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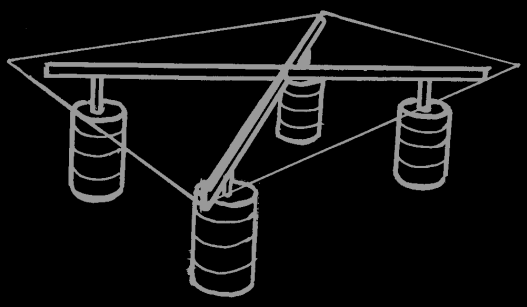
The Journal of Sustainable Product Design



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Battery-powered lawn mower by Husqvarna

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Increased creativity and innovation are critical to sustainable solutions

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GENERAL INFORMATION

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Welcome to the second issue of The Journal of Sustainable Product Design

Martin Charter and Anne Chick

Editors, The Journal of Sustainable Product Design

If we are to move towards sustainability, we need to imagine what a more sustainable world will be. Most of us really haven't thought that through. Quite understandably, the majority of people do not understand the academic concept of sustainable development. Indeed, research for the Department of Environment in the UK, indicated that 'sustainable development' was seen as a government construct to keep people out of environmental issues. However, if we re-phrase the question and ask people what sort of world they would like to live in, we are likely to come up with some answers that are likely to be entirely consistent with 'expert' viewpoints of sustainability. Sustainability is not about re-arranging the eco-designed deckchairs, it is about questioning the purpose of the ship. It will require re-thinking and new thinking. As with the Zen master and his pupils it may require a whack on the back with a hard stick! A strong image, but a provocative one!

How do we translate these issues back into something applicable to product and service development and design? A key issue is we must not forget customers. Many companies have forgotten to talk to customers and have focused inwardly on the technological and engineering improvements required for, primarily, eco-design eg. using less energy, using less components, using less packaging, etc. The Kambrook kettle is a good example of an attempt to create a dialogue with customers and understand customer behaviour. The market research led to a new perspective, which led to the development of a greener solution (JSPD, Issue 2). Husqvarna AB's solar-powered lawn mower is a different type of example (JSPD, Issue 3). From a sustainability viewpoint, it is not the answer, but it demonstrates that new ideas can reach the marketplace if the conditions are right. These slightly 'off the wall' concepts create discussion, and make at least some people think about new solutions! People must have examples, that catch their imagination. If you cannot *see* it, you cannot *do* anything about it! The door must open...

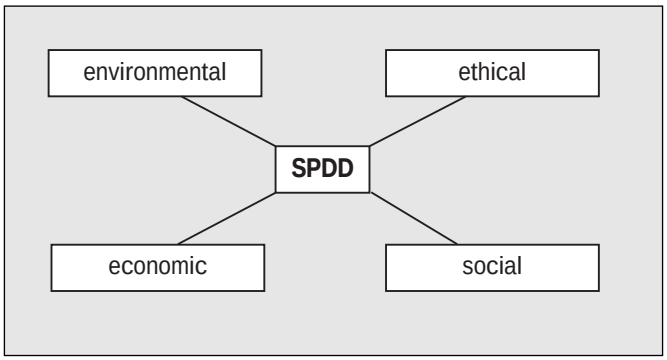
The lawn mower is an interesting example. The first question is do we need it? Behind this is a key question: what are needs? Maslow developed a 'hierarchy of needs' which illustrated a series of levels, that could only be attained when the previous level has been satisfied:

- physiological
- safety
- belongingess
- esteem
- self-actualisation

From a Northern perspective much of the discussion over sustainable product development and design (SPPD) and eco-design relates to self-actualisation (essentially, developing oneself to your fullest potential). However, from a Southern perspective, SPDD relates to basic needs eg. food to live and 'design for necessity', eg. shoes from car tyres. There are shifts happening in the North where some are asking themselves 'do we really need it?' This may mean that green consumers in suburbs shift from using solar-powdered lawn mowers with no human intervention to being rural or semi-rural sustainable consumers using mechanical lawn mowers that cut the grass and keep you fit!

Lawn mowers: power systems

- human-powered
- battery
- solar
- clockwork?



SPDD: e3s innovation

The process of product creation starts with an idea and develops into a concept. Therefore if people who generate ideas have no concept of sustainability, then we may only get random advances.

Allowing for constraints of 'time to market', costs, etc. there should be wider stakeholder input into the product development process, with sustainability thinking injected as early as possible into the process. Considering the issues at the design stages is too late, as many decisions will have been made and opportunities missed.

SPDD is a much broader agenda and requires innovation across e3s issues (environmental, economic, ethical, social).

This means not just developing innovative new products, but innovative and new ways of using and re-using products ie. shifting 'products to services'. SPDD will mean developing new processes to deliver those products/services whilst working and cooperating with internal and external partners much more closely.

In this issue, articles by Ursula Tischner and Professor Ab Stevels focus on designing for environmentally-driven sustainability, and particularly highlight designing for eco-efficiency. Professor Stevels suggests that there are four sequential steps of eco-design, with the fourth level being longer-term design for a sustainable society. Jonathan Williams provides an example of a new tool that has been developed that analyses product-related eco-efficiency, particularly amongst electronic products.

Annica Bragd analyses the lessons learnt by a Swedish gardening equipment manufacturer, when developing, marketing and launching battery and solar-powered lawn mowers. A key lesson learnt is that stakeholder education is essential, particularly amongst customers and distributors.

The interview with Professor William McDonough starts to broaden out the SPDD agenda to include a more holistic concept that includes social and ethical considerations. Colin Beard and Rainer Hartmann highlight some new perspectives on sustainable design, in which environmentally-positive (e+) design thinking will become a more creative and influential avenue for designers.

O2 Global Network pages update readers on new eco-design developments, including Philips decision to progress its 'end of life' management strategies. There is a focus on O2 Japan, including a report on the Tennen Design conference that highlighted the need to consider 'values' in eco-design thinking.

The Journal continues to search for case studies and articles the explore both eco-design, and particularly new and 'blue sky' thinking in the areas of sustainable consumption and sustainable product development and design. The aim is to build the Journal's international focus as a platform for debate and analysis.

Feedback and comments are always useful. •

Learning from the introduction of green products: two case studies from the gardening industry

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The development of environmentally sound products or green products is being increasingly considered as an important strategic issue by Swedish companies. But so far very few companies have detailed practical experience of handling these projects. This indicates that there is a real need for systematic documentation of the experience and knowledge generated in the green product development and marketing process. This article presents a study of a Swedish manufacturing company in the gardening industry, with examples of technologically innovative products and the problems and opportunities associated with the green product development process. The study highlights that the learning associated with green products seems to be different in comparison to conventional products. Therefore the article argues that there is a more complex and multi-dimensional learning process taking place in the introductory phase of green products.

Introduction

What are green products? In reality green products do not exist: products are either more or less green, or greener; all consumer or industrial products cause environmental harm. Therefore it is easier to describe products as having green characteristics such as being non-polluting, energy efficient, recyclable, noiseless, etc. Over the last decade there have been a range of green products that have been launched into a wide variety of consumer and 'business to business' market sectors. What experience have companies' generated from developing green products? Of course, the answer(s) to this question are of considerable interest to companies working with green products today. During 1996 an empirical study (Bragd & Wolff, 1996) was carried out, where the above question was the central theme. The aim was to obtain a general view of the management of green products, in the context of the corporate learning

Solar Mower

Environmental considerations break down traditional lines of responsibility within the company and change the boundaries in relation to its external environment.

process, based on the rationale that continuous improvment, new technology and innovation are essential prerequisites for the development of environmental activities. The empirical study comprised 70 interviews from two manufacturing and one sales company. The interviewees were product developers, marketing staff, environmental co-ordinators, purchasing staff, product line managers, project members, retailers and customers. This article is based on the findings of this study and will focus on Husqvarna AB's green product experience resulting from the launch of two lawn mowers. Following the case studies there is a discussion regarding the learning process resulting from these projects. Practical examples conclude this article, showing where improvements can be made in relation to the introduction of green products.

Background

Environmental activities of proactive Swedish companies

The complexity of environmental activities and the new approaches taken by Swedish companies explains why academia and business are interested in further exploration. Environmental considerations break down traditional lines of responsibility within the company and change the boundaries in relation to its external environment. Corporate environmental activities taken as a result of green issues are as a result of both externally regulated processes and internally-driven forces. Environmental driving forces can be very different, for example they can be competition-driven to obtain 'first-mover' advantage, or consumer-driven, regulation-driven, or media-driven eg. over environmental risks. For example, at the beginning of the 90s in Sweden, there was intensive public debate over high emission and noise levels. Another key driving force is management's belief in the strategic importance of environmental issues and the commitment of the staff.

A key aspect of the development of the green product market in Sweden was the entrance and involvement of the municipalities. In 1995, several municipalities became involved in the green product debate when they produced environmental reports on how to deal with environmental issues in their organisations. The environmental reports declared that the municipalities would buy greener products. This was a very important step, and it pushed forward the development of new green products in Sweden.

Husqvarna AB

In the following section, Husqvarna AB's experience in green product development will be discussed using two of its technologically innovative products. The origin of Husqvarna AB's environmental activities derives from many years of experience of improving ergonomics and the work environment. The company transferred its experience from the research and development (R&D) of chain saws to lawn mowers. From 1993 the company developed several

applications of catalyst technology for small engines and became known in various countries for its involvement in green products. Today the green range includes innovations from step-by-step improvements to new niche products.

Husqvarna AB is taking part in an internal as well as an external learning process in relation to green product development. The learning process has covered both product development and marketing processes. One of the lessons learnt at a corporate level has been that the company has had a focus on technology and a technology-oriented product strategy. The management has now recognised this and is now going through a change process, towards a market-orientated approach. This process of re-orienation has been triggered primarily by the work on green products.

From a 'technology-orientated' gardening company to...

The demand for shorter product development time, shorter introduction processes and quicker 'time-to-market' has put increasing pressure on companies in the gardening industry, and more broadly on Swedish industry. To increase their competitiveness many companies are becoming increasingly technology-orientated. These companies strive to produce high quality products and continuously improve products, as they believe their customers strive for quality. Therefore the production of marketing plans comes second to the development of the technology. Research has highlighted many examples of limited internal communication between the marketing and the product development departments, which leads to an inefficient use of resources. In the long-term the technology is unlikely to be fully utilised or transformed into a competitive advantage, if there is no understanding of the customer. The absence of marketing concepts, the lack of long-term product strategies and bad product cost estimations are also evidence of a bias towards strong technology-orientated strategies.

The second case study, the Solar Mower is an example of weak market orientation. A key lesson was that, in order to make the customer pay a higher price it is not enough to just present the raw technology. The presentation of the technology must be supported by an appropraiate image ie. modern and environmentally-sound. In addition, it must be aimed at a specific target group. The experiences gained from this product made the company aware of the need to revise current marketing and selling practices as well as explore different forms of distribution.

...a move towards a 'market-orientated' gardening company

One reason for re-focusing on a more market-orientated approach was that the company could not act on all market opportunities and satisfy every customer's need. However focusing on tight target marketing does not guarantee the success of every new product. It is more likely to act as a risk reduction exercise and contribute to an earlier discovery of product failures, if market research and information has been gathered effectively. This was highlighted by the author's research which indicated that green products appeared to need a higher level of market differentiation. To take advantage of opportunities, organisations developing green products will need to be adaptable to both technological change and market changes. The organisation must also learn to understand green customer preferences and environmental legislation in different markets. Also, the marketing and communications activities associated with green products need to be adapted to locally-based green consumer demand and to the level of environmental awareness not only linguistically, but also conceptually.

Case studies

The case studies present two green products: a battery-powered lawn mower and a solar-driven lawn mower. The structure of the case studies is a short background followed by a description of the driving forces, the product development process and the marketing activities. The experiences gained from the development of the products conclude the studies.

Battery-powered lawn mower

Case study one: the battery-powered lawn mower

Background

The battery-powered lawn mower was the first so called green lawn mower launched by Husqvarna AB. The positive experience resulting from the launch of the product was one reason why the company started to further examine the eco-profile of a broader range of gardening products. This product, an acquired patent in 1992, showed that it was possible to mow grass using a battery-driven engine. However, to be competitive additional technological improvements were needed such as weight loss, performance improvements, power increase and considerable noise reductions. When the product was launched in 1993, it was presented as an outstanding product compared to competitive electronic lawn mowers, due to its wireless rechargeable battery-driven engine with 1.5 hours of running time. In addition, the product had no exhaust fumes and low noise levels. At the time, competitors had no alternative products. This 'first mover' advantage has now been eroded due to several reasons:

- decreasing prices of lawn mowers
- fierce competition
- the product is easy to mass distribute and does not need a maintenance service
- new mass market distributors have entered the market for battery-driven tools and machines.

This product is a business success in that it corresponded to a market need, but was priced high due to high production costs.

The 'second generation' of Husqvarna's battery-driven mowers was launched in 1996. From a green point of view, the product development work was different compared to the 'first generation'. The product development group decided to develop a machine that used minimum energy without loss of performance, quite contrary to the 'first generation' lawn mower, where 'horse power' was an important part of the selling argument.

Driving forces

At the beginning of the 90s, fierce public debate took place in Sweden in relation to lawn mowers as polluters. The core of the debate was that a lawn mower pollutes more during one hour than a car travelling between the two biggest cities in Sweden. Clearly this was a debate that Husqvarna AB had to respond to, particularly as the issue increased and triggered the environmental consciousness of company employees, which led to discussion over environmental aspects of the products.

At the beginning of the 90s, a fierce public debate took place in Sweden in relation to lawn mowers as polluters.

Another driving force was the development of new battery-driven tools, where producers of electrical supplies and tools were pushing the development of the technology. A key issue was the visionary leadership of the managing director who strongly believed in the development of batteries and encouraged the staff to progress research and development in this area.

In 1995, 'Carb 95', the Californian state's legislation on engine emissions eg. lawn mowers came into force. It lead the company to look for alternatives to conventional lawn mower engines, as the US was an important export market and the Californian market was an important 'reference group' for future product success.

Product development

Husqvarna AB had developed a competence in mechanical construction work and had many years of experience in the engineering industry. The battery mower was basically an electrical construction and the technological competence had to be bought externally, which led to high levels of initial investment.
The battery-powered mower is a green product in the sense that it is free from exhaust fumes and it is noiseless, and the chassis material is made of recyclable plastic. What is interesting is that initially there were no green product development strategies, as the product development group did not consider the above mentioned as environmental characteristics but as product features. This was partly to do with the batteries, which were not perceived to be green or even as greener forms of power. The product developers argued that the mower should not be marketed as an environmental product.

The selling arguments used were:

'...a rechargeable battery-driven mower, which does not disturb the neighbours.'

'...light weight.'

'...equipped with vibration damping grip.'

'...does not emit exhaust fumes.'

'...has a low noise level.'

The technological experiences gained from the 'first generation' were not passed onto the 'second generation' due to a management decision to shift product development and production from Sweden to Norway. however, the manufacturing of the 'second generation' products used an approach that was completely different to that used in the rest of the industry. The new idea was to produce a machine that minimised the use of energy and power without performance loss. This was a different way of thinking in the gardening industry because competition was usually based on products with lots of horsepower. The product development group was particularly concerned about how to minimise the use of natural resources and how to extend the battery's life cycle eg. by automatically turning the battery off before it ran out. The *new* new product development group displayed a clearer understanding of environmental issues and looked to implement this in new eco-designed products.

Experiences of the battery-powered mower

The following seven points present implicit and explicit experiences from the introduction of the battery-powered mower. These experiences have emerged from the interviews and are an interpretation of the material.

The core of the debate was that a lawn mower pollutes more during one hour than a car travelling between the two biggest cities in Sweden.

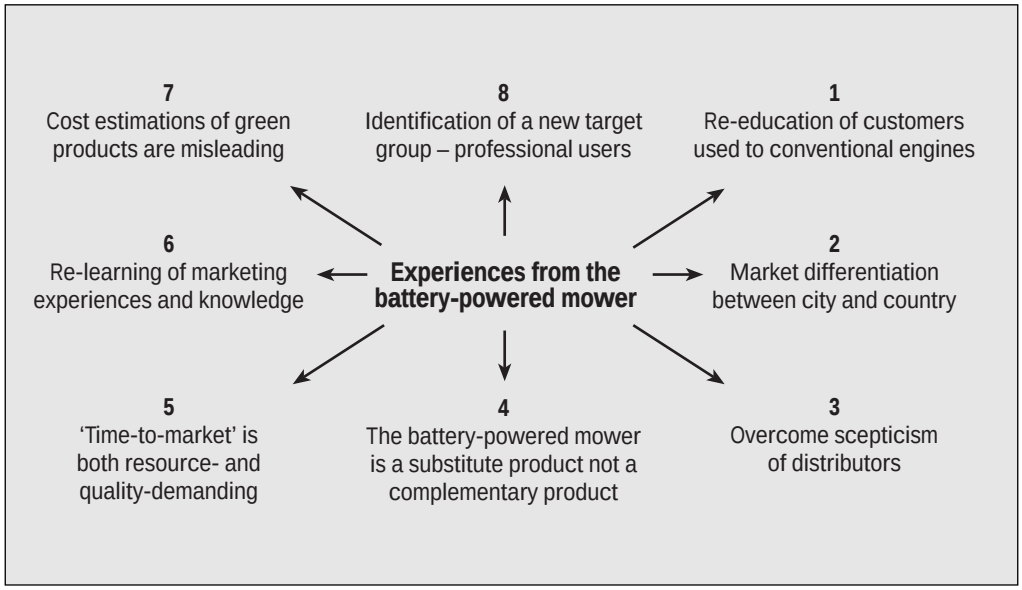

Figure 1: Experiences resulting from the launch of the battery-powered mower

- 'Re-education of customers *used* to conventional engine-technology' – the traditional 'engine-using' customers had to be convinced about the benefits of the new way of mowing grass using battery power. The customers said: 'it doesn't smell or sound like a lawn mower'. The selling efforts at 'point-of-sale' were also more extensive then expected.
- 'Market differentiation between city and country' – issues of market differentiation and demand patterns appeared after launch. The product appeared to fit customers' requirements in well-populated areas. However, the company claimed the countryside was two to three years behind more populated areas regarding interests and demand. Thus the question is, if the product had been marketed using environmental arguments – how would the countryside's demand have developed? This aspect had not been considered in the original marketing activities.
- 'Overcome scepticism of distributors' – it is important to overcome the distributor's scepticism concerning new green products. In this case the distributors did not approve of the product because they would lose maintenance business. The battery-driven mowers did not a require a great deal of maintenance in a traditional sense, due to an electric ignition system and no need for oil changes, etc. To overcome the distributors' resistance, more time and resources should have been invested in education.
- 'The battery-powered mower is a substitute product not a complementary product' – from a strategic point of view this experience may be the most important. Because of satisfactory sales and faith in the development of battery technology the company chose to continue with the battery-driven mowers, which contributed to the discontinuation of electric mower development.
- '"Time-to-market" is both resource and quality demanding' – in this case the product was resource intensive. The 'time-to-market' issue was an essential consideration due to the seasonality of the gardening market. The industry is fragile because if the product is not in outlets by the Spring, there is a risk of missing a season of sales, which clearly can jeopardise the success of the product. The balance between increased 'time-to-market' and

quality aspects for the launch of new products is a difficult task.

- 'Re-learning of marketing experience and knowledge' – this includes the distribution network and the development of new learning and re-learning processes within Husqvarna AB's organisation. This includes the learning of new selling practices and the revision of past practices. There was a gap between past selling practices and the requirement for the selling of green products. At 'point-of-sale', there was a need for product information, especially on environmental aspects. The benefits of eco-designed products need to be fully communicated if business success is to be achieved. Appropriate education, training and information programmes are essential if green products are to win market share.
- 'Cost estimations of green products are misleading' – cost estimations and pay-back are inaccurate measures of the overall impact of the product. The problem is related to the lack of predictability of future revenues of green products. There is also a need to develop new accounting practices that 'factor-in' externalities eg. use of natural resources.

Case study two: The Solar Mower

The product: The Solar Mower

This case study describes the launch of a solar-driven mower. The technology of using daylight as fuel to drive a lawn mower is an incremental step towards environmentally sound products, as it does not use fossil fuels or electricity in generating power. Therefore it does not emit exhaust fumes or other pollutants in generating power either in the garden or at the power plant. The product is a robot, which mows at random and looks after itself without human intervention. The product starts automatically in the morning when there is enough sunlight. On cloudy or rainy days it takes things a little easier, depending on the available light. The working zone of the mower is bound by a hidden, low voltage wire loop, which is powered by a discrete solar panel.

Course of events

The original product patent was acquired in 1993 and was introduced in the same year as a prototype to the distributors. This generated enormous interest from the public and media. However, production did not start until 1995 due to production adjustments, with sales to the final customer starting later that year. The product is a business success because it has increased brand awareness but due to high pricing the product has not been a sales success.

Driving forces

In the beginning of the 90s the gardening business started to become a mature market with falling margins, with new product introductions incorporating minor product modifications. In the research survey, interviewees stated that the gardening industry was 'standing still' and that 'we were waiting for something to happen'. The company had been looking for future alternatives for a long time and the concept of a solar-driven mower embodied the modernity and vision that management was looking for. When the product's inventor presented the prototype at a trade fair in 1991 the whole industry laughed and said 'there is not a market for that yet', 'that looks like a toy, can it mow?' However Husqvarna AB expressed the opposite opinion 'this looks very interesting, let's do something about it, let's meet the inventor'. The project group saw the product's potential as an 'image maker', ie. as a product that would help create an image of an innovative company developing innovative products. Another key issue was that the company had rationalised extensively at the end of the 80s and had entered the 90s as a slim organisation. The fact that the company was solid and could invest was an important factor in the decision to move the project forward.

Product development

The new solar technology shifted the focus from horsepower to watts as an energy source (with the product using the same power as an electric bulb). A micro computer is programmed to mow randomly with small razor knives instead of a traditional rotating knife. The solar technology required new competence and attracted several external consultants and distributors who wanted to take part in the generation of the technology.

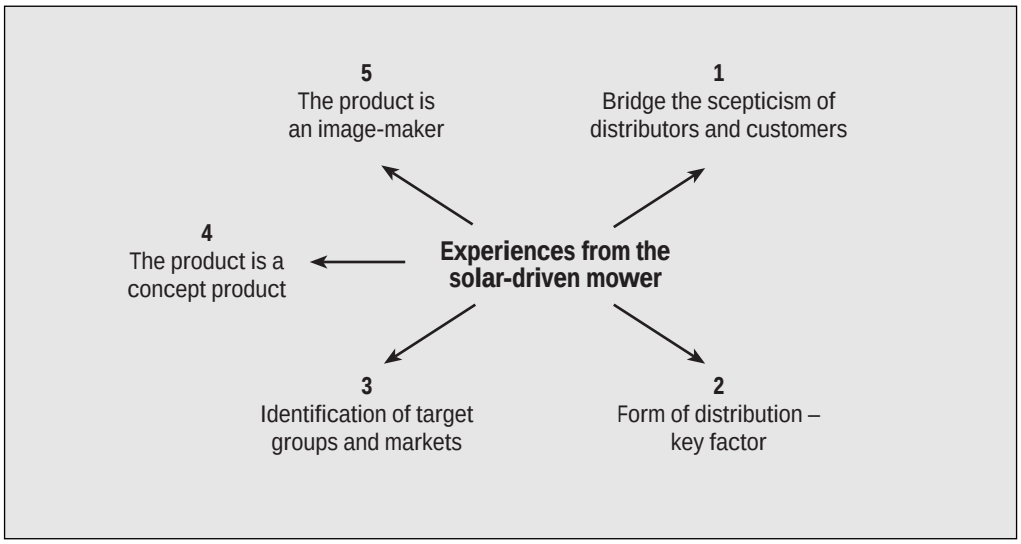

Figure 2: Experiences resulting from the launch of the Solar Mower

The product is a new concept, which requires customers to change their perceptions of how to mow grass.

Marketing

The lessons were extensive. The Solar Mower is a niche product and required specific marketing. The product is a new concept, which requires customers to change their perceptions of how to mow grass. The marketing had to be based on symbolic aspects, which had to be visible to the customer ie. modern and futuristic. The product had to perform, but it had to give the perception of functionality and usefulness. The Solar Mower reflected its consumers, and communicated that they are modern and/or environmentally conscious. To help the customer appreciate the product, it was not enough to present the raw technology, it had to create an image that related to the target market. The product required demonstration and demanded more information compared to conventional products, simply because customers had no experience of solar-driven mowers.

Experiences

The following five points present implicit and explicit experiences from the introduction of the Solar Mower. The experiences have emerged from the interviews and they are an interpretation of the material.

- 'Bridge the scepticism of distributors and customers' – the project presented evidence of the need for product demonstration to generate sales. The distributors learnt this before Husqvarna AB, stating that the selling, negoiation and demonstration took valuable time away from the selling of other products. Initially, there where doubts expressed by some distributors of the ability to sell the product at all. A perception of customers was 'nice product but can it really mow?'

- 'Form of distribution is a key factor' – the form of distribution in Sweden as well as in other markets did not correspond to the demand in well-populated areas.
- 'Identification of target groups and markets' – the profile of the target market for the product was unknown before launch. The process of launching helped uncover the customers, their needs and how much they were willing to pay. The marketing department tried to cover too many markets and launched the product at the same time with the same concept. In retrospect, the product should have been tested on a 'reference market' and market research should also have been conducted. The distributors should have been involved on a larger scale to 'check the market' before launching. The launch was an educational process for the company in which valuable information and knowledge was discovered. Today it is possible to detect target groups for the product such as professionals and 'business to business' markets such as, industrial areas, holiday camps, hotels and recreational areas.
- 'The product is a niche product' – the marketing of the Solar Mower should have been treated differently from mainstream products, especially the communication and selling practices.
- 'The product is an "image maker"' – the company were able to position the Solar Mower at the innovative end of its green product portfolio ie. at the 'easy' end are products such as the lawn mower with a catalytic converter. The company's brand awareness has increased because of the product. The product signals to the customer the vision of the company, as one which develops new innovative products. In addition, the customers are now also aware that the company also works in the gardening product industry, and is not exclusively a manufacturer of chain saws and forestry products.

Discussion – what, where, and how to understand green products?

What can we learn from the case studies?

Husqvarna AB started to generate experience regarding environment-related issues at the beginning of the 90s. The two case studies are partially a result of the company's efforts to understand the complexity and the new learning required to develop green products. Lessons learnt include:

- there are different driving forces for green products compared to conventional products
- green products require a different form of communication and information profile
- there is a degree of insecurity over the marketing of environmental messages
- it is important to find forms of distribution that fit the requirements of the product's characteristics
- new knowledge can be found amongst customers, in different organisational departments and within distributors.

Where can we find new experience in the company?

Project groups, environmental coordiantors and distributors have generated new experience and knowledge as a result of the green product launches, but the knowledge is limited to each person. Members of project groups have acted as 'intrapreneurs' and have searched for information and knowledge in different parts of the organisation. The 'individual search process' takes time and resources, and has not lead to the diffusion of knowledge. So, the company faces the task of trying to facilitate the knowledge transfer processes, especially the transformation from 'individual knowledge' to 'organisational knowledge'. This will be the first step towards improving the organisational learning structure in relation to green product development.

How can a company increase its organisational learning?

The main element of organisational learning is the ability of the entire company to create knowledge, and to diffuse and use it in products, services and systems. When organisations learn, they learn from individuals in other departments, subsidiaries, or from other organisational arrangements (Kim, 1993). Procedures are needed to collect and diffuse experience and knowledge so that it becomes organisational knowledge. Husqvarna AB has realised that in order to learn

The study indicates that learning processes resulting from green product development seem to be different in comparison to the learning resulting from conventional products

more in relation to green products, 'follow-up projects' and documentation must be completed as a way of making knowledge more explicit. Experience shows it is cross-functional and cross-hierachy group discussions coupled with documentation, which are important elements in the knowledge diffusion process. The study indicates that learning processes resulting from green product development seem to be different in comparison to the learning resulting from conventional products. The organisational approach has to be built to respond to, not only technological change, but also market changes. It must also learn to understand green customer preferences, local environmental awareness and environmental legislation in different markets. This illustrates that there appears to be a multi-dimensional learning process taking place in the introduction phase. The company needs to focus on the internal learning ie. learning within the company (individual and intra-functional), as well as external learning (customers and the competition) in order to increase the understanding of the issues surrounding green product development.

Practical examples of 'missing links' in the organisational learning process of green products

The examples from the case studies illustrate the necessity to 'organise new knowledge', an area where there is inertia. It takes time for an organisation to learn and establish a programme to encourage organisational learning. However, before new learning can take place, unlearning has to happen. Unlearning becomes increasingly difficult the more established and integrated the cognitive structures are (Hedberg & Wolff 1997). Green products are more information- and education-intensive than conventional products in the introduction phase.

There are our key actors in this process:

- customers
- company staff
- the marketing department
- distributors.

The following examples show the lack of information and education in the introductory phase of green products.

The *customers* hold certain beliefs and myths about the performance, capacity, quality and the price sensitivity of green products. These beliefs should be dealt with at 'point-of-sale', as customers want answers to their environmental questions such as 'what is a catalytic converter', 'what kind of environmental certification does this product have', 'how much does the product effect the environment', etc. These questions take time for the distributor to answer, and they need training and information.

Company staff appear to have great personal interest in environmental issues. There were requests for product-related environmental information concerning the effects of products during production and use phases, as well as the content of the products. The existing product

specification was not sufficient; it needed to be complemented with relevant environmental information. Many of the interviewees wanted to be presented with 'credible' hard facts concerning the green products. It was felt by employees that sales arguments should not be based on arguments such as 'saving the Earth'.

The *distributor* is a linchpin in the sale and promotion of green products. Therefore, the training of this group is crucial to the success of green products. This group was not fully informed of the issues before market introduction, which had a negative effect on sales. The localisation of the distributor and the development of the competence of the distributor are areas of key importance.

The *marketing department* built up its own base of environmental knowledge from scratch. In relation to certain aspects it had to unlearn certain marketing practices. The launch strategy was a kind of 'green' training for the marketing staff, as they gained an important insight into how to market such products. The marketing department also found that the experiences of distributors were essential in order to adjust activities.

Conclusion

Many Swedish companies are incorporating environmentally-related activities into their product ranges. These companies are experiencing a learning process, which is highlighting the need to communicate collective environmental knowledge within the organisation. The findings from the case studies indicate the need for different approaches to developing and implementing marketing and product development strategies, when launching green products. This paper argues that there is a more complex and multi-dimensional learning process taking place in the introductory phase of green products compared to conventional products. Green products require a higher degree of market differentiation. Therefore green marketing will need to address the issue of local adjustments, with greater efforts to educating and training those involved in the product development process, particularly those in distribution networks. Product development strategies need to be formulated to correspond to local green consumer demands. To build on the experiences of green product development effective knowledge collection and then diffusion mechanisms must be established, particularly in complex organisational structures. •

References

Bragd, A. and R. Wolff, 'From product concept to market concept'. A pilot study concerning environmental sound products. GRI, Gothenburg Research Institute, (1996).

Bragd, A, 'The organising of environmentally sound products'. A forthcoming licentiate thesis. GRI, Gothenburg Research Institute, (1997).

Kim, D. H. 'The link between Individual and Organizational learning', in Management Review, (Fall 1993) pp1-24, 37-50.

Hedberg, B. and R. Wolff, 'Organizing, learning and strategizing – From construction to discovery.' Contribution to the Ladenburg Kolleg on Organizational Learning, (1997).

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Sustainable design: re-thinking future business products

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Environmental impact reduction is starting to influence product design. But 'sustainable design' will need to move on, to find innovative solutions to overcome the threats to global natural capital for future generations. Design, if freed from a compliance mentality, the overpowering dominance of science and other barriers to creativity and innovation, may well start to develop different patterns of thinking. Their products may actually revitalise earth systems by producing 'e-plus' effects, as well as saving vast sums of money. Nature itself, with billions of years of design experience, can offer many solutions. The campaigning environmental movement is pushing for a new solutions agenda, and forming partnerships with business to develop new products that do more with less earth resources. This article gives practical examples from clothes to washing machines, from cars to toothbrushes, from countries where resources are abundant to those where resources are scarce. Ideas and checklists are offered to help design re-think and to move to resource reduction and 'e+' products.

Introduction

This article seeks to cultivate a 'sustainable design' culture that moves on from the prevailing tendency to focus on the environmental impact reduction of a product. Beyond design for recycling, repair, re-usability, and recovery (Fiksel, 1996, Burall, 1991, Fussler et al., 1996) lies exciting opportunities to re-think design, not only to produce more with lower levels of natural resource consumption, but to design products which can create an environmental contribution or payback.

Weizsaecker et al., in 'Factor Four', a new Report to the Club of Rome, commented that 'changing the direction of progress is not something a book can do. It has to be done by people... motivation needs to be experienced as compelling and urgent by a critical mass of people otherwise there won't be enough momentum to change the course of our civilisation.' (Weizsaecker et al, 1997, p xix).

Sustainable design requires a greater critical mass of people

with the confidence to overcome the notion that: 'the development of environmentally responsible new products was regarded as a very difficult and complicated task which went beyond the expertise and experience of the majority of personnel... (except) ...the scientists and environmental experts.' (Dermody et al, 1996, p 377). Business' entrepreneurial spirit can be re-directed to promote creative thinking patterns for the effective use of natural assets and, as de Bono suggests, to achieve this there needs to be 'provocative operations' that defy logic.

Driving design

A recent Harvard Business review article commented that 'Businesses spend too many of their environmental dollars on fighting regulation and not enough on finding real solutions' (Porter, M.E., van der Linde, C., 1995). Finding 'solutions' to the environmental problems is going to be increasingly difficult. But what are *real* solutions and to what extent could new thinking benefit sustainable design? If sustainable design involves designing products that meet the needs of the present generation without compromising the ability of future generations to meet their own needs, then the utilisation and condition of the remaining Natural Capital should be a fundamental concern to designers. Current estimates by the Centre for Ecological Analysis at the University of California label nature as worth £20 trillion p.a. That is twice the worldwide total gross national product at £11 trillion p.a. (The Independent, 1997). Extrapolations by Weizsaecker et al suggest that global waste is currently in the order of £6 trillion p.a. (Weizsaecker et al., 1997). Thus we 'waste' more than half of the world's GNP at present – much of this is from inefficiency in design: 'Business should sack the unproductive Kilowatt-hrs, tonnes and litres rather than their workforce' (Weizsaecker et al., 1997).

The sustainable designer – a chimera of scientist, artist, and economist

The scientific 'mindset' currently dominates our environmental agenda and design programmes; driven by compliance, legal and technical requirements and environmental management systems (EMS) rather than innovation and opportunity. Some commentators have argued that sociologists have not entered the debate because of the technocratic managerialism which dominates environmental policy and practice. They note that the 'gap between 'lay' perceptions of environmental crisis and official scientific, technical and policy discourse, is of course, one area for sociological explanation' (Redclift & Benton, 1994, p.1). In the post Brent Spar analysis of the battle between Greenpeace and Shell senior managers at Shell commented that as scientists they were trained to look at 'fact' not emotion – this cost the company dearly. Researchers are familiar with the limitations of such positivist barriers: it is easy to be seduced by complex data that appears as infallible as 'fact'. BT have tried to overcome such problems by including representatives from many sectors of society, including school children who represent the concerns of the next generation, on their liaison panel within their environmental management system (Tuppen, 1993). Many people around the globe could be given the opportunity to contribute to the sustainable design process.

Scientists, particularly engineers and chemists, head up many of the environmental units to be found in Fortune 500 companies; their thinking patterns are more likely to be associated with environmental damage limitation rather than eco-design. Products and services are often concentrated on life cycle assessment (LCA) with limited connection to life style change (LSC). The discourse of the latter is not that of scientists but of the green lobby and to some extent the public [Redclift & Benton, op cit.] Scientists may thus be spending time re-designing the wrong products – efficiency and impact reduction dominating over effectiveness and true sustainable design. B&Q, the British 'do-it-yourself' retailer that has made great strides in environmental management, has recently completed a detailed evaluation of the global warming effect per item of hammers shipped from Taiwan into the UK. (B&Q, 1995, and personal discussions with Dr Alan Knight/B&Q). Whilst acknowledging that the social science data is less convincing, LCA involves detailed and expensive

Impact → / Quantity ↓	A	B	C
x	**Ax** high impact + high quality	**Bx** medium impact + high quality	**Cx** low impact + high quality
y	**Ay** high impact + medium quality	**By** medium impact + medium quality	**Cy** low impact + medium quality
z	**Az** high impact + low quality	**Bz** medium impact + low quality	**Cz** low impact + low quality

Figure 1: The simple IQ test

scientific analysis and is not always possible for many companies because of the sheer volume of their products. B&Q have over 44,000 products from 500 suppliers (B&Q, 1995). It is virtually impossible to identify accurately the specific environmental impact of every product. Some of the *energy* directed to the meticulous and detailed analysis of impact reduction could be redirected into innovative design. Sustainable design requires a multi-disciplinary approach; using the best bits of the right brain creativity and left brain logic.

The environmental impact judgement process can be simple and effective. Such a simple system is the ABC-XYZ-approach, adopted from financial controlling (Vollmuth, H., 1994). While the environmental impact is valued by the figures A, B, C the quantitative importance is valued by the figures x, y, and z (see Figure 1).

The importance of action increases from lower right to upper left in the diagram. The diagram shows if a high impact is combined with very low quantities it might be much more effective to focus attention on lower impact items that have their impact multiplied by large amounts.

Science on its own can create design paralysis. This can be illustrated by the comparative LCA for phosphates in washing powders conducted by the Oeko-Institut, Freiburg, Germany. The study took four years at an estimated 4 million DM. By the completion of the study phosphate containing powders had been generally phased out! (Hartmann, 1997).

Social science and design; lifestyle change, leisure and work

Boundaries of work, leisure and charitable work are beginning to fade. Portfolio lifestyles and 'downshifting' are already happening. New forms of consumer liberation are

Myths and legends: innovation or ideas?

'Parties are a time to drink and create fertiliser' as was the case with the organic gardener who asked the men to urinate in a swing bin to the rear of the house. Strange behaviour maybe, but the opportunity to collect free fertiliser was one the gardener couldn't afford to miss. Now translate the idea to motorway stations and urine could be seen as an opportunity, to sell it rather than pay to dispose of it. A Swedish company (Servator AB) entered this market recently and now offers composting toilets promoted through the internet [Internet 1996.]

A new breed of scrap merchants are also emerging, opportunist recycling in the wake of telecommunications growth. Deutsche Telekom for example report that they produce about 1.5 million tons of electronic scrap per year. What is interesting is that just one ton of electronic scrap has the potential to yield:

- 200 kg copper
- 80 kg iron
- 1 kg silver
- 0.5 kg gold!

One major recycling company in Germany is said to turnover DM 2 million/day of gold per day [DTAG (1995)].

'Saving paper doesn't save trees'. That will be the case in the future. If paper isn't made solely from trees then the old well known saying doesn't hold true. Body Shop for example supported a community initiative in India to make paper out of the Water Hyacinth, an abundant river weed.

Reprinted from an article by Beard & Hartmann in European Business Review (vol. 97, no. 5) 1997.

Figure 2: Myths and legends – innovation or ideas?

happening too, recognising the need to shift the existing powerful 'retail therapy effect' of leisure shopping and spending into new directions. Such trends will significantly influence product design. The main product of one of Britain's largest conservation charities, the British Trust for Conservation Volunteers, involves turning environmental work into a leisure activity. This is their most profitable and popular green *service* product development: people pay to work and landowners pay to get the work done. Many thousands of people each year pay to work: work paid for twice and enjoyed as leisure! Providers of Management Development programmes that use the outdoors are now realising that the environment is both a location and a new product: by doing conservation projects such as rebuilding dry-stone walls or replanting forests rather than climbing and abseiling – as the basis of their process skills development – they actually contribute positively to the natural environment. This creation of 'e-plus' or 'environmental positive [e+] could be an important idea for designers. Current thinking often starts with the notion that everything has a negative impact on the environment; this *is* a design barrier.

Patterns of thinking – barriers and opportunities

What do these short examples in Figure 2 tell us? The ideas were simply offered to inspire some creative thought. Innovation needs to move up a gear to

The Trabant

Car production in the German Democratic Republic provides us with an interesting example of creative thought. With waiting periods of about 20 years for an ordered car, and with car life cycles running at 8–10 years, a whole new business emerged rebuilding the 'Trabant' [the 'mini' of the East], buying and selling all parts for this car and rebuilding the cars after accidents or after 20 years on the road. Special refashioned body panels were being sold to make a 20 or 30 years old car look new and fashionable. The 'Trabant', because of a shortage of sheet metal, had a car body made from a steel frame with screwed on panels that were made of pressed cotton soaked with synthetic resin (Beard and Hartmann, European Business Review, 1997). This so-called cotton in fact was often second hand clothes felted and pressed to car body shape panels.

Figure 3: The Trabant

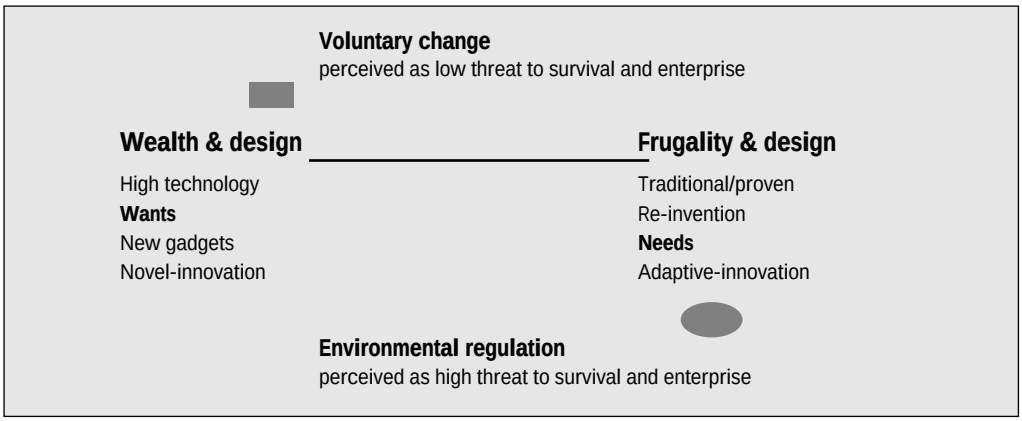
overcome the 'can't do' barriers.

Innovation and creativity was the theme of a recent 1997 Institute of Personnel and Development (IPD) conference in Harrogate and one speaker, Clifford Pinchot, described the struggle that many of the world's creative people have faced to get their products to be developed fully (see JSPD Issue 1, p. 53–56). 'Creativity and innovation', he comments, 'are often suppressed'. In 'People Management', the Journal of the IPD, the comment is made that 'Innovation is experiencing a renaissance': the Department of Trade and Industry (Dti) actually has an Innovation Unit and there are now MBAs in Innovation, and two thirds of secondary schools in Singapore teach innovative thinking and in New Zealand children as young as two are being taught to think creatively. The article also asks how much potential invention is locked up inside 'ordinary employees' (Pickard, J., 1996).

Different forms of design innovation flourish in times of war or when resources are very scarce. Frugality produces innovative patterns of thought, as constraint drives a 'design for necessity'.

Innovation lethargy is a major barrier towards the product greening process. Just as we have learnt that the North has often attempted to design and export inappropriate technology to the South, failing to adjust and adapt to a different kind of creativity requirement, so we must learn from the emerging creativity patterns of East and West Germany. Figure 4 offers the notion that different patterns of environmental design may emerge under conditions of wealth as opposed to poverty or frugality; shown on the horizontal axis. 'Elegant frugality' is a key design principle of Lee Eng Lock, the Singaporean designer of the world's most efficient air-conditioning system (Weizsaecker et al., 1997, p. 53). Industry also sees competition as threatened by environmental legislation rather than the view that it could drive creativity and enterprise. Dominant thinking patterns are thus embedded in the top left hand quadrant; here it is thought, lies opportunity and the competitive position. This thinking is erroneously driving sustainable design whereas the bottom quadrant is seen as the position of low design opportunity and a less competitive position.

The car industry should be awash with creativity (Weizsaecker et al). However, some of the design ideas have been a survival response to increasing regulatory pressures to reduce the transport impact on the environment. Whereas 'German and Japanese car makers captured early-mover advantages, ...US car makers chose to fight regulations' (Porter, M.E., van der Linde, C., 1995). Environmental regulation, rather than voluntary change, can either be perceived as a threat to business or in practice a positive driving force creating opportunities for innovation and sustainable design.



Above
Figure 4: Barriers to sustainable design; the square and the circle

Solutions campaigning

Greenpeace showed industry that any car produced today can be built with a 50% fuel reduction for about the same price with no compromise on safety. The average car fuel efficiency for new cars is still under 40 mpg. There were lots of declarations of interest by industry and other institutions but little action. Greenpeace eventually gave a loan of £1.1 million to the engineering company in Switzerland who developed the Twingo SMILE car [Small Intelligent Light and Efficient] (Brent Spar Conference, 1996). Cars are denounced as a major source of pollution, yet with some basic changes they could become the street air cleaners, hoovering and filtering the polluted air and possibly cleaning the streets. The shift from unwelcome to welcome is not too far away; another 'e+' example in the making (see JSPD Issue 1, p.44).

Left
Figure 5: Solutions campaigning

A growing number of select business' are emerging as a potentially powerful positive social force, doing more with its purchasing power and innovative *energy*. At the same time campaigning organisations are now re-focusing some of their *energy* on what has become known as the 'solutions agenda' moving from detective work and the 'politics of blame' to the support of innovative problem-solving. Greenpeace for example are investing large sums of money through their 'solutions campaigning' to lead the way in some areas of eco-design (see Figure 5).

Natural ideas and design

But, eco-innovation is rarely driving patterns of thought on design boards; we often fail to effectively learn from evolution. The earth systems have had some 4.6 billion years on the drawing board. The stock markets actually confirm that much of the earth's clever design and current resource wealth still exists in the central band of the earth where, unlike Europe, the sketch pad was not wiped clean by an ice-age 15,000 years ago. Many of the new emerging markets are related either to genetic and plant/animal stock, species patenting, biotechnology or to general development in areas where tropical natural resources are traded for infrastructure development. For example, Eli Lilly is one of the world's largest drug manufacturer and has made large profits out of plants such as the Madagascar Periwinkle. The

Disposable toothbrush heads

We have for years used razors with disposable 'heads' but many people continue to use toothbrushes that are totally disposable.

company currently trades at an astonishing £45 a share, one of the most expensive on the stock market.

Then there is the case of the outdoor clothing industry which has for many years struggled to produce the ideal material that keeps us warm and dry – but doesn't 'sweat'. Plants came to the rescue. Gore-tex, Sympatex, Supplex and Pertex have all attempted to solve the problem. But in 1996 a new product was designed (partly funded by the UK Dti) called Stomatex which warms and breathes by following the natural design of plant stomata; sadly the copyright fee to nature will not be paid. Patagonia on the other hand, have recently been able to make their outdoor fleece jackets out of recycled plastic bottles – producing fibres that are small enough to feel soft to the touch. Here we see economy (rules) meeting ecology (natural logic) head on as business communities increasingly seek to understand natural systems; as waste markets develop alongside stock markets, as linear economic product development models are replaced by cyclical ecologically focused models. Waste stock exchanges for example have recently emerged on the internet.

Following strict German legislation for waste handling and recycling, incineration facilities have mushroomed within the last few years. This has created change and opportunities for the waste industry. Only a few years ago waste was transported around Germany, exported, or illegally dumped to dispose of it; the operators nowadays are urgently seeking waste for processing. A waste war has commenced and disposal fees could drop significantly (Der Spiegel, 1996). Resource exchange agencies will in the future offer four parties a profit:

- those who get rid of their waste
- those who buy in their recycled material
- the recycling stock agent who charges a commission
- and the environment.

Seeing it differently

We have for years used razors with disposable 'heads' but many people continue to use toothbrushes that are totally disposable. The photograph shows the development of simple re-design principles – yet disposable toothbrush heads still haven't reached retail shelves, eg. UK. The simplest ideas are still to be discovered. Why do washing machines not filter out detergents rather than releasing chemicals directly into water systems. Filter systems to collect household water from baths and sinks – and potentially from washing machines and dishwashers were recently reported (Stansell, 1997). Products that produce cleaner output water than the input source are possible; such a washing machine would be a good example of an 'e+' product. For example, Hoechst AG claim that the cooling water from the river Main which they have to clean prior to use is returned cleaner than it was.

Water is certainly precious; for Europe as a whole 53% of water abstracted is for industry, 26% for agriculture and 19% for

Living buildings

Many very exciting and innovative rooftop ideas have already been generated such as solar power, rainwater collection, living/growing roofs and so on. But the roof is the least interesting aspect of the high rise concrete forests currently growing at an alarming pace in the Asian Pacific. Perhaps new construction ideas could contribute yet more if we focus on the most significant surface areas; not on the roof but on the sides or walls. The Twin Towers in Malaysia completed in 1996 reach up to the sky with 88 floors and 451.9m from street level. This means that the walls are now the largest surface area. Here lies the creative opportunity!

The primary energy on earth is produced by green tissues in plants. If such photosynthesis systems could be incorporated within construction materials, it could be possible to produce energy and bio-mass just from sunlight, water and the carbon dioxide (CO_2) of the air? Scientists have recently developed a chlorophyll like substance, that if closed between two sheets of glass produces roughly the same amount of electric power that silicon based photovoltaic cells do when exposed to sunlight. This new system is at the early developmental stage but can possibly produce much cheaper electricity than silicon photovoltaic cells (The Open University 1996). Blue-green algae are also bred in huge glass tubes or plastic bags producing high amounts of bio-mass. A constant flow system could be incorporated within the panels of a skyscraper which could provide a considerable amount of bio-mass being used for either nutrition, bio-fuels or sugars (the raw material of future plastics) and fix CO_2 in our cities at the same time. Air born pollutants could be filtered through the air conditioning systems supplemented with suitable filters. Living coatings could also be introduced onto concrete surfaces to produce an 'e+' effect.

Figure 6: Living buildings

Shifting design principles:

E-reduction (e-) E-zero (eø) E-plus (e+)

Figure 7: Shifting the 'E'

household use... and one-third of European countries have relatively low availability of water ie. less than 500m³/person/year (Industrial Environmental Management, 1997). So as water prices rise we will re-examine this environmental resource 'product' and the purpose of the household or factory roof may change (see Figure 6). People are not really sure what water costs but at £0.60-0.70 per m³ compared to £2600 for the same amount of beer it seems good value!

Conclusions

Two useful charts are shown below giving simple steps to improve creative thinking (see Figures 7 and 8). It is important to *see* the product first – by taking a closer look – and then break it down into its constituent parts. We use washing machines that dispose of water and detergents into the drainage system and into the water supply but we could filter this out and dispose of it separately. We could design cars to clean the polluted city air, and we can design buildings that can contribute to pollution control and clean air. Design is getting interesting and we have many examples of design for disassembly, design for recycling, for repairing, for reducing pollution and so on. But design for 'e+' is new.

In the near future sustainable design will start to focus on new markets and products; shifting from simple environmental impact reduction through zero

Check it, challenge it and change it!

Metaphor	Product	People	Barriers
1 CHECK the product – just look!	· What does it look like now? · What is it made up of? · Is it each component 'e+' or 'e-'? · How environmentally unfriendly is it? · Use the ABC/XYZ analysis	· Audit · Product analysis · Deconstruct · Observe · Collect information · Watch people	· No time to look · Activity trap · Environment as a threat to competition · Can't see
2 REVIEW – challenge its design	· Does it have to be like this? · Can it be different? · What do we think about this? · What are our 'E' values at home with the family and our children? Transport these to work.	· Challenging public and private beliefs and values · Preferences · Seeing it differently · Visioning, fantasising, brainstorming · Challenging existing thinking · Creating new thought patterns. Take a risk – use imagination and humour	· Resistance to change · Environment as soft · Environment is not my worry · It's not in my interest · Yes but… · Pessimism
3 CHANGE its design… or the product	· New products · Natural designs · Natural ingredients · Natural payback · Reducing 'e-' · Moving to 'e+'	· New lifestyles · Downshifters · Teleworkers · Job sharers · Local social responsibilities · Your business as a social force	· Innovation lethargy

Reproduced from an article by Beard and Hartmann in European Business Review (Vol. 97, no. 5); 1997.

Figure 8: Check it, challenge it and change it

thinking (zero emissions) to environmental contribution and 'e+' products. The whole basis of product design will be challenged as we look to new ways to contribute, in any way, towards undoing and repairing environmental damage. Business is producing little 'environmental profit' from the earth's natural capital resulting in a bank account that leaves little to sustain future generations. Sustainable design barriers exist in the form of mindsets, minimalist anti-legislation thinking, impact reduction thinking, new needs and consumer gadgets and science as the 'solution'. However, new green product drivers are coming into play:

- nature as a designing force
- solutions campaigning
- the legitimacy of creativity, innovation and emotion as well as science and logic

References

B&Q, 'How Green is My Front Door?' B&Q's Second Environmental Report, Eastleigh, (1995), p. 66

Bural, P, 'Green Design', (New York, Mcgraw-Hill, 1991)

de Bono, E. and J. Pickard, 'A fertile grounding' in People Management, Vol.2, No 21, (24 Oct. 1996), p. 34

Der Spiegel, 'Sie reißen sich um jede Tonne', no. 39/96, 1996, pp. 40–48, 23.9.

Dermody, J. and S. Hammer-Lloyd, 'Greening New Product Development: The Pathway to Corporate Environmental Excellence', in: McDonagh, P., Prothero, A. (eds.), 'Green Management', (London, Dryden press, 1996), pp. 367-387

DTAG (Deutsche Telekom AG, Environmental Affairs Office), 'Deutsche Telekom's Environmental Management System', (Darmstadt, 1995), pp 24–25

Fiksel, J., 'Design for Environment', (New York, McGraw-Hill, 1996)

Fussler, C. and P. James, 'Driving Eco Innovation' (London, Pitman Publishing, 1996)

Hartmann, R., 'Environmental Management and Controlling in European Telecommunication Enterprises', Diplomarbeit (Masters Thesis), Fachhochschule Fulda, (Germany, 1997)

Industrial Environmental Management, 'Water stress in Europe', (March 1997), p.8

Internet, http://www.icbl.hw..../~cjs/trabinfo.html, p. 1, (17.10.1996)

Local Authorities of Alsbach-Haehnlein, Germany, Abwassersatzung der Gemeinde Alsbach-Hähnlein, (1992)

Pickard, J., 'A fertile grounding', in People Management, Vol. 2, No 21, (24 Oct. 1996), pp. 28–37

Porter, M.E., C. van der Linde, 'Green and Competitive', Harvard Business Review, (Sept.- Oct. 1995), pp. 120-134

Redclift and Benton 'Social Theory and the Global Environment', (London, Routledge, 1994)

Schoon, N., 'What price nature? At £20 trillion a year it is truly our most precious asset', in The Independent, (15 May 1997), p.9

Stansell, J., 'Filter system recycles water in the home', in The Sunday Times, (1 June 1997), p. 3.12

The Open University, 'Renewable Energy', BBC2, (27.11.1996, 00:30)

Tuppen, C., 'An Environmental Policy for British telecommunications', in Long Range Planning, Vol 26, No 5., (1993), pp 24-26.

Vollmuth, H., 'Controlling-Instrumente von A-Z', 2. ed., (Planegg/München, 1994)

Weizsaecker, E. von, Lovins, A.B and L.H. Lovins, 'Factor Four-doubling wealth halving resources, The new Report to the Club of Rome', (London, Earthscan, 1997)

- the possible contribution of the social sciences now entering the environmental debate
- the re-focusing entrepreneurial spirit with business as a new social force as we shift from LCA to lifestyle change (LSC).

Filtering out the negative environmental impact (e-) will occur in product creation and what leaves the factories of the future will generate environmental benefit (e+). Industry will re-focus on merging economic principles to ecological ideas, and challenge environment as an economic eternality.

Greener businesses and greener designers will need to think differently and talk differently ie. transport not cars, cleaners not polluters, dirt/detergent filters in washing machines, insulation as walls, living walls, work as leisure, waste markets as stock markets. The momentum will gather pace as business re-focuses itself as a social force linked up to natural ecological systems through an industrial ecology mindset. We will think 'natural value design' rather than 'volume design' in the future. •

Sustainability by design: new targets and new tools for designers

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This article discusses the new targets for design resulting from the 'Sustainable Development' paradigm . Solutions will have to be created that 'meet the needs of the present without compromising the ability of future generations to meet their own needs'. Besides consideration of economic, social and ethical issues, this concept will demand greater limitations on the process of technology by the state and will require designers to upgrade their environmental knowledge and abilities. A practical requirement for designers therefore is that product improvements must lead to a life-cycle-wide lowering of material inputs (including the materials consumed for the provision of all energy inputs), reduction of waste and emissions, as well as the elimination of toxins. This practice is called 'Design for Environment', 'ecological design' or 'eco-design'.

Besides the eco-design of products the process of sustainable design should also deal with eco-efficient service concepts, such as product sharing – 'environmental leasing' and joint use ie. substituting for the production of new products, thus revising approaches of product 'use'. Tools that help to attain these targets are being introduced, some of which are discussed in this paper.

Introduction

Following the Earth Summit in 1992 over 100 countries committed themselves to the concept of 'Sustainable Development'. The World Commission on Environment and Development defined this new paradigm as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).

This paradigm leads us towards a new dimension in product policy and design. It is no longer sufficient just to environmentally optimise certain aspects of a product. To be really ecological, in the sense of sustainable development, improvements must lead to a life-cycle-wide lowering of material inputs (including the materials consumed for the provision of all energy inputs). Otherwise, if considerable material additions are necessary to achieve better performance of an isolated parameter, for instance, fuel consumption in cars, such 'improvements' may become ecologically counter-productive.

Under this new paradigm we have to deal with the concept of 'needs' and social aspects. A sustainable product policy should create products that are able to meet the needs of people, especially the essential needs of the world's poor. And we have to realise the limitations imposed by the state of technology and social structures on the environment's ability to meet present and future needs. These limitations must be reduced to a minimum.

To meet these demands we need 'dematerialised goods', an eco-efficient service-oriented economy and the revision of product use, thus – we need new scenarios of 'Efficiency and Sufficiency'.

What are sustainable products and how to design them?

With respect to the above definition of sustainable development a sustainable product could be described as 'a product that meets a definite need by using the smallest amount of materials and energy and creates the smallest amount of waste and toxins in its whole life cycle'. At the Wuppertal Institute for Climate, Environment and Energy the 'Seven golden rules for eco-efficient goods' were formulated (Figure 1).

The eco-efficiency revolution

A technical eco-efficiency revolution is required. With eco-efficient design it is possible to provide the same high quality service with a fifth, tenth or even less energy and materials. The goal is in all cases to reap as many units of service as possible from each 'service delivery machine,' with as little material (and low material intensive energy) inputs as necessary. This holds equally for tableware, cars, and railroad infrastructures, during their manufacturing phase, through 'use' cycles (maintenance, operation, cleaning, repair, collection, sorting, re-manufacturing, recycling etc.) to the environmentally acceptable disposal (legally prescribed). In all phases, transportation and packaging intensities need to be considered.

In order to assess the resource intensity of goods and services in a consistent manner, and thus to accomplish a first comparison of the respective environmental impacts, 'MIPS' has been developed at the Wuppertal Institute. 'MIPS' stands for 'Material Inputs Per units of Service' and must be computed from 'cradle to grave'. It counts all material and energy-inputs needed to provide a defined service unit. The MIPS concept allows for, for example, the monitoring of progress toward sustainability on the product or process level, or for companies, regions, or countries. MIPS does not account for toxic materials or noise pollution, but leads to time and cost-efficient estimations (see Footnote).

There are two ways for designers to reach a low-MIPS product or service, each with a different validity:

Seven Golden Rules

- The assessment of the environmental impacts of goods has to integrate the whole life cycle (from 'cradle to grave')
- The service intensity of processes and goods has to be increased drastically
- The material intensity of processes and goods has to be reduced drastically
- The energy intensity of processes and goods has to be reduced
- The land-use through processes and goods has to be reduced
- The emission and use of toxins have to be eliminated
- The ecologically sound use of renewables has to be maximized.

Figure 1: Seven golden rules for eco-efficient goods
Source: Schmidt-Bleek/Tischner, 1995

- By re-designing existing products and inventing new ones which meet eco-efficiency demands. This requires the designer to consider the original purpose of the product, and how this service could be fulfilled with the minimum of harmful environmental effects during the product's entire 'cradle to grave' life cycle.
- By adopting a more systematic approach, to reflect the reorganisation of production and consumption systems, but not necessarily resulting in a new product, but in a new service. Such systematic solutions are usually more effective than changes to the product. Nevertheless, they require behavioural changes on the part of producers and consumers, thus they may be more difficult to implement.

Rather than designing, producing and consuming more and more new products we need to create both, new dematerialised goods and alternative ways of selling services to the user. Concepts like product sharing, joint use, multiple purpose, and 'environmental leasing' are possible steps in that direction.

- **Define the problem**

  The bundle of services which the product or service should offer must be defined as clearly as possible.

- **Search for dematerialised solutions**

  Is it possible to fulfil the requirements without producing a new product? If not, then search for new solutions which provide an appropriate service.

- **Select the best ideas**

  Eliminate obviously unrealistic options and choose the most promising solutions, with the purpose of preserving the environment.

- **Detail the solutions selected**

  Environmentally relevant product properties and the package of services defined in step 1 must be considered.

- **Evaluation**

  The solutions in Step 4 should be compared, as well as current solutions, to find which will be the most effective. Ensure that all existing optimisations have been taken into account. Use MIPS to estimate the environmental impact potential.

- **Implementation (or return to Step 2)**

  If a new solution appears advantageous, then it should be implemented, otherwise return to step 2 and try again. If it seems to be impossible to find a better and more environmentally sound design, the research should be terminated and directed towards another problem which could be solved more efficiently.

Figure 2: A new planning method for eco-efficient design
Source: Schmidt-Bleek/Tischner, 1995

Steps toward sustainable design

The first question in a new design process should be: precisely, what kind of service must the new good or service fulfil? and what are the problems that need to be solved? With this in mind, the designer should search for environmentally sound solutions that reduce the 'cradle to grave' consumption of matter and energy to a minimum, as well as waste and harmful substances (Figure 2).

In designing eco-efficient goods and services, ecological parameters should be considered before those for health, ergonomics, safety, and beauty. This is because only the availability of ecologically sensible goods and services will prevent our ecological collapse in the future, making all other considerations less basic (Figure 3).

The most important decision in an ecologically-oriented product policy process is, what kind of customer demands and needs the company should deal with.

- Does it have to produce and sell a product to meet this demand?

Manufacturing phase:
- material intensity
- energy intensity
- renewable resource inputs
- useful material outputs
- waste intensity
- wastage in production
- transport and packaging intensity
- hazardous materials
- efficient use of land area
- water consumption

Use phase
- material throughput
- energy inputs and outputs
- water consumption
- weight
- size and area coverage
- auto-control, auto-optimisation
- multifunctionality
- potential for subsequent uses
- potential for joint use (eg. by several households)
- longevity
- surface properties
- anti-corrosivity
- reparability
- structure and ease of disassembly
- robustness, reliability
- likelihood of material fatigue
- adaptability to technical progress

After first use phase
- material composition and complexity
- collecting and sorting opportunities
- recycling potential of parts and materials
- incineration potential
- potential for composting
- impact on environment after disposal.

Figure 3: Checklist for environmentally relevant product properties
Source: Tischner/Schmidt-Bleek, 1993

- Is it possible to offer a service?
- Is it possible to offer product leasing?
- How long should the lifespan of the product be extended?

These are questions that must be answered to find the best solutions in terms of ecology and economy. These basic strategic decisions influence the whole production, distribution and consumption system that is connected with a good or a service offered by a company.

There are three main reasons why companies are interested in ecologically sustainable or environmentally conscious design:
- they have problems with environmental laws or other conditions and are forced to improve their products or production processes in terms of ecology
- they expect sales advantages by integrating environmental and social aspects into product development and their marketing activities
- strong personalities lead the company and integrate social and environmental responsibility into business activities (and their whole life).

For other companies, which are not concerned about environmental and/or social issues, designers need to have sound business arguments to convince management that eco-design is the right thing to do. That is always easy where ecology and economy go together and eco-efficient design leads to cost-effective solutions. In other cases one possibility is to undertake efficient eco-design without telling the company that this is the design process you are undertaking. Another is to find business benefits for the company such as marketing opportunities or ecological aspects as part of an unique selling proposition (USP). Thinking longer term is an essential part of these strategies. Experience shows that eco-designers can produce improved solutions the earlier they are integrated into the planning process, provided that they are able and willing to deal with issues relating to the strategic decisions of the company.

Ultimately, eco-design is only as effective as the people who utilise it, because apart from the best available eco-efficient technologies, we also need a change in people's behaviour. Efficiency in technologies alone cannot solve the ecological problems if we continue to buy and discard as many products as we do today. Consumers also should realise that it is not always necessary to own a product, to be able to use it. With a little organisation, a system of sharing should be feasible and relatively effortless for such products as cars, lawn mowers, washing machines, electric drills, etc. Furthermore, the goods we own should have their useful life extended as long as possible through effective repairing and then through selling them into an efficient second-hand market. This means a change in our patterns of use, as well as increasing product responsibility on the part of consumers and producers alike.

Figure 4: FRIA, designed by Ursula Tischner

Figure 5: The carpet sweeper, designed by Agim Meta

FRIA – an example for sustainable design

The FRIA (Figure 4) is a hybrid between a traditional larder and a modern refrigerator. Once installed, the FRIA, unlike other kitchen furniture, remains in place. Built into a wall near the kitchen. The FRIA remains there until the building is demolished. During its entire life span the FRIA needs no material input apart from a small amount for energy and minimal spare parts.

When the FRIA is installed near an exterior wall it can utilise the outside air for cooling in winter. Cold air is conducted into the cooling chamber if the temperature is low enough. This method saves a great deal of energy.

The FRIA is designed to use circulating air for cooling. There are three cooling compartments. The two uncooled compartments are for storing canned goods and other non-perishable items. The cooled compartments are located in the most ergonomically suitable position, the freezer is at the top, the cooling chamber in the centre, and at the bottom a drawer at 'cellar temperature' for storing items such as fruits and vegetables. The temperature can be controlled from outside the appliance and the cooling volume can be adjusted from 100 to 220 litres. This makes the FRIA adaptable to a user's personal needs.

The FRIA's doors are convex, which is not just an aesthetic design feature, but a functional element. Despite its narrow width, the FRIA has a large interior volume and a small surface-to-volume ratio. This means that less of the low temperature is lost through its housing, as is the case with a normal fridge, which can lose up to 80 percent of its energy in this way.

The FRIA's cooling system could be a standard compressor unit, but almost any new technology is possible. This is because the cooling system is installed independently from the cooling chamber, which makes it easy to exchange. In this way technical improvements could be installed at convenient intervals. Through its installation into a wall recess the product can be insulated with alternative chloroflurocarbon-free (CFC) materials, such as blown concrete, cork or recycled paper. The blow-moulded doors can be filled with aerogel, which has improved insulating properties compared to CFC-containing polyurethane foams and is environmentally harmless. With this insulation material, the FRIA has even better insulating properties than today's best 'eco-refrigerators'. This, combined with the cold outside air being conducted into the cooling chamber in winter and the possibility of decreasing the cooling areas individually, reduces the FRIA's energy consumption to at least 50 percent less than that of a conventional fridge.

The FRIA even considers the user's taste, as it offers the option of matching the front of the doors and the handles to existing kitchen furniture.

Figure 6: Example of a Kambium kitchen

The eco-efficient carpet sweeper

Using a fly-wheel as a mechanical energy accumulator, the eco-efficient carpet sweeper cleans very effectively by brushing the floor without consuming any electricity. The brushes rotate even when the user stops moving the appliance, making it possible to sweep into corners and under furniture. This is helped by the fact that the brushes protrude beyond the dust box. Details such as the low height of the box, the ergonomically-shaped handgrip and an adjustable handle make for ease of use.

The carpet sweeper is able to replace the conventional vacuum cleaner in most cleaning situations. This would mean a lot of energy and material could be saved by using the carpet sweeper instead of a material and energy-intensive vacuum cleaner. Furthermore, this new cleaning tool is designed for durability. It is easy to repair and has a steel box, which can easily be recycled. All its retail parts are replaceable, which means that it could have a life span of an estimated forty years. That is at least four times longer than conventioanl vacuum cleaners generally last (Figure 5).

Kambium kitchens: individual, ecological and long lasting

The Kambium Furniture Workshop, Inc. is a small- to medium-sized German company with approximately 35 employees and a fairly horizontal organisational structure, typical for a company of this size. The managing directors decided very early to commit themselves to environmental principles. This environmental optimisation started with the choice of the company's location in an area excellent for wind farming. This was followed by the architecture of the factory which incorporated amongst other concepts that of building-biology. Next came the distribution philosophy: all sales within a 100 km radius are delivered with no outer non-reusable transportation packaging.

Kambium kitchens (Figure 6) are situated at the high end of the market in every respect. The average price is 40,000 DM, as

the quality and durability of the product is extremely high. The use of modern computer technologies (CAD/CAM) facilitates the production of very individual kitchens, tailored to the customer's specifications. Unlike other kitchen manufacturers, Kambium uses no pre-processed mass-panels, all the kitchens are entirely handmade. They are made primarily from wood originating from European sustainably managed forests (short transportation distances). The kitchen's surfaces are impregnated with natural oils thereby avoiding the need for toxic varnishes. One will never find a model that is no longer produced or out of stock. It is always possible to obtain spare parts, and have repairs undertaken. All these aspects together ensure that Kambium kitchens are extremely long-lasting. When however, the client no longer has a need for the kitchen it can be easily recycled or disposed of since it does not contain harmful substances.

A research project was undertaken by the Wuppertal Institute for Climate, Environment and Energy together with Kambium, which analysed the kitchen designs and service. The checklist of environmentally relevant product properties (Figure 3) as well as MIPS were used in the strength and weakness analysis of the kitchen designs. As a result of the analysis technical and organisational improvements were suggested to the company, some of which are to be implemented.

Conclusions

Product designers should accept the 'Sustainable Development' paradigm as a challenge and try to:

- design useful environmentally benign products (eco-design); and
- suggest eco-efficient service-concepts and dematerialised solutions.

Thus a technical eco-efficiency revolution and new environmentally sound consumption patterns could be facilitated. MIPS as a time- and cost-efficient measure of the environmental impact potential of goods and processes could be used for estimations within the design process. Planning methods should integrate environmental and social questions right from the beginning. For that purpose a checklist of the environmentally relevant product properties regarding the whole life cycle of goods was developed by the author together with the Wuppertal Institute. By using tools like the above mentioned, asking the right questions and reflecting also on social aspects, designers could become part of the solution, instead of being part of the problem, like most of them are today! •

References

Friends of the Earth (Ed.), 'Towards Sustainable Europe', (Wuppertal Institut, Germany, 1995)

Schmidt-Bleek, F., 'MIPS re-visited', in Fresenius Environmental Bulletin, Vol. 2, No. 8 (August 1993) pp. 407 – 412.

Schmidt-Bleek, F., 'How to reach a Sustainable Economy?', in Wuppertal Papers, No. 24, Wuppertal Institut, Germany, (August, 1994).

Schmidt-Bleek, F., and U. Tischner, Produktentwicklung. 'Nutzen gestalten – Natur schonen', Wien: Wirtschaftskammer (Dosterreich, 1995)

Tischner, U., and F. Schmidt-Bleek, 'Designing Goods with MIPS', in Fresenius Environmental Bulletin, Vol. 2, No. 8 (August 1993) pp. 479 – 484

World Commission on Environment and Development, 'Our Common Future', (Oxford, Oxford University Press, UK, 1987).

Footnote

1. For further information concerning MIPS contact the Wuppertal Institute, Döppersberg 19, 42103 Wuppertal, Germany.

Professor William McDonough, Dean of School of Architecture, University of Virginia, US

Martin Charter

Joint Coordinator, The Centre for Sustainable Design, UK

William McDonough is an architect and industrial designer. He is principal of William McDonough & Partners, Architects and Planners as well as co-founder of the product design and consulting firm McDonough Braungart Design Chemistry in Charlottesville, Virginia.

In September 1994, he was appointed Dean of the School of Architecture at the University of Virginia, where he is the Elson Professor of Architecture. He received his Bachelor of Arts from Dartmouth College and his Master of Architecture from Yale University. In 1996, he received the Presidential Award for Sustainable Development from President Clinton.

Background

In preparation for the World's Fair in the year 2000, the City of Hannover, Germany commissioned Mr. McDonough to author 'The Hannover Principles: Design for Sustainability', a document providing design principles for all participating architects. A founding member of the American Institute of Architects (AIA) Committee on the Environment, Mr McDonough represented the AIA as well as the International Union of Architects at the Earth Summit in Brazil in June 1992. He served as advisor to the President's Council on Sustainable Development and was the lead designer for the 'Greening of the White House'.

In February of 1993, Mr McDonough delivered the Centennial Sermon, entitled 'Design, Ecology, Ethics and the Making of Things', at The Cathedral of St. John the Divine. He has initiated a new approach to ecologically considered design and manufacturing as a step towards the Next Industrial Revolution, and advocates the formulation of Declarations of Interdependence.

Mr McDonough's design work ranges from products to buildings to cities to regions. He has worked with the City of Chattanooga, initiating their Zero Emissions Zoning Concept and leading the design of the City's South Side Plan. For the City of Atlanta he articulated the 'Solar City' concept, and for the City of Pittsburgh he worked with the Heinz Family Foundation to craft a year-long colloquium on the subject of Pittsburgh as the 'Environmental City'. He designed a furniture factory for Herman Miller that has won Business Week's design of the year award for 1997, and for DesignTex, a subsidiary of Steelcase, he recently designed a line of environmentally safe fabrics working with Michael Braungart and the EPEA in Germany, and the Rohner Company and Ciba Geigy in Switzerland. The fabrics, made with biodegradable fibers and re-engineered chemical manufacturing processes, were awarded a Gold Medal at NeoCon 1995, the annual showcase of the contract

furniture and fabric industry, and have been invited into the permanent design collection of the Chicago Athenaeum.

Mr McDonough advises major corporations such as Interface Corporation and Monsanto on sustainable industrial protocols and environmental ethics, and is active in the conception and development of new products with chemist Michael Braungart.

What do you consider to be the key issues that will affect business arising from the sustainable development agenda in the next 3 to 5 years?

I think the most exciting issue will be the prosperity and creativity considerations that sustainability will foster. I have worked with chairpersons and CEOs of major companies, and they are realising that one of the biggest issues they must address is what the concept 'sustainable development' means for their organisation. Because when they take their leadership position and say, 'I want to see this sustainability issue get addressed', they quickly realise they don't know what it is they are actually asking for, and that their people don't know how to respond. Everything gets very confusing very quickly, because it's all relatively new. Sustainable development has many different definitions; it can really only be understood as a local phenomenon with universal implications (there are no 'universal solutions'). We have to make it up as we go along – forever. It's going to take everyone.

For example, from Michael Braungart's and my perspective, business has been mistaking eco-efficiency for sustainable design. That is a fundamental problem, because eco-efficiency is an impoverished agenda in terms of the real creative possibilities. With eco-efficiency you're inhabiting a world where you wake up in the morning and feel guilty, then spend your day figuring out how to feel less guilty. A sustainable design agenda, on the other hand, says you wake up in the morning and feel hope. You measure your progress against locally-considered ideal conditions which hold sustainability as only the lowest maintenance aspiration. One must begin to humbly imagine what an ideal might look like in order to measure progress toward it. Then it becomes a positive, creative event, not one that simply measures a negative progress relative to the status quo. So considerations beyond sustainability lead to a positive rather than a negative agenda.

It is important that business does not just look at the 'eco' part of any equation – saying that part is primary, or even that it's the focus of an agenda – because it's really just one element of a complex set of interdependencies that we are only beginning to understand. The agenda is much richer than the 'eco' element. We all know the complete search is for propitious balances across social, ethical, economic and environmental issues.

From my perspective, business has the important task of rendering both the goals and the processes visible. Unless you have something visible against which you can chart your course, it is very difficult to take these discussions much further. My colleague Michael Braungart and I are working on an indexing process where a consensus-building exercise helps individuals and groups imagine what going beyond 'sustainable' might look like in each specific arena of interest, whatever it is you are working on, at all scales, from the region down to the molecule.

Once people come together around a common question, it is astonishing how consistent the understanding of sustainability can be among people with diverse interests. They can actually identify and agree on positive characteristics and find a common aspiration very quickly.

During this process you hear two kinds of questions. One might be, 'Wouldn't it be better if we used less of a persistent toxin?' That would be an eco-efficiency question. Another would be, 'Wouldn't it be great if we could drive this whole system from our current solar income instead of with fossil fuels?' This is a fundamental design question and reflects the real excitement, along with the tremendous opportunities, of the process.

Because we are interested in a design discussion, a rich agenda of choices starts to unfold. But first, and principally, we must understand what the nature of the decision-making framework will be, so everyone has a

common understanding of the issues.

The first thing we must do, as designers in the material world, is to recognise the world as having two metabolisms: a biological metabolism and a technical metabolism. Then we can begin to frame the discussion that builds up the concepts of 'products of consumption' consumed in the biological metabolism, or 'products of service' circulating in the technical metabolism (we have trademarked these terms for use in our work). In that way, as we move into the design discussions, we can frame the conditions in advance on the materials side. The discussion must be driven by the opportunities of these two metabolisms. Once people understand the concepts, then you have a framework in which you can have a conversation. You test yourself against them and then fine-tune your design process. The hardest part of this for people to understand is that it's not just about eco-efficiency: it is actually about re-design. Almost every modern product can benefit from this exercise.

What do you consider to be the key principles of Sustainable Product Design for business?

I have articulated three principles and six criteria. The principles are:

- waste equals food
- use current solar income
- respect diversity.

We've added new criteria to the traditional industrial revolution criteria.

The traditional criteria are:

- cost (can I afford it?)
- performance (does it work?)
- aesthetics (do I like it?)

Our additional criteria, which enrich the design agenda, are:

- is it ecologically intelligent? (do its materials comply with our principles?)
- is it just? (is everything equitably considered?)
- is it fun? (do I get up in the morning wanting to do it?)

This is something Michael Braungart and I are developing together with our colleagues.

We have created a company called 'McDonough Braungart Design Chemistry' to work with these principles and criteria. On the one hand, we look at the specific effects of the assemblies of the molecules, which is what Michael can do in a highly effective way, while also developing benign alternatives with the same end result. On the other hand, we look at design and ask ourselves, 'How do we make this attractive and prosperous? How does this fit within our cultural enjoyment? How does this spark the imagination and become something we want to do?' Not something less delightful that we feel like we must do for some 'moral' or 'ethical' reason. We all know the design side really has to balance equity, economy, and ecology. Because it won't matter if you have the most secure, integral and robust ecological product; if it's unattractive, people won't value it. If it's destroying some cultural situation somewhere else, or causing people to suffer, people shouldn't give it the same value as something benign.

Jaime Lerner, Governor of Parana State and the former mayor of Curitiba, Brazil, says, 'When you project a tragedy, unless you do something, you have the tragedy'. For example, if we look at a city which has 600,000 people and will have over one million in 20 years, we can get very nervous when we consider it in light of what has happened in Sao Paulo or Rio. The pundits say, 'Look what's going to happen. It's going to be terrible. We're going to have crime and destitution, and we're going to lose our children.' Then guess what happens? They get proved right. Ironically, they have a vested interest in being right about their projection. So, as Jaime says, the strategy cannot be one of tragedy. It has to be a 'strategy of change', because what's happening now will not work to avoid the tragedy. As you adopt a 'strategy of change', you then find yourself operating on a new set of principles, which is why I've been trying to develop new design principles, leading to prosperous change.

Business needs to enjoy the sudden bursts of energy that create incredible new opportunities for products that we didn't even know we could want because they didn't exist! We didn't realise some of these new design concepts themselves existed, and that's what's so exciting. So for business people, this is the real hot one, this is the entrepreneurial front-line, and it is the place where the next round of magnificent industrial prosperity will occur. It is imperative that we re-design every-

thing. So imagine getting it right. How about that strategy! The only way to pursue the 'strategy of change' is to start changing. You have to begin immediately. Even if it's just a faltering step, you have to start moving. You can't sit back and say, 'I'll wait until I see what else is going on', because then you're already in the tragedy, and that is the tragedy.

There's an interesting story about Confucius.

Essentially, a master of ceremonies comes in and says, 'Confucius, there's a problem. You put this person in charge of the ritual and he's constantly questioning the ritual. Why put him in charge of the ritual?' Confucius answers, 'That is the ritual!'

It doesn't matter how conservative you are, the most conservative position you can have is to question the ritual, because that's what strengthens it. Infusing all of this is the need for change and the need to stimulate creativity. The fact that this process is delightful, and that it has to be, is what will make it happen. It is intensely profitable for those who participate – significantly profitable!

Could you give a couple of examples from the work you've done on textiles and are looking to do with carpets?

We're looking at re-designing whole sectors of the industry, and these principles are being adopted by large companies in design and industry. The carpet and fabric designs, which I won't talk about specifically, are in some cases so much more efficient in terms of their delivery and material flows that there is no question they will allow the company to out-compete any competitor. This is simply because of their effectiveness, and all of this grew out of our design process. Modelling design on nature makes you realise nature is, by its own nature, inherently efficient and effective. Once you start to adopt these ideas, your whole company and its products can become more effective. We are now looking at, from a design perspective, a point where the designers and the people working on these new products will be getting royalties on billions of dollars of production. This should catch everyone's interest.

There are hundreds and thousands of things ready to be redesigned, but we must be very careful to avoid what Michael Braungart calls 'ecologism'. If all we're going to do is insist on recycling a package that wasn't designed to be recycled in the first place, we're going backwards. That's very bad design. It will create infrastructures that we don't want, and we'll have invested in interests that are actually counter-productive; instead of recycling, for instance, we will actually be 'down-cycling', a term Michael and I use to describe most recycling today, where products lose quality and are used to make less sophisticated products on their way to their eventual 'grave', a landfill or an incinerator. This redesign issue is something very important, and it has to be very attractive. That's why designers have to be so involved. Our redesign of textiles did not just create a safe material (see JSPD, Issue 1, 1997, p.57), it created a more efficient, safer production system, more profits for all concerned, less regulatory need, and a factory that might never need to release water again. Because if the water coming out of your factory is cleaner than the water going in, you'd rather use your effluent than your influent. You can 'close the loop'. This is not eco-efficiency. This is re-design. It eliminates regulations – regulations which, in many cases, can be seen as signals of design failure.

I want to envision the big opportunities. We're a bit unimpressed by the need to design something so that everyone understands its ecological or social dimensions. We think people should actually be able to throw something away and enjoy that act without feeling like they're some sort of criminal. Right now, there is guilt coupled with bad design: 'Oh yes, we will recycle, but we'll drive 10 miles to recycle!' This doesn't make sense in the big picture. Our challenge is to change the design, because people are confused by systems of 're-cycling' that are not effective in the long run.

There is also a challenge for these products and services to play a role in educating people about the positive aspects of sustainable product design. They should be full of 'embodied' information. But in the end these things will happen because they are simply smarter, and

people like to be smart. In a wonderful way this re-design has what you might call a spiritual dimension, because it leads to the 'dematerialisation' of design. If you imagine the safely designed 'product of consumption' that grew out of our work, you have something that goes back to the soil safely. Or, if it is a technical 'product of service', it goes back to a high quality industrial cycle. Neither product needs to end up in a landfill- that would mean you've failed in your design. Once you actualise these concepts, what happens is truly fascinating: things literally dematerialise. You have much less stuff and much higher 'design intelligence'. As human beings get better and better at things, instead of using more stuff, they use less stuff, with a higher 'embodied intelligence' to replace it! Buckminster Fuller, the inventor and creative thinker, said something like, 'The better technology gets, the more it disappears'. I think that's the key to the whole product business, because it gets everybody going in a creative way, respecting and optimising material and human resources.

Some companies begin to realise new design principles in the process of instituting eco-efficiency. But when they begin to articulate the desire to be better than what they have been, we ask them to do more than just try to be more efficient; that may just prolong their agony. We say re-design instead. It's much more powerful and productive!

What do you think are the key characteristics of a more sustainable firm?

Adaptability. I think Darwin had it. The whole idea of 'survival of the fittest' has been misinterpreted, especially in business. It's really 'survival of the 'fitting-est'; it's about niches, about understanding a place where you are safe, where you get nourishment, where you don't have as much deadly competition. Looking for nourishment without competition is a very legitimate attitude, one that is fair and not abusive. We need to think in terms of areas of potential surplus where we can find pleasant forms of non-competitive nutrition. That should and can apply to working processes as well. We're actually designing buildings where the chairman of the board might give up the corner suite to share the joy of working next to her assistant sitting near a logistics manager, for example.

We know linear hierarchies don't matter any more. Everyone has their role to play, and everyone should revel in it. It's a much more thrilling prospect, and it's creative and fun. As I mentioned earlier, the decision-making frame has always included the three components of cost, performance, and aesthetics.

- can I afford it?
- does it work?
- do I like it?

That's been as much as we've been dealing with. What we're saying now is to add three more:

- is it ecologically intelligent?
- is it just?
- is it fun?

Because we're not having fun anymore! Everybody feels like they are working all the time. There's this whole idea of a leisure class, a leisure society, but the reality is that everyone feels like they are working two jobs. It doesn't make any sense. A lot of that has to do with the fact that we're not enjoying an effective structure. We're not designing well. We've built a system that makes us think we have to be active all the time, that we have to work for lots of stuff we don't really need.

Jefferson had it right: it's 'life, liberty and the pursuit of happiness, free from remote tyranny'. This time, it's inter-generational remote tyranny we have to free ourselves and future generations from – the tyranny that is us and our bad design. •

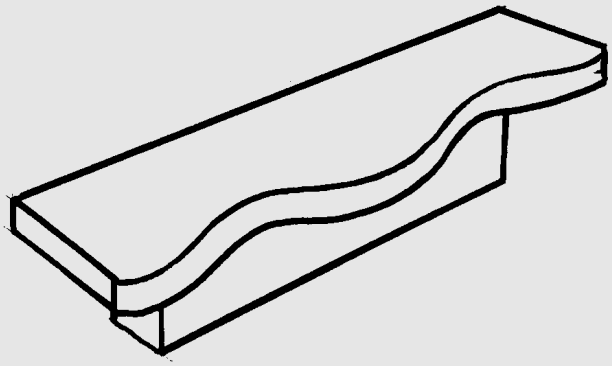
This is an updated and edited version of an interview conducted by Martin Charter, originally published in 'The Green Management Letter', Euromanagement bv, The Netherlands.

Metzzo

In a partnership between a UK specialist recycling company, Sheffield Hallam University and designer Andrew Hewitt, a range of products are now available which are manufactured from a composite composing of 20% cement and 80% recycled glass cullet. This research project was made possible through funding from the UK's Department for Trade and Industry and British Glass.

The composite utilises crushed bottle glass as an aggregate in a cement binder, producing a material which is both functional and aesthetically attractive. The material is increasingly being used in a wide range of applications within the architectural, commercial and domestic markets.

'Metzzo' has been vigorously tested and successfully submitted for several British Standard tests. Its performance compares favourably with that of its competitors in the architectural flooring and cladding materials market.



Top: Café table

Above: Sketch for exterior public seating

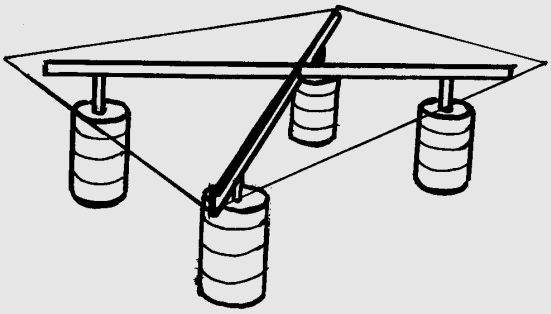
Right: Portal

Illustrations used include designs by Paul Chamberlain, Andrew Hewitt, Melanie Jordan and James Roddis.

Production methods follow proven concrete technology where the material is cast into moulds prior to curing and surface polishing. Colour balance is achieved through initial selection of glass materials and by the use of specialised colouring agents. Unlike conventional materials, the casting process permits the incorporation of design elements, designated by shape and colour, within the final product. Additional effects can be achieved by encapsulating precast sections within a panel. This has been further developed to include the use of glass rods, producing solid panels with a startling light transmission potential.

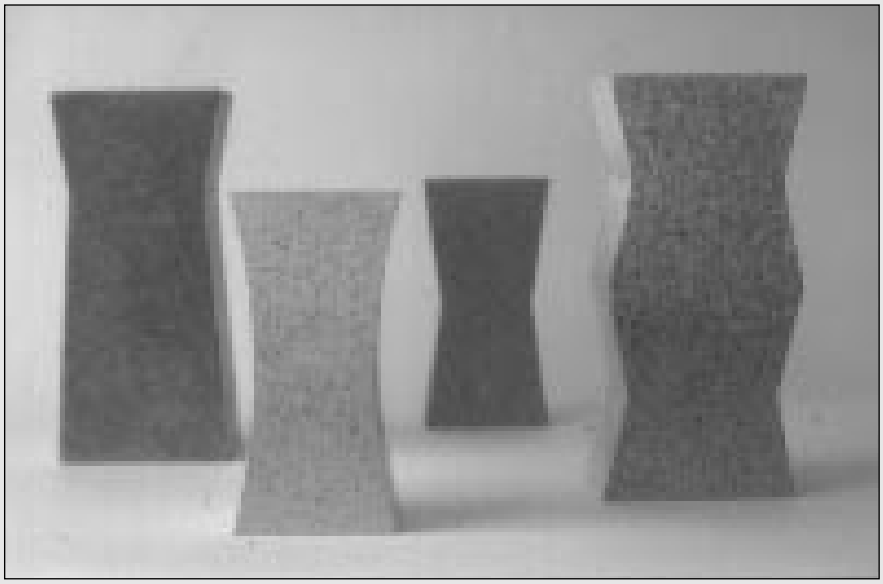
The material is very versatile and there are tremendous product opportunities. Initially, production is being limited to four main product areas: tables, seating, lighting and a selection of vessels. Products can also be specially designed and manufactured to fit a customer's requirements, incorporating any of the features outlined above or by developing new concepts to meet their needs.

While the illustrations shown represent such domestic factory produced items, Metzzo will eventually be used in products such as internal and external flooring and road/motorway curb stones. The research team are at present working with some Finnish universities to develop potential mass produced products for the material and a more streamlined manufacturing process.



Above: Sketch for a table with a glass top using Metzzo legs

Below: Pillar vessels



A design tool for eco-efficient products

Jonathan Williams & Calum Morrison

Director, Group for Environmental Manufacturing, UK

Project Manager, The Planning Exchange, Scotland

Dr Jonathan Williams is currently Managing Director of Contech Design Ltd, holding company for the Group for Environmental Manufacturing (GEM). Here he is responsible for launching and promoting a variety of innovative projects, with emphasis on exploiting environmental market opportunities, technology development and training products. He is also Managing Director of the technology transfer and research management company Marinetech South Ltd. Previously he managed the environmental team at the Centre for Exploitation of Science and Technology (CEST) where he created the ACORD consortium and was responsible for projects exploring new synergies between commercial advantage and environmental improvement. He has extensive industrial experience within the energy sector, ranging from international petroleum development projects to renewable energy technologies. He has engineering degrees from Cambridge University and Imperial College, with a Masters in Information System Design from Cranfield University.

Producer responsibility is a growing issue in various markets. Operationalisation of this concept is starting through the application of eco-efficiency. The article highlights a tool that has been developed to improve the quality of eco-design decision-making throughout the life-cycle of the product.

Introduction

Many sectors of industry are facing up to the challenge of producer responsibility. This stewardship of products through all stages of the life cycle is demanding a radical reappraisal of product distribution, use and 'end of life' processing within the context of conventional design and concurrent engineering.

Some 'priority waste stream' sectors face specific, regulatory responsibilities for their products at 'end of life'. But in addition all manufacturers are having to cope with increasing costs of waste disposal: direct costs of disposing of production waste, and a less direct loss of competitiveness arising from significant 'end of life' disposal costs. 'Business as usual' strategies are rapidly becoming increasingly untenable.

Product stewardship is also requiring firms to examine the resource efficiency of their products: how to extract the maximum customer value from the minimum resource consumption. Wasteful resource utilisation implies unnecessary material expenditure and also liabilities for materials not appearing in the final product. Already there are commercially driven examples of firms adding high-value services alongside their traditional commodity products – more customer value for no extra (and sometimes less) resource consumption.

These changes in the business environment are challenging traditional approaches to new product development and production management. Existing design tools, focusing on functionality, production cost and attractiveness at point of sale, are insufficient. What is needed in addition is assistance with management of whole-life value, and its integration within the design process. The Regional Eco-Efficiency Demonstrator Initiative (REDI) project was conceived as a timely response to that need.

The REDI Project

The Regional Eco-efficiency Demonstrator Initiative (REDI) was launched in late 1995 to show how eco-efficiency and commercial viability could be aligned within new product designs. A wide range of companies has been involved, reflecting the supply-chain and whole-life orientations of the project. Funding has been received from the Esme Fairburn Charitable Trust and the European Commission, as well as from companies and business support organisations.

A major deliverable from REDI is a software tool which aims to assist the designer to minimise 'end of life' liabilities and maximise whole-life value in a number of ways. Firstly, by entering the product specifications into the software tool, the designer is warned of any potentially hazardous materials included, wherever they may be located within the product. This allows at the very least, for the designer to be aware of the liabilities in the product and to quantify them for further reference. This information can then be used within scenarios, to identify vulnerability of particular designs to future regulatory developments.

Secondly, by tracking the value throughout product life, REDI gives the user a snapshot of the 'value-adding' and 'value-reducing' processes throughout the product's life, tracking material fluxes from raw resources to finished products and waste streams. A key element of this functionality is the ability to model the scrap and waste rates of the various process flows that the product undergoes and also to estimate overall material recovery percentages.

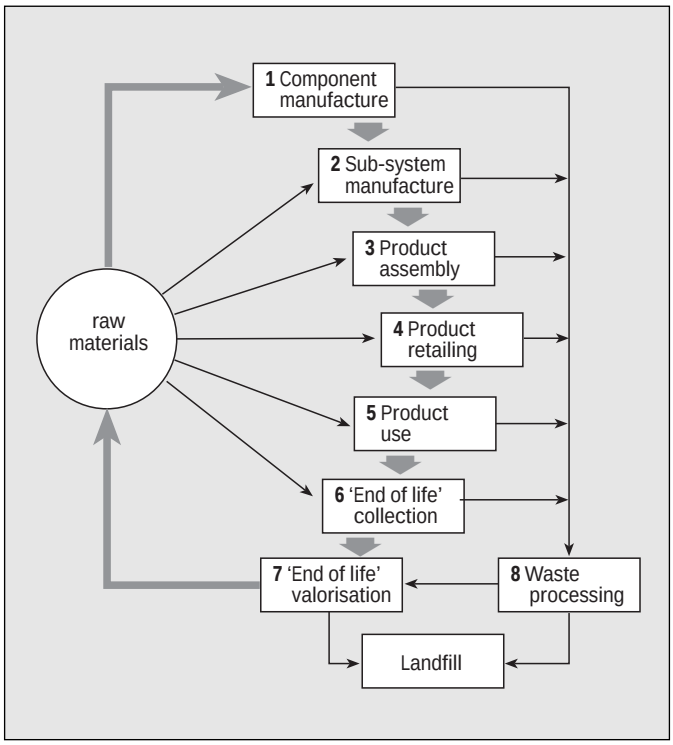


Figure 1: Representation of product life cycle within REDI

This whole-life orientation of the REDI model is illustrated in Figure 1. Each stage of the life-cycle, from component manufacture to waste processing, is modelled; each draws on material/energy resources, and each creates waste. These fluxes of material flows are modelled so that resource and waste burdens can be calculated for each unit of output from the production process.

The design tool

The concept of eco-efficiency is central to the REDI design tool. Eco-efficiency is a measure of how much customer value is offered by the product compared with the resources needed to create that value. By modelling value-adding and value-reducing processes throughout the product's life, its overall eco-efficiency can be derived, in the form of an eco-efficiency index. Designers can use this index to explore the optimisation of eco-efficiency at an early stage of product design. This is a novel aspect of design tools, and an important function of the REDI project is to appraise how useful this eco-efficiency approach could be in a commercial design context.

One of the major uses of the REDI tool will be the management, and 'designing out', of liabilities resulting from the product's 'end of life' and manufacturing phases.

It is recognised that small firms have an important role in achieving a more eco-efficient industrial base. Yet many recent initiatives (eg waste minimisation) have encountered difficulties in attacting small firms. Therefore REDI has been constructed to allow an easy entry route for small firms.

The design tool has initially focused on the electronic equipment sector, working closely with a range of leading companies including Hewlett-Packard, Rank Xerox, NCR, Telecom Sciences and the Scottish Electronics Forum. It is intended to extend the application of the tool to other sectors once the approach has been validated for electronic equipment.

Whole-life liability management

One of the major uses of the REDI tool will be the management, and 'designing out', of liabilities resulting from the product's 'end of life' and manufacturing phases. Many of these liabilities are hidden costs falling outside the conventional design brief (eg. the cost of complying with Control of Substances Hazardous to Health (COSHH) regulations due to the use of particular solvents during manufacture).

Of particular significance is the cost of producing, handling and disposing of packaging used to ship components and assemblies from supplier to manufacturer. These costs are rarely considered in product engineering, but they can end up being substantial. It is only by tracking all such packaging throughout the life-cycle that it is possible to quantify the cost, and thereby to focus management attention on reducing cost.

In addition, it is important to ensure that designers are aware of all hazardous materials used in the product, particularly if these end up being shipped in the product where they can contaminate otherwise recoverable resources at 'end of life'. This is presently extremely difficult, for two reasons:

- product designers do not usually possess information on material composition of bought-in components
- nor are they usually fully aware of regulatory constraints affecting the use and disposal of different materials.

The REDI tool addresses these needs, making information available in a form which is valuable to small and large firms. It achieves that by incorporating within the tool two databases. One is a component database which contains information on common components used in electronic equipment. Initially a demonstration component database has been created, covering a limited range of components, to allow the tool to be used and evaluated.

The second database contains information on materials and regulations pertaining to those materials. This data resource allows REDI to flag up potential hazards, without getting bogged down in details of environmental regulations. However it will be possible to link REDI to one of

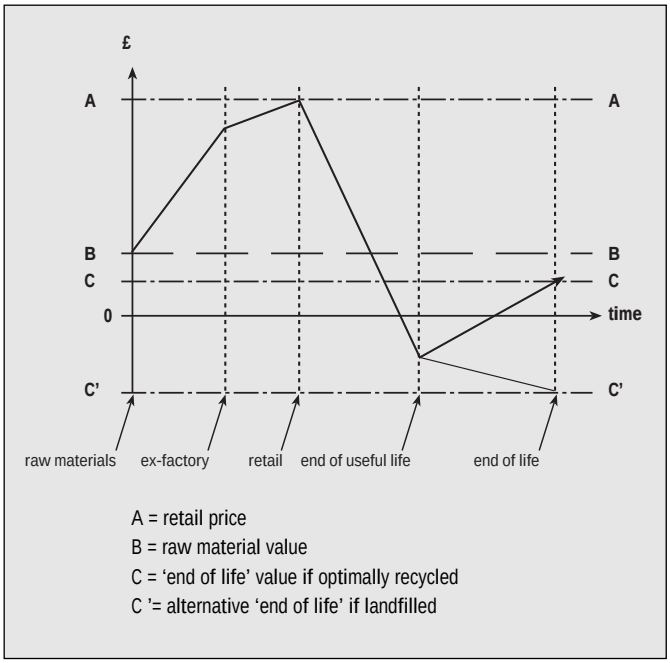


Figure 2: Value profile of a typical product

the proprietary environmental databases to access more detailed information.

Whole-life value management

As already mentioned, the ability to optimise 'value-added' against resource utilisation is essential to develop eco-efficient products. REDI achieves this by calculating the embedded value in a product at every stage in its life. A typical profile of product value is illustrated in Figure 2. This shows a modest raw materials value (£B) rising through the manufacturing processes to a maximum value at the point of sale (£A). As the product is used, it steadily loses value (ignoring some discontinuities due to maintenance and repair) until it finishes up in, say, a municipal waste site. Here it has a negative value since it requires some waste processing and its materials are not yet available for re-use.

At this stage, the product can either by treated by a recovery system which releases its intrinsic value, and brings the net value back up (£C); or it can be disposed of without recovery of its intrinsic resources, incuring a further loss of value (£C').

Based on information from recycling plants, the designer can input recovery rates and costs for the product and its constituents. This allows REDI to create the value profile, whereupon the designer can explore how design decisions affect the profile. In the case of a poorly designed product, where the 'end of life' processing costs are high, it may not be possible to achieve a positive 'value-added' by any 'end of life' process. In such a case, the fate of the product will be governed by regulatory constraints rather than by commercial judgement.

Eco-efficiency index

The index is computed as the ratio between maximum product value (in the above case £A) and the net whole-life material value consumed in achieving that product value (£B less £C). That is: heco = A/(B−C)

The index is a convenient way of summarising the eco-efficiency performance of a design. It assumes that the value at point of sale (A) can be taken as the price a consumer is prepared to pay to acquire the product, ie its retail price. Material values B & C can be computed by the REDI model: clearly, designs which improve the net value of resources extracted from product (C), and/or which reduce the resources consumed in manufacture (B), will attract an improved eco-efficiency index.

Maximising impact

The next stage in the project will address the evaluation of the REDI tool. Participating companies will be given an opportunity to experiment with the tool, to apply it to product design situations relevant to their own businesses.

It is important to get feedback from smaller firms at this stage, so the project is working with organisations which serve the

The tool is structured on economic factors, since these will drive moves towards eco-efficient products in the commercial world.

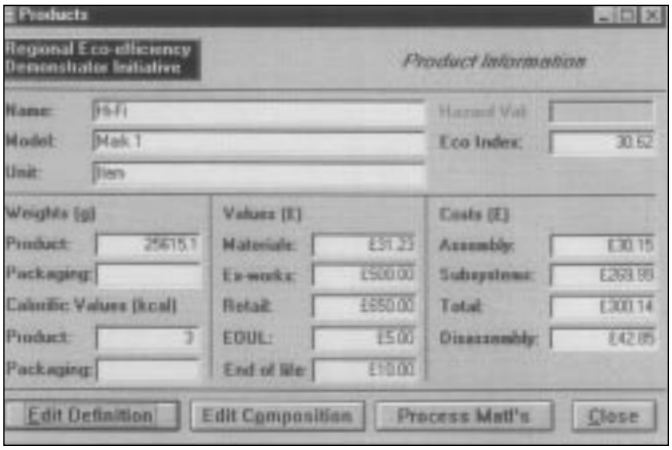


Figure 3: REDI product information screen

interests of small and medium enterprises.

Using the design tool

In order to maximise the value of REDI, considerable effort has gone into the user interface. The tool is coded in Microsoft Access with Visual Basic controls, offering an efficient development environment and flexibility to customise the user interface. An example of a screen, showing a product information summary, is illustrated in Figure 3.

Conclusions

The REDI project has successfully developed a design tool which allows designers to optimise the eco-efficiency of products. At this stage, it has been focused on electronic equipment, but this applicability can be expanded once the use of the tool has been validated.

The design tool is structured around a whole-life representation of material flows required to manufacture, use and dispose of products. Economic values of material flows are built into the tool, since 'end of life' processing is dependent upon the intrinsic value of resources embedded within products.

An eco-efficiency index has been proposed, and is built into the tool. The formulation of this index needs to be appraised by designers and engineers.

The tool differs from conventional life cycle analysis models, in that it does not attempt to quantify every emission and resource utilisation. Instead, it quantifies whole-life material utilisation and recovery, and presents this information in a form directly useful to the design process. The tool is also unashamedly structured on economic factors, since these will drive moves towards eco-efficient products in the commercial world.

The next stage in the work seeks to generate feedback on the tool from designers and engineers, in the context of both large and small company environments. •

Moving companies towards sustainability through eco-design: conditions for success

Professor Dr Ir A L N Stevels

Senior Advisor Environmental Engineering, Environmental Competence Centre, Philips Sound & Vision, the Netherlands

Ab Stevels studied Chemistry at the Eindhoven University of Technology and, after being employed at Philips Electronics Eindhoven in 1966, he received his PhD in Physics and Chemistry at the Groningen University, the Netherlands.

In 1969 he joined the Philips Research Laboratories and worked on various subjects in solid state chemistry and materials science. After changing to the Glass division in 1981, he worked in various capacities: glass technologist, laboratory manager, head of development and general manager of the Optics business. In 1989 he was transferred to the Consumer Electronics division (his assignments included the management of the laser optics business and projects in Asia). From January, 1993 he has been senior advisor on environmental engineering of Philips Consumer Electronics and from December 1995 he was appointed part-time professor in Environmental Design at the Faculty of Industrial Design Engineering, the Delft University of Technology, the Netherlands

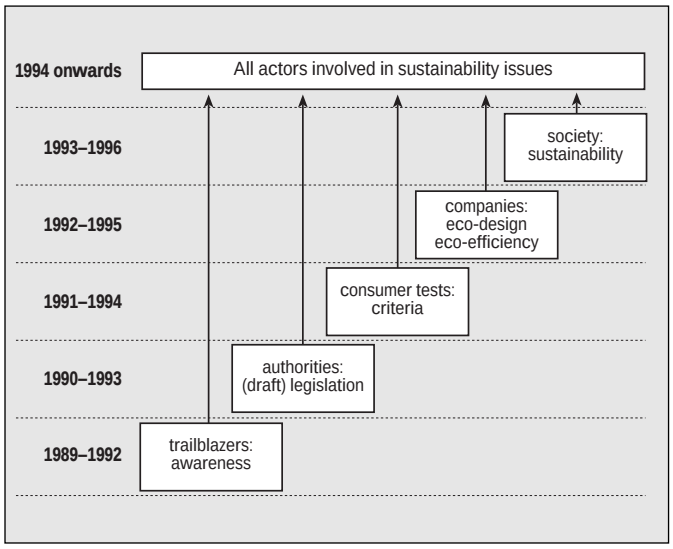
Experiences in moving companies towards more sustainability through eco-design are highlighted in this paper. Incremental improvement of environmental product attributes is well underway especially in those areas where eco-design can be linked to cost reductions. More radical re-design of products is currently still hampered by lack of appropriate validation methods. Finding product alternatives and introducing them to the market will require intensive stakeholder dialogue. The formulation of common goals will be crucial to move society towards sustainability.

Introduction

The need to achieve sustainable development poses an enormous challenge for society. It is estimated that in order to make this happen, the burden on the environment in industrialised countries will have to be reduced by at least a 'factor 10' in fifty years time (Weterings & Opschoor, 1992). Over a shorter time scale Von Weizsacker, Lovins and Lovins (Weizsacker, Lovins & Lovins, 1995) advocate an increase in the eco-efficiency of consumption by a 'factor 4'. In order to realise this a number of techno-economical, social and ethical issues will have to be tackled. This paper highlights the role of companies in achieving the societal goal of sustainability through eco-design. Basically this is a technical issue; however, this paper will show that mindset and corporate culture are important conditions for success.

The Brundtland Commission report (The Brundtland Commission, 1997) brought the concept of sustainability to the attention of a wide audience. However, in the subsequent years various actors have became more and more involved in the debate. This is illustrated in Figure 1. In business the increasing eco-efficiency of production processes has been progressing for several decades; with, the oil price shocks of the early seventies and eighties greatly accelerating efforts. Nowadays the concept of eco-efficiency is well accepted in smart industrial practice; but attention to eco-efficiency of products has evolved only recently.

Figure 1. Involvement in sustainability issues



When developing eco-design projects it is important to know exactly what level of eco-design the company or Business Unit should be aiming for

This figure shows that after the initial awareness phase, national governments in various countries stepped in with (draft) legislation and regulation. Between 1991–1994 the first environmental criteria appeared in consumer product tests and in eco-labels; shortly after this leading companies started to implement product-related eco-design and eco-efficiency considerations. More recently it has been realised that product-based eco-efficiency as such is not good enough to realise breakthrough gains. The systems/infrastructure in which the product functions has to be considered as well.

This paper suggests that eco-design has several levels of sophistication. For each of the first three levels, ie. improvement of current design, radical re-design based on existing product concepts and product alternatives, experience from Philips Sound & Vision (S&V) is described, both in terms of critical success factors and support tools used or needed.

Levels in eco-design

The eco-design process has been described by Brezet, Cramer and Stevels (Brezet, Cramer & Stevels, 1995) as a staircase with four steps.

First step: incremental improvement of products

Second step: (complete) re-design of existing product concepts

Third step: alternative fulfilment of functionality, new concepts

Fourth step: functionality concepts completely fitting into the sustainable society.

When developing eco-design projects or implementing eco-design in a wider sense in organisations, it is important to know exactly what level of eco-design the company or Business Unit should be aiming for.

Level	Purpose	Type of institution department involved	Environmental validation	Investment	Change of consumer lifestyle	Infrastructure change needed
4	Functionality completely fitting into sustainability society	Technical universities	Complete life cycle analysis? Complete life cycle cashflow?	+++++	+++++	++++
3	Alternative fulfilment of functionality	Industrial research (technical universities)	Life cycle analysis? cycle cashflow?	+++	+++	++++
2	Complete redesign of existing concepts	Pre-development departments (technical universities)	Environmental weight Eco-indicator Life cycle cost	+	+	–
1	Incremental improvement	Development departments (technical universities)	Common sense Checklists	–	–	–

Figure 2: Levels in design for environment

Figure 2 illustrates that the choice of the level has far-reaching consequences for the type of information required, type of institution/department involved, the environmental validation (the 'greeness' of the result), financial aspects, consumer life style and infrastructure.

It can also be concluded from Figure 2 that activities on level 1 and level 2 are well within the span of control of individual companies. For success at level 3 and 4, consumer life style and infrastructure changes in society play a major role.

Level 1: eco-design activities, incremental improvement

Level 1 eco-design actions can be carried out by all companies launching products into the market and every employee can contribute to it. Commonsense plays an important part in these type of activities. Essentially it is bringing together the following type of information:

By counting, eg.

- how many parts are in the products?
- how many types of material have been used?
- how many screws or other fixtures are in place?

By measuring, eg.

- energy consumption
- weight
- presence of environmentally relevant substances
- disassembly time of the main parts?

By calculating, eg.

- what is the cost of environmental improvements?
- what are the yields of environmental improvements?

Bringing together information almost automatically leads to the generation of 'green' improvements

Philips Environmental Policy Statement

Environmental care is an integral part of the industrial and product policy of Philips.

The four basic principles are:

- sustainable development
- prevention is better than cure
- the total effect on the environment counts
- open contact with the authorities.

These principles lead to the following policy statement:

- Philips is committed to environmental care in all its operations. All parts of the organisation will incorporate this into the management of their activities.
- Philips encourages the assessment of the total environmental impact when introducing new processes, products and packaging.
- Philips recognises the importance of an on-going involvement and commitment of management and of all employees.
- Philips will strive to conduct its industrial and commercial activities in such a way that the quality of the environment now and in the future preserved. Philips supports the Business Charter for Sustainable Development of the International Chamber of Commerce (ICC), dated March 1991.
- Philips is committed to complying with all applicable environmental laws and regulations and emphasises the necessity of international harmonization of environmental regulations.
- Philips will cooperate with governments, regulatory bodies, industries and consumer organisations and will take the initiative, where necessary, to promote workable and improved codes of practice and effective laws and regulations.
- Philips encourages the collection and qualified recycling of products at the end of their useful life by third parties. In this respect, Philips will provide the necessary information concerning its products.
- Philips will strive to inform the customer in such a way that he will be able to take the respective environmental consequences into account in his decision to buy, provided an assessment of the total environmental impact of its products has been made.

Source: Philips Electronic N.V

Experience has shown that the process of bringing together information, as described above, almost automatically leads to the generation of 'green' improvements (and also leads to improvements outside the strict environmental area). The reason for this is due to the complexity of today's products and because most companies are still organised into specialised departments focusing on particular parts of the total product concept (ie. mechanical, electrical, electronic, manufacturing planning, etc). Eco-design is essentially a cross-functional activity!

In order to successfully integrate level 1 eco-design activities, basically four types of action are needed:

- formulation of the environmental vision, policy and overall targets by management
- incorporation of an environmental section into the individual product specification
- eco-design training and the publication of an environmental design manual with mandatory design rules, directives and recommendations, background knowledge on how to successfully execute eco-design
- follow-up both at management level ('review') and in the product creation process (environmental release).

In order for an organisation to start operating in this way, a business rationale must be developed, technical matters should be addressed and environmental awareness should be generated.

Environmental Design Manual

Part 1: Sound & Vision (S&V), Business Electronics (BE) and Communication Systems (CS) environmental requirements

- how to use the manual
- summary of mandatory design rules
- environmental weight and calculation method
- marking and labelling of mechanical parts
- packaging
- customer information
- purchasing directives
- banned Substances
- batteries
- ozone depleting chemicals

Part 2: Business group specific environmental standards

Part 3: Environmental policy: S&V, BE and CS environmental organisation environmental recommendations and information

- chemical content
- power consumption
- end-of-life costs & design recommendations
- environmental management systems
- LCA/Eco-indicator
- eco labels

Part 4: Annexes

- environmental release status of:
  - passive components
  - active components
  - electromechanical components
  - key components
  - laminates (for PWBs)
  - plastics
  - metals
  - chemicals
- Philips CE list of environmentally relevant substances
- summary of legislation and regulations
- ICC Charter
- related documents.

The business rationale for level 1 eco-design activities is primarily based on compliance with legislation/regulation and to changes where eco-design and cost reduction are directly linked, such as product weight and packaging weight reduction, reduction of (dis)assembly time, reduction of wiring/cabling and the application of recycled material.

Experience indicates that successful eco-design generates environmental improvements and cost reduction, which contradicts the well-established prejudice that ' the environment' only costs money.

It is more difficult to derive market advantages from level 1 eco-design activities; as, both private and original equipment manufacturers (OEM) customers simply expect that quality companies continuously introduce environmental improvements in their new product generations. Moreover, level 1 eco-design improvements are straightforward and easy for competitors to follow, so commercial advantages will be short-lived.

Philips Sound & Vision (S&V) has approached eco-design activities both through a 'top-down' and a 'bottom-up' approach. The 'top-down' approach was launched through the formulation of a vision/policy statement in 1991. This was followed by the implementation of an environmental programme called 'The Environmental Opportunity'. On a company-wide basis the following three goals are set:

- certification according to ISO 14001 of all operations by the year 2000
- 25% reduction in energy consumption in all operations by the year 2000
- 15% packaging reduction in all operations by the year 2000.

Each Business Unit has to establish a programme addressing:

- eco-design
  - energy consumption of products
  - materials application
  - 'end of life'/durability
- supplier requirements
- environmental communication
- environmental know-how network.

Key instruments for the 'bottom-up' approach are the Environmental Design Manual

The need to drastically improve the eco-efficiency of products and services through level 3 eco-design also calls for an intense stakeholder dialogue.

and training programmes. The Environmental Design Manual gives the mandatory design rules (to be checked at product release), design directives and design recommendations. The supporting text and information tables are organised in such a way that they not only invite the designers/developers to fulfil the requirements, but also to surpass this minimum as much as possible (see JSPD, Issue 1, p. 7).

Training programmes include the following items:

- introduction
  - what is eco-design
  - environmental product analysis
  - environmental validation
- how to environmentally improve
  - energy consumption
  - materials application
  - chemical content
  - packaging
  - 'end of life' properties
- ISO 14001
- business and environment
  - eco-design as business issue
  - environmental business analysis/roadmaps
  - green consumer behaviour
  - environmental product strategy
- legal and political issues
- implementation of eco-design
- 'end of life'/recycling specials.

Level 2: eco-design activities, radical re-design based on existing concepts.

In level 2 eco-design activities existing product concepts are environmentally improved up to the limits which physics, chemistry and electronics will allow. This is difficult to achieve through a 'Plan-Do-Check-Action' approach. Therefore level 2 eco-design projects are being organised in pre-development or research laboratories.

Going for the limits for energy consumption, materials application and 'end of life'/durability of a single product always implies compromises and 'trade-offs' as to what is the best or the better environmental option. Drastically improving one item (eg. energy consumption) can have negative implications for other items, such as materials or 'end of life'. Therefore level 2 activities require environmental validation; Life Cycle Assessment (eco-indicator calculations) and Life Cycle Cost calculations are needed to track down the best options, with commonsense and the checklist-based activities of level 1 – no longer applicable to a higher level of sophisication.

In order to find out what the best approach for radical re-design in an industrial setting would be, the S&V Business Unit has organised a 'Green TV' project. In this project attention has been focussed on both the technical issues, and corporate culture issues, like how to overcome barriers and prejudice and how to simulate green creativity. The experience in this project has shown that it is very beneficial to allow 'open thinking' in the first stage of the project. This means that the normal boundary conditions of an industrial project, quality, cost price and throughput time, are set aside for a certain period of time. Later on these are brought in again. Practice with the Philip's 'Green TV' project

STRETCH: checklist of environmental opportunities

Minimisation of production impact
- minimisation of waste, emissions and energy use
- respect for biodiversity

Minimisation of product impact
- reduction of toxic substances
- minimisation of materials consumption (eg. through miniaturisation, weight reduction, systems integration)
- minimisation of use of non-renewable resources
- minimisation of fossil energy consumption (eg. through energy efficiency and durable energy use)

Efficient distribution & logistics
- produce where you consume
- direct distribution to consumer

Intensity of use
- lease versus sell
- collective use

Durability of products
- reuse
- technical upgrading
- longer lifetime
- repairability
- refurbishing
- ageing with quality

Recyclability of materials
- reduction of materials diversity
- materials cascading
- design for disassembly
- selected, safe disposal

Figure 3: STRETCH methodology

showed that solutions were found in avenues which otherwise would have been eliminated beforehand.

This has resulted in a product of where the environmental load is approximately 30% lower than in the comparable current products. The advantages break down in the following way:
- reduction of energy consumption: 30%
- plastic weight reduction: 32%
- reduction of hazardous substances: 100%
- use of recycled materials: 69% of total weight
- recycling potential: 93%

The cost price of this product is approximately the same as current products. The main roadblock for 'massive introduction' (the production of large quantities for market introduction) is the investment which has to be made to transform the present production facilities into that suitable for the 'Green TV'. This transformation would also have consequences for suppliers, as they would have to change their parts geometries and moulds and would have to learn to work with new (mostly recycled) materials.

The above mentioned reasons suggest that the results of the 'Green TV' project can only be implemented 'step by step' over a longer period of time.

Level 3: eco-design activities, product alternatives

As is shown in Figure 2 the implications of level 3 eco-design activities go beyond individual companies. The risks can be enormous:
- product alternatives might require huge investments with unsure returns
- product alternatives might invalidate current investments and might force a supplier base to change significantly
- the customer may not be prepared to buy the new products/service; if 'environmental gains' do not go hand in hand with other customer benefits, many people will not buy the product (however, 'environmental gains' are unlikely to be key purchasing criterion for the majority of people)
- the infrastructure to fully exploit the environmental gain is not (yet) available.

Companies wanting to start level 3 eco-design activities have therefore to approach their environmental product strategy from a much wider perspective.

The best way to do this is to link it to existing corporate and business strategy development. S&V has developed a tool to address 'level 3' type issues. The first two steps of STRETCH (Selection of sTRategic EnvironmenTal Challenges) therefore consist of:
- identification of the crucial driving forces in the business over a timescale of 3–10 years.
- making of a limited number of plausible scenarios leading to a shortlist of potential product/market strategies.

This identifies potential environmental opportunities and threats in relation to the identified scenarios. These are then applied to individual products and with the help of a checklist (see Figure

Current LCA methodology will have to develop further to enable consideration of emissions within well defined systems boundaries, and also to include the depletion of resources

3) the opportunities are scored on different scales:

- environmental scale (eg. eco-indicator/LCA)
- customer benefit (financial, ease of use, emotional)
- business benefit (cost reduction, expected increase in sales)
- feasibility.

In order to be selected for implementation, the option must lead to a substanial decrease in environmental load. The last step is to communicate the STRETCH results to the organisation and to develop the implementation plan.

At S&V brainstorm sessions have been held at a Business Unit level following the STRETCH methodology. The outcome of these sessions has indicated the substantial business and environmental potential for considerably enhancing the durability and eco-efficiency of products.

Eco-efficiency is defined here as:

$$\frac{\text{Utility (units of service)}}{\text{Life Cycle Impact (milliPoints)}}$$

As a result several advanced research and development (R&D) projects have been started.

The need to drastically improve the eco-efficiency of products and services through 'level 3' eco-design also calls for an intense stakeholder dialogue. The purpose of such a dialogue should be to test the results of the STRETCH brainstorms in a societal context. The reason for this is that to realise 'level 3' improvements involves big changes in companies, as a result of the risks associated with consumer acceptance and the uncertain fit into existing physical and societal structures. In order to make 'level 3' improvements in a market economy all stakeholders should be prepared to adapt themselves and contribute accordingly. Development of clearly communicated and agreed societal objectives and terms of reference is essential.

Rather than starting from the existing situation it is recommended to use the 'back-casting' technique: first define the goals to be realised in eg. the year 2010 and go back in time in order to define what needs to be done.

The benefits of such an approach are:

- focus on relevant items
- clear roadmaps for the various actors
- definition of conditions for success both in material and immaterial respect.

This methodology has been elaborated in a paper by the author (Stevels, 1997). The 'backcasting' technique has been applied to 'take back' of consumer electronic products. In this case the environmental validation of issues to be addressed are simple, ie. reuse/recycling quotes and cost (Stevels, 1997).

In cases where several parts of the life cycle have to be addressed detailed environmental validation of various 'level 3' avenues is a major problem. Current Life Cycle Assessment (LCA) methodology will have to develop further to enable consideration of emissions within well defined systems boundaries, and also to include the depletion of resources, embedded toxicity and

reuse/recycling in (half) open product systems. In addition LCA will need to address the issue of the industrial and infrastructure transformation leading to better environmental performance of individual products.

Level 4: eco-design activities, sustainable product concepts

As yet, there appears to be no experience at 'level 4', with the lessons from 'level 3' changes still being learnt by leading companies.

Conclusion

In this paper the experience of a division of a Philips has been described. It is shown that eco-design can be successfully integrated into current business operations. Critical success factors for this process are indicated.

It also highlights that in order to achieve breakthroughs in reducing the environmental load of products, stakeholder dialogue must be intensified. Moreover, environmental validation methodologies such as LCA need to be extended to draw meaningful conclusions about what avenues are likely to lead to sustainability. •

References

R.A.P.M. Weterings and J.B. Opschoor. 'Environmental space as a challenge for technological development'. (RMNO publication no. 74, Rijswijk, the Netherlands, 1992)

E.U., van Weiszecker, A.B., Lovins and L.H. Lovins, 'Factor four, twice the affluence, half the use of natural resources' (Droemer Knaur, Mnnchen, Germany 1995)

The Brundtland Commission, 'Our common future. Report of the World Commission on Environment and Development', (Oxford University Press, Oxford, United Kingdom 1987)

J.C. Brezet, J.M. Cramer and A.L.N. Stevels, 'From Waste management to Environmental Innovation', (Rathenau Institute, The Hague, the Netherlands, 1995)

A.L.N. Stevels, 'Design for Environment' (UNEP, Asia Pacific Technical Monitor 1997, p. 27–33)

J.M. Cramer and A.L.N. Stevels, 'Experiences with Strategic Environmental Product Planning within Philips Sound & Vision' (Proceedings Of the Greening of Industry Network conference, Heidelberg, Germany, Nov. 1996)

A.L.N. Stevels, 'A Roadmap for eco-efficient take-back of Consumer Electronics Products' (Proceedings Globec 1996/Recycle 1996, Davos (Czechoslovakia, March 1996)

Special feature: O2 Japan

Edited by Sytze Kalisvaart, Fumi Masunda, Misato Yomosa

Chair of O2 Global Network, Product designer, TNO Industrial Technology, the Netherlands

Liaison Officer, O2 Japan, Director of Open House, Japan

Product Planner, Japan

The Journal of Sustainable Product Design has developed a partnership with the O2 Global Network to further disseminate information and ideas on eco-design and sustainable product design. O2 Global Network is an international network of ecological designers. The O2 Global Network is organised into national O2 groups which work together to provide various services such as: O2 Broadcasts, which report live from O2 events using email and the Worldwide Web (WWW); O2 Text meetings, a meeting place on the Web; the O2 WWW pages, which provides an overview of activities; O2 Gallery, an exhibition of eco-products on the Web; and, an O2 mailing list.

For further information on the above activities and the O2 Global Network contact: O2 Global Network
Tourslaan 39
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internet: http:www.wmin.ac.uk/media/O2/O2_Home.html

'O2 News' will update readers of the Journal on the latest eco-design issues from around the world and on O2's national activities. In this issue O2's activities in the Netherlands are highlighted.

Eco-design update: news on eco-design projects worldwide

'Take back' at Philips

Philips have decided to set up a product 'take back' system in the Netherlands, thus forcing the Dutch trade organisations covering consumer electronics manufacturers and importers to become involved in the system. This means that product 'take back' for consumer electronics will be a reality starting January 1999. The companies will be responsible for those 'end of life' products which are not collected by shops and local communities. Shops will be required to accept 'end of life' products when selling a new one.

Mitsibushi joins the Future 500 round table

Mitsibushi has become one of the founding members of the Future 500 CEO round table. 'Future 500' was set up in contrast to the Fortune 500. The companies in Future 500 will be the leading companies involved in green technologies and products and will aim to significantly increase resource productivity.

Japanese Eco-Indicator

In Japan, Pré Consultancy has started to translate the Eco-Indicator '95 system from the Dutch to the Japanese situation. The initial work has recently been completed and presented to the JLCA (Japanese Life Cycle Analysis) association. Presently, a heated debate about the type of weighting of environmental effects is going on in Japan. In contrast to the US, there has been no discussion about the necessity of such an indicator for designers.

Green consumer guidelines

SC Johnson Wax Inc. has developed a set of 'Environmental Education Materials Guidelines for Excellence' to be used in schools. This is based on a Roper Study in 1995, which found that customers are willing to take environmental issues into account, but do not have a basic understanding of environmental issues. SC Johnson Wax concluded that environmental education may help restore customers' trust in industry. Furthermore, it will enable consumers to make more educated choices in purchasing

products, so that they can distinguish an 'environmentally considered' product from a generic product. Up to now a company could produce a green product without the consumer recognising it – unless it was highlighted. In the long term, SC Johnson Wax expects that environmental education will help generate new professionals that can deal with the complexities of combining industrial and environmental interests.

Source: Puget Sound Business Journal 1997, http://www.amcity.com:80/Seattle/ stories/092297/focus5.html

Green consumer survey

The percentage of US customers who do not care about the environment ('Basic Browns') has risen from 28% in 1990 to 37% in 1996, according to the Green Gauge Report conducted by Roper Starch Worldwide, US. The percentage of 'Greenback Greens', who are willing to pay 20% more for environmentally sound products has declined from 11% to 5%. Environmental factors are not as important as product issues such as quality, price, brand and convenience of purchase, etc. However, the US government is increasingly purchasing in an environmentally sound manner, incorporating 'green' criteria in procurement. Finally, nearly 75% of Americans think that they should take more positive action towards the environment (the 'guilt gap') with recycling the only green activity that has increased.

Sources: The Hartman report, the Hartman Group, Bellevue, WA; American Demographics

Buying recycled

In a new book by Joel Makower, '10 Easy ways to buy recycled' there are various examples of products made out of waste or recycled materials. Makower states that 'If you're not buying recycled products, you're not really recycling'. Examples include a doll made out of recycled soda bottles and organic cotton; key chains, clipboards and magnets made out of used computer circuit boards; wallets, backpacks and book covers out of recycled plastic bottle fibres and coffee tables from bicycle inner tubes, chains and gears. Joel Makower is the author of 'The Green Consumer' and editor of the 'Green Business Letter'.

Source: Earth Action Network, 1997, http://www.emagazine.com:80/0997gl consumer.html

Green glass

The German company Seiler's patented 'high temperature vitrification technique' – a process which makes ceramic glass products out of steel mill dust, garnet blast media residue and industrial wastewater treatment sludge was accepted by the California Environmental Agency as a recycling technique. Since the process is no longer considered a waste treatment process, Seiler can start marketing the products for abrasives, roofing tile granules and architectural materials.

Source: Business Wire news

O2 news

New O2 contacts

O2 liaison officers were appointed recently in the Philippines, Mexico and India and will now inform designers in their country about O2. Liaison officers have already been appointed in Japan, Germany and USA.

The Netherlands Design Institute to coorperate with O2

The Netherlands Design Institute (NDI) will cooperate with the O2 Global Network and other organisations interested in creating the O2 Website. Any suggestions, comments and contributions are welcome. In 1998, O2 will have its tenth anniversary and O2 Netherlands its fifth.

O2 Focus: Japan

O2 Japan was launched in 1992 with an O2 exhibition in Seibu. This was followed by the Tennen ('Nature') Design conference in 1995.

'Tennen Design' ecological design conference

Tennen Design, the Japanese ecological design conference, highlighted that the Western problem solving approach was insufficient for developing eco-design solutions if not balanced with an approach that recognises 'values'. Eco-designers try to find fixes for product-related environmental problems, but in most cases this is an incremental approach allowing for budget,

time and constraints. A theme that arose was 'are we producing sustainable solutions or are we just going nowhere fast': doing good things, but possibly in the wrong direction? A suggestion from the conference was that it is equally important to consider the 'values' that we strive for. It is important to consider the 'value' that the product will attain for the customer in 15 or 30 years time and how this relates to environment. Then the designer should consider how this should and will influence his/her design now and in the future.

The Tennen Design conference was held in the shintoist Honen In temple in Kyoto, the temple city of Japan. Workshops had themes like 'Design that will last 100 years', 'Ecological machines' and 'Information environment and design'.

Monks read email

A parallel conference was connected by email to Delft in the Netherlands. The concept was to provide a comparative Western perspective on the ideas that developed at Tennen Design. Monks from the Honen In temple and participants translated the printouts of the East-West conversation for each other.

A green laptop

Some of the inevitable misunderstandings from the e-mail workshop actually led to new ideas. For example, the question of whether a laptop computer could be made green or more sustainable evolved from the workshop entitled 'from symbiotic to assimilated design'. This led to the concept of a vertical bath tub which the user enters. Gestures in the fluid are transmitted to the other people by movements in the fluid. The computer as an environment itself, in which you can swim.

Conclusion

As with any workshop, the concepts generated needed considerable development. However, the aim of the conference was to act as a catalyst for new thinking. As Misako Yomosa, one of the organisers, puts it: 'I think of the conference as an initiation of continuing activities toward eco-oriented society'.

The Tennen Design Forum continues its work as a loose network.

More info: http://www.joho-kyoto.or.jp/~tennen/

The Japanese designer – interview with Fumi Masuda

Q: You have worked with European and US designers. Would you say the situation of the Japanese designers is similar?

A: Well, no. The position of industrial designers in Japan is unusual. Over 90% of the whole population of industrial designers in this country is employed by industry. Independent industrial designers are minorities. Major manufacturing industries such as Toyota Motor Co. or Matsushita Electric Co. have huge design centres and each of them employ 200 to 500 industrial designers in-house. They always work in collaboration with product planning, marketing and engineering groups and are usually specialists in particular product areas like computers, office furniture and so on.

Q: Are they technically-oriented or aesthetically-oriented designers?

A: Industrial designers are generally recognised as having responsibilities in relation to the forms and images of the products.

Q: What about influencing product definition?

A: This is hard to say, as most work for big companies. Some of them are acting as design managers instead of being product design specialists. Several designers work as consultants for comparably small local companies and may have more influence.

Q: Would you say Tennen Design had an average public?

A: Roughly speaking, half of the designers at Tennen Design Forum '95 were independent designers from Tokyo and the others were employed designers from the Kansai area (Kyoto and Osaka).

Q: So what else can we expect from Tennen Design?

A: Tennen Design is a temporary group or a non-regular event which has happened twice (the workshop in '95 and an exhibition in '96). The participants shared a very special time and space before going back to their own life. Someone may organise another Tennen Design sometime when he or she feels the

awareness and attention is running out. No goal, no strategy.

Q: Is O2 a factor in Japan? It is European by origin and may still be rather European in approach.

A: I always respect the O2 way of thinking, which is very practical and realistic, in other words, quite Western. I hope we could show our way of thinking from the Eastern side. This is still difficult to explain to a Westerner. O2 is actually quite well known among young Japanese industrial designers. Quite a few of them would be interested in getting involved; the only barrier is the language problem.

Q: 'What about the man on the street? Does he or she bother about environmental problems?'

A: Japanese people are generally aware of, or at least understand, the importance of the environmental issues. For many it is a deeply a cultural subject rather than a technical matter. They have a long history of living symbiotically with nature. But, I think they need some more time to remember how pleasant it used to be.

Recycling developments in Japan

If you don't know how your products are going to be recycled, how can you ever design for it?

Background

In Japan, 24 million air conditioners, television sets, refrigerators and washing machines are bought annually. 14 million are thrown away per annum, which constitutes 620,000 tons of waste (over 1.2 % of household waste). To cope with the volume of household waste (50 million tons a year, 124 million inhabitants), a legal framework was set up in 1991. This will evolve into more specific and stricter laws over the years. Officially called 'law for the promotion of using recycled resources', the law is usually referred to as 'the recycling law'. Therefore smart thinking implies that larger consumer products should be designed for recycling with consideration of 'take back' also included.

Pilot plant

Hitachi, together with two government agencies, set up a home appliance recycling pilot plant. To allow for effective separation of the materials, the connections, form enclosures and surface layers need to be released ('unlocked'). To achieve this the pilot plant uses cryogenics. Low temperatures (-150 degree C for steel) make the materials so brittle that they can be easily milled into small mono-material pieces. This is especially relevant for complex components like motors and compressors, where materials are closely intertwined. Even the paint comes off the steel. After the metals, the somewhat 'warmer' nitrogen can still be used for unlocking plastics.

Plastics

A new technique for plastics separation uses the temperature at which it becomes brittle. After cooling and milling, materials with can simply be separated by sieving. Only polyvinylchloride (PVC) is recycled, polyethylene (PE) is reduced to oil and polystyrene (PS) is burnt.

Bottom line

At the facility, recycling of refrigerators costs about ¥3500 (US$28), and recycling of televisions and washing machines about ¥1100 (US$9). With this capacity (3000 ton/year), Tokyo alone would need 7 plants. Therefore, Hitachi, MITI, Mitsubishi and Sony aim to build a plant with 4 times this capacity. •

Adapted from Technieuws, issue 1, 1997, Dutch Department of Economical Affairs.

Review of SimaPro 4.0

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If you have ever had cause to consider Life Cycle Assessment (LCA) software, you will almost certainly have come across SimaPro. Since PRé Consultants released the very earliest version of SimaPro in 1990 it has led the field in terms of licence sales around the world. To date, the MS-DOS based SimaPro 3.1 (SP3.1) still manages twice the market share of its nearest rival. Now the next generation, SimaPro 4.0 (SP4.0), is due for release.

Unlike SP3.1, SimaPro 4.0 runs in the ubiquitous Windows environment (Windows 3.x, 95 and NT4) and whilst retaining everything which has made the earlier SimaPros successful, SP4.0 contains several new features, a revised and expanded database structure and an array of different ways to manipulate data and results.

Very simply, SimaPro will analyse the environmental impacts of a product, or compare the impacts of two or more products. It uses a modular system whereby you can combine individual *processes* (ie. materials, transport, industrial processing and waste disposal options) from its central process database to make more complex ones. Processes are then placed in *assembly boxes* representing complete products. In this way, infinitely complex flows of materials and processes (process trees) can be built up and these are stored in a *life-cycle box* which forms the top of the tree. The software can apply various weighting methods to calculate the resulting environmental impacts for the whole life-cycle arising from raw materials usage and substance emissions. These impacts are worked out for any number of criteria such as ozone depletion, greenhouse effect, summer smog, etc, and the results are presented in a detailed tabular or graphic form.

A typical life-cycle box can contain several assemblies, details of the product's use phase, ie. its working life, and its final disposal options. Disposal options include *disposal scenarios* which allow you to direct waste units to final disposal, recycling, or re-use; *disassembly boxes*, which let you describe how a product might be broken up into its component parts for recycling or waste disposal; and *re-use* boxes which describe the processes involved in supplying a product for re-use.

Using the program – creating a process tree

As with a number of LCA programmes, SimaPro 4.0 may appear a little overwhelming at first. However, the guided tour in the accompanying user manual is certainly comprehensive, and providing you take the time to follow it through from start to finish, you should become familiar with most of its features fairly quickly. The programme is laid out in a logical manner, with separate tabbed pages for each of the important components and once you have learned the basics, SimaPro

Figure 1: A process tree showing the simple lifecycle 'use of filter'. Upward flows show inputs; downward flows show disposal.

is remarkably straightforward and consistent, despite its complexity.

At the heart of the software is the information contained in the process records detailing materials, transport, industrial processes and waste disposal. Linking these processes together to form a process tree is done by inserting the name and amount of a 'daughter process' into the appropriate *inputs from technosphere* part of a parent process' record, or into an assembly box. The operation is made very easy through the use of pop-up dialogue boxes containing processes for you to select, and at any time you can switch to a tree diagram showing the component parts of the current process or assembly you are constructing. Raw materials and emissions for each process record are selected from a separate substances database.

A very helpful feature is that the software lets you enter amounts in process records and assemblies using any scale you choose, as, for example, SimaPro is fully aware that 0.001 tons is really 1000 grams. This reduces the time taken to add data and probably increases data accuracy too! You can even define your own unit conversions in case you want SimaPro to calculate in units it does not initially recognise.

The structure of process records has been designed to conform to the relevant sections of the *Society for the Promotion of Lifecycle Design (SPOLD) Common Format for Lifecycle Inventory (LCI) Data*. The SPOLD format is likely to become the standard for LCA data and it makes good sense to include that standard in LCA software, making it much easier for organisations to share information. However, the SPOLD format is also somewhat unwieldy and asks that the user enters large amounts of text which contributes nothing to actual calculations. With this in mind, PRé have included the option to use, view, edit and add records in a much abridged form, using essential data only. Unfortunately, adopting an external data format has left no obvious place to include transport processes in the new style records. Transport must now be entered under energy/heat to conform with SPOLD, though it is categorised elsewhere in the software as a distinct process type, quite separate from energy.

SimaPro 4.0 is supplied with over 930 process records using data by Delft University of Technology, the Netherlands; PRé Consultants, and an officially licensed and peer-reviewed version of the BUWAL 250, 1997 database. You can add your own processes to the database, import them from other SimaPro users, and modify those supplied with the software to suite individual circumstances. SP3.1 users can convert their databases for use in SP4.0.

Using the programme – calculating the impacts

Calculating impacts from a 'process tree' can be done at almost any time – the model certainly doesn't need to be complete, though obviously the more complete your model, the more complete your results. Clicking the analyse button will set SimaPro calculating the inventory and the environmental impacts for a selected process or

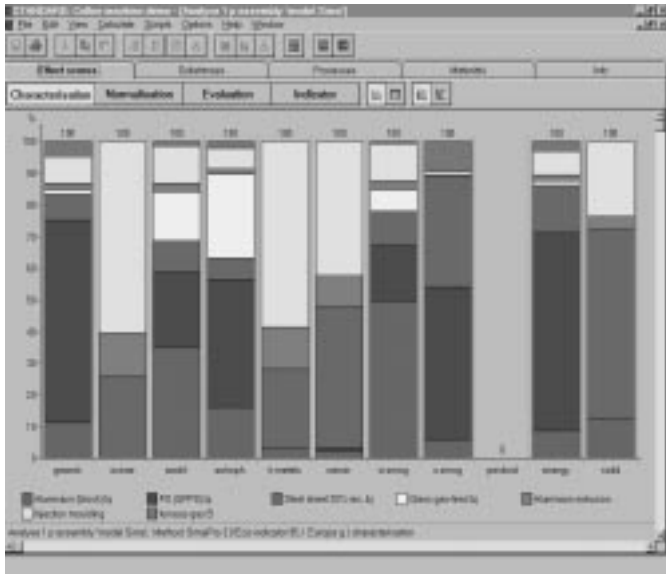

Figure 2:
Graphic display for characterisation stage of a product using the Eco-Indicator 95 evaluation method

box. If you have more than one data object open, clicking the compare button will calculate the inventories and impacts for all of these so that the results can be viewed side by side.

SimaPro uses various evaluation *methods* which will classify substances according to their effects on environmental impacts such as acid rain and ozone depletion. PRé's much used Eco-Indicator 95 (included in the software) will:

- Show the relative contributions of each calculated process to a list of environmental effects (scaled to 100%);
- Normalise these contributions to the effects of an *average European inhabitant over one year*;
- Evaluate the effects by applying a weighting factor to derive the overall *seriousness* of the impacts with regard to human health and ecosystems;
- Aggregate all impacts in the evaluation stage to arrive at a single figure for the environmental impact of each material and process in the model.

SimaPro also comes with methods by CML (University of Leiden) and BUWAL's ecopoint method. As with processes, you can create your own methods or edit those supplied. In this way you can include new substances in calculations, alter their overall effects, and add additional environmental criteria against which to measure the product's impacts.

SimaPro will check to see if any substances in your model are missing from the selected evaluation method before it does any calculating. After that, the software will calculate all available data and present the user with some gloriously colourful graphs.

The graphical displays are easy to understand, but if you need to be specific, you can click the table button to view the precise impact results in tabular form. Either way, tables and graphs can be exported or pasted to other Windows applications for further manipulation.

Clicking the substances page tab will take you to the inventory, or impact table. This lists the amounts of all substances included in the calculations under their respective materials or processes. There are separate tables for raw materials, airborne, waterborne and solid emissions, emissions to soil and non-material emissions such as heat and land use.

SimaPro can also display impact data on a process tree diagram. Here, each element details the name and amount of the process or box it represents and shows its contribution to environmental impacts by means of a numerical value and a vertical bar like a thermometer. The thermometers can display cumulative impacts for the whole tree, or absolute impacts for each element. They can represent any of the impact criteria available in the evaluation method used.

Conclusion

Whether you want to carry out a quick analysis or more detailed LCA calculations, SimaPro 4.0 is a useful aid. In the Windows environment it is straightforward to use and has a logical and uniform feel about it. Process data now conforms to a common standard, rather than to the whims of an individual software producer. Data, results and graphs can be exported or pasted to other Windows applications for presentation or further analysis.

The way it has been designed, SimaPro is perfectly capable of modelling a full range of products, from packaging to electronics, but the results will obviously depend upon the quality of data used. PRé are at pains to stress that the whole LCA methodology is constantly being updated and changed, and that you will not find a *definitive* answer with SimaPro. However, with the range and quality of data provided, and the flexibility to update and add your own, SimaPro offers a comprehensive tool for use in LCA calculations. •

Paul Stockdale is a freelance author and has a background in Wastes Management and Environmental Technology.

References

Siegenthaler, C.P., Linder, S. and Pagliari, F., 'LCA Software Guide 1997' (Adliswil, Switzerland: Swiss Association of Environmentally Conscious Management, 1997).

PRé Consultants, Amersfoort, the Netherlands.

DIARY OF EVENTS

Managing eco-design 1: online conference

Managing eco-design 2: online conference
Textiles, design and environment: online conference
Sustainable Product Design 2: online conference

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27–29 October 1997

Recycling Council of Ontario 18th annual conference and trade show
Toronto, Canada

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30 October 1997

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31 October 1997

Managing eco-design: 2nd International conference
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1–3 November 1997

European roundtable on cleaner production
Oslo, Norway

✉ Jostein Myrberg
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12–14 November 1997

ENTREE 97: the seventh conference on environmental training in engineering education
Sophia-Antipolis, France

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16–17 November 1997

First European waste forum
Brussels, Belgium

✉ Brussels Institute for Management of the Environment (IBGE)
Service Info –
Environment Gulledelle 100
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17–18 November 1997

Take it back 97: conference on packaging and product stewardship
Virginia, US

✉ 6429 Aubren Avenue
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19 November 1997

Product re-thinking workshop
New York, US

✉ Caroline Nunley
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19–21 November 1997

Right Light 4: fourth European conference on energy efficient lighting
Copenhagen, Denmark

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27 November 1997

Wave of factors: reduction factors for sustainability
Rotterdam, The Netherlands

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27 November 1997 and March 1998

What will new packaging legislation mean to your business: packaging waste alert seminars
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3–4 December 1997

Eco Procura 97: The European forum for eco–purchasing of products and services
Freiburg, Germany

✉ Claudia Grotz
International Training Centre (ITC)
International Council for Local Environmental Initiatives (ICLEI)
European Secretariat

5–8 December 1997

The Design and Environment Conference
Canberra, Australia

✉ Catalyst '97 Conference
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fax +61 6 201 2279/61 6+ 201 5034
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7–8 April 1998

Ecotextile 98: Sustainable Development
Bolton, UK

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26–28 October 1998

Green Building Challenge 98
Vancouver, Canada

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Contributor guidelines

The Journal of Sustainable Product Design is targeted at Environmental directors, managers, Design managers, Product designers, Academics and Environmental coordinators in local and central government worldwide.

Submissions

Three copies and a $3^{1}/_{2}$" Macintosh – or IBM compatible disk should be sent to:
Martin Charter or Anne Chick
The Journal of Sustainable Product Design
The Centre for Sustainable Design
Faculty of Design
The Surrey Institute of Art & Design
Falkner Road
Farnham
Surrey GU9 7DS
UK.
Email submissions should be sent to: cfsd@surrart.ac.uk.

A black and white photograph of the author(s) should be supplied.

Presentation

Articles submitted to the Analysis section (peer reviewed) should be between 2,500–5,000 words. Shorter articles of 1,000–1,500 words are also requested for the Case Study and Innovation sections. Manuscripts should be typed in journal style, double spaced (including footnotes and references) with wide margins, on one side only of good quality A4-size paper.

Manuscripts should be arranged in the following order of presentation.

First sheet: Title, subtitle (if any), author's name, affiliation, full postal address and telephone, fax number and email. Respective affiliations and addresses of co-authors should be clearly indicated. Please also include approximately 100 words of biographical information on all authors.

Second sheet: A self-contained abstract of up to 150 words summarising the paper and its conclusions.

Subsequent sheets: Main body of text, footnotes, list of references, appendices, tables (on separate sheets), and illustrations.

Authors are urged to write as concisely as possible. The main title of the article should be kept short, but may be accompanied by a subtitle. Descriptive or explanatory passages, necessary as information but which tend to break the flow of the main text, should be expressed as footnotes or appendices.

Bibliographic references: All bibliographical references should be complete and comprising of authors and initials, full title and subtitle, place of publication, publisher, date, and page references. References to journal articles must include the volume and number of the journal. The layout must adhere to the following convention:

Author, A., and B. Author, 'Title of book: Subtitle' (Place of publication: publisher, date), pp.xx–xx. or

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