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Halls, Lobbies and Porches: Transition spaces in Victorian architecture

Ranald Lawrence

The environmental design and integration of new technology in Victorian buildings demonstrates a profound understanding that was a combination of experimental scientific advance (e.g. fluid dynamics) and the intuitive application of professional knowledge by architects and engineers. Architects at this time retained direct control of the dimensions of windows, room volumes, air inlets, and chimneys that together constituted the chief variables determining the success or failure of building services.

Arguably much of this tacit knowledge was lost in the first half of the twentieth century; in particular the architect's understanding of the role of transition spaces such as porches and lobbies, assisting in the process of adaptation from outside to inside, or between spaces with different environmental (thermal, lighting or acoustic) properties.

This paper will examine three significant examples of transition spaces (the House of Commons, the Natural History Museum, and the Glasgow School of Art) and identify step changes in the purpose and design of such spaces. The environmental role of these spaces will be described in relation to the wider evolution of the design, and the developing discipline of building services in the nineteenth century.

The paper will conclude by reflecting on the purpose of transition spaces and how the development of modern heating, ventilation and air conditioning (HVAC) systems has replaced their key role in providing thermal comfort. In recent years, adaptive comfort theory has aided a rediscovery of the importance of these spaces.

Introduction

The construction of public museums, libraries, courts, town halls and other new types of institutional buildings accelerated at an unprecedented rate in the nineteenth century.[1] The future that these new complex types of public buildings anticipated was to be bigger, cleaner, brighter and more spacious than the past, raising new technical questions that architects and engineers were expected to be able to answer for the first time. The design of grand staircases and halls demonstrated an unprecedented faith in new technologies of construction: iron, steel, concrete and glass. Improved building technology, together with a greater sensitivity to personal hygiene, also drove the development of new methods to ensure adequate heating and ventilation. Enough fresh air had to be supplied to accommodate the crowds of people who would visit on special occasions, and sufficient illumination was required for public events and spectacles. At the same time these new buildings, maintained largely by taxation, had to be affordable and functional for day-to-day occupation.

The grandeur of these 'marble halls' and the development of early building science began to justify new ways of structuring architectural space, challenging the solidity and 'massiveness' of buildings of the past, and dissolving boundaries between inside and out. These developments were as pragmatic as they were symbolic – the outside city was often cold, dark, and dirty – and the new public interiors were a place of refuge for important objects as well as people. The spaces between – the porches, entranceways, and lobbies that connected the outside with the new pristine interiors – became spaces of increasingly sophisticated functional as well as environmental transition.

Towards the end of the nineteenth century the use of advanced technology spread to more commonplace building types.[2] The American surgeon John Billings'

1893 guide for architects, *Ventilation and Heating*, detailed various strategies for servicing a wide range of buildings, including schools and hospitals. He recommended careful analysis of existing practise and practical experiment as a means to perfect air quality.[3] In America, the Sturtevant Company offered combined fan and heating systems for installation in buildings from 1869.[4] In their standard design, a centrally located fan and boiler room in the basement would distribute tempered air through a series of radiating plenums to the external walls of the building, from where it would rise in a series of ducts to classrooms on each floor. The plan of the schools was kept as compact as possible to reduce the distance the air had to travel from the fan as well as minimising heat losses to the outside. Orientation was demoted to a position of secondary importance, and the focus shifted to isolating the interior from the outside.

The twentieth century saw a standardisation of environmental conditions as regional/vernacular responses to local climates were discarded in favour of new technologies and codified design guidance, for example regarding the sizing of air-conditioning systems. According to Colin Porteous, the development of modern air conditioning at the beginning of the twentieth century "signalled the loss of a science of ventilation that had prevailed for more than 60 years."[5] Much of the tacit and scientific knowledge gained in the previous century was abandoned; in particular the historic role of porches, lobbies and other transition spaces as thermal filters, assisting in the process of adaptation from outside to inside, or between spaces with different environmental requirements.

If we are to tackle the unsustainability of our current model of environmental control inside buildings[6] we need to understand how the question of provision of individual comfort was replaced by generic performance standards that assume that all internal environments should be broadly the same, regardless of location or purpose.

The control of the highly specialised environments of Victorian buildings, and their relationship to the outside climate (together with the technology that maintained them – gas and electric light, radical new combined heating-and-ventilation systems) demonstrated an unparalleled integration of social, economic and environmental goals that we can still learn from today.

Transition spaces and thermal adaptation

Recent research in the field of thermal comfort has highlighted the importance of the inclusion of a range of dynamic environments inside buildings, offering more possibilities to provide thermal comfort to a greater range of occupants than static interior environments, as well as improving thermal comfort perception.[7] For example, research by Nikolopoulou and Steemers has shown how outdoor microclimates can enhance thermal comfort to a much greater extent than laboratory models suggest.[8]

Expanding on this idea, Pitts has highlighted the role of thermal transition spaces in assisting adaptation to indoor microclimates, as well as their potential to reduce energy use by supporting the provision of a wider comfort range than in buildings conceived as only one environment.[9] In 'Intermediate Environments', Potvin characterises adaptation as "difficult", "conscious" or "subliminal"[10], and argues that the most adept for promoting comfort is 'subliminal' adaptation, such that the individual is gradually exposed in steps to a change in environment.

It is possible to describe a hierarchy of microclimates, from outdoors to indoors. Transition microclimates serve as intermediate spaces, which permit "a progressive adaptation to a new environment. Whereas environmental determinism creates uniformity, environmental diversity increases the morphological possibilities of architecture and urban form".[11]

Historic examples of transition spaces

Some of the simplest historic examples of intermediate spaces come from the appropriation of glass to utilise solar gain. As Henrik Schoenefeldt has narrated, the history of 'glass architecture' is closely entwined to the development of horticulture in the 17th, 18th and 19th centuries, and the use of these environments for human purposes is a relatively late and radical experiment of the Victorian era.[12] In his history of arcades, Geist documented their specific historic importance as spaces of transition, either to provide direct access to shops and dwellings or to the interior of a block.[13]

Equally important to the evolution of transition spaces was the relationship between the developing science of building physics and the study of disease. In *The Architecture of the Well-Tempered Environment*, Banham highlights the connection between research that physicians conducted into the causes of disease believed to be transmitted by air, and strategies for improved ventilation in the home. These included experts such as Dr. Hayward, who designed his Octagon House in Liverpool (1867) as a testbed for maintaining a pure internal atmosphere in a domestic setting. The principle rooms of the Octagon House were arranged off intermediate lobbies separated from the stair, allowing the lobbies to function as a vertical supply duct of warm air – an active environmental buffer between the outdoor atmosphere and the family living spaces.[14]

At a larger scale, the environmental design and integration of technology in new public buildings in the mid to late Victorian period demonstrated a profound level of understanding that was a combination of the new science of fluid dynamics (the efficient flow of air through buildings gained through decades of practical experimentation), and the intuitive application of this knowledge by architects who retained direct control of the physical dimensions of windows, room volumes, air inlets, and chimneys that together constituted the chief variables determining the success or failure of building services. This article examines examples of transition spaces in three buildings: the new House of Commons, the Natural History Museum, and the Glasgow School of Art.

The House of Commons

Maintaining the viability of the nation's parliament at the heart of the most populous city on the planet presented an increasing challenge as the nineteenth century drew on. The site of the Palace of Westminster on the north bank of the Thames, effectively the sewer for a population that grew from over 1 million in 1801 to over 6 million in 1901, became ever more problematic. Mid-century, up to 250 tons of lime was poured into the river to treat the effluent every week (Fig. 1).[15]

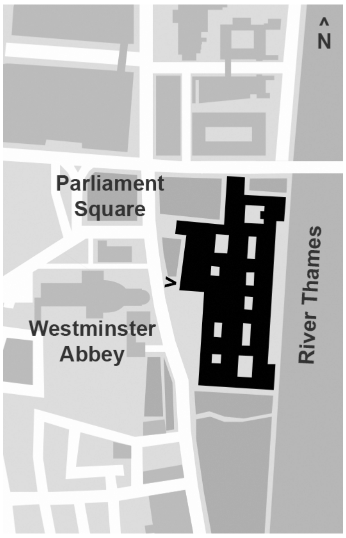

Figure 1. Location plan of Houses of Parliament at 1:10,000.

Following the destruction of the old Houses of Parliament in 1834, David Boswell Reid was appointed to develop heating and ventilating systems for the new Palace of Westminster in 1840.[16] Architect Charles Barry's design had envisaged conventional natural cross-ventilation through opening windows in combination with fireplaces for warmth, an arrangement that was soon deemed inadequate given the insalubrious atmosphere. While the ‘Great Stink’ of 1858 was yet to occur, major cholera epidemics in 1831, 48-49 and 53-54 were widely attributed to airborne miasmas carried from the Thames. Reid, who trained as a doctor, developed his first design over a period of six years, requiring intensive negotiations with Barry regarding space for plenums and the treatment of air underneath the chamber.[17] Eventually the relationship between architect and doctor-turned-engineer broke down, and after two enquiries Reid’s input was reduced to the design of the House of Commons chamber alone.

Reid’s design to filter and temper the air included two separate systems of inlets and extracts, one above the ceiling of the chamber and one underneath the floor (Fig. 2). The roof system was supplied from a roof inlet facing east to the Thames, or a secondary inlet above St. Stephen’s Porch (depending on local air conditions). A fan located in the roof to the north of the Central Lobby drew the air across an array of steam pipes to the centre of the ceiling above the House of Commons, where it entered through vents in the ceiling adjusted by sliding valves. The floor system was supplied either through inlets in the Elizabeth Tower to the north or inlets from Cloister Court and the Commons’ Inner Court to the south. From there the air was drawn through passages in the basement to heating and cooling chambers on the ground floor. Apparatus first tested and fine-tuned in the Temporary House of Commons was used to heat, cool, and adjust the humidity of the air, before mixing in an equalising chamber.[18]

Treated air entered the House through cast-iron plates in the floor, risers in the aisles, the back of the benches, and gaps in the central ceiling panels. Foul air was extracted from the ceiling either side of the central panels, as well as through the floor in front of the benches. During votes, valves were used to close the extracts in the ceiling and open extracts in the Commons’ Lobby, the Ladies’ and Stranger’s Galleries and the Division Lobbies.

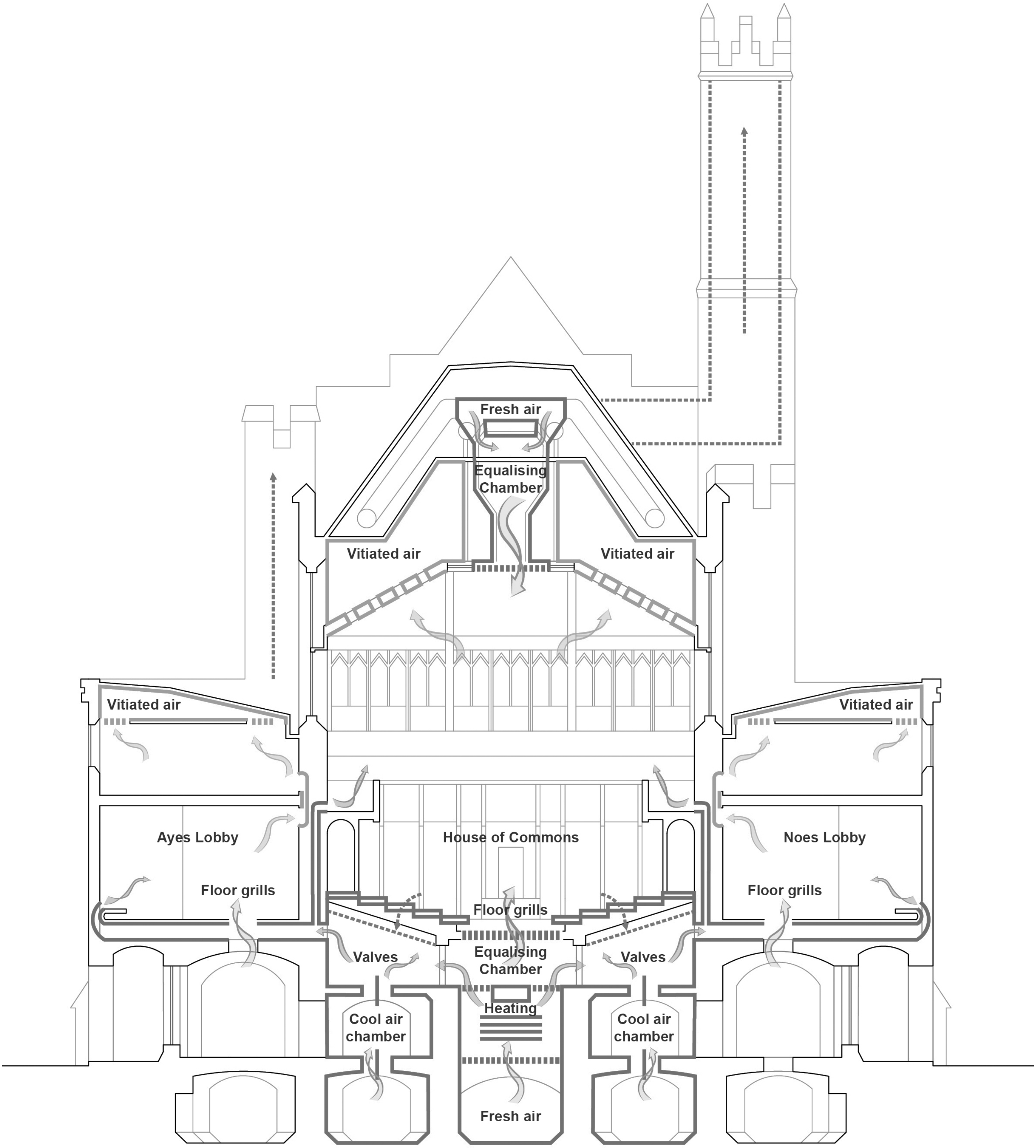

Figure 2. Section of Houses of Commons showing environmental systems at 1:200.

The intricacy of this system was intended to permit rapid changes to be made both to the temperature and flow of air supplied to the House, necessary to maintain comfortable conditions as the House and division lobbies rapidly filled and emptied according to an often unpredictable parliamentary agenda. Duplicate inlets meant that, for example, warm air could be shut off and replaced with another source of fresh air without having to wait for steam pipes in any one heating chamber to cool down. Reid may also have been responding to criticism of his design for the temporary House of Commons, which relied on ventilation through the floor alone. This was considered to be largely successful except for its propensity to blow dust into the faces of Members of Parliament sat on benches to either side.[19]

Following the opening of the chamber in 1852 it was found that the complexity of the system, with inlets and extracts at both ground and upper levels, made it difficult to balance the air pressure inside the House. The heat from the six gaslights of Barry's initial design also prevented air from the ceiling inlets from descending into the chamber, a problem compounded by the fact that the fan in the floor system had to be turned off because it resulted in too much noise.[20] Tests conducted in March and April 1852 showed temperatures ranging from 62F (17C) at ground level to 73F (23C) in the galleries (23C). This was considered to be too warm with 64F (18C) recorded as the 'most satisfactory temperature'.[21]

Eventually drastic adjustments were made. The gaslights were replaced with smaller Argand gas fittings in the ceiling panels. The heat from the combustion of these fittings was used to boost the draw of the extract shaft above the ceiling. The Elizabeth Tower inlet was converted into an additional extract shaft, drawing air out through the floor plates (which had been converted into extracts). The increased draw from the stacks was then used to draw fresh air directly into the equalizing chamber from the Star

Chamber and Commons' Courts to east and west, without the need for additional mechanical fan propulsion. According to a 1903 survey of carbon dioxide levels, at which time the gas light fittings were still in use in combination with the ceiling extracts, the air quality inside the House was determined to be very good.[22]

Henrik Schoenefeldt's recent research has questioned the supposed failure of Reid's scheme, arguing instead that it represents 'a highly complex and sophisticated system that was the outcome of extensive inquiries into technical, environmental and human aspects of ventilation and climate control.'[23] Schoenefeldt's analysis focused on the experimental nature of the installation and the control regime put in place. However, equally important is how this environmental regime supported the rituals that developed around the procedures of the House of Commons, which have now become so ingrained that their functional origins have been largely forgotten.

The remnants of Reid's design were destroyed when the House of Commons was bombed during the Blitz, and the replacement post-war design by Giles Gilbert Scott included modern air-conditioning. However the layout of the reconstructed House is broadly similar, and it is possible to understand the architectural and environmental sequence of spaces from the original plans of the building.

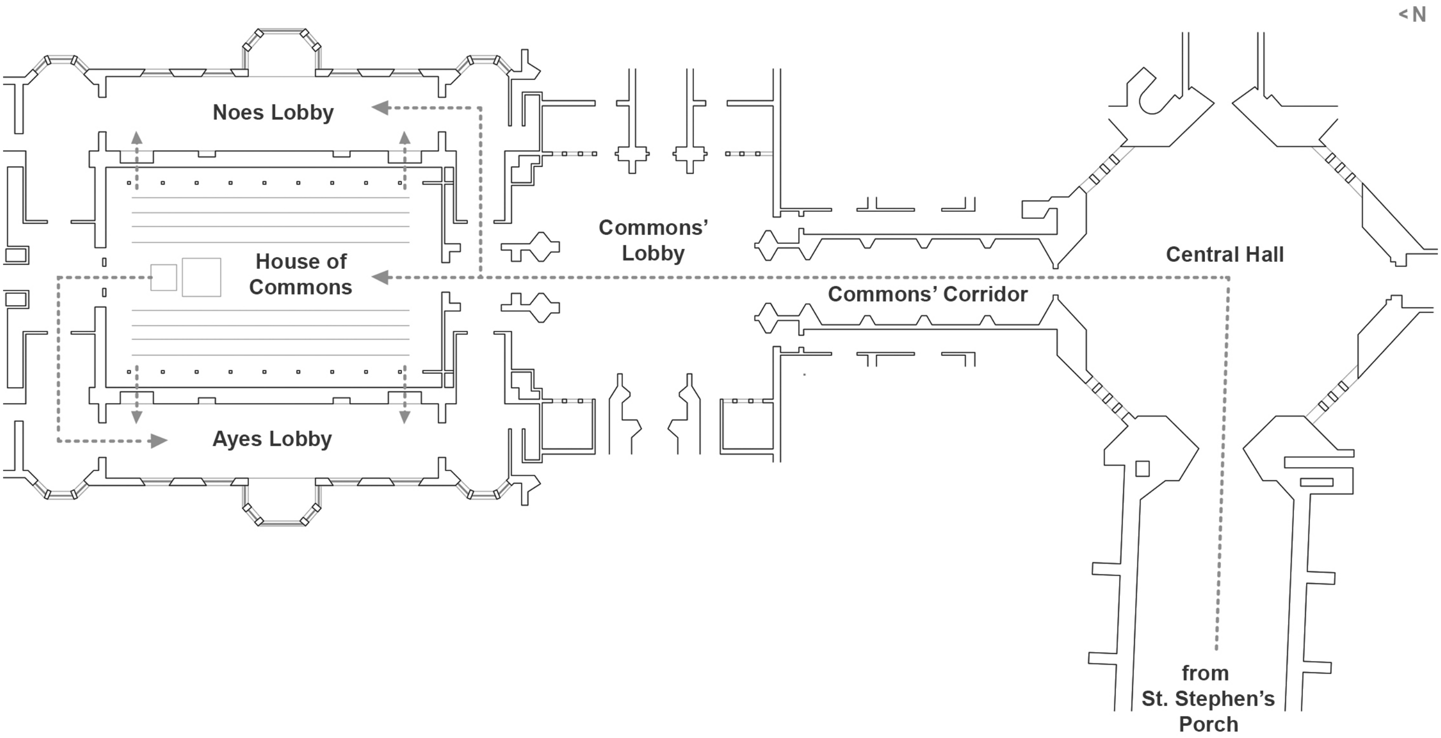

Figure 3. Plan showing entrance sequence to House of Commons at 1:500.

The main entrance to the Commons' Lobby is from the Central Hall via the Commons' Corridor (Fig. 3). From the Commons' Lobby, various offices belonging to parliamentary staff and committees are accessed via corridors to east and west, with the chamber itself accessed through an elaborate gothic screen and ante-chamber to the north.

The original Commons' Lobby was a lofty glazed cathedral-like space serving as a waiting room for MPs to meet before and after debates. As the primary entrance to the House of Commons, the Lobby was a hotbed of political intrigue, with petitioners seeking to influence members' opinions or votes on the policies of the moment (hence the origins of the term 'lobbying'). As Henry Barraud's painting of 1873 reveals, MPs would huddle together to discuss proceedings in their coats and top hats, which were not removed until inside the chamber (Fig. 4).

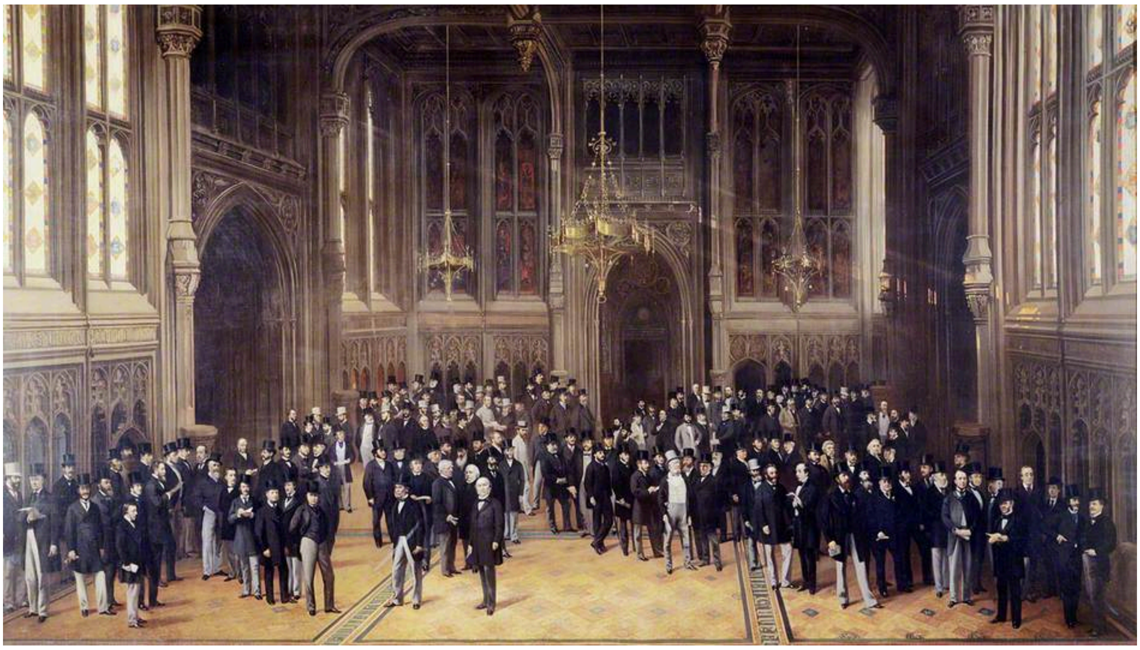

Figure 4. Lobby of the House of Commons, Artist: Henry Barraud. 1872–1873.

The division lobbies represented a spatial evolution of the practice of dividing members for votes.[24] In the new House, a pair of corridor-like ante-chambers were provided either side of the main chamber. The Ayes lobby faces Star Chamber Court to the west, while the Noes lobby opens onto Commons' Court to the east. When a vote or 'division' is called, members have eight minutes to assemble in their chosen lobby. The Ayes lobby is entered from behind the Speaker's Chair at the north end of the main chamber, whereas the Noes lobby is entered from the Commons' Lobby ante-chamber to the south. After eight minutes the doors are locked, and MPs names are recorded and counted as they exit at the opposite end of each lobby (Fig. 5).

Figure 5. The Ayes Division Lobby. 1905.

The introduction of the Division lobbies in the new House played a passive but nonetheless crucial environmental role. Together with the Commons' lobby they acted as air locks and thermal buffers, tempering fluctuations in temperature due to large numbers of MPs[25] entering and leaving the chamber – which measured only 14 x 21m. They also offered MPs relief from the stale and stuffy conditions that could develop inside the chamber during long debates (Fig. 6).

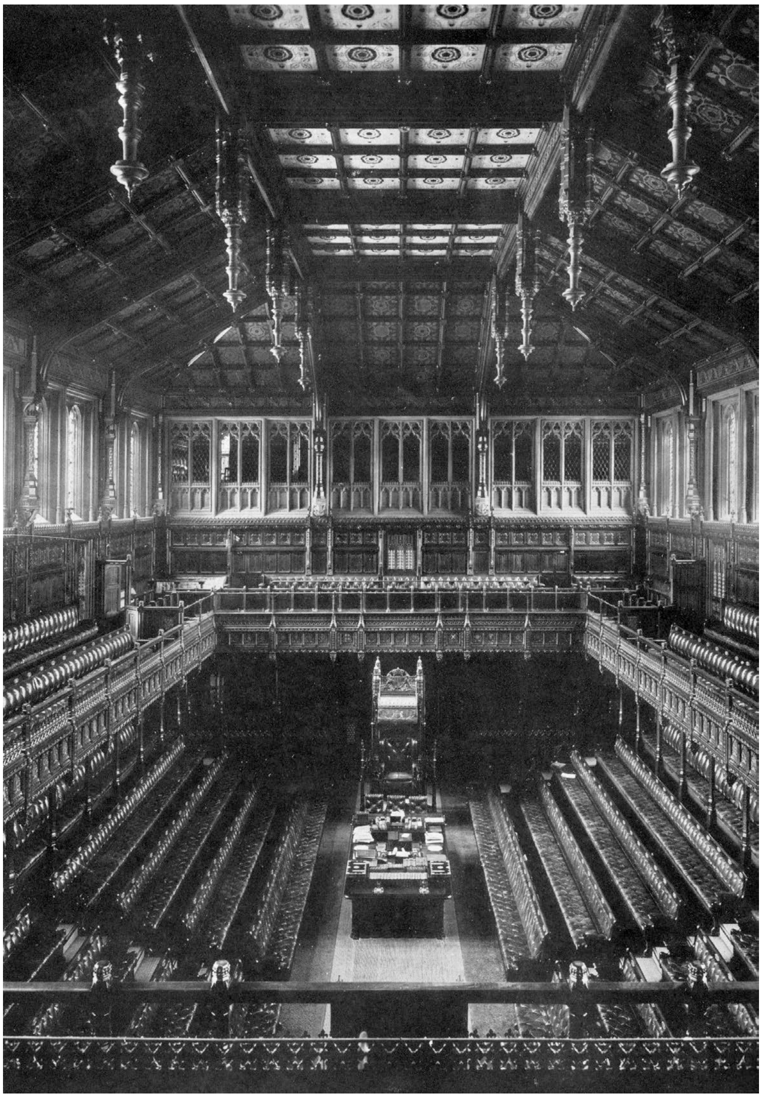

Figure 6. The Chamber of the House of Commons. Report from the Select Committee on House of Commons-Rebuilding, Parliamentary Papers, 1943-44.

The rapid heat gains and losses experienced by parliamentarians filing in and leaving in short spaces of time must have presented more of a challenge than even the atmosphere of the city outside, and goes some way to explain the elaborate design of Reid's system, as well as the time and effort that went into monitoring conditions inside the House. The chamber was fitted with eight thermometers, permitting temperatures to be regularly recorded by attendants under the supervision of the Sergeant at Arms.

Sensitive adjustments could be made to both temperature and airflow in the Equalizing chamber in response to feedback from the MPs and Speaker.[26]

Reid's concept of a continuous feedback loop that could respond to weather conditions, atmospheric pollution, as well as the continuously changing population and demands of the House was clearly ambitious given the technology available at the time. However, contemporary evidence suggests that parliamentarians were able to adapt to the changing internal conditions through adjustments to their dress, activity and location (for example, moving from a standing group discussion in the Commons' Lobby to a sedentary position in the chamber itself, where coat and hat might be removed). The ritual of the 'division' also provided an opportunity for the build-up of hot air inside the chamber to be purged, while parliamentarians might move into the fresher air in the division lobbies with views to the outside during breaks in proceedings.

While the design of the environmental systems of the House of Commons might therefore be summarised as a story of technological ambition ahead of its time[27], the lived experience of the spaces reveal the sophisticated ways in which the behaviour and activities of Victorian society were adapted and fine-tuned to the ever-changing environment indoors as well as outside.

The Natural History Museum

The Natural History Museum was conceived to house the growing collection of plant and animal specimens from the British Museum. When Richard Owen has appointed Superintendent of the Natural History Department in 1856, he perceived that a separate institution with far more floor space was required to prevent the degradation of the collection that had occurred since Sloane's original bequest a century earlier. A site was purchased in leafy South Kensington, by then a fast-growing suburb home to

‘Albertopolis’: the South Kensington Museum and the Government School of Design, the Royal Horticultural Society, and the soon to be constructed Royal Albert Hall (Fig. 7). Alfred Waterhouse was selected to design the new building after the death of Francis Fowke in 1865, and his idiosyncratic terracotta Romanesque design on the site of the 1862 International Exhibition building is a development of curator Richard Owen’s 1859 diagram, ‘Idea of a Museum of Natural History’ (Fig. 8).[28] The collections were to be systematically catalogued as in an encyclopaedia.

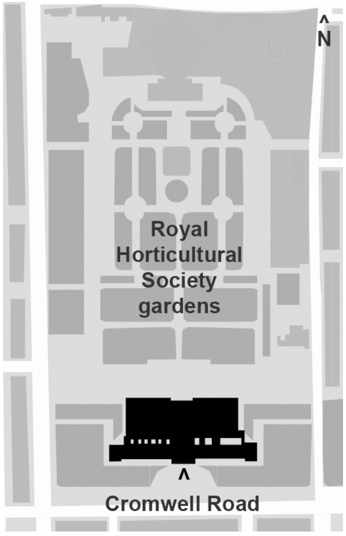

Figure 7. Location plan of The Natural History Museum at 1:10,000.

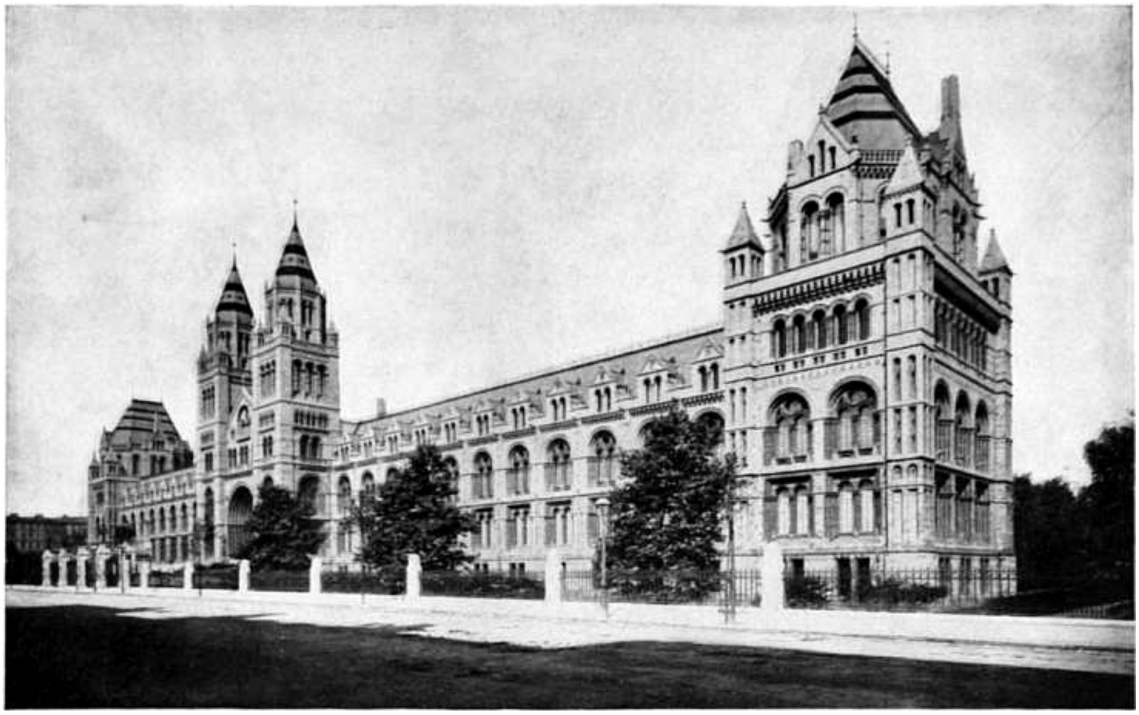

Figure 8. The Natural History Museum from Cromwell Road. The Encyclopaedia Britannica, 1911.

The Great Hall is effectively the heart and lungs of the building. As the first space encountered on entry it provided a respite from adverse weather conditions as well as an opportunity for the Museum authorities to monitor and observe the circulation of visitors. It also protected the precious collections from the pollution of the street outside. The Great Hall is flanked by 58m towers to the south (serving as exhaust stacks), and 50m towers to the north, described by Waterhouse as “Smoke and Ventilation Towers”, serving boilers in the basement. The heat from this central smoke shaft was also used to draw air up additional exhaust shafts surrounding it.[29]

Either side of the Great Hall three storeys of galleries front the lawns to Cromwell Road. North of these galleries are twelve top-lit transverse specimen galleries. The Fossil collections are housed to the east and non-extinct specimens to the west. A key concern was the protection of the specimens from excess heat or moisture - the target design temperature range was 54-60F (12-16C).[30] In 1873, Waterhouse recommended that the heating and ventilation pioneer Wilson Weatherley Phipson be appointed to design a scheme capable of meeting these stringent requirements.[31]

The location of the air supply was carefully considered. Fresh air was drawn into six ducts from the Royal Horticultural Society gardens to the north. Prior to the construction of the Science Museum the gardens acted as a natural filter to the polluted air carried on the prevailing south-westerly wind. The ducts ran underneath the transverse galleries. Each duct was composed of a warm air channel, heated by arrays of steam pipes fed by the boilers, above a cold air channel, allowing the temperature to be locally mixed and controlled in each gallery. The air entered each gallery through grills located near the floor, and was extracted at ceiling level, making use of thermal buoyancy to guarantee continuous flow (Fig. 9).

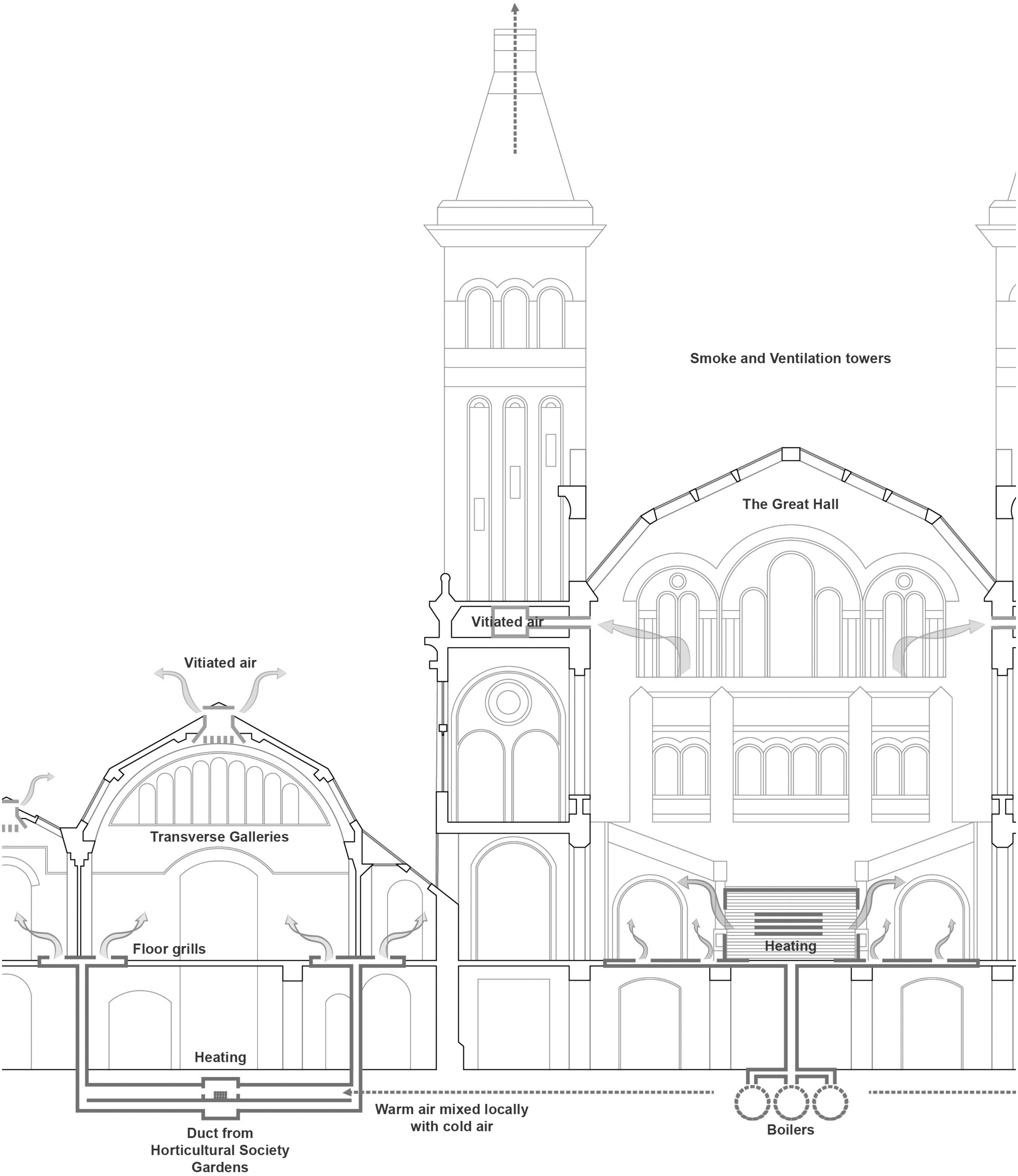

Figure 9. Section of Natural History Museum showing environmental systems at 1:200.

It is clear from correspondence with the client that Waterhouse had a good understanding of the spatial and logistical requirements necessary to integrate a complete heating and ventilation system into the design of the Museum, as demonstrated by his inclusion of the ventilation towers in the design prior to Phipson's appointment.[32] While the requirement for visitor comfort was apparently never explicitly elucidated[33] – the complex system was justified for purely functional purposes (conserving specimens) – we can see that was an important consideration in the design of the Museum, in parallel with the requirements of the collection.

Figure 10. The Great Hall looking north.

The Great Hall was designed as a thermal buffer space between the outside and the collections held in the front and transverse galleries (Fig. 10). Phipson proposed that the large volume of air in the Great Hall be actively heated to counter the heat loss through the main doors, tempering the thermal transition to the individual galleries, which were then conditioned further according to the requirements of the collections. Hot air was supplied to the hall through grates in the floor and from vents underneath the grand staircase.

The location of the hall above the boilers also ensured that visitors would be warmed by heat radiating from the floor. This space is reminiscent of one of the grand Victorian train stations of the period. Visitors would spend most of their time inside the building on their feet, in their outdoor clothes. The park benches lining the space reinforced the semi-outdoor quality of the Great Hall. From here visitors had the choice of moving at ground level into the south facing galleries, or rising up the grand staircase to the upper levels of the front galleries. The transverse galleries could only be accessed from the front galleries at ground level (Fig 11).

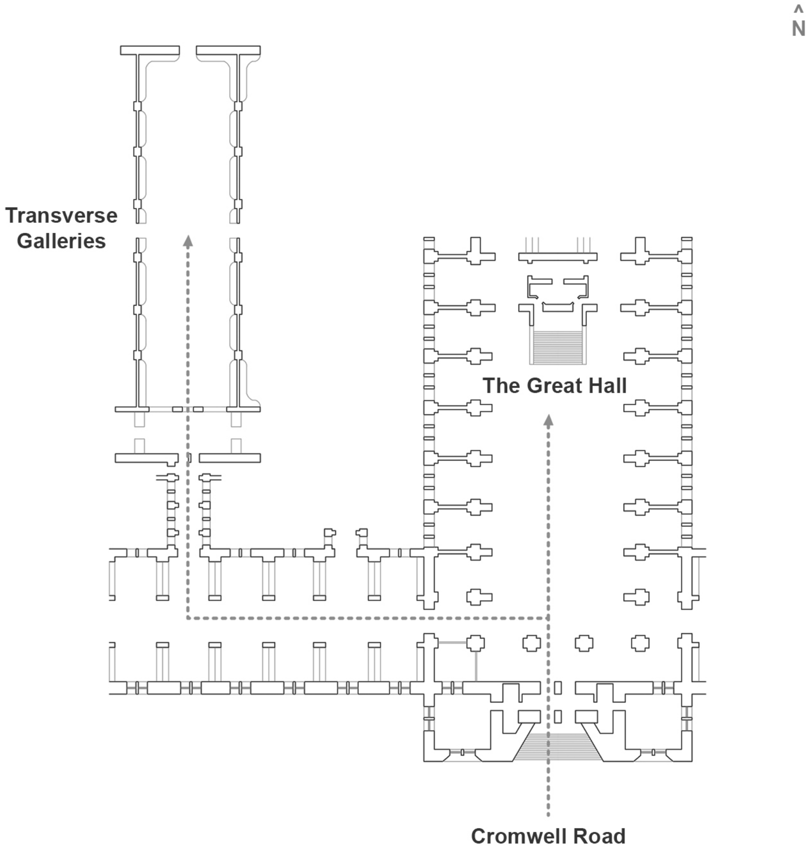

Figure 11. Plan showing visitor route through Natural History Museum at 1:500.

A visit to the Museum left much to chance: the path chosen dictating the exhibits that would be encountered. It would be impossible to see everything in one visit; instead the Museum rewarded return visitors, who might choose a different route on each occasion, rather like weekend walks in the park. The nature of this experience meant that, rather like the Great Exhibition building, the Museum became a place to see and be seen – an indoor promenade untainted by pollution outside – as much, if not more than, an institution for education.

The maintenance of the collections at stable temperatures in all weather and seasons was a significant challenge given the unpredictability of the total number of visitors as well as numbers in individual galleries (Fig. 12). Further local control was provided in the front galleries by opening windows or adjustable vents connected directly to the outside. In summer the skylit transverse galleries could warm rapidly in strong sunshine; however the visitor could be gradually acclimatised through their progression from the outside, to the main hall, to the front gallery, to the gallery in question.

The atmospheric experience of the Museum today is similar to that of the building when it opened. At ground level the mass of the heavy pillars lend a timeless archaeological quality enhanced by Waterhouse's ornate terracotta reliefs of botanical and zoological specimens. The coolth ensured by the thermal mass of the stone and the direct views of the sky reinforce the sensation of outdoors. The vaulted staircases and bays surrounding the Great Hall are reminiscent of the aisles of a cathedral; a monastic quality that is reinforced on moving into the front galleries where display cases are lined up as rows of lecturns lit from the side. As the scale diminishes the furniture and light fittings become more domestic, and visitors feel more enclosed and protected. In winter, steam pipes and radiators provide pockets of warm air for visitors to linger.

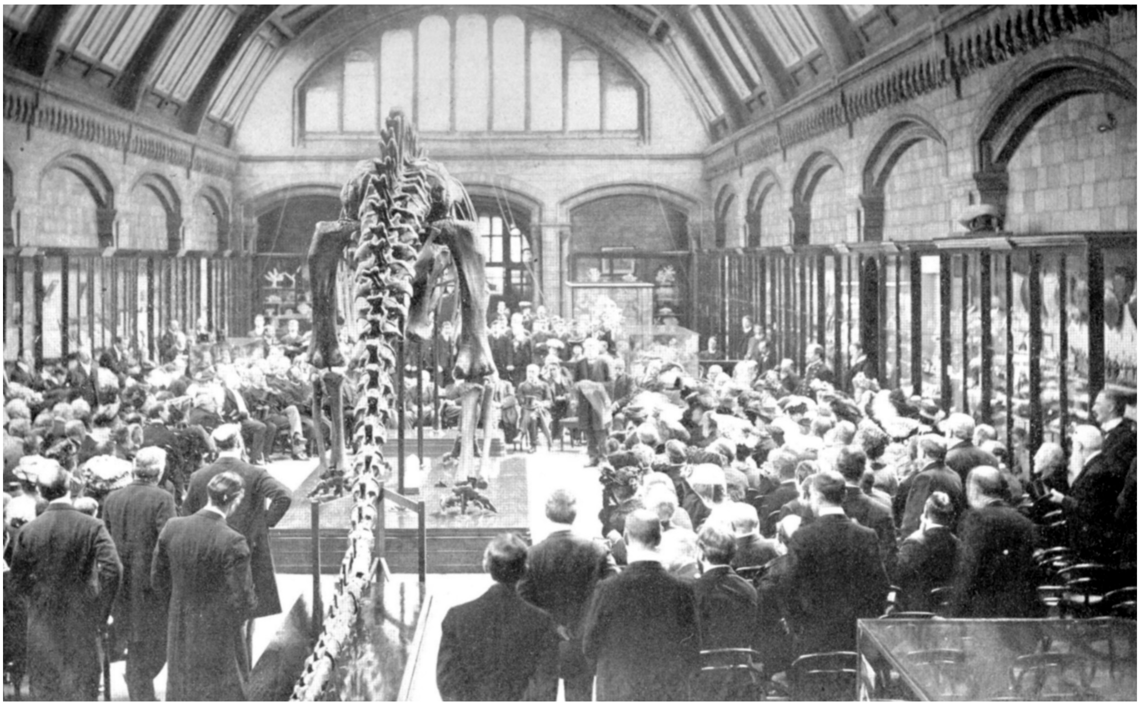

Figure 12. Diplodocus skeleton on display in one of the transverse galleries. 1905. Trustees of the Natural History Museum.

The Glasgow School of Art

Orientation is key to understanding Charles Rennie Mackintosh's design for the Glasgow School of Art. Located on a prominent site to the north of Sauchiehall Street at the top of Garnethill, with a prospect southwards back over the city to the Clyde, the school occupies the whole breadth of a city block (Fig. 13). In common with his other architectural works (Windyhill, Hill House and Scotland Street School), Mackintosh designed the building around an east-west spine wall that divides north and south spaces, with the majority of the studios taking advantage of the north light from Renfrew Street (Fig. 14). This formal device is critical to the environmental regulation and disposition of the interior.[34]

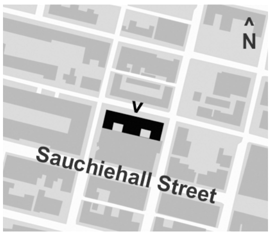

Figure 13. Location plan of the Glasgow School of Art at 1:10,000.

Figure 14. The Glasgow School of Art from Renfrew Street.

Working with the Glasgow firm of James Cormack and Sons, Mackintosh installed a Sturtevant system in the art school, with one fan supplying air to the first phase of the school (the eastern wing), completed in 1899, and a second fan added to double the power of the system with the completion of the western wing in 1910. However, taking a similar approach to that of Waterhouse at the Natural History Museum, Mackintosh worked to completely integrate the technology with his own architectural and spatial aspirations. Mackintosh located the fan room underneath the central entrance. While in a standard Sturtevant installation multiple plenums would feed vertical ducts in the external walls, here a single plenum runs the length of the building underneath the main corridor, tapering to maintain pressure along its length.[35] The plenum feeds ducts rising up the central spine wall, the thermal hearth of the building. Hoppers could be opened incrementally to control the volume of conditioned air entering each space to north and south (Fig. 15).[36]

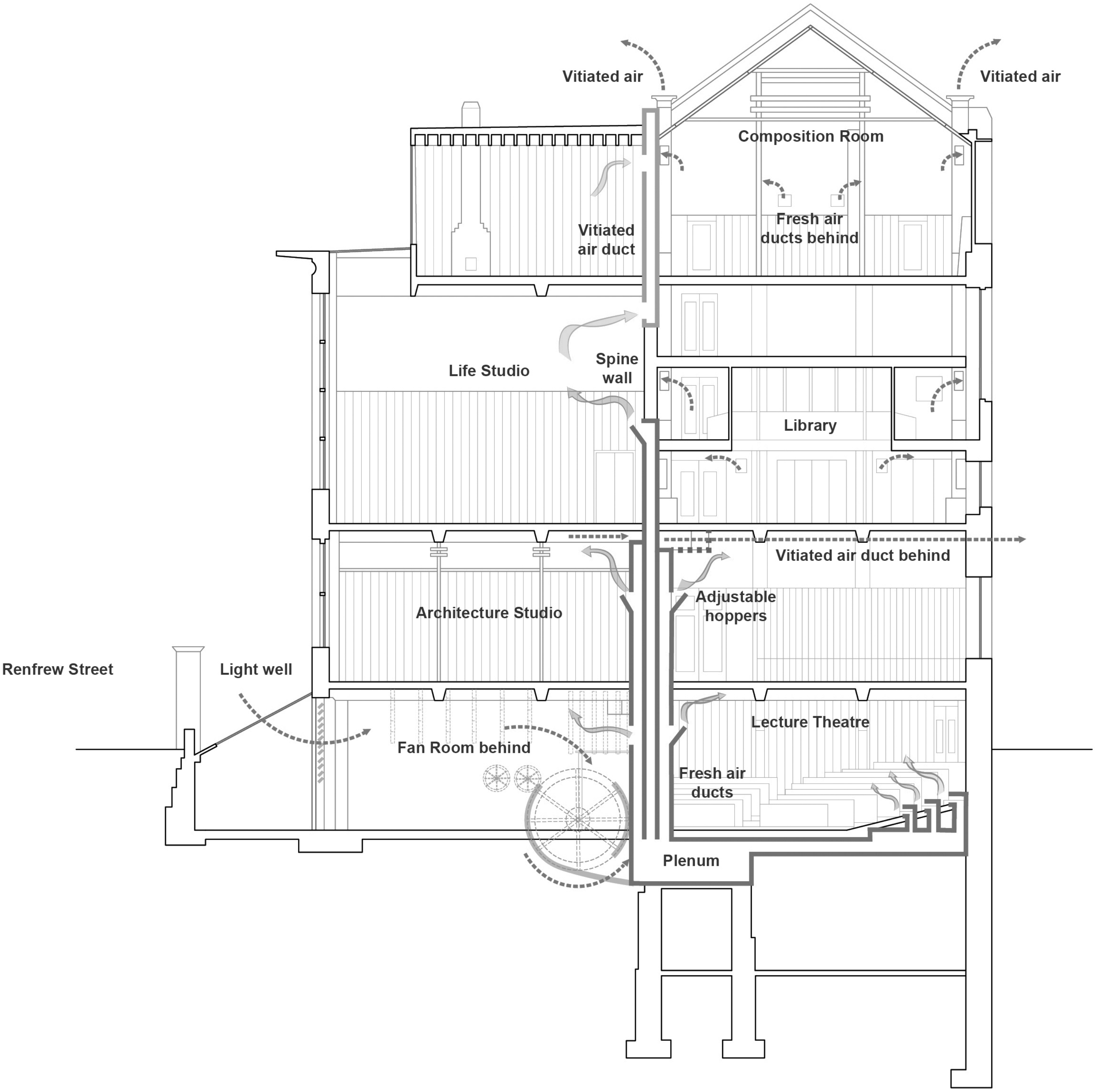

Figure 15. Section of the Glasgow School of Art showing environmental systems at 1:200.

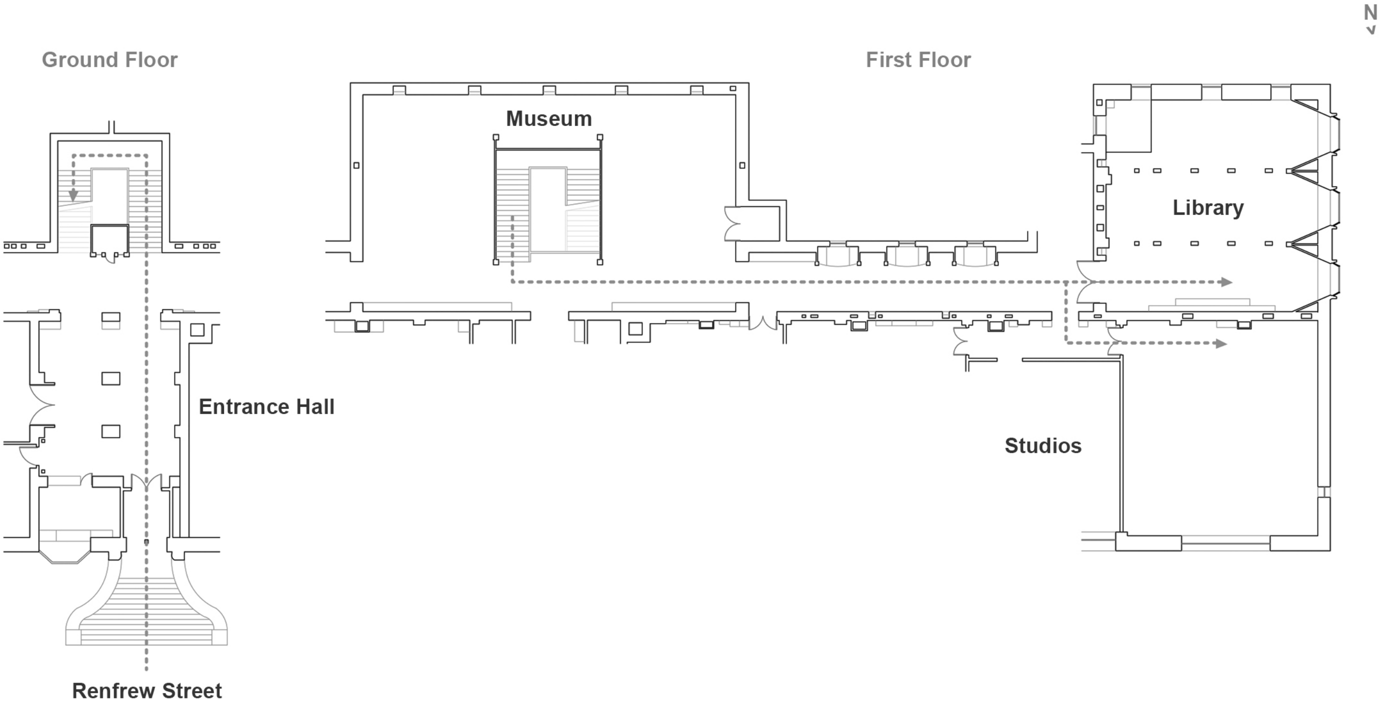

Figure 16. Plan showing visitor route through the Glasgow School of Art at 1:500.

Visitors to the building follow a similar route to the treated air, passing from Renfrew Street through a pair of double doors acting as an airlock into the entrance hall above the boiler room (Fig. 16). Black external doors symbolically give way to white doors internally: the city of soot is left behind for the refinement of art culture (Fig. 17). From the entrance hall, warmed by the boiler underfoot, a corridor leads east or west to north facing studios, and a central staircase gives access to the museum – lit by a large glass skylight as if an outside space, only clean and warm for viewing art (Fig. 18). Corridors give access to more studios and the library at first floor level, and workshops in the basement (Fig. 19).

Figure 17. Entrance porch.

Figure 18. Museum.

Figure 19. Hoppers for controlling ventilation in corridor.

When the system was tested in February/March 1910 temperatures in the studios and library ranged from 58-64F (14-18C). The life drawing studio measured 68-73F (20-23C), showing how the system could be adapted to provide different conditions as the use of different spaces dictated (Fig. 20). Other spaces, including the corridors and loggia at the top of the building were allowed to be freer running, benefitting from solar gains from the horizontal sun in winter and with opening windows for additional ventilation in summer.

Figure 20. A life studio facing north.

The placement of seating carrels in the corridor and drawing desks in the loggia of the western wing of the school shows a sophisticated recognition of the opportunities afforded by the orientation of the building on the site, with its outlook over the Clyde valley to the south. Mackintosh's bespoke adaptation of the Sturtevant system respects the ever-changing quality of the local weather, exploiting its dynamic qualities to heighten the experience of thermal alliesthesia (pleasure derived from thermal stimuli[37]), particularly the importance of the sun in a cool and damp climate (Fig. 21).

The network of ducts and hoppers in the thick stone spine wall transform it into an experimental environmental system embedded within the architectural fabric of the building, providing coolth or warmth in harmony with the weather and time of year.

Figure 21. The loggia.

Conclusion

This paper has examined several examples of transition spaces in significant Victorian buildings and identified step changes in the design of thresholds analysed below. The environmental role of key transition spaces has been described in each case study in relation to the wider evolution of its design, and the developing discipline of building services.

In the twentieth century, HVAC technology has largely come to replace the key role transition spaces played in Victorian buildings, which have often been dismissed as leaky, draughty and inefficient in use of space. Misplaced efforts have been made to retrofit modern air conditioning systems into these buildings at the same time as making the fabric more airtight.

The history of transition spaces demonstrated by these three case studies reveals a complex story. The use of transition spaces permitted the development of ever more sophisticated environmental systems to fine-tune and control conditions in critical environments – whether it be a debating chamber, a gallery of specimens or a life drawing studio – while ensuring the provision of experiential diversity through moderating environments connecting indoors with outdoors. At the same time the evolution of technology presaged the increased mechanisation and homogeneity of the architectural environment in the twentieth century.

The first case study examined the design of an innovative ventilation and heating system in the new House of Commons. Conflict between architect and engineer – probably partly caused by the radical complexity of the engineer's design – contributed to the partial failure of this system, which had attempted the complete thermal control of a relatively small space characterised by sudden fluctuations of heating load in the middle of the polluted atmosphere of Victorian London. Almost three decades later, the science of building services had advanced to the stage that Alfred Waterhouse could successfully integrate a complete system into the Natural History Museum in harmony with the site as well as the functional and experiential requirements of the building. Finally, at the turn of the century, Mackintosh's Glasgow

School of Art shows the potential of the deployment of standardised equipment into a relatively small public building, but most importantly how this enabled the design of a diversity of environmental conditions that supported the ability of building occupants not only to adapt to their immediate environment but also to enjoy the building's relationship with its physical and climatic setting.

However, Mackintosh's highly customised use of an off-the-shelf installation in the Glasgow School of Art proved to be an exception to the rule. Increasingly standardised equipment and a kit-of-parts approach to building services led to the conceptualisation of the environment as a machine, as Reid had predicted more than half a century before.

The invention of the air curtain has now made it possible to maintain all spaces, including entrance foyers, within ever-narrower comfort ranges. The ubiquitous use of raised floors and suspended ceilings to house services in modern public buildings and other places of work has reduced our connection to the outside world and increased the complexity and cost of construction, at the same time as building in obsolescence and reducing the useful lifespan of modern buildings. The three case studies in this paper also demonstrate that perceived comfort temperatures have risen dramatically over the past century, from about 14-18C (the Natural History Museum has a lower target range, but this can partly be attributed to the requirement for the preservation of specimens) to a typical thermostatic range of 21-25C in modern office buildings. As we have become increasingly divorced from weather, time and season, we are seemingly less willing to adjust our clothing or activities to adapt to our environment.

However, in recent years, adaptive comfort theory has aided a rediscovery of the importance of transition spaces and transient environmental experiences, demonstrating for example the impact of thermal history on thermal perception.[38] Research suggests that it is possible to positively alter thermal perception through the judicious use of transition spaces, reversing the negative effects of air conditioning.[39]

The historic precedents explored in this paper demonstrate that environmental diversity not only offers improved opportunities for thermal comfort and adaptation compared with mechanically controlled interiors, but can also enhance our perceptions and experience of the architectural environment. Furthermore, the spatial cost of these spaces can be offset by the flexibility they offer for informal meetings, gatherings, and events, and the financial and energy savings to be made through a reduction in the scale and specification of HVAC equipment.

The design of Victorian institutional buildings such as those described in this paper necessarily involved empathy for how different groups of people would encounter them. The development of transition spaces, and the environmental diversity they provided, involved careful consideration of the interconnectedness of interior and exterior in order to orchestrate entrance sequences intelligently and improve the comfort of users. The result is a richer, more stimulating set of conditions than is often available in contemporary buildings, which often look and feel the same regardless of where they are in the world.

References

[1] R. Dixon & S. Muthesius, *Victorian Architecture*, Oxford: Oxford University Press, 1978.

[2] For example, the medical profession had raised concerns about the health implications caused by overcrowding within school buildings as early as the 1860s. One report by the Schools Enquiry Commission of 1868 estimated that only a quarter of schools reached minimum acceptable environmental standards. See M.V.J. Seaborne & R. Lowe, *The English School: Its Architecture and Organization: 1870-1970*, London: Routledge & Kegan Paul, 1977, ii, p. 5.

[3] J.S. Billings, *Ventilation and Heating*, New York: The Engineering Record, 1893.

[4] B. M. Roberts and CIBSE Heritage Group, *Building Services Heritage*, CIBSE Heritage Group, 2003, p. 21.

[5] C. Porteous, *The New Eco-Architecture: Alternatives from the Modern Movement*, London: Taylor & Francis, 2001, pp. 141–142.

[6] See for example the performance gap between predicted and measured energy use. R. Lawrence & C. Keime, ‘Bridging the gap between energy and comfort’, *Energy and Buildings*, vol. 130, 2016, pp. 651-666.

[7] T. Parkinson, R. de Dear & C. Candido, in *Proceedings of 7th Windsor Conference: The changing context of comfort in an unpredictable world*, Windsor 2012, London: Network for Comfort and Energy Use in Buildings, 2012.

[8] M. Nikolopoulou & K. Steemers, ‘Thermal comfort and psychological adaptation as a guide for designing urban spaces’, *Energy and Buildings*, vol. 35, no. 1, 2003, pp. 95–101.

[9] A. Pitts, *Thermal comfort in transition spaces*, Buildings, vol. 3, no. 1, 2013, pp. 122–142.

[10] A. Potvin, ‘Intermediate environments’, in K. Steemers & M.A. Steane (Eds.), *Environmental Diversity in Architecture*, Abingdon: Spon Press, 2004, pp. 121-142.

[11] Ibid., p. 121.

[12] H. Schoenefeldt, ‘The Crystal Palace, environmentally considered’, *arq: Architectural Research Quarterly*, vol. 12, no. 3-4, 2008, pp. 283-294.

[13] J.F. Geist, *Arcades: The History of a Building Type*, Cambridge, Mass.: MIT Press, 1985.

[14] R. Banham, *The Architecture of the Well-Tempered Environment*, Chicago: University of Chicago Press, 1969, pp. 35–39.

[15] *The Illustrated London News,* 3 July 1858, p. 11.

[16] H. Schoenefeldt, ‘The Historic Ventilation System of the House of Commons, 1840-52: revisiting David Boswell Reid’s environmental legacy’, *Antiquaries Journal*, vol. 98, in

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press, p. 3.

[17] The transformation of Barry's plans from openable windows to sealed building is retraced in detail in: H. Schoenefeldt, 'Architectural and Scientific Principles in the Design of the Palace of Westminster', in *Gothic Revival Worldwide: A.W.N. Pugin's Global Influence*, Leuven: University of Leuven Press, 2016, pp. 175-199.

[18] Ibid., pp. 21-25. A detailed examination of the process of fine tuning, taking into account Member perceptions of the indoor climate conditions, is provided in: H. Schoenefeldt, 'The Temporary Houses of Parliament and David Boswell Reid's architecture of experimentation', *Architectural History*, vol. 57, 2014, pp. 175-215.

[19] R. Bruegmann, 'Central Heating and Forced Ventilation', *Journal of the Society of Architectural Historians*, vol. 37, no. 3, 1978, p. 151.

[20] H. Schoenefeldt, 'The Historic Ventilation System of the House of Commons, 1840-52: revisiting David Boswell Reid's environmental legacy', *Antiquaries Journal*, vol. 98, in press, p. 28.

[21] House of Lords: 384, Ev 66, Q 675, Oral statement given by Goldsworthy Gurney, 8 May 1854.

[22] W. J. Atkinson Butterfield, 'Chemical Analyses of the Air in the House of Commons', *Journal of Hygiene*, vol. 3, 1903, pp. 486–97.

[23] H. Schoenefeldt, 'The Historic Ventilation System of the House of Commons, 1840-52: revisiting David Boswell Reid's environmental legacy', *Antiquaries Journal*, vol. 98, in press, p. 2.

[24] Previously the Ayes would have been counted in an adjoining room while the Noes, content with the status-quo, remained in place. 'Divisions in the House of Commons: House of Commons Background Paper', House of Commons Library: SN/PC/06401, 2013, p. 10.

[25] 654 members were elected to Parliament in 1852.

[26] H. Schoenefeldt, 'The Historic Ventilation System of the House of Commons, 1840-52: revisiting David Boswell Reid's environmental legacy', *Antiquaries Journal*, vol. 98, in press, p. 26.

[27] Reid's description of the House of Commons as a 'piece of apparatus', and architecture's primary role as 'sustaining an artificial atmosphere', presages the architecture-as-machine metaphors of the early modern movement. See D. B. Reid, *Illustrations of the Theory and Practice of Ventilation*, London: Longman, Brown, Green, & Longmans, 1844, pp. 275, 70. See also R. Bruegmann, 'Central Heating and Forced Ventilation', *Journal of the Society of Architectural Historians*, vol. 37, no. 3, 1978, p. 160.

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[28] M. Girouard, *Alfred Waterhouse and the Natural History Museum*, London: The Natural History Museum, 1981.

[29] J. Cook and T. Hinchcliffe, 'Designing the Well-Tempered Institution of 1873', *arq: Architectural Research Quarterly*, vol. 1, no. 2, 1995, p. 74.

[30] Public Records Office: Works 17-18, p. 3.

[31] Phipson had installed a revolutionary fan and heating system at the University of Glasgow (designed by Sir George Gilbert Scott) between 1866 and 1870. Like Reid's design at the Houses of Parliament this was a fan driven system, but with localised boiler heating in dispersed chambers feeding groups of classrooms and lecture halls, and extraction assisted by the heat from the boiler flues running up the centre of the extract shafts. After his work at Glasgow Phipson's career took off, and he was responsible for installations at the Royal Albert Hall in 1871, the Natural History Museum in Kensington in 1881, and the Royal Infirmary in Liverpool in 1889.

[32] Ibid., p. 74.

[33] Ibid., p. 71.

[34] D. Hawkes, *The Environmental Imagination: Technics and Poetics of the Architectural Environment*, London: Routledge, 2008, pp. 19–21.

[35] The fan room included the now familiar array of steam pipes, as well as horse hair screens for cleaning and humidifying the supply air.

[36] R. Lawrence, 'The internal environment of the Glasgow School of Art by Charles Rennie Mackintosh', *The Journal of Construction History*, vol. 29, 2014, pp. 112-113.

[37] T. Parkinson & R. de Dear, 'Thermal pleasure in built environments: physiology of alliesthesia', *Building Research & Information*, vol. 43, no. 3, 2015, pp. 288-301.

[38] M. Nikolopoulou, & K. Steemers, 'Thermal comfort and psychological adaptation as a guide for designing urban spaces', *Energy and Buildings*, vol. 35, no. 1, 2003, pp. 95-101.

[39] G. Vargas, R. Lawrence & F. Stevenson, 'The role of lobbies: short-term thermal transitions', *Building Research & Information*, vol. 45, no. 7, 2017, pp. 759-782.