

# Well Living Lab:

Technology yields evidence-based insights on indoor environments

**In a unique research center, scientists use technology to transform indoor spaces and volunteers help them determine which are healthiest**

*by Marilyn Larkin, MA*

Most *Journal on Active Aging*<sup>®</sup> readers are aware of the wellness benefits of outdoor environments, with easy access to flora, fauna, streams and fountains, meditation and walking paths and other features from nature. Multiple International Council on Active Aging surveys show such amenities to be popular in active-aging settings.<sup>1,2,3</sup>

Much less is known about the power of the indoor environment to affect health and well-being in communities and organizations—and that knowledge is critical, says Dana Pillai, president of Delos Labs, the research arm of New

York City-based wellness real estate and technology company Delos. Pillai is also executive director of the Well Living Lab<sup>™</sup> (United States).

Established by Delos and Rochester, Minnesota-based Mayo Clinic, the Well Living Lab is a testament to the power of collaboration to enable research that will transform the indoor spaces we live in. The research team at the Lab is comprised of scientists from both Mayo Clinic and Delos, creating a unique team of experts in human health and behavior, combined with environmental and engineering expertise.

The lab's mission—to transform human health in the indoor environment—leverages and expands upon the principles of the WELL Building Standard<sup>®</sup>. WELL combines best practices in design and

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*The Well Living Lab in Rochester, Minnesota, studies how indoor environments impact health and well-being*

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*At the Well Living Lab, Executive Director Dana Pillai concentrates on a research issue in the conference room. The facility's research team manipulates indoor environments with technology to investigate the impact on study participants*

construction with evidence-based medical and scientific research (see the sidebar on page 35). Administering the standard is the International WELL Building Institute™ (IWBI), led by global sustainable business leader Rick Fedrizzi.

“Lighting, temperature, sound, HVAC [heating, ventilation and air conditioning] systems, and ergonomics of furniture placement are just some of the elements of the indoor environment that can influence health, well-being and productivity,” Pillai states. “We need focused studies in these areas, and we need them now.”

“We spend more than 21 hours—about 90% of our day—indoors,” notes Brent A. Bauer, MD, medical director of the Well Living Lab and director of the Mayo Clinic’s Complementary and Integrative Medicine Program. “If we’re committed to wellness, we’re missing a big part of it if we don’t address indoor

spaces. Between home, work, fitness centers and healthcare facilities, our exposure to indoor environments is at an all-time high.”

## What are the risks?

A large body of research documents the adverse health effects of the indoor environment. Several years ago, the US National Academies’ Institute of Medicine published a special report<sup>4</sup> focusing on the topic, and how climate change might make things even worse. Among the findings:

- Poor indoor conditions cost the US economy tens of billions of dollars annually due to illnesses and allergies and lost productivity.
- Indoor air environments can be contaminated by chemical, organic and particulate pollutants that migrate from outdoors, or emanate from indoor sources such as gas stoves, building materials, radon, and second-hand smoke.

- Dampness and water may encourage the growth of fungi and bacteria, which in turn can infect people.
- Poor ventilation is associated with health problems as well as lower productivity.

The US Environmental Protection Agency<sup>5</sup> says some health effects—for example, eye, nose and throat irritations, headaches, dizziness, fatigue—may show up after multiple (or even single) exposures to an indoor air pollutant. Symptoms of diseases such as asthma may be aggravated or worsened. [Ed. A recently published international review of the literature detailed these and other impacts of indoor environmental quality on occupant well-being and comfort.<sup>6</sup>]

According to the US Centers for Disease Control and Prevention,<sup>7</sup> additional indoor environmental concerns include, among others, too much noise, which can contribute to high blood pressure; certain types of artificial light, which can interfere with sleep; and poor ergonomics, which can contribute to poor posture. The Well Living Lab is beginning to address many of these issues.

## ‘Human-centered’ studies

Traditionally, studying the indoor environment would involve bringing study participants into a clinical laboratory setting for an hour or two or overnight to test the effects, for example, of various permutations of light, sound and temperature. Instead, the Well Living Lab is recreating real-world environments, and some participants have actually moved in (at least part time).

The 7,500-sq.-ft. lab has about 5,500 sq. ft. of lab space on the third floor of a Mayo Clinic office building and has six modules. Currently, five modules are configured as two different types of open office environments and one module is configured as an apartment for future residential and overnight studies.

Eight individuals have been participating in initial studies in the office module. Bauer explains, “We took their computers from their workstations in another Mayo building and brought them to the lab, where they continue to do the same work as before, while simultaneously allowing us to gather data—through daily surveys and various sensors—exploring how they respond to our manipulation of the environment.”

Participants have been working in the lab for more than a year. The first office study ran from May to September 2016, after which the research team took a break to work on the other modules. “But,” says Bauer, “the participants elected to stay in the experimental office space because they’re quite happy in it.”

Working with a seasoned group of volunteers has advantages, according to Bauer. It does away with the novelty factor and the period of adjustment, which can take up to a month for new volunteers. Having people already acclimated to the space assures the researchers that their interventions really make a difference in how participants are experiencing the space, and individuals are not simply reacting to the fact that it’s new and different.

### **Life in the lab**

Volunteers who work in the lab accept that they’re in an environment that is constantly shifting, although they never really know when or what things are being manipulated. More than 100 sensors are continuously at work, enabling the researchers to measure and control the lights, temperature, humidity, airflow and air quality. Shades can be raised or lowered, automatically or in pre-set configurations. The impact of environmental changes on the participants is tracked by motion sensors, robust “research-grade” wearables (not available over the counter), cameras, and new technologies that enable researchers to test cognition and sleep.

Technology is used to create a series of what Bauer refers to as “scenes.” For example, one scene requires that the lights be set at a certain brightness, the temperature at a certain level and noise controlled so that it’s “white”—a mixture of sound waves that create a continuous background noise.

For other scenes, the researchers may change a single element, such as the lighting, or two elements, such as the shades and temperature. “Often, we manipulate three or four elements, which is what happens in the real world, where elements usually are experienced together, not in isolation,” Bauer says.

Scenes run for up to four weeks at a time, during which participants provide subjective ratings of their comfort and report on their sleep patterns at home, which are known to be influenced by what goes on during the day. “We also look at productivity—how much work people actually do in one scene versus another,” Bauer adds. By integrating the sensors with the building controls, the researchers can do analyses on this “deep” or “big” data, in which thousands of measurements are taken in a minute or even a second.

The pilot study completed last fall did not yield novel revelations, Bauer acknowledges. But the study did confirm previous research. “We learned that the participants didn’t like it when we set the temperature too cold; productivity suffered and their mood suffered,” he recalls. “They tended to do better with the shades open, so they could look outside. And they didn’t like background noise, especially when it was human voices.”

Bauer observes, “While we didn’t find anything earth-shattering, the fact that we could pick up those signals in a small sample reassured us about the design and capabilities of the lab, and the ability of the technology to capture those kinds of responses.”

### **Tools for healthy aging**

By the first quarter of 2018, the Well Living Lab researchers will shift much of their attention to healthy aging, which will require converting several of the modules into residential space, according to Bauer. One of the key areas of focus will be sleep—in particular, circadian lighting. Light stimulates the body’s circadian clock and helps it keep circadian rhythms synchronized over 24 hours. Disruptions in these rhythms can harm physiological functioning, neurobehavior [disorders include depression and dementia, for example] and sleep.<sup>8</sup>

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### **Resources**

#### **Delos**

<http://www.delos.com>

#### **Delos: Well Living Lab**

<http://delos.com/research/well-living-lab>

#### **Green Business Certification, Inc. (includes LEED and WELL)**

<http://www.gbci.org>

#### **International WELL Building Institute**

<https://www.wellcertified.com>

#### **Mayo Clinic’s Complementary and Integrative Medicine Program**

<http://www.mayo.edu/research/centers-programs/complementary-integrative-medicine/complementary-integrative-medicine-program/overview>

#### **Well Living Lab**

<http://welllivinglab.com>

#### **Well Living Lab Alliance**

<http://welllivinglab.com/membership-alliance>

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*The Well Living Lab's remote monitoring control center allows researchers to track input from sensor technology and observe study participants, both inside and outside the Lab environment*

“We know that blue light during the day seems to enhance activity and alertness,” Bauer says. “So, we’ll be using that knowledge to find an optimal way to use lighting to help stimulate cognitive function, and also to help participants sleep.”

The lab will also work on falls prevention, setting up sensors on the floor and looking at the impact of different surfaces on gait, stability and falls risk.

“The goal across all of these studies, whether they’re residential, office, hospitality or hospital-room space, is to find elements that are changeable, so people know what to do the next time they model a building or upgrade an existing structure,” Bauer states. “It’s important to know what makes the most sense and what will give the most bang for the buck in terms of improving health, safety and productivity.”

The researchers have already spent a few nights in the current apartment module

to ensure it really feels like a residential space and not a laboratory. While human testing hasn’t started yet, diffusion experiments are underway to help the team understand how scents are carried through the space. This will have implications for aromatherapy and other olfactory manipulations, according to Bauer.

Dana Pillai adds that the WELL can be applied to senior living communities, so developers of communities that serve older adults can have some direction for optimizing health and wellness for residents and staff. IWBI is open to partnering with organizations interested in piloting community and facility standards.

“If an organization wants to participate in research directly and has a sufficiently large pool of interested residents, we’ll bring in our technology,” Pillai says. This includes data-capturing devices for temperature, lights, air quality, sound levels and other environmental elements, as

## Mark your calendar

Dr. Brent Bauer will copresent on a panel with Lilian Myers of IBM’s Watson Health Consumer Group at the ICAA Conference 2017. Bauer and Myers will discuss wearable and artificial intelligence (AI) technologies and share insights on how these will impact quality of life for older adults. In addition to current applications for these technologies, the duo will explore future applications and how these technologies may benefit these customers as well as the organizations that provide them with wellness opportunities, healthcare and housing.

**Thursday, October 12**

**7:00 a.m.–8:15 a.m.**

“Wearable and artificial intelligence technology: Changing how we live, work and play” with Dr. Brent Bauer and Lilian Myers

To learn more about the conference or to register, visit <http://icaa.cc/conferenceandevents/overview.htm>.

well as motion sensors to help researchers understand the residents’ levels of activity, social interaction and other behaviors.

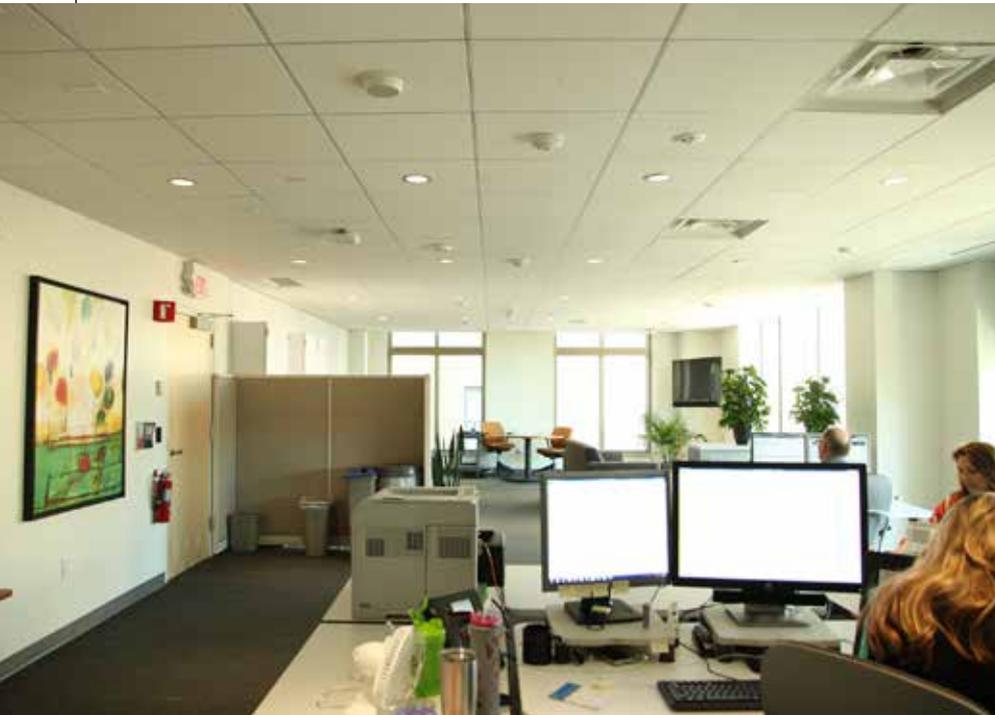
One of the aims is to quantify the benefits of specific architectural design interventions that might generate greater social contact, according to Pillai. For example, studies have shown a connection between comfortable, brightly lit shared spaces with good acoustics and social connectivity, particularly among older adults who may be losing vision and/or hearing, he explains.

“We hope our research team can pick up this connection and actually measure

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*With about 5,500 sq. ft. of lab space, the Well Living Lab has six modules that researchers can reconfigure into different 'real-world' settings. Recently, they explored two different types of open office environments*

the quantity of light exposure individuals get in the space and tie it to how often they go there, how much activity is in the space, and who else in the community frequents that space," Pillai says. "These are the kinds of findings that will help us with architectural design that promotes wellness."

## What's ahead

Once some organizational partnerships are in place, Pillai envisions doing larger scale observational studies. "Because of the lab's infrastructure, we can't have a large sample size in that setting," he explains. "With partnerships in an active-aging community or in a facility, we'll have enough participants to show associations between specific interventions and people's behaviors, which in turn can promote health and well-being as well as return-on-investment. With enough participants and study power, we might also find links to modifiable risk factors for disease."

Bauer adds, "Once we fully understand what all this great technology can do, I believe it will fade into the background as it makes our life better. We'll reach a point, not too far down the road, where when I walk into my home, it will recognize who I am—that I'm 50 years old and have asthma, for example—and automatically kick up the HVAC system to mitigate my symptoms. It will know I need brighter light to help me read, and automatically adjust the light."

"So when organizations think about using technology," Bauer continues, "it should not be one more thing that's added to the to-do list. Rather, it is to give the optimal chance for the built environment to promote health, and seamlessly, so we don't have to work on it."

Bauer acknowledges that some people fear the kind of scenario he describes—"but I'm excited about it! I see technology as a great tool, and I am definitely

## Well Living Lab Alliance

The Well Living Lab Alliance is a consortium for organizations, companies and associations interested in advancing the study of the built environment's impact on health, be it for the enhanced development of products and services, or the translation of research into actionable strategies. Members pay between USD\$75,000 and \$300,000 for an annual membership that provides various benefits, including workshops, early access to research findings, and an invitation to the annual Well Living Summit. As of July 2017, the alliance has 15 organizational members from industries such as healthcare technology, manufacturing, construction and property management.

More information on the Well Living Lab Alliance is available at <http://welllivinglab.com/membership-alliance>.

not afraid that my house will take over. We will always remain in charge and in control," he reassures. "Once we've exerted that control by setting the technology up, for the most part it will simply do what we need it to do to optimize our health and well-being." 🌀

*Marilynn Larkin, MA, is an award-winning medical writer and editor, an ACE-certified personal trainer and group fitness instructor, and originator of PosturAbility®, a program that boosts posture and self-esteem. She is also ICAA's Communications Director and a regular contributor to the Journal on Active Aging®.*

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**Images courtesy of Well Living Lab**



*This Well Living Lab office module included dynamic glazing on the windows and full-spectrum LED lighting*

## WELL Building Standard

The WELL Building Standard, released in 2014 and administered by the International WELL Building Institute, sets performance requirements in seven areas relevant to occupant health in the built environment—air, water, nourishment, light, fitness, comfort and mind.

The standard includes more than 100 best practices that address the design and operations of buildings and how they impact health and well-being. These include strategies to:

- reduce or minimize sources of indoor air pollution
- limit the presence of unhealthy foods and promote fruit and vegetable variety

- encourage integration of exercise and fitness into everyday life
- use design, technology and treatment strategies to optimize cognitive and emotional health
- encourage distraction-free and comfortable indoor environment
- welcome innovation

Organizations can apply for certification for new and existing buildings, new and existing interiors, and core and shell building projects that implement requisite features into the entire base building. These features include building structure, window locations, heating, cooling and ventilation systems, and water quality, among others.

WELL Certification is based on performance and requires a passing score in each

of the standard’s seven categories. Certification is awarded at Silver, Gold and Platinum levels.

WELL also is third-party certified by Green Business Certification Inc., which administers the Leadership in Energy and Environmental Design [LEED] certification program and the LEED professional credentialing program. LEED programs will be familiar to many International Council on Active Aging® members.

For more details about the WELL Building Standard, see <http://standard.wellcertified.com/features#>.