The 1960s-era Westminster City Hall has seen its population nearly double beyond the capacity for which it was originally built, a situation that was putting strain on its VT system.

Twice as Nice

Modernization project retrofits double-deck elevators with destination control at 1960s-era Westminster City Hall in London.

by Hongliang Liang

Consulting firm MovvéO Ltd. was engaged for a challenging modernization project that would require creative and innovative engineering: replacing a high-rise building's single-deck elevators with double-deck units, the first time such a project has been undertaken in the U.K. The project would take place at the 19-story city hall in Westminster, London.

The building has seven lifts, with six main lifts in a central bank and a goods lift. An eighth lift, an executive (directors') lift, was decommissioned and removed, with its shaft becoming a conduit for pipes and cables. The six main lifts service floors G-18, and the goods lift, which also functions as a firefighters' lift, services floors LB to 19. The six passenger lifts were originally installed by Otis in the 1960s and were refurbished in 2007. They are of a robust basic design suitable for a commercial office environment but, because of increased building population, have seen their performance deteriorate. A full refurbishment, including machine and control-system replacement, would be required to achieve any significant improvement.

The goods/firefighters' lift was originally installed by Otis in the 1960s and underwent a partial refurbishment in 1992. Its control system, machine and door system were considered to be at the end of their life. Also, the system was not up to current requirements for a firefighting lift.

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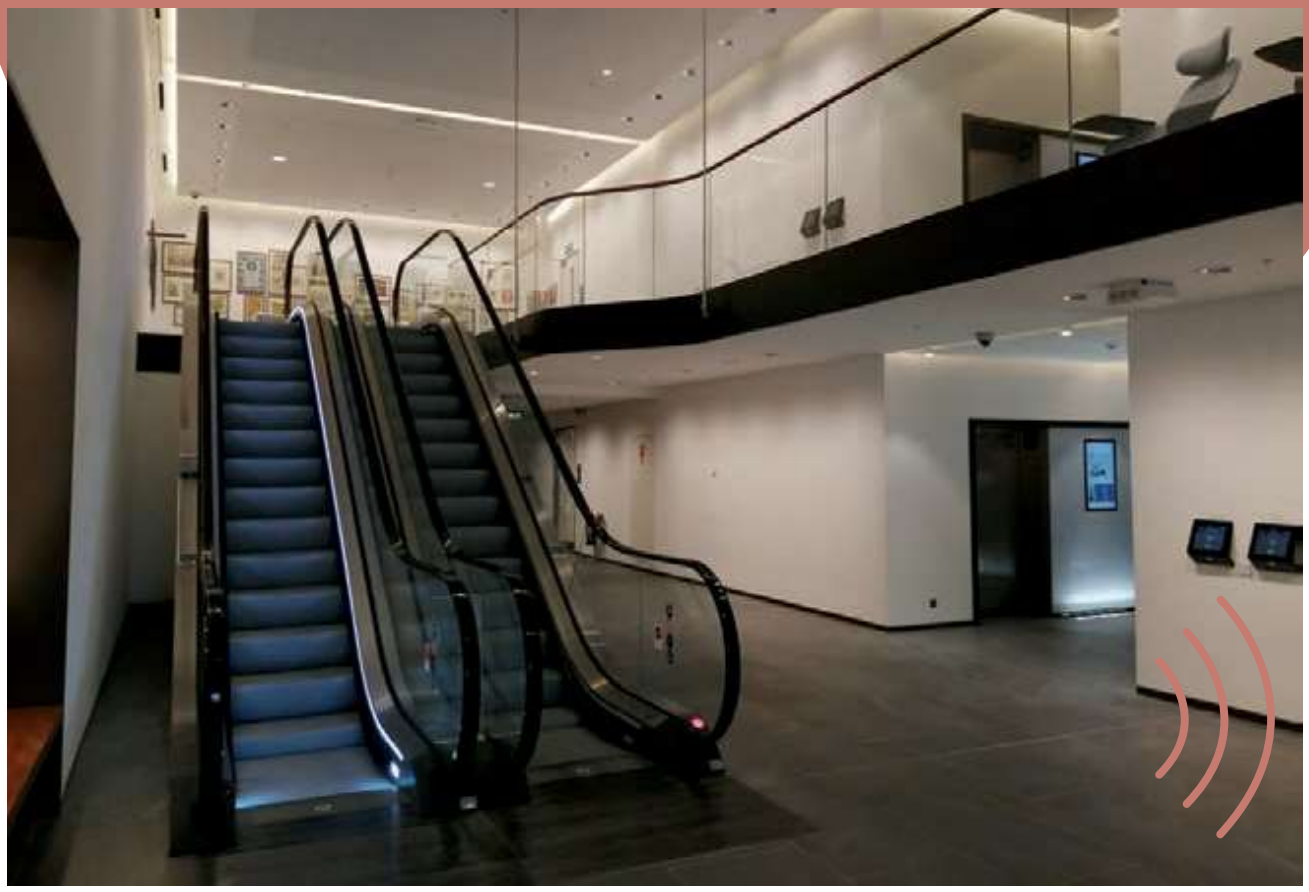

Escalators take building tenants and visitors up to the new mezzanine, which provides access to the upper decks of the new double-decker lifts.

Ground-floor lift lobby

Original lift machine

The vertical-transportation (VT) system was inadequate to meet the evolving demands of the building's population, especially at peak times. The City Hall building and its VT were originally designed for an occupancy of one person per 14 m^2 of net office space, but, in recent years, the population has nearly doubled. It was clear that capacity needed to be increased.

The development of a concept design was commissioned by the client, and a report was produced. Various lift strategies were considered, including refurbishment of the existing lift cars, but that option was rejected in favor of six new double-decker lifts with destination control and a pair of escalators from the ground floor up to a newly created mezzanine level accessing the upper decks of the lift cars.

Traffic Analysis

The building was being refurbished to high-class, commercial-grade offices. It has 19 floors above ground and two levels of basement, with the top floor to be used as gallery/meeting-room space. The main objectives in evaluating the lift traffic performance are:

- Gather data presented by the architect in terms of building geometry, population schedules, floorplans, client briefing, etc.
- Agree on design criteria for VT-system traffic performance
- Identify feasible solutions for the VT system
- Provide an analysis of lift traffic performance based on peak traffic scenarios

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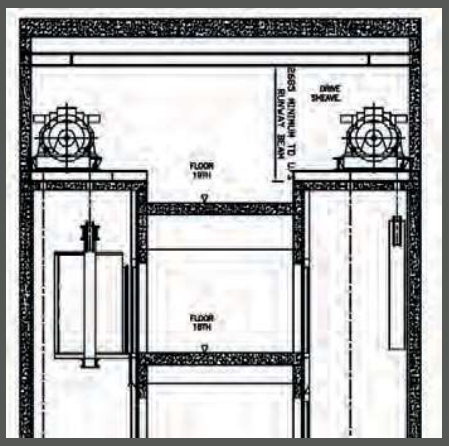
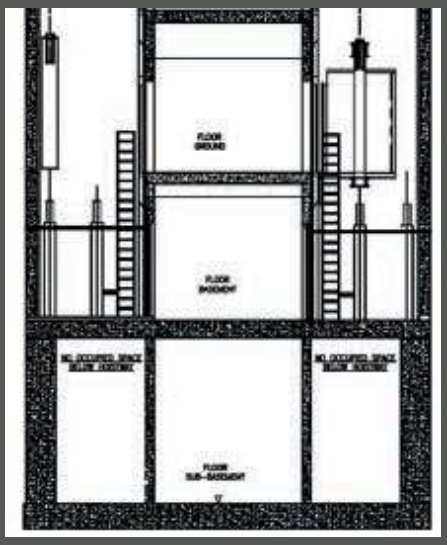
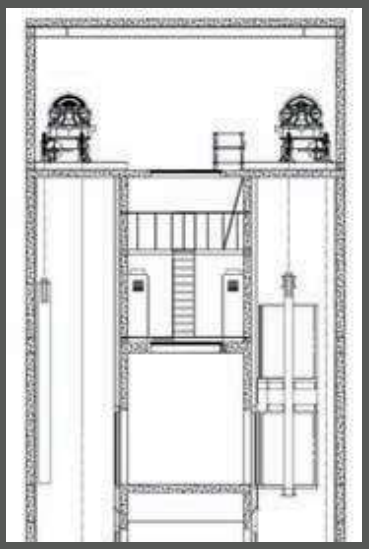


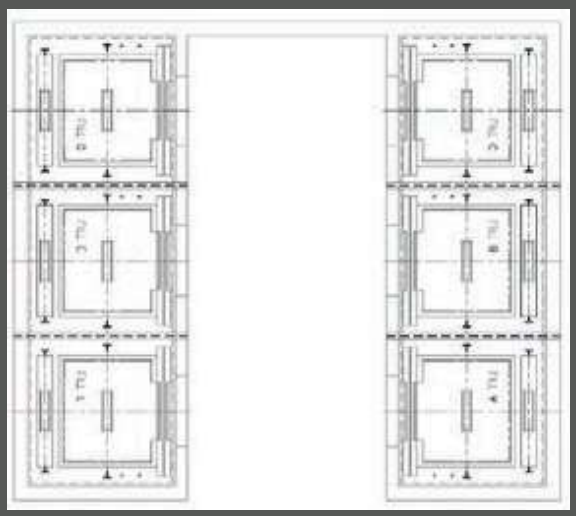
A section view of the original machine room (All computer-aided-design drawings for this project were produced by your author.)



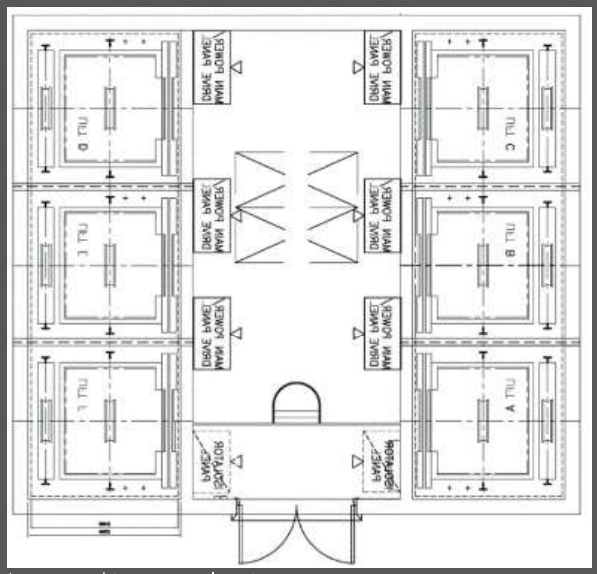
Section view of an existing pit



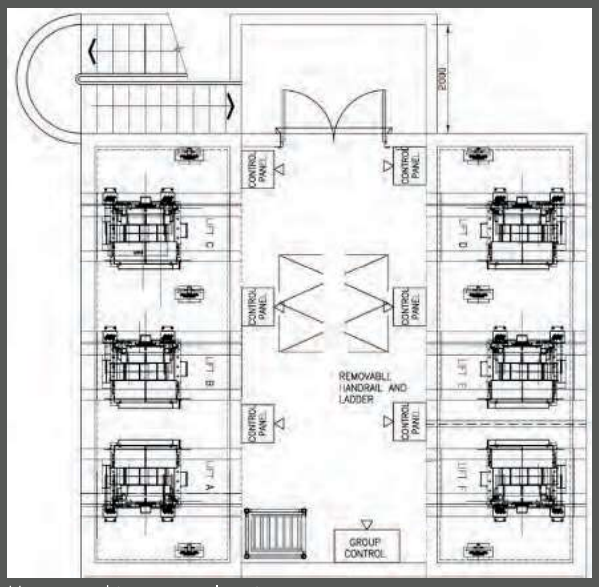
Section view, new machine room and headroom section



Shaft plan view



Lower machine-room plan view



Upper machine-room plan view

Lift Arrangement	Average Waiting Time (s)
6 Single Deck Cars Conventional Control	2367 *
6 Single Deck Cars Destination Control	1034 *
5 Double Deck Cars Destination Control	108
5 Double Deck Cars + 1 Single Deck Destination Control	32
6 Double Deck Cars Destination Control	23

** lift system saturated causing large queues at main lobby*

Table 1: A summary of potential VT solutions

Lower machine room, where a ladder and an intermediate platform reduced the rise to less than 2.5 m to avoid the need to install a stair

A site survey was conducted to gather more information on existing lift shaft sizes, pit depths, overhead spaces, machine-room heights, etc. Based on the survey, generic layout drawings were assembled for the six-car group of double-deck lifts, indicating that typical capacity might be 1200 kg per deck, or 16 persons. Numerous potential VT solutions were analyzed and summarized (Table 1). The aim was to achieve a lift installation that would meet the highest possible British Council for Offices standard for lift service; that is, a 5-min "up-peak" handling capacity of 15% of the working population and an average waiting time (AWT) of less than 25 s.

The only solution that met the criteria is essentially one group of six double-deck passenger lifts serving the above-ground office floors.

Design Criteria for Office

The design criteria developed was necessarily general and sufficiently flexible to suit the ultimate space planning program, while optimizing the VT solution around the known user requirements. In the case of this building, simulations were based on the latest population estimates as supplied by the architect, BDP, during a 2016 progress review meeting.

The population density (usable area in square meters per person) as a criteria was probably the most critical, because this loading factor determined the estimated population: hence, the number of floors that could be serviced by any given number of lifts. The criteria selected had to be conservative and viable, allowing latitude for changes in the building's use and occupancy. It also needed to be realistic and reasonably reflect the actual occupancies in similar buildings in the area.

The traffic simulations and design, therefore, at this stage, were based upon an occupancy of approximately 6 m^2 of usable area per person at levels one through 16 and a slightly lower value at floors 17-19. A 15% absenteeism factor was then applied across all floors.

A cutout was made in the machine-room roof for lift machine transportation to the machine room by using a tower crane. Runway beams were fixed below the slab for installation and future repair or modernization, or full machine replacement.

Office Population

Based on direction given by clients, the population assumptions for each level and overall total building population was broken down as follows:

Office Zone Population

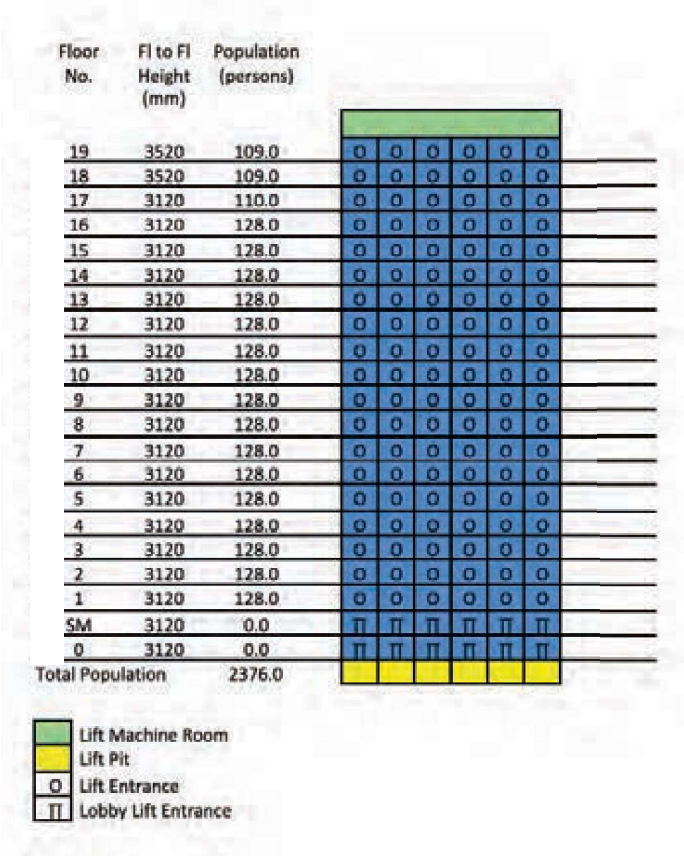
Based on the above total building population, the split zone population for each lift group was broken down as in Table 2:

Performance Standards

The effectiveness of a group of lifts during morning up-peak, lunch peak and evening down-peak traffic is judged by comparison with established standards of performance as follows.

OFFICE BUILDING AVERAGE SYSTEM RESPONSE TIME PERFORMANCE STANDARDS		
GRADE OF SERVICE	DISTRIBUTION OF SYSTEM RESPONSE TIMES - % ANSWERED WITHIN	
	30 s	60 s
EXCELLENT	≥75	≥98
GOOD	≥70	≥95
FAIR	≥65	≥92
UNACCEPTABLE	<65	<92

Table 3: Typical measurements are for the all-day period, the peak hour and the peak 15 min. The peak 15-min period should approximate these standards; in extremely heavy traffic, the performance may drop one grade.



Building Zone	Floor Served	Zone Population(persons)
Passenger Group	01/SM, 1-19	2,376

Table 2

The "system response time" is represented as when a hall call is registered in the building, its location (i.e., floor number and associated direction of travel) and the duration for which it remains registered. These durations, when averaged over a designated period, result in an "average system response time." This is one standard we use to classify the quality of lift service. We use system response time distribution figures in our specifications as performance criteria for microprocessor-based group lift supervisory control systems. The following standards apply:

AWT is the time period, in seconds, from when a passenger registers a landing call at the main-floor lift lobby until the lift arrives and the doors open, over 5 min of heavy peak traffic. AWT relates to the "quality" of lift service during a heavy peak traffic period. Table 4 indicates the standards used to evaluate levels of service based on AWT.

Lift Group Handling Capacity

"Lift group handling capacity" is used to evaluate the "quantity" of lift service during the heavy peak traffic period. This is the number of persons, or percentage of the zone population, that can be transported by the lifts in the same 5-min period of traffic used to measure AWT. The following chart indicates the standards used to evaluate levels of service based on lift group handling capacity for the morning up-peak and evening down-peak.

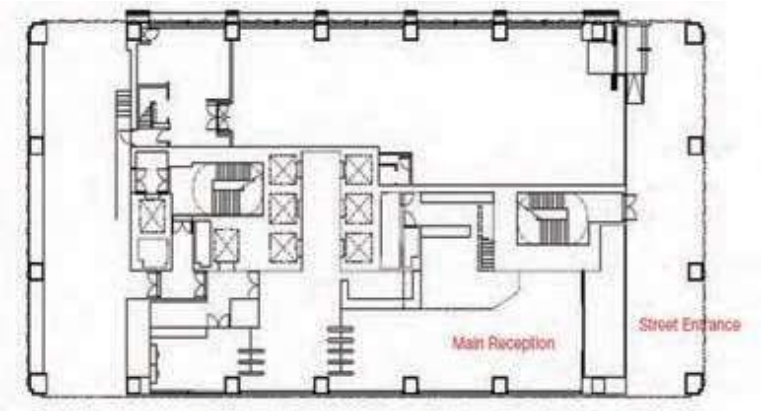
Continued

OFFICE BUILDING AVERAGE WAITING TIME PERFORMANCE STANDARDS (5-MINUTE, A.M., HEAVY PEAK)	
GRADE OF SERVICE	AVERAGE WAITING TIME
EXCELLENT	≤20 s
GOOD	≤25 s
FAIR	≤30 s
UNACCEPTABLE	>30 s

Table 4

OFFICE BUILDING LIFT GROUP HANDLING CAPACITY PERFORMANCE STANDARDS (5-MINUTE, A.M., HEAVY PEAK)			
GRADE OF SERVICE	BUILDING OCCUPANCY TYPE		
	DIVERSIFIED TENANCY	MIXED TENANCY	SINGLE TENANCY
EXCELLENT	≥14%	≥15%	≥16%
GOOD	≥12%	≥13%	≥14%
FAIR	≥11%	≥12%	≥13%
UNACCEPTABLE	<11%	<12%	<13%

Table 5



Challenges in Design

A new machine room had to be built, and the original shaft was extended from the 18th to the 19th floor. Consideration had to be made for the fact that, since the original shafts were for single-deck elevators, the new double-deck elevator shafts would be subject to at least double the loads. Also, the pit depth could not be extended because of limitations regarding the building's foundation. The manufacturer's solution of reduced buffer stroke was accepted.

For this project, the rated load of the six double-deck elevators is 1200 kg/1200 kg, which is not significantly different from the rated load of 1600 kg or 2000 kg, typical of single-deck lifts normally used in office buildings, so any loss in energy consumption was deemed acceptable. In any event, the desired traffic performance could only be delivered with six double-deck lifts.

Author's Notes

Independent analysis of options, generic design encouraging competition, careful vetting of the contractor's design and ensuring performance parameters are achieved are just some of the areas where consultants can add value to a project, as they did in this one.

This article is dedicated to the memory of Adrian Godwin, chairman and sole owner of MovvéO, who passed away in April 2019, just as the Westminster City Hall project was being completed. With Godwin's passing, MovvéO ceased operations.

Hongliang Liang, CEng MCIBSE, launched Aliang Lift Design Studio Ltd. in April 2020. The company provides survey and design work for modernization and full-replacement projects. Liang also offers traffic analysis, VT system design, detailed design and tender negotiation services for redevelopment and new development projects. He has more than 25 years' experience in the industry, working in design, installation, quality control, inspection, maintenance service, product development, modernization and full replacement. He has worked for Zhuhai Chang-Fat Elevator Engineering Co., an agent for Mitsubishi (Hong Kong). After spending a year as a qualified inspector for the local government, Hongliang founded a lift company, which, in 2000, became an agent for Toshiba Elevator (Shengyang) Co. He arrived in the U.K. in 2001, earning an MSc in engineering design and management from Huddersfield University in 2003. He then worked with several VT companies, taking on projects such as introducing Chinese escalators to the U.K. market and helping design a lift controller. He also worked on various projects with thyssenkrupp Elevator UK, International Lift Equipment and KONE, where he worked on more than 200 replacement and modernization projects. Hongliang joined MovvéO in 2014 as senior design manager, a role that made him involved in all aspects of VT design.