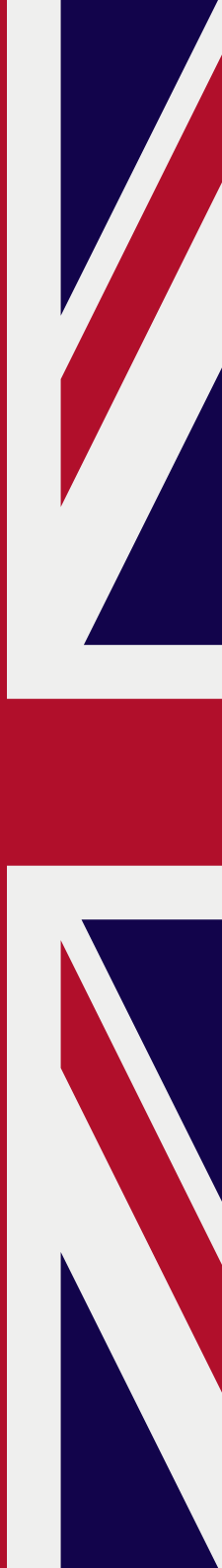
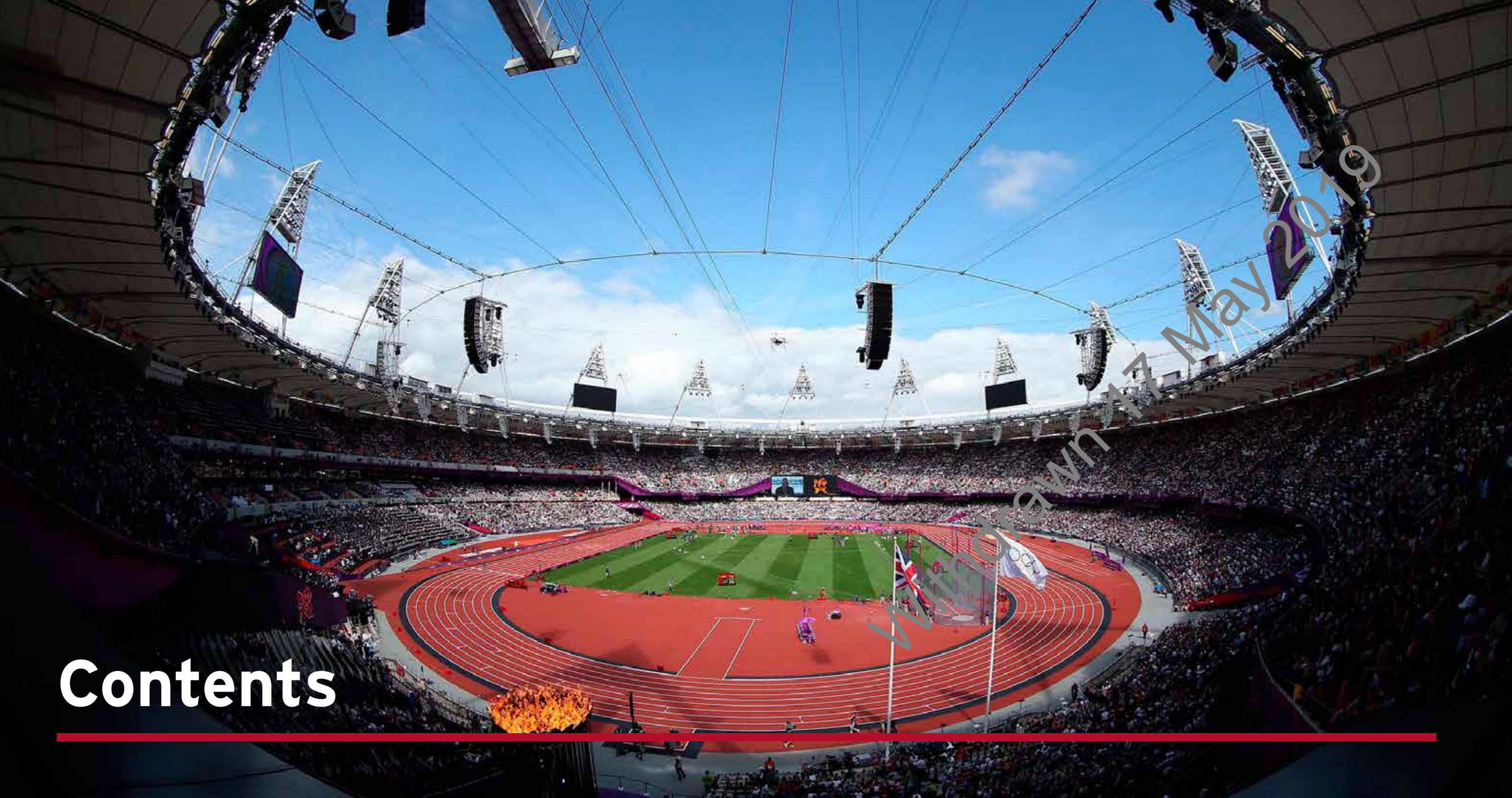


# Enabling London 2012 and Beyond: UK Advanced Engineering

Withdrawn 17 May 2019

**INNOVATION  
IS  
GREAT**  
BRITAIN





# Contents

<b>Sporting Technology</b>	<b>6</b>	<b>Infrastructure</b>	<b>30</b>
<i>McLaren Applied Technologies Limited</i>	8	<i>Warmafloor</i>	32
<i>Renishaw plc</i>	9	<i>Chapman BDSP</i>	33
<i>Delcam</i>	10	<i>ArcelorMittal</i>	34
<i>BAE Systems</i>	11	<i>Linemark UK</i>	36
<i>Sports Technology Institute</i>		<i>Heskins Limited</i>	37
<i>Loughborough University</i>	17	<i>Greyhound Chromatography</i>	
<i>Sportfit Limited</i>	19	<i>and Allied Chemicals</i>	38
<i>STRUCTeam Limited</i>	20	<i>BSP International Foundations Limited</i>	39
<i>MotivePro</i>	21	<i>Atkins</i>	40
<i>TECOSIM</i>	22	<i>Arup</i>	46
<i>The Premiere Group</i>	23	<i>Buro Happold</i>	47
<i>Environmental Ergonomics Research Centre</i>		<i>Leon Paul</i>	51
<i>at Loughborough University</i>	24	<i>Polypipe</i>	52
<i>P2i Limited</i>	26	<i>Scandpower, part of Lloyd's Register Group</i>	54
<i>Cytec</i>	28	<i>Arena Group</i>	56
		<i>Group Rhodes</i>	57

# Introduction



## The UK's advanced engineering Olympic Legacy

*The United Kingdom is one of the world's most vibrant and forward-looking economies, as the ongoing story of London 2012 demonstrates. The advanced engineering capabilities of UK companies played a vital role in the production and delivery of what has been recognised as "the greatest show on earth".*

UK firms have long played a role in the delivery of high-profile global projects, providing the inspiration, innovation, knowledge and skills needed to deliver effectively. In 2012, the UK delivered the greatest Olympic and Paralympic Games ever. This brochure demonstrates the huge range of advanced engineering capabilities and expertise involved in the development and manufacture of sporting technology and the construction of sporting venues and infrastructure linked to London 2012, the 2010 Winter Olympic Games, and to other major sporting events.

The case studies presented showcase just a few of the innovative contributions that UK companies have made to the global sporting world. There are two main sections, reflecting the breadth of the UK's advanced engineering industry offer:

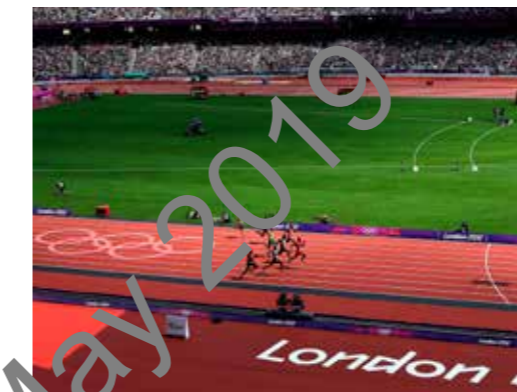
- The case studies presented in **Sporting Technology** look at how scientific and engineering expertise has been combined to maximise the performance of Olympic athletes.
- The **Venues and Infrastructure** case studies introduce the engineering capabilities that enabled the games to take place so successfully.

With world-leading capabilities across the full range of engineering disciplines - from advanced materials to manufacturing technologies - the UK has the skills and resources needed to compete and thrive in today's global economy.





# Sporting Technology



## The technology and science behind sporting success

*Behind the sporting technology innovations that led to London 2012 sporting successes are the advanced design capabilities, technologies, materials and instrumentation delivered by UK-based firms.*

The Olympic and Paralympic Games are a showcase of the world's elite athletes. Underpinning many of London 2012's and the 2010 Winter Olympic Games' sporting successes are the advanced science and technology capabilities that deliver a competitive edge. When competing at this level, sporting victory and an Olympic medal can be achieved by the tiniest of margins. Precision is essential and every detail, from reducing drag to enhancing muscle performance, makes a difference.

The UK firms showcased here display a range of technologies and capabilities as high performing as the athletes they support. The UK's leading aerospace and automotive businesses have applied advanced engineering best practice in their fields to the development of sporting technologies. Precision engineers and instrumentation specialists have applied their expertise to delivering solutions for sports. The use of advanced materials within innovative applications has provided performance enhancements and improved designs.

The sporting technologies delivered by UK companies to support London 2012 were game changing and can be applied to the global sporting events of the future.

# State-of-the-art technology



McLaren Applied Technologies contributed its world-class know-how to cycling

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## World-class expertise, know-how and experience help win Olympic Gold

*High-performance equipment, data collection and analysis delivered by McLaren Applied Technologies (MAT) provides athletes and teams with competitive advantage, leading to a Gold medal win.*

Professional teams and athletes from across the world are benefiting from McLaren Applied technologies' breakthroughs in product and performance. As part of a three-year agreement with UK Sport, signed in April 2009, MAT contributed its world-class know-how and experience to a number of sports at the 2010 Winter Olympic Games and London 2012 Olympic and Paralympic Games. MAT supported Britain's athletes in cycling, canoeing, rowing, skeleton, bobsleigh and sailing.

MAT provided the high-performance equipment, smart technology and data collection and analysis expertise that enabled Team GB athletes to gain a competitive advantage. Successes include the company's involvement with the team of British Olympic skeleton champion, Amy Williams, a 2010 Winter Olympic Gold medallist.

## The Games in numbers



Helped win 9 medals



Chris Hoy accelerated from zero to 44 mph in less than 10 seconds



The fastest sailing boats can reach speeds of 30 knots



British competitors in the sprint have completed 180 strokes per minute



Wheelchair rugby players covered up to 6km each game

# Innovative measurement technologies

Performance enhancing bobsleigh blade design



## Measurement technologies support championship bobsleigh blades development

*Measuring success: World-leading metrology company Renishaw helped develop bobsleigh blades that enabled a World Champion to stay a step ahead of the competition.*

When new regulations were announced limiting all bobsleigh team competitors to a single specification of steel, with creativity only allowed in blade form, women two-person bobsleigh champion Sandra Kiriasis turned to metrology company Renishaw for a solution. This led to Renishaw playing a key role in developing blades that would help bobsleigh teams meet new regulations.

Working with manufacturing specialists Siemens, Sescoi and Iscar, Renishaw used its innovative measurement technologies, including the REVO five-axis measuring head for co-ordinating measuring machines, to scan the existing blades. This quickly captured many thousands of data points to enable the blades' form to be defined in great detail. Following machining, the finished blades were checked using the Renishaw OMP400 touch probe, a strain gauge-based product which allows highly accurate on-machine measurement to be performed.

Kiriasis went on to win the subsequent bobsleigh World Cup and World Championships in emphatic style, citing the blades as being the secret of her success. This led to a formal partnership agreement between her team and Renishaw, which also lends its expertise to international motorsport.

Advanced instrumentation



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# Complete footwear solution

## Boosting athletes' performance with custom-made footwear designed using computers

*Computer-designed sports shoes: Delcam provides manufacturers with CAD/CAM software, enabling them to provide bespoke footwear for athletes.*

A sports shoe tailored exactly to an individual athlete's requirements can boost sporting performance, having a real impact on their success. Using CRISPIN, specialist CAD/CAM software developed by Delcam, sports shoe manufacturers can scan a sportsperson's feet and engineer custom-fitting shoes in less time and to greater accuracy than traditional methods. The software is a complete footwear solution designed to help sports shoe companies speed up their design and manufacturing processes and reduce their product time to market.

It includes a wide range of features that can be used in different ways. These include scanning 'lasts', the plastic or wooden mould used to form the shoe, or feet, to produce custom-fitting shoe designs, and for last engineering and grading. CRISPIN enables manufacturers to develop concept footwear designs by modelling on the computer. The powerful software can also provide sole unit engineering, grading and pattern development and machining. Pattern grading and assessment, and pattern engineering and layouts for auto-stitching machines can be completed using build-in modules.

Athletes benefit from the high quality technical manufacturing data output by Delcam's software. Manufacturers can use the software for nesting and cutting pattern parts from leather or other materials, and for footwear costing. Delcam also supplies systems for podiatrists and orthotics specialists, who use the software to manufacture orthotic insoles for athletes and professional sportspeople as well as for people needing orthotics for medical reasons.



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# Aerodynamics expertise

## Applying aerodynamics to help Britain's Paralympic wheelchair athletes 'fly' down the track

*Reducing drag: BAE Systems' scientists' and engineers' modelling and materials expertise improves racing wheelchair performance.*

Perfecting wheelchair design to meet the needs of individual users and their sport provides British athletes with a competitive edge.

Through the technology partnership with UK Sport, BAE Systems' engineers and scientists are working with UK Athletics and wheelchair manufacturer DRAFT to investigate and improve the designs of racing wheelchairs. The project's objective is to help athletes improve their performance by assessing existing designs to see where the chair or use of the chair can be advanced based on each athlete's specific circumstances.

Applying its considerable experience in design engineering, BAE Systems is assisting the investigation by using some of the world's leading software for computational fluid dynamics modelling and finite element analysis. Its engineers use lightweight composite materials for improved structural rigidity and agility, and aerodynamics is a vital element of BAE Systems' vehicle design, from aircraft to submarines.



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# World-first design features



© Phil Searle, British Skeleton



Amy Williams wins Gold

Withdrawn 17 May 2019

## Advanced design, modelling and materials help win Winter Olympic Gold

*Speeding to Gold: BAE Systems' expertise enhanced the training and equipment for athletes and coaches, leading to a Gold medal win.*

Aiming to take on and beat the world's best winter sports competitors, sporting association British Skeleton considered all options in its approach to training, preparation, clothing and equipment for the 2010 Winter Olympic Games. A key element was perfecting a new sled design, codenamed 'Blackroc' by its University of Southampton student designers, who were partnered with UK Sport Podium Innovation Partner, BAE Systems.

The Blackroc system, which underwent comprehensive aerodynamic assessment, enables athletes to make precise and repeatable setup of the runners, allowing for changing ice conditions. This helped ensure that athlete Amy Williams' body position, kit and equipment were primed to cut through the winter air in Whistler at optimum speed - which in Amy's case meant reaching over 143 km/h to win Gold for Great Britain.

The unique design features on the Blackroc sled include adjustable components as well as interchangeable structural parts, allowing bespoke design to the individual athlete's size and sliding style. This makes the sled more responsive to the athlete and gives them greater steering control. Prototype parts were manufactured by engineers who usually worked on defence and aerospace equipment at BAE Systems' Advanced Technology Centres in Great Baddow and Bristol.

### Blackroc at a glance

 Reached over 143 km/h

 Gold medal won

 Components manufactured by BAE Systems

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# Millisecond accuracy



## Innovative performance monitoring technology helps Britain's cyclists win Olympic Gold

*Turning battlefield tech into Olympic Gold: BAE Systems applies battle space laser-timing technology to training and equipping medal-winning British athletes and coaches.*

To give British cyclists a further edge in training in the run up to London 2012, BAE Systems installed a sophisticated performance-monitoring system at the Manchester Velodrome.

The advanced timing technology allows up to 30 cyclists to train simultaneously, a great improvement on more traditional 'break-beam' systems, which are unable to differentiate between individual athletes.

BAE Systems' engineers repurposed a battle space identification system using laser-timing technology, representing an entirely new approach to monitoring performance in cycling. The timing system, which uses a laser able to read a personalised code from a retro-reflective tag attached to each bike, is installed at multiple points around the track and with millisecond accuracy gives individual recordings for each cyclist.



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# Sophisticated measuring equipment



## Skate performance monitoring technologies take Britain's speed skaters to Olympic finals

*Taking the strain: BAE Systems uses sophisticated measuring technologies to design advanced stability aids used by Britain's skaters in the 2010 Winter Olympic Games finals.*

Previously there was no knowledge of how ice skates performed during races, so BAE Systems' engineers conducted a research and development project to discover ways to improve the performance of British speed skaters. The unique project assessed skate performance to find areas for improvement, helping the athletes to travel faster with greater stability.

Several athletes and their skates were equipped with sophisticated strain gauges and data-logging equipment during a day's training. Measurements were then taken as the athletes recorded sprint starts, cornering, top-speed sprinting and braking.

A new prototype part was designed using innovative aerospace materials. It provides fantastic stability and, with calibration equipment, allows for much more accurate blade set-up.

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# Boosting athletic performance

## Athletes' performance enhanced with an innovative breathing-muscle trainer

*Athletes can improve breathing and enhance their performance with RespiBelt from OPRO and Progressive Sports Technologies. Worn around the ribcage, this cutting-edge garment trains the muscles of respiration giving a specificity not usually achieved during training.*

Research, including trials by British Triathlon and the English Institute of Sport, has shown that RespiBelt can have a significant impact on athletic performance. The product is an innovative breathing-muscle trainer that is worn rather than placed in the mouth, as is the case with other products on the market.

RespiBelt loads the breathing muscles around the ribcage through a compressive garment, which has a series of specially developed elastic resistance elements. These can be adjusted to change the training load on the breathing muscles.

Athletes can integrate breathing-muscle training with all their other training without interruption, unlike mouth-based devices. And due to the close fit of the RespiBelt garment, it also provides a great platform for mounting global positioning system (GPS) and heart-rate monitor hardware on to it.

RespiBelt was utilised by world-leading coach Alberto Salazar and the Nike Oregon Project Team, which includes double Olympic Champion Mo Farah and 10,000 metres silver medallist Galen Rupp, as part of the athletes' training preparations in the build-up to the London 2012 Games.

Based in Loughborough's world-leading Sports Technology Institute, Progressive Sports Technologies provides a comprehensive range of research-led product development services to major global sports brands. World leader in the design and manufacture of custom-fit and self-fit mouth guards, OPRO International Ltd was in 2007 awarded the Queen's Award for Innovation in recognition of its groundbreaking work in the field of oral protection.



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# Support frame delivers Paralympic medal success



## Technology brings success for Paralympic archer

*An ergonomic shooting stool specifically designed and created for Paralympic archer Danielle Brown continues to deliver medal success at major Games.*

Paralympics GB athlete Danielle Brown successfully defended her Paralympic women's compound archery title at the London 2012 Games. Danielle who suffers from reflex sympathetic dystrophy in her lower legs has been supported by the University's Sports Technology Institute, after an approach for assistance from UK Sport in the design and production of a specialist frame which would enhance her performance.

The Institute's team of engineers were able to create an ergonomic shooting stool that was finely tuned to Danielle's requirements, with custom features to assist the initial set up and a change of concept to ensure positional consistency of the archer. The modifications ensured there was consistent positioning of the lower limbs and that the total load was spread over a greater area, making maximum use of the permitted space.

The redesign eliminated the sinking of the frame on soft ground and the wider base made it much more stable on indoor shoots. As a consequence, Danielle's performance immediately improved. Within the first week of use and in poor weather conditions, she had beaten her previous personal best score. The following week in good weather, she achieved an official world record.

Since the intervention from the Sports Technology Institute Danielle's performances have continued to improve. As well as retaining her Paralympic title at London 2012, back in 2010 Danielle won a gold medal in the women's team event at the Commonwealth Games, becoming the first Paralympian to represent England in an able-bodied event at the Games.



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# State-of-the-art coaching aid



## Enhanced rehabilitation and conditioning with digitally-controlled stretching machine

*High-performing athletes can maintain and increase flexibility and recover from injury faster using Sportfit's award-winning Sports Injury Rehab Assistant (SIRA).*

Coaches and trainers who have traditionally been able to measure an athlete's speed, strength and stamina, can now also accurately measure another vital performance component, flexibility.

Sportfit's award-winning Sports Injury Rehab Assistant (SIRA), is the first digitally-controlled stretching machine of its kind, delivering four of the seven types of stretching required for good body conditioning in two safe and easy movements. It can be used for both rehabilitation and conditioning, making it an ideal everyday tool for sports men and women to help maintain and increase flexibility.

As well as helping athletes perform stretches in a controlled and uniform manner, SIRA can also measure individual movements, thanks to a state-of-the-art software that allows the user to store and log their progress.

Invented and engineered by John Lockwood, SIRA was developed over a four-year period with the help, feedback and input of numerous physiotherapy experts and sports scientists. The technology is also used by professional sports men and women who play for some of the UK's leading football and rugby clubs.

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# Lightweight Design, Maximising space



© Philip Demler

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## High-performance yacht design maximises space and delivers racing-yacht performance

*Super Yacht Cup 2012 victory achieved in yacht featuring innovative high-performance composite material designed to maximise space without compromising performance.*

The winning crew of the Cowes 2012 Super Yacht Cup were sailing Wally Cento Class yacht the 'Hamilton', the first vessel of its kind to incorporate the 100 foot Box Rule. Designed by naval architects Judel Vrolijk, and built in the UK at Green Marine, the 'Hamilton' and subsequent vessels in its class are designed to combine two philosophies. These are of the luxury sailing that the Wally is world famous for and a high-performance sailing characteristic more typically expected of round-the-world racing yachts.

The challenge was to design a structure that maximises interior space while dealing with racing-yacht loads with which, for example, the compression load on the low sprit is greater than 80 tonnes. Advanced materials structural engineering specialist STRUCTeam's structural design is a critical element of the success of the 30m yacht.

STRUCTeam drew on its experience with high-performance racing yachts and lifting keel structures to meet the challenge. Its design utilises advanced composites, including various modulus carbon fibres and advanced honeycomb materials, and delivers a structure at the minimum weight whilst providing the expected level of reliability. The new boats have been designed to surf and plane, achieving downwind speeds of greater than 25 knots.

# Haptic-based motor skill learning



## Motion data informs proprioception to improve performance

*Vibrotactile sensors and real time feedback help rack up points for rhythmic gymnasts.*

Originally working with dancers and musicians, inventors Professor Gregory Sporton and Jonathan Green wanted to explore how motion capture data could be used to enhance performance. Noting that visualisation techniques were of limited use to performers in the act of performing, they wanted to improve movement perception without distorting posture or creating an artificial environment for learning and refining physical technique.

The result was MotivePro, a modular body-based sensor system that created a duplex relationship between the performer and the computer, providing real-time feedback through visuals, sound and vibrotactile feedback. MotivePro gives performers a new insight into their relative and actual physical position in the process of moving, shifting the emphasis from the visual to the kinaesthetic. Rhythmic gymnast Mimi Cesar was able to identify high value point scoring movements for her sport. This allowed her to maximise training to focus on technical improvements the judges would score more highly.

The intention of MotivePro was to shift the focus from visual feedback given post-performance to haptic feedback given in the execution of the movement. In motor-skill learning, this kinaesthetic feedback is always the most effective, but very difficult to impart in action. MotivePro also enables the compilation of comparative archives that allow athletes to measure subtle technical improvements against previous performances, looking out for adaptations or changes over the course of time. The technology has further applications beyond sport and performance and is currently used in an NHS trial on manual handling training.

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# World-class Olympic Torch design



## Advanced design technology helps to produce reliable Olympic Torch

*TECOSIM took the original design concept of the London 2012 Olympic Torch to production with minimal deviation from the designer's original theme and overcoming the demanding operational challenges.*

London 2012's Torch Relay was a huge success, engaging with millions as it travelled across the United Kingdom. The central feature of the Relay was the torch, with its unique design. Engineering consultancy TECOSIM was nominated to support the design team to deliver an Olympic Torch that met demanding test targets and tough product design challenges. These included the 8,000 holes in the torch skins and a burner exposed to the elements, a first for Olympic Torch requirements.

TECOSIM approached the torch design with a combination of advanced engineering tools and traditional research and development methodologies, finely balancing the need for minimal form change versus meeting strict targets within cost and technological constraints. The client was able to sign off the product against minimal physical tests and prototypes that correlated perfectly to the digital product development.

The development time and cost was reduced significantly by applying TECOSIM's virtual development process. This enabled greater research in other key areas, such as materials and burner development.

TECOSIM's engineering expertise brought to life the beautiful design concept that not only was the most reliable torch produced to date, but also helped capture the imaginations of everyone who came to see the Torch Relay.



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Website: www.tecosim.co.uk

# Precision design and manufacture

## Laser technology lit the way of the Olympic Torch

*The Premier Group employed innovative five axis laser cutting technology to engineer and manufacture the 8,000 London 2012 torches.*

The Premier Group has, at its disposal, the UK's largest dedicated laser cutting facility and a heritage that demands a 'right first time' approach. These hallmarks were fully tested during the engineering and manufacturing of the 8,000 triangular gold-coloured torches - one for each of the torch bearers who took part in the relay to the Opening Ceremony. The torches were manufactured from an aluminium alloy, each with a burner enclosed and fuelled by a gas canister, which burned long enough for the bearer to run about 300 metres before passing the flame to the next bearer.

The Premier Group's extensive engineering experience and capacity for technological innovation are the attributes that won it the contract to manufacture the London 2012 torches. The company's world-class skill set and technology allowed it to develop a process to manufacture the unique design of the Olympic Torch to the exacting standards required, and all within a challenging time frame.

As well as laser cutting, the Premier Group has over 20 years of experience offering other disciplines, namely: tool manufacture, sheet metal, press shop, quality and inspection, project management and computer aided engineering.



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# Heated shorts improve cyclists' performance

## 'Hot pants' improve cyclists' performance by maintaining muscle temperature

*Heated trousers developed by Loughborough University, British Cycling and adidas improve cycling performance by keeping core muscle groups warm between warm-ups and races.*

ADIPOWER muscle-warming trousers improve athlete's performance by keeping warmed-up muscles heated. In use, battery powered filaments sit over core muscle groups, maintaining the temperature between the athlete's warm-up and the event, delivering similar performance-enhancing results as tyre warmers in Formula 1 racing.

Team GB's track sprint cyclists used the trousers during London 2012. One of them, Sir Chris Hoy, went on to become the most decorated British Olympian of all time by winning two gold medals in London 2012's team sprint and keirin events.

Researchers from global sports brand adidas, the University of Loughborough's Environmental Ergonomics Research Centre and British Cycling spent three years identifying a scientific basis for the improved performance.

*Sir Chris Hoy wearing ADIPOWER 'hotpants'*



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# Innovative moisture management nanotechnology

## Dry shoes run faster with ground-breaking liquid repellent nano-coating

*Sports shoe performance is enhanced without affecting the look or feel by applying P2i's liquid repellent nano-coating that keeps footwear dry, and therefore light-weight, throughout the race.*

The performance of world-class athletes is enhanced by P2i's technology, as dry shoes run faster. The polymer technology keeps wearers comfortable and dry by repelling water, sweat and other liquids, while maintaining optimum control of temperature and breathability. Across a marathon for example, the weight of the footwear does not increase as runners pass through water mists or dump water on themselves to cool.

Invisible to wearers, the protective layer is over one thousand times thinner than a human hair. The technology is molecularly bonded to the product, making it extremely durable. This ensures that the protection lasts as long as the material itself and is not compromised by everyday wear.

P2i's technology applies a nanoscopic protective polymer layer to the whole shoe, so that when liquids hit the surface they simply roll off, instead of being absorbed by the shoe fabric. Working with premium sports footwear brands such as KSwiss, Scott, Hi-Tec, Nike, adidas, Timberland, Magnum and Teva, P2i aids the performance of world-class athletes.



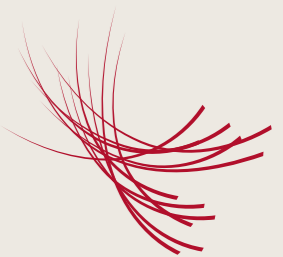
*polymer technology keeps wearers comfortable and dry by repelling water, sweat and other liquids*



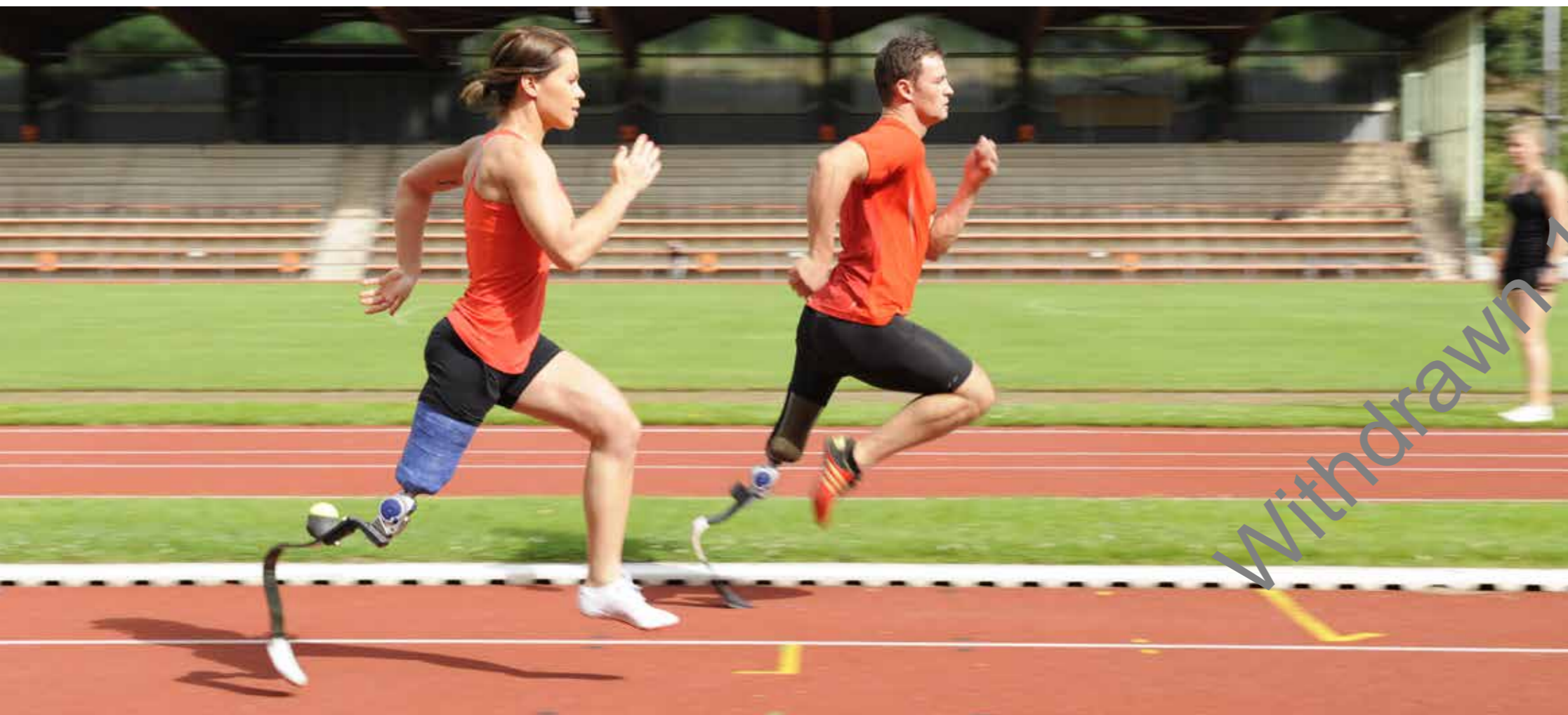
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**Invisible to wearers, the protective layer is over one thousand times thinner than a human hair. The technology is molecularly bonded to the product, making it extremely durable.**



# Record-breaking designs



## Cutting-edge composites enable top performers to achieve their medal aspirations

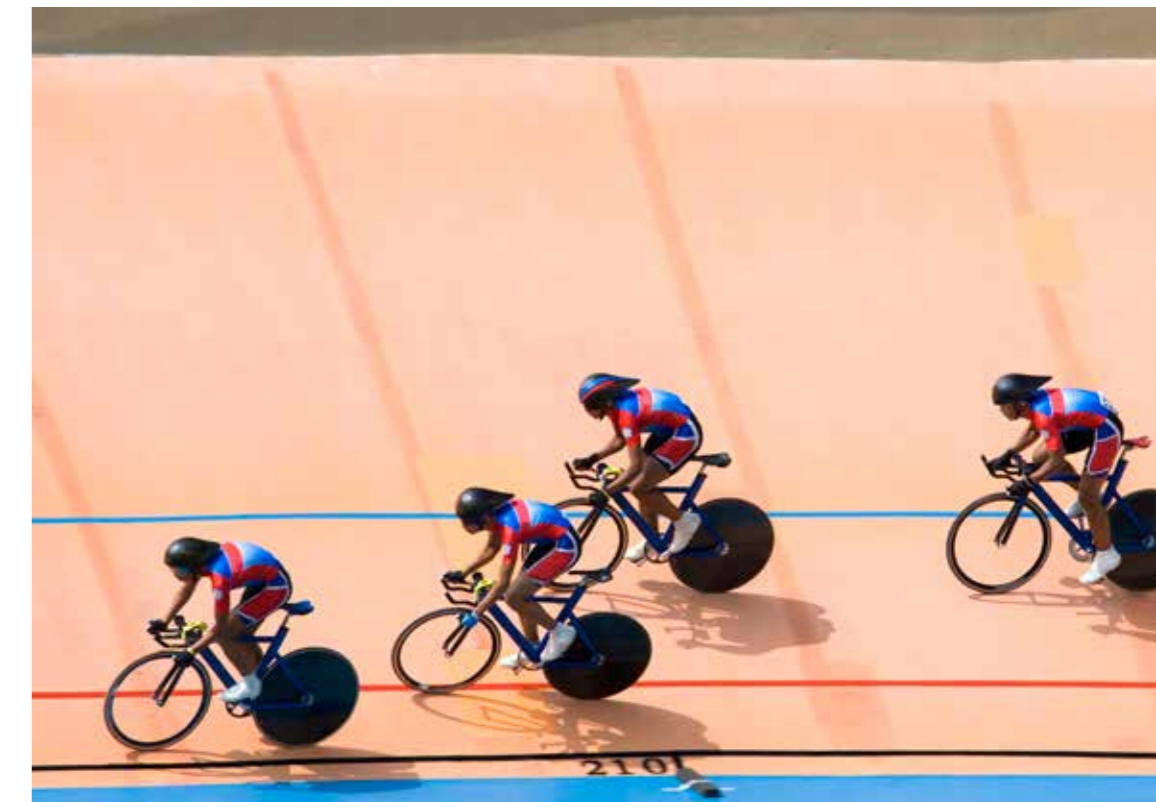
*Advanced composite materials developed by Cytec Industrial Materials enable enhanced sporting performance and can be found in a huge range of sporting equipment.*

Design in sports equipment has advanced at a record-breaking pace as a result of incorporating high-performing composite materials into sports equipment. These materials can be easily processed and feature outstanding strength and performance characteristics, helping athletes achieve their best-possible results at national and international sporting events.

Cytec specialises in producing carbon and glass-fibre reinforced plastic (CFRP and GFRP) materials. The firm's low temperature moulding and medium temperature moulding series of pre-impregnated materials offer features that are particularly suited to the requirements of the sports and leisure industry.

Typical applications include jetskis, snowboards, wakeboards, rowing boats, powered boats and canoes. Composites can also be found in tennis and squash racquets, the frames, wheels, handlebars and pedals of bicycles and in boots for climbing, skiing and skating. Specialist sporting applications include pole vault poles, and composites are also used to produce artificial limbs, wheelchairs and other specialised equipment.

These examples have all successfully utilised the benefits of pre-impregnated materials for swift development of prototype designs and progressive technical improvement, enabling top performers to achieve their medal aspirations.



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## Hosting the greatest show on earth

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*Housing, transport, sporting venues and infrastructure were required to support over 10,500 athletes, a workforce of 200,000 and 20 million spectator journeys.*

The construction of the London 2012 Olympic Park in Stratford, East London, was one of the largest urban regeneration projects in the world. In addition to the Olympic Park, there were a further 15 venues in London, 13 venues in cities and towns outside of London and 50 logistics, transport and training venues. The UK's world-leading engineering and construction firms ensured that the venues were delivered on time, to specification and on budget.

Work began on London 2012 as early as 2005. From the outset, the games were destined to be the most sustainable and accessible ever, and designed to leave a lasting legacy. The sporting venues and infrastructure, such as the athlete's villages, were all carefully future-proofed. In contrast, many of the venues were of necessity temporary, yet were expected to perform at the same level as permanent venues, and leave no trace when they were dismantled.

The UK companies that played a part in ensuring London 2012 was the greatest ever games have learned unique lessons, and participated in many 'firsts'. These can be applied to the masterplanning, design and construction of major sporting venues and events throughout the world.





# Bespoke high-performance surface heating

## Performance and sustainability: keeping Olympians comfortable with underfloor heating

*Demanding energy efficiency requirements together with the need to keep athletes in optimal condition led Warmafloor, part of Wavin Group, to design an integrated underfloor heating system for 5 of the towers in the London 2012 Athletes' Village.*

To ensure a comfortable living environment for visiting athletes, as well as optimum energy and cost efficiency for building managers, Warmafloor designed, supplied and installed a bespoke surface heating system at the Athletes' Village, in Stratford. Designed as a blueprint for sustainable living and intended to set the highest standards for innovative construction techniques, Warmafloor used a system of high-performance polybutylene heating pipework to deliver consistent room temperatures at what became the first large-scale, high-density, high-rise scheme to be developed to the Code for Sustainable Homes Level 4.

The success of the Athletes' Village resulted in Warmafloor's involvement in other sporting venue projects. These include the Weymouth and Portland Sailing Academy, Broxbourne Canoe Centre and St Mary's College in Twickenham. In addition, the company won other projects contributing to the regeneration of east London, including Westfield Stratford City Shopping Centre, Stratford Regional Station and Chobham Academy.



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# Sustainable technical solution

## Creating an environment for record-breaking cycling with an energy-efficient Velodrome

*Turning up the heat for record-breaking racing: ChapmanBDSP delivers energy efficient building services for the London 2012 Velodrome.*

The heating, lighting and ventilation services in the London 2012 Velodrome faced a complex and unique challenge. The temperature needed to be high enough to allow cyclists to go faster while still being comfortable for spectators. The building and environmental services design also had to enable the venue to cope with the challenging ambient and lighting requirements of televised events and normal daily amateur training sessions. All of this at the same time as ensuring minimal energy consumption.

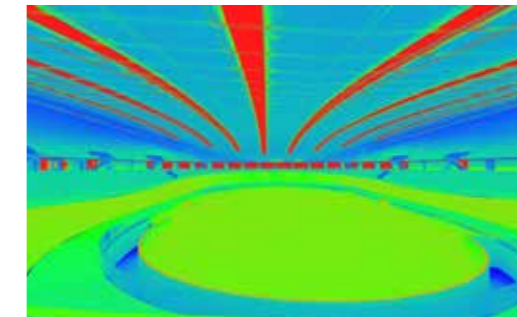
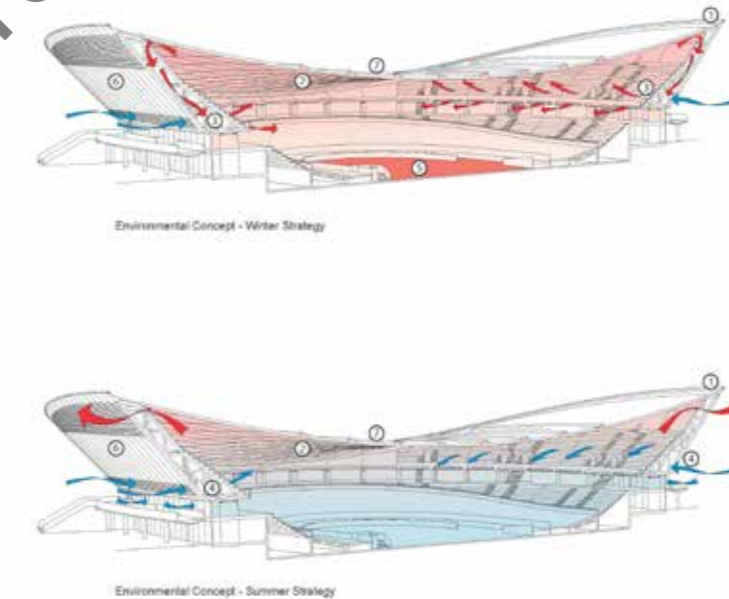
As the Velodrome's building services, lighting and environmental designer, ChapmanBDSP provided a technical solution that met all the specifications and surpassed the sustainability targets. Whilst mechanical systems deliver the warm temperatures required for record-breaking races in winter, the Velodrome can be naturally ventilated during most of the year, significantly reducing energy consumption and carbon emissions.

To cater for different uses, the heating system is divided into three main components which are carefully integrated with the building passive systems. Furthermore mechanical equipment is broken down into small modules and cleverly accommodated in the architectural form. Broadcast quality lighting can be off most of the time, enabled by natural light carefully crafted into the building.

Withdrawn 17 May 2019

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# Recycled from scrap

## Symbolic steel structure builds on sustainable foundations

*Observing a sustainable agenda: the iconic ArcelorMittal Orbit in the heart of the London 2012 Olympic Park is constructed from steel containing 60% recycled scrap.*

Showcasing the versatility and strength of steel, the ArcelorMittal Orbit, designed by Anish Kapoor and Cecil Balmond, is a landmark sculpture built on the site of the London 2012 Olympic and Paralympic Games. At least 60% of Orbit's steel, which comes from ArcelorMittal's facilities around the world, is recycled from scrap.

At 114.5 metres, the ArcelorMittal Orbit is the UK's tallest sculpture. Situated on the Olympic Park between the Stadium and the Aquatics Centre, the Orbit features two observation decks, at 80m and 76m.

The London Organising Committee for the Olympic and Paralympic Games (LOCOG) operated the ArcelorMittal Orbit during the games in the summer of 2012. After a period of transformation, the Legacy Company is expected to then re-open the ArcelorMittal Orbit as a visitor attraction within the Queen Elizabeth Olympic Park.

Integrated steel and mining company ArcelorMittal was a Tier Two supporter of London 2012.



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# Low-carbon ethos

## Grass-marking technology helps stadiums and sports grounds lower their carbon footprints

*Innovative grass-marking technology from Linemark UK promotes sustainability by reducing paint consumption by up to 75%, cutting energy and water consumption, and using recycled packaging.*

Ground staff typically use 3-4 litres of paint for every 10 litres of water when marking out athletics stadiums and sports pitches. Linemark UK's Impact Gold Paint system makes it possible to mark pitches with just one litre of undiluted paint.

The system, which was awarded the prestigious Queen's Award for Innovation in 2011, also reduces excessive water usage to a minimum. And the energy costs associated with transportation and the use of recycled plastic containers enables sporting facility managers to lower their carbon footprint.

Linemark UK's products have been used for nearly 20 years at some of the most prestigious stadiums in the world, including Old Trafford, Stamford Bridge and Twickenham in the UK. The company provide environmentally friendly grass-marking machines and liquids that are convenient for its customers and produce the most dazzling lines for all to enjoy. Linemark UK also supplies paint for use in sports advertising, such as for national and international rugby matches where logos are painted onto pitches.



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# Industry-leading range of anti-slip tapes



## Slip risk at Olympic venues reduced by designing-in anti-slip precautions

*The risks of slips, trips and falls at Olympic venues during London 2012 were reduced by Heskins' anti-slip materials being incorporated throughout the design and build stages.*

Slip risk management is a high priority for stadium designers, fitters and operators. Designing out risk to help prevent any fall or slip injuries includes specifying anti-slip materials. Anti-slip solutions provider Heskins worked closely with architects and designers of the Olympic venues, integrating its materials into the construction and liaising with specifiers to help ensure that everything met each venue's requirements.

Heskins has supplied its anti-slip materials to every Olympic Games since the company started in 1997, and has experienced increasing demand for its products. The firm has developed industry-leading non-slip materials using the latest plastics, minerals and adhesives. Its range includes products that will adhere to any surface, survive hostile environmental conditions, are available in printed formats and can be provided cut to any required shape or size.

Heskins also provides advice on slippage requirements, such as coefficients of friction and placement, as well as specialist knowledge to support access for visually impaired stadium users. All of this helps provide stadium operators with the risk management tools they need to reduce risk and improve safety.



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# Interpreting molecular fragments

## Advanced and accurate drug detection supporting anti-doping at sports events

*Reducing the margin of error: Supplying high purity reference chemicals and consumables for Gas Chromatography used to support doping control at major sports events.*

Athletes breaching the International Olympic Committee's tough rules on anti-doping risk harsh sanctions, and may even suffer a lifetime ban on competing in their chosen sport. Accurate and sophisticated testing of athlete's samples using gas chromatography is a key way of detecting banned substances. Greyhound Chromatography has been supplying certified chemical drug standards and chromatography consumables to research and analysis laboratories worldwide for more than 30 years. Greyhound manufactures an extensive range of fused silica gas chromatography capillary columns, which are used to test such samples.

When deposited into a gas chromatograph (GC) instrument, the athlete's blood sample is vaporised and swept along the specially coated, hair-thin, capillary column tubing by a flow of inert gas such as helium. Different chemical compounds found in the athlete's samples travel at varying speeds, exit the GC at different, characteristic times and enter a mass spectrometer. The spectrometer breaks the molecules into fragments whose patterns can be interpreted by a computer to deduce the structures of unknown molecules, such as drugs.

Greyhound Chromatography supplies certified drug and other reference standards of chemical compounds of very high purity, against which an athlete's sample is compared to ensure the accurate detection of banned substances.

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# Powerful hydraulic hammers

## Reducing road traffic by linking the Olympic Park with the River Thames with a new canal

*Hydraulic piling hammers supplied by BSP International Foundations allowed the construction of a new canal, enabling waterborne transport between the Olympic Park and River Thames.*

To reduce the amount of road traffic around the rapidly developing Stratford area, a navigable channel was constructed to link the London 2012 Olympic Park site with the River Thames. Operating before and during the Games, the new canal allowed barges to transport aggregates and construction materials to the site, and waste and recycling away from it. This required the building of a new 90m long lock, Prescott Channel Lock, and two new lock gates on the lower River Lea.

Leading manufacturer of hydraulic hammer and compaction equipment BSP International Foundations has been at the forefront in the design, development and manufacture of piling and ground improvement equipment, such as hydraulic hammers, for over a century. The firm supplied a mid-range CX110 impact piling hammer, a nine-tonne ram, and an HP125 hydraulic power pack. The powerful equipment installed over 1,200 tonnes of steel sheet piling during the construction of the lock, driving the double sheet sections down to the required level.



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Withdrawn 17 May 2019



## Leaving a legacy

### Winning multidisciplinary team ensures event delivery for successful Games

*Atkins' engineers and designers provided the technical expertise to deliver the venues and infrastructure for London 2012.*

Atkins was selected as the official engineering design services provider for the London 2012 Games. It was responsible for delivering the Olympic Park site ready for construction and creating the ecology for the largest new urban park in the UK for a century. The company's involvement started with a team of four people and grew to almost 1,000 at the peak of activity. And it handed over two main venue sites to contractors nine months ahead of schedule.

Atkins also supported the delivery of more than 120 temporary venues, including Horse Guards Parade and Greenwich Park. It helped to create the facilities and infrastructure to meet the needs of athletes and officials during the Games, as well as residents in years to come. Experts from the firm developed an aviation strategy to ensure the safe arrival of international heads of state throughout the Games.

In addition, Atkins worked with the Olympic Delivery Authority to build the capacity of London's transport infrastructure, including the North London Line, the Docklands Light Railway and Crossrail.



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# Leaving a legacy

## Powering the Olympic Park: designing an enduring underground utilities superhighway

*Atkins solved the unique challenge of designing the utilities to cope with peak demand during London 2012 and providing efficient power for 23,000 legacy homes.*

As the Olympic Park's scheme designer, Atkins' challenge was to create a utilities infrastructure to meet the needs of the games and of the 23,000 homes intended to be part of the Park's legacy.

One of its biggest challenges was how to design a system that would experience peak demand during the games, but that could then efficiently supply a lower demand for several years afterwards while the Olympic Park was developed for new communities.

Atkins secured the support of power, water and communications companies supplying the Olympic Park site, ensuring its infrastructure design could overcome the site's physical restrictions. It then designed a network snaking around the many obstacles on the Olympic Park, connecting utilities underneath the waterways, roads and rail lines, and around the major venues. The result was 100 kilometres of trenches, 300 kilometres of ducts, 20 kilometres of pipework, and 140 electrical substations served by 100 kilometres of cabling.

Atkins was central to the commercial negotiations too, helping select owners and operators for the Park's utilities. The utilities infrastructure project was delivered under budget and ahead of schedule, with many of the protocols developed having become industry standards for large regeneration projects.

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### The results

 100 kilometres of trenches

 300 kilometres of ducts

 20 kilometres of pipework

 140 electrical substations

  
served by 100 kilometres of cabling

# Unique overlay sustainability



## Placing sustainability at the heart of temporary building design and construction

*Atkins and the London Organising Committee of the Olympic Games (LOCOG) created a Temporary Materials Handbook with guidance on how to manage the sustainability impact of temporary buildings.*

London 2012 required the construction of multiple temporary venues, or overlay, which could meet the demanding sustainability vision for the games. The temporary buildings were also required to meet a wide range of needs, from the 15,000 seat beach volleyball complex to a temporary Olympic-standard field of play on an elevated platform for equestrian events.

The reuse of the construction materials used in overlay in the UK has traditionally been inconsistent, and the supply chain producing components has not been geared up to take back its products for recycling and reuse. What was needed was to identify which sustainable materials were available and what would happen to them after the games.

The resulting Temporary Materials Handbook provided guidance to specifiers on how to select materials with the objectives of zero waste to landfill, protection of human health and the environment, and minimised embodied energy. What's more, Atkins and architect Populous developed a 'kit of parts' which were collections of building elements that passed the sustainability test and had a single look and feel across all the venues.

The handbook and kit-of-parts approach are frameworks that enable sustainable overlay to be created at events beyond London 2012.

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# Creating an integrated and accessible Games



## Integrated design puts accessibility at the heart of Olympic venue construction

*Atkins' from the outset helped create accessible venues ensuring that all London 2012 visitors, athletes, workers and officials felt welcome at the games.*

London 2012's venues and infrastructure were required to accommodate the needs of a broad range of stakeholders, including athletes, spectators, officials, workers, volunteers and the media. The London Organising Committee of the Olympic Games (LOCOG) was responsible for delivering the temporary venues for the games, and commissioned Atkins to provide inclusive design consultancy.

In partnership with LOCOG, Atkins delivered accessibility advice for venues across the UK, which included 15 venues bordering the Thames and in central London, 13 venues in cities and towns outside of London, and 50 logistics, transport and training venues. From the outset, access consultants were included within the design teams to ensure temporary venue designs were inclusive, eliminating redesign and saving costs. Based on British Standards, Building Regulations and best practice, LOCOG and Atkins created the London 2012 Overlay Access File (LOAF). This design guide provided overlay designers and constructors with tools and best practice not normally found in accessibility guidance.

The result was permanent and temporary games venues and supporting infrastructure designed to very high inclusivity standards. The legacy has been a greater appreciation of how user-centred design is integrated into the design processes of major permanent and temporary venues.

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# Assessing transport plans

## Keeping the games moving

*Arup played a key role in the transport planning for London 2012, helping devise traffic management plans and models for crowds, vehicles and public transport.*

Transport planning for London 2012 was a major undertaking. Visitor numbers to the Olympic Park topped 200,000 a day, and total spectator journeys in London during the games exceeded 20 million, peaking at 3 million on the busiest days.

Arup had been involved in transport planning for London 2012 since 2006. Its work included advising the design teams on transport issues, negotiating with stakeholders and other authorities, crowd, highway and public-transport modeling, and design of transport-mitigation measures.

Significant projects undertaken by Arup included the transport assessment for the Olympic Park planning application, the development of a traffic management plan to ensure construction of the Olympic Park could be carried out as efficiently as possible, with minimal impact on the local community, the assessment of the access and transport modes of construction workers to the site, modelling the growth and routing of construction traffic over time and assessing the effects of the Olympic Route Network on London's roads.

In addition, Arup designed a crowd model of the Olympic Park, designed to ensure that spectators could move around safely and easily. This required conducting an assessment of the potential cycling and walking demand for both spectators and workers.



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# Setting new construction standards

## Team Stadium sets new standards for the construction of Olympic stadia

*Demanding design criteria were met by Team Stadium, the design and construction consortium responsible for constructing London 2012's stadium.*

The London 2012 Olympic Stadium was designed to meet stringent low impact requirements. The consequence of the brief was the significantly lower roof when compared to past Olympic main stadia designs. The stadium was delivered by Team Stadium, an integrated design and construction consortium which included Buro Happold, Populous and Robert McAlpine, and that worked on the project from design concept to opening ceremony.

The final design, an innovative lightweight cable support roof, fulfilled a double function, protecting spectators from the elements and athletes from wind and other climatic factors that can adversely affect performance. It also acted as a support for 500 tonnes of lighting towers. These 14 iconic pyramid towers needed to be positioned approximately 25 metres above the roof to ensure the best lighting conditions. Anchoring them was a challenge overcome by collaboration between the engineer, architect, main contractor, steelwork contractor and lighting contractor.

Team Stadium was able to deliver the venue within budget and schedule, a clear year ahead of the games. Perhaps the Team's greatest achievement was that by making every design decision with safety in mind, not speed of delivery, the Stadium was completed without loss of life; setting new standards in the construction of an Olympic Games.



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# Most accessible games ever

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## Tactile plans for Olympic venues opened up London 2012 to the visually impaired

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*Tactile plans enabled visually impaired visitors, athletes, workers and other stakeholders to confidently navigate through London 2012 venues.*

Inclusive and accessible design principles were embedded into the Olympic Delivery Authority's (ODA) design, procurement and construction processes from the outset. As early as 2005, Buro Happold's inclusive design team played a key part in the Olympic Park Masterplan's inclusive design. This included consultation with and involvement of well-informed disabled people, local access groups and other relevant stakeholders, to help deliver an environment that fully met everyone's performance requirements.

Buro Happold produced the tactile plans of the original 2005 Masterplan and continued to provide tactile plans for consultation on venues and facilities. These included the stadium, basketball arena, velodrome, media hub and the water polo venue. During the development of the legacy communities scheme for the Olympic Park Development Company (now the London Legacy Development Corporation), Buro Happold produced tactile plans to demonstrate the proposed housing for the scheme.

The ODA was praised by the International Paralympic Committee (IPC) for the tactile plans, which gave access to the 2012 Masterplan in a way that they had not experienced with previous games.

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# Masterplanning the Olympic Park

## Turning a wasteland into a 'winning land' with a positive long-term legacy for East London

*As part of the EDAW Consortium, Buro Happold supplied strategic engineering advice and design for the masterplanning and design of the Olympic Park and Legacy proposals.*

The London 2012 Olympic Games was a very significant milestone in a longer-term strategy for the planning, design and construction for the new quarter in East London. It meant that for every plan generated for the Olympic Park, a second plan was prepared to identify how the underlying infrastructure and many of the venues would benefit the future development of the area and benefit its residents.

From 2005, the EDAW Consortium of architects and engineers, including Buro Happold, developed a masterplan to deliver the most accessible and sustainable games ever whilst providing a legacy for a new London quarter. To underpin the masterplanning, Buro Happold and other consortium members developed a huge 3D physical site model. Subsequent collaborative working between teams delivered solutions for infrastructure and the creation of an inclusive design strategy document.

One of the greatest achievements of the whole project was the planning and design teams' creation of an approach that ensured most of the investment in the development of the Olympic Park was also of value in shaping a platform for the delivery of a future, mixed-use, urban quarter for East London.



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# Domed polycarbonate lighting

## Innovative toughened lighting design delivers visually dramatic and safe fencing piste

*Double safety boost for fencers at the London 2012 fencing pistes: Leon Paul developed a robust LED lighting system for signalling hits to surround the Olympic fencing pistes.*

The challenge for London 2012 fencing field of play designers was to find a low-profile lighting design that provided dramatic illumination for the audience and could withstand the impact of an athlete landing on the lights.

Leading fencing product manufacturer Leon Paul has worked on the development of fencing pistes for numerous high-profile sporting events. The firm responded to the challenge by developing domed polycarbonate lighting to run in a 'u'-shape around the back of the fencing strip.

The floor lights were constructed within electrostatic powder-coated mild steel frames, with location lugs so the units could be easily installed. Each interlocking light's dimensions were 210x2500x40 mm with 3 mm domed polycarbonate lens covers. The light emitting diode (LED) lighting technology was powered by a 12 volt DC power control system.



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# High-performance plastic pipework

## Innovative drainage systems contribute to Olympic Park's sustainability targets

*Water conservation was key factor in the London 2012 Olympic Park's design, with Polypipe's green water infrastructure helping meet demanding sustainability targets.*

With its ethos of good waste management, recycling and an appreciation of embedded carbon, Polypipe won multiple projects for the London 2012 Olympic Park.

The UK owned and headquartered firm touched almost every building within the Olympic footprint. It deployed 740 kilometres of pipe and two million fittings, surrounding everyone at the games in a web of Polypipe drainage, ducting and water supply systems.

Lean techniques and speed were paramount to Polypipe's Olympic brief. The Athletes' Village, for example, was equivalent to building a city in three years. Polypipe was able to prefabricate and pre-test modules, like its storey-height, vertical drainage stacks. These were brought to the site complete and simply plugged into place.

Many applications from the games are now in the Polypipe range. The green roof above the athletes' accommodation gave rise to the only siphonic drainage solution of its type. Demand for fire resistance that exceeded building regulation specifications led to the pioneering Firetrap system, which protects pipes from flames for four hours. And cleaning harvested rainwater to health authority standards for the Olympic Park's medical centre gave rise to a new type of titanium dioxide filter.



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# Managing risk through crowd modelling studies

## Crowd modelling of London's transport infrastructure for safety and risk management

*Scandpower's crowd modelling studies enabled planners to ensure safe transport for visitors throughout the London 2012 Olympic and Paralympic Games.*

During London 2012, 8.8m tickets were available and 20 million spectator journeys were made throughout London, including 3 million on the busiest of days. Plans were required to ensure both journeys and visits to the venues were safe, with any potential risks identified and designed out.

The London Organising Committee of the Olympic and Paralympic Games (LOCOG), Transport for London (TfL) and London Underground commissioned Scandpower to conduct crowd modelling studies. The models, which included hazard identification and building overcrowding risk assessment methodologies, were incorporated into transport and crowd management plans at Olympic venues.

In addition to its specific experience in crowd modelling and risk management, Scandpower also has extensive experience in designing infrastructure to facilitate more efficient passenger/visitor flows, including building usability reviews and wayfinding and signage design.



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# Superior spectator comfort and sustainable venue solutions



## Temporary demountable stadium gave fans optimum comfort and provided a true sustainable solution for Olympic infrastructure

*A 15,000 seat custom-designed temporary stadium made visitors to the London 2012 Beach Volleyball feel like they were in a permanent venue.*

The only 'turnkey' operator contracted by the London Organising Committee of the Olympic Games (LOCOG), Arena Group delivered the total event overlay on Horse Guards Parade, The Mall and St James's Park. This included the 15,000 capacity temporary Beach Volleyball stadium.

The biggest challenge to delivery was time. Though planned over a two-year period, the whole 32-acre site had to be completed from scratch in just 42 days. No one in the world had ever built a venue of this scale and complexity in such a demanding timeframe and this was made possible by creating a strong team who managed the pressures and understood the location.

Despite its temporary nature, the Beach Volleyball stadium provided everything expected of a world class permanent venue. Spectator experience was critical. Arena Group designed and built the venue using its patented clearview® seating system. clearview® is the only seating solution which allowed LOCOG and architects to achieve their ambitious design; showcasing the London skyline by removing the upper fourth side of the stand, whilst maintaining capacity and clear sightlines.

Temporary venues such as the Beach Volleyball Stadium at Horse Guards Parade were a central part of LOCOG's commitment to sustainability. At London 2012, the same amount of temporary overlay was used as at the Olympics Games hosted by Sydney, Athens and Beijing combined. Arena's sustainable approach minimised environmental impact with over 90 per cent of the materials used on site, including demountable seating, structures and interior fit out, coming from Arena's own inventory. These were recyclable and will be re-used at future major events.

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# Innovative minting machines

## Minting London 2012's £5 commemorative coins using advanced coining technology

*Creating a legacy: Group Rhodes HME Minting division supplies advanced coining machines used in the production of the £5 commemorative coins for London 2012.*

The London 2012 Olympic and Paralympic Games commemorative £5 coin was designed to provide an enduring memento of the event. Leading UK original equipment manufacturer Group Rhodes' HME Minting division developed the K-Series coin and medal-embossing presses used in the production of the unique coins.

The HME K-Series offers a market-leading solution to a wide variety of coining, embossing, forming and sizing operations. Its knuckle joint under-driven coining machines are available in 180, 360 and 600 tonnes capacity, and can emboss a range of exotic materials, including silver, gold and platinum. The powerful coining action of the HME knuckle-action drive, combined with a choice of manual or fully automated feed systems, make these machines ideally suited for the production of medals and proof coins.

Designed and built for quality, value and reliability, Group Rhodes' HME K-Series minting machines feature a compact frame construction that minimises deflection through equal load distribution. Pre-loaded linear bearings provide slide guidance for accurate die alignment. Pneumatic slide balancing, motorised top tool wedge adjustment and a multi-strike facility ensure a high degree of proof coin detail. The latest generation of minting machines for circulation coins can produce more than 750 pieces per minute.



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# Summary



## Benefitting from London 2012's enduring advanced engineering legacy

*Starting in 2005, delivering an unrivalled Olympic and Paralympic Games in 2012, and offering a lasting legacy far into the future, London 2012 has provided innovative advanced engineering solutions supplied by UK companies. These firms have not only delivered success in sporting infrastructure, but also in the events themselves, helping athletes to win medals, surpass their personal bests and even to achieve world records.*

The UK's ability to deliver major projects such as the London 2012 Games on time, on budget and to the highest sustainable standards, makes UK companies the perfect partners for major sporting events and other global projects.

Over 2,000 companies were involved in the delivery of the London 2012 Games. This brochure has featured just a tiny number of those from the advanced engineering sector. All are open for business and able to provide some of the most technologically advanced and innovative engineering solutions anywhere in the world.



## UK Trade & Investment

### UKTI

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 from which 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.

UK Trade & Investment is responsible for the delivery of the Solutions for Business product "Helping Your Business Grow Internationally." These "solutions" are available to qualifying businesses, and cover everything from investment and grants through to specialist advice, collaborations and partnerships.

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