Energy conservation must be on the forefront of our minds and actions. Our building is an energy hog and will be unless we take the proper steps to fix the existing problems. The following paper addresses four ways in which we can repair our building and ourselves so that we can achieve our goal of becoming a “net-zero” building. Become “net-zero” may sound absurd or impossible but by taking the following steps we can become closer and closer to achieving our goal. The four topics of energy conservation are as follows: first, energy consumption awareness; second, providing a recycling center for the college; third, the creation of climate zoning; and fourth, the installation of a double-skin on the building.

ENERGY CONSUMPTION AWARENESS

The conservation of energy must begin with mental awareness. Understanding where, when, and how a building consumes energy is the first step one must take to before renovating, constructing a building, or addressing the issue of sustainability in an existing building. Through educating ourselves, and those around us, we can change our behaviors that are hindering sustainability and forge a new path to redirect those negative behaviors in a positive way. In order to do this, we are suggesting the following: first, teaching students how much energy is conserved each day in the Architecture building; second, applying a “building dashboard” to our college; and third, living the principle of education.

As a whole, most students do not understand how much energy they are consuming. On a recent visit to the school at 2:00 am we found that there were over 15 computers running (not including the 27 computers running in the lab), multiple sections of lights were on (even in faculty offices), and personal appliances and other items were still on, including the lights in the vending machines. When students are educated on how much energy a computer takes to run, for a fridge to operate, or how much energy is consumed by a single light being left on for eight hours, their approach to energy conservation will drastically change. By presenting energy facts and energy costs to students and faculty we feel that it will benefit our energy consumption greatly. Each individual, if motivated properly, will be more willing to do his or her part.

The following chart shows the energy consumption of the computer lab and its expenses (expenses are based on local Rocky Mountain Power charges for typical residential areas).
Educating each individual student once isn’t enough. Education and energy conservation is perpetual. To constantly remind ourselves of how much energy we are consuming, we are purposes that a “building dashboard” be installed in our building. A Building Dashboard features an easy-to-understand, web-based display that provides occupants with real-time feedback on building resource use. Students and faculty can check out the building’s current energy consumption instantly, or look at consumption patterns over time. Students and faculty would also be able to see how much money our school is spending or the pounds of carbon dioxide our building is emitting into the atmosphere. By installing a Building Dashboard we can know when and where we are using the most energy (Building Dashboard/Orb, luciddesigngroup.com). As a group we can then adjust our behaviors to be more conducive to sustainability.

Another feature that can be added onto our building, in conjunction with a building dashboard, is an “energy orb.” “This ‘orb’ tells how your building is performing right now by translating levels of consumption into a spectrum of colors. If consumption is high, the orb will glow fiery red. If it's mellow, the orb is yellow. If it's lower than usual, you'll find the orb glowing a cool green” (Building Dashboard/Orb, luciddesigngroup.com). Through installing a real time energy
orb we can become more consciously aware of how much energy we are consuming and then take corrective measure to address and fix the problem.

After we have educated ourselves and installed the proper systems to continually teach us how much energy we are consuming we must then apply the knowledge we have obtained and live it. Simply knowing that we are consuming too much energy isn’t enough. Faculty and students must make it a group effort to correct our negative behaviors and be more sustainable.

RECYCLING CENTER

One huge conservation issue is the amount of waste produced by the students and faculty of the Architecture program. Waste is abundant, and participants and facilitators of the college of architecture lack a culture of disciplined recycling and reuse. We recommend that changes take place in 3 ways to decrease waste and increase awareness in regarding recycling. First, provide a location to recycle materials. Second, instill a desire in the students to recycle whenever possible and avoid waste. Third, use the faculty to encourage sustainable behaviors.

Our first recommendation would be relatively easy to implement, and could prove to be a significant means of reducing the waste output of the Architecture building. It would require a nominal amount of centrally located space, some bins for storage, and a conscientious student body that looks for opportunities to save. Some possible locations include: the west side of “the wall” on the third floor, under the stairs on the first floor, or in a corner of the planning studio in the basement studio. The design of the recycling center could take place as a studio assignment, and could be built by the students. We feel that the recycling center would be successful as long as students only place material that can actually be used again in the space, and if they maintain the cleanliness of the space. Last year’s end of school waste filled a 1024 cubic feet dumpster 3 times, an estimated 30% of which could have easily been reused. A simple recycling center could alleviate this unjustifiable waste a significantly lower the waste stream that leaves the building.
The second important step to lowering the waste that is produced by the program is to increase student awareness about waste. Currently, most students are unaware of just how much waste is produced in the building, and don’t have any external motivation to reuse and recycle. We were only informed recently that any “contaminants” in the recycling bin cost the University money, so we had little motivation to segregate our materials. Increased awareness of our impact will help motivate and educate students and visitors to the building to save more and waste less. This awareness could come from a building dashboard program or from something as simple as a desktop widget.

Our final suggestion requires the cooperation of the faculty. They have a wonderful opportunity to propagate a culture of sustainability. They can post all of their assignments online to encourage paperless reading and learning. They can take a circumspect approach to preparing assignments to decrease waste and cost for the students. They often arbitrarily assign dimensions for diagrams and models that don’t coincide with standard material sizes, often creating large amounts of waste. We also propose that studio professors withhold the release of final grades until all students clean their workspaces and remove all of their trash and place unwanted but usable materials in the recycling center. This motivation would save materials and would alleviate the need for paying $1,600 dollars to 4 students to clean up the building at the end of the school year.

Through these three improvements we could significantly decrease our waste and improve our perspective regarding recycling. None of these steps are difficult if all the involved parties will put forth even a small effort. All who participate will feel the benefits, and the results will be visible and enjoyed by everyone.

CLIMATE ZONING

HVAC control comes in many different configurations depending on the size, complexity or the application. Commercial modulating zone control systems and direct digital controls (DDC) are two options for zoning commercial buildings.

Direct Digital Controls can add more flexibility to an HVAC system by allowing an operator to control and adjust a system from a local or remote computer, as well as having system alarming capabilities. The operator can change set points for conditions such as air and water temperature and time schedules. This flexibility and control comes with an added cost of additional sensors, wires, transmitters, workstations, labor and other components of DDC.

Modulating zone control: The basic principle of operation for a modulating zone control system is to allow a single HVAC system to be controlled by multiple thermostats strategically placed in areas called zones. The conditioned air entering each zone is controlled by a zone damper located in a main supply trunk line or multiple dampers located in branch lines. This is a cheaper system with fewer components.
Direct Digital Controls and Modulating Zone Control both have two choices to distribute air. The first is called Constant Air Volume (CAV), and the second is Variable Air Volume (VAV). In CAV systems, the temperature control of a space is achieved by changing the temperature of a constant supply of air. In VAV systems, the temperature and humidity control of a space is achieved by varying the amount of supply air delivered to each space at a constant temperature. VAV systems are more versatile and efficient.

Ideas to save energy: Moving air great distances require much more power than moving water. Instead of having a single central air-handling unit on the roof of a multi-story building where air has to travel through long vertical ducts, a unit could be placed on each floor. This allows for hot and cold water to circulate vertically which is more efficient than traveling air.

At the School of Architecture at the University of Utah we use a chiller plant that supplies hot and cold water to our building. We can upgrade our system by running hot and cold lines to an Air Handling Unit on each floor and zone. This would require an Air Handling Unit in built into each zone. It would also require closing off the tops of the walls and installing doors in between the central Major II studio and the Grad studios. It would also require a glassed in closing surrounding the Bailey Gallery and the upper hallway. Closing off these areas will allow for a more efficient system that doesn’t allow for air bleeding into other areas. It also allows for a more comfortable interior climate control. The upper south studio receives the majority of direct heat and sunlight year round and therefore is hotter than the central and south studios. A byproduct of closing off these areas is added security of student supplies and equipment.

The School of Architecture has the computing recourses to handle a Direct Digital Control system, which would aid in efficiency. We also use a chiller plant to cool and heat our building, why don’t we use this system in the most efficient way possible by using individual Air Handling Units and zoning? And a better zoning system would cut energy usage and create a more comfortable climate for each group of students and faculty.
DOUBLE-SKIN FAÇADE

*Heat extraction double-skin façades:*

Another supportive reserve available for conservation is heat extraction double-skin façades. This system relies on sun shading located in the intermediate or interstitial space between an exterior glass façade and an interior façade of a structure, in order to control solar loads. The concept is similar to exterior shading systems, which is another dependable system; in that solar radiation loads are blocked before entering the building. An exception to this would be that heat absorbed by the between-pane shading system is then released within the intermediate space, and drawn off through the exterior skin by natural or mechanical ventilative means. One obvious advantage is that cooling load demands on the mechanical plant are diminished with this strategy.

This concept is manifested with a single exterior layer of heat strengthened safety glass or laminated safety glass, with an exterior air inlet and outlet opening controlled with manual or automatic throttling flaps. The interior façade layer consists of fixed or operable, double or single-pane, casement or hopper windows. Within the intermediate space are retractable or fixed “Venetian blinds” or roller shades. This operation can be manual or automated.

During cooling conditions, the “Venetian blinds” (or roller shades) cover the full height of the façade and are tilted to block direct sun. Absorbed solar radiation is either convected within the intermediate space or re-radiated to the interior and exterior. Low-emittance coatings on the interior glass façade reduce radiative heat gains to the interior. If operable, the interior windows are closed. Convection within the intermediate cavity occurs either through thermal buoyancy or it is wind driven (In some cases, mechanical ventilation is used to extract heat). The effectiveness of ventilation driven by thermal buoyancy, or the “stack effect”, is determined by the inlet air temperature, height between the inlet and outlet openings, size of these openings, degree of flow resistance created by the louver slant angle, temperature of the louvers and interfacial mixing that may occur at the inlet or outlet openings if there is no wind.
Box windows are single-story double-skin façades that are divided by structural bay widths or on a room-by-room basis. The upper stories of the shaft can become appreciably hot, lending to increased heat gains and thermal discomfort. Corridor façades are single-story façades that have no vertical divisions except those required at the corners of the building or elsewhere for structural, acoustic, or fire protection reasons. Here, air flow is expected to take a diagonal path across the face of the façades and inlet and outlet openings are staggered to prevent air exchange between the two openings.

The position of the “Venetian blind” in the air cavity can affect the rate of the heat transfer to the interior, and the amount of thermal stress on the glazing layers. If they are placed too close to the interior façade, inadequate air flow around the blind may occur and conductive and radiative heat transfer to the interior will increase. The blinds should be placed toward the exterior pane with adequate room for air circulation on both sides. With the possibility of wind-induced ventilation or high velocity thermal-driven ventilation, the bottom edge of the blind should be secured to prevent fluttering, as well as lots of noise. Heat recovery strategies can be implemented using the same construction to reduce heating load requirements during the winter.

The system is rather complicated when considering all the factors that will ultimately result in increased thermal comfort. Its application to our current building structure is possible in certain areas. The best possible solution and application would be to incorporate the system in areas where the building’s concrete frame is cantilevered out over the existing glass façade. Other areas that wouldn’t allow for a double-skin façade would be optimal areas to utilize operable shades (i.e. the shop area, and other flush conditions).

CONCLUSION

Through implementing these design concepts to our building we can become one step closer to achieving our net-zero goal. By educating ourselves we become consciously aware of our surroundings. Through the installation of a recycling center we become more responsible for our own waste and material consumption. Climate Zoning can cut our energy consumption and cost by simply revisiting the building plan and adapting it to our needs. Adding a double-skin façade to our building can substantially increase passive heating and cooling. These are steps that we can and must take. Our goal is possible, but it must begin with conservation.
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