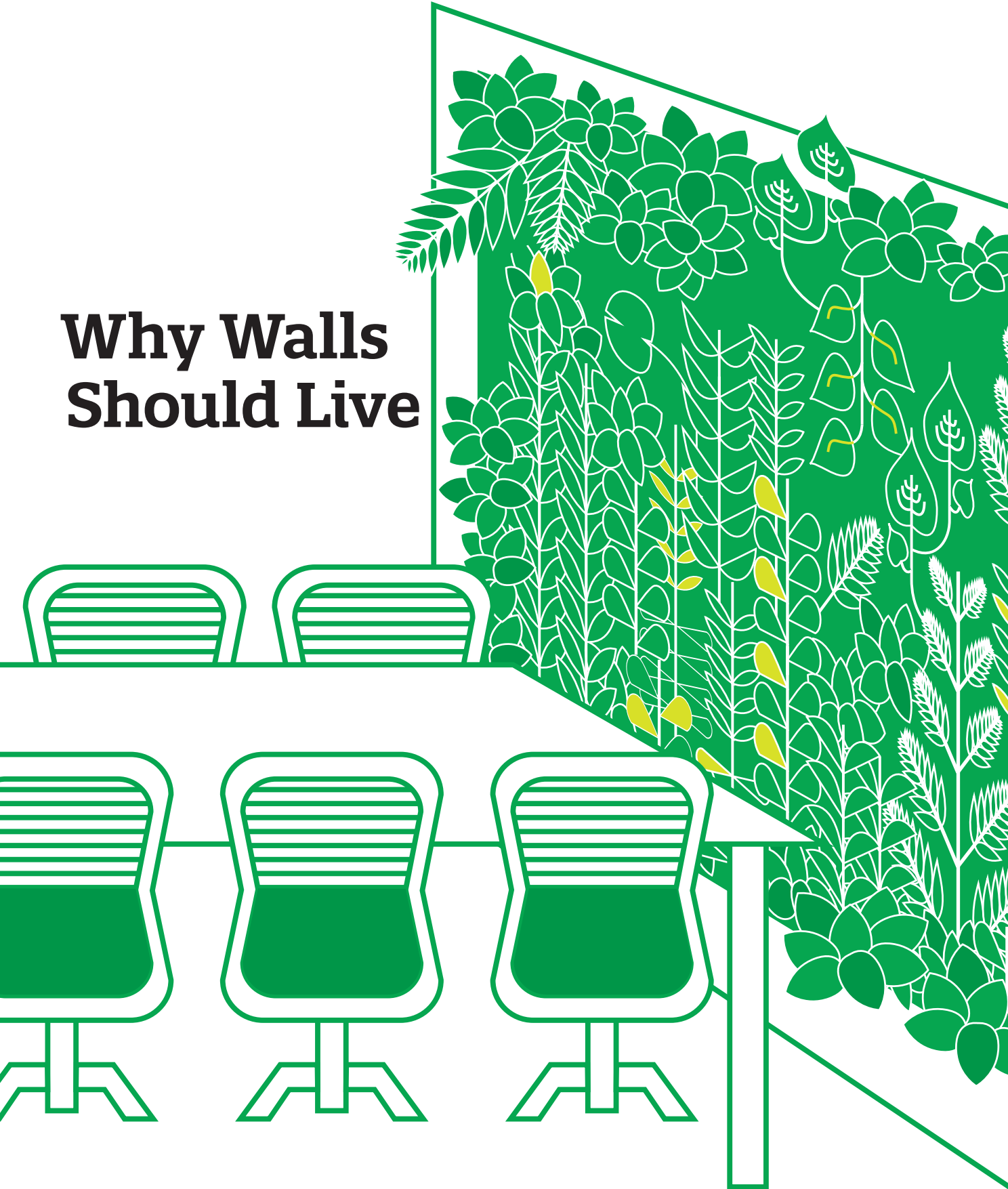


Why Walls Should Live



Why Walls Should Live

Can living walls have an impact on indoor air quality and occupant comfort?

Living walls can dramatically improve indoor air quality—but their effects may go far beyond just filtering air.

WHAT WE DID

We conducted an experiment to test the effect of a living wall on indoor air quality and thermal comfort of occupants in a real-life working environment. We used two conference rooms in Gensler's Shanghai office—one served as the control room. For the other room, we created a "green" room by installing a living wall, specifically using plant species known to target indoor air pollutants and improve indoor air quality (IAQ) levels. The plans, furniture fit-out, and ventilation of the two rooms were identical, and differences in lighting plans were only slight.

The living wall was installed in February 2015. Over the course of six months—March to August 2015—we monitored levels of CO₂, particulate matter (PM_{2.5}), total volatile organic compounds (TVOC), relative humidity (RH), and temperature in the two rooms. We used this data to conduct a detailed comparative analysis at the conclusion of the study, uncovering measurable impacts of living walls on the workplace environment, as well as areas in which additional research is needed. We also surveyed 60 members of Gensler Shanghai who used the two rooms to gather input on their experience and preferences related to the green room.

THE CONTEXT

Addressing the mounting issues of pollution and air quality is of paramount concern to human health, particularly in cities like Shanghai that suffer from consistently sub-standard air quality. And the problem isn't only outside the buildings, it's also within. Indoor air quality (IAQ) is of particular concern today: workers spend the majority of their waking hours in the office, and some even note finding refuge at the office when air quality outside or within other places is particularly bad.

Today, IAQ is most often managed via mechanical ventilation systems to address levels of CO₂, PM_{2.5}, and TVOC in the air. This approach has a significant downside, however: managing air quality via mechanical

systems increases the energy required to manage buildings, with a negative impact on overall sustainability and resilience (as well as operating costs). In the long run, these systems ultimately contribute to the problems of pollution they are meant to solve because of higher fuel use.

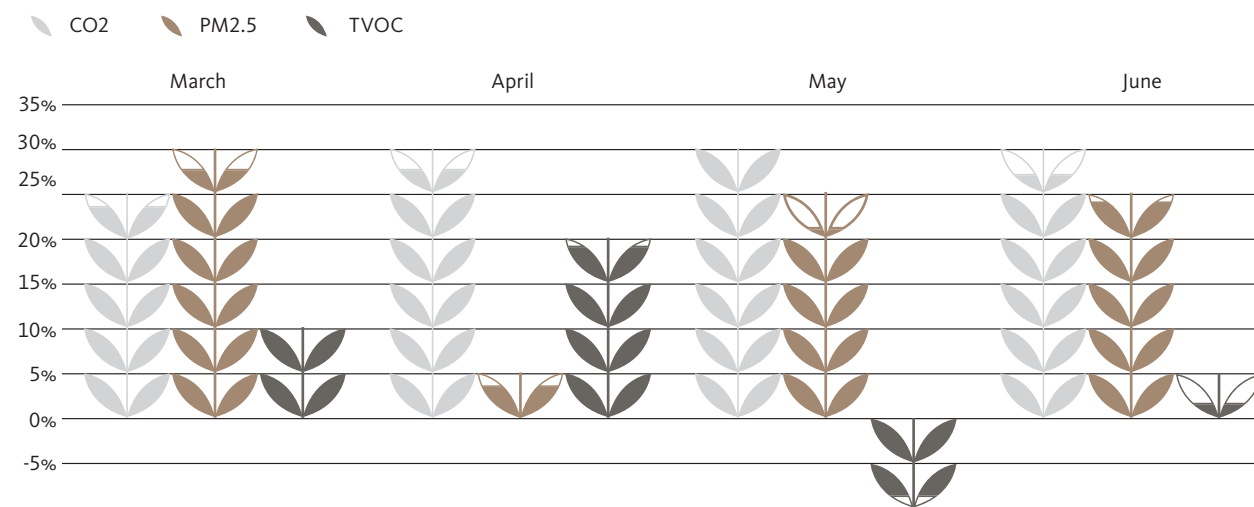
If we instead instead could manage indoor air quality by introducing living or "green" walls into indoor environments, the impact on the health and experience of the occupants—as well as overall building operation—could be significant. Indoor potted plants have been shown to reduce levels of CO₂, PM_{2.5}, and TVOC in prior studies. We seek to not only confirm this effect, but quantify the impact of indoor plantings to inform future use.

THE RESULTS

The living wall showed significant, positive improvements to IAQ over the course of our study. The greatest observed effects were on overall levels of CO2 and PM2.5, which showed overall average reductions of 24 percent and 21 percent respectively compared to our control. Importantly, the effect of the living wall is positive not only in the long term, but also over short periods of time. The living wall also proved more resilient. When a disruption occurred, resulting in a spike in measured levels of CO2 and PM2.5, the control room was slower to return to baseline levels than the room with a living wall. This ability to mitigate change is particularly important on days when outdoor air quality is poor, as this has a direct impact on the quality of air indoors.

The green room also had higher overall temperature and humidity. The presence of the living wall, and the added lighting needed to maintain it, kept the green room comparatively warmer than the control room. This is likely due to the added heat generated by the plant lights, as well as heat released from plants in the form of water vapor. We observed a similar trend for the relative humidity (RH) of the two rooms as well—the green room’s humidity was comparatively higher. The gap in humidity appeared to be falling over the course of our study, however, and the green room humidity levels overall became less volatile with time, so the humidity impact may be temporary.

Percent reduction of CO2, PM2.5, and TVOC levels from March to June, 2016



Users see health benefits from the living wall, but challenges to thermal comfort. Two-thirds of users surveyed (65 percent) preferred the green room to other conference rooms, noting that they enjoyed the presence of plants and found the greenery relaxing. Users also felt the air quality in the green room was superior, and four in five (79 percent) believed the room was an overall benefit to their health. However, users noted the higher temperature and humidity of the room as negative impacts of the living wall. The smell of the room was also noted by many users, potentially an impact of the soil mix used.

- 79%** Feel like there are health benefits from using the green room
- 76%** Sense a reminder of nature from view of plants, inspiring a mindful break
- 70%** Feel that the green room is more humid than other conference rooms
- 65%** Prefer the green room with the living wall
- 70%** Feel happy working in the green room

DESIGN IMPLICATIONS

Living walls provide a significant opportunity to improve indoor air quality.

Not only did we observe an overall positive effect on IAQ, but the room also showed a greater ability to bounce back from events negatively impacting air quality. As a result, the green room recorded significantly less time that IAQ would be considered dangerous to human health than the control room.

Building systems and sensors must be well coordinated with living wall installations.

The secondary effects of the living wall—higher temperatures and humidity, and the added smell—must be mitigated by building HVAC systems. If handled well, the overall impact of the added heat and humidity could prove to be neutral or even positive over the course of a full year, depending on climate.

The greatest health and bottom-line impact may come from distributed greenery.

When contained within individual spaces, as in our study, the effects of the living wall were significant, but also easy to negate if the rooms were not kept properly sealed (for example, doors left open). The enclosure of the rooms was necessary for our study, but for a broader and more sustained impact on indoor environments, distributed installation of plants may prove beneficial.

User perception and behavior may be a challenge for broad adoption.

Direct user input showed a preference for the green room aesthetically, but also the need to manage its thermal comfort as previously noted. We conducted additional analysis of users’ actual behavior via the office’s conference room reservation system, and saw no significant increase in utilization of the green room over the control room.

A 1989 NASA study identified the positive impacts of indoor plants on air quality, advocating a plant for every 100 square feet of home or office space, and identifying the most effective plant species: “If man is to move into closed environments, on Earth or in space, he must take along nature’s life support system.”
 – NASA study by B.C. Wolverton, Anne Johnson & Keith Bounds



WHAT'S NEXT

Our study showed the significant benefits of green or living walls installed within office environments, but also raised a number of questions warranting further analysis. The inconclusive effects on TVOC levels are of particular interest and concern. Understanding how to mitigate the effects on thermal comfort and smell via different plantings and soil mixes will also be key to broader adoption.

The Gensler Research Institute

The Gensler Research Institute is a collaborative network of researchers focused on a common goal: to generate new knowledge and develop a deeper understanding of the connection between design, business, and the human experience. Through global and local research grants, and external partnerships, we seek insights focused on solving the world's most pressing challenges. We are committed to unlocking new solutions and strategies that will define the future of design.

Research Team

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