ENVIRONMENT IMPACT OF PRODUCTS AT THE END OF THEIR LIFETIME

AXINTE CRINA, CRISTEA ION

University of Bacau

Abstract: As compared to the standard design process, one of the most salient new elements in ecodesign is that manufacturers now have to start thinking about what happens with the product after it leaves the factory. Additionally, manufacturers must develop different scenarios for what happens to the product when the user no longer use it; in other words, what happens in the product end-of-life phase?
This paper deals with the product end-of-life alternatives: what they are and when can be applied?

Keywords: environmental impact, products, end of life

1. INTRODUCTION

The explosive development, especially during the last 30 years, of the material products and, hence, of the manufacturing industries, lies to seriously effects on the environment with negative implications, even disastrous here and there (acid rains, death of Rin fishes, the graves accident from Seveso - Italy, Bhopal - India, Cernobîl - Ukraine, depletion of the ozone layer, climatic changes, etc.).
Environmental impact occurs not only at using the product but also at all stages of a product life cycle. That is, whether we want it or not, all our products affect in some way our environment during their life-span: during production, the environment is always affected by the extraction of raw materials, the emissions from production, and so on; when we buy the product, we will use it, and this usage also results in a pollution of the environment (e.g., if the product runs on electricity); at the end of the product lifetime, we disposes of it and it pollutes the environment again (fig. 1).

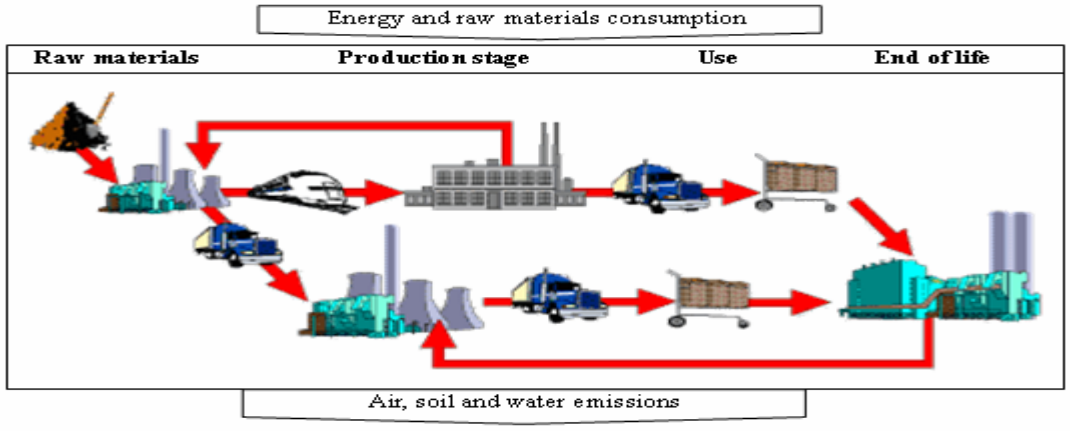

Fig. 1 Product lifecycle

In the light of these circumstances, the fallowing question is increasingly evident:

How can we decrease these impacts?

The answer could be expressed by three words that have become very familiar over the past few years: **reduce, reuse** and **recycle**. These 3 Rs serve as an icon to guide us through the uncharted jungle of environmental first aid. They are our first steps on the road to "repairing" the earth.

2. END OF LIFE ALTERNATIVES AND THEIR IMPACT ON THE ENVIRONEMNT

Waste reduction, reuse and recycling are valuable components of the solid waste management system. Many countries are adopting or proposing legislation requiring responsible end-of-life product management. The actual world's environmental policies are based on the concept of **waste hierarchy** [1], which classifies waste management strategies according to their desirability. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. Hence, waste prevention is the most preferred alternative and what can not be prevented it must be reused, recycled and recovered as much as possible, landfill disposal being the least preferred solution (fig. 2).

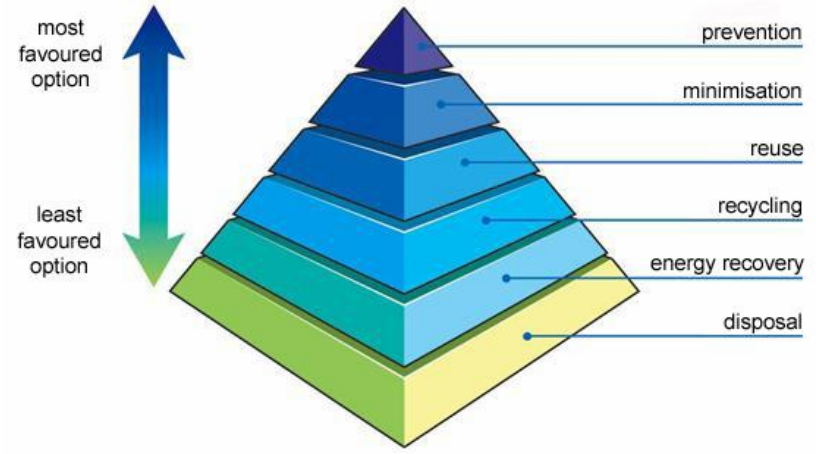

Fig. 2 The waste hierarchy

This waste hierarchy has not to be perceived as a rigid formula, especially if we take into account that the different methods of waste processing may have a different impact on the environment. Nevertheless, the aim is to advance towards a society of recycling and recovery, that is to rise on the hierarchic scale.

2.1 Reduce

Waste prevention, or **source reduction**, is the most preferred method of waste management and one in which everyone can participate. Source reduction refers to any change in the design, manufacture, purchase, or use of materials or products (including packaging) to reduce their amount or toxicity before they become municipal solid waste [2].

Source reduction has the following benefits:

- *saves natural resources*: using less material when make items means that less raw materials will be extracted and finally less waste will be generated. So, optimising the use of raw materials, purchasing durable, long-lasting products rather than disposable ones, buying only what we need, using recycled materials, buying products that do not have a lot of packaging, etc. are ways to decrease waste and save the earth resources and make them available for the future generations.
- *reduces waste toxicity*: seeking products and packaging that are as free of toxics as possible, using less hazardous alternatives for certain items (e.g., cleaning products and pesticides), sharing products that contain

hazardous chemicals instead of throwing out leftovers, reading products label directions carefully, using the smallest amount necessary are some sample guidelines by toxicity reduction can be achieved.
- *reduces costs*: preventing waste also can mean economic savings for communities, businesses and individual consumers.

2.2 Reuse

What we can not reduce we should try to **reuse**. Because it takes so many resources to make a product and along its entire life cycle so much waste are generated, it should be ideal that every product be reusable.
A "reusable" product is one that is designed to be durable and used over and over again, instead of being "disposable" and thrown away after one use.

The importance of designing and purchasing products and packages that are reusable becomes clear if we consider that for every ton of consumer garbage there is 5 tons of waste at the manufacturing stage and 20 tons of waste at the site of initial resource extraction (mining, pumping, logging, etc.) [3]

Reuse can extend a product life many times. Reusing products before they are recycled or thrown away can save virgin natural resources, energy, reduce disposal needs and costs.

By seeking out and buying good quality products that will last a long time we can reduce the waste. The longer a product can be used, the better, since it does not need to be replaced by a new one. When we buy less expensive items, we may initially save money, but in the long run we may have to replace the less expensive item two or three times in the same time period the better quality item would last. And each time the cheaper product is replaced, it has to be manufactured more resources and creating more waste. It is also important to look for products with lifetime guarantees - if a company promises to repair a product for a certain lifetime, chances are it will last longer before it needs fixing.

Another way products can be given a second (or third or fourth) life is by being repaired, rebuilt, restored, or reconditioned and then reused: typewriter and computer printer ribbon cartridges can be reinked or refilled, tires can be retreaded, cars can get new engines, etc. For many products, individual parts can be reused to repair items - auto dismantlers particularly salvage the useful parts of crashed cars for resale, rather than simply recycle the whole car as scrap metal.

Upgrading a particular appliance can also extend the life span of a product, if the design allows. It is quite standard practice, for instance, to fit larger hard disks or additional memory, better processors, new power supplies or different mass storage devices to computers. Computer manufacturers now design products with a modular structure that allows various components to be removed, upgraded or replaced, enabling many of the original parts to be retained virtually indefinitely, or at least until they are beyond repair; in this way the useful life of the product as a whole is extended.

Some products can be remade through what is known as "remanufacturing," an industrial process in which products are reassembled using old restored parts and a few new parts to produce a unit that is of the same quality as, if not superior to, the old. Currently automotive parts, industrial equipment, office machinery, and appliances form the largest market of remanufactured products.

Products that are no longer required by their original users can sometimes be reused by others. One person’s trash could be another person’s treasure. Instead of discarding unwanted products that are still serviceable, try to selling or donating them to charity or community groups. In this way, things that are no longer used are put back into circulation, avoiding them from being thrown away.

Increasing product lifetime through better design, repair of broken or worn items, and continuing to reuse a product for its entire lifespan is more effective than recycling, because it does not need to be reprocessed before it can be used again. Simply doubling the lifetime of any product will halve the energy consumption, the waste and pollution, and the ultimate depletion of all the materials used to make it.

2.3 Recycling

When a product cannot be reused or repaired, **recycling** would be the next alternative. Recycling is a series of activities that includes collecting recyclable materials that would otherwise be considered waste, sorting and processing recyclables into raw materials such as fibers, and manufacturing raw materials into new products [1]. Collecting and processing secondary materials, manufacturing recycled-content products, and then purchasing recycled products creates a circle or loop that ensures the overall success and value of recycling. As consumers, we can participate in making the recycling cycle work by making sure we recycle everything that can be recycled and purchasing as many products made from recycled material as we can. Gluts of recyclable materials can become worthless if there are not enough buyers of recycled products. When we buy recycled products, we create an economic incentive for recyclable materials to be collected, manufactured, and marketed as new products. Thus, buying recycled has both economic and environmental benefits.

Apart from the common materials that are usually recycled such as paper, plastics, glass, aluminium, etc. there are a lot of other materials that could be recycled. When considering the recyclability of a product there are two separate and distinct issues: first, *can a product or material technically be recycled* and second, *in real life can a product or material practically be recycled*? The difference between these two definitions of recyclable is controversial in the product/packaging-labelling world. Some say that any product or material that can technically be recycled should be labelled “recyclable.” Others say that the attribute “recyclable” should only be used on a label if, in fact, it can really be recycled in the community where the product or package is sold. While recyclables such a glass or newspapers can be recycled almost everywhere, other recyclables like plastics or motor oil can only be recycled in the limited number of areas where programs have been set up. In this case, the fallowing question appears: it is economically feasible to recycle a product? Sometimes virgin raw materials are cheaper than recycled materials, thanks to governments’ subsidies and policies. Transportation issues can also come into play: is it better for the environment to use a local raw material or recycled material transported from a great distance? So, any time the aspects concerning the recyclability of a product are analysed, the boundary conditions of the system it belong have to be very clear specified and always be kept in mind the impact on the environment.

As end of life alternative, recycling has multiple benefits: reduces the needs for landfills and incineration by reducing the amount of waste, conserves natural resources, saves energy, reduces emissions of many greenhouse gases and impacts global worming, creates jobs, supplies valuable raw materials to industry and stimulates the development of greener technologies, reduces the expenses due to avoided costs. But all these advantages can not be attained if there is not social implication – from government and industry, to organizations, small businesses, and people at home. In this sense a major role are played by the environmental education.

2.4 Incineration

When product, component or material reuse and recycling are not possible, **incineration**, preferable with energy recovery, is another end of life option.

Incineration is the process of destroying waste material by burning it at very high temperatures. Incineration is often alternatively named "energy-from-waste" (EfW) or "waste-to-energy" because, in effect, incineration of waste allows to recover the useful energy content of the disposed materials.

Though incineration has a series of advantages (reduces the stress on landfills, recovers the solid waste energy, treats waste emissions under controlled conditions), as a waste management tool it is becoming controversial because of the incineration solid outputs, that contain toxic metals such as lead, cadmium, copper and zinc as well as small amounts of dioxins and furans that must be treated with expensive air pollution control equipment to avoid contributing to acid rain, ozone depletion and air pollution. Therefore, while incineration seems to be an effective way of dealing with waste, its reputation leaves something to be desired.

2.5 Landfill disposal

Landfills are the final resting place for all our noncombustible, nonrecyclable materials, as well as ash from incineration and residues from recycling. Even if landfills cost millions of dollars to build and tens of millions to maintain, landfill sites are still a predominant alternative of waste disposal in most countries.

A landfill is a carefully designed structure built into or on top of the ground which purpose is to bury the trash in such a way that it will be isolated from groundwater, will be kept dry and will not be in contact with air. Under these conditions, trash does not break down very rapidly. In fact, when a landfill is closed, the site, especially the groundwater, must be monitored and maintained for up to 30 years to ensure that the eventual leaks will be discovered before their toxins contaminate the environment.

The older landfills, built according to old, less strict directives, can create a number of adverse environmental impacts, including wind-blown litter, attraction of vermin, groundwater contamination with leachate, fires caused by the improperly disposed of chemicals or methane gas that results from organic matter decomposing, etc. All these disadvantages are prevented in the case of modern landfills, designed and managed according to increasingly restrictive limits imposed by the new legislation.

3. CONCLUSIONS

The product designer will not be able to define directly the end-of-life scenario for his products but he can try to analyze how the design will perform in different end of life scenarios. One should always keep in mind that by developing products that are designed environmentally responsible in the early stage of their conception, by using the design principles like: standardisation, modularization, structural simplification, minimization of number of parts, timeless design, high quality, informativity, serviceability, availability of spare parts, etc., he will influence indirectly what happens with products after their useful life. An effective design will ensure that at the end of their useful lives, products are recycled into new materials, that they are kept out of landfills and the natural resources are conserved.

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