Sustainable Design
A partnership between architecture & engineering
Master Builder
Michaelangelo

BUILDERMAS TER
Traditional Collaborative Design Approach

Integrated Design Approach
Velodrome, London 2012 Olympics
London, UK

Category: Sport
Value: Not Disclosed
Dates: 2007 - 2012
Client: Olympic Delivery Authority
Architect: Hopkins Architects
Structural Engineer: Expedition Engineering
Landscape Architect: Grant Associates
Quantity Surveyor: CLM Delivery Partner
BDSP Role: M & E Services Consultant
Environmental Consultant
Lighting Consultant
How to break a world track record

The clue lies in the periodic table
How to break a world track record
Gas physics – the science

Molecular mass of dry air
Nitrogen = 28 & Oxygen = 32

Molecular weight of water
Hydrogen = 2 & Oxygen = 16

As you increase the humidity, the water molecules displace some of the oxygen and nitrogen molecules.

Therefore

For a constant volume, air density decreases

How to break a world track record
… and with it comes speed!
Velodrome, London 2012
The conflict of interest – cyclist v spectator

- Hot & humid - min 24°C, ideally 28°C
- Minimal air movement
- 2000 lux evenly distributed

Velodrome, London 2012
International events v general training conditions

- 18° to 26°C according to season
- Good air movement in summer
- 300 lux evenly distributed
Velodrome, London 2012
International events v general training conditions

- Hot & humid - min 24°C, ideally 28°C
- Minimal air movement
- 2000 lux evenly distributed
- 20 days per year

- 18°C to 26°C according to season
- Good air movement in summer
- 300 lux evenly distributed
- 345 days per year

Velodrome – Environmental Concepts

Summer Strategy
1. Natural Ventilation Air Inlet
2. Natural Ventilation through Fruit Bowl
3. Natural Ventilation Air Outlet
4. Fans to boost Natural Ventilation

Winter Strategy
1. Underfloor Heating
2. Heated Fresh Air
3. De-saturation Fans

Environmental Design Concepts – Heating/Cooling/Ventilation
Airflow Studies
Option 1

Airflow Studies
Option 2
Airflow Studies
Option 7 – Final

London 2012 Olympics – Environmental Targets
Velodrome Carbon Emissions

Targets
Predicted
London 2012 Olympics – Environmental Targets
Velodrome Water Consumption

Targets
Predicted

Velodrome, London 2012
why?

lack of knowledge?
lack of technology ?
are we blind; how big is our ego?
do we lack capital?
so what is the problem?
Attitude!

Integrated Design Approach

ARCHITECTURE

ENVIRONMENTAL ENGINEERING

STRUCTURAL ENGINEERING
The Role of the Environmental Consultant
Bringing Architecture & Engineering together

Design Team Work – it is all about communication
Accra, Ghana

One Airport Square
Accra, Ghana
One Airport Square
Structural/architectural/environmental integration

Solar protection – Irradiation mapping on façades - Overhangs
Typical floor plate – overhangs
Horizontal shading - In-situ concrete

Typical floor plate – design development/optimisation
Horizontal shading – overhangs studies

Typical Floor – as per 15th of April
Typical Floor – as per 16th of May
Overhangs parametric study – V2 floor plate
% energy in use reduction v. overhang depth & orientation

One Airport Square
Daylight distribution

Typical Floor Modelling
Glass - Guardian Clear with Sun Guard coating
External structural beams included
Daylight distribution on a typical floor

For 60% of the UA
Daylight Factor > 2%
Meets Green Star targets

Glare study
One Airport Square
Daylight – Atrium canopy

Guardian glass 69% light transmittance

Parametrics
Varying Transparent/Opaque ratios
One Airport Square

Daylight – Atrium canopy

Solar Control glass
50% light transmittance

80% with fins
min value 3.69% DF

60% with fins
min value 2.83% DF

Level +8
Level +7
Level +6
Level +5
Level +4
Level +3
Level +2
Level +1
Level M
Level G

Parametrics
Varying Transparent /Opaque ratios

One Airport Square

GS energy model – Inputs

Office Usable Floor Area
Total Car Parking Area
Total Basement Car Parking Area
General Area (including Car Parking)

ENERGY USE

<table>
<thead>
<tr>
<th>Resource</th>
<th>SADH</th>
<th>Net Building</th>
<th>Actual Building</th>
<th>User and owner</th>
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<tr>
<td>Fuels (kWh)</td>
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<td>Car Park Lighting</td>
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<td>External Lighting</td>
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<td>Lighting (work)</td>
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<td>Staff Power (users)</td>
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<tr>
<td>Supplementary Cooling (tenant)</td>
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<tr>
<td>Utility (all energy)</td>
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<td>1,072,338</td>
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</tbody>
</table>

- Includes most energy users:
  - Space cooling
  - Fresh air provision
  - Fans, pumps consumption
  - Car Park ventilation consumption
  - etc ....
One Airport Square
GS energy model – Results

Mechanically ventilated model (cooling set point at 26°C): achieves 7 Green Star points and is 40% better than the notional model.

Mixed mode model (cooling at 28°C): achieves 10 Green Star points and is 50% better than the notional model.
Diagonal grid structure

Diagonal grid structure – precast concrete
Diagonal grid structure – precast concrete
Prefabrication – manual labour

Off site (but very close) batch production
Diagonal grid structure – precast concrete
Installation on site

One Airport Square, Accra
Thinking tomorrow – acting today

Greenhouse gas emissions will be increasingly scrutinized, regulated and priced
Political, Legislative & Economic Drivers
Environmental Timeline

Legislative Framework
The effect of climate change on companies’ operations are now so tangible that the issue is best addressed with the tools of a strategist, not the philanthropist.
Implementing best practices in managing climate-related costs is the minimum required to remain competitive
Go beyond operational effectiveness and become strategic

1st Cost (short term/immediacy) v. Operational/Lifetime Costs (medium/long term)
Capital Cost v Operational Costs

Initial Capital Costs

Recurrent Costs:
Maintenance, depreciations, staff-related costs etc.

25 Year whole life expenditure profile of office occupiers – inc salary

Longevity of Investment
Rate of change over time

 replacements

0 25 75 100

IT
Furniture
M & E
Facade
Structure
Foundations
Future proofing – consider tomorrow today strategically, so as to be able to adapt to both foreseeable and unforeseeable market changes
Future Proofing
Today vs Tomorrow

TODAY

- Water
- Transport
- Energy
- Pollution
- Noise/Air
- Biodiversity
- Climate / Outdoor
- Amenity
- Waste

TOMORROW

- Water
- Transport
- Energy
- Pollution
- Noise/Air
- Biodiversity
- Climate / Outdoor
- Amenity
- Waste

Extremely Relevant
Very Relevant
Relevant
Not Very Relevant

Carbon Exposure
Design Methodology – The Economic Case

\[
\text{Design Methodology} = \frac{\text{Efficiency}}{\text{Renewables}} = \% \text{X}
\]
Sao Paulo, Brazil

Brooklin IV
Sao Paulo, Brazil
Typical floor plan
Cellular plan configuration

Typical floor plan
Open plan configuration
Typical floor section
Precast concrete panels – thermal mass

Office Floors
Optimising thermal performance

Case A - Typical Building in the North

Energy Optimisation of a typical office floor

The design optimisation process utilises an internal computer-based model of the building. The model considers a range of factors, including

- Internal heat gains
- External heat gains
- Ventilation heat gains
- Lighting heat gains
- Equipment heat gains
- Occupant heat gains

The model is calibrated to match the actual performance of the building, ensuring accuracy in the simulation.

Case B - Manual ventilation and thermal control

Case C - Rose Control

Optimising Cooling Loads

Case D - Spraying office approach

If the heat generated in the office space exceeds the capacity of the cooling system, the excess heat will be discharged to the external environment. The efficiency of the cooling system can be optimised by adjusting the system parameters, such as the setpoint temperature and the airflow rate.

The following graphs depict the cooling load reduction achieved by implementing different control strategies. The percentage reduction is calculated based on the difference between the cooling load with and without the control strategy:

- Case A: 61%
- Case B: 69%
- Case C: 77%

The bar chart on the right indicates the proportion of the cooling load that is reduced by each control strategy.
Office floors – façade optimisation
Daylighting studies

Economic framework – creating ‘value’
Sustainability is the key driver of innovation

Environmental design - value
Different energy prices – moderate, high and extreme increase in energy price

Investment Return

Day 0
Occupancy Start

Green Building - GB
GB - Moderate Increase
GB - High Increase
GB - Extreme Increase

Traditional Building - TB
TB - Moderate Increase
TB - High Increase
TB - Extreme Increase
Achieving more with less – truly intelligent design, requires appropriate ‘thinking/design time’ – saving on design time is a false economy

each building has its unique set of issues to be managed

Intelligent/integrated design – choosing the right team

paying proportionately more on fees to deliver intelligent design can generate disproportionate increase in asset value
Economic Framework
Cost v Value

Risk management

Speed of construction
Minimisation of waste

Prefabrication
Use technology to design out technology

Apply sophisticated design tools to simplify design solutions

Visual and operative prototyping –

BIM – embedded intelligence

Achieving more with less – truly intelligent design, requires appropriate ‘thinking/design time’ – saving on design time is a false economy

each building has its unique set of issues to be managed
Intelligent/integrated design – choosing the right team
paying proportionately more on fees to deliver intelligent
design can generate disproportionate increase in asset
value

we should challenge and be prepared to be
challenged in an open and constructive debate

we must change our mind set
We can't solve problems by using the same kind of thinking that we used when we created them.

A. Einstein