Sustainable Product Design for Energy & Environment and Model Making

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Abstract: *The abstract Purpose - The purpose of this paper is focuses on the importance of sustainable product design for the conservation of energy and environment and, to understand the requirement of such efforts in the prevailing energy issues at large. Encourage the students, product designers to work on sustainable product design and model making.*

Design/methodology/approach- A phenomenographic approach was used in the research. With the ever-increasing concerns about energy and the environment, it's become critical to these factors into product designs and sustainable building forms. Simultaneously, it has become critical to analyse the product configuration cycle in order to reduce the product's carbon impact. Not only is the environment served, but also society and the economy.

Finding- The three core issues of sustainability are the environment, society, and economy. Professionals (such as product designers, architects, and planners) are responsible for implementing energy saving and sustainability plans during the product design cycle. As a result, the primary goal of product design and configuration must be to reduce the use of non-renewable energy sources.

Practical implications – This study presents product designs and sustainable built form suggestions through comparative perspectives in the field of sustainability. This paper also elaborates prototypes/model making and case studies from different systems and settings.

Keywords: **Sustainable Product Design, Energy and environment, Model making/Prototype**

1. Introduction

People are becoming more aware of the negative consequences use energy and resources also on social environment as society progresses. As a result, a criterion for sustainable product development that connects society, economics, and environment should indeed be established (Dasgupta, P. 2007).The implementation of energy design emerges through beginning sustainable development but is an important part of mankind. It combines traditional and eco-design elements to create a new sustainable design based on the idea of sustainability. It is not harmful to following generations to comply with their demands while also meeting the needs of current generations in order to achieve environmental, social, and economic balance, as well as to improve optimal society's continued and coordinated development (Anastas, P. T., & Zimmerman, J. B. (2003). Human life, profession, production, energy, urbanisation, transportation, communication, as well as economy all play a role in sustainable design. These are redesigned to compensate for the detrimental impact that the advancement of science and technology has had as a result of such thinking. With rising product demand, it's more important than ever to think about product sustainability. Integrating sustainability into all stages of the product design cycle is one strategy to lessen a product's negative effect on society, the economy, as well as the environment. So, sustainability is concerned with three problems: society, environmental, and economics. To reduce negative effects on the environment throughout the product's life cycle as well as to conform with the Sustainable Development Goals, sustainable product design examines environmental and social factors at the earliest phases of the product project development.

Economic principles, Social and environmental sustainability are very important for sustainable product design (Neelam C. et al., 2014). Plan becomes an awesome device by which humankind moulds the world we live in during the period of large-scale manufacturing, when all exercises are in general meticulously planned. The scope of this tool clearly extends to environmental management as well.

After examining the fundamental notions of Industrial Ecology, it is possible to consider how these ideas may be translated into the design of modern cycles and products. Configuration, which consists primarily of trim energy and materials streams for such purposes of meeting humanity's needs, eventually transforms into a cycle of change

whenever the needs that drive it are summarised in the examples and streams of similar concepts, absorbing the evolving ecosphere's standards (Ehrenfeld, J. 2008). The concept of a practicable plan evolves from controllable improvement in the early stages, and it is now an important aspect of humanity's response to global environmental changes. It combines traditional and eco-plans into a new economic plan based on the concept of sustainability. It will not harm people in the future if they are able to meet their needs while also meeting the needs of the present era, achieving environmental, social, and economic harmony, and maintaining and composing the development of human civilization. The ideas of human existence are included in a reasonable plan, work, production, energy, urbanisation, transportation, correspondence, and the economy are all aspects of the economy (Munn, R. E. (Ed.). 2002).

2. Objectives

To impart knowledge to the students, Product designers and professionals regarding design and development of sustainable products using emerging renewable sources of energy such as solar, wind and bio energy.
To understand and appreciate the need for energy efficient and environmental friendly products through model making/prototype.
To identify various barriers involved in commercialization of energy products.

3. Design for environment

Sustainability and design is about reimagining how to meet necessity growth while eliminating adverse environmental and health repercussions. It is not always about new technologies. The concept of "decoupling," which aims to disrupt the link between economic expansion and environmental destruction, is crucial (Caïd, N. 2006). As a result, in the start of the 1990s, it was possible to have a broad understanding of the effects of environmental challenges on the design movement, spanning the most diverse zones and described by the after effects of the major encounters (Clark et al., 2009). These interactions were followed by a period of increased awareness of new requirements for asset protection, which blended in a wide range of ground-breaking ideas developed without the use of traditional design approaches to coordinate environmental requests. In the last decade, the definition of Design for Environment has progressed, despite the fact that it was not always evident. It was first introduced in a reductive manner as a design strategy aimed at reducing modern waste and increasing material utilisation, and as a result, it gained a more appropriate measurement.

3.1 Product design for energy and environment

Sustainable design is a design concept that aims to improve the quality of products and lifestyle environments while reducing or eliminating negative environmental effect. Sustainable design also includes the desire to find the optimum solution that combines environmental concerns with functional, comfort, aesthetics, cost, and a variety of other design considerations. While it implies intent, skilled designers who have effectively integrated the concepts into their design process may find that sustainable design is an instinctive process.
Sustainable design is a method of thinking about how design decisions affect the environment, building occupants, and the bottom line. Prioritizing sustainable design in most cases does not imply ignoring other programme criteria such as time and money.

Instead, consider sustainable design as a collection of criteria to consider when making design decisions.
Product design for the environment is a strategy for lowering the environmental impact of products. Polluting processes and the consumption of vast quantities of raw materials can have a negative influence on the environment (Davi N. A et al., 2017). The impact can also be negative due to the enormous amount of energy consumed and the challenges encountered during disposal. As a result, one must evaluate a product's complete life cycle, from conception through disposal. The following three criteria must be taken into account when creating products. The systematic examination of design performance in relation to environmental, health, safety, including sustainability objectives all throughout product and process development cycle is known as Design for Environment.

3.2 Sustainability as a concept

In the last two decades, the notion of sustainable design has risen to prominence. It is a philosophy that recognises that human civilization is a component of the natural world, and that nature must be conserved and perpetuated in order for the human community to continue. Sustainable design expresses this concept via innovations that demonstrate conservation principles and promote their adoption in our daily lives.
The idea that over life is formed and sustained on a practical community basis, and that most of these diverse communities (bioregions) have mutually supportive life systems that are typically self-sustaining, is a corollary concept that promotes sustainable design. Advancing technology must operate predominantly within bioregional patterns and sizes, according to the notion of sustainable design. They must preserve biological variety and environmental integrity, contribute to the quality of air, water, and soils, include bioregional constructability, and limit human-induced consequences.
Sustainability, whether referred to as "sustainable design," "sustainable product creation," "design for nature," "environmentally aware and caring design," or "holistic resource management," is the potential of natural and cultural systems to be perpetuated into nearly everything.
Sustainability does not need a reduction in life quality, but it does necessitate a shift in mindset, a shift in ideals toward less consumerist lifestyles. Global interconnectedness, environment protection, social responsibility, and economic feasibility must all be included into these developments.

These are the design principles that must be followed in order to achieve sustainability:
a. Insist on humankind's and nature's right to live inside a healthy, supporting, diversified, and long-term manner.
b. Recognize the importance of interdependence. Human design components interact with and rely on the natural world, having wide-ranging ramifications at all scales. Extend your design choices to include even far-flung consequences.
c. Value the interplay between spirit and matter. Consider the present and emerging linkages among spiritual and material awareness in all facets of human settlement, including society, housing, industry, and commerce.
d. Accept responsibilities for the effects of design choices on human well-being, environmental viability, and coexistence rights.
e. Create long-lasting, safe items. Do not impose maintenance or careful administration of possible dangers owing to negligent production of goods, processes, or norms on future generations.
f. Get rid of the notion of waste. Evaluate and optimise the whole life-cycle of products in order to achieve the condition of natural systems where no waste exists.
g. Rely on the flow of natural energy. Human creations, like the living world, must draw their creative energy from a never-ending supply of solar energy. Integrate this energy in a sensible and efficient manner.

h. Recognize the constraints of design. Design does not fix all issues, and no human construct lasts forever. In the presence of nature, those who construct and plan should be humble. Treat nature as a role model and mentor, not as a nuisance to be avoided or subdued.
i. Continually improves through exchanging information. Encourage direct and open dialogue among partners, patrons, manufacturing, and users in order to reconcile long-term sustainability concerns with ethical responsibility and rebuild the intrinsic linkage between natural technology and human activity.

A. Customer demand.
Creating a product that impacts the environment less becomes a market advantage.
B. Government pressure.
1. Government agencies/departments (Ministry of new and renewable energy, National Institute of Solar Energy.) also enforce reduced environmental impact standards for products.
2. Such regulatory pressure will only grow with time.
many countries now have for products such as packaging, computers, and transportation vehicles with required recycling of the components.
C. ISO requirement (the International Organization for Standardization)
1. Standards (ISO14001-2015) are also being developed to support design for the environment as a practice.
2. Underlying all of these activities are the market forces that demand design for the environment as a necessary part of modern product development

4. Sustainable product design

Sustainable products would be those who benefit the environment, society, and economy while protecting public health, welfare, and the environment over their entire life cycle, from raw material extraction through final disposal. It is the process of designing a product in accordance with social, economic, as well as sustainable development principles. It is the process of designing a product in accordance with social, economic, and environmental sustainability principles (McLennan, J. F. 2004).
Sustainable design must take a different approach than traditional design that takes into account these mental shifts. Every design option must be considered in relation to the cultural and natural heritage of a local, regional, and global contexts in the new design approach.
Design for Sustainability is still in its infancy, there are no standards in place. It entails a slew of difficult tradeoffs and a dearth of hard-and-fast rules. Engineers can use standards issued by a variety of organizations to help them design for the environment. Long checklists are frequently included in these standards, and they include:
1. Material reuse as well as recovery - avoid composites, standardize materials including fasteners, and select recyclable materials.
2. Disassembly - makes it easier to separate components and avoids permanent attachments of incompatible materials like welds.
3. Simplicity - provide standardized designs for multifunctional components.
4. Minimize waste by reducing product size and weight, as well as packaging.
5. Reduce the amount of energy used in manufacturing and the amount of energy utilized by products.
6. Design for multifunctional goods and parts, specify recycled and renewable materials, employ remanufactured elements, design for product durability and performance, then design for closed system cycling.
Design for Sustainability - The process of creating physical and intangible goods that take into account all aspects of long-term sustainability, including nature, economy, and social values.

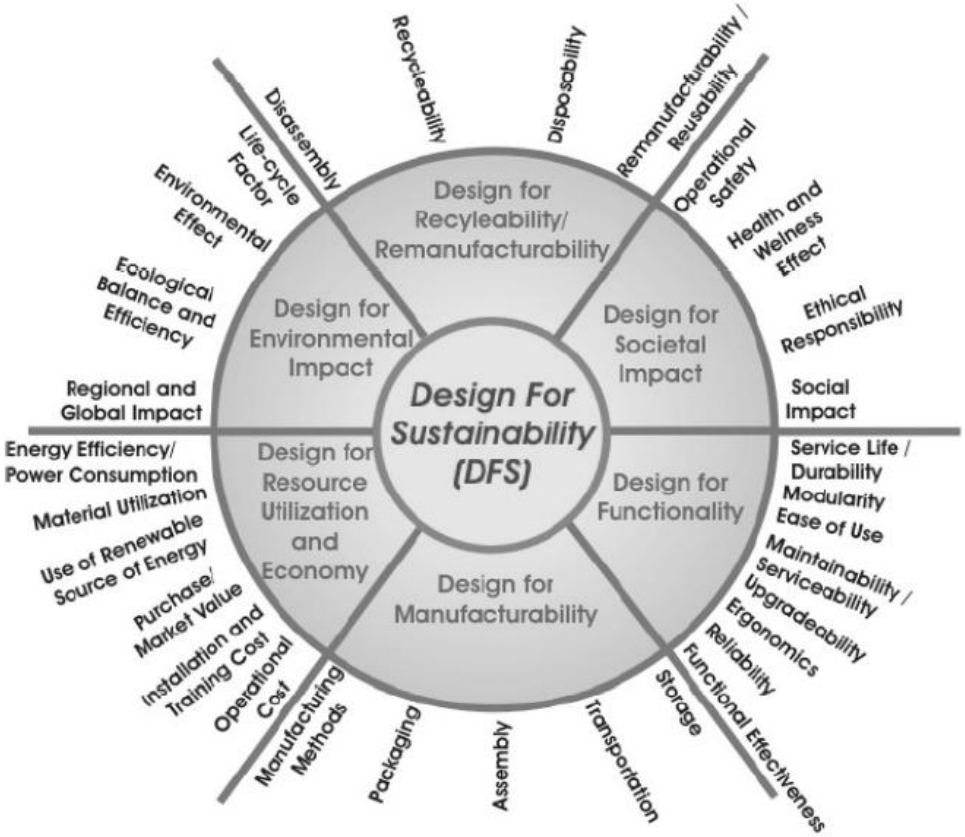

Figure no1 Important components of "Design for Sustainability"

Managing innovation for long-term development: When developing new products, numerous conflicting factors must be considered, such as cost, aesthetics, usefulness, and ease of production. The term 'Design' is frequently used to refer to crucial requirements, such as Design for Durability and Design for Production. Design for Environment, also known as eco-design, and Design for Sustainability, also known as sustainable product development process, have grown in popularity as interest in sustainability has grown.

4.1 Benefit of eco-friendly products

Preserve Energy: Eco-friendly products, such as solar-powered boards, harness the sun's energy. They appear to be a viable alternative to petroleum-based energy delivery.

Improved Health: Eco-friendly items and green structures are safer for the environment since the materials used are free of harmful synthetic compounds and parts.

Saves Environment: They save the environment by avoiding the use of fossil fuels. They also aid in lowering carbon dioxide levels in the environment, so preventing environmental change.

Material savings: Eco-friendly goods ensure productivity by utilizing non-harmful materials without sacrificing quality.

Saves water: A green construction helps to protect water. It also provides for alternative water sources, such as water, as well as water reuse.

Costs Less : Green constructions are less expensive since they incorporate water and energy conservation. Construction may be more expensive up front, but in the long run, it is a way of contributing to a solid and lower activity and maintenance expenses.

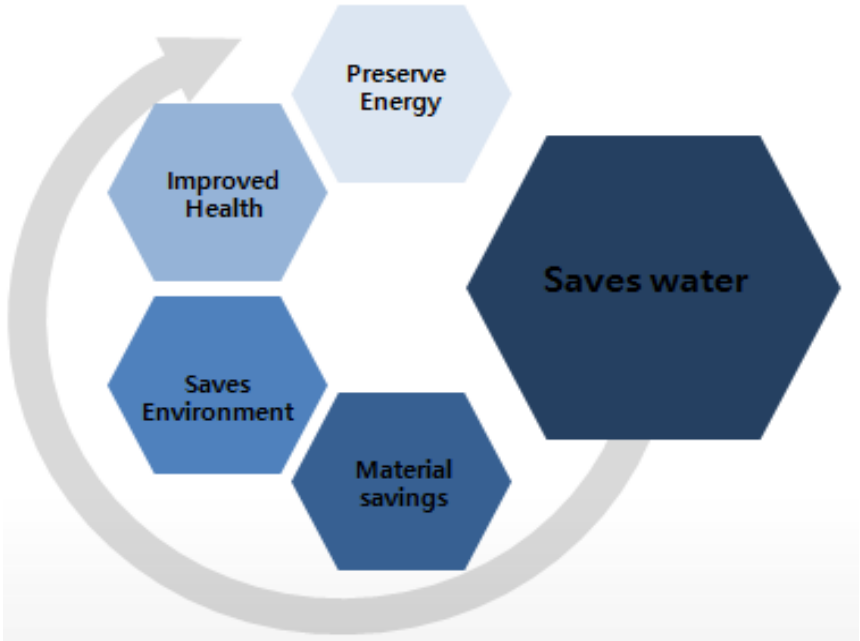

Figure no.2 Benefit of eco-friendly products

4.2 Stages of product life cycle (SPLC)

The SPLC is a method for examining environmental effects during all phases of a product's life cycle, from beginning to end. From the extraction of raw materials to the final removal of the product, this includes preparation, fabrication, appropriation, use, repair and maintenance, and removal or recycling. (Neelam C. et al., 2014). With raw materials extraction to definitive mien, SPLC illustrates the environmental, social, and economical benefits of products across their whole life cycle. LCA is a tool for analysing the many environmental effects of a product or application.

Figure no.3 Stages of Product Life Cycle

It is a standard method that contributes to the dynamic cycle by supporting the government in characterizing a public arrangement. SPLC should be used to aid in the attainment of carbon credits. Carbon credits are a cost-effective way to reduce ozone-depleting substance outflows by adjusting discharge reductions. Sustainable Development is required to safeguard people's interests in the future.

5. Examples of environment friendly product through Physical Model making / Prototype.

Design is indeed a problem-solving process founded in the production of new useful items and a decision-making process based on the design of courses of action (Simon, 1969). In a Smart/Green vehicle, alternate energy sources including biodiesel, solar energy as well as rechargeable electricity, rooftop materials, and so on are used in below Figure 2. This will save/reduce the utilization our regular fuel sources, such as diesel, gasoline, and so on (Dasgupta, P. 2007). The vehicle series will be developed with multifunctional in mind to match the diverse lifestyles of modern people.

Students work:

Solar foldable scooter (based on solar energy using solar panel)

By : Krishna Kabbra, M.Des ,PIADS (Second Year)

Figure no. 4 Solar Foldable Scooter

Chair design by: Sarang Holey, M. Des, PIADS (Second Year)

Figure no. 5 Chair Design

Seating furniture: Made of News Paper scrapes having stable strength

Fruit basket: Made by wooden “karchi” shaped object and given an elegant shape of a Flower
By: Prof. Rupesh Surwade, M. Des, PIADS.

Figure no. 4 Seating Furniture and Fruit basket

These new prototype products and services provide better functionality and simplicity of use, increased longevity, easier disassembly or recyclability, reduced manufacturing impacts that save money for the corporation, and better materials sourcing and production that benefit communities. To put it another way, sustainability adds value through higher quality and lower prices, which are the two primary motivators for many of these consumer purchases. The application of sustainability to the design of new projects is most effective when it fits the needs derived from the user's relationship with consumption and experience with prior products. Since that allows the interaction between human-product to be accumulated and more durable through the perception and understanding of values associated with the project, the usability will act as a maximizing agent of tangible and intangible values of the products or services while minimizing the damages of the ecological footprint, the user experience will act as a trying to maximize agent of tangible and intangible values of the products or services while reducing the damages of the ecological footprint.

6. Conclusions/Discussion

The user experience with sustainable products is still mostly (mostly) tied to products that are inefficient or have a material reuse feature (Davi N. A et al., 2017). Sustainable Development is required to protect people's interests in the future. Designers are also concerned with ways to improve sustainability, human living situations, and develop new values and ideals (Kristensen, 2004). Mass mindfulness is essential to achieve environmental sustainability and energy improvement. Product designers are dealing with energy challenges and are beginning to consider their environmental responsibilities by implementing life cycle evaluation methodologies (Anastas,P.T.,& Zimmerman, J.B. 2003).The use of controllable or non-standard products has a lower environmental impact and can be sustained for a longer period of time. The goals of maintainable design are to reduce or limit the use of nonrenewable resources, to monitor inexhaustible resources, and to reduce or limit the use of nonrenewable resources. Sustainable design should be a progression and expansion of traditional design methods. Although we acknowledge the enormous strides that have happened in the sustainable environmental aspect, the focus is also on product design and related processes.

REFERENCES

[1] *Anastas, P. T., & Zimmerman, J. B. (2003). Peer reviewed: design through the 12 principles of green engineering.*

[2] *Ashby, M., & Johnson, K. (2003). The art of materials selection. Materials today, 6(12), 24-35.*

[3] *Clark, G., Kosoris, J., Hong, L. N., & Crul, M. (2009). Design for sustainability: current trends in sustainable product design and development. Sustainability, 1(3), 409-424.*

[4] *Caïd, N. (2006). Decoupling the environmental impacts of transport from economic growth.Davi Neiva Alves, Matheus Tymburibá Elian and Eduardo Romeiro Filho (2017) The role of the user experience on sustainable aspects of Product Design, ISSN: 2318-6968 Agosto 2017 vol. 3 num. 6 - SBDS + ISSD 2017*

[5] *Dasgupta, P. (2007). The idea of sustainable development. Sustainability Science, 2(1), 5-11.Ehrenfeld, J. (2008). Sustainability by Design Yale UniversityPress. New Haven and London.*

[6] *Finkbeiner, M., Schau, E. M., Lehmann, A., & Traverso, M. (2010). Towards life cycle sustainability assessment. Sustainability, 2(10), 3309-3322.*

[7] *Kristensen, T. (2004), "The physical context of creativity", Creativity and Innovation Management, Vol. 13 No. 2, pp. 89-96.*

[8] *Kaur, K., Singh, T., & Kumar, A. (2012). Use of renewable resources in wireless communication networks. International Journal of Research in Engineering & Applied Sciences (IJREAS), 2(2).*

[9]

[10] *McLennan, J. F. (2004). The philosophy of sustainable design: The future of architecture. Ecotone publishing.*

[11] *Munn, R. E. (Ed.). (2002). Encyclopedia of global environmental change. Chichester: Wiley.*

[12] *Neelam Chaudhary, Tanvir Singh & Amit Kumar (2014) Sustainable Product Design: A Review IJECT Vol. 5, Issue Spl-1, Jan - March 2014 ISSN : 2230-7109 (Online) | ISSN : 2230-9543 (Print)*

[13] *Partha Dasgupta,"The idea of sustainable development",Sustain Sci (2007), Springer.*

[14] *Robert, K. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is sustainable development? Goals, indicators, values, and practice. Environment: science and policy for sustainable development, 47(3), 8-21.*

[15] *Simon, H.A. (1969), "The sciences of the artificial", The Sciences of the Artificial, 3rd ed., MIT Press, Cambridge and London.*

[16] *Yadav, S. K., & Mishra, G. C. (2013). Environmental life cycle assessment framework for Sukker production (raw sugar production). Int J Environ Eng Manag, 4(5), 499-506.*