

The semiotics of eco-design: Overview, Benefits, and Inclusion in Designer Education

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ABSTRACT:

This article discusses the semiotics of eco-design approach. Firstly, it explains the methodologies of eco-design, mainly the Life Cycle Assessment (LCA), which is a method used in eco-design to examine the environmental impact of a product or system across its entire life cycle, from raw materials through a disposal. Secondly, it highlights the seven eco-design Wheel strategies: materials with low impact, material reduction, production optimization, distribution system optimization, lowering the environmental impact of the use, lifetime optimization, and end-of-life optimization. The primary purpose of these seven strategies is to help avoid, reduce, and minimize the product's environmental impact throughout its lifecycle. Furthermore, this paper identifies the seven stages of developing an eco-design product or project, which are as follows: project preparation, environmental aspects, improvement ideas, development of concepts, details on the product, plan of action for pending legislation, and evaluation. Besides that, the author emphasizes the eco-design approach's environmental, economic, and social benefits. Last but not least, the article mentions ways to include eco-design in designers' education to guarantee that the future generation is equipped with the knowledge and skills required to create environmentally friendly goods and systems

Keywords: Semiotics/ Eco-design/ Eco-design strategies/ Methodologies/ Designers' education.

1. Introduction :

Eco-design, often known as sustainable design, is a design approach that identifies how products and systems affect the environment. It aspires to produce ecologically conscious, commercially feasible, and socially responsible designs. In light of this, eco-design is an important topic for semiotic investigation. There are several methodologies to follow and numerous strategies and stages highlighting elements and steps to consider while producing a new product. That is why adopting the semiotics of eco-design approach may result in various advantages, including environmental, economic, and social advantages. As a matter of fact, eco-design is more vital than ever in today's environment and is critical in encouraging sustainability and crafting a greener future.

In this context, what are the methodologies, strategies, and stages of eco-design?

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What are the benefits of eco-design?

And how to incorporate and what is the importance of eco-design semiotics in designers' education?

1. Literature framework

In the late 1960s, when the widely recognized vision of the entire Earth grew to cultural prominence, the phrase "ecological design" originated in design, architecture, and planning (Kallipoliti 3). Furthermore, in the late 1970s and early 1980s, eco-design arose in response to rising environmental issues such as resource depletion and waste creation (Kallipoliti 17). Designers and politicians began to examine the environmental effect of goods and systems and the need for more sustainable design techniques during this period (Lafferty 68).

In fact, Victor Papanek, a designer, writer, and activist, was among the first to address sustainable and social design concerns in the 1960s. Following that, in 1971, Victor Papanek published his most influential book, "Design for the Real World," emphasizing the importance of designing for sustainability and providing the foundation for the discipline's development (Scarzella 1). Furthermore, in 1996, Sim van der Ryn and Stewart Cowan, pioneers of sustainable design, argued in their book *Ecological Design* to integrate human activities with natural processes in fields such as architecture, industrial ecology, sustainable agriculture, and water treatment. Plus, they pointed out inherent flaws in production and design methods that are prescriptively out of sync with the melodies and periods of the natural world (Kallipoliti 30). Meanwhile, eco semiotics investigates the relationship between ecology and semiotics whereas human activities may be investigated in relation to ecosystems (Mazitova 10).

In this context, various terminology is used to describe the consideration of environmental implications in products: 'Design for the Environment' (DfE), 'green design,' or 'environmental design' (Kallipoliti 49). However, the prefix 'eco-' in 'eco-design' provides a connection between products' environmental and economic features (Rojas Luiz et al. 4). The term "design" broadly encompasses actions such as design, project, and planning, including developing a creative path from a problem or need to its answer. This path must be adaptable and open to accommodate various methods and processes. As a result, eco-design was defined as incorporating environmental considerations into the product creation process (Varžinskas et al. 33). Plus, it can meet several of the United Nations' 17 Sustainable Development Goals.

Likewise, eco-design is a tool that was created to make it easier and faster to compare environmental and economic indicators of competing for constructive solutions (Bourgeois et al. 2).

Moreover, eco-design also refers to a new intelligent and proactive design approach in keeping with the Bruntland report's declaration of sustainability. It entails considering environmental concerns during the product creation process to reduce environmental consequences throughout the product's lifetime while maintaining other critical requirements such as efficiency, reliability, and budget. Instead of focusing on the manufacturing and use phases, the eco-design method broadens the scope of traditional design toward a more sustainable design by learning and aiming to lessen the environmental consequences of goods and solutions across their entire life cycle. Similar definitions, such as Sakao (2007), emphasize that eco-design attempts to prevent environmental contamination over a product's life cycle are echoed by other sources (Franzénet Guo 2). Also, the European Environmental Agency (EEA) defines eco-design as the analysis of the environmental concerns at all phases of the product development process, aiming for goods with the minor environmental effect feasible throughout the product life cycle. Moreover, by balancing ecological and economic requirements, environmental issues are included in the product creation process (EEA Glossary). As a result, the key characteristic of eco-design that makes it a viable object for semiotic analysis is its propensity to link people with nature, to broaden their awareness within the environment, and to synchronize human behavior with ecology (Orr 31-32).

Additionally, according to (Franzénet Guo 11),eco-design method may be viewed as a set of principles and guidelines that contain the required tools to handle a specific situation, assisting in pursuing more innovative and inventive solutions. Furthermore, (Schäfer and Löwer 7) include all of these notions under the umbrella of eco-design and propose three distinguishing features: first, It pertains to product design and development; second, it aims to reduce the environmental effect of these items; and third, it considers the entire product life cycle. Besides that, by recognizing that every created product, location, or habitat has a more significant presence in the world than its position as a realized item is crucial; it projects and expands the existence of all things about more enormous environmental forces and the nexus of global flows (Kallipoliti 2). To sum up, eco-design has grown and expanded over time, and it is now generally regarded as a vital tool for creating a more sustainable future.

2. Methodologies of eco-design

There are various methodologies of eco-design. For instance, the Life Cycle Assessment (LCA) is an approach used in eco-design to assess a product's or system's

environmental effect across its entire life cycle, from raw materials through a disposal. The primary goal of LCA is to identify areas where changes may be made to minimize a product's or system's environmental effects. LCA standards are provided by the International Organization for Standardization (ISO) in ISO 14040 and 14044 (Varžinskas et al. 37). As figure 1 shows, the following are the four significant steps of an LCA:



Figure1: the four steps of Life Cycle Assessment LCA

Source: Ecochain(<https://ecochain.com/hub/life-cycle-assessment-hub/>)

2.1. Goal and scope definition

The aim and scope define the most critical decisions, which are frequently subjective. For example, the LCA's goal is a full definition of the product and its life cycle and a description of the system boundaries. While the system boundaries define what is included in the evaluation and what is excluded. For instance, small amounts of substances that contribute little to the total footprint might be excluded from the scope of the analysis. As a result, the system boundaries exclude it (Golsteijn 1).

2.2. Life cycle inventory

It is about gathering information on the inputs and outputs of each life cycle step (ICCA5), such as energy consumption, emissions, waste related to each stage of the life cycle, and other environmental impacts.

2.3. Impact assessment

Following the establishment of the assessment's purpose and scope (Stage 1) and the collection of data about your building (Step 2), the following step is to quantify the environmental impacts of your products (Luz 5). This is possible by using defined impact categories such as climate change, ozone depletion, and human toxicity and analyzing the environmental impact of the life cycle based on the data obtained.

2.4. Interpretation and reporting

This critical stage occurs as an ongoing process throughout the previous three phases to analyze the findings in the context of project goals. (Sanyé-Mengual et al 9). In

this step, there should be an analysis of the impact assessment results and presenting them in a detailed report with improvement suggestions.

In this context, LCA is a comprehensive and systematic technique to evaluate a product's or system's environmental effect. It may be an effective tool for eco-design, assisting in identifying areas where changes can be made to reduce environmental consequences. Additionally, it may be applied to a wide range of products and systems, from consumer items to industrial processes, and can give valuable data for decision-making and design optimization.

3. Strategies of eco-design:

Several methods are highlighted within the Eco-design. The main goal is to aid in the prevention, reduction, and minimization of the environmental effect of the product during its lifecycle. These tactics highlight factors that should be considered while developing a new product. As a matter of fact, each product is distinct from the others, beginning with the concept, continuing through the manufacturing process, and ending with the product's disposal. As a result, each product addresses a unique set of requirements. In this context, the tactics to be used should be chosen after assessing the nature of the product. It is critical to remember that, because of the tight interaction between the various strategies and the stages of the lifecycle, while applying the strategies, the influence of one stage must be recognized and not transferred to another.

The Lifecycle Design Strategies (LiDS) Wheel divides the implementation process into four levels: conceptualization, manufacturing, application, and end-of-life.

Simultaneously, there are seven eco-design strategies Wheel as shown in figure 2.

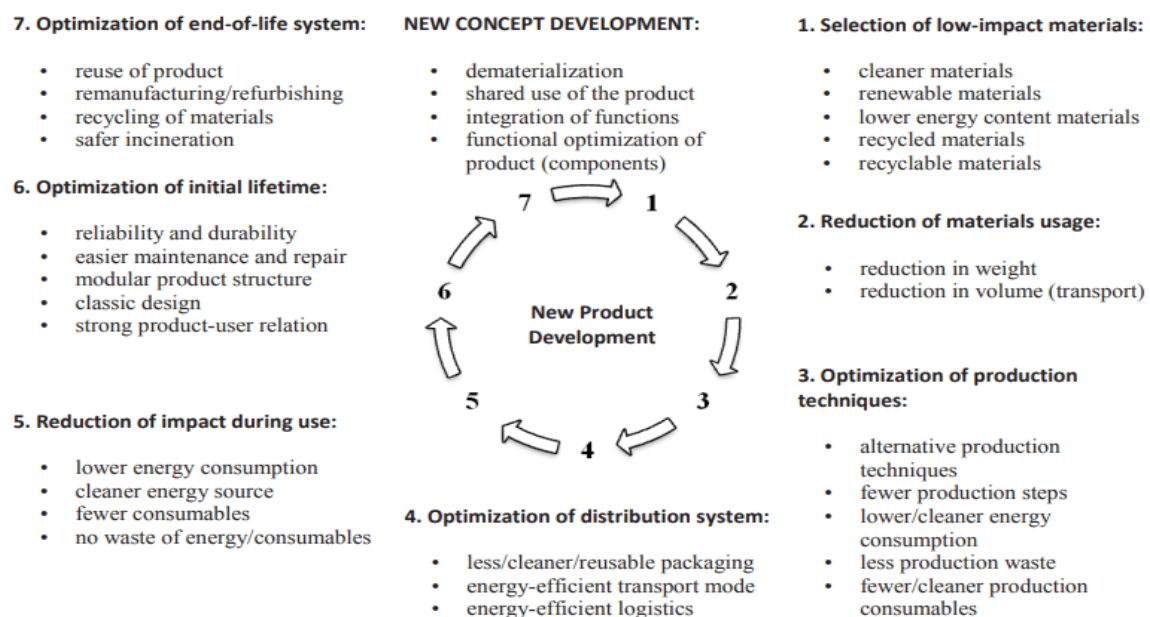


Figure 2: The seven eco-design strategies Wheel

Source: (Hemel and Cramer 441)

Strategy 1 Materials with low impact: It is frequently associated with renewable materials with lower energy content. Furthermore, it might be connected to recycled or recyclable materials or materials that are produced in an ecologically responsible manner, such as avoiding dangerous chemicals (Fernández 11).

Strategy 2 Strategy material reduction: In this strategy, materials utilized are reduced in weight and volume. For example, folding and stacking mechanisms (Dorothea Huulgaard et Remmen 21).

Strategy 3 production optimization: This third strategy pertains to selecting alternative manufacturing procedures, which frequently include fewer production stages (Lott Alves et al. 102). For instance:

- Alternative manufacturing methods.
- Reducing the number of production phases.
- Reducing energy use.
- Waste reduction.
- Cleaner manufacturing consumables.

Strategy 4 Distribution system optimization: Strategy four insists on choosing ecologically friendly distribution methods like reducing the amount of packing material utilized (Olkowicz et Grzegorzewska 207) or using low-impact modes of transportation.

Strategy 5 Lowering the environmental impact of the use: Lowering the environmental impact of use could be achieved through, for example, a reduction in the amount of maintenance necessary, more environmentally friendly energy sources, reduce the use of throwaway items, and the use of sanitary consumables (Lott Alves et al. 102).

Strategy 6 Lifetime optimization: Strategy six focuses mainly on reliability and durability to increase the lifetime of products. More straightforward maintenance and repair can achieve superior dependability and longevity (Huulgaard and Remmen 21) At the same time, product modularity can be achieved by classical design or product-user solid bonds.

Strategy 7 end of life optimization: The final strategy is recycling, remanufacturing, modernizing the product, and reusing its recycling materials (Olkowicz et Grzegorzewska 207).

4. Seven stages to develop an Eco-design Project/ product

Stage 1- Project preparation: The goal of this stage is first to select the teamwork. It will consider the organization and its size, the decision-making independence, the

diverse team, the needed departments, and the necessity for external partnerships (Fernández 15). After that, the designer or the firm need to choose a product. The product must be adaptable, visibly impacted by driving variables, and reasonably straightforward (at least in the first projects). Moreover, this stage contains internal and external motivators. External factors include administration (legislation and regulation), the market, competition, the social environment, and others (sectoral associations, etc.). At the same time, internal factors include product quality, image, and expenses, among other things (innovation, corporate social responsibility, employee engagement, and so forth).

Stage 2- Environmental aspects: There are numerous ways to identify and analyze the environmental characteristics of the product throughout its LCA and determine which of them you want to intervene in the design and product development project (Bourgeois 3). Some examples of tools are the followings:

- Matrix MET, wherein each stage of the product Life Cycle uses a qualitative approach of inputs and outputs (Knight et Jenkins 553).
- Eco-Indicators are a straightforward quantitative instrument and more precise than the MET approach. In this approach, prioritization is determined by numerical computations.
- Software for life cycle analysis is an assessment of the life cycle. There are several examples, the most notable of which are: Eco-it, EcoScan, Simapro, Idemat, and GaBi Software are a few examples.

Stage 3- Improvement ideas: Once the designer identifies the major environmental issues, brainstorming some improvement ideas is important (Knight et Jenkins 550). Plus, various ideas will emerge throughout the process, which should be prioritized to focus on the best. In this context, there are various strategies for this. Some tools examples:

- Eight eco-design approaches
- Idea generation.
- Prioritization in a matrix.

Stage 4- Development of concepts: After the ideas for environmental improvement are created, and the essential ones are chosen, the development stage begins, leading to the creation of the new product (Knight et Jenkins 550). The purpose is to get product solutions that comply with the solicitation papers.

Stage 5- details of the product: This step seeks to provide a clear definition of the chosen concept for the final design. Iterative processes will be used to get from the defining stage to the level of detail.

Stage 6- Plan of action for pending legislation: Stage 6 is strategy integration in design and management (Fernandez 15).

Stage 7- Evaluation: In this stage, the designer should evaluate the project to see how it has been completed and improved. The assessment results will be critical in training, informing, and motivating the rest of the team, as well as incorporating green marketing into the company's marketing campaigns or initiatives, establishing a difference and leadership position (Fernandez 15).

5. **benefits of eco-design**

In fact, eco-design semiotics can represent part of an optimism approach for a better future because eco-design considers a product's total environmental effect from the beginning of its life cycle. Consequently, eco-design is particularly important in the overall notion of the circular economy (Varžinskas et al. 33). Furthermore, eco-design should be included early in product and package development to attain the best benefits. In this context, eco-design has numerous environmental, economic, and social benefits.

5.1. *Environmental benefits*

Living creatures are interdependent from their environment, as semiotic tradition emphasizes, and their placement in environment is essential to analyse interpretive activity (semiosis) (Maran 71). It is in this context; eco-design has huge environmental benefits. Firstly, eco-design can reduce waste by highlighting sustainable materials and processes, which reduces waste and increases product lifetime. Secondly, eco-design can lower carbon footprint by optimizing inputs and outputs of the manufacturing process, employing renewable materials, minimizing energy usage in manufacturing and transportation, and encouraging recycling (Sanyé-Mengual 4). Additionally, eco-design promotes resource efficiency, decreasing the impact on natural ecosystems and conserving precious resources for future generations, leading to better natural resource preservation (Boks 1348). Furthermore, having eco-design results in more incredible biodiversity by reducing environmental and ecosystem loss, as it may assist in protecting biodiversity and support a diverse range of species. Likewise, through the use of non-toxic materials and processes, eco-design may minimize air and water pollution, enhancing the health of residents and ecosystems, which results in better air and water quality (Varžinskas et al. 35).

Eco-design improves human health by employing non-toxic materials and minimizing indoor air pollution. Eco-design may lead to better indoor settings, which can benefit the health of those who use the space. Furthermore, eco-design approaches may encourage using Environmental Management Systems (EMS). Environmental data, as external drivers, may be utilized for user communication and marketing while enhancing the presence of the environment as a decision-making factor during purchasing (Sanyé-Mengual et al. 4).

Overall, eco-design has the potential to enhance the environment greatly and contribute to a more sustainable future for everybody.

5.2. *Economic advantages*

Eco-design may assist in cutting costs and boost production and distribution efficiency for designers and firms motivated by resource optimization like raw materials and energy consumption. Both variable and fixed costs can be lowered by implementing efficient production methods. For instance, less demand for outflow cleaning and internal recycling and lower demand for resources and energy efficiency (Sanyé-Mengual et al. 4). Besides that, eco-design increases competitiveness. Every designer who uses eco-design and the semiotics of eco-design concepts can obtain a competitive advantage in the market by distinguishing themselves from other designers and appealing to environmentally sensitive consumers (Borchardt et al. 50). Besides that; businesses may gain from green procurement as well as new green market needs. Also noteworthy is that eco-design can create new jobs in renewable energy, sustainable materials, and environmental consultancy.

Furthermore, designers can enhance their brand image thanks to eco-design. Add to that, they can improve their reputation and image by attracting customers who are environmentally concerned and appreciate sustainability (Sanyé-Mengual et al. 10). Likewise, the semiotics of eco-design increases designers' creativity. The reason is that eco-design drives innovation and creates new, long-lasting technologies and products, resulting in long-term economic advantages.

Overall, eco-design has the potential to provide a variety of economic benefits to designers, communities, and society as a whole, so promoting long-term economic growth and prosperity.

5.3. *Social advantages*

Eco-design results in healthier indoor and outdoor settings. To elaborate, it improves the quality of life for individuals who live and work in these areas and provides access and accessibility to green spaces. Hence improving mental and physical health and promoting public health and well-being, especially for vulnerable groups like children and the elderly (Sanyé-Mengual et al. 4). On top of that, it increases community participation and engagement by encouraging individuals to participate in sustainability activities and boosting environmental awareness. Furthermore, thanks to respecting sustainability and the environment, eco-design help lowering exposure to poisons and pollutants; eco-design may Promote cultural diversity as it helps preserve traditional and indigenous knowledge and practices while encouraging the development of new, sustainable technology.

Overall, eco-design can provide many social advantages, benefiting individuals, communities, and society.

6. The semiotics of eco-design in designers' education

Integrating the semiotics of eco-design techniques into designer education will ensure that the next generation has the knowledge and skills necessary to build environmentally friendly products and systems (Watkins et al. 625). On top of that, it is beneficial to develop an educational atmosphere in which semiotic interaction with nature occurs during courses or as a leisure activity (Mazitova 40). Here are several examples:

- Incorporate eco-design principles into classroom instruction: This might involve teaching students about the environmental effect of materials and production processes and how to reduce this impact through sustainable design approaches (Macdowell 143).
- Provide hands-on experiences: giving students hands-on experiences in the semiotics of eco-design can help them comprehend the ideas and build their design abilities. This might include programs focusing on sustainable materials, waste reduction, and energy efficiency.
- Promote interdisciplinary learning: the semiotics of eco-design encompasses a variety of fields, including engineering, materials science, and environmental science. Encouraging students to investigate these areas and incorporate their findings into their design work can contribute to a more holistic and long-term approach to design.
- Encourage industry collaboration: collaborating with industry to give students opportunities to work in the real-world (Watkins et al. 629). Eco-design projects can help students get a deeper grasp of the practical implementations of eco-design concepts.
- Stress the importance of life cycle analysis: It is an essential technique in eco-design since it evaluates a product's environmental effect over its complete life cycle (Macdowell 137). Students may learn to make informed judgments regarding the sustainability of materials and manufacturing processes by including life cycle analysis in their design curriculum.

By incorporating these techniques into designer education, we can guarantee that the next generation has the knowledge and abilities to build environmentally friendly goods and systems, contributing to a more sustainable future for our world.

Conclusion:

In a nutshell, eco-design is essential to sustainable development and has a critical role in lowering the environmental effect of goods and systems. Eco-design provides a framework for producing environmentally friendly and socially responsible goods and systems by embracing decreasing resource usage, increasing sustainability, and

stimulating innovation. As we confront the issues of climate change and resource depletion, adopting eco-design is becoming increasingly vital in today's society. We can assist in building a more sustainable future for future generations by emphasizing eco-design and implementing its ideas into our design approaches. Ultimately, the trend is projected to continue as customers become more conscious of environmental concerns and demand ecologically friendly items.

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