



PHILIPS

Smart Buildings

Living buildings



Crédit Agricole, Paris

Although they are not taking it for granted, forward-thinking developers, owners, and tenants have started treating sustainability as a given — they simply assume that maximizing sustainability is part of their brief.

In addition, they look toward a broader vision of integrating office buildings into the environment, using nature and organic design principles as inspiration.

This broader vision includes bringing nature physically into the office, via green walls, vertical gardens, indoor waterfalls and aquariums, daylighting, and work spaces that offer views of gardens and orchards. Biophilic design is catching on, especially in the US, where organizations from Google to the federal government are bringing nature into their office blueprints, strengthening the bond between humans and the natural world, even in technology-intensive spaces.

As an example, researchers have been working on building “green walls” for water cooling, eliminating the need for cooling towers. These green walls would also provide air filtration and new habitats for insects and birds.

Innovations such as these can often save enough money to offset the costs of installation and maintenance.

While energy efficiency, cost reduction, and green building certification remain important goals, future office designs also take employee health and happiness into consideration. Flexible work spaces, app-based access to building information and services, and responsive environments can increase employee productivity, reduce employee stress, improve cognitive function, and encourage collaboration and creativity.

Eric Ubels, Chief Technology Officer at OVG, the leading real estate developer in the Netherlands, puts it this way: “Since 2004, we have only built sustainable buildings, even if the client doesn’t want it. But it’s not just about sustainability. It’s about comfort, it’s about intelligence, and more important it’s about the health of people in those buildings.”¹

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Eric Ubels,
Chief Technology Officer at OVG



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Sustainability: the triple bottom line

According to the World Business Council on Sustainable Development, “Sustainable development involves **the simultaneous pursuit of economic prosperity, environmental quality and social equity**. Companies aiming for sustainability need to perform not against a single, financial bottom line but against the triple bottom line.”²



As demonstrated by innovative new office buildings, such as The Edge, in Amsterdam, LED-based connected lighting systems can provide the foundation for organizations to achieve their targets against all three of these bottom lines. Because they are distributed throughout occupied spaces, and because they can readily tie into a building's IT and management networks, **LED-based connected lighting systems offer a platform for creating a “digital canopy”** that can deliver an entire range of advanced applications.

Sensors, integrated within the light fittings and distributed throughout the illuminated space, can give businesses rich data on occupancy patterns, energy usage, and various aspects of the indoor environment, such as light levels, carbon dioxide levels, temperature, and humidity. Building managers can use this data to adjust and fine-tune

the delivery of resources to support sustainability goals. The biggest wins in this area occur when multiple services are integrated together into a single management system – for instance, when daylighting and shading systems work together with lighting and HVAC systems.

In one well-designed system, for example, shades would respond to light levels at the windows to let in the appropriate amount of daylight. An algorithm could govern the proper degree of shading, taking into account glare as well as temperature levels. Electric lights would dim and brighten appropriately to supplement the amount of available daylight, or to replace daylight after the sun sets. Similarly, cooling and heating would be coordinated with the shading system, dynamically adjusting to maintain desired temperature levels along with ideal light levels.

Coordination among these systems is partly a question of sharing real-time and historical data on conditions and occupancy. Data sharing and coordinated management — through software dashboards and mobile apps, for example — depend on a level of system integration that traditional building management and sensor networks simply cannot offer. “The importance is the combination . . . In a very advanced, healthy, intelligent building, you don't just look for a light system, or an elevator system, or a locker system. It all needs to integrate to get to the full experience of sustainability . . . And of course, at the end of the day, it's all for the people who are working in that building,” says Ubels.

Location beacons, also integrated into the lighting system, can create an indoor positioning grid that offers office workers new levels of personalization, convenience, and control. Businesses can use connected technology to let employees control the lighting and temperature in their immediate environment, through mobile apps that can detect employee location relative to specific luminaires and other building resources. Putting control in the hands of users allows businesses to minimize ambient light levels, reducing energy consumption while increasing employee comfort and satisfaction.

Indoor positioning, combined with occupancy sensing, can also enable new applications that support employee comfort and efficiency, such as wayfinding; the most exciting of these new applications illustrate one definition of “smart” in the context of smart buildings. **Based on knowledge of usage patterns, data on employee preferences, and real-time monitoring, the building can anticipate and automatically satisfy employee needs.** For instance, the building can notify

an employee of the most convenient parking space before she arrives on campus, or can reserve the best meeting room based on availability and location of invitees. The building can also recommend the most congenial place for an employee to set up for the day, based on his preference for light levels, temperature, and activity level.

Adaptive applications also have important implications for building management. Buildings that implement learning structures with the ability to adjust and adapt themselves can choose the least resource-intensive behaviors automatically, without requiring human intervention or interpretation. Organizations thus save on energy consumption while at the same time streamlining their management activities and operations. For example, the building could suggest the best available conference room for a meeting of several people who are sitting in different areas of an office floor, or on different floors. By taking into consideration the current location of each employee relative to available rooms, the building can calculate the

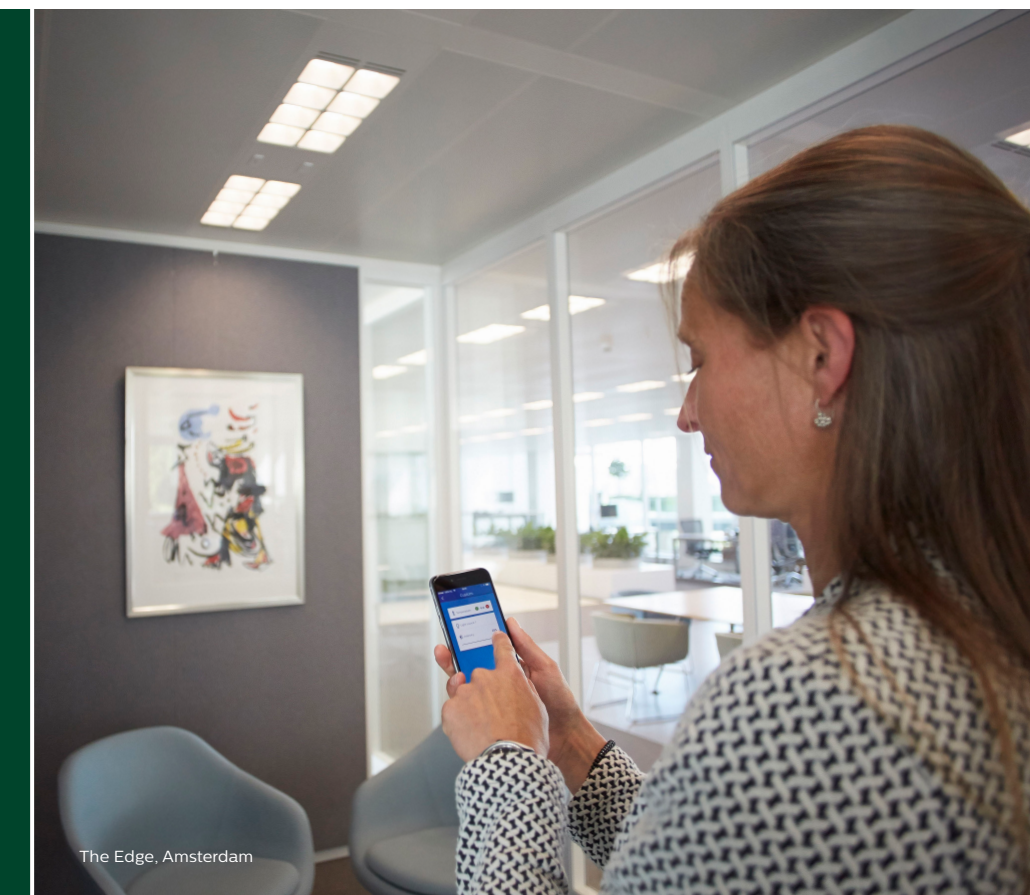
room that will require employees to consume the least amount of electricity via elevators and interior hallways, where occupancy sensors may increase light levels as individuals pass along them.

Of course, not every building that needs a lighting or resource management system is new, so not every system can be built from scratch. New technology solutions offer sustainable lighting support in existing buildings. Lighting refurbishment and LED retrofitting programs, using wireless controls and existing electrical networks, will give many older buildings a workable and affordable path toward eventual conformity with green building targets and energy-efficiency legislation.

An increasing number of organizations are also taking advantage of innovative financing options, such as licensing or renting lighting systems, instead of owning them. These options can contribute to sustainability efforts, especially when the companies licensing or renting the lighting have a vigorous recycling program in place.



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The energy-positive workplace

Buildings contribute as much as 40% of the world's CO₂, so the impact of making buildings carbon neutral is potentially world-altering. With this in view, governments around the world are responding to the challenges of environmental change with legislation that aims to reduce emissions from all buildings to as near to zero as possible.

One exciting development in the smart building space is the use of different kinds of surfaces that react to the environment and manage themselves without intervention.

Architect Doris Kim Sung, who teaches at the University of Southern California's School of Architecture, proposes using different material palettes to eliminate the need for massive mechanical HVAC systems, which consume an enormous amount of energy and release a lot of heat into the atmosphere.

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Doris Kim Sung,
University of Southern California's
School of Architecture

“The human skin is the organ that naturally regulates the temperature in the body,” explains Sung. “It has pores, it has sweat glands, it has all these things that work together very dynamically and very efficiently. And so what I propose is that our building skins should be more similar to human skin, and by doing so can be much more dynamic, responsive, and differentiated.”³ To this end, Sung has developed the concept of thermal bimetals, combinations of two different metals that work together to regulate heat, light levels, and ventilation in buildings. These bimetals require no controls and consume no energy.

In 2014, materials scientists Troy Townsend and Edward Foos published a study describing a spray-on nanocrystal coating, engineered to control the amount of heat and light that can pass through it. The nanocrystals would be applied to the outsides of windows, where they are invisible to building occupants. The coating admits natural while allowing the interior spaces to remain cool. Artificial light would be required only on especially bright days when windows need to be shaded.

Innovations in materials such as these promise to do much to help buildings achieve the coveted Net Zero Energy building certification from the International Living Future Institute.

To achieve Net Zero Energy status, **“One hundred percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis,** without the use of on-site combustion,” and the building must also meet requirements related to appropriate siting, beauty and spirit, and inspiration and education.⁴

Because the bar has been set so high, very few buildings in the world have achieved legitimate net zero status to date. Still, some thinkers are looking beyond the energy-neutral horizon to envision buildings that are energy positive — that is, that produce more energy than they consume. Eric Ubels is keen to point out that The Edge employs a combination of technologies — including solar panel façades, connected lighting that can automatically adapt to changing lighting conditions, and aquifer thermal energy storage — to achieve energy efficiency of 102% — that is, the building is more than neutral.

“A neutral building up 'til today does not exist, if you include the coffee machines, the computers, the screens, and all the technology that you put in the building,” says Ubels. “But [at The Edge,] all the energy being used for the building itself is produced by the building, even slightly more than that.”⁵



Doris Kim Sung, dO|Su Studio Architecture, Los Angeles, USA

Net zero by 2050



The Bullitt Center, Seattle. Photo credit: Nic Lehoux

The World Green Building Council (WorldGBC) recently announced Advancing Net Zero, a project to ensure that all buildings are net zero by 2050. In this ambitious initiative, **net zero means either net zero energy or net zero carbon.**

Like the definition used by the International Living Futures Institute, net zero energy here means that all of the energy needed to power the building is generated through on-site renewable resources. According to Architecture 2030, a non-profit organization whose mission is to rapidly transform the built environment in response to the climate change crisis, a net zero building is a building which achieves net zero carbon emissions annually through energy efficiency and on-site or off-site renewable energy.⁶ “The definition of zero carbon

varies across countries (and schemes), but can include an element of carbon offsetting,” adds the WorldGBC.⁷

Because the definition of “net zero” can differ in different locations, the WorldGBC plans to work with national Green Building Councils to establish certifications in the countries that they administer. Initial participating countries include Australia, Brazil, Canada, Germany, India, the Netherlands, South Africa, and Sweden, each of which will develop trainings for green building professionals.

How important is the net zero project? Very. The International Energy Agency (IEA) estimates that carbon emissions from buildings, if they continue unchecked, will contribute 6°C to global warming by the end of the century.⁸ What would happen then, according to leading scientists? “Such a rise,” the London’s *Independent* newspaper reported, in 2009, “would have cataclysmic and irreversible consequences for the Earth, making large parts of the planet uninhabitable and threatening the basis of human civilisation.”⁹

The last time global temperatures rose to such an extreme, at the end of the Permian, 251 million years ago, 95% of all species on earth were wiped out. Whether or not such doomsday projections will come to pass, it’s clear that drastic measures must be taken to mitigate the threat of global warming by reducing the dozens of gigatons

of CO₂ that buildings are emitting. Terri Wills, CEO of WorldGBC, has said, “The success of our ambitions to keep global warming to within 1.5 to 2 degrees will depend on our ability to advance net zero buildings . . . Net zero buildings will be a defining contribution in our efforts to tackle climate change.”¹⁰

Advancing Net Zero is also significant as it puts into action the commitment that WorldGBC made at COP 21, the most recent meeting of the United Nations Framework Convention on Climate Change (UNFCCC), which was held toward the end of 2015 in Paris, France. The key result of COP 21 was the Paris Agreement, a global agreement on the reduction of climate change, which sets a goal of limiting global warming to less than 2°C compared to pre-industrial levels.¹¹ In support of the Paris Agreement, WorldGBC, its 74 Green Building Councils, and their 27,000 member companies around the globe, committed to eliminating 84 gigatons of carbon emissions by 2050, through net zero buildings and carbon-zero renovations.

“Getting down to zero won’t be easy,” says Wills. “This will be a long and challenging road but together with the dedication and expertise of our Green Building Councils and partners, we can create a thriving market for highly efficient buildings and make net zero the new normal.”



Net zero

All new buildings and major renovations should be net zero starting in 2030. 100% of buildings should be net zero by 2050

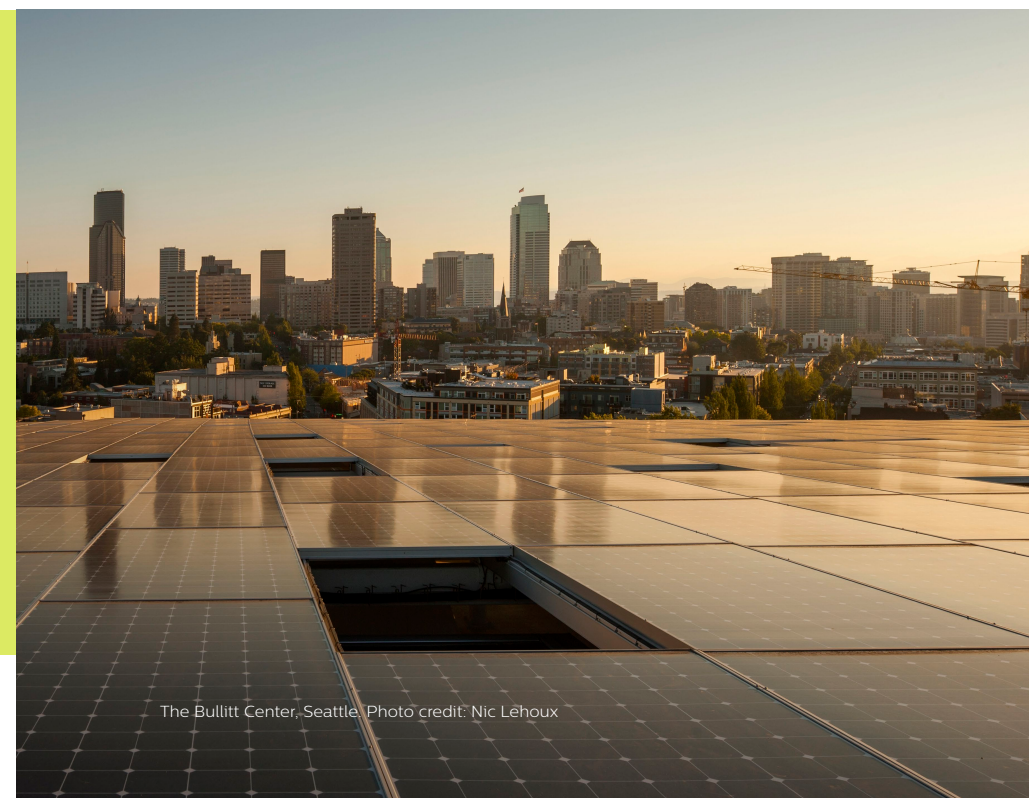


75,000 professionals

trained on net zero building by 2030, and 300,000 by 2050

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Net zero buildings will be a **defining contribution in our efforts to tackle climate change.**”

Terri Wills,
World Green Building Council



The Bullitt Center, Seattle. Photo credit: Nic Lehoux



Certification

All Green Building Councils which operate certification schemes, having a net zero tool in place by 2030

Ready, set, **retrofit**

To hit the 2050 target, the Advancing Net Zero initiative sets a goal of **making all renovations of the existing building stock net zero by 2030**, along with all new building. Although the effort must be global to succeed, the WorldGBC is “starting in Europe where 35 per cent of buildings are over 50 years old, and are badly in need of energy efficiency improvements,” as CEO Terri Wills has said.¹²

Reaching the 2030 goal requires a rapid acceleration in renovations of the existing built environment, starting now — and the WorldGBC is wasting no time. In March 2016, thirteen European Green Building Councils kicked off BUILD UPON, the world’s largest collaborative project on building renovation.

BUILD UPON seeks to design long-term national renovation strategies in each of the thirteen participating countries. By working with hundreds of different organizations involved in building renovations, BUILD UPON aims to establish specific actions that “will spark the retrofit revolution we need to reach 2 degrees.”¹³

In practice, the pace of building renovation must double to at least 3% per year to reach the 2030 target. Focusing on building ownership and tenancy changes may prove to be an effective strategy, as the number of buildings that change owners or tenants is almost exactly the number needed to double renovation rates. To ensure that these renovations are net zero, governments and businesses must offer a combination of incentives, such as financing and other economic stimuli, and regulations and policies that enforce net zero measures. A successful strategy would likely include measures tailored specifically for public sector buildings, commercial buildings, and residential buildings.

Private and public sector commitments are also key to accelerating building renovation rates. Philips Lighting is doing its part; in December 2015, the company announced its intention to become carbon-neutral by 2020. Philips Lighting CEO Eric Rondolat also urged other leaders and businesses to set more aggressive targets to prevent climate change. “As it stands, we’ve reached the climate change checkout and all the contributions from around the world have proved insufficient to prevent a potentially catastrophic rise in global temperatures,” Rondolat stated. “The world must set more ambitious goals to improve energy efficiency.”¹⁴

Rondolat went on to say that “Faster adoption of LED lighting, and a drive to renovate existing city infrastructure and greater use of solar-powered LED lighting would have a huge impact.”¹⁵ LED lighting, especially when combined with digital controls and smart lighting management, is an important example of an energy-efficiency technology available today that can help achieve the crucial 2°C threshold. LED retrofits already underway offer compelling evidence. For example, a 2013 LED street lighting replacement project has helped the City of Los Angeles, California, USA, realize a 63% reduction in energy usage, and at least US\$9.5 million annual savings in operational and maintenance costs.¹⁶

Philips Lighting also believes that new business models, such as lighting-as-a-service, where the supplier retains ownership of the lighting system and the customer pays for the light used, can help remove investment and budget barriers that often stall renovation efforts. Philips Lighting is already achieving promising results by moving from an “invoicing hardware” approach to a “leasing services” approach. A major LED lighting renovation at Schiphol Airport in Amsterdam, the Netherlands, uses the lighting-as-a-service approach, allowing the airport to realize 50% energy savings over the legacy lighting system while virtually eliminating upfront costs.¹⁷



Green is good

If fictional cutthroat Wall Street financier Gordon Gekko were a developer today, his signature line might be “Green, for lack of a better word, is good.” **Being green is business common sense**, and ethical, social, and environmental concerns are increasingly part of corporate strategies.

This is not entirely altruism — building green can polish up an organization's brand, generate positive PR, and attract top talent, while also reducing operating costs and increasing asset value.

World Green Building Trends, a 2013 report from McGraw Hill, produced in association with the World Green Building Council, identifies a “sea change” in corporate motivation for green buildings since 2008. “At that time, ‘doing the right thing’ was the primary trigger for green building. The focus on market transformation in 2008 also indicates that those building green were primarily motivated by an idealistic desire to have a positive impact. However, green building is increasingly seen as a business opportunity . . . The market is being driven by the bottom line.”¹⁸

Reports from around the industry illustrate how green thinking translates into business value. The Bank of America Tower at One Bryant Park in Manhattan was designed so that 90% of its employees had views of parks, green roofs, or rivers. According to a report by sustainability consulting and strategic planning firm Terrapin, the bank was designed “specifically to create an iconic building with the explicit purpose of attracting and retaining the best employees.”¹⁹

According to a 2012 report from Net Impact, an international nonprofit dedicated to using the power of business to create a more socially and environmentally sustainable world, **58% of US millennials would be willing to accept less pay in order to work**

for an organization that shares their values, and 45% would give up 15% of their pay to have a job that seeks to make a social or environmental difference in the world.²⁰

Statistics such as these show that being green is no longer a trade-off between profit and conscience. With continual technology breakthroughs and growing understanding of sustainability requirements, green thinking and good business practices are combining to create a win-win-win situation: good for employees, good for business, and good for the environment.



Delta, Amsterdam

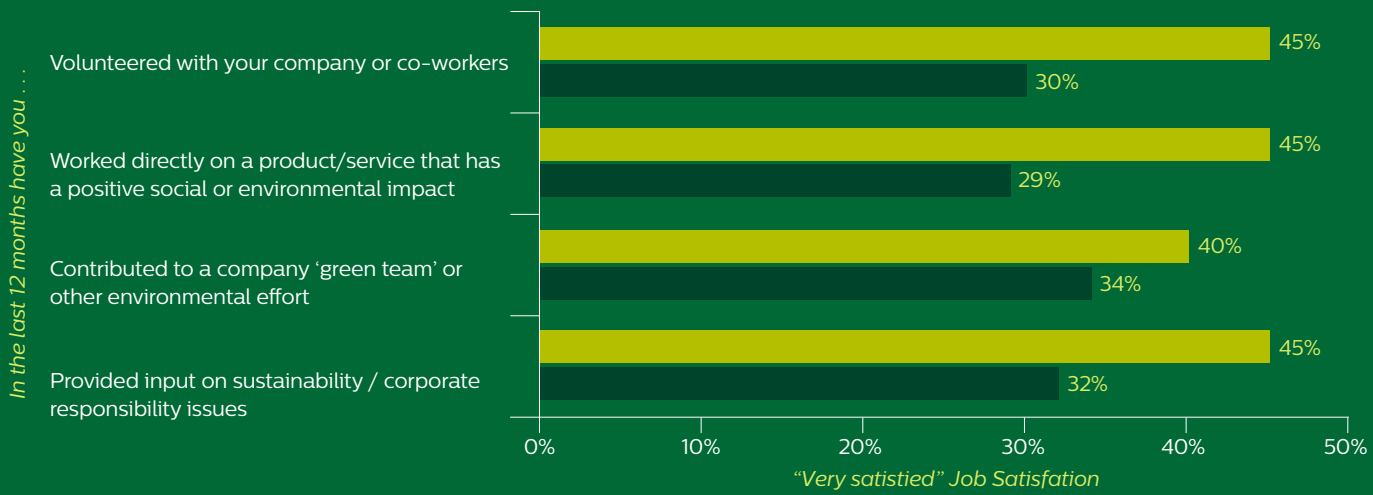


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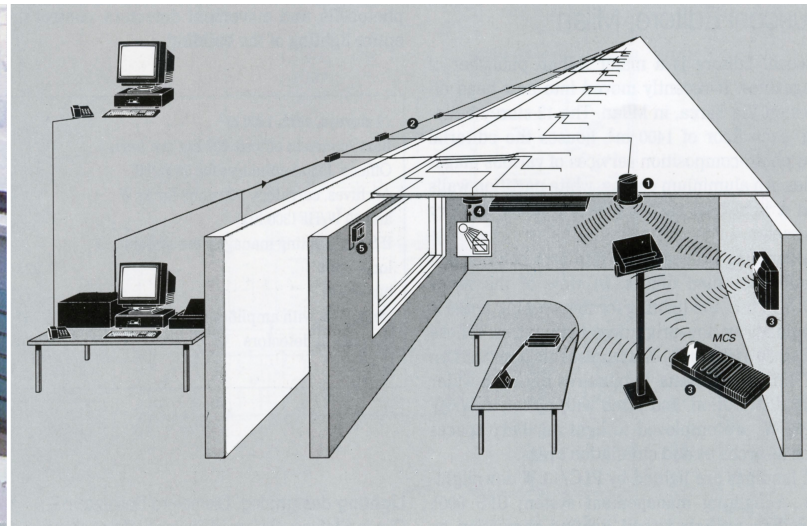
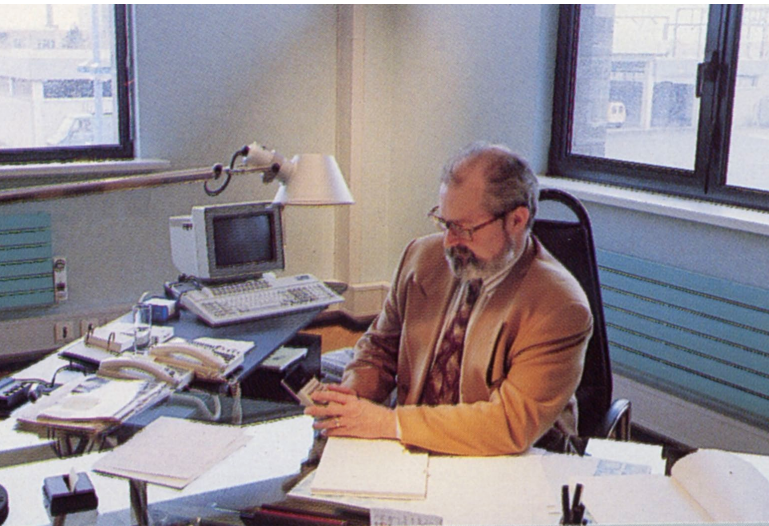
The relationship between social/environmental work effort and job satisfaction*



*Net Impact Report: What Workers Want in 2012. Prepared by: John J. Heldrich Center for Workforce Development Rutgers, The State University of New Jersey

Back to **the future**

While the technology for creating adaptive and responsive spaces has just begun to mature in the last two years, the idea is nothing new. **Innovative thinkers have been envisioning just such a transformation of working and living spaces, as far back as the late 1990s.**



In 1998, Philips engaged a group of researchers at Palo Alto Ventures to develop concepts and a presentation around computing trends and responsive environments that can anticipate and seamlessly fulfill users' needs. The team included Eli Zekha, Simon Birrell, Clark Dodsworth, and Brian Epstein, now a professor of philosophy at Tufts University in Medford, Massachusetts, USA.²¹ On June 22, 1998, Roel Pieper, executive vice president for strategy and planning at Philips, delivered a keynote address, based on the group's research, at the inaugural Digital Living Room Conference in Laguna Niguel, California, USA. Although the address focused primarily on homes, it predicted significant future office trends with startling accuracy.

The address described what the researchers called "ambient intelligence" — an "implicit, anticipatory model" of human interaction with electronic devices in inhabited spaces. This model agrees in several important ways with the types of smart office spaces being constructed at The Edge and elsewhere.

In the researchers' view, invisible, dedicated devices would be embedded throughout the environment. These devices would be personalized: they would know who you are, what you like,

and how you tend to behave. They would adapt and change in response to you and the environment; they would, in fact, be able to anticipate and automatically fulfill your needs as far as possible, without conscious mediation on your part. The researchers called this behavior "pre-sponsive," not just "responsive."²²

These remarks are especially astonishing when you remember that, in 1998, all the critical components of smart spaces — the Internet of Things, connected LED-based lighting systems, sensor networks, the data storage and throughput required for mining and analyzing sensor data, ubiquitous high-speed data communications — were all at least fifteen years in the future.

"Only when there's a seamless integration of technology with life, only when technology is more than a curiosity but an everyday and unsurprising way of satisfying our everyday needs and desires — only then will we have seen the beginnings of the true technological revolution," wrote the researchers in 1998.²³ With the future office, that revolution is now here.

Keeping all this in mind, the next question is an obvious one: What further transformations can we expect over the next twenty years?

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