SUSTAINABLE BUILDING DESIGN: Case Study

Greater London Authority Building

Foster & Partners with Arup Engineering

360° Panorama from ‘London’s Living Room’ by author

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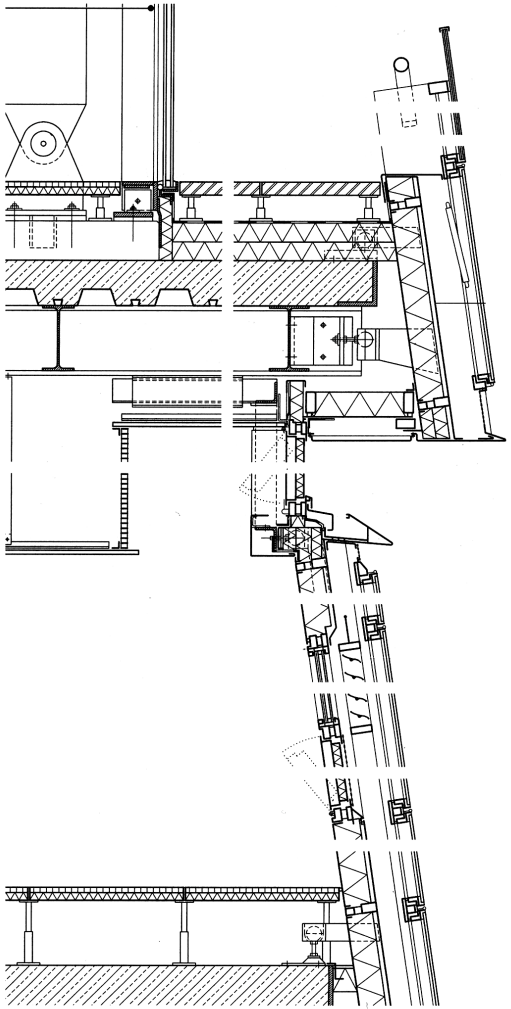
A successful ‘green’ or sustainably designed building is thought of and conceived as a total system incorporating all feasible methods of efficiency, responsibility, and coherence to a set of well designed principles pertaining to an environmental conscience. The Greater London Authority building, located on the south bank of the River Thames in London, England, designed by Foster and Partners embodies these principles and is successful as a result of a fully incorporated system of sustainable initiatives and activities. Typically, buildings of this size, 12,000 m^2, are not seen as efficient models to prescribe to a strict adherence of sustainable principles because of the associated higher initial construction costs and lack of control of users of the environmental systems and, as such, are not seen as adequate models of efficiency. This viewpoint is, however, changing and Foster and Partners is leading the way in Europe with a number of recently completed high profile sustainable buildings including Frankfurt’s Commerzbank, Berlin’s Reichstag, and the nearly complete Swiss Re headquarters in London. The Greater London Authority building, designed by Foster and Partners together with the engineering firm of Arup, is designed as a building which challenges a number of issues currently plaguing the building industry in terms of building comfort, cost, and systems while incorporating a very public level of usage and occupation. Their approach has resulted in a careful consideration of solar orientation and, as such, heat loss and gain, reduction of loads placed on mechanical systems, the production and consumption of heat energy produced by the building’s inhabitants and the efficiency of structural component implementation and tasking and, finally, material types. The result is a gleaming building that defines a profound point of departure for the future of London’s environmental policies on a political, physical and aesthetic vernacular, and is fostering a unique future of growth for the greater London area and its inhabitants.

The unique shape of the Greater London Authority building is not merely a statement of modern design but is the result of a unique process of computer aided modelling implemented to produce the most efficient space. The result is a building that, ‘embodies its democratic function by not having a front and back’[1], and maximizes the benefits of its site and solar

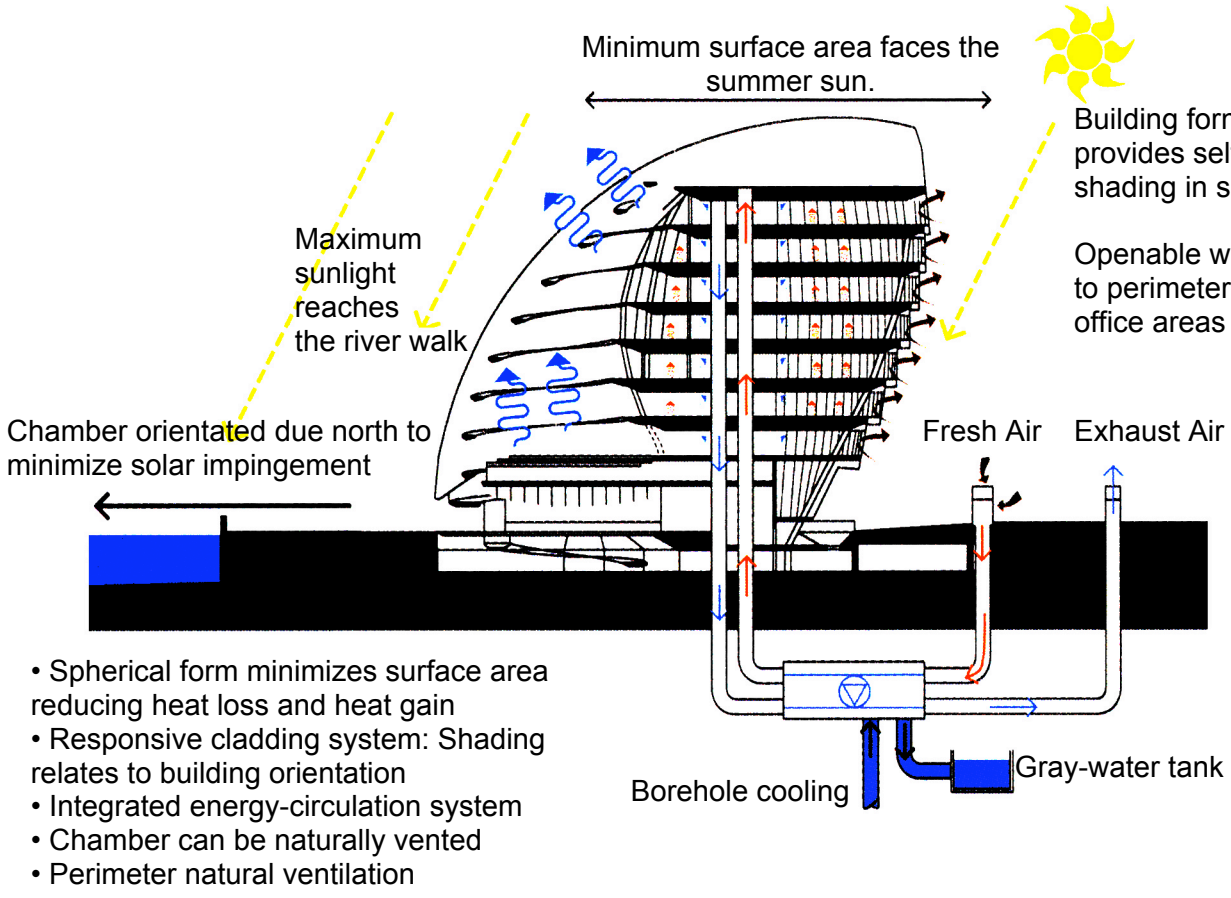
orientation. The shape is a derivative of a sphere, geometrically modified to allow for the greatest amount of usable volume with the least surface area, and when compared to a cube of the same volume, has 25% less surface area. This creates a dramatic reduction in thermal loads applied to the building's skin under normal applications but Foster and Arup further modified the model to allow for solar shading from the intense summer sun over the south facing portion of the building by stepping out each floor, shading the one below (See wall section[2]). 'The building's hybrid form achieves optimum energy performance and minimises the surface area exposed to direct sunlight.'[3] The north-facing portion of the building, inclined at an oblique angle to the sun to maximize day lighting and minimize solar heat gain, is the only portion of the exterior façade to incorporate completely transparent glazing. This serves three purposes. It allows for a maximum of daylight to enter the debating chamber, allows for diffused daylight to penetrate deep into the offices located within the center of the floor plan and maintains a strong transparent connection to the context of the city,



Wall Section

the Thames, and the citizens walking along the riverfront. The combination of shaded and unshaded glazing throughout the envelope of this building is the result of a highly engineered model, which minimizes heat transfer across the building membrane and defines an intricate strategy of maintaining daylight while reducing solar gain. A pre-determined value for maximum allowable heat gain per square meter was derived from complex sun light simulation on computer models and was then applied to the surface applications where necessary, further reducing loading. The precise situation of the building maintains existing sightlines within the historical context of the city and does not overpower the surrounding landmarks such as London Bridge, Tower Bridge and the Tower of London, adhering to a conscience of preservation and minimal disruption to its surroundings while creating a dynamic tension between the technical developments of the new millennium and those of the historical past. Both Foster and Partners and Arup gave great consideration to the orientation of the Greater London Authority building resulting in a vast array of benefits in terms of sustainability and conscientious design, including a tremendous reduction in heat gain during the summer months, excellent day lighting while maintaining a strong civic duty by remaining transparent to the population it represents.

Building on the effective nature of the orientation of the Greater London Authority building, Foster and Partners designed a mechanical system that furthers the concept of efficient energy use and deployment. As the building is located in the cool temperate climate of London, England, an area subject to only a few days of frost in the winter and high levels of precipitation and moderate temperatures in the summer, the designers are able to make great use of this relatively low net change in temperature between summer and winter extremes by implementing a number of effective passive environmental control systems (See Energy Conservation Strategies Diagram[4]). While the most significant component to the success of the environmental systems of this building is the orientation, a multitude of controls and additional passive environmental systems were included to maintain comfort and consistency in air change frequency, heating, cooling and lighting. When heating is required in the building, a pair of gas-fired boilers heat water which is pumped through the

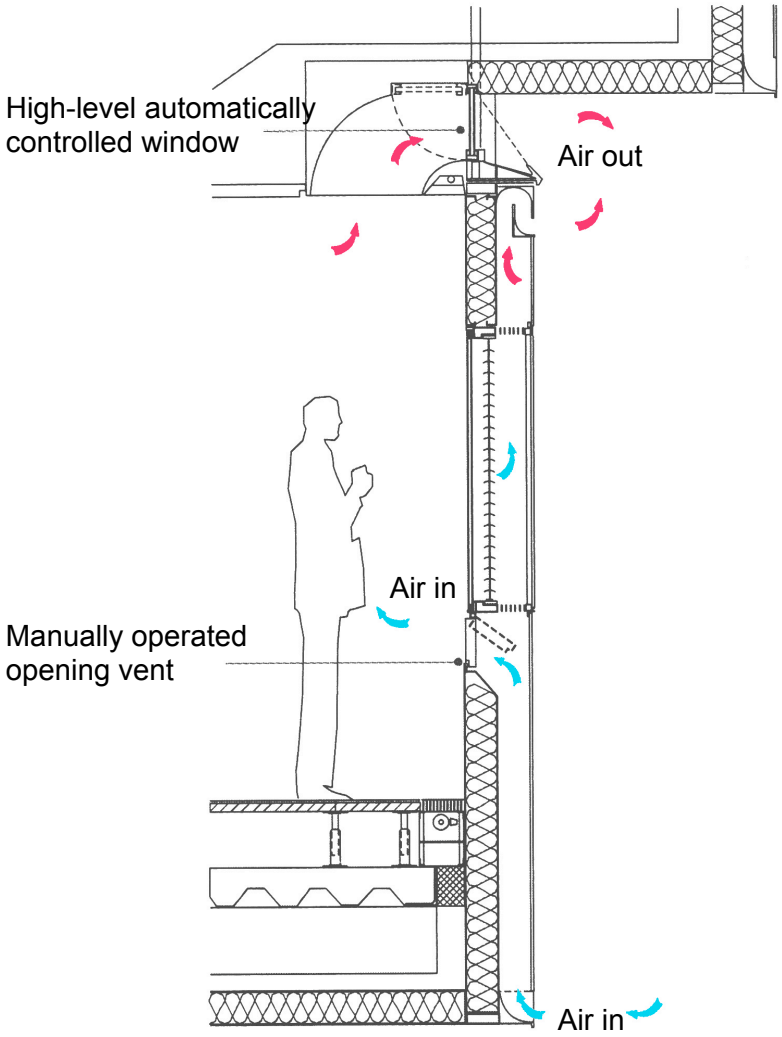


Energy Conservation Strategies Diagram

structure of the building to a series of convector heaters [5]located throughout the offices and in under-floor radiant heating. The hot water is also used to pre-heat incoming fresh air through the air-handling units. Water flow to the radiant and convector heaters is controlled by a number of variable-speed pumps reducing the energy consumption by restricting flow when it is not needed. Fresh air enters offices through a number of grills at floor level and vents in the facades in offices on the perimeter of the building. When the façade vents are opened, the local heating and cooling

system is automatically shut off to conserve energy consumption. During winter months, heat and moisture generated from the buildings inhabitants, equipment and computers is extracted from the outgoing air and again used to pre-heat incoming cold air. In order to cool the building in summer months, a network of water chilled beams run throughout the office ceilings providing the majority of cooling required. The cold water circulating through the beams is chilled by water supplied by a pair of special boreholes dug 125 meters below London, which feed into a vast water table providing water at a steady temperature of 12-14°C. This ground water is also used in the cooling coils of the fresh air exchange system, and for flushing toilets further reducing the demand on local resources by lowering water consumption. In conjunction with the carefully planned use of water, Arup designed an intricately balanced 'Building Management System', which maintains environmental conditions throughout the building by monitoring usage of the various portions of the building's program. For example, the chamber and committee rooms are chilled only when they are in use and airflow to various rooms is regulated to provide the required amount of fresh air (See Air Flow Diagram[6]). As with all instances in building design, comfort is directly determined by air flow, humidity, and ambient temperature and when combined, these can create a tremendous impact on the effective quality of a design but Foster and Arup have managed to capitalize on a climate that allows for the implementation of a number of sustainable and 'green' environmental initiatives reducing the demand placed on energy that otherwise would have been required. "It (the GLA) is expected to consume 75% less energy on mechanical systems than a typical air-conditioned office building"[7]

The sustainable and environmental initiatives employed in the design of the Greater London Authority building are a coherent set of operations hidden within the shell of the building and are not immediately realised, as such. The vernacular does little to reveal the true nature of the building. The embodiment of the thought of designing a building such as this as one single entity, containing all the systems required in a sustainable and responsible manner is reflected through the structure and material palette employed by Foster and Partners. Their choice of materials with a typically



Air Flow Diagram

higher embodied energy is balanced with a trade-off for longevity, low maintenance, and durability. Furthermore, the rationale behind designing the building as one unified system is evident in the multi-purpose tasking of various elements of the structure. For example, incorporating the hot water plumbing in the horizontal members of the structure, warming the atrium, using the dramatically coiling staircase as a sound attenuator for the assembly chambers resulting in excellent acoustic properties in the public gallery and the assembly seating area. The main structure, although unique in terms of the building's profile, defines a grid at the office level floors allowing for a very flexible space accommodating the needs of a number of unforeseen tasks with little or no modification, furthering the concept of a reduction in operating costs and renovations to manipulate changing spatial requirements. The floors and ceilings are raised and suspended respectively to minimize maintenance costs and down time. Additionally, the mechanical shading on the south façade is located inside the glazing unit to reduce damage, maintain cleanliness and remaining efficient. Foster and Partners have managed to produce an

efficiently operating structural system and hide it as affectively as they have the other significant elements of the Greater London Authority building.

When approached as a complete, comprehensive and coherent design, Foster and Partners have proven that designing an environmentally responsible building on the scale of the Greater London Authority building can, in fact, result in a profound statement of success, and the future direction of architecture in Europe and potentially the rest of the world. As a culmination of careful consideration of orientation and siting, mechanical systems and structure and materials, an architect can design an incredibly successful building, but when these elements are considered as separate entities, the success is less notable and in fact can be of greater detriment than benefit. Foster and Partners have proven once again that not only are they more than capable of leading the world with forward-thinking architecture, but they are also evidently, leaders in environmentally conscious 'green' design and are leading the way in sustainable construction. The Greater London Authority building provides the statement to back up the new joint initiative between the City of London and Arup Engineering in developing a set of policies to reduce pollution, congestion, and improve quality of life in the downtown core. "If ever a building announced to the world that a new day had dawned, Foster and Partners' new London City Hall does so with a clarity not seen in a city building in this country for quite some time."[8] Finally, by allowing citizens to experience the building, its environmental concepts and creating an element of interaction between the chamber members, the coiling staircase, and the view offered to the public at the top from 'London's Living Room', Foster and Partners have championed the concept of successful 'green' design and construction.

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[1] Foster and Partners: The Greater London Authority Building
http://www.fosterandpartners.com/internetsite/

[2] Architectural Record. 02.2003. "London City Hall" Jayne Merkel. P. 119

[3] Foster and Partners: The Greater London Authority Building

http://www.fosterandpartners.com/internetsite/

[4] Architectural Record. 02.2003. "London City Hall" Jayne Merkel. P. 118

[5] Architectural Record. 02.2003. "London City Hall" Jayne Merkel. P. 119

[6] Architectural Record. 02.2003. "London City Hall" Jayne Merkel. P. 116

[7] ArchitectureWeek: – Design – Foster's New City Hall – 2003.03.05
http://www.ArchitectureWeek.com/2003/0305/design_2-1.html

[8] Architectural Record. 02.2003. "London City Hall" Jayne Merkel. P. 113

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