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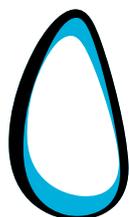
The 2011 Lloyd's Register Educational Trust Lecture **Engineering the Olympics**

John Armit CBE FREng
Chairman, Olympic Delivery Authority

Thursday 1 December 2011

Royal College of Physicians
11 St Andrews Place
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ISBN 1-903496-76-4

November 2011

Published by
The Royal Academy of Engineering
3 Carlton House Terrace
London
SW1Y 5DG
Tel 020 7766 0600
Fax 020 7930 1549

Copies of this report are available online at:
www.raeng.org.uk/LRET2011

Registered Charity Number: 293074



**John Armitt CBE FREng
Chairman, Olympic Delivery
Authority**

Engineering the Olympics

Abstract

The construction work for the London 2012 Olympic and Paralympic Games is a complex job. It has been compared to building two of the Heathrow Terminal 5 in half the time.

John Armitt is Chairman of the Olympic Delivery Authority (ODA), the body responsible for delivering this work. In his lecture he will describe the various engineering and construction challenges from governance, land assembly, budget agreement, stakeholder relations, planning, programme management and how they were overcome. In addition to time and cost, the ODA adopted six key themes which were taken into account in all decisions regarding the development and building of the infrastructure, stadia and housing:

- legacy
- health, safety and security
- sustainability
- equality and inclusion
- employment and skills
- design and accessibility.

Today the work is largely complete so it is a good time to reflect on what has been achieved, what has been learnt and the challenges ahead.

John Armitt

John Armitt was appointed Chairman of the ODA on 1 September 2007. He was previously Chief Executive of Network Rail from October 2002 and Chief Executive of Railtrack plc from December 2001, and has extensive experience in the building, civil engineering and industrial construction markets.

John Armitt is a civil engineer and joined John Laing in 1966 as a graduate engineer. During the next 27 years, he worked on major construction projects in the UK and overseas, spending the last seven as Chairman of Laing's International and Civil Engineering Divisions. From 1993 to 1997 he was Chief Executive of Union Railways, the company responsible for development of the high speed Channel Tunnel Rail Link. In 1997 he went back to construction as Chief Executive of Costain, a position he held until 2001 when he joined Railtrack just after it had been put into administration.

John Armitt is also Chairman of the Engineering and Physical Sciences Research Council and is a Non-Executive Director of the Berkeley Group.

Introduction

Good evening, some years ago I served on the Lloyds Register Council so it is a particular pleasure and honour to be asked to give this lecture.

We are now only 239 days from the Opening Ceremony of the 30th Olympics, the 2012 Olympic and Paralympic Games. So it is a good time to be able to look back on what has been achieved since London was awarded the Games in 2005 and forward to the final preparations.

It will be the third time London has hosted the Games, 1908 and 1948 being the previous occasions, but this was the first time London had to bid in competition with other cities. In the run up to the final decision, announced in Singapore, Paris was many peoples hot favourite so why do we think London won?

The bid led by former Olympian Lord Coe promised to deliver the best Games ever, to create a vision of sport which would act as an inspiration and legacy for children around the world. Also a legacy for sport in the UK, a physical legacy of regeneration in London and a wider social and economic legacy with a focus on sustainability.

The 550 page bid set out how the Games would be delivered, locations, finances, transport (a particular concern in London of the International Olympic Committee), plans for the Olympic Village and the development of the Olympic Park on the brown field site known as the Stratford lands in East London.

The Olympic and Paralympic Games are the largest single event in the world, described as the most complex event a country has to organise outside of going to war. Figure 1 is a reminder of some of the basic statistics: 205 competing nations, 17,000 athletes and officials, 26 different sports, each competition the equivalent of a World Championship, covered by 22,000 accredited journalists in London. There will be 8.8 million tickets sold and similar but lower figures for the Paralympic Games which will be returning to London after the inaugural Games at Stoke Mandeville in 1948.



Figure 1

Delivering the Games

A critical aspect of any major event is governance structure. Figure 2 shows how this has been established for the London Games.

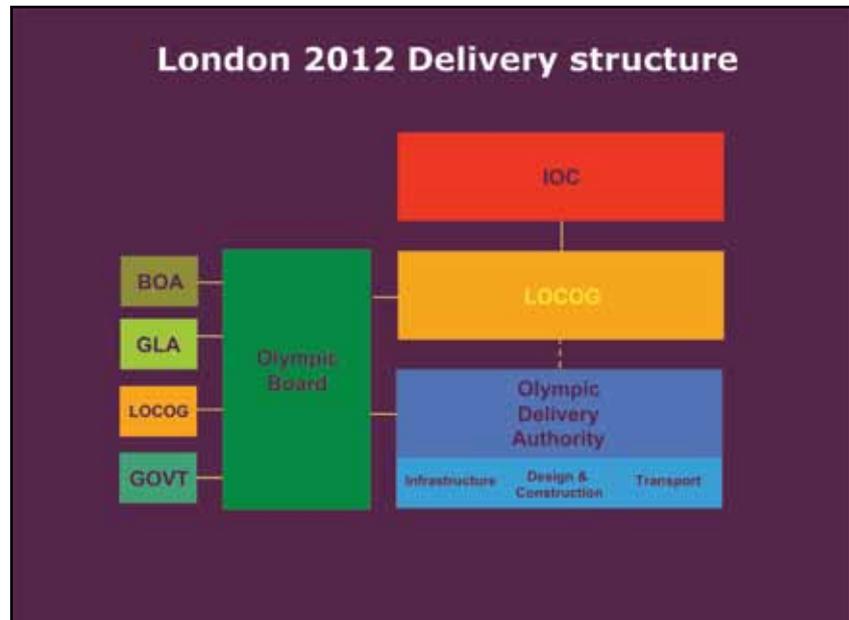


Figure 2

The awarding body and ultimate client is the International Olympic Committee. An approximately 100 strong body made up of representatives of various nations largely ex-Olympians or sports administrators. Responsible to them is the OCOG, the organising committee for the Olympic Games, for London, LOCOG. They are responsible for putting on the Games and ensuring their success, it is chaired by Lord Coe. In London the budget for LOCOG is approximately £2bn. It is a private sector body and raises its funds through ticket sales and sponsorship.

For London an Act of Parliament established the Olympic Delivery Authority (ODA). It is a public body responsible for the delivery of the infrastructure and the transport and has a budget of £8bn and is funded by the Lottery, Central Government and the Greater London Authority. Oversight of LOCOG and the ODA is by the Olympic Board. Members are the Government Ministers, the Mayor of London, Lord Coe, and Lord Moynihan representing the British Olympic Association (BOA). In summary, LOCOG put on the show, the ODA builds the theatre and the BOA provide the British Athletes and are hosts to the competing countries and their athletes.

I would now like to move on to the particular activities of the ODA, the body I have chaired since 2007. We are a Non Departmental Public Body responsible to the Secretary of State at the Department for Culture, Media and Sport. Our responsibility is to deliver the infrastructure, venues, athletes' village, transport infrastructure and devise and implement effective transport plans all to time and cost, all in a sustainable manner and to leave a lasting legacy.

An early decision was the extent to which we would build a complete team to deliver these objectives ourselves or the degree to which we would seek support. The ODA is clearly a limited life body and so to build up a team of approximately 700 people from scratch with no long term future would be very difficult, hence we decided to appoint a Delivery Partner. The respective roles were that the ODA would act as client and would establish the

specification for the various venues and infrastructure, let the main contacts, set the standards required across six key themes from safety to employment to sustainability, to deal with the external stakeholders, and deliver the transport plan.

The role of the Delivery Partner was to manage the construction programme on behalf of the ODA and to support the ODA in delivering the overall objectives. The Delivery Partner managed the complex logistics across the Olympic Park, including security.

The ODA peaked at about 250 staff, the Delivery Partner CLM at about 550. CLM was incentivised to meet the programme and to contain the whole programme within budget. The ODAs executives was similarly incentivised so there was an alignment of objectives between the two teams.

To ensure the overall programme it was split into six phases as shown in figure 3. This was also described as the 2:4:1 policy. Two years to plan, four years to design and build, one year for trials.



Figure 3

The early stage focused on determining the location of the various venues, their outline design and submitting a planning application. The ODA had been given planning powers but to ensure local support a Planning Committee chaired by the ODA but with representatives from the local authorities was established. It was supported by planning officers and effectively was divided from the ODA by a 'Chinese wall'. It has proved very effective and to all intents and purposes normal planning process has been followed and the ODA has not had to use its ultimate authority.

In parallel the London Development Agency (LDA) through its Compulsory Acquisition Powers assembled the site, providing compensation to approximately 100 companies who were moved to new locations. In addition three groups of travellers also had to be provided with new facilities off-site.

In July 2007 the LDA was able to hand the 600 acre site across to the ODA and the second phase lasting a year of Demolish, Dig, Design could be commenced. This period was devoted to preparing the site, carrying out design to the point where design and build tenders could be issued for the various venues and demolishing some 200 buildings.

By July 2008 as the Beijing Games commenced, we were able to start our third phase of the Big Build. This phase was to last three years leaving a year for the fourth phase of testing in the run up to the Games themselves which are then followed by the transformation for legacy use.

Engineering works really commenced in the Demolish, Dig, Design phase. The Stratford site is surrounded by the Lee Navigation Canal to the west, the A12 to the North and by the East Anglia railway lines from Liverpool Street to the South and East. It is bisected by the River Lee and criss-crossed by other railway lines predominately the North London Line and the Chancel Tunnel Rail Link (HS1). It had been used for hundreds of years for all sorts of industry from farming, to early plastics such as Bakelite to car breaking. It had been used for a dumping ground of buildings demolished in the Second World War and was heavily contaminated with heavy metals, petro carbons, arsenic etc. Across the site 52 pylons supported National Grid power lines, an early project was to construct two 6km long tunnels 3m in diameter and up to 30m below the ground into which the power lines could be diverted and the pylons dismantled so freeing up the site for development. This project alone cost £300m, but was executed without significant problems.



Olympic Park, November 2007

Dealing with the contaminated soil presented an early challenge for our sustainability credentials. Traditionally such soil would be dug up and transported to land fill and clean material imported. This, however, would have meant extensive lorry movements on the local roads, land fill, and the use of raw materials. So it was decided to clean and recover the contaminated soil. Two million tonnes was treated primarily by soil washing, (see figure 4) 95% of the soil was recovered with only 5% going to licensed land fill. The contaminants stuck to the finest grains of soil and you are left with a very fine cake-like material. At peak we had 60 laboratory technicians measuring the cleaning process with hundreds of samples being taken every day. The result was we were able to reuse the material for backfill, drainage, embankments etc.

I mentioned the 200 buildings which had to be demolished, 90% of the material was recovered for recycling, some of which was incorporated in the new construction, for example the paving slabs, hardcore, kerbs and bricks. Some of the buildings were carefully dismantled and sold to overseas buyers.



Figure 4 - Soil washing machines

The River Lee runs through the Olympic Park and clearly had the potential to be a key attraction. However it is tidal and at low tide would reveal not only the mud banks, but the shopping trolleys and old bikes. So another early project was the building of a navigable lock where the Lee enters the Thames thus enabling us to control water levels and essentially maintain high water through the Park, control flooding and at the same time dredge and clean the river through the Park.



Lock on the River Lee

By July 2008 we were ready to start the Big Build Phase of the project and I will now take you through the key structures and venues. I have already referred to the undergrounding of the power cables but this was just one of many infrastructure schemes. A site wide 2 km by 1.2m diameter trunk sewage system up to 18 meters deep has been installed, and a pumping station that lifts the sewage into the 19th century Bazalgette sewers which are on the southern edge of the Park.



Pumping Station

A combined cycle energy centre provides 90MW of heating, 52MW of cooling and 12.3 MVA of electricity. It has been built by a major energy company and will be operated under a concession for the next 40 years. It is fired by natural gas and as part of our sustainability programme can also use biomass fuel for 20% of its heating capacity.



Energy Centre

The primary sub-station building has already won architectural awards for its simple basket weave black brick structure which is lit at night from the inside, while the main building is clad in a corten steel mesh giving a rugged industrial context. Distribution through over 100km of 11kv cabling is also under a 40 year concession.

Extensive gas, electrical, communication and water networks have been laid in dedicated pathways across the site while most buildings operate a rain water harvesting system with water used for irrigation and urinal systems.

An experimental black water treatment plant treats 600,000 litres per day, again providing non-potable water for irrigation and urinals.



A variety of bridges on the Olympic Park

Extensive road and bridge networks intersect the site. Some 35 new bridges have been built. Most are composite steel concrete deck structures but many have been built in two parts. During the Games pedestrian and vehicle flows will be much greater than in legacy and so bridges have been built so one part is designed for legacy whilst the other part is of a more temporary nature and can be removed and recycled after the Games.

Let me now move on to the various stadia. A starting point for any city hosting the Games is to determine the extent to which existing sports facilities can be used, to the extent they are not suitable the next decision is should we build a temporary venue or is there justification for a new permanent venue. This decision process has been used by the ODA for each and every venue.

The Olympic Stadium

The main stadium was a major challenge. A capacity of at least 80,000 is required for the main ceremonies and for the major track and field events. For the UK in legacy only national football stadia and a handful of major premiership clubs can utilise such a capacity. Wembley could have been adopted but security and transport to move hundreds of athletes and officials across London and separating the main stadium from the Olympic Park made it impracticable.

At the early stages of design of the new stadium, despite some interest, it was not possible to identify a committed long term user of the stadium.

In Singapore we had committed to the IOC that part of the London legacy would be a new international standard athletics stadium. However international athletics meetings typically attract only 15-20,000 spectators.

A unique decision was made therefore in 2007 to build an 80,000 seat stadium for the Games which could be demounted after the Games to a 25,000 seat athletics facility, so reducing the risk of a post Games white elephant. Using the natural fall of the land a permanent lower bowl, with its entrance at ground level in the North, was designed for 25,000 seats. On top of this a lightweight simple steel structure supports 55,000 seats. Separately another steel structure supports the roof. The upper compression ring of the main roof truss consists of surplus gas main pipes, another example of recycling saving cost and energy. The inner torsion wire ring is stressed to 1200 tonnes and supports not only the roof edge but the fourteen, 34 tonne lighting towers. The terraces were all pre-cast concrete to standard designs to simplify manufacture and installation.



The Olympic Stadium

The bolted steel structure can be easily dismantled although since its completion strong interest has been expressed by major football clubs in its operation in legacy.

The stadium has been designed so that all hospitality and other facilities associated with major stadium have been pulled out of the structure and are standalone demountable buildings on the external concourse. Even so there are some 700 separate spaces under the stadium including a 60m warm up track.

The stadium weighs a quarter of that in Beijing and has already won many plaudits for its simplicity and elegance.

The Aquatics Centre

The Aquatics Centre featured, as an example of the quality of venue London would build, in London's bid for the Games in 2004. The iconic design by Zaha Hadid captured the imagination.

Post award, addressing the mix of Games and legacy requirements it was decided to scale down the original design. Consequently the core legacy building with a capacity for 3000 spectators is increased during Games time to 17,500 with the addition of two large wings which will be removed after the Games.

The centre consists of a 50m competition pool, a 50m warm up pool and a dive pool.

The roof span covers the competition pool and dive pool, it spans 110 meters and has an overall length of 160m. The main beams are 11m deep at the centre and the steel roof structure weighs 3,000 tonnes. To speed up the programme the roof was erected prior to the construction of the pools and the main building. One complication was that the National Grid cable tunnels passed under the pool and so a major load transfer stub was required for the north end piers to reduce the load around the tunnels. Consequently the roof was erected away from what would ultimately be its floating end. This meant it had to be fixed and then the whole roof raised after completion to install the sliding bearings. A tense moment!

The warm up pool is installed under the Olympic Park main spectator access bridge of which the structure is integrated into the Aquatics Centre.



The Aquatics Centre under construction

The fact that the two temporary wings are not air-tight has been a significant challenge for the engineers in creating the very strict environmental conditions required for the Games.

To provide maximum flexibility of use in legacy the floors of the pools can be raised to create various pool depths from 3m to zero. Pool end booms can be moved to divide the 50m pool into two for recreation use or for water polo.



The Aquatics Centre during Games time



The Aquatics Centre in legacy

After the Games the two temporary wings which are clad in a phthalate free PVC which has been developed by manufacturers specifically to meet the ODA specification can be removed, recycled and full height and full length glass walls installed to create the iconic legacy design.

The Velodrome

The Manchester Velodrome built for the Commonwealth Games in 2000 has been an enormous success in legacy and so the decision to build a permanent facility in London, which did not have an indoor cycle track, was an easy one. The 6,000 seat velodrome is the most energy efficient and for many the most beautiful building in the Olympic Park. It achieves a 31% improvement over 2006 Building Regulations Part C. This has been achieved by developing a

compact design which minimises the overall heated volume of air in the main cycling arena and uses natural ventilation for the main passive cooling strategy together with high levels of thermal mass, night time ventilation and natural light through a continuous glass curtain wall at podium level and extensive roof lights.



The Velodrome during construction

Following an intensive review of the 100m span roof it was possible to use a lightweight cable net design reducing the steelwork required by 1000 tonne and so creating further savings in the size and depth of the foundations.

The exterior is clad in a Columbian redwood whilst the track is Siberian spruce. All timber used on the Olympic Park was sourced through an established panel of suppliers using accredited sustainable sources.

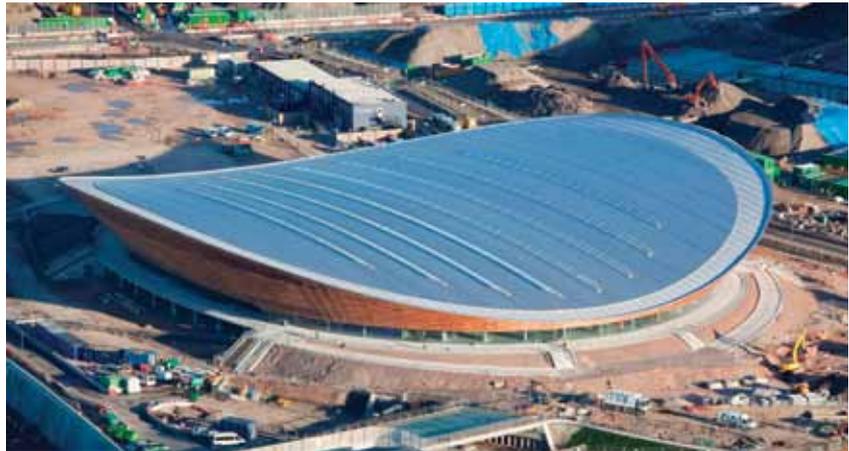
The track is simply made of 2m lengths of 40mm square sections lost nailed into place on a timber and steel frame. The designer is confident the track design will be one of the fastest in the world.



Inside the Velodrome

Chris Hoy our Olympic Gold medallist acted as a consultant during the design process which resulted in a seating arrangement to ensure maximum interaction between cyclists and spectators particularly at the steep end walls of the circuit.

Alongside the Velodrome is the BMX circuit and in legacy a one mile road racing circuit will be added together with a mountain bike track incorporated into the parkland so every type of competitive cycling will be catered for. The legacy operator will be the Lee Valley Regional Park Authority.



The Velodrome

Temporary Venues

Next to the velodrome is the 12,000 seat basketball arena. There is no economic case for such an arena in legacy, existing facilities did not meet Olympic standards or had transport and security issues so it was decided to build a temporary stadium.

It is a very large but simple portal frame structure with a PVC covering and demountable seating. All the Olympic Park stadia sit on piled foundations due to the large areas of made ground but for the basketball stadium the piles are stone columns which will not present long term obstructions. The structure is owned by the contractor who will be able to take it away for potential use elsewhere. The site will then be used for future housing.



The Basketball Arena

Another temporary stadium on the Park is the water polo facility. Similar in concept to basketball the 6,000 seat enclosure is a demountable steel structure. Concrete for the pool structure would have been cheaper but a steel reusable option was considered more sustainable.

Handball Arena

The other permanent venue on the Park is the 7,000 seat handball arena. A simple box structure but with a concourse level glass curtain wall similar to the velodrome will bring in natural light, whilst light pipes through the roof create a very bright natural light so reducing energy needs especially in legacy, when it will be multi-sport community facility.



The Handball Arena

The building of steel and precast concrete is clad in recycled copper sheeting which creates a very variable visual appearance according to the weather conditions.



Inside the Handball Arena

International Broadcasting Centre/Media Press Centre

The largest facility on the Park is the International Broadcasting Centre, 280m long, 50m wide and 30m high it will house the TV broadcasting studios. A temporary structure was considered but as it was two thirds of the cost of a permanent building it was decided to build a structure which was very flexible for legacy use. The simple steel frame enclosing 50,000sq m was erected in nine weeks. The structure can be divided into three parts in order to provide flexibility for legacy occupiers.

Alongside is a conventional office block for the print media, the media are also provided with a 1500 space multi story precast concrete frame car park. During the Games a large tented village providing catering and other support facilities from hairdressers to a post office is provided for the 22,000 strong media team



International Broadcasting Centre/Media Press Centre

Offsite

Not all the events take place on the Olympic Park. At Broxbourne a white water canoe venue has been built which is already open to the public. At Weymouth the National Sailing Academy has had its marina expanded and will host the sailing. The Eton Dorney rowing centre has also been adapted to meet Olympic requirements. A temporary shooting venue is being built at Woolwich Barracks, the buildings can be dismantled and reused elsewhere after the Games.



Broxbourne White Water Canoe Course

Existing venues being utilised are the O2 for gymnastics, The Excel Centre for martial arts, table tennis and weightlifting, Wembley Arena for badminton and Earls Court for volleyball.

Tennis will be at Wimbledon and football at various stadiums around the country.

Parklands

A core feature of the London Olympic Park, to be known as the Queen Elizabeth Olympic Park after the Games, is the River Lee and associated landscaping. Early design decisions were how to open up the views of the river which were quite steep sided to soften hard edges and to create a variety of landscape styles through the Park. In essence in the north of the Park the ground has been rolled back from the river to create undulating slopes which are accessible to all and which create a natural amphitheatre around the river.

The area is planted out with 2,000 mature, natural species trees such as oak, willow, aspen, cherry and with thousands of wetland plants alongside the river which will be able to naturally flood into these areas.

To the south of the Park the landscaping takes on a more formal feel, especially around the stadium. A half mile long river side area is planted with flowering species from the different continents of the world so that visitors will be able to relate to plants from their home countries. A total landscape and parkland area of 100 hectares will have been created, important not only for the Games but to ensure the use of the Park in legacy.



The Parklands

Care has been taken during the creation of the parklands to include new habitats for various species, and several hundred bird and bat boxes have been installed as well as artificial otter holts. King Fishers have already been seen on the river.

Olympic Village

A central feature of every Olympic Park is the housing for athletes and officials. The Athletes' Village consists of 2814 apartments which will house 17,000 athletes and officials. The apartments which vary from one to four bedrooms are very specifically designed for legacy use and adapted for the Games primarily by not installing the kitchens which will create more bed space. The new kitchens will be retrofitted after the Games.

The apartments are ten storey structures mostly built around a football pitch sized landscaped quadrangle which sits at first floor level over a car park. Ten different architects ensured a variety of facade treatments around a consistent floor plate. The buildings are built to a BREAM level four specification ensuring low energy and water use, whilst 200 apartments are specifically designed for people with disabilities.

In legacy 50% of the apartments will be affordable homes whilst 50% will be for rent or sale in the open market. The Village was originally to be built by a private sector developer and lent to LOCOG for the Games. However the financial crisis of 2008 meant that funding was not available on sensible terms and too much risk would be left with the ODA. So it was decided to use our contingency monies together with other savings to fund the construction and then look to sell the village to recover the money. This has now been successfully achieved with the affordable homes bought by a housing association and the market homes by a private sector consortium. In addition to the housing a 1,800 pupil academy has been built along with a polyclinic for serving the legacy population.

Extensive landscaping of the central open area of the Athletes Village includes the planning of a further 2,000 mature trees up to 15 years old and water courses which flow down to a wetlands bowl and then feed into the River Lee. A further 6,000 homes are planned for the Olympic Park over the next 20 years.



The Olympic Village

Transport

Transport is a vital aspect of any Olympic Games, highlighted at the Atlanta Games when athletes missed their events due to transport problems. Transport is not only central to the athletes state of mind and preparation but also for the officials who move around between different venues, in addition to the hundreds of thousands of spectators travelling every day of the Games.

The whole transport operation has to take place whilst keeping London and the UK moving. In line with the city's aim of hosting a 'public transport' Games the base planning assumption has been that 80% of spectators will choose rail

as their preferred mode of travel. The remainder will be bus, coach, park and ride, water taxi and the most sustainable modes of walking and cycling.

The planning by the ODA of the transport requirements has to recognise the 800,000 extra journeys particularly on the underground, a normal day is in excess of 3 million journeys, and to take into account the likely timing of those journeys relative to the start and finish times of the events.

Investment has been made by the ODA of £500m in rail improvements. These have included expansion of the circulation capacity of Stratford Regional Station, track layout changes to improve capacity, a new DLR station adjacent to Stratford International, and co-funding with Transport for London the expansion of the whole DLR service by the addition of more carriages and longer platforms. Further co-financing of improvements to the North London Line, with Network Rail, has increased capacity by 45%.

During the Games a new high speed service running on the Channel Tunnel Rail Link will operate between St Pancras and Stratford International, and Ebbsfleet and Stratford International. Journey times will be only seven minutes between St Pancras and Stratford and ten minutes between Ebbsfleet and Stratford. There will be up to 12 trains an hour in each direction, each train consisting of 12 carriages, capacity will be 25,000 passengers an hour. Discussions between the ODA and Network Rail and 17 train operators have resulted in additional services and later running trains for the national rail services and a halt to all rail renewal works during Games time.

Park and ride services will operate around London which together with long distance coaches will bring spectators to a special transport mall being built on the Hackney Marsh playing fields adjacent to the A12 at the north of the Park.

To assure the timely and swift movement of athletes, officials, the Olympic family of some 5,000 and the media around London, between venues and hotels, there is a designated Olympic Route Network (ORN). These routes, some with lanes reserved for Olympic vehicles only occupy about 2% of London's road network but naturally cause some debate, particularly amongst taxi drivers and local businesses who fear an impact on their daily routine. This is being addressed by a major communications programme known as Traffic Demand Management (TDM) which seeks to inform, advise, and cause changes to normal goods delivery or work shift patterns so that by Games time London life, whilst inevitably being different, does not cause too much inconvenience.

Day to day oversight and delivery of London services during the Games will be carried out by TFL and their service operators. A central control facility will be able to monitor and manage road and rail including the management of several thousand road traffic signals. Out of London transport systems will be managed and operated by Network Rail, train and bus operators all of whom are used to dealing with major events and have contingency plans for congestion and other exceptional circumstances.

As an ODA priority theme accessibility was integral throughout all levels of transport planning and operation. The key areas developed with delivery partners to provide accessible transport during Games are:

- *Public transport infrastructure improvements e.g. platform levels, lifts, ramps*
- *Making the best use of existing accessible elements of public transport*
- *Provision of a Games time journey planner with accessible routes*

The Games present particular challenges that are unique to each host nation and the wider Games environment. Staff from LOCOG and the ODA were seconded to Beijing and Vancouver to work in operational and planning functions to gain vital experience.

Procurement

From the previous sections of this paper it will be clear that the ODA has been procuring a vast range of services and contractors from security to landscaping to major building and civil engineering. The procurement strategy had to assure value for money, programme adherence, fit for purpose, sustainable development whilst supporting our key themes of safety, equality and inclusion, environment, training and legacy.

Risks to the achievement of these objectives had to constantly be monitored at every level to ensure they could be identified and mitigated.

A series of board-level workshops were held at an early stage in which a detailed impact analysis of each policy ambition was considered. The impact and likely level of achievement in each policy area considering time, budget and practical constraints was debated in depth. The result was a widely endorsed procurement policy (ODA 2007) that focused on best value in each tender rather than cost. The assessment of best value was built around the use of a balanced score card.

The policy was subject to widespread consultation before publication with the supply chain and other key stakeholders. The procurement code then became an operational 'bible' which ensured a consistent treatment of areas such as evaluation criteria, contract terms and performance metrics all based on the balanced scored card.

A second fundamental procurement activity was the design of a packaging strategy. This constituted the grouping of requirements into packages to be put to the market to enable effective delivery, encourage a strong market response to drive competition and ensure delivery and risk mitigation were managed effectively. The model created eight clusters that could be applied generically to projects both on and off the Olympic Park and which could be expanded to accommodate any additional project specific requirements that arose within the clusters. Figure 5 illustrates the clusters, with two cross cutting clusters of logistics and security.

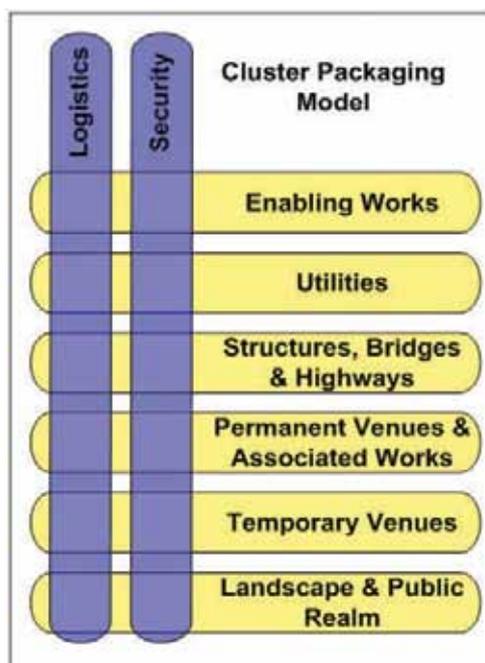


Figure 5

The model has been effective in supporting delivery and programme management. Supply capacity was not exceeded within the clusters and delivery was to programme. The creation of the logistics clusters enabled achievement of several of the ODA's policy objectives particularly in the area of environment and suitability. Provision of centrally sourced concrete, aggregates, fuels and waste services helped to ensure we exceeded our target of at least 50% of bulk materials being transported by rail or water freight. It also enabled us to use standardised supplies and components and the use of the centrally sourced timber supply panel mentioned earlier.

Contractually we selected the NEC3 suite of contracts. They provide:

- *A flexible approach giving a range of options relative to the level of design information available and the procurement option being considered.*
- *The proactive management of risk as an inherent and fundamental element of all of the contract forms.*
- *Transparency for the assessment of the impact or charge.*
- *A collaborative approach supporting timely delivery which was fundamental for the ODA.*
- *A proven record of use and understanding within the supply chain.*
- *For all the major stadia we used the Design and Build target price forms.*

I would now like to return to the key themes I have mentioned previously. At an early stage it was recognised that the Olympic project created an opportunity to raise the bar in a number of areas where it was felt the construction industry could do better and ensure that the 2012 Games contributed to a legacy of economic, social and environmental benefits for London and the UK.

These themes were:

- *Health, safety and security*
- *Employment and skills*
- *Sustainability*
- *Equality, diversity and inclusion*
- *Legacy*
- *Design and accessibility*

The ODA developed and published a strategy for each of these themes, outlining strategic goals as well as specific objectives which the authority committed to achieve in the course of the delivery of the construction programme.

To ensure these programme wide objectives for the priority themes were delivered specific targets were deployed through individual projects and the tier one contractors.

There is no doubt in my mind that this consistent focussed attention by a client body, reflected in contractual documents and a continuous monitoring and publishing of performance can deliver real change. The following slides (figures 6.1, 6.2, and 6.3) show some of the results in these key themes.

Employment – creating job & training opportunities

- 40,000 - have worked on the Olympic Park and Olympic Village during the Big Build phase of the project
- 25% - approximately one in five people are from the five Host boroughs – Greenwich, Hackney, Newham, Tower Hamlets, Waltham Forest
- 13 % - Previously unemployed
- 457 - apprentices have worked on the project



Health and Safety

- The ODA has achieved health and safety record better than industry average since start of project
- The Olympic Park has an on-site medical centre with health checks for every worker.
- 70 million hours worked and 24 million hours without RIDDOR reportable incident
- Accident Frequency Rate (AFR) since commencement of project is 0.17, well below the industry average
- Education and health promotion campaigns are run across the site



Sustainability

- 75p in every £1 spent on long-term regeneration of the area
- 50% of construction materials delivered to the Olympic Park by rail or water.
- 90% of demolition materials from site reclaimed for re-use of recycling
- 100% timber for sustainable sources
- 58% Potable water reduction



Figures 6.1 6.2 6.3

Conclusion

The infrastructure for the 2012 Games has been delivered on or ahead of time and under budget.

The principal reasons for this are as follows.

- *Cross party political support*
- *A fixed deadline*
- *Early attention to Governance structures*
- *A sensible budget*
- *Clear client leadership*
- *Rigorous approach to programme control and change management*
- *Strong assurance and risk management*

As part of its legacy the ODA has published in conjunction with various professional organisations on a dedicated website, open to the public, some 300 separate papers which identify lessons learnt from the delivery of this major programme. These can be found at www.london2012.com/learninglegacy.

Today, December 1 2011, there are only 35 weeks to go before the Opening Ceremony. All of the venues are complete and most of the Athlete Village has been handed over to LOCOG. The ODA's task is largely complete and we now hand over the baton to LOCOG. For LOCOG the next eight months will be a period of intense and accelerating activity.

The Opening and Closing Ceremonies have to be planned and rehearsed. The broadcasters have to install their studios, cameras and miles of cabling, 16,500 fixed telephones and 7,000 internet stations will be installed across 894 locations. 75,000 volunteers have to be recruited and trained and 65 hectares of tents erected for retail, catering and back of house facilities. The security channels similar to an airport must be installed and temporary hired seating erected at locations such as Greenwich Park for the equestrian, Eton Dorney for the rowing, Horse Guards Parade for the beach volleyball.

During this period trial events will be held at various venues to ensure the timing equipment and event logistics work satisfactorily.

There is much to be done but I am confident that in July next year London will be ready to host the greatest show on earth.



The completed Olympic Park

The Royal Academy of Engineering

The Royal Academy of Engineering - Britain's national academy for engineering - brings together the country's most eminent engineers from all disciplines to promote excellence in the science, art and practice of engineering. Our strategic priorities are to; drive faster and more balanced economic growth; lead the profession; foster better education and skills and promote engineering at the heart of society.

The Lloyd's Register Educational Trust

The Lloyd's Register Educational Trust (The LRET) is an independent charity that was established in 2004. Its principal purpose is to support advances in transportation, science, engineering and technology education, training and research worldwide for the benefit of all. It also funds work that enhances the safety of life and property at sea, on land and in the air. The LRET focuses on four categories:

- 1 **pre-university education:** through appropriate organisations (but not individual schools), promotes careers in science, engineering and technology to young people, their parents and teachers;
- 1 **university education:** provides funding for undergraduate and post-graduate scholarships and awards at selected universities and colleges (does not fund students directly);
- 1 **vocational training and professional development:** supports professional institutions, educational and training establishments working with people of all ages;
- 1 **research:** funds existing or new centres of excellence at institutes and universities.

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