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ENVIRONMENTALLY FRIENDLY INDUSTRIAL PRODUCTS - RECYCLING CONSIDERATIONS

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Abstract. *The state of play in regulations of industrial countries reflects the growing pressure for industry to take into account of the environment. To judge the total impact of a product on the environment manufacturers have to do a "life cycle assessment". This sums up all negative effects over the lifetime of a product.*

In response to the increased focus on responsible solid waste management, design for recycling means both design for easy disassembly and design with recyclable materials. In both cases, an effective design will ensure that at the end of their useful lives, consumer goods are recycled into new materials, that they are kept out of landfills, and the natural resources are conserved.

Key words: *environmental suitability, ecological industrial products, design for recycling, disassembly, environmental protection, life-cycle assessment, solid waste management*

INTRODUCTION

Environmental issues related to solid waste management have taken on growing significance in recent years. The state of play in regulations of industrial countries reflects the growing pressure for industry to take into account of the environment. Efficient solutions to recycle end-of-life consumer goods are needed.

Not long ago, solid waste management was focussed mainly on packaging issue. Nowadays, it comprises generation and proper handling of all solid waste. Communities, especially those of industrial countries recognize that recycling programs should also address the special collection of larger items such as major applications. Stringent regulations in many countries are aimed to remove these products from landfills.

The European Union has been promoting certain standards for the end-of-life

consumer goods since 1990. The main goals of those standards are:

- to reduce waste generation as much as possible
- to improve treatment of waste itself
- to promote the use of recyclable products

The electromechanical and electronic end-of-use products make up 2% of waste produced by the European Union yearly, Peleari, L. (1995). Although it is not a very significant amount, they have to be taken into account for the general improvement of the quality of life.

Durable consumer goods such as automobiles and major appliances are relatively voluminous items, and their disposal without proper treatment causes huge space consumption. On the other hand, methods such as shredding does not economically recover many materials. Therefore, producers need to rethink design, and through an new concept enable efficient and economical procedures to regain useful substances.

Consumer goods recycling is not on the top of agenda on environmental problems in East European and developing countries. However, awareness of this problem and analysis of the steps undertaken in leading industrial countries can help them to develop appropriate recycling infrastructure in due course, and enable their industry to get ready for competition at foreign markets already affected by stringent environmental policies.

1. DESIGN FOR ANTICIPATED RECYCLING

To judge the total impact of a product on the environment manufacturers have to do a "life cycle assessment" and to establish information feedback on every step of product existence (Fig. 1). This sums up all negative effects over the lifetime of a product.

Design for recycling means both design for easy disassembly and design with recyclable materials. Basic conditions for effective recycling of major appliances is possibility to separate different materials as well as materials from the same group, but with significantly different characteristics. New design concept takes into account of environment and recycling in early phase, to enable more convenient processes, to increase productivity and thus amount of products recycled. Some general criteria to achieve this ambitious goal are:

- implementing of modular solutions, with sections and grooves for dismantling of parts made of different materials
- application of materials with more pronounced recyclability; for instance, decreasing use of PVC in favour of styrene resins, etc.
- using advantages of alternative assembling techniques (clips, etc.), with no classical screws and/or permanent junctions
- avoiding "hybrid" components, and searching for so called monomaterial solutions,

Those principles, based on *Design for Recycling* concept, Papeschi, R. (1995), should enable more economical procedures and significant energy savings during recyclable items processing. Design for recycling concept is recently supported with specialized software packages such as DFE, "Boothroyd & Dewhurst, Inc." and "TNO" that provide valuable assistance under design procedures. Further development of expert systems in the field of environmentally friendly product design should be expected in the near future.

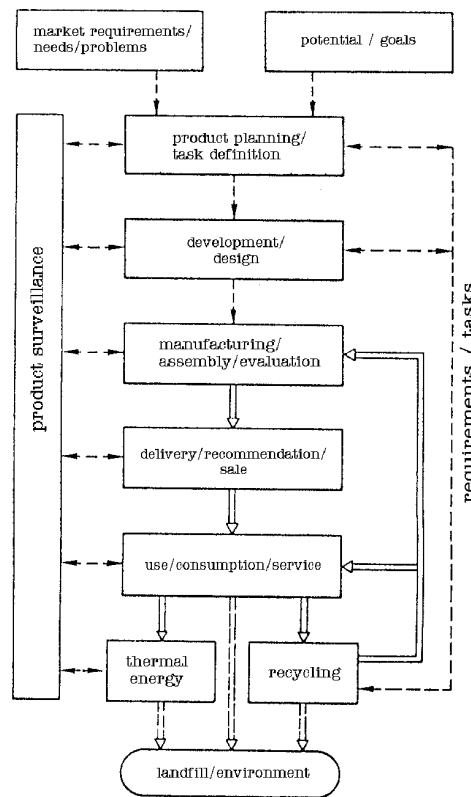


Fig. 1. Product life cycle and information feedback

2. RECYCLING PACKAGING

Over 50 million tones of packaging is produced in Europe every year, PAPESCHI, R. (1995.). Recycling packaging is one of the first solid waste management issues which is meant to be considered internationally, in a framework of European Union. Inequalities in legislation acted as a barrier to free trade, and this prompted proposal for an EU scheme to iron out differences between member states.

Document "Toepfer", for example, constrained German operators to recycle at least 60% of produced plastic packaging. The European Union then overtook the content of this document, and since 1995. the same obligation has been spread to the other member states.

Germany and France carried out European directives on packaging waste (EC packaging waste directive) and implemented their national schemes since January 1993. Manufacturers, distributors and vendors are all obliged to take over, recycle or use again their packaging on customers request.

German regulation divides waste into transport packaging and sales packaging, and both are the liability of manufacturers and vendors alike. The method of recycling de-

depends on the distribution channel used. Manufacturers who sell direct have their own deals with recycling firms, whereas resellers often split the cost of recycling with the product makers.

Some companies have set up special groups to define a packaging strategy. Munich-based distributor "Computer 2000" uses returnable boxes to make deliveries. Company has a deal with its carrier to return the container back to them to be used again for further shipments.

As a rule, distributors insist that all suppliers use recyclable material in their packaging. It allows them to become members of the nationwide "Green Dot" scheme, allowing end-users to drop off packaging at any collection point.

3. THE ISSUE OF ELECTRONIC WASTE

Packaging is not the only area in which recycling laws are beginning to have an impact. The Commission of European Union has designated electronic waste as a "priority waste stream". It has given the Italian Environment Ministry the task of setting up a pilot project to study how a national recycling scheme for discarded consumer electronics could work in practice in order to establish an EU-wide law. It makes it obligatory for firms to collect old machines and retrieve components. The law also deals with new appliances coming onto the market, in an effort to constrain manufacturers to take account of recycling when designing new products. Germany was ahead once again in the field of recycling used electronic devices. Companies usually sign contracts with their carrier to collect the scrap and pass it on to recycling plants. Estimated cost of this form of recycling is about 3 DEM per kilogram, Newman, J. (1993), and it affects adding five to ten percent of the cost of, for example, computer products. Of all the equipment covered by the law, computers make up at the moment about 10 percent, the rest coming from household appliances. Rapid increase in percentage of computer scrap is expected in near future.

4. APPLIANCE RECYCLING

Domestic appliances are, being one of the most widely-spread form of durable consumer goods, in focus of many operators dealing with solid waste. In the year 2000, alone, an estimated 53 million appliances will be discarded by their owners. In 1994., about 38 million appliances have been recycled, generating roughly 200 million of steel scrap.

Today, almost entire value gained from recycled appliances comes from metals. Their relatively high recyclability rate is, therefore, due to high steel content. However, the percentage of steel in appliances, as well as the appliance's total weight, is getting significantly lower than it used to be. It could decrease an appliance's value to the recycling industry. That value should be maintained by improving methods to economically recycle other materials, preferably in one closed loop system over the entire lifetime of a product (Fig. 2).

Traditional procedure of treating major appliances begins with shredding. Appliances are being loaded onto a conveyor belt, which takes them to a shredder. This reduces the appliances to fist-sized pieces. A medium-sized shredder uses 36 hammers weighing more

than 100 kilograms. Magnets pull out the pieces of iron and steel scrap from the nonferrous metals and other materials. Approximately 75 percent of the shredded appliance materials is ferrous metal that is used to manufacture new steel, including steel for new appliances. The aluminum, copper, and other nonferrous metals go to smelters of these materials for reuse in new products. Possibilities to improve and modernize procedure are mainly in developing products designed for disassembly in early stage of conception. It would simplify procedure and provide energy savings in further steps of processing.

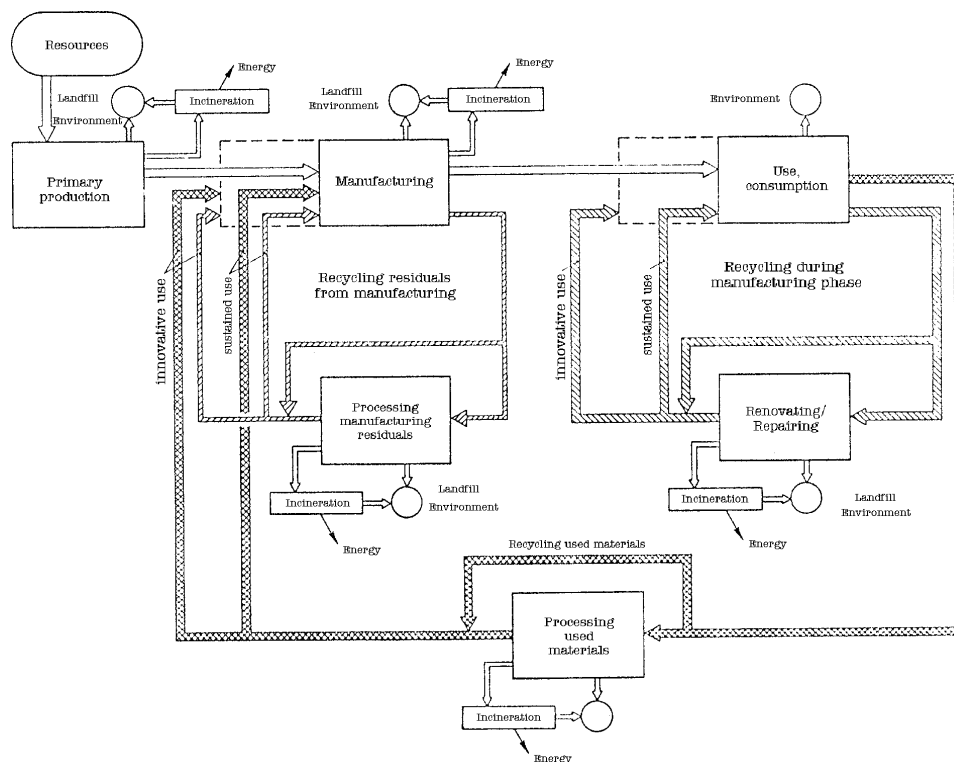


Fig. 2. Closed loop system of materials flow in phases of manufacturing, consumption and reuse according to VDI - 2243 [9]

5. RECYCLING OF PLASTICS

While metal recycling requires well-known and thus relatively simple procedures of separation, recycling of plastic parts should be considered under product design, anticipating further use of secondary material. Even if the problem of separation different materials from an appliance has been solved (with products suitable for dismantling), identification of plastics should be done in order to make use of it in the most proper way.

German producer "Grundig" labels all plastic parts heavier than 100 grams (technical and commercial name, and code). General acquiring of this principle could help producers of plastic components to organize their own recycling scheme on local or

micro-regional level. This concept is particularly suitable for industries in East Europe and developing countries, since it could be implemented even before national recycling infrastructure is established.

6. ECO-LABEL: MARK OF ENVIRONMENTAL RESPONSIBILITY

Environmental legislation can give environmentally responsible manufacturers an advantage over their competitors by targeting their products at environmentally-conscious consumers. The voluntary Eco-label scheme, Newman, J. (1995), agreed by EU ministers few years ago, allows for considerable input from the industry in determining standards.

The scheme works by defining environmental standards for a product group. Manufacturers can then apply to have their products tested. If they meet the required standards, they receive an Echo-label. European printer manufacturers, for example, have submitted a scheme which proposes that any printer maker from Europe or outside can have its product tested for noise, ozone emissions and content of recyclable components.

That is the right way environmental laws should influence industry, and direct customer's attention to environmentally sound products. Increased consciousness on those issues would then lead to structural improvements itself.

7. CONCLUSION

Recycling of end-of-life consumer goods is a must of contemporary civilization. Legislation will have a far-reaching effects on industry, from manufacturers through the supply chain to vendors. It should support efforts in search for solutions in the field of solid waste management. Environmentally responsible manufacturers should be awarded advantage over competition.

To judge the total impact of a product on the environment manufacturers have to do a "life cycle assessment". This sums up all negative effects over the lifetime of a product.

Environmental concern is becoming increasingly important in all fields and aspects of industrial, environmental, commercial and social activity. Environmental protection is of necessity multi-faceted and multi-dimensional in nature.

Possibilities to improve and modernize present procedures generally depend on developing products that are designed environmentally responsibly in early stage of their conception. An effective design will ensure that at the end of their useful lives, consumer goods are recycled into new materials, that they are kept out of landfills, and the natural resources are conserved.

REFERENCES

1. Janković, J., Glišović, S.,: *Consumer Goods - Recycling Concerns, Proceedings of Sixth International Symposium "ECOLOGY '97."*, Union of Bulgarian Scientists, Bourgas, 24-26 June, 1997., page. 15. - 18.
2. Newman, J. (1993): *Rules and regulations to protect Europe's environment.* - European Computer Sources 2 (7): 88-85
3. Papeschi, R. (1995): *Problemi e Prospettive Di Progetto Per I Prodotti Monomaterici e Riciclabili.* - *Apparecchi elettrodomestici* 1: 115-118

4. Peleari, L., A. (1995): *Il recupero dei prodotti elettrotecnici ed elettronici a fine vita*. - *Energheia* 2: 6
5. Simpson, D. (1995): *Built-in Recyclability*. - *Appliance* 52 (8): 31-33
6. Stahel, W.: *Langlebigkeit und Materialrecycling*. Essen: Vulkan - Verlag 1991.
7. VDI - 2243 : *Konstruieren recyclinggerechter technischer Produkte*, Düsseldorf: Verlag 1993
8. *Waste Age*, Vol. 27, N° 1 (1996.)

EKOLOŠKA PODOBNOST INDUSTRIJSKIH PROIZVODA - PROBLEMI RECIKLIRANJA

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Savremena zakonska regulativa industrijalizovanih zemalja odražava rastući pritisak na industriju u pogledu primene mera očuvanja i zaštite životne sredine. Od proizvođača se očekuje da u skladu sa najnovijim zakonskim aktima preuzmu odgovornost za uklanjanje i obradu svojih isluženih produkata, čiji efekti na stanje životne sredine u svim stadijumima radnog veka treba da budu minimalni. Da bi se u potpunosti obuhvatio uticaj proizvoda na životnu sredinu, neophodno je izvršiti "analizu životnog ciklusa proizvoda" (life cycle assessment). Ovakvom se analizom sumiraju svi negativni efekti u toku nastajanja, upotrebe i odbrade ostataka industrijskih proizvoda.

Kao odgovor na povećanu pažnju koja se globalno posvećuje odgovornom zbrinjavanju čvrstog industrijskog otpada, u primeni je nova strategija konstruisanja pod nazivom "design for recycling" (projektovanje za recikliranje, tj. projektovana reciklabilnost). Ova strategija podrazumeva dva osnovna principa: projektovanje rastavljivih jedinica i upotrebu reciklabilnih materijala i kombinacija materijala. Kvalitativno napredna konstrukcija obezbeđuje da se potrošna dobra po isteku upotrebne vrednosti efikasno koriste kao sirovinska baza za nove materijale i trajno i bezbedno uklanjaju sa deponija doprinoseći tako rešavanju globalnog problema zagađenja.

Ključne reči: *ekološka podobnost, reciklabilnost, analiza životnog ciklusa, upravljanje čvrstim industrijskim otpadom*