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How Green is that Office Building in the Window?

By Mohamed H. Issa

When green buildings first entered the market, they came with the promise of lower energy and water bills, more environmentally-friendly materials and resources, and improved indoor environmental quality. Now that green buildings have been in use for a few years, the verdict is still out on whether they are fully living up to that promise.

“There is an obvious lack of data about the performance of green buildings”, says Dr. Guy Newsham, leader of the Lighting group in the Indoor Environment program at the National Research Council – Institute for Research in Construction (NRC-IRC). “There is little follow up once buildings are built on how they will be used, or whether they meet design requirements and standards”.

That is why Newsham is leading an investigation at NRC-IRC that aims to evaluate indoor environmental quality and energy use in green and comparable conventional office buildings across Canada and the Northern US. It is funded by the Panel on Energy Research and Development (a government R&D program administered by Natural Resources Canada), and receives supplemental funding from ten other partners. “These include provincial departments, utility companies, an office furniture manufacturer, and a lighting research foundation”, explains Newsham. “We have also received in-kind support from the Canada and US Green Building Councils and the Building Owners’ and Managers’ Association”.

The study lasts four years. “We started in 2008, and spent two years identifying buildings and reviewing existing literature” says Newsham. “We started measurements last spring and have completed them in 15 buildings already. We expect to be finished data collection this fall; with the analysis of the data completed by the following spring.”

The first step in the study involved conducting a more extensive analysis of the data collected by the US Green Building Council and the New Buildings Institute on the energy performance of more than 100 LEED buildings in the US. “We needed to review what was out there before undertaking our own analysis” explains Newsham.

The next step is to collect data from the study buildings in three general areas: buildings’ physical environment, occupant satisfaction and behaviour, and energy use data. A mobile cart (Figure 1) of instruments (developed for this investigation) is positioned in selected locations in each building to take snapshot measurements of indoor environment variables in personal workspaces, meetings rooms and corridors. Measured parameters include temperature, air speed, humidity, light level, noise level, concentration of various gases such as carbon-dioxide, and formaldehyde, and a count of airborne particulates. Six indoor weather stations (Figure 2) measure temperature, air speed, humidity, light level, noise level, and carbon-dioxide concentration in fixed locations every 15 minutes for several days.

An online web-based survey is administered to building occupants to assess occupant satisfaction and behaviour concurrently with the site visit. The survey includes core questions regarding environmental and job satisfaction, job demands, and demographics, and aspects related to organizational commitment, workplace image, noise and thermal comfort, health, commuting patterns and environmental attitudes.

The study also examines energy use data, collected from from monthly utility bills or other systems, and data from individual building systems



Figure 1: Measurement Cart

(e.g. daylighting harvesting system) in order to compare energy use in green versus comparable conventional ones.



Figure 2: Indoor weather station

Newsham, a physicist by training, co-manages this project with Alexandra Thompson, an environmental psychologist in the Ventilation and Indoor Air Quality group within the IE program.

“There is growing recognition of the importance of behavioural scientists in this type of study” notes Newsham. “Now that many engineering solutions have been found, we need to get people to use and adopt them”. That is where environmental psychologists fit into the equation.

“Environmental psychologists tend to use strong research designs and statistical approaches that can make for robust studies of how building conditions affect occupants”, says Thompson. “That being said, because buildings are complex systems, there is a lot of assumed knowledge about their operation that we as environmental psychologists do not know. This is why this collaboration with building scientists is essential.”

Newsham and Thompson hope that this study can lead to more significant changes down the road. “The most obvious impact is that of refining existing green building rating schemes” explains Newsham. “We also hope that this larger dataset can help us identify how to improve buildings in general and that those improvements would eventually find their ways to existing building codes and standards.”

Another pressing issue is the role of the occupant in building management. “Occupants need to be active components of building operations, and assume control for their indoor environments. They need to learn about what they are exposed to in their own homes and the effects of such exposures”, says Thompson. Thompson also believes that more organizations need to adopt post-occupancy evaluations as routine. Newsham agrees, adding that there is a need to develop a simpler set of measures and simpler evaluation protocols for these routine evaluations. “We can’t expect building operators to use our equipment or to have the skillset that we have here”, he says.

It is precisely this skillset that made the involvement of the lighting group, the ventilation and indoor air quality group, and the acoustics group in the IE program a necessity. “This kind of evaluation is multidisciplinary” says Newsham. “The collaboration was essential to design the protocols for the study, and decide on the measurements we wanted to make”, he explains. Thompson thinks that this collaboration will also only produce stronger, more valid results. “It takes more work, but it’s well worth the effort”, she says.

With respect to future research opportunities, Newsham would like to see research that focuses on other aspects of green building performance, such as actual water use, land use, materials and other resources use, as well as commissioning and maintenance. “There is also the whole issue of the market value of green buildings. Do they sell for more? Are they leased more frequently?” Newsham believes they should also find ways to measure organizational productivity and absenteeism. “Green buildings are marketed on improved productivity and health; yet there is little empirical evidence to substantiate these claims” he observes. Thompson agrees, adding that research that focuses on vulnerable populations such as children and pregnant women and how they are affected by their indoor environments is also needed.

More information about the study is available at <http://www.nrc-cnrc.gc.ca/eng/projects/irc/post-occupancy.html>.