conseguir los datos relevantes respecto a las alternativas materiales y los procesos de producción que permiten el reciclado, el ahorro y la protección del entorno es el reto actual: la formación de los diseñadores, la construcción de redes de información disponibles son claramente herramientas indispensables que necesitan tiempo e inversiones. Además, la comunicación e interrelación interna en la empresa que se debe producir entre todos los agentes de ésta no sólo es labor del diseñador, aunque hayamos insistido en su papel: todos deben contribuir e influirse.

Por fin, el diseñador tiene una responsabilidad en la educación del consumidor tan importante como la de los otros agentes sociales anteriormente mencionados. Frente a la revolución ecológica no tenemos elección. El proceso de agotamiento de los recursos naturales es un hecho cierto. Sin embargo, podemos elegir la manera en que se va a producir el cambio. Unos ven el ecomundo como un regreso a nuestras raíces naturales, esto es, vivir de lo que la tierra nos proporciona. Otros ven el ecodiseño como el dominio del ser humano sobre sus propios impulsos de consumo en masa y de gasto. Significa el aprendizaje de una nueva forma de producir, de consumir y de reutilizar. Finalmente, los hay que ven aún más allá: el agotamiento de los recursos naturales es algo inevitable, hagamos lo que hagamos. Se llegará a un punto en que se tendrá que sintetizar cada uno de los elementos vitales. El proceso de reciclado sería una etapa intermedia hacia este mundo sintético que predicen; etapa durante la que se podrían desarrollar las técnicas sofisticadas de la síntesis.

El reciclado sería una solución sólo a medio plazo que no puede ser sostenible siempre, dada la pérdida de las propiedades de la materia a medida que va siendo reciclada.

Como se puede percibir, el ecodiseño es todavía un tema muy abierto que ofrece un reto de creatividad muy importante. Se trata de cambiar poco a poco las costumbres y las mentalidades: hace falta encontrar soluciones para seducir y convencer al público.

Ecodesign: new forms for production and design. The new challenges

The problem

Concern for environmental matters has burst out again in full force. Recent years have brought about a series of events, each of which has had a greater or lesser impact on the public, such as the problems derived from the greenhouse effect, the ozone layer, uncontrolled dumping, serious contamination problems in large cities, all of which have set public authorities on the alert. The Rio summit, an apparent failure, was the first time that practically all the nations of the planet had come together to face the problems of the environment on a global scale. The subject is so pressing that even the vice-president of the United States, Al Gore, has written a book on the matter with highly individual ideas on the role of leader that corresponds to his country in the ecological battle.

The problem is not new and possible acts that might alleviate or reduce its severity have been called for by different groups for many years so, although there has been a delay, late is better than never. Among these groups stands out that of the designers, some of whom have always been active and in the vanguard and thus well aware of the problem. Nevertheless, specific acts are missing, perhaps because the designer has a smaller impact than we think on the world of production, which has shown little or no sensitivity towards ecology. What is lacking above all is a code of behaviour that can be transferred collectively to the process of projection. These are the principal subjects of discussion we wish to cover in this article.

The ecological problem occurs with special virulence in the early seventies as a result of a commission of the Club of Rome, which gave rise to the Meadows Report from the MIT (Massachusetts Institute of Technology). This presented, for the first time ever, a scientific quantitative evaluation of future growth and the evolution of parameters of population, industrial production, natural resources, food production and contamination.

For the first time there is mention of limiting growth. The conclusions of the Meadows Report can

be summarized as follows: if population growth, industrialization, contamination, food production and the exploiting of resources continue at the same rate, the limit for humanity is about a hundred years away. It is, however, possible to alter this tendency and reach a state of global balance. Naturally, the sooner this change begins, the greater the possibility of success.

The Meadows Report was widely disseminated, was criticized, was misunderstood: it was felt to propose «zero growth», to use the language of propaganda of the period, and it was finally silenced by the 1973 petrol crisis, which apparently endangered western production. From then on new advances in technology were achieved, energy sources were replaced, there was less dependence on petroleum, crude oil prices fell as did the external debt of exporting countries, etc. In short, new development figures were arrived at for the rich countries, higher poverty rates for the less developed countries and, more recently, a new awareness of growth.

To commemorate in some way the twentieth anniversary of the Meadows Report, and taking into account the relevance of the subject, the old forecasting programmes were set in motion again in order to bring the figures up to date. Without going too deeply into the predictions, the conclusions of the study were these: the use of certain resources and the generation of certain contaminants has surpassed the acceptable rates. If there is no reduction in the flow of materials and energy there will be a drastic per capita reduction in food, the use of energy and industrial production.

This effect is not inevitable if policies of growth are revised and if there is a rapid and drastic increase in efficiency in the use of materials and energy.

A balanced society is technically and economically possible. But to achieve this, greater emphasis must be placed on sufficiency, justice and quality of life than on quantities produced.

These conclusions lead us to the concept of the viable society, which must be the initial basis on which to construct the principles of ecological design. A viable society is one which attends to the needs of the present without jeopardizing the ability of future generations to look after their own needs.[1]

The conditions necessary for a viable society can be summed up as follows: rates of utilization of resources must not exceed their rates of regeneration, rates of utilization of non-renewable resources must not exceed the rates at which their renewable substitutes are being developed and, finally, the emission of contaminating agents must not exceed the assimilating capacity of the environment. This leads to a broad vision of the problems and means, above all, that the solution of an environmental problem must not create or exacerbate other problems. Every response must be carefully contemplated: there is not a single equation.

The responses

In the face of the revival of awareness of the problem of environment for the survival of humanity, there have appeared important responses which should be analysed by consumers, companies and governments: responses, all of which can form a framework for the principles of a system of ecological design.

The consumer response

An interesting study carried out in Great Britain in 1990 by Ogilvy & Mather divided consumers into four groups, distinguished by their attitude to environmental problems. The first group would be the activists, who represent 16% of the population: these are conscious of the problem, well acquainted with the situation and possible solutions and are active advocates of the cause. They believe in technology and its

ability to help solve the problem but think that first it is necessary to preserve the environment before promoting further growth.

Another group would be that of the realists, representing 34% of consumers, who are worried, who are pessimistic about the solutions and who appreciate the conflict between short-term profits and the environment.

There is another group, relatively numerous, 28% of the population, who are not particularly worried although they recognize the problem and are conscious of it but who expect that technological advances, government action or some other external element will change the situation spontaneously. The rest are the indifferent; for these the problem does not exist or they themselves have much greater and more pressing problems.

1. World Commission on Environment and Development (WCED), *Our Common Future*, Oxford University Press, 1987.

This data shows the high degree of social sensitivity which exists concerning the problem of the environment; but, in addition, this sensitivity is growing day by day and is aided by the repercussions the theme merits in the media. For example, the percentage of consumers willing to pay more for a «green» alternative to the products they usually buy increased from 40% to 47% in just six months. Ecological sensitivity is also unequally distributed among different countries. According to data supplied by the European Commission, number one in the ranking of «green» awareness is Italy, while France occupies the last place. Spain is in an intermediate position: 41% of the population are aware of and show concern for the problems of the environment.

The response of the administration

Public administration has assumed responsibilities in practically all countries. The pioneers have already reaped their first successes. Japan is a good example. In 1979 it passed a law concerning the use of energy. In 1988 Japan's energy consumption had reduced by 6% compared with that of 1973 while in the same period the GDP had increased by 36%. Holland and Denmark are leaders in Europe as far as environmental legislation is concerned.

The present approach of the EU (European Union) can be summed up in the following points:

- Integration of environment policy into other policies (industrial, I+D, etc.).
- Stricter standards for member countries.
- Investment in environmental improvement.
- More and speedier information.
- Increase in legislation.
- Promotion of studies of the environment.

The response of companies

Companies have also appreciated the concern that exists and some see that efficiency in the use of resources and respect for the environment serve to increase profits and offer the consumer a greater added value. There is beginning to exist a significant body of literature on cases of companies that incorporate functions of responsibility for the environment into their directive staff. For example, 3M has had an active environment policy since 1975 and has a department called Environmental Engineering and Pollution Control at a first level of responsibility together with I+D, production, etc. Philips also has an environmental coordinator with wide functions.

At all events the involvement of higher management is fundamental. In countries such as Germany and Denmark this has already been achieved. A study shows that in 1990 75% of West German companies and 80% of Danish companies have a member of management with environment responsibilities and 75% of the German companies and 90% of those in Denmark had planned or redesigned their products so as to respond to ecological requirements.

At this moment there is a growing recognition of design as one of the key factors in the protection of the environment, whether by creating products that are energetically more efficient, by looking for new uses for recycled materials or facilitating the reuse of used products. In this way, innovation in the design of the product can permit successive reuse (for example, using recycled vegetal fibre for paper for photocopies, laser, ink-jet, computer print-outs, correspondence, school materials, book publication, the press, packaging, etc.).

The probable effect of increasing the share of the market is complemented by a possible associated reduction in production costs, a point which is made fairly evident by the use of recycled materials instead of raw materials. Or by the discovery of new uses for recycled products, as is the case of a new plant in Dietz (Germany), which can convert up to 1,500 t of used cardboard into a special thermo-mouldable, waterproof conglomerate which is expected to have wide uses in the furniture, sound reproduction and building industries; other uses that are being investigated are combustible briquettes (with a high calorific value), pallet separators, etc. Just as happens with the implanting of quality techniques in a company, so it is more economic to design the «ecological» product than to attempt to incorporate this feature once it is «outside» the factory.

There is a change of strategy: from a simple response to environmental problems, which assumes the solution to be the recycling of products at the end of their functional life, to a new range of activity, from the first phases of design until the end of the useful life of the product, such as the use of reusable parts, re-

duction of wastage, materials and energy during the functional life of the product, design for assembly or disassembling (at the end of the functional life of a product, how its parts can be disassembled and the materials reused).

The leading companies in the different sectors have already begun this transformation of the product and its process of manufacture. Various important examples can now be quoted, within the European framework, of the impact of the new environmental awareness on the development of new products:

- The development in Opel-General Motors (Figueruelas) and SEAT (Martorell) of new models of vehicles with three-way catalysers, thereby anticipating the deadlines established by the community directives: all this in new manufacturing surroundings increasingly integrated into and less «aggressive» towards the environment.
- The presentation in Cebit'92 by the VDMA (German Association of Machine and Installation Manufacturers) of new models of computers which will permit complete recycling of materials by the manufacturers once their useful life is over.
- Investments of up to 20,000 million pesetas by the FIAT group in order to allow for 100% recycling of the components of their new vehicles (already designed with a view to recycling).
- The presentation by Olivetti of a new range of biodegradable ribbon cartridges for printers and typewriters.
- Initiatory German legislation which will oblige future manufacturers of consumer goods to undertake the collection and recycling of packaging for their sale or containers for their

transport, or to facilitate the use of reusable containers (Gruene Punkt label).

It is in the areas of resource reduction and recycling that designers can have the greatest impact.

One form of reducing waste is by avoiding it and a good design reduces the amount of material needed, while complying, of course, with all mechanical and security requirements.

Nowadays recycling is the strongest motive for reducing solid waste but most recycling programmes are concerned with the packaging, which may not be able to be transformed into durable products.

The future of environmental design is the analysis of the life cycle (ALC), which consists of a thorough study of what is needed to produce a product, how it is to be used and what will be done with it after its functional life.

Each facet of the life of a product has an impact on the environment and the ALC determines this impact in relation to the product or process. An ALC can quantify resource and energy use from the beginning to the very end of the life of a product. Data generated by the ALC helps directors and designers to make the correct decisions.

We find ourselves, therefore, in a changing situation. We can consider the application of environmental criteria in the design of a product or in its manufacturing process as being a factor of competitive advantage today. But it is also becoming apparent that if they are not applied, this omission can become a factor leading to exclusion from the market.

The ecodesign

In future the success of a product will be attributed not only to its capacity for communication or its effectiveness, but also to its minimum impact on the environment. Successful green products will be those that offer a high quality identical to the product they are replacing, solutions to new problems, equal efficacy and an equivalent cost. This is the conclusion arrived at in a study carried out by Andersen Consulting and the DDI on design in Spain.

Ecological design, «ecodesign», can be reduced to one basic standard which we will call that of the three R: reduce, recycle and recuperate.

Up till now the definition of a good design has included factors such as ease of use, production considerations, assembly, an examination of its functions, etc. Today a good design must consider the consequences the product will have on the environment from the moment of its creation to its death.

An ecological design should take into account the following principles:[2]

- Increase the efficiency of the product in its use of materials, consumption of energy and all other resources.

2. Burall, P., *Green Design*, The Design Council, London 1991.

– Minimize the problems of contamination caused by the materials chosen.

– Reduce to the minimum any harm to the environment which the use of the product can cause in the long term.

– Ensure that the planned life of the product is the most appropriate in environmental terms and that the product will function efficacyly during the whole of its useful life.

– Take into account the effects on the environment at the end of the life of the product.

– Ensure that the packaging, the instructions for the use of the product and, in general, its very appearance promote its effectiveness and encourage respect for the environment when it is used.

– Minimize nuisance of all kinds, such as noise and smell.

– Analyse and minimize possible security faults.

These are the basic principles of ecodesign, to which one should add a last and important consideration: there does not exist a single equation, it is a constant and permanent equilibrium. For example, no doubt seems to exist for any person with an ecological conscience, those we used to call «activists», that a paper bag is more respectful towards the environment than a plastic bag. However, they create similar problems for waste collection, they can be destroyed with apparent ease, but with the difference that a paper bag consumes three times more energy than one made of plastic and ultimately it is the plastic bag that has greater possibilities of reuse. Perhaps the dilemma is not «plastic bags» or «paper bags» but simply «fewer» bags.

The ecodesign of the product should centre on the consideration of three key aspects: energy, materials and the life-cycle of the product.

In the first aspect, the design of a product must aim at increasing the energetic efficiency of the product and at developing the use of clean forms of energy. The search for and use of insulation to reduce heat loss in electrical appliances such as refrigerators and ovens, the higher energetic output in the choice of light sources, the aerodynamic improvements in means of transport are all examples of design application with a view to energy saving.

In the aspect of materials to be used, the design must take into account various factors. The first should be to minimize their use. Sometimes a change of form can reduce the amount of material needed. In other cases the thickness and weight of the material used may be reduced by better structural calculations.

Another aspect to take into account is the choice of materials, bearing in mind a long-term energetic balance. Thus, for example, the use of plastic in cars reduces fuel consumption considerably because of the lower weight and we should also remember that 13% of crude oil consumption is for petrol and only 4% for the manufacture of plastics.

The use of recycled materials has a positive effect in reducing waste and avoiding greater destruction, although on occasions they impose obligations on the designer, who must adapt himself to the new medium and to the qualities it presents. Thus, although there does exist recycled paper of excellent quality, if we aim at the same degree of whiteness, this supposes double the consumption of bleach.

Account must be taken of the use of renewable materials as opposed to non-renewable, and of the former the most easily renewable must be chosen. Care is also necessary in the choice of materials for the finish of the product, such as paints, pigments, tints, etc.

Finally, the designer should think of the life-cycle of the product. The designer traditionally finished his work thinking only of the moment when the product would be launched on the market. Designing products that show respect towards the environment, «ecodesigning», basically means designing with the whole life-cycle of the product in mind: from its birth to its death, passing through the whole of its useful life.

The problem of waste is serious. Tons of refuse is produced of which a mere 2% is recycled. An average family throws away each year the equivalent of 6 trees in paper, 30 kg of metal, 50 kg of plastics and 70 kg of glass. The design of the product must minimize waste either by simplifying its recycling possibilities or by facilitating its collection.

During the life of the product, which should be as long as possible, the reuse of the product and its possible dual or multiple uses must be borne in mind. A recent exhibition in the Barcelona «La Primavera del Disseny» (The Springtime of Design) with the name of «Altera Utilitates» showed in a fresh and easy way the possible dual uses of products. Perhaps we should be designing seriously for such a double function. This does not mean the disappearance of «use and throw-away» products, which can in some cases suppose greater saving: it means rationalizing their design and production. While thinking about the life of the prod-

uct, the designer must also think about its maintenance and repair possibilities. The containers one can see in the streets of any town are a good example of products which, with very little effort or money can be made operative again, but which have been abandoned by their owners without knowing this. It is true that this extension of the life-cycle can work against improvements which might be introduced as the result of technological innovations, but there are occasions when it would not be necessary to change the whole product but simply part of it in order to obtain a significant improvement. Designing modular products so that new components proceeding from innovations can function alongside other more traditional elements is one of the challenges facing design.

In the same way it is desirable for the designer to think of the recuperation and recycling of components. In order to facilitate recycling it is essential to consider the combination of materials used. For example, the presence of copper in steel scrap raises the price of recycling to an extraordinary extent. Likewise, the presence of other plastics or aluminium in polystyrene makes its reuse difficult or even prevents it, though on its own it is very easy to recycle.

The final consideration to be given while thinking of the life of the product should be to the consumer by making the product easy to use and easy to destroy, taking into account the collection, classification and selection of waste.

Design must aim to improve products and their relationship with the environment. To achieve better products we must consider the following points:

- The elimination or replacement of noxious products.
- The elimination or reduction of harmful ingredients or components.
- The substitution of materials and processes detrimental to the environment.
- The reduction of the weight or volume of products.
- The production of more concentrated products.
- Production on a large scale.
- The combination of the functions of more than one product.
- The limitation of excessive proliferation of models and styles.
- Design that is aimed at a more efficient use of products.
- The lengthening of the life-cycle of products.
- The maximum reduction in the amount of packaging that will be thrown away.
- Designing so that the consumer can reuse the products.
- The production of goods that can be easily «remanufactured» either wholly or in part.

It is not an easy task to design the products that our present-day society asks for. But has it even been?

The challenges of the ecodesigner

It is clear that the designer has an important role to play in the «era of ecology» and that with the progressive depletion of natural resources this development will become very evident. We do not know yet what this world in search of balance will look like.

What is certain is that bringing about this revolution in behaviour and mentality, setting out from the logic of zero growth, supposes a growing awareness and gradual integration of the needs and challenges of the «ecoworld».

In this sense the designer can develop a very important function if he also integrates the challenges of ecodesign and its objectives.

«Ecodesigning» means giving substance in the long term to a creative idea, to the object to be saved, protected and recycled, and thinking of a suitable process of recycling suitable for the product in its first stages of development in order to reduce environmental costs.

«Ecodesigning» means bearing in mind the following four development challenges, important above all because ecodesign is still in its beginnings and its bases have not yet been established:

1. The task of carrying through an idea up to its production: in terms of costs, access to materials, techniques available and its forseeable success. To all this the designer must add the ecological dimension of the final product during the whole of its life-cycle; for this reason he will have to keep a constant lookout for sources of information concerning other alternatives for production and materials which respect the environment.
2. His second challenge will be to influence the company with respect to types of materials and tech-

niques to be used in the production process, overcoming without hesitation all inertia encountered in the face of change.

3. Thirdly his role will become more than ever a role of coordinator of his company's production process. In other words, he will have to bring about a synthesis among the agents of production, that is to say, a high level of intercommunication, interchange of ideas and interpenetration of tasks, guiding it all towards «ecoconceptualization».

4. His last challenge will be aimed more at the consumer. It is necessary to integrate the consumer into this new philosophy of production, which naturally implies a new way of consuming. With this aim the designer can:

- Design and conceive new forms of communicating which encourage ecological consumption.
- Mould and educate the consumer by eliciting new modes of behaviour in the face of consumption: saving, buying for the long term, reusing, respecting the environment, recycling...

He has at his disposal all the creative medium of his imagination to show consumers the urgent side of ecological application and to induce them towards a new form of consumption.

The designer thus exerts two types of influence as far as the environment is concerned. On the one hand, he influences internally the agents which make up the company (engineers, producers, distributors) and, on the other, he acts as an instructor in new methods of production.

The need to be more versatile and willing to obtain the significant data concerning alternative materials and production processes which permit recycling, saving and protection of the environment are the present-day challenges: the education of designers, the construction of networks of available information are clearly indispensable tools that require time and investment. Moreover, the communication and internal interrelations within the company which must arise among all its agents are not only the work of the designer, although indeed we have insisted on the role he plays: everyone must contribute and influence.

Finally, the designer has a responsibility for the education of the consumer which is just as important as that of the other aforementioned social agents. Faced with the ecological revolution, we have no choice. The process of the exhaustion of natural resources is a fact. We can, however, choose the way the change will occur. Some see the ecoworld as a return to our natural roots, that is, living from what the Earth offers us. Others see ecodesign as the control of the human being over his own impulse towards mass consumption and spending. It means learning a new way of producing, of consuming and of reusing. Finally, there are those who see even further ahead: the exhaustion of natural resources is something inevitable, whatever we may do. A point will be reached when it will be necessary to synthesize every one of the vital elements. The recycling process would be an intermediary stage on the way to this synthetic world they predict; a stage during which we would be able to develop sophisticated techniques of synthesis.

Recycling would be no more than a half way stage which cannot be valid for ever, given the loss of the properties of the material as it is being recycled.

As can be seen, ecodesign is still an open subject which offers an important creative challenge. It is a question of gradually changing habits and mentalities: it is essential to find solutions which will attract and convince the public.