



**KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN  
MALAYSIA**

**A Study on the Sustainable Product  
Development (SPD) Practices among the  
Malaysian Companies**

Thesis submitted in accordance with the requirements of the  
Kolej Universiti Teknikal Kebangsaan Malaysia for the Degree of  
Bachelor of Manufacturing Engineering (Honors) Manufacturing (Process)

By

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KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA

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## **APPROVAL**

This thesis submitted to the senate of KUTKM and has been accepted as fulfillment of the requirement for the degree of Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process). The members of the supervisory committee are as follows:



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## ABSTRACT

The concept of Sustainable Product Development (SPD) has emerged recently, and is distinct from the ideas of eco-design, cleaner production and design for the environment. This research set out the principles of sustainable product design (SPD) and the criteria for measuring the "eco-efficiency" of products. This research also contains the basis of a sustainable approach to product design in an attempt to clarify the key issues which are liable to influence the outcome of the development of new products. This report describes research undertaken to establish a set of sustainable characteristics for product design. It describes in detail how the characteristics can be used as a tool to influence the design process. Thus, SPD attempts to create product designs that are sustainable in terms of environmental burden and resource use, whilst developing product concepts as parts of sustainable whole systems that provide a service or function to meet essential human needs. The hypothesis underpinning this research is that design professionals are in a unique position to influence patterns of consumption by incorporating sustainability into new products. One way of achieving this outcome is by providing the design professional with an understanding of sustainability at the earliest phase in the design process. The study leads to conclusions on the economic and social conditions needed for sustainability in product development.

## **DEDICATION**

*For My father, mother and family.*

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# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Product development and sustainability are a recent combination of terms which have evolved from the recognition of the importance that design, manufacturing, material choice, product type, use and final disposal have on the environment. The recognition of a single global environment in which all activities are interrelated and affect each other is bringing researchers to an in depth recognition of the importance of the design process and its relationship to the environmental impact of products. This analysis has led towards the search for more fundamental changes at design, production and user levels aimed at moving towards sustainable development:

*The process through which all the physical and spiritual needs of the people of the planet will be permanently satisfied. Improving (and in some cases, maintaining) the present socio-environmental conditions.*

The goal of sustainable development becomes particularly relevant in the context of small enterprises in developing countries. These small enterprises are fundamental as they provide one of the few employment opportunities for local people. However, in many areas these small enterprises represent a menace to the environment. In the context of small enterprises in developing countries SPD is defined as follows:

*SPD is the process which creates product designs that are sustainable in terms of the environment and resource-use whilst considering the need for the product.*

In other words, SPD is the process of planning and designing that integrates resource-use efficiency and product quality elements into a product. Furthermore, sustainable Product Development (SPD) addresses values and it focuses on elementary needs, in the future, especially of people in developing countries. SPD focuses on the functions to be delivered through products, systems and services. It considers the properties and availability of resources and their distribution among nations and generations, in the past, present and future. It is embedded in, respecting and building upon the context of local physical, natural, social, cultural and economic conditions. These may be enriched on the basis of an input of sustainable principles, concepts and resources from elsewhere. (CFE Foundation, 1999)

Design has been included in the Product Life Cycle as it is seen as one of the major factors in defining the Sustainable Development impact because it will have an influence on all other parts of the life cycle. Reducing the overall impact by innovative new design is also a significant opportunity for any company.

On the supply side, industry's first response to the combined pressures of new regulations and increasingly "green" demand was to redesign existing products. This was an initial step on the road to what is now known as ecodesign (also called life cycle design or, especially in the US, design for environment). Much work was done on specific aspects of particular products, such as: reducing in-use consumption of energy and water by household appliances; increasing the amounts of recycled or recyclable materials used in manufacture; and reducing material intensity for given products. This groundwork provided a basis for development and expansion of the ecodesign concept. (Weenen, 1997)

As experience was gained, it became possible to extract generic principles. As a result, guidelines, "how-to-do-it" manuals, advice centres, and software tools

incorporating life-cycle analysis are now becoming available, allowing companies, of all sizes in virtually all sectors and in all parts of the world, to apply ecodesign principles at every stage of their operations.

Ecodesign has made a considerable contribution to reducing the environmental impacts of consumption. However, some experts believe the concept must continue to evolve if consumption patterns are to be changed sufficiently to achieve true sustainability. This evolution, with ecodesign dovetailing into sustainable product design, will call for radical thinking, including reflection on the very nature of "products". Taking a truly life-cycle view of a product requires a shift away from the conventional model, in which the purchaser acquires responsibility for disposal at the moment of purchase.

## **1.2 Problem Statement**

There is growing worldwide interest in environmental aspects of product development. All of us have responsibility to reduce environmental damage and improve the quality of life for ourselves. Most of the current focus is on reducing the problems of current products, such as:

- Improving energy efficiency
- Making products easy to disassemble for re-manufacturing to avoid waste problems
- Minimizing the amount of materials used in packaging.

One of the key requirements is to improve resource efficiency by assessing:

- The impact of raw materials in the design of products
- The methods of disposal of finished products

- The amount of waste generated in the product life cycle, ie attempt to prevent and minimize waste in the design process

In addition there is a need to use design to minimize the environmental, social and economic impacts during use and final disposal. This research about Sustainable Product Development will look at sustainable development throughout the Product Life Cycle.

### **1.3 Objectives of the Research**

For this project, there are few aims to achieve during implementation of this project for this semester such as:-

- To provide a working definition of sustainable or 'green' product development (SPD)

In order to provide a working definition of sustainable or 'green' product development, the definition of what is SPD is briefly defined and information, concept and some contents from existed report from previous research which is related about SPD is discussed briefly in this report.

- To gather the perception of product designers and manufacturing engineers on SPD.

The perception of product designers and manufacturing engineers on SPD is gathered in literature review chapter where some of the engineer which has previously reported based on their experience about what is SPD and how they applied it in their work.

- To investigate the available practices among a sample of Malaysian manufacturing companies.

By creating and providing appropriate questionnaire related to the concept of the Sustainable Product Development (SPD) practices, the questionnaire have been passed around to few Malaysian manufacturing companies to get respond or feed



back to investigate either they applied or not the available practices based on related practices from Sustainable Product Development (SPD).

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Definition of Sustainable Product Development (SPD)

Sustainable Product Development (SPD) can be defined as resource-, context- and future-oriented product development, aimed at providing elementary needs, a better quality of life, equity and environmental harmony. It goes beyond ecodesign, which usually focuses on the environmental optimization of existing products. SPD is concerned with changing patterns of production and consumption. A great deal of local knowledge on renewable resources is available in developing countries. (Weenen, 1997)

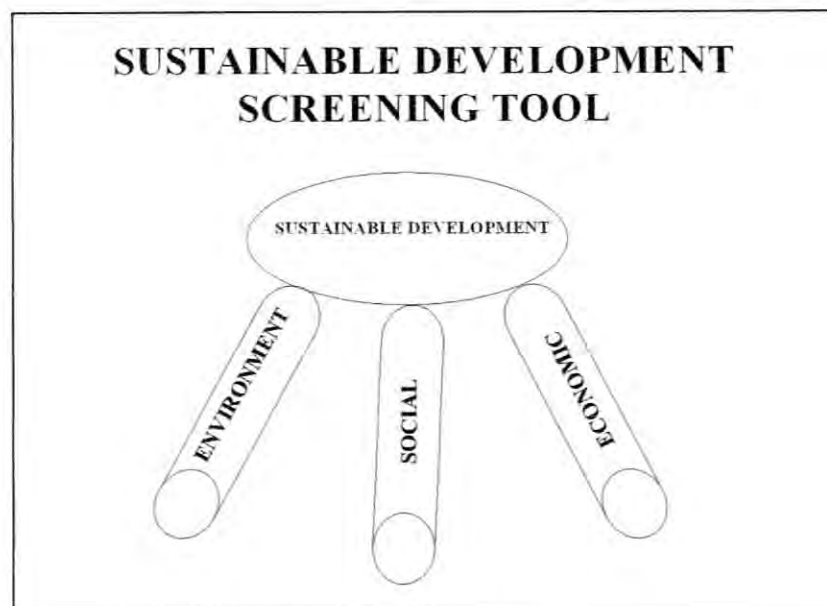


Figure 2.1: Sustainable development screening tool

Sustainability is an economic, social, and environmental concept. It is intended to be a means of configuring civilization and human activity so that society and its members are able to meet their needs and express their greatest potential in the present, while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals indefinitely. Sustainability affects every level of organization, from the local neighborhood to the entire planet. It is sometimes a controversial topic.

Sustainable development depends on two things: *what types* of products are made, and in *what quantity* they are made. The issue of quantity of production can only be settled by knowing the carrying capacity of the environment. Even then, the concept of restricting production raises complex questions of social and international equality. Consumption is normally limited by market forces. Even with new tax regimes, market economics will be inadequate to restrict consumption of products and the question of social benefit arises - is the product really needed? Hence it is useful to define the nature of a sustainable product or at least to have some absolute measure of "degree of sustainability" - which we will call "eco-efficiency". This will allow social benefit to be set against environmental cost. (Simon and Sweatman, 1997)

SPD and eco-design are terms for strategies that aim to integrate environmental considerations into the design process, but confusion exists between the definitions of these terms. Life cycle thinking forms the basis of both these terms. Eco-design aims to minimize the consumption of energy and resources and the subsequent consequence on the environment, concentrating on reducing the impact of individual stages of a products life span. A SPD priority is the reduction of environmental impact in the whole system. This requires the designer to consider the design of a product in context of material extraction, production, distribution, need, societal issues, human factors, function and disposal. (Cull and Malins, 2003)

The UNEP-WG-SPD defines sustainable product development (SPD) as going beyond the environmental optimization of products and the ideas of eco-design and design for environment, to consider the service and function of the product, and the related social benefits versus the impact on sustainability. In other words, SPD asks, "Is the product really needed?"

"Ecodesign" is usually defined and implemented as environmental optimization of product design in each and every phase of the product development process and covering each and every phase of the product life cycle, from raw material extraction up to disposal of the wasted product. Usually it is presented as a step-wise process, an organizational arrangement, with the objective that a company will benefit both from an economic as well as an ecological point of view. However, this concept has been developed in the western industrialized world, in reaction to the waste and emission problems connected to the products. After having paid much attention to process improvement (pollution prevention, prevention of waste and emissions) it became clear that the products from the improved processes also had an important influence on the environment. Similar to the pollution prevention approach (a step-wise assessment of the production process to find options for improvement) an ecodesign approach was developed and stimulated. (CFE Foundation, 1999)

## **2.2 The characteristics of Sustainable Product Design**

The characteristics of sustainable product design are stated and described as followed where the characteristics of SPD have been divided into five taxonomies. (Cull and Malins, 2003)

The formulation of the characteristics of SPD is an ongoing and iterative process. The characteristics aim to provide the designer with a framework of understanding of the

problems and opportunities of SPD. The designer will be able to build upon this framework as advances within the field occur. Designing a sustainable product requires the consideration of all stages of its life span: the function; manufacture; distribution; the consumers' needs and desires; product performance and interaction; and appearance. Unlike other attempts these characteristics of SPD address all these aspects, describing problems with current practice and design opportunities in the framework of production and people: pragmatic and qualitative.

The characteristics of SPD have been divided into five taxonomies these are as follows:

- The product is designed with an *end of life strategy*: An appropriate and safe method of disposal once the useful life of a product has expired is determined prior to production. Clear instructions, written or visual on appropriate disposal of a product are provided. This taxonomy address characteristics such as recycling and eco-labeling; reuse; familiar fastenings which allow the user to repair or remanufacture; the use of biodegradable materials e.g. in food packaging; and durability extending a products useful life.
- The product is design to *do more with less*: Efficient use of resources and energy during production, distribution, use and disposal. This includes the use of local production and resources creating employment; applying renewable energy e.g. wind, water, solar or man-powered, and renewable resources; the creation of virtual products that provide services e.g. sharing of products; miniaturization; and multi-functional products e.g. the Black & Decker Quattro tool.
- The design of a product *influences individuals to adopt sustainable and sufficient patterns of consumption*: this taxonomy maintains the need to develop alternative forms of the act of consumption in order to encourage consumers to adopt purchasing behavior that serves their needs without having detrimental consequences on available resources, economies or the environment. This must be achieved through a period of transition that does not correspond with a scenario of giving up (Manzini, 1994). Characteristics include exploring alternative forms of products such

as virtual products or services; questioning the needs the consumer is trying to achieve through the purchase of a product; and customization.

- Product scripts address *real behavior, satisfy real needs and encourage users to be proactive*: The intended plan of use of a product should address real, rather than ideal behavior patterns, satisfy real needs rather than transient fashionable or market-driven needs (Fuad-Luke, 2002). It should also encourage the adoption of sustainable behavior through product scripts. Characteristics include constraining actions that result in use that is not sustainable; research and observation; inclusive design and considering the needs and wants of a consumer.
- The product displays *seductive, simple and appropriate aesthetics*: The aesthetics of a product play a significant role in its adoption, aim to create the 'I like it, I want it, and what is it?' (Seymour, 2002) element in a product. This taxonomy requires a move away from the transient styles and stereotypical aesthetics in order to design a competitive product. The characteristics ask: what type of consumer is the product trying to attract? And what lifestyle image does it offer the consumer?

### **2.3 Environment Guidelines for New Product Development Concept**

Below are environment guidelines for new product development concept which is consists of raw material selection, raw material legal requirements, raw material disposal, and general environmental considerations. (Bournemouth University, 2005)

#### **(A) Raw Material Selection**

Obviously the key to material selection is the required function and performance of the new product. However, in selecting the particular raw material the designer should be aware of some of the environmental issues which may be raised later in the project.

- (1) **Energy Usage:** this is the key to global warming and acid rain and often the energy used to produce the raw materials is the major contribution in the complete Life Cycle from cradle to grave.
- (2) **Resource:** The concern is both the use of non-renewable resources and the amount of resources used to produce a tonne of the raw materials selected.
- (3) **Source:** Transport of material may be a significant element in the environmental impact, and also there may be some encouragement to support the development of third world operations.
- (4) **Pollutants:** Some materials are identified as harmful to the environment – CFCs, PVC, chlorine, solvents etc. (see Environment and Materials Manual).
- (5) **Disposal:** The material may be a special waste and has to be treated in the appropriate manner – incineration. Ideally the waste raw material should not be limited to a specific disposal method (see (C) later).

## (B) Raw Material Legal Requirements

- (1) **Pollution:** the raw material could harm the environment if released to air, land or water (see Environment and Materials Manual).
  - (a) **Air:** This could cause acid rain, global warming or ozone depletion.
  - (b) **Ozone Depletion:** There is a method of defining the ozone depletion potential (ODP) of materials.
  - (c) **Land:** It may easily contaminate the land – solvent, biocides, heavy metals etc.
  - (d) **Water:** There are restrictions on the chemicals and amounts of materials that can be discharged as effluent. Some materials are banned.

- (2) **NUISANCE:** independent of any authorisation of a process there is a duty not to cause a nuisance to residents via odour noise, dust, plumes etc. Dust and noise should be controlled within the process design and the odour potential of some materials is listed in the Environment and Material Manual.

**(C) RAW MATERIAL DISPOSAL**

The principal should be to minimise the amount taken to final disposal, and the disposal method should be safe and low environmental impact

- (1) **RE-USE:** The raw material can be re-used in the process, and no limited shelf life.
- (2) **RECYCLE:** Common material which can be used in other processes, not a special one off chemical.
- (3) **STORAGE:** No special conditions.
- (4) **METHOD:** May need special requirements, storage, transport and final disposal. This should be highlighted.

**(D) GENERAL ENVIRONMENTAL CONSIDERATIONS**

To minimise the environmental impact the following should be evaluated:

- (1) **AMOUNT:** The key is to reduce the amount of materials used and extend the frequency of use, i.e. minimise the amount of material for longest possible time.
- (2) **USE:** Changing the use can have a dramatic affect on the whole of the Life Cycle. Examine carefully the current and proposed procedures and possibilities of re-usable products. Can it be re-used for another purpose?
- (3) **DISPOSAL:** In general choice of raw material and disposal method has the largest environmental impact. Disposal should not be restricted to only one method as thee will be local national requirements to meet.