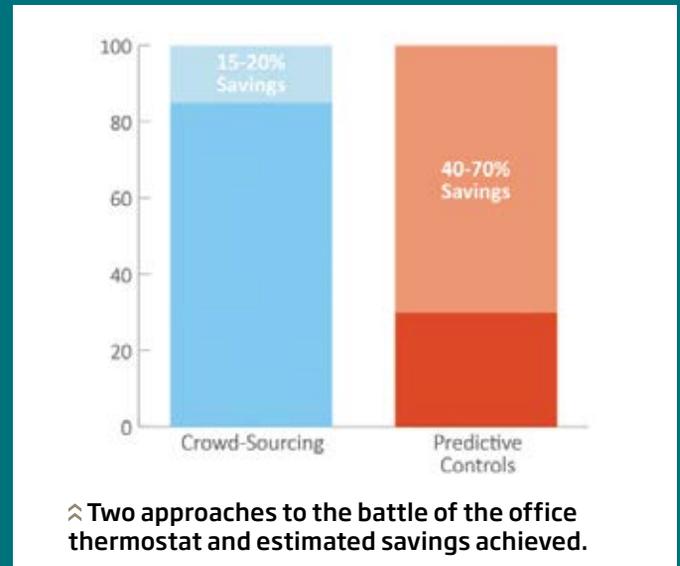


# THE FUTURE OF CLOUD COMPUTING, BIG DATA AND BUILDINGS

Learn solutions to solve building thermal problems to increase profit and employee productivity, while reducing energy usage.

BY DEEPINDER SINGH

*Images courtesy of 75F.*



Winter is right around the corner, and with this seasonal change we shift our activities and our wardrobes. As outdoor temperatures fall, the fundamental HVAC problems that ail most commercial buildings are exposed. Facility managers are busier than ever answering complaints from building occupants that are dissatisfied with their thermal environment. Thermostat wars occur at various times of year, whether it's cold or warm. A 2016 *Wall Street Journal* article titled "Let the Office Thermostat Wars Begin," detailed the familiar divisive issue that all offices face—what temperature is right to set the office thermostat to. The article cites a 2009 survey of 452 facility managers by the International Facility Management Association in Houston, TX, where more than three in five participants use personal fans, heaters, blankets or gloves to keep comfortable indoors.

While some look at these headlines and find the stories endearing, we see a far greater importance to ending the thermostat war. We see it as one of the most important factors to achieving a company's triple bottom line—economic, social and environment. Attacking the thermostat war head-on does more than just reduce occupant complaints. When employing the right solution, solving your building thermal problems increases profit (economic), increases employee productivity (social) and reduces energy usage (environmental). The HVAC industry has an important role to play and this feature depicts one way the industry and its customers can achieve it.

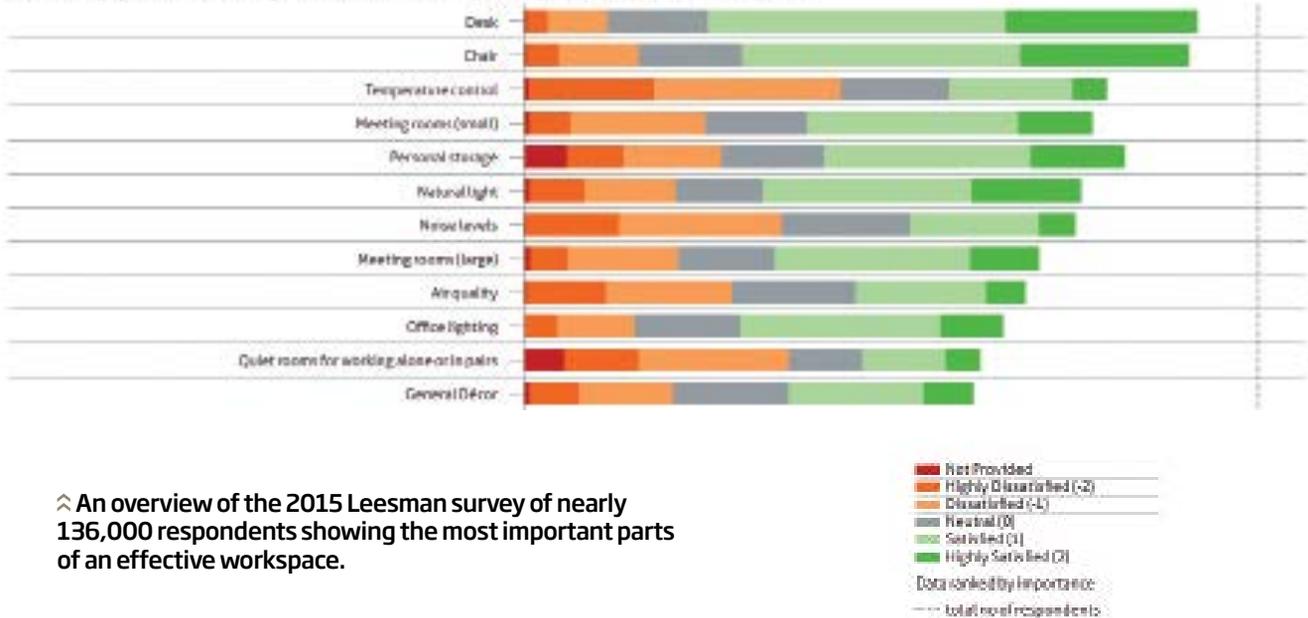
## The Case for Comfort

As a facility manager or sustainability officer, you are charged with the hard task of proving the ROI before implementing any type of solution—some of which are truly intangible. The referenced studies can help make what was once intangible into more tangible proof points. A focus on employee and guest comfort is a crucial factor and directly impacts a company's bottom line. Merriam Webster dictionary defines "comfort" as "a state of physical ease and freedom from pain or constraint." A broader view of comfort is "the variable driving employee productivity and guest satisfaction that most affects a company's bottom line."

In 2004, a Cornell University study linked warmer temperatures to fewer typing errors and higher productivity. Alan Hedge, professor of design and environmental analysis and director of Cornell's Human Factors and Ergonomics Laboratory, conducted a month long study where office workers were exposed to varying temperatures. Researchers recorded both the time spent typing and the time spent correcting errors. The study explored the link between changes in physical environment and employee productivity. This is what they found:

1. When the office temperature increased from 68°F to 77°F, typing errors fell by 44% and typing output jumped 150%.
2. Results also suggest raising the temperature to a more comfortable thermal zone saves employers about \$2 per worker, per hour.

**Q.3 Which physical features do you consider to be an important part of an effective workspace?**



^ An overview of the 2015 Leesman survey of nearly 136,000 respondents showing the most important parts of an effective workspace.

This study suggests that the right temperature can increase productivity, but how important is the thermal environment within the employee's environment? A 2015 Leesman survey of nearly 136,000 respondents revealed that the top three features identified as the most important part of an effective workspace are the desk, chair and temperature control.

Not only that, but temperature control also had the highest number of dissatisfied people, meaning that technology is not keeping up with thermal comfort as a main priority for employees.

Results from the 2015 Harvard Center for Health and the Global Environment study show how green building affects health and cognitive function. A total of 24 participants spent six full work days in an environmentally controlled office space at the TIEQ lab at the Syracuse Center of Excellence. They were exposed to conditions representative of conventional and green office buildings in the U.S., as well as green buildings with enhanced ventilation:

→ *Conventional*: ~500 parts per million (ppm) as typical volatile organic compound (VOC) levels and 20 cu ft per minute (cfm) of outdoor air flow per person.

→ *Green*: VOC levels reduced to approximately 50 ppm and 20 cfm outdoor air per person.

→ *Green with enhanced ventilation*: VOC levels reduced to approximately 50 ppm and 40 cfm outdoor air per person.

At the end of each day, participants were administered a cognitive test. The results were staggering. On average, cognitive scores were 61% higher in green building conditions and 101% higher in enhanced green building conditions.

The green building movement is undergoing a fundamental shift. It is not just enough to reduce carbon footprint. Definitive

studies like the one published by Harvard not only help build the business case, but also refocus the industry on why we build buildings in the first place: to provide an environment in which occupants can thrive. These studies also highlight the importance that a proper HVAC strategy has on employee productivity and a company's bottom line.

### Now what?

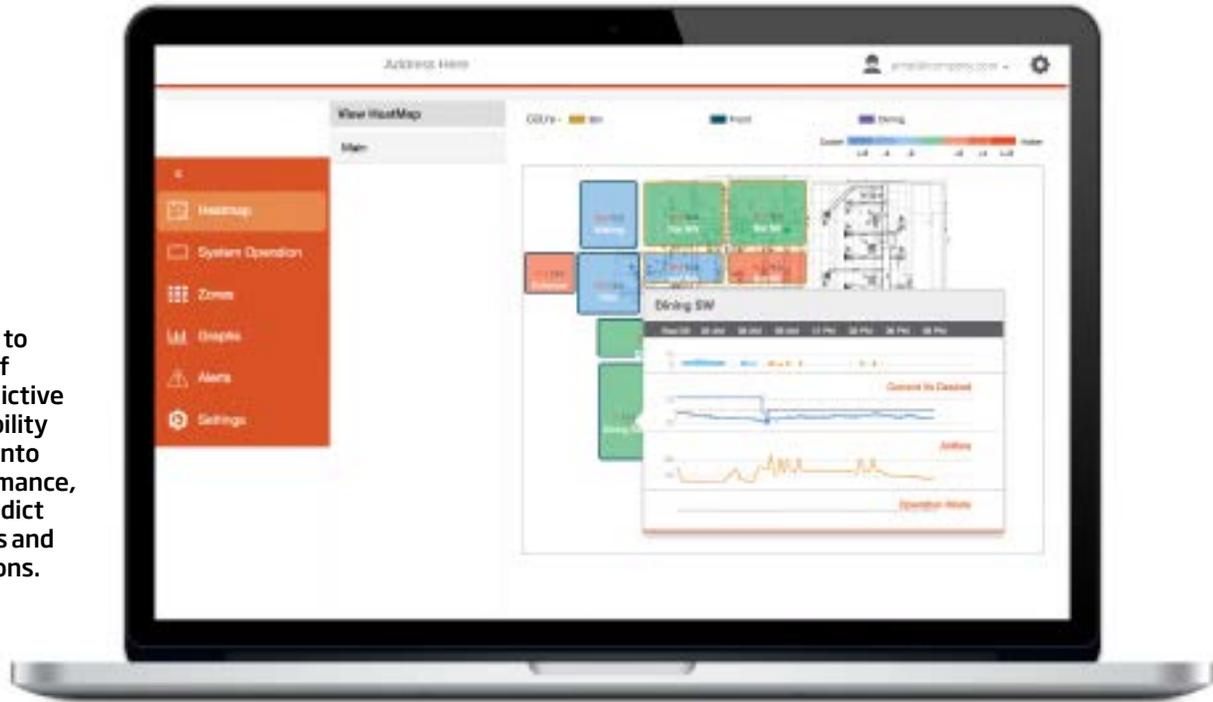
We now know air temperature and quality affect productivity and cognitive function. What does this mean for businesses? In today's world, longevity not only means having a strategic energy plan, it means having a robust and well-thought-through strategic performance plan.

Before panicking about how this will add to the "to-do" list, know that the good news is there is technology that can help. The development of the Internet of Things (IoT) and cloud computing has fundamentally shifted the way we can deliver comfort to employees. Today, buildings are more customized and sophisticated than ever.

Just take a look at the Edge. Located in Amsterdam, the Edge is the most connected building on the planet. Fully realizing the potential for IoT with an unprecedented network of more than 40,000 sensors working together, the Edge maximizes comfort and minimizes energy usage. Efficiency, lighting and thermal comfort were so important that the building features more than 28,000 light, heat and motion-detecting sensors. When employees arrive, the building assigns each individual a desk, the space is set to their desired temperature and the lights dim or brighten based on saved preferences.

While all buildings cannot be the Edge, there is a way to harness the power of IoT and cloud computing to optimize

**>> With the ability to take in hundreds of data points, a predictive solution has the ability to provide insight into equipment performance, which can help predict equipment failures and verify service actions.**



comfort for the masses. To date, there have been three types of IoT approaches to the problem:

1. Hyper-individualization;
2. Crowd-sourcing; and
3. Predictive Control.

The first approach, or what I call “Hyper-individualization,” is at its infancy stage and the technology is still quite expensive for the masses. Personal Comfort Systems “Hyper Chair” is an example of this type of approach. A Hyper Chair has luxury car-like climate controls built in where employees can heat or cool their chair to any desired temperature. They can do so from an interface on the chair, or a smartphone. Now employees have a personal thermal environment that uses much less energy than current methods (maximum power of 15 W compared to 1,500 W for a space heater). Unfortunately, the chair costs about \$1,900.

The second approach, “Crowd-sourcing,” places control in the hands of employees. An example of this is Comfy. Created by Building Robotics, Comfy is a smartphone app that allows occupants to democratically regulate room temperatures. Based on a majority voting system, occupants can say they are comfortable, too hot or too cold. Once votes are tallied, hot or cool air is pushed into the space accordingly. Crowd-sourcing a building’s thermostat settings has its advantages. It attacks occupant frustration with comfort head-on. Whether or not individuals receive the temperature they want, there is certainly a placebo effect of feeling like you are being heard. Additionally, employee calls regarding discomfort decrease. The downside is that these systems do not regulate air quality, nor do they actually solve the HVAC equipment issues that are creating discomfort in the first place.

The third approach deploys “Predictive Control” systems that work to create individual thermal zones while improving indoor air quality. Ubiquitous sensors and cloud computing technology

make collecting data easy. Collecting data on many thermal comfort points, like air temperature and humidity, allow predictive systems to deploy proactive strategies.

In fact, what was once considered a theory—continuous commissioning—is now a possibility. A typical HVAC system is set up for a static set of conditions. A building, however, is a dynamic entity. In the morning the eastern part of a building experiences solar gain as the sun rises. As the sun shifts throughout the day, the western part of the building’s temperature will rise. An intelligent solution can take temperature readings from different parts of the building and load them onto servers in the cloud. The power of cloud computing allows algorithms to crunch this historical data and create a thermal model of the building. The algorithms take the weather forecast and predict how the building will behave. The system then determines an optimal control strategy and sends it back into the building before temperature imbalances occur. We call this “Dynamic Airflow Balancing.”

Now, to tackle the issue of air quality. Traditional demand-control ventilation and enthalpy economizer solutions have one major issue. Economizers offered in the market today get enthalpy data from a module installed on the rooftop unit. Should that module fail, the economizer fails.

Leveraging IoT and cloud computing offers two advantages: first, it can use live weather feeds to obtain outdoor enthalpy data rather than rely on inaccurate readings from an RTU module; and second, sensors throughout the building monitor CO<sub>2</sub>, NO<sub>2</sub> and CO levels, along with indoor enthalpy.

With a full understanding of building enthalpy and particulate levels, the system provides superior air quality while offering free cooling when conditions are appropriate; a solution we call Outside Air Optimization. When bringing in outside air, humidity is also measured to ensure the indoor environment doesn’t become uncomfortable or cause mold to grow. Deploying strategies like this and Dynamic Airflow Bal-

# Energy Usage for

2016-05-01 to 2016-05-14



**80.0%** OAO energy savings  
5,866,989 BTU saved

**23.7%** free cooling savings  
92h 39m of free cooling  
2,034 kWh Saved

⤴ Potential OAO and free cooling savings.

ancing not only keep employees comfortable and productive, but data shows that these strategies can save anywhere between 40%–70% in HVAC energy usage.

A predictive solution that leverages cloud computing algorithms can deliver more than just comfort and energy savings. With the ability to take in hundreds of data points, a predictive solution has the ability to provide insight into equipment performance, which can help predict equipment failures and verify service actions. Predictive maintenance is not a new term in the HVAC industry; it has been around for decades. According to the U.S. Department of Energy, past studies on predictive maintenance have shown it can reduce maintenance costs up to 30%, eliminate breakdowns 70%–75% of the time, minimize downtime and increase production.

With all this technological advancement, it is shocking that there are very few companies developing new and innovative solutions that tackle both efficiency and wellness simultaneously. It is really up to business and property owners, facility managers and sustainability officers to demand more from their providers. Do not settle on the traditional way of doing business. Your employees and guests are far too important. ☺

*Deepinder Singh founded 75F in 2012 after he designed some of the world's fastest core networks for Tier 1 service providers like AT&T, NTT and Verizon. With almost 25 years' experience in electronics*

*and computing, he has brought a wealth of embedded products to the market. His key goal in every endeavor is to simplify operational complexity and make products intuitive. For more information, visit [www.75f.io](http://www.75f.io).*

The advertisement features the Sanhua logo at the top, which consists of three stylized flower-like icons and the word 'SANHUA' in blue. Below the logo, the text '4-WAY REVERSING VALVES' is written in a bold, black, sans-serif font. A central image shows a 4-way reversing valve with copper pipes and electrical wiring. To the right of the valve, the text reads: 'Sanhua supplies over 50 million Four-Way Reversing Valves annually to the commercial and residential HVAC industry worldwide.' At the bottom left, there is a QR code and a small URL. At the bottom right, the 'Chilligo' logo is displayed with the tagline 'ideas worldwide'.

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