Journal of Engineering and Applied Sciences 11 (4): 822-827, 2016
ISSN: 1816-949X

Sustainable Development: Learning from Nature

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Abstract: Humans are significantly contributing to global warming from the burning of fossil fuels for energy, agriculture, industrial processes and transportation. This situation affected the environment. Consequently, billions of people will be facing threats of flooding, severe storms, shortages of clean drink able water, food insecurity and increased risks of disease. These impacts have been well documented by the international panel on climate change. Learning from nature is very useful in mitigating the environmental issues toward a sustainable development. Accelerating in designing environmentally friendly products is essential to reduce the current and long-term impacts of climate change. This study discusses some issues relevant to recycling, energy consumption and energy conservation. Some recommendations were made about conceiving environmental friendly products while saving energy.

Key words: Energy conservation, sustainable development, environment, global warming, Malaysia

INTRODUCTION

Energy and matter are essential constituents of both the universe and living organisms. Matter is anything that has mass and occupies space. There are four fundamental states of matter: solid, liquid, gas and plasma. According to the law of mass conservation, matter is neither created nor destroyed. It is rather recycled over and over again (Cuningham, 1994). Thus the total mass in a system is the total mass flow out and the stored mass into the system. This law is very important for industrial ecology application and for environmental studies (Rubin, 2001). This is because all types of natural and human-designed systems can be environmentally evaluated based on conservation of mass. For instance, cities consume food, fuel, water and other materials and export materials such as manufactured goods. Cities also generate waste products and emit some toxic gases from the combustion of fossil fuels. Nutrients from sewage and from fertilizer runoff may pollute rivers and many others. Figure 1 shows mass flow into and out of a city.

While the law of conservation of matter is important, it is also essential to look into the nature of transformation of matters. One of the biggest challenges with the extensive usage of matters is the difficulty or the impossibility to be transformed back perfectly to their initial components.

For instance while it is possible to recycle a block of concrete, it might not be possible to transform it back to water, sand, gravel and cement. Further, matters also are subjected to natural decay. The human alteration by the usage of cement in producing for instance concrete has affected the overall natural process of recycling. This situation applies for many products.

This poses three major issues which need to be resolved. The first challenge is about finding the best procedure to reuse the recycled products. The second challenge is about making the recycling process economically viable and environmentally friendly. The third challenge requires investigating the impact of excessive usage of natural materials on environment and health. The third issue is the most difficult to overcome. This is because, the best available solution is to minimize wastage and usage. This means less disturbance of the earth.

From many possible alternatives in minimizing wastage, cradle to cradle which considers materials as nutrients circulating in healthy, safe metabolism appears to be the best biometric approach. This concept must be fully aligned with the ecosystem perspective. Figure 2 shows the concept of biological and technical nutrients in the cradle to cradle design framework.

Energy efficient in manufacturing product: The development of any product requires energy. There are several forms of energy that can be used. It can be used in mechanical potential energy form, chemical potential energy form, electrical potential energy form, nuclear potential energy form and other forms. The selection of the form of energy is subjected to environmental and economic factors. The source of all energy is the sun.

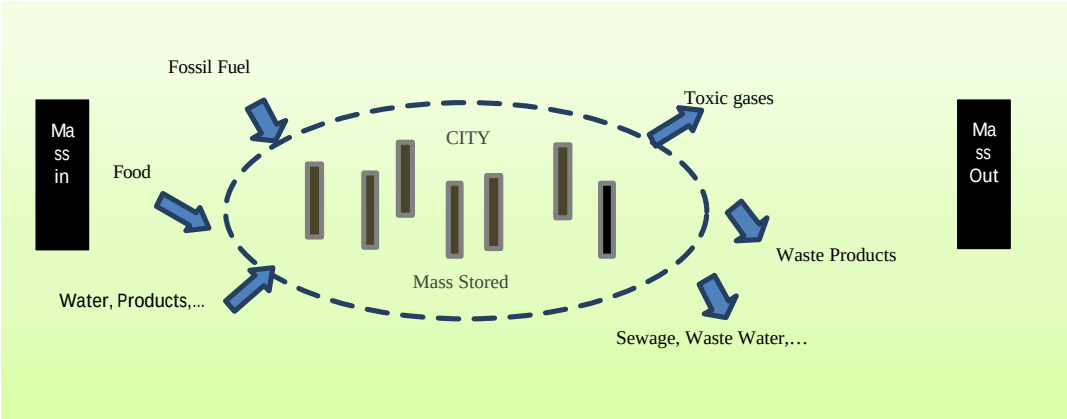

Fig. 1: Mass flow into and out of a city

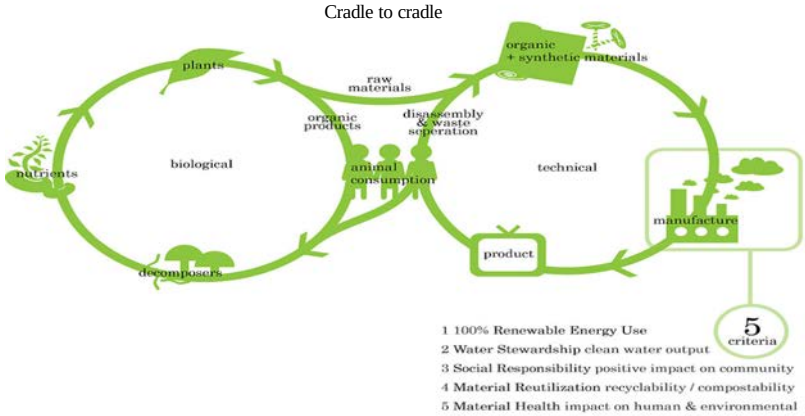

Fig. 2: Biological and technical nutrients (zhiying lim)

According to the first law of thermodynamic, energy can be transformed from one form to another. It cannot be created or destroyed. However, the second law of thermodynamic or the entropy law is about energy quality. The entropy will always increase over time. This means when energy is converted to do work, its quality irreversibly degrades. High-quality energy is transformed into lower-quality energy.This means with each successive energy transfer in a system, there will be less useful energy to do work than it was before.

Currently energy is also wasted prior usage. This is in generating electricity. Once the electricity is generated, there will be a second natural wastage of electricity due to the efficiency of the system to perform the work. This is in addition to the required energy to perform the work. Consequently, the best approach to conserve energy may be the direct use of the primary available energy with least possible transformation. For example, cooking can be accomplished via the usage of natural gas, electrical oven, solar energy, coal and many other forms of energy. So, the usage of electrical oven may not be recommended. This is because electricity is not a primary energy. Further, the selection of energy form depends on the required amount, cost and availability. This is while minimizing pollutants and protecting the earth. This information, gives a perspective in minimizing energy wastage by using different energyforms.

Learning from nature, leads us to conceive that an environmentally friendly product should have divers forms of energy. The product itself will contain the energy needed to do the work. A smart product may be designed for self-reparation with possible transformation to multiple useful small friendly products. This concept is developed based partly on gaia hypothesis and ecosystem concepts.

In the Gaia hypothesis, the entire mass of living matter on Earth is conceived as a vast homeostaticthat continuously modifies its earthly environment for its own survival. In this view, homeostasis is a process that maintains the stability of the environment in response to changes in external conditions. Gaia hypothesis is still open to debate. Figure 3 shows the Ostasis project for houses. The concept of the Ostasis project was

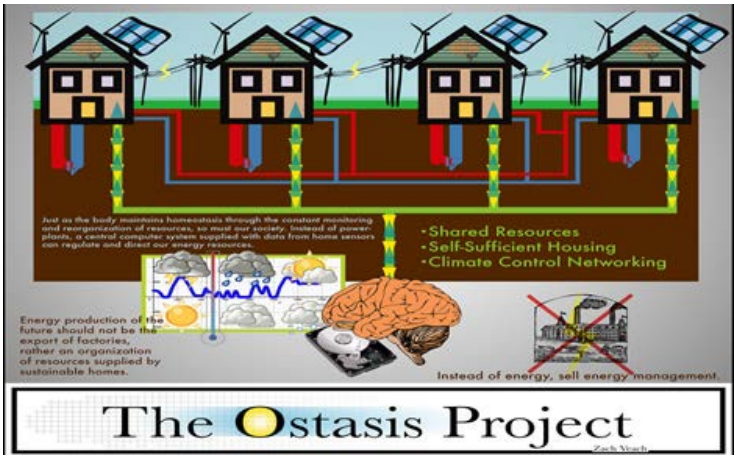

Fig. 3: The ostasis project (Source: and concept zachary veach)

developed based on three factors: shared resources, self-sufficient housing and climate control networking. It is a dynamic system of self-sustaining homes, attached to a network of shared resources. Consequently, to maintain equilibrium, the concept is about redirecting resources by individual buildings instead of relying on receiving energy from power plant.

MATERIALS AND METHODS

Renewable energy: Scientists agree that humans are significantly contributing to global warming from the burning of fossil fuels for energy, agriculture, industrial processes, and transportation. Billions of people will be facing threats of flooding, severe storms, shortages of clean drinkable water, food insecurity and increased risks of disease. A rise in temperature as small as 1°C could have important and rapid effects on mortality of some organisms.

The excessive burning of fossil fuels affected the global climate (Nejad and Poorsabzevari, 2016). The release of greenhouse gases has increased significantly due to global warming. For instance, Methane has increased by 150%. It is 25 times more effective per molecule at trapping heat than carbon dioxide. The increase in CO_2 also affects the acidity of water. Ocean acidification has a detrimental effect on coral reefs and crustaceans. While the usage of renewable energy is recommended to reduce pollution and fossil fuels usage, the long term impact of renewable energy from different sources is not well established.

For instance, fossil fuels required biological and geological processes over a long period. The entire process took place without affecting the environment. It is the human extensive worldwide exploitation of fossil fuels which drastically affected negatively the environment and the climate. This concept is recommended to be considered when generating energy such viabiogas.

Solar energy is considered a renewable energy. Electricity generation from solar energy did not produce carbon dioxide. However, the excessive capture of solar energy may also affect the environment. This is because the distribution of solar radiation in the atmosphere will be affected; thus, it will affect the climate and the environment. Other alternatives in generating renewable energy may lead to other unpredictable environmental issues. Consequently, diversification in energy usage seems to be crucial. To sum up, due to the limited available facts on renewable energy, It is recommended to make decisions based on the best currently available information. The implementation procedure should be kept so that further adjustments in the future will be made when more information becomes available.

Ecosystem: An ecosystem is an interdependent system of living organisms (biotic) such as plants, animals, and microorganisms interacting with one another and with the nonliving components (abiotic) such air, water and soil in their environment. The study and management of ecosystems represents the most dynamic field of contemporary ecology. Learning how ecosystems function, improve our ability to predict how they will respond to changes in the environment. Ecosystem research in developing environmentally friendly products links fundamental ecology, environmental ecology and environmental problem-solving. Ecosystems also operate by usingenergyand cyclingmatter. These are considered the basic ecosystem functions. Energy does not cycle over time, so a continuous flow of high-quality energy is required to maintain their structure and function. Figure 4 show the natural flow of matter and energy

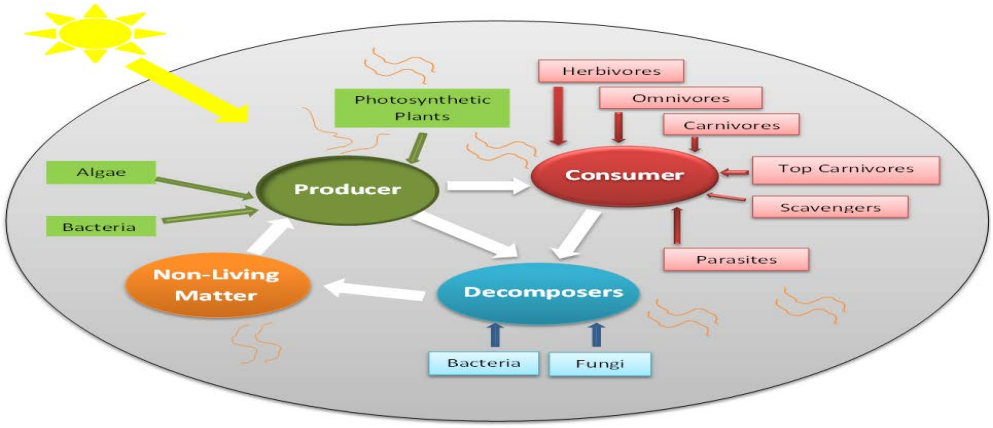

Fig. 4: Flow of matter and energy in ecosystem

in ecosystem. It requires four components. Those are producer, consumer, decomposers and non-living matter.

Currently, Ecosystems around the world are threatened by environmental stressors such as land-cover change, extraction of natural resources, biological disturbances and pollution (Staudt *et al*., 2013).

Biomimicry in building design and engineering: Biomimicry is about imitating few characteristics of organisms by humans. A useful knowledge on biology work may lead for new approaches in generating renewed energy. This is while ensuring safe healthy environment, and well-being. For instance, it has been reported that plants and some bacteria are able to harvest light from the sun then convert it into both energy and the organic materials by photosynthesis. Biomimicry is not only about generating energy, it about producing designs, products and systems. In fact, it is widely known that many designs, products and systems were successfully implemented based on biomimicry. This is also the case in building design and engineering.

Musgum mud huts: Numerous living systems have progressed to make useful materials for their specific needs. For instance, some spiders produce different types of silk for different uses. Silks stretch up their lengths with extraordinary tensile strength. Human tried to imitate nature for housing design and other aspects. This may be the case of the Musgum house. The Musgum is an ethnic group in Cameroon. Musgum houses are described as beehive type or shells. The height of the house may reach up to 9 m. The Musgum houses were built with natural mud. Mud does not generate carbon dioxideduring the process of its manufacture. It is lower in embodied energy. It is an environmental friendly natural product compared to current building materials such cements, bricks. Musgum house had dome shape. The dome shape helps in supporting the maximum possible weight with least material.The optimization of the material usage is reflected by minimizing the thickness of wall while ensuring stability. The wall is thicker at the base and it is gradually lessened till the topmost of the building. A circular opening is made at the top of the house to allow the air to freely circulate. The design and construction of the house result in the sensation of freshness and coolness when the outdoor is hot. Further, the exterior wall of the house provides a foothold for workers. A typical model of Musgum dwelling is shown in Fig. 5.

The natural air-conditioned space: Another interesting project inspired by termite mound was built by Pearce. The Eastgate complex in Zimbabwe was built by Pearce. It does not require air conditioning to maintain the temperature. Therefore, no carbon dioxide will be added for indoor cooling. The inspiration was from the remarkable mound-building termites of southern Africa. The concept is about designing naturally well air-conditioned mound. In fact, termite mounds are efficiently well controlled to maintain humidity and temperature regardless of the fluctuating outdoor air temperatures. Figure 6 shows termite mound in Australia. The tallest mounds are about 9 m located in Africa.

Termites maintain the temperature inside their shells to within one degree of 31°C. Termite mounds are carefully constructed to capture the breeze and regulate temperature by air flow through convection. The mounds are also well-kept against drying and predation. In fact; termites' structures have been widely used as exemplars of biomimetic designs for climate control in buildings (Chai and Chen, 2015). Currently, it is expected that such buildings inspired by biomimetic may go further by

Fig. 5: Musgum mud huts (Ostorero in 2003)

Fig. 6: Termite nests (j brew-cathedral termite mound)

Fig. 7: Veiled chameleon (chiswick chap)

learning from nature. It means that the buildings are expected to be as alive as their populations and the living nature in which they are embedded (Chai and Chen, 2008).

Other cases: Chameleons are widely known for their ability to alter colour at will. It is vital to all aspects of chameleon behaviour (Krystal and Herrel, 2014). Figure 7 shows veiled chameleon. There are many different reasons about colour-changing in chameleons from camouflage to attracting a mate and many others. In a nutshell, when the chameleon's skin is relaxed, it selects one colour; when it stretches the colour changes. The chameleon skin was artificially designed. Interestingly, another new material was inspired by the octopus. It was reported that the invented material could be used on windows and building facades. It, allows structures to control heat according to ambient temperature and sunlight. This alters their transparency.

RESULTS AND DISCUSSION

Sustainable development: Sustainable development is about promoting economic growth, a healthy environment and vibrant communities. This is by ensuring an

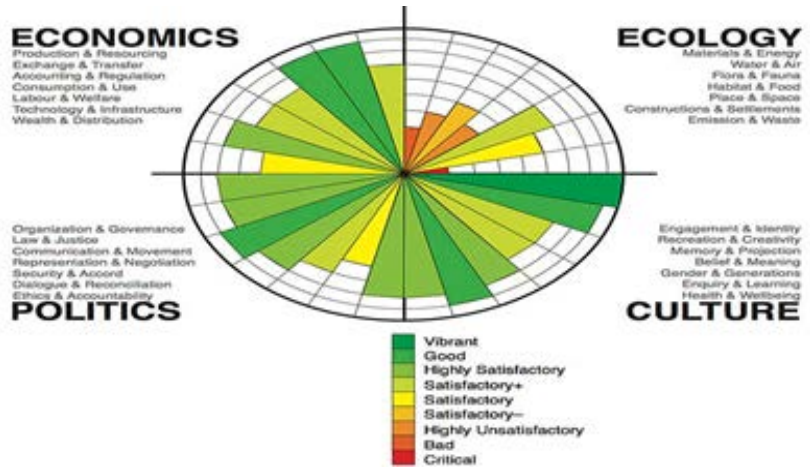

Fig. 8: Circles of sustainability in melbourne (paul james)

environmentally friendly business for better quality of life for the present and future generation. Itis a process for meeting human needs from then atural resources and ecosystem services upon which the economy and society depend. The space and time should be considered while looking for quality of life. For instance, the green features of sustainable building materials may be divided into three main features. The first key feature is for the manufacturing process. It is related to waste reduction, pollution prevention, recycled, embodied energy reduction and the use of natural materials. The second key feature is for the building operation. It is related to energy efficiency, water treatment and conservation, nontoxic, renewable energy sources, longer life. Finally, the waste management is the third key feature. It is about biodegradable, recyclable, reusable and others (Turner and Soar, 2008). For instance nature not only uses the energy, it needs but recycles almost everything.

It is necessary to mention that sustainably goes beyond the environmental concept explained in the ecosystem, it also includes other factors affecting human welfare such politics, cultures, economics and ecology. Figure 8 shows the sustainability of the metropolis of Melbourne across the four domains of sustainability-economics, ecology, politics and culture as developed by the UN Global Compact, Cities Programme.

CONCLUSION

This review explored some observations about current environmental issues in developing environmentally friendly products. This study goes beyond recycling and using renewable energy to developing environmentally friendly procedure. It provided insight of different aspects of recycling that should be considered prior conceiving an environmentally friendly product. This study also recommended a diversification in energy usage from different sources. It highlight the importance of avoiding when possible transformation of energy from one aspect (such fossil fuel) to electricity due to the wastage in generating electricity. Energy and mass conservation starts by minimizing wastage. Other issues relevant renewable energy usage discussed and recommendations are made.

REFERENCES

Chai, H.S. and V.R. Chen, 2015. Multi-state phenomena and hysteresis of counterflow flame over tsuji burner. Int. J. Technol. Eng. Stud., 1: 15-19.

Cuningham, W.P., 1994. Understanding our Environment. Wm.C. Brown Publishers, Melbourne, Victoria, Australia, ISBN: 9780697204561, Pages: 389.

Krystal, A.T. and A. Herrel, 2014. The Biology of Chameleons. University of California Press, Berkeley, California, ISBN: 9780520957381, Pages: 312.

Nejad, E.B. and A.R. Poorsabzevari, 2016. A new method of winner determination for economic resource allocation in cloud computing systems. J. Adv. Technol. Eng. Res., 1: 51-56.

Rubin, E.S., 2001. Introduction to Engineering and Environment. McGraw Hill, Boston, Massachusetts, ISBN: 9780072354676, Pages: 696.

Staudt, A., A.K. Leidner, J. Howard, K.A. Brauman and J.S. Dukes et al., 2013. The added complications of climate change: Understanding and managing biodiversity and ecosystems. Front. Ecol. Environ., 11: 494-501.

Turner, J.S. and R.C. Soar, 2008. Beyond biomimicry: What termites can tell us about realizing the living building. Proceedings of the First International Conference on Industrialized, Intelligent Construction, May 14-16, 2008, Loughborough University, Leicester, UK., pp: 43-60.