National Conference On Green Design

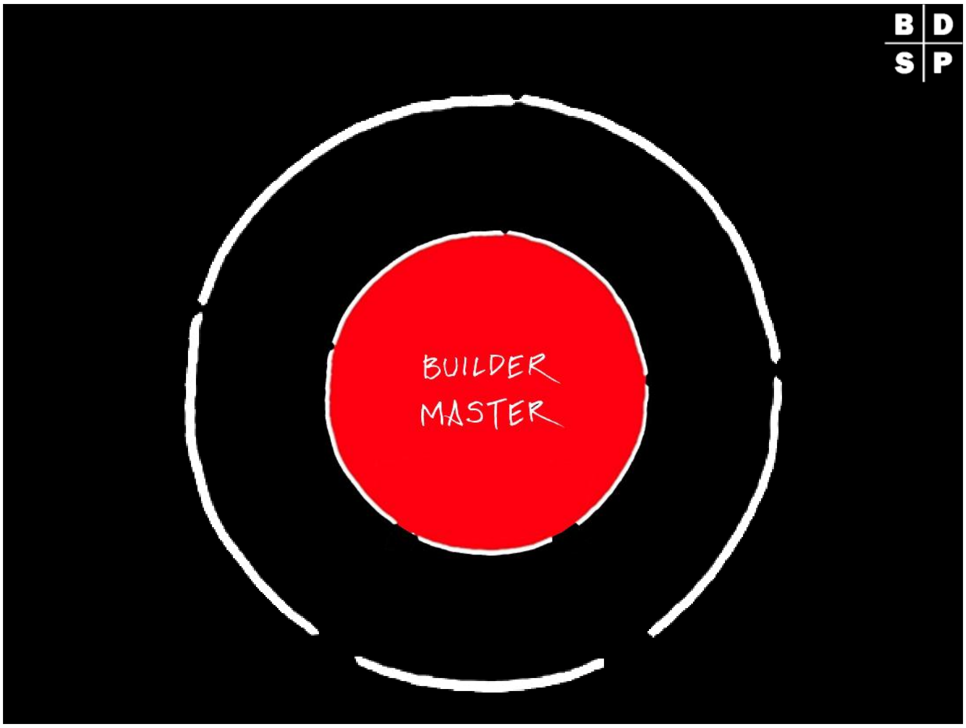
Klaus Bode – 15th February 2013

B D
S P

Sustainable Design

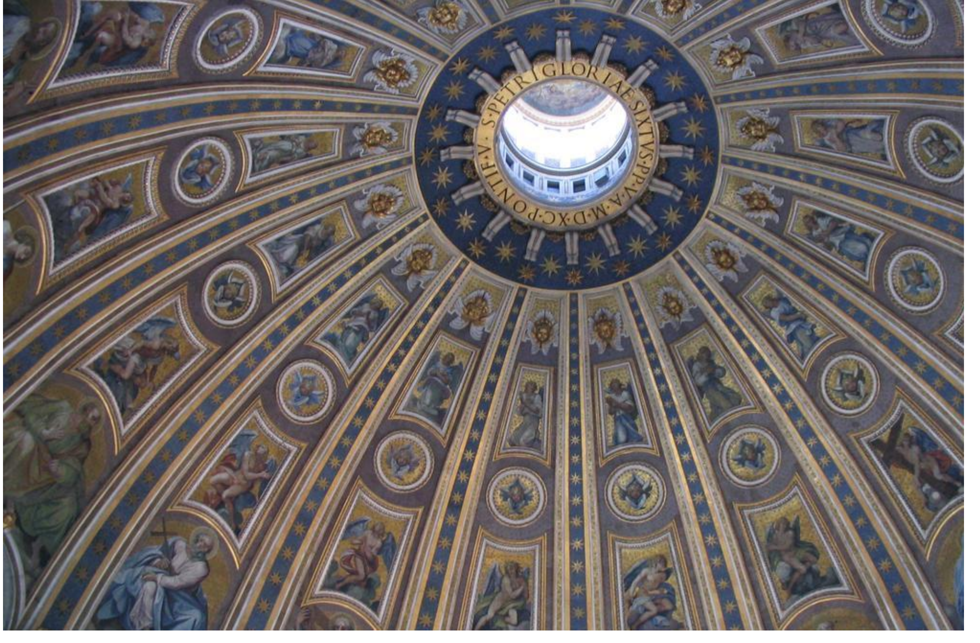
A partnership between architecture & engineering

B D
S P



Master Builder
Michaelangelo

St. Peter's, Rome

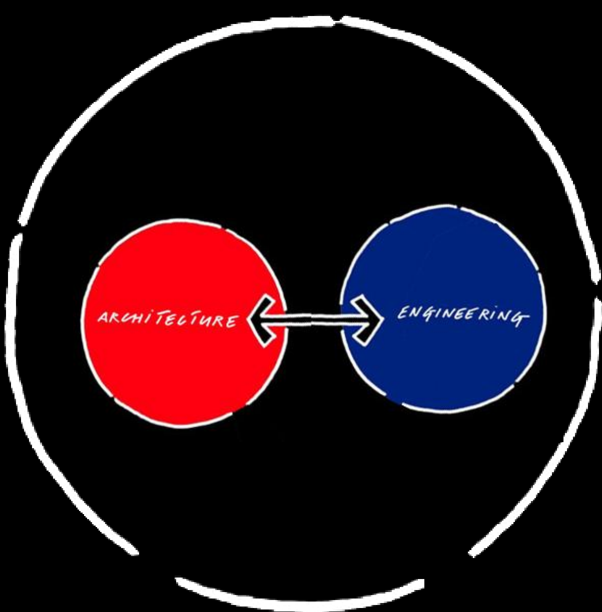


Master Builder
Dogon Village Elder

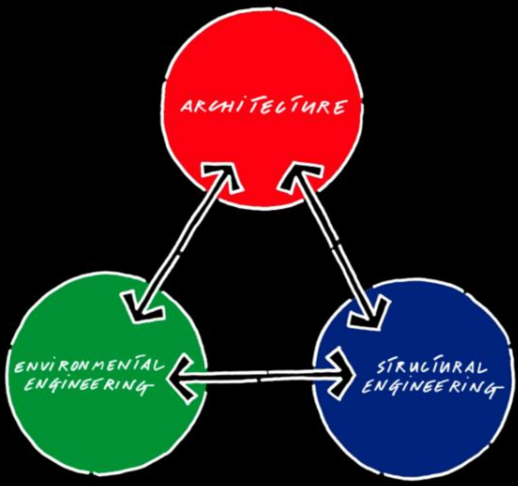
Dogon Village, Mali

BDSP

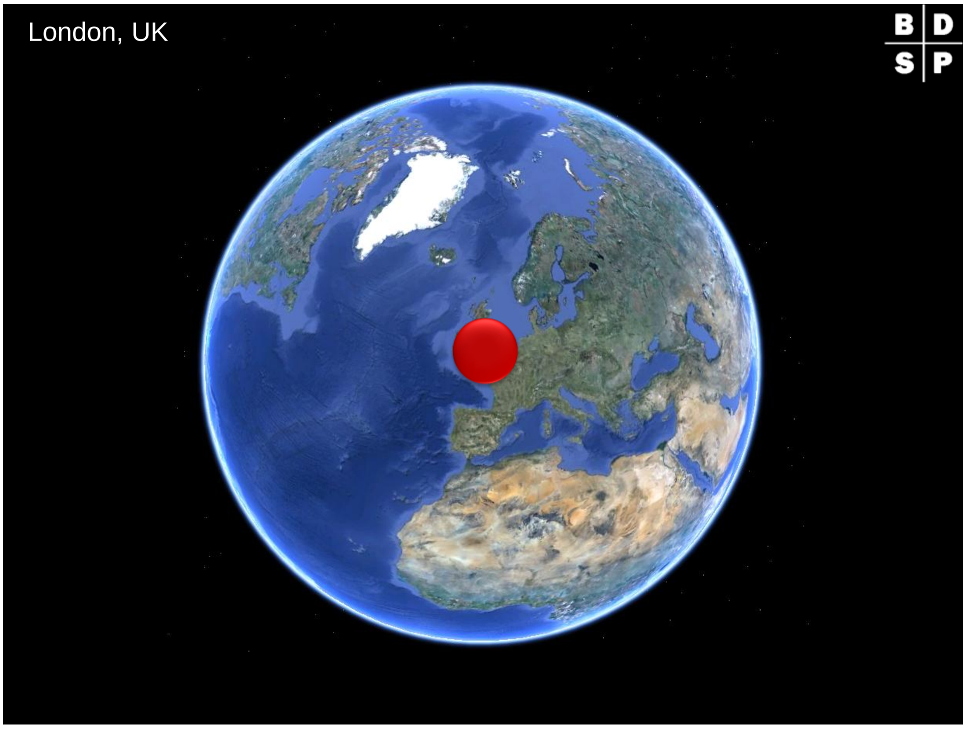
BDSP



Traditional Collaborative Design Approach



Integrated Design Approach


London, UK
B D
S P

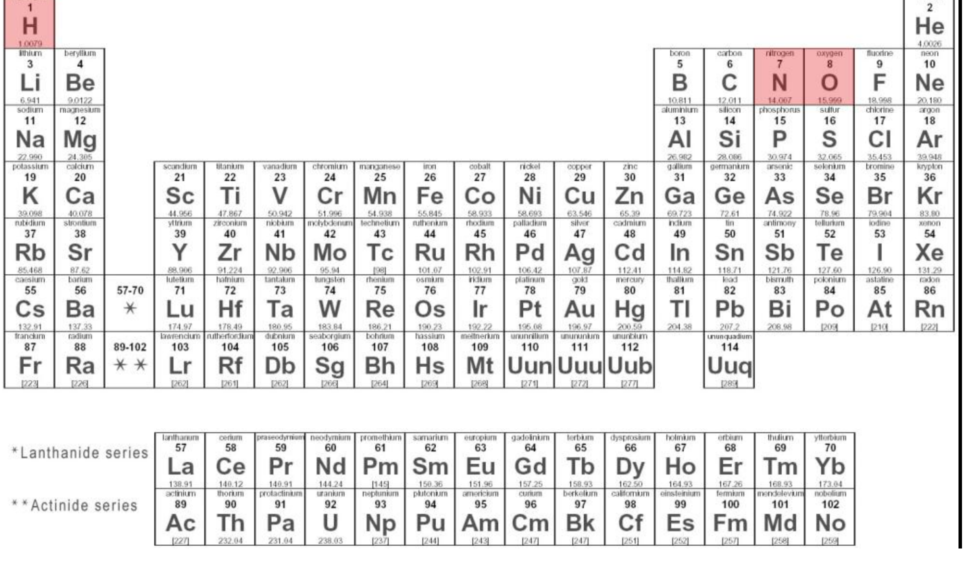

Velodrome, London 2012 Olympics
London, UK
B D
S P
Category: Sport
Value: Not Disclosed
Dates: 2007 - 2012
Client: Olympic Delivery Authority
Architect: Hopkins Architects
Structural Engineer: Expedition Engineering
Landscape Architect: Grant Associates
Quantity Surveyor: CLM Delivery Partner
BDSP Role: M & E Services Consultant
Environmental Consultant
Lighting Consultant

How to break a world track record

B D
S P

How to break a world track record
The clue lies in the periodic table

B D
S P



How to break a world track record

Gas physics – the science

BDSP

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

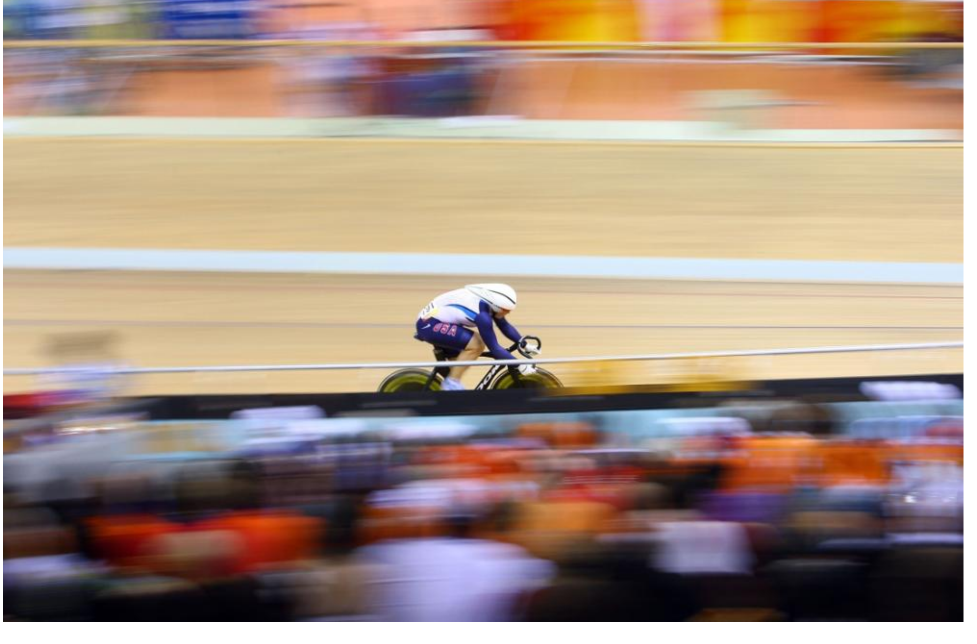
therefore

for a constant volume, air density decreases

How to break a world track record

… and with it comes speed!

BDSP



Velodrome, London 2012
The conflict of interest – cyclist v spectator

Velodrome, London 2012
International events v general training conditions

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

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

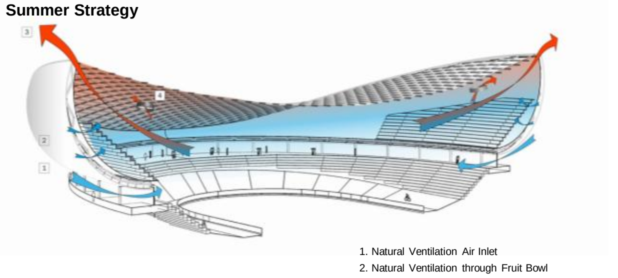
Velodrome, London 2012
International events v general training conditions

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

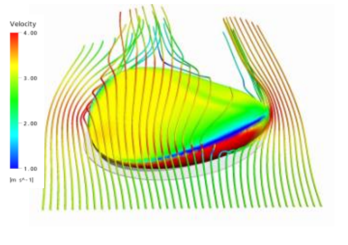
- 18° to 26°C according to season
- Good air movement in summer
- 300 lux evenly distributed
- 345 days per year

Velodrome – Environmental Concepts

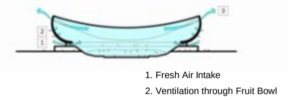
Summer Strategy



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

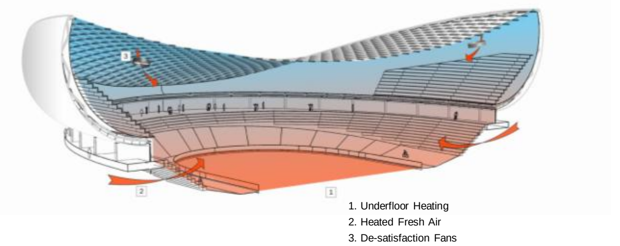


Natural Ventilation



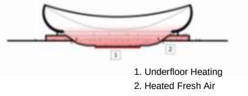
1. Fresh Air Intake
2. Ventilation through Fruit Bowl
3. Stale Air Exhaust

Winter Strategy



1. Underfloor Heating
2. Heated Fresh Air
3. De-satisfaction Fans

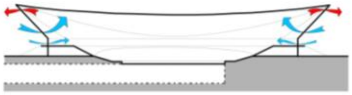
Active Heating

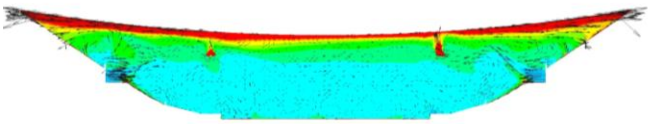


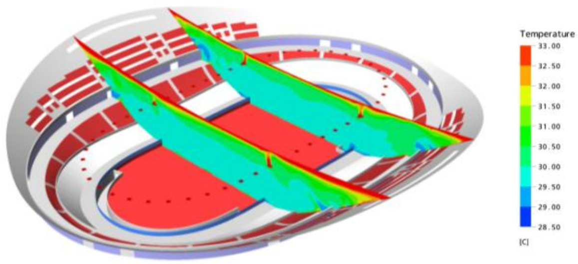
1. Underfloor Heating
2. Heated Fresh Air

Environmental Design Concepts – Heating/Cooling/Ventilation

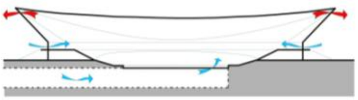
Airflow Studies
Option 1

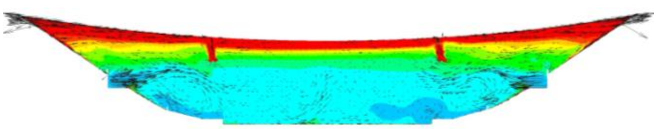


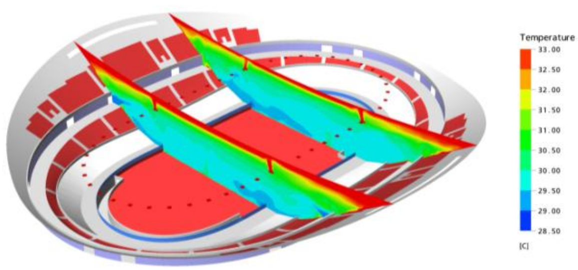




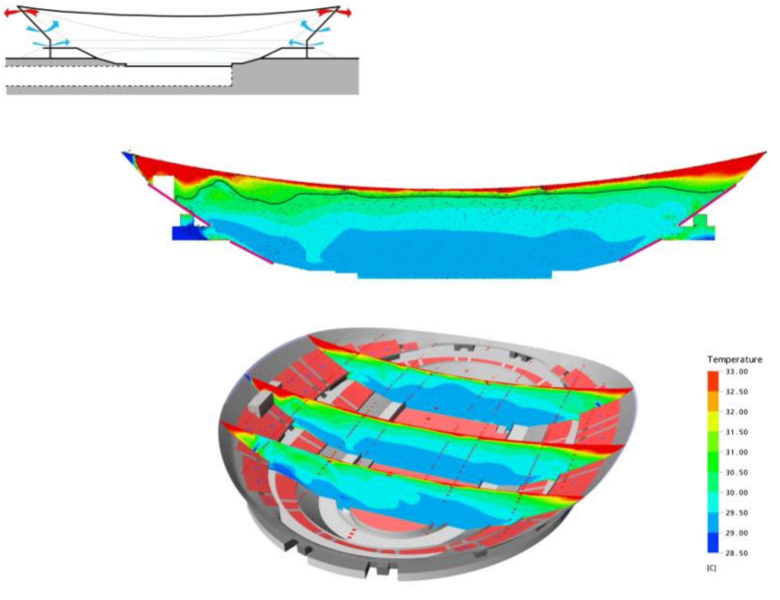
Airflow Studies
Option 2



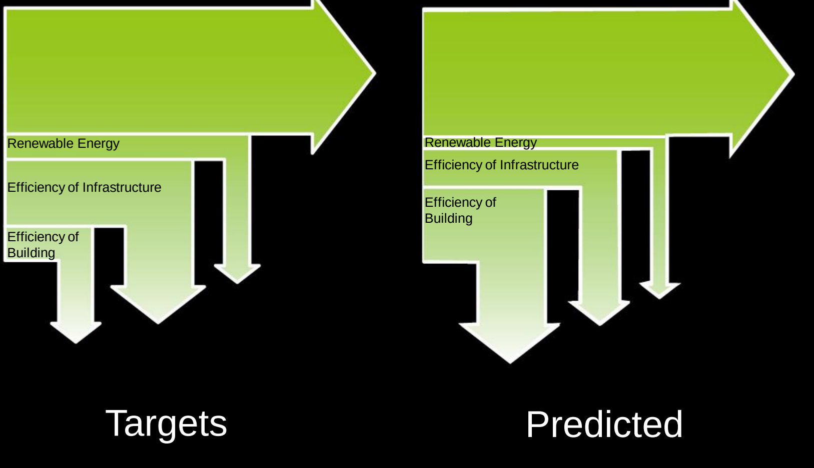




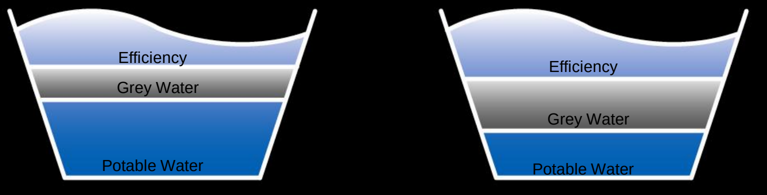
Airflow Studies
Option 7 – Final



London 2012 Olympics – Environmental Targets
Velodrome Carbon Emissions



London 2012 Olympics – Environmental Targets
Velodrome Water Consumption

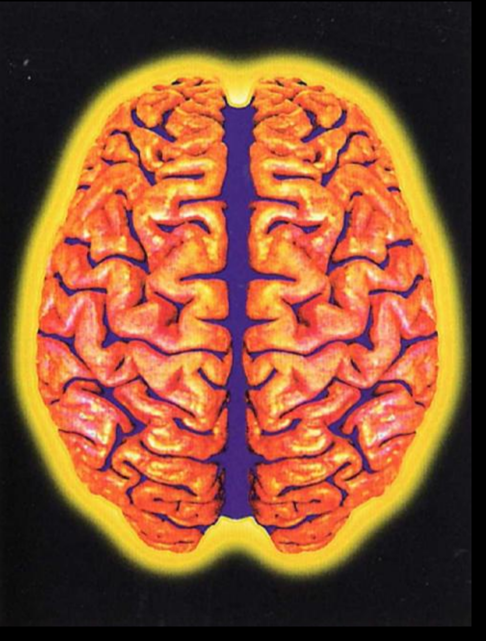


Targets Predicted

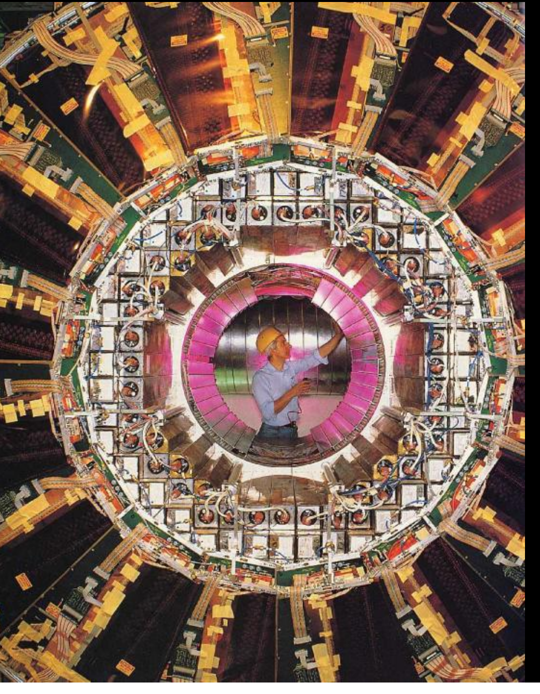
Velodrome, London 2012

why ?

lack of knowledge ?



lack of technology ?



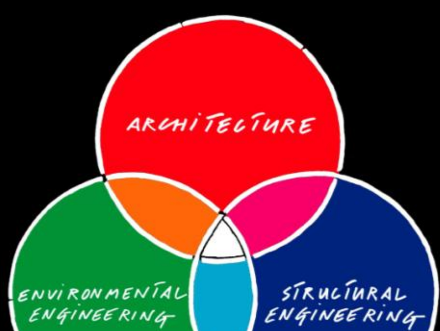
are we blind; how big is our ego?

do we lack capital?

so what is the problem?

Attitude !

Integrated Design Approach



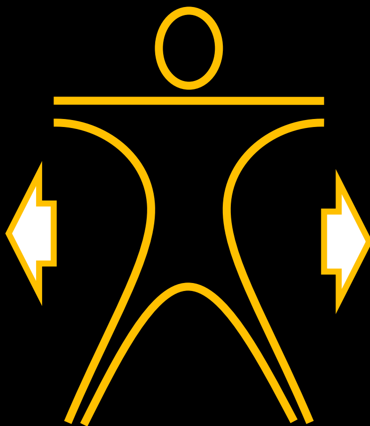
The Role of the Environmental Consultant

Bringing Architecture & Engineering togther

Architect

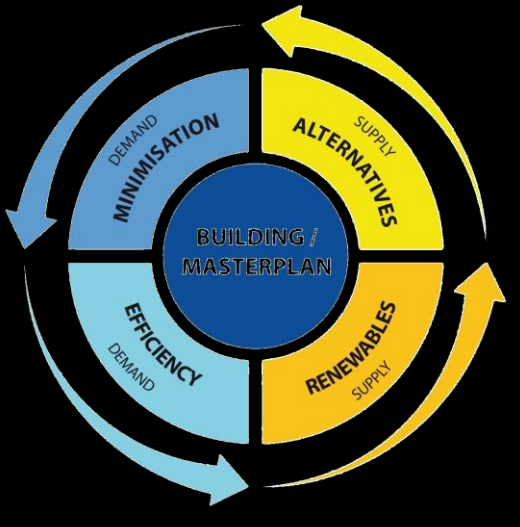
Environmental Consultant

Engineer

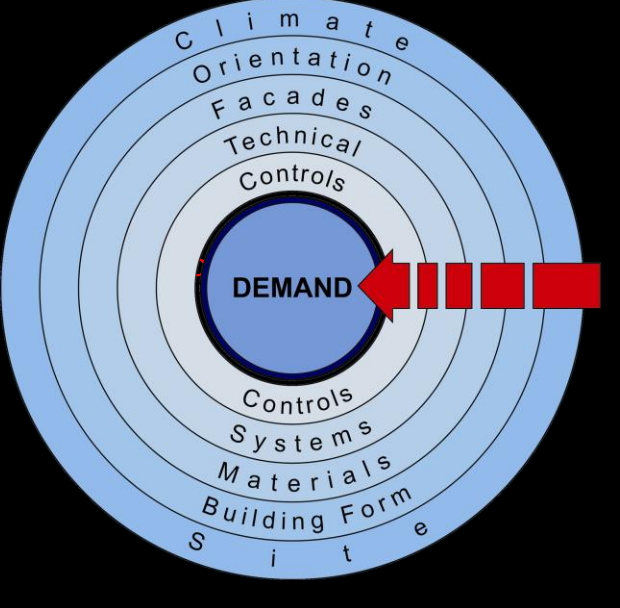


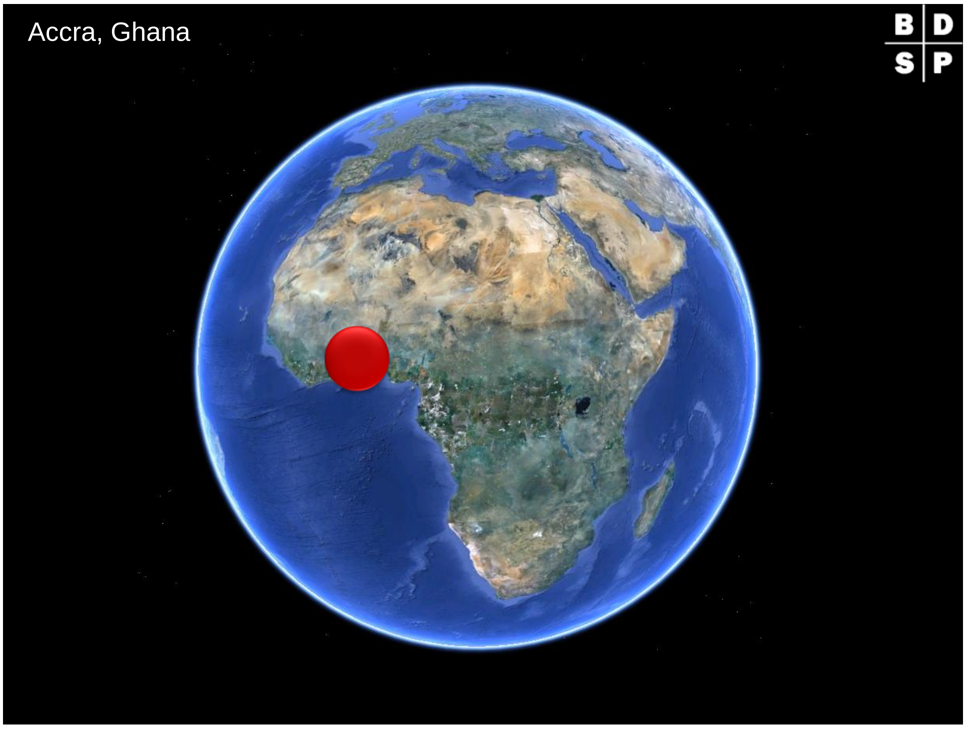
Design Team Work – it is all about communication

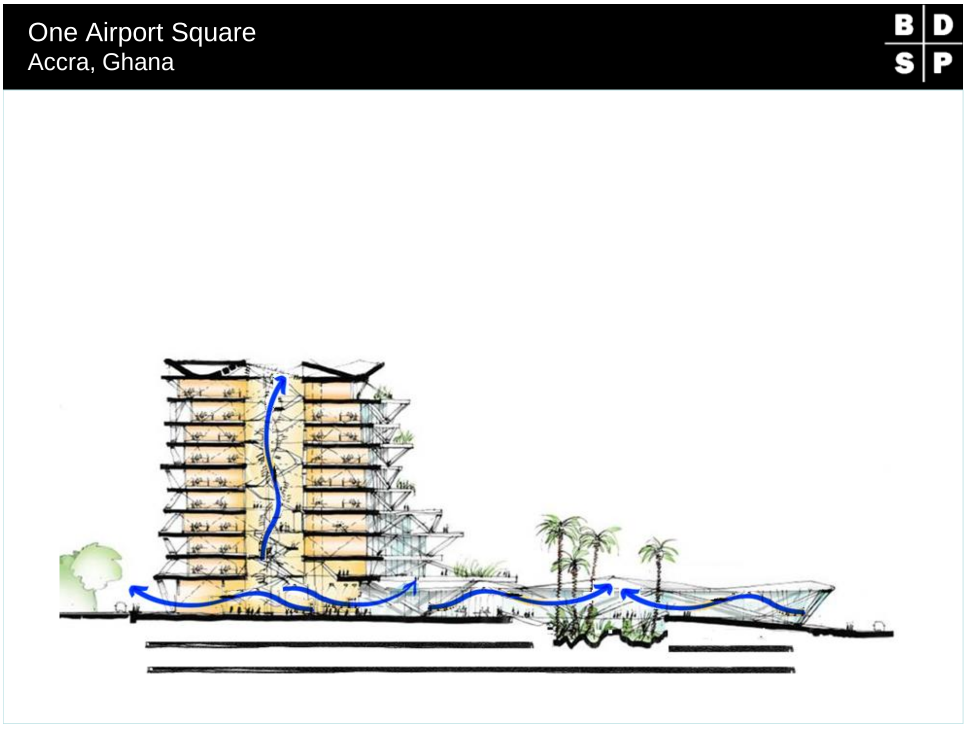
BDSP Design Methodology



BDSP Design Approach

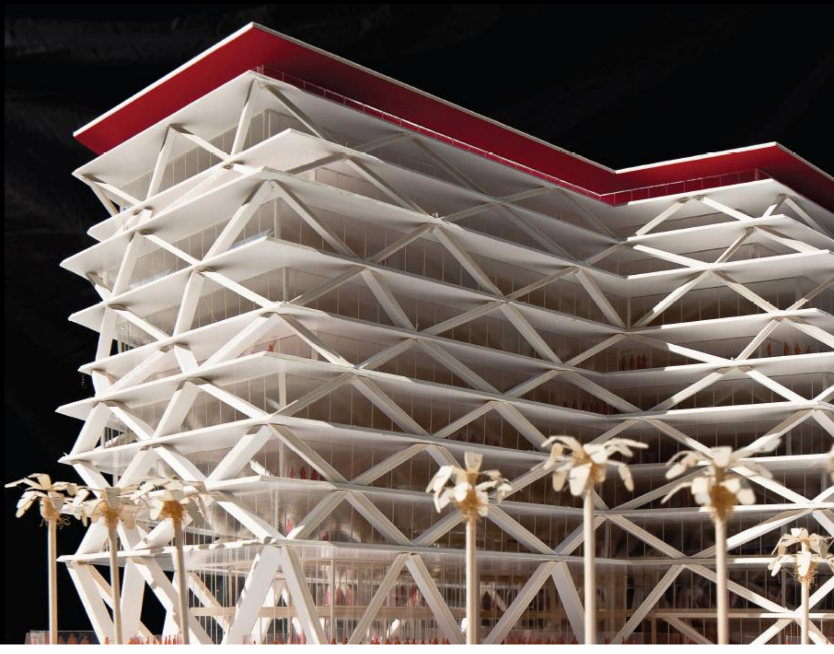



Accra, Ghana
B D
S P


One Airport Square
Accra, Ghana
B D
S P

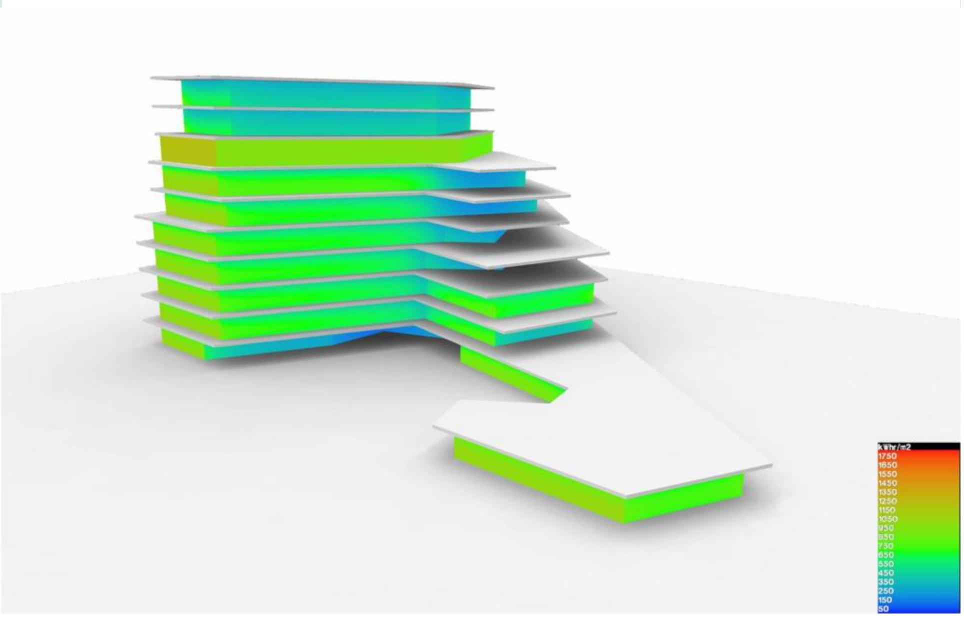
One Airport Square
Structural/architectural/environmental integration

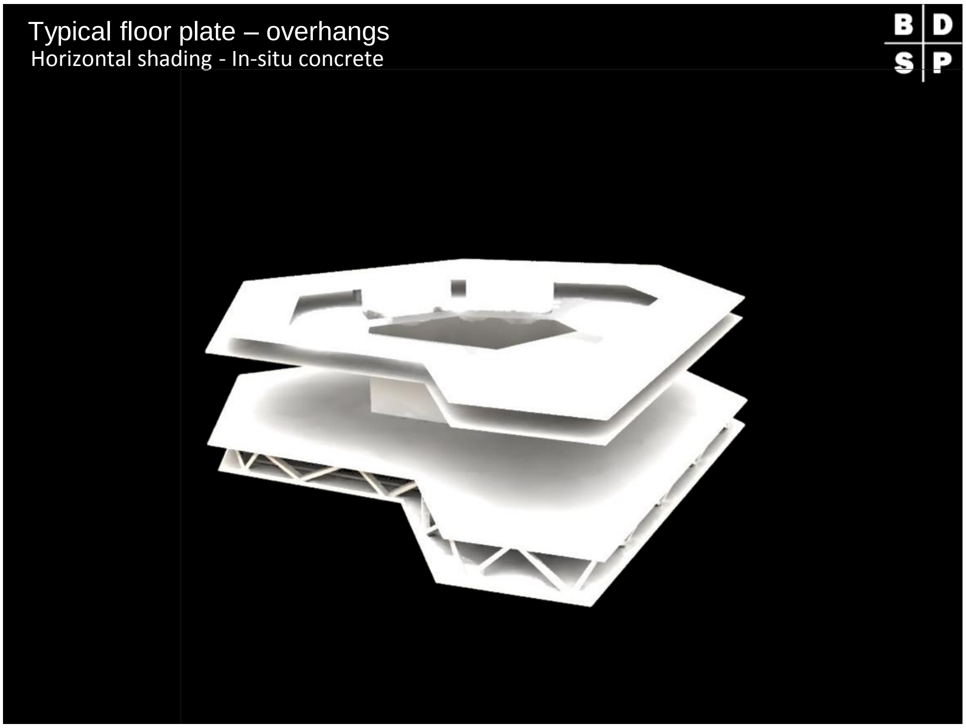
BDSP

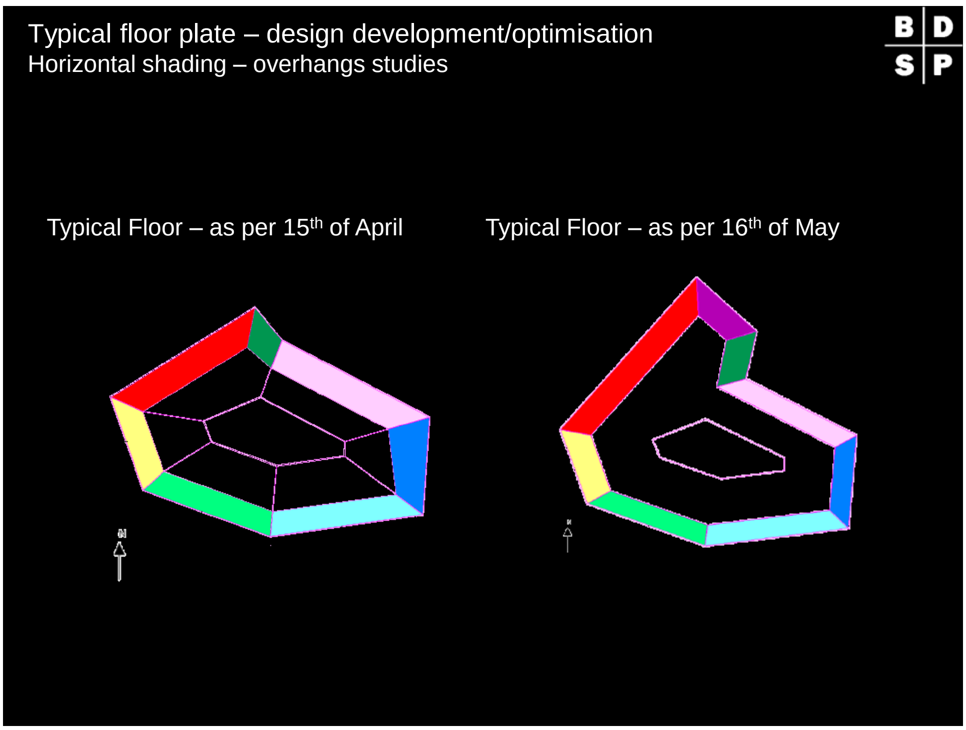


One Airport Square
Solar protection – Irradiation mapping on façades - Overhangs

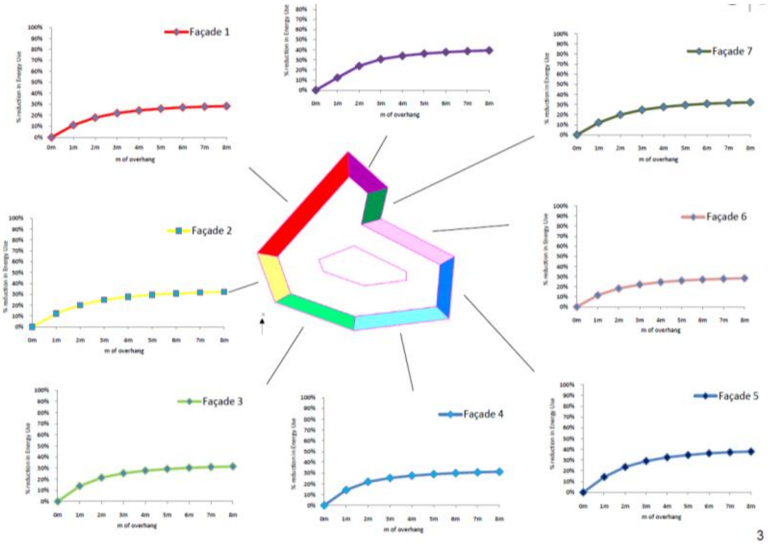
BDSP



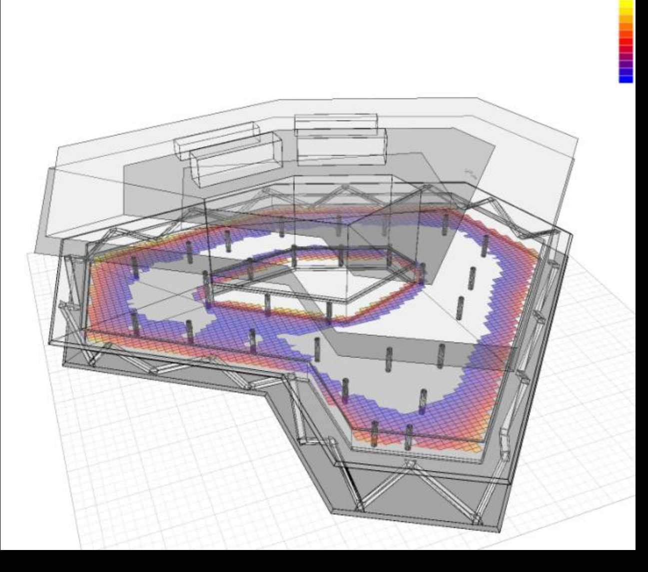

Typical floor plate – overhangs
Horizontal shading - In-situ concrete


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

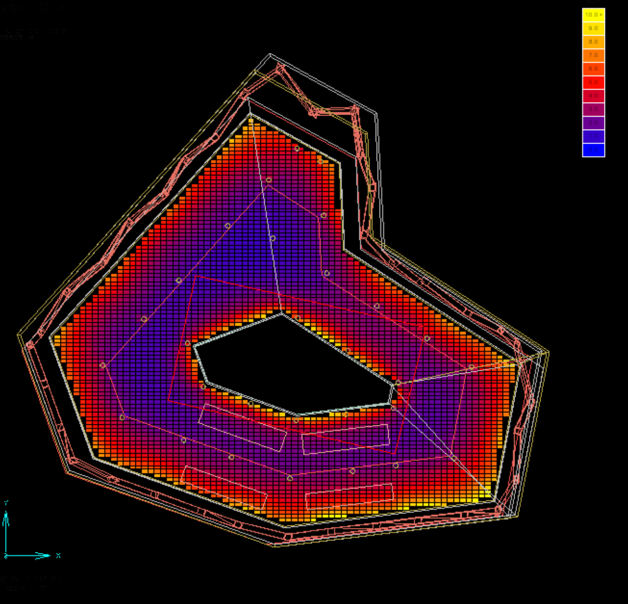


Typical Floor Modelling

Glass - Guardian Clear with Sun Guard coating

External structural beams included

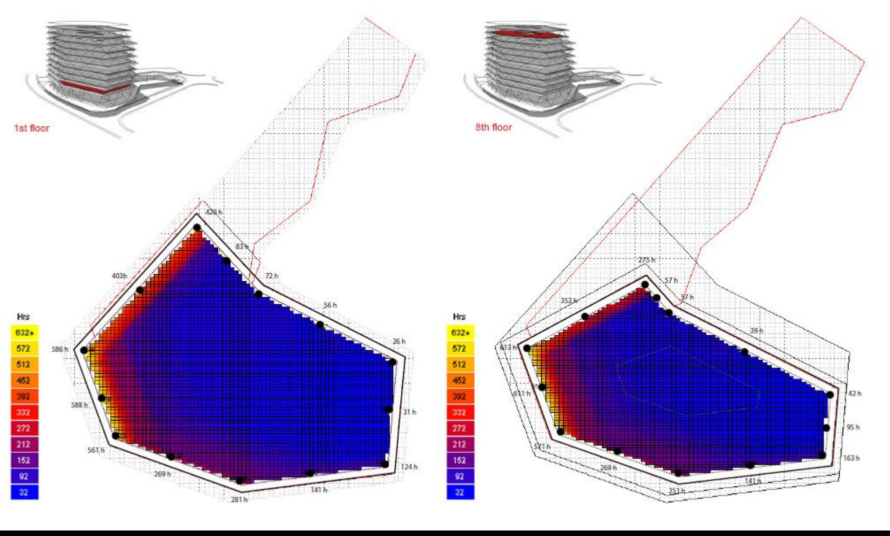
One Airport Square
Daylight distribution on a typical floor



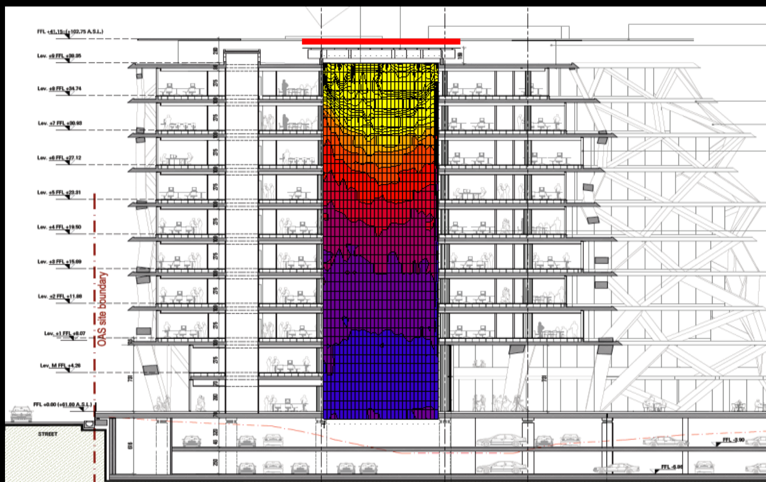
For 60% of the UA
Daylight Factor > 2%

Meets Green Star targets

One Airport Square
Glare study

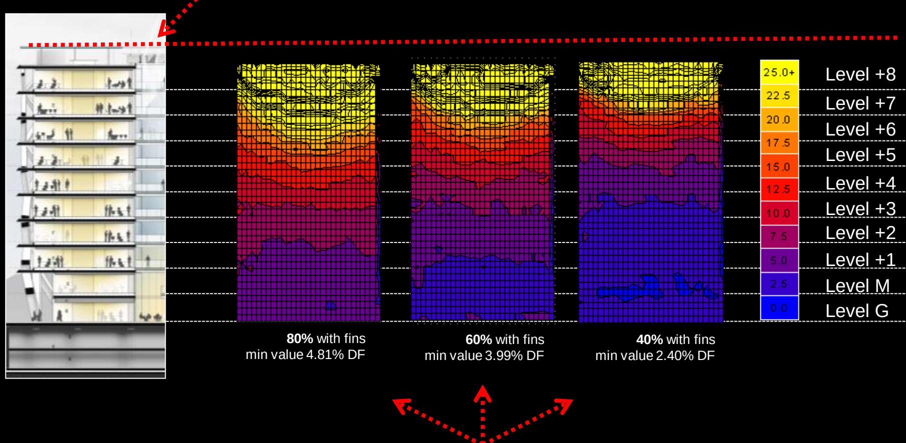


One Airport Square
Daylight – Atrium canopy



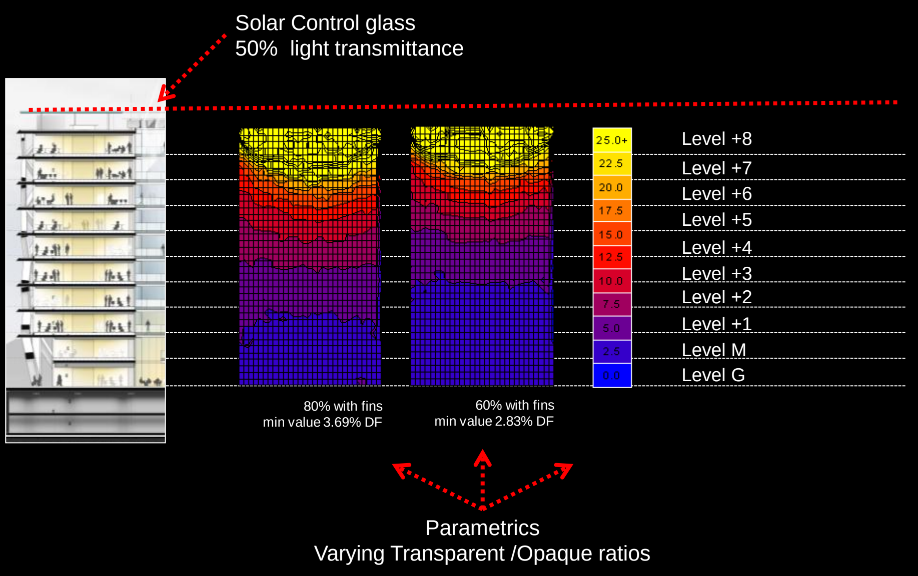
One Airport Square
Daylight – Atrium canopy

Guardian glass
69% light transmittance



Parametrics
Varying Transparent /Opaque ratios

One Airport Square
Daylight – Atrium canopy



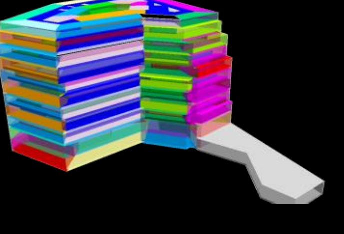
One Airport Square
GS energy model – Inputs

Office Usable Floor Area	15,200 m²
Total Car Parking Area	7,058 m²
Sub Basement Car Parking Area	3,347 m²
External Area (excluding Car Parking)	3,516 m²

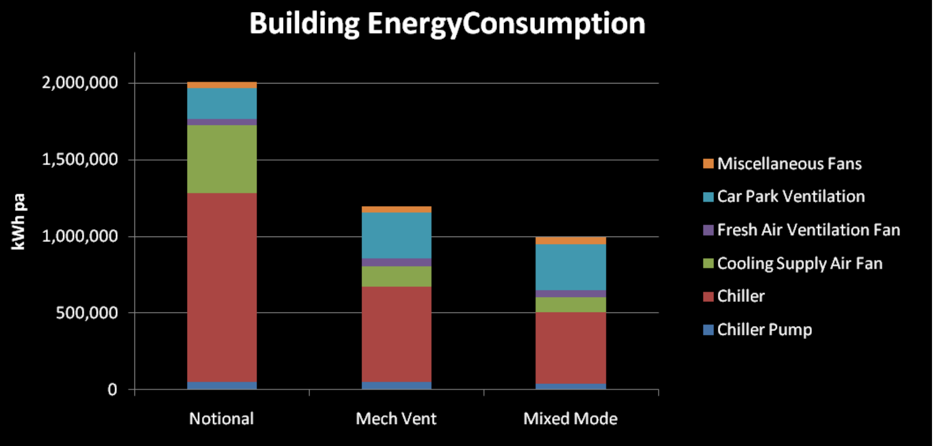
ENERGY USE

	Notional SANS 204 Building	Actual Building	
	Electrical use kWh/year	Electrical use kWh/year	Gas use kWh/year
fuel CO_2 factor	1.2	1.2	0.202
Heating	-	-	
Cooling & Heat Rejection	1,226,672	622,000	
Pumps	53,574	49,000	
Fans	444,055	134,000	
Extract and Miscellaneous Fans	284,000	393,000	
Non Tenant Area Lighting	50,000	30,000	
Car Park Lighting	63,522	63,441	
External Lighting	21,096	21,096	
Lifts	7,500	7,500	
Domestic Hot Water	42,264	-	
Miscellaneous Equipment	12	12	
Lighting (tenant)	12	12	
Small Power (tenant)	12	12	
Supplementary Cooling (tenant)	122,667	122,667	
SUB TOTALS (kWh/year)	2,315,386	1,442,740	-

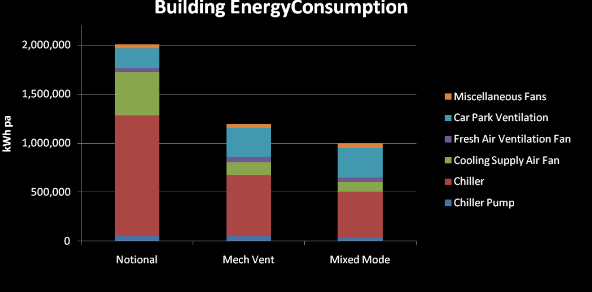
- Includes most energy users:
  - Space cooling
  - Fresh air provision
  - Fans, pumps consumption
  - Car Park ventilation consumption
  - etc ….



One Airport Square
GS energy model – Results



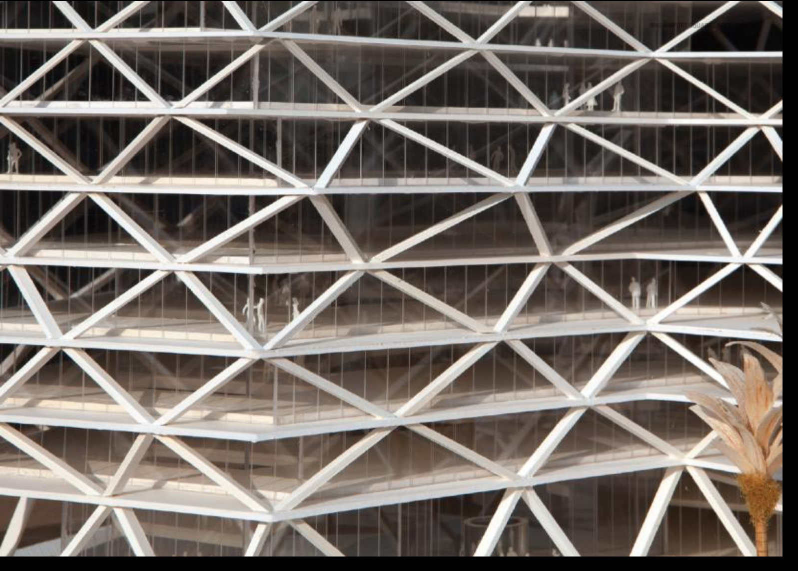
One Airport Square
GS energy model – Conclusions



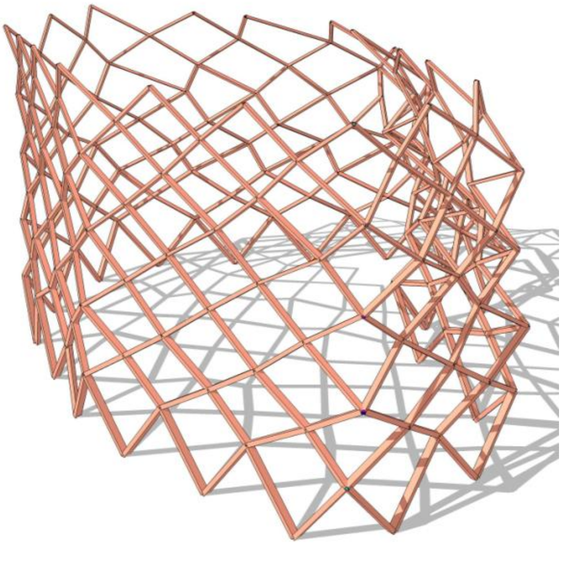
- Mechanically ventilated model (cooling set point at 26^{0}C): achieves **7** Green Star points and is **40%** better than the notional model.

- Mixed mode model (cooling at 28^{0}C): achieves **10** Green Star points and is **50%** better than the notional model.

Diagonal grid structure



Diagonal grid structure – precast concrete

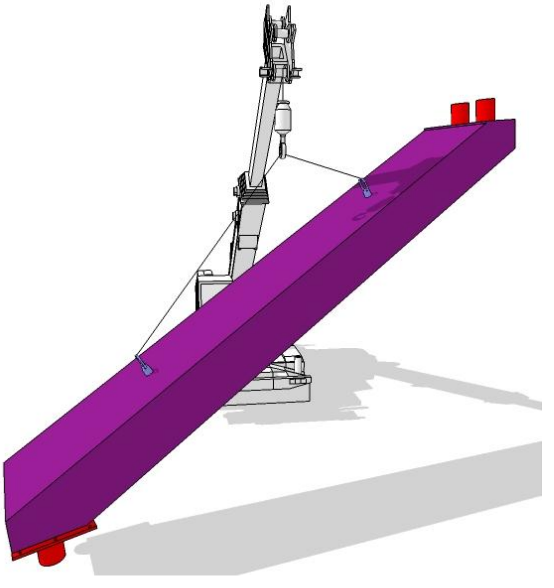


Diagonal grid structure – precast concrete
Prefabrication – manual labour

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

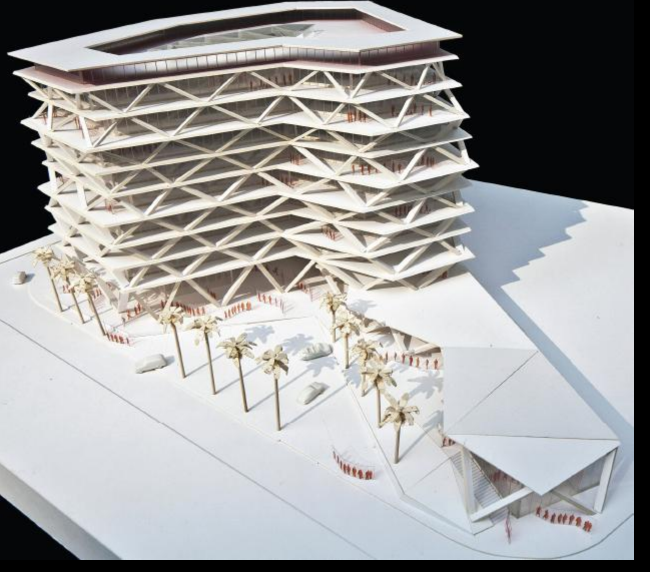
Diagonal grid structure – precast concrete
Installation on site

B D
S P



One Airport Square, Accra

B D
S P



BD SP

Thinking tomorrow – acting today

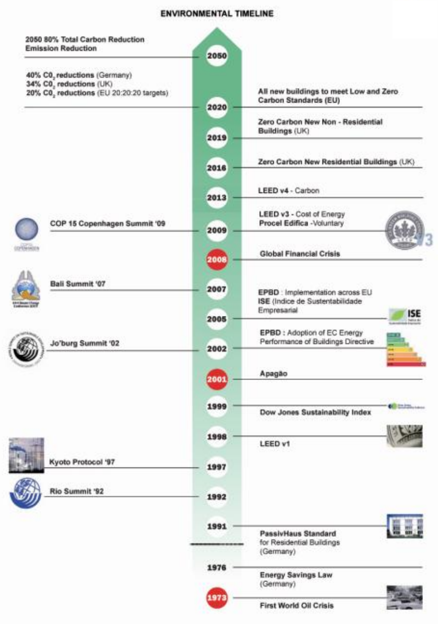
Political, Legislative & Economic Frameworks
Today & Tomorrow

BD SP

Greenhouse gas emissions will be increasingly scrutinized, regulated and priced

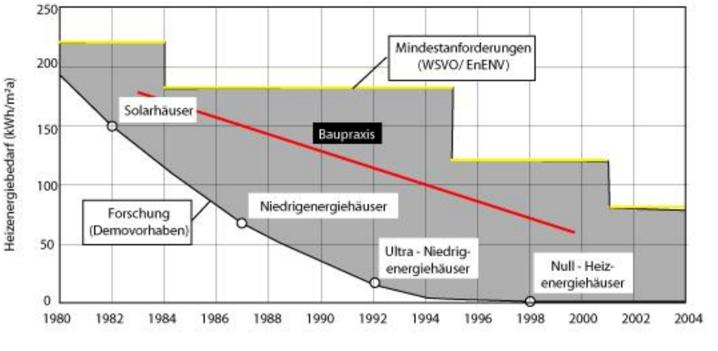
Political, Legislative & Economic Drivers
Environmental Timeline

BDSP



Legislative Framework
Development of Energy Efficient Housing in Germany (1980 – 2004)

BDSP



Climate Change
Strategic Measures

B D
S P

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.

Danger of 'Greenwash'

B D
S P

Source: ASA website
Analysis: Futerra

Wiping away 'Greenwash'
Characteristics of 'Greenwash'

B D
S P

Source: ASA website
Analysis: Futerra

Economic Framework
Minimum Business Position

B D
S P

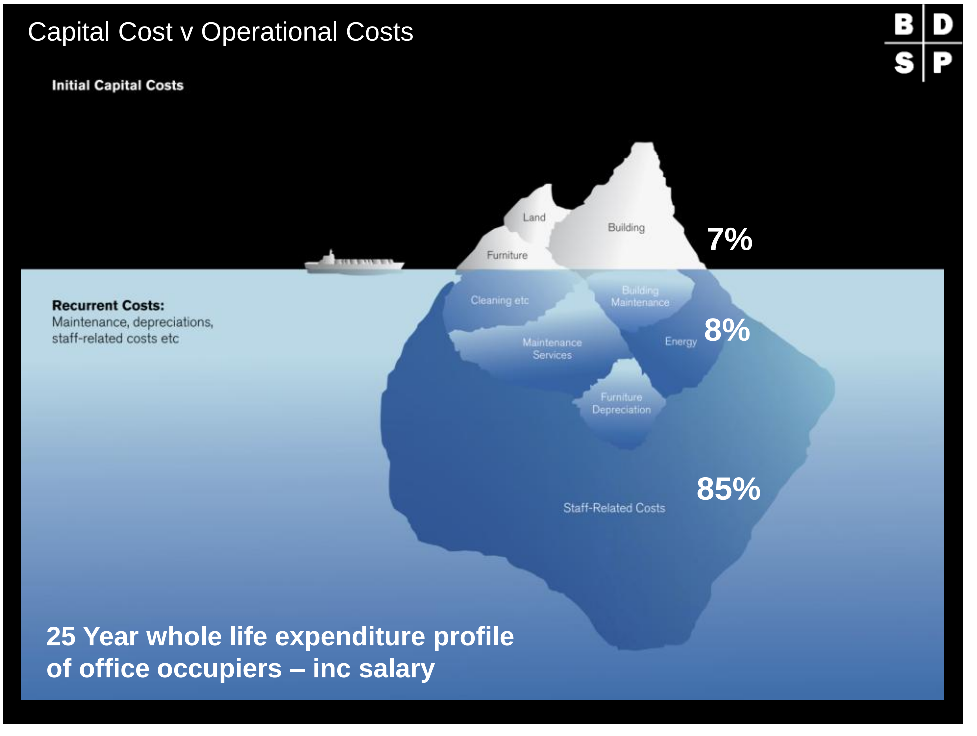
Implementing best practices in managing climate-related costs is the minimum required to remain competitive

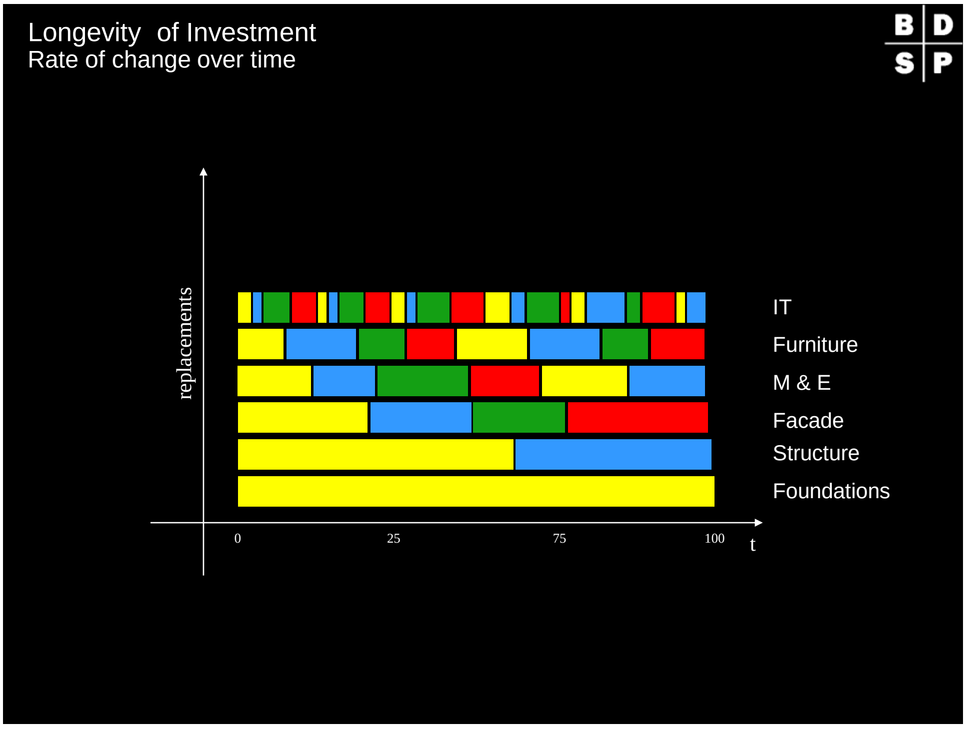
Economic Framework
Optimum Business Position

Go beyond operational effectiveness and become strategic

Economic Framework
Cost v Value v Investment

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

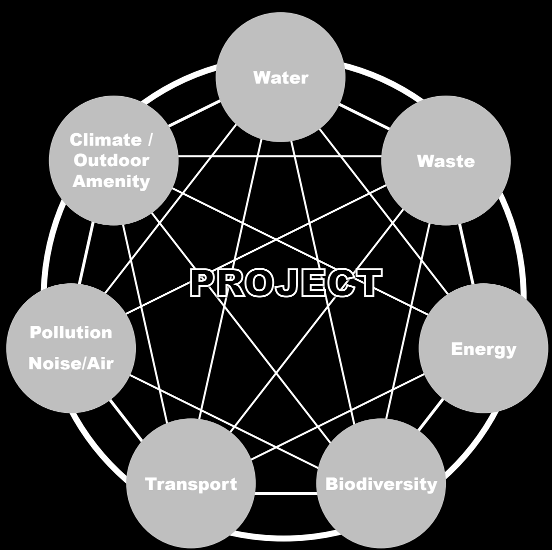

Capital Cost v Operational Costs
Initial Capital Costs
Land
Building
Furniture
7%
Recurrent Costs:
Maintenance, depreciations,
staff-related costs etc
Cleaning etc
Building Maintenance
Maintenance Services
Energy
8%
Furniture Depreciation
85%
Staff-Related Costs
25 Year whole life expenditure profile
of office occupiers – inc salary

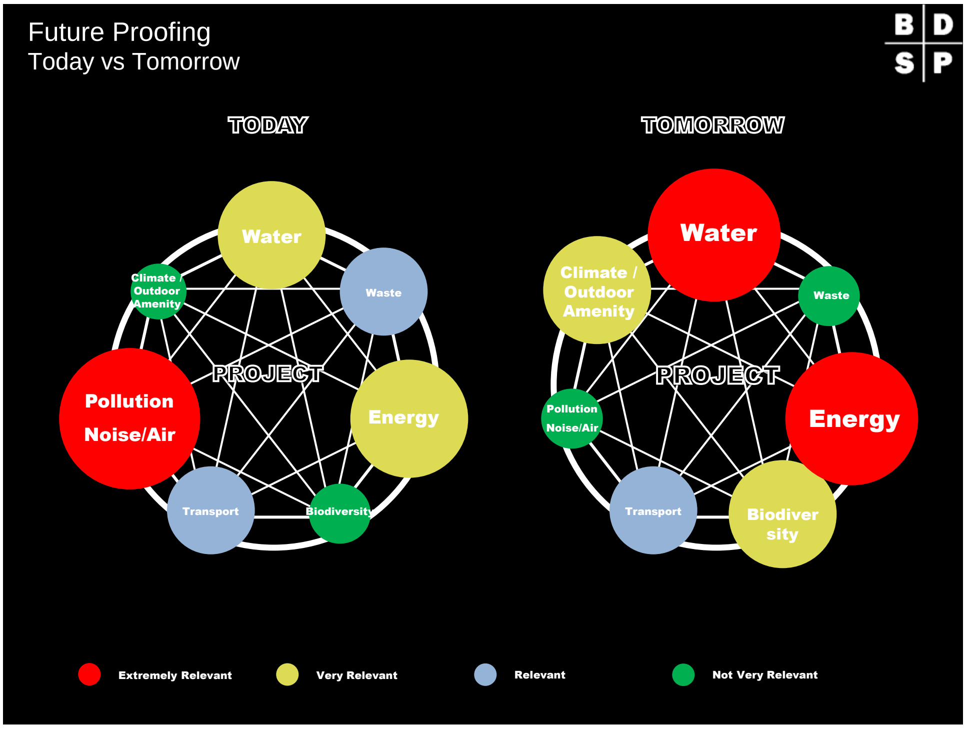

Longevity of Investment
Rate of change over time
replacements
IT
Furniture
M & E
Facade
Structure
Foundations
0
25
75
100
t

Economic Framework
Cost v Value

Future proofing – consider tomorrow today strategically, so as to be able to adapt to both foreseeable and unforeseeable market changes

Future Proofing




Future Proofing
Today vs Tomorrow
TODAY
Water
Climate / Outdoor Amenity
Waste
PROJECT
Pollution
Noise/Air
Energy
Transport
Biodiversity
TOMORROW
Water
Climate / Outdoor Amenity
Waste
PROJECT
Pollution
Noise/Air
Energy
Transport
Biodiver sity
Extremely Relevant
Very Relevant
Relevant
Not Very Relevant

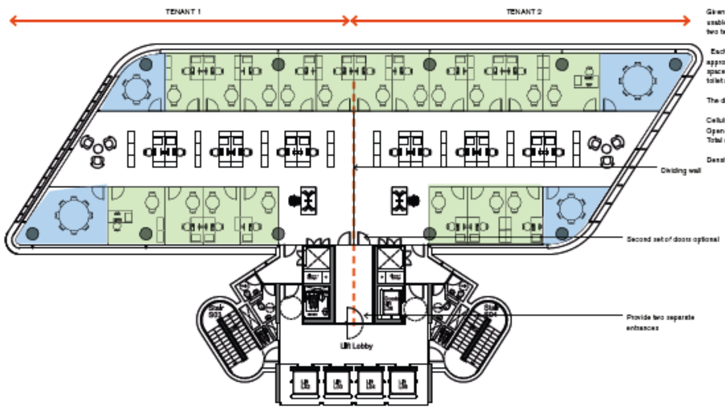

Carbon Exposure
Design Methodology – The Economic Case
DEMAND
MINIMISATION
EFFICIENCY
DEMAND
÷
RENEWABLES
SUPPLY
= x%

Sao Paulo, Brazil

Brooklin IV
Sao Paulo, Brazil

Typical floor plan
Cellular plan configuration

BDSP



Cellular Layout: Two Tenant Split

Given the relatively small size of the usable office floor plate, a maximum of a two tenant split has been illustrated.

Each tenant would occupy approximately 245 sqm of usable office space with their own male and female toilet and cleaners' cupboard.

The disabled toilet would be shared

Cellular offices: 18 No desks
Open plan: 12 No desks
Total desks: 30 No

Density 15.8 m2 per person

Cellular offices
Meeting Rooms

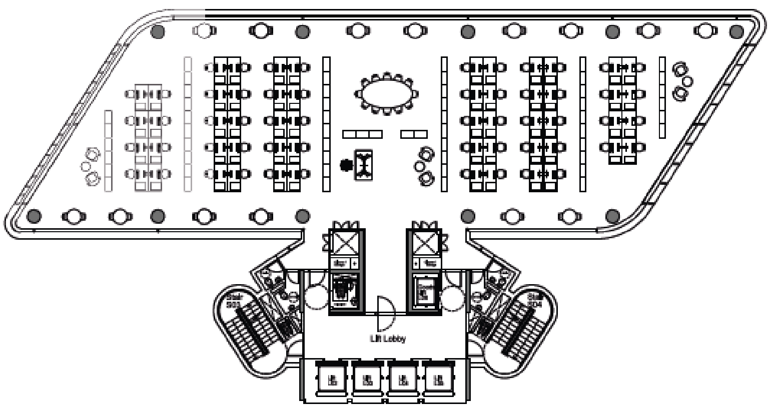
Typical floor plan
Open plan configuration

BDSP

Open Plan Layout

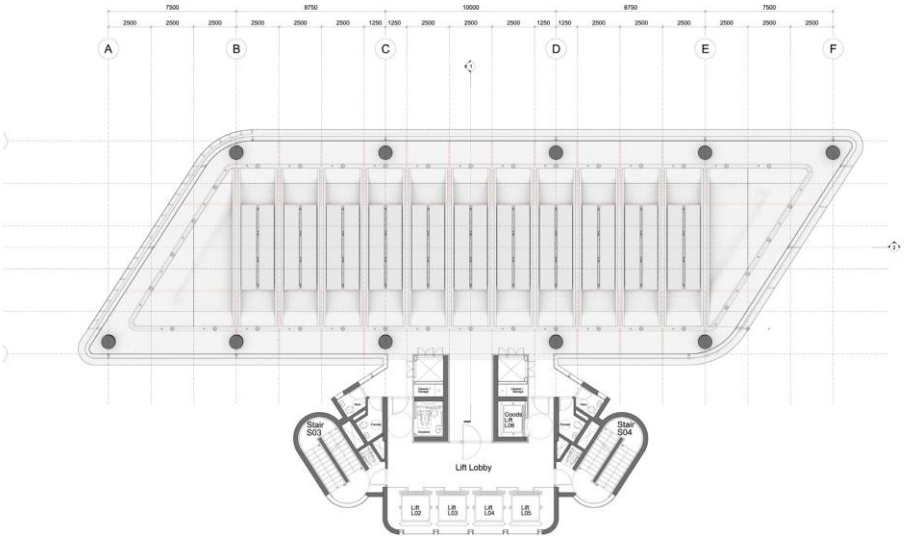
56 No desks

Density 5.3m2 per person



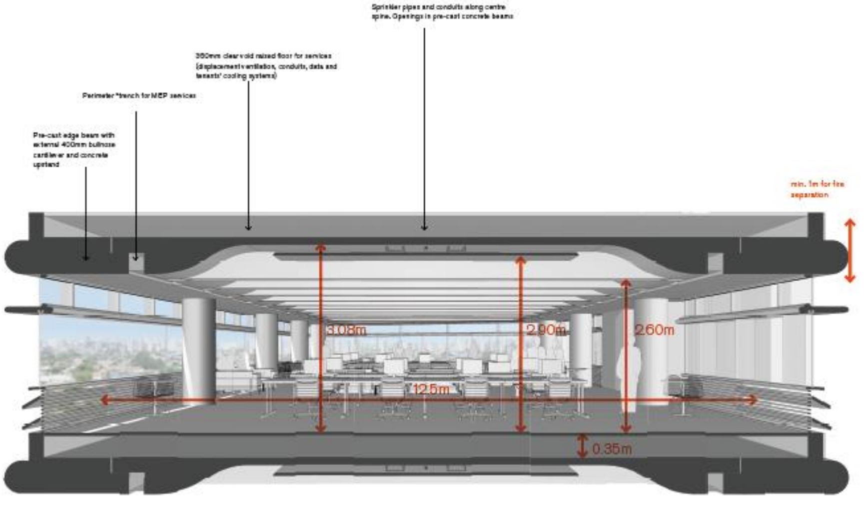
Typical floor plan
Architectural & structural grid

BD SP



Typical floor section

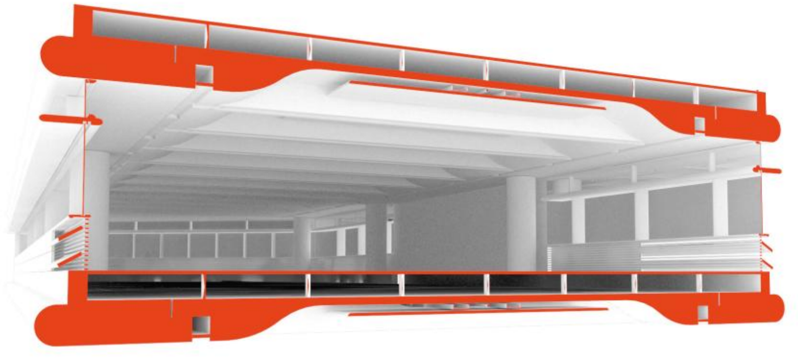
BD SP



Typical Tower Section and Internal View

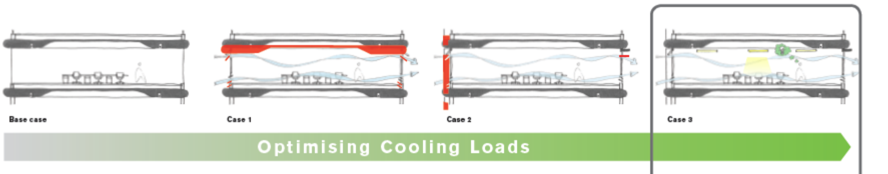
Typical floor section
Precast concrete panels – thermal mass

BDSP



Office Floors
Optimising thermal performance

BDSP



Energy Optimization of a typical office floor

The following analysis summarises the design optimisation process adopted for Brooklin IV and its comparison with a typical São Paulo building. The analysis establishes a 'green' model representative of the 'optimised' case that the developer would provide to the tenant.

Further analysis shows the possible variations that may be done by the tenant after occupying the building and how it would affect the performance of the 'green' model.

Base case: A typical Building in São Paulo

A typical building in São Paulo's climatic context was simulated for Annual Cooling Energy Use. The building was assumed without any natural ventilation, solar shading and with no internally exposed thermal mass. The glazing proportions, occupancy pattern and internal loads (lighting and equipment) were kept the same as a typical Brooklin IV office floor to have a realistic comparison. The following cases show a comparison in terms of reduction in cooling requirement when compared to the base case.

0%

Case 1: Natural ventilation and thermal mass

As established in the concept design stage, natural ventilation (both day and night) and thermal mass are critical strategies to achieve indoor comfort and reduce the cooling loads. From the dynamic thermal analysis, it was found that a significant decrease of cooling loads, more than 60%, was achieved by applying these strategies. Additionally these strategies will help in reducing internal temperature fluctuations.

For the daytime ventilation, the lower and upper windows were assumed to be open so as to flush out as much heat gains as possible. During the night-time, the top window was assumed to be open to maximize airflow and contact between the cool outside air and the thermal mass of the roof. This helps in purging out the heat (gained over the day) from the thermal mass.

61%

Case 2: Solar Control

Sao Paulo receives a large amount of solar radiation annually, both in form of direct and diffused radiation. Also, high temperatures in combination with solar radiation can cause significant discomfort. The direct component of the radiation is significantly reduced by external shading while the diffused and reflected component can be controlled by using solar controlled glazing an solar blinds.

The analysis model was tested for the shading design, as currently proposed for Brooklin IV. The key shading strategy includes: horizontal shades on North facade, vertical shades on south facades, combination of horizontals and verticals on the south east facade and dense Cobogo shading on the North West facade. The analysis confirms a further 10% improvement over the naturally ventilated building by adopting solar control and shading alone provides around 25% improvement when compared to base case.

69%

Case 3: Optimising office approach and 'Green' operation

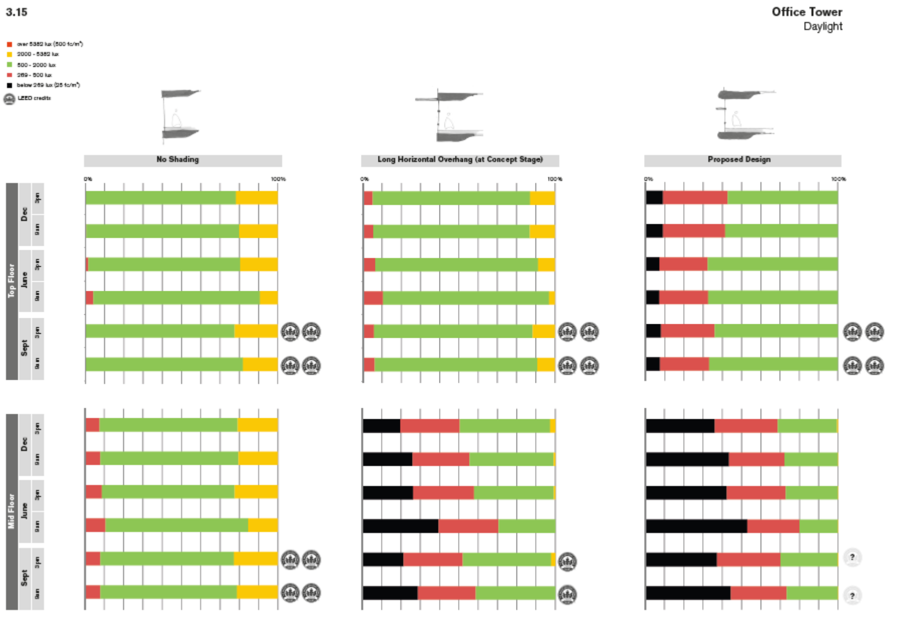
Due to shallow plan depth, Brooklin IV has been designed to maximize daylight to the indoor spaces. Therefore with reduced need for artificial lighting and using intelligent control systems like daylight linking and efficient office equipment, the total internal loads can be reduced. Further improvement may be achieved by an environmentally responsive thinking of the tenant to maximize the efficiency of the office space, and to use the passive strategies as proposed.

This case therefore represents a 'green' building model that the Brooklin IV team intends to develop for the tenant. It was observed that this 'green' model would require about 75% less cooling compared to a typical São Paulo Building.

The variations analysed below represent the possible variations by tenant after occupying the building that may affect the buildings' performance.

77%

Office floors – façade optimisation
Daylighting studies

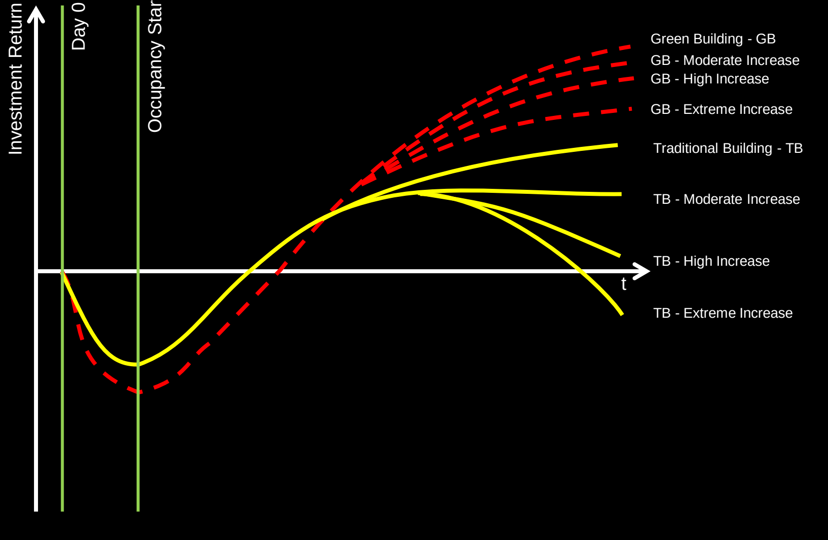


Economic framework – creating ‘value’

Economic Framework
Innovation

Sustainability is the key driver of innovation

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



Economic Framework
Cost v Value

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

Economic Framework
Cost v Value

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

Economic Framework
Cost v Value

Speed of construction

Economic Framework
Cost v Value

B D
S P

Minimisation of waste

Economic Framework
Cost v Value

B D
S P

Prefabrication

Economic Framework
Cost v Value

Use technology to design out technology

Apply sophisticated design tools to simplify design solutions

Visual and operative prototyping –

BIM – embedded intelligence

Economic Framework
Cost v Value

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

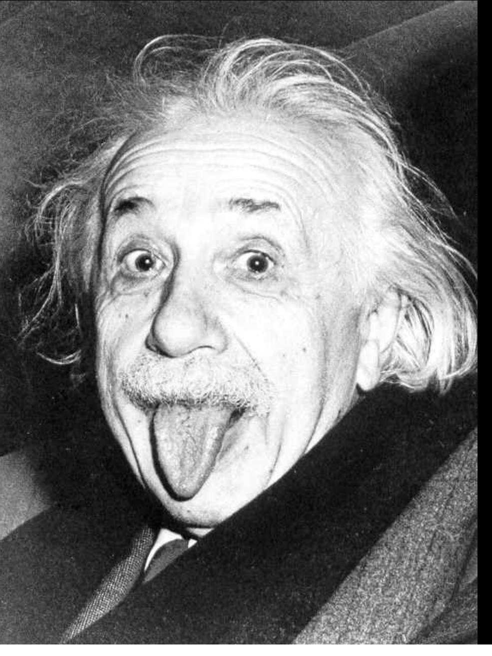
Economic Framework
Cost v Value

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