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Campus as a Living Laboratory

Building a Better Kottman

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Executive Summary

As Ohio State's School of Environment and Natural Resources moves across the Olentangy River to its new location, the university has a unique opportunity to explore sustainable and innovative building techniques for its various new structures. The new Kottman Hall, the central environmental hub of The Ohio State University, is one such opportunity: We can finally practice what we preach about both sustainability and environmental responsibility. Our plan for the new Kottman Hall seeks not only to optimize the student experience, but also to maximize sustainability through one strategic aim: enhanced classroom design. Our particular approach to classrooms is driven by biophilic design, the belief in man's instinctual bond with nature and the need to integrate the environment into daily life (Biophilia 1984).

Our biophilic proposal first outlines a commitment to both passive and active solar design. By implementing this strategy in classrooms, we can eventuate not only SENR's symbolic goal of sustainability, but also advance the university's larger goal of carbon neutrality by 2050. Passive solar design involves myriad approaches, including direct gains systems, connective loops, and thermal storage walls, while active solar design focuses on the strict implementation of photovoltaic technology. That said, plant placement is another tenet of biophilic design that could be very beneficial if applied to the new Kottman Hall. The inclusion of plant life and vegetation yields countless benefits, from increased air quality to improved student and faculty mood — even lower stress levels. Our proposal also stresses the use of natural materials, such as sustainably sourced wood and stone, as yet another biophilic strategy with scores of positive psychological benefits.

By incorporating these aspects of biophilic design into the classrooms of the new Kottman Hall, we believe that we can encourage sustainability and all the while optimize the student experience. This project presents a fantastic opportunity to create innovative, environmentally minded spaces and revolutionize Ohio State's conception of classrooms, education and sustainability.

Introduction

At its core, the environmental movement is rooted in progress, innovation, and the symbiotic union of man and nature. A field as essential and up-and-coming as environmental science thus demands state-of-the-art educational institutions that mirror its values. As contributors to the new Kottman Hall, the central environmental hub of The Ohio State University, we have built on this notion, challenging ourselves to set the bar. For shouldn't we, as OSU's School of Environment and Natural Resources, practice what we preach? That said, our particular plan seeks to both optimize the student experience and increase sustainability through enhanced classroom design. Through various principles of biophilic design — namely sustainable materials, passive solar design, and plant placement — we hope to transform Kottman's outdated, cave-like classrooms into new and sustainable spaces that most benefit students.

Introduction to Biophilic Design

The term biophilia first began to permeate our culture upon the 1984 release of Dr. Edward O. Wilson's book, simply entitled *Biophilia*. In it, Wilson argues that we as human beings have an instinctual bond to natural systems — an intrinsic "urge to affiliate with other forms of life" — and that we should integrate as much of the environment as possible into our everyday lives (Biophilia, 1984). In the thirty years since the book was published, a substantial amount of data has been compiled to back up Wilson's hypothesis. As a group, we propose the application of a biophilic mindset when building Kottman Hall, specifically the Kottman Hall classrooms. For although lectures will transpire indoors, students should still feel connected to nature and receive its countless benefits. Ultimately, there should be no extreme distinction between architecture and the environment, for by separating the two we restrict heightened learning and health opportunities for all (Molthrop, 2011). The infusion of biophilic design in the New Kottman — primarily through plant placement, passive solar design, sustainable materials and a number of tried-and-tested design principles — will undoubtedly optimize the student experience.

Energy

Embedded in our biophilic design plan is a commitment to energy efficiency and the overall reduction of greenhouse gases. As was stated in the Intergovernmental Panel on Climate Change's 4th Assessment Report, the mitigation of greenhouse gas emissions from buildings, which at large account for approximately one-third of all energy-related CO2 emissions, is not only essential, but also very probable (Ürge, 2014, p. 26). In fact, approximately 30% of all building emissions can be avoided by 2020, with new buildings in particular saving 80% of operational expenses "often at no or little cost" (26). That said, as one of the nation's premier environmental institutions, it is SENR's duty to lead the charge in energy efficient classrooms. Our team envisions that through a holistic, two-pronged approach — a dedication to both passive solar and active solar design — we can eventuate not only SENR's symbolic aim, but also that of the university at large: carbon neutrality by 2050.

Passive Solar Design

As the first prong of our solar approach, passive solar design is, by definition, the "use [of] natural energy flows [to] transfer thermal energy into, out of, and through a building" (Anderson, 1978, p. 57). A passively-powered building's heating, cooling and lighting is powered not through mechanical systems like pumps and fans, but through its own interdependent mechanisms: with passive solar, the building itself becomes the system (Baird, 2008). This ever-growing approach can be divided into five different fields: roof ponds, attached greenhouses, direct gain systems, connective loops, and thermal storage walls (Anderson, 1978, p. 60). However, given our team's strict focus on the optimization of *indoor* classrooms, we will only discuss the latter three. Direct gain systems are particularly noteworthy for their sheer simplicity: they "[admit] sunlight directly into a space to be heated" using double paned, south-facing glass. Because the sun rises in the east and sets in the west, it is critical that the longest side of the building (the side used for solar gain) is angled within 5 degrees of true south. It is important to note, though, that this southern orientation applies strictly to buildings in the Northern Hemisphere (Orientation/South Facing Windows, 2012). With direct gain, incoming light shines onto an absorptive surface — be it concrete, masonry, slate, brick, plaster or even water — and is stored as thermal energy (Anderson, 1978, p. 61). This thermal mass then functions to minimize heat during the day and radiate heat at night (Affordable Passive Solar

Handbook, 2005). That said, convective loops also use an absorptive surface, but instead utilize thermal mass through the cyclical warming and cooling of air and/or water. One example of a connective loop is the thermoinspiring air collector, a relatively simple design that functions as follows: air is first warmed between two-paned-glass and a blackened surface absorber, expands and rises to a collector, and subsequently flows into an adjoining room through a vent. The cooled air is then pulled into a collector through a vent placed at the base of the wall, and the cycle repeats.

Though the simplicity of the direct gains and connective loop systems may seem farfetched, both methods are used in about 70 million buildings nationwide (Anderson, 1978, p. 72). If implemented in tandem with thermal storage walls — dark masses placed "directly behind south-facing glazing" — these systems can further increase thermal absorptivity (65) and eliminate dependence on fossil fuels. In fact, when executed correctly, direct gain systems and connective loops (also known as "indirect gain systems") can respectively harness about 60 - 75% and 30 -45% of the energy that strikes windows (Affordable Passive Solar Handbook, 2005). As for Columbus, passive solar has already proven effective. Take, for example, the Whetstone Branch Library. After implementing passive solar designs, including a southern orientation, increased sun shading and maximized daylighting, the library witnessed a 46.8% savings in energy (Hedge, 2002). But the benefits of passive solar are not only rooted in reduced operational costs and a minimized carbon footprint: its benefits are linked to enhanced student experiences, as well. Myriad studies have found that natural light provides a learning environment where students perform better (Edwards, 2002) — where writing and reading beneath bright lights allows for the easy perception of appropriate details in objects (Butler 719). In a study of daylighting by Heschong-Mahone, office workers performed 10-15% better in both mental function and memory recall, Call Center workers processed calls 6-12% faster, and students completed math and reading tests 20-26% more quickly (Heschong Mahone Group, 1998). Proven to improve the mood, health, and concentration of students (Molthrop, 2011), natural light is a critical component of passive solar design.

Although passive systems are in theory simple, they are often complex in practice due to variations in topography and local climate. Take, for example, the solar chimney system of the Singapore Zero Energy Building. Based on "solar assisted ducts that [link]… lower floor classrooms and upper floor halls," this passive cooling system is tailored to Singapore's irradiance and would thus require alterations were it implemented here in Columbus (Tan, 2012, p. 26). So while it would be helpful in theory to base Kottman's passive solar plan on past successes — be it the direct gains systems of the Cambridge School in Weston, Massachusetts or St. George's School in Wallasey, England (Anderson, 1978, p. 61) — this overlooks the notable climactic differences between these regions. However, from this complexity emerges opportunity: student- and faculty-led research projects that explore how best to tailor passive solar design to Columbus' unique climate. To determine and design the optimum passive solar strategy, a cross-disciplinary consortium of engineers, architects, and social and natural scientists is essential.

With the aforementioned passive mechanisms in mind, a rough image of a new Kottman classroom takes shape. Large windows, floors and walls made from thermal mass material, and natural ventilation systems are among many potential design choices that will be considered. Natural light — a critical component of our passive solar plan — will reduce the need for artificial lighting, optimize the student experience, and be maximized through classroom and corridor configuration. While two-sided-corridors and internal halls restrict natural and thereby encourage artificial lighting, a one-sided corridor configuration with large openings will allow for sufficient daylight (Baird, 2008). Furthermore, the building will avoid east-west oriented windows, which tend to cause glare and absorb unwanted heat, and instead embrace north-south oriented windows that allow in winter sunlight and restrict summer heat gain (Daylighting, 2012). Thermally-resistant, glass-glazed skylights are another efficient — not to mention aesthetically pleasing — option for both natural lighting and ventilation. And of course, both user-discretionary and automated controls — including movable window insulations, reflectors, awnings, and shades (Anderson, 1978, p. 72) — will be emplaced to further heighten efficiency and control discrepancies in passive design.

Active Solar Design

While passive solar can be complicated, these complications can be mitigated through active solar design — the implementation of photovoltaic technology — as a sort of "backup." By installing active solar technology alongside passive solar design, the New Kottman can further maximize sustainability and all the while optimize the student experience.

Like passive solar design, active solar design harnesses the sun's energy to light, heat, and cool buildings, though it differs in its use of photovoltaics, small pumps and fans. Through the on-site generation of electricity, the energy once lost to long-distance, utility-to-building transmission can be eliminated. On-site photovoltaic cells would convert solar energy into electricity through their implementation as rooftop shingles, walls, and skylights (Baird, 2008). European researchers have even developed highly efficient, translucent photovoltaic cells that can be easily and seamlessly installed in windows (Grimnes, 2011). And given that universities across the globe have begun investing in solar technology, we as a leading environmental institution should not fall behind. We envision Kottman among the ranks of Lillis Hall and TheLivingLearning Center, two University of Oregon buildings that boast photovoltaic glass and solar water heating systems (The EE Eight, 2013). Another notable example is Cebula Hall of Saint Martin's University— a platinum-certified LEED structure. This building boasts not only "large roof-top solar [panels] that [let] students study tracking devices, solar orientation and the production of solar energy," but also "a photovoltaic array that produces more than 15 percent of the building's power and provides power back to the electrical grid (Saint Martin's, 2011)." This process, often called "net-metering," allows institutions to funnel unused, solar-generated electricity back into the electric grid for credit (Baird, 2008).

Plant Placement

The inclusion of plant life and vegetation within Kottman classrooms is central to our biophilically-minded design plan and, as we will discuss in greater depth, yields myriad benefits. With no natural elements in a closed off indoor space, air quality can decrease significantly. Both plastic and synthetic sources, for example, send high levels of carbon dioxide and volatile organic compounds into the air, leading to heightened concentration loss and drowsiness (Daly, Burchett & Torpy, 2010). Though it goes without being said, these behaviors are detrimental to any classroom setting and should be minimized. Studies have shown that simply adding potted plants to a room can greatly improve air quality, as plants help absorb floating chemicals like nitrogen oxide, sulfur oxide, ozone, carbon dioxide, particulates, etc. (Daly, Burchett & Torpy, 2010). From the research of Dr. Bill Wolverton, Dr. Ron Wood, and Professor Margaret Burchett, we now know that several common species of interior landscape plants can remove benzene and hexane in the range of 50% to 75% (Daly et al., 2010). That said, the simple addition of plants in Kottman allows students and faculty to breathe easier and enjoy a number of other benefits. In addition to air quality, plant inclusion has been shown to improve student satisfaction and mood, inspire interest, provide plants as educational tools, raise test scores, lower stress, and improve the overall health and wellbeing of individuals (Daly et al., 2010). When concentration is improved, the overall academic performance of students is directly influenced. In an experimental study, one classroom of students was given plants to place around the room while another classroom continued lectures without natural elements. By the end of the year, the class with plants to admire was significantly ahead of its plantless counterpart in mathematics, science, and spelling test scores (Daly et al., 2010). Plants can also be used as hands-on educational examples during discussions of environmental and agricultural integration, vegetation maintenance, the growth process, conservation, and more (Daly et al., 2010).

With these benefits in mind, the logistics of plant integration — including placement mechanisms and species selection — should be considered. Green walls, otherwise known as vertical gardens or biowalls, can serve as an effective and beneficial means by which to integrate plants. Acting as indoor air purifiers and natural cooling systems, green walls can enliven any space and have already witnessed recent spikes in popularity: nearly 80% of all green walls were constructed in or after 2009 (Benefits of Green Plants). In a study that linked student performance to plant integration, plants were generally placed in the front of classrooms so as to maximize visibility. They were also found hanging from ceiling tiles, on tabletop surfaces, on the floor and near entryways (Doxley, 2009). A number of plant species can survive indoors, and given our proposal of naturally lit classrooms, the availability of sunlight will not be an issue. From vegetables to small pine trees, the possibilities are endless (Planet Natural, 2014). We, however, suggest three particular plants that have proven to best mitigate indoor pollution: the snake plant, spider plant, and the golden pothos (Papincha, Holdcomb, Best, & Decoteau, 2009). Many students throughout the College of Food, Agriculture and Environmental Science also have a knowledge of and interest in plants and could easily take part in the decision-making process through online polling. Weighing student and administrator input alongside that of Ohio State's horticulture department is prudent.

Design Principles

Alongside the integration of plants, we propose the implementation of several strategic design principles to guide the building of Kottman classrooms. Designers and researchers at Herman Miller, for example, have outlined a number of biophilic strategies, including fractal patterns, biodiversity and a balance of "prospect and refuge," that we believe should be echoed in the new Kottman. First, fractal patterns — "irregular, self similar geometries that occur virtually everywhere in nature" (HermanMiller, 2007, p. 6) — not only reduce stress levels by 60%, but are also shown to improve human performance and over-all wellbeing. Fractal patterns can be as simple as textiles or furniture that mimic patterns formed by nature, including twigs, branches, limbs, etc. Second, biodiversity should be reflected within buildings through "interesting and changing artifacts, unique architectural details, and graphic or video displays… [which] can provide the stimulating qualities of mystery and surprise that are present in the natural environment" (6). Lastly, classrooms that balance expansive, long-range views and darker, more enclosed areas can satisfy our intrinsic, hunter-gatherer need for privacy and openness (5). Other design principles include the inclusion of paintings, photographs and other works containing natural elements (Molthrop, 2011, p. 39); windows with landscape views (38); and natural elements including wood, stone and, as we already discussed, live plants (38). These biophilic principles and design strategies are rooted in a number of research studies and psychological theories.

In work done by Stephen and Rachel Kaplan, as well as Roger Ulrich, subjects have indicated preference to natural environments or savannah-like landscapes over non-green, urban built spaces (Howell, Dopko, Passmore, & Buro, 2011). Studies of biophilic architecture continue to result in favor of integrating the natural with the manmade (Joye, 2010), and the absence of such integration leads to consistent support for ballot initiatives concerning parks and recreation (Peck, 2014). So while we may have urbanized and distanced ourselves from nature in some respects, we subconsciously strive to keep it close. There are two major theories that support this notion. Known as psychoevolutionary theory, the first harkens back to Darwin and links evolution to our emotional ties with nature. It posits that throughout human history, the environment has continuously provided our means for survival, and we are thus drawn to natural areas because of these survival instincts. Given that "feelings do not happen in isolation," the care nature has provided is now deeply embedded in us and can trigger intense emotional responses (Plutchnik, 2001). And while psychoevolutionary theory deals more with emotion and our early history, the second theory of attention restoration deals more with our present ability to focus. It maintains that in learning situations, natural settings have encouraged and intensified focused concentration. Nature instinctively relaxes and restores people in the outdoors, which holds true indoors, as well. Spaces fused with natural elements — including plants, sunlight, or other biophilic design principles — harness that powerful, inherent human-environment connection, ultimately resulting in heightened positivity, satisfaction, and concentration (Molthrop, 2011).

The final major benefit to biophilia in the classroom is overall "well-being." Well-being and mindfulness were the subject of a two part 2011 study of psychology students at a Canadian university, which used a series of questions to measure student connectedness to nature and the resultant effect. The first experiment correlated connectedness with psychological and social well-being, but not emotional well-being or mindfulness. The second part varied in that half of the results agreed with the first part, regarding the psychological and social. But they disagreed as a correlation was also found with the emotional and mindfulness. The take away is that while not all people find exactly the same value in nature, everyone gains some sort of benefit from nature (Howell et al., 2011). A mindful connection is especially important, as it is said to enhance the richness and vitality of moment-to-moment experiences. A less broad definition offered by Brown and Ryan (2003) put it as "being attentive to and aware of what is taking place in the present" (p. 822). Of course, the greatest example of biophilic design resulting in better well-being can be found in hospitals. Studies have shown how patients with windows and views of the natural world have shorter hospital stays and require fewer medications than those in closed rooms. Hospitals are stressful places not unlike educational institutions, but inviting nature into patients' rooms can provide healing (Molthrop, 2011). Applying these findings to a classroom setting, it is possible that students might not become as sick as often if plants, ventilation, and sunlight were integrated (Conniff, 2009). This research pertaining to health benefits should definitely be considered when designing rooms for Kottman Hall. After all, is it not interesting that we go out of our way to surround the sick with life, but do not do the same for the healthy?

Materials

Given biophilic design's heavy emphasis on natural materials like wood and stone, we believe it is necessary to ensure the sustainable nature and sourcing of these materials. Nearly 50% of all extracted natural resources are "building related" (Domonell, 2013), with foundations, walls, pipes and panels consuming nearly 25% of the global wood harvest, 40% of the stone, sand and gravel harvest, and 3 billion tons of overall raw materials (Tretsiakova-McNally, 2009). With this in mind, we propose a number of necessary considerations when selecting classroom materials, including "energy efficiency, elimination or reduction of generated waste, toxicity, water conservation, [and] affordability" (Adedeji, 2013). Embodied energy — the energy required to manufacture, transport, and assemble building materials — should also be minimized (Tretsiakova-McNally, 2009), and suppliers within a 500 mile radius of the site should be sought (Domonell, 2013). Recycled materials are ideal, though when "considerable distances are involved, the use of new materials may consume less energy than recycling" (Harris, 1999). That said, balancing the biophilic and sustainable nature of materials is not all that daunting, as highly-processed, man-made materials like concrete, bricks, plastics and metals are often more energy intensive than natural materials. In fact, many designers and scientists believe that "using wood products in construction [results] in lower energy demands and significant cuts of greenhouse gas emissions compared to non-renewable alternatives such as steel and concrete" (Tretsiakova-McNally, 2009). That said, we propose the responsible and efficient use of reclaimed, certified, and engineered wood products that use natural, low-toxic finishes and that are built for disassembly. In this way we incorporate a biophilic material in as sustainable a manner as possible. With an embodied energy of 110 kWh/m, timber is a much more environmentally friendly resource than copper or steel, which possess respective embodied energies of 133,000 and 103,000 kWh/m. Other sustainable, biophilically minded materials include crushed granite aggregate, cellulose insulation, and mineral wool (Harris, 1999). While keeping in mind their biophilic properties, we plan to integrate as many sustainable materials into our classrooms as possible.

Discussion

With these various biophilic design proposals in mind, there exists one remaining question: cost. Turner Construction's Rod Wille, the company's senior vice president of sustainable construction, says basic green design is not necessarily more expensive, noting that "good-quality building with basic LEED certification as a goal shouldn't cost any more money (Suttell, 2006)." LEED, or Leadership in Energy and Environmental Design, is a green building certification process that provides a point-system framework for building sustainably (LEED, 2014). That said, the basic sustainable construction of the new Kottman will likely stay within the current price range. However, our proposal of various added features, including indoor plants and photovoltaic arrays, is where extra costs will likely come into play. In order to design and build a cost-effective Kottman Hall, contractors must view the building's green components as a whole — not simply as a large number of small additions. Plans and budgets must be formulated early, as it is unwise to make split decisions (for example, the installation of wooden floors) halfway during a project. The failure to be continuous throughout the design and construction process is how large costs pile up (Suttell, 2006). For our proposal, the biophilic components must be included with the overall plan and vision of the building . And given the symbolic importance of this building for both SENR and OSU, a budget with room for leading innovations is essential; designers should be allowed some degree of "wiggle room" and flexibility within the new Kottman budget. With these ideas in mind, one example of a small but nevertheless important cost is classroom plants. Lowe's, and other home and garden stores, offer spider plants, snake plants, and golden pothos anywhere between one and six dollars per plant (Lowe's Home Improvement, 2014). If we would include roughly 1000 plants at an average of three dollars per plant, the total would be 3000 dollars for the beginning design (Lowe's Home Improvement, 2014). Seemingly small costs like these can accumulate and should thus be included with the overall holistic design plan.

While these small costs are indeed important, it is also critical that we address the building's larger, more expensive ventures: solar design and sustainable building materials. As for the former, passive solar design may initially cost more, though its features often pay for themselves. Passive solar's heating, cooling and lighting capacity allow for reduced maintenance, installation, unit and operational costs (Passive Solar Design, 2000). It is estimated that per each square foot of double-paned, south-facing glass, 40,000 to 60,000 Btu (Estimating

Passive Solar Saving, 2014) can be saved per year. When in tandem with low emissivity glass, these savings can increase by 15-30%. And while we understand that the features and thus costs of passive solar buildings vary along regional lines, we believe it is important to at least consider the savings of existing buildings. Take, for example, the passively powered Kosmer House in Upstate New York. Built by Bruce Bromwell, the founder of Adirondack Energy First and builder of over 350 passive solar buildings, this home boasts staggering energy savings: heating costs of $2.50 a day, which is about 70% less than a similarly-sized conventional home (Proven Passive Solar, 2008). While exact savings are difficult to estimate given variability in design, the forward-thinking nature of passive solar renders it a sound investment both environmentally and economically. On that note, active solar costs should likewise be considered alongside passive costs. Given our proposal of a number of active solar features — including photovoltaic rooftop arrays and translucent window cells — we cannot provide an exact price for our active solar plan; however, it should be noted that the global market for photovoltaic technology has been trending in a positive direction. In fact, the average price of photovoltaic modules has dropped by $2.60/Watt — a decline of about 80% — from 2008 to 2012 (Chen, 2013). With this trend in mind, the costs and benefits of our proposal are further illuminated: While passive and active solar may be pricier at the get-go, to invest in both is to invest in the future.

As for the second aforementioned cost, we must also consider the trade-offs of building with natural and sustainable materials: How do we effectively maximize their benefits and all the while minimize costs? Though daunting, this question can in part be answered through the assessment of a material's lifespan. By selecting sustainable materials with long-term performance in mind, we can ensure their increased durability, decreased maintenance, and lower long-term cost (Choosing Green Materials and Prodcuts, 2012). That said, there are also a number of no-cost material solutions that are both sustainable and affordable. These include (but are certainly not limited to) the following: low VOC sealants, adhesives and paints; recycled content ceiling tiles; recycled content ceramic tile; reclaimed nylon in carpet; and reprocessed or consolidated latex paint (Sustainable Materials, 2014). And given the existence of a number cost-*competitive* sustainable materials — including agricultural-based products and vinyl replacements like linoleum — the notion that sustainable materials must be expensive is anything but true. Sustainable materials require not necessarily a large budget, but rather careful planning, comparison and analysis in their selection.

Logistics aside, our biophillically-minded proposal is cost effective from a psychological standpoint, as well. Although the cost of plant placement, natural materials and solar design may be somewhat higher, their benefits — namely heightened productivity and mood — carry an undoubted economic weight. When biophilia is present in school buildings, for example, students are less likely to skip class or even dropout (Browning, Garvin, Fox & Cook, 2012). Across all grades and accounting all missed school days, these costs would otherwise amount to 1.7 billion dollars in wasted taxpayer money (Browning et al., 2012). Through biophilia, we can at least begin to eliminate this glaring waste. That said, other studies have even revealed decreased crime rates in biophilic areas. If people living around the campus area were less likely to vandalize CFAES buildings and property, the school could decrease the need for costly repairs (Browning et al., 2012). The potential economic benefits of biophilia, not to mention the countless environmental and psychological benefits mentioned above, are extremely important when constructing a budget. In considering all the costs alongside all the benefits, we advance this holistic, economically responsible approach.

With all this in mind, the hard costs of the new Kottman are difficult to pinpoint for one glaring reason: Green buildings are not nearly as popular as we would like them to be. However, the overall popularity of green buildings is growing rapidly, and in 10 years they will likely be considered common (Suttell, 2006). Greg Kats, principal of Capital E, a Washington D.C. consultancy focusing on clean energy, begs the question, "If someone today orders a new building that will take 36 months to build, isn't it smarter to build one that has added value and a healthy environment than one that barely meets code? You have a choice between a building designed to be healthy and efficient or one that is not. We don't need hundreds of sustainable buildings in the future; we need thousands (Suttell, 2006)."

Conclusion

As our team unearthed benefit after research-backed benefit of biophilia, we quickly decided that a biophilic approach to the new Kottman Hall was essential. The students and staff all deserve to work in an inviting atmosphere that encourages both inspiration and learning. Our once dark, cave-like classrooms will be turned on their axes: With the help of plant décor, solar design, and natural materials, the goal of enhanced green classrooms is made possible. Let us strive "to create not just a place for classes, but rather a building that would help to redefine the relationship between humankind and the environment— one that would expand our sense of ecological possibilities (Molthrop, 2011)."

By incorporating various aspects of biophilic design into the classrooms of the new Kottman Hall, we believe that we can encourage sustainability and all the while optimize the student experience. With this two-pronged goal in mind, we hope to create a state-of-the-art educational institution that mirrors the values of our college and university in a way that benefits both students and the environment. This is a fantastic opportunity to create a space that revolutionizes the way The Ohio State University thinks about classrooms, education, and sustainability in the future.

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