Dunlap & Partners
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Always asking … "What if …?"

Productivity – Improving productivity is not always an administered function.

Productivity is not solely a function of task enthusiasm, skill and efficiency. Productivity is also impacted by the environment in which tasks are performed. The Center for the Built Environment reports that, of the seven areas of indoor environmental performance (thermal comfort, air quality, acoustics, lighting, cleanliness of space, spatial layout and office furnishings) it has tested, thermal comfort and acoustics are the top two productivity effectors. None of the others are even close. As a mechanical and electrical design firm that puts a big bull's eye on our performance. We like to think that it's nice to be appreciated and loved. You can get more information on the Center for the Built Environment's research at cbesurvey.org.

Thermal Comfort

A seminar presentation at the ASHRAE Annual Meeting in January, 2008, presented the results of several studies on the effects of indoor temperature on office work performance and school work tasks performance. The premise tested is that the brain fatigues faster at elevated temperatures. Of course, being engineers we have to make the analogy to a CPU operating in a warm environment. The warmer the environment the harder the CPU has to work to reject the same heat as in a cooler environment. The result is assumed to be that the CPU fails earlier (or the brain fatigues faster) in a warm environment. Interesting premise if it can be demonstrated.

For school children, research data was presented that demonstrates a 3.5% loss of productivity per degree Celsius above the ASHRAE Standard 55 baseline of 23.3 degrees Celsius (74 degrees F). In adult office workers the loss in productivity is 2.1% per degree Celsius above the ASHRAE baseline. This puts a premium on our ability to predict and design effective zoning and be able to explain that zoning to our clients in advance of getting field

research feedback after occupancy. It also highlights the fact that the building manager would be well advised to reduce the conference room temperature for late afternoon meetings!

Acoustics

The impact of noise on productivity is intuitive. Intrusive noise is disruptive and interferes with concentration as well as hearing. Background noise, which masks irritable sounds, is a good thing at the right levels. If the STC rating of the construction is sufficient, the dominating factor in the creation of background noise is the HVAC system. There's that bull's eye again!

The 'right level' of background noise is or can be defined by octave band metrics (notably NC and/or RC curves). The problem with using those metrics as yardsticks is that too few individuals have a fundamental understanding of how to use them (If you want to watch some eyes glaze over start an NC/RC conversation at a cocktail party). A more user friendly measurement tool is the dBA. Made popular by OSHA in the 1970's, it is a single number that has the objective of simulating the way the human ear perceives loudness. It is easy to measure and it's comparison to everyday sounds make it easy to understand. For example, 20 dBA is the equivalent of a whisper, 35 dBA is the equivalent background for a residence (when the teens and the parents are not arguing), 45 dBA is the target background for a school classroom, 50 dBA is the average background in an office and 90 dBA is a very loud factory background.

The LEED for Schools Standard makes minimum acoustic performance a prerequisite for certification. The basis of this requirement is rooted in research that measured the noise level (dBA) at the back of classrooms at the end of the academic day when the teacher's voice is tired. The level at which the background noise impacted the ability to comprehend what the teacher was saying was reported to be 45 dBA. The LEED Standard makes additional points available for a background noise level design of 40 dBA and 35 dBA, respectively. In order to satisfy the prerequisite and get any additional points is to demonstrate, post mortem, that the spaces comply (always a very dicey situation) or document that the HVAC systems are designed according to ASHRAE guidelines. We can provide the measurement of the former, but we highly recommend the latter for your project.

Dunlap & Partners uses a software design package which employs ASHRAE algorithms to predict the background noise levels generated by the HVAC system. We can use that package to refine the equipment selection, location, duct configuration, duct routing and insulation

thickness to reach target background noise levels. ASHRAE publishes a great primer on HVAC acoustics entitled, A Practical Guide to Noise and Vibration Control for HVAC Systems. We recommend it to anybody interested in learning more about HVAC acoustics. The ASHRAE website address is www.ashrae.org.

Ventilation Rates

The same January, 2008 ASHRAE Annual Meeting Seminar cited above also presented the results of research on the effect of increased outside air ventilation on occupants. Specifically, in the office environment, by introducing outside air during unoccupied hours (i.e. not closing the outside air dampers at night to save energy) productivity increased by 3.5% and there was a measureable reduction in sick leave. In the school environment, a 30% increase in ventilation rate over the base rate prescribed by ASHRAE Standard 62 resulted in a 6.25% increase in test scores. Doubling the ventilation rate resulted in a 14.5% increase in productivity in the same school environment.

The LEED Standard offers a point for a 30% increase in ventilation over the ASHRAE Standard 62 rate. We have not yet had a client try for this credit, but based on the statistics above, it should be considered. Coupling a 130% outdoor air system capability with carbon dioxide sensing to limit the actual amount of outside air introduced to coincide with occupancy is worthy of serious consideration.

Daylighting

The Daylighting Collaborative (www.daylighting.org) states that 'research shows that people thrive in a naturally lighted environment. Shoppers linger longer and buy more; students do better on tests; and office workers are more productive and absent less often'. Easy to postulate and intuitively easy to believe, but where's the beef to back up the assumption?

The Energy Center of Wisconsin has research data that shows the positive impact of daylighting on lighting energy cost as well as HVAC energy cost. That data can be accessed from the Daylighting Collaborative website. Another compelling study can be found at www.innovativedesign.net/studentperformance.htm. That study cites data from a 1992 research project in Alberta, Canada in which elementary student attendance was compared between an environment with full spectrum lighting versus 'normal artificial lighting. The children in the full spectrum (daylit) environment attended 3.2 to 3.8 more days per year than

their counterparts in the artificially lit space. More comparative data is cited in that study from a research project in Johnston County, North Carolina. The County School System compared the test scores of children in daylit schools to those in artificially lit schools of the same general population profile. The performance in the daylit schools was better by a range of 3% to 14%. As a parent of school age children that should get your attention! It has ours and we encourage the evaluation of daylighting for use in our projects.

Humidity

ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy, does not give a recommended lower humidity level for thermal comfort during heating season. The Standard is quite specific about the upper limits of relative humidity in the summer to prevent conditions conducive to mold growth. Many people assume that a 50% relative humidity target year around is reasonable to expect. Unfortunately, the moisture content of outside air in the winter results in very low relative humidity levels when that air is heated to maintain target indoor conditions of 68 F to 72 F. Adding moisture to the airstream to increase the relative humidity brings into play a whole new set of challenges. How is the moisture to be injected and how is it to be controlled? Is the space equipped with an adequate vapor barrier in the façade that will prevent moisture migration and condensation on construction materials? If the problems can be satisfactorily addressed, is it worth the effort?

We have not seen specific research on the measureable health effects of low humidity. It makes sense that dry sinuses result in elevated levels of absenteeism and lower productivity, but we haven't found the data to support that assumption. We do know that humidification is a topic of increased awareness among lay people as well as HVAC practitioners and we believe that ASHRAE Standard 55 will address it in future versions. In the meantime, it is incumbent upon the design team to be certain that the Owners' Project Requirements, as regards relative humidity particularly, are educated and realistic.

Summary

Dunlap & Partners understand that the systems which we design impact the health and productivity of the people occupying the spaces we condition. We take very seriously our responsibility to communicate with our clients about these issues. If you would like to talk with us call John Dunlap at (804) 358-9200 or email John.