Title: **The Pandemic-Resilient Office Tower**

Authors: Dan Kaplan, FAIA, LEED AP, FXCollaborative
Sara Davis, AIA, LEED GA, FXCollaborative

Subjects: Building Case Study
COVID
Social Issues
Sustainability/Green/Energy

Keywords: COVID-19
Occupancy
Office
Public Health
Sustainability
Workplace

Publication Date: 2020

Original Publication: CTBUH Journal 2020 Issue IV

Paper Type:
1. Book chapter/Part chapter
2. **Journal paper**
3. Conference proceeding
4. Unpublished conference paper
5. Magazine article
6. Unpublished

The Pandemic-Resilient Office Tower

Dan Kaplan

Sara Davis

Authors

Dan Kaplan, FAIA, LEED AP
Sara Davis, AIA, LEED GA
FXCollaborative
1 Willoughby Square
Brooklyn, New York
United States 11205
t: +1 212.627.1700
e: communications@fxcollaborative.com
fxcollaborative.com

Dan Kaplan, FAIA, LEED AP, is a Senior Partner at FXCollaborative. Kaplan serves in a design and leadership capacity for many of the firm's complex, award-winning projects. Adept at creating large-scale, high-performance buildings and urban designs, he approaches each project with the mission that it must elevate and resonate with the larger urban, cultural, and climatic totality. Notable projects include Allianz Tower (Istanbul), 1 Willoughby Square (New York), Fubon Financial Center (Fuzhou, China), and Eleven Times Square (New York). Kaplan holds a Bachelor of Architecture degree from Cornell University and is a registered architect in numerous US states.

Sara Davis, AIA, LEED GA, is a Senior Associate at FXCollaborative. With more than 15 years of experience with large mixed-use, commercial, and educational projects, Davis' flexible yet rigorous problem-solving approach facilitates communication to advance a cohesive design program, while considering what the project goals are and how architecture and design can respond to wide-ranging environmental issues. She currently serves as Project Architect for the 167,000 square-meter 3 Hudson Boulevard office building under construction in Manhattan. Davis holds a Master of Architecture degree from the Illinois Institute of Technology and is a registered architect in Illinois.

Dan Kaplan and Sara Davis will present "The Pandemic-Resilient Office Tower" at the CTBUH 2020 virtual conference, *The Post-Crisis City: Rethinking Sustainable Vertical Urbanism*, on 17 November.

Abstract

This paper examines architectural design strategies to create a "Pandemic-Resilient Office Tower." In addition to incorporating a suite of measures to impede the spread of disease, the design's defining feature is its ability to flex between normal and health-crisis modes. The building's operation is optimized for both of these conditions, and will seek to anticipate unknown stressors. A proposed Class-A office building in Manhattan's Hudson Yards that features this approach is analyzed, including qualitative and quantitative considerations. Building entrance sequence, lobby layout, vertical circulation, core design, wellness, and productivity aspects are considered, lessons learned and insights for further research are shared, and larger questions relating to a resilient design ethos and its lessons for both health and climate crises are explored.

Keywords: COVID-19, Office Design, Resilience, Sustainability, Tall Buildings

Introduction

Our world has entered into a new era of pandemic and epidemic risk. Prior to the COVID-19 pandemic, the number of similar outbreaks had been increasing. Now with COVID-19, we are experiencing a human, social, and economic toll unprecedented in our lifetimes. In this new period of heightened risk, it is vital to re-examine conventional planning parameters for nearly the entire urban realm, including for tall office buildings. Throughout history, high-rise office building design innovation has chiefly been driven by a single-minded pursuit of efficiency, which, critically, has generally been made assuming ideal conditions. However, as we are collectively discovering, the result is that our tall buildings are unable to function effectively under more challenging circumstances. Resiliency has gained a new-found urgency.

This concept of resilient design urgently needs to be expanded to include pandemic and epidemic risk. Prior to the outbreak of COVID-19, resilient design was focused on preparing for cases of natural or man-made disasters, severe weather, fire, and adapting for longer-term climate change. However, the pandemic has exposed the inadequacy of our built environment to mitigate disruption from extreme public health crises. High-rise office buildings, with their high concentrations of occupants in close quarters accessed by densely packed elevators, are an especially weak link. This presents a new dimension to resilient design criteria: in addition to anticipating external pressures (e.g., heat waves), internal stressors (e.g., physical distancing) need to be considered. Applying this expanded definition of resiliency triggers a healthy re-examination of long-held planning parameters and design strategies. Using a side-by-side comparison of a design test case, this paper focuses on expanded resilient design considerations that include pandemic and epidemic risk, and outlines some of the resulting design solutions for high-rise office buildings.

Reflections on Office Building Design

To better understand how high-rise office buildings can be more resilient, it is useful to reflect on the design principles that have shaped their evolution. Since the early 1900s, when Cass Gilbert, architect of the Woolworth Building, famously quipped, "A skyscraper is a machine that makes the land pay," commercially-driven concerns have been the catalyst for tall office buildings (Irish 1989). The 1930 publication *The Skyscraper: A Study of its Economic Height* concluded, "Given the high land values in central business sections of our leading

Figure 1. Empty street in Midtown Manhattan during the COVID-19 pandemic, April 2020. © iStock.com / Yanlin Hou

cities, the skyscraper is not only the most efficient, but the only economic utilization of certain strategic plots" (Klaber 1930). According to Yeang (1995; 2000), floor slab efficiency of a typical high-rise office building is generally not less than 75 percent. More recently, these numbers are continuing to increase up to as much as 90 percent. To continue to accomplish these aggressive net-to-gross efficiency ratios and balance development economics, building and infrastructure designs are growing increasingly tight, with little room for compromise. Of course, imagination, civic pride, and competitiveness all have significant roles; however, it is economic efficiency that continues to be a driving force for innovation. Compressed core footprints that maximize leasable space, long lease-spans that minimize columns, and ever-more responsive vertical transportation and MEP services are all in the service of increasing occupancy densities. An industry-wide focus on optimization reduces both initial capital and running costs. These twin imperatives—increased occupancy and decreased costs—have been enabled by greater sophistication in engineering, material sciences, and architectural planning. In addition, underlying design parameters, especially as they relate to occupancy, have been tightened to assume optimal conditions.

We are now discovering that our hyper-optimized towers are unable to adapt to the spatial needs for occupancy during a health crisis. They cannot accommodate the occupancy densities and deliver the performance levels originally targeted. For example, Manhattan office buildings were able to reopen following a set of guidelines issued by the state, which included maintaining a physical distance of 6 feet (2 meters) or more between all individuals. To evaluate the rate of office employees returning to work, the Partnership for New York City shared the results of a survey of office employers in Manhattan completed in the middle of August 2020. Although New York allowed companies to reopen their offices at the end of June, the Partnership survey found that only eight percent of employees had returned to the office as of mid-August, far fewer than expected (see Figure 1). Among the largest factors influencing the pace of employees returning to the office was the availability of office space for physical distancing.

Planning Principles for Pandemic-Resilient Design

In *How Buildings Learn*, Stewart Brand noted that "all buildings are predictions; and all predictions are wrong" (Brand 1994). Efficiency based on optimistic assumptions can be hazardous to the effective performance of buildings; a strategic dose of inefficiency is necessary. The need to rethink design principles for flexibility and adaptability in response to health crises is apparent. It is not only important to incorporate a suite of measures to impede the spread of disease, but also, high-rise office buildings should have the ability to readily flex between normal and physical distancing modes.

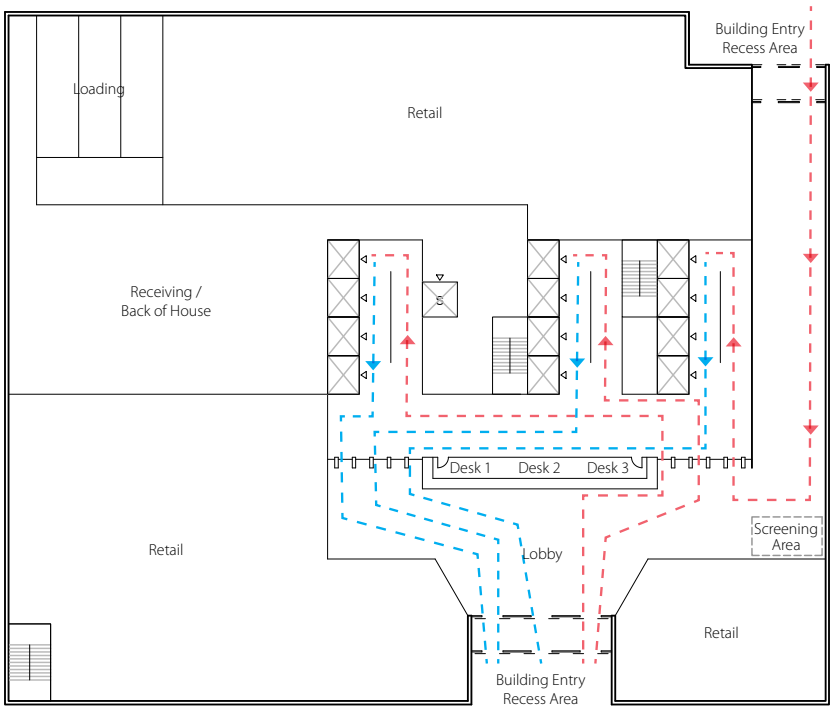

Figure 2. Lobby floor plan from a case study of a Manhattan office building designed for physical distancing, showing one-way circulation systems. © FXCollaborative

Figure 3. Elevator lobby rendering of the base design from a case study of a Manhattan office building. © FXCollaborative

Figure 4. Elevator lobby rendering of the pandemic-resilient design from a case study of a Manhattan office building allowing for physical distancing. © FXCollaborative

With this specific lens, we consider the following planning principles:

- Pinch point-free circulation
- Open office layouts for social distancing
- Enhanced vertical transportation
- Wellness and productivity
- Robust ventilation and filtration

To evaluate and compare features of the above principles, a proposed Class-A office building in Manhattan's Hudson Yards was used as a case study. The case study began with the base case of a conventional, 600,000 square-foot (55,750 square-meter) mid-block building. The base-case design prioritizes usable area reaching 85 percent efficiency and features a center core, conventionally arranged with opposing elevator banks, standard toilet rooms, a modest lobby, and so forth. The base-case design was then reconsidered and modified, incorporating the pandemic resiliency design principles resulting in a test case. This allows for a side-by-side comparison.

Pinch Point-Free Lobbies

The Centers for Disease Control (CDC) have identified that "limiting close face-to-face contact with others is the best way to reduce the spread of COVID-19." In addition to mask-wearing, the agency recommends maintaining physical distance of at least 6 feet (2 meters) or two arms' length away from people not in one's household. In considering pandemic adaptability, public spaces should accommodate expanded physical distance—three to four times what is normal—between occupants during a health crisis. In order to promote adequate occupant spacing and orderly flow, a one-way circulation pattern can be created from the building entrance to the elevator entrance, with an adaptable space for health screening prior to entering the elevator lobby (see Figure 2). Larger building lobbies support and encourage pinch point-free circulation, avoiding narrow intersections of cross traffic. Reducing or eliminating touch points throughout public spaces should also be implemented by including touch-free security turnstiles, elevator controls, and automatic doors at building entrances.

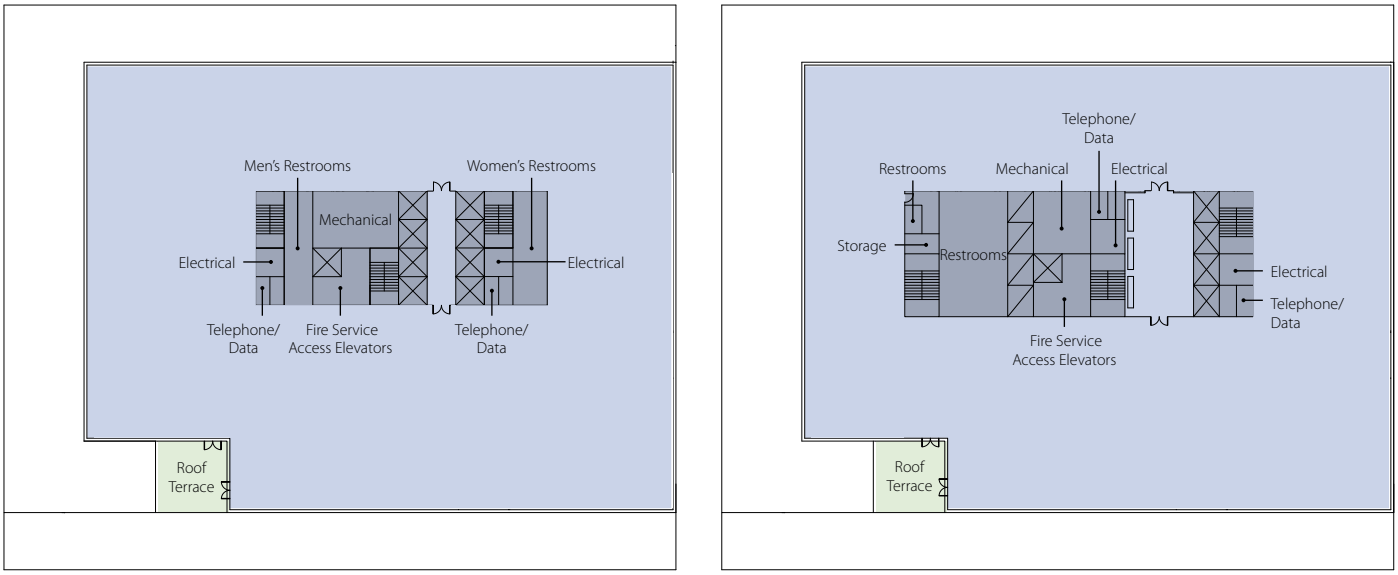

Figure 5. Left: Typical office floor plan of the base design from a case study of a Manhattan office building. Right: Typical office floor plan of the pandemic-resilient design from a case study of a Manhattan office building, allowing for a wider range of uses and configurations in the core, and more social distancing. © FXCollaborative

Elevator Lobbies

Elevator lobbies are a critical element of pinch point-free planning. In the test-case design, enlarging the elevator lobbies from the standard 10 feet (3 meters) to 18 feet (5.5 meters), coupled with single-loaded elevator banks, allows for one-way, physically distanced circulation at the entry level during pandemic mode (see figures 3 and 4). In non-pandemic mode (normative) mode, this configuration results in a more gracious entry experience and space for potential programming (kiosks, furniture, artwork, etc.). On typical office floors, the additional width may initially seem to be inefficient (see Figure 5). However, as the test case reveals, it allows for a wider range of uses and configurations in what is normally a restricted area of the core (see Figure 6). Rather than the awkward and narrow spaces left between the elevators, the wider space can more appropriately accommodate functions such as reception areas or conference rooms. On bypass floors, restrooms are often located between elevator banks, and the more generous width offers far greater flexibility in restroom planning (see Figure 5).

Restroom Planning

Consistent with planning principles for public spaces, restroom designs should also allow for physical distancing, be free of pinch points, and incorporate touchless devices, and configurations should allow for one-way or oversized access. In the case study, the more generous width between elevators allows for all of these, as well as the potential for single-user, individual restrooms (see Figure 6).

Figure 6. Restroom layout studies from a case study of a Manhattan office building. © FXCollaborative

Beyond the appeal of privacy and separation in normal circumstances, individual restrooms can provide for enhanced measures in a health crisis. Full-height partitions between occupants provide the opportunity for individual ventilation and filtration, and the individual cabin also allows for implementation of UV lighting for sterilization when unoccupied. In all cases, touch points throughout restrooms can be reduced or eliminated by using automatic or doorless restroom entries and touch-free plumbing fixtures.

Open Office Layouts for Social Distancing

In the case study, three tenant layouts were analyzed to compare densities achievable on the typical office floor (see Figure 7). In the pre-COVID base case, where the driving factors are efficiency in core design and increased occupancy through side-by-side benching arrangements, the usable area is 26,520 square feet (2,460 square meters) with a density of 129 square feet (12 square meters) per person. The same plan during a health crisis that requires physical distancing between occupants can only accommodate less than 50 percent of the base-case occupancy, resulting in a density of 245 square feet (23 square meters) per person. The third condition integrates the pandemic-resilient test-case core and fit-out. The larger core results in a slight reduction of usable area at 25,871 usable square feet (2,403 usable square meters), and the population density is adjusted from 129 square feet (12 square meters) per person in the base case to 151 square feet (14 square meters) per person in the pandemic-resilient case—a reduction of only 14 percent. The replacement of benching-style workspaces to individual workstations tailored to physical distancing requirements results in a small loss in office floor density, while providing pandemic resiliency (see Figure 8).

Efficiency and Resiliency

Design considerations for pandemic resiliency do not necessarily result in a significant loss of occupancy. In the office building case study, the core footprint increased when revised according to the above planning principles, with more useful

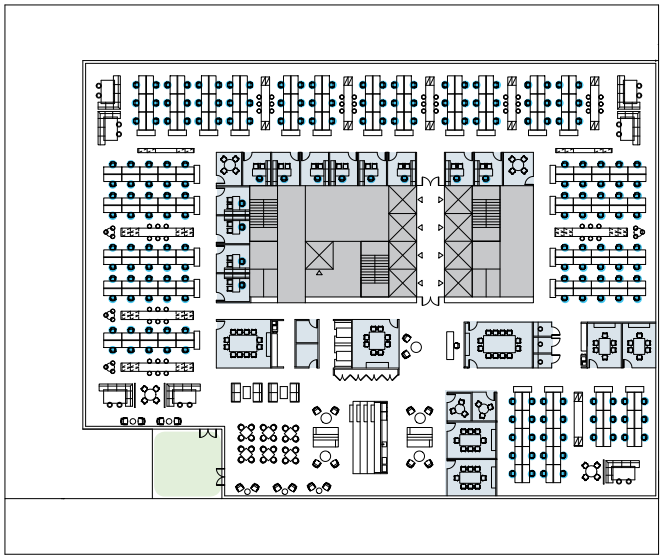

Figure 7a

129 SF (12 m²)/PP
26,520 USF (2,460 m²)

265P Max Occupancy
95:5 Ratio WS/Office
1:1:3 Task Seat to Collab Seat

Headcount

194	Workstations
12	Offices
--	Alternate Schedule
206	**Total**

Collaboration

74	Enclosed Meeting
3	Phone
198	Open Collaboration
275	**Total**

Figure 7b

245 SF (22.7 m²)/PP
26,520 USF (2,460 m²)

265P Max Occupancy
89:11 Ratio WS/Office
1:0:8 Task Seat to Collab Seat

Headcount

97	Workstations
12	Offices
-97	Alternate Schedule
109	**Total**

Collaboration

32	Enclosed Meeting
3	Phone
54	Open Collaboration
89	**Total**

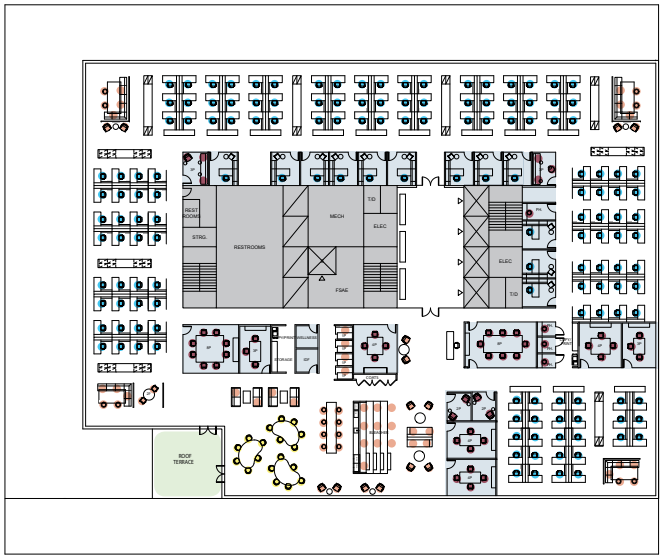

Figure 7c

151 SF (14 m²)/PP
25,871 USF (2,403 m²)

265P Max Occupancy
92:8 Ratio WS/Office
1:0:8 Task Seat to Collab Seat

Headcount

140	Workstations
12	Offices
18	Touchdown
171	**Total**

Collaboration

48	Enclosed Meeting
4	Phone
66	Open Collaboration
117	**Total**

Workstations/Offices Alternate Schedule Enclosed Meeting/Phone Open Collaboration

Figure 7. Interior layout studies from a case study of a Manhattan office building. Figure 7a (top) is the base case with side-by-side benching arrangements in non-pandemic mode. Figure 7b (middle) is the base case design during pandemic mode. Figure 7c (bottom) is a revised layout, using individual workstations for physical distancing and pandemic-resilient design. © FXCollaborative

space provided within the core. The tenant fit-out, with properly selected systems furniture, will allow for full, continuous occupancy during a health crisis that demands social distancing. The next challenge is moving occupants vertically to and from each office floor.

Vertical Transportation

To comply with pandemic-related physical distancing recommendations, the capacity of standard elevator cabs reduces significantly. Cabs that were designed in optimal conditions to accommodate 16 occupants should now only accommodate four occupants. Accomplishing resiliently designed office floors with only a 14 percent reduction in occupancy is only beneficial if the elevator system is also enhanced. Programmable, advanced dispatch control systems are commonly incorporated into current high-rise designs, and are a beneficial first step to aid in responsive and effective elevator performance. In addition, oversized elevator cabs (with capacity of 4,000 pounds/1,800 kilograms) allow for additional space between occupants during health crisis periods and support planning principles for pinch point-free design.

Advancements in elevator systems design are also evolving and emerging. Thyssenkrupp's TWIN system allows for two elevator cabs to travel independently in the same elevator shafts and, with careful study, can increase capacity by up to 40 percent. Advances such as this, along with larger cabs, would allow the vertical transportation system to function in pandemic mode, with normal wait times in the range of 45 to 50 percent of peak capacity, far greater than the 25 to 30 percent that existing systems can handle.

Encouraging the use of egress stairs as communicating stairs is another strategy for resiliency. This helps reduce the occupant load on the elevator system when physical distancing is required, contributes to wellness and productivity of occupants, and reduces energy consumption. To encourage the use of the egress stairs, adequate space must be provided for circulation with oversized egress stair width. Locating egress stairs prominently and enhancing their finishes and lighting to an appropriate "front-of-house" standard will further prevent them from being overlooked as "back-of-house" or service-only spaces (see figures 9 and 10).

Wellness and Productivity Considerations

An important aspect to resiliency includes consideration of occupant wellness and productivity. During health crisis mode, access to daylight and connection to the outdoors to alleviate stress are to be heightened. Ample daylight throughout the usable office area should be a priority when studying the appropriate shell-to-core depths. Although greater spans can be accomplished, it is important to determine the ideal depth for ample natural light throughout the floor plate. Also consider the integration of outdoor space such as terraces, or interior bridge spaces with office floors (see Figure 11). These spaces provide occupants with flexibility of workspaces, particularly during health crisis modes when smaller collaborative areas cannot be used. While a significant improvement to air quality from a planted, living wall may be

Figure 8. Altering desk arrangements can offer social distancing at a low total seat penalty. The top image is of the typical side-by-side benching arrangements and the lower image is of individual workstations for pandemic-resilient design. © Haworth

"Substituting a larger core reduces the population density from 129 square feet (12 square meters) per person in the base case to 151 square feet (14 square meters) per person in the pandemic-resilient case—a reduction of only 14 percent."

“Consider making localized fan-filter air purification visible during periods of increased health risk. This is more psychologically comfortable for occupants, who then will know there is filtration occurring.”

challenging to accomplish throughout an office building, the integration of living walls for the purposes of improving occupants' wellness and productivity is more easily accomplishable, and can be focused on the most impactful areas (see Figure 12). There are various types and levels of certification that are evolving and expanding to address healthier indoor environments during pandemic and epidemic periods. Certifications such as LEED, Fitwel, and WELL provide tools and guidance for improving wellness and productivity that can be shared and communicated with the building occupants.

Visible enhancements to air filtration and ventilation can offer reassurance to building occupants during periods of health concern. There are numerous measures within the base building design that can adapt in a health crisis mode, but many of these are not seen by the building occupants. Consider making localized fan-filter air purification visible during periods of increased health risk. The sight of these units makes occupied spaces (such as elevator cabs) more psychologically comfortable for occupants, who then will know there is filtration occurring.

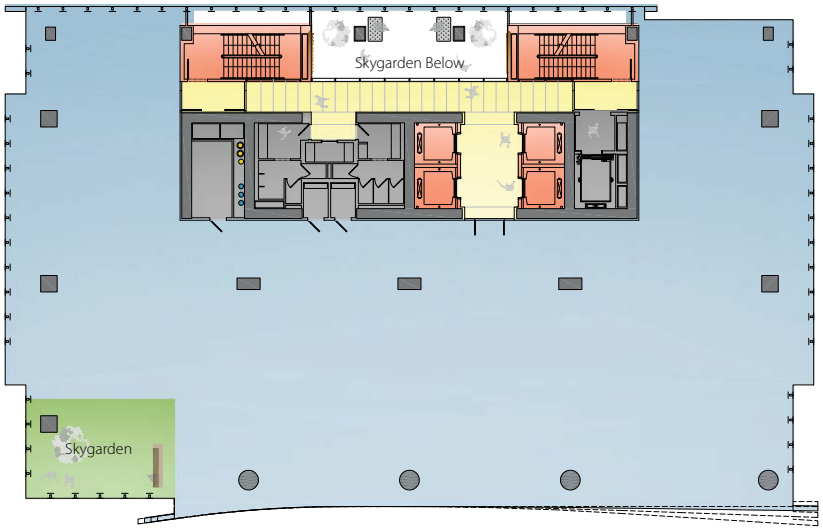

Figure 9. A side-core office floor plan encourages access and use of egress stairs, and provides opportunities for outdoor space. © FXCollaborative

Figure 10. Rendering of office floor plan with access to outdoor terrace and egress stair. © FXCollaborative

Enhanced Ventilation and Filtration

In response to the pandemic, enhanced ventilation and filtration systems are being analyzed, studied, and scrutinized by the mechanical engineering community. These enhancements need to be adaptable for a wide range of potential circumstances, some of which may contradict one another. A few of these considerations specifically for pandemic-resilient design include:

- Smaller, decentralized HVAC zones and minimizing common building ventilation systems.
- Allowance for outside air purges with the use of pre- and post-workday purges, as well as an increase in outside air volumes throughout the workday.
- Improvements to air filtration within base building air handling equipment.
- Consideration of UV lights in unoccupied spaces and in air handling equipment.

Conclusions/Insights for Further Research

Like so many aspects of our lives, the pandemic has laid bare the brittleness of our

hyper-optimized planning approach to high-rise office buildings. The anticipation of future health crises, along with the ever-increasing stressors borne from climate change, present the tall building community with an opportunity for a wide range of improvements to our long-held assumptions and parameters. There is ample territory for re-examination and reinvention, from underlying circulation planning and vertical transportation design, to the ubiquitous detail elements of doors and hardware. The result should be a more robust building stock, able to support occupants in a wider range of conditions and circumstances, including public health crises, over a longer period. Alex Gordon, president of the RIBA, introduced the 3L rule in 1972: "long life, loose-fit, low energy" (Gordon 1972). Tall office buildings (and high-rise buildings in general) could use a greater dose of the loose-fit ethos to better respond to an increasingly variable future. ■

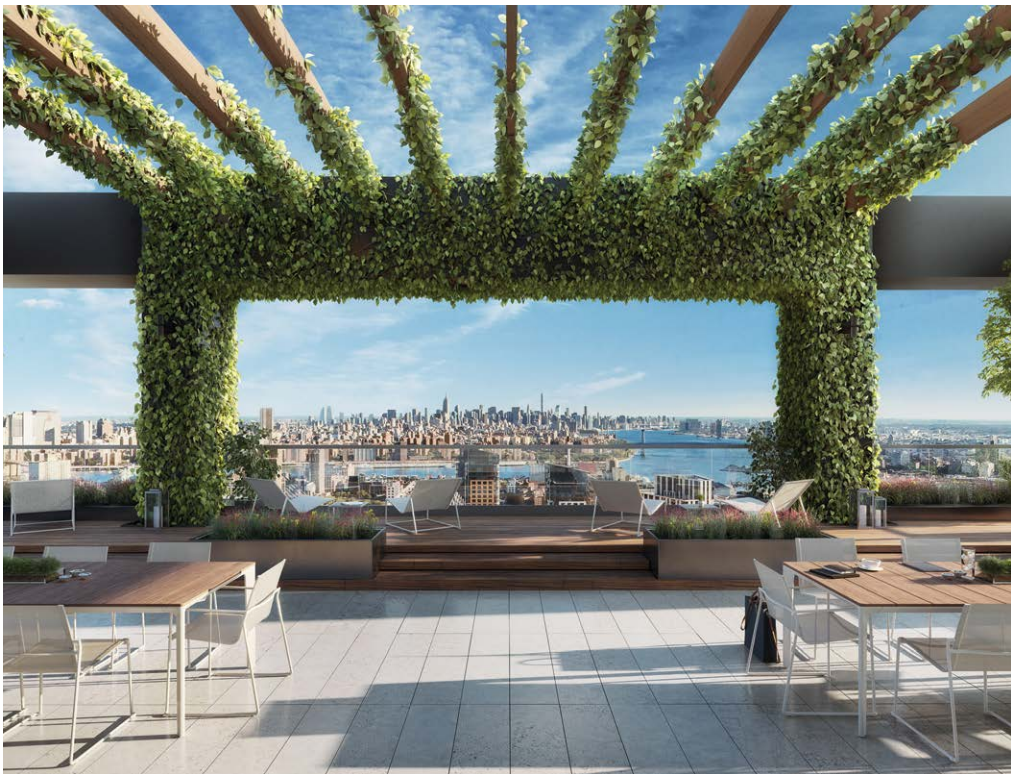

Figure 11. Rendering of an office building outdoor terrace. Access to outdoor spaces can help with air circulation and psychological comfort. © DBOX

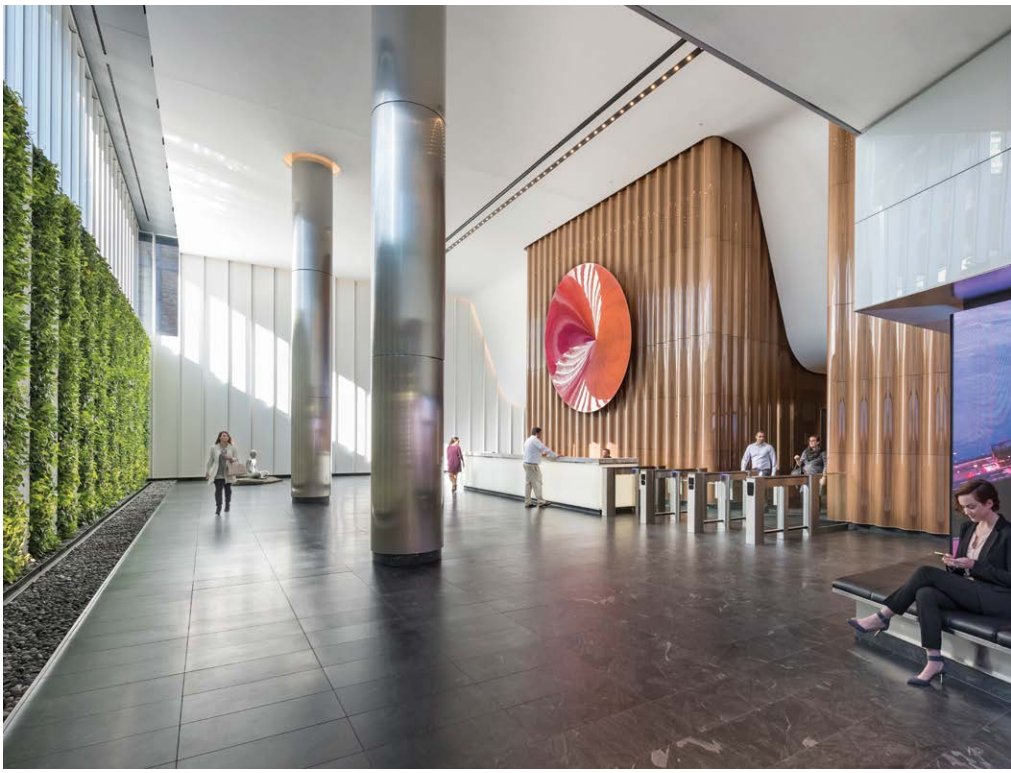

Figure 12. Image of office building lobby with living wall, which can be used to bolster the sense of well-being in interior spaces. © Anton Grassl / Esto

References

Brand, S. (1994). ***How Buildings Learn: What Happens After They're Built.*** Penguin Books.

Centers for Disease Control and Prevention (CDC) (2020). "Coronavirus Disease 2019: Social Distancing." www.cdc.gov updated July, 15 2020

Clark W.C., Kingston J. L. (1930). ***The Skyscraper: a Study in the Economic Height of Modern Office Buildings.*** American Institute of Steel Construction, Inc.

Gordon, A. (1972). "Long Life, Loose Fit, Low Energy." Royal Institute of British Architects (RIBA).

Irish, S. (1989). "A 'Machine That Makes the Land Pay': The West Street Building in New York." ***Technology and Culture, 30.*** pp. 376–397.

Klaber, E. H. (1930). "The Skyscraper: Boon or Bane?" ***Journal of Land and Public Utility Economics, 6(4).*** pp. 354–358.

Watts, S.; Kalita, N.; Maclean, M. (2007). "The Economics of Super-Tall Towers, The Structural Design of Tall and Special Buildings," (16). pp. 457–470.

Yeang, K. (1995). ***The Skyscraper, Bioclimatically Considered.*** Academy Editions, London.

Yeang, K. (2000). ***Service Cores: Detail in Building.*** John Wiley and Sons, London.