK Sport."The data logger sits underneath the seat and allows information to be collected from the cranks. By the time an athlete gets off the bike they have all the information they need about their workout."

As with much of the research UK Sport is involved with, the technology is centred around fuel-based diagnostics – not just evaluating how fast an athlete can go, but understanding the underlining physiology behind training.

"The big push is in creating much more meaningful knowledge to accelerate the development of the athlete," notes Dr Drawer. "To do this we rely on things like advanced software, telemetry and miniature sensing technologies."

One such sensor, developed at Imperial College London, is inspired by the semicircular canals of the inner ear responsible for controlling motion and balance.

Resembling a hearing aid, the device fits behind the ear and gathers large amounts of data about posture, step frequency, acceleration and response to shock waves travelling through the body as an athlete's feet hit the ground.

A miniature processor inside the earpiece collects data and transmits it wirelessly to a laptop so that the athlete's performance can be monitored at the trackside in real time. This process allows a coach to detect problems such as incorrect posture at the start of a run, and rectify them.

Skeleton crew

One of UK Sport's most successful cases has been the creation of 'Arthur', the skeleton bopsled that propelled Amy Williams to Britain's first individual gold medal win at a winter Olympics in three decades.

Working in collaboration with Sheffield Hallam and Southampton Universities, BAE recruited PhD students Rachel Blackburn and James Roche to crack the problem of customising each sled.

Previously, sleds used by the British team were shared between men and women of varying heights and sizes. "The balance would be all wrong, it wouldn't suit an individual athlete's sliding style. As a result, everybody suffered," says Davies. "What we had to do was make each sled configurable to each athlete."

As well as using advanced materials such as carbon fibre to build

Laura Hopperton reports on how technology is transferring between sport and industry ahead of this summer's Olympic Games.

Left: BAE Systems' data logging system
Below: Amy Williams with 'Arthur', her skeleton bobsled

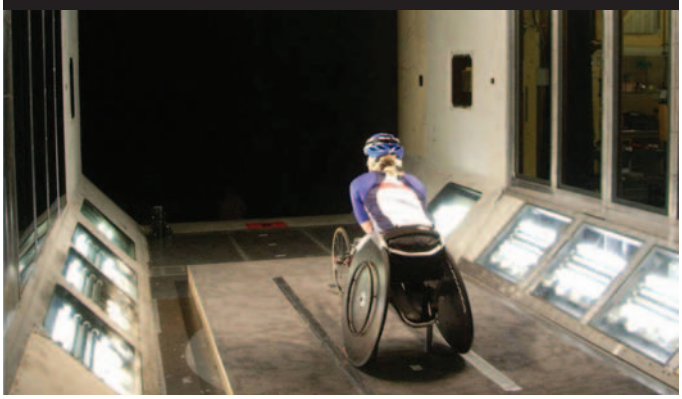
lighter and stronger sleds, the engineers used finite element analysis to redesign the vehicles' internal structure. This meant that the energy of an athlete's unique movements and technique could be transferred efficiently into the way the sled was propelled.

Davies explains: "The sled that Amy had suited her riding style so perfectly that, instead of battling the sled all the way down the slope, it felt part of her and it felt more responsive to her movements. Understanding the individual athlete's requirements is a critical part of the design process, something that can take days to talk through and months to get right."

Drawer also notes the importance of optimisation and points to an innovative new rapid manufacturing process being used to create bespoke high performance sports footwear.

The technology, developed at Loughborough University, works by first quantifying the effects of the sports shoe on the foot's movement by analysing 3D motion data and force data. This information is gathered from a series of sprint-related tasks performed by the athlete

Computational fluid dynamics data from BAE's wind tunnel facility has helped wheelchair athletes improve their aerodynamic efficiency



wearing sprint shoes of differing stiffness and a barefoot equivalent control shoe.

Selective laser sintering is then applied to sinter small particles of plastic to create precise, complex 3D components, removing the need for expensive moulds and tooling. The researchers are then able to easily change the properties of the footwear to match the needs of the individual athlete.

The Loughborough team recently applied the technology to help Paralympic sprinter Ben Rushgrove control his running style and help prevent injury. The researchers conducted in-depth analyses of his gait and the impact made with the ground whilst he was sprinting using high-speed video footage. It was identified that Rushgrove's disability caused a lack of muscular control on the medial side of his foot, resulting in severe foot injures.

"In the case of Rushgrove, the team was able to explore how to use personalised running shoes to support his feet more effectively when subjected to the impact forces of sprinting," said Professor Mike Caine, director of Loughborough's Sports Technology Institute. "What we learnt from working with him has enabled us to better understand the potential benefits of this emerging technology."

Drawer says: "Because every athlete is so different, being able to use rapid manufacturing processes to make sure equipment is optimised to their specific needs can help them gain a real advantage. We also use the technology a lot when working with Paralympic athletes to help them better manage their health and welfare."

Designing differently

In 2010, Drawer led a project between UK Sport and BAE to help wheelchair athletes reduce their drag resistance and therefore increase speed. Shelly Woods, a Paralympic silver and bronze medallist in Beijing, and David Weir, a Paralympic Games multimedallist, spent time in BAE's wind tunnel facility in Wharton as part of the initiative.

Computational fluid dynamics data gathered from the wind tunnel sessions were used by UK Sport to review the aerodynamic efficiency of the athletes' seating position in the chair to highlight the optimal racing position for different situations on the track.

"The whole premise of getting athletes behind the wind tunnel is to try and reduce drag and is a major application in all sports where people are travelling very fast," says Davies.

"An athlete and a wheelchair has an effect on the aerodynamics, so we needed to make them as streamlined as possible. We were looking at the equipment they were using – at the chair itself – but most importantly, the athlete's positioning and movement. So we could quickly and easily do a large number of experiments and provide a very accurate model of the most streamline and efficient position to be in."

Sensors recorded force measurements and from those readings, the most efficient position could be established. "In wind tunnels, data can be collected in real time so we can collate information quickly and do a large number of experiments," Davies notes. "Normally, we would have a section of wing, a nose cone or a tail and we'd conduct exactly the same kind of experiments to get the most aerodynamically streamline profile of the equipment. The big challenge for us was adapting the wind tunnel speed."

The tests were the first phase of a project to help wheelchair athletes improve their performance with the support of technology. Another aspect of the initiative was to examine the overall design of the chair to see where improvements could be made. The assessment encompassed factors affecting performance, from the material the chair is made from, right down to the ease with which it can be stored, set up and maintained.

Both BAE and UK Sport are now looking ahead to the 2014 Winter Olympics and the Rio 2016 Olympic Games. Drawer believes a lot of the technologies will eventually have applications in the medical sector. "We're also looking at remote healthcare," he says. "Olympic level sports provide a great model to test and develop technologies which can move into and benefit society at large."

Davies concludes: "We've been overwhelmed by the huge applications for what we do in sport. When we first began talks with the British cycling team, for example, we weren't sure what we could offer. It was quite exciting. The partnership has not only been a great platform for us to demonstrate some of our most innovative technologies, but a means to inspire the next generation."

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