

JOURNAL REPORT | THE FUTURE OF CITIES

Green Buildings. Literally.

'Biophilic' designs incorporate elements of nature both outside and inside. It's aesthetically pleasing—and makes people feel, and perform, better

BY KEN WELLS

MOST PEOPLE, when they think of "green" buildings, take that to mean structures built with energy conservation in mind. But, increasingly, buildings are becoming literally green, as cities and companies around the world embrace biophilic design—the concept of surrounding buildings with nature, even on their upper floors, and bringing the outdoors indoors by including natural elements in their interior design.

Planted terraces that wrap around buildings, indoor man-made water features such as ponds and waterfalls, plantings that can cover entire interior walls, cascades of windows to maximize natural light—all are key elements of biophilic design, as are expanded views of nature itself.

Aesthetics are clearly a driver of the biophilic movement, but it is also motivated by the bottom line. Biophilic design can result in significant energy savings, and research indicates that employees in buildings designed with biophilic elements not only feel better about their workplace but perform better, too. For example, a landmark 2003 study of 100 employees in a call center of the Sacramento Municipal Utility District showed that workers who sat with views of nature handled up to 12% more calls per hour than those who had no view.

Plants everywhere

Clif Bar & Co.'s state-of-the-art bakery in Twin Falls, Idaho, is in the vanguard of the movement. Its profusion of windows, skylights and tubes designed to bring sunlight deep into building interiors bathe the facility in gentle natural light. Wall-size projections of nature bring images of mountains, rivers and forests into the bakery's core. An imposing stone interior corridor is designed to mimic the Snake River Canyon, one of the most stunning geographic features of the West.

And there are plants every-



DAVIDE PIRAS/STEFANO BOGERI ARCHITETTI

where: Low-maintenance plants decorate the light-filled common areas where workers gather, giving these indoor spaces an outdoor feel. Outdoors, a number of patios used by employees for breaks and dining are planted with or surrounded by drought-tolerant native plants, including more than 570 trees and 5,700 shrubs and grasses. The bakery also was sited to offer unimpeded vistas of the nearby mountains of the Sawtooth National Forest.

The idea behind the design of the \$90 million, 300,000-square-foot bakery, completed in 2016, was to make it "the kind of place all of us would like to work," says Rich Berger, vice president of engineering and food supply for the maker of organic energy bars and snacks based in Emeryville, Calif.

Bill Browning, a founding partner of Terrapin Bright Green, a New York-based consulting firm focused on sustainable development, is among America's leading biophilic experts. He has been consulting with companies including Walmart and Marriott International's Westin Hotels & Resorts to bring biophilic design into their building plans.

Walmart teamed up with Mr. Browning as he first began to explore how bringing elements like abundant natural

light into retail workspaces could improve not only productivity but also sales. From experiences with a prototype green store that featured abundant natural light, the company began to find that sales per square foot were significantly higher for departments located in the daylight sections of stores than in those with artificial light, according to a joint report by Mr. Browning and the company.

At Westin, "we believe people have an innate need to interact with nature," and so the company gears all of its design with biophilic principles in mind, says George Fleck, the chain's vice president of global brand marketing and management. He points to one of Westin's newest properties, the five-story, 116-room Westin Buffalo in Buffalo, N.Y. The hotel incorporates planted walls, soaring banks of windows and exposed wooden beams into its common areas and decorates its guest rooms with carpets, walls and art suffused with earthy tones and replicating patterns of nature.

Health and profit

A pivotal piece of research backing up the premise of biophilic design is a 1984 study published in the journal *Science* that found that a suburban Pennsylvania hospital's gallbladder-surgery patients



PATRICK BINGHAM/HALL

The Bosco Verticale apartment towers in Milan (left) have about 800 trees on their terraces. In Singapore, the ParkRoyal hotel has almost 4 acres of lush terraces, many with water features.

who had views of green space from their rooms had shorter recovery times than those who didn't. Many other studies have since confirmed such health benefits.

Today, the Khoo Teck Puat Hospital in Singapore, completed in 2010, features vast indoor courtyards of tropical plants surrounding patient areas. Fins along the building's exterior channel prevailing northeast winds into the building, enhancing airflow by 20% to 30% and reducing the need for air conditioning.

Singapore is also home to one of the pioneers of biophilic design, the architectural firm WOHA, founded by Wong Mun Summ and Richard Hassell in 1994. The WOHA-designed ParkRoyal on Pickering hotel in Singapore, part of the Pan Pacific Hotels Group, features almost 4 acres of lushly planted, self-sustaining terraces interlaced with waterfalls, ponds and other naturalistic features.

The 367-room hotel has been largely sold out since it opened in 2013, and suites go for more than \$500 a night. "It's a project that shows that an investment in green design can translate into real profit," says Mr. Hassell.

WOHA is working on 14 biophilic projects in seven countries, according to Mr. Hassell. One of them is a park and classroom cluster as part of a

new campus for the Singapore Institute of Technology that will cocoon campus buildings in an urban forest.

Awards for innovation

Biophilic design has earned some prestigious recognition. The dual towers of the Bosco Verticale apartment complex in Milan are clothed in staggered terraces featuring about 800 trees—enough to cover a 3-acre forest. The project won Europe's International High-rise Award in 2014 for the continent's most innovative building.

While designing buildings with huge green spaces, green walls and terraced gardens can be challenging—using trees requires building in load capacity—some projects get around that by the choice of plants they use. At One Central Park in Sydney, hydroponic plants require no soil and minimal water to thrive, alleviating the issue of structural overloading. The mixed residential and commercial building features a series of hanging gardens that clad the exteriors of its two residential towers with more than 85,000 plants, and includes 22 interior green walls.

Green walls add only modest costs to new construction, since bringing in water and drainage is no more complicated than installing the necessary plumbing. As for maintenance, "our focus has been

on building walls where there is minimal plant loss and therefore a lower cost of operation over time," says Richard Kincaid, founder of Chicago-based Sagegreenlife, which specializes in green-wall construction.

In the U.S., biophilic projects are popping up across the country. Among the notable ones is a project by CookFox Architects of New York that has transformed a blocky five-story parking garage adjacent to the city's High Line elevated green space into a light-filled, 10-story office complex that is nearing completion.

With the High Line as inspiration, "the idea was to rethink the site for the biophilic workplace of the future," says Rick Cook, a CookFox founder. "Every single floor will have access to outdoor spaces and gardens."

"An outdoor garden begins on the second floor, north-face terrace and rises to connect the second-, third- and fourth-floor terraces with a wide stairway that features planting beds and integrated seating," Mr. Cook says. "Each floor above also features a terrace in varied locations," he says, and to top it all off, "there are rooftop gardens at the 11th and 12th floors."

Mr. Wells is a writer in Chicago. He can be reached at reports@wsj.com.

What Driverless Cars Will Bring to Cities

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create a so-called Transportation Mobility Cloud that could essentially serve as an air-traffic control center for a city trying to manage different transportation providers, such as public buses and privately owned robot taxis.

Traditionally, each mode of transportation has been trying to ensure it is working in the most efficient way possible, says Marcy Klevorn, president of Ford Mobility. "You can't solve the problem by having everything optimized for itself," she says. "One of the things we want to do is help the different modes of transportation talk to each other."

LESS PARKING, MORE SPACE

Autonomous cars can drop people off and then go somewhere else to park—or to shuttle other people around. That means less need for parking space, which could open up huge possibilities for space-crunched downtowns. Some cities have as much as 30% of land devoted to cars for roads and parking, according to Brooks Rainwater, director of the Center for City Solutions at the National League of Cities.

Some see the advent of autonomous cars as the spark to reimagine a city with pedestrians at the center of development—whether that involves making wider sidewalks, adding green space and parks or converting former downtown parking-garage towers into housing or retail space.

Another change could be in the design of buildings. Half of a new building's footprint is typically devoted to parking, says Ryan Snyder, a principal at consultancy Transpo Group and a faculty member at the University of California, Los Angeles, urban-planning department. If fewer spaces are needed for autonomous cars, those spaces could be turned into retail or living space—potentially leading to lower costs for residents and businesses.

CHANGING STREETSAPES

As autonomous vehicles take over the roads, they will learn to coordinate traffic flow. Autonomous vehicles could be directed to pull out of the way of emergency vehicles or public buses to create virtual lanes for those higher-priority vehicles, for instance.

But cities could also begin to use streets and sidewalks in a more flexible way, changing the dynamic of communities, Mr. Snyder says. For instance, streets could more easily be used for events like farmers markets, because automated vehicles could find routes around the

blocked-off areas without causing traffic jams.

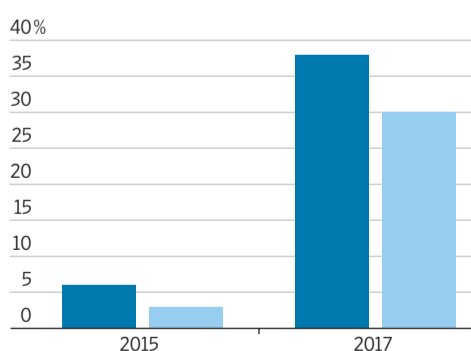
Sidewalks might also change in front of large office buildings, as robot taxis and shuttles pick up and drop off huge numbers of passengers. Planners may create wider pick-up and drop-off zones, perhaps indented to allow traffic to flow easily around them. The curbs may also have sensors that can notify an autonomous vehicle when it is safe to pull over, says Grayson Brulte, who advises governments on driverless technology.

Drivers of Change

Analyses of long-range transportation plans for the 50 largest U.S. cities just two years apart found a jump in the number of cities planning for big technology-based changes.

■ Plans mentioning autonomous vehicles

■ Plans addressing transportation network companies such as Uber or Lyft



Source: National League of Cities THE WALL STREET JOURNAL.

THE CONGESTION QUESTION

Some proponents of driverless cars believe the shared vehicles will cut down on clogged streets.

Research by Larry Burns, the former head of research and development for GM and a consultant for Waymo, suggests that a community needs only a small number of robot taxis to handle its transportation needs. In research for Columbia University's Earth Institute, he found that if a city's population density is greater than 750 people per square mile—the level of most U.S. cities—then it can ensure service with a fleet of robot vehicles amounting to just 15% of its current total of conventional cars.

But some experts aren't so sure robotic cars will ease congestion. Bruce Schaller, an expert in transportation planning, published a report last year that suggested ride-hailing services

in New York City added to congestion on the road, even as the number of taxi trips decreased, as people gravitated away from public transportation. He says that there's a real concern that autonomous vehicles will lead to lower fares and more riders, creating "more trips in already-congested cities."

In Austin, Mr. Adler says he's generally positive about autonomous technology's potential benefits but says he could envision it leading to greater congestion problems. For instance, he imagines a resident who typically takes three children to different events and runs errands in a single vehicle. In a future with driverless cars, the resident might decide to send each child to those activities in separate robot cars while using another vehicle to run the family errands.

NEW REVENUE STREAMS

Governments, which already tax gasoline and car purchases, may likely turn to taxing autonomous vehicles for using the roads, through perhaps a usage fee.

One idea that has emerged is a so-called zombie-cars tax, which was first proposed in Massachusetts last year, that would aim to tax vehicles on a per-mile fee to avoid people letting their cars drive around empty.

Mr. Snyder, the urban-planning consultant, for example, suggests cities might charge a fee to have curb access in high-traffic areas or give preference to vehicles with multiple people, such as a shuttle.

DRIVING THE RICH AND POOR APART

While some believe enhanced public transportation will provide benefits for communities that have limited public transit now, others worry the technology might favor the rich.

Lauren Kuby, a City Council member in Tempe, Ariz., which has seen a test fleet of Uber Technologies Inc.'s self-driving vehicles, says she's intrigued by the possible benefits of the vehicles. But she fears that "AVs could encourage sprawl, especially if people own their own AVs." In this scenario, Ms. Kuby says, "AVs could siphon off ridership from public transportation, eroding revenue, which then justifies cutting service, hurting those who depend on it but who cannot afford the higher cost of ride-sharing AVs."

Similarly, Richard Florida, an expert in urban planning and a professor at the University of Toronto, expects that autonomous cars will push the poor from middle suburbs out to exurbs, because the ease of using the cars will lure

wealthy people to move to suburbs that haven't seen reinvestment in more than a generation.

"Self-driving cars are likely to make those [middle suburbs] more valuable and turn them from working-class areas to more upscale areas," he says. "You'll get a metropolitan area where more and more of the less-fortunate population is pushed out to the periphery."

There are also concerns that self-driving vehicles will cost people their jobs, such as those who currently drive taxis, Ubers or public buses. But many companies believe that humans won't be displaced entirely soon, noting that there will be a need for people to maintain the fleets and monitor them.

A MATTER OF SAFETY

Perhaps the biggest unknown for driverless vehicles—and the thing that could most delay their arrival—is safety, a renewed concern after a test vehicle by Uber was involved in a fatal crash earlier this year in Tempe.

Columbus, Ohio, was picked in 2016 by the U.S. Department of Transportation as a test city for advanced transportation technology. The city planned to deploy an autonomous shuttle around an indoor-outdoor shopping complex. But it has reconsidered the route after realizing some of the current technology's limits.

The problem was that the vehicles they were looking at couldn't go fast enough to keep up with traffic, and the city was concerned about the need to make a left-hand turn against traffic, a driving move that has proved difficult for developers to implement safely, says Brandi Braun, the city's deputy innovation officer. The program is now re-evaluating where to deploy such shuttles.

Mr. Higgins is a reporter in The Wall Street Journal's San Francisco bureau. He can be reached at tim.higgins@wsj.com.

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