THE NATIONAL COLLEGE OF ART AND DESIGN

GREEN DESIGN

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INTRODUCTION

Since beginning this thesis, the environment has suddenly become a major talking point. Every day there are television news items, documentaries and countless newspaper articles on the subject. There have been several international conferences, the most important of which had over 140 countries represented at it, dealing directly with the ozone layer crisis. The environment has finally become a mainstream issue and most public opinion studies place concerns for the environment as the most overriding worry throughout society. The so called greening of Mrs. Thatcher, however cynical, is generally welcomed and must mark an important turning point.

The main argument of this thesis is that the concept of designing from "cradle to grave" is not being brought to product design. Legislation requires that manufacturers of known toxic chemicals draw up detailed management procedures for all aspects of handling and disposal methods of their produce. While the manufacture of dangerous chemicals could be viewed as undesirable, at least the legal constraints force manufacturers to consider all the implications of what they are producing. Unlike for example the nuclear industry, which continues to use fissionable materials without any realistic plan for disposing of the waste products. The nuclear industry provides a useful analogy for the industrial design process. Within the terms of their basic specification, that is to produce a power station which can generate huge quantities of energy, which can be turned on and off at the flick of a switch, the average reactor is probably very well designed. But what about its effects on the local community, or regarding the radioactive waste, the whole environment? Reactors, like most designed products are conceived and designed to fulfil specific roles. They are designed by designers who have been taught narrow specialized disciplines. At no stage in a products origination is its whole effect on the environment in which it will intrude, be considered.

Chapter I

One of the most direct influences designers can have on the environment is through their choice of materials. Designers rarely consider the full environmental performance of the products they work on, usually their interest goes only as far as the initial production and selling; the modes of use and disposal are generally ignored. This philosophy of production is leading to immense problems of pollution and wastage of natural resources. The short sighted approach adopted often creates products which cause problems in one or more of the following ways: by endangering the health of the consumer; by causing significant damage to the environment during manufacture or eventual disposal; by consuming a disproportionate amount of energy in either manufacture or use and by causing unnecessary waste due to an unduly short useful service life. In all of these matters material choice is important. An examination of domestic and industrial waste reveals the scale of some of these problems.

New York city has the highest rate of civic waste and refuse per capita in the world (1). The city produces over 24,000 tons of waste a day. This waste consists of valuable metals, glass and ceramics, paper and wood, plastics and food waste, most of which could be re-utilized somehow, instead of just being buried in land fill sites. Worse still it contains huge amounts of toxic substances: mercury from batteries and paints; cadmium from fluorescent light strips and countless other dangerous chemicals from the various solvents, cleaning agents and wood preservatives used every day. Cynthia Pollock describes the city as a mine:"Every day New York disposes of more aluminium than is produced by a small bauxite mine, more copper than a medium sized copper mine and more paper than a good sized timber stand."(2)

1.Cynthia Pollock,The State of the World pg.102
2.Ibid. pg.104

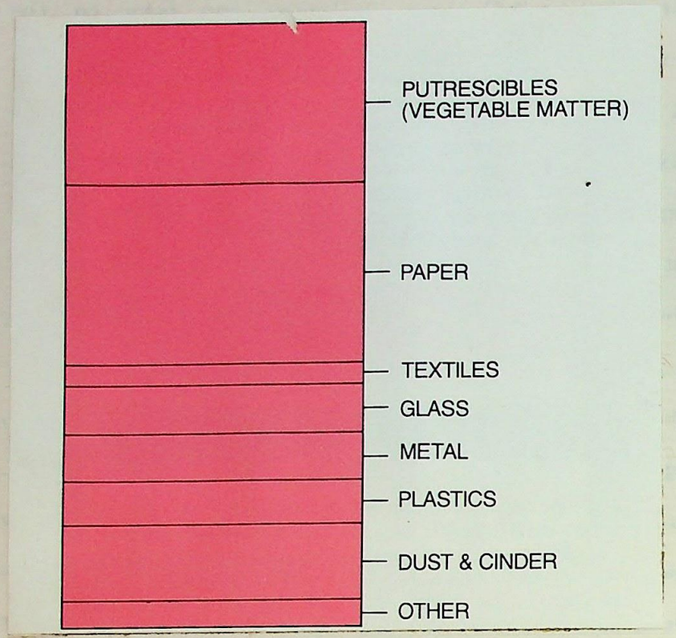


fig.1 Composition of UK household waste by percentage weight

If one divides the waste into its constituent parts (fig.1) the different materials and the environmental problems associated with their use and disposal can be examined in detail.

Glass

Glass represents around ten percent of household and industrial waste by weight. In the UK around six billion bottles and jars are used every year, which represents over three and a half million tonnes of glass. Glass is an extremely energy intensive material to produce, and finding and extracting the great bulk of raw material necessary can have a large impact on the environment. However it is fundamentally an environmentally acceptable material, especially when compared with its usual substitute, Polyethylene Terephthalate (PET) (see chapter 2). The raw materials for glass consist mainly of: silicates (sand); calcium carbonate (limestone); sodium sulphate and sodium carbonate. Other mineral sulphates and carbonates are added to make different qualities of glass, but all of the materials are extremely common; silicates form a very large proportion of the Earth's crust. Glass has the advantage of being both re-usable and recyclable. The milk bottle is an excellent environmental product, on average it can be re-used over 20 times, some can last up to 50 times and when they are finally un-usable they are recycled. Glass can effectively be recycled infinitely. Every tonne of crushed glass or cullet can replace an original 1.2 tonnes of raw material, and because it is already crystalline, processing cullet saves an energy equivalent of 135 litres of oil per tonne in manufacturing. Simultaneously using cullet reduces processing emissions dramatically. Although glass is totally un-biodegradable, and particularly as litter glass waste can be very dangerous,the efficiency of recycling makes its use acceptable. Recycling glass is a profitable

business and is developing rapidly. At the moment in Ireland the Rehabilitation Institute is organizing a nationwide collection scheme, collecting the glass, usually in supermarket car parks, sorted into the three basic colours. The collected cullet is being sold to Irish Glass Plc. In West Germany where recycling schemes are well established, and there is a very positive consumer response, they are able to recycle nearly 40% of their entire glass production (that is over one million tonnes) and this rate is improving annually. Glass is overall a good material for use. The vast majority is used in packaging, i.e. in simple applications where it is easy to clean and separate from the waste stream. Unfortunately its use is being increasingly replaced with plastics, primarily it seems because consumers are afraid of glass packaged products being smashed on the way back from the supermarket. Whether this is a real concern or one fostered by the packaging/plastics industry is unclear. The traditional milk delivery system, now only common in the UK and Ireland is also probably coming to an end, mainly it seems because of heightened awareness and anxiety about hygiene among consumers and their perception that re-using is somehow not clean enough.

Metals

Metal waste is high at around ten percent of all waste and probably accounts for the greatest value in industrial/domestic refuse. Metals are not biodegradable to any great extent, while many rust or oxidise to some degree, the process is slow and some metals, particularly aluminium and its alloys, do not decay at all. All metals are recyclable however. The entire production of Irish Steel Holdings, of approximately 200,000 tonnes is based on scrap iron and steel, about 40% of which is collected in Ireland.(3)

3. The Environment Awareness Bureau, Recycling Makes Sense.

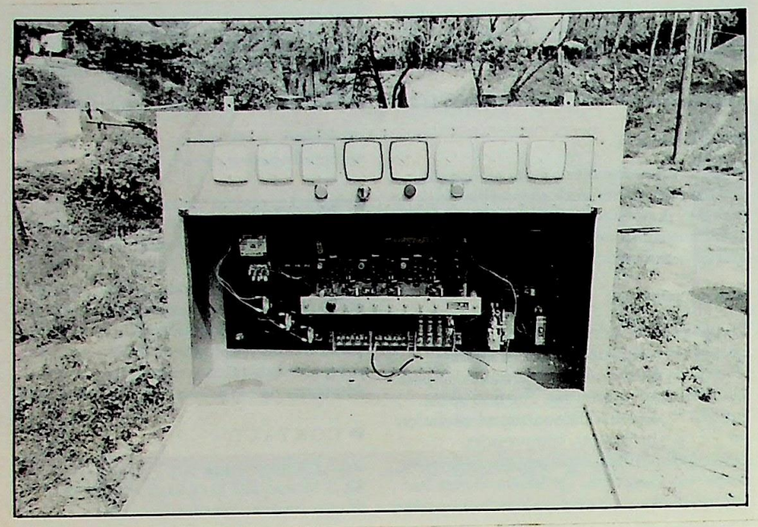


fig.2 The Warren Spring Laboratory "Intelligent Dustbin"

Large quantities of metals however are still dumped, especially aluminium and tin cans, where separating them from waste is seen as uneconomical on anything but a massive scale. Metals, unlike glass, paper and textiles which usually occur in simple forms, occur mostly in far more complex products: radios, televisions, cars etc. and recycling is made very difficult because of the need to identify and separate a wide range of different materials. Around £4.5 million worth of scrap metal is buried in Britain, one million tonnes made up of fridges, washing machines and other similar types of machines which remain uneconomical to dismantle (4). Scrap merchants can remove much of the ferrous metal from larger items, such as cars using electromagnets, but otherwise waste has to be sorted by hand. This only results in a 40% recovery rate. At Warren Spring Laboratory in Britain a machine has been developed to deal with at least part of this problem(5).It is designed to identify and sort out up to 14 different types of metal.(fig.2) The metal, loaded in lumps is scanned with X-rays which are re-emitted at different frequencies for different metals. The lumps are then sorted by blasts of compressed air into separate bins. Although this is a beginning it seems unlikely that such technology will be available on a significant scale for a number of years.

Aluminium in particular is an environmental problem; nearly a quarter of all aluminium production is used in soft drink cans (Americans apparently drink more soft drinks than tap water.) Aluminium is the most energy intensive material in large scale use, the amount of energy to process the raw material bauxite is such that its use at all should be seriously considered. However aluminium can be recycled, and using recycled waste can cut the production energy use by 95%. Re-melting one tonne of aluminium eliminates the need for four tonnes of bauxite and 700 kilograms

4. John Elkington, The Green Consumer Guide, pgs.23-26
5. John Elkington Associates, The Green Designer, pg.16

fig.3 A reverse vending machine

of petroleum coke, while reducing emissions of air pollutants such as aluminium fluoride by 35 kilos per tonne. In many countries, particularly the US, reverse vending machines have been introduced (fig.3). These machines accept returned containers, usually aluminium cans, and give out a refund - often a token for a further purchase - so they are simply an automation of the glass bottle deposit system. In the United States, with a combination of reverse vending machines and other deposit schemes over half of the 300,000,000,000 aluminium cans sold since 1981 have been collected.

Paper and Wood

Every year each of us uses two trees worth of paper and board. Currently 30% of the paper we use is recycled, to make writing pads, cardboard containers, egg boxes and paper towels etc. Paper is of course entirely biodegradable, the problem is simply the enormous bulk of paper we use (around 27% of all waste). This is largely due to packaging, although office stationery and newspapers are responsible for a large share. The raw material for paper is wood fibre from trees. With deforestation such a critical issue recycling is becoming essential. Recovering one print run of the New York Times Sunday issue would save 75,000 trees alone (6) It takes two tonnes of wood to make one tonne of paper, but recycled paper pulp is far more efficient. A mill using recycled waste can cut its costs by 50 to 80%. At the same time recycling uses far less water in production. Paper cannot be re-used infinitely; on every cycle through the mill its fibres become shorter, but there is a range of products that can be made when papermaking is no longer possible, such as animal bedding, insulation, egg cartons etc. Thus by using only 50% recycled paper over 75% of new

6. Cynthia Pollock, State of the World, pg. 110

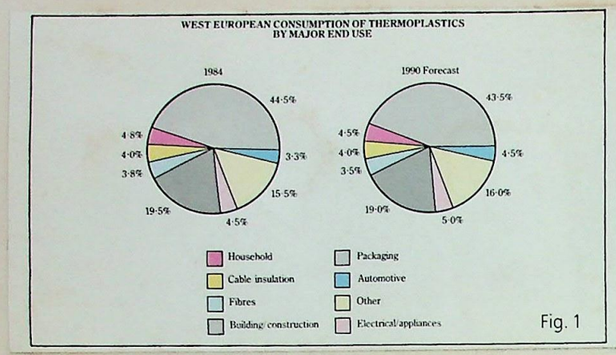


fig.4 Use of plastics by end use

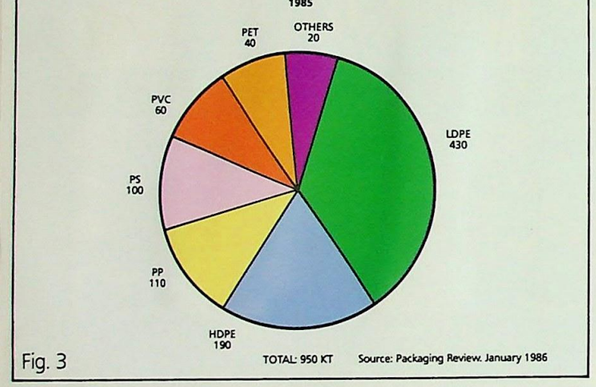


fig.5 Packaging plastics, by percentage of material type used

demand can be met. Japan currently leads the field in paper recycling at 48% of their production. Paper of course has traditionally been a very important material in Japan for a much wider range of uses.

The use of timber is even more critical to tropical deforestation. The majority of tropical hardwoods used come from badly managed and unsustainable resources. Tropical hardwoods are used in furniture, doors, window frames and boat building etc. Friends of the Earth have published a useful booklet "The Good Wood Guide" whose function is to let consumers and designers know what hardwoods are acceptable or unacceptable for use. One of the advantages of this approach is that, although sustainably managed resources are in a minority, their development will be encouraged.

Plastics

The use of plastics is undoubtedly the most critical area for the designer. Some five to seven percent of waste (by weight) now consists of plastics, and this percentage is growing rapidly. The main use of plastics is in the packaging industry, around 44% (fig.4). There are nearly 50 types of plastic or polymers in common use, and the raw material for all of them is oil. Other petroleum sources such as natural gas and coal are used, and it is even possible to use non-petroleum materials as a base, such as wood, shale or even waste vegetable matter, although all of these involve a far greater cost, and none of these sources are used commonly. Plastics do not biodegrade properly and plastics recycling is a very complicated issue. In 1985 in Britain alone 950,000 tonnes of plastics were used in packaging applications (see fig.5). That consisted of: 430 kilotons of low density polyethylene (LDPE); 190 kilotons of high density polyethylene (HDPE); 110 kilotons of polypropylene (PP) and 100 kilotons of polystyrene. None of these materials can be successfully recycled. The main obstacle to

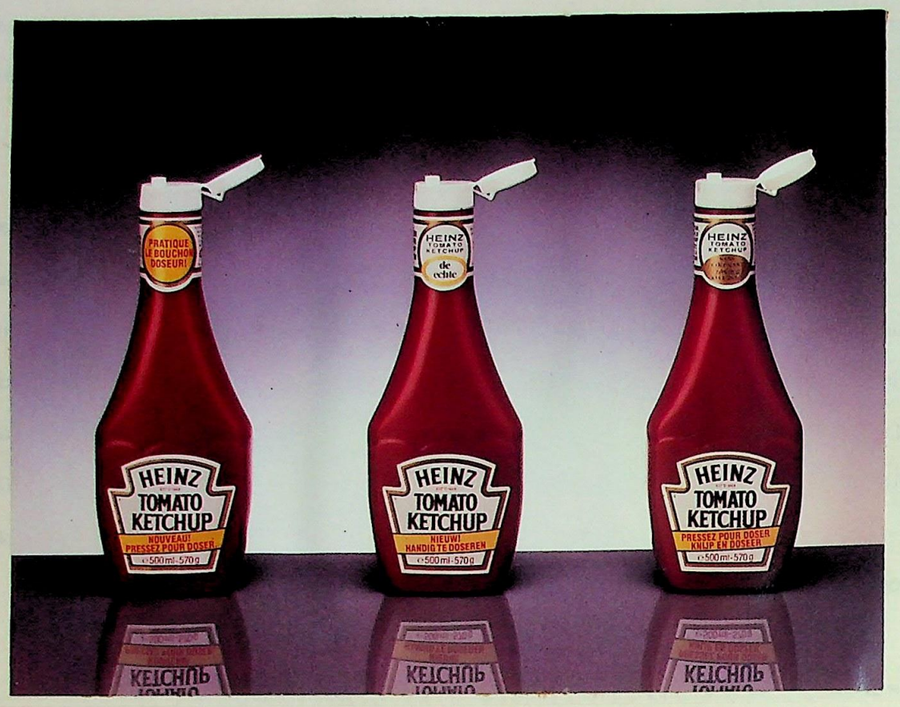


fig.6 Multi layered polymer Ketchup bottles

recycling is, as with metals, the need to identify and separate the different polymers from the waste stream, and additionally with plastics, cleanliness is a concern. It is very difficult to effectively clean waste plastic materials without damaging the basic polymer structure. Similarly unlike the "intelligent dustbin" process for metals, plastics are not readily identifiable and so are not easily segregated. A further problem is that plastics are often incorporated into packs with a range of other materials, or a combination of different polymers which make economical separating impossible. There is an increasing tendency in the packaging industry to produce multi-layered structures, where several different polymers are extruded and used as one lamination. For example Heinz have recently replaced their glass ketchup bottle with a plastic container.(fig.6) This marvellous achievement of polymer technology won a British Plastics Federation award in 1987 for its innovative features, including its: "light weight squeezability, flip top closure allowing portion control and the mono web backingless self adhesive label system."(7) The bottle is constructed of five differing forms of polypropylene and polyester, which have been co-extruded and blown into shape. The different layers all have slightly different properties; for example one will be an ultra violet light stable polymer, one will be impermeable to air and carbon dioxide, the next hydrophobic. Thus altogether they produce a material which shares all of these properties. This system of manufacture completely rules out recycling as an option, and of course consumers would never consider re-use as an option for a plastic container. Plastic has the image of being cheap, of being disposable, even though in many applications it is capable of being used over and over again. Many people react in horror at the suggestion of reusing plastic cutlery for example, even though the polystyrene from which it is made is well able to stand sterilization. Just what the advantage of

7. ICI, Packaging Progress, No.5, 1988

fig.7 A soft drink packaged in ICI's PET product "Melinar"

this product over what most people would consider to be more attractive alternative of glass is unclear. Despite the level of development and technology that has gone into this product,it is still not as stable or impermeable to glass. Its only plus points are lower weight and its being shatterproof.

Some plastic recycling is possible using waste from high volume production, for example waste from injection moulding sprues, the important point being that the waste is kept uncontaminated. About seven percent of the UK polypropylene production is from this sort of recycled waste, but this is only possible within the original manufacturing environment. The main problem with recycling plastics is contamination; thus although about a tenth of the polyethylene film used in Britain for industrial purposes is collected for recycling, it is only suitable to produce a heavy low quality black sheeting used for the building industry.

One attempt to recycle single identifiable plastics involves the PET bottles used for soft drinks and mineral waters (see fig. 7) There are a number of PET bottle collection schemes throughout the world, but as yet it is still impossible to turn a used PET container into a new one. Rather the polyester is shredded and is used as a filler for cushions and sleeping bags, and other similar applications. In Ireland Wellman International Ltd. are operating such a scheme, collecting used containers and using them as a filling fibre. They have developed their own process for removing labels, the aluminium caps and the polyethylene base of the bottles. This kind of recycling process is suitable for areas where a deposit system operates, or where collection is done on a voluntary basis. Recycling rates of 70% have been achieved in Germany and the Netherlands, but this again depends on a widespread participation by the community. One of the main problems with PET recycling schemes is the huge quantities of bottles required in order to make a sufficient quantity by weight. One tonne of PET is worth around

£120, but this takes 20,000 bottles. The economics of collection speak for themselves, even though in Ireland we use some 50 million bottles annually. Another relatively common plastic recycling process is practised by Superwood Ltd. in Bray Co. Wicklow. which takes any quantities of mixed domestic or industrial plastic waste. These wastes are converted into products like fencing posts, crash barriers and pier supports. Their product is simply a mix of finely chopped plastic waste in a resin base. Although on one hand this is a positive development, it is still really only delaying the eventual disposal of the original waste material.

Chapter 2

Recycling

Most municipal waste is still buried in landfill sites, and they are becoming increasingly saturated. Communities are becoming more aware of the hazards of having these sites in their own backyards, so finding new sites becomes harder. Theoretically everything consumers discard is potentially available for re-use or recycling. Recycling paper , plastics and organic waste lessens the global demand for energy and materials; using aluminium waste instead of bauxite cuts energy needs by 95%, making paper from waste pulp can save whole forests, while reducing the energy requirement by 75% and the need for clean water by around half. Meaningful recovery rates for many materials seem hard to achieve, a recovery rate of just half the consumer waste stream is seen as optimistic. Achieving such high rates is difficult and quickly becomes un-economical due to the amount of handling involved. Similarly most materials lose their value when mixed with others; paper, for example, suffers when it is mixed with organic waste. Glass and metals become contaminated in general waste streams and suffer in

comparison to materials from fresh resources. Plastics are most often found in complex combinations with other materials; for example foil lined packaging films such as Melinex which render retrieval impossible. Recycling on a massive scale is only possible if the economic benefits are seen to be obvious. This is possible if, for example, recycling requires less government subsidizing than collection and landfilling. It is a matter of time before the real economic advantages of a non polluting method of handling waste become clear. Many state authorities in the US are at this stage already, simply because they can find no new sites to bury their refuse. To take quite an extreme example, in Philadelphia (1) a tonne of recyclable newsprint can be sold for $20 to $25 as a raw material, yet it costs the city $90 to dispose of it in a landfill site. If the city were to pay a recycling company $45 to collect it and allow them to sell it as a raw material, then both sides would be ahead.

The other major option open to communities for disposing of waste is incineration. Un-separated waste direct from the collection truck has an energy content of 8,400 kilojoules, which is about half that of coal. The energy content of paper and plastics are 16,000 and 38,000 kilojoules respectively (2). Thus an incineration plant can produce quite substantial quantities of energy. This process however conflicts with recycling, for example paper and plastics form the main energy bulk of waste, yet more energy is actually saved by using the paper waste for recycling instead of raw fibre, than is liberated by its combustion in an incinerator. Plastics have an even higher fuel content than paper, but producing a plastic product from waste instead of resin saves around 85% of the energy otherwise used. The British Plastics Federation are much in favour of incineration as it offers a neat way out of the waste disposal problem for

1. Cynthia Pollock, State of the World, pg.112
2. BPF, Fact Sheet - Recycling

While there is a general trend towards more natural, healthy food products, within this trend there are two separate strands. The larger of these two groups is not interested in home cooking or preparation, but rather is quite happy to eat ready prepared packaged food, albeit with "natural" or "freshly made" printed on the package. This trend towards convenience foods relies entirely on packaging plastics.

plastics. There are several commercially successful projects of this kind operating at the moment. At Edmonton in North London an incinerator running on domestic waste produces electricity which is sold to the Eastern Electricity Board. Currently a similar scheme is being planned for Ireland, with the backing of the minister for the environment. The major problem with this process is atmospheric pollution created by combustion. Most plastics, especially Polyvinylchloride (PVC) contain dioxin precursors, that is substances which on combustion liberate dioxin, one of the most toxic substances known. In fact combustion of nearly all materials liberate some minute quantity of dioxin along with countless other harmful substances. The health risks involved with incineration of plastics has lead to the Japanese banning their use as unsuitable for combustion.

Incineration as a method of waste disposal is really just an alternative to dumping. It does not address the problem of using up resources at all, the only benefit being that a proportion of the energy locked into the materials is regained.

Packaging

One of the key problems of waste of resources is the sheer volume of packaging used in the "convenience" lifestyle. Around 50% of supermarket packaging uses plastics, particularly LDPE and CFC blown Polystyrene cartons. There are certain advantages to plastics in packaging; The British Plastics Federation is quick to point out that the alternatives to packaging with plastics would use far more energy in production, and would create twice the weight and four times the volume of waste.

"In the industrialized world less than two percent of food is spoiled between production and consumption. In the developing world between 30 and 50% is wasted, much of this due to inadequate packaging."(3)

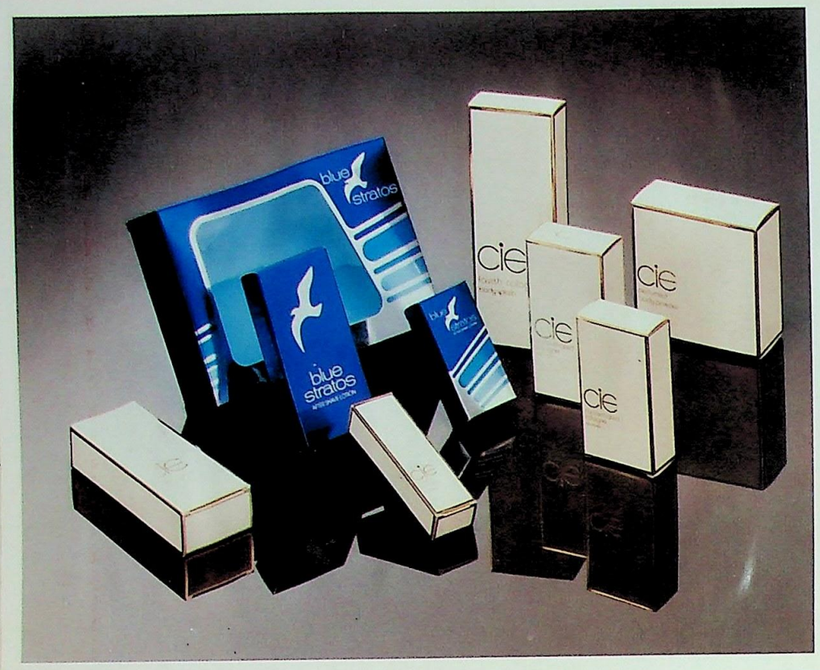


fig.9 Typical superfluous cosmetics packaging

However while this may be the case, and thus might justify a proportion of the packaging used, the vast majority is quite superfluous. The cosmetics industry is a good example of an industry where packaging is all important in adding value to and marketing a product (fig.). One can buy products in glass aerosol containers with two part plastic nozzles, set into expanded polystyrene foam cases,inside a cardboard box with perhaps an acrylic window. The whole then vacuum wrapped in polyethylene film and quite probably handed over the counter in another plastic bag. The body shop has made a point of avoiding the excesses typical of this industry (see chapter 3) and is proving very successful.

The more combinations of materials and designs used in packaging, the more difficult re-use, recycling and proper disposal become. Although wine makers and breweries are happy to sell their produce in glass with simple paper labels, the soft drinks industry feels the need to use more complicated packaging to improve their marketing. This situation can be changed by legislation. In Denmark and Norway less than 20 different types of returnable containers for drinks are allowed on the market. West Germany has already banned the use of PET bottles, and as far back as 1977 the Danish government banned the use of all one way, or non-returnable drink containers, including aluminium cans. In the future, legislation might come about to force manufacturers to use the "cradle to grave" management concept where materials' production, use and conversion would be closely controlled, as they are in the hazardous waste industry. In the mean time it should be the designer's responsibility to design products and packaging with energy efficiency and waste reduction in mind. (see fig.8)

A partial solution to the problem of plastics waste is offered in the form of biodegradable plastics.

3. BPF, Environment Update

Degradable plastics.

Degradable plastics are designed to disintegrate once their useful life is over. There are three methods of degradation in use: through reacting to sunlight, bacteria or to specific chemicals.

Photodegradable plastics are broken down by exposure to sunlight. They are made photodegradable when they are manufactured by adding a chemical catalyst that will start the degradation on exposure to strong ultra-violet light. Uses for these plastics include agricultural mulch films, transparent polymer films which are laid over farm soil to retain warmth and moisture and thus bring about earlier crop growth. Chemically degradable plastics are used for example to protect car bodies during manufacture and transit. A car body is covered in a plastic film which can be washed off using specific chemical solvents. Neither of these plastic types are useful in packaging applications and is probably not very environmentally desirable.

The third type, biodegradable plastics offer more scope for use. Biodegradable plastics degrade on contact with bacteria in the soil when they are buried. They can be manufactured synthetically, or the same effect can be achieved by adding natural starches to ordinary plastics (the process used in the Body Shop packaging bags and containers.) In a broad sense wood could be described as a biodegradable polymer.

Two companies, Marlborough Biopolymers Ltd. in the UK and Belland in Switzerland have developed true biodegradable polymers.

Biopol

There has been a definite trend this century to replace natural products with synthetic alternatives in mass production. In most cases this is not because the natural products were inadequate, in fact most early

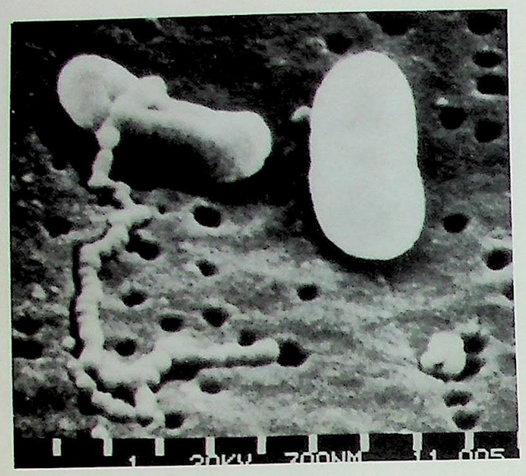


fig.11 Alcaligenes eutrophus cells producing Biopol

fig.10 Biopol copolymers

plastics were made to imitate the natural products they were replacing as much as possible. The reasons for developing the synthetic alternatives were convenience and cost. Plant fibres and animal products, for example cotton and leather, are subject to wide fluctuations in quality and availability. However with oil based polymers, the consistency of quality and availability can be far more guaranteed. More importantly oil-based polymers are far cheaper and much more easily processed and handled. But all natural polymers have the fundamental advantage of being renewable resources, and additionally they can be disposed of in the knowledge that they are biodegradable. Marlborough Biopolymers Ltd. has to some degree combined these advantages and made a new plastic material that is truly biodegradable and is derived completely from renewable resources, but at the same time, which can be made in bulk, like oil based polymers. It can be spun, filmed or moulded like an ordinary thermoplastic. The polymer is a type of polyester called poly(3-hydroxybutyrate) or PHB, and is produced by bacteria (see electronmicrograph.) These bacteria can be grown in large tanks on a variety of raw materials, like sugars, ethanol or even mixes of gases such as hydrogen and carbon dioxide. By careful control the bacteria produce PHB, rather as animals produce fat, and up to 80% of the cells weight can be in the form of PHB granules. This process was known since 1925 but the technology required to exploit it has only recently been developed. The PHB itself is a polymer very similar to polypropylene, which is used, for example, in washing up bowls and crisp packets. By mixing the PHB with another bacterially produced polymer, 3-hydroxypentanoate (HV) a wide range of co-polymers can be made. Thus, depending on the proportions of HV to PHB, at the low end a hard and brittle polymer similar to unplasticized PVC or polystyrene is got; in the mid range the polymers are like polpropylene and HDPE; and at high levels of HV in the mix very tough polymers like LDPE are made. This co-polymer range is manufactured under

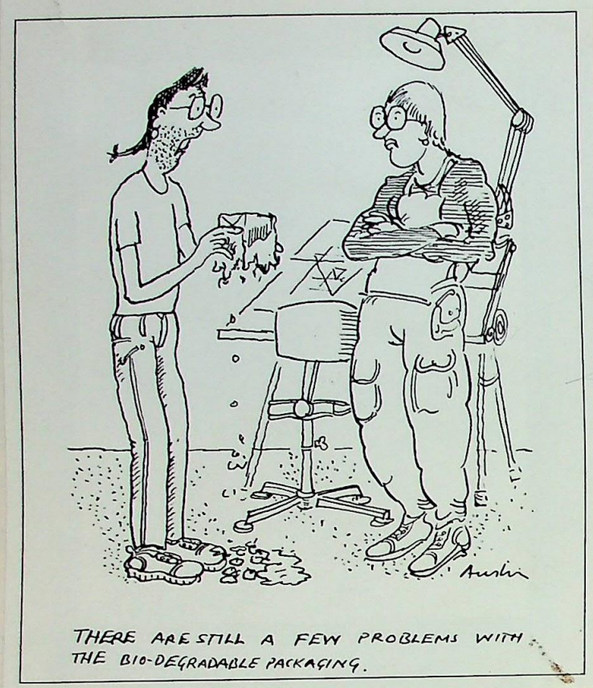


fig.12 A cartoon from Design magazine of May 1988. While it is obviously meant to be humourous, the cartoon does reflect a general prejudice within the design community concerning bio-degradable polymers.

the tradename Biopol.

One of the drawbacks of Biopol is its cost. The process of extraction and purification of the base polymers is expensive and currently the raw materials, fermentation sugars are kept at an artificially high price by the EC. At the moment Biopol costs £20 per Kg, but it is intended to reduce this to £10 per Kg when large scale production begins (polypropylene currently costs £9 per Kg.).

Biopol is truly biodegradable which is important. On contact with soil bacteria, fungi or algae it can be completely converted to carbon dioxide. This is as opposed to many apparently biodegradable plastics which simply break down to their constituent monomers (basic plastic molecules). Biopol degrades in a range of environments; in order of importance: anaerobic sewage; soil; sea water; in animal tissue and finally in air. However the decay rate in air is so slow as to be negligible which makes its shelf life suitable for a whole range of packaging applications.

Environmentally viable packaging is becoming a critical issue, and biodegradable plastics should provide one answer. Legislation governing the use of non-degradable plastics has been or is about to be introduced in many countries, and MBL report a lot of interest in Biopol. They hope to launch their first Biopol product on the market in Germany in late 1989. Unfortunately MBL is only a small subsidiary of ICI, a company which produces a large proportion of the plastics used in Europe, and it is perhaps acting as ICI's environmental conscience at the moment. There seems to be a lot of resistance to biodegradability as a solution within the plastics industry (fig.12):

"Before grasping at the idea of degradability as a simple cure all solution, the question that must be answered is will it actually solve the perceived environmental problem?"(4)

4. BPF, Environment Update

This from the BPF's fact sheet on the environment. In their attempts to denigrate the usefulness of degradable plastics, they use the ludicrous argument that non-degradable plastics are useful in forming a stable base in landfill sites, something which biodegradability will rule out. Similarly that as the consumer knows a product is degradable they will become more careless with waste and create a larger litter problem.

Chemical Pollution

One problem biodegradability will not address is the environmental effect of the enormous volume of pollution created by industry during processing and manufacturing. So far materials have been discussed in terms of waste, but as well as representing a squandering of limited natural resources, the use of different processes and manufacturing techniques in industry is responsible for chemical pollution of the entire planet. This is a question of our whole philosophy of production and consumerism. Since the industrial revolution we have succeeded in permanently altering the earth's chemical cycles. Four problems in particular stand out: the greenhouse effect and its influence or food crops; the demise of the forests from atmospheric pollution, particularly from burning fossil fuels ; the risks to human health from constant exposure to chemical pollutants in the environment and the depletion of the ozone layer. These consequences result directly from everyday industrial activities that have collectively reached proportions that have permanently altered natural systems.

According to the OECD there are over four million chemicals which have been introduced to the environment; 563,000 of these are in common use and about a hundred of them are produced in excess of 50,000 tonnes a year. Very few of these chemicals have ever been tested, usually only those that are to be introduced directly into the environment, such as agricultural chemicals or food preservatives, are tested. Between 500 to 2000 new

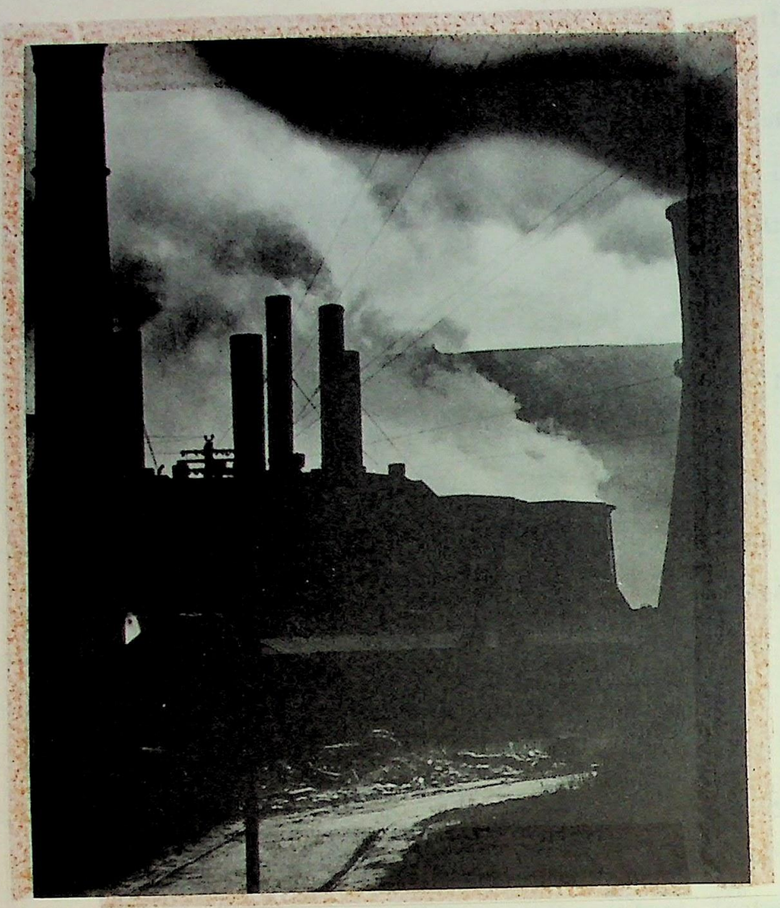


fig.13

chemicals enter large scale commercial use each year, of which only 150 or so are subjected to long term testing. But these do not include the numerous by-products generated during the production of chemicals (fig.13). These number in the millions and according to a United Nations Environment Programme report (UNEP)

" ...the number of further substances that combinations of these could produce is so great as to defy imagination."(5)

Examples of common pollutants include the vinylchloride monomer (VCM). This substance, a known carcinogen used to be used as an aerosol propellant until 1974, which caused around 40 million kilograms to be deliberately dispersed into the environment. This has now stopped but still over 45 million kilograms are lost to the environment every year during production for other purposes. VCM is used among other things as a plasticiser for wrapping materials such as cling film, in order to make them more elastic, and it is known that it leaches in small quantities into the foodstuffs it contains.

Another common pollutant is trichloroethylene which is used as an industrial solvent, for degreasing machine parts and for fabricating plastic components. Trichloroethylene has been proven to be carcinogenic by the National Cancer Institute in England yet thousands of workers use it every day without taking any suitable safety precautions. The Health and Safety executive has set a safety level of 100 parts per million in food stuffs and refuses to alter this on the grounds that the NCI tests were not on humans(6). They maintain that this safety limit will not be altered until a detailed survey of its effects on human workers has been made, yet they have no immediate plans to make such a survey.

It appears that this attitude is far from uncommon; more often than

5. Edward Goldsmith, The Great U-Turn, Pg. 101
6. Ibid. pg.120

fig.14

not when a particular substance is described as being non-dangerous this is simply because no-one has yet managed to prove that it is unsafe. Rather like with our legal system, a particular substance remains innocent until proven guilty; a state of affairs which seems completely irresponsible.

The combination of different chemical pollutants create "synergistic effects"(7), that is they create new and generally more complex pollutants. For example benzene in itself a carcinogen, as a pollutant in water , when in combination with chlorine (in itself relatively harmless) which is added as a water purifier to drinking water, and in the presence of ultra-violet light gives rise to hexachlorocyclohexane (HCH). HCH is an extremely toxic insecticide. This kind of reaction occurs frequently in polluted water supplies, the river Rhine, perhaps one of the most badly polluted rivers in the world contains countless complex organic chemicals, most of which are not understood and are quite unpredictable. It is clear that we cannot understand the effect of pollution on our environment by making thousands of independent surveys into individual substances. Rather it is the effect of pollution as a whole on the entire planet's ecology that must be studied. It is simply not acceptable to clear single substances after limited research, when the number of combinations with other substances possible in our very polluted environment are so enormous. Using current methods of assessing toxicology it is possible for manufacturers to maintain the innocence of each one of the nearly four million chemicals they generate, whether directly or indirectly as a product of their activities.

7. Sandra Postel, State of the World, pg. 157

Chapter 3

The future of waste/pollution

Every thing produced by industrial activities finds its way into the environment. The total quantity of pollution released is directly proportional to the level of industrial activity. Despite all the positive measures being introduced currently throughout the developing world to control emissions, still they are increasing at a rate of around five percent per annum. By the end of this century, if economic activity continues to grow at the present rate, the quantity of waste released will have increased fourfold, with waste accumulating on the land, in rivers and seas and in the atmosphere. Many waste products accumulate in biological systems which absorb them readily. Humans at the top of most food chains inevitably suffer to the detriment of their health. One of the most measurable symptoms of this pollution is the cancer rate which is increasing rapidly. It appears that the disease could become generalized in the populations of industrialized countries in a few short generations. It is already generalized among fish populations in many American east coast rivers, and the river Rhine for example (that is, where any fish exist at all.)

The most dramatic consequence of pollution however is the change to the Earth's climactic systems. The, by now well documented, problems of the green house effect and ozone depletion appear to be leading to a climactic catastrophe, if we continue to use energy at the present rate. But by the time researchers clearly establish a marked change in the climate, or the antarctic ozone layer, the situation appears already to be irrevocable. This means we have to act before the consequences of industrial pollution become fully apparent.

Design

The environmental consequences of industry discussed above are a direct result of the type of design practice used throughout industry.

"Design reflects the predominant values of the society which gives rise to it. Thus with profit maximization as its central concern , emphasis is placed upon the notion of an ever increasing rate of production and consumption based on disposable products, with significant wastage of energy and materials."(1)

While our society as a whole certainly bears the brunt of the responsibility for this situation, the designer him/herself a product of this society has a greater responsibility. The modern designer is able to create whole lifestyles: through creating styles and fashions which are constantly changing, fuelled by marketing and advertising. While materialism is a product of society, consumerism is more the invention of the design world, of marketing and of advertising. The notion of a disposable society was created largely by designers producing cheaper, quicker to manufacture products, not primarily because they were intrinsically more useful or desirable, but because new technologies have made them possible, and the ability to maximize profits makes them essential. Perhaps the Japanese epitomize this philosophy. Below are two examples of Japanese "disposable" design, design which represents the antithesis of green design.

Japanese design, disposability

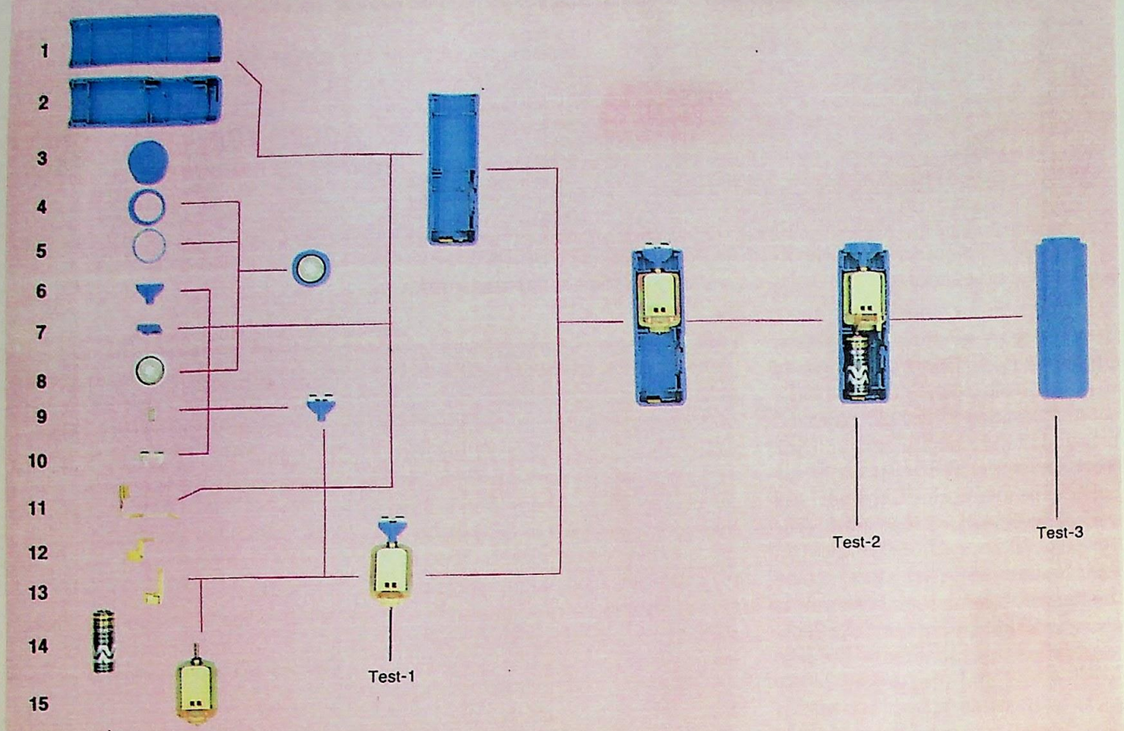
Fujicolor is a very large international company founded in Japan, which provides a wide range of photographic and other optical equipment. In

1. Victor Papanek, Design for the Real World. pg.32

fig.15

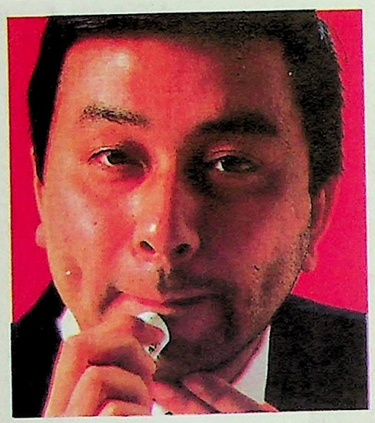
1985 they introduced a new product, the Fujicolor Utsurun-Desu,(fig.15) a lens equipped film; that is a simple disposable camera. Its structure comprises a plastic lens, a film winding device and a shutter mounted on the cardboard box of a 24 exposure 110 cartridge colour film. The concept behind the camera's development was that most people at some moment have wanted to take a photograph but didn't have a camera with them, the Utsurun-Desu would be an inexpensive, throwaway camera that could be bought on the spot for only a little more than the price of a film. While the concept is over 20 years old, it only entered serious development in 1984. One problem encountered was that in Japan a very basic non-disposable camera was available for under 2000 yen. Thus Fujicolor aimed its product to sell for less than 1500 yen in order to be competitive. Obviously a non-disposable camera at only a slightly greater cost would appeal to most purchasers, therefore the product was given the added marketing advantage of requiring absolutely no skill or prior experience with cameras. The user doesn't need to unwrap and load the film, no doors or catches need opening or closing, no switches need to be set, all the user need do is press the button, and when the roll of film is finished, return the whole camera to the processor. When the product was launched on the market in July 1986 it was an instant success, over one and a half million were sold before the end of the first year. Although the camera was mainly intended to be bought by a teenage market, the largest user group was found to be business men in their 30's and 40's.

The second example of a Japanese consumer product is the Choysol disposable electric shaver. The product concept came from the company director Eiji Okada, the founder of Minimum,the manufacturer. While working as a salesman he felt a need for a compact shaver to use in his car or on a commuter train if he was in a rush or had forgotten to shave in the morning before leaving home. Thinking there must be many people with the same problem he decided to develop one himself. The result was Choysol,



1. Body 2. Cover 3. Cap 4. Net Ring 5. Net Stopper 6. Top 7. Switch Knob
8. Outer Blade Net 9. Spring 10. Inner Blade 11. Movable Contact 12. Fixed Contact
13. Plus Contact 14. Dry Battery 15. Electric Motor

Actual size of Choysol



With the company president at the head of the test force. all merchandise is fully tested before being shipped

fig.16

about the size of a disposable cigarette lighter and costing only 500 yen. After its launch it became something of a media topic. By the end of the year one million units had been sold, in a market usually worth only about 600,000 units annually. The product is made of 15 parts which clip together without the need for screws or soldering (fig.16). Convenience was the most important factor, so it was decided it would run 15 to 20 minutes on one 1.5 volt manganese battery. The battery cannot be replaced although it wears out long before the rest of the product. Since costs are kept so low the product only costs slightly more than the retail price of the battery alone, so it was considered unnecessary making the battery replaceable. The user would find it simpler to just buy a whole new shaver, which of course dramatically improves sales figures.

That is perhaps the key to these products. Consumers can very easily be swung by convenience as a selling line. Consumers buy them not because they fulfil a genuine or important need, rather, like the business men who buy the shaver, they admire its convenience and cleverness. A large part of the sales volume of these products is made up by novelty purchasers; for example over 40% of Choysol sales are as promotional gifts or competition prizes.

Both products demonstrate very well the philosophy of disposability. Profits are maximized, not by selling a small volume of well designed and expensive products, but by selling a huge volume of simple, low cost products, which are so cheap the user feels no compunction in throwing them away. Replacing them won't hurt their pockets. It should be emphasized that both of these products are extremely well designed from an engineering standpoint; as far as their primary function goes. Both won the Japanese ministry of International Trade and Industry award for excellence in 1987. But the primary function of both is conceived not as taking simple photographs, or providing a convenient shave, rather it is to make profit

for the manufacturer.

Both products also demonstrate one of the major problems of recycling as a solution, that was discussed earlier. They are small and intricate, involving a wide range of different materials, both metals and plastics which cannot be segregated for useful recycling. This form of design represents a complete squandering of raw materials and energy. The battery from the shaver alone contains mercury and cadmium, both cumulative poisons, and in manufacturing can take up to 50 times as much energy to produce as it usefully contains. Needless to say the battery cannot be recycled either.

Design and Domestic products.

Environmental irresponsibility of this nature is of course not only common to Japan. It seems to be inherent in the notion of designing for profit. Every year in Europe the major producers of domestic products display their new product ranges at Domotechnica (last year in Cologne.) The producers of "white goods", that is fridges, cookers, food mixers etc.. can't expect any more significant breakthroughs in product development any more. Similarly the markets for existing products are saturated. Thus demand is stimulated by annually adding features, or simply emphasizing already existing ones with impressive presentations and advertising campaigns. The current trend in an attempt to create added value, or at least perceived added value, is to add on high technology electronic features to their products. Dishwashers and washing machine are given complex multi-programme consoles, from which the housewife is supposed to be able to select the one most suitable to her. AEG are developing a "voice interactive dialog" washing machine which can recognize up to 100 command words (it is proudly announced to be 90% accurate) so that the housewife can strike up conversations with her kitchen equipment. The Uk manager of

fig.17

Electrolux, a Scandinavian firm, in an interview with the financial times admitted that: "Electronic features are not a demand that originates with the consumer..."(2) many make machines more difficult to operate, look at for example the daunting control console of a typical microwave.(fig.17) Alternatively entirely new markets can be created; the Japanese introduced a complete bread making machine - just add the ingredients and it mixes, kneads and bakes automatically; the Australians introduced a microprocessor controlled automatic ironing machine.

"Industrial design in particular differs from its sister arts of architecture and engineering. Whereas architecture and engineering routinely solve real problems, industrial designers are often hired to create new ones."(3)

While this approach to design is the norm, the concerns of the environment seem bound to suffer. However, a change in this situation is beginning to come about, mainly it appears from the consumers themselves. Environmental awareness although at a very low level amongst the industrial community, is at a much higher level among consumers.

"The green consumer is likely to be an increasingly important influence in the world of industrial and product design. Designers who ignore the fact, or who allow their clients to ignore it, risk losing out on some of the most exciting market opportunities of the 80's and 90's. They also risk losing their jobs."(4)

There is a good deal of evidence that the environment is now a mainstream issue. In 1986 the Consumer's Association (UK) found that

2. Carl Gardner, "A High level of mediocrity", Design, May 1988, pg.26
3. Victor Papanek, Design for the real world, pg.12
4. John Elkington, The Green capitalists, pg.27

environmental pollution was one of the most important subjects of concern to its members. A Gallup survey in Britain (1988) found that damage to the environment ranks with world war as the most important threat to mankind. In the US a similar survey found that the environment was the third most important issue for the new administration after the drug problem and arms control. The most obvious example of this new awareness and its influence was in the campaign to stop manufacturers using chlorofluorocarbons (CFCs)

in aerosols. Friends of the Earth produced a list of ozone friendly products in 1988 and were about to follow it up with a list of bad products, but three days before publication the eight major manufacturers of aerosols announced that they would phase out CFCs by 1989. This was well in advance of any proposed legislation - which is yet to be published - but these companies recognized the enormous commercial damage that could be done top them if they were seen to be damaging the environment. Some other companies, Johnson's Wax in particular, accelerated this change by pre-emptively labelling their products as "ozone friendly" before the competition. More proof of this awareness is in the increasing memberships of environmental organizations. Over three million people in Britain alone belong to one or other of these groups. Television is responsible for much of this growing awareness. Documentaries and news reports are becoming almost daily. Some manufacturers are catching on to this, not least because a good environmental image can be a very strong marketing point.

AEG

AEG is a good example of what might be described as an intermediate environmental producer. That is one in which concern for the environment is purely part of a marketing strategy. AEG are a German company which produces a wide range of domestic appliances as well as heavier industrial

fig.18

fig.20

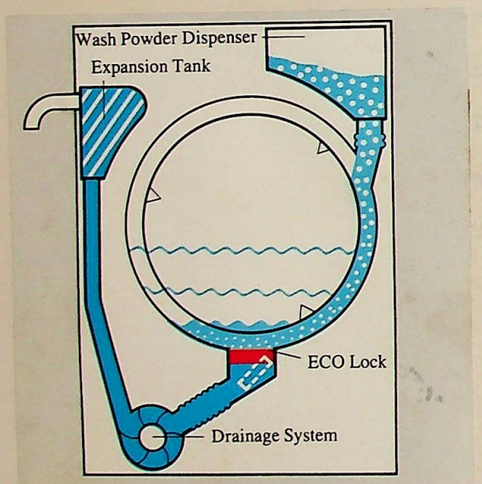


fig.19

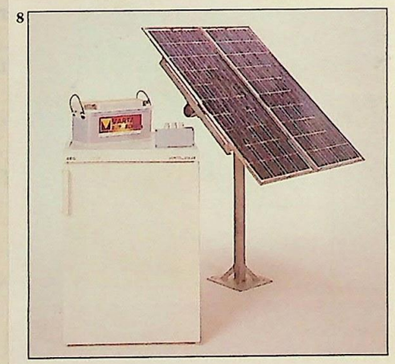


fig.21

machinery. Since 1973 they have publicly professed a "long term commitment to conservation and ecology"(5), this is mainly demonstrated by designing very energy efficient machines. This range of domestic appliances are sold with a green triangle label symbolizing what they term their "dual eco-system".(fig.18) For example the Sensotronic washing machine uses an electronic sensor to determine the build up of soap suds in a wash, the temperature and the quantity of rinse water required. Through careful monitoring the build of excesses of soap or temperature are prevented, thus less water and therefore less energy are required. The machine can perform a normal wash using 75 litres of water and 2.1 kilowatts of electricity. While this is still considerable, it is an improvement on competing machines. Other well designed features include what they call an "Eco-lock" (fig.19) a simple valve that prevents un-dissolved detergent draining from the machine, which means less detergent is required (about 20% less) A second example is the dishwasher range, by approaching the design from an energy efficiency point of view, power use is reduced by around 50% of that of normal machines, and water consumption by 25%. They even suggest that using one of their dishwasher is more energy efficient than handwashing, which is probably true if one discounts the huge initial energy cost of producing a dishwasher.

All of these products make a positive concession to environmental concerns, and importantly demonstrate a useful application of electronic technology, unlike much domestic equipment at the moment. Other products AEG are developing include a domestic solar powered water heating system and even a solar powered cooker. Whatever about the relative technical and efficiency merits of these products, the significant fact is that a company like AEG feels it necessary to tackle environmentalism in its marketing.(fig.20)

This "intermediate" level of environmental concern is now quite

5. AEG, Brochure 1989

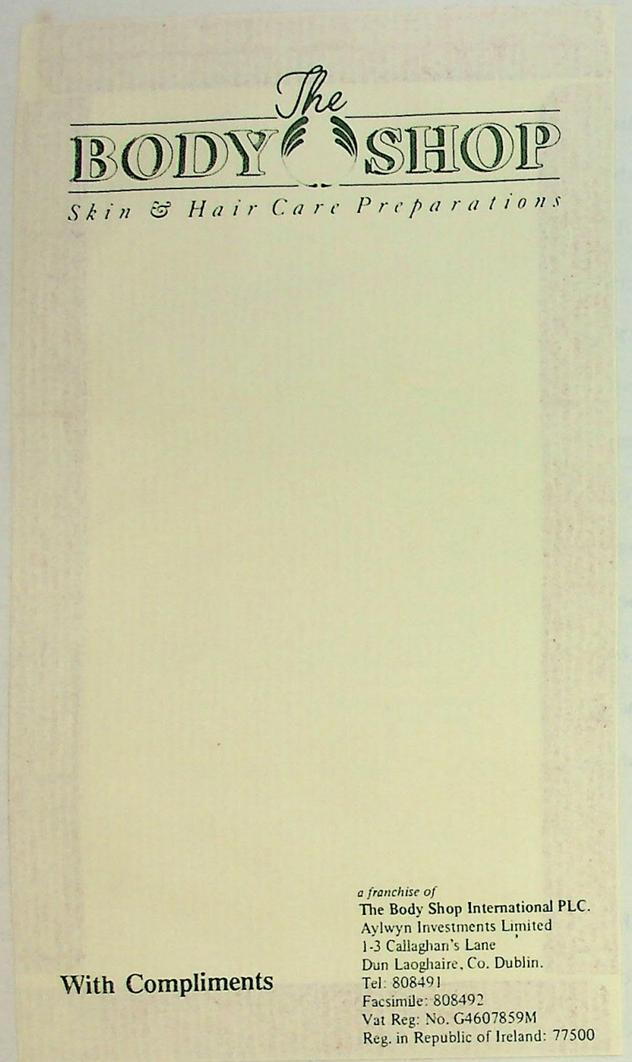


fig.22 All the body shop literature, stationary and advertizing material wherever possible makes use of recycled paper.

common. The design consultancy Brand New has made a survey among typical mass-market consumers, those assumed to pay least attention to green issues and found an appreciable distrust and mood of anger towards industry in general. Dorothy MacKenzie, the managing director of product development reports that a majority of the consultancy's clients put environmental impact high on their list of priorities:

"Suddenly the environment has become a major mass-market issue - not many companies or individuals will succeed just because they are considered green by consumers, but those that ignore the issue must realize that their competitors will not, and this will have an effect on market shares."(6)

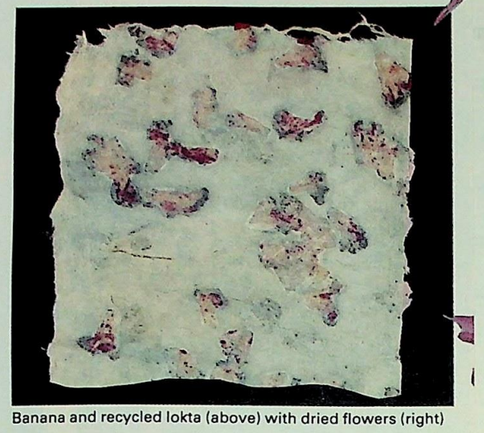
But these concerns are directly about company profits, not about the environment. AEG does make energy efficient, less polluting products, they also have a very clean non polluting manufacturing operation, but yet they have plans to manufacture talking washing machines. Secondly they have not tackled the original problem of disposing of their products when they eventually wear out. Their machines are still designed only to last a few years, usually only as long as the motor that powers them.

The Body Shop

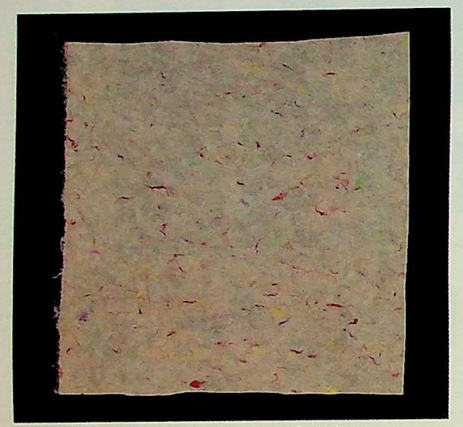
True green design doesn't seem to exist yet on any scale. The greenest company in operation at the moment is possibly the Body Shop chain of franchises. The Body Shop (fig.22) began as a single outlet in Brighton and within ten years has become an international network of shops, 243 in 27 different countries, 82 of which are in the UK. Their products wherever possible are made from natural ingredients from renewable resources. Of equal importance to their philosophy is their no-animal testing stance.

6. John Elkington, The Green capitalists, pg.27

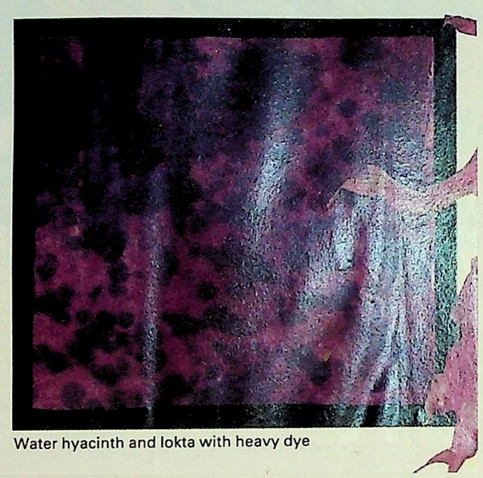
Banana, recycled lokta and water hyacinth



Banana and recycled lokta (above) with dried flowers (right)



Water hyacinth (ie duckweed) and recycled lokta



Water hyacinth and lokta with heavy dye

fig.23 Nepalese paper products from the Body Shop

This code of practice established by Anita and Gordon Roddick, the founders, is completely at variance to the other major cosmetics companies. As distinct from their competition, where strict secrecy is maintained, the Body Shop has a policy of open communication about all respects of their products; ingredients and methods of manufacture. They do not create whole new product ranges seasonally like most manufacturers, rather they concentrate on gradually improving and adding to the range.

The product range currently numbers over 300 and is constantly developing. Their packaging is kept as staightforward as possible. The company has a strict no-nonsense packaging rule, most of the products come in one of five different sizes of clear plastic container. These containers, like the plastic carrier bags used, are made from a mixture of polyethylene and starch (cellulose) which acts as a biodegradable polymer. At the early stages of the company a refilling service was offered in order to reduce packaging waste, although how well this worked is unclear, certainly only a minority of customers returned their containers for refilling.

The trend towards health consciousness and environmental awareness as demonstrated by the Body Shop is very positive and is becoming more and more popular. In purely commercial terms the company has been successful, in ten years its turnover has grown to £18 million, and they have now got a number of imitators, cashing in on the same imagery. The company's policy of conserving the environment, "thinking globally and acting locally"(7) is sincere and is manifested in a wide range of projects worldwide. The new Nepalese paper products being typical,(fig.23) where a traditional third world craft has been encouraged and developed to produce a range of highly decorative paper products. The raw materials for these papers are a combination of flowers and grasses and waste paper pulp.

7. "The Body Shop", Marketing, Nov.1988

Product design for the mass market has simply not reached the standard of the Body Shop. Of course low volume production, hand made furniture, ceramic ware and steelware etc. have been made for centuries and still are in a completely environmentally viable way. Where mass production begins so do the problems. A company which markets a range of domestic products with a very natural or even conservationist air is Habitat. Attempting to gain the same market sector as the Body Shop, Habitat consciously produce heavy earthenware, and simple wooden furniture appealing to the new low-tech domestic image. Yet their concern with things natural is only skin deep. Their wooden products for example, almost without exception use woods from unsustainable resources.

Conclusion

Edward Goldsmith in The Great U-Turn uses the concept of a surrogate world in competition with the real world, in order to illustrate the problems of industry. The surrogate world is the world of material goods and technology which is built up on the real world. The competition occurs because the surrogate world, or technosphere extracts resources from the real world's finite supply, and dumps its waste back there. As industrialization continues and increases in intensity these waste products become greater in volume and toxicity, as synthetic materials take over from naturally occuring materials. Hence the problems of waste dealt with in Chapters one and two.

These two separate worlds can be seen as the conceptual worlds inhabited by different types of people. The designer or engineer works in the surrogate world of technology and industry, whereas the environmentalist lives in the real world. It seems obvious that what is

required is a greater understanding of both world views on the part of the producers. Industry and the environment are seen as mutually antagonistic but this need not be so. With better environmental education this situation can change. Design is largely about creating solutions within a set of constraints, or requirements. It is only necessary to better define those constraints to take into account the whole world. This education will have to start soon, not least because more and more consumers are beginning to demand a high environmental performance from their products.

"The task of designing, producing and selling genuinely environment friendly products (and there will be environmentally friendly plastics) that are also commercially viable and socially acceptable is one of the most exciting challenges we face." (8)

8. John Elkington, The Green Consumer Guide, pg. 362

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