The Best Building on Campus

Ty Newell, PhD, PE
Emeritus Professor of Mechanical Engineering
October 12, 2016

VISION:
Create aesthetically pleasing spaces for our Students, Staff and Faculty in the Mechanical Science and Engineering Department that have been designed with their health and comfort as the primary design focus. The MechSE Department has been home to pioneers in the building sciences for decades, and our Alumni and Faculty continues its leadership role in industries and academic institutions around the world. In the words of former ASHRAE President (and UI MechSE Alumnus) William Bahnfleth: "…a critical shift in thinking from a goal of indoor environments that are acceptable to the occupants to those that are truly healthy and productive."

Some Design Ideas to Consider:

1) Localized environmental (air quality and comfort) control. "Local" fresh air delivered to offices and classrooms for maximum occupant productivity and health. No centralized duct system with associated costs, health, noise and discomfort issues.
2) Online control and monitoring of all office and classroom spaces, including temperature, humidity, VOCs (Volatile Organic Compounds), carbon dioxide, and electric utility. Note that Johnson Controls offers a cold temperature minisplit heat pump with SEER 30 and -20F operation capability that is WiFi connected.
3) Low/no emission building materials and furnishings. Removal of all carpeting, draperies (aka, Scandinavian design principles) from MEB and no carpeting, draperies utilized in the new addition.
4) Economic optimization of building envelope. For MEB renovation, a 50% reduction of windowed area from the present. For the new addition, restricting the window-to-wall area ratio to a maximum of 20% which provides abundant daylighting while minimizing occupant discomfort, minimizing noise (windows act as loudspeaker membranes), and reduced cost (windows cost $50 to $100/sqft versus $10/sqft for solar PV panels as a façade material and $10/sqft for a superinsulated wall).
5) High efficiency LED lighting throughout renovated and new building areas.
6) Develop a "rolling" renovation strategy for MEB that causes minimal disruption. Faculty and staff are moved as the renovation proceeds through the building in a manner similar to that conducted during renovation of the Empire State Building. Note that the Empire State Building decreased its energy usage to a level that moved it from the bottom 10% (highest energy usage) to the top 10% of large building energy intensity.
7) Develop a list of non-allergenic and "safe" chemical cleansers, sanitizers, polishes, etc in conjunction with custodial staff and MechSE Faculty/Staff/Students. Approximately 8-10% of our Student, Staff and Faculty have respiratory sensitivities such as asthma. Providing a "safe" breathing environment will be a welcome relief to our many building occupants.

The Best Office on Campus:

The Mechanical Science and Engineering Department is ready to embark on two large building projects: renovation of the Mechanical Engineering Building and construction of the new east tower. MechSE has the opportunity to excite our Alumni, create a productive and healthy working environment for our Faculty, Staff and Students, and to demonstrate to our campus and beyond how to design economically efficient, healthy, comfortable and sustainable buildings. Our department can create a vision for future building practice on campus in which a building occupants' health and comfort are foremost in design objectives, with sustainable building construction and operation as primary economic constraints.

Located on the first floor of the Mechanical Engineering Building along Green Street is the best office on campus. The MechSE Undergraduate Advising office, constructed by our own F&S personnel, demonstrates what could and what should be standard design practice on our campus. Localized air quality and comfort controlled by a space's occupants.

In today's manufacturing world of "six sigma", why is the building industry allowed to design to a standard of 20% occupant dissatisfaction? Yes, building ventilation and comfort conditioning design standards are based on a level in which 20% of building occupants are dissatisfied. And what about the other 80%? They are not satisfied, either. They are simply *not dissatisfied*. A survey [1] conducted by researchers at the University of California at Berkeley's Center for the Built Environment of over 200 commercial and institutional building with over 30,000 occupants quantifies this dissatisfaction, and demonstrates that today's building standards often exceed 20% dissatisfaction.

The cost impact of poor air quality is staggering. A recent study [2] from the Harvard TH Chan School of Public Health calculated building occupant productivity cost of $6500 per year (the value of approximately 10-15% cognition impairment) based on ASHRAE's ventilation standards. Note that the cognition capability due to carbon dioxide levels from today's building standards is not a "soft", qualitative estimate. Carbon dioxide significantly impairs many important areas of cognition, including creativity, problem solving, information processing, and decision making. How can we expect to be the among the world's best universities if we don't create indoor environments required for the highest cognition performance? The same Harvard study determined that the cost to improve air quality to a level that minimizes cognition degradation would be only $40 per year per occupant in the harshest of North American climatic zones. A new building design paradigm is needed in which the health, productivity, and comfort of a building's occupants are paramount, coupled with economic optimization of a building's lifetime cost to guide design choices.

MEB's UG Advising demonstration office is the best office on campus because it was designed with the health and comfort of people as its first concern. Photos 1, 2 and 3 show the remodeled MechSE UG Advising Office from outside and inside. From the outside, as shown in Figure 1, the office has half the window area of other offices and classrooms in the MEB. The exterior wall has been insulated on the inside, reducing the impact of cool surface radiative discomfort of the occupants. As described by Lstiburek [3], window area to wall area ratios should be kept less than 20% for energy efficiency and comfort.

Figure 2 shows how a mini-split heat pump and fresh air vent can be incorporated into office and classroom spaces. Individual mini-split heat pumps hve exceptional efficiency (eg, Johnson Controls "Z" series mini-split heat pump is WiFi connected with a SEER of 30 and cold weather heating to -20F). Mini-split heat pumps are rapidly moving through the US market for conditioning schools, hotels, and office buildings because of high efficiency, low cost and simplicity.

Figure 3 is a display of the localized temperature and air quality controls. Both carbon dioxide and Volatile Organic Compounds must be sensed because either can be the dominate pollutant. Building occupants will be able to control their local comfort and air quality preferences, which are at the heart of the Berkeley survey's dissatisfaction.

All of our offices and classrooms can have the same high level of indoor environmental quality as in our demonstration office. We simply need to prioritize our building occupants' health and comfort above all else. The payback in human performance and satisfaction will be readily apparent.

[1] C. Huizenga, S. Abbaszadeh, L. Zagreus and E. Arens, Center for the Built Environment, University of California, 390 Wurster Hall #1839 Berkeley, CA 94720-1839 USA, "Air Quality and Thermal Comfort in Office Buildings: Results of a Large Indoor Environmental Quality Survey", Proceedings of Healthy Buildings 2006, Lisbon,Vol. III, 393-397.
[2] Piers MacNaughton [1], James Pegues [2], Usha Satish [3], Suresh Santanam [4], John Spengler [1] and Joseph Allen [1] , "Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings", Int. J. Environ. Res. Public Health 2015, 12, 14709-14722; doi:10.3390/ijerph121114709
[1] Department of Environmental Health, Harvard T.H. Chan School of Public Health
[2] United Technologies Climate, Controls & Security, Syracuse
[3] Psychiatry and Behavioral Sciences, SUNY-Upstate Medical School, Syracuse, NY
[4] Industrial Assessment Center, Biomedical and Chemical Engineering Department, Syracuse University
[3] J. Lstiburek, Building Sciences, Inc, "Why Green can be a Wash", ASHRAE Journal, March, 2008

Photo 1 UG Advising office with local fresh air vent and reduced window area. Yellow oval shows UG Advising Office with upper window replaced with insulated panel and local fresh air supply vent. Note window shades drawn in the excessively windowed offices and classrooms. Efficient, localized comfort conditioning such as the low temperature mini-split heat pump in the UG Advising Office can replace unsightly window AC units at a cost much lower and an efficiency much higher (SEER 30) than central conditioning systems, while keeping building occupants healthier and more productive than centralized ventilation systems.

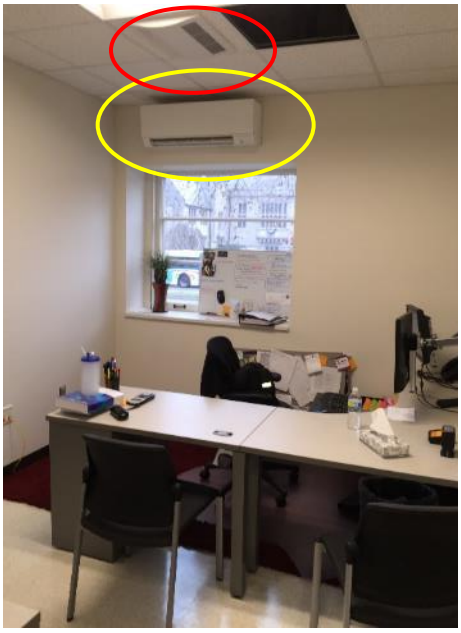

Photo 2 Interior view of MechSE UG Advising office with local comfort control (high performance, low temperature mini-split heat pump) and fresh air ventilation. The yellow circle identifies the quiet, high efficiency, cold temperature mini-split heat pump unit. These units are standard in commercial and institutional buildings outside of North America. The red circle shows the fresh air vent connected to the local energy recovery unit hidden above the office ceiling. Local fresh air allows each office and classroom to be efficiently managed, increasing occupant productivity and satisfaction, while minimizing the spread of illness to the building's occupants.

Photo 3 Local comfort control and air quality control in the MechSE UG Advising office. Both VOCs (Volatile Organic Compounds) and carbon dioxide concentration must be measured and fresh air ventilation automatically activated when either exceeds occupant selected thresholds. Local comfort is equally important with simple control of heating and cooling.