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DESIGN FOR SUSTAINABILITY AND DESIGN FOR ENVIRONMENT PRACTICES IN AUTOMOTIVE INDUSTRY

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Abstract

In order to preserve the earth and maintain strengthen acceptance in automotive industry it should be made commitment to sustainability and environmental consideration into account. At present, product development process in automotive industry in Malaysia is characterized by the increases of complexity and frequent changes caused by frequent innovations, fast-growing system complexity, expanding role of software and changing business relationships. This study is based on Design for Sustainability (DFS) & Design for Environment (DfE) and spread out the principle of sustainable and environmental in product design concept. Environmental and sustainable product is a goal to be achieved in every manufacturing process. In way to achieve the goal, many practice or instruments had been introduced and developed. DFS and DfE are the practice or approach that had been used widely in a few industries. This study also attempts to clarify the issues which are liable to influence the outcome of the development of new products or redesign of an existing product to become a green product. This research describes a set of sustainable and environmental characteristics for product design as early as at development stage. It goes deeper into how the characteristics shall be implementing as a tool to guides the design process.

Keywords: Sustainability, Environment, Automotive industry

1. Introduction

Design usually gives meaning in the context of applied arts, engineering, architecture and other creative endeavors. A term of "to design" refers to the process of originating and developing a plan for a product, structure, system, or component. While a term; "a design" is used for either the final plan (e.g. proposal, drawing, model, description) or the result of implementing the plan. More recently, processes (in general) have also been treated as products of design, giving new meaning to the term *"process design"* [1].

In a crucial transition from short term environmental management to long term systems design, ecological principles and concepts are becoming increasingly integrated into our everyday lives, influencing where and how we live. DFS is an inspiring, radical and detailed collection of the eco-solutions that can be applied to a range of design challenges. The ideas as on offer integrate social, political and economic factors, and promise a substantial reduction of resource depletion. Their application not only gives benefits to the environment but also improves overall quality of life, raising standards of health and bringing about greater social and environmental equity. Many car manufacturer is doing up to their very best level to ensure they are manufacturing the best car that suit with what people needs. This has been a tough task since the car manufacturing started hundreds of years ago. It involves many aspects and requires a few design tools.

2. Design for Sustainability

Growing in global concerns about environmental problems such as climate change, pollution and biodiversity loss and about social problems related to poverty, health, working circumstances, safety and inequity has fostered sustainability approaches for industry. A serious attention is essential to improve product design which some sustainability approach can be used

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such as DFS. DFS is one of the most useful instruments available to enterprises and governments to deal with these concerns. DFS is includes a more limited concept of Ecodesign or DfE. In some developed economies, DFS is closely linked to wider concepts such as systems innovations and other product life cycle.

There are many organizations have developed various tools and approaches to help companies to reconsider their design and produce products to improve profits and competitiveness and at the same time reduce environmental impacts. In 1997 UNEP (United Nations Environment Programme), in conjuction with Delft University of Technology in Delft, the Netherlands and other experts such as in Ecodesign, published the ground-breaking manual "Ecodesign: A Promising Approach to Sustainable Production and Consumption". Sustainability is concern with the well-being of the future [2]. For a product to be sustainable, a product must meet a number of challenges linked to people, planet and profit as shown in figure 1. DFS goes beyond how to make a 'green product' and now embraces how best to meet consumer needs more sustainable on a systematic level. These profit-driven strategies go by many names such as Sustainable Product Design.

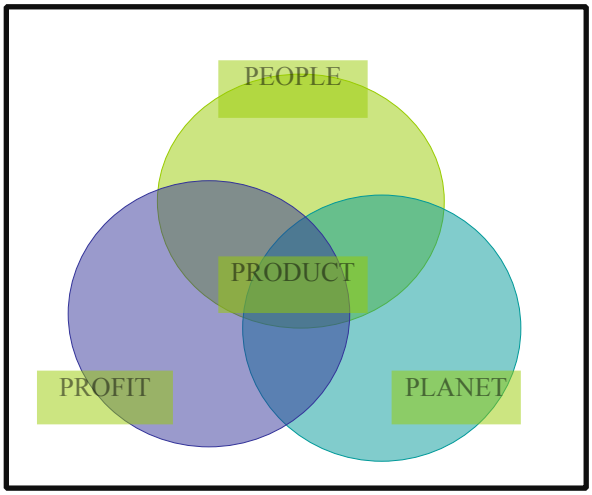

Figure 1: People, Planet and Profit challenge

Environmental factors are relevant to sustainability. That's means industries take environmental and social concerns as a key element in their long term product innovation strategy. This tells that, company implies environmental and social factors into product development throughout the life cycle of the product, throughout the supply chain and with respect to their socio-economic surroundings to ensure the sustainable of the product.

Nature uses the sun's energy to create interdependent systems in which complexity and diversity imply sustainability. In contrast, industrialized society extracts energy for systems designed to reduce natural complexity. The challenge for humanity is to develop human design processes which enable us to remain in the natural context. Almost every stage of the design, manufacturing and construction processes requires reconsideration. Linear system of thought or short-term programs which justify ignorant, indifferent or arrogant means are not satisfied enough to serve the future of the interaction between humanity and nature. We must employ both current knowledge and ancient wisdom in our efforts to conceive and realize the physical transformation, care and maintenance of the earth.

2.1 Elements of evaluating design for sustainability cases

There are about six elements can be access for the ancient world. The world can still perceived along these lines and they are presented here as an outline to frame the primary concerns of the environmental elements. These elements used as guidelines for accessing any design consideration.

2.1.1 Earth

In design, the earth is consists of both the context and the material. There must a struck balance between a context and material which provides a meaningful and livable diversity of scale. A full range of experience from the "urban" to the "wild" is essential to the landscape within which human culture evolves. A Design should provide benefits to flora and fauna as much as to humans just to preserving the world and environment for our next generation.

To preserve the earth, designers have the responsibility to consider the relation between materials used and an effective practical of modern technology such as non-toxic water treatment system and less hazardous paints. There are several considerations that designers should concern on such as:

i. Materials should be considered in light of their sustainability such as; process of extraction, manufacturing, transformation and degradation through a proper resource management and biodiversity on a global and local scale.
ii. Recycling of materials is essential in certain situation. But recycled materials shall not be considered when the product designed for disposability. The reuse of entire structures of product must be considered in the product fails to be reused to future human needs.
iii. Each of solid waste that unconsidered must be demolish with in a non-toxic way. In nature, waste equals food. Any waste which cannot be shown to be part of a naturally sustainable cycle is aimed to be eliminated.

2.1.2 Air

The air is the element which we can sense most immediately. When the air is polluted, all creatures can feel it. Local atmospheric pollution may have felt global consequences, so the overall design must not contribute for further atmospheric pollutions. Some evaluation on design must be done such as in terms of their atmospheric effects, including those on ozone depletion and global warming.

i. Air pollution implications of all design systems will be considered in the evaluation of designs. General air quality issues should also be considered to insure that no off-site or on-site air pollution results from the design.
ii. Wind patterns in all seasons should be evaluated for both detrimental and beneficial effects on site configuration.
iii. Noise pollution should be accounted and minimized as much as possible.

2.1.3 Fire

In plays the most dramatic symbol of the human ability to harness natural energy. Energy is important to achieve comfort and convenience and to transform materials to something useful effect. In this context, designers are encouraged to instill their designs with the ability to operate based on on-site renewable energy sources, without reliance on fossil fuels or any energy sources that can harm to the environment. Nowadays, impossible means nothing because by the technologies and wide range of material selections available, more design which maintains comfort levels passively without fossil fuels. This should be considered a minimum condition of energy design.

2.1.4 Water

Water is the most basic element of life of the planet. In some area, it will be a celebrated as a fundamental of life-giving resources. This shows how big water gives impact on human nature. Contaminated water in lakes, oceans and rivers which caused by human activities can be harmful to organism and plants in the water bodies. It is a current major problem in the global context. If the water is not treated it can cause of deaths and diseases. So that industry should not increase the pollutants water but reduce it to minimal pollutants.

2.1.5 Disposal

Most people are actually unwilling to throw electronics directly in the trash. Regardless of whether this is motivated out of desire to reclaim value or a concern for environmental affects, it suggests that more sustainable user behaviors are achievable. Unfortunately, many items are stored away at end of service. As they continue to become obsolete over time, the opportunity for reuse declines. More research needs to be done to determine why people chose to store products as opposed to other end of service choices. Perhaps, if options for redistribution were made more accessible, the storing of still-functioning products would not be as common as it been nowadays as it should be disposal.

2.1.6 Remanufacturing for Reuse

Remanufacturing is the process of disassembly and recovery at the module level and, eventually, at the component level. It requires the repair or replacement of worn out or obsolete components and modules. Parts subject to degradation affecting the performance or the expected life of the whole are replaced. Remanufacturing differs from other recovery processes in its completeness: a remanufactured machine should match the same customer expectation as new machines. There are three types of remanufacturing activities, each with different operational challenges. The types are:

remanufacturing without identity loss, repetitive remanufacturing without identity loss and remanufacturing with loss of original product identity.

3. Design for Environment

In manufacturing, transportation, forestry, construction, energy and other industrial sectors, mounting empirical evidence suggest that radical improvements in resource productivity are both practical and cost effective, even in the most modern industries. DfE is the systematic application of environmental and human health considerations at the product design stage. DfE aimed to avoid or minimized significant environmental impacts and increase resource efficiency at all stages of product's life cycle. It is also can be elaborate in names of product life cycle. Demand from environmentally conscious consumers and the proactive role taken by many companies has added DfE as a dimension that the design and manufacturing community must consider.

The rate of innovation and changes within the automotive industry is accelerating. This is due to changes in customer needs. In this present age, customers are ever demanding in what they expected from their car and how best it meets their needs. A new technology allows designers to challenge every aspect of a car from a design, from styling through body construction. Through tight of industry competition, it led to a searching for a new winning car concept. Commitment of reducing waste and pollutants, serving resources and using recycled materials at every stage of the product life cycle is another responsible for car manufacturer to preserve our earth.

3.1 Principle Design for Environment

3.1.1 Choosing the Right Material

Choosing the right material means gaining both maximum quality and protects the environment as well. For that, designers are force to seek for materials that are non-toxic, renewable resources, increasing the percentage of recyclable materials and give preference to recycled goods over virgin materials. Materials should recommend for use in products and processes are assessed prior to approval for potential health and environment impacts. Besides that material selection could be access through other several aspects such as;

i. Production methods
ii. Market or Customer' demands
iii. Design
iv. Price/profit
v. Environmental impact, and
vi. Lifetime.

3.1.2 Exhaust Emission

There are two main traditional which concerns about different type of exhaust emissions that affect environmental and health:

i. Impacts from emission such as nitrogen oxides (NOX), particulates, unburned hydrocarbons (HC) and also carbon monoxides (CO2).
ii. Impacts from emissions of greenhouse gases such as carbon dioxide (CO2) which is classified as non-toxic.

There is some reduction possible to be achieving by Low Emission Vehicles (LEVs) system. This system was one of the programs offer by National Low Emission Vehicle (NLVE) which had been practiced very well at United States and Canada. This system had been produced by General Motors since the year of 2004.

3.1.3 Fuel Consumption

Emissions of greenhouse gases from our vehicles are closely related to the fuel efficiency. Emission of greenhouse gases is non-proportion to the fuel efficiency. The better of fuel efficiency will emit the least of greenhouse gases. So that, a better fuel efficiency means fewer emission of CO2. Carbon dioxide (CO2) is emitted by the clean combustion of gasoline or diesel fuel from an engine. In this new millennium, cars should produce with better fuel efficiency. There are several solutions towards the fuel efficiency issue such as:

i. Introducing new or more efficient engines.
ii. Adapting engine to use alternative fuels such as NGV and LPG.
iii. Increase number of hybrid cars
iv. Introducing Electric car.

3.1.4 Reduction of CO2 Emissions and Performance

Automotive carbon dioxides (CO) emissions occur because internal-combustion engine today runs on fossil fuels such as gasoline and diesel. Burning off fossil fuels will release carbon-dioxide (CO2) into the air. Impact emission of greenhouse gases to the atmosphere can cause climate change and for long term period it can dreg into global warming where we had faced today.

To reduce emission of greenhouse gases through fuel efficiency, performance through lightweight design also can contribute to least emission of greenhouse gas. A heavyweight vehicle needs higher fuel consumption compare to lightweight vehicle in the same class. So, by reducing weight of the vehicle we can increase its fuel efficiency as well reduces emission of greenhouse gases. Weight saving is a great challenge for engineers to develop while try to meet customer demands for extra comfort, convenience, security and safety features.

3.1.5 Alternative Fuel

At present, we used fossil fuels such as gasoline and diesel in most of the car. To preserve our earth we must do something regarding climate change and global warming. To overcome this climate change and fight towards global warming, this fossil fuel needs an alternative fuel for replacement; General Motors (2006). There several alternatives found and now still under development stage such as:

i. Fuel cells

The fuel cell is realistic alternative to the internal combustion engine and is now under intense development by General Motor Corporation. The fuel cell uses the reaction between hydrogen and oxygen to produce electricity.

ii. Hybrids

A hybrid technology combining two or more power sources to move a vehicle such as combine an internal combustion engine with one or more electric motors.

3.2 Elements Evaluating Design for Environment

3.2.1 Reducing impacts of raw materials

Strategies for reducing the environmental impacts of extracting and processing raw materials can be divided into those concerned with conversing resources using low-impact materials and biodiversity conversation. One of the concerns of reducing impacts of raw material is use of renewable material. *Renewable materials* are material that can be formed again in a short time in nature and give no or very little impact on the environment. Example of renewable material is wood. Wood harvested from trees. A tree is cut, used in a product and a new tree is planted to replace the cut tree. The new growing tree will bind the carbon dioxide formed when the old tree is burnt. This is an example of the life cycle of a renewable material. If a forest has been cut down and no new trees have been planted again, the environmental balance is interrupted. This can lead to climate change and earth destruction [3].

3.2.2 Reducing Impact of Manufacturing and distribution

There are several ways in which companies can help maximize environmental impacts of the product life cycle during:

i. Manufacturing
   a. Minimizing the variety of materials
   b. Avoiding waste of materials
   c. Reducing the number of components and assemblies
   d. Integrating function
   e. Simplify assemblies
   f. Selecting low impact materials and processes

ii. Distribution
   a. Reducing the weight of the product and its packaging to save energy in transport
   b. Ensuring transport packaging is reusable and/or recyclable
   c. Maximizing the efficiency of packaging
   d. Choosing an efficient transport system

3.2.3 Green Design

A green design tool must be able to provide an optimal green design that has minimal environmental impact with respect to both product and process. The greenness of a product design is based on attribute hierarchy with eleven top-level attributes such as; sub-assembly reusability, label, internal joints, material

variety, material identification, recycled content in material used, chemical usage, additives, surface finishes, external joints and hazard level of the material used [4]. From a process perspective the greenness of the sub-processes are based solely on the disposition of the byproducts (output streams) the processes generate. A totally green process is an ecologically closed loop system where the outlet streams are completely recycled back into the process steps.

3.2.4 Eco Efficiency

Business Council for Sustainable development coined the term eco-efficiency to describe the efforts by businesses to take the environment into consideration in their operations. Eco-efficiency is a combination of economic and ecological efficiency. It is basically about doing 'more with less'. Doing more with less means, producing more goods and services with less energy and fewer natural resources, resulting in less waste and pollution, eco-efficiency directly links environmental performance to financial performance as a process is made more efficient, financial as well as environmental benefits will be realized [5].

There are seven key principles that every business should consider to developed products, introducing process changes or taking other actions with environmental implications. The seven key principles are:

i. Reduce the material intensity of goods and services.
ii. Reduce the energy intensity of goods and services.
iii. Reduce toxic dispersion.
iv. Enhance material recyclability.
v. Maximize sustainable use of renewable resources.
vi. Extend product durability
vii. Increase the service intensity of goods and services.

The environment must be seen as a part of the development process and not be taken as things that free to use. It can only state with some degree of certainty as to how much of our natural resources are being depleted and how much of hazardous material and the consequences of which are extremely difficult to quantify which introduced to environment by mankind.

4. Conclusion

As the conclusion, our environment really needs human's attention to ensure it can maintain the balance of eco-system. Today the earth is struggled to withstand the global warming while human is increasing the pollutions. This is not how it should be. A serious attention and follows by immediate action is essential to improve the quality of the environment besides improving product design which some sustainability and environmental elements to be used. Sustainability is commonly concern with the well-being of the future while DFE aimed to avoid or minimized significant environmental impacts and increase resource efficiency at all stages of product's life cycle. It is an evolving discipline and undoubtedly will go through several phases and approaches for good. The scenario now is to ensure a thing that seems to be safe today wills not turning out to be quite the opposite in the future but to be something that precious and human's priority.

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