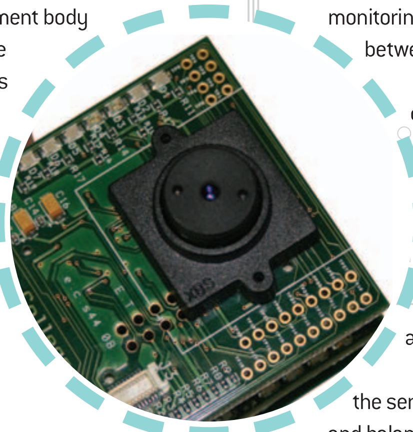
London calling

With the London Olympic and Paralympic Games fast approaching, UK industry and academia are working together to ensure British athletes reach the highest levels of excellence. By **Chris Shaw**.

As London prepares itself for the 2012 Games, a number of programmes have been set up to provide UK athletes with access to the latest in training technology. UK Sport, a Government body which invests around £100million a year in the World Class Performance Programme, supports 1400 athletes across 24 Olympic and 20 Paralympic sports.



Then there is the Elite Sport Performance Research in Training with Pervasive Sensing (ESPRIT) project, led by Imperial College London in partnership with UK Sport and supported by Queen Mary University of London and Loughborough University. Researchers from the three universities are working alongside British sports via UK Sport's Research and Innovation programme.

Not surprisingly, much of the research is clouded in secrecy, partly to give British athletes a competitive advantage, but also because the technology often draws from classified defence applications.

Dr Scott Drawer, UK Sport's head of research and innovation and co-chair of ESPRIT. explained: "We cover a wide range of development programmes, from equipment related solutions – bike design for example – through to measurement and sensor technologies. Many of the solutions are coaching tools, providing real time diagnostics."

UK Sport has a number of partners, including BAE Systems, which is providing £1.5million of its engineering time and access to more than 18,000 UK based engineers and scientists. UK Sport Technology Partnership project manager at BAE Systems, Owen Evans, explained: "In their normal day jobs, the designers 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 transfer 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 British cyclists an edge in training. The laser timing technology, derived from a battle space identification system, provides a new approach to monitoring cyclists. According to Evans, 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 what Evans describes as 'millisecond accuracy'.

Meanwhile, ESPRIT researchers have designed a range of miniaturised wearable and track side sensors, computer modelling tools and smart training devices to help improve British athletes' performance. The miniature wearable sensors monitor different aspects of athletes' physiological performance, in order to monitor and optimise training for competitive performance. The sensors include wireless wearable nodes to measure biochemical information, heart rate, EEG, ECG, muscle activity, joint speed and contact forces. Athletes can then use this information to understand how they are progressing with their training.

The team is also developing small track side sensors, for detailed monitoring of an athlete's body movements and location, and interactions between a team during training.

Dr Drawer observed: "Much of the research is really about fuel based diagnostics – not just evaluating how fast an athlete can go, but understanding the underlining physiology behind training. For example, non invasive sensors can track what's taking place in the blood, without the need to take blood. So many of the technologies can equally be transferred to the medical sector – and we're also looking at remote healthcare. Olympic level sports provide a good model to test and develop technologies which can move into society at a later stage."

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 sensor 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 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.

The constant stream of real time information flowing from these sensors means medical staff could use the technology to monitor the elderly and people living with chronic diseases – like degenerative arthritis or Parkinson's disease –without the patient needing to visit their doctor.

Many commercially available technologies to monitor athletes' performance are often large, unsuitable for use in the field or able to measure only one aspect of an athlete's or team's performance. Consequently, the data collected is not realistic enough for sports scientists and coaches to understand how athletes are performing in a training or competition environment.

To address this, the ESPRIT team is developing wireless 'pervasive' sensing technologies that extract continuous information under normal training and competition environments. This provides coaches with more accurate and regular feedback about their athlete's performance than is currently possible.

The researchers have also created prototype networks of miniature video camera sensors, called Vision Sensor Networks, which coaches can use to monitor an athlete's movements and assess their strategies while training.

"Inertial sensors can also be used on boats alongside gps sensors to record how fast an athlete is moving and what's happening with the joints," Drawer added. "The systems can also be used in canoeing, rowing, sailing and

Left: Owen Evans, BAE Systems

Above: Many of the sensor technologies have the potential to transfer to the medical sector

Left and below: British Paralympian, Shelley Woods, using Airbus' wind tunnel to establish the best aerodynamic efficiency

cycling. Another key training tool is a wind tunnel."

Wind tunnels have proved to be particularly successful for wheelchair athletes and BAE Systems has run a series of tests at Airbus' dedicated facility in Filton.

Shelly Woods, pictured, a Paralympic silver and bronze medallist in Beijing, and David Weir, a Paralympic Games multimedallist, recently spent a full day testing in the Airbus wind tunnel.

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 tests were the first phase of a project to help wheelchair athletes improve their performance with the support of technology. Another aspect of the project, which is set to run until 2011, will be to examine the overall design of the chair to see where improvements could be made. The assessment will encompass 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.

"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," explained Evans. "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."

The technology originates from BAE's Military Air Solutions (MAS) business unit at Woolton where all the UK's jet fighters are built. "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."

According to Dr Drawer, development programmes for Paralympic athletes are plagued by restrictions, rules and regulations that have to be adhered to. "Many of the restrictions are based around ergonomics because disabilities vary tremendously," he said. "The key question is 'how do we make that wheelchair better for that particular athlete?'. The platforms we have developed are equally valid for other extreme environments, especially the sensors which have proved to be robust and reliable, so the technology is transferable."

Systems and engineering technology provider Frazer-Nash is also working with UK Sport to help wheelchair athletes improve their performance. Working alongside former Paralympian Dr Ian Thompson and Angle Consulting, the team has developed an instrumented wheel for measuring the power exerted when pushing a racing wheelchair.

The 'Powerwheel' measures the driving force put into the push rim by the athlete, then measures data using a load sensing element and transmits it wirelessly to a mini-computer. The data is interpreted, displayed and stored on the computer, enabling the athlete and coaches to analyse the information and build a profile of the push, showing how power and speed is developed.

For the project, strain gauge technology was attached to lightweight interface elements between the push rim and the wheel. The gauges were connected into a wireless transmission system and multiple locations were selected to derive the desirable athlete performance characteristics through the wheel push rim.

To minimise technical risk and reduce development time cycles, Frazer-Nash used off the shelf electronic processing systems and the information could be live streamed and data logged, depending on the specific need of an athlete. The data could then be streamed to a wheelchair mounted minicomputer or directly to a pc or laptop.

Frazer-Nash also developed bespoke software packages to allow simple configuration, display and detailed analysis of the data.

And beyond London 2012? Dr Drawer concluded: "Ultimately, we're driven by performance and giving athletes the best opportunity to be a success. Beyond that, these technologies will benefit society.

"High performance sport can play a massive role in developing a fundamental model for science, medicine and engineering. Athletes push themselves to the extreme, so it's an interesting model to base our development platform against."