Imperial College London

Foster + Partners

CIVE60001 – Civil Engineering Design 3

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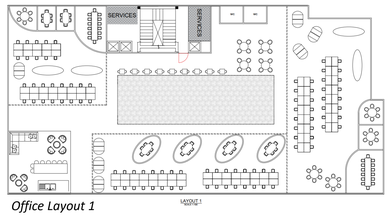
Project Summary

We were tasked with designing the redevelopment of 1 St James Square, a large office building located in central London. This regeneration included design of a new exterior façade, consideration of floor plans for both commercial and public use and development of a sustainable natural ventilation system that could be supplemented through mechanical means. Our design philosophies throughout the project were:

Sustainable Redevelopment | **Economic Viability** | **High Performance Workspace**

OFFICE SPACE

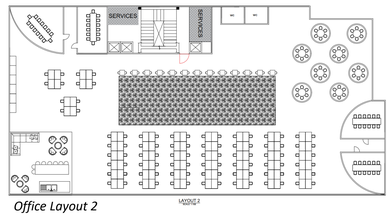
- Implementation of additional floor to have 10,000m^2 of flexible workspace.
- Recreational area in the SW corner overlooking The Square, with seating and kitchen facilities.
- Locations of all features selected to suit the ventilation and daylighting strategy.
- Considerations made towards the acoustic environment and the biophilic design within the offices.



Office Layout 1

Layout 1 – Multi-tenant Strategy

- Workspaces with sliding partitions to segregate the sections occupied by different tenants.
- Each working area has access to private meeting rooms, individual workspaces, tables/booths for collaborative working.



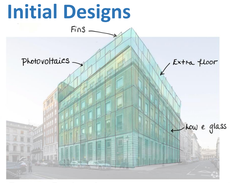
Office Layout 2

Layout 2 – Single-tenant Strategy

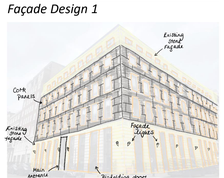
- Open plan workspace that is more suited to one tenant.
- Larger private meeting rooms to host meetings with greater numbers of people.
- Standing desks overlooking The Square.
- Working pods for smaller collaborative tasks.

FAÇADE DESIGN

Initial Designs



Façade Design 1

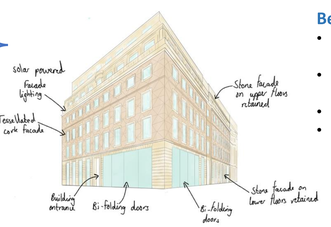


Façade Design 2

Final Design

Key Components

- Solar powered façade lighting – Lighting will face downwards to reduce light pollution
- Bi-folding doors – opens up the building to the public realm
- Cork panels – sound absorbing, thermally insulative sustainable material
- Fits within public realm, matching Georgian style buildings in the square

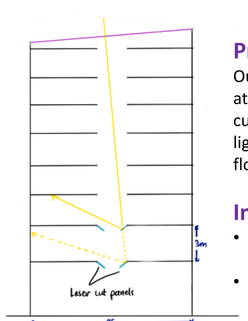


Annotated sketch of the façade

Benefits of Cork

- Naturally insulative and thermally efficient
- Fire resistant following sodium borate treatment
- Lightweight
- Viable for prefabrication

DAYLIGHTING



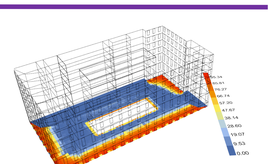
Sketch of the atrium with reflectors

Proposal

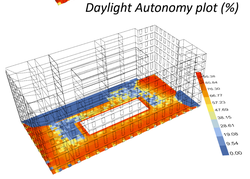
Our design uses the central atrium and specially placed laser cut panels to provide natural lighting to occupants on all floors.

Impacts

- Reduces artificial lighting and energy consumption.
- Reduces annual operating costs by £2400 .



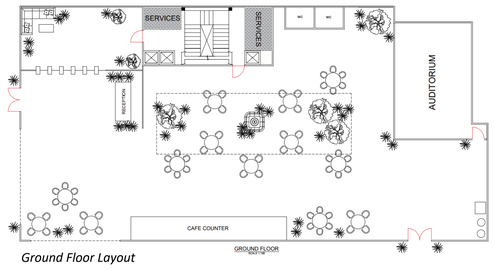
Daylight Autonomy plot (%)



Useful daylight illuminance (%)

INTEGRATION WITH THE PUBLIC REALM

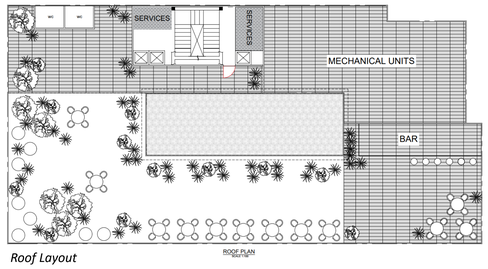
Ground Floor



Ground Floor Layout

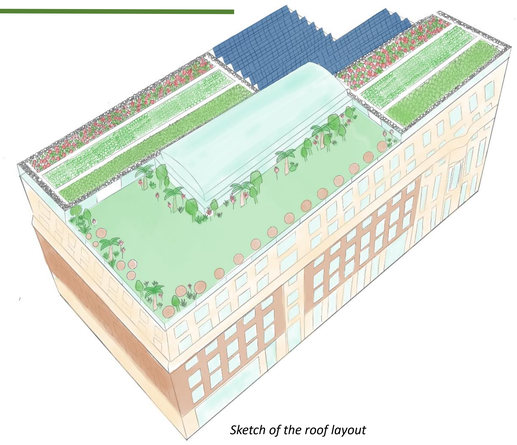
- Open to the public with bi-folding doors opening to The Square.
- Café serving food and beverages and promoting sustainable practices.
- Water feature and greenery surround the seating area for a calming effect.
- Auditorium for private conferences or events as an extra source of income.
- Sustainability Zone with water refilling stations and recycling bins. Also, an interactive panel displaying environmental performance of building.

Rooftop



Roof Layout

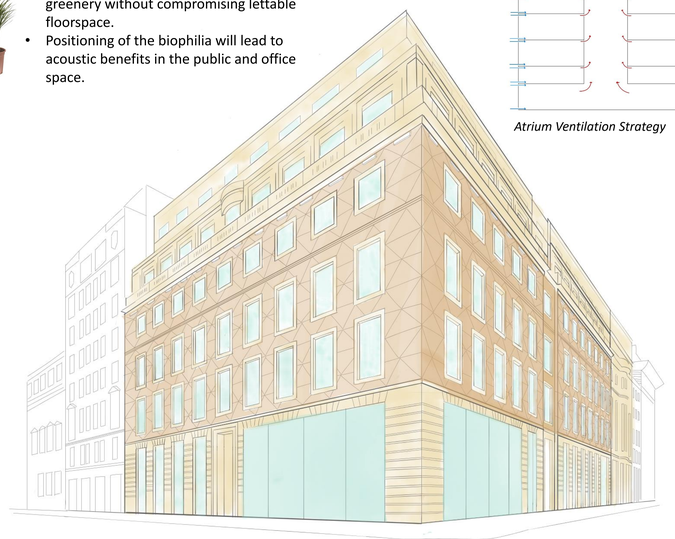
- Open to the public with a rooftop bar with panoramic views of The Square.
- Existing mechanical units removed and required units placed in NE corner.
- Atrium design to act as an outlet for the natural ventilation system.
- Tables with seating or to stand around surrounded by a biophilic design.
- Solar panels and Green Roof designs placed above the sheltered areas (indicated by the rectangular hatching).



Sketch of the roof layout

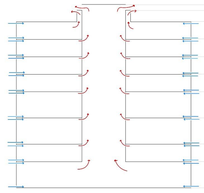
BIOPHILIA

- Plants will improve the air quality in the indoor environment.
- Human wellbeing and efficiency will increase
- Incorporation of green walls to improve. greenery without compromising lettable floorspace.
- Positioning of the biophilia will lead to acoustic benefits in the public and office space.



Architectural and Environmental Design of 1 St. James's Square

VENTILATION



Atrium Ventilation Strategy

Natural Ventilation : Our ventilation strategy uses **buoyancy forces**, driven by the indoor and outdoor temperature difference, as well as the **wind** to provide flow through the building without carbon intensive mechanical ventilation. Design aspects were developed to enhance these effects:

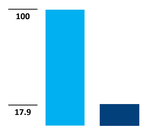
- Multi-level openings at each window
- Fully glass-enclosed atrium
- Adaptable louvre based vents
- Separation of the top floor

Ventilation Breakdown

Out of 365 days:

- **211** use **natural** ventilation
- **120** use **mixed** ventilation
- **34** use **mechanical** ventilation

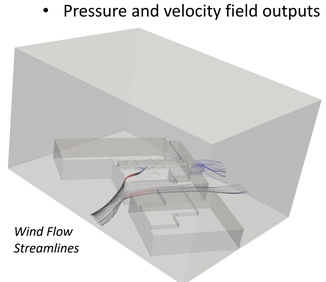
Energy Savings



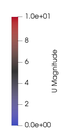
- **Our naturally ventilated** strategy uses over **82% less** energy than an equivalent **mechanical system** over the course of a year

CFD Analysis

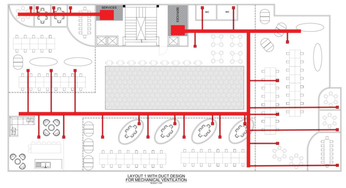
- Steady state, compressible flow solver
- Pressure and velocity field outputs



Wind Flow Streamlines



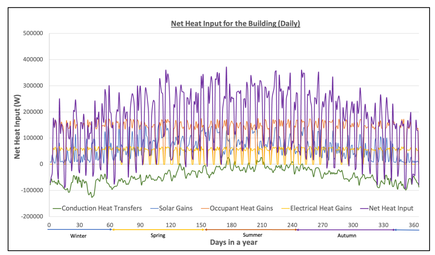
Mechanical Ventilation



Mechanical Ventilation Duct Design

- Ducts will run through ceilings in building and pump external air into floors.
- Main mechanical ventilation units will be located on the roof.
- Ductwork has capability to mechanically ventilate entire floor if required.
- Will ventilate all enclosed offices mechanically.

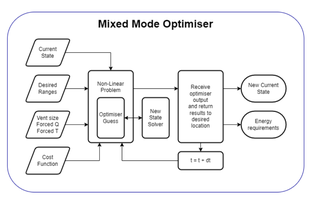
Heat Transfers

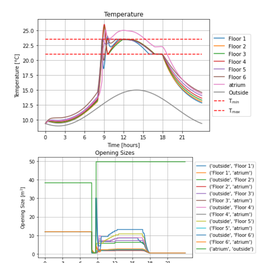


Annual Heat Input

- Heat input for most of the year.
- Occasional heat output due to conduction during colder seasons.

Python Model & Control System

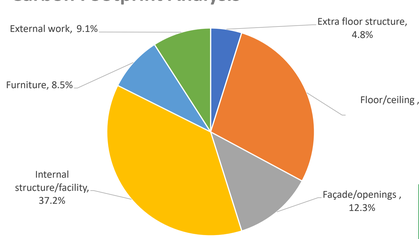




- Model developed to analyse building response to transient rather than steady state conditions.
- Can accept any user inputs on external or internal conditions, building layout, vent sizing.
- Control system developed from this model to size vents appropriately to have workspaces within the target temperature range using natural ventilation, reducing carbon intense forced ventilation.

SUSTAINABILITY & FINANCIAL VIABILITY

Carbon Footprint Analysis



- Embodied carbon: 1,256,000 kg CO2
- Operative carbon: 35,000 kg CO2 per annum
- Expected payback period: 9 years

Cost & Return Analysis

- Budget estimation: £ 32,696,900
- Profit estimation: £ 8,305,000 annually
- IRR: 6.52% per year
- Payback period: 3.42 year
- Income improvement: 25.2% more than former design

ACOUSTICS

Internal Acoustics

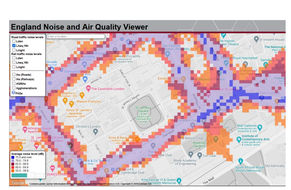
Challenge:
Noise generated from occupants and appliances

Solution:
Floors of office spaces overlain with carpet
Sound proofing foam placed on underside of desks to absorb sound
Biophilia will reduced sound reflection
Partitioned floor layout with flexible floorplans

External Acoustics

Challenge:
Noise generated pedestrians and traffic

Solution:
Cork has a noise reduction coefficient (NRC) of 0.15, and can absorb 40% of the sound
Double glazed windows will reduce sound by 40-50dB within concerned frequency range



Noise map of the local area