2.1 Sustainable Operations

Introduction

As a new world economic order unfolds, organizations and corporations are beginning to re-examine the very systems on which their operations have been built. In a time when conservation and efficiency are becoming priorities, questions have been raised not only concerning the consumptive nature of existing procedures, but also the consumptive process in which these procedures take place.

Profitability is still the impetus and determinant of the long-term success of any company, but today there is a growing desire to lower costs by utilizing new, more energy efficient means and sustainable solutions. ARUP is an international consulting firm that has concentrated much of its efforts in developing and evaluating design strategies for companies that are interested in saving money while becoming more energy efficient. Companies are becoming interested in energy consulting mainly to help maintain a socially and economically viable franchise. Today, standard procedures of building operations and management are becoming increasingly connected to sustainability and now are concerned both with profitability and relationships with people and the environment. The emerging synthesis of sustainability with commercial businesses gives companies and designers new exciting opportunities to make a difference.

Arup

Sir Ove Arup started a firm in the UK in 1945 with the concept that “A design team which produces a total, balanced, efficient design can help to produce a better environment.”

Arup has grown into a global firm of designers, engineers, planners and business consultants providing a diverse range of professional services to clients around the world. They employ a fully-integrated multi-disciplinary approach which brings together specialists to address design problems. Most recently they have been involved with developing some of the world’s most up-and-coming sustainable designs. Arup specializes in three main global business areas: buildings, infrastructure and consulting. They have over 10,000 staff working in more than 90 offices in 37 countries.

ARUP intends to make changes in a building that will affect a positive financial outcome for the owner. They implement creative changes that can make elements operate in different ways than originally designed, while still functioning as an effective business unit for that company and adding to their bottom line for doing the project.

They use a holistic approach to design that brings in all the important elements of excellent building. ARUP has a belief in total archi-
tecture, going beyond aesthetics and bringing in all the trades and elements in an integrated fashion, not an individual basis.

**Facility management**

The life cycle cost analysis of buildings shows that the cost of facility management over the life of a building is significantly greater than any up front costs such as initial design and construction of the facility. Economic analysis confirms that the design of a building for specific occupancy loads yields greater cost savings than typical economic construction practices.

Buildings have a huge impact on our natural resources, as evidenced by the fact that they account for the following portions of overall world resource consumption:

- 12% water consumption
- 30% Greenhouse gas emissions
- 65% Waste output (construction/demolition)
- 70% Electricity consumption

Green building methods can reduce these portions by the following amounts:

- 30% Energy
- 35% Carbon
- 30-50% Water Use
- 50-90% Waste cost

**Maintenance and operations**

Large companies typically split their budget for operations into two sectors: operations and maintenance. This is due to the way that money is allocated, with operations involving more of the capital panning for expenses and budgets and maintenance having some planned budgeting but also being a little more reactive to unplanned events.

The people who manage the maintenance and operation of a company have a significant impact on the performance of a building and its functions. When applying sustainability to building design/renovation, the amount of support from the owner plays a big roll in how sustainable the project can be. This becomes harder to control as organizations become larger. Small organizations typically require only dealing with the owner and facility manager. With larger organizations there are many people who will have an influence on how sustainable the building will become. The sources of input range from almost every position, from the President/CEO to the janitors. Today, changes are being seen in the process, as new tenants of a building start to demand that the building be LEED certified and construction companies are beginning to use sustainable building practices more regularly.

**Sustainability and energy**

Currently there is still no single standard code that is used to evaluate a building for energy efficiency, yet many do exist and are being used as design and construction guidelines. Some of the better known ones are the following:

- LEED – Leadership in Energy and Environmental Design
- ASHRAE 90.1- American Society of Heating and Refrigerating for Air-conditioning Engineers
- International Energy Conservation Code
- Title 24 - California code of regulations
- BREEAM – Building Research Establishment Environmental Assessment Method

**Carbon protocols**

Carbon standards and monitoring are currently at a very early stage and are being introduced to larger regulating groups including the United States government. There are several carbon protocols, all of which are voluntary. They include: non-governmental, governmental, and international regulations, voluntary emissions trading, and regulatory cap-trade. Some of the protocols that incorporate all of these areas are:

- GHG (greenhouse gas) Protocol

This protocol helps lay out an applicant’s carbon footprint. “A carbon footprint is a measure of the impact our activities have on the environment, and in particular climate change. It relates to the amount of greenhouse gases produced in our day-to-day lives through burning fossil fuels for electricity, heating and transportation etc.”

Greenhouse gas protocol is the most widely used international accounting tool to understand, quantify, and manage greenhouse gas emissions. There are many components directly controlled by a company that contribute to its carbon footprint, such as cars, power plants, factories, etc. that can be calculated. A company can also be indirectly in control of some of these components, such as electricity. While a company can reduce electrical consumption, it cannot control the kinds of fuel that the power company uses to supply that energy. A third way that companies produce carbons is through the products that they use. Office tools such as desks or chairs have an even more removed sense of carbon emissions which add to the consumer’s footprint. This protocol is an analytical way of calculating a company’s carbon emissions and assigning categories and values to them. Categories differ for different applications such as electricity, land use, and generation projects, but the protocol still lacks an assessment for buildings.

Figure 2: Facility management costs compared to capital construction costs
ISO Standard 14064
ISO 14064 provides a set of unambiguous and verifiable requirements to support proponents of Greenhouse Gas (GHG) emission reduction projects. It aims to achieve clarity and consistency between stakeholders and those reporting GHG emissions. The ISO Standard outline is attempting to take many of the disparate standards and consolidate them into a focused application in order to become the primary standard. The Carbon Protocol standards have yet to make a big impact on buildings and the building code. This is mainly due to the lack of a single or outstanding comprehensive guideline for buildings that can provide a well-designed management of regulations for reporting.

Change is coming
Building codes are changing often but a much larger and more rigorous change is approaching rapidly. Several states have already put mandates into legislation to reduce carbon levels by 10-20% by the year 2020. For example, California has enacted a law that will reduce carbon output from the state down to 1990 levels by the year 2020. This would essentially require cutting the projected amount of carbon output by 50%. This is a significant undertaking that is already having an effect on building designs and the way they are used and operated. The method of enforcing this law is still being decided by legislators.

Maintaining sustainability
There are six steps that can improve a building’s level of sustainability. They include:
Baselining
Conservation
Efficiency
Sustainability
Offset
Reporting and Quality Management

1 - Baselining
This process provides a method for establishing a baseline of gauged energy efficiency and understanding how well the building maintains this certified level of sustainability every day. Just because a building earns a LEED rating, does not mean that it will maintain it. Measures will be needed soon to verify that these buildings do in fact maintain their efficiency. Buildings need to be able to adapt and keep up with evolving technology in order to maintain an assumed level of sustainability. This approach will prove economically viable to a company as technology continues to develop. Establishing a boundary for what organizations are going to encompass in this baseline depends on what can be controlled and by how much. This must be determined by each organization based on their goals for sustainability.

This process involves using a given year of past performance as the base year. This will allow the company to see how they are performing on a very technical level. Once the building’s performance has been gauged and understood, it is then appropriate not just to try to maintain that performance, but also to set a reduction target. This will set a goal for the building’s performance and will allow for easy comprehension of how to move towards those goals.

2 - Conservation
The best way to increase sustainability and stay sustainable is to conserve (reduce or eliminate need). This can be achieved in multiple ways:

- **Purchasing**: Buying local products or discouraging unnecessary use through measures like an employee awareness program.
- **Transportation**: The larger the company, the greater the potential to reduce employee energy use by employing alternative modes of transportation. The amounts of energy used can be reduced through using alternative fuels for fleets, locating near a mass transit hub, encouraging car-pooling, shifting work hours, or creating virtual office programs.
- **Waste**: Waste is a resource that has yet to be optimized in our society. Resource reduction, conversion to fuel, and recycling can all help impact the amount of waste that is created amongst a company or even individual.

- **Energy**: With today’s modern buildings and technology it is very easy to leave a building’s temperature settings at a given level and forget about them. Studies on human comfort levels at different times of the year show that people can tolerate cooler indoor temperatures in the winter and warmer indoor temperatures in the summer because of the ways that they are dressed in preparation for the exterior temperatures. With this information we should be programming the indoor temperatures of buildings to fluctuate based on many parameters such as the exterior temperature, time of day, and individual heating or cooling needs of rooms. In return, this would reduce energy requirements.

3 - Efficiency
After conservation, the next step is to increase the efficiency of what is used. This can be accomplished in multiple ways, including purchasing, production efficiency, and energy efficiency.

When businesses purchase goods, an emphasis should be put on trying to buy sustainable goods such as energy star rated appliances. The production methods of companies can also be remodeled in ways that conserve more energy while optimizing the production of the same service or even improving it. This is done through better equipment efficiency and improving information technology operations. Energy efficiency falls mainly in the area of improving HVAC systems and their upgrades. Eventually, an outdated HVAC system’s costs for performance will be a greater expense than the combined up front costs and performance costs.
of a newer, more energy efficient system. In the same regard, co-generation technology and lighting upgrades are two additional measures that help to conserve energy in a large way.

4 - Renewable sources:

With the remaining need for some energy to run our optimized systems, businesses can look to renewable sources of energy to supply that need at the lowest possible environmental cost.

Some of these sources include:

- Wind Energy
- Biomass heating and cooling
- Solar PV
- Solar Thermal
- Geothermal
- Hydro
- Microhydro
- Wave
- Tidal

5 - Offset

If all the steps are taken and there is still a need for more energy, it will be preferable to look toward other ways of utilizing renewable resources. One would be purchasing renewable energy from other manufacturers or locating your own off-site sources for renewable resource harvesting and then having that energy transported to your location. One of the more controversial ways of offsetting a building’s carbon output is to purchase another company to reduce their own. This may seem to be a way of cheating to be considered sustainable, but in fact it helps to promote the use of sustainable resources and also decreases pollution that would have otherwise been released into the atmosphere.

6 - Reporting and quality management

Once a plan is enacted for a sustainable and energy efficient building and an accurate baseline is established, the next step is maintaining it. With this, a comparison between the baseline and the current operations will supply data on any progress or regressions. Using this report, a plan for the next steps and projects can be made while continuing to tracking further progress. This becomes a continuous loop that will ultimately keep the building functioning at its highest potential.

Many tools are available in the market today for measuring a building’s efficiency. Building control systems can provide a well balanced picture of how the building is performing on an incremental basis that allows the operator to tweak and fine tune the different systems of the building throughout the year and over time. This information helps the people monitoring the system to ascertain what is happening. Alarms or triggers are another way in which a building can control its performance. By referring to a baseline of data on how it is expected to perform, a monitoring program allows the controls to either adjust the measure or alert the system operator.

Economic balancing

Sustainable measures are always seen as expensive and with the high price tag many companies automatically decide not to venture into sustainable ways of building. The ideal situation balances out the energy savings with the capital investment. This will help the owner reach a sustainable goal that is sensible while also providing financial balance. Many options are arising in the market today for reducing consumption and dependence on others. They include commissioning, retrocommissioning, and energy conservation measures.

Commissioning

The idea of commissioning is modifying a building to achieve the level of efficient operation for which it was originally designed, before initial occupation. This is typically done to buildings that are not performing as well as expected. The complexities of building systems are hard for owners to really understand and so the need for this larger review by outside sources is consistently necessary. Commissioning is a traditional practice but is being seen now as something that should be refined to provide further investigation into a building’s actual performance.

LEED provides two types of commissioning at two different levels. Fundamental commissioning uses basic techniques for reviewing a building’s performance, whereas LEED enhanced commissioning goes beyond that, being involved in the whole design process to ensure that everyone is aware of how the building is expected to operate starting from the first day. This suggests involvement in the beginning programming stages setting up an owners requirements document to identify what the owner expects the building to do. Then, during the design stage, the commissioning professionals will continue to come back and evaluate the design of the building in terms of the owners requirements to make sure that everything is matching up and there are no problems that get past the design stage without being addressed. Once the building is constructed, the commissioning experts will return a year later to make sure that the building is performing to its expected capacity.

Retrocommissioning

This is a recently initiated way of commissioning that looks at older buildings to help them perform at least to the level that they should have when they were new, but also looks at how we can make them operate even better than when they were new with the use of more modern technology. Many state utilities are starting to develop programs to give incentives to companies to bring in professionals to retrocommission their building.
Energy conservation measures

These provide a way of determining if it is appropriate and affordable to change out an older technology for a newer one. The report often goes into a lot of detail about how much possible modifications will actually save in energy, money, and the environmental impact over time. A company that specializes in this field of work is ESCO, Energy Service Company. They submit proposals to companies for installing measures to increase energy conservation and also provide financing.

BIM - Building integrated modeling

Three dimensional modeling of buildings allows ARUP and other consultants to really understand how a building is going to go together and the construction sequence necessary to retain all of its defining characteristics. In addition, it also allows for the more technical and finite questions of the construction process to be addressed, if not answered, while the design of the building is still being worked out. From a sustainability perspective, this method helps designers to estimate the effort needed to build a project, gives a more precise idea of materials needed, and helps to produce a product that is more efficient and more sustainable. The model data will also aid in understanding what standards should be set for energy consumption and in flagging issues of concern that may hinder that attempt. The computer model can also apply massive amounts of data to a building that allow asset managers to track things that are installed in a building and its life cycle.

Conclusion

Sustainable methods and ideas will continue to influence our daily lives and our buildings for the foreseeable future. As we adjust to the economic issues at hand, we as architects and educated citizens must continue to reexamine the very standards that are used to set building performance and the way that those operations must be integrated into a daily routine and lifestyle. Consumption is at the very heart of our global environmental crisis and drastic measures need to be taken to change not only our wasteful systems of living, but also the very essence of our misguided human behaviors.

Notes

1. Sir Ove Arup, November 1968

Figures

Figure 1: http://www.flickr.com/photos/martha-ann/2986984196/in/
Figures 2-5. Contributed by Michael Sweeney from his own personal collection.

Resources


Biography

Michael Sweeney is a registered professional engineer who is passionate about bringing energy conscious and financially optimized building solutions into reality for his clients. A LEED accredited professional, Michael has over 17 years of experience in building energy consulting, building systems design, and in developing and marketing web-based building energy information systems. Michael is currently the leader of Arup’s emerging strategic energy consulting business in the Americas. Michael’s past rolls include acting as the Director of Marketing for Enerwise Global Technologies – a leader in energy information systems; and partnering a successful start-up consulting firm in Houston that grew to over 12 employees and over $1M in revenue within two years. A graduate of Kansas State University, Michael has a degree in Architectural Engineering and has since gained a wealth of technical and business experience.