Buildings & Cities

Schoenefeldt, H. (2020). Delivery of occupant satisfaction in the House of Commons, 1950–2019. *Buildings and Cities*, 1(1), pp. 141–163. DOI: https://doi.org/10.5334/bc.57

RESEARCH

Delivery of occupant satisfaction in the House of Commons, 1950–2019

Henrik Schoenefeldt[1]

Abstract

The debating chamber of the House of Commons was rebuilt and completed in 1950. It has acted as a learning laboratory for 70 years for occupant satisfaction. Although trials and experiments were undertaken to assess and refine its design empirically, under real-life conditions it did not perform as the design consultants had envisaged. The present study of its history between 1950 and 1954 illustrates that its performance was scrutinised by users, became the subject of scientific investigations, and underwent further physical and operational changes. These critical engagements with performance in use are ongoing. A second period of use is also examined covering the period 1995–2019 using archival research and interviews. This reveals the sociotechnical nature of day-to-day operational procedures, involving collaboration between users and staff as well as between technical and non-technical staff. This process enabled a strong engagement with technical, environmental and human aspects of performance. Insights into the practical reality of building operation are illustrated along with process of continual learning and active stewardship.

Practice relevance

The post-occupancy history of the House of Commons provides a unique-case, rich study on continual institutional learning about environmental control in public buildings. It sheds a critical light on the nature of facilities management as a practice, and also challenges the traditional boundaries drawn between those responsible for the design, post-occupancy evaluation and routine operation of buildings. Facilities management could not be confined to the technological operations administered by technical staff, but depended on collaboration with occupants and non-technical staff, enabling the integration of social and technological processes. Much understanding was based on ephemeral knowledge that staff had acquired through social interactions and practical experience. The paper illustrates how such practical knowledge of performance was acquired, retained and used in facilities management practice. This expanded approach is also critical for design consultants to gain more appropriate knowledge about the actual use and performance of buildings.

Keywords: architectural science; environmental control; facilities management; feedback; Parliament; post-occupancy; thermal comfort; user satisfaction; workplace

1. Introduction: re-envisioning environmental control

The current debating chamber of the British House of Commons[1] was rebuilt in the 1940s to replace the original 19th-century chamber, which had been damaged during the Second World War. Although its interior was largely rebuilt to match the previous one, it was equipped with a modern ventilation and air-conditioning system (Stamp 2000). Its design was the outcome of a collaboration between the Ministry of Works, scientific advisors and external design consultants. The latter included the architects Giles and Adrian Gilbert Scott, the mechanical engineer Oscar Faber & Partners, and the air-conditioning contractor Benham & Sons (*Surveys* 1951a). It was a bespoke system designed to address the specific challenges of environmental control inside the debating chambers, and its development was also underpinned by physical experiments. The architectural critic Furneaux Jordan (1951: 213) wrote:

[1] Kent School of Architecture and Planning, University of Kent, Canterbury, UK. ORCID: 0000-0002-1768-0255

Corresponding author: Henrik Schoenefeldt (h.schoenefeldt@kent.ac.uk)

> The engineers, the specialists, and the National Physical Laboratory have, for the greater comfort and smoother working of the House [of Commons] achieved a mechanical tour de force. In 1835 it was precisely these mechanical things—the ventilation and the water supply—that were a failure, whereas in 1950 the technical specialists in their precision and ingenuity have matched the master masons who four hundred year ago built Henry VIII's chapel across the road.

Jordan's poetic commentary reflected a high degree of optimism about the capabilities of modern science and technology in advancing environmental design. At the core of Faber's scheme was the belief (Faber 1944a; Stradling 1944) that design solutions could be improved and verified empirically through physical experiments. This belief was also advocated, financed and supported by the Ministry of Works, which also collaborated with the National Physical Laboratory (NPL) and Medical Research Council (MRC) in the design and execution of experiments (NPL 1948). The process began with a review of historic performance data and studies from the previous debating chamber. This was followed by simulation with scale models and full-size mock ups, focusing on air flow and the thermal environment (Schoenefeldt 2020b).

Underlying this approach was the belief that latest scientific research methods could resolve longstanding issues with thermal comfort that had been encountered before the war (Faber 1949a, 1949b). The objective behind Faber's scheme, strongly influenced by earlier studies undertaken by the NPL between 1913 and 1921, was to reconcile the conflicts between requirements for ventilation and thermal comfort, which affected its design physically and operationally. In the former chamber, where the air was supplied through perforated floors, MPs had been exposed to the cooling effect of rising currents. Faber addressed this problem by adopting a new configuration of inlets that introduced fresh air from above. The galleries were supplied through openings inside the ceilings, whilst the air for the principal floor was injected horizontally through slots below the galleries (Faber 1944b). In addition, his objective was to increase control over the indoor climate, first by using mechanical ventilation and air-conditioning, and second by exploiting advances in environmental monitoring and control technology (**Figures 1** and **2**).

The expectations for the new system to deliver an optimal environment for members of parliament (MPs) engaged in political debate were high. Its post-occupancy history, which is the subject of this paper, reveals that these expectations were overly optimistic. The models did not accurately predict its actual behaviour under in real-life conditions, and after its completion it faced significant issues, which occupied the Ministry, and the minds of some critical MPs, for several years after Faber's involvement had ended. The post-occupancy history of the House of Commons reveals that its performance was the subject of an ongoing learning process and relied on active stewardship for the last 70 years. This history illuminates the practical challenges with realising Faber's objective to overcome the 'defects of old House of Commons' focusing on problem of thermal comfort (Faber 1944a).

The post-war debating chamber has been in continual use for 70 years. Over this period the House of Commons accumulated an extensive body of recorded data and experience about its performance. This paper does not cover the entire period, but focuses on two key periods.

The first part focuses on the first five years of occupancy from 1950 to 1955, examining the design of the original monitoring and control procedures, and early encounters with the system's performance in use. These illustrate how questions of performance were examined and addressed in the context of routine operational procedures and through scientific studies, fulfilling a similar function to what is now called post-occupancy evaluation (POE).

The second part retraces the development of current operational practices between 1995 to 2019. This period was influenced by substantial institutional and technological changes introduced 45 years after the original system was adopted.

2. Methods

The operational design of Faber's system continually evolved. This operational history offers intimate insights into the process by which knowledge of its actual performance in use was acquired, recorded and used.

The past practices, focusing on the period 1950–55, were reconstructed using historic records from the Ministry of Works, which included correspondence and minutes, technical reports as well as private letters from MPs. These sources provide evidence of occupants' self-reported experiences, opinions and expectations, but also illuminate how staff had interpreted them and responded.

The use of such records, as will be discussed below, is problematic. The evidence disproportionally represents the views of an outspoken minority of occupiers. In contrast to modern survey techniques (*e.g.* the building use survey,[2] which was designed to provide the full cross-section of views held by the user group), the user feedback collected in the House of Commons was based entirely on reactive responses from dissatisfied individuals. However, the objective of this paper is not to provide systematic performance evaluation, but to illuminate the social interactions that allowed occupant feedback to feed into the control, evaluation and improvement of the internal environment.

The development of current practices (1995–2019) was retraced using institutional records and data as well as semi-structured interviews with staff involved in day-to-day operations.[3] The interviews were used to make explicit a tacit knowledge that staff had acquired in the context of their direct experience of the chamber. These also provide insights into a learning process for the individuals involved. As a research method qualitative interviews have limitations in terms of offering objective descriptions of the sociotechnical process. They engage with experiences of this process,

Figure 1: Cross-section of the interior of the debating chamber of the House of Commons showing the ornamental outlets in the ceiling, galleries and wooden panels: 1, ornamental fresh air inlets along the edge of the ceiling (for the gallery level); 2, fresh air inlets (in three tiers) below the gallery, serving the principal floor level; 3, extract openings on the south end of the table; 4, extract openings behind the Speaker's chair; and 5, high-level extract openings along the edge of the central ceiling panel. Source: Author.

which are highly subjective, and it also likely differs between individuals. Its needs to be acknowledged that responses could be subject to bias of the subject, both conscious and unconscious, or affected by the unintentional influence of the researcher's expectations on the subject (Kvale 1994). Interviews were conducted with multiple individuals to gain insights into their different, at times conflicting, viewpoints, and collectively these enabled one to gain some understanding of what could be described as the shared collective experience of sociotechnical process.

These processes were examined through the lenses of Donald Schön's theory of organisational learning and Bruno Latour's actor–network theory (ANT). Although the operational design of the House of Commons was not informed by these theories (predating it), they offer useful theoretical frameworks for interpretation. The case study interviews

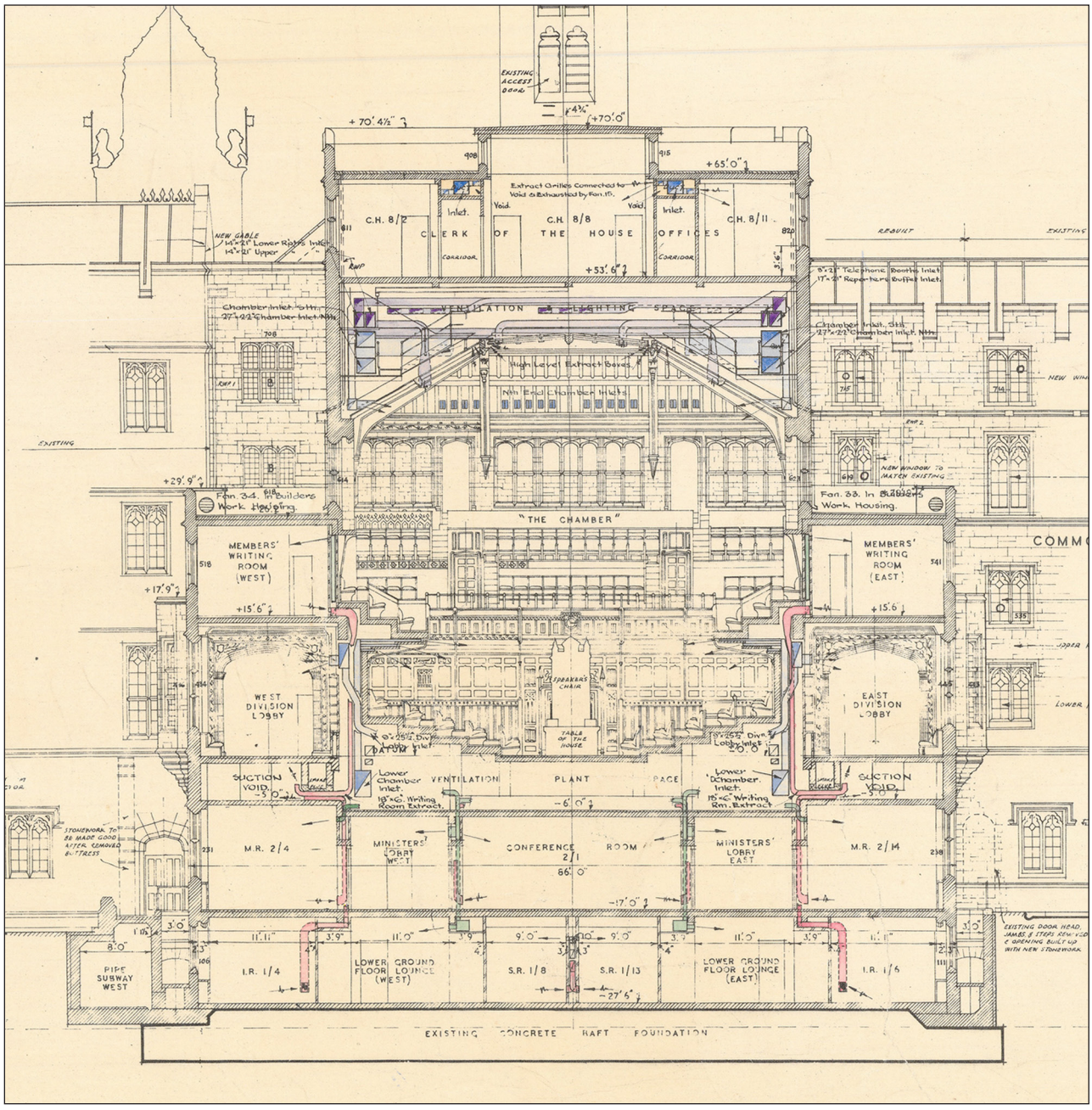


Figure 2: Cross-section, September 1951, showing Faber's arrangement of air inlets below the gallery and within the ceiling. Source: Parliamentary Archives.

provide insights into a learning process described by Schön as 'reflection-in-action'. The interviews also afforded a retrospective review of these experiences by fostering a process that Schön referred to as 'reflection-on-action' (Schön 1983). If examined from the perspective of organisational learning theory (OLT), these processes can also be understood as part of the mechanisms of organisational learning. Curato (2006: 26) described organisational learning as the 'product of organisational members' involvement in the interaction and sharing of experience and knowledge'. In the context of the current case study, organisational learning about building performance was enabled through technology, human agency and institutional structures.

In the case of the House of Commons, the task of managing indoor climates could not be confined to the administration of technological operations overseen by engineers. It was extended to the engagement of non-technical staff in order to establish qualitative feedback loops. This facilitated the flow of information between staff and MPs as well as between technical and non-technical staff. This established social feedback processes alongside technical ones, which formed two distinct, yet complementary, activities. If viewed through the lens of ANT, the system could be described as a network of human and technical actors. According to this theory, the term 'actor' refers to people (*e.g.* MPs and staff) or technologies (*e.g.* environmental sensors) that in some causal way affects the production of a shared knowledge or understanding. The term 'network' refers to an assemblage of actors (human and non-human) and their relationships as defined by their specific function and place within the network (Latour 1996, 2011).

3. Management continuity

The Ministry of Works, which had worked closely with the consulting engineers, took over the responsibility for operating and maintaining the system in 1950. Transferring the facilities management to the Ministry ensured continuity of ownership over its performance once it was occupied. Over the first four years the Ministry acquired extensive knowledge about the House's performance through its involvement in day-to-day operations and through scientific investigations. It engaged with technical, environmental and human factors. From 1940 until 1970, the Ministry employed its own facilities management division at the Palace of Westminster,[4] which was managed by the resident engineer, a role held by Arthur Hattersley between 1950 and 1957 (Bedford 1955). For the operation of Faber's system, the Ministry employed a dedicated team of four control engineers, who were stationed inside a control room below the chamber (Ministry of Works 1960) and supervised by an engineer-in-charge (House of Commons 1953–54). At times, the Ministry also engaged engineers from its central office in Lambeth Bridge House, using their expertise and skills to support Hattersley in assessing and improving the system.

The rebuilt chamber was equipped with a semi-automated monitoring and control system using electromechanical technology.[5] It exemplified a technology at the transition from a past era where environmental control was an entirely manual process towards one shaped by early developments in automation.

The system of the pre-war chamber, which originated from the mid-19th century, was manually operated (Schoenefeldt 2018, 2019). Staff collected, recorded, and reviewed external and internal climate conditions, using conventional thermometers and handwritten log-books, and also had to control ventilation, temperature and humidity manually.

In the rebuilt chamber many of these manual operations were performed by electromechanical devices, such as power-operated actuators for the control of valves and automated monitoring equipment, which supplied the engineers with data on fan speeds, temperature and humidity. The monitoring system was composed of electrical sensors, which were connected to dial indicators and strip chart recorders,[6] logging temperature and humidity readings on paper (Faber 1948). This was integrated into the automatic control loop of the air-conditioning plant, which adjusted the cooling or heating load if the sensors detected a deviation from the setpoint (Ministry of Works 1955) (**Figure 3**).

The system was set to maintain stable thermal conditions. In 1952, the Parliamentary Secretary reported that the usual temperature was 65°F (18°C), and during late sittings, when MPs tend to prefer high temperatures, it was raised to 67.5°F (20°C) (House of Commons 1952a). In comparison with modern building management systems (BMSs), however,

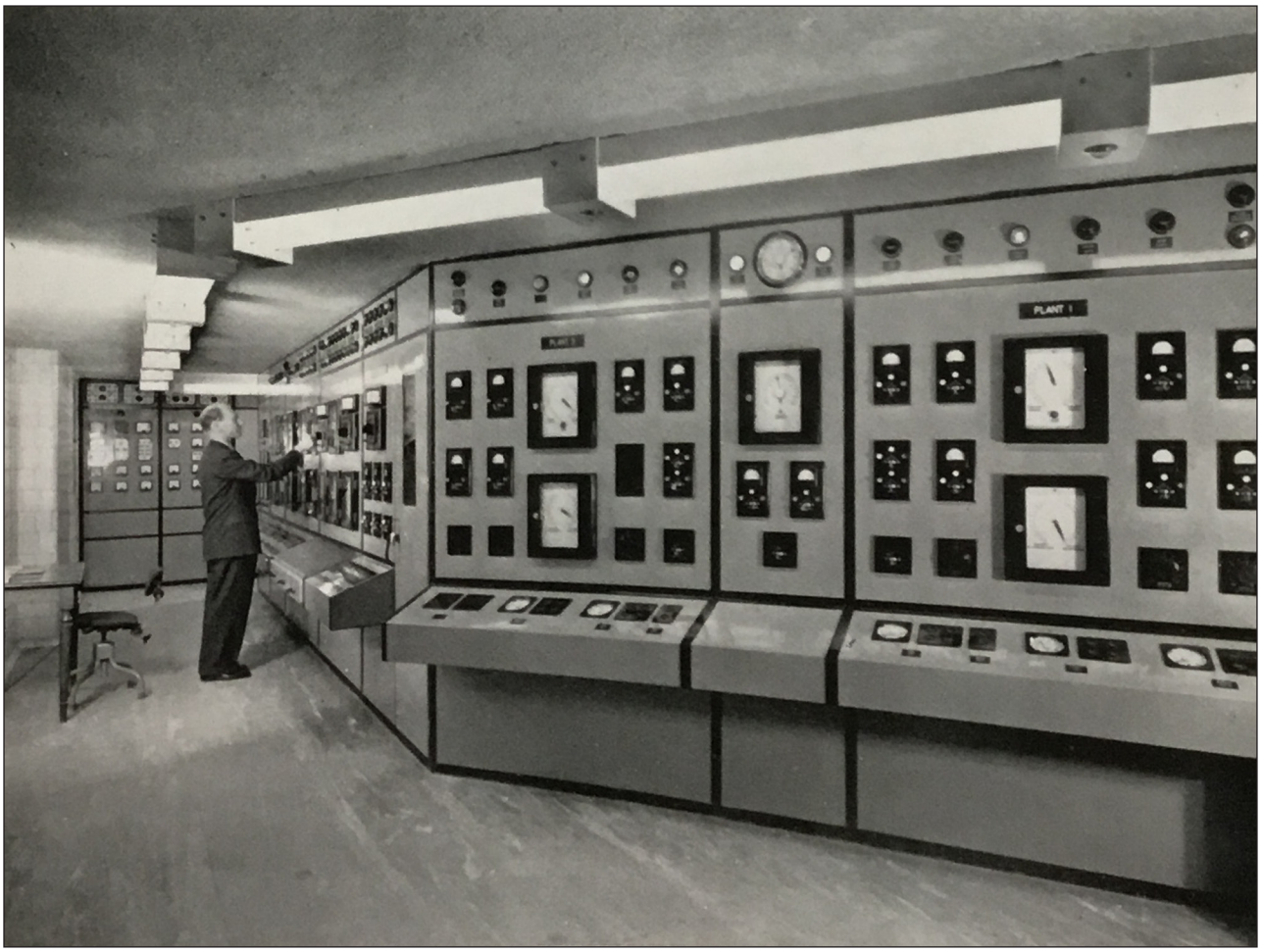
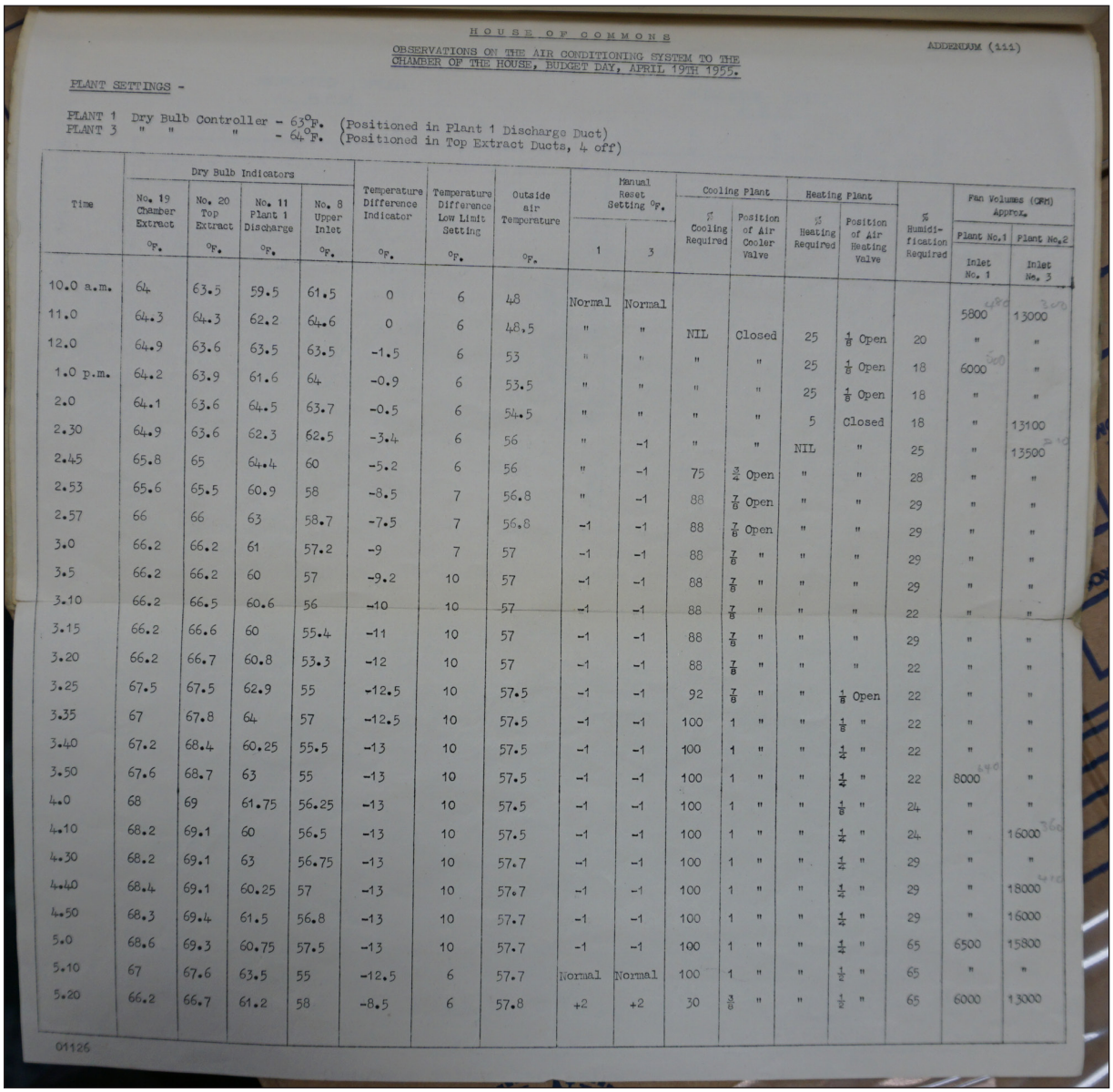


Figure 3: Original control room, 1951. Source: Parliamentary Archives, MOW/4/36.

the extent of automation was limited. Monitoring and control remained a highly involved process and relied on manual interventions to become dynamic and responsive (**Figure 4**).

The automatic control covered temperature and humidity, but other important functions were still performed manually by the control engineers, which included regulating the mechanical ventilation or responding to changes in activity, both of which were critical to limit the impact of internal heat gains from bodies. Mitigating the impact of these heat gains was slow and difficult with an automatic system that was entirely reactive and did not include ventilation. The issue was that electromechanical controls only responded after the thermal conditions had deteriorated. It also took time for the adjustments to show a noticeable effect on the climate (Fletcher 1954a). Faber & Partners had been aware of this issue and from the beginning had introduced manual procedures that enabled staff to take a more pre-emptive approach (Scott 1945). This involved undertaking early adjustments informed by direct observations of changes in activity, and, where possible, make predictions of possible changes. The latter included the rise or fall in the number of MPs in the chamber before and after debates, or the movement of several hundred MPs during votes, both of which affected climate and air quality. The engineers closely monitored occupancy levels and parliamentary proceedings using a periscope and microphone (*Illustrated London News* 1950; *The Times* 1950; Bransby 1959a) (**Figures 5** and **6**). The eye of the periscope was situated in the ceiling at the south end of the chamber provided a view of the Speaker's chair, table and front benches.

Environmental control was also informed by reviews of feedback given by MPs and other users, for which a separate qualitative feedback loop was established. The original control manual, produced by the Ministry of Works in 1955, noted that the system was operated in an automated mode under normal conditions, but was adjusted manually when



HOUSE OF COMMONS

OBSERVATIONS ON THE AIR CONDITIONING SYSTEM TO THE CHAMBER OF THE HOUSE, BUDGET DAY, APRIL 19TH 1955.

ADDENDUM (111)

PLANT SETTINGS -

PLANT 1 Dry Bulb Controller - 63°F. (Positioned in Plant 1 Discharge Duct)
PLANT 3 " " " - 64°F. (Positioned in Top Extract Ducts, 4 off)

Time	Dry Bulb Indicators: No. 19 Chamber Extract °F.	No. 20 Top Extract °F.	No. 11 Plant 1 Discharge °F.	No. 8 Upper Inlet °F.	Temperature Difference Indicator °F.	Temperature Difference Low Limit Setting °F.	Outside air Temperature °F.	Manual Reset Setting °F.: 1	3	Cooling Plant: % Cooling Required	Position of Air Cooler Valve	Heating Plant: % Heating Required	Position of Air Heating Valve	% Humidification Required	Fan Volumes (CFM) Approx.: Plant No.1 Inlet No. 1	Plant No.2 Inlet No. 3
10.0 a.m.	64	63.5	59.5	61.5	0	6	48	Normal	Normal							
11.0	64.3	64.3	62.2	64.6	0	6	48.5	"	"						5800	13000
12.0	64.9	63.6	63.5	63.5	-1.5	6	53	"	"	NIL	Closed	25	⅛ Open	20	"	"
1.0 p.m.	64.2	63.9	61.6	64	-0.9	6	53.5	"	"	"	"	25	⅛ Open	18	6000	"
2.0	64.1	63.6	64.5	63.7	-0.5	6	54.5	"	"	"	"	25	⅛ Open	18	"	"
2.30	64.9	63.6	62.3	62.5	-3.4	6	56	"	-1	"	"	5	Closed	18	"	13100
2.45	65.8	65	64.4	60	-5.2	6	56	"	-1	"	"	NIL	"	25	"	13500
2.53	65.6	65.5	60.9	58	-8.5	7	56.8	"	-1	75	¾ Open	"	"	28	"	"
2.57	66	66	63	58.7	-7.5	7	56.8	-1	-1	88	⅞ Open	"	"	29	"	"
3.0	66.2	66.2	61	57.2	-9	7	57	-1	-1	88	⅞ "	"	"	29	"	"
3.5	66.2	66.2	60	57	-9.2	10	57	-1	-1	88	⅞ "	"	"	29	"	"
3.10	66.2	66.5	60.6	56	-10	10	57	-1	-1	88	⅞ "	"	"	22	"	"
3.15	66.2	66.6	60	55.4	-11	10	57	-1	-1	88	⅞ "	"	"	29	"	"
3.20	66.2	66.7	60.8	53.3	-12	10	57	-1	-1	88	⅞ "	"	"	22	"	"
3.25	67.5	67.5	62.9	55	-12.5	10	57.5	-1	-1	92	⅞ "	"	⅛ Open	22	"	"
3.35	67	67.8	64	57	-12.5	10	57.5	-1	-1	100	1 "	"	⅛ "	22	"	"
3.40	67.2	68.4	60.25	55.5	-13	10	57.5	-1	-1	100	1 "	"	¼ "	22	"	"
3.50	67.6	68.7	63	55	-13	10	57.5	-1	-1	100	1 "	"	¼ "	22	8000	"
4.0	68	69	61.75	56.25	-13	10	57.5	-1	-1	100	1 "	"	⅛ "	24	"	"
4.10	68.2	69.1	60	56.5	-13	10	57.5	-1	-1	100	1 "	"	¼ "	24	"	16000
4.30	68.2	69.1	63	56.75	-13	10	57.7	-1	-1	100	1 "	"	¼ "	29	"	"
4.40	68.4	69.1	60.25	57	-13	10	57.7	-1	-1	100	1 "	"	¼ "	29	"	18000
4.50	68.3	69.4	61.5	56.8	-13	10	57.7	-1	-1	100	1 "	"	¼ "	29	"	16000
5.0	68.6	69.3	60.75	57.5	-13	10	57.7	-1	-1	100	1 "	"	¼ "	65	6500	15800
5.10	67	67.6	63.5	55	-12.5	6	57.7	Normal	Normal	100	1 "	"	½ "	65	"	"
5.20	66.2	66.7	61.2	58	-8.5	6	57.8	+2	+2	30	⅜ "	"	½ "	65	6000	13000

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Figure 4: Sample log-sheet, 1954. Source: Strategic Estates Archives, Westminster, a loose sheet to be found in the document titled Ministry of Works (1955).

Figure 5: The chamber as seen through eyepiece of a historic periscope. Source: Author.

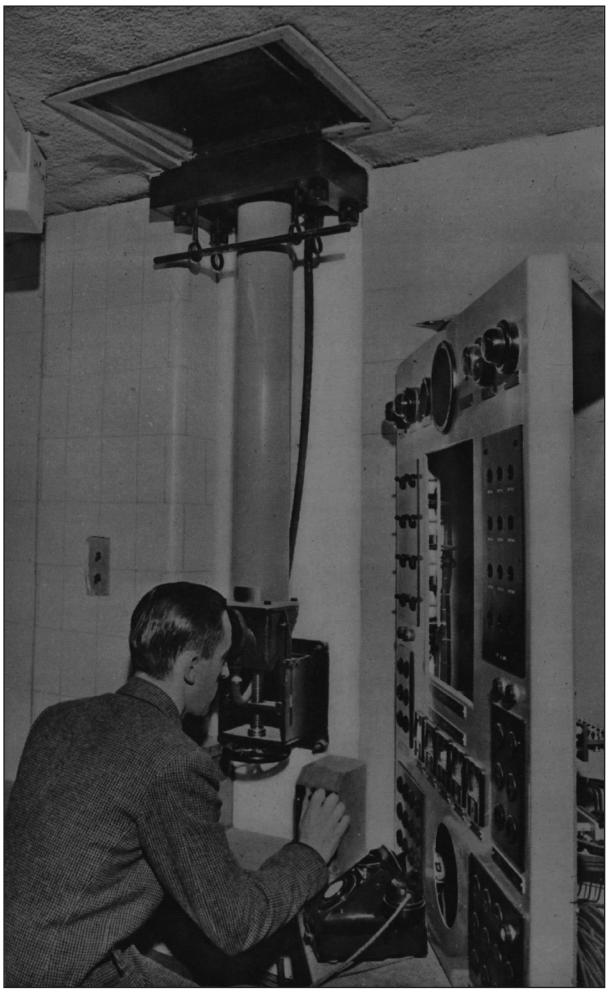

Figure 6: A periscope operated by an engineer-in-charge. Source: Parliamentary Archives, MOW/4/36.

the standard climate settings were 'not to the Members['] liking' (Ministry of Works 1955). User engagement formed an integral part of the routine monitoring and control procedures. In the 1950s, MPs used multiple ways of communicating their experiences to the technical staff (**Figure 7**). The official instruction that MPs had received from the Ministry was either to contact the resident engineer, who acted as the official liaison mediating between MPs and the control room (Bedford 1955), or to liaise directly with the engineer-in-charge of the control room (Bransby 1959b). Their interactions with MPs were recorded in log-books and the Ministry also kept files of written correspondence (Hattersley 1952a). The Chief Engineer of the Ministry wrote that

> for each shift log sheets are made up reporting air conditions, plant operation and complaint received and how they dealt with by the operating staff. (Fletcher 1954b)

The records also show that MPs often shared their concerns with the Minister or Parliamentary Secretary instead. The Parliamentary Secretary, who was an MP assisting the minister in his role as head of the Ministry of Works, became extensively involved with resolving day-to-day practical challenges, but also led initiatives to assess and improve its performance.

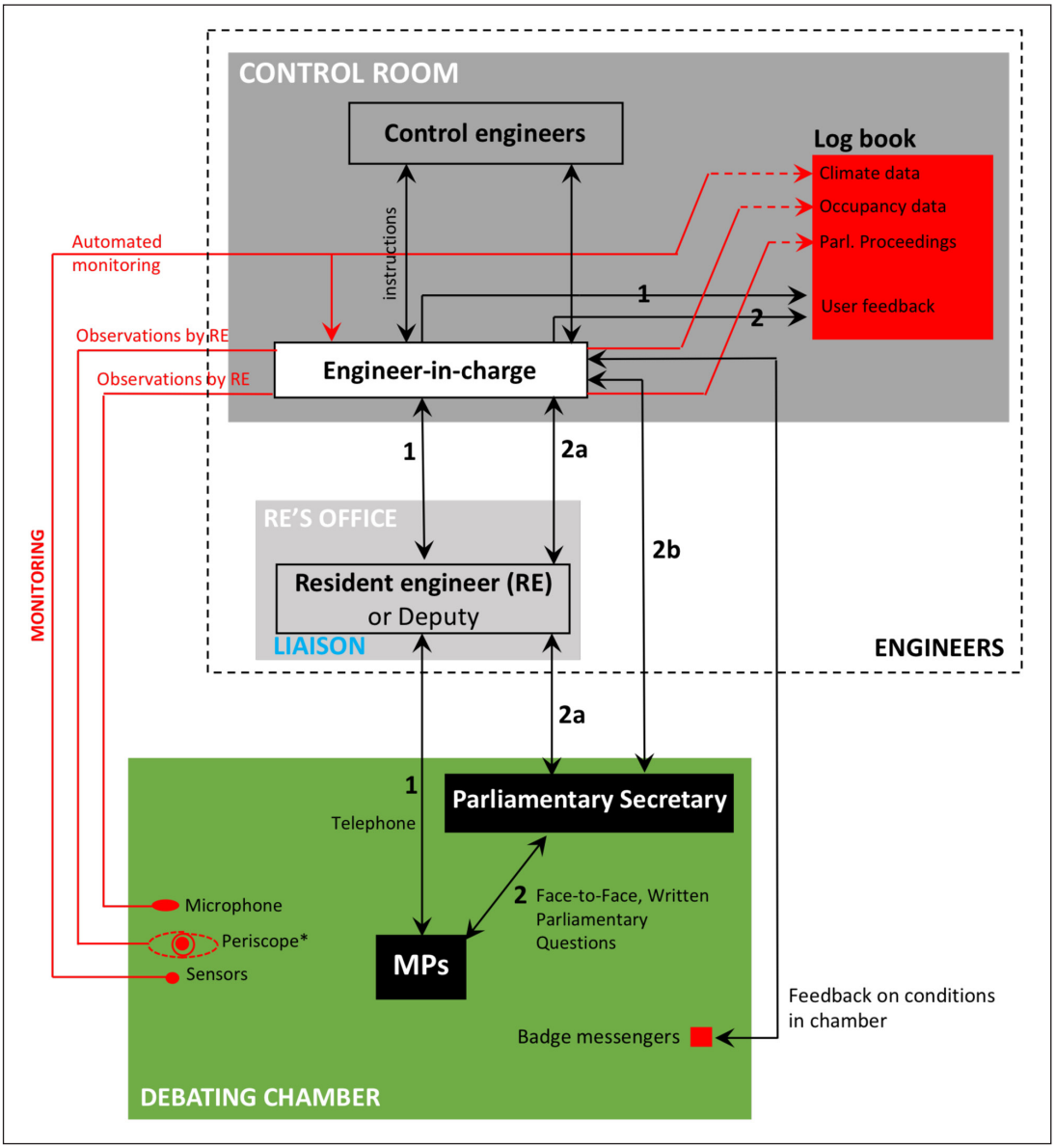

Figure 7: The system integrating social and technological feedback loops, 1950s: Scenarios 1, MPs communicate with the resident engineer (RE); 2a, MPs communicated with the Parliamentary Secretary (PS), who subsequently liaises with the RE or control engineers (CE) directly; and 2b, MPs communicated with the PS, who subsequently liaises with the CE. Source: Author.

4. Pre-occupancy trials, September 1950

The Ministry of Work's involvement began with a collaboration with Dr Oscar Faber in a series of pre-occupancy trials in September 1950. The objective was to evaluate the system's performance under different levels of occupancy and also to test and refine the control regime and settings. Eric de Norman, Deputy Secretary of the Ministry, wrote on 22 June 1950 that the:

> engineers are anxious to see how their machinery works when it is full, empty and partially filled, so that they can regulate the apparatus to suit the changing conditions which will occur when the chamber is in use.
> (De Norman 1950)

To allow the tests to take place under conditions close to real life, Faber convened a series of mock sittings in which volunteers would take the place of MPs (Mole 1950). To procure the large number of volunteers required for these sittings, the Ministry collaborated with the British Army. It supplied several hundred troops from different regiments, which included soldiers from the Grenadier, Scots, Welsh and Irish Guards as well as the Royal Life Guards (Hunter 1950). Three sittings, each lasting several hours, were undertaken in September. The first sitting, held on 7 September and involving 400 guardsmen (*Evening Telegraph* 1950a), was followed by a second trial with 950 troops on 11 September, which was used to test system under the most crowded conditions. On 29 September, another test was undertaken with 700 civil servants (*Evening Telegraph* 1950b), and further trials were conducted without human participants. An array of electric heaters was installed to simulate body heat.

The trials revealed that Faber's request for such tests was not unjustified. The currents of fresh air were not behaving as intended, and to rectify this issue Faber adjusted the operational settings and reduced the number of supply apertures in active use. The velocity of the supply air entering below the gallery, for instance, was found not to be sufficient to allow the incoming air to flow horizontally above the heads of MPs without causing noticeable draughts. Cool air was observed 'cascading on to the heads'.[7] To introduce the same volume of air at a higher speeds, Faber closed two-thirds of the inlets below the gallery. The trials also revealed cold air descending from the ceiling, which occurred if the incoming air was 10°F (6°C) lower than the atmosphere within the chamber. To address this issue Faber adjusted the speed of the incoming air and closed one-third of the ceiling apertures.

5. Performance in use, 1950–55

These trials marked the final stage in Faber's formal involvement. The new debating chamber of the House of Commons formally opened on 26 October 1950 and the responsibility for its operation was transferred to the Ministry. The need to engage with questions of performance, however, did not cease. Responding to criticism from MPs about the internal climate conditions, it became subject of inquiries for over four years. In the first year the Ministry had received complaints from MPs about draughts and unstable temperatures. According to Charter Ede, MP for South Shields, there were 'excessive variations' in temperature and 'terrific blasts' that made it impossible for MPs to keep papers on their knees. He reported that Winston Churchill on two occasions had 'turned up in a great coat with the collar turned up' to demonstrate his sense of discomfort (House of Commons 1952b). Throughout 1951 attempts were made to improve the operational settings. The resident engineer reduced the velocity at which fresh air was entering the chamber, from 18,000 to 15,000 ft^3 (509 to 425 m^3) per min at the ceiling and from 8000 to 6000 ft^3 (226.5 to 170 m^3) under the gallery; and the air extract behind of the Speaker's chair was also temporarily closed.

5.1. Criticism from a loud minority, March–May 1952

Initially these changes reduced the severity of the complaints, but from March 1952 the environmental conditions became the subject of renewed criticism and drove the Ministry to commission a formal investigation. Over three months the Parliamentary Secretary, Hugh Molson, received letters from several MPs about the climate, and criticism was also voiced during Parliamentary Questions. On 20 March 1952, William Shepherd, MP for Cheadle, wrote to Molson that the:

> chamber, with all its lavish extraction equipment, is unhealthily hot for those who sit other than on the first two rows.

David Eccles, who had been appointed Minister of Works in 1951, admitted that the chamber was 'on the warm side' (Eccles 1952) and instructed the engineers to lower the temperature. Shepherd, who had sent another letter to the Secretary a week later, wrote that he 'noticed a decided improvement' of the temperature, but noted that it 'badly affected the throats of Members' (Shepherd 1952). Other MPs, however, disagreed with Shepherd's evaluation. Following these adjustments the Ministry received several responses claiming that the atmosphere had become too cold. On 26 March 1952, Colonel Thorne, Assistant Serjeant-at-Arms, reported that the atmosphere felt cold, and one of the messengers noted that a 'draught of cold air could be felt coming down' inside the Speaker's gallery. Ronald Bell, MP for South Buckinghamshire, in contrast, felt that the atmosphere was still too warm. These conflicting views are significant as they illuminated the difficulties of accommodating differences in experience. As the main issue was the

subjective nature of thermal comfort rather than technological, the Parliamentary Secretary recognised that they had to manage expectations, which they addressed in open statements to the whole House as well as letters and oral responses to discontented individuals. In a formal note, circulated within the House in early May, Molson explained what he considered achievable. He wrote that the complaints were not the outcome of technical 'defects', but an 'inevitable human reaction to uniform conditions' (Brock 1952a). In an oral response given during Parliamentary Questions on 23 May, Molson also explained that it was unrealistic to expect the system to provide conditions that satisfied every individual. He noted that views were not:

> all in agreement. It is clear that there is a diversity of taste and that all hon. Members cannot simultaneously be satisfied. (House of Commons 1952a)

Although the number of complaints was small, the minister considered it sufficient to justify a formal investigation. He saw the problems as evidence that Faber's system was not performing satisfactorily. On 1 May 1952, he wrote there was a 'general used-up or potted feeling in the air' (Molson 1952) and in a letter to the Medical Research Council (MRC) he noted that they had spent:

> a great deal of money on ventilation and air-conditioning plant for the new Houses of Commons. The results have been disappointing and there is a good deal of dissatisfaction among MPs with the conditions. (Root 1952)

Molson recommended undertaking a scientific inquiry, stressing that sufficient data had been collected over the past two years to enable a thorough evaluation (Ministry of Works 1952). Doubting that MPs would trust the results of studies undertaken by the Ministry alone, he collaborated with the MRC. On 3 May he wrote that 'complainers will not be satisfied unless an investigation is carried out by some expert'. This study was led by the physiologist Dr Thomas Bedford, Director of the MRC's Environmental Hygiene Research Unit at the London School of Hygiene and Tropical Medicine (*BMJ* 1963). The fact that a physiologist rather than an engineer was approached is significant as it highlighted an awareness that the study had to engage with physiological and technological aspects. Bedford was very familiar with the general problem. He had been involved in the design of Faber's system (Bedford 1944), acted as a government advisor on health and safety standards for factories, focusing on thermal stress (Bedford 1936), and in the 1930s had also led a thermal comfort study inside the House of Lords, combining environment monitoring with user surveys (Schoenefeldt 2002a, 2020b). The focus of Bedford's investigation in the House of Commons was on MPs' physiological reactions to thermal stresses inside the chamber. Owing to time constraints, it focused primarily on the study of air movement, which Bedford considered to be the main cause of discomfort (Brock 1952b).

5.2. A first scientific inquiry, 1952

To avoid disruptions, the study was conducted in an empty chamber over 10 days during the Whitsun recess. Bedford submitted his report to the Ministry on 26 June 1952 (Bedford 1952) and his recommendations were also discussed in reports by Hattersley and the Ministry's chief engineer (Hattersley 1952a; Sizer 1952). The study involved a collaboration between engineers and physiologists. Bedford was assisted by Hattersley and two engineers from the Ministry's Field Test Unit, which was a research facility that had experience with the study of thermal comfort in housing.[8] Two engineers from the NPL, who had taken part in the development of Faber's scheme, were also engaged. The study was based on the retrospective analysis of user feedback and climate records, examinations of internal air currents, involving smoke tests and measurements, and trials with alternative control regimes. The analysis of the post-occupancy data was undertaken by Barbara Tredre, a climate physiologist from the MRC.[9] It was based on 46 complaints that had been logged in Hattersley's diary throughout April and May 1952. More than half of these complaints referred to problems with draughts, whilst those referring to temperature or air quality were relatively few in number. Eight comments described the atmosphere as too cold, 10 as too hot, whilst only three mentioned problems with the air feeling 'stuffy'. It also revealed that problem with draughts were concentrated in small areas, with the largest number referring to draughts at the bar end of the chamber. The majority of these reports came from the Serjeant-at-Arms, who had his chair in this area. MPs also reported sensations of draughts at the front benches near the table and cold downdraughts from the ceiling were observed within the galleries.

Smoke tests and measurements confirmed that internal air movement was a significant issue. Some parts of the chamber were suffering from insufficient, others from excessive air movement. The temperature, in contrast, rarely reached uncomfortable levels.[10] Although the temperature was not excessively high or low, Bedford warned that the monitoring of air temperature and humidity was insufficient to gain a full understanding of the thermal stimuli to which MPs were exposed. Other environmental factors were not routinely monitored, such as air movement and the radiant heat exchanged between the bodies of MPs sitting in close proximity. The latter was prominent during crowded debates, and to compensate for the impact of radiant warmth Bedford recommend reducing the air temperature by 2–3°F (1–1.5°C).

The first investigation into air movement, which focused on the bar end of the chamber, confirmed that the Serjeant-at-Arms' complaints were not unjustified. Bedford reported that 'considerable air movement' with velocities of 50–60 ft/min (0.25–0.30 m/s) were measured around the Serjeant's seat.[11] The smoke tests showed these were largely caused by cross-currents forming between the inlets in the south-east corner of the gallery and the outlets in the wall panels on the opposite side ('3' in **Figure 8**). Another source of draughts in this area was an imbalance in the atmospheric pressure between the chamber and surrounding lobbies. This caused air to rush into the chamber through the open doors. In order to rectify these two problems, Bedford experimented with modifying the settings and openings. To prevent the inward currents Bedford found that the supply had to exceed the extract by 4500 ft^3/h (127 m^3/h). To reduce the intensity of the cross-currents Bedford temporarily closed the outlet as well as eight inlets below the gallery.

The other trials focused on the issue of insufficient air movement at the back benches.[12] He argued the velocity was too low and lacked variety, both of which contribute towards the sensation of 'stuffiness' that MPs were reporting. Readings taken at each row revealed that whilst the front bench had an average velocity of 19–22 ft/min (5.8–6.7 m/min), which Bedford considered 'pleasant', on the back benches the average velocity was only 7–9 ft/min (2.1–2.7 m/min). He argued that air is perceived as 'stuffy' at velocities < 12 ft (3.6 m), a sensation that was further heightened by high temperatures. To address these issues Bedford's team undertook trials by increasing the velocity and also alternating the supply between the two galleries. Several trails, in which the direction was changed at intervals of 1–3 min, were undertaken, but the idea of alternating the supply was abandoned. Whilst succeeding in raising the velocity at the back, the adjustments had produced excessive currents along the front benches.

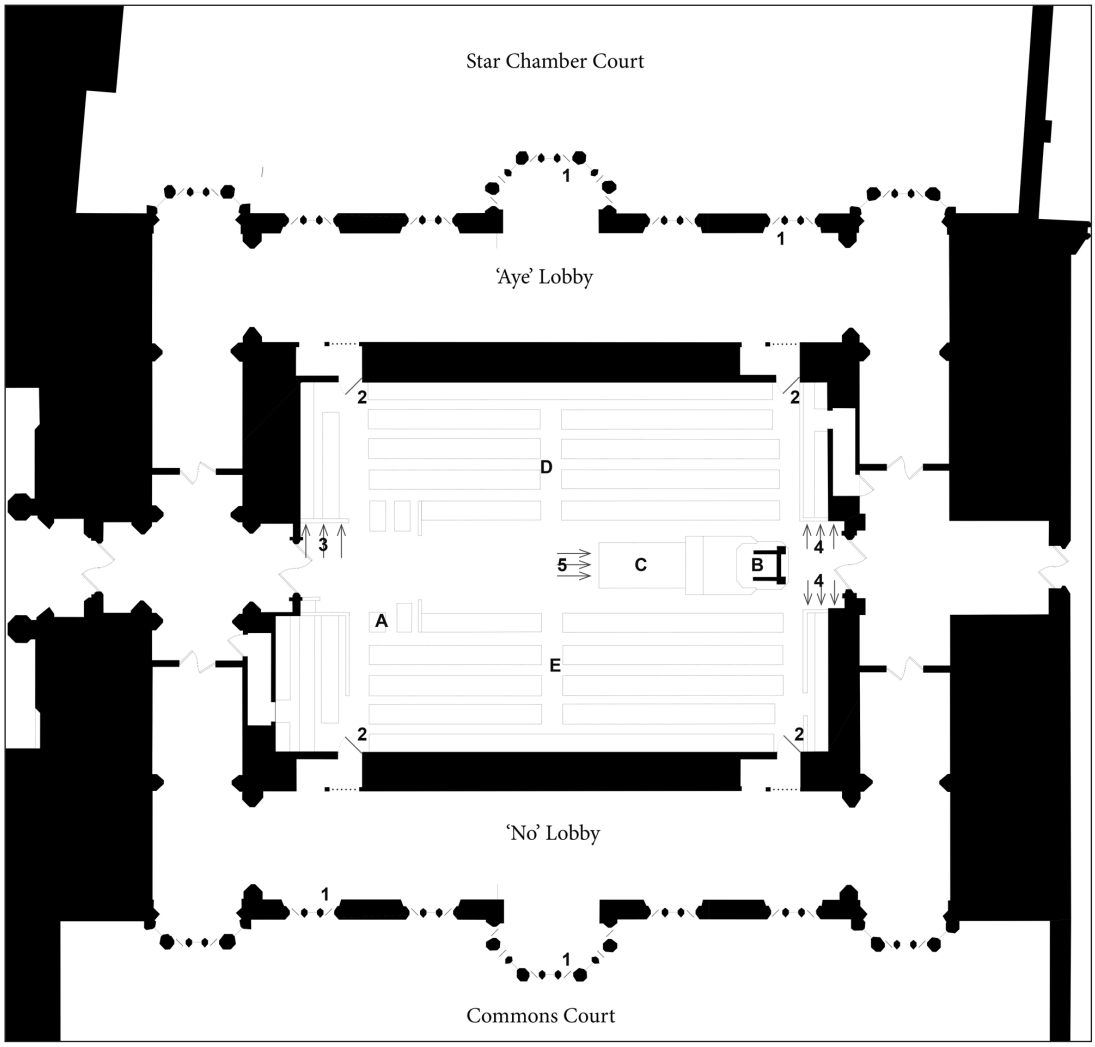

Figure 8: Diagrammatic floor plan of the House of Commons showing the doors and windows used for natural ventilation: A, Serjeant-at-Arms chair; B, Speaker's chair; C, Table of the House; D, Benches of the Government; and E, benches of the Opposition. Natural ventilation: 1, operable windows inside the division lobbies; and 2, doors between the division lobbies and the debate chamber that are occasionally used by the doorkeepers to enable cross-ventilation in the chamber. Low-level air extracts: 3, air outlets opposite the Serjeant-at-Arms chair; 4, air outlets behind the Speaker's Chair; and 5, air outlets at south end of the table. Source: Author.

At the end of the study Bedford recommended revisions to the control regime and settings. As part of these revisions some of the original fresh air inlets and extract openings were sealed. The system originally had three extracts on the main floor of the chamber, which were situated at the bar end, in the base of the table and behind the Speaker's chair (**Figure 8**). However, following Bedford's advice only the outlet inside the table was kept in use, and the total amount air extracted at floor level was reduced to 2000 ft^3/min (56 m^3/min). These and earlier changes made in 1950 and 1951 illustrated that the relationship between operational and physical aspects of Faber's design was fluid rather than static. It was evolving in response to new insights gained through empirical observations.

The recommendations were implemented under Hattersley's direction and reportedly yielded noticeable improvements. In September 1952, Hattersley wrote that it had reduced internal draughts (Hattersley 1952b). In March 1953, Molson reported that the number of complaints had fallen, and that through practical trials, which took into account the experience of MPs, the system had achieved a:

> temperature, humidity and circulation of the air in the Chamber which is agreeable to the majority. (House of Commons 1953)

On the following day, the daily newspapers *The Times* (1953) and the *Daily Telegraph* (1953) report that MPs felt more content with the conditions. In his original report of 1952, however, Bedford had warned of unrealistic expectations. He wrote that 'owing to wide variation in individual preference' complaints about the indoor climate could not be completely eliminated (Bedford 1952).

5.3. Medical concerns, 1954

The question of how far the system could be expected to accommodate individual needs was not entirely settled, but the Ministry was forced to revisit it two years later, following the receipt of renewed criticism in 1954. As before criticism came from only a small number of MPs, but on this occasion it referred to respiratory problems. It began with comments that George Wigg, MP for Dudley and Stourbridge, had made in January 1954 during a public talk to the Stourbridge Civic Society. He described the system as an 'engineering failure' and claimed that it was responsible for him and other MPs developing 'acute sinus trouble' and 'awful headaches'. Similar comments from other MPs were reported in the *Daily Telegraph* (1954a) and the *Evening Standard* (1954).

Having received this level of attention in the media, the Parliamentary Secretary and Minister became directly involved with resolving these issues, working closely with the engineers, MPs and external consultants. Reginald Bevins, who had succeeded Molson as Parliamentary Secretary, shared and defended Wigg's views. In a letter, dated 19 January 1954, Bevins wrote that the:

> atmosphere in both chamber and division lobbies is often very bad' and that there is 'an extraordinary amount of sinus trouble amongst Members.

He reported that the condition in the chamber and division lobbies got 'invariably bad' at the closing stage of debates. Bevins subsequently requested his engineers to lead two investigations: one looking at ways of mitigating overheating under crowded conditions, the other to determine whether air-conditioning was actually causing these ailments (Newis 1954).

Recognising that this was a medical rather than a technical question, Bevins engaged Victor Medvei, Chief Medical Officer of HM Treasury, as an advisor (Bevins 1954a). Medvei, himself not an expert in this field, consulted several ear, nose and throat specialists in the United States who had more experience with the effect of air-conditioned environments. It is to be noted that in the UK the use air-conditioning technology was still limited during the 1950s, whilst it had already been widely deployed in the United States for three decades (Banham 1984: 173–187; Cooper 1998). On 30 January 1954, Medvei submitted a report to the Ministry. He believed that the cause was the medical conditions of individuals rather than technical problems. MPs suffering from sinusitis or other respiratory ailments were more sensitive to climates, in particular excessive dryness and heat (Medvei 1954a). Instead of making further adjustment to the general climate, which, he believed, was likely to adversely affect the majority, Medvei proposed introducing personal adaptative measures. One proposal was to enable affected MPs to take short retreats from the conditions in the chamber whenever it became unbearable. The other solution was to supply MPs with personal inhalers and decongestive nasal sprays, allowing them to 'humidify their own nasal passages directly'. These proposals reflect a significant adjustment in expectation. It not only recognised limitations in the capacity of air-conditioned environments to accommodate individual needs, but also considered a level of personal adaption acceptable.

Medvei's advice was not grounded on new studies but drew on existing knowledge (Medvei 1954a). Only after his first report did he conduct some simple field observations. These he undertook on 10 February 1954 to obtain some first-hand experience of the climate under crowded conditions. This was during the closing stage of an important debate on a trade agreement with Japan, which was attended by over 550 MPs and involved two votes (House of Commons 1954a). In his second report, dated 12 February 1954, Medvei gave an account of his experience. He wrote that, as the chamber was filling, the 'atmosphere became gradually stuffy, hot and my nose and throat dry'. Medvei admitted

that the air could get uncomfortable and produce dry noses and throat. In terms of the approach to accommodating individuals with respiratory problems, however, he stood by his original verdict. He wrote that it was more advisable to deal with complaints:

> individually and not from the point of view of interfering with your already complicated regulation of the air conditioning plant.

He warned that raising the humidity could result in a 'stuffy and relaxing' atmosphere, making MPs feel drowsy and less alert (Medvei 1954b).

5.4. Further trials in use, March–April 1954

After Medvei's review, Bevins instructed the engineers at the Ministry to investigate Medvei's claims. Whilst the records do not provide evidence of whether adaptive measures were trailed or adopted, Paul Fletcher, Chief Engineer of the Ministry, undertook several trials to improve the conditions mechanically (Fletcher 1954b). The trials were undertaken between March and April 1954. In contrast to Faber and Bedford's earlier studies, which been undertaken with volunteers, Fletcher's trials were performed during actual sittings. The objective behind this change was to enable MPs to assess the result directly and provide feedback on their experience.

The first trials investigated how far the heat under crowded conditions could be avoided by the cooling the supply air more substantively.[13] According to Fletcher, this reduction had succeeded in reducing the temperature increase by 3–5°F whilst the chamber was occupied by 1000 people. He found that the temperature of the supply air could be reduced to < 52°F without creating uncomfortable draughts (Fletcher 1954b). During the budget debate on 6 April 1954, Bevins reported that the temperature did not exceed 70.5°F (21°C), whilst it had reached 75°F (24°C) during previous budget debates (Bevins 1954b).

Separate trials were undertaken to verify how far adjustments to humidity levels could alleviate respiratory problems without compromising the comfort of the majority. On 17 March 1954, further complaints about respiratory problems were received and reported in the *Daily Telegraph* (1954b) and *The Times* (1954). Bevins, himself sceptical of Medvei's advice against raising humidity, instructed his engineers to assess its impact experimentally (Bevins 1954c). The first experiment took place on 25 March. The relative humidity was raised from 46% to 56% and eight MPs, identified as suffering from respiratory problems, were invited to give written evidence on their experience. Bevins received four written responses, giving mixed opinions. Beresford wrote that although it became too warm towards the end of the sitting, he generally felt 'quite comfortable' (Beresford 1954). Barnett Stross, MP for Stoke-on-Trent Central, wrote that the atmosphere had become 'less enervating and more satisfactory than usual'. When the chamber was full the air 'seemed fresh compared with other occasions' and at 10 p.m. it was also 'less dry than it used to be' (Stross 1954). John Morrison, MP for Salisbury, and Peter Remnant, MP for Wokingham, disagreed. Morrison did not notice any improvements (Morrison 1954), and Remnant wrote that chamber was 'much too hot, stuffy and oppressive' (Remnant 1954). As the opinions were inconclusive, further trials were conducted on 30 and 31 March, after which Bevins and Fletcher reviewed the results (Fletcher 1954c). Bevins reported that he had received verbal feedback from MPs, agreeing that the atmosphere has become more satisfactory (Bevins 1954d). He and Fletcher agreed undertaking a more long-term trial with the new settings to determine whether further interventions was required (Travis 1954).

On 21 May 1954, the House held a short adjournment debate on the subject, which Bevins had proposed to give MPs an open forum and the opportunity to share and discuss their experiences with him (House of Commons 1954b). Five MPs gave speeches. Ede felt the engineers achieved a 'great degree of control'. Marcus Lipton, MP for Lambeth Brixton, noted that he currently felt 'far too cold', but that the conditions were generally good. Alfred Bossom, MP for Maidstone, also felt that it had become well-managed, but asked if a more stimulating climate could be produced to prevent MPs from falling asleep during sittings.[14] He claimed that has 'seen a good many colleagues dozing' and proposed recreating the qualities of air found on Brighton's seaside. His view stood in contrast with the verdict given by Sommerville Hastings, MP for Barking, who said:

> as I sit here, I can feel a slight current—not unpleasant—of air. I think it is fresh and invigorating air.

Bevins also used the debate to talk about the nature of thermal comfort, stressing that it was impossible to 'please everyone'. He reported of evenings, when, although the temperature had been lower than normal, MPs would testify that the atmosphere felt 'hotter than it had ever been before'.

5.5. An emerging regime of social interaction

These and other inquiries illustrate the extent to which the Ministry had engaged with questions of performance over the first four years. Much of the focus was on assessing and improving indoor climates based on MPs self-reported experience. Whilst some responses highlighted tangible problems with the physical conditions, others illuminated the variability between individuals to differences in temperature, humidity or air movement. The former could generally be overcome through technical adjustments, but the latter was a personal factor over which the engineer did not

have control. This problem led the Ministry to shift some its focus from operational optimisation towards managing user expectations (House of Commons 1952a; Brock 1952a). This response highlights a growing awareness that environmental control was as much a social as a technical process. The task of managing, anticipating and responding to a varied set of (social) expectations became a central constituent of its operational regime.

6. Technological and organisation renewal, 1994–2019

The House of Commons benefitted substantially from the continuity of in-house management for its operation and performance in the period 1950–94. It also escaped the drive towards privatisation and the outsourcing of facilities management function in the 1990s, which was critical for ensuring continuity of staff and retaining the tacit knowledge it had accumulated.[15] The Ministry of Works remained in control of its operations for 20 years, after which it was absorbed by the Department of the Environment. In 1972, its facilities management responsibilities were transferred to the Property Services Agency (PSA). In 1994, reflecting a wider drive towards the devolution of property management, the Houses of Parliament became independent of PSA control and established its own in-house facilities management (FM) department. In this context the FM department was restructured.

The original control room of the House was decommissioned and its technical and social functions were integrated into a new central control room, the Engineers Control (EC), and responsible for overseeing facilities management across the whole Palace of Westminster. The original control and monitoring system was replaced with a BMS, which marked a transition from electromechanical to digital technology. The use of the periscope was also discontinued (*House of Commons Staff News* 1996). It was replaced with attenuator screens that allowed staff to follow televised proceedings.[16]

6.1. Automated control

The introduction of the BMS was significant as it reduced the level of human intervention required to maintain routine monitoring and control operations. This led to the roles and responsibilities of the control engineers being redefined. Phil Sturgeon, Operations Manager of Engineers Control, reported that before the adoption of the BMS, the House of Commons had a separate team of control engineers that concentrated on tasks directly associated with operating the air-conditioning (Sturgeon 2019). The monitoring and control procedures had become fully automated in the BMS. The responsibility for ensuring that the climate stayed within the set parameters was held by the shift leaders and two assistants. In contrast to the 1950s, they were not required to monitor the system constantly. Jamie White, one of the shift leaders, reported that the BMS was generally checked at hourly intervals and between those times only if they received automatic alerts or calls to notify them if the MPs felt uncomfortable (White 2019). White reported that they sat at the desk to receive phone calls, followed the televised proceedings via the attenuator screens, and when complaints were received, made adjustments to the set-point temperature, raising or lowering it by 1–4°F. At times the shift leader also sent engineers to check or correct technical faults and, on occasions, the Speaker, Deputy Speakers or doorkeepers summoned an engineer to liaise with them about the conditions. The EC also collaborated with the reactive maintenance staff in resolving physical problems with the plant or to conduct small studies. The latter included smoke tests, which were undertaken in June 2014 to study the behaviour of air currents near the Speaker's chair (Engineers Control 2014).

The use of television screens enabled staff to observe proceedings with greater ease than with the periscope.[17] Shift teams used the screens to monitor activities and look out for visual cues of discomfort. If it was hot, in particular during the summer or major debates, MPs were observed fanning themselves with order papers or taking off their jackets, and when it was too cold, some MPs were seen wearing coats and scarfs (Howse 2019). Sturgeon (2019) noted that:

> if we know there is a big debate we have a look at the screen, he looks a bit hot, he looks a bit cold, and we have a look at the BMS if it is working ok.

White (2019) noted that if MPs were 'wearing scarfs or jackets then you know that there is something wrong'.

6.2. Formalising the user-technology interface

Following the introduction of the new BMS system, further organisational changes were made to improve the mechanisms of social interactions. In these, user-engagement and collaboration between technical and non-technical staff received particular attention. These were reconstructed using semi-structured interviews with key stakeholders, which offered intimate insights into the sociotechnical network (**Figure 9**).

To formalise and centralise user engagement, the Parliamentary Maintenance and Operations Department (PMO) in 1998 established the Parliamentary Maintenance Helpdesk (PMH). The objective was to create a one-stop service centre for all facilities maintenance queries in the Houses of Parliament. Bryan Dyett, head of the PMH, characterised its primary role as the 'message takers for the Palace for things that need to be fixed reactively', which covered operational and physical maintenance (Dyett 2019). This included the task of informing the EC about feedback about the climate of the chamber. Before these changes, the EC interacted with MPs and staff directly. Michael McCann, Director of the PMO, argued that whilst the old method had the advantage of offering a more direct and personal relationship with

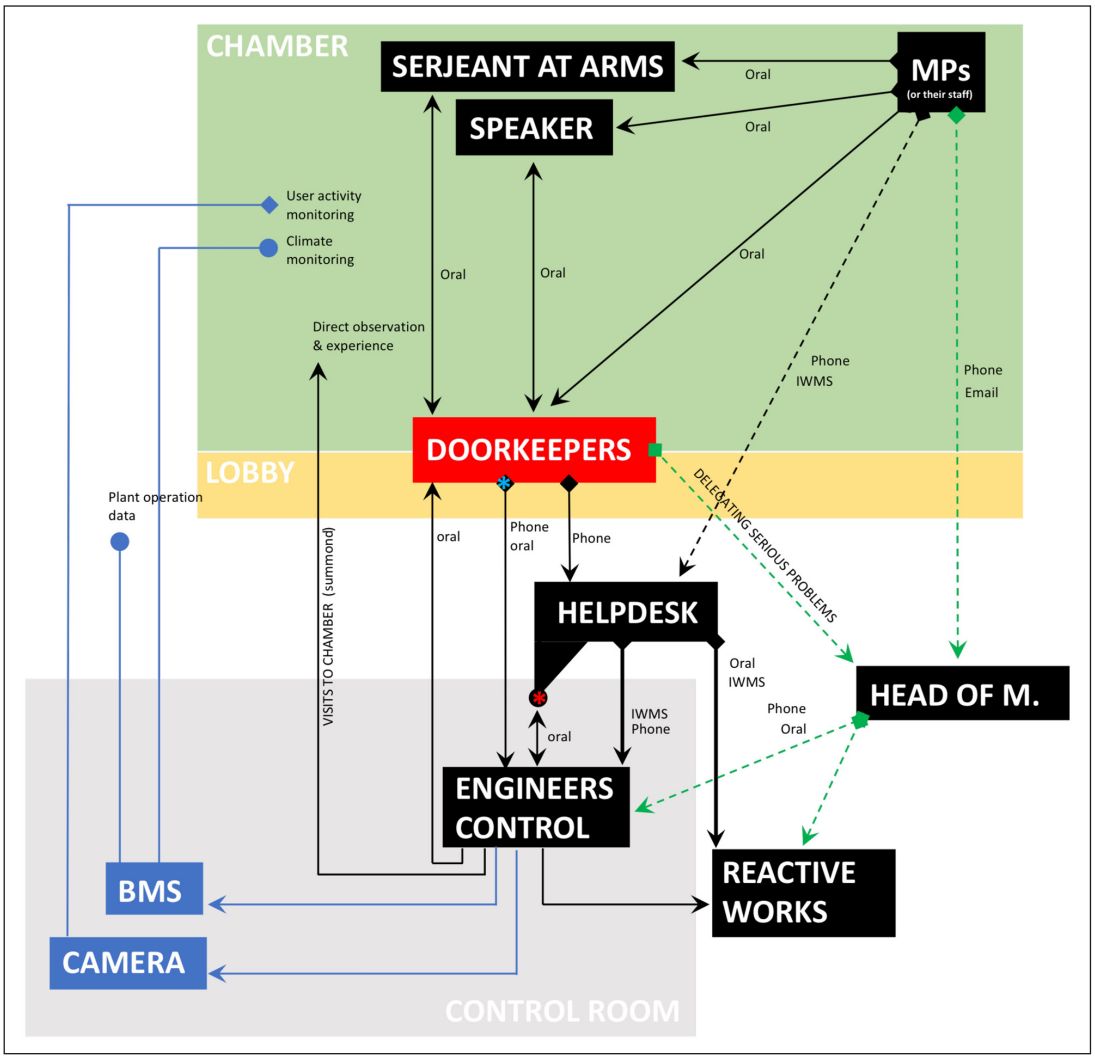

Figure 9: Sociotechnical network of the climate control system, including the current user participation mechanism. Source: Author.

users, the process was not well-managed. He reported that 'it was quite chaotic, you couldn't see who was dealing with what' and that the helpdesk was introduced to bring 'more structure from a management point of view' and enable statistical data to be collected centrally (McCann 2019). Being independent from the EC, the helpdesk established user-engagement as a specialist role. This role was performed by a team of four staff, which managed the communication with the House on behalf of the EC.[18] The helpdesk held the responsibility for interacting with users, creating logs and directing tasks or information to the EC or the reactive works teams. The process was managed with the aid of specialist software known as an 'integrated workplace management system' (IWMS).[19] This allowed the helpdesk to log queries digitally on a central database, fulfilling similar functions to the handwritten diaries in the 1950s.

The MPs' section on the Parliamentary intranet mentions that all queries regarding ventilation and climate control are handled by the helpdesk, and it offers MPs and their staff to communicate with them using phone, email or issue reports online through the IWMS. In practice, however, the helpdesk's direct interaction with MPs was limited. Direct interactions were handled by the doorkeepers within the chamber, who acted as the helpdesk's primary liaisons. Dyett, who had managed the helpdesk for 21 years, reported that most user feedback was communicated through the doorkeepers (Dyett 2019). McCann stated that although it was practically possible for MPs to communicate directly, it was extremely rare. This was also confirmed by the log-book entries. The logs for the 12 months leading up to September 2019, for instance, showed that 23 of 24 reports were issued by doorkeepers. The logs provide some insights into the type of environmental feedback the doorkeepers shared with the helpdesk.[20] An extract from the database, covering the period between 10 October 2013 and 3 September 2019, contains 85 individual entries (PMO 2019). These comprised brief summaries of feedback as well as instructions for operational adjustment, making reference to temperature and air movement. As shown in **Figure 10**, the majority of the reports referred to issues with temperatures being either too low or too high. Of the total of 85 reports received, 48 refer to the chamber as being too cold and 37 as being too hot. Requests were largely for reactive adjustments made to improve conditions whilst the House was sitting, but there were also cases where the doorkeepers instructed precautionary measures to mitigate the impact of

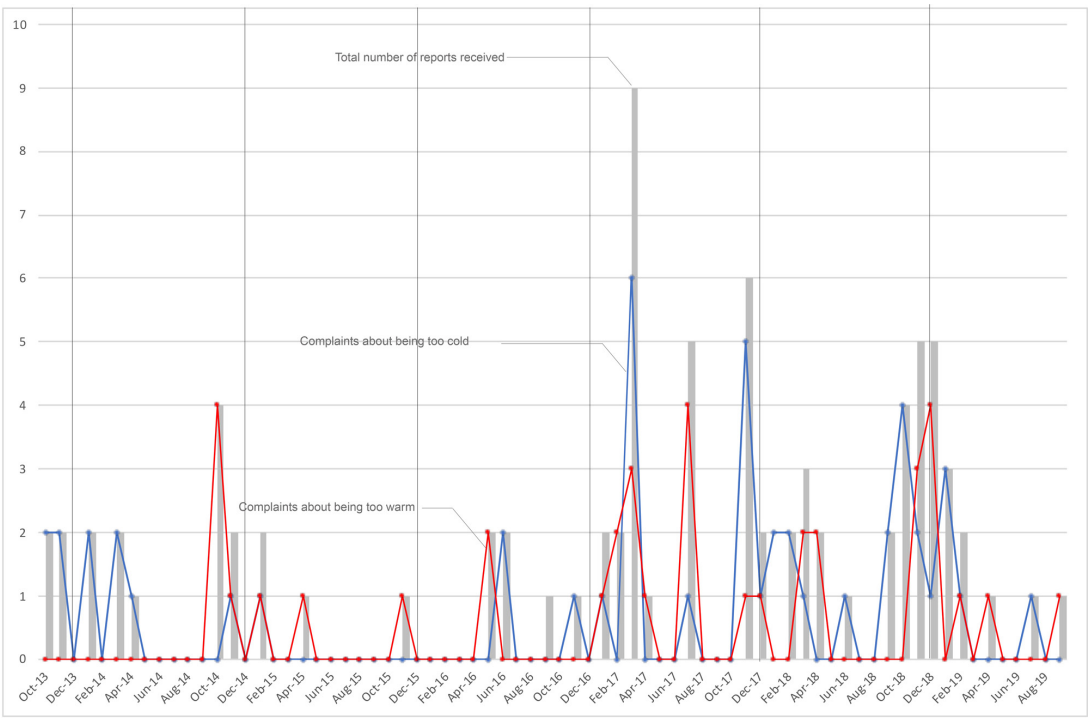

Figure 10: Number of user reports referring to the climate conditions that were formally logged each month between October 2013 and August 2019. Source: Author.

foreseeable changes in activity. On 12 July 2017, for instance, they requested the interior to be cooled 'right down in time for prime ministers questions', and on 8 November 2017 asked the temperature to be lowered 'after 17:00 today for youth Parliament tomorrow'.

6.3. Ephemeral knowledge

The number of reports the helpdesk had logged each month was low. It typically did not exceed two reports per month. Between 2013 and 2019 there were only five months for which it ranged from four to six reports, and in one month it had nine reports. This could be interpreted that the extent of user interaction was small, but the interviews reveal that most communication occurred informally without being recorded. The helpdesk used the IWMS to log communications electronically, but the doorkeepers often communicated with the EC directly, bypassing the helpdesk, and only a few of these direct conversations were formally recorded. McCann admitted that there was little documentation of the communication with the chamber. Phil Howse, Principal Doorkeeper, noted that most of the doorkeepers' communication with EC was done orally and that the actual number of interactions was at least twice as high. He estimated that he typically made one to two calls each day to request adjustments, and critical comments from MPs were received on three days per week. White, one of the technical shift leaders, also confirmed that only a small proportion of the oral feedback was recorded, noting that 'Everything that is logged on there is not everything that happens.' This was because the processing of user feedback was not treated as a maintenance issue but as part of routine operational procedures. It should also be noted that the purpose of the log was not to create a repository for environmental performance data. It functioned as a tool for recording assigning and tracking maintenance tasks (Eyre 2019). This lack of data is highly significant as it impeded the capability to operate as a learning organisation, affecting its ability to learn effectively from its own experience.

6.4. Creating feedback loops

Processes were adopted to establish a qualitative feedback loop linking user perceptions to operations. This illustrates that environmental control was not reduced to a technical problem that could be delegated to engineers, but that it relied on much wider collaborations between technical and non-technical staff. The doorkeepers were part of the security staff employed by the Serjeant-at-Arms Department, but they hold the primary responsibility for managing the climate inside the chamber, collaborating closely with the EC and the helpdesk. According to Howse (2019), the responsibility of the doorkeeper is to ensure that the House is 'comfortable for Members', and Martyn Fitzgibbon, who is one of the deputy principal doorkeepers, emphasised that:

> the MPs are our customers. So it becomes a major part of the day, because they have to be comfortable in their working environment. (Fitzgibbon 2019)

Stationed physically within the chamber and lobbies, the doorkeepers can directly experience the climate conditions and interact with MPs about their experiences. Sturgeon (2019) noted that they:

> are actually in the environment [at] all times, there are a range of people of a range of ages and they are quite demanding on what temperature they think it is, whether it should be slightly higher or lower.

The doorkeepers acted as primary point of contact for MPs. MPs often shared their experience when passing the doors, but if conditions were more severe, they also come forward to speak to them. The communication with the EC was managed by the principal doorkeeper, who regularly liaised with his team about the environment. This is significant because local variations within the chamber are not captured by monitoring system of the BMS as its main sensors are situated within the supply and extract ducts rather than in the space occupied by MPs. Moreover, other environmental factors affecting thermal comfort, *e.g.* air movement and radiant heat, were also not measured. The BMS was not providing data that accurately represented the conditions to which MPs were exposed. The system was designed to provide data on the condition of the air at the point of exit and entry, whilst averages were used to estimate the general conditions inside the chamber itself. Their impact was only rendered visible by the qualitative feedback from MPs and doorkeepers. Noticeable differences were reported in the galleries and at the Speaker's chair. The Speakers liaise with the doorkeepers behind the chair if they want the climate to be adjusted.

6.5. Engaging with human factors

The user feedback gave staff at the doors and within the EC a deeper understanding of how the thermal environment affected MPs. It provided evidence for the problems of managing the physical conditions. According to the accounts given by the doorkeepers and engineers, the number of critical comments was affected by the weather, the changes in occupancy and the length of time MPs were required to sit in the chamber. An increase in the number of complaints occurred during the height of winter and summer, when optimal conditions were more difficult to sustain, but also due to variations in temperature resulting from fluctuation in attendance. Martyn, one of the deputy principal doorkeepers, reported that MPs felt cold, in particular:

> if you have less clothes on because it was warm in there before [...] especially the women, if they take a jumper or a jacket off, and they are not leaving and still sitting there, it obviously becomes cold for them.

The complaints were not always an indication of physical problems, but also highlighted personal differences in experience of climate (as was also found in the 1950s). The majority of complaints came from a small number of individuals who were more sensitive to the climate. Another major cause of difference was the length of time individual MPs sat in the chamber. MPs become less tolerant if they were exposed to the environment for extensive periods. Martyn noted that:

> If one is just gone in there it is quite warm. Somebody else who has been sitting there for five hours says 'I was warm but now I feel cold', that is when you get this conflict.

Speakers and the Serjeant-at-Arms are particular exposed as they are required to sit for very long periods, and as a result the doorkeepers and the EC gave their views closer attention. Martyn noted that 'the Speaker sits in there for several hours, MPs can go out and come back again later'.

6.6. Physical interventions

The doorkeepers were not only observers but also have an active role in the process of evaluating and improving the internal climate, responding to the effect of changes in activities and weather conditions. Their role involves the opening and closing of doors during votes. Therefore, the doorkeepers were always well-informed about the activities. They ensured that environmental control and parliamentary procedures were synchronised, a prerequisite to achieving a 'system' that was responsive to user activities.

To improve conditions, the doorkeepers contacted the EC to request adjustments to the air-conditioning, but they were also authorised by the Serjeant-at-Arms to improve conditions through their own physical interventions, including routine, reactive and proactive measures. One routine undertaken by the Principal doorkeepers at the start of their morning shift is to check the conditions in person[21] and take measures to pre-cool the chamber as it is difficult to cool when occupied. On most mornings, Howse (2019) reported he opens the:

> exterior windows and the doors to the chamber to get the air flow needed to get it [the temperature] down.

The air-conditioning alone was not always sufficient to maintain adequate climate conditions. This had driven the doorkeepers to undertake simple physical interventions. Martyn and Howse reported that they would temporarily introduce cross-ventilation for natural cooling. Inside the chamber it was deployed for three purposes. In addition to

pre-cooling and refreshing the atmosphere before sittings, and mitigating overheating issues in summer or under-crowded conditions, natural ventilation was deployed to compensate for the slow response by the air-conditioning, which caused difficulties with maintaining stable temperatures during changes in occupancy. Cross-ventilation was often used to reduce the temperature more quickly. According to Dyett (2019), complaints are received when there are changes in attendance and the system was unable to respond at the speed required to prevent temperatures from rising or falling. As the clerestory windows inside the chamber are fixed shut, the doorkeepers opened the four doors leading to the Division Lobbies and the external windows inside the lobbies to 'create a draught that way'. Similarly, doorkeepers used windows inside the two Division Lobbies to mitigate overheating issues during votes. 'Prior to an actual vote,' Howse said, 'we go around open all the windows, making sure it is as good as it can be for them' and he also noted they if there are multiples votes, 'it can be very warm in there, even with the windows open, even in mid-winter'.

These local interventions, alongside the challenges faced in the 1950s, illuminate the practical challenges associated with the operation of Faber's system. This illustrates that the original idea of a mechanically conditioned chamber was difficult to implement under real-life conditions. It also demonstrates that technical limitations were compensated through measures not designed by specialist consultants. Instead, measures were introduced by non-technical staff, drawing on their practical experience. The doorkeepers took a central role in adapting and sustaining practices of environmental control, which complemented those of the control engineers. The involvement of the doorkeepers illustrates that environmental control was a collaborative endeavour. But this raises the important question: Who holds responsibility for building performance? What does this responsibility entail if the primary focus of building performance management is on engaging with occupants' expectations?

7. Conclusions

The House of Commons offered a unique, detailed and rich case study on its engagement with questions of environmental performance. This paper reveals that the responsibility for its performance in use could be limited neither to tests during the pre-occupancy stage nor to the involvement of technical specialists. Substantial investment into the experimental verification during the 1940s addressed physical and operational aspects of its design, but this approach did not eliminate the need for further engagements at the post-occupancy stage. These additional engagements are critical to understand how knowledge of building performance was gained, shared and used within the institution, covering technological and environmental factors as well as questions of management and user experience. Some of this knowledge was acquired empirically through formal trials and scientific studies undertaken by specialists. Other knowledge was underpinned by the experiences that staff and users had acquired in the context of day-to-day operations. This experience offers critical insights into the practical reality of Oscar Faber & Partner's system in use. This research illuminates technical limitations but also illustrates how some staff, such as the doorkeepers, used their practical experience to adapt its operational practices. The latter was only possible as staff was given agency, immediate authority to act upon their knowledge.

This research reveals that a gap exists between the traditional roles of design and facilities management. In the case of the House of Commons, this gap was filled through additional human actors, who took on roles and responsibilities that were not fulfilled by traditional facilities management. The function of these additional human actors was to complement technical solutions, but also to engage with MPs about their experiences and expectations. This included personal interactions with MPs at the doors as well as the formal communications with senior officers inside the House, such as the Sergeant-at-Arms, Speaker and Deputy Speakers. As a direct consequence, building management became dependent on a partnership between staff of the House, MPs and facilities management. Admittedly, these additional actors are not available in more conventional buildings, but could these practices of the House of Commons be adapted to provide a model for other buildings involving different forms of agency and improved feedback?

The operation of the House of Commons was dependent on the coexistence of two distinct cultures of organisational learning. These had the characteristics of what Curato (2006) describes as 'organic' and 'mechanistic' organisational learning design. The latter refers to organisations that follow centralised and highly formalised operational procedures. In the 1950s and again in the 1990s, strongly formalised processes were introduced at institutional level with the aim to centralise and systemise the procedures needed to collect, record and review performance data and use them to inform operational adjustments. This also applied to the collection and processing of occupant feedback. In addition to technological and environmental monitoring, which had become subject to a high degree automation, these included attempts to formalise procedures for social interactions, using central helpdesk and electronic logging system, and applied to the communication between staff and occupiers as well as between technical–non-technical staff.

These procedures were complemented by, and to a large extent also highly dependent on, the informal learning processes in which staff was constantly engaged. These had the qualities of an organic approach to organisational learning, which was decentralised, informal and also depended on the personal initiatives of individuals and the self-management amongst the staff. The initiative of the doorkeepers was a prominent example, who made local interventions building on the direct experience of the climate conditions, the behaviour of the mechanical system and encounters with issues of user satisfaction.

These learning processes have not been formally documented and were excluded from the recorded institutional memory, but they are important to understand fully the practical reality of environmental control inside the House of Commons. It reveals a reliance on active stewardship, involving technical as well as non-technical staff. Although

advances in automation have reduced the level of human intervention in the more routine technical operations, human agency has remained central in enabling building management processes to become not only technically but also socially responsive. Its success depended on experiential and social knowledge, as well as measured data supplied by the BMS. As such the system could be interpreted as a network of human and non-human actors. It constitutes an assemblage of people and technologies, each of which had a specific function and place within the network, in order to sustain the complex social and technical feedback processes. Parts of these networks were established *a priori* following a clear design that set out formal roles for human and technical actors. A first 'design' established in 1950s was superseded by another design in the 1990s, responding to technological and managerial changes. Other parts of the network had evolved over time following an interactive approach, and these yielded more informal and less visible functions within the network. These have been rendered visible through interviews.

In order to harness fully its opportunity to act such as a learning organisation, the House of Commons needs to develop the capability to use formally recorded data alongside the wealth of practical knowledge and experience that staff have accumulated over the years. This raises the challenges: How can ephemeral knowledge be effectively captured, retained and also used to feedforward into design? How could this knowledge feed forward into the design of the new environmental strategy for the chamber in the context of its forthcoming restoration of the Palace of Westminster?

The forthcoming restoration programme of the Palace of Westminster certainly offers Parliament a rare opportunity to review its past experience and use it to underpin the exploration of new approaches to environmental control, including the experience of the impact of the permanent adoption of semi-virtual sittings and voting procedures, which were trialled during the coronavirus disease (Covid-19) pandemic in 2020. The use of natural ventilation was part of manual interventions to compensate for the limitations of the mechanical air-conditioning system. These manual procedures were largely *ad hoc* interventions not formally embedded within an overarching strategy of environmental control. Could they become part of a mixed-mode system in which natural and mechanical ventilation are fully integrated and centrally controlled? It is technically feasible for the windows and doors within the Divisions Lobbies (and also the clerestory windows of the chamber itself, which are currently fixed) to be equipped with actuators and sensors, and their management to be automated through the new BMS, linking the mechanical and natural systems. The more significant question is: What user feedback systems and human agency should accompany this?

Undoubtedly the UK's primary legislative chamber is a unique setting, but the sociotechnical processes studied within the context of the House offer lessons for the design of building management practices in other types of public buildings. Open-plan offices, hospitals, law courts or schools face the same fundamental question of how to manage shared environments that are occupied by larger number of users for extended periods of time. They exemplify a way of engaging with the 'the soft issues that affect the comfort and satisfaction of users' which, according to Way and Bordass (2005), are rarely addressed in a systematic way in the procurement of building services. Equally it could be argued that this operational history also offers insights into some the practical implications of implementing what the Royal Institute of British Architects (RIBA) in its *Sustainable Outcomes Guide* (RIBA 2019) describes as an outcomes-based approach to design. In the revised *Plan of Work* (RIBA 2020), it refers to the post-occupancy phase in the building life-cycle (Stage 7—Use) as a period that will 'last for the life of a building' (RIBA 2020). As such it aims to go beyond the scale of Soft Landings. This provides an intermediate phase of professional aftercare, which typically last three years, but it does not provide a framework for a culture of continual feedback and learning in the context of the internal management of buildings.

Notes

[1] The House of Commons is the primary legislative chamber of the British Parliament and based in the Palace of Westminster, London.

[2] For information about the building use survey, see https://busmethodology.org.uk and https://www.usablebuildings.co.uk/UsableBuildings/Unprotected/BUSOccupantSurveyQ&A.pdf.

[3] Interviews were undertaken with seven members of staff: David Eyre (26 June 2019), Bryan Dyett (5 September 2019), Phil Howse (21 October 2019), Martyn Fitzgibbon (21 October 2019), Michael McCann (3 September 2019), Phil Sturgeon (18 November 2019) and Jamie White (18 November 2019).

[4] For a detailed account of the Ministry of Works' role in operating and maintaining state-owned facilities, which included the parliamentary estate in Westminster during the 1950s, see Emmerson (1956: 70–72).

[5] Electro mechanical technology was at the 'mainstay of air conditioning controls' in the 1940s (Mittal, Kaur, & Sharma 2015: 195–197).

[6] These devices were supplied by Negretti and Zambra, a meteorological instrument maker (*Surveys* 1951b: 62–63).

[7] This could be interpreted as a failure of the simulations to supply engineers with reliable data on the performance on their scheme, but it has to be noted that the simulations were only used to determine the general feasibility of Faber's scheme, whilst the purpose of the *in situ* trials was to assess experimentally and refine operational regimes and settings (Prosser, Edmonds, & Steffens 1950).

[8] The unit was involved in building research, in collaboration with the London School of Hygiene and Tropical Medicine, looking into the effect of climate and ventilation on living conditions in housing and the effect on occupants (House of Commons 1945–46, 1948).

[9] Barbara Tredre was an environmental physiologist undertaking research into indoor thermal comfort, the effect of climate on human metabolism and mental health (Tredre 1965, 1973).

[10] According to readings recorded between 21 April and 11 June 1952, it varied between 65°F (18°C) and 71°F (21.6°C) near the floor, and between 67 and 71°F at roof level. At the floor, the temperature remained within the intended range of 66°F (19°C)–68.9°F (20.5°C) for 82% of the time, and for only 1% of this period readings > 70°F (21°C). For 10% of the time, temperatures < 66°F (19°C) were recorded, but Bedford believed this was sufficient for the atmosphere to feel to cool if chamber were only sparsely occupied. The temperature in the upper part of the chamber > 70°F (21°C) for 18% of the time, but rarely reached > 71°F (21.6°C) (Bedford 1952).

[11] At 0.3 m/s, draughts are felt in cold climates during the summer.

[12] The area had average air speeds of 9 ft (2.7 m or 0.045 m/s) per min, with peaks of 25–32 ft (7.6–9.7 m or 0.12–0.16 m/s) per min.

[13] Hitherto the control engineers were instructed to reduce it by only 2–3°F when the chamber was crowded, but during Fletcher's trails, it was lowered by 12°F.

[14] The idea was not new. It builds on earlier studies on the problems of monotonic environments inside the chamber that been studied by Leonard Hill in 1913–14. He advised introducing more variable climate to increase the alertness of MPs (Schoenefeldt 2019).

[15] According to Leaman, Stevenson, & Bordass (2010), the outsourcing of building experts and facilities management can weaken designers' and clients' ability to gain feedback on building performance in use.

[16] These changes were possible after the House of Commons had permitted the live broadcasting of parliamentary debates, which was not granted until 1989.

[17] When the periscope was in use, engineers had to view proceedings through an eye-piece, and as it did not allow them to view the whole chamber in a single glance, the lens had to be turned towards the galleries or the back benches. The process was described in an article in *House of Commons Staff News*, published shortly after the original control room had been decommissioned: 'The view of the Speaker's chair was the only one actually horizontal; to gain an insight into what was happening on the government or opposition benches the lens had to be rotated a few degrees either way, giving decidedly a slanted view of the proceedings!' (*House of Commons Staff News* 1996).

[18] The helpdesk staff manage the feedback process during opening hours (0700–1800 hours on sitting days), but after 1800 hours it is handed to the shift leaders at EC, requiring them to interact directly with the doorkeepers.

[19] Dave Eyre, Reactive Works Manager, reported that three generations of software had been deployed since the helpdesk was established: Pharo, Royal Blue and Archibus. At the time of the interview, Parliament was preparing for the adoption of 'Planon' (Eyre 2019).

[20] Archibus log for the period between 10 October 2013 and 28 June 2018. The data are held by the Parliamentary Maintenance and Operations Department.

[21] The doorkeeper did not take their own measurements, but evaluated the conditions qualitatively based on their own perception. Howse (2019) reported that they: 'gauge the temperature. In the morning we got normal clothing on, and we know it's warm, but obviously when we got these uniforms on, it would be very warm for us to be in there, some know straight away if it is too warm or cold'.

Acknowledgements

This research was informed by conversations had with Richard Ware, James Tobin and Andrew Piper from the restoration programme, and Mark Collins, archivist at Strategic Estates. The research was also supported by staff at the House of Commons, in particular Phil Howse, Martyn Fitzgibbon, and the PMO Michael McCann, Jamie White, David Eyre, Byan Dyett and Phil Sturgeon who took part in the research interviews.

Competing interests

The author has no competing interests to declare.

Funding

This paper was based on research the author undertook as part of a research project within the Palace of Westminster Restoration and Renewal Programme between November 2019 and December 2020. The project entitled, 'Expert Historic Ventilation Advice for the Palace of Westminster', was funded through a grant from the corporate officer of the House of Lords.

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How to cite this article: Schoenefeldt, H. (2020). Delivery of occupant satisfaction in the House of Commons, 1950–2019. *Buildings and Cities*, 1(1), pp. 141–163. DOI: https://doi.org/10.5334/bc.57

Submitted: 18 February 2020 **Accepted:** 06 May 2020 **Published:** 01 June 2020

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